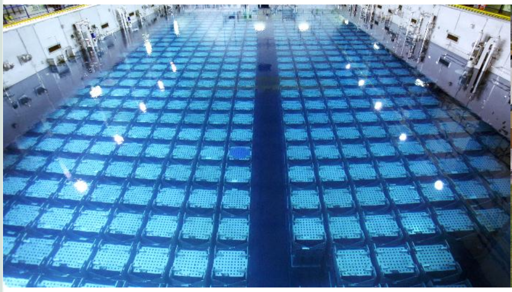

France

Sixth National Report on Compliance with the Joint Convention Obligations

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

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RÉPUBLIQUE FRANÇAISE

October 2017

Cover photographs credit (left to right):

Spent fuel storage pool at the La Hague AREVA NC plant, © AREVA

Aube disposal centre (CSA), © ANDRA

CIRES storage and disposal centre, © ANDRA

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1 | THE GENERAL 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 concerned, a distinction is made between activities regulated by the Public Health Code (medical activities for example), those subject to the regulations for Installations Classified on Environmental Protection Grounds (ICPE) and, finally - beyond a certain threshold in terms of activity and specific activity – set by decree 2007-830 of 11th May 2007, those subject to the regulations for Basic Nuclear Installations (BNI).

The legislative framework applying to BNIs, for their entire lifetime, is Act 2006-683 of 13th June 2006 on transparency and security in the nuclear field, known as the "TSN Act". This Act has been codified in the Environment Code. Act 2015-992 of 17th August 2015 concerning energy transition for green growth (known as the "TECV" Act) and ordinance 2016-128 of 10th February 2016 concerning various nuclear safety provisions, supplement the BNI legislative system.

The management of radioactive substances (materials and waste) is for its part governed by programme Act 2006-739 of 28th June 2006 on the sustainable management of radioactive materials and waste, known as the "Waste Act". This Act has also been codified in the Environment Code. The ordinance of 10th February 2016 extended this scope to allow the complete transposition of directive 2011/70/EURATOM of 19th July 2011 establishing a community framework for the responsible and safe management of spent fuel and radioactive waste.

Under the terms of these Acts, France has an independent safety regulator, ASN, and an organisation in charge of the management of radioactive waste, ANDRA, which is independent of the radioactive waste producers.

These Acts also set the rules regarding public information and participation.

2 | NUCLEAR INSTALLATIONS IN FRANCE

Numerous nuclear installations are in service in France, that is:

- 58 nuclear power reactors;
- an enrichment plant;
- nuclear fuel cycle facilities;
- research facilities for the nuclear power generating or other fields, including those carrying out research into the management of radioactive waste;
- radioactive waste reprocessing and packaging facilities;
- radioactive waste storage facilities (interim solution);
- 3 radioactive waste surface disposal centres (final solution): two BNIs for low and intermediate level, short-lived waste (one under surveillance, the other in service) and an ICPE which receives very low level waste;
- a plant producing radiopharmaceuticals and irradiators;
- facilities undergoing decommissioning.

All the facilities listed above, as well as those currently undergoing decommissioning or which are part of the fuel cycle, produce or manage radioactive waste. The nuclear power reactors (EDF) and research reactors (CEA, ILL) use fuels which, after use, become spent fuels. These are stored on-site and then on the AREVA site at La Hague or in certain CEA facilities pending reprocessing and then disposal.

BNIs are under construction:

- an EPR reactor on the EDF site in Flamanville;
- the Jules Horowitz experimentation reactor on the Cadarache site;
- the DIADEM storage facility dedicated to very irradiating waste on the CEA site in Marcoule;
- ITER on the Cadarache site.

The commissioning application of the activated waste packaging and storage facility ICEDA (intermediate level, long-lived EDF waste) is currently under instruction.
Two ANDRA disposal facility projects are currently being studied:

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

One should also mention the existence of the former uranium mines, which generated mining waste rock, as well as mining processing residues during processing of the ore to extract the uranium.

3 | SUMMARY TABLE FOR FRANCE

Type of responsibility	Long-term management	Financing	Current practice / Installations	Planned installations
Spent fuel	Reprocessing	The owner finances reprocessing.	La Hague reprocessing plant (licensing of plants to be modified to reprocess all spent fuels).	N/A
Waste from the nuclear fuel cycle	Disposal	The producer finances. Ring-fenced assets are required by law for ultimate waste.	LLW/ILW-SL wastes are disposed of in the CSA and VLLW in the CIRES; storage for the other waste.	New disposal centres for HLW, ILW-LL and LLW-LL (under study).
Waste not from energy production	Disposal routes must be set up for certain waste.	The producer finances.	Disposal centres for VLLW and LLW/ILW-SL waste. Management by decay for very short-lived waste	Projects ongoing for substances containing radium and other waste (LLW-LL).
Decommissioning	Immediate dismantling after shutdown.	The licensee finances. Ring-fenced assets are required by law.	Dismantling initiated immediately after shutdown.	
Sealed sources removed from service	Return to manufacturer. Disposal or recycling routes being implemented.	System of insurance between users and suppliers or deposit of a bond with ANDRA.	A few sources are disposed of in the CSA and CIRES. Storage in specific facilities.	New disposal centres for HLW, ILW-LL and LLW-LL (under study). Storage in the CSTFA.
Ore extraction and preparation waste	Stabilised in-situ and reinforced monitoring.	Responsibility of licensee (AREVA)	Stabilised mines.	N/A

TABLE 1: SUMMARY MATRIX FOR FRANCE

4 | THE CHALLENGES FOR FRANCE IDENTIFIED AT THE 5TH REVIEW MEETING

During the 5th review meeting of the Joint Convention, the following challenges were identified for France:

1 – continuation of the deep geological disposal programme for high level and for intermediate level, long-lived waste, with transition to industrial implementation, along with the submission of the creation authorisation application (more specifically see chapter H.3);

2 – the decommissioning of fuel cycle facilities (such as AREVA's UP2-400 plant in La Hague) (see chapter F.6);

3 – continued efforts to successfully complete the management of legacy waste (see chapter H.2);

4 – continued assessment of the situation and requirements in order to define management procedures for used sealed sources (see section J);

5 – consolidation of the management strategy for low and very low level waste, more specifically that resulting from the decommissioning of facilities (see chapter F.6);

5 – implementing the responses to ASN's requests resulting from the stress tests performed in the wake of the Fukushima Daiichi accident (see chapter A.3);

7 – decommissioning of the GCR reactors and management of the resulting waste (see chapter F.6).

5 | THE MAIN CHANGES SINCE THE 5TH REPORT

5.1. The regulations

The legal system for BNIs was extensively overhauled by Act 2006-686 of 13th June on transparency and nuclear security (known as the "TSN Act") and its implementing decrees, more specifically decree 2007-1557 of 2nd November 2007 on basic nuclear installations and the regulation of the transport of radioactive substances in terms of nuclear safety. Since 6th January 2012, the TSN Act, the Waste Act and Act 68-943 of 30th October 1968 on civil liability in the field of nuclear energy (known as the "RCN" Act) have been integrated into the Environment Code. Further to the TSN Act of 13th June 2006, this overhaul continued with the publication of the BNI Order of 7th February 2012 and 13 statutory resolutions.

Since the publication of the 5th report, the main resolutions issued by ASN regarding the field covered by the Joint Convention concerned the study of waste management and the summary of the waste produced in the BNIs (resolution 2015-DC-0508 of 21st April 2015), the content of the BNI safety report (resolution 2015-DC-0532 of 17th November 2015), managing the detrimental effects and environmental impact of BNIs (resolution 2016-DC-0569 of 29th September 2016) and the packaging of radioactive waste and the conditions for acceptance of packages in the disposal facilities (resolution 2017-DC-587 of 23rd March 2017).

This system is supplemented by ASN guides which present ASN doctrine but which are not binding.

In 2015 and in 2016, the TECV Act, the ordinance of 10th February 2016 and decree 2016-846 of 28th June 2016 modifying the decree of 2nd November 2007 concerning the modification, final shutdown and decommissioning of basic nuclear installations and subcontracting, represented new milestones in BNI regulation. These texts contain a number of advances concerning:

- enhanced transparency and information of the citizens;
- changes to the BNI authorisation system, in particular regarding decommissioning;
- oversight of the use of contractors and subcontractors;
- changes to the BNI final shutdown and decommissioning system;
- reinforcement of ASN's means of inspection and powers of sanction;
- clarification of the organisation of the oversight of nuclear safety and radiation protection;
- enhanced monitoring of former nuclear sites.

In 2016, two regulatory texts also further defined the deep geological disposal project. Act 2016-1015 of 25th July 2016 supplemented article L.542-10-1 of the Environment Code, clarifying the notion of reversibility. The order of 15th January 2016 concerning the cost relating to the implementation of long-term management solutions for high level and intermediate level, long-lived radioactive waste, set the cost of the project at 25 billion euros in the economic conditions of 31st December 2011.

For the management of used sealed sources, decree 2015-231 of 27th February 2015 modified articles R.1333-52 and R.1337-14 of the Public Health Code so that holders of used sealed sources that had either expired or were no longer needed could have them recovered not only by their initial supplier, but also by any supplier of authorised radioactive sources or, as a last resort, by ANDRA.

The regulatory changes are part of a process of European-wide safety harmonisation. Therefore the ordinance of 10th February 2016 completed the transposition of directive 2011/70/Euratom of 19th July 2011 establishing a community framework for the responsible and safe management of spent fuel and radioactive waste. In addition, Council Directive 2013/59/Euratom of 5th December 2013 setting out the basic standards for health protection against the dangers arising from exposure to ionising radiation and reinforced oversight of TENORM waste is currently undergoing transposition.

The regulations also incorporate the principles ("reference levels") defined by the Western European Nuclear Regulators Association (WENRA) defining a baseline of common requirements.

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

The licensees face significant challenges in the decommissioning of facilities and the management of radioactive waste and materials.

To deal with these challenges, they must have overall strategies covering decommissioning and waste management on the one hand and all of their installations (civil BNIs and secret BNIs (INBS)) on the other.

ASN and the Defence nuclear safety regulator (ASND) asked CEA to present it in 2016 with an overall reassessment of its strategy for decommissioning and the management of its radioactive materials and wastes, covering its BNIs and INBS. The file, received in December 2016, is currently being examined.
In June 2014, ASN and the ASND asked AREVA to send them its national strategy for waste management and decommissioning. The file, received in June 2016, is currently being examined.

With regard to EDF, ASN in 2014 examined the revision of its waste management policy file. The file was then reviewed by the Advisory Committees of experts in 2015. This file was examined at the same time as that concerning EDF's decommissioning strategy. In March 2016, EDF informed ASN of a complete change in its strategy for the GCR reactors, entailing a decommissioning postponement of several decades. This change in strategy is linked to major technical difficulties in decommissioning of the reactors "under water", as had been initially planned. ASN asked EDF to send it a number of files to demonstrate that this change still meets the regulatory requirements for decommissioning as rapidly as possible and to enable this new strategy to be examined in the light of the safety requirements applicable to these installations. Some of the files were transmitted in March 2017, with the remainder being expected by the end of December 2017.
EDF is also required to ensure the overall consistency of its industrial choices for fuel management, jointly with AREVA and ANDRA. ASN examines this consistency on the basis of a "Cycle-Impact" file transmitted by EDF, drafted jointly with AREVA and ANDRA and updated every ten years. In 2015, ASN asked EDF that an overall revision of said file be carried out in 2016 in order to obtain a robust long-term overview of the changes that could affect all cycle activities and the consequences of these changes on the facilities and transport activities.

On 30th June 2016, EDF sent ASN the updated "Cycle-Impact" file. This update comprises a number of innovations with respect to the previous approaches initiated in 1999 and 2006: on the one hand, the study period which usually covers ten years, was increased to fifteen years; on the other, the radioactive substances transport contingencies were explicitly incorporated into the study and the scenarios for final shutdown of nuclear reactors were examined over the time-frame considered, more specifically assuming stable electricity demand until 2025, to take account of the programming anticipated by the TECV Act. Finally, the strategy for managing and storing spent fuels pending reprocessing or disposal is part of the scope of the assessment.

This file is currently being examined by ASN, which will issue its position on these points in 2018.

5.3. Review of the safety management systems of AREVA, EDF and CEA

The TECV Act introduced new provisions concerning the management of subcontracting in nuclear installations. These provisions first of all include existing aspects of the BNI Order of 7th February 2012, more particularly the ban on the licensee delegating the monitoring of outside contractors performing an "activity important for the protection of interests" (AIP). They also introduce the possibility of managing or limiting the use of contractors or subcontractors for certain AIP.

Article 63-2 of the "BNI Procedures" decree of 2nd November 2007, amended by the decree of 28th June 2016, states that when the licensee entrusts the performance of services or work important for the protection of interests to an outside contractor, within the perimeter of its facility either in operation or undergoing decommissioning, they may be performed by subcontractors of no more than tier two.

The TECV Act also makes it possible to manage and monitor the performance of AIP outside the perimeter of a BNI.

The checks on the safety management systems are part of the inspections and examinations for which the opinion of the Advisory Committees of experts may be required. The opinion of the Advisory Committee for reactors was requested more specifically in 2015 concerning the management of EDF subcontracting of the maintenance work carried out in the NPPs.

For AREVA, a final opinion will be given on all the managerial processes put into place on the various sites following all of their reassessments which will be completed in 2016. Since 2016, ASN has also been monitoring AREVA's preparations for splitting up the group into several legal entities, including New Co (which will take over the Romans-sur-Isère and SOMANU sites) and New AREVA (which will take over the other French BNIs of the AREVA group).

With regard to CEA, two ASN inspections dedicated to safety management were performed on the Cadarache and Saclay centres in 2016. These were able to assess and check the effective implementation of the measures resulting from the CEA undertakings and ASN requests. These provisions were considered to be on the whole satisfactory, subject to reinforcement of the organisational and human factors (OHF) and safety skills of certain personnel in charge of events analysis and project management.

5.4. Decommissioning of nuclear installations

5.4.1. Issues and adaptations of the regulatory framework

About thirty BNIs have been decommissioned and delicensed and another thirty BNIs of all types (power generating or research reactors, laboratories, spent fuel reprocessing plants, waste processing facilities, etc.) have been shut down or are undergoing decommissioning as at the end of 2016. Given the context, the safety and radiation protection of the decommissioning operations in these installations represent major challenges for the industry and are a subject of major interest for ASN.

The TECV Act and the decree of 28th June 2016 allowed:

- on the one hand the integration into the legislation of the principle of decommissioning in as short a time as possible, which already appeared in article 8.3.1 of the BNI order and in ASN decommissioning doctrine;
- on the other, a revision of the procedures regulating the final shutdown and decommissioning of BNIs. Thus:

- o the licensee must inform the Minister responsible for nuclear safety and ASN of its intention to definitively cease the operation of its facility at least two years before the planned shutdown date;
- o the licensee is no longer authorised to operate its facility as from its final shutdown;
- o the licensee is obliged to submit its decommissioning file no later than two years after giving notification of its intention to definitively shut down its facility;
- o finally, if a basic nuclear installation stops functioning for a continuous period of more than two years, its shutdown is deemed to be final. The Minister responsible for nuclear safety can, at the request of the licensee and by a reasoned order issued after consulting ASN for its opinion, extend this two-year duration by a period not to exceed a further three years.

5.4.2. Ongoing decommissioning work

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

The decommissioning of the old gas-cooled reactor (GCR) vessels is a major challenge owing to the large volume of waste generated and the difficulty in finding a disposal solution for the graphite stacks they contain. EDF presented a new decommissioning strategy for all of its facilities, which means that the decommissioning of the last reactor has been put back to 2100. This strategy will be carefully examined by ASN in the coming months: a position statement will in particular need to be issued on this new GCR decommissioning time-frame.

With regard to the environment, nuclear safety and radiation protection, ASN considers that the decommissioning operations on the Chooz A reactor are being carried out satisfactorily. Chooz A was the first pressurized water reactor built in France. The decommissioning of this power plant is considered to be a precursor for the future decommissioning of the pressurised water reactors, the technology used in the French nuclear power reactors currently in operation. In 2016, the decommissioning work on the reactor vessel started with opening of the closure head and continued with work to prepare for immersion of the vessel prior to cutting.

As for the decommissioning of the UP2-400 facilities at La Hague, the challenges are mainly the retrieval operations for the legacy waste stored in them, prior to dismantling (see below).

With regard to the Eurodif enrichment facility, which has been shut down since 2011 and for which the decommissioning application is currently being reviewed, the large quantity of metal waste liable to be produced during the decommissioning operations must be taken into consideration. It will be necessary to check that the strategy proposed corresponds to the waste volume and harmfulness reduction targets and to the recommendations of the National Plan for Radioactive Materials and Waste Management (PNGMDR), more specifically with regard to the feasibility of metal waste recycling.

Generally speaking, the licensees will need to continue to devote the resources necessary for rapid dismantling and to ensure a final state in which the entirety of the potential source term (dangerous substances, including those that are radioactive) has been removed.

5.5. Radioactive waste and materials

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

5.5.1. A robust management framework: an Act and a national management plan revised every three years

The PNGMDR, ratified by the “waste” Act, is a core oversight element of the national management policy implemented by France.

After the first three editions of 2007, 2010 and 2013, a new PNGMDR for the period 2016-2018 was drawn up and transmitted to Parliament in early 2017, based on the work done by a pluralistic working group (co-chaired by the Minister in charge of energy and by ASN). It was the subject of a “strategic environmental assessment” aiming at identifying probable impact on the environment, an opinion by the environmental authority and a public consultation, which was organised during the course of October 2016.

It was published at the beginning of 2017. Decree 2017-231 of 23rd February 2017 establishing the prescriptions of the PNGMDR incorporates the long-term management provisions of this plan into the regulatory part of the Environment Code (articles D.542-74 to D.542-96). The order of 23rd February 2017 specifies the studies and actions to be carried out.

France was the first in Europe to produce a plan of this type and played an active role at the European level in the draft directive mentioned above, the aim of which is to have each member State produce a radioactive waste management plan.

In addition, France may also resort to national public debates. A debate on radioactive waste management was thus held for 4 months, ahead of the Waste Act.

The drafting of the PNGMDR is based on the *National inventory of radioactive materials and waste*, the first edition of which dates from 2004 and which is revised every three years. Since the end of 2016, all these data are published on France's open public data platform (www.data.gouv.fr) and on the website of the National Inventory (www.inventaire.ANDRA.fr).

5.5.2. Management of radioactive materials and reutilisation prospects

The status of the research, the data acquired, the progress achieved and the studies still to be carried out on the reutilisation of radioactive materials are described in the PNGMDR. In addition, CEA coordinates research into separation-transmutation, together with other research organisations, notably CNRS.

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

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

5.5.3. Improving existing management modes

5.5.3.1. LEGACY WASTE

Certain legacy waste is not packaged or has been packaged in a manner today considered to be inadequate (deterioration of the containers for example) and not compatible with the subsequent management procedures as required by Article 6.7 of the BNI order. Moreover, article L. 542-1-3 of 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 recovery and packaging of legacy waste (process known as RCD) can be technically complex. These difficulties are one of the factors explaining the delays and the cost overruns involved in these operations. The RCD operations and compliance with the corresponding 2030 deadline represent challenges of different natures for each of the three main licensees.

For EDF, the main challenge is the management of graphite waste. At present the graphite sleeves resulting from the partial decommissioning of the former GCR reactor series are stored mainly in the Saint-Laurent-des-Eaux silos. Pending the deployment of new graphite waste storage capacity, EDF is taking steps to improve the safety of its facility. In 2015, ASN thus completed a review of the commitments made by EDF during the periodic safety review of the facility, which was completed in 2014, and is waiting for the additional studies requested.

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

For AREVA, the RCD operations correspond to a major commitment made within the context of the ministerial authorisations for start-up of new spent fuel reprocessing plants in the 1990s. As the schedule has slipped, RCD operations are now becoming urgent and ASN regulated them in resolution 2014-DC-0472 of 9th December 2014, with a precise schedule to ensure compliance with the 2030 deadline.

Decree 2017-231 of 23rd February 2017 concerning the prescriptions of the PNGMDR 2016-2018 regulates the continuation of ILW-LL waste packaging studies and requires that the licensees present a progress report on this work to the Minister in charge of energy and to ASN, before each update of the PNGMDR.

5.5.3.2. MINING WASTE

In recent years, studies were submitted within the framework of the PNGMDR 2013-2015 in order to improve understanding of the long-term behaviour of the mining residue disposal sites. These studies concerned:

- the strategy to be chosen for the changes in the treatment of water collected from the former mining sites;
- the doctrine for assessing the long-term integrity of the embankments surrounding the residue disposal sites;
- the comparison of the surveillance data and the results of modelling to improve the relevance of the surveillance systems and the evaluation of the long-term dosimetric impact of the residue disposal sites;
- the evaluation of the long-term dosimetric impact of the waste rock piles and waste rock in the public domain;
- the phenomena of uranium transport from the mining waste rock piles to the environment;
- the mechanisms regulating uranium and radium mobility within uranium-bearing mining residues.
- These studies are being continued within the framework of the PNGMDR 2016-2018.

5.5.3.3. MANAGEMENT OF VERY LOW LEVEL WASTE (VLLW)

The existing VLL waste disposal centre (CIRES) – which has been operational since 2003 – was designed for 30 years of operation, mainly for waste produced by the decommissioning of the first generation of nuclear facilities. As at the end of 2016, the volume of waste emplaced in the CIRES was about 303,000 m^3, or 47 % of the authorised capacity (650,000 m^3). The latest production estimates for VLL waste confirm that additional disposal capacity will need to be created. In accordance with the PNGMDR 2013-2015, ANDRA submitted an overall industrial scheme meeting the need for new VLL waste disposal capacity. This scheme was examined by ASN, which sent the Government an opinion on 18th February 2016 concerning the management of VLL waste.

In accordance with the PNGMDR 2016-2018, the licensees will be required to fully explore the potential for reutilisation of certain materials, study the conditions for increasing the disposal capacity of the CIRES with no increase in footprint and thus optimise the current disposal capacity for VLL waste. ANDRA must study the extension of the existing CIRES capacity and the creation of a new VLL waste disposal centre.

The licensees shall also study the feasibility and relevance of creating disposal facilities for certain VLL Waste, on or close to their own sites, in particular for waste with the lowest specific activity.

5.5.4. The management routes to be implemented:

5.5.4.1. MANAGEMENT OF HIGH LEVEL WASTE (HLW) AND INTERMEDIATE LEVEL, LONG-LIVED WASTE (ILW-LL)

The management of HLW and ILW-LL waste is studied from the three complementary viewpoints identified in the Act of 30th December 1991 and then taken up in the Waste Act of 28th June 2006: reversible deep geological disposal, packaging and long-term storage and separation and transmutation of long-lived radionuclides (see above). Research is also being carried out into the processing and packaging of these wastes.

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

In this project, called CIGEO (industrial centre for geological disposal), the underground facilities of the disposal centre are being envisaged within a layer of clay about one hundred metres thick, at a depth of about 500 m. The research carried out by ANDRA in the Meuse/Haute-Marne laboratory is contributing more specifically to the study of the feasibility and safety of such a repository.

Since the 2013 public debate on CIGEO, two texts were published in 2016 concerning this project. The 25th July 2016 Act specified the procedures for the creation of a reversible deep geological disposal facility. The ministerial order of 15th January 2016 set the cost of the project at 25 billion euros (in the economic conditions of 31st December 2011).

ASN also continued to examine the project: in 2014 on the safety data for the closure structures and the expected content of the facility's safety options file; in 2015 on the control of operational risks and the cost of the project; in 2016, on the file entitled "Components development plan".

Finally, the ANDRA board also decided to submit a safety options report (DOS) to ASN on the CIGEO facility project before applying for the creation authorisation for the facility. ASN welcomed this decision favourably and notified ANDRA of its requirements concerning the contents of this report in a letter dated 19th December 2014. The review of the report submitted by ANDRA began in the spring of 2016 and underwent an international peer review organised by the IAEA and held in France from 7th to 15th November 2016. ASN will draw on the conclusions of this review when issuing its opinion on the DOS for the CIGEO project in the summer of 2017.

In accordance with ASN's request, the review by the experts specifically focused on the R&D programme relating to development of the project, CIGEO monitoring as planned by ANDRA and the definition of safety scenarios for operation and for the long-term.

The team of experts expressed confidence with regard to the robustness of the deep disposal concept on the basis of the safety case supplied by ANDRA. It also identified areas of research liable to further reinforce the safety case.

5.5.4.2. MANAGEMENT OF LOW LEVEL, LONG-LIVED WASTE (LLW-LL)

LLW-LL waste requires specific management, appropriate to its long lifetime, which rules out disposal in the existing industrial facilities. Difficulties were encountered in the initial siting process for a LLW-LL disposal repository. A new process was restarted in 2012 and, within the framework of the PNGMDR 2013-2015, ANDRA supplied an interim report on the creation of a disposal facility in the Soulaines area. A 10 km² zone was selected for geological investigations in the north of this area. ASN considers that this area will not be able to accept all the LLW-LL waste anticipated. Within the framework of the PNGMDR 2016-2018, ANDRA must continue its investigations on this site and evaluate the inventory of LLW-LL waste liable to be disposed of in it, while looking for alternative management solutions for waste which it will not be possible to emplace there.

An overall industrial system for management of all the LLW-LL radioactive waste shall also be submitted before the end of 2019.

5.5.5. Contaminated sites and soils

For several decades now, the public authorities have devoted continuous efforts to the management of contaminated sites, usually linked to the former radium industry. This entails case-by-case management, regulated by the circular of 17th November 2008, intended for the Prefects, requiring a precise diagnosis of the site and the contamination involved. The management of contaminated sites was the subject of both a methodology guide for the management of industrial sites potentially contaminated by radioactive substances, published in 2011, and ASN doctrine defined in 2012 specifying the fundamental principles.

Among the recent changes to the corresponding regulations, article L. 125-6 of the Environment Code, modified on 26th March 2014, requires that in the light of the information at its disposal, the State must produce Soil Information Sectors (SIS). These must comprise land for which (more specifically in the case of a change in usage) the available soil contamination data warrants the performance of soil surveys and contamination management measures in order to protect public health and safety and the environment. The decree of 26th October 2015 defines the implementation procedures. The Regional Directorates for the Environment, Land Planning and Housing (DREAL) coordinate the SIS definition approach, under the authority of the Prefects. The ASN divisions make their contribution by proposing sites that are contaminated by radioactive substances of which they are aware.

5.5.6. Sealed radioactive sources

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

5.5.6.1. OVERVIEW OF THE CONDITIONS FOR DISPOSAL OF USED SEALED SOURCES

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

The CSA and the CIRES now have acceptance specifications allowing the disposal of radioactive waste packages containing these used sealed sources.

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

On the basis of a report presenting the conclusions of this working group, sent out in 2014, the PNGMDR recommends that ANDRA examine the reassessment of the CSA and CIRES acceptance criteria, draw up acceptance criteria for used sealed sources for its LLW-LL waste disposal project currently being designed and include the case of used sealed sources in the drafting of the preliminary acceptance specifications for the CIGEO project.

By the end of 2017, ANDRA is required to present a report on the implementation of the previous recommendations, in order to obtain an overall optimised scheme for management of used sealed sources.

5.5.6.2. RECOVERY OF USED SEALED SOURCES

All users are required by article R. 1333-52 of the Public Health Code to have their suppliers collect the sealed radioactive sources delivered to them, as soon as they are no longer needed and no later than ten years following the date of first registration as it appears in the supply form.

Since 1st June 2015, decree 2015-231 of 27th February 2015 modified articles R. 1333-52 and R. 1337-14 of the Public Health Code, to make recovery possible by any supplier of sealed radioactive sources (and not just the original supplier) and, as a last resort, by ANDRA.

5.6. Financing of 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 costs, including the cost of decommissioning and the costs linked to management of the spent fuels and radioactive waste. They are required to secure future financing of these costs by immediately creating a portfolio of dedicated assets.

Compliance with these regulatory obligations is verified by the ministries responsible for the economy and for energy. Under the terms of article 29 of the “Waste" Act, the Government receives a three-yearly report assessing the long-term costs, the methods and choices made for management of the dedicated assets and a quarterly inventory of these dedicated assets.

Under the terms of article 12 of the decree of 23rd February 2007 and an agreement signed between ASN and the DGEC, ASN analyses the reports transmitted in order to give an opinion on the consistency of the decommissioning and spent fuels and radioactive wastes management strategy.

ASN thus published opinions on the three-yearly reports issued by the licensees in 2007, 2010, 2014 and 2017. In its opinion, ASN *"notes that the level of detail in the content of the reports submitted by the licensees differs"*. More specifically, with regard to EDF, ASN recommends that it provide *"the breakdown of decommissioning and post-operational clean-up costs BNI by BNI, taking account of the specific features of each facility*."

ASN more specifically recommends that when evaluating the costs, the licensees should take account of the cost of soil remediation operations, with independent accounting of the costs linked to waste recovery and repackaging operations, of the impact of modifications to the facilities, further to the conclusions of the stress tests, on the decommissioning costs and should reassess direct disposal of spent fuels.

5.7. Integration of the lessons learned from the Fukushima accident

Following the nuclear accident in the Fukushima Daiichi nuclear power plant, France considered that stress tests should be carried out on French civil nuclear facilities with respect to the type of events which led to this accident.

Batch 1 priority facilities

Following this process of stress tests on the "Batch 1" priority facilities, ASN sent its conclusions to the Prime minister in early 2012. It considered that the facilities examined offered a sufficient level of safety such that immediate shutdown was not necessary for any of them, but that their continued operation required an increase in their robustness to extreme situations, beyond existing safety margins, as rapidly as possible. In its resolutions of 26th June 2012, ASN set additional prescriptions to be followed by the licensees. In particular, the licensees will be required to set up a "hardened safety core" of material and organisational measures to control the fundamental safety functions in extreme situations. Reinforced provisions were requested to reduce the risk of uncovering of the spent fuels in the pools.

For the NPPs, the ASN resolutions of 21st January 2014 gave requirements concerning the hardened safety core. The scale and nature of the work involved required planning on the part of EDF in order to optimise its deployment in each of the NPPs. The first phase, between 2012 and 2015, enabled mobile resources to be deployed.

For the fuel cycle plants, ASN prepared draft resolutions indicating the requirements concerning the hardened safety core. Following the review of the proposals made by AREVA, the ASN resolutions of 8th January 2015 prescribed hazard levels and the corresponding requirements for the hardened safety core, along with the deployment deadlines for all the facilities.

Batch 2 and Batch 3 facilities

For the lower-priority facilities, known as "batch 2", the stress test reports were submitted by the licensees in September 2012. The facilities more specifically concerned include those being decommissioned by EDF, the Iter facility, CIS bio and the CERCA plant in Romans. ASN and its technical support organisation have begun to review these reports. Following the review by the Advisory Committees in July 2013, ASN ruled on the proposals from the licensees in its resolutions of 8th January 2015.

Finally, of the thirty or so other facilities of lesser importance, known as "batch 3", ASN set out a calendar at the end of 2013 for CEA submission of the stress test reports, a process which will run until 2020. The deadlines are associated with the dates of the periodic safety reviews, of commissioning or of initiation of decommissioning of these facilities.

Implementation of all the measures arising from the stress tests involved exceptional mobilisation on the part of the industrial firms concerned.

5.8. International peer review missions run by the IAEA

After the IRRS (*Integrated Regulatory Review Service*) mission in November 2006 (and the follow-up mission in March-April 2009), ASN hosted a 2nd complete IRRS audit mission in November 2014.

The reports from the 2006[1], 2009[2] and 2014[3] missions can be consulted in full in English, with a French summary, on the ASN website.

An IRRS mission to follow-up the 2014 mission is scheduled for October 2017.

In addition, an ARTEMIS type mission, an integrated peer review service set up by the IAEA and concerning management of waste, spent fuel, decommissioning and post-operational clean-out, is scheduled for January 2018.

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

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[1] http://www.asn.fr/Media/Files/Final-IRRS-Mission-Report-France-2007-03-12-2

[2] http://www.asn.fr/Media/Files/00-Publications/2009_IRRS_FRANCE_FOLLOW-UP_MISSION_REPORT

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

5.9. International activities

ASN's international activities are carried out within the legislative framework defined by article L.592-28 of the Environment Code.

In order to promote a high level of safety and to reinforce safety and radiation protection culture worldwide, France continued to be closely involved in international work, maintaining its active participation in the working groups, more specifically on five IAEA committees (NUSSC, RASSC, TRANSCC, WASSC and EPReSC), ENSREG, WENRA and the NEA.

Bilateral relations between ASN and its foreign counterparts are a priority focus for international actions. They are a forum for exchanges on topical subjects and for the implementation of cooperative measures.

SECTION A | INTRODUCTION

1 | GENERAL INTRODUCTION

1.1. Purpose of the report

The Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, hereinafter referred to as the “Joint Convention”, is the result of international discussions that followed the adoption of the Convention on Nuclear Safety, in 1994. France signed the Joint Convention at the General Conference of the International Atomic Energy Agency (IAEA) held on 29 September 1997, the very first day the Joint Convention was opened for signature. She approved it on 22 February 2000 and filed the corresponding instruments with the IAEA on 27 April 2000. The Joint Convention entered into force on 18 June 2001.

For many years, France has been taking an active part in the pursuit of international actions to reinforce nuclear safety and considers the Joint Convention to be a key step in that direction. The fields covered by the Joint Convention have long been part of the French approach to nuclear safety.

This report is the fifth of its kind. It is published in accordance with Article 32 of the Joint Convention and presents the measures taken by France to meet each of her obligations set out in the Convention.

1.2. Facilities involved

The facilities and radioactive materials covered by the Joint Convention are much diversified in nature and are controlled in France by different regulatory authorities (see Section E).

Over and above a specific threshold of radioactive content, a facility is under the “basic nuclear facility” (*installation nucléaire de base* – BNI) scheme and placed under the control of the French Nuclear Safety Authority (*Autorité de sûreté nucléaire* – ASN). Below that threshold, if a nuclear installation is subject to authorisation according to the nomenclature of “classified facility on environmental-protection grounds” (*installation classée pour la protection de l’environnement* – ICPE), this facility is placed under the control of the Ministry for the Environment.

Facilities that contain only small amounts of radioactive materials or do not meet the above-mentioned criteria are not subject to any regulatory control in that respect.

1.3. Authors

ASN prepared this report and co-ordinated the contributions not only from the General Directorate for Energy and Climate (Direction générale de l’énergie et du climat – DGEC) part of the Ministry of Ecology, Sustainable Development and Energy (Ministère de l’écologie, du développement durable et de l’énergie – MEDDE), the Nuclear Safety and Radiation Protection Mission of the MEDDE and Institute for Radiation Protection and Nuclear Safety (Institut de radioprotection et de sûreté nucléaire – IRSN) and the French National Radioactive Waste Management Agency – (l’Agence nationale pour la gestion des déchets radioactifs - Andra) but also from the major operators of nuclear facilities, including Électricité de France (EDF), AREVA, and particularly its subsidiary AREVA NC, the French Atomic Energy and Alternative Energies Commission (Commissariat à l’énergie atomique et aux energies alternatives – CEA), the International Organisation ITER and the Laue-Langevin Institute (ILL). The final draft was completed in September 2014 after consultation with all French parties concerned.

1.4. Report structure

For her sixth report, France drew from the experience it acquired from its participation in the previous meetings on the Joint Convention and the Nuclear Safety Convention. It constitutes a self-supporting report based on existing documentation and reflects the viewpoints of the different actors (regulatory authorities and operators). Hence, for each of the sections in which the regulatory authority is not the only party to express its opinion, a three-step structure was adopted, as follows:

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

This report is structured according to the “guidelines regarding national reports” for the Joint Convention, i.e., an “article-by-article” format, with each one being addressed in a dedicated section bearing the corresponding text of the relevant article of the Joint Convention on a shaded background at the top of the section. After the Introduction (Section A), the various sections deal successively with the following topics:

- Section B Policy and practices under the Joint Convention (Article 32-1);
- Section C Scope (Article 3);
- Section D Spent-fuel and radioactive-waste inventories, together with the list of the corresponding facilities (Article 32-2);
- Section E Legislative and regulatory system in force (Articles 18 to 20);
- Section F Other general safety provisions (Articles 21 to 26);
- Section G The safety of spent-fuel management (Articles 4 to 10);
- Section H The safety of radioactive-waste management (Articles 11 to 17);
- Section I Transboundary movements (Article 27);
- Section J Disused sealed sources (Article 28);
- Section K General Efforts to Improve Safety.

A few annexes complete the report (Section L).

It should be noted that regulatory discussions common to the safety of spent-fuel management facilities and to the safety of radioactive-waste management facilities have been inserted in Section E in order to prevent partial duplications between Sections G and H, as recommended by the guidelines for drafting national reports.

1.5. Publication of the report

The Joint Convention does not require the report referred to in Article 32 to be communicated to the public. Nevertheless, pursuant to its information mission and in a constant concern to improve the transparency of its activities, ASN has decided to make the report available to any interested party. Consequently, the report is available in both English and French on ASN’s website: www.asn.fr.

2 | MAJOR DEVELOPMENTS SINCE THE LAST FRENCH REPORT

2.1. Evolution of nuclear safety control

2.1.1. European legislative framework

Council Directive 2009/71/Euratom of 25th June 2009 aims to establish a Community framework to ensure nuclear safety within the European Atomic Energy Community and to encourage the Member States to guarantee a high level of nuclear safety.

Pursuant to the 2009 directive, France submitted a first national implementation report to the European Commission on 22nd July 2014.

Following the Fukushima Daiichi accident in 2011, the Heads of State and Government asked the Commission to review the legislative and regulatory framework in force in the field of nuclear installation safety and to propose any improvements that would appear necessary. During the period 2013 to 2014, France played an active role in the negotiations on the revision of the text of Directive 2009/71/Euratom cited above. The amending Directive 2014/87/Euratom was adopted by the Council on 8 July 2014..

The 2009 directive as amended in 2014 more specifically applies to processing facilities, spent fuel storage facilities and to certain radioactive waste storage facilities (when on the same site as another nuclear facility).

In addition, another directive establishing a community framework for the responsible and safe management of spent fuel and radioactive waste was adopted on 19 July 2011 (directive 2011/70/Euratom) for transposition into national law before August 2013.

Under the terms of the directive, each Member State must submit a report on the implementation of the text by August 2015.

In the case of France, the legislative provisions transposing the 2011 directive have been incorporated into the national regulations.

The 2011 directive deals with two essential aspects of the management of radioactive waste and spent fuel: first, it specifies the obligations relating to safe management by reiterating the basic principles of the IAEA and of the Joint Convention, and second, it sets the framework for the national management policies to be developed and implemented by every Member State. Hence, the European Union (UE) now requires every Member State to establish a national management programme for spent fuel and radioactive waste.

The directive reiterates notably the distinction that exist between “spent fuel” and “radioactive waste”, the qualification as “waste” for any spent fuel requiring that no further use be scheduled or envisaged for that spent fuel (especially, no intended processing).

The national programme must comply with the following principles:

- the production of radioactive waste must be kept at the lowest possible level;
- spent fuel and radioactive waste must be managed safely, including over the long term:
- management costs for radioactive waste and spent fuel must be supported by those who produce them and sufficient financial resources must be available when necessary;
- in principle, radioactive waste must be disposed of in the Member State where it was produced (including when it involves a by-product that was separated from exported radioactive waste or spent fuel in a foreign processing plant), with the possibility of storing such items in a third-party country being restricted to certain conditions;
- Member States must establish their own national legislative, regulatory and organisational framework, including notably a licensing system for the facilities and activities involving the management of radioactive waste and spent fuel, together with an appropriate system of control and enforcement dispositions;
- Member States must designate a single competent authority for waste safety. That authority shall be separated from any other organisation involved in the promotion or use of nuclear energy or of radioactive substances. Its task will be notably to develop and manage a licensing system. It must also be allocated the necessary financial and human resources to fulfil its missions;
- irrespective of their involvement, all organisations associated with the management of radioactive waste or spent fuel must implement training or R&D provisions in order to fulfil the implementation requirements of their national programme, and
- the public must have access to all necessary information relating to the management of spent fuel and radioactive waste and must be able to participate effectively in the decision-making process concerning the management of spent fuel and radioactive waste, pursuant to the national legislation and international obligations.

The prime responsibility for the safety of facilities and/or management activities lies with licensees. However, that directive reiterates explicitly the responsibility of Member States in last resort for the management of any spent fuel and radioactive waste that is produced on their territory.

The directive applies to all management steps for spent fuel and radioactive waste, including production, handling, pre-treatment, processing, conditioning and storage, as well as the final elimination of the waste. The directive applies only to radioactive waste resulting from civilian activities (pursuant to EURATOM competencies). It does not apply to extracting industries for which there separate Community regulations already exist.

2.1.2. Overhaul of the general technical regulations

Following the publication of the Act no 2006-686 of 13 June 2006 concerning Transparency and Security in the Nuclear Field (TSN Act) – now codified in the Environment Code - and of its enforcement decrees, a thorough consolidation of the general technical regulations for BNIs has been launched. In fact, that approach was consistent with the determination to harmonise nuclear safety throughout Europe by integrating in the new regulatory set the principles (“reference levels”) developed by the Western European Nuclear Regulators’ Association (WENRA), which has been working for several years at constituting a reference system of common prescriptions. The work conducted by WENRA resulted from a reflection on existing reactors and the experience feedback generated by their operation and control.

The work to overhaul the BNI general technical regulations led to the publication of order of 7 February 212 (BNI order). The majority of the provisions of this order entered into force on 1st July 2013.

This overhaul of the regulations applicable to BNIs continued with the publication of Act 2015-992 of 17th August 2015 concerning energy transition for green growth (known as the “TECV” Act) and ordinance 2016-128 of 10th February 2016 comprising various nuclear provisions (see § E.1.2 for more details).

ASN statutory resolutions clarify this new regulatory framework. Since 2006, 13 statutory resolutions concerning nuclear safety have been adopted. The more recent ones, in 2015 and 2016, are notably:

- in 2015: ASN resolution 2015-DC-0508 of 21st April 2015 concerning the study of waste management and the inventory of waste produced in the BNIs; ASN resolution 2015-DC-0532 of 17th November 2016 on BNI safety analysis reports:
- in 2016: ASN resolution 2016-DC-0569 of 29th September 2016, modifying ASN resolution 2013-DC-0360 of 16th July 2013 concerning the management of nuisances and the impact of BNIs on health and the environment;
- in 2017: ASN resolution 2017-DC-0587 of 23rd March 2017 on the conditioning of radioactive waste and the conditions for acceptance of radioactive waste packages in disposal facilities.

This arrangement is supplemented by ASN guides which present ASN doctrine but which are not legally binding; guides N° 6 on BNI final shutdown, decommissioning and delicensing, N° 7 on the transport of radioactive substances on the public highway, N° 14 on the remediation of structures in BNIs, N° 15 on the management of activities in the vicinity of BNIs, N° 23 on the definition and modification of the BNI waste zoning plan, N° 24 on the management of soils contaminated by BNI activities, N° 25 on the drafting of an ASN statutory resolution or guide (procedures for consultation with the stakeholders and the public) and N° 27 on the stowing of radioactive packages, materials or objects for transportation, were created or updated in 2016. The complete list of ASN guides is presented in appendix L.5.2.

2.2. Evolution of the radioactive-waste-management policy

2.2.1. Publication of the new National Management Plan for Radioactive Materials and Waste (PNGMDR)

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

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

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

The Environment Code sets the guidelines to be followed by the Plan (see B.1.3).

After the first three editions of 2007, 2010 and 2013, a new PNGMDR for the period 2016-2018 was drawn up and transmitted to Parliament in early 2017, based on the work done by a pluralistic working group (co-chaired by the DGEC of the Ministry for the Environment, Energy and the Sea (MEEM) and by ASN). For the first time, it was the subject of an environmental assessment and an opinion from the environmental authority. It was then the subject of a public consultation at the end of 2016 and was made public in early 2017. The decree of 23rd February 2017 defines the broad outlines and the order of 23rd February 2017 establishes its prescriptions.

France was the first to produce a PNGMDR and played an active role at the European level in the draft directive mentioned above, the aim of which is to require each Member State to produce a radioactive waste management plan.

2.2.2. Changes to management solutions under development

For high level and intermediate level long-lived waste, ANDRA carried out basic studies to define an overall industrial architecture for the CIGÉO project.

These studies, entrusted to an industrial lead contractor, are based on a range of requirements established by ANDRA (safety, reversibility, operation, integration). These requirements consolidated the acquired scientific and technical results as well as the recommendations by the assessors following the investigation of the technical options presented by ANDRA in 2009. The draft inter-département local development scheme drafted by the State jointly with local players and ANDRA identifies the challenges as related to local integration of the project (need for infrastructures, housing, training, etc.).

The Environment Code requires the organisation of a public debate on the disposal facility project prior to the submission of its creation authorisation application. This debate was organised by the French National Public Debate Commission (CNDP) in 2013. The minutes and report of the public debate were published on 12 February 2014.

On 6 May 2014, ANDRA presented its intentions for the CIGÉO project following the public debate, unanimously voted by its Board meeting of 5 May. To take account of the opinions and expectations expressed during the debate and in order to conserve the step-based approach initiated by the 1991 Act, ANDRA has decided to continue with the CIGÉO project, although with the adoption of four changes to it, clarifying its proposal concerning reversibility and making undertakings for subsequent operation:

- Integration of a pilot industrial phase when the installation starts up, in order to test all disposal facility functionalities in real conditions; On the basis of an inventory representative of the high level and intermediate level, long-lived waste to be disposed of, this phase will first of all comprise inactive tests, followed by radioactive waste package disposal operations. The transition to routine operations will take place after ANDRA has produced a report summarising the results of this phase;

- Implementation of a regularly revised master plan for operation of the disposal facility, produced with the stakeholders;
- Modifications to the schedule, with the goal, subject to the necessary authorisations, of beginning construction of the repository in 2020 with start-up by means of a pilot industrial phase in 2025;
- Greater involvement in the project by civil society.

ANDRA thus launched Preliminary Design (APS) studies, entrusted to an industrial organisation, with a range of engineering capabilities organised into sub-systems around a system industrial lead contractor. This Preliminary Design process took place in 2014 and 2015 and was used as the technical support file for a safety options report, delivered to ASN and IRSN for review at the beginning of 2016, but also for a technical recoverability options report, also delivered at the beginning of 2016, a first draft of the CIGEO Operations Master Plan (PDE), a document requiring nationwide consultation and, finally, a "local stakeholders input data document", enabling the Meuse and Haute Marne départements on the one hand to be involved in a consultation on the basis of project technical data and, on the other, to be able to draw up a Regional Contract with the State in preparation for the arrival of the CIGEO industrial facility.

The year 2016 was marked by:

- the publication of a ministerial order, setting the total cost of ownership of the project, for its operating lifetime, at 25 billion euros (in the economic conditions of 31st December 2011);
- legislation supplementing the 2006 Act, to define and characterise the reversibility of a deep geological disposal facility.

Following on from the APS, at the beginning of 2016, ANDRA launched a Detailed Design (APD), which will constitute the basis for a creation authorisation application file, to be submitted to ASN in 2018. Feedback from the examination of the safety options report by an international review organised at the end of 2016 by ASN will be taken into account in this creation authorisation application. Account will also be taken of feedback from consultation with the region as well as feedback from the national consultation on subjects related to project governance, in a new edition of the Operations Master Plan.

For low level long-lived waste, ANDRA presented the various management scenarios studied for this waste, according to its nature, in late 2012. Further to the guidelines issued by the State for the continued search for a site, geological investigations were initiated in 2013 on the territory of the Soulaines local authority, close to the disposal centres operated by ANDRA for LLW/ILW-SL and VLL waste. As requested by local government officials, a consultation Committee was set up under the aegis of the State, to define the incentives and steps associated with project development, with the existing local information committees being regularly informed of the progress of the project. A geological analysis on the other BNI sites in France is also being carried out together with AREVA, CEA and EDF. The PNGMDR recommends continued work to characterise the waste, R&D on processing and the feasibility of the envisaged management scenarios (see decree and ministerial order of 23 February 2017). Evaluation of the studies carried out until 2015 that lead to ASN's opinion of 29 March 2016 allows guidelines for the subsequent phases of the project to be defined, more specifically indicating which scenarios are to be adopted for management of the various types of LLW-LL waste and the various methods to be envisaged subsequently.

3 | INTEGRATION OF EXPERIENCE FEEDBACK FROM THE FUKUSHIMA ACCIDENT

Following the nuclear accident at the Fukushima Daiichi nuclear power plant and the demands made by Prime Minister on 23 March 2011 and the European Council on 24 and 25 March 2011, ASN considered that stress tests needed to be carried out on French civil nuclear facilities with respect to the type of events which led to this accident.

ASN decided that stress tests would be conducted on all facilities liable to present risks in the case of events of the same nature as at Fukushima Daiichi and not only on nuclear power reactors. The exercise first of all concerned the priority facilities (more specifically NPPs, all fuel cycle plants operated by AREVA and some of the CEA facilities; batch 1). It then concerned lower priority facilities (batch 2 and 3). The list of facilities concerned according to their level of priority is given in appendix L.4.

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

Following this process, ASN submitted its conclusions to the Prime Minister in early 2012 (see ASN opinion 2012-AV-0139 of 3 January 2012 and the ASN report available in English on the ASN website). It considered that the facilities examined offered a sufficient level of safety such that immediate shutdown was not necessary for any of them. At the same time, ASN considered that their continued operation requires that their robustness to extreme situations be increased beyond their existing safety margins, as rapidly as possible.

In its resolutions of 26 June 2012, which can be consulted in English on its website, ASN sets prescriptions for the licensees, which include the need to create a “hardened safety core” of robust material and organisational measures designed, in the extreme situations studies by the stress tests:

- to prevent a severe accident or limit its progression;
- to mitigate large-scale releases;
- to enable the licensee to perform its emergency management duties.

3.1. NPP reactor pools

The pools of NPP reactors were the subject of stress tests (see § G.2.2.3. below). The licensee demonstrated the robustness of its facilities.

On 26 June 2012, these stress tests led ASN to issue a resolution for each of the NPPs, with regard to the creation of a hardened safety core of material and organisational measures concerning the spent fuel pools, in order to guarantee cooling of the fuel. Furthermore, requests were made for enhanced instrumentation of the pools, including in the event of loss of electrical power, for prevention of their accidental emptying, placing the assemblies being handled in a safe position, evaluating the behaviour of the pool so that local intervention can be carried out if necessary and checking the robustness of these structures to induced hazards, notably by a falling fuel packaging during handling.

ASN supplemented its requests by 19 resolutions dated 21st January 2014 setting additional requirements for deployment of the hardened safety core in the EDF NPPs. The scale and nature of the work involved require both time and planning in order to optimise their deployment in each of the NPPs. Their deployment will comprise three phases.

Phase 1 (2012-2015) saw the deployment of temporary or mobile measures to reinforce the response to the main situations of total loss of the heat sink or electrical power supplies. EDF considers this phase to be completed. Phase 2 (2015-2020) will allow the deployment of finalised resources to deal with the above-mentioned situations. With regard to the spent fuel pools, this will involve the installation of high-capacity back-up diesels, an ultimate water source with a make-up system for each spent fuel pool. This phase is currently at the deployment stage. Phase 3 (as of 2016) will supplement phase 2, in particular to take account of other potential accident scenarios. At the end of this phase, all the resources deployed on the facilities should be able to cover the most extreme situations considered by the stress tests.

For spent fuel pool management, EDF considers that *“the resources deployed in phase 2 of the modifications made subsequent to the stress tests allow a significant improvement in water make-up to the BK pool for heat sink loss situations going beyond the situations…considered in the safety baseline requirements in force (in terms of number of plant units concerned on a given site, duration of situations and robustness to hazards) through the deployment of the first basic elements of the hardened safety core…”*

3.2. The fuel cycle plants

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

Pursuant to the resolutions of 26th January 2012, the additional prescriptions stipulated in the light of the conclusions of the stress tests require that the AREVA group take the following measures for these facilities assessed in 2011:

- proposal by the licensee of a “hardened safety core” of material and organisational measures:
  - implementation of reinforced measures to reduce the risk of the spent fuel stored in the La Hague pools becoming exposed by emptying of the pool;
  - for the silos at La Hague, feasibility studies with a view to setting up technical arrangements, such as geotechnical containment or equivalent effect, with the aim of protecting the underground and surface water in the event of a severe accident;
  - for the AREVA NC MELOX plant, the adoption of provisions:
    - aiming to restore then maintain the cooling function within a time compatible with the temperature rise in the STE rods storage unit and other fissile materials storage units;
    - aiming to protect against the loss or deterioration of the high negative-pressure extraction network for building 500 and its extension;
- measures relative to emergency management and social, organisational and human factors (SOHF).

The proposals thus made by the AREVA group to define the hardened safety core were reviewed by ASN and its technical support organisation and were presented to the Advisory Committees in April 2013. Following this review, the ASN resolutions of 8th January 2015 prescribed the hazard levels and requirements associated with the “hardened safety core” and the deadlines for deployment of this “hardened safety core” on all the cycle facilities.

ASN will continue to monitor the implementation of the additional safety measures required following the stress tests and more specifically the AREVA proposals concerning the definition of systems, structures and components robust to extreme hazards and the management of emergency situations, in particular the degree of compliance with the new prescriptions. More specifically, for the La Hague site, the work done following the stress tests should be completed in the first quarter of 2017. ASN will check its correct performance and the correct functioning of the equipment installed, along with the corresponding provisions.

At the same time, ASN will issue a position statement on the reference contingencies to be considered for the "hardened safety core" (in particular seismic and tornado aspects) and define how to reach a decision on sites for which seismological data is limited and which require special approaches.

With regard to SOCODEI, the stress tests on the low level waste processing and packaging centre (CENTRACO) have been transmitted to ASN. The provisions already implemented were considered to be satisfactory.

3.3. CEA facilities

Three CEA experimental reactors (OSIRIS, MASURCA and RJH) were among the Batch 1 priority facilities for which prescriptions were set by ASN resolutions of 26th June 2012, in order to propose the definition of a "hardened safety core" of material and organisational provisions for controlling the fundamental safety functions in extreme situations.

PHENIX and the plutonium technology facility (ATPu) undergoing decommissioning are also among the Batch 1 priority facilities and will be dealt with specifically in § 3.5.

The stress tests approach was continued for the 22 facilities of Batch 2. These include CEA research facilities and the emergency management resources on the Cadarache and Marcoule sites.

After analysis of these stress tests, in its resolutions of 8th January 2015, ASN prescribed requirements for CEA associated with the equipment and provisions of the "hardened safety core" for the facilities (Batch 1 and 2) and centres which so require, as well as the deadlines for their deployment, which should continue until 2018.

During the course of 2016, ASN issued a position statement on CEA's measures to prepare for and manage extreme situations, with regard to social, organisational and human factors (SOHF) covered by the ASN resolutions of 26th June 2012 and 8th January 2015.

This work will be completed in 2017 with the review of the on-site emergency plans (PUI) for the Cadarache and Marcoule centres. The technical information file concerning the robust emergency management rooms for the Cadarache centre was the subject of a position statement and requests for additional information from ASN, which will need to be taken into account for its completion by the end of 2017.

Finally, the examination of the extreme natural hazards adopted for the hardened safety core in the facilities is currently being finalised.

For the Saclay site, CEA submitted its stress tests report on 30th June 2013. The review of this report led ASN on 12th January 2016 to prescribe the deployment of an emergency management hardened safety core. CEA complied with the initial deadlines of this resolution and is transmitting additional studies and justifications concerning its ability to activate its emergency organisation in extreme situations. These elements are currently being examined by ASN.

Finally, of the thirty or so other facilities of lesser importance, known as "batch 3", ASN set out a calendar on 21st November 2013 for submission by CEA of the stress test reports, a process which will run until 2020. These deadlines are associated with the dates of the periodic safety reviews, of commissioning or of initiation of decommissioning of these facilities.

3.4. The high flux reactor in the Laue-Langevin Institute

The stress tests on the HFR were performed by the ILL pursuant to the ASN resolution of 5th May 2011 and were reviewed by ASN, the Institute for Radiation Protection and Nuclear Safety (IRSN) and the Advisory Committees for reactors and for plants. Following this review, ASN asked the ILL in its resolution of 10th July 2012, to deploy a "hardened safety core", to verify the robustness of certain equipment items, to propose modifications to reinforce others and to carry out improvement works (ultimate reflooding system, new emergency control post).

After a review by the Advisory Committees concerned in April 2013, ASN considered that the hardened safety core proposed by the ILL and the associated requirements were satisfactory and prescribes their implementation in a resolution dated 21st November 2013.

In the light of the lessons learned from the Fukushima Daiichi disaster, the ILL therefore proposed making significant reinforcements within an ambitious time-frame. This process continued satisfactorily in 2016, in the same way as with the containment seismic depressurisation system used to minimise gaseous releases in accident situations. In its resolution of 22nd November 2016, ASN agreed to postpone implementation of the last reinforcement, now expected in 2017, that is commissioning of a groundwater system (CEN). This system would be used to cool the reactor spent fuel pool using groundwater.

3.5. Facilities undergoing decommissioning

ASN asked the BNI licensees to carry out stress tests, including for those facilities undergoing decommissioning.

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

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

The stress test on BNI 74 consisting of storage silos for the graphite sleeves from the operation of reactors A1 and A2 at Saint-Laurent-des-Eaux was transmitted on 15th December 2015 and is currently being reviewed.

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

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

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

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

3.6. Waste disposal facilities

In its resolution 2013-DC-0386 of 17th December 2013 ASN issued prescriptions requiring ANDRA to perform stress tests on its waste disposal facilities [Manche repository (CSM BNI 66) and Aube repository (CSA BNI 149)] on the occasion of their next periodic safety review.

The CSA stress test was transmitted in August 2016 and is currently being reviewed. The stress test for the CSM should be transmitted in 2019.

3.7. French participation in the European stress tests

On 26th April 2012, one year after the Fukushima Daiichi disaster, a joint statement by ENSREG and the European Commission concluded the stress tests conducted on the European nuclear power plants (NPP). This statement emphasised the need to implement an overall action plan to ensure that these stress tests would be followed by safety improvement measures implemented in a consistent manner in each country.

The ENSREG global action plan required the nuclear safety regulator of each member country to publish a national action plan by the end of 2012. In December 2012, ASN published the action plan for France. The national action plans then underwent a peer review, which was concluded by a seminar organised by ENSREG, held in April 2013 in Brussels. For France, the seminar summary report in particular emphasized the comprehensive nature of the action plan presented, the importance that ASN attached to the transparency of the stress tests process, the ambitious nature of the content and the implementation times for the measures to improve safety in the nuclear power plants decided on in the wake of the Fukushima Daiichi accident, and the consideration given to organisational and human factors, including conditions regarding the use of subcontractors.

Further to this seminar the decision was taken to assess the status of implementation of the actions in each country after two years. ASN therefore updated and published its action plan in December 2014, in accordance with the ENSREG recommendations.

As in the preceding exercise, the updated national action plans were examined by all the European safety regulators. ENSREG organised a seminar in April 2015 so that each safety regulator could present its national action plan and answer questions raised by its counterparts and the public.

ASN intends to update its action plan by the end of 2017.

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

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

i) its spent fuel management policy;

ii) its spent fuel management practices;

iii) its radioactive waste management policy;

iv) its radioactive waste management practices;

v) the criteria it applies to define and classify radioactive waste.

1 | GENERAL POLICY

The Management Policy for Radioactive Materials and Waste is consistent with the legal framework constituted by two acts and their implementation instruments, as follows: the *Law of 30 December 1991* (*1991 Law*) and *Waste Act of 28 June 2006.*

The policy is described in detail in the PNGMDR, which has been developed notably on the basis of the *National Inventory of Radioactive Waste and Materials* (*Inventaire national des matières et déchets radioactifs*) (see § A.2.2.1).

The policy relies on the following three principles:

- research and development (R&D);
- transparency and democratic dialogue;
- adequate funding for radioactive-waste management and decommissioning activities.

1.1. Planning Act of 28 June 2006 Concerning the Sustainable Management of Radioactive Materials and Waste (Waste Act)

The Waste Act was published after 15 years of research prescribed by the 1991 Law. Its scope covers all radioactive materials and waste and prescribes the orientations and objectives of R&D investigations on the management of radioactive waste for which no management solution is yet in service. The law prescribes also the financing modalities for decommissioning and waste-management costs. It reiterates the fact that it is forbidden to dispose of any foreign waste in France.

This act describes also various dialogue tools with the public and the funding principles of research projects and radioactive-waste management. This act more specifically amended and supplemented the Environment Code (articles L542-1 to L542-14 and L.594-1 to L.594-14). The ordinance of 10th February 2016 recently amended and supplemented these articles. It is thus planned to assess the legal and organisational system governing the management of radioactive waste and its implementation, and the organisation of ten-yearly peer reviews of the regulations and organisation in place for the management of radioactive materials and waste. The code also stipulates that the Government is vigilant about enhancing the legal and organisational setup with regard to the management of radioactive materials and waste, taking into account experience feedback, the results of the reviews and the technical and scientific developments in this area. The Code also provides for the assessment of the legal and organisational setup governing the management of radioactive materials and waste and its implementation, and the organisation of ten-yearly peer reviews of the regulations and organisation in place for the management of radioactive materials and waste.

	Decrees	Law Article	Publication Date
National Management Policy for Radioactive Materials and Waste	Prescriptions of the 2016-2018 National Management Plan for Radioactive Materials and Waste	**Art. 6**	23 February 2017
	Management of foreign waste and processing contracts	**Art. 8**	3 March 2008
	Appointment of CNE members	**Art. 9**	5 April 2007
	Nature of information to be transmitted for National inventory	**Art. 22**	29 August 2008
Support for research conducted at the Meuse/Haute Marne URL	CLIS	**Art. 18**	7 May 2007
	GIPs – Generic decree	**Art. 13**	14 December 2006
	Delineation of the proximity zone–- GIP Meuse and Haute-Marne	**Art. 13**	5 February 2007
	“Support” tax: fraction paid by GIPs to communes located within the 10-km zone	**Art. 21**	7 May 2007
	Coefficient of “incentive” and “technological diffusion” taxes	**Art. 21**	26 December 2007
	Consultation zone for the creation of a repository	**Art. 12**	To be published
Funding provisions	Coefficient of the additional “research” tax	**Art. 21**	26 December 2007
	Securement of long-term nuclear charges	**Art. 20**	23 February 2007
	Implementation of the CNEF	**Art. 20**	20 June 2008

TABLE 2 : LIST OF DECREES TAKEN PURSUANT TO THE WASTE ACT ON 31 DECEMBER 2016

1.2. An all-encompassing management policy for radioactive substances

1.2.1. Definitions

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

A radioactive substance is a substance containing radionuclides, whether natural or man-made, whose activity or concentration justifies a radiation protection control.

A radioactive material is a radioactive substance for which a subsequent use is planned or envisaged, after processing, if need be.

Nuclear fuel is considered as a spent fuel when, after having been irradiated in the reactor core, it is permanently removed from it.

Radioactive waste consists of radioactive substances for which no subsequent use is planned or envisaged.

Ultimate radioactive waste consists of radioactive waste that are impossible to process under the current technical and economic conditions of the time, notably by extracting their recoverable share or by reducing their polluting or hazardous character.

The storage of radioactive materials or waste consists in placing temporarily such materials within an especially-fitted surface or shallow facility for that purpose, pending their recovery.

The disposal of radioactive waste is an operation consisting in placing such substances within an especially-fitted facility with a view to preserving them potentially for ever.

The disposal of radioactive waste within a deep geological formation is the disposal of such substances within an especially-fitted facility for that purpose in accordance with the reversibility principle.

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

1.2.2. Radioactive materials

Radioactive materials consist mainly of the depleted uranium generated by enrichment plants, of the spent fuel unloaded from nuclear reactors and of the fissile materials extracted from irradiated fuel (uranium and plutonium) after processing of spent fuel.

Currently speaking, radioactive materials are partly recoverable in certain existing systems, as follows:

- plutonium from spent fuel processing is used to manufacture MOX fuel which can be used by 24 nuclear power reactors operated by EDF;
- depleted uranium resulting from the enrichment of natural uranium is not widely used (only in the fabrication of MOX fuel) and is stored;

- part of uranium from spent fuel processing (about two third of the annual production) could be re-enriched and could be consequently used for the fabrication of the fuel types acceptable in the four reactors of the Cruas Nuclear Power Plant (NPP).

The integration of certain radioactive materials, which are not considered as waste, was discussed initially within the Working Group for the Development of the PNGMDR.

As for the OPECST, it stated in its report of 15 March 2005 that the scope of the Plan should be extended to recoverable materials in order to prevent any shadow zone in the management of radioactive waste. The application of that recommendation helped making the Plan consistent with the scope of the National Inventory of Radioactive Materials and Waste, as established by ANDRA. The PNGMDR also includes thorium and uranium from spent fuel processing.

The 2016-2018 PNGMDR is not taking any stand on the status of recoverable materials, but it advocates that the owners reinforce the long-term valorisation perspectives and that ANDRA study the feasibility of their disposal in cases where they would not be reused. The future of those materials is reviewed during the update of the PNGMDR.

1.2.3. Inventory of Radioactive Materials and Waste

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

- list the radioactive materials and waste present on French territory as at 31st December each year, on the basis of the information provided annually by the holders of the materials and waste;
- establish forecasts of future radioactive materials and waste production at dates defined by ministerial order and, for the waste, at the end of operation of the waste producing facilities, based on information provided every three years by the holders of the radioactive materials and waste;
- outline the broad trends for the production of radioactive materials and waste applying several prospective scenarios.

To ensure transparency, a pluralistic Steering Committee has been established by ANDRA to follow the national inventory preparation. Chaired by the Director-general of ANDRA, this Steering Committee includes representatives from various administrations (Ministries, ASN, HCTISN …), civil society, associations for environment protection and waste producers.

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

The National Inventory also present an estimation of the quantities of materials and waste with several prospective scenarios based on assumptions of continued or non-renewal of nuclear power production.

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

Since the end of 2016, all these data are published on the French public data open platform (www.data.gouv.fr) and on the national inventory website (www.inventaire.andra.fr).

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

The PNGMDR constitutes a key element for steering the national management policy effective in France.

The first plan was tabled before Parliament in March 2006. It was the result of the work that had been launched by the Minister of Ecology and Sustainable Development on 4 June 2003 and carried out by a pluralistic working group placed under the aegis of ASN and the Directorate-General of Energy and Raw Materials (Direction générale de l'énergie et des matières premières – DGEMP) and consisting of representatives from the Administration, radioactive-waste producers from the nuclear and non-nuclear sectors, ANDRA, IRSN, environmental associations, as well as a member from the CNE.

Nurtured by that work, the Waste Act then confirmed the principle of the national management plan. It also provided that a decree set forth its requirements; hence, the decree for the first Plan was issued on 16 April 2008, whereas the decree stating the requirements for the current Plan was issued on 23 February 2017 and integrates in the regulatory part of the Environment Code (articles D.542-74 to D.542-96) perennial provisions of the PNGMDR framework. Specific prescriptions are listed in a ministerial order of 23 February 2017.

The PNGMDR is based on the knowledge of the different types of waste, and notably on the national inventory (see §B.1.2.3). The National Plan is drawn and updated every three years by the government and tabled before Parliament, which in turn refers it to the OPECST (see § E.3.4.1). In addition, the CNE (see §E.3.4.2) is responsible for assessing every year the progress made by investigations and studies on the management of radioactive materials and waste.

1.3.1. Legislative framework for the implementation of the PNGMDR

1.3.1.1. DRIVING PRINCIPLES OF THE PNGMDR

The driving principles of the PNGMDR are those of the Waste Act:

- seeking to reduce the quantity and toxicity of radioactive waste, notably by processing spent fuel and conditioning radioactive waste;
- storing all radioactive materials pending processing and all ultimate radioactive waste pending disposal in especially-fitted facilities for that purpose;
- after storage, disposing in a deep geological repository any ultimate radioactive waste that may be unsuitable for disposal in surface or shallow installations, due to nuclear-safety or radiation-protection concerns.
- The PNGMDR is also based on the following principles:
- compliance with principles of protection against ionising radiation (justification, optimisation, limitation) of environmental protection (precaution principle) and of responsibility of waste producers (polluter-pays principle);
- principle of an integrated approach from production to storage/disposal;
- determination of long-term management systems adapted to the characteristics of the different waste categories, particularly concerning the storage of waste for which no long-term management solution exists so far or the taking-over by the community of “orphan waste” resulting most of the time from historical activities;
- traceability of radioactive waste management;
- information and active involvement of citizens.

1.3.1.2. OBJECTIVES OF THE PNGMDR

The main objectives of the PNGMDR are recalled in Article D.542-75 of the Environment Code:

- Management strategies must be adapted to the heterogeneity and the level of dangerousness of the waste considered and proportionate to the technical, economic, and safety-related issues involved.
- The use of the radioactive waste disposal facilities must be optimized.
- The radioactive waste management routes must take account of the volumes of waste transported and the distances to be covered.

The PNGMDR focuses mainly on the following fields:

- to seek long-term management solutions for every category of radioactive waste being produced;
- to continuously improve and optimise existing routes;
- to analyse the long-term management solutions and their optimisation adopted in the past and to justify an intervention, if improvements are necessary, with a view to achieving a type of management that will always keep improving in clarity, rigour and safety;
- to take over and to condition historical radioactive waste;
- to ensure the consistency of the overall management mechanism for radioactive waste, irrespective of its radioactivity level;
- to ensure the consistency of the entire radioactive waste management system, regardless of the level of radioactivity or the origin;
- to take due account of public concerns and expectations about the future of radioactive waste.

In order to achieve those goals, it is important to organise a global and national reflection from which to draw the main lines of a policy aiming at ensuring a sound management of all radioactive waste, especially by determining long-term management venues and financing means for the management of radioactive-waste categories lacking a final solution.

1.3.2. Implementation of the PNGMDR in 2016

1.3.2.1. SCOPE OF THE PNGMDR

The PNGMDR applies to all radioactive waste categories:

- all “waste resulting from nuclear activities” (regulated activities due to the presence of radioactivity involved);
- all “waste resulting from activities involving the handling of radioactive materials, but exempted from regulatory control”, which include significant concentrations of radioactivity or are very important in number, and which require specific measures (e.g., smoke detectors);
- all “waste containing natural radioactivity”, which may be reinforced following a human activity without calling necessarily upon the radioactive properties of the materials, and whose radioactive concentration is too high to be overlooked from a radiation-protection standpoint, and
- all tailings resulting from the processing of uranium ore being disposed of in ICPEs.

In addition, the PNGMDR takes radioactive materials into account (see § B.1.2.2).

1.3.2.2. CONCLUSIONS OF THE 2016-2018 PNGMDR

The 2016-2018 edition of the Plan continues and expands on the steps taken in the previous version. It relies in particular on the National Inventory of Radioactive Materials and Waste, published by ANDRA in July 2015, which evaluates the waste production prospects for the coming decades, along with the storage capacity requirements.

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

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

It proposes the following measures in particular.

Consolidation of the prospects of recycling radioactive materials

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

Optimisation of the very low level (VLL) waste management route

The PNGMDR addresses this subject from several aspects:

- it prescribes work on the reduction of the volumes of waste produced and on recycling;
- disposal solutions providing alternatives to a centralised VLL waste disposal facility must be examined;
- In 2020 ANDRA must update the overall industrial scheme developed in 2015 for the management of the VLL waste, which incorporates the creation of a new disposal facility for VLL waste;
- the environmental impact of transport operations must be assessed and reduced.

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

New directions for low-level long-lived waste (LLW-LL)

The PNGMDR demands:

- the continuation of more detailed geological investigations on the Soulaines site;
- more detailed studies relative to the treatment of graphite waste which would enable the radiological inventory disposed to be reduced;
- the integration of part of the low-level long-lived waste (LLW-LL) inventory into the CIGÉO "reserves", which corresponds to an extended inventory for CIGÉO, which at present is outside the scope of the initial authorisation that will be requested;
- the search for a second LLW-LL waste disposal site to provide a management solution for all the waste of this type in this medium term.

An overall industrial scheme for the management of all LLW-LL radioactive waste must be submitted before the end of 2019.

Continuation of the work on the high-level and intermediate-level long-lived waste (HLW/ILW-LL)

The PNGMDR demands the continuation of the CIGÉO programme by ANDRA and the producers of high-level and intermediate-level long-lived waste (HLW/ILW-LL). When ANDRA makes the creation authorisation application for CIGÉO it will have to detail the required quantity and nature of packages to enable the pilot industrial phase planned before definitive commissioning to 1) consolidate the safety case, and 2) demonstrate that the facility is capable of gradually building up to handle industrial disposal rates. The PNGMDR also provides for ANDRA and radioactive waste producers to take this industrial pilot phase into account when preparing delivery schedules for packages intended for deep geological disposal.

A better estimation of storage requirements

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

1.4. Formal ban on the disposal of foreign radioactive waste in France

In order to take due account of her industrial activities regarding the processing of spent nuclear fuel or radioactive waste, France adopted the legislative principle to ban the disposal of all foreign radioactive waste on French soil.

The Environment Code reaffirmed that principle: hence, no radioactive waste either originating from abroad or resulting from the processing of spent fuel and of radioactive waste abroad shall be authorised in France.

In addition, the Waste Act specifies that the introduction of any spent fuel or radioactive waste on French soil for processing purposes shall be conditional upon the conclusion of intergovernmental agreements prescribing a maximum date for the return of the ultimate waste in the country of origin. Furthermore, every inter-governmental agreement shall specify provisional periods for the reception and processing of those substances, and, if need be, any subsequent prospect for using the radioactive materials separated during processing.

Operators who process spent fuel or radioactive waste originating from abroad must implement a waste-attribution mechanism approved by a ministerial order.

The law requires operators to prepare and publish every year a report describing the inventory and streams of foreign radioactive substances, together with a section on future prospects.

Lastly, that legislative mechanism must be completed by a regime of administrative controls and punitive sanctions.

1.5. Management policy based on research and development

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

For HL-IL/LL waste, three complementary research areas have been identified and described in the Waste Act as follows:

Separation and transmutation of the long-lived radioelements

On 21st December 2012, the CEA gave the Government a report presenting the results of research relating to 4th-generation nuclear systems and the proposed directions for research. Research has continued since then, notably with the conceptual studies and preliminary design study of the ASTRID sodium-cooled fast neutron reactor demonstrator and the exploration of processes and devices for the transmutation of americium, which has been identified as the most relevant target because of its contribution to radiotoxicity and to the long-term thermal load of the final waste.

The feasibility of separating the americium after recovering the uranium and plutonium has been demonstrated on actual samples (kg) of spent fuel. In principle there are no obstacles to extrapolating these processes to the industrial scale, but substantial development work would still be necessary.

The feasibility of transmutation of americium is less well advanced. Two concepts remain envisaged, but only one of them (transmutation in "homogeneous" mode) has been experimented at the scale of pellets under representative conditions[4]. It is confirmed that only fast-neutron reactors (FNR) can allow effective transmutation of americium, and the continuation of studies in this area will necessitate complementary experimental irradiations in an FNR; these could be carried out at the needle scale in the ASTRID reactor.

A progressive approach was presented in 2012 for the deployment of FNR in the French nuclear power fleet, aiming at initially deploying a limited number of FNRs in synergy with the fleet's pressurized water reactors (with large-scale deployment only being envisaged in a second phase). Studies of industrial scenarios are being conducted with EDF and AREVA to refine this approach. It emerges that several increasingly ambitious "steps" could mark the gradual deployment of FNRs in the fleet: a few units to begin with to stabilise the spent MOX fuel inventory, then more substantial deployment for multirecycling of plutonium, and beyond this, eliminate the need for natural uranium and implement the transmutation of americium. These latter stages are nevertheless a very distant prospect, and the transmutation of americium will not concern the waste already produced.

[4] The two concepts are as follows: the concept of recycling by dilution in the reactor fuel (so-called "homogeneous" mode, leading to equilibrium at an americium content of about 1% in the fuel), and the concept of recycling in the core periphery, within "americium-bearing UO2 blankets" (one row of such blankets containing 10% americium in equilibrium); this latter concept has the advantage of limiting the number of actinide-bearing objects and of not further affecting operation of the reactor core.

It is also important to underline that in its Opinion 2013-AV-0187 of 4th July 2013 on the transmutation of long-lived radioactive elements, ASN had considered that "*the gains hoped for from transmutation of minor actinides in terms of safety, radiation protection and waste management do not appear to be determining in view more specifically of the induced constraints on the fuel cycle installations, the reactors and transport operations, which would have to implement highly radioactive materials in all the stages. This would especially be the case with the transmutation of curium*". In its opinion of 25th February 2016, ASN adds that "*the continuation of studies on separation and transmutation cannot find any justification from the nuclear safety and radiation protection aspects*".

Reversible deep geological disposal of waste

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

Studies and research are under way with a view to preparing the file that will accompany the facility creation authorisation application. The conditions of reversibility are defined by the act of 25th July 2016. ANDRA's studies and research are based in particular on experimental results obtained in the underground laboratory in the Meuse/Haute-Marne departments. In operation since 2002, this laboratory allows *in situ* study of the geological environment (characteristics in the broad sense, by including the behaviour of the radionuclides), the behaviour of the materials interacting with the host rock, the effects (thermal, hydraulic, mechanical, chemical) of the disposal facility on the host rock and the development and testing of processes for excavating, observing, monitoring and closing the disposal facility. The underground laboratory's studies were deployed progressively to meet the various milestones of the disposal facility; after being directed primarily towards the characterisation of the geological environment and the constructability of the disposal facility in 2005 to satisfy the repository principle feasibility file, following the act of 2006 the laboratory focused its studies on the materials and technological aspects of the disposal facility in order to provide the elements necessary for the CIGÉO creation authorisation application.

The reversibility of disposal, required by the waste act of 2006, is a significant change with respect to the act of 30th December 1991. Act 2016-1015 of 25th July 2016 detailing the conditions of creation of a reversible deep geological disposal facility for high-level and intermediate-level long-lived radioactive waste thus provides a definition of the reversibility applicable to CIGÉO and indicates its implementation conditions.

When the creation authorisation application is examined, the safety of the deep geological disposal facility will be assessed in the light of the different stages in the incremental development of the facility, including its definitive closure. Only an act (law) will be able to authorise definitive closure of the facility.

The reversible waste disposal within a deep geological formation is developed in the report (see section D and chapter H.3).

Storage

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

Unlike disposal, storage is a temporary situation, offering an interim solution for keeping waste safely and securely pending the commissioning of the disposal centre. The studies and research explored the various aspects of the complementarity between storage and reversible disposal. Storage is necessary but can never be a final solution for the management of high level waste and intermediate level, long-lived waste.

In 2012, ANDRA submitted the results of its studies and research on storage, in accordance with the Waste Act. The report supplied by ANDRA details the various principles, criteria and technical options concerning storage and thus marks the completion of several years of studies. It was supplemented in 2014 by recommendations for the design of storage facilities as a complement to the disposal facilities. It was drawn up in collaboration with AREVA, the CEA and EDF. It addresses provisions that are favourable for the durability and monitoring of the facilities, and design aspects relating to disposal reversibility.

Investigations on deep geological disposal and on storage are conducted by ANDRA and developed in § F.2.2.1.1. So far, research on partitioning and transmutation are funded by a CEA subsidy.

1.5.2. Low-level long-lived waste

The *Waste Act* set the development of disposal solutions for LL/LL waste, and particularly for radium-bearing and graphite waste. In 2012, ANDRA submitted a report on possible management scenarios for LL/LL waste, according to their nature.

The nature of the long-term management for that waste category relies notably on waste characterisation and on studies concerning their behaviour under disposal situations.

The PNGMDR recommends also an R&D synthesis on processing possibilities for radium-bearing and graphite waste. Several international exchanges, for instance, have taken place in the framework of the European Programme, called

“*Carbowaste*”, and of the IAEA co-ordinated research project entitled “*Treatment of Irradiated Graphite to Meet Acceptance Criteria for Waste Disposal*”.

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

This preliminary reconnaissance work carried out from 2013 to 2015 provided an initial conceptual representation (a) of the geological environment, particularly the presence of a clay formation, the formation of "teguline" clays (types of clays often used to make tiles in the past) over the majority of the sector with a thickness of up to 80 m and (b) of the ground water flows particularly through the teguline clay formation to the subjacent aquifer of the Albian period.

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

Thus, with regard to the waste, (1) the characterisation work conducted by the CEA and EDF on graphite waste and bituminised sludge led to a significant reduction in the radiological inventory of chlorine-36 and iodine-129 respectively, and (2) the work of EDF has shown, on the scale of laboratory reconstructions, virtually total decontamination of the chlorine-36 in the graphites by heat treatment (this however was not the case for carbon-14). With regard to radionuclides, the retention of chlorine-36 and carbon-14 in the concretes has been consolidated and the retention of "inorganic" carbon-14 in the teguline clays was established.

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

The results as a whole were synthesised in the interim report submitted to the government in July 2015. This first reconnaissance phase pinpointed a zone of about 10 km^2 displaying the most favourable geological characteristics on which to focus continuation of the study of a near-surface disposal facility for LLW-LL waste.

This interim report formed the subject of exchanges in 2015 and 2016 between ANDRA on the one hand and ASN and IRSN on the other, which led to the fundamental questions being posed with regard to the demonstration of the feasibility of a near-surface disposal facility for LLW-LL waste. The continuation of the work is governed by the PNGMDR 2016-2018 (see § 1.3.2.2).

1.5.3. Other waste categories covered by research programmes

The PNGMDR, through its updates, keeps track of the waste for which a management route is not yet defined. The term "route" as used here means the method of management (treatment, packaging, etc.) of the waste so that it can be accepted by a disposal facility that is suitable for the characteristics (radiological, etc.) and hazardousness of the waste.

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

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

These types of waste, which have their own specific problems, nevertheless represent limited quantities, apart from waste contaminated by asbestos (several thousand cubic metres).

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

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

- characterisation of the sites to decommission and of the waste produced;
- sorting and treatment of the waste;
- new materials for disposal;

- innovation and society (Social Sciences and Humanities theme).

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

On this same decommissioning theme, which will bring the majority of the future waste streams, ANDRA is also mobilising its resources:

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

It assists the authorities in defining the policy guidelines to adopt for the management of decommissioning waste.

Lastly, ANDRA is involved in various case files and/or studies, especially the prospective characterisation studies for the disposal of waste from future nuclear power reactor fleets, including in particular the 4th-generation fast-neutron reactors.

1.6. Management policy based on transparency and democracy principles

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

- Locally and continuously, through the setting up of Local Information Committees (CLI) for the treatment and disposal facilities;
- With the general public: the PNGMDR, based on the national inventory of radioactive materials and waste published by ANDRA, is a cornerstone of transparency. It forms the subject of a strategic environmental assessment, an opinion from the Environmental Authority and a public consultation. The public consultation for the PNGMDR 2016-2018 was organised during October 2016. Furthermore, France can also have recourse to national public debates. A 4-month debate on the management of radioactive waste was thus organised prior to the waste act. Another debate concerning the CIGÉO project for reversible deep geological disposal of radioactive waste was organised over a 6-month period in 2013, in accordance with the Environment Code before filing the creation authorisation application for a deep geological disposal facility;
- At Parliamentary level: the regulatory framework for the authorisation of a deep geological disposal facility is governed by article L. 542-1-10 of the Environment Code amended by Act 2015-1015 of 25th July 2016. It is presented in detail in section H.3.1. The main regulatory change introduced by this act concerns putting in place an industrial pilot at the start of operation to consolidate the reversible nature and the safety case of the facility, in particular 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, an opinion from ASN and the opinions of the neighbouring regional authorities.

Lastly, according to the Environment Code, any officer responsible for nuclear activities and any company referred to in Article L. 333-10 of the Public Health Code must establish, update and make available to the administrative authority all required information for the performance of that control. The Waste Act includes penalties in case of non-compliance on the part of operators.

The decree No.2008-875 of 29 August 2008 specifies the scope and nature of the information required to prepare the National Inventory of Radioactive Materials and Waste.

1.7. Funding the Management Policy for Radioactive Materials and Waste

With due account of the challenges relating to radioactive-waste management, public authorities are concerned with securing sufficient funds not only for investigations and for management itself, but also for BNI decommissioning.

1.7.1. Securing funds for the managing radioactive waste and spent fuels and decommissioning nuclear facilities

The French funding system for decommissioning BNIs and managing the resulting radioactive waste rests on the full financial liability of industrial operators.

BNI operators must establish conservative estimates of the charges for decommissioning their facilities and for managing their spent fuel and radioactive waste; they must also set aside specific provisions in their accounts and constitute specific financial assets to cover the provisions, with the understanding that such assets be entered separately.

The market value of that portfolio of dedicated assets must be at least equal to the value of the provisions (except for the charges associated with the operating cycle, notably with regard to the charges for the management of recoverable spent fuels in an facility either existing or under construction. Even though spent fuel processing costs are not submitted to the constitution of covering assets, management costs for radioactive waste resulting from that processing are. That obligation for covering provisions already exists since the commissioning of the facility. However, a transit period has been initiated starting on the enforcement date of the Waste Act in order for operators to set up their constitution plan of covering assets.

Hence, it is possible to secure the funding of those long-term charges, while preventing that their burden rest on taxpayers or future generations.

In order to prevent and to limit the charges to be borne by future generations, those dedicated assets must have sufficient levels of security, diversification and liquidity. In order to achieve that goal, regulatory provisions must prescribe clear admissibility rules for those assets (notably concerning the asset category and the diversification level of the portfolio).

In addition, all assets allocated to those estimates must be protected by law, including in case of financial hardships on the part of the operator: in case of the operator's bankruptcy, only the State, in the course of its duties, has the right, with regard to those provisions to ensure that operators comply with their obligations relating to decommissioning and to radioactive-waste management.

The law also provides for a State control supported by regulatory and enforcement powers, including the seizure of funds (see § F.2.3.2). That control must be valid notably on the basis of the reports to be submitted every three years by operators in order to describe not only the costs for decommissioning activities and waste management, but also the modalities selected by operators to allocate the assets corresponding to the coverage of the associated financial charges.

1.7.2. Funding research and development and design studies on deep geological disposal

The R&D and the design studies for the deep geological disposal centre carried out by ANDRA are financed by taxes and contributions levied on the radioactive waste producers. The "research" tax and the "design" special contribution, are described in greater detail in § F.2.2.1.1. They are a means of securing ANDRA's funding sources.

The amount of this tax and this contribution are calculated as the product of a lump imposition by an adjustment factor. Hence, on the basis of current BNIs, ANDRA receives more than 200 M€ every year.

2 | FRENCH SPENT-FUEL-MANAGEMENT POLICY

2.1. General processing/recycling policy

With the 58 NPPs operated by EDF, France generates a yearly output in the order of 400 TWhe of nuclear power (384 TWhe in 2016), which, in turn, produce an average of approximately 1,150 t of spent fuel every year.

For that nuclear spent fuel and similarly to other countries, France has selected a processing/recycling strategy for spent fuel that was confirmed by the *Waste Act*, since the PNGMDR is required to comply with the following guideline: "Reducing the quantity and toxicity of radioactive waste must be sought, notably by processing spent fuel and by processing and conditioning radioactive waste".

The selected strategy for managing the spent fuel generated by research reactors must be developed in relation to the characteristics of the fuel and may involve either processing/recycling or direct disposal (see § G.7).

2.2. Justification of the processing/recycling option

France estimates that this processing/recycling strategy presents a certain number of energy and environmental advantages.

Recycling nuclear materials forms an integral part of the security of supply. Not only does recycling allow for re-using current energy resources in the form of the uranium and plutonium that is still present in spent fuel (close to 95%) and that would otherwise be discarded within an open cycle, but new reactors might also reduce the consumption of natural uranium by as much as 25%, if all the nuclear materials were recycled, due to an equal share of MOX fuel and to the re-enrichment of uranium from spent fuel processing. That strategy improves proportionally the security of supply and contributes to the diversification of supplies, which is especially significant for a country such as France, which benefits from little indigenous resources. Lastly, the strategy provides useful energy materials for an eventual wide use of future fast-neutron reactors.

Processing spent fuel proves interesting with regard to the long-term disposal of radioactive waste. As a matter of fact, not only is processed waste conditioned in a sustainable fashion, thus facilitating their handling, storage and disposal, but the reduction in volume and thermal load of the waste packages facilitates long-term disposal, since the footprint and the volume of management facilities decrease proportionally, thus lowering disposal costs and limiting the impact of uncertainties on disposal costs. In addition, since conditioning packages of processed waste by vitrification provide a high-quality containment, it represents an environmental benefit compared to the direct disposal of spent fuel, especially within a strategy aiming at recycling materials, and notably plutonium, in fast-neutron reactors where it induces a decrease in the long-term radiotoxicity of ultimate waste.

From a strictly more political standpoint, that strategy is consistent with the determination to limit the charges to be borne by future generations, by calling upon the best existing technologies, by making the best possible use of energy resources and by leaving all options open for the future, irrespective of the fact that fast-neutron reactors are involved or not.

Lastly, using plutonium in MOX fuel in order to consume about only a third of the plutonium needed, not only alters heavily the isotopic composition of the remaining plutonium, but it also ensures that such technology remains non-proliferating. Moreover, France is adapting the stream of processing/recycling operations to the consumption needs in MOX fuel in order to minimise the inventory of separated plutonium. By using processing/recycling technologies in a few facilities regulated by international safeguards and scattered around the world, it is possible to reduce proliferation risks worldwide: thanks to processing/recycling services, it is possible to prevent the accumulation of spent fuel in a large number of storage facilities around the world, in favour of final waste, since that category is not submitted to IAEA safeguards.

In the framework of that strategy, spent fuel is considered as an energy material intended for future reuse and not as waste. Hence, it leaves open the recycling option for recoverable materials as energy resources in future fuel types and reactor systems. That item is also addressed in the section below.

2.3. Policy implementation

In France, the processing/recycling strategy is enforced with the following implementations:

- one fuel-processing plant (La Hague facilities) and one MOX-fuel fabrication plan (MÉLOX facility at Marcoule),
- a nuclear fleet of 58 reactors, 22 of which are licensed to run with MOX fuel (up to one-third of assemblies), with a further four reactors being licensed to operate exclusively with assemblies made of processed and re-enriched uranium.

With due account of such a reactor fleet running on MOX fuel and of reactors authorised to load uranium from spent fuel processing, France is therefore saving approximately 17% of natural uranium in its fuel consumption.

In order to avoid inventories of useless separated plutonium, the fuel is processed as prospects develop for the extracted plutonium ("flux-adequacy principle").

All spent fuel pending processing is stored in the ponds of the La Hague Plant after having been stored in the individual NPP cooling ponds.

2.4. Prospects

2.4.1. Prospects for Generation-IV reactors

In the case of spent MOX fuel, which contains a high concentration of plutonium with a high energy potential, and of uranium oxide (UO_2), which is manufactured from uranium processed from spent fuel, the current strategy consists in storing them and if so, processing them at a timely moment with a view to using the resulting plutonium in fast-neutron reactors. Hence, the development of new reactor generations at term or not will prove determining in order to specify the storage period for those fuel types, as well as their future and their destination. In addition, experimental MOX processing campaigns (65 t of MOX processed up to date) have already taken place at La Hague and demonstrated the feasibility of that operation.

The development of such Generation-IV fast-neutron reactors would allow for a better optimisation in the use of energy resources. For an equal quantity of natural uranium, the recoverable energy could be up to 100 times higher than with current reactors. That is the reason why France is so deeply involved in research activities on those reactors of the future (ASTRID prototype), which represent a key technology for the sustainable use of nuclear systems.

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

2.4.2. Precautions for the future, (as a complement to that long-term strategy)

The *Environment Code* instituted a securing mechanism for long-term nuclear charges (see § B.1.6.1), from which are excluded all charges relating to the operating cycle. Inversely, any non-recyclable spent fuel present in existing facilities (spent MOX and spent processed and re-enriched uranium) must be allocated accounting provisions on the basis of a direct-disposal scenario and of a financial coverage by the dedicated funds referred to in § B.1.7.

Furthermore; any holder of recoverable materials must, for preservation purposes, carry out all relevant studies on potential management systems in case such materials were to be considered as waste in the future (see § B.1.2.2 and § B.4.1.2).

3 | SPENT-FUEL MANAGEMENT PRACTICES

3.1. Spent-fuel management by EDF for its nuclear power reactors

EDF is responsible for the future and the processing of its spent fuel and all associated waste, with no possible transfer of responsibility and without any time limit.

EDF's current strategy is to process spent fuel, while optimising the energy yield of nuclear fuel.

After cooling in the pools located in the fuel buildings of nuclear reactors, spent-fuel assemblies are transferred to the AREVA NC plant at La Hague.

After a few years, the spent fuel is dissolved in order to separate the reusable materials from HL waste, which is then vitrified. Plutonium is recycled into MOX fuel; uranium can be recycled into fuel after re-enrichment (URE fuel).

Recycling of uranium from spent fuel processing has been stopped in 2013 and its restart is under study.

With 24 900 MWe reactors authorised to load MOX fuel and the four reactors of Cruas NPP authorised to load URE fuel, the resulting saving in natural uranium is estimated at approximately 17%.

To check the coherence of the whole fuel cycle, EDF, in connection with fuel-cycle industrialists, provides periodically a prospect file on the analysis of the compatibility between the evolving characteristics of new and spent fuel and the developments in the cycle facilities, transport, storage, processing and recycling ("cycle-impact" file).

ASN completed its review of that file in 2010 (see G.1.3). In mid-2016, EDF provided an updated version of this file which is currently under review.

3.2. Spent-fuel management by the CEA for research reactors

The CEA's reference strategy is to send, as soon as possible, all non-reusable fuel for processing to facilities dealing with the back-end of the fuel cycle.

Most of the CEA's spent fuel is sent for processing to the La Hague plant (AREVA NC).

Pending their processing at the La Hague Plant, the CEA stores its spent fuel at two facilities on the Cadarache Site, in accordance with specific safety rules. Those facilities include a dry-storage bunker for spent-fuel elements cooled in pits by natural convection (*casemate d'entreposage à sec d'éléments combustibles usés avec refroidissement des puits par convection naturelle* – CASCAD) in order to store most of the spent fuel from the CEA's activities in the civilian nuclear sector, as well as an underwater storage facility (CARES pool).

Storage facilities still exist at Saclay and Marcoule: the fuel they contain are disposed of progressively. Those that are still laying in the BNI-22 PÉGASE ponds at Cadarache and in the BNI-72 will be disposed by the 2025 time frame.

All planned technological solutions until now include staggered processing at La Hague's plant possibly via a preliminary storage in Cadarache's CASCAD or CARES facilities.

3.3. Spent-fuel management by AREVA

AREVA provides French operators with all required resources for implementing their spent-fuel management policy.

That range of services is also made available to foreign electricity utilities with a similar policy. In such cases, spent fuel is shipped to La Hague where it is cooled in pool for an appropriate time. Recoverable products are recycled, either immediately or at a later date, depending on market conditions. The waste is packaged and returned to its owners, in accordance with Article L.542 of the *Environment Code*.

The separation of recoverable materials and the various residues, as well as their specific packaging, are performed at the La Hague plant, while the recycling of plutonium into MOX fuel is performed at the AREVA NC MÉLOX plant in Marcoule, where the authorised capacity stands at 195 HMt (heavy metal tonne).

The feasibility of processing/recycling of MOX, FNR and URE fuels was demonstrated in the La Hague plants through specific industrial campaigns covering about a hundred metric tons of fuels in the La Hague, UP2 400, UP2 800 and UP3 A units.

4 | APPLICABLE CRITERIA FOR THE DEFINITION AND CLASSIFICATION OF RADIOACTIVE WASTE

4.1. Definition of "radioactive waste"

The legal definitions of "radioactive substance", "radioactive waste" and "radioactive material" are provided in § B.1.2.1.

Two aspects are worth commenting on:

- When a substance starts to be considered as radioactive?
- Is this substance be considered as a recoverable substance or a waste?

4.1.1. Radioactive character of substances

4.1.1.1. EXCLUSION

Most materials are radioactive by nature. Their radioactivity is due mostly to potassium 40 and to the radionuclides of the uranium and thorium families. That radioactivity is generally low and does not require the corresponding radiological risk to be taken into account, entailing no particular precautions (except for radon in the home, but this does not fall within the scope of this report). If not used in a process which leads to this radioactivity being concentrated, these materials are then considered as non-radioactive and managed as this.

4.1.1.2. EXEMPTION

The French regulatory framework stipulates that it is not substances that are exempted but the processes that use the substances. As a consequence, nuclear activities are exempt from the authorisation or notification stipulated by the Public Health Code if they comply with one of the following two conditions (Article R.1333-18):

- the quantities of radionuclides present at any moment on the location where the practice is carried out do not exceed the exemption thresholds set by the Code, regardless of the activity concentration of the substances concerned, and
- the concentration, per unit mass, of the radionuclides present at any moment on the location where the practice is carried out does not exceed the exemption thresholds set by the Code, provided that the masses of the substances concerned do not exceed one metric ton.

The exemption thresholds appearing in the Code apply to the total stock of radionuclides held at any time by an individual or a company for a specific activity, with any division designed to artificially reduce the stock, or any dilution of a substance aimed at reducing the activity concentration, being prohibited.

The Code also defines rules in the case of mixing of radionuclides.

4.1.1.3. CLEARANCE

Some countries, pursuant to European directive 96/29/Euratom of 13 mai 1996 and the associated technical recommendations, accept unconditional clearance levels, below which a waste produced by a nuclear activity can be considered conventional waste based on measurements. The French regulatory framework defines a different approach: any substance which falls within the scope of the regulations applicable to the uses of radioactivity for BNIs or from the small-scale nuclear sector, requires specific management if it has been in contact with radioactive contamination or has been activated by radiation. This entails management of radioactive waste, including processing and/or disposal, in duly authorised facilities. This is why France has a specific solution for the long-term management of very low level (VLL) waste that is the CIRES dedicated disposal facility in the Aube *département*.

With regard to the potential for recycling, the materials from a nuclear activity can be recycled on condition a derogation of the Public Health Code is obtained (article R.1333-4).

Up to this day, the recycling or reuse of materials, even if very slightly radioactive, is performed only in the nuclear industry (nuclear facilities, waste containers, biological shielding in waste packages, etc.).

France's position is therefore to be more demanding than the recommendations made by international organisations with regard to radiation protection on which the policy of several other countries is based when management of VLL waste is involved.

4.1.2. Prospect analysis for the future use of nuclear materials (implying that they are not considered as waste)

Among radioactive substances, some are considered for a future use, thus justifying the clearance from the qualification as "radioactive waste". The PNGMDR takes into account those materials and their prospects for future use (see § B.1.2.2). The observations made by the PNGMDR are presented below followed by the ASN's opinion and the PNGMDR's recommendations.

Pursuant to the *Decree of 27 December 2013*, all owners of radioactive materials for which recovery processes have never been implemented have submitted to the government in late 2014 a status report on the studies dealing with the recovery processes they are contemplating.

4.1.2.1. SPENT FUEL

Pursuant to the French policy, most spent fuel is considered as recoverable materials. More particularly, in the case of UOX fuel, the recovery of civilian spent fuel is already applied from an industrial standpoint. In the case MOX fuel, the feasibility of the process has been demonstrated. Similarly, but except for limited quantities of certain types of spent fuel from research reactors, the feasibility of the process for the fuel being unloaded from research reactors or nuclear-driven ships is confirmed.

4.1.2.2. URANIUM AND PLUTONIUM

Depleted uranium offers a recovery potential, since it may be:

- enriched to the same extent as natural uranium;
- used in MOX fuel;
- used in future Generation-IV fast-neutron (if France decide to acquire such reactors).

The fact that the first two recovery systems are already available is sufficient to justify on its own that depleted uranium constitutes a recoverable material since its use is already scheduled or contemplated.

With regard to the share of uranium-238 contained in depleted uranium, whether it has been processed from spent fuel or not, it may be recovered over the very long term in Generation-IV fast-neutron reactors.

In cases where Generation-IV fast-neutron reactors may not be developed, those materials would become waste once their content of uranium-235 would stop to be recoverable. At that point, they ought to be managed as waste over the very long term. That long-term strategy falls in line with the framework prescribed by the *Environment Code*.

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

4.1.2.3. AIRBORNE MATERIALS

The SOLVAY Company holds some radioactive materials that include airborne materials, such as rare-earth oxides and traces of uranium. SOLVAY has conducted various technico-economic feasibility studies on the recovery of those airborne materials. It also identified several processing and recovery prospects for the rare earths contained in the airborne materials it holds. Hence, the recoverable character of those materials has been confirmed.

4.1.2.4. THORIUM

AREVA and SOLVAY are envisaging several possibilities for reusing thorium-bearing materials, which led to them being classified as radioactive materials. As far as thorium-bearing materials are concerned, no management system is fully operational at industrial scale so far for the recovery of the quantities held by AREVA and SOLVAY. There are also large uncertainties for the short- and medium-term purposes of a recovery system based upon thorium-fuelled reactors. The fine-tuning of the relevant processes and the design of the different types of thorium-fuelled reactors require further and more significant research and development efforts. In addition, the economic aspects of the potential uranium resources of that system still need to be demonstrated.

4.1.2.5. ASN'S OPINION

ASN submitted to the ministers concerned its Opinion No. 2016-AV-0256 of 9th February 2016 on the studies submitted by AREVA, CEA, EDF and SOLVAY at the end of 2014. In this opinion ASN states is position for each type of reusable material.

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

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

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

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

- "that it is vital to ring-fence funding for the long-term management of thoriferous substances;
- that, if the forthcoming clinical studies relative to the use of lead-212 for targeted alpha radiotherapy should be conclusive, AREVA should justify the quantity of thoriferous substances necessary for the production of the radiopharmaceutical, with the remainder in any event being requalified as radioactive waste;
- that all the thorium must be requalified as radioactive waste if these clinical studies are not conclusive."

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

4.1.2.6. PNGMDR RECOMMENDATIONS

The decree of 23rd February 2017 establishing the prescriptions of the PNGMDR 2016-2018 set out the following requirements:

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

4.2. Classification of radioactive waste

4.2.1. Criteria and categories

The usual French classification of radioactive waste is based on two parameters of importance for defining the appropriate management mode: the activity level of the radionuclides it contains and their radioactive half-life.

With regard to the radioactive half-life, a distinction is made between very short-lived waste, for which the half-life is less than 100 days, short-lived waste, for which the radioactivity stems mainly from radionuclides with a half-life of 31 years or less, and long-lived waste, which contains a significant quantity of radionuclides with a half-life of greater than 31 years.

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

- **high level waste (HLW)** mainly consists of vitrified packages of waste from spent fuels after processing. These waste packages contain the vast majority of the radioactivity contained in all the waste produced in France, whether fission products or minor actinides. The activity level of the vitrified waste is several billion Bq/g. Owing to their high level of radioactivity, this waste gives off heat;
- **intermediate level, long-lived waste (ILW-LL)** comes mainly from spent fuels after processing and from the maintenance and operation of the processing plants. This primarily consists of structural waste from nuclear fuels, that is the hulls (cladding sections) and end-pieces, packaged in cement-encapsulated or compacted waste packages, as well as technological waste (used tools, equipment, etc.), or even waste resulting from the treatment of effluents such as certain sludge. The activity of those residues ranges between 1 million and 1 billion Bq/g. There is either no or negligible heat release;
- **low-level long-lived waste (LL-LL)** mainly consists of graphite and radium-bearing waste. The graphite waste comes mainly from the former gas-cooled reactor (GCR) technology. The graphite waste (graphite sleeves of the fuels stored and the stacks still in place) mainly contains long-lived beta radionuclides such as carbon 14 and chlorine 36. Their activity level is from ten thousand to a hundred thousand Bq per gram. The radium-bearing waste, most of which comes from non-NPP activities (such as the processing of ores containing rare earths), mainly contains long-lived alpha emitter radionuclides, with an activity of between several tens of Bq par gram and several thousand Bq per gram. This waste category also comprises other types of waste such as certain legacy bitumen packages, residues from the uranium conversion processing carried out in the Comurhex plant in Malvesi, etc.;
- **low-level and intermediate-level short-lived waste (LIL-SL)** results mainly from the operation, maintenance and dismantling of NPPs, fuel-cycle facilities and research establishments, as well as, for a slight share, from activities relating to medical studies.;

- **very-low-level waste (VLL)** is mostly due to dismantling of NPPs, fuel-cycle facilities, research establishments and, to a lesser extent, from the operation and maintenance of this type of nuclear installations. The activity level of this waste is generally below one hundred Bq per gram. Its activity level is generally lower than 100 Bq/g, and
- **very-short-lived waste** comes mainly from the medical and non-NPP research sector.

For practical purposes, the following acronyms are often used:

Acronyms	Designation	French acronyms
HL	**High level**	**HA**
IL-LL	**Intermediate level – long-lived**	**MA-VL**
LL-LL	**Low-level long-lived**	**FA-VL**
LIL-SL	**Low-level and intermediate-level short-lived**	**FMA-VC**
VLL	**Very-low-level**	**TFA**

TABLE 3: ACRONYMS USED FOR THE DIFFERENT WASTE CATEGORIES

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

This categorization allows the association of each waste category, one or several corresponding long-term management solutions already implemented or still under study. The following table presents the long-term management solutions.

For the purpose of establishing the 2016-2018 PNGMDR, ASN delivered seven opinions to the government on different topics related to each waste category.

4.2.2. Absence of single and simple classification criterion

There is no single classification criterion for determining the category of a waste. The radioactivity of the various radionuclides present in the waste must be studied to enable it to be classified. However, in the absence of a single criterion, it is possible to give the specific activity range within which each waste category is generally situated. This is shown in the previous section.

A particular waste may appear to correspond to one of the categories defined above in terms of radioactivity but will not be accepted in the corresponding management route because of other characteristics (chemical composition, potential attractiveness). This is notably the case with waste containing significant quantities of tritium, a radionuclide that is hard to contain, or sealed sources, which can be attractive.

Numerous criteria are therefore required to determine the acceptability of a given waste in a given route. The licensees of disposal facilities determine acceptance specifications to define the acceptable waste packages. It is the conformity with these specifications which in the end defines the category of a given waste.

<table>
<tr><th></th><th></th><th>Very short-lived waste (i.e. containing radionuclides with a half-life < 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 a significant quantity of radionuclides with a half-life > 31 years</th></tr>
<tr><td>~ hundreds Bq/g</td><td>Very low level (VLL)</td><td rowspan="3">Management by radioactive decay</td><td colspan="2">Recycling or dedicated surface disposal (CIRES – the industrial grouping, storage and disposal centre in the Aube département)</td></tr>
<tr><td>~ Millions Bq/g</td><td>Low level (LL)</td><td rowspan="2">Surface disposal (Aube disposal centre, CSA)</td><td>Solutions being studied under Art. 4 of the Waste Act</td></tr>
<tr><td></td><td>Intermediate level (IL)</td><td rowspan="2">Solution planned under Art. 3 of the Waste Act

(Planned CIGÉO disposal centre)</td></tr>
<tr><td>~ Billions Bq/g</td><td>High level (HL)</td><td>Not applicable[5]</td><td></td></tr>
</table>

TABLE 4: RADIOACTIVE WASTE CLASSIFICATION PRINCIPLES

[5] The high level very short-lived waste category does not exist.

5 | RADIOACTIVE WASTE MANAGEMENT POLICY

5.1. General framework

The *Law No. 75-633 of 15 July 1975 Concerning Waste Elimination and Material Recovery* (Article L. 541 of the *Environment Code* and hereinafter referred to as the *"1995 Law"*) and completed by *Law No. 92-646 of 13 July 1992 Concerning Waste Elimination and ICPEs,* and its implementation decrees defines a regulatory framework applicable to the management of all types of waste.

The management policy for radioactive materials and waste is part of the more precise of the *Waste Act* (see A.2 and B.1).

5.2. Conventional waste, radioactive waste and VLL waste

5.2.1. Conventional and radioactive waste in BNIs

Management of the radioactive waste from basic nuclear installations (BNIs) is governed by strict regulations defined by the procedures decree, the BNI order and ASN resolution 2015-DC-0508 of 21st April 2015.
The waste management study is transmitted in the BNI commissioning authorisation application file. It must contain more specifically:

- a description of the operations leading to the production of the waste;
- the characteristics of the waste produced or to be produced;
- an estimation of the waste production streams;
- the waste zoning plan stipulated in article 6.3 of the order of 7th February 2012 which justifies the methodological principles relative to:
  - the delimiting of potential nuclear waste production zones (ZppDN), that is to say in which the waste produced is contaminated, activated or likely to be, and conventional waste zones (ZDC), enabling a reference waste zoning map to be drawn up,
  - the procedures implemented for the temporary or definitive waste zoning declassification or reclassification measures,
  - the traceability and conservation of the historical record of the zones or structures and soils which 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 (this includes 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).

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

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

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

With regard to the waste zoning plan, the absence of a clearance level implies that the waste coming from ZppDN's s must be managed in routes where its contamination, activation or potential contamination by radioactive substances is taken into account with respect to the interests mentioned in article L. 542-1 of the Environment Code.

5.2.2. Waste with enhanced naturally-occurring radioactivity

5.2.2.1. NATURE OF WASTE

Waste containing enhanced naturally-occurring radioactivity results from the transformation of raw materials containing naturally-occurring radionuclides that are not used for their radioactive properties, fissile or fertile. Their radioactivity is due to the presence of natural radionuclides, such as potassium-40, and radionuclides from both the uranium-238 and thorium-232 families. These radionuclides can be found concentrated in waste due to transformation processes.

There are two types of waste with enhanced naturally-occurring radioactivity, as follows:

- *VLL-LL waste*, such as historical stockpiles of phosphogypsum coming from the fertiliser production and coal-ash coming from coal power plants, and residuals coming from alumina production, foundry sand, refractory waste from zirconium-based refractories used notably in the glass industry, etc. , and

- *LL-LL waste,* such as certain waste resulting from the processing of monazite, the fabrication of zirconium sponges, existing and future residues from the dismantling of industrial facilities originating, for instance, from plants for manufacturing phosphoric acid, for processing titanium dioxide, processing zircon flour and former activities involving the processing of monazite.

5.2.2.2. THE ORDER OF 25 MAY 2005, THE CIRCULAR OF 25 JULY 2006 AND THE EUROPEAN DIRECTIVE 2013/59/EURATOM OF 5 DECEMBER 2013

The *order of 25 May 2005* concerning professional activities utilising raw materials naturally containing radionuclides but not used for their radioactive properties requires the licensee of an installation belonging to one of the activity sectors listed in this order:

- to carry out a study to measure exposure to naturally occurring ionising radiation and estimate the doses to which the population is liable to be exposed owing to said installation, and
- to evaluate the doses received by the workers.

The circular of 25 July 2006 concerning classified installations – Acceptance of technologically enhanced or concentrated naturally occurring radioactive materials in waste disposal centres, defines the procedures for acceptance of TENORM waste in “conventional” waste disposal facilities. It specifies that the waste concerned by this circular is that originating in one of the activities mentioned by the order of 25 May 2005.

European Council Directive 2013/59/Euratom of 5th December 2013 laying down basic safety standards for protection against the dangers resulting from exposure to ionising radiation extends the scope of the obligations specific to waste displaying technologically-enhanced natural radioactivity to waste from "natural radioactive substances", that is to say above the threshold of 1 Bq/g (for the uranium decay chains) is currently being transposed into French law. The currently applicable regulations concerning activities involving enhanced natural radioactivity shall therefore be modified and supplemented in 2017 through the transposition of this directive.

5.2.2.3. FORMER PRODUCTION AND CURRENT PRODUCTION

It is first of all worth recalling that it is hard to produce an exhaustive list of the industries liable to produce this type of waste. On the basis of the list drawn up by the order of 25 May 2005, the current production of TENORM waste is mainly due to the following activity sectors:

- ore processing and transformation industries;
- refractory ceramics production industries;
- zircon production and utilisation industries;
- industries producing or using compounds comprising thorium;
- water treatment installations;
- spas.

5.2.2.4. MANAGEMENT OF TENORM WASTE

There are several modes for managing TENORM waste:

- disposal in conventional disposal centres duly authorised for this purpose;
- disposal in facilities dedicated to radioactive waste (existing or planned facilities);
- depots on the production sites (legacy waste);
- reutilisation/recycling solutions.

The management of waste with high natural radioactivity is going to be profoundly changed by the transposition of the provisions of Council Directive 2013/59/Euratom of 5th December 2013 laying down basic safety standards for protection against the dangers resulting from exposure to ionising radiation, which is planned for 6th February 2018 at the latest.

TENORM waste disposed of in conventional disposal centres

In France, for nuclear activities subject to the BNI and secret BNI (BNIS) regime as well as for nuclear activities authorised or notified pursuant to Article L.1333-4 of the Public Health Code, mentioned in Article R.1333-12 of the same Code, any waste that is contaminated, activated, or liable to be so shall, as a precautionary measure, be the subject of specific, reinforced management which more specifically includes the disposal of ultimate waste in a centre dedicated to radioactive waste. The French regulations make no provision for the clearance of very low level waste.

For the other nuclear activities, the justification or otherwise of radiation protection monitoring is assessed in accordance with the provisions of the Public Health Code, taking account of the three fundamental principles of radiation protection: justification, optimisation and limitation of the radiation doses, and of the fact that the sum of the effective doses from nuclear activities received by any member of the public may not exceed 1 mSv per year. Therefore, when an acceptability study concerning the radiological impact associated with acceptance of the waste is able to demonstrate that radiation protecting monitoring is not justified, the waste may, in certain conditions, be accepted in conventional disposal facilities. This is notably the case for certain waste containing technologically enhanced naturally occurring radioactive materials.

There are currently 4 centres in France which hare licensed to accept this type of waste. The main two are Villeparisis in the Ile-de-France region and Bellegarde in Languedoc-Roussillon.

TENORM radioactive waste disposed of or to be disposed of in disposal facilities dedicated to radioactive waste (existing or planned facilities)

Very low level TENORM waste which cannot be accepted in conventional waste disposal facilities is disposed of in the industrial grouping, storage and disposal centre (CIRES) in Morvilliers. The 2012 edition of the National Inventory identifies 7,800 m^3 of waste in this category as at the end of 2010, excluding waste generated by spas, paper mills and the combustion of biomass.

Low level, long-lived TENORM waste is included in the industrial management schemes for low level, long-lived waste studied by ANDRA. The 2012 edition of the National Inventory identifies 17,000 m^3 of TENORM waste in this category (excluding waste generated by spas, paper mills and the combustion of biomass). Pending disposal, this waste is stored on certain production sites.

Depots of TENORM waste on the production sites (legacy waste)

The depots of legacy waste are mainly the result of the production of phosphoric acid used to manufacture fertiliser, alumina production and thermal power plants (disposal of coal ash). These sites no longer take any new waste and are under appropriate surveillance. They are identified in the National Inventory of Radioactive Materials and Waste produced by ANDRA (see § B.1.2.3 above). The volume of this legacy waste is estimated at 40 million metric tons.

5.2.2.5. THE RECOMMENDATIONS OF THE 2016-2018 PNGMDR

The regulatory framework concerning the management of waste containing radionuclides of natural origin will be reviewed within the context of the transposition of *Council directive 2013/59/Euratom* of 5 December 2013, which sets basic standards for health protection against the dangers resulting from exposure to ionising radiation, currently being transposed into French Law.

5.2.3. Disposal of radioactive waste in conventional disposal facilities

In the past, waste containing radioactive substances consisting mostly of sludge, earth, industrial residues, rubble and scrap metal generated by the historical activities of conventional industries, or even the nuclear civilian or military nuclear industry, had been disposed of in conventional technical burial facilities *(centre d'enfouissement_technique* – CET), most of which are now closed or have been rehabilitated.

In general, two types of facilities were involved in the disposal of such waste, as follows:

- disposal facilities for hazardous waste, previously known as "Class-1 burial facilities";
- disposal facilities for non-hazardous waste, previously known as "Class-2 disposal facilities".

The Order of 30 December 2002 concerning the disposal of hazardous waste and the Order of 15 February 2016 concerning the disposal of non-hazardous waste both prohibit the elimination of radioactive waste of artificial origin in such facilities. That ban dates back to the early 1990s. Radiological-detection procedures upon entering disposal facilities must be implemented in order to prevent any radioactive waste from being introduced on site, and if need be, to refer them to the competent approved system.

The national inventory published by ANDRA includes 11 disposal sites having received waste containing radioactive substances in the past.

Those include, for instance, the Vif dump (Isère département), where the fabrication-process residues from the AREVA NP (ex-Cézus) Plant, the phosphate-transformation waste that had been disposed of at the Menneville Dump (Pas-de-Clais département) or at the Pontailler-sur-Saône (Côte d'Or département) and Monteux (Vaucluse département) Dumps that accommodated the waste resulting from the sewage sludge from the Valduc CEA Centre and from the fabrication of zirconium oxides, respectively.

A dump in Solérieux (Drôme département) contains fluorspar originating from the COMURHEX Plant.

Those former disposal sites are submitted to the monitoring measures imposed upon classified facilities (mainly with regard to implementing measures against chemical-pollution, verifying the absence of settlements and implementing public-utility easements, if need be). For all sites listed in ANDRA's inventory, which have recorded the highest radioactivity level, more or less comprehensive monitoring completed in proportion to the site provide for a radiological monitoring of groundwater, as in the case of the Vif, Solérieux or Monteux Dumps.

5.3. Sealed sources unlikely to activate materials

The use of sealed sources not likely to activate materials does not generate any other radioactive waste than the source itself. Existing regulatory mechanisms are described in § F.4.1.2.3 and F.4.1.2.4, whereas prospects (disposal, lifetime extension, justification of the use of sealed sources) are mentioned in Section J. The management of disused sealed sources constitutes an integral part of the PNGMDR.

5.4. Unsealed sources and radioactive waste from ICPEs and mining residues

Radioactive waste from ICPEs or sites regulated under the Public Health Code must be disposed of in the same facilities as those defined for BNIs.

Facilities that receive conventional waste must not receive any radioactive waste whatsoever, although some waste with enhanced naturally-occurring radioactivity may be accepted under the conditions specified in § B.5.2.3.

After use, unsealed sources are considered as liquid radioactive waste and are normally entrusted upon ANDRA, which, in turn conveys them to CENTRACO's facility for processing. However, if the half-life is below 100 days, the waste may be managed through its natural decay.

Waste containing radionuclides with a half-life of less than 100 days, may however be managed by radioactive decay.

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

5.5. Stakeholders' responsibilities

Article L. 542-1 of the *Environment Code* prescribes that "any producer of spent fuel and of radioactive waste shall be liable for those substances, without any prejudice to the liability of their holders as persons responsible for nuclear activities". However, different stakeholders also intervene in waste handling: transport companies, processing suppliers, managers of storage or disposal facilities, as well as R&D organisations aiming at optimising that management.

The responsibility of the waste producer does not relieve the above-mentioned stakeholders of their own responsibility concerning the safety of their activities. The scope of the waste producer's responsibility encompasses his financial liability. The fact for a producer of radioactive waste to transfer his waste to a storage or disposal facility does not relieve him from his financial responsibility for it (see also § F.1.2.2).

In accordance with PNGMDR orientations, waste producers must continue to minimise the volume and activity of their waste, not only upstream when designing and operating their facilities, but also downstream by managing their waste. Compliance with that objective shall be controlled by ASN in the framework of the approval process of studies on BNI waste and by the cost associated with the take-over of that waste, thus encouraging necessarily the producers to minimise their quantity of waste. The topic of waste reduction is addressed in § B.6.1.1 and H.1.2.3 for LIL-SL waste and in § B.6.1.3.5 for HL/IL-LL waste (AREVA NC): those sections show the advances achieved in the field over the last two decades. The quality of waste conditioning shall also be guaranteed, with due account of long-term radiation-protection and safety goals

Research organisations contribute to the technical optimisation of radioactive-waste management in terms of both the production level and the development of treatment, conditioning and characterisation of the conditioned waste. A sound co-ordination of research programmes is necessary in order to improve the overall safety of that management.

5.6. Role of ANDRA

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

Its role has been defined by three acts:

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

Placed under the authority of the Ministries responsible for energy, the environment and research, ANDRA is independent of the radioactive waste producers. It is the State operator for the implementation of the public policy for radioactive waste management. Its mission comprises several activities:

- operate two above-ground disposal facilities in the Aube department, namely the CSA (Aube waste repository) dedicated to low-level and intermediate-level short-lived waste (LLW/ILW-SL), and the CIRES (Industrial centre for grouping, storage and disposal) dedicated to very low level (VLL) waste;

- manage the closure of the CSM (Manche waste repository), the first French above-ground disposal facility for low-level and intermediate-level radioactive waste;
- study and devise disposal solutions for the types of waste which do not yet have a disposal route, namely low-level long-lived waste (LLW-LL) and high-level and intermediate-level long-lived waste (HLW/ILW-LL): the CIGÉO project;
- look for and study solutions to optimise radioactive waste management in order to preserve the radioactive waste disposal facilities, which are a rare resource;
- ensure a public service mission for:
    - the collection of old radioactive objects held by individuals (old luminescent watches and clocks, objects containing radium for medical uses, certain minerals, etc.);
    - the clean-out of sites contaminated by radioactivity;
    - every three years, production of the national inventory of radioactive materials and waste present on the French territory (the last edition was published in 2015);
- informing and communicating with all audiences;
- preserving the memory of its disposal facilities;
- sharing and capitalising on its know-how internationally.

5.7. ASN policy

Through the codified TSN Act, ASN is tasked on behalf of the State with regulating the safety of basic nuclear installations (BNIs) and radiation protection for all civil nuclear facilities and activities, in order to protect workers, patients, the public and the environment from the risks linked to nuclear activities. Moreover, in accordance with this Act, ASN must contribute to informing the public.

ASN's aim is to ensure efficient, legitimate and credible nuclear oversight, recognised by the population and constituting an international benchmark. To do this, ASN's constant objective is to achieve and maintain high levels of competence, independence, rigorousness and transparency.

ASN's policy is to advance the management of radioactive materials and waste in a manner that is safe, coherent and structured. It considers that the drafting of the PNGMDR and its recommendations is essential for implementing this improvement policy and is therefore closely involved in it. One of the priorities is the existence of safe management solutions for each category of radioactive materials and waste, regardless of their activity, their lifetime, or their origin, preferring final management solutions. This presupposes identifying the foreseeable need for storage and disposal facilities and ensuring compliance with the requirements of the *Environment Code* and the hierarchy of management modes (reduction at source, recycling, reuse, incineration, and disposal).

For ASN, this policy must be accompanied by strict monitoring of all activities concerned by radioactive waste management. It in particular attaches importance to the safety of each step in the management of radioactive waste (production, processing, packaging, storage, transport and disposal).

The aim is to ensure that the BNI licensees and waste producers assume their responsibilities for the management of radioactive waste. To do this, ASN establishes rules and guides, checks the safety examinations and reviews by the BNI licensees involved in the management of radioactive waste, conducts inspections of the licensees – in the facilities or in the headquarters -, encourages and takes part in project progress meetings to identify any potential difficulties as early as possible review periodically the waste management strategies of the large nuclear operators. Checks are also carried out on the general organisation set up by ANDRA for the design and operation of disposal centres and for the acceptance of waste from the producers in the corresponding facilities. Whenever necessary, this oversight work leads to resolutions or opinions, which are made public.

As was indicated earlier in this section, the management of VLL waste is based on the use of zoning relative to waste production, leading to the absence of a clearance threshold. ASN will be vigilant in ensuring that the work to transpose Directive 2013/59/Euratom of 5th December 2013 setting basic radiation protection standards does not compromise the French policy in which there are no clearance levels for waste from basic nuclear installations while at the same time reinforcing oversight of waste containing enhanced natural radioactivity.

The policy of ASN is to inform the public impartially. This information is provided through the Annual report on the state of nuclear safety and radiation protection in France which it gives to Parliament each year, and various publications and information provided on its website.

ASN has also published a guide detailing the ways in which the licensees and industry players concerned, the public and the associations contribute to the preparation of draft statutory resolutions or ASN guides concerning the BNIs (Guide No. 25).

With this new guide ASN proposes 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,

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

6 | RADIOACTIVE-WASTE MANAGEMENT PRACTICES

6.1. BNI radioactive waste

6.1.1. Management by EDF of waste generated by its nuclear power reactors

Most of the waste resulting from the operation of pressurised-water reactors (PWR) consists of VLL, IL or LL-SL waste. It contains beta and gamma emitters and only a few or no alpha emitters. It may be divided into two categories:

- process waste resulting from the purification of circuits and the treatment of liquid or gaseous effluents, in order to reduce their activity level prior to discharge. It comprises ion-exchange resins, water filters, evaporator concentrates, sludge that can be pumped, pre-filters, absolute filters and iodine traps;
- technological waste arising from maintenance activities. It may be solid (rags, paper, cardboard, plastic sheets or bags, wood or metal pieces, rubble, gloves, protective clothing, etc.) or liquid (oils, solvents, decontamination effluents, including chemical cleaning solutions).

The following tables show the annual distribution of waste arising from the operation of EDF nuclear reactors in 2013. Data are expressed in the volume of conditioned packages that are intended for disposal at the CIRES or CSA facility, directly or after processing at CENTRACO. Those masses or volumes of packages represent the output in 2013; most packages had been shipped, but some of them are still on the sites at the end of the year.

VLL waste to be disposed of at the CIRES

2015 Results (58 PWR)	Disposal facility	Mass of disposed waste (t)	Activity (TBq)
Process waste	CIRES	**375**	0,0003
Technological waste	CIRES	**1 350**	0,0012
TOTAL		**1 725**	**0,0015**

TABLE 5: MASS AND ACTIVITY OF NUCLEAR OPERATIONAL WASTE PRODUCED BY EDF IN 2015 AND TO BE DISPOSED OF AT CIRES

Nota: the values presented above, given in metric tonnes of VLL waste packages are to be distinguished from those reported in B.6.4 in m^3 which correspond to the volumes of waste packages delivered to CIRES in 2015.

Disposal of LIL waste to be disposed of at the CSA

2015 Results (58 PWR)	Disposal facility	Gross volume before conditioning *(m^3)*	Volume of disposed packages at CSFMA *(m^3)*	Activity (TBq)
Process waste	CSA/CTO(*)	**1 150**	**4 020**	**279**
Technological waste	CSA/CTO(*)	**8 900**	**2 500**	**9**
TOTAL		**10 050**	**6 520**	**288**

TABLE 6: VOLUME AND ACTIVITY OF NUCLEAR OPERATIONAL WASTE PRODUCED BY EDF IN 2015 AND TO BE DISPOSED OF AT CSA

(*)CTO (CENTRACO): Processing and Conditioning Plant operated by SOCODEI (EDF subsidiary).

Nota: the difference between these values and those presented in § B.6.4 comes from time-lag between production and delivery. In 2013, volume produced are lower than volumes delivered.

Technological waste represents the main stream with 88% of the total volume of gross waste and is:

- after on-site compacting, either directly shipped, in 200-L metal drums to the CSA press for further compaction and final disposal after concrete encapsulation in 450-L metal drums. Certain non-compactable technological waste is conditioned in 5-m^3 or 10-m^3 metal boxes. Lastly, the most radioactive technological waste is conditioned on site in concrete containers and disposed of directly in the CSA, or
- if the LL waste involved can be cremated, shipped in metal or plastic drums to the CENTRACO Incineration Unit, whereas LL-contaminated scrap is sent to the melting unit of the same plant in 2-, 4- and 8-m^3 metal boxes. The waste resulting from CENTRACO processing includes:
    - ashes, clinkers (incineration residues), which are encapsulated in 450-L metal drums, then disposed of at the CSA, and
    - 200-L ingots (melting residues), which are disposed of at the CSA, or at the CIRES, if their activity level warrants it. Similarly, according to their mass activity, ventilation filters for the treatment of gases and smoke, stags and refractories, which are renewed periodically, are disposed of the CSA or at the CIRES.

CENTRACO's low-level-waste processing and conditioning plant, located in Codolet, near the Marcoule Site in the Gard département, and operated by SOCODEI, specialises in the treatment of low-level and VLL waste, either by melting metal scrap or incinerating combustible or liquid waste (oil, solvents, evaporation concentrates, chemical-solution effluents).

Thanks to that facility, part of low-level or VLL metal scrap is recycled in the form of biological shielding for packaging other more radioactive waste within concrete containers.

It should be noted that the reduction in the volume of technological waste finally disposed of in the CSA as a result of incineration or melting, was severely affected in 2012 and 2013 by the industrial accident concerning the CENTRACO melting furnace (September 2011). This led to an increase in the volumes of packages disposed of in the CSA on this period. In 2015 the volume of technological waste disposed in the CSA is back to usual level.

Process waste is packaged in concrete containers with a metal liner. Water filters, evaporator concentrates and liquid sludge are encapsulated in a hydraulic binder in fixed facilities, such as the nuclear auxiliary building or the plant's effluent-treatment station.

For the packaging of ion-exchange resins, EDF uses the MERCURE process (encapsulation in an epoxy matrix) with two identical mobile machines.

Packages produced by both machines are intended for the CSA. The steel biological shields inserted into the containers may be manufactured using the low-contaminated steel recycled in the CENTRACO facility.

NPP maintenance may require the replacement of large components, such as reactor-vessel heads, steam generators, racks (fuel-storage modules in pools), etc. Those special residues are either stored on site or in the BCOT (Base chaude opérationnelle du Tricastin) at Tricastin or disposed of at the CSA or the CIRES.

Over the last 25 years, significant advances have been made on LIL-SL waste quantities coming from the NPP operation. The volumes of that type of waste in relation to the net power output has decreased considerably, with the volume of relevant packages dropping from about 80 m^3/TWhe in 1985 to slightly less than 20 m^3/TWhe today.

The decisive factors leading to the drop during the 1985-95 decade are chiefly organisational (reduction of potential waste at source, feedback sharing, good practices) and technical (implementation of changes to the treatment process of liquid effluents, denser packaging of certain waste by grouping and/or pre-compacting) Those improvements proved effective for the waste generated directly by reactors or resulting from reactor maintenance.

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

Improvement actions are carried out particularly with regard to the following issues:

- "waste zoning" (see § B.5.2.1);
- waste production reduction at source (ion-exchange resins, water filters and technological waste), and
- waste sorting before routing to the best management system.

It is worthwhile noting that the results of those actions are enhanced and constitute sound elements to judge of the individual environmental performance of each EDF site in service.

6.1.2. CEA management of the waste generated by its nuclear research establishments

The CEA's strategy regarding radioactive waste management may be summed up as follows:

- recycling historical waste as soon as possible, through recovery and characterisation operations, as well as suitable processing and conditioning systems;
- minimising the volume of generated waste;
- producing only waste categories with a predefined management solution;
- sorting waste at the level of the primary producer, in accordance with predefined waste-management systems, especially in order to prevent waste upgrading or subsequent recovery operations;
- directing waste towards existing systems (ANDRA's final disposal facilities or, failing that, the CEA's long-term interim storage facilities), while ensuring a removal rate equal to the production rate, in order to avoid encumbering experimental facilities or waste-treatment and conditioning plants that are not designed for the long-term interim storage of significant waste volumes;
- once Andra has defined the specifications for acceptance of LLW-LL and ILW-LL packages, directly packaging the LLW-LL primary packages and, to a lesser extent, the ILW-LL primary packages in disposal packages, then sending all the LLW-LL and ILW-LL packages to the future disposal centres;
- implementing those actions under the best possible nuclear-safety, radiation-protection and technico-economic conditions.

6.1.2.1. TREATMENT WASTE FROM RADIOACTIVE LIQUID EFFLUENTS

Radioactive aqueous effluents produced by the CEA are treated at Cadarache, Saclay and Marcoule facilities. Treatment stations are designed primarily to decontaminate such effluents, and to discharge them into the environment pursuant to the discharge licence of each site. Their function is often also to package the residues from this treatment.

In Cadarache, the AGATE facility, commissioned in 2014 is dedicated to evaporation treatment of beta-gamma emitting effluents. The concentrates are transferred to Marcoule to be treated and conditionned in the liquid effluents treatment station (STEL) with the site's own alpha and beta-gamma emitter effluents. The treatment is based on treated by evaporation and/or precipitation-filtering; resulting sludge are embedded in bitumen matrices to form packages intended either for disposal at the CSA or for storage pending final disposal. Bitumisation will be replaced by cementation in the 2018 timeframe.

In Saclay, a facility called STELLA, is used to treat beta-gamma effluents by evaporation, whereas concentrates are embedded in a cement matrix for disposal purposes at the CSA.

6.1.2.2. SOLID RADIOACTIVE WASTE

Since the end of 2003, all VLL waste produced by the CEA has been sent to the CIRES. Since 2003, CEA has been evacuating approximatively 160,000 m^3 (as of 31 December 2015) of VLL waste, with annual volumes between 11,000 and 17,000 m^3.

Solid LIL-SL waste is either treated in the CEA facilities before expedition to CSA, or pre-conditioned and then transferred untreated to the CSA for definitive conditioning purposes, or incinerated at CENTRACO.

Solid waste that is compacted at the CEA is embedded or immobilised in a cement matrix.

The CEA has about 25 waste-acceptance certificates for those waste packages at CSA, thus allowing it to dispose currently of about 4,300 m^3/a.

In the case of non-acceptable types of radioactive waste in the existing waste disposal facilities, the CEA has storage facilities, whose capacity and design, notably with regard to safety, are consistent with its production forecasts and to the creation details of facilities for permanent disposal that ANDRA is due to implement.

The CEA's LL/LL waste is:

- graphite waste generated by R&D activities regarding gas-cooled reactors (GCR) and heavy-water reactors (HWR) and from operating reactors in the series. Most of the waste, consisting of graphite piles from the reactors, is temporarily stored in shut-down reactors themselves, and
- radium-bearing waste.

It will be accepted as soon as ANDRA commissions the dedicated disposal facility.

For low and medium radioactivity ILW-LL waste intended for geological disposal, the packaging and storage facility (CEDRA, BNI 164) replaced the existing dedicated disposal facility (BNI 56), which is of an outdated design and reaching saturation. This facility, commissioned in April 2006, will allow storage of this waste until opening of the CIGÉO disposal facility.

Furthermore, for highly radioactive waste, CEA intends to commission a storage facility called DIADEM on the Marcoule site in 2019.

On the Marcoule site, the storage facility known as the multi-purpose interim storage facility (EIP) can be used to store LLW-LL and ILW-LL bitumen packages resulting from treatment of site effluents in the STEL, in particular those from the operation and then post-operational clean-out.

The delays attributable to:

- the uncertainties about the date of commissioning of CIGÉO;
- the postponement of opening of the future disposal facility for LLW-LL waste;
- the postponement and extension in time of the removal schedules for certain types of waste;
- the prioritisations of the CEA in a constrained budgetary context;

will lead to the construction of new EIPs (multi-category intermediate waste storage facilities).

The retrieval scenario for the Marcoule bitumens is already based on the entry into industrial service of the extension EIP 3-4 in 2019, the construction of which is scheduled.

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

This primarily concerns:

- tritiated waste: it has been decided to study a storage facility for the decay of tritiated waste following treatment and packaging by the producers. This facility will be named Intermed. A storage duration of 50 years will reduce the tritium inventory by a factor of 16 due to its natural decay, which should facilitate the acceptance of this waste in a disposal facility that should take over from the CSA;
- sodium-bearing waste generated by R&D activities regarding fast-breeder reactors and the operation of experimental or prototype reactors in that series. The waste will be treated by 2017, by using facilities that already exist or that will be built within the perimeter of the PHÉNIX reactor, which is currently being dismantled. After processing and stabilisation, the waste will be disposed of at ANDRA's CSA or CIRES, and
- contaminated metal waste, such as lead and mercury, for which decontamination processes are available and have been used respectively at Marcoule and Saclay and (mercury distillation and lead fusion). Possible options include lead recycling in the nuclear sector and final disposal by ANDRA (after physical and chemical stabilisation in the case of mercury). Continuation of the recycling process is the subject of technical and economic analyses.

Achieving the technical-economic optimum in waste management is a major concern for CEA. Its policy is therefore to use packaging appropriate to storage on its sites and also directly acceptable by ANDRA. It is with this in mind that CEA plays an active role in the discussions being held around the various ANDRA projects. This also implies maintaining a coherent range of service, packaging and storage facilities and transport containers in good condition.

6.1.3. Management by AREVA of the waste generated by its fuel-cycle facilities

Most of the waste generated by the operation of AREVA's facilities are currently managed on the basis of direct logistic flows and are shipped directly to ANDRA's disposal facilities. AREVA tends to favour that management mode, which contributes in limiting notably the quantity of stored waste. In 2015, 87% of operating waste having operating disposal or recovery routes were handled.

All pending waste includes residues for which suitable systems are being developed or are not operational so far.

They include especially LL/LL waste that is produced by the AREVA NP Plant (ex CEZUS) on the Jarrie Site (Isère département) during the fabrication of zirconium sponges. Those residues are stored in a specific facility in order to ensure the safety and the absence of any impact not only on the operating staff, but also on the public and the environment.

With regard to managing HL or IL/LL waste, which is being examined within the framework of the law, AREVA's share represents a minor part of the national inventory (see § B.6.1.1).

Those residues consist mainly of historical waste from the previous generation of treatment plants that were in operation from the 1960s to the 1980s. It is stored at Marcoule and at La Hague. Almost all HL historical waste in the history of the French nuclear industry is packaged today in standard vitrified-waste containers (*conteneur standard de déchets vitrifiés* – CSD-V).

Among the legacy high level waste stored at La Hague, the molybdenum solutions of fission products resulting from the processing of "UMo" spent fuels (consisting of Uranium/Molybdenum alloy) used in the gas cooled reactors (GCR) required the development of a technologically innovative process known as the "cold crucible". "UMo" fission product solutions retrieval and "cold crucible" vitrification in the R7 facility began in January 2013.

On the other hand, the majority of intermediate level legacy waste is still to be retrieved and/or packaged (see § H.2.2.3). Large-scale programmes are devoted to legacy waste retrieval and packaging (RCD), owing to the major safety and radiation protection implications, and this is one of AREVA's major commitments. IL-LL dismantling waste must also be considered, since it will represent a few thousands of cubic metres after packaging.

All waste resulting from the spent fuel after treatment owned by foreign customers shall be returned to them as soon as technical conditions allow it in accordance with the *Environment Code*. Hence, most of the activity of the waste conditioned under the UP3 Service Agreement contracts – which is the main reason for the construction and initial operation of the modern La Hague Plant – has been shipped back to the customer's country of origin.

With regard to the sizing of planned disposal facilities, AREVA's relative share is estimated on the basis of current inventories and thanks to the forecasts submitted by its French customers. Those forecasts serve as the basis for their financing conditions.

Lastly, it is worth noting that AREVA's waste volume and relatively low share in the national yield vary only slightly. AREVA's HL waste consists mainly of historical waste, whose volume is definitely standing still. The volume of IL-LL waste packages from AREVA, the CEA and EDF is well known and the forecasts have proven to be reliable. Among the prospective factors that are taken into account to set volumes, the evolution in packaging methods for waste yet to be packaged, the operation pattern at La Hague, future commercial agreements and the volumes of decommissioning waste are among the factors used in drawing such forecasts.

6.1.3.1. FISSION PRODUCTS

HL solutions of fission products are concentrated by evaporation before being stored in stainless-steel tanks, equipped with permanent cooling and mixing systems, as well as a uniflow scavenging system for the hydrogen generated by radiolysis. After a period of deactivation, solutions are first calcined, then vitrified via a process developed by the CEA. The resulting molten glass into which the fission products are incorporated is then poured into stainless-steel containers. Once the glass has solidified, the the standard packages of vitrified waste (CSD-V) are transferred to an interim-storage facility where they are air-cooled.

6.1.3.2. STRUCTURAL WASTE

Since the end of 2001, the hull-compaction workshop (atelier de compactage des coques – ACC) at La Hague has been processing IL-LL structural (hulls and end-pieces from spent fuel) and has led to the fabrication of standard packages of compacted waste (CSD-C) that replace with a significant gain in volume compared to the cemented packages in the past. That process is also designed to condition certain categories of technological waste.

6.1.3.3. WASTE RESULTING FROM THE TREATMENT OF RADIOACTIVE EFFLUENTS

AREVA NC La Hague

Since most of the activity and volume of liquid effluents generated by AREVA NC originate from its plant at la Hague, the company is therefore seeking to enhance effluent management on that site.

Initially, the La Hague site had two radioactive effluent-treatment plants (STE2 and STE3). Effluents were treated by co-precipitation and resulting sludge were encapsulated in bitumen and poured into stainless-steel drums in the most recent of the facilities (STE3). Those drums are stored on site. The yield of both plants has been virtually zero over the last decade, because most of acid effluents are now evaporated in the various spent fuel-processing workshops, whereas concentrates are vitrified (§ F.4.2.3.2).

The investments necessary to retrieval and packaging operations regarding "historical" sludge, especially those from the seven STE2 silos are engaged. Conditioning modalities are currently under study.

The shipment of waste to AREVA's foreign customers under contracts predating the Waste Act takes place in the form of effluent packages vitrified using the cold crucible method.

At La Hague, AREVA also has a workshop for mineralising organic effluents by pyrolysis in the MDS/B Workshop, which produces suitable cemented packages for surface-storage purposes.

Lastly, the water in the fuel-unloading and storage pools is purified on a continuous basis by ion-exchange resins. Once out of use, those resins constitute process residues that are encapsulated in cement (CBF-C2 packages) in the Resin Packaging Workshop (*Atelier de conditionnement des résines* – ACR) before being transferred to CSA.

SOCATRI, AREVA NC Pierrelatte

Those sites also have management modalities and facilities designed to reduce the quantity of radioactive materials and chemical compounds they contain in order to reduce their impact on the environment. The facilities on the Tricastin Site have been mutualised and used by all operators (EURODIF-Pro - *European Gaseous Diffusion Uranium Enrichment*, SET - *Société d'enrichissement du Tricastin*, AREVA NC and SOCATRI) of the platform.

At SOCATRI, the New Treatment Station for Uranium-bearing Effluents (*Station de traitement des effluents uranifères nouvelle* – STEUN) was commissioned in 2008.

SOMANU

This site relies on the facilities of other operators (CEA at Saclay and AREVA NC at La Hague) for the treatment and management of their liquid effluents.

Wastes and effluents from the dismantling operations performed by AREVA on behalf of other nuclear operators (in particular CEA and EDF) are managed according to the management systems implemented by these operators.

6.1.3.4. SOLID TECHNOLOGICAL AND STRUCTURAL WASTE

AREVA NC La Hague

Solid technological waste is sorted out, compacted and encapsulated or immobilised in cement in the AD2 Workshop and then sent to CSA. If they do not meet ANDRA's technical specifications for surface disposal, packages are stored, pending a final disposal solution.

AREVA NP Romans, AREVA NC Tricastin (EURODIF Pro, SET, SOCATRI)

The waste produced by all industrialists is treated and conditioned at the STD and SOCATRI facilities. The objective of the TRIDENT Project is to implement a mutualised facility on the SOCATRI Site. The preparatory works necessary to implement this new workshop have started. Most of the waste includes VLL residues (80%), whereas the rest consists of low-level residues.

AREVA NC Malvési

Compactable waste is first conditioned in situ before being shipped to the CIRES or Tricastin facility and managed the same way as those resulting from the Pierrelatte platform. Packaging waste (drums) and packages used for the transfer of raw materials towards the site are processed internally, and the processes involved refer to volume reduction and incineration.

The overall waste being processed by the AREVA group's facilities are subject to specific checks and sorted at source and to an assessment of its radiological activity during management.

6.1.3.5. RECENT ACHIEVEMENTS AND VOLUME REDUCTIONS CONCERNING HL/IL-LL WASTE

With regard to waste-management in general, significant results were achieved in the following areas:

- progress in packaging the past waste streams: historical waste, shutdown of old facilities, etc.;
- optimisation of spent-fuel treatment prior to packaging (recycling, etc.), and
- progress in packaging (including volume reduction).

In the field of HL/IL-LL waste, those actions as a whole have particularly ensured that the waste resulting directly from the spent fuel treated at La Hague is currently packaged:

- in CSD-V containers for vitrified fission products and minor actinides, and
- in CSD-C containers for compacted metal structures.

Thanks to the experience acquired, bitumised waste was eliminated from the latest generation of plants, by recycling effluents and vitrifying residual streams. Compacting has also reduced the volume of structural waste by a factor of 4. Lastly, actions to improve waste management (workshop zoning, sorting at source, recycling, measurement performance, etc.) have contributed significantly to reducing the volumes of technological waste. The annual volume of HL/IL-LL waste, for instance, dropped by a factor of more than 6 in relation to the treatment plant's design parameters, down from an expected volume of about 3 m^3/t of fuel processed, to less than 0.5 m^3 at present.

6.2. Radioactive waste resulting from industrial, research or medical activities

This chapter concerns the nuclear activities defined by Article R. 1333-12 of the Public Health Code, that is nuclear activities authorized or declared under the Public Health Code (including those intended for medicine, human biology or biomedical research). It does not apply to:

- basic nuclear installations (BNIs) mentioned in article L.593-2 of the Environment Code;
- defence-related nuclear facilities and activities mentioned in article L.1333-15 of the Defence Code;
- nuclear activities listed in the nomenclature of the installations classified on environmental protection grounds, pursuant to Articles L. 511-1 to L. 517-2 of the Environment Code (ICPE);
- installations subject to authorisation pursuant to the Mining Code (Articles L.162-1).

These activities are regulated and authorised by ASN.

Medical, veterinary, research and industry sectors are the main activities using radionuclides which require this framework.

These fields of activity produce small quantities of radioactive waste in comparison to those produced by the nuclear power industry. However, the waste is much diversified and some, notably in the field of biological research, may have specific characteristics (putrescible waste, chemical risks, biological risks).

The medical sector includes all public or private establishments using radionuclides for analysis or treatment in the field of medicine. It mainly covers three fields:

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

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

Liquid waste is managed in two different ways, depending on the lifetime of the radionuclides it contains (decay processing or treatment at CENTRACO then disposal of incineration residues in the disposal facilities operated by ANDRA, see § B.6.2.2.2).

Apart from sealed radioactive sources, solid waste is managed by decay or disposed of as defined in § B.6.2.2.1.

In the field of medical and biological research, the most frequently used radionuclides are VSL, SL (tritium and Cobalt 57) or long-lived (carbon 14). They often appear in the form of unsealed sources (small volumes of liquid samples).

Some research laboratories are located within hospitals and the residues they produce are often managed directly by the hospital services themselves along with those resulting from therapeutic activities.

Physics laboratories come in different sizes and include various equipment, including particle accelerators. Waste categories may involve any given radioelement (including activation products). On the other hand, no waste poses both a radiological hazard and a significant biological or chemical hazard. The management of waste, radioactive materials and sealed sources is paid by the relevant laboratories. Most of the generated waste consists of LIL-SL and VLL residues.

In the field of academic research, there is no national overview on the status of radioactive-waste management. That sector encompasses strong specificities (labour turnover, different spread-out practices within establishments, limited means, etc.). The residues generated by universities are quite similar to those produced by biological and medical research. They may involve biological or chemical hazards.

Waste resulting from industrial activities outside the nuclear field come from:

- past or present use of radioactive sources (sealed or unsealed). There are no longer any manufacturers of sealed sources in France, with the exception of AREVA NP (ex CERCA), which manufactures sealed calibration sources. There are however many users. They are to be found in the nuclear and non-nuclear industries (measurements, inspections, molecule detection, and industrial irradiation). The management of sealed sources which are no longer used is covered in section J of this report;
- non-nuclear industries concerning chemistry, metallurgy or energy production, which handle mineral raw materials with natural radioactivity, even though they are not intending to use this radioactivity (this subject is covered in B.5.2.2).

6.2.1. Provisions applicable to nuclear activities defined by Article R.1333-12 of the Public Health Code

The regulatory part of the Public Health Code (Article R. 1333-12), states that for the activities concerned: "the effluents and waste contaminated by radionuclides or liable to be so contaminated owing to a nuclear activity, of whatsoever nature, must be collected, treated or disposed of, taking account of the characteristics and quantities of these radionuclides, the corresponding risk of exposure and the disposal routes chosen. An ASN resolution, approved by the Ministers responsible for health and the environment, sets the technical rules with which the disposal of effluents and waste shall comply".

To be specific, the order of 23rd July 2008 approving ASN Resolution 2008-DC-0095 of 29th January 2008 defines the requirements for the management of contaminated waste and effluents for these nuclear activities mentioned in article R. 1333-12 of the Public Health Code. In addition, ASN published a guide indicating the methods of application of the abovementioned resolutions (Guide No. 18 on the elimination of effluents and waste contaminated by radionuclides produced in facilities authorised under the Public Health Code).

All the methods of managing the contaminated solid and liquid waste of a medical establishment must be described in a contaminated waste and effluents management plan (cf. § B.6.2.3) drawn up by the person responsible for a notified or licensed activity covered by article R. 1333-12 of the Public Health Code if that activity generates radioactive waste or effluents.

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

6.2.2. Management of solid and liquid radioactive waste produced by nuclear activities defined by Article R.1333-12 of the Public Health Code (in particular biomedical research and nuclear medicine activities)

6.2.2.1. SOLID WASTE MANAGEMENT

Solid waste containing radionuclides with shorter half-lives than 100 days

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

They result from waste sorting according to its half-life radioactivity level, conditioned as early upstream as possible in specific garbage bins and placed in storage room pending their elimination after decay.

In order to verify the non-contamination of waste intended for the management systems for non-radioactive waste, detection devices such as warning beacons or portals are installed at the exit of all establishments equipped with a nuclear-medicine service.

Solid waste containing radionuclides with longer half-lives than 100 days

Waste containing radionuclides with a half-life of longer than 100 days must be disposed of in radioactive waste management routes. This waste is then collected and managed by ANDRA. The management routes are more specifically incineration in CENTRACO, with the residues produced by this operation being disposed of in ANDRA's disposal facilities. Certain solid waste can be disposed of in the CIRES if its characteristics are compatible with the acceptance specifications issued by ANDRA (VLL).

In the case of waste containing tritium, the order issued in application of the PNGMDR 2016-2018 requires ANDRA to continue drawing up the inventory of waste generated by small producers. Work will have to be carried out to find appropriate routes for the tritium-bearing liquid and gaseous waste from small producers before 2025. The tritium-bearing solid waste from small producers will be stored in storage facilities provided for the tritiated waste that will be produced by ITER – INTERMED - for which the creation authorisation application will be filed by the CEA (see § B.6.2.4). ANDRA will have to study the envisaged management strategy for this waste pending commissioning of this installation which was recently pushed back. In case of justified necessity and for limited quantities, the acceptance in SBNIs (Secret BNIs) of such waste from defaulting companies could be envisaged.

6.2.2.2. MANAGEMENT OF CONTAMINATED LIQUID

Liquid effluents containing radionuclides with shorter half-lives than 100 days

Liquid effluents containing radionuclides with a half-life of less than 100 days can be managed by decay and then, following survey, can be discharged into the sewage system in conditions identical to non-radioactive liquid effluents.

In order to ensure their radioactive decay, those effluents are directed either towards a storage tank, a container system or a mechanism that prevents any direct discharge in the drainage system. In practice, certain establishments equipped with a nuclear-medicine service encounter technical problems when installing such devices, with due account of the large volumes of effluents to handle.

Liquid effluents containing radionuclides with longer half-lives than 100 days

A licence for discharging effluents containing radionuclides with longer half-lives than 100 days in the drainage water system may be granted by ASN under certain conditions (see § F.4.1.4.3). In this case, discharge limits are set.

Liquid effluents containing radionuclides with a half-life of longer than 100 days are collected by ANDRA and mostly incinerated in the CENTRACO facility.

With regard to liquid tritiated effluents produced in this sector, the above-mentioned *decree of 27 December 2013* requires that ANDRA continue with the preliminary studies into their treatment. The corresponding volume is about 0.2 m^3.

6.2.3. Management plan for contaminated waste and effluents

The contents of the contaminated waste and effluents management plan (see § B6.2.2) is defined in article 11 of ASN's resolution 2008-DC-0095. It shall in particular present the procedures for sorting, packaging, storage, monitoring and disposal of the solid and liquid waste produced by the establishment.

That plan is established either at the level of the nuclear-medicine service or of the establishment when several units producing contaminated waste or effluents and using common resources are involved.

This management plan is enclosed with any authorisation application specified in Article L. 1333-4 of the Public Health Code. It must be updated regularly to integrate any changes within the establishment (waste zoning, etc.).

It is also recommended for the management plan to describe:

- the measures to heighten personnel awareness regarding waste and radioactive effluent management;

- the action to take in the event of contamination and/or triggering of the fixed station detection system, where applicable;
- the conditions for transporting the waste between the place of production and the various storage sites;
- information on the verification of correct functioning of the liquid detector installed in the retention system (frequency to be defined and justified).

6.2.4. ITER activities

ITER (BNI 174) is an experimental facility situated at Cadarache which is designed to scientifically and technically demonstrate control of thermonuclear fusion obtained by magnetic confinement of a deuterium-tritium plasma during long-duration experiments with significant power (500 MW for 400 s). This project enjoys financial support from China, South Korea, India, Japan, Russia, the European Union and the United States. ITER Organisation was restructured in 2016 with the appointment of a new Director-General in 2015 and the setting up of project teams.

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

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

Radioactive waste

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

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

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

The INTERMED tritiated waste storage facility

The safety options file for INTERMED was submitted to ASN in 2014. Its commissioning is envisaged for 2017. The lateness in the ITER project schedule has repercussions on the INTERMED project schedule and the strategy for the management of tritiated waste from small producers. In its opinion of 24th November 2016, ASN asked CEA to take into account the shift in the projected date of INTERMED commissioning in the studies to compare tritiated waste management solutions carried out for the PNGMDR and to define, before 31st December 2017, a revised strategy for the storage of tritiated waste from installations other than ITER The CEA announced the planned postponement of the commissioning date, planned for 2026 or 2027.

6.3. Mine-tailing management

The management of former uranium mines is the subject of continuous attention from French public authorities since those mines were closed. Once the sites were secured, their management continued by restoration, rehabilitation and monitoring measures. The rehabilitation of the residue disposal sites consisted in putting in place a solid cover over the residues to act as a geo-mechanical and radiological protective barrier designed to minimise the risks of intrusion, erosion, dispersion of the products emplaced and the risks linked to external and internal (radon) exposure of the surrounding populations. Public access to these sites is nonetheless prohibited.

In order to reinforce of AREVA, responsible for managing those sites and of public authorities, the Minister in charge of Environment and Energy, together with ASN Chairman, have decided, in accordance with the 22 July 2009, 8 August 2013 and 4 April 2014 Circulars to implement an action plan resting on the following principles:

- control of the actions taken by AREVA NC on former mining sites to be conducted by the Regional Directorates for the Environment, Land Planning and Housing (*Direction régionale de l'environnement, de l'aménagement et du logement* – DREAL), in co-operation with ASN; reinforcement of preventive measures against intrusions on such sites and corresponding improvement proposals;
- knowledge improvement on environmental and health impacts of former uranium mines, and on their monitoring, and better environmental description of those sites;
- management of mine tailings through better knowledge on their uses and, if necessary, by reducing their environmental and health impact;

- develop investigations on the impact of the utilization of materials subject to radon emission in housing construction;
- improvement of information and consultation practices (notably at the local level).

All these actions are currently ongoing. AREVA has sent the authorities all the expected environmental reports. The studies submitted by AREVA in compliance with the 2010-2012 PNGMDR enabled progress to be made on the questions of evaluating the long-term health and environmental impacts of the disposal of mining treatment residues (physical-chemical characterisation of the residues, geo-mechanical strength of the embankments and long-term radiological impact of the disposal sites) as well as of the former uranium mining sites (management of diffuse discharges and water treatment, long-term impact of mining waste rock).

Local information and consultation was reinforced, in particular by transforming the CLIS into site monitoring commissions set up to create a forum for exchanges and information about the action taken by the licensees and to promote information of the public.

An additional specific programme on the Memory and Impact of Uranium Mines – Synthesis and Archives (*Mémoire et impact de mines d'uranium: Synthèse et archives* – MIMAUSA), carried out by the IRSN in connection with the General Directorate for Risk Control (*Direction générale de la prevention des risques* – DGPR) and ASN, was launched in 2003 in order to collect historical data on all uranium-mining sites in France and on the environmental-monitoring devices that have been installed. It constitutes a working tool for the State services in charge of determining rehabilitation and monitoring programmes and a tool for the information of the public. Since the end of 2008, the database is accessible on the following website: http://mimausabdd.irsn.fr. MIMAUSA thus allows access to the environmental reports submitted by AREVA, as well as to the second-level checks performed by IRSN on these reports.

Furthermore, a pluralistic expert group (*groupe d'expertise pluraliste* – GEP) on uranium mines in the Limousin area (around Limoges in central western France) was implemented in November 2005 at the initiative of the Ministers in charge of the environment, industry and health. The missions entrusted upon the GEP were not only to assess the current impacts of the operation of ancient uranium mines on a few sites, but also to cast a critical judgement on the monitoring of former mining sites in the Limousin area in order to enlighten the Administration and the operators about management prospects over the more or less long term.

On 15 September 2010, the Limousin GEP submitted to both the Minister of Ecology and Sustainable Development and ASN's Chairman its final report and recommendations for the management of old uranium-mining sites in France. ASN and the Ministry responsible for the environment are engaged in an action plan dedicated to implementing these recommendations and entrusted the GEP Chairman with the duties of presenting its conclusions and recommendations to the local and national consultation bodies and of evaluating the effective implementation of its recommendations.

In November 2013, the GEP sent ASN and the DGPR of the Ministry responsible for the environment its report presenting the conclusions of this latter mission. The GEP reached positive conclusions concerning its involvement and noted that its recommendations remain fully pertinent. In order to retain the pluralistic approach the GEP brings to the question of the former uranium mining sites, ASN and the DGPR proposed creating a network of site monitoring commission experts, to whom the task of appraising issues of local and national scope so warranted by the social component would be entrusted.

In addition, the action undertaken by public authorities since the 1990s concerning the long-term of disposal facilities for uranium-mine tailings is reflected in the provisions of the PNGMDR. The studies provided by AREVA NC at the end of 2012 in that framework constitute a significant improvement for the guaranteed safety of those disposal facilities. In October 2012, ASN issued an opinion on those studies and formulated recommendations in several fields (long-term evolution and modelling of the physico-chemical characteristics of tailings resulting from ore processing, dyke behaviour, needs dealing with cover reinforcement of tailing-disposal facilities, impact assessment of mine dumps, including the radon, water treatment, impact of discharges, etc.). The actions to be performed were largely repeated in the 2013-15 PNGMDR, and in the *decree of 27 December 2013*.

6.4. Waste management by ANDRA

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

- The CSM, which is a disposal facility "undergoing closure" in the terminology of the regulations, insofar as ANDRA is still scheduling improvement work on the CSM cover (see § D.3.2.2.1);
- the CSA, which is a disposal facility in operation and also comprises waste packaging facilities (drum compacting, injection of metal containment structures) and disposal facilities (see § D.3.2.2.2).
- These two facilities come under the system governing basic nuclear installations.
- ANDRA also operates the CIRES (Industrial centre for collection, storage and disposal) which comprises:
- treatment and packaging facilities for very low level (VLL) waste;
- a disposal facility for VLL waste which is described in § D.3.2.2.3;

- a grouping building for transit before transfer to the treatment facilities for the waste collected by ANDRA, particularly waste from the medical sector and institutional research ("small producers" waste);
- a treatment building for the waste from the "small producers" in which operations such as the grinding of the tritiated scintillation bottles, separation of the solid part from the liquid part, or preparation by assembly of liquid containers can be carried out. This building was commissioned in 2016 and now enables ANDRA itself to treat waste whose packaging it previously subcontracted;
- 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 the CEA), universities, hospitals, etc. A removal guide lays down the conditions of collection of the waste for which ANDRA has treatment processes allowing its elimination or disposal. With regard to waste for which disposal routes are not yet available, the producers address their collection requests to ANDRA who examines them on a case-by-case basis.

This activity concerns 850 ANDRA customers of whom 200 each year make collection requests in application of the removal guide. On this account 2,373 packages were collected in 2016, corresponding to a volume of 220 m^3.

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

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

As at the end of 2016, waste of this type represented a volume of 756 m^3 out of a total storage capacity of 4,500 m^3.

SECTION C | SCOPE OF APPLICATION (ART. 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 processing facilities as part of a processing activity is not covered in the scope of this Convention unless the Contracting Party declares processing to be part of spent fuel management.*

ii) *This Convention shall also apply to the safety of radioactive waste management when the radioactive 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 the 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 in Articles 4. 7. 11. 14. 24 and 26.*

1 | STATUS OF SPENT-FUEL PROCESSING IN SPENT-FUEL MANAGEMENT

At the Diplomatic Conference held on 1-5 September 1997 at IAEA Headquarters to adopt the Joint Convention, France, Japan and the United Kingdom made the following declaration (Final Proceedings § 12 – Analytical Report of the Fourth Plenary Session § 93-95 – GC(41)/INF 12/Ann. 2):

"The United Kingdom, Japan and France regret that no consensus could be reached on the inclusion of processing in the scope of the Convention.

They declare that they shall report, within the context of the Convention, on processing as part of spent fuel management.

The United Kingdom, Japan and France invite all other countries that undertake processing to do the same."

In accordance with her commitments and through this document, France reports on the measures taken to ensure the safety of spent-fuel processing facilities, which she considers as spent-fuel management facilities for the purposes of the Joint Convention, that is, corresponding to the definition of spent-fuel management facilities appearing in Article 2 of the Joint Convention.

2 | RADIOACTIVE WASTE

This report deals with all radioactive waste resulting from civilian uses, and notably the residues generated by the nuclear fuel cycle and by various activities especially in medicine, industry and research.

3 | OTHER SPENT FUEL AND RADIOACTIVE WASTE TREATED WITHIN CIVILIAN PROGRAMMES

Spent fuel and radioactive waste produced by military or defence programmes, when transferred to civilian programmes, are included in the inventories and treated in the facilities presented in this report.

All disposal facilities are civilian in nature. Hence, ANDRA is free to take all appropriate measures to determine the quality of the waste packages intended for its facilities, even if the waste originates from military or facilities concerning Defence. ASN also double-checks their quality after ANDRA in order to verify notably that the implemented procedures at waste producers' premises and in disposal facilities actually guarantee the quality of the received packages and, hence, the safety of the disposal facilities. Inspections are conducted by ASN and, if need be, in conjunction with the French Authority for Defence Nuclear Safety (Delegate for the Nuclear Safety of National Defence Activities and Facilities – (*Autorité de Sûreté Nucléaire Défense* – ASND).

Any transfer of radioactive materials or waste between civilian and military facilities must be duly approved by both authorities in order to ensure transparency and to verify their acceptability in the receiving facility.

4 | EFFLUENT DISCHARGES

Effluent discharges are addressed in Chapter F.4.

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

This report shall also include:

i) a list of spent fuel management facilities subject to this Convention, their location, main purpose and essential features;

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 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;

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.

v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

1 | SPENT-FUEL MANAGEMENT FACILITIES

1.1. Spent-fuel generating facilities

In France, most spent fuel is produced by 58 PWRs ranging from 900 to 1,450 MWe. Commissioned between 1977 and 1999, they are distributed over 19 EDF sites. The fuel they use is either based on uranium oxide that is slightly enriched with uranium 235 (uranium which can originate from spent fuel processing), or a mixture of depleted natural uranium oxide and separated plutonium originating from spent-fuel processing (MOX).

The other spent-fuel categories originate from nine active or stopped research reactors of different types, with a thermal power ranging from 100 kW and 350 MW, and commissioned between 1964 and 1978. Eight of them are located in CEA facilities at Cadarache, Marcoule and Saclay, and the last, at the Laue-Langevin Institute (*Institut Laue-Langevin* – ILL), located near the CEA facility in Grenoble.

The inventory of each facility is shown in annex L.1.1.

1.2. Spent-fuel storage or processing facilities

Some BNIs are involved in spent-fuel management. They include experimental laboratories, storage facilities and treatment plants, all dealing with spent fuel, and are managed by EDF, the CEA or AREVA. The inventory of those facilities is shown in L.1.2.

1.2.1. AREVA facilities

1.2.1.1. BACKGROUND

The AREVA spent-fuel management facilities currently in service are located at La Hague, in a complex located on the northwest tip of the Cotentin Peninsula, at 20 km west of Cherbourg.

Pursuant to the three *Decrees of 12 May 1981,* AREVA NC was licensed to build the UP3-A and the UP2-800 treatment facilities with the same capacity to treat spent fuel from light-water reactors (LWR) and an STE3 facility designed to treat effluents from both units before discharge into the sea.

The different buildings of the UP3-A, UP2-800 and STE3 facilities were commissioned between 1986 (spent-fuel reception and storage) and 1992 (R7 Vitrification Workshop), with most treatment buildings coming on line in 1989-90. The last facilities to be commissioned include the ACC (hull-and-end-piece compacting) and the R4 Workshops (end of the plutonium line in unit UP2-800) buildings in 2001.

The backbone of those units includes facilities for the receipt and interim storage of spent fuel, shearing and dissolution, chemical separation of fission products, final purification of uranium and plutonium, as well as treatment of effluents.

Decree No. 2003-31 *of 10 January 2003 Authorising COGEMA to Modify the Perimeters of La Hague BNIs* increased the treatment capacity of both facilities to 1,000 t/a of initial heavy metal, although the total capacity of the complex remains limited administratively to 1,700 t.

The recycling of materials resulting from spent fuel processing with the current generation of nuclear reactors represents raw material savings of up to 25% in natural uranium and preserves this material for far more efficient use in the generation IV reactors.

The total quantity of plutonium recovered during processing operations is today recycled in the form of MOX fuels in light water reactors belonging to AREVA's customers.

Historically, the Belgian, Dutch, Swiss and French (EDF) customers of AREVA recycled the uranium resulting from the processing of spent fuels; up to two-thirds for EDF and all of it for Belgium, the Netherlands and Switzerland.

1.2.1.2. SPENT-FUEL STORAGE FACILITIES

Spent fuel awaiting treatment is stored in two stages: first in pools adjacent to the reactor building in NPPs and later in pools at AREVA La Hague, until they are treated.

The capacity authorised for the La Hague plant corresponds to a total of 17,600 metric tons, broken down as follows:

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

TABLE 7: AUTHORISED STORAGE CAPACITIES OF AREVA NC LA HAGUE'S POOLS

1.2.2. Other storage facilities

The SUPERPHÉNIX fast-breeder reactor, the sodium-cooled industrial prototype reactor with a 3,000 MW thermal-power output, was shut down permanently in 1997. For fuel-disposal purposes, a dedicated workshop (*Atelier pour l'évacuation du combustible* – APEC) consisting mainly of a storage pool, located on the EDF Creys-Malville Site, was commissioned on 25 July 2000. Irradiated fuel assemblies were removed from the reactor between 1999 and 2002, and washed, before being stored in APEC.

Pending a permanent solution (processing and disposal), all non-reusable fuel from the CEA's civilian programmes is stored either in dry-storage pits at the CASCAD Facility or under water (pool storage) at the PÉGASE Facility in Cadarache. The destocking of that facility started in 2006 by sending OSIRIS-type fuel towards the CARES storage facility (BNIS) and is continuing. Spent fuel from the CEA is also stored at Saclay's BNI-72 pending disposal.

2 | INVENTORY OF SPENT FUEL HELD IN STORAGE FACILITIES

Most spent fuel stored in France originates primarily from PWRs and boiling-water reactors (BWR), thus containing either uranium oxide or MOX, and secondarily, from research reactors. It is stored at the various facilities mentioned in the preceding paragraphs.

Locations	Mass of French spent fuel in storage (t)
La Hague	**9 681**
EDF NPPs	**4 221**
CEA centres	**88**

TABLE 8: MASS OF FRENCH SPENT FUEL STORED IN FRANCE AT THE END OF 2015

Origin	Belgium	France	Italy	Switzerland
Mass (t)	0.157	9 681	31.3	0.148

TABLE 9: ORIGIN OF THE SPENT FUEL STORED ON THE LA HAGUE SITE AND CORRESPONDING QUANTITIES AT THE END OF 2015

3 | INSTALLATIONS PRODUCING RADIOACTIVE WASTE AND RADIOACTIVE-WASTE MANAGEMENT FACILITIES

3.1. Installations producing radioactive waste

3.1.1. Basic Nuclear Installations (BNI) in operation

The BNIs in operation produce radioactive waste. Installations producing or managing spent fuel are listed in annex L.1. Installations producing or for the management of radioactive waste except BNIs undergoing decommissioning are listed in annex L.2.

3.1.2. BNIs undergoing decommissioning

Radioactive waste is also produced in BNIs being dismantled (shut-down reactors, laboratories and plants), the list of which appears in Chapter L.3 (it should be noted that the list in Appendix 3 includes delicensed facilities no longer producing radioactive waste).

3.1.3. Classified facilities on environmental-protection grounds (ICPE)

France has licensed about 800 ICPEs due to the radioactive substances they hold and use. Most of these facilities hold sealed sources and do not therefore generate radioactive waste. They are scattered throughout the country and consist notably of analytical and research laboratories, industrial facilities (manufacturers of sealed radioactive sources, plants using naturally radioactive ores, irradiators).

3.1.4. Polluted sites

Certain sites have been polluted by radioactivity, such as those that hosted radium-related activities (extraction) in the past or using radium-bearing or tritium-bearing materials (paints). For end-of-life ICPEs, Articles R.512-39-1 and following of the *Environment Code* set site rehabilitation obligations.

Rehabilitating such sites may generate radioactive waste resulting from decontamination and excavation.

Waste from rehabilitation work has a low specific activity. Some radionuclides are long-lived and radium-bearing waste involves a danger due to radon emanations. Since management systems for the latter are not available so far, the waste must be stored pending the availability of a disposal facility for LL-LL waste likely to accommodate them.

ANDRA keeps an up-to-date inventory of all those sites in its *National Inventory of Radioactive Waste and Recoverable Materials,* the latest edition of which was published in 2012 (available on ANDRA's website: www.andra.fr). It was developed on the basis of various information sources, including the Database of French Former Industrial Sites and Service Activities likely to have initiated a pollution (*Base de données des anciens sites industriels et activités de service* – BASIAS) (basias.brgm.fr) and the Database of French Sites Polluted or Potentially Polluted by Chemicals and Requiring an Action by Public Authorities (*Base de données des sites pollués (ou potentiellement pollués) par des produits chimiques et appelant une action des pouvoirs publics* – BASOL): http://www.basol.environnement.gouv.fr.

3.2. Radioactive waste management facilities

In addition to the facilities which produce and carry out the first steps in the management of radioactive waste, the treatment and/or storage facilities and the disposal facilities given in Appendix L.2.2 are shown on the following map. Most of these facilities are BNIs. However the very low level (VLL) waste disposal facility, CIRES, is an ICPE.

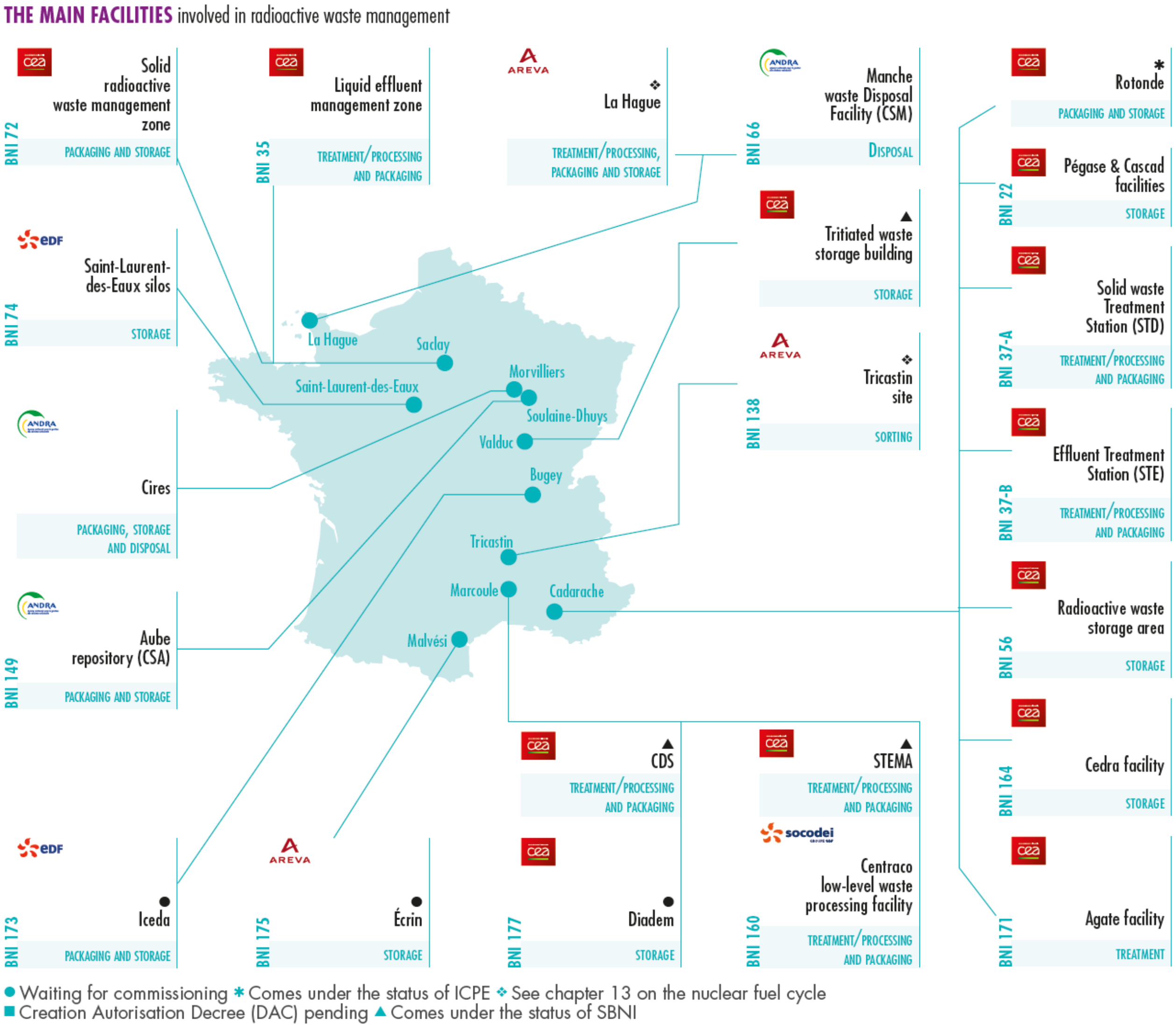

FIGURE 1: RADIOACTIVE WASTE MANAGEMENT FACILITIES (EXCLUDING NATIONAL DEFENCE INSTALLATIONS)

3.2.1. Radioactive-waste treatment facilities

3.2.1.1. STORAGE OF HL WASTE AT LA HAGUE

CSD-V packages are stored in three facilities: both the R7 and T7 production workshops, which are equipped with appropriate halls, and the modular “E/EV” facility, which has an extension since September 2013.

The storage capacity is as follows:

- UP2-800: Storage R7: 4,500 packages;
- UP3-A: Storage T7: 3 600 packages;
- UP3-A: Storage E/EV-SE: 4,320 packages; E/EV-LH: 8,411 packages; E/EV-LH2: 8,424 packages (planned in 2021).

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

		Current capacities
Capacity (number of CSD-V)	 + +	8 100 R7 + T7 4 320 E/EV-SE 4 199 E/EV-LH *(+ 4 212 dès sept. 2017)*
Total	=	16 619
CSD-Vs stored by end 2015	-	14 555
Available spaces	=	2 064

TABLE 10: RADIOACTIVE WASTE PRESENT ON THE LA HAGUE SITE ON 31 DECEMBER 2015

2 064 spaces are free on 1st January 2016. A total of 5247 CSD-V packages have been returned to foreign customers, from 1 January 1995 till 31 December 2015, thus representing a return rate exceeding 97%.

3.2.1.2. IL-LL WASTE

In the IL-LL waste category, most currently-produced packages result from compacted metal structures of processed assemblies called "CSD-C". However, most of the existing output, which has already been stored, originates from the operation of plants of older generations that were in service from the 1960s to the 1980s. Those residues, which are currently being stored in pools and silos, have led to the creation of a retrieval and conditioning programmes. Most selected conditioning modes involve compacting, bitumisation and cementation.

Standard containers of compacted waste (CSD-C)

The capacity of the Storage Workshop for Hulls and End-pieces (*Atelier d'entreposage des coques et embouts compactés* – ECC) currently stands at more than 24,000 places and allows for the storage of the packages to be generated over the next 6 years, with due account of the plant's programme. An extension of a capacity of 6,000 places is planned to be commissioned by the 2022 timeframe.

Drums of bitumised waste

The current production of bitumen drums at La Hague is almost nil, following the implementation of the new effluent-management system (*nouvelle gestion des effluents – NGE*), which ensures the concentration and vitrification of radioactive effluents (see § B.6.1.3.2).

Current capacities are sufficient to store all bitumen drums that already exist.

Packages of cemented waste

Asbestos-cement containers (*conteneur amiante ciment – CAC*) are no longer produced since 1994. They reached a total number of 753 packages, but only 306 constitute IL-LL waste. The other packages are intended for disposal at the CSA.

The production of fibrous-concrete packages (CBFC'2) started to replace CACs in 1994. Most of that production will slow down significantly as the stream of technological waste is gradually incorporated in the Compacting Workshop (*Atelier de compactage – ACC*), which was commissioned in 2002.

3.2.1.3. OTHER STORAGE FACILITIES

There are a certain number of disposal facilities apart from the AREVA NC listed below, including:

EDF's storage facilities

EDF stores graphite waste (LL-LL waste) originating from the old GGR system, especially in the silos of the Saint-Laurent A NPP.

EDF also stores IL-LL waste on the sites of its operating NPPs, including control clusters and poison clusters. Those residues will be conditioned at stored in the ICEDA facility (Conditioning and Storage Facility for Activated Waste (*Installation de conditionnement et d'entreposage de déchets activés*), the commissioning application file of which has been submitted to ASN in July 2016.

ILW-LL waste from decommissioning of first generation NPPs will be produced from end 2017/beginning 2018 onward and will also be conditioned and stored in the ICEDA facility.

EDF plans to create a new facility by 2030 to store the graphite wastes from the dismantling of Saint Laurent A's silos.

CEA's storage facilities for CEA-generated waste

In its facilities, the CEA stores IL-LL waste and some HL waste. At Cadarache, the old trenches and ditches of BNI-56 are used to store waste that is intended for retrieval for storage purposes in more recent amenities. A new facility (Unit 1 of CEDRA) has been commissioned. At the BNI-72 in Saclay, historical residues are also stored. CEA transmitted to the Minister in charge of nuclear safety the decommissioning application file for this facility. Waste stored in this BNI must be re-stored in more recent facilities.

CEA currently builds the storage facility DIADEM in Marcoule which will be dedicated to irradiating βγ emitters or α emitter-rich for a commissioning planned for the 2019 timeframe. The DIADEM facility will be complementary to CEDRA.

Storage facilities for waste enhanced with naturally-occurring radioactivity

Waste enhanced with naturally-occurring radioactivity includes notably the LL-LL radium-bearing waste (FA-VL) stored at La Rochelle (resulting from rare-earth industry) and at Jarrie (resulting from the fabrication of zirconium sponges).

Storage facilities for non-CEA generated waste on CEA sites

For historical reasons and due to their skills, CEA facilities, mostly those at Saclay and at Cadarache, host various waste categories that it did not generate itself. Those residues are intended disposal in facilities that are only at the project stage for the time being (radium-bearing waste and disused sealed sources).

ANDRA's storage facilities

In 2012, ANDRA commissioned a storage facility in its industrial grouping, storage and disposal centre (CIRES), primarily intended for low level, long-lived waste, in particular that resulting from the Agency's public service duties (see § B.6.4).

3.2.2. Waste-disposal facilities

3.2.2.1. THE CENTRE DE LA MANCHE DISPOSAL FACILITY (CSM)

The Manche Disposal Facility (*Centre de stockage de la Manche* – CSM), which is managed by ANDRA, was commissioned in 1969. Located in Digulleville, Cotentin Peninsula (Normandy), it is very close to the La Hague Spent-fuel Processing Plant (AREVA) and accommodated approximately 527,000 m^3 of waste packages prior to its shutdown on 30 June 1994.

The general design principle was to dispose of waste packages on or in structures, as well as to collect and control separately all remaining rainwaters from the waters likely to have been in contact with packages. The structures, the design of which varied over time, consisted of concrete slabs on which the packages were either stacked directly or stored in concrete bunkers built on those slabs. The structures were loaded in open air, whereas rainwaters were collected peripherally from the structure and directed to the nearby AREVA NC Plant by a pipe network through underground drifts. The decision to dispose of packages by stacking them directly or by disposing of them in a concrete box depended on the radiological activity of the packages and/or the sustainability criterion of the packaging.

The repository occupies a site of about 15 ha and was covered in 1997 with a bitumen membrane within an assembly of draining or impermeable layers designed to prevent water seepages. The cover layer was planted with grass in order to favour the evaporation of rainwaters and to prevent the erosion of the top layer of the cover.

The CSM is in what the new terminology applicable to BNIs refers to as the closing phase (preparatory phase that formally prefigures closure and the start of monitoring, which will take place once all the cover redevelopment work has been completed) since January 2003 (decree 2003-30 of 10th January 2003), even though in practice this situation was initiated in 1997 after the cover construction work was completed. The transition from the operating phase to this phase involved the same type of process as that applied for the creation of a BNI, including a public consultation. The activities carried out on the CSM since 1997 concern the following points:

- checking the sound operation of the disposal facility, including:
  - the stability of the cover;
  - the impermeability of the cover, and
  - an estimate of water seepages in the cover and at the base of the structures;
- detecting any abnormal or altered-evolution situation:
  - the radiological and chemical monitoring of the water table;
  - irradiation checks under shutdown conditions/inside the fence, and
  - atmospheric-contamination checks, and
- following up the radiological and physico-chemical impact of the facility.

The impact assessment of the CSM is the subject of public annual reports, which may be consulted on ANDRA's website (www.andra.fr).

The periodic safety reassessments are carried out every ten years. The latest safety assessment of the centre was carried out by ASN in December 2009. ASN notified its conclusions concerning the files in a letter sent out on 15 February 2010. In accordance with the strategy it proposed, concerning the evolution of the cover, ANDRA performed work to consolidate the embankments around the edge of the cover on three sectors where ground movements were noticed. The aim is to assess the effectiveness over a period of about ten years, before moving onto the subsequent redevelopment stages over the other sectors. The redevelopment work will reduce the gradient of the cover slopes. Concatenating periods of work and of observation, this phase could extend to 2060.

In 2015, ANDRA submitted a complementary file to ASN to detail the different aspects concerning the evolution of the CSM over the long term, that is to say a description of how the CSM will evolve and the associated conditions (drainage, embankments, cover, monitoring). This file provides information aiming at demonstrating that the bituminous membrane will be capable of protecting the disposal over a time frame of several hundred years, with the sealing performance nevertheless being monitored by taking periodic samples of the membrane, among other things.

Technical requirements relating to the CSM's monitoring phase provide a list of all required information to be archived over the long term. Documents must be archived safely under suitable conservation conditions and in two copies deposited in two separate locations. The documentation designed to maintain the memory of the disposal facility was assembled and a copy was deposited in the French National Archives.

This documentation includes a "summary record" which in 170 pages describes the history and main characteristics of the facility and a "detailed record" containing technical documents about the construction, operation and closure of the CSM, and those concerning its safety.

The CSM's Local Information Committee assessed the CSM "summary record" in 2011 and 2012. Moreover, 3 information search exercises were carried out in 2012 on the entire memory records system: 2 ANDRA internal assessments and one international assessment, involving the Local Information Committee. These exercises led to initiate changes in the ordering of the documents conserved, notably to create a more operational link between the "summary record" and the "detailed record", which is hard to utilise owing to its volume. Moreover, routinely, all consultation of the detailed record by ANDRA personnel is subject to a feedback sheet to descibe how well the consultation was performed and any difficulties encountered.

3.2.2.2. LIL WASTE DISPOSAL FACILITY (CSA)

Located at Soulaine-Dhuys, Aube département, in Eastern France, the CSA for LIL-SL waste was commissioned in January 1992 and is managed by ANDRA.

The CSA, which benefits from operating experience feedback from the CSM, is authorised to hold a volume of 1 million cubic metres of waste packages. The site covers an area of 95 hectares, of which 30 are for actual disposal.

Besides disposal operations, the facility is also involved in waste-conditioning activities, consisting either in injecting cement mortar in 5- or 10 m^3 metal boxes or in compacting 200-L drums and immobilising them with mortar into 450-L drums.

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 the memory of the existence of the disposal sites. Table 15 gives the deliveries of LLW/ILW-SL and VLL waste packages which, after complementary treatment if necessary, are placed in the CSA or CIRES disposal facilities.

Disposal structures consist of cells, in which packages are emplaced. Waste-loading operations are protected against rainwaters. Packages with a metal cover are concreted in the structure, whereas packages with a sustainable-concrete cover are stabilised with fine gravel in the structure. Once the structure is full and the packages have been immobilised, a closing slab is poured over the top and covered by a temporary impermeable layer, pending the installation of the final cover with its impermeable clay layer. The apron of the structures is made of reinforced concrete and covered with an impermeable polymer; it also includes a perforation in order to recover any potential seepage waters.

On 31 December 2016:

- the total volume of disposed waste amounted to approximately to 316,000 m^3, and
- 136 structures had been closed down on a planned total of approximately 400.

Given an annual delivery of around 15,000 m^3 and the fact that the disposal facility was designed originally for an annual input of 30,000 m^3, the facility will probably remain in operation beyond 2060. The figures of the National Inventory show that it should be capable of absorbing the low and intermediate level, short-lived waste produced by the operation and decommissioning of the nuclear facilities currently authorised.

With regard to radiological protection, the *Public Health Code* (Book III, Title III, Chapter III) states that the total impact of all nuclear activities (except medical uses) on the public shall not exceed an annual dose of 1 mSv. As for ANDRA, it allows a maximum dose of 0.25 mSv/a under normal conditions during both the operating and post-closure monitoring phases. For all other altered-scenario situations, this value may be exceeded. The criteria to be used for assessing whether the calculated impact is acceptable include mainly the exposure mode and time, as well as the conservative calculation hypotheses being selected (see H.5.1).

Radionuclides	Tritium	Cobalt 60	Strontium 90	Caesium 137	Nickel 63	Alpha emitters
Radiological capacities (TBq)	**4 000**	**400 000**	**40 000**	**200 000**	**40 000**	**750**

TABLE 11: RADIOLOGICAL CAPACITIES DEFINED FOR SOME RADIONUCLIDES

(Creation-license, decree of 4 september 1989)

The centre's package acceptance criteria are derived from the long-term operational safety studies.

Radiological capacity levels were defined for a certain number of radionuclides in the *creation authorisation decree of 4 September 1989*.

Other limits were set forth in the facility's technical specifications. For instance, the 1999 revised technical prescriptions have been consolidated in the General Operating Rules and impose relevant radiological capacities for chlorine-36, niobium-94, technetium-99, silver-108m and iodine-129.

For all radioelements, except for chlorine-36, the consumption fraction of the radiological capacity lies below the fraction of the consumed volume capacity. The capacity in chlorine 36 was set by ASN after examining the long-term safety conditions of the disposal facility in order to take into account the take-over of some graphite waste that used to cause radiation-protection problems on their storage site. In the case of that specific radioelement, the share of consumed capacity is close to 90%, compared to 28% in volume-capacity consumption. Hence, the specific activity of the chlorine-36 concentration in the acceptable waste contained in the disposal facility is very low (5 Bq/g) is carefully monitored.

Over and above radiological hazards, other risks relate to toxic chemicals (Pb, Ni, Cr VI, Cr III, As, Cd, Hg, Be, U, B, Sb) and are divided into two different classes depending on their pathway to human beings: ingestion or inhalation. The method being used is similar to that for preparing ICPE impact statements.

The creation authorisation decree for the CSA was modified on 10 August 2006 in order to include an explicit reference to facility discharges and to formalise the corresponding limits in the Ministerial Order of 21 August 2006.

The discharge order also provides for a quarterly assessment of gaseous discharges from disposal structures.

The flexibility of the CSA's disposal conditions meant that it could accept non-standard waste packages such as large sized waste packages, enabling the waste producers to limit the doses received during the cutting work. Consequently, 55 EDF pressurized water reactor closure heads have been delivered to the CSA. Special packages of lateral neutron shielding from the Creys-Malville NPP (breeder reactor) have also been accepted. Disposal of such waste is currently subject to ASN authorisation on a case-by-case basis. This option makes it possible to optimise the management of decommissioning waste.

In 2006, ANDRA has been licensed by ASN to dispose of sealed sources provided that their half-life was shorter than that of caesium-137. The licence prescribes the relevant admissible activity limits for the radionuclides involved per source.

3.2.2.3. VLL WASTE DISPOSAL FACILITY (CIRES)

The CIRES disposal facility for VLL waste, commissioned in 2003, has a capacity of 650,000 m^3 and is located in Morvilliers, Aube département, a few kilometres away from the CSA. It covers an area of 45 ha. At the end of 2016, about 360,000 m^3 of waste had already been disposed of there. Given the total radiological activity it will contain in the future, the facility is not subject to BNI regulations, but to ICPE regulations.

The design of the facility follows the same principles applicable to disposal facilities for hazardous waste.

Waste must be solid and inert. Dangerous wastes are subject to stabilization according to the same rules that are used for non-radioactive waste. With due account of the activity level of the waste involved, the only purpose of conditioning is to prevent any dispersal of radioactive materials during transport and disposal operations. Protected against rain under a mobile roof, the waste is placed in cells hollowed out in the clay formation. A bottom membrane reinforces the impermeability of the system. Once full, each cell is backfilled with sand and covered with another membrane and a layer of clay. An inspection shaft is used to check the cell and especially to detect any potential water infiltrations into the cell.

As in the case of the CSA, ANDRA allows a maximum impact value of 0.25 mSv/a for the CIRES in normal conditions, either during operation or after shutdown. For instance, the impact of the CIRES on members of the public is estimated at $3 \cdot 10^{-5}$ mSv/a under normal conditions after 200 years. For all other post-monitoring scenarios, such as road construction or a children's playground, dose estimates range between 0.02 and 0.05 mSv/a.

As for the CSA, all risks associated with toxic chemicals have been taken into account.

The CIRES was designed before any experience feedback was available on the enforcement of the French regulations regarding waste management in BNIs (implementation of waste zoning, no clearance threshold).

The waste stream currently foreseen may generate an earlier saturation than expected of the CIRES' regulatory capacity, whose initial operating lifetime was expected to last about 30 years. Hence, some studies were launched in order to improve the density of the waste intended for disposal, to optimise the use of disposal space and to assess the feasibility of a recycling system for VLL metal waste. Those activities are monitored in the framework of the PNGMDR. In particular, thanks to optimisation of the use of disposal space, the technical capacity of CIRES would now appear to be about 40% higher than its regulation capacity, which, provided regulatory modifications are made, would postpone its saturation at least up to the 2030 timeframe without changing the installation's perimeter.

Moreover, in mid-2015 ANDRA proposed an overall industrial scheme that meets the needs for new disposal capacities for very low level radioactive waste. In addition to the recycling options, this scheme envisages the possibility of creating disposal facilities of simpler design than CIRES in the vicinity of certain decommissioning sites for the less radioactive waste should disposal capacity needs increase. In effect, between a third and half of the waste received at CIRES to date in application of the waste zoning requirement does not present a risk with regard to radiation protection.

As for the CSA, the search for overall optimisation of waste led to the development of solutions for the acceptance of large components, without having to cut them up for packaging in standard packages. These solutions should be deployed taking account of the various issues, in particular safety, technical, economic, calendar, of all the waste management phases. In this way, 4 steam generators from the Chooz NPP have been disposed of in CIRES after extensive decontamination on the NPP site, enabling them to be downgraded from LLW/ILW-SL status to VLL status. This solution cannot necessarily be extended to all the steam generators of the NPPs in service. However the inventory of outsized waste led ANDRA to design a disposal vault dedicated to this type of package, the construction of which was initiated in 2016.

3.2.3. Mine-tailing disposal facilities

In line with economic criteria, the poorest ore underwent static processing and the rest, dynamic processing. Depending on the nature of the ore, the processing method called upon either an acid or basic medium. On most French sites, uranium was leached with sulphuric acid, whole sodium chlorate acts as oxidiser, if necessary.

Those processes left virtually all ore components intact once uranium was placed in solution. Any residual uranium amounted to about 0.1 kg/t and could not be extracted owing to its low solubility or its inaccessibility to the acid. However, all highly insoluble radium remained in the solid residue.

The uranium mining industry, which is today no longer active in France, generated 50 million metric tons of mining residues. These residues are currently spread over 17 disposal sites in former mine works (see table in D.4.2). These disposal sites are installations classified on environmental protection grounds and subject to the authorisation system in accordance with section n° 1735.

The rehabilitation of the residue disposal sites consisted in installing a solid cover over the residues to create a geo-mechanical and radiological protective barrier. The licensees also set up installations to treat the water overflowing from the hydraulic ponds created by the mine workings or galleries. These stations reduce the uranium and radium concentrations in the water before it is discharged into the environment.

After rehabilitation of the sites, it may be necessary, on some of them, to maintain installations for treatment of the mine drainage water and/or excess water removed from the residues. Studies are being carried out concerning the long-term fate of these sites, more specifically with respect to the PNGMDR and the decree establishing its prescriptions (see B.6.3).

4 | BURE LABORATORY

Following the decision taken in 1998 by the government to select the Meuse/Haute-Marne Site to host an underground research laboratory (URL), the first stope-preparation activities were undertaken in 2000, whereas the access shafts were sunk in 2001.

Since 2002, ANDRA has been conducting in particular at the main level at a depth of 500 m within the Meuse/Haute-Marne URL a series of experiments designed to assess in situ the thermal, hydraulic, mechanical and chemical properties of the host clay rock, to understand its behaviour to various solicitations (mechanical, hydric/hydraulic, thermal or chemical) from the repository and to reproduce the expected interactions between the materials that are likely to be used in the repository and the host rock. In parallel, ANDRA is testing *in situ* and, via technological demonstrators, the realisation techniques of various architectural components for disposal purposes (drifts, disposal cells, closing structures, seals) as well as their behaviour in real situation.

More than 1,600 m of drifts have currently been excavated and made available for the scientific and demonstration programme. Nearly 14,000 measurement points are installed in the underground laboratory and transmit information continuously about the behaviour of the rock and the structures built.

Priority focus is given to the following R&D orientations:

- In terms of scientific knowledge:
    - Carry on of long term tests on the behaviour of disposal materials (concrete, glass, steel);
    - Assessment of thermo-hydro-mechanical behaviour of the host clay rock under a thermal load (overpressure, thermal expansion…);

    - Characterisation of the evolution of hydro-mechanical and hydraulic properties of the host rock near-field damaged zone generated by excavation works following paths of constraints or deformation, in particular, its hydraulic cicatrisation and compressibility;
    - Assessment of the effect of humidity of ventilation air on the damaged zone's hydric and hydro-mechanical state;
    - Characterisation of the evolution of constraints on supports and claddings for different cladding/supporting techniques (compressible shims, thick shotcrete, poured concrete, liner segments);
    - Characterisation of damaged zone associated with different cladding/supporting methods (flexible and rigid cladding, liner segments) and different sizes of gallery;
- In terms of technological knowledge:
    - Excavation of HL cells;
    - Excavation of large size galleries;
    - Installation of liner segments as a cladding/supporting method;
    - Installation of a seal core.

All of the work done in the underground laboratory should contribute to the production of scientific and technical data to support the preparation of the creation authorisation application file for the deep geological disposal facility (see § H.3.2.1).

5 | RADIOACTIVE WASTE INVENTORY

5.1. Annual production of radioactive waste

The average annual waste production and its origin in 2012 is summarised in Table 12, according to the classification described in § B.4.2.

Type of waste	Volume (m^3)	Fuel cycle and electricity production (%)	Nuclear research (%)	Others (%)
VLL waste	**15 000**	**68**	**28**	**4**
LIL-SL waste	**13 000**	**~80**	**~20**	**Low**
LL-LL waste	**520**	**25**	**0**	**75**
IL-LL waste	**110**	**80**	**20**	**0**
HL waste	**150**	**100**	**0**	**0**

TABLE 12: ANNUAL PRODUCTION OF RADIOACTIVE WASTE IN 2015

The shares of IL-LL and HL waste shown in Table 12 include all waste conditioned through the processing of the spent fuel produced in France.

Percentages were calculated on the basis of the waste conditioned into packages. Spent fuel held in storage facilities is also ignored when calculating percentages. The “Miscellaneous” category comprises only waste resulting from polluted site clean-out (LL-LL) and the non-nuclear industry and medical sectors (VLL, LIL-SL waste).

5.2. Existing waste in storage facilities

5.2.1. Waste volume resulting from spent-fuel processing (French share)

All ultimate waste contained in the spent fuel processed in the La Hague facilities belong to two categories: fission products and structural waste.

Fission products and structural waste are conditioned into CSD-V and CSD-C packages, respectively. As shown in Table 13, the large majority of CSD-V packages among the total number of existing or upcoming packages on 31 December 2015, belonged to France, with due account of the fact that most of the activity (97,4 %) of processed foreign spent fuel has been shipped back.

In the case of CSD-C packages, the share of remaining packages on 31 December 2015 was higher than for vitrified packages, since the priority was given by AREVA to activity over mass.

	Total number of stored packages on 31.12.15	Estimated share of processed spent fuel belonging to French owners before 31.12.15 (%)
CSD-V	**14 555**	98.5
CSD-C	**14 284**	64.3

TABLE 13: QUANTITIES OF WASTE PACKAGES CURRENTLY-STORED ON 31 DECEMBER 2015

5.2.2. Waste volume resulting from spent-fuel processing (foreign share)

In accordance with the Order of 2 October 2008, all foreign CSD-V and CSD-C packages are shipped back to their countries of origin according to the activity levels and the mass of the imported spent fuel, respectively.

	Estimated share of every foreign State with regard to processed spent fuel before 31.12.15 (%)							
	Germany	Australia	Belgium	Spain	Italy	Japan	Netherlands	Switzerland
CSD-V	0	<0.1	0	0,5	0,6	0	< 0.1	1.1
CSD-C	23.5	0	0.6	0.4	1.4	11.9	0.4	1.4

TABLE 14: ESTIMATED INDIVIDUAL FOREIGN SHARES OF EXISTING AND UPCOMING CSD-V AND CSD-C PACKAGES, IN RELATION TO THE TOTAL AMOUNT OF PACKAGES ON 31 DECEMBER 2015

5.2.3. Other stored waste (at the end of 2015)

The inventory of other stored waste at the end of 2015 (in conditioned waste volume equivalent) is the following:

- IL-LL waste different from those coming from spent fuel treatment : 46 300 m^3;
- LL-LL waste: 87 200 m^3;
- LIL waste not already stored at CSA: 67 000 m^3;
- VLL waste not already stored at CIRES: 154 000 m^3;
- Tritiated waste: 5 500 m^3;
- for certain VLL and low-level waste categories, which have been lacking a disposal system for a long time (oils, resins, scrap metal, etc.), EDF has created some dedicated and regulated areas (VLL-waste areas) in which those residues are stored pending their evacuation;
- disused radioactive sources: 1 700 000;
- mine tailings: 50 million tonnes (see table below). They constitute a specific VLL-waste category, which is managed separately.

Region	Storage site	%	Quantity (thousands of tonnes)
Alsace	Teufelsloch	0.01 %	**4**
Auvergne	Rophin	0.06 %	**30**
	Saint-Pierre	1.2 %	**605**
Bourgogne	Bauzot	0.03 %	**16**
	Gueugnon	0.4 %	**226**
Languedoc	Le Cellier	12.0 %	**5,967**
	Le Bosc (Lodève)	1.0 %	**5,445**
Limousin	Bellezane	3.1 %	**1,646**
	Le Bernardan (Jouac)	3.7 %	**1,863**
	Brugeaud	25.3 %	**12,547**
	Lavaugrasse	15.1 %	**7,488**
	Montmassacrot	1.5 %	**737**
	La Ribière	0.4 %	**197**
Midi-Pyrénées	Bertholène	0.9 %	**476**
Pays-de-Loire	La Commanderie	0.5 %	**250**
	L'Ecarpière	22.9 %	**11,350**
Rhône-Alpes	Bois-Noirs Limouzat	2.6 %	**1,387**
		100 %	**~50,000**

TABLE 15: INVENTORY OF URANIUM MINE WORKS AND OF MINE TAILINGS (IN MILLIONS OF TONNES)

5.3. Waste intended for final disposal

At the end of 2016, the total volume of disposed VLL, LL and IL-SL waste amounted to about 1 213 000 m^3 as broken down in the following Table.

	Volume (m^3)
Immersion of 14,300 t (1967 and 1969)	9,900
Centre de la Manche	527,000
CSA	316,000
CIRES	360,000

TABLE 16: STORED VOLUMES OF TFA, FA, MA SL AND LIL-SL WASTE ON 31 DECEMBER 2016

At the end of 2016, no IL-LL or HL waste had ever been disposed of permanently in France.

6 | NUCLEAR FACILITIES BEING DECOMMISSIONED

At the end of 2016, more than 30 facilities of all types (power or research reactors, laboratories, fuel processing plant, waste treatment facilities etc.) were shut down or being dismantled (cf. L 3.1 and L.3.2), in particular:

- 9 former nuclear-power reactors (EDF)[6];
- 16 CEA facilities[7];
- 7 AREVA facilities including 4 at the La Hague site[8].

[6] Chooz A, Chinon A1, A2 et A3, Brennilis, Bugey 1, Saint Laurent A1 et A2, Superphénix

[7] RAPSODIE, le LHA, ATUE, LAMA, ATPu, LPC, PROCÉDÉ, SUPPORT, ULYSSE, PHÉNIX, STED, HL Waste storage unit, OSIRIS, PHÉBUS, Solid radioactive waste storage yard, MASURCA

[8] UP2-400, ELAN IIB, Atelier HAO, AREVA NC Pierrelatte, SICN Veurey-Voroize (INB 65 et 90), EURODIF-Pro

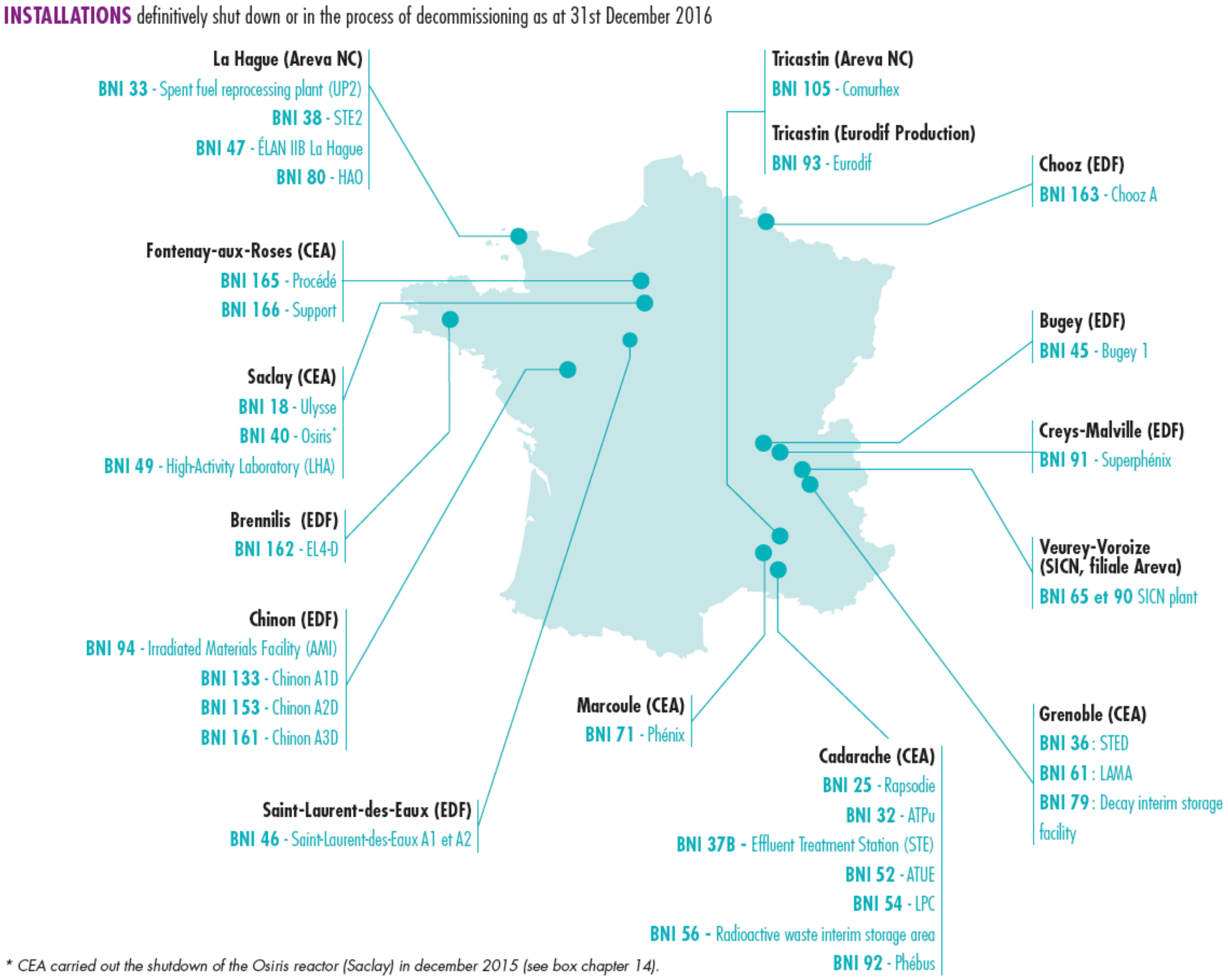

FIGURE 2: NUCLEAR FACILITIES BEING DECOMMISSIONED ON 31 DECEMBER 2016

SECTION E | LEGISLATIVE AND REGULATORY SYSTEM (ART. 18 TO 20)

1 | GENERAL FRAMEWORK (ARTICLE 18)

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

1.1. General legal framework for nuclear activities

Guaranteeing the safe management of nuclear activities involves two closely-related aspects: radiation protection and nuclear safety.

With respect to radiation protection, there is only one set of regulations in France.

With regard to nuclear safety, however, the facilities and radioactive substances subject to the Joint Convention are much diversified in nature and are controlled by various regulatory structures.

Over and above a specific threshold set by *Decree No. 2007-830 of 11 May 2007 Concerning the BNI Nomenclature,* all nuclear facilities are called BNIs and are placed under ASN's control.

To that category belong especially all facilities producing, storing or processing spent fuel from reactors, spent fuel processing plants, storage facilities, etc., as well as facilities whose "main purpose is to manage radioactive waste" as defined in the Joint Convention (except for the CIRES, which constitutes an ICPE) and a large number of facilities containing radioactive waste, although waste management is not their primary purpose: all in all, BNIs amount to a total of 127 on 31 December 2016.

Below the above-mentioned threshold, any facility containing radioactive substances may constitute an ICPE and be placed under the control of the Ministry for the Environment, among approximately 800 other similar facilities.

It should be noted that national-defence facilities follow the same activity-classification system. Specific competent authorities are supervised by the Minister for Industry and/or National Defence. However, since all radioactive waste generated by those facilities are eliminated in civilian waste-elimination facilities, the long-term management of those residues forms an integral part of ASN's control mission.

Lastly, radioactive sources are the subject of specific regulations and are placed under ASN's control, since April 2002. Sealed sources are regulated as soon as they exceed an exemption threshold for every radionuclide as prescribed by *Public Health Code*. That threshold has been set very low.

It should be noted also that the consistency of safety control is ensured by a constant interaction between regulatory authorities whose high officials meet frequently. General regulations applicable to several types of facilities are being developed by joint working groups. Although informal, those contacts are very effective.

The French structure for nuclear safety and radiation protection relies notably on the primary and full liability of operators, according to which the responsibility of a hazardous activity lies essentially with the person who carries it out or practises it (BNI operators, such as the CEA, AREVA NC, AREVA NP, and EDF; radioactive-material conveyors, radioactive-source users, etc.) and not with public authorities or other parties. On this account the regulations applicable to the BNIs are based chiefly on the *Environment Code* and its implementation decrees, in particular the *BNI Procedures Decree,* and the *BNI Order*.

Several legislative and regulatory provisions relative to the BNIs stem from or take up international conventions and standards, notably those of the IAEA.
Several European community texts apply to BNIs. The most important are the Euratom Treaty and the two directives establishing a community framework for the safety of nuclear facilities (directive 2009/71/Euratom modified by directive 2014/87/Euratom) and for the responsible and safe management of spent fuel and radioactive waste (directive 2011/70/Euratom).

1.2. National texts

The legal system applicable to BNIs was revised in depth by Act 2006-686 of 13th June 2006 on transparency and security in the nuclear field, called the "TSN" act, and its application decrees, and in particular decree 2007-1557 of 2nd November relative to basic nuclear installations and oversight of the transport of radioactive substances from the nuclear safety aspect ("BNI procedures" decree). Since 6th January 2012, the provisions of the three main Acts specifically concerning BNIs – the TSN Act, the Programme Act 2006-739 of 28th June 2006 on the sustainable management of radioactive materials and waste (known as the "waste" Act) and Act 68-943 of 30th October 1968 on civil liability in the nuclear energy field (known as the "RCN" Act) – are codified in the Environment Code.

Furthermore, Act 2015-992 of 17th August 2015 relative to energy transition for green growth ("TECV" Act) and Ordinance 2016-128 of 10 February 2016 introducing various provisions concerning nuclear activities have brought significant changes to the legislative framework governing the oversight of BNI activities. The Ordinance of 10th February 2016 also includes provisions that have allowed completion of the transposition of Directive 2011/70/Euratom of 19th July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

1.2.1. Environment Code

The provisions of chapters I, III, V and VI of title IX of book V of the *Environment Code* underpin the BNI licensing and regulation system.

The legal system applicable to BNIs is said to be “integrated” because it aims to cover the prevention or control of all the risks and detrimental effects, whether or not radioactive, that a BNI could create for man and the environment.

About fifteen decrees implement the legislative provisions of book V of the Environment Code, in particular *Decree n°2007-830 of 11 May 2007* concerning the list of BNIs and *BNI Procedures decree* as amended, concerning BNIs and the regulation of the nuclear safety of the transport of radioactive substances. The provisions of chapter II of title IV of book V of the Environment Code (drawn in particular from the codification of the “*Waste” Act*) introduce a coherent and exhaustive legislative framework for the management of all radioactive waste.

1.2.1.1. ENVIRONMENT CODE (TITLE IX OF BOOK V)

The legislative base governing the safety of BNIs in France is title IX of book V of the Environment code, and more specifically its provisions taken from the TSN Act that created ASN as an independent administrative authority. The provisions of the Code reiterate that the environmental protection principles apply to nuclear activities, particularly the polluter-pays principle and the principle of public participation. They reassert the three broad principles with regard to radiation protection: justification, optimisation and limitation. They set out the fundamental principle of the responsibility of the licensee as regards the safety of its installation. The progress brought by the TSN Act in terms of transparency and the right of the general public to information in the nuclear field, including in particular the obligation for licensees to draw up an annual report, have been reinforced by the TECV Act.

The Local Information Committees (CLI), provided for by the Act, include representatives of the States, elected officials, members of associations and of the regional authorities and the departmental councils (elected assemblies at the head of the French *départements*) in particular. The act gives them the possibility of creating an association and ensures their long-term funding. It provides for a federation of CLIs to give a foundation for the National association of CLIs (ANCLI).

The TECV Act reinforces the provisions for transparency and information around BNIs, relying in particular on the CLIs, which are open to representatives of neighbouring countries when sites are situated in a département sharing a border with these countries, and whose areas of competence are increased with, for example, the annual organisation of a public meeting open to all and the possibility of the CLI addressing any subject within its area of competence.

Moreover, the TECV Act introduces new provisions into the Environmental Code concerning the control of subcontracting, the BNI modification system coming under the competence of ASN (licensing and notification) and it overhauls the system for final shutdown and decommissioning of BNIs by adopting the principle of decommissioning in the shortest possible time frame.

Lastly, the abovementioned Ordinance of 10th February 2016 introduces into the Environment Code the principle of a 10-yearly assessment of the regulations governing nuclear safety and radiation protection with a view to ensuring their continuous improvement. Such international reviews will also have to be organised every six years on a specific theme relating to nuclear safety or radiation protection within the BNIs in the event of an accident leading to situations necessitating off-site emergency response measures or population protection measures.

The ordinance increases the licensee's responsibility and extends it expressly, beyond the safety of the facility, to the control of all the risks and inconveniences that its installation presents for the protected interests. It specifies the responsibility of the owner of the land and also introduces the possibility of ASN having "third-party appraisals" performed at the expense of those responsible for an activity it oversees.

1.2.1.2. ENVIRONMENT CODE (CHAPTER II OF TITLE IV OF BOOK V)

These provisions related to wastes are described in B.1.1.

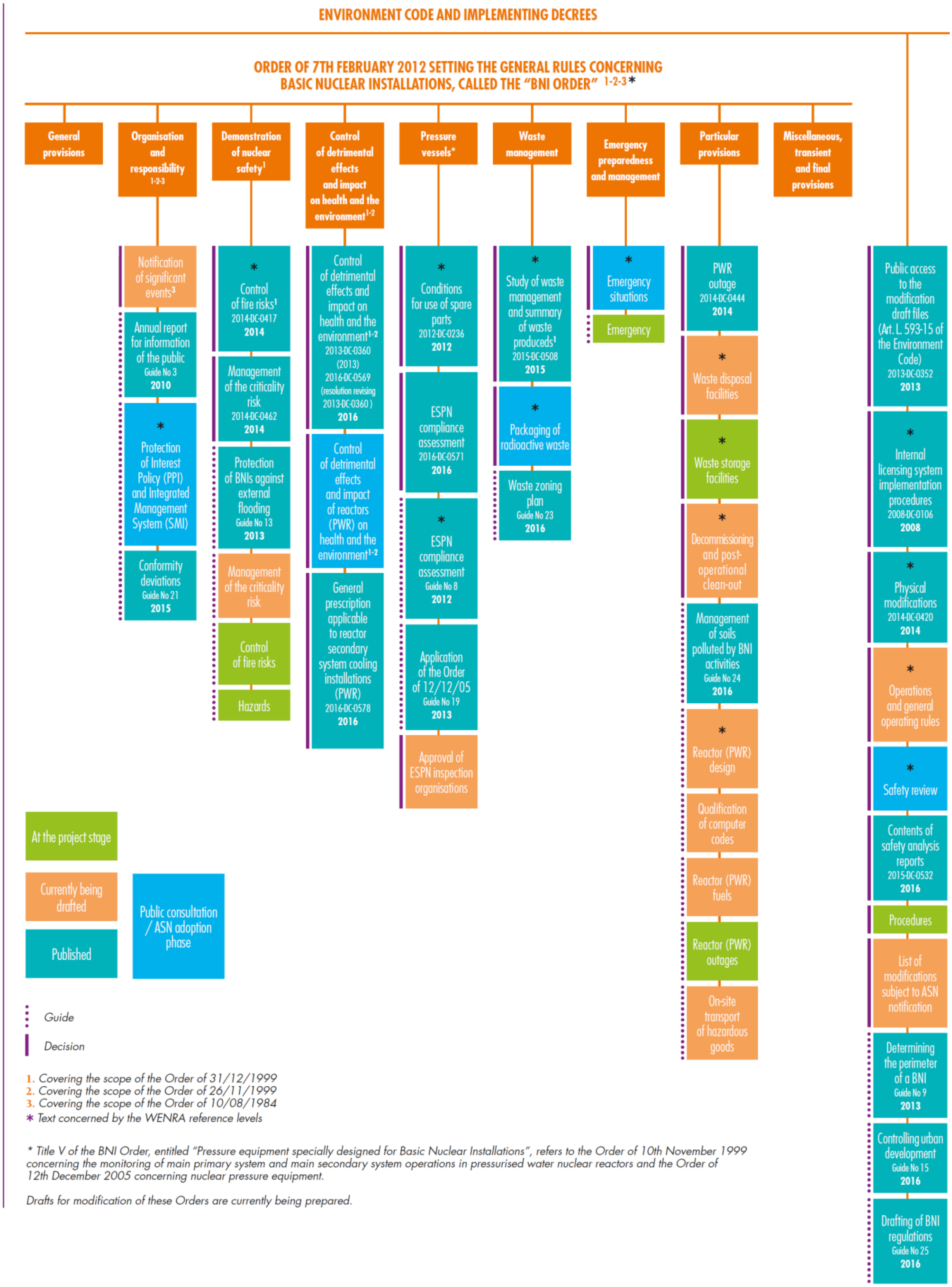

FIGURE 3: STATUS OF PROGRESS OF THE OVERHAUL OF THE GENERAL TECHNICAL REGULATIONS APPLICABLE TO BNIS AS AT 24TH JANUARY 2017

1.2.2. Decree 2007-1557 of 2 november 2007 ("procédures" decree)

Decree 2007-1557 of 2nd November 2007 concerning BNIs and the regulation of the nuclear safety of the transport of radioactive materials is issued in application of article L. 593-43 of the environment code.

The "procedures" decree defines the conditions of application of the law with respect to authorisations for creation, commissioning, modification, final shutdown, decommissioning and delicensing of BNIs, and with regard to inspection and administrative or penal sanctions applicable to licensees. It also includes provisions relative to the prescriptions that ASN can set for the licensees.

It was amended by a decree of 28th June 2016 to set the conditions of application of the provisions introduced into the Environment Code by the TECV Act in 2015 and which concern regulation of the use of subcontracting by BNI licensees (limitation of the number of subcontracting tiers in particular), the conditions of the procedure for ASN-authorisation of noteworthy modifications and the overhauling of the final shutdown and decommissioning procedure.

1.2.2.1. "BNI" ORDER OF 7 FEBRUARY 2012

Issued pursuant to Article L. 593-4 of the *Environment Code*, the "BNI" Order defines the essential requirements applicable to the BNIs to protect the interests listed in the Act: public safety, health and sanitary conditions; protection of nature and the environment.

In addition to the general principles taken from the former Order of 31 December 1999 and the WENRA reference levels (responsibilities, management principles, traceability, etc.), the title 6 of this order contains some new requirements concerning packaging:

- application of the acceptance specifications of the disposal facilities for which the packages are destined;
- for waste for which the disposal route is still being studied: packaging subject to ASN approval;
- or legacy waste: re-packaging as rapidly as possible so that the waste can be placed in a disposal facility.

These requirements are supplemented by title 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.

1.3. Legal framework for ICPEs and mines

The legal framework of the ICPEs is set by the *Environment Code* and its Book V in particular. This legislation succeeded from an act dated 1917 which in turn succeeded from a decree dated 1810.

In France, the State regulates the control of pollution, as well as industrial and agricultural risks. In that capacity, it formulates a policy for controlling industrial risks and nuisances. Those legal instruments provide in general terms the criteria for deciding whether a facility may be hazardous or inconvenient either for the comfort of the neighbourhood, or for public health, security and hygiene, or else for agriculture, for the protection of nature and the environment, or for the conservation of sites and monuments.

The ICPE legislation introduces a very simple system. The industrial activities that come under this legislation are inventoried in a list that subjects them to a system of either licensing, registration or declaration, depending on the activity in question and the quantity of hazardous products involved.

The polluter-pays principle is a basic principle of the environmental policy. It consists in making the polluter pay for any damage caused to the environment due to his activity and, in particular, to the impact of discharged liquid and gaseous effluents, or even waste.

The Mining code was created via the *decree of 16 August 1956*, by taking up the fundamental law on mines of 21 April 1810. In France, common law states that "ownership of the ground includes ownership of what is above and below it" (Article 552 of the *Environment Code*). The Mining code however nuances this rule by specifying that the substances of the "mines" can be conceded by the State. They are thus outside the law of ownership and the State attributes the use and sets the conditions of mine operation.

In mining law, one must clearly distinguish the difference between:

- the right to the substance granted by a mining title: an exclusive research permit for exploration, an operating license (until the end of 1994 except in geothermal applications or overseas) or a concession for operating the mine. The mining title (concession in perpetuity or limited concession, depending on its date of institution, operating license or exclusive research license) is delivered by the Minister responsible for mines.
- the license to start research or mining work: granted by prefect's decision on account of the mining policing authority exercised by the prefect without necessarily obtaining the agreement of the owner of the land. This license relates to the valorisation of the substance (substantial research work and mining work) and sets the conditions for operating the mine in compliance with the various interests set by the Mining code.

1.4. Public Health Code

The *Public Health Code* (*Code de santé publique* – CSP) describes the overall nature of "nuclear activities", that is, all activities involving a personal exposure risk due to the ionising radiation emitted by either an artificial source, whether substances or devices are involved, or a natural source when natural radionuclides are or were processed because of their radioactive, fissile or fertile properties. It also covers all "interventions" designed to prevent or to reduce any radiological risk following an accident associated with environmental contamination.

The *CSP* describes also the general international radiation-protection principles (justification, optimisation, limitation) adopted by the International Radiological Protection Commission (ICRP) and integrated in IAEA requirements and in *Euratom Directive No. 96/29*. Those principles orient all regulatory actions for which ASN is responsible.

The *CSP* also instituted the Radiation Protection Inspectorate, which is in charge of controlling the application of its radiation-protection prescriptions.

Lastly, the Code defines a system of administrative and penal sanctions which was reinforced by the abovementioned Ordinance of 10th February 2016, by the creation of a complete system of monitoring, policing and administrative and criminal sanctions, carried out primarily by ASN and the radiation protection inspectors, with reference to the system mentioned in chapters I to III of title VII of book I of the Environment Code.

2 | LEGISLATIVE AND REGULATORY FRAMEWORK (ARTICLE 19)

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.

2. This legislative and regulatory 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 the 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, and ;

vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and radioactive waste management.

3. When considering whether to regulate radioactive materials as radioactive waste. Contracting Parties shall take due account of the objectives of the Convention.

This section deals successively with radiation-protection regulations and the relevant regulations for the three categories of nuclear activities mentioned in E.1.1: BNIs; ICPEs and the special case of mines and sealed sources.

2.1. General regulatory framework for radiation protection

The regulatory framework for radiation protection was updated during the harmonisation with *EURATOM Directives 96/29, 97/43,* and 2013/59 and is presented with the matching regulations in chapter F.4.

2.2. Regulatory framework for BNI safety

Besides general regulations, such as those relating to labour law and the protection of nature, BNIs are subject to two types of specific regulations: licensing procedures and technical rules.

The purpose of ASN's control is to verify that the operator of a nuclear facility assumes fully his responsibilities and obligations with regard to safety. That external control does not relieve the operator from his responsibility to organise and to monitor his own activities, especially those contributing to safety.

2.2.1. Framework of BNI procedures

The French legislation and regulations prohibit the operation of a nuclear facility without the relevant licence. In that framework, BNIs are regulated by the *Environment Code* and by *BNI procedures Decree,* which provide for a creation-licence procedure and a series of further licences during the major steps in the lifetime of those facilities: commissioning, changes to the facility, final shutdown and decommissioning (or, in the case of a disposal facility, the post-closure monitoring phase). Any operator who runs a nuclear facility without the required licences or does not comply with their conditions is liable to police measures and the administrative and criminal penalties referred to mainly in Chapters I to III and VI of the Environment Code. The enforcement of the different licensing procedures runs from the siting and design phases to the final delicensing phase.

2.2.2. BNI siting procedures

Well before applying for a licence to create any BNI, the applicant must inform the administration of the future site or sites on which he intends to build his facility.

On the basis of that information, ASN requires that the socio-economic and safety aspects of the project be reviewed. ASN also analyses the safety-related characteristics of the site(s), such as seismicity. hydrogeology, industrial environment, cold-water sources, etc.

Furthermore, pursuant to Articles L. 121-1 of the *Environment Code,* the creation of any BNI is subject to a public-debate procedure, national procedure which must not be confused with the more local public inquiry procedure):

- statutorily, in the case of any new site for the production of nuclear power or any new site not intended for the production of nuclear power, but involving a cost exceeding 300 million euros, and
- eventually, in the case of any new site not intended for the production of nuclear power, but involving a cost ranging between 150 and 300 million euros.

The construction of a BNI is subject to the issuance of a building permit by the prefect in accordance with the procedures specified in Articles R. 421-1 and following, and Article R. 422-2 of the Town Planning Code.

Lastly, the French government has to inform all neighbouring countries in accordance with treaties in force, especially the Euratom Treaty and also the Convention on Environmental Impact Assessment in a Transboundary Context signed in Espoo.

2.2.3. BNI design, construction and safety assessment procedures

2.2.3.1. SAFETY ASSESSMENT

Safety options

Any person who intends to run a BNI may, before submitting a licence application, seek ASN's advice on all or part of the selected options In order to ensure the safety of the proposed facility. ASN's opinion must be duly notified to the applicant and must contain all complementary studies and justifications to be included in the creation-licence application, if submitted.

In general, ASN requests the competent Expert Advisory Group (*Groupe permanent d'experts* – GPE) to examine the project.

ASN informs the potential applicant of its opinion in order for him to be aware of the questions for which he will have to provide answers in his creation-licence application.

Safety options must then be presented in the licence application through the preliminary safety report.

The purpose of the preliminary procedure is not to replace any subsequent regulatory reviews, but rather to facilitate them.

Safety review and assessment of BNI creation-licence applications

All documents to be submitted in any application to create a BNI are listed in the *BNI Procedure Decree*. The applicant must provide, for instance, an environmental impact study, as defined in the *Environment Code*, and a preliminary safety report. No application may be submitted before the siting process and the preliminary studies are sufficiently advanced. The modalities for the safety review and assessment of the facility are described in § E.2.2.3.2.

Prerequisite safety review and assessment for BNI commissioning

In any licence application to commission a BNI, the applicant must provide a safety report containing an update of the preliminary safety report. Modalities for the safety review and assessment of the facility are described in § E.2.2.4.

Periodic safety reviews and re-assessments

In accordance with the Environment Code (Article L. 593-18), operators must review periodically the safety of their facility by referring to the best international practices. The purpose of such review is to assess the state of the facility by comparing it with applicable rules and to update the assessment of the risks or inconveniences raised by the facility with regard to security, health and the environment, by taking into account the state of the facility, the acquired experience feedback, the evolution of knowledge and applicable rules for similar facilities. All operators concerned must submit to ASN and the Minister in charge of nuclear safety a report containing the conclusions of such review and, if need be, the proposed steps to be taken in order to correct any detected anomaly or to improve the safety of their facility.

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

Re-assessments must be held every 10 years. However, the licensing decree may provide for a different frequency, if the particularities of the facility deem it necessary.

For the installations subject directive 2009/71/Euratom of 25 June 2009 which establishes a common framework for the safety of nuclear installations, the frequency of periodic re-assessments must be at least of once every ten years.

2.2.3.2. CREATION LICENCES

Submission of creation-licence applications

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

The coordination of the licensing procedure is led by the competent services under the authority of the Minister responsible for nuclear safety. The said services task ASN with the technical examination of the application file and submit the impact analysis to the opinion of the Environmental Authority within the General Council for the Environment and Sustainable Development.

Consultation of the public and the local authorities

The authorisation can only be granted after holding a public inquiry. Since 2011 the public inquiry regime is harmonised, and the procedure applicable to BNIs is no longer an exception but is incorporated into the general regime. The purpose of this inquiry is to inform the public and obtain public assessments, suggestions and counter-proposals, in order to provide the competent authority with all the information it needs prior to any decision.

The inquiry is conducted according to the provisions of the Environment Code. The Prefect opens the public inquiry in every commune which has any part of its territory located within a 5 km radius of the installation perimeter. This inquiry shall last at least one month and no more than two months. The file submitted by the licensee to support its authorisation application is made available. However, as the safety analysis report is a bulky document (containing the inventory of the risks the installation can present, the analysis of the measures taken to prevent these risks and a description of the measures designed to limit the probability of accidents and their effects) and is difficult for non-specialists to understand, it is supplemented by a risk control study. The opinion of the Environmental Authority is appended to the public inquiry file.

The principle of electronic information in the context of the public inquiry was written into the legislative part of the Environment Code by Ordinance 2016-1060 of 3rd August 2016 reforming the procedures for informing the public and ensuring public participation in the development of certain resolutions that could have an impact on the environment. More specifically, giving the public the possibility not only of consulting the file via the Internet throughout the duration of the inquiry but also of submitting its comments by this means is now the rule.

Consultation of technical organisations

For the technical examination of the application, in particular of the preliminary safety report supporting the creation-licence application, ASN is technically supported by IRSN and the Advisory Committees of Experts (GPE).

Once the application examined and the conclusions of the consultation are known, ASN must submit to the Minister in charge of nuclear safety a proposal designed to serve as the basis for the potential decree licensing the creation of the facility.

The creation authorisation decree (DAC)

If all the conditions are met, the minister responsible for nuclear safety sends the licensee a preliminary draft decree granting creation authorisation (DAC). The licensee has a period of two months in which to present its comments. The minister then obtains the opinion of ASN. ASN Resolution 2010-DC-0179 of 13 April 2010, gives the licensees and the CLIs the possibility of being heard by the ASN Commission before it issues its opinion.

Any BNI-creation licence must be issued through a decree signed by the Prime Minister and countersigned by the Minister in charge of nuclear safety.

The decree sets forth the perimeter and characteristics of the facility.

It must also specify the term of the license if any, and the commissioning delay of the facility. It must also impose the availability of essential means for protecting public security, health, hygiene, nature and the environment.

ASN requirements for the enforcement of the licensing decree

For the enforcement of the licensing decree, ASN may establish any design, construction and operating requirements it deems necessary for protection of the above-mentioned interests.

ASN must also define any requirement relating to activities involving water intakes by BNIs and discharges resulting from nuclear facilities. Specific requirements prescribing BNI discharge limits must be validated by the Minister in charge of nuclear safety.

These decisions are subject to public participation pursuant to Article L.123-19-2 of the *Environment Code* which specifies public participation for all decision with a direct and notable impact on the environment.

2.2.4. BNI operating procedures

2.2.4.1. BNI OPERATING PROCEDURES

Commissioning corresponds to the first loading of radioactive substances in the facility or the initial operation of a particle beam.

Prior to commissioning, the operator must submit an application containing an update of the preliminary safety report, the general operating rules, a waste-management study, the on-site emergency plan and, except for disposal facilities, an update of the decommissioning plan, if need be.

Once checked that the facility complies the objectives and rules defined in the *Environment Code* and its accruing instruments, ASN may license the facility to be commissioned.

The licence resolution must be mentioned in the *Bulletin officiel de l'ASN*. ASN must also notify the operator as well as inform the Minister in charge of nuclear safety and the Prefect concerned. It also informs the CLI.

Before the evolution or completion of the commissioning-licensing procedure, ASN may issue a partial-commissioning licence for a limited time period and in certain specific cases, notably if special operating tests need to be performed requiring the introduction of radioactive substances in the facility, and provided that the resolution is published in its *Bulletin officiel*.

ASN's resolution to authorise commissioning must prescribe the time period within which the operator must submit a report on the end of the commissioning phase, including a summary report on the commissioning tests to be performed in the facility, a status report on experience feedback and an update of the documents filed for the commissioning-licensing application.

2.2.4.2. SIGNIFICANT CHANGES TO THE FACILITY

During operation, the licensee informs either the Minister responsible for nuclear safety or ASN of any substantial or noteworthy modification relating to the installation.

Case of a substantial modification of the installation

A new license - examined in the manner and following the procedure described earlier for a creation authorisation - must be obtained in the case of a "substantial" modification.
A modification is considered to be "substantial" in the cases mentioned by the procedures decree:

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

The other modifications necessitating a modification of the authorisation decree, changes of licensee or modifications of the perimeter are subject to an alleviated procedure.

Case of a noteworthy modification of the installation

Noteworthy modifications to a basic nuclear installation, to its authorized operating conditions, to the elements that led to its authorisation or its commissioning authorisation, or to its decommissioning conditions, are subject, depending on their significance, to either notification to ASN or authorisation by ASN.

This recent provision entered into application in February 2016; pending the issue of an ASN resolution - which is currently under preparation - setting the list of modifications that are subject to notification (modifications which do not significantly call into question the BNI safety analysis report or the impact study), noteworthy modifications of this nature for which the licensee has put in place an in-house oversight system authorised by ASN, are subject to notification. All other noteworthy modifications are subject to authorisation.

2.2.4.3. INCIDENT FOLLOW-UP

Under the Environment Code, the licensee of a basic nuclear installation or the person responsible for the transport of radioactive substances is obliged to notify ASN and the administrative authority, without delay, of any accidents or incidents that occur on account of the operation of that installation or the transport activity and which could significantly prejudice safety, public health or the protection of nature and the environment. Operating experience feedback (OEF) encompasses events occurring in France and abroad, when it appears relevant to take them into account to reinforce nuclear safety, radiation protection and protection of the environment. OEF from French events more specifically concerns events referred to as "significant". ASN defines the criteria for the notification of events it considers significant in publicly accessible guides: such events are then notified by the licensee to ASN who manages them in a database. The notifying party assesses the urgency of notification in the light of the confirmed or potential seriousness of the event and the speed of reaction necessary to avoid an aggravation of the situation or to mitigate the consequences of the event. The notification time of two working days, tolerated in the notification guides made available by ASN to the persons responsible for nuclear activities, does not apply when the consequences of the event require the intervention of the public authorities. ASN classes these events systematically on the INES scale when it is applicable.

An event that would not be considered significant must nevertheless be taken into account by the licensee as an anomaly or deviation and recorded with a view to taking corrective action if necessary or analysing trends. This information is made available to ASN, during inspections for example.

2.2.4.4. FINAL SHUTDOWN AND DECOMMISSIONING

The legislative and regulatory framework of final shutdown and decommissioning

The technical provisions applicable to the installations that a licensee wants to definitively shut down and decommission must satisfy the general regulations concerning safety and radiation protection. These concern more particularly the measures taken with respect to the external or internal exposure of workers to ionising radiation, the criticality, the production of radioactive waste, discharges of effluents into the environment and measures to reduce the risks of accidents and mitigate their effects.

Nevertheless, decommissioning activities have particularities that must be taken into consideration (change of the nature of the risks, rapid changes in the status of the installations, duration of operations, etc.). A licensee planning to definitively shut down its installation must notify the Minister responsible for nuclear safety and ASN of its intent, indicating in its notification the date on which shutdown is to take place. No later than two years after notification (unless this deadline is extended, which is not planned for in the case of electricity production pressurised water reactors), the licensee must submit a file detailing the planned decommissioning operations. Decommissioning of the BNI is prescribed by a decree issued after obtaining the opinion of ASN and holding a public inquiry.

The decree, which modifies the creation authorisation decree, prescribes the decommissioning operations, defines the decommissioning stages and characteristics and, if applicable, the operations incumbent upon the licensee after decommissioning.

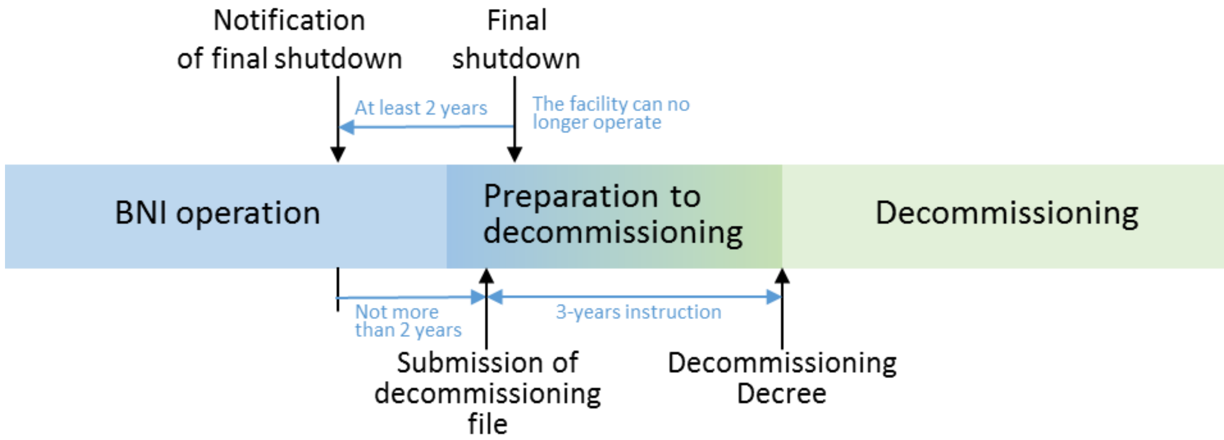

FIGURE 4: FINAL SHUTDOWN AND DECOMMISSIONNING PROCEDURE

The BNI procedures decree sets out the content of the file to be provided by the licensee:

- to support its notification of final shutdown of a BNI;
- then, no later than two years after its final shutdown notification, the content of the decommissioning file.

Consultation of the CLI and the public for the decommissioning decree through a public inquiry is set by law and has become mandatory.

For basic nuclear installations devoted to the disposal of radioactive waste, final shutdown is defined as being the definitive stopping of reception of new waste and decommissioning is taken as meaning all the operations in preparation for closure of the installation after final shutdown, and closure itself; the phase following closure of the installation is qualified as the monitoring phase.
Specific provisions for the shutdown of a deep geological repository are mentioned in the Environment Code, including the fact that the shutdown of that repository may only be licensed through an act.

Implementation of final shutdown and decommissioning operations

For other facilities than radioactive-waste disposal facilities, final-shutdown and decommissioning operations are divided into two successive work phases, as follows:

- final-shutdown operations consist mainly in tearing down any installations outside the nuclear island, which are not required for maintaining its monitoring and safety, the maintenance or the reinforcement of containment barriers or the preparation of the status report of radioactivity, and
- decommissioning operations involving the actual nuclear section itself may be undertaken once final shutdown operations are completed or postponed (with the understanding that the immediate-dismantling objective should be prioritised, see F.6.1).

In certain cases, such operations as the unloading and evacuation of nuclear substances, the elimination of fluids or any decontamination and clean-up action may be carried out in accordance with the creation- licensing decree, provided that they do not lead to any non-conformity with the former rules and that they are conducted in full compliance with the safety report and the general operating rules in force, except for some occasional changes, if need be. In all other cases, those operations are regulated by the licensing decree for final shutdown and decommissioning.

Decommissioning of facilities and implementation of public easements

Any decommissioning application must include especially a description of the state of the site after decommissioning and clean-out, including an analysis of the state of the soil and a description of potential remaining constructions of the initial facility and of their state.

If all decommissioning operations reach the final expected state as approved by ASN, the facility may be decommissioned and removed from the list of BNIs (delicensed) in accordance with the procedure referred to in the licensing decree for the final shutdown and decommissioning of the facility.

The decommissioning application must contain especially a statement on the expected state of the site after decommissioning, including an analysis of the soil and a description and state of the likely facility constructions to remain.

In order to preserve the past memory of a BNI on a given site and to forecast, if need be, the future use of the facility, public easements relating to soil use on and around the actual footprint of the facility may, in accordance with the *Environment Code,* be instituted after the decommissioning or disappearance of the facility.

Public easements relating to soil use and the conduct of work subject to an administrative statement or licence may also be undertaken on existing facilities, including those in service, in accordance with the *Environment Code*.

2.2.5. BNI technical rules

Technical rules and practices relating to nuclear safety are set in a multi-tier series of texts, as summarised in L.5.1 and L.5.2, in ascending order of detail. The first of those texts are statutory, but relatively general in nature; their scope is broad and, most of the time, does not involve technical details. The latter ones, however, detail specific subjects, and their legal format is more flexible.

As mentioned in section A, a comprehensive revamping of the general technical regulations applicable to BNIs has started once the TSN published and has progressed substantially.

2.2.5.1. GENERAL TECHNICAL REGULATIONS

General technical regulations deal currently with three major topics: pressurised equipment (only very limited relation with facilities within the scope of the Joint Convention), quality organisation (see chapter F.3), external nuisances and risks resulting from BNI operation (see § E.2.2.6.2).

In accordance with Article L.592-20 of the *Environment Code*, ASN also takes decisions in order to complete the implementation modalities prescribed by the decrees and orders relating to nuclear safety and radiation protection, except for those relating to occupational medicine.

All ASN resolutions pertaining to nuclear safety and radiation protection are subject to the validation of the relevant Minister in charge of nuclear safety or radiation protection, as the case may be.

Those resolutions, together with the mandatory opinions ASN provides on decree drafts, are published in its *Bulletin officiel*, which may be consulted on ASN's website (www.asn.fr).

2.2.5.2. BASIC SAFETY RULES AND ASN'S GUIDES

On various technical subjects concerning both power reactors and other BNIs, ASN issues *Basic Safety Rules* (*Règles fondamentales de sûreté* – RFS). Those documents consist of recommendations that define safety objectives and describe practices that ASN deems satisfactory to ensure compliance.

They are not statutory in nature. An operator may choose not to follow the provisions of any RFS, as long as he is able to prove that the alternate method he proposes ensures that the prescribed safety objectives are met.

Through its flexibility, that type of text allows for technical requirements to be updated according to technical advances and new knowledge.

In the framework of the general technical regulatory reform, RFSes will be replaced by "ASN Guides".

All RFSes and guides referring more particularly to facilities within the scope of the Joint Convention are listed in Annex L.5.

2.2.6. Scope of BNI control

ASN's supervision constitutes a statutory mission designed to check that any nuclear operator assume his full responsibilities and comply with all regulatory provisions relating to radiation protection and nuclear safety. Those supervisory activities help ASN ascertain its opinion on the performance or the challenges of a specific operator or nuclear activity.

2.2.6.1. NUCLEAR SAFETY CONTROL

As part of its supervisory activities, ASN takes a keen interest in the physical equipment of the facilities, in the workers responsible for their operation, as well as in working methods and organisational arrangements from the initial design stages to final decommissioning. ASN examines the steps taken with regard to safety, control, the limitation of occupational doses received in facilities, as well as specific modalities for managing waste, controlling effluent discharges and ensuring environmental protection.

ASN's central services co-ordinate and lead regional interventions of other ASN divisions in those fields, deal with significant national issues, as well as draft and enforce the national nuclear-safety policy.

2.2.6.2. ENVIRONMENTAL PROTECTION

The prevention and mitigation of nuisances and risks arising from the operation of BNIs are regulated by Title IX of Book V of the *Environment Code* (integrated system) and its implementing decrees, as well as by the BNI Order.

Generally speaking, ASN's policy in terms of environmental protection tends to be similar to that applied to conventional industrial activities. For example, the BNI Order requires the implementation of the best available techniques at an economically acceptable cost, taking account of the particular characteristics of the environment of the site.

This approach entails the definition of limits applicable to the discharges of chemical substances and to the reduction of the authorised limits for discharges of radioactive and chemical substances. The previous regulatory framework made provision for discharge permits of limited duration. As these permits expire, they are renewed in accordance with the above provisions. This renewal is an opportunity to examine whether it is possible to reduce the discharges from the installations and improve their monitoring conditions.

2.2.6.3. WORKING CONDITIONS IN BNIS

Generally speaking, controlling compliance with labour regulations (especially in the case of labour agreements, working hours, staff representatives, health and safety, conciliation procedures during labour disputes, advice and information of employers, employees and staff representatives about their rights and obligations) is the responsibility of labour inspectors.

In the case of NPPs, the legislator entrusted the functions of labour inspectors upon ASN-designated engineers or technicians among the agents placed under its authority.

In other BNIs where ASN is not responsible for labour inspections, exchanges with other labour inspectors constitute a valuable source of information on the state of labour relationships in the framework of an overview of nuclear safety and radiation protection that grants a larger significance to people and to organisations.

Lastly, Ordinance 2016-128 of 10th February 2016 introducing various provisions relating to nuclear activities has confirmed, through the creation of an article L. 593-42 in the Environment Code, that the BNI system covers the collective aspects of occupational radiation protection (for example the sizing of biological protections, optimisation of radiation protection zoning, etc.).

2.2.7. Control modalities for BNIs

There are many ASN supervisory procedures, consisting mainly of the following:

- on-site inspections or in services associated with operators, worksite inspections during maintenance outages, and on-site technical meetings with BNI operators or the manufacturers of equipment used in facilities, and
- the review of applications and supporting documents submitted by operators.

2.2.7.1. INSPECTIONS

In order to take into account health and environmental issues, the operator's performance in terms of nuclear safety and radiation protection, as well as the number of activities falling under its jurisdiction, ASN designates on a periodic basis which activities and topics represent the strongest challenges and on which it will concentrate its inspections and apply a direct control at a given frequency. Waste and effluent management is one of the priority topics.

In order to ensure a sound distribution of inspection means in relation to the nuclear-safety, radiation-protection and environmental-protection goals of the different facilities and activities involved, ASN draws up a provisional annual inspection programme, which identifies the facilities, activities and topics to be inspected. The programme is not communicated to the persons in charge of nuclear activities.

To achieve its goals, ASN has a team of inspectors that are selected according to their professional experience and their legal and technical knowledge. Nuclear-safety inspectors are ASN engineers accredited after a training programme adapted to the scope of their duties and then designated as such by an ASN resolution. They perform their control mission under the authority of the Director-General of ASN; they must take an oath and are bound by professional secrecy.

Every year, ASN carries out about 800 inspections in BNIs and on shipments of radioactive substances.

In 2016, 649 inspections were carried out in BNIs and on pressure equipment, and about 23% of the inspections were unannounced. These inspections can be broken down into 88 inspections of PE (pressure equipment), 246 inspections in LUDDs (laboratories and plants) and 315 in the NPPs (nuclear power plants).

Figure 5 shows the distribution of the inspections by theme. The themes relating to nuclear safety and social, organisational and human factors represent more than 50 % of the BNI inspections. 12 % of the inspections, i.e. a total of 72 inspections, are devoted to themes associated with environmental monitoring, waste and effluents in the BNIs (see graph below).

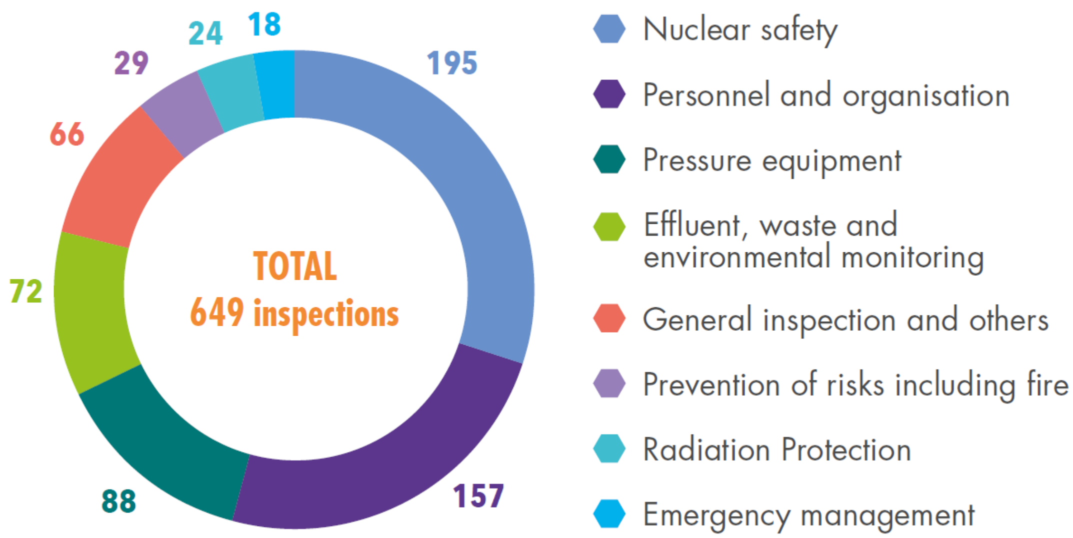

FIGURE 5: BREAKDOWN OF BNI INSPECTIONS IN 2016 BY THEME

2.2.7.2. TECHNICAL REVIEW OF DOCUMENTS PROVIDED BY OPERATORS

The operator is required to provide ASN with relevant information in order to ensure the efficiency of its control. The content and quality of that information is designed to demonstrate that the objectives of the regulations, along with the operator's own objectives, are met. ASN is responsible for checking the thoroughness of the case and the quality of the demonstration.

The review of those cases may lead ASN to accept or not the operator's proposals, to require further information or studies, or even backfitting activities. ASN must formulate its requirements in the form of resolutions.

The review of the supporting documentation submitted by the operators and the matching technical meetings organised with them constitutes one of the control means used by ASN.

Significant events

Any "significant event" (see § E.2.2.4.3) relating to the safety of a BNI, to the radiation protection of workers, members of the public and the environment, or to the transport of radioactive materials, must be declared to ASN at the earliest opportunity.

ASN ensures that the operator has conducted a sound analysis of the event and taken all appropriate corrective steps to correct the situation and to prevent its recurrence, and has also disseminated the relevant experience feedback.

The analysis of a significant event deals with the compliance of current regulations regarding the detection and declaration of significant events, the immediate steps to be taken by the operator in order to maintain or to restore the facility under safe conditions, and finally, the relevancy of reports on significant events to be submitted by the operator.

Together with the IRSN's technical support, ASN carries out a deferred review of the experience feedback from events. All information provided by territorial divisions and the analysis of all significant-event reports and periodic status reports submitted by operators constitute the organisational base for ASN's experience feedback. That experience feedback may lead to requests to improve not only the operator's facilities or organisational structure, but also the regulations themselves. It is taken into account in the preparation of the inspection program mentioned in § 2.2.7.1.

The figure below shows information relative to significant events having occurred in the laboratories, plants, installations undergoing decommissioning, and waste processing, storage or disposal facilities (LUDD).

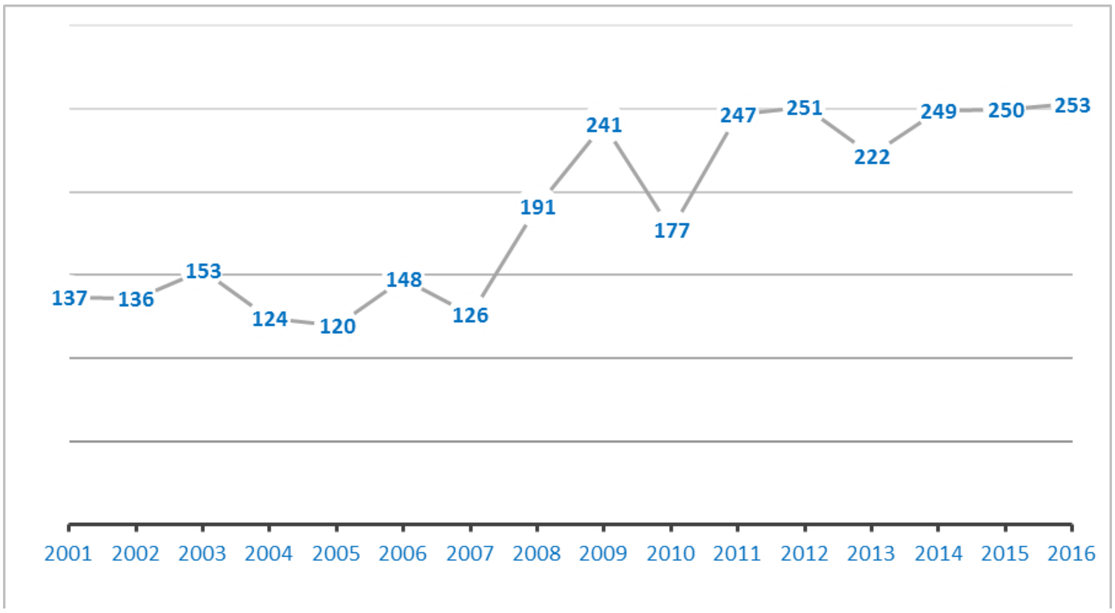

FIGURE 6: TREND FOR TOTAL NUMBERS OF SIGNIFICANT EVENTS NOTIFIED FOR LUDD FACILITIES BETWEEN 2001 AND 2016

The total number of significant events is stable since 2009.

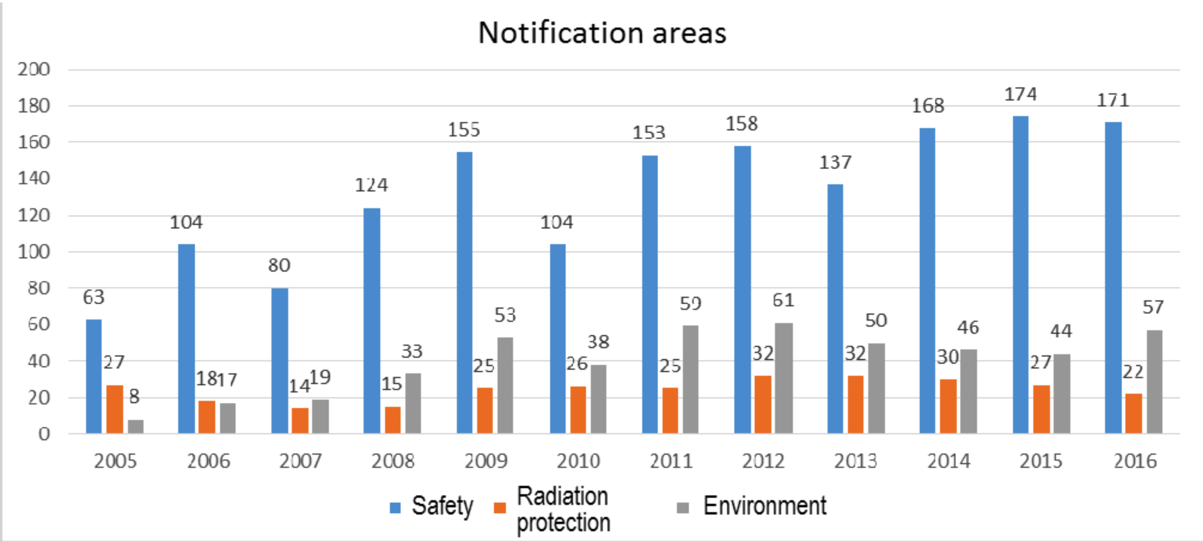

FIGURE 7: BREAKDOWN OF SIGNIFICANT EVENTS BY NOTIFICATION AREAS (2005 – 2016)

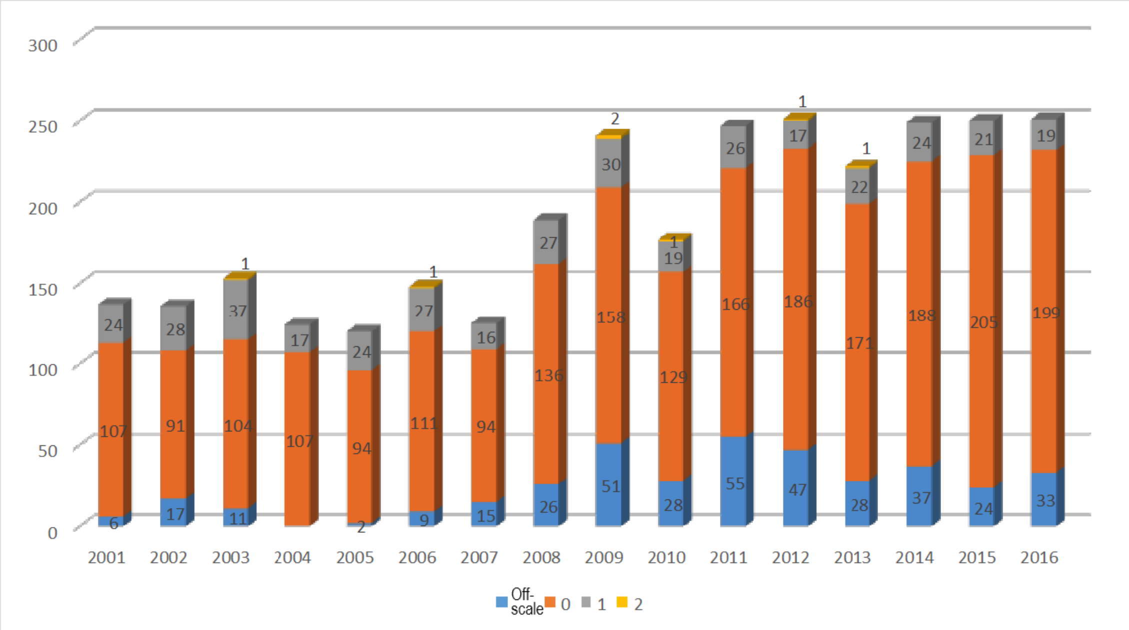

FIGURE 8: INES CLASSIFICATION USED FOR SIGNIFICANT EVENTS RELATIVE TO LUDD FACILITIES (2001-2016)

Other information presented by operators

On a periodic basis, operators must submit activity reports and status reports on liquid and gaseous effluents they discharge and the waste they generate.

Similarly, operators provide a wealth of information on specific topics; such as the seismic resistance of the facilities, fire protection, supplier relations, etc.

Review of submitted information

Whenever it deems it necessary, ASN may call upon its technical support organisations, primarily the IRSN, for advice. Safety assessment implies the mobilisation of many specialists and effective co-ordination in order to identify key aspects relating to safety- and radiation protection. The IRSN's assessment relies on studies and R&D programmes focusing on risk control and knowledge improvement on accidents. It is also based on comprehensive technical exchanges with operating teams who design and run the facilities.

For several years now, ASN has been seeking to diversify its technical support organisations by calling upon both French and foreign organisations.

For major issues, ASN requests the opinion of the competent GPE before which ASN itself or its technical support organisation tables the results of its assessments; for the majority of other matters, safety analyses are the subject of an opinion to be sent directly to ASN by the IRSN.

2.3. The regulatory frameworks of the ICPEs and mines

2.3.1. The regulatory framework of the ICPEs

The regulations governing the ICPEs are applied by the department Prefects under the coordination of the DGPR. For each heading of the ICPE nomenclature, the inspectorate develops formal prescriptions for the licensees through prefectural orders. The latter take into consideration the particularities of the installations and their environment.

General regulations are drafted by the Ministry for the Environment in full compliance with European directives and French international commitments. The DGPR co-ordinates inspections and is responsible for supervising the technical, methodological, legal and regulatory framework at the national level.

ICPE Regulations are based on an integrated approach, which means that:

- a single environmental-protection licence is issued per industrial site (rather than several licences, including one for liquid discharges, one for gaseous discharges, one for risks, etc.). The integrated approach enables all environmental impacts to be taken into account (air, water, soil, noise, vibrations) along with the industrial risk, and
- a single authority is competent to apply the legislation. In France, only the State is competent with regard to the ICPE legislation. It acts via the Prefect (State representative in each *département*) assisted by the relevant ICPE Inspectorate in France, the State is the only body competent to legislate on the ICPEs. The State intervenes through the Prefect (State representative in each département) assisted by the ICPE inspectorate.

Facilities with a low environmental impact are subject to a simple declaration procedure.

Between the declaration and registration thresholds, a declaration must be made to the Prefect of the département, general prescriptions must be adhered to and the installation may be inspected. Between the registration and licensing threshold, prior authorisation from the Prefect of the département is necessary. Beyond the licensing threshold, the license is issued after a public and administrative inquiry, subject to the report by the ICPE inspectors and the opinion of CODERST (Departmental Council for the Environment and for Health and Technological Risks).

The licensing process concerns the most polluting or hazardous activities. The licensing procedure begins with a licence application containing an impact statement and a risk study. This application is subject to various consultations, notably with local communities, and a public inquiry. The procedure ends with the issue (or denial) of the licence in the form of a prefectural order containing requirements.

While the requirements for facilities subject to declaration and registration are standardised, requirements imposed on licensed facilities are set on a case-by-case basis, depending on the characteristics of the facility. Certain categories of facilities, however, are the subject of ministerial orders with a view to setting forth the minimum requirements to be included in licensing orders.

2.3.2. Regulatory framework for mines

The regulations governing mines is different to that for the ICPEs, mainly for historical reasons, and also because the working of mines poses specific technical problems. The Prefect of the département, the Government local representative, is the oversight Authority. However, the mining titles (concessions or operating permits) and the subsequent operating licenses are issued at national level after obtaining the opinion of the CGEIET (General Council for the Economy, Industry, Energy and Technologies).

The regulations governing mines covers the actual mining works and the legal dependencies of the mines; the majority of the ore processing and residue disposal facilities are currently classified as ICPEs (see § E.2.3.2.2).

For mining operations, the discharge of radioactive substances into the environment is regulated by Decree No. 90-222 of 9 March 1990 Completing the General Regulations of Mining Industries and its implementing Circular of 9 March 1990. The Decree forms the second part of the “Ionising Radiation” Section of the *General Regulations of Mining Industries* instituted by Decree No. 80-331 of 7 May 1980 in accordance with Article L. 162-5 of the Mining Code. In the framework of the transposition of European Council directive 2013/59/Euratom on basic safety standards for protection against the dangers arising from exposure to ionising radiation of 5 December 2013, some of the prescriptions of Decree No 90-222 are being modified.

Those regulations apply to the actual mining works, as well as to legal outbuildings, including associated surface and other essential installations, notably for the mechanical preparation of the ore before chemical treatment, which is not subject to the Mining Code, but to the *Environment Code*.

The end of all or part of mining operations, must be declared by the operator and must indicate which steps he intends in order to take to protect the interests referred to in Article 161-1 of the Mining Code. The Prefect either acknowledges the declaration or specifies additional measures. The mining work stoppage procedure concerns all the work and all the structures and facilities vital for operation, and which have never been duly declared abandoned or completely stopped with respect to the applicable regulations in effect at the time of industrial stoppage of the works. This procedure is governed in particular by the Mining code, by Decree 2006-649 of 2 June 2006 and specified in the circular of 27 May 2008. Stoppage of the works is the subject of a prior declaration to the competent authority.

The ministerial Order of 8 September 2004 details the composition of the file for declaring final stoppage of the mining work and use of the mining facilities.

It is important to note that if the mining regulations become applicable as of the start of mine research or operation work, the procedure for stopping the mining work is not applicable if the mining title has given rise to no research or operating work necessitating a start of works procedure.

Pursuant to the Law of 30 March 1999*,* hereinafter called the *“*1999 Law*”,* when major risks are likely to compromise the safety of property or persons, the operator must install and operate the necessary equipment for monitoring and preventing such risks. Once the claim expires, the responsibility for risk monitoring is transferred unto the State.

The State drafts and implements mining-risk prevention plans in accordance with Decree No. 2000-547 of 16 June 2000 Regarding the Enforcement of Articles L174-5 to L174-11 of the Mining Code*,* subject to the completion of the work stoppage procedure.

3 | REGULATORY BODIES (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 final and human resources to fulfil its assigned responsibilities.

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

Several Ministries are involved in defining, implementing and overseeing radioactive materials and waste management policy. Within the Ministry for Ecology, Sustainable Development and Energy (MEDDE), the General Directorate for Energy and Climate (DGEC) draws up policy and implements Government decisions concerning the civil nuclear sector, while the Nuclear Safety and Radiation Protection Delegation (MSNR), under the joint authority of the MEDDE and the Minister responsible for health, drafts, coordinates and implements the Government's roles concerning civil nuclear safety and radiation protection.

3.1. The French Nuclear Safety Authority (ASN)

The TSN Act created ASN (*Autorité de sûreté nucléaire*), an independent administrative authority tasked with the oversight of nuclear safety and radiation protection for all civil nuclear activities.

ASN contributes to the informing of the public. It also contributes to operational management of radiological emergencies.

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

3.1.1. ASN independence, regulatory body

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 other two commissioners are appointed by the president of the National Assembly (lower house of the French Parliament) and by the president of the Senate (upper house), respectively.

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

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

The duration of the mandate of the members is six years. It is non-renewable. A member's functions may only be terminated in the event of incapacity or resignation as recorded by a majority vote of the Commission. The President of the French Republic may also terminate the term of any commissioner in the event of severe dereliction of duty.

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

ASN opinions

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

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

The OPECST

ASN regularly reports on its activity, notably by submitting its annual activity report to Parliament, to the Government and to the President of the Republic. For Parliament, it is before the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) that ASN each year presents its annual report on the situation of nuclear safety and radiation protection in France;

Created in July 1983, the OPECST is tasked with informing Parliament of the consequences of scientific and technological choices so that it can take informed decisions. The OPECST is assisted by a scientific council made up of members who reflect the diversity of the scientific and technical disciplines. The role of the OPECST members is to study the organisation of nuclear safety and radiation protection within the administration and with the licensees, to compare their characteristics with those of other countries and to verify that the authorities have the means to carry out their mission. The Office's reports are drafted before voting a law in order to prepare the legislative decision, or afterwards for follow-up of implementation of the text passed. The members of the OPECST also played an important part in the development of the TSN Act.

3.1.2. Organisation

ASN is led by a five-member Commission and constituted by central services and territorial divisions, which are placed under the authority of the Director-General, who is in turn supported by three assistants, an advisor and a principal private secretary.

The TSN Act lists the different categories of either regulatory or individual resolutions to be taken by ASN, such as the following:

- technical regulatory resolutions for the enforcement of decrees or orders relating to nuclear safety and radiation protection;
- commissioning licences of BNIs, and
- licences or certifications relating to the transport of radioactive substances or to medical establishments or equipment using ionising radiation.

Some of those resolutions are subject to validation by the Minister in charge of nuclear safety or radiation protection.

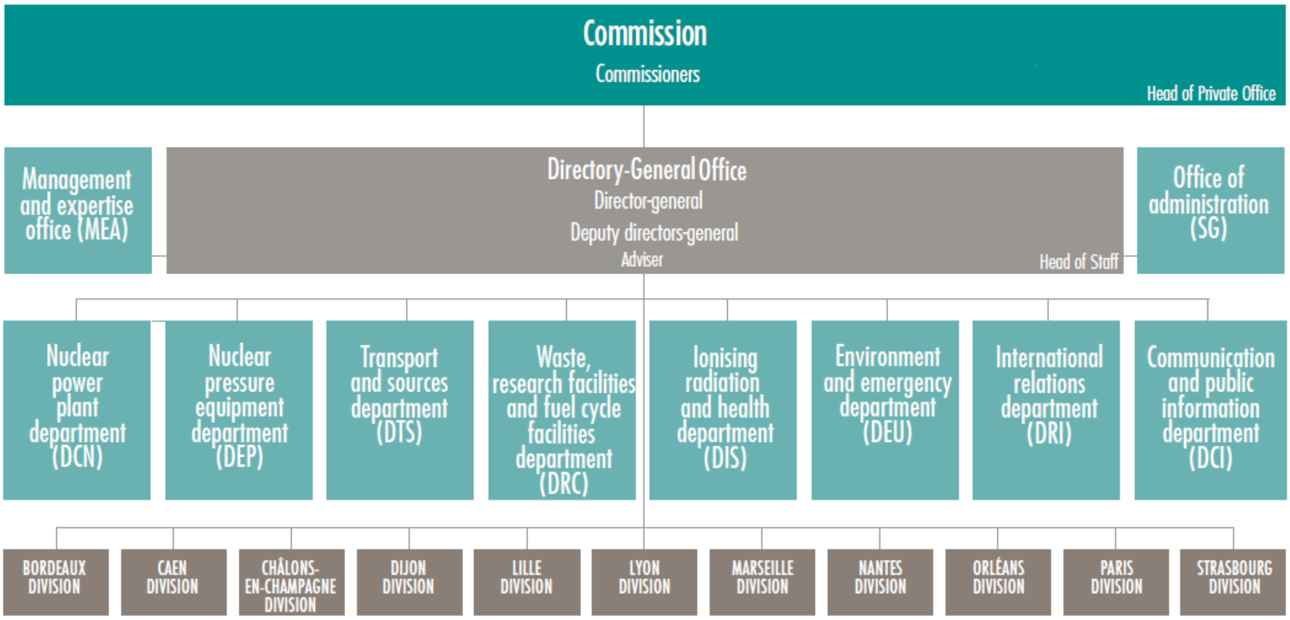

FIGURE 9: ASN'S ORGANISATION CHART ON 31 DECEMBER 2016

3.1.2.1. ASN COMMISSION

The commission and its operation are detailed in § E.3.1.1.

ASN has its own *Rules of Procedure,* which govern its organisation and operation, as well as its own *Ethical Code*. The former describes the relevant conditions and limits within which any Commissioner may delegate part of his/her powers to its President and the President may delegate his/her signing authority to agents within ASN services.

3.1.2.2. ASN CENTRAL SERVICES

ASN's central services comprise eight directorates, the Secretariat-General, which is also in charge of communication, and the Section of Legal and Corporate Affairs.

Directorates are responsible for managing national matters pertaining to their jurisdictions. They participate in the drafting of general regulations and the coordination of the overall action of ASN divisions. They are also involved in international works.

3.1.2.3. ASN TERRITORIAL REPRESENTATIVES AND DIVISIONS

ASN's territorial divisions carry out their activities under the authority of territorial representatives designated by ASN President. The Director of the relevant regional DREAL assumes the responsibility of representative. He is put at the disposal of ASN and does not report to the Prefect about his mission regarding nuclear safety and radiation protection. A delegation of signing authority by the Director-General confers authority to territorial representatives for local decisions.

Divisions perform most of the field control of BNIs, transport of radioactive materials and activities relating to the small-scale nuclear sector.

In emergency situations, divisions assist the Prefect, who is responsible for public protection, and ensure that all *in-situ* operations to secure the facility are monitored. For emergency-preparedness purposes, ASN's divisions also take part in the development of emergency plans drawn up by the Prefects and in periodic crisis drills.

Divisions contribute to ASN's public-information mission. Moreover, they take part in CLI meetings, and maintain also regular contacts with local media, elected officials, environmental associations, operators and local administrative partners, such as prefects, regional hospitalisation agencies (*Agence régionale d'hospitalisation* – ARH), Regional Directorates for Health and Social Affairs (*Direction régionale des affaires sociales et de la santé* – DRASS), etc.

3.1.3. Human resources and their management at ASN

3.1.3.1. RESOURCES

Human resources

On 31 December 2016, ASN's effective amounted 482 employees, divided as follow:

- 397 permanent or contract agents;
- 85 seconded agents from public corporations, including Social Welfare – Paris Hospitals (*Assistance publique – Hôpitaux de Paris*), CEA, IRSN, ANDRA, SDIS[9].

At the same date, the average age of ASN employees was 43 years 8 months.

Central services and divisions were distributed as shown in the following Table.

Central services	Territorial divisions	Total
266	**214**	**482** (included 2 seconded abroad)

TABLE 17: DISTRIBUTION OF ASN STAFF ON 31 DECEMBER 2016

Financial resources

Since 2000, all staff and operating resources for the fulfilment of ASN's mandate have been drawn from the general State budget.

In 2016, the State budget dedicated to the control of nuclear safety and of radiation protection in France stood at 176.54 M€ and was distributed as follows:

- 41.93 M€ of payroll appropriations (payment of staff)
- 38.86 M€ of administrative appropriations for the central services and the eleven regional divisions of ASN
- 85 M€ of appropriations devoted to the IRSN technical support to ASN and 10.6 M€ for other IRSN missions.
- 0.15 M€ for operation of the HCTISN (High Committee for Transparency and Information on Nuclear Security – HCTISN).

BNI Tax

Article 16 of the TSN Act also specifies that the President of ASN is in charge of payment invoices and settlements, on the State's behalf, of the BNI tax instituted by Article 43 of the *2000 Finance Act* (*Law No. 99-1172 of 30 December 1999*), The outcome of the tax for 2016 amounted to 576.82 million euros and is deposited in the State's general budget.

Additional taxes on radioactive waste

With regard to nuclear reactors and spent-fuel treatment plants, the *Waste Act* also instituted three additional BNI taxes, called "research", "economic-incentive" and "technological diffusion" taxes, respectively, and allocated

[9] Local fire and rescue department

them to the financing of economic-development actions as well as of ANDRA's research activities on waste storage and deep geological disposal facilities.

In 2016, those taxes generated 145.92 M€. Lastly, the Act 2009-1673 of 30 December 2009 instituted an additional tax on the disposal facilities that is paid over to the municipalities and public establishments of intercommunal cooperation situated around the disposal facilities. The returns from this tax represented 3.3 M€ in 2016.

Special contribution

Lastly, the Supplementary Budget Act for 2013 created a special contribution that is payable until the date of creation of the deep geological disposal facility, as mentioned in 2° of article 3 of Planning Act 2006—739 of 28th June 2006 relative to the sustainable management of radioactive materials and waste;

The product of this contribution amounted to 134.1 M€ for 2016.

	Amount (in million euros)		
Operators	BNI Tax	Special contribution	Additional taxes on radioactive waste
EDF	543.6	104.6	112
AREVA	16.5	6.7	7.2
CEA	6.5	22.8	21.5
ANDRA	5.4		3,3
OTHERS	4.8		1.92
TOTAL	576.82	134.1	145.92

TABLE 18: DISTRIBUTION OF CONTRIBUTIONS FROM OPERATORS

3.1.3.2. HUMAN-RESOURCE MANAGEMENT

Training of agents

Skill management

Companionship" arrangements, as well as initial training and continuing education, whether general in nature or relating to nuclear techniques, constitute key elements of ASN's professionalism.

Managing staff skills is based notably on a formalised curriculum of technical training courses for each agent in accordance with a detailed and regularly updated training reference system. For instance, an inspector must follow a series of predefined training sessions involving technical, legal and communication techniques, before being certified to carry out inspections. In 2016, ASN agents spent about 4 000 days in technical training spread over 212 sessions within 131 different courses. The financial cost of those training sessions provided the other organisations than ASN amounted 520 k€ in 2016.

The percentage of training costs with respect to the payroll also includes the payroll costs of the 4,219.5 "trainee days" (national and local training plans), the 184 internal instructor days and the payroll for the personnel responsible for training. In 2016 training costs totalled 2.2 M€, that is to say 7.4% of the ASN payroll.

Inspector qualification

Since 1997, ASN has been involved in developing an inspector-qualification system relying on the recognition of their technical skills. A certification Committee was created in 1997 in order to advise the Director-General on an overall qualification mechanism. The Committee reviews notably suitable training curricula and qualification reference systems for each ASN service and holds hearings with inspectors as part of the confirmation process.

Half the Certification Committee includes confirmed senior ASN inspectors, while the other half is composed of competent persons in the fields of nuclear-safety control, know-how and education, as well as ICPE control, its jurisdiction will be extended to radiation protection.

The Committee met twice in 2016 and proposed to qualify 3 nuclear safety inspectors and 3 radioprotection inspectors as "confirmed inspectors". On 31 December 2016, 56 ASN nuclear-safety inspectors are confirmed inspectors and represent approximately 20% of all nuclear-safety inspectors.

Internal quality management

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

- an organisation manual containing organisational notes and procedures defining rules for the conduct of each of its missions;
- in-house and third-party audits to ensure rigorous application of the requirements of the system and regular questioning of the practices and the appropriateness of the baseline requirements for the needs;
- listening to stakeholder feedback:

- activity and performance indicators for monitoring the effectiveness of the action;
- a periodic review of the system in the drive for continuous improvement.

Applying an approach of continuous progress, ASN hosted an IRRS (Integrated Regulatory Review Service) mission in 2006 which focused on all areas of nuclear safety and radiation protection and led to a follow-up mission[10] in 2009.

From 17th to 28th November 2014, ASN hosted a new IRRS mission to examine all of its activities, chaired by Mark Satorius, COO of the American Nuclear Regulatory Commission and by Ann McGarry, Director of the Office of Radiological Protection at the Irish Environmental Protection Agency.

During the mission, twenty-nine experts from the nuclear safety and radiation protection authorities of nineteen countries and from the IAEA met the ASN teams and the other State services concerned.

This extremely detailed mission confirmed the robustness and rigour of the regulation and monitoring carried out in France by ASN. The positive points or best practices highlighted included ASN's work as an independent regulatory body, the effective regulatory structure enjoying support from IRSN and the Advisory Committees of experts, France's long-standing commitment to safety and the robust and efficient organisational structure, attaching considerable importance to the impartiality of the commissioners, Advisory Committees and all the personnel, the extensive involvement of the stakeholders in the regulatory processes and the transparency of the decision-making process, the broad communications and, finally, the coordination between the oversight organisations involved in emergency planning and the efficient interaction with the licensees in this field.

Several points requiring attention were reported:

- the need to assess the regulatory framework for monitoring exposure in the medical field to check its completeness and the coordination between the organisations involved;
- the reinforcement of the system used by ASN to assess and modify its regulatory framework;
- the need to specify in ASN's integrated management system all the processes ASN needs in order to fulfil its role.

The conclusions of the mission also show that new means must be examined in order to guarantee that ASN has the human and financial resources it needs for effective oversight of nuclear safety and radiation protection in the future.

The IAEA final report was transmitted to France in the first quarter of 2015 and posted on the ASN website. A follow-up mission to the IRRS mission of 2014 is planned in October 2017.

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

3.1.4. ASN's technical supports

In preparing its resolutions, ASN benefits from the skills of its technical-support organisations, with the IRSN providing the most extensive contribution. In addition, ASN has been striving for several years to diversify its suppliers among national and international organisations.

3.1.4.1. INSTITUTE FOR RADIATION PROTECTION AND NUCLEAR SAFETY (IRSN)

The IRSN was created by *Law No. 2001-398 of 9 May 2001* and constituted by Decree No. 2002-254 of 22 February 2002. The Decree separated the former Nuclear Protection and Safety Institute (*Institut de protection et de sûreté nucléaire* – IPSN) from the CEA and merged it partially with the Office for the Protection Against Ionising Radiation (*Office de protection contre les rayonnements ionisants* – OPRI) in order to form the IRSN as a larger and single body to be responsible for research and assessment in the fields of nuclear safety and radiation protection.

BNIs safety assessments, including radioactive-waste storage and disposal facilities, are conducted on the basis of operators' proposals in order to provide ASN with relevant assessments to carry out its control activities. For larger tasks, such as the review of safety reports, major changes to facilities, waste-discharge licences, transversal issues such as safety and radiation protection management by operators) ASN relies on the opinion of a relevant GPE on the basis of operator data and of their critical analysis by the IRSN. For other projects (minor modifications to installations, steps taken after minor incidents, package specifications), safety analyses are the subject of assessments sent directly to ASN by the IRSN.

ASN also calls upon the IRSN's help to review the steps chosen by the operator to guarantee the safe transport of radioactive or fissile materials.

Hence, in 2016, with regard to "civilian" BNIs, other than nuclear reactors in service, the IRSN provided ASN with approximately:

- 104 positions concerning minor modifications to facilities or incidents and waste package specifications, and

[10] Link to the IRRS mission and follow-up mission reports: http://www.asn.fr/L-ASN/International/Les-relations-multilaterales-hors-Europe/L-Agence-internationale-de-l-energie-atomique-AIEA/Les-audits-de-l-AIEA-en-France

- 9 positions for the GPE and 12 positions on major changes or new facilities,

The IRSN also provided ASN with 44 positions concerning the safe transport of radioactive materials.

About 200 experts and specialists were involved in the preparation of those positions.

The IRSN also carries on research on radiation protection, radiation ecology and the safety of facilities. Those investigations relate to the main risks encountered in the facilities subject to the Joint Convention (criticality, fire, dispersion and mechanical strength of structures) and disposal facility safety after closure. These works involve more and more co-operation with French and international bodies.

3.1.4.2. OTHER TECHNICAL SUPPORTS

In order to diversify its skills and to benefit from other specific competencies, ASN also has its own budget.

A significant part of that budget is dedicated to topics associated with radon exposures to populations in homes and to the activities of the Steering Committee for the management of post-accidental phase (*Comité directeur pour la gestion de la phase post-accidentelle* – CODIRPA).

Since 2012, ASN has continued or initiated collaborations with, for example:

- the Building Industry Scientific and Technical Centre (CSTB): subjects associated with the exposure of populations to radon in the home (action spanning 2012-2014);
- the National Institute of the Environment and Risks (INERIS): on the theme of the environment, chemical pollution in particular, and the theme of social, organisational and human factors applied to the transport of radioactive substances;
- the Nuclear Protection Evaluation Centre (CEPN): support for post-accident work - study aiming at improving the system for training in patient radiation protection - assistance with the coordination, implementation and functioning of networks of radiation protection officers (RPOs).

ASN wishes to give impetus to the use of diversified expertise, and to that end it set up a European framework agreement with expert appraisal organisations in 2013.

3.1.4.3. ADVISORY EXPERT GROUPS (GPE)

In order to prepare its most important resolutions, ASN also relies on the opinions and recommendations from seven GPEs, which are competent respectively in the fields of waste (GPD), pressurised nuclear equipment (GPESPN), radiation protection in the medical sector (GPMED), radiation protection outside the medical sector (GPRADE), reactors (GPR), as well as transport, laboratories and plants (GPU).

More particularly, they review the preliminary, temporary and final safety reports of every BNI. They may also be consulted on various evolutions with regard to regulations or doctrine.

For each of the topics they deal with, the GPEs base their opinion on the reports prepared by the IRSN, a special working group or by one of ASN's directorates. In every case, they issue an opinion, accompanied by recommendations, if need be.

The GPEs consist of appointed experts for their skills. They originate not only from universities and associations, but also from operators who are interested in the topics being addressed. Every GPE may call upon any recognised person for his/her specific skills. The participation of foreign experts diversifies the approach methodology to issues and benefits from international experience.

In its transparency approach with regard to nuclear safety and radiation protection, ASN has been publishing since 2009 the documents relating to the meetings of those GPEs.

In order to increase the independence of this expertise and to foster the transparency of its work, ASN has defined new procedures for the selection and nomination of the GPE members, notably by opening them to experts from the "civil society".

The modifications in the composition of the GPEs in the area of nuclear safety will provide additional guarantees of independence of their opinions with respect to the nuclear licensees, transparency in the selection of the Committee members and technical quality of the opinions.

3.2. Nuclear-safety and radiation-protection mission (MSNR)

The Nuclear Safety and Radiation Protection Mission (*Mission de sûreté nucléaire et de radioprotection* – MSNR) is the ministerial service placed under the authority of the Minister of Ecology and Sustainable Development in order to deal on their behalves with the issues pertaining to the government's jurisdiction in the field of nuclear safety and radiation protection. Its missions are defined in Article 8.1.3 of the *Order of 9 July 2008*. The MSNR thus:

- coordinates and follows the files coming under the competence of the Minister responsible for nuclear safety and radiation protection (coordination of BNI procedures, preparation of regulations in collaboration with ASN, etc.);
- participates in the development of the national emergency organisation (accidents affecting nuclear installations or radioactive material consignments, 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 uranium mines and the ICPEs containing radioactive substances;
- coordinates and monitors the management of sites and soils other than BNIs polluted by radioactive contamination (in relation with the Bureau of Soils and Sub-Soils);
- proposes the State's intervention priorities in terms of rehabilitation of orphan contaminated radioactive sites (CNAR - National Commission for Assistance in the Radioactive Field) in relation with Andra and the DGEC;
- provides secretariat services to the High Committee for Transparency and Information on Nuclear Security (Haut *Comité pour la transparence et l'information sur la sécurité nucléaire*) (see § E.3.4.3.4).

3.3. ICPE Inspectorate and Mine Inspectorate

The ICPE inspectorate checks compliance with the technical prescriptions imposed on the licensees. This means that its work focuses equally well on the equipment of the installations and the persons responsible for operating it, as on the working methods and the organisation. It also intervenes in the event of complaints, accidents or incidents. If the inspectorate observes that the prescriptions are not appropriate, it can propose that the Prefect imposes additional prescriptions through an order. If the licensee does not comply with the compulsory measures, it is liable to 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.

With respect to mines, prospecting and operation are subject to the supervision by the administrative authority represented by the relevant prefect and the DREALs. Inspections are performed by DREAL engineers specialising in mining industries.

As the old uranium mines are no more operated, the supervision implemented concerns the site rehabilitation, security and environment impact monitoring.

3.4. Other actors involved in safety and radiation-protection control

3.4.1. Parliamentary Office for the Assessment of Scientific and Technological Options (OPECST)

Created by *Law 83-609 of 8 July 1983,* the OPECST is a parliamentary delegation comprising eighteen members of the National Assembly and eighteen senators (and their substitutes), whose mission is to inform Parliament about the impact of scientific and technological choices, particularly with a view to ensuring that decisions are taken with the full knowledge of the facts.

The OPECST is assisted by a Scientific Council consisting of 24 members from various scientific and technical disciplines.

From its outset, the OPECST strictly limited the work scoping of its rapporteur's whose duties are to examine the organisation of safety and radiation protection, both within the Administration and on operators' premises, to compare its characteristics with those of other countries and to check that authorities have sufficient resources to perform their mission. Supervision concerns both the operation of administrative structures and the review of technical cases, such as the future of radioactive waste or shipments of radioactive materials, as well as socio-political matters, such as the conditions under which information about nuclear topics is disseminated and perceived.

Hearings are open to the press and have become a well-established tradition at the OPECST. They allow all interested parties to express their views, to put across their arguments and to debate publicly any given topic under the guidance of the OPECST Rapporteur. The full minutes of the hearings are appended to the rapporteur's reports and represent therefore a substantial contribution to the information of Parliament and the public, and to the transparency of decisions.

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

3.4.2. The advisory bodies

3.4.2.1. THE NATIONAL REVIEW BOARD (*COMMISSION NATIONALE D'ÉVALUATION* – CNE)

The National Review Board (*Commission nationale d'évaluation* – CNE) consists of scientific personalities and was created in 1991 in order to assess investigation results on the management of HL-LL radioactive waste; more particularly, it is also responsible for preparing an annual report of its assessment activities and to follow international investigations on radioactive-waste management. The Environment Code formalised activities of the CNE in the sense that the Committee continues to prepare an annual assessment report, which now concerns investigations on all radioactive materials and waste in relation to the PNGMDR objectives.

In addition, the membership of the Committee specified by the law (renewable mandate once, turnover of half the members every three years). Ethical rules were also adopted in order to ensure full impartial assessments. The powers of the Committee have been strengthened in the sense that the law now prescribes that all assessed research establishments must provide the CNE with any required document to establish its annual report.

3.4.2.2. HIGHER COUNCIL FOR THE CONTROL OF TECHNOLOGICAL RISKS (CSPRT)

The CSPRT (Higher council for the prevention of technological risks) is a consultative body that gives its opinion in all cases where required by law or regulations, and notably in the area of BNIs or ICPEs (installations classified on environmental protection grounds). It studies any draft regulations or question relating in particular to ICPEs, BNIs or pressure equipment which the Ministers responsible for these matters or which ASN, in the case of questions concerning BNIs, considers worthwhile submitting to it. The council is made up more specifically of representatives of the administrations concerned and of ASN, representatives of the licensees, personalities chosen for their competence, representatives of associations, representatives of the interests of the regional authorities and representatives of the interests of the employees of the ICPES and the BNIs, among others. As for the texts introducing individual measures relative to a BNI (creation or decommissioning authorisation decree, for example), they are subject to a procedure whereby ASN hears the licensee and the CLI, provided for by an ASN Resolution of 13th April 2010.

3.4.2.3. HIGH COUNCIL FOR PUBLIC HEALTH (HCSP)

The Higher Council for Public Health (*Haut Conseil de la santé publique* – HCSP), created by Act No. 2004-806 of 9 August 2004 Concerning the Public Health Policy forms a scientific and technical advisory entity placed under the Minister in charge of Health.

The Council contributes to the determination of multi-annual objectives regarding public health, assesses the achievement of national public-health objectives and contributes to their annual follow-up. In connection with health agencies, it provides public authorities with the required assessment for the sound management of health hazards, as well as for the design and assessment of policies and strategies regarding health control and security. Lastly, it provides prospective reflections and advice on public-health issues.

3.4.2.4. HIGH COMMITTEE FOR TRANSPARENCY AND INFORMATION ON NUCLEAR SECURITY

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

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

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

The High Committee comprises 40 members appointed for a six-year term; they include parliamentarians, representatives from CLIs, environment protection associations (as mentioned in the *Public Health Code*), managers of nuclear activities, labour unions, IRSN, ASN and State services concerned as well as selected personalities for their skills.

The High Committee met for the first time on 18 June 2008 and has been holding four plenary meetings every year since then. It also issues two three reports or opinions on current or fundamental issues. For instance, it has submitted on 12 July 2010 to the Minister of Ecology and Sustainable Development a report on information and transparency with regard to the management of nuclear materials and radioactive waste generated at all stages throughout the fuel cycle and a report dated 28 March 2013 prior to the public debate on the CIGÉO project for deep geological disposal of radioactive waste.

3.4.2.5. ACCREDITATION COMMISSION OF LABORATORIES OF RADIOLOGICAL MEASUREMENTS IN THE ENVIRONMENT

Radiological measurements in the environment are made public. According to French regulations (Article R. 1333-11 of the *Public Health Code*), they must be collected within a single network. Called the National Measurement Network *of Environmental Radioactivity* (*Réseau national de mesure de la radioactivité de l'environnement*), the guidelines are set by ASN and the IRSN ensures its management. In particular, the network collates all the environmental analysis results, analyses that are imposed by the regulation and on operators and those generated by various State services and corporations. In order to ensure that published results are based on satisfactory measurements, a laboratory-accreditation process was set up.

ASN Resolution 2008-DC-0099 of 29 April 2008 details the organisation of the national network and sets the provisions for the approval of environmental radioactivity measurement laboratories.

The approval procedure includes the presentation of an application file by the laboratory concerned after taking part in an inter-laboratory test (ILT), its examination by ASN and a review of the application files by a pluralistic approval commission.

The task of the approval commission is therefore to ascertain that the measurement laboratories have the organisational and technical skills to provide the network with high-quality measurement results. It is this commission that is responsible for proposing to ASN the granting, refusal, withdrawal or suspension of approval. It makes its proposal on the basis of the application file presented by the candidate laboratory and on its results in the inter-laboratory tests organised by IRSN.

Chaired by ASN, the commission comprises qualified persons and representatives from government departments, laboratories, standardisation bodies and IRSN. ASN Resolution 2013-CODEP-DEU-2013-061297 of 12 November 2013 appointing the members of the approval commission for environmental radioactivity measurement laboratories.

The laboratories are approved by ASN resolution published in its Official Bulletin.

Resolution 2008-DC-0099 mentioned above was modified by resolution 2015-DC-0500 of 26 February 2015 in order to:

- change the composition of the national network's Steering Committee to have increased representation of environmental protection associations in particular;
- create a new type of approval for the sanitary control of foodstuffs.

3.4.3. Health and safety agencies

3.4.3.1. HEALTH WATCH INSTITUTE (INVS)

The Health Monitoring Institute (*Institut de veille sanitaire* – InVS), which reports to the Minister for Health, is responsible for the following tasks:

- monitoring and observing public health on an ongoing basis, collecting health-risk data and detecting any event likely to alter public health;
- alerting public authorities, and especially the three health and safety agencies presented below in case of any threat to public health or of any emergency situation, and recommending appropriate steps.

3.4.3.2. NATIONAL AGENCY FOR MEDICINES AND HEALTH PRODUCT SAFETY (ANSM)

The ANSM (National Agency for the Medicines and Health Product Safety) was created on the 1 May 2012. It is a public institution reporting to the Ministry of Health and has taken over the functions of the AFSSAPS (French Health Product Safety Agency) along with other new responsibilities. Its key role is to guarantee the safety of health products throughout their life cycle, from initial testing through to monitoring after receiving authorisation to put them on the market.

3.4.3.3. NATIONAL HEALTH SECURITY AGENCY FOR FOODSTUFFS, THE ENVIRONMENT AND THE WORKSPACE (ANSES)

The National Health Security Agency for Foodstuffs, the Environment and the Workspace (*Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail* – ANSES) is a public administrative establishment placed under the supervision of the Ministries for Health, Agriculture, the Environment, Labour and Consumer Affairs (*ministères chargés de la santé, de l'agriculture, de l'environnement, du travail et de la consommation*). It was created on 1 July 2010 by the amalgamation of two French health agencies: the French Food Safety Agency (*Agence française de sécurité sanitaire des aliments* – AFSSA) and the French Environmental and Occupational Health and Safety Agency (*Agence française de sécurité sanitaire de l'environnement et du travail* – AFSSET).

It fulfils watch, assessment, research and reference missions on a broad scope encompassing, human health, animal health and welfare, as well as plant health. It provides a transverse reading of health issues and, hence, is able to grasp as a whole the exposures to which human beings may be submitted through their life and consumption patterns, or the characteristics of their environment, including their professional one.

Within the Agency's jurisdiction, its mission is to assess risks, to provide relevant authorities all useful information on those risks, together with the skills and scientific as well as technical support for drafting legislative and regulatory provisions and for implementing risk-management measures.

Section F | Other General Safety Provisions (Art. 21 to 26)

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 license 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.

1.1. Spent-fuel management

Spent fuel from civil nuclear activities is produced and stored in BNIs. The fundamental principle of the overall specific organisation and regulatory system for BNI nuclear safety, which has been integrated in the law and in regulatory instruments for many years, is the prime responsibility of the operator. It was reiterated in the Environment Code.

The BNI order of 7 February 2012 sets the essential requirements with which BNI licensees must comply.

In the name of the State, ASN ensures that such responsibility is assumed. The respective roles of ASN and of the operator are divided up as follows:

- ASN sets forth general safety objectives;
- the operator proposes and justifies the technical procedures to achieve them;
- ASN ensures that those propositions are appropriate to meet the set objectives;
- the operator implements the approved procedures;
- during inspections, ASN checks the sound implementation of those procedures and draws corresponding conclusions.

Furthermore, any BNI licensee assumes civil liability pursuant to the Convention on third-party liability in the field of nuclear energy (Paris Convention).

1.2. Radioactive-waste management

The respective responsibilities and roles of the different parties involved in radioactive-waste management are described in B.5.4 and B.5 and summarised below.

1.2.1. ASN and BNI operator with regard to radioactive-waste management

The respective roles and responsibilities of ASN and of the operator of any BNI are similar to those described in F.1.1 with regard to the spent-fuel management.

1.2.2. Operator producing radioactive waste and operator of radioactive-waste-management facilities (waste-treatment company, storage keeper, ANDRA)

A producer of radioactive waste remains responsible for the management of its waste. Even if the producer sends the waste to a facility operated by another company for processing or storage, it remains responsible for it, without prejudice to the responsibilities of that other company as a nuclear installation licensee. Thus, the licensee of the facility in which the waste is stored and/or processed is responsible for the safety and radiation protection of its facility during its operation or its decommissioning. Likewise, for the disposal facilities, ANDRA is responsible for the safety and radiation protection of the facilities it operates.

The producer of radioactive waste remains responsible for its waste, even once the waste is stored or disposed of: the waste ownership is not transferred to ANDRA. However, as specified above, this principle does not exclude ANDRA's responsibility as BNI operator and in relation to the *Paris Convention*.

The responsibility of the waste producer lies mainly with financial aspects. In that respect, the practice in France, as applied in ANDRA's contracts, but not formalised into regulations, is based on the unlimited possibility in time to turn back to producers, if need be (notably in the case of potential consolidation work or additional provisions resulting from new legal or regulatory obligations).

There are a few exceptions to that rule, but they only involve a very small share of radioactive waste, such as those originating from "small producers", like biological research laboratories and medical items (radium needles, etc.) or radium-bearing products (salts, compasses, etc.) that were used in the past or result from the clean-up of polluted sites, as part of ANDRA's public-interest mission.

In addition, In case of defaulting responsible entities (e.g., company bankruptcy, actual or alleged insolvency of the responsible officer or officers, etc.), the State may supersede them in order to control risks on the concerned sites. That is notably the case of a certain number of sites contaminated with radioactive substances used in the radium or clock-making industries (radium-based paint) in the early 20th century. In accordance with Environment Code, ANDRA is not only in charge of collecting, transporting, taking over radioactive waste and rehabilitating sites contaminated with radioactivity upon the request and at the expense of the responsible entities or upon public request when the responsible entities for that waste or those sites are defaulting.

The Environment Code provides that ANDRA must benefit from a State subsidy in support of the Agency's public-interest missions. In order to issue an opinion on the use of that subsidy, the National Assistance Commission on Radioactive Issues (*Commission nationale des aides dans le domaine radioactif* – CNAR) was created within ANDRA. Whenever possible, the State is also in charge of suing liable entities in order for any incurred expenses to be reimbursed.

With regard to radioactive sources, the respective responsibilities of users, suppliers and manufacturers, as well as ASN's role, are described in Chapter F.2.5 and in Section J.

2 | HUMAN AND FINANCIAL RESOURCES (ARTICLE 22)

Each Contracting Party shall take the appropriate steps to ensure that:

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

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

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.

2.1. Regulatory framework for BNIs

Article L.593-7 of the Environment Code provides that "*the creation licence of any BNI shall take into account the technical and financial capabilities of its operator which must allow him to carry out his project […] particularly with regard to covering expenses incurred by the facility's decommissioning and rehabilitation, the monitoring and maintenance of its implementation site, or in the case of radioactive-waste disposal facilities, to covering final-shutdown, maintenance and monitoring expenses*" with due regard of the interests mentioned in Article L.593-1 of the Environment Code.

The TECV Act, the "BNI procedures" Decree of 2nd November 2017 modified by the Decree of 28 June 2016 and Title II of BNI Order indicate a number of requirements regarding the licensee's technical capabilities and its obligations in terms of outside contractor monitoring (see F.3.1).

With regard to the provisions for charges relating to decommissioning and the management of radioactive waste and of spent fuel, the Environment Code specifies the associated obligations imposed upon BNI operators and describes the methodology to be used in order to enforce those obligations (see B.1.6. and F.2.3.2).

2.2. Presentation of safety-allocated resources by BNI operators

2.2.1. ANDRA's human and financial resources

2.2.1.1. ANDRA'S FINANCIAL RESOURCES

Created in 1979 within the CEA structure, ANDRA was transformed into a public industrial and commercial establishment (*établissement public à caractère industriel et commercial* – EPIC) by the 1991 Act and the Waste Act of 28 June 2006. That status ensures the independence of the Agency.

ANDRA's structure was clarified in Decree No. 92-1391 of 30 December 1992 and consolidated in Articles R. 542-1 of the Environment Code, and modified again by Decree No. 2110-47 of 13 January 2010, thus providing the Agency with the following components:

- a Board of Directors, consisting of a member of the National Assembly or of a senator, six State representatives, seven qualified personalities representing economic activities with an interest for the Agency's operations, three qualified personalities and eight staff representatives;
- a chief executive officer appointed by decree;
- a government commissioner, who is the Director-General of Energy at the Ministry in charge of Energy;
- a finance Committee;
- an advisory market Committee;
- a national commission for radioactivity aids (CNAR);
- a scientific board.

ANDRA's internal structure is described in L.6.1.

Since 1 January 2007, ANDRA is financed by the following sources:

- Commercial contracts for ANDRA's industrial activities[11] (operation and monitoring of radioactive-waste disposal facilities, specific studies, take-over of waste or rehabilitation of sites). EDF, AREVA and the CEA constitute the major waste producers with whom the Agency has signed contracts.
- A subsidy for the preparation of the *National Inventory,* the collect and take-over of "small-scale" radioactive waste owned by individuals or local communities and the rehabilitation of sites contaminated with radioactive substances in cases of default of the liable entity. Indeed, in accordance with the Environment Code, "the Agency must receive a State subsidy in order to contribute to the financing of the public-interest missions entrusted upon the Agency pursuant to conditions described in Subsections 1 to 6 of Article L. 542-12".
- An assigned tax. Pursuant to Article L.542-12-1 of the Environment Code, ANDRA manages an internal "Research fund" intended for financing research and studies on the storage and deep geological disposal of high-level and intermediate-level long-lived radioactive waste. The Research fund is financed by a tax that is additional to the "Research" tax that already exists for BNIs. This additional tax has been instituted in place of the commercial contract that bound ANDRA to the main producers in order to "guarantee the funding of research and the management of radioactive waste over the long term". The tax is collected from the waste producers by ASN in accordance with the "polluter pays" principle, on the basis of flat-rate sums set by the Environment Code and multiplying factors set by decree. The flat-rate sums vary according to the facilities (nuclear power plant, fuel processing plant, etc.).

Moreover, since 1 January 2014, the CIGÉO project design studies and any preliminary work are financed by a "design" fund internal to the Agency (Article L.542-12-3 of the Environment Code), which is financed by contributions paid by the waste producers.

Lastly, the waste Act provides for a new financial measure for the future (2015/2019) by prescribing that funds for the construction, operation, final shutdown, maintenance and monitoring of HL-IL/LL waste-storage or disposal facilities built or operated by the Agency will be guaranteed through an internal fund created within ANDRA's accounting system and supplied by the resources drawn from the contributions of BNI operators, as designated by agreements.

As mentioned in B.1.6, BNI operators must set aside sufficient funds corresponding to the management charges for their waste and spent fuel (and to decommissioning activities) and allocate sufficient assets for the coverage of those requirements, thus representing a certain level of guarantee for the funding of ANDRA's activities over the medium and long terms.

ANDRA's financial statements and annual reports are downloadable from its website (www.andra.fr).

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3. Due to their nature, commercial contracts are subject to conventional commercial risks and may therefore generate benefits or involve intrinsic risk.

2.2.1.2. ANDRA'S HUMAN RESOURCES

At the beginning of 2017, ANDRA's staff amounted to approximately 650 agents, 69 % of which were engineers and managers. Some 120 employees were assigned to general management or transverse support functions, such as human resources, purchasing, management, accounting, finances, legal services, information systems, and communication.

About 140 people contribute directly to the operational industrial activities (particularly operation or monitoring of above-ground disposal facilities) and providing services, particularly with the aim of optimising the management of radioactive waste in France. They include agents in charge of checking that delivered packages comply with the facility's safety rules. In that regard, the Agency intends to develop and to maintain a strong safety culture through training and daily operating procedures (notably in line with its quality and environmental-protection approach).

The formalisation of safety principles, assistance to operators in their implementation process and control of their sound implementation, the development of safety-analysis methods and experience feedback from the operation of disposal facilities pertain to the Safety, Environment and Strategies Division, capitalising on knowledge of the packages and inventories, the inspection of packages, consisting of 75 agents whose duties involve also quality and environmental-management activities.

With a staff of about 100 employees, the Research and Development Division supports ANDRA's overall activities in various fields such as geology, hydrogeology, materials, the biosphere and modelling. In that context, this division participates in safety studies for both operational and planned disposal facilities.

With an effective of about 85 employees, the Engineering and CIGÉO Project Division leads design studies for future waste-management solutions by integrating safety and security concerns very strongly at all stages, in conjunction with the Safety, Environment and Strategies Division.

The Meuse/Haute Marne Centre manages the Underground Research Laboratory which has a team of about 100 employees. Its task is to ensure the operation and maintenance of the laboratory, to conduct experiments, to survey the future disposal site and to perform communication-related activities and dialogue with stakeholders in order to facilitate the acceptance of the future CIGÉO disposal facility.

2.2.2. CEA's human and financial resources

2.2.2.1. CEA'S 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 packaging of waste resulting from the clean-out and decommissioning of "legacy" installations, including the waste produced and stored on the sites during the operation of these installations, the financing comes from dedicated funds, towards which matching State contributions were ratified in 2010 by a meeting of the Nuclear Policy Council. CEA must comply with the annual budget allocated to it by the State, which has the effect of smoothing out the multi-year project spending curves and postponing the lower priority operations so that the work considered to have priority is completed. At the same time, CEA takes steps to reduce operating costs and the overheads associated with installations that are shut down, with a specific action plan designed to increase the means necessary for performing clean-up, dismantling and waste recovery and packaging operations.

By virtue of their nature, these funds present guarantees of availability to ensure the safety of the spent fuel and radioactive waste management facilities throughout their working life.

Furthermore, for these facilities, like all the nuclear installations it exploits, CEA makes the necessary provisions for their decommissioning in accordance with the regulations in effect.

2.2.2.2. CEA'S HUMAN RESOURCES

The CEA is a government-funded research organisation set up in October 1945 in order for France to gain access to atomic energy and to develop its applications in the energy, health-care and national-defence sectors. The CEA's organisation chart is shown in Annex (See L.6.2).

As at 31 December 2015, CEA counted 15,958 permanent employees (10,056 managerial and 5,902 non-managerial employees). Female employees represented 32.3 % of the staff. In addition, CEA hosted 1,582 doctoral students and 230 post-doctoral researchers. The employees assigned to the CEA's civil programmes are divided among 5 Centres situated in Saclay, Cadarache, Marcoule, Fontenay-aux-Roses and Grenoble.

Human resources dedicated to nuclear safety, except for employees assigned to radiation protection and security, include some 300 agents (engineers), such as facility-safety engineers, engineers and experts in support units and safety-skill centres, and engineers in safety-control units. The designation of persons for these functions is dependent on examination - at the appropriate level - of the ability of these persons to fulfil the functions, particularly with regard to their training and experience. Key staff members such as the installation heads can only be designated if the Security Central Directorate and the Directorate for Protection and Nuclear Safety has approved their designation.

In 2009, the CEA installed more safety-management-specific indicators (monitoring of the staff associated with safety, case-quality and compliance with associated deadlines). Those indicators are monitored by the Centres' management and the overall reporting is handled by the Directorate for Protection and Nuclear Safety. They provide a means of ensuring that on the whole the human resources allocated for safety are sufficient in quantity and quality.

2.2.3. AREVA's human and financial resources

2.2.3.1. ORGANISATION OF AREVA

AREVA's major shareholders at the end of 2015, are shown in the following table.

Shareholder	Share (%)
CEA	54,37
État	28,83
KUWAIT Investment Authority (KIA)	4,82
Public	3,99
Bpifrance Participations SA	3,32
EDF	2,24
FCPE AREVA	1,23
Groupe Total	0,95
AREVA autocontrôle	0,24

TABLE 19: DISTRIBUTION OF AREVA SHAREHOLDERS

In 2015, the turnover of the AREVA Group amounted to 4,199 M€ and the net income of the Group reached 2 038 M€ At that date, in accordance with standard IFRS 5 concerning activities that are transferred, intended for transfer, or abandoned, AREVA NP, AREVA TA, Canberra, the group's wind and solar activities are accounted for separately in the Group's profit and loss account and balance sheet and are notably no longer consolidated in the published turnover.

As at the end of 2015, the group employed 39,761 staff, including 92% in the nuclear sector (excluding support functions).

Unit managers have the responsibility to decide about the allocation of competent staff members for the execution of the required tasks and, consequently, to assess their skills. In order to achieve that goal, that responsibility refers to the initial training and experience; it also identifies the need for additional training, qualification or certification for specific tasks. It benefits from the support of the competent services of the Human Resources Division and of its functional extensions in the establishments themselves where they are responsible for providing and recording training sessions.

2.2.3.2. FINANCIAL ASPECTS

Although AREVA provides waste-treatment services, electricity utilities retain ownership of their own waste and in fact AREVA holds little waste of its own.

The provisions set up by AREVA for waste-management liabilities are based on the overall volume of all waste categories yet to be disposed of. Those provisions take into account all waste to be managed, including waste from past practices and decommissioning operations. For thoroughness' sake, it should be mentioned that packaging and disposal costs are included, as well as removal and conditioning costs for historical waste. Provisions set up by AREVA on 31 December 2015 totalled 6.8 billion euros at present value and covered the liabilities of the BNIs owned by the group and referred to the Environment Code. Provisions concern the following subsidiaries and facilities: AREVA NC at La Hague, Marcoule, Pierrelatte, and Cadarache, and the commitments for SICN, AREVA NC at Malvési and Marcoule (MÉLOX), EURODIF-Pro and SOCATRI at Tricastin, SOMANU at Maubeuge, and AREVA NP Romans.

The liabilities concerned include: facility decommissioning, waste-recovery and conditioning programmes and existing waste with no management solutions.

At the end of 2015 the pre-discounting provisions for the group as a whole (i.e. including the activities held for sale), on the perimeter of the Environment Code, amounted to 13.5 G€, including the cost of transport and disposal of ultimate waste for 3 G€. On 31 December 2015, the realisable value of that liability coverage was estimated at 6.8 G€. At that date, the group had already completed a robust and conservative assessment of its liabilities and had constituted and secured financial assets that would be sufficient overall to provide a coverage rate above 95 % (within the scope defined by law). Moreover, as early as 2002, the group instituted a suitable governance programme by creating the Monitoring

Committee on End-of-Life-Cycle Obligations in order to follow up the coverage of clean-out and decommissioning expenses.

AREVA also constituted and secured assets to cover expenses relating to its end-of-life-cycle obligations for ICPEs located in France, as well as for nuclear facilities in foreign countries. On 31 December 2015, corresponding provisions totalled 496 million euros at present value.

2.2.4. EDF’s human and financial resources

2.2.4.1. EDF’S HUMAN RESOURCES

At the end of 2016, the workforce of EDF's Nuclear Operations Division (DPN), responsible for operating the nuclear reactors, stood at about 23,000 distributed among the 19 NPPs in operation and the 2 national engineering units. Engineers and managers represented 36 % of the workforce (8400 staff), supervisors 60 % (13,700 staff) and operatives 4 % (1000 staff).

To these 23,000 staff must be added EDF’s human resources devoted to design, to new constructions, to engineering of the NPPs in service and support functions, and to decommissioning of nuclear reactors:

- about 4,500 engineers and technicians from the “Engineering, New Nuclear Projects” Directorate (DIPNN) and the “Deconstruction Projects, Waste” Directorate (DP2D) divided between management (75%) and supervisors (25%);
- nearly 1,900 engineers and technicians from the Division for Fleet Engineering, Deconstruction and Environment (DIPDE);
- nearly 220 engineers and technicians from the Nuclear Fuel Division (DCN);
- more than 600 engineers and technicians from EDF’s Research and Development Division (EDF R&D).

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

If one considers only those whose role and duties exclusively concern nuclear safety, more than 450 persons are involved.

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

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

The staffing has significantly increased these last years to deal with the skills renewal process currently under way and with the projects for the NPPs in service and to reinforce skills with regard to severe accident management (for example with the creation of the FARN – the nuclear rapid intervention force). Recruitment numbers have been very high in these last years: in 5 years, nearly 6,500 new employees have joined the DPN (30 % of the workforce).

Staff training volumes have also risen greatly in the last 10 years, with a twofold increase between 2007 and 2012 (from 1.2 million to 2.7 million hours) and reached 3 million hours in 2015. The initial training curricula have been added to and adapted to this context, with the evolution of "Nuclear joint know-how academies”, along with programmes that have been revised for each specific professional sector. Reactive training programmes are also deployed on the sites, based on experience feedback from other international licensees.

Similarly, with regard to engineering, the Engineering, New Nuclear Projects Directorate (DIPNN) has since 2006 been running a “key nuclear engineering skills development plan” (PDCC), involving the units of the DIPNN and other divisions of the DPNT (Nuclear and Thermal Fleet Directorate) and R&D. This approach aims to develop 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.

New engineers at the DIPNN or the DIPDE follow a 5-week training course on the fundamental know-how of the “design” engineer (operation, safety and quality culture, security and radiation protection, etc.).

2.2.4.2. EDF’S FINANCIAL RESOURCES

With a net installed power of 132.3 GWe[12] worldwide as at 31 December 2016 for a worldwide production of 583.9 TWh, the EDF Group has, among the world's major energy producers with the lowest CO2 emissions per kWh[13] produced thanks to the share of nuclear power, hydroelectricity and other renewable energies in its production mix.

[12] Source : EDF. Chiffres calculés conformément aux règles de consolidation comptable.

[13] Source : comparaison basée sur les données publiées par ces dix groupes.

In France, the net production of electricity by EDF in 2016 was 432 TWh, of which 384 TWh was from nuclear sources (with an installed power of 63.13 GWe), 42 TWh from hydroelectricity and 12 TWh from fossil fuel, out of a total of 531.3 TWh from all the producers taken together.

In 2014 and 2015, nuclear power production was 415.9 and 416.8 TWh respectively (for the same installed power).

In 2016, the Group achieved consolidated sales of 71.2 billion euros, a gross operating surplus (EBITDA) of 16.4 billion euros and a net income of 4.1 billion euros.

The provisions created by EDF (in present values in accordance with international standards) at the end of 2016 amounted to about 19.6 G€ for the back-end of the nuclear fuel cycle (spent fuel management and radioactive waste long term management) and to about 16.4 G€ for the deconstruction of NPPs and the last cores management.

Those provisions were created on the basis of estimated waste-processing and disposal costs, at a gradual rate determined by burn up in the reactor with due account of future expense schedules.

With regard to the decommissioning of nuclear reactors and to the treatment of the resulting waste, in particular, EDF sets aside accounting reserves proportional to investment costs throughout the operating period of those reactors, in order to cover expenses at term. Provisions consist of the sum of assets being set aside every year for decommissioning EDF's 58 power reactors currently in operation, plus the assets for decommissioning nine EDF reactors permanently shut down, for which dismantling has begun.

In addition, in order to secure the funding of its long-term nuclear commitments, EDF has set in place over the past years a portfolio of assets dedicated exclusively to the coverage of the provisions associated with NPP deconstruction and to the back-end of the fuel cycle.

The Environment Code and the implementing provisions 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 (decommissioning of nuclear power plants, long-term management of radioactive waste). As at 31 December 2016 these dedicated assets represented a realisable value of 25.7 billion euros, compared with 24.4 billion euros of net present cost for the long-term nuclear obligations (share of the provisions that must be covered by dedicated assets).

EDF considers that that it has enough financial resources to meet the safety needs of each nuclear facility throughout its entire lifetime, including spent-fuel management, waste treatment and facility deconstruction.

2.2.5. Human and financial resources of ILL

The ILL is a research institute founded in 1967 by France and the Federal Republic of Germany; it was joined by the United Kingdom in 1973. Its high-flux reactor (HFR), with an output of 58.3 MW, was commissioned in 1971 and provides access for the scientific community to the most intense neutron source, primarily for basic-research purposes.

The ILL is managed by three associate countries: France (CEA and CNRS), Germany and the United Kingdom. Ten other scientific partners partake also in its funding. In 2016, its budget amounted to 98 million euros.

At the end of 2016, the ILL had 486 employees with 24 different nationalities, 30 of which were assigned to safety. The ILL also relies on external competences and expertise.

2.3. State Control

2.3.1. Control of the administrative authority for securing the funding of long-term nuclear charges

As for funding the decommissioning and the management of radioactive waste, the Environment Code describes the control modalities for financial securing, whereas the obligations to be borne by operators are described in B.1.7.1.

The administrative authority consists jointly of the Ministers in charge of Economy and Energy. The General Directorate for Energy and Climate (DGEC), with the French Treasury general directorate (*Direction générale du trésor*), assumes that mission by delegation from the relevant Ministers. Pursuant to Article 20 of the Waste Act, operators must submit every three years to the DGEC a report describing an assessment of their long-term charges, the methods they apply to calculate accruing provisions to those charges and the choices they made regarding the composition and management of the assets dedicated to the coverage of those provisions. Every year, they must also provide the DGEC with an update note of that report and inform it without delay of any event likely to modify its content.

In accordance with Article 12 of 23 February 2007 Decree, the administrative authority must submit the above-mentioned report to ASN in order to review the consistency of the strategy for decommissioning and for the management of spent fuel and radioactive waste submitted by the operator with regard to nuclear security. ASN must convey its opinion to the administrative authority within four months (See § F.2.3.2).

The administrative authority disposes of prescriptive and enforcement powers. In case any insufficiency or inappropriateness is detected, it may, after having collected the operator's observations, prescribe the necessary measures for it to pass from a *de facto* to a *de jure* situation by establishing the delays within which it must implement them. Those delays, which take due account of existing economic conditions and the current situation of the financial markets, must not exceed three years.

If any of those prescriptions are met within the set deadline, the administrative authority may order, with a daily penalty, that the necessary assets be constituted and that any measure be taken with regard to their management.

Any operator who fails to meet his obligations is liable to an administrative penalty to be imposed upon him by the administrative authority. In the case of any non-compliance with the assessment of charges and the constitution of assets, the amount of the penalty must not exceed 5% of the difference between the amount of the operator's constituted assets and the amount prescribed by the administrative authority. In case of violation of any information obligations described above, the penalty must not exceed 150,000 €.

In addition, if the administrative authority notes that the application of the provisions of the Environment Code is likely to be obstructed, it may impose, with a daily penalty if need be, upon the operator to pay to the fund the required amounts to cover his long-term charges.

The administrative authority may also order that audits be conducted at the expense of operators in order to control their assessments of their charges and the method they use to manage their assets.

2.3.2. ASN support to the administrative authority with regard to the oversight of long-term nuclear expenses

ASN has no competence in the financial aspects relative to the oversight of long-term nuclear expenses, but it analyses and compares the submitted reports in order to give an opinion on the coherence of the strategy for installation decommissioning and the management of spent fuel and radioactive waste.

A convention between ASN and DGEC for the application of the procedures of the ASN control on long term nuclear expenses defines:

- the conditions in which ASN produces its opinions pursuant to Article 12, paragraph 4 of the Decree of 23 February 2007 on the coherence of the strategy for installation decommissioning and the management of spent fuel and radioactive waste;
- the conditions in which the DGEC can call upon ASN's expertise pursuant to Article 15 of paragraph 2 of the same decree.

ASN has thus published opinions on the three-yearly reports submitted by the licensees to meet the requirements of the Environment Code, first in 2007, then in 2010, 2014 and 2017.

In its opinion CODEP-CLG-2017-022588 of 8 June 2017, ASN recommends the operators to evaluate their nuclear expenses linked with

- the operations of remediation of civil engineering structures and grounds with the aim of obtaining a final state for which the totality of the radioactive and dangerous substances have been evacuated, or in case of a justified impossibility, a final sate for which the remediation operation have been conducted as far as possible;
- the non-availability of some facilities at required time;
- storage, retrieval and conditioning of radioactive wastes.

2.4. Specific case of ICPEs

The ICPE legislation requires that financial guarantees be constituted for open pits, waste-storage facilities and the most dangerous ICPEs, which are subject to a licence with a public-utility easement.

When the Prefect calls upon those financial guarantees, the State takes over the role of the operator and becomes the client responsible for site remediation.

Depending on the nature of the hazards or inconveniences of each facility category, the purpose of those guarantees is to ensure that the site is monitored and maintained under safe conditions, and that relevant interventions are made in case of accident before or after closure, in order to cover the operator's potential insolvency or legal extinction. However, it does not cover any compensation due by the operator to any third party who may suffer prejudice owing to pollution or an accident induced by the facility.

Those steps apply especially to ICPEs used for radioactive-waste disposal; but, in practice, only disposal facilities for uranium-mine tailings and the CSTFA are currently concerned in France. The operator is responsible for his facility throughout its operating lifetime and at least 30 years after closure, after which the State decides whether to assume responsibility for the site or not. In the case of ANDRA's CSTFA, the Agency will probably retain responsibility for monitoring the facility indefinitely.

For the ICPEs subject to authorisation and utilising radioactive substances, the ministerial order of 23rd December 2015 prescribes the provision of financial guarantees to safeguard the facilities.

For mines, Article L.162-2 of the Mining Code obliges the setting up of financial guarantees to ensure, depending on the nature of the hazards or inconveniences of each installation category, the monitoring of the site and the safety of the installation, any interventions in the event of an accident before or after closure, and restoring to initial condition after closure. Existing sites are required to ensure this guarantee as of 1st May 2014. Furthermore, the relinquishing of mining concessions at the end of operation was already subject to the condition of taking the measures prescribed by the prefect to preserve the health and safety of the general public and the environment. However, waiving any mining claim at the end of its operating life was already subject to the implementation of measures prescribed by the Prefect with a view to protecting public and environmental health and safety.

2.5. Specific case of radioactive sources

Given the provisions of Articles L. 1333-7, R. 1333-52 and 53 of the Public Health Code, all users of sealed radioactive sources are required to have those sources collected by their supplier, by a supplier different than the original one or by ANDRA, as soon as they become out of use and, in any case, no later than 10 years after purchase.

The supplier is required to take back the sources upon the simple request of the user. He must also constitute a financial guarantee in order to cover any impact resulting from the potential deficiency of the sources. Lastly, in accordance with Article R1333-52, he must declare any sealed source that was not turned back to him within the prescribed deadline at the same time.

The collecting organisation must deliver a removal certificate to the user, thus allowing the latter to be released from his liability with regard to the use of the source. On the basis of that document, the source is withdrawn from the user's inventory in the *National Source Inventory* managed by the IRSN, but its traceability is preserved in IRSN archives. The existence of that old computerised inventory, which undergoes regular technical improvements, ensure the sound management of thousands of sealed sources, while tracing back their history.

Pursuant to *the Law of 1 July 1901 on Association Contracts,* source suppliers formed in 1996 a non-profit association, called *Ressources,* with a view to constituting a mutualised guarantee fund to reimburse ANDRA or any other certified organisation the costs associated with the removal of sources from users, either in the case of default of the supplier normally responsible for removing them or in the absence of any supplier likely to do so when orphan sources are involved.

3 | QUALITY ASSURANCE (ARTICLE 23)

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

3.1. ASN requirements concerning BNIs

The BNI Order repealed the 1984 Quality Order relating to design, construction and operation quality.

This order provides a general framework for the steps any BNI operator is required to take in order to design, to achieve and to maintain a satisfactory quality level for his facility and its operating conditions, with a view to ensuring its safety.

The BNI Order also requires that:

- detected discrepancies and incidents be corrected with rigour and that preventive actions be taken;
- appropriate documents provide proof of the results achieved;
- the operator supervises his suppliers and checks the sound operation of the organisation hired to ensure quality.

Concerning more particularly the control of external suppliers, the Order further specifies that:

- the licensee notifies the outside contractors of the necessary provisions for application of this order.
- the licensee itself monitors or has others monitor the outside contractors to ensure that they apply the notified provisions. More specifically, the licensee ensures that the goods or services provided are subject to inspection to verify their conformity with the specified requirements.
- the licensee presents the methods used to monitor the outside contractors. It specifies more particularly the principles and organisation of this monitoring and the resources assigned to it.

The Act of 17th August 2015 and the decree of 2nd November 2007, as modified by decree 2016-846 of 28th June 2016 concerning the modification, final shutdown and decommissioning of BNIs and subcontracting, reinforced the provisions concerning subcontracting in order to regulate or limit the use of contractors or subcontractors for the performance of certain activities owing to their particular importance for the protection of security, public health and safety, protection of nature and the environment. The provisions of the BNI order will be modified and supplemented to take account of the new provisions of the Act and the decree.

ASN may now issue prescriptions for the licensee concerning activities performed outside the perimeter of the BNIs and which contribute to the BNI safety case, whether carried out by the licensee or by its suppliers, contractors, or subcontractors. These activities are monitored by ASN and the nuclear safety inspectors.

Generally speaking, ASN monitors correct application of the regulations by the licensee, notably the BNI order, by means of inspections. Inspectors must especially examine the steps taken by the operator and his suppliers (operator's obligations to suppliers, supplier documentation, results of operator's controls over suppliers, etc.). Visits or inspections may take place on suppliers' premises, and inspectors have the right to interview any employee on relevant issues. Any observation made during an inspection must be forwarded for action to the operator who remains responsible for his facility, including for the tasks performed by his suppliers. The efficiency of internal verifications performed by operators is also assessed by ASN through inspections.

Lastly, experience feedback from incidents and accidents occurring in BNIs, the analysis of malfunctions, together with inspection findings, all enable ASN to assess the compliance of every BNI operator with the BNI Order.

3.2. Steps taken by BNI operators

3.2.1. ANDRA's Quality, Security and Environment Policy

ANDRA benefits from a solid legislative and regulatory framework that describes its role and the matching expectations. More particularly, the Waste Act specifies that the Agency is responsible for the long-term management of radioactive waste and contributes to the national radioactive-waste management policy. Its missions are detailed further in B.5.6.

ANDRA has resolutely adopted a sustainable-development approach for quality, health-security and the environment, which are consistent with the provisions of Standards ISO-9001 (quality), ISO 14001 (environment), OHSAS-18001 (health-security), and the prescriptions of the BNI Order for BNIs. Since 2010 ANDRA had the triple certification by the French Standardisation Agency (*Agence française de normalisation* – AFNOR), which covers all ANDRA's activities throughout its sites.

3.2.2. CEA's Quality Assurance Policy and Programme

Protecting the environment and developing a security, safety and quality culture are priorities in the implementation of the Medium- to Long-term Plan (*Plan à moyen et long termes* – PMLT) and the CEA's multi-annual objective and performance contract with the State.

The main quality measures undertaken at central CEA level concern project-based management, identification of the processes, control of their interfaces and the production of a generic internal reference baseline defining the applicable rules, the associated organisation and the appropriate training. This management system is adapted for application in the various CEA departments, some of which have obtained certification (ISO 9001, 14001 and OHSAS 18001) or laboratory accreditation (ISO 17025, good laboratory practices) of their thus-adapted system.

The DEN (Nuclear Energy Division) and its Departments (in the Cadarache and Marcoule centres and the department delegated to nuclear activities in the Saclay centre), which are more specifically responsible for CEA's fuel and waste processing and storage facilities, have obtained the triple certification of ISO 9001 (quality), ISO 14001 (environment) and OHSAS 18001 (health and safety at work) for all their activities.

In this context, the DEN - which operates all CEA's BNIs - has included in its integrated management system provisions enabling it to ensure compliance with the requirements of the BNI order, particularly in terms of quality, for the activities important for the protection of the interests mentioned in Article L. 593-1 of the Environment Code (security, public health and safety, protection of nature and the environment).

In the area dealing with BNI design, building, operation and decommissioning, the CEA has a methodological baseline guide on project management with special instructions on "managing facility projects" and "clean-out and decommissioning projects", which highlight the specification in relation with waste management, particularly to regulatory obligations.

Good practices are identified, enhanced and made available to all concerned units. Comments and non-conformities may be noticed thanks to audits and internal inspections, thus generating corrective and preventive actions.

3.2.3. Quality Assurance Policy and Programme of AREVA

AREVA is committed to a sustainable-development approach since 2001.

AREVA adopted a charter of values in which the priority is given to a very high safety. This charter has been replaced at the beginning of 2017, by a code of ethics complemented by a compliance policy in the framework of New Areva (see L.3).

A Nuclear Safety Charter (accessible on AREVA's website: www.areva.com) details commitments in the field of nuclear safety and radiation protection, as follows:

- organisational principles – Primary responsibility of the operator; power delegations with regard to safety; competent supports with regard to safety in every establishment; independent internal control; organisation of crisis management; body of independent safety inspectors of the organisations;
- action principles – implementation of facility safety throughout the lifetime cycle of the facility; collection, analysis and diffusion of experience feedback; participation of every collaborator in the implementation of the preventive measures; voluntary approach with regard to radiation protection; similar treatment for collaborators and

subcontractors ; maintenance of skills and training activities, notably with the professions involving nuclear safety and radiation protection;

- transparency and reporting – declaration process for nuclear events; annual report of the General Inspectorate, presented to the Monitoring Council (*Conseil de surveillance*) and made public; status report on the operational security of nuclear facilities to be distributed to the Local Information and Consultation Committees (*Commission locale d'information et de concertation*).

The Health-Security policy (accessible on AREVA's website: www.areva.com) aims at zero impact of the activities on the health and security of employees, subcontractors and nearby populations of the industrial sites.

One of the Group's major challenges consists in guaranteeing that its Customers receive products that are safe, that meet the Group's commitments and are delivered on time, while ensuring the performance necessary to achieve this goal at fair cost.

Management systems, since 1978, were completed over the years by the environmental and health-security aspects before developing into the ISO-9001, ISO-14001 and OHSAS-18001 integrated management systems, which were certified for all establishments concerned, notably by processing-recycling at AREVA NC Sites in La Hague and Pierrelatte, MÉLOX. That certification is subject to periodic re-assessments to be carried out by a third-party organisation.

Pursuant to the BNI Order of 7 February 2012 and of Decree 2016-846 of 28 June 2016, AREVA assesses the ability of providers likely to perform activities on its sites or participate in safety activities in view of their selection and monitors its service providers and subcontractors. The AREVA group policy on safety and environment is transmitted to companies that wish to participate in bidding markets with high safety and environment stakes. A confirmation of receipt and of appropriation of the policy is demanded. Furthermore, an Acceptance Commission for Radioactive Clean-out Companies (*Commission d'acceptation des entreprises d'assainissement radioactif*) monitors the service providers concerned and grants the necessary "certificate" in order to apply for radioactive-clean-out or dismantling markets. Finally, AREVA has limited to two the number of contracting levels and has made systematic the practice of a formal monitoring plan

Furthermore, the environmental, medical and dosimetric analysis laboratories are approved by ASN in their domains under the order of 8 July 2008; these COFRAC accreditations are linked to radioactivity measurements, the presence of radionuclides in the environment and the protection of workers.

Among other specific actions within the sustainable-development approach should be mentioned the reporting of overall indicators with regard to continuous-improvement management, the environment, social as well as societal issues – *Sustainable Tool for Advanced Reporting (STAR).*

3.2.4. EDF's Quality Assurance Policy and Programme

La politique de management par la qualité, qui vise prioritairement les activités importantes pour la sûreté, porte sur les objectifs suivants :

The steps taken by EDF with regard to the quality of spent-fuel and waste management, as well as of the decommissioning of its activities, are part of its general quality and safety organisation.

They are designed to ensure that the design, construction and operation of its nuclear reactor fleet are safe and efficient, both technically and economically.

The management-through-quality policy, which applies in priority to safety-related activities, focuses on the following objectives:

- Promoting EDF's quality system on the basis of past achievements. The need to ensure safety in NPPs has led EDF to develop a quality system based on personnel skills; work planning, and formalisation and homogenisation of methods.
- Promoting EDF's quality system as an efficient tool for professionals. The fundamental responsibility for the quality of an activity lies with the persons conducting it. Their competence, experience and culture are vital to attain the expected quality level. The *Quality Manual* emphasises not only the quality requirements applicable to all activities and operational processes in BNIs, but also the key role of every actor (involvement of line management, staff, partners and contractors).
- Tailoring EDF's quality-assurance requirements to the significance of the activities. Important safety-related activities have already been identified. Each activity is analysed beforehand with regard to its inherent problems and consequences (especially, safety) resulting from potential failures, thus highlighting the essential quality characteristics of the activity, and particularly, the required quality level. The resulting quality-assurance measures, especially in terms of specific methods and procedures to be applied, incorporate various lines of defence against potential failures.
- Giving EDF the required organisation and resources. Attaining quality targets requires that activities be clearly assigned and that roles, responsibilities and co-ordination among the various players be defined at all levels within the company. Control processes, such as self-controls, controls by another qualified person, verification

actions, guarantee that quality. All those elements participate in the overall defence-in-depth. The achievement of quality is confirmed by the preparation of documents throughout the activity, from the preliminary analysis to the final report. The preservation of those documents ensures the traceability of the operations, especially in the field of safety.

- Relations with service providers. In order to ensure the quality of contracted services, EDF monitors the activities it entrusts upon its service providers. That form of monitoring does not release the provider from his contractual responsibilities and notably from those relating to the application of quality requirements and the guarantee of valid results.
- Anticipating, preventing and progressing at EDF. In order to prevent defects and to improve results, EDF uses an experience-feedback approach based on collecting detected deviations, analysing them, searching for their deep causes, validating good practices and promoting their widespread use. The know-how of EDF’s fleet is enhanced by incorporating the experience of other operators. The efficiency in collecting deviations is reinforced by applying progressively a “low-noise signal” approach.
- Monitoring implementation at EDF. More particularly, EDF monitors not only the transport chain by conducting audits and spot checks at conveyor premises, but also spent-fuel processing operations in the AREVA facilities.
- Quality assurance of computerised databases. EDF’s quality-assurance requirements for the operation and maintenance of the spent-fuel and radioactive-waste database are taken from EDF’s *Quality Manual* in the same way as for safety-related activities.

For radioactive waste, site inventories and computer databases (a computer application called “DRA”) ensure the traceability of output, interim-storage facilities and shipments of radioactive waste packages to disposal facilities, directly or after processing (incineration, fusion).

3.2.5. The ILL's quality assurance policy and programme

The ILL for its part continues its commitment to protect the interests defined by the Environment Code through simple procedures that guarantee the availability of the personnel on the ground and for the joint analyses prior to work operations.

The ILL has continued its efforts in project-based management, process identification and control of their interfaces.

The ILL has implemented an integrated management system to meet the requirements of the BNI order. It is an evolution of the previous quality organization manual. It will soon be complemented by the implementation of processes in order to fully comply with the BNI order and, if necessary, by reviewing the processes involved in the protection of the interests. With the aim of ensuring efficiency, particularly in the protection of interests, this approach implies upstream prioritisation in order to favour investment in the most necessary actions.

The ILL thus endeavours to identify the good practices, add to them and make them available to all the units. Nonconformities can be evidenced by all personnel categories and by audit procedures. They result in corrective and preventive measures.

3.3. ASN oversight and its analysis

Article L. 593-6 of the Environment Code states that the licensee of a BNI is responsible for managing the potential risks and drawbacks of its facility for the interests mentioned in article L. 593-1. For this purpose, article L. 593-6 also states that the licensee must set up a formal integrated management system (IMS) to ensure that the requirements concerning the protection of the above-mentioned interests are taken into account.

These requirements concerning safety management by the licensees are regulated by title II of the order of 7th February 2012 as part of an integrated approach proportionate to the issues. It mentions that the licensee draws up and undertakes to implement a protection of interests policy (PPI). The licensee must also ensure that it is disseminated, known, understood and applied by all the personnel required to implement it, including outside contractor personnel. The licensee must also define and implement an integrated management system (IMS) which ensures that the requirements concerning the protection of interests is systematically taken into account in any decision concerning the facility, along with organisational measures and appropriate resources.

With regard to the monitoring of outside contractors, the licensee must ensure that its policy is applied and that the operations it performs and the goods and services it supplies comply with the defined requirements. This monitoring - that is proportionate to the potential impact of the activities concerned in terms of protection – is documented and carried out by persons with the necessary skills and qualifications. The monitoring of outside contractors who carry out an activity important for the protection of the interests mentioned in article L. 593-1 of the Environment Code (AIP) is the responsibility of the licensee, which may not entrust it to a contractor. However, the licensee may occasionally obtain assistance in this monitoring. Finally, the last chapter of section II of the order of 7th February 2012 deals with the means of information of the public. Article 2.8.1 states that *“The licensee determines the procedures to allow any person:*

- *to have access to the information made public at the initiative of the licensee or pursuant to the legislative or regulatory provisions applicable to it;*

- *to obtain the information mentioned in article L. 125-10 of the Environment Code.*

These procedures are published on a website chosen by the licensee, updated periodically and transmitted for information to the local information committee."

Act 2015-992 of 17th August 2015, called the TECV Act, introduced new provisions concerning the management of subcontracting in nuclear installations. These provisions first of all include existing aspects of the BNI Order of 7th February 2012, more particularly the ban on the licensee delegating the monitoring of outside contractors performing an "activity important for the protection of interests" (AIP). They also introduce the possibility of managing or limiting the use of contractors or subcontractors for the performance of certain AIPs.

Article 63-2 of the "BNI Procedures" decree of 2nd November 2007, amended by the decree of 28th June 2016, states that when the licensee entrusts the performance of services or work important for the protection of interests to an outside contractor, within the perimeter of its facility either in operation or undergoing decommissioning, they may be performed by subcontractors of no more than tier two.

The TECV Act also makes it possible to manage and monitor the performance of AIP outside the perimeter of a BNI.

The findings of the inspections in the BNIs, in the head office departments of the licensees or their suppliers and the experience feedback from incidents and significant events occurring in the BNIs enable ASN to verify and analyse compliance with these provisions.

ASN monitoring also relies on the assessments conducted at its request by IRSN and the Advisory Committees of experts.

3.3.1. ASN opinion on EDF's quality assurance policy and programme

ASN monitoring of the organisational aspects at EDF is notably based on inspections on-site, at the suppliers and in the head office departments, as well as on analysis of the significant event (ES) reports. With regard to the reactors in operation, 7 inspections targeting management of safety and organisation and thus dealing more specifically with implementation of the PPI and the IMS were carried out over the period 2014 - 2016. These inspections fall within the broader framework of ASN oversight of the steps taken by EDF to verify integration of SOHF in general into all the phases of the lifetime of an NPP.

The Advisory Committee for reactors was also asked for its opinion in 2013 on the topic of safety and radiation protection management during reactor outages and in 2015 on the management of subcontracting of maintenance activities by EDF in NPPs.

The EDF organisation was also inspected at the end of 2014 as part of an IAEA OSART[14] Corporate mission.

Finally, a professional guide concerning the implementation of the regulatory requirements of the PPI and the IMS is also currently being drafted.

3.3.2. ASN opinion on AREVA Group's quality assurance policy and programme

With regard to AREVA, during various BNI periodic safety reviews, ASN examined the managerial processes which it had not been possible to deal with by the overall safety management review, the conclusions of which were transmitted to AREVA on 21st September 2012. A final opinion will be given on all the managerial processes following all of these reviews, which are scheduled to end in 2018.

ASN nonetheless considers that AREVA must make up its delay in integrating EIP regulations[15].

Finally, since 2016, ASN has been monitoring AREVA's preparations for splitting up the group into several legal entities, including AREVA NP (which will take over the Romans-sur-Isère and SOMANU sites) and New AREVA (which will take over the other French BNIs of the AREVA group).

3.3.3. ASN opinion on CEA's quality assurance policy and programme

CEA submitted a safety and radiation protection management report in 2009. This report was supplemented in 2010 and was the subject of examination by and then requests from ASN in 2011. Two specific ASN inspections of the Cadarache and Saclay centres in 2016. These actions were able to assess and check effective implementation of the CEA provisions resulting from its undertakings and the ASN requests. These provisions were considered to be on the whole satisfactory, subject to reinforcement of the organisational and human factors (OHF) and safety skills of certain personnel in charge of events analysis and project management. The next examination on the management of safety and radiation protection is scheduled for 2020 or 2021. The targeted topics will be discussed with CEA when its three-yearly reports are transmitted.

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[14] "Operational Safety Review Team"

[15] These regulations aim to ensure that each element of a BNI on which the licensee based the facility's safety case effectively meets the requirements of this safety case.

3.4. Specific case of ICPEs

The French waste-management legislation entrusts the responsibility for waste elimination upon the producer or holder of the waste. It structures the control process for elimination networks by requiring certain waste producers, conveyors and eliminators generating nuisances to submit relevant declarations.

The headings of the ICPE nomenclature relating to waste processing were modified by three successive decrees between end of 2009 and mid-2010. The purpose of that change was to stop classifying waste-treatment activities in relation to the origin of the waste, but in relation to their nature and their dangerousness in line with the significance of hazards and inconveniences generated by the processing modes of such waste.

As in the case of all special industrial waste, all radioactive waste produced by ICPEs must be subject to specific precautions collection time and throughout storage (appropriate packaging and labelling), shipment (compliance with the *Regulations for the Transport of Dangerous Goods*) and treatment (exclusively in a licensed ICPE). For all those operations, the Administration must be kept informed.

Any producer of special industrial waste who entrusts upon a third party to transport more than 100 kg of waste must issue a follow-up checklist for hazardous waste. The form must accompany the waste up to the recipient facility, which may be a disposal facility, a consolidation centre or a pre-treatment facility. The final treatment centre must return the last sheet to the producer within one month in order to guarantee that the waste has been taken over. The producer must send a waste sample to the operator of the recipient facility in order to obtain his approval prior to shipment.

A chronological register of all shipment operations must be kept by the producers of dangerous industrial waste and contain all relevant information contained on the slips. Operators of facilities receiving waste (whether dangerous or not) must keep two registers in order to show incoming and outgoing waste shipments. All registers must remain at the disposal of the ICPE Inspectorate.

Any person producing more than 10 t of dangerous waste per year must submit to the Administration an annual declaration summarising the types of waste being produced, the corresponding quantities and the elimination systems. All facilities receiving waste, whether dangerous or not, must also declare the quantities of waste they accepted during the previous year and the type of treatment they performed (elimination or recovery).

3.5. Specific case of sealed radioactive sources

Par ailleurs, le code de la santé publique et le code du travail imposent à tous les détenteurs de sources de connaître, à tout moment, l’inventaire de leurs sources et de transmettre cet inventaire annuellement à l’IRSN. Lors de l’examen des demandes de renouvellement, de situations de cessation d’activité, de vérifications ponctuelles ou bien à l’occasion d’inspections, l’ASN vérifie systématiquement le respect de ces dispositions et le devenir des sources scellées.

Specific licensing conditions for the fabrication, possession, distribution and use of sealed radionuclide sources, which are derived from the current general regulations, include suitable steps to trace back every movement of those sources. These provisions were detailed in ASN Resolution 2015-DC-0521 of 8 September 2015 on the monitoring and registration of radionuclides in the form of radioactive sources and products or devices containing them.

The monitoring of every movement (acquisition, transfer, import, and export) lies with the IRSN, which must keep up to date the source national inventory and notify ASN in case of anomaly.

In addition, the Public Health Code and the Labour Code requires all source holders to be able to know their exact source inventory at all times and to send this inventory annually to IRSN. ASN verifies systematically that requirements are met and how sealed sources are evolving, when reviewing renewal applications, in cases of termination of activity and during spot-checks or inspections.

4 | RADIATION PROTECTION DURING OPERATING LIFETIME (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, 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 limitation 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 being taken into account, and

ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation 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.

4.1. General framework of radiation protection

4.1.1. Legislative bases of radiation protection

At a European level, the Euratom Treaty and more specifically its articles 30 to 33, defines the procedures for drawing up community provisions concerning protection against ionising radiation and specifies the powers and obligations of the European Commission with regard to their implementation. The corresponding Euratom directives are binding on the various countries, such as the new European Council directive 2013/59/Euratom of 5th December 2013 setting basic standards for health protection against the hazards arising from exposure to ionising radiation. This directive, published in the Official Journal of the European Union on 17th January 2014, revokes Euratom directives 89/618, 90/641, 96/29, 97/43 and 2003/122.

The legal framework for nuclear activities in France, which has been extensively modified since 2000, will therefore once again be updated with the transposition of directive 2013/59/Euratom: Ordinance 2016-128 of 10th February 2016 comprising various nuclear provisions more specifically enabled the legislative provisions of chapter III of title III of book III of the first part of the Public Health Code concerning radiation protection to be rewritten, while retaining the existing fundamental principles and requirements. The transposition work should be completed before February 2018.

BNIs are also subject to a particular system stipulated by the Environment Code (chapter III of title IX of book V). In accordance with this code, it is the responsibility of ASN to authorise commissioning of a BNI and define the prescriptions concerning its design, construction and operation. It is in this respect that ASN defines the prescriptions concerning water intake and liquid and gaseous discharges of substances from the facility, whether or not radioactive.

4.1.1.1. THE PUBLIC HEALTH CODE

Principles of radiation protection

The general principles of radiation protection applicable to all nuclear activities are given in chapter III of title III of book III of the first part of the Public Health Code. They were updated by the ordinance of 10th February 2016 concerning nuclear activities.

Article L. 1333-1 of the Public Health Code defines nuclear activities as “activities comprising a risk of human exposure to ionising radiation related to the use either of an artificial source, whether substances or devices, or of a natural source, whether natural radioactive substances or materials containing natural radionuclides. They also include the steps taken to protect individuals from a risk following radioactive contamination of the environment or products from contaminated areas or manufactured from contaminated materials”.

Article L.1333-2 of the Public Health Code defines the general principles of radiation protection (justification, optimisation and limitation). These principles underpin the regulatory measures for which ASN has responsibility.

The scope of application of this chapter of the Public Health Code includes the measures necessary to prevent or mitigate the risks in various radiological exposure situations: in addition to steps taken to protect individuals from a risk following radioactive contamination of the environment or from products from contaminated areas or manufactured from contaminated materials, the steps taken in a radiological emergency situation or in the event of exposure to a natural source of ionising radiation, radon in particular, are also concerned. All of these steps must now meet the justification and optimisation principles.

Justification principle

The principle of justification is defined as the principle "that a nuclear activity can only be undertaken or carried out if it is justified by the advantages it provides individually or collectively, in particular in health, social, economic or scientific terms, when compared with the hazards inherent to ionising radiation to which the persons are likely to be exposed ".

Assessment of the expected benefit of a nuclear activity and the associated health detriment may cause an activity to be prohibited, if the benefit does not appear to outweigh the hazard.

Optimisation principle

The principle of optimisation is defined as the principle that “the level of exposure of persons to ionising radiation resulting from a nuclear activity, the likelihood of occurrence of the exposure and the number of exposed persons must be kept as low as reasonably achievable, with current technical knowledge, economic and social factors being taken into account, and, as applicable, the medical purpose.”

For instance, that principle, referred to as ALARA, explains why discharge licences reduce the admissible amount of radionuclides present in radioactive effluents from nuclear facilities and requires that exposures be monitored at workstations in order to reduce them to the strict minimum.

In the context of the implementation of the principles of justification and optimisation, the assessment of the expected benefit of a nuclear activity and the corresponding health drawbacks may lead to non-authorisation or prohibition of an activity for which the benefit does not seem to outweigh the risk. In this case, either prohibition is declared generically (for example: prohibition of the incorporation of radioactive substances in consumer goods), or the license required on account of radiation protection will not be granted or renewed.

On account of the prohibition to incorporate radionuclides into consumer goods (Articles R. 1333-2 and 3 of the Public Health Code), the sale of irradiated precious stones, of accessories such as key-rings, of hunting equipment (sighting devices), of navigation equipment (bearing compasses), of river fishing equipment (strike detectors) equipped with sealed sources of tritium, of lightning arresters, is prohibited.

For the existing activities, the justification is reassessed if the state of knowledge and techniques so justifies. This is the case with smoke detection and various other activities that are tending to disappear on account of technical advances in particular.

In the case of smoke detection, where several types of radionuclides have been used (americium 241, plutonium 238, nickel 63, krypton 85), although this technique was justified a few years ago due to the resulting advantages for human safety, this is no longer the case given that new detection techniques using optical technology have been developed and meet the regulatory and normative fire detection requirements. Pursuant to the Public Health Code, this change makes it obligatory to organise the withdrawal of smoke detectors containing radionuclides. The Order of 18 November 2011 derogating from article R. 1333-2 of the Public Health Code for smoke detectors with ionization chamber sets a regulatory framework for the gradual withdrawal of ionic smoke detectors from service, with the aim of having no more in use in 10 years' time. The widespread use of these detectors makes it necessary, ultimately, to have disposal facilities in order to dispose of them. Suggestions were made in this respect in the preparation of the PNGMDR.

Limitation principle

The principle of limitation is defined as the principle that “the exposure of a person to ionising radiation resulting from these activities may not raise the sum of doses received beyond regulatory limits, except when that person is subject to exposure for medical or biomedical research purposes.”

All personal or occupational exposures induced by nuclear activities are subject to strict limitations. For a member of the public, for instance, the annual effective dose limit from any nuclear activity must not exceed 1 mSv while equivalent dose limits for crystalline lenses and the skin are set at 15 and 50 mSv/a (average value for any skin area of 1 cm²), respectively. Any dose in excess of those limits is deemed unacceptable and is liable to administrative or criminal penalties.

4.1.1.2. LABOUR CODE

The Labour Code contains various provisions specific to the protection of workers, whether paid employees or not, exposed to ionizing radiation (Title V of Book IV of Part IV) which supplement the general principles of prevention. It establishes a link with the three principles of radiation protection in the Public Health Code.

4.1.2. Regulatory aspects concerning human protection against ionising-radiation hazards due to nuclear activities

4.1.2.1. GENERAL PROTECTION OF WORKERS

Articles R. 4451-1 to 144 of the Labour Code created a single radiation-protection regime for all workers (whether paid employees or not) likely to be exposed to ionising radiation during their professional duties. Those provisions include the following:

- the application of the optimisation principle and the principle of prevention to eliminate or, as far as possible minimize the risks arising from workers' exposure to ionizing radiation, by means of risk prevention measures applied at source and taking into account technical progress;
- dose limits are set at 20 mSv effective dose over 12 consecutive months, 500 mSv equivalent dose for skin and extremities and 20 mSv for eye crystal over 12 consecutive months;
- the dose limit for pregnant women or more precisely for the child to be born (1 mSv during the period between the declaration of pregnancy and birth).

The publication of implementing orders provides further details for enforcing those new provisions.

Radiation-protection zoning

Requirements concerning the delineation of monitored, controlled and regulated areas (especially controlled areas) have been enacted by the Order of 15 May 2006*,* irrespective of the sector involved and will be reviewed in the framework of the transposing of Directive 2013/59/Euratom of 5 December 2013.

4.1.2.2. GENERAL PROTECTION OF THE POPULATION

Besides the specific radiation-protection steps prescribed by individual licences concerning nuclear activities for the benefit of the population in general and of workers, several general steps of the *Public Health Code* contribute to protecting the public against the hazards of ionising radiation.

It involves in particular the decision to prohibit any addition of natural or artificial radionuclides in the list of consumer goods, food and feed in addition to that they may naturally contain (see § F.4.1.1.1). Restrictions also exist for construction products. However, the Ministry for Health may grant a waiver, after consultation with the HCSP, except with respect to foodstuffs and materials placed in contact with them, cosmetic products, toys, jewellery and feed.

Furthermore, the use, outside BNIs, of all materials or waste resulting from a nuclear activity is also prohibited, if they are contaminated or likely to have been contaminated with radionuclides used or generated by that activity.

It also involves the annual efficient dose limit received by a member of the public due to the performance of nuclear activities (see § F.4.1.1.1).

A national network for collecting radioactivity measurements in the environment was constituted in 2009 in order to collect data to be used for estimating the doses received by the population. The network collates different results from the environmental surveys imposed by the regulations and performed by different State services and public corporations, or by territorial communities and associations upon request. Results are accessible to the public since 1 January 2010 (www.mesure-radioactivite.fr). The management of the network has been entrusted upon the IRSN, while its orientations have been set by ASN (ASN Resolution 2008-DC-0099 of 29 April 2008 *Concerning the Institution of a National Network for Collecting Radioactivity Measurements in the Environment and Setting the Laboratory Certification Procedures.*)

In order to ensure the sound quality of the measurements, all network laboratories must comply with certain certification criteria, which include notably intercomparison tests. The list of certified organisations may be consulted on ASN's website (www.asn.fr*).*

The management of waste and effluents generated by BNIs and ICPEs is subject to the provisions of specific regulatory systems concerning those facilities, whereas the management of waste and effluents originating from other establishments, including hospitals, where the use or possession of radioactive materials is authorised by the Public Health Code, is described in B.6.2.

Although the Euratom directive authorises clearance thresholds (i.e., the generic radioactivity level below which any effluent and waste from a nuclear activity may be disposed of without monitoring), French regulations do not include that notion (see § B.4.1.1.3). In practice, waste and effluent elimination is monitored on a case-by-case basis when the activities generating them are subject to licensing, which is the case for BNIs and ICPEs. Otherwise, discharges are subject to technical specifications.

4.1.2.3. LICENSING AND DECLARATION PROCEDURES FOR IONISING-RADIATION SOURCES

The licensing or declaration system, which covers all ionising-radiation sources, is described in full in Chapter III of Title III of Book III of the Public Health Code. These systems have been supplemented in the framework of the transposition of the Euratom Directive by a new intermediate simplified authorization system: the regime of registrations

Applications for authorizations and registration and declarations are filed with ASN territorial divisions.

All medical, industrial and research applications are concerned by those provisions, as long as they are not exempt. More specifically, they pertain to the fabrication, use, holding, distribution, including import and export (from and towards a country outside the European Union) of radionuclides or products or devices containing some or electric devices emitting ionising radiation, including import and export.

It should be noted that, in accordance with Article L.1333-9 of the Public Health Code, industries covered by the Mining Code, BNIs and ICPEs and defence-related nuclear activities and facilities fall under specific regimes.

Procedures for submitting licence applications or declarations, are specified in ASN resolutions validated by Orders (resolutions ASN 2008-DC-108 and 109, ASN 2009-DC-148 and ASN-DC-2010-192).

4.1.2.4. RADIOACTIVE-SOURCE MANAGEMENT RULES

General rules relating to the management of radioactive sources are detailed in the Public Health Code. They were detailed in 2015 in ASN Resolution 2015-DC-0521 of 8 September 2015 on the monitoring and recording of radionuclides in the form of radioactive sources or contained in products or devices.

Those general rules include the following:

- it is forbidden to acquire or alienate any source without any authorisation;
- any acquisition, distribution, import and export of radionuclides in the form of sealed or unsealed sources, or of products or devices containing radionuclides, must be declared to the IRSN beforehand, since that the recording of such a declaration can be used in any further control by customs services;
- a traceable account of radionuclides contained in sealed or unsealed sources and of products or devices containing radionuclides, must be available in every establishment, and a quarterly record of deliveries must be sent to the IRSN by suppliers;
- the loss or theft of radioactive sources must be the subject of a declaration.

The elimination or recovery system for obsolete or disused sources includes the following requirements:

- any user of sealed sources is required to have his obsolete, deteriorated or disused sources removed at his own expense, once they are out of use;
- the supplier is required to collect unconditionally and upon the simple request of the user, any of the latter's disused or obsolete sources.

On this latter point, Decree 2015-231 of 27th February concerning the management of used sealed sources, which came into force on 1st July 2015, modified Articles R.1333-52 and R.1337-14 of the Public Health Code, in order to enable those in possession of sources to have used sealed radioactive sources that have expired or reached the end of their service life recovered not only by their initial supplier, but also by any other authorised supplier of radioactive sources or, as a final resort, by ANDRA. The spirit of this modification is to address the difficulties expressed by those in possession of sources with regard to locating the original suppliers and optimising the cost of recovery.

The source suppliers are required to provide financial guarantees. These guarantees may take the form of bonds deposited notably with ANDRA or with banks, or by joining an association set up by the source suppliers. The table of guarantees is drawn up and revised by ANDRA every year.

4.1.3. Radiation protection in BNIs

"Nuclear activities" include those performed in BNIs, which are the subject of specific attention, due to the significant risks of exposure to ionising radiation.

In the framework of the procedures referred to in the Environment Code and the BNI Procedures Decree, all BNI operators must demonstrate how they comply with radiation principles (see § .4.1.1.1) as early as the design stage and at every further stage in the lifetime of their facility for which ASN delivers a licence, that is, its creation, its commissioning and its decommissioning.

In addition, article L. 593-42 of the Environment Code states that the BNI system covers worker collective radiation protection aspects (for example sizing of biological protections, optimisation of radiation protection zoning, etc.) (see § E.2.2.6.3).

BNIs are the subject of further safety reviews, during which the operator must demonstrate that he is constantly improving safety and radiation-protection levels.

In addition, radiation protection in BNIs is the subject of controls whenever the facilities are undergoing changes that have an impact on the radiological protection of workers.

Lastly, inspections are also conducted throughout the term of the licence.

4.1.4. Discharge licences

4.1.4.1. BNI DISCHARGE LICENCES

By nature, nuclear facilities generate radioactive effluents. In general, their operation also involves water intakes and discharges of non-radioactive liquid and gaseous effluents into the environment. The licence covers all water intakes and effluent discharges, whether liquid or gaseous, radioactive or not.

The legal system of the BNIs was extensively overhauled by the TSN Act and its implementation decrees, particularly the BNI procedures decree.

The purpose of the change is to integrate better environmental considerations with nuclear-safety and radiation-protection issues through the creation- or decommissioning -licence application. Consequently, the operator is now required to submit a single application covering all aspects in the form of a creation- or decommissioning-licence application. The content of the application and the matching procedure are detailed in the BNI Procedures Decree. If approved, the application is followed by a licensing decree. ASN then sets out in a resolution the relevant technical considerations relating to discharges (limit values, monitoring of discharges in the environment, information, etc.) through technical prescriptions. With regard to specific discharge limits, ASN’s resolution is subject to the validation of the Minister in charge of nuclear safety.

The first discharge limits were prescribed on the basis of a lower impact than current health-effect thresholds. Optimisation efforts encouraged by authorities and implemented by operators have generated a considerable reduction of those emissions.

Moreover, following publication of the TSN, ASN engaged the overhauling of the general regulations applicable to BNIs.

Entry into effect on 1 July 2013 of the BNI Order represents a major step in the revising of the regulations relative to BNIs, and in particular its Title 4 – Control of nuisance effects and the impact on health and the environment.

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

- the use of the best techniques available within the meaning of the ICPE regulation);
- limiting discharges and noise emissions to the level of the thresholds in the general regulations applicable to ICPEs;
- a ban on the discharge of certain hazardous substances and discharge into the water table;
- setting up monitoring of emissions and of the environment;
- the general application to the equipment necessary for operation of BNIs, of a number of ministerial orders applicable to identical installations governed by the ICPE regulations;
- the production of an annual discharge forecast and an annual impact report by the licensee: this forecast - which is necessarily below the upper regulatory limit - is intended to bring them to adopt forward-looking discharge management that is as precise as is technically possible.

The BNI order was supplemented by ASN Resolution 2013-DC-0360 of 16 July 2013 on the control of nuisance effects and the impact of basic nuclear installations on health and the environment.

This resolution was updated by ASN resolution 2016-DC-0569 of 29th September 2016, which notably clarifies various provisions concerning the environmental monitoring programme to be implemented by the licensees around their facilities.

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 radioactivity resulting from discharges into the environment represents about 100,000 measurements and 40,000 samples annually in France. These data are sent every month to ASN and to the national network of environmental radioactivity measurements. The results were placed on-line on the website of the national network of environmental radioactivity measurements (RNME) in February 2010. Any member of the public may now go to the www.mesure-radioactivite.fr site to consult all environmental radioactivity measurements taken by the licensees during the course of their regulation monitoring around their sites.

4.1.4.2. ICPE AND MINE DISCHARGE LICENCES

In the case of ICPEs, regulations require that a risk approach be integrated. Discharge licences and conditions are set in the general facility licence (see E.1.2). The general principles for setting discharge conditions and limits are identical to those for BNIs, because they stem from the same laws (in particular Act No. 92-3 of 3 January 1992 Concerning Water part of the Environment Code, Second Book).

Mine discharges are regulated by the second part of Title “Ionising radiation” of the *General Mining Industry Regulations*. The commissioning licences issued by prefect’s orders specified those conditions. However, it should be noted that all facilities associated with mines and the discharges of which are likely to have the most significant impact (ore-processing plants, etc.) are generally classified as ICPEs and their discharges are regulated consequently in that framework.

4.1.4.3. DISCHARGE LICENCES FOR OTHER ACTIVITIES SUBJECT TO THE PUBLIC HEALTH CODE

The general provisions for the management of waste and effluents contaminated by the nuclear activities referred to in Article R. 1333-12 of the *Public Health Code*[16] are prescribed by the 23 July 2008 Order validating ASN’s Resolution No. 08-DC-0095 (see B.6.2.1).

The management procedure for contaminated effluents must be described in a framework document called the Management Plan for Contaminated Waste and Effluents (MPCWE).

According to the *Public Health Code*, ASN may deliver a licence for the discharge in the cleanup-water network of effluents containing radionuclides with a radioactive half-life exceeding 100 days. In preparation for such a licence, the MPCWE must justify not only those discharges, with due account of the technical and economic restraints, but also the efficiency of the implemented provisions to limit the discharged activity, an impact study describing the effects of the discharges on works, the population and the environment, as well as the procedures set in place to control discharges and suspend them, if certain criteria are not met.

In addition, it is worthwhile noting that “any discharge of wastewater, other than domestic, in the public network must be authorised in advance by the manager of the network”. Those effluents must be subject to a licence, thus specifying, for instance, the monitoring characteristics to be borne by wastewaters before discharge, together with the discharge-monitoring conditions”; that licence must be delivered pursuant to the Public Health Code.

4.2. Radiation-protection steps taken by BNI operators

4.2.1. Radiation protection and effluent limitation at ANDRA

Radiation protection and effluent minimisation of are key areas in ANDRA’s environmental policy.

4.2.1.1. RADIATION-PROTECTION OBJECTIVES

For the public, ANDRA considers that the dosimetric impact of disposal facilities running under normal operation must be at as low a level as reasonably achievable and must not exceed a fraction of the regulatory limit of 1 mSv/a set by the *Public Health Code* (Book III, Title III, Chapter III). As mentioned in § D.3.2.2.2 and D.3.2.2.3, ANDRA sets a threshold of 0.25 mSv/a for itself. That guideline is consistent with the recommendations of the IAEA, the ICRP or the French RFSes applicable to the design of HL-LL waste-disposal facilities.

With regard to workers, ANDRA has decided to be stricter than Directive 96/29/Euratom (consolidated into the Public Health Code) and to set a more ambitious target for itself. Given the growing importance of the optimisation principle and the experience feedback from the CSA, ANDRA set itself the operational protection goal of not exceeding an annual dose of 5 mSv/a as early as the design stage. That objective must be reached for all ANDRA and contractors’ employees working in ANDRA facilities.

4.2.1.2. MONITORING BY ANDRA AT ITS OPERATING DISPOSAL FACILITIES

Monitoring the impact of ANDRA’s disposal facilities involves the application of a monitoring plan proposed by ANDRA and approved by ASN. Monitoring goals concern three topics:

- verifying the absence of impact;
- checking compliance with technical requirements set by the administrative authority (ASN for the CSA and by the Prefect for the CIRES);
- detecting any anomaly as early as possible.

Radioactivity is measured in air, surface waters (rivers, run-offs), groundwater, rainwaters, river sediments, flora and the food chain (e.g., milk). Facility personnel are submitted to individual dosimetric monitoring.

Monitoring results are forwarded periodically to ASN. Both the CSM and the CSFMA publish them in quarterly brochures that are distributed to the public and to the press. They are also presented officially to the CLIs of the relevant facilities.

At the CSM, the dose received by any intervening agent is inferior to the detection threshold of individual passive dosimeters in use (< 0,05 mSv). In 2015, the maximum recorded doses at the CSA and the CIRES were of:

- 1.20 mSv for the CSA with a collective dose of about 14 man mSv;

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[16] All authorised or declared nuclear activities are concerned, except for those that are performed in the following facilities:

- 0.35 mSv for the CIRES with a collective dose of about 0.8 man mSv (active dosimetry), including the dose from grouping activities.

In addition, ANDRA completes the radiological monitoring of the disposal facilities by checking the physico-chemical quality of the water and by conducting an ecological monitoring of the environment.

4.2.1.3. EFFLUENT DISCHARGES AND RELEASES FROM ANDRA FACILITIES

In order for the CSM to move unto its monitoring phase, disposal structures were protected from rainwaters by alternating layers of permeable and impermeable materials, including notably a bitumen membrane. It resulted in a drastic reduction in the volume of collected waters at the base of the disposal structures.

Furthermore, since the regulatory process for the transition unto the monitoring phase is conducted in the same way as for the creation of a BNI, ANDRA submitted in 2000 a licence application for radioactive and chemical discharges. The application covered surface waters (collected rainwaters over the bituminous membrane) and their discharge in rivers, as well as the collected water at the base of the structures and transferred to the AREVA Plant in La Hague before being discharged into the sea. The discharge Orders of 11 January 2003 constitute the CSM’s regulatory reference system.

For hypothetical reference groups, the impact of the CSM is estimated in 2015 at less than 21,3 10^{-5} µSv for discharges into the sea and at 0.20 µSv for discharges into the closest stream.

With regard to the CSA, discharge conditions are regulated by the discharge Decree No. 2006-1006 of 10 August 2006 and Order of 21 August 2006.

Radioelements	Gaseous discharges (GBq/a) (conditioning workshop)	Liquid discharges (GBq/a)
Tritium	**50**	5
Carbone 14	**5**	0.12
Iodine	**2.10^{-2}**	-
Other beta-gamma emitters	**2.10^{-4}**	0.1
Alpha emitters	**2.10^{-5}**	4.10^{-4}

TABLE 20: DISCHARGE LIMITS PRESCRIBED FOR THE CSA IN THE 21 AUGUST 2006 ORDER

The volumes of effluents produced by disposal facilities are very small as a result of the steps taken to shelter the operation by installing mobile roofs over the structures, following the experience feedback from the CSM.

In 2015, the discharges at the CSA resulted into an impact, as calculated for a hypothetical reference group, in the order of a thousandth of µSv/a for liquid discharges and of two orders of magnitude lower for gaseous discharges.

4.2.2. Radiation protection and effluent limitation at the CEA

4.2.2.1. OCCUPATIONAL RADIATION PROTECTION

The management programme for occupational external and internal exposures of CEA workers is applied when the designing work starts on a facility and continues throughout its operation and decommissioning. Any operation entailing a risk of ionizing-radiation exposures is conducted according to the ALARA optimisation principle, which applies to both the layout and equipment of the premises. The layout is designed to facilitate tasks, to limit the intervention time and to avoid passing or stopping in the vicinity of any radiation source. It integrates operating needs as well as inspection, maintenance and waste-removal requirements.

The optimisation process is also combined with workplace organisation that covers the classification and monitoring of work premises, as well as the classification, protection and monitoring of workers, as follows.

- Workplace classification with due account of potential radiological risks, which is often integrated as early as the design stage, is checked and updated throughout the operating life of the facility on the basis of the results of radiological monitoring at the workstation.
- Worker classification depends on the likely occupational exposure level to be received. In order to minimise such exposures, collective as well as individual protection measures are implemented: biological protection systems, static and dynamic containment in case of internal exposure.
- Workplace monitoring is provided by collective real-time measurements (external and internal exposure) or time-delayed measurements.
- Individual monitoring of workers' exposure to ionizing radiation is ensured by individual dosimetric monitoring (passive dosimetry) and / or by anthroporadiometry measurements and radio-toxicology analyzes according to the type of radiological hazard.

In 2015, 5,988 CEA employees were subject to dosimetric monitoring. The measured dose for 90% of the employees did not exceed the recording threshold (100 µSv), while for the remainder the annual average individual dose was 0.33 mSv/year. The maximum measured dose was 3.60 mSv:year.

4.2.2.2. WORKERS' AND PUBLIC EXPOSURE

The design of biological-protection systems at facilities located near accessible areas to non-classified employees or to members of the public is assessed on the basis of an ALARA exposure level below the regulatory threshold for the public (1 mSv/a effective dose).

The same applies, all the more so, to the general public outside the fences of the different CEA sites. Although based on conservative hypotheses, the impact, calculated from the actual releases from the facilities at each center, is extremely low, with an annual dose estimate for the reference groups systematically well below 10 µSv / year in 2015.

4.2.2.3. 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 some of these effluents may be either filtered, or transferred to a facility for possible processing, or discharged into the environment after verification, or disposed of as waste in authorised management routes.

The effluent checks, their discharge conditions and monitoring of the environment are subject to the environmental management system implemented in each centre. This approach demonstrates the ability of the centres to improve their environmental performance for all their activities and bears witness to their desire to reduce their environmental footprint.

All steps are taken to limit the effluents discharged: separation and collection of the effluents at source according to their radiological and physico-chemical properties and processing in appropriate facilities.

These discharges of radioactive effluents into the environment are subject to the general regulations and to regulations specific to each site (interministerial orders or ASN resolutions setting prescriptions for water intake by and discharge of liquid and gaseous effluents from the facilities), defining the authorised limits for the discharges (annual, monthly limits, maximum added concentrations in the receiving environment), the discharge conditions and environmental monitoring procedures.

When carrying out sampling and measurements, the centres call on the services of test laboratories, the competence of which is verified notably by means of periodic inter-laboratory comparisons and COFRAC (French accreditation committee) accreditations.

Discharges of liquid effluents

Only liquid effluents with very low radioactivity levels and whose characteristics (radiological and physico-chemical) are compatible with the limits specified in the texts regulating discharges may be released into the environment after verification. Radioactive effluents are systematically stored in special tanks, according to their nature and level of activity. They are then transferred to one of the CEA radioactive effluent treatment plants. After treatment, a large part of the radioactivity recovered is isolated in the form of solid waste. The radioactivity checks prior to discharge comprise continuous measurements and subsequent laboratory analyses of the total alpha and beta activities, of specific pure beta emitter radionuclides, such as tritium, gamma emitter radionuclides and alpha emitters.

Effluent discharges to the atmosphere

With regard to discharges with very low radioactivity levels, the effluents are first of all filtered on leaving the nuclear facilities, in order to reduce the emission of radioactive particles into the atmosphere. The discharge outlets are equipped with continuous monitoring systems and sampling devices for subsequent laboratory measurement of the radioactivity of the aerosols and gases (tritium, carbon 14, total alpha, total beta-gamma, halogens).

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

On all the sites, gaseous radioactive effluent discharges are well below the authorised discharge limits.

4.2.2.4. ENVIRONMENTAL MONITORING

Environmental monitoring is carried out in the immediate vicinity of each centre, in addition to the effluent discharge checks. The monitoring programme is updated regularly and adapted to changes in activities and local characteristics.

This monitoring ensures that the measures taken by the facilities are effective. Samples covering the main radionuclide transfer routes into the environment are taken for subsequent analysis by the CEA test laboratories.

This monitoring has numerous objectives, more specifically:

- to detect any abnormal rise in the level of radioactivity in the near environment of the centre;
- to identify the radiological status of the environment and monitor its development over time;
- to verify compliance with the prescriptions applicable to the facilities.

Every year, environmental monitoring therefore represents several tens of thousands of radiological and physico-chemical analyses. The levels of the substances in the environment are extremely low and often undetectable even with the most sophisticated measuring instruments.

Water monitoring

The hydrographic system, which receives the liquid effluents discharged, is closely monitored in the vicinity of the centres. Regular samples are taken from the surface waters (streams, rivers, creeks, lakes or ponds) upstream and downstream of the effluent emission point, as well as from the groundwater.

The measurement results show that the radioactivity levels in the water are very low and often undetectable even with the most sophisticated equipment and methods.

The radioactivity measured is essentially natural in origin (potassium 40 and radionuclides of the decay chains of uranium and thorium). Tritium is the main artificial radionuclide detected at low levels in the environment of certain centres.

The surface waters receiving effluents and groundwaters are also monitored. This concerns a large number of physico-chemical, biological and microbiological parameters. This monitoring includes the following elements: suspended solids, potassium, uranium, nitrogen or phosphorus compounds, metals and organic compounds.

Atmospheric monitoring

Atmospheric radioactivity in the environment is continuously monitored by more than 140 measuring instruments providing real-time data.

Dosimeters positioned around the perimeter of the site measure the ambient gamma radiation, primarily due to natural radioactivity, the intensity of which varies significantly with the geological nature and geographical location of the site.

Atmospheric radioactivity is mainly due to radon and its decay products fixed on dust in suspension in the air, as well as to natural radionuclides such as beryllium 7. The activity of the atmosphere fluctuates with the seasons and with variations in the amount of dust in the air, but is on average stable from one year to another.

Monitoring of soils and sediments

Sediments in the water courses receiving liquid effluents undergo radiological monitoring and periodic searches for metals.

The radioactivity of the soils in which radionuclides are liable to build up, in the form of dry and wet deposits, is characterised every year.

Monitoring of flora and fauna

Each centre monitors the level of radioactivity in the foodstuffs produced nearby. Local products, whether or not edible (grasses, fruit, vegetables, fish, milk, etc.) are regularly measured.

The radioactivity in plants and milk is primarily due to naturally occurring potassium 40.

Tritium is detected in the grass sampled from the environment of those sites with licenses for the most significant emissions. It is only detected in milk extremely locally and at trace levels.

The measurement of metal elements is also carried out from time to time on certain species of aquatic mosses.

In 2015, the CEA laboratories - which have held COFRAC accreditation for many years - held 114 COFRAC accreditations and 180 approvals issued by ASN for taking environmental radioactivity measurements. In 2015, some 23,000 samples were analysed for the purpose of environmental radiological monitoring.

CEA transmits its environmental radioactivity measurement results to the national network of environmental radioactivity measurements and they can be freely accessed via a dedicated website (www.mesure-radioactivite.fr). As a key player since this network was set up, nearly 17% of the data available on the website come from CEA, which had already transmitted 220,000 measurement results by mid-2016.

4.2.2.5. SHARED INFORMATION

All of the results are transmitted to the supervisory authorities. CEA also ensures that the environmental monitoring results concerning its centres are distributed as widely as possible to the public.
All CEA sites maintain regular relations with their local authorities and their local information committees (CLI) or information committees (CI).

This information supplements the publication of the annual “transparency and nuclear security” reports, in accordance with article L.125-15 of the Environment Code, for its BNIs, which are available on www.cea.fr. These reports describe the working of the facilities, the emissions of effluents in the environment, the radioactive waste produced and any incidents. They present all the inspection and monitoring measures taken.

4.2.3. Radiation protection and limitation of effluent discharges at AREVA

4.2.3.1. RADIATION PROTECTION AND EMISSIONS

Occupational exposure

Controlling occupational radiation exposures has always been one of AREVA's major concerns. When the facilities currently in service at La Hague were designed in the early 1980s, the occupational design limit was set at 5 mSv/a (i.e., 25% of the limit applied throughout Europe 15 years later). It was clear at the time that such dose was due only to external exposures as work was only carried out in zones with no permanent contamination.

The average occupational individual exposure at La Hague (AREVA group employees and contractors) remains low and stable (figure 10). In 2016, the average exposure was 0.10 mSv/a, while the collective dose amounted to 623 man.mSv.

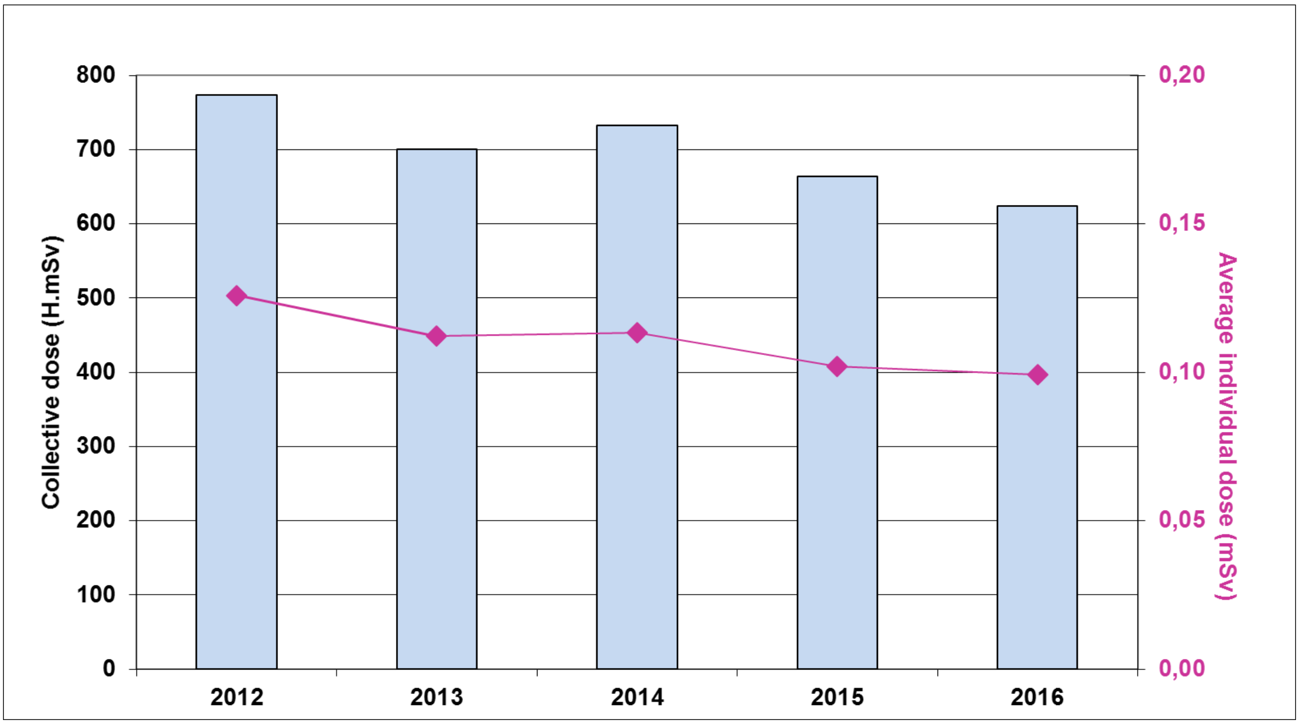

FIGURE 10: ANNUAL DOSES RECEIVED BY EMPLOYEES AND CONTRACTORS AT THE LA HAGUE SITE

Those results were achieved by the following means.

- Designing efficient and reliable process equipment at the front end, thanks to extensive R&D programmes.
- Generalising the use of remote operations.
- Adapting the conventional installation of biological shielding to all likely operating and maintenance situations.
- Ensuring the strict containment of the facilities by providing at least two full physical barriers between the radioactive materials and the environment. Chemistry amenities are completely welded and enclosed in leak-proof cells. They are ventilated by a completely separate network, including the outlet to the atmosphere. Mechanical equipment is fitted with dynamic containment systems (pressure drop, air curtains) and placed in closed cells in which the mechanical penetrations to the working zones were studied very closely. Dynamic containment supplements static arrangements by establishing a series of pressure drops ensuring that air circulates from the least contaminated to the most contaminated zones. Ventilation is provided by several self-sufficient and separate systems based on the contamination level of the ventilated premises in order to prevent any contamination backflow in case of malfunction. All those means ensure that the premises are kept operational under safe conditions in order to prevent internal exposures.
- Taking into account all maintenance operations, as early as the design stage, a decision which has resulted in the equipment being specifically designed on the basis on those operations in order for consumables (pumps, valves, measurement sensors, etc.) to be replaced b, remote means, without any breach in containment and with full biological protection (use of mobile equipment-removal enclosures).
- Continuing the prevention work which involves evaluating and controlling risks before acting, in order to limit occupational exposure by reducing the possible causal *factors*.
- Rigorously applying the principle of dose optimisation so that the dosimetry results remain at the lowest possible level, in the light of current technology, economic factors and the nature of the operations to be performed, as prescribed in the French regulations.

Public exposure

Current provisions limit exposures around the buildings to values that are practically indistinguishable from natural background radiation. Consequently, visitors moving on the site should not receive higher doses than the limits recommended by national authorities.

That is the case, even more so, for the public outside the site fence.

The radiation level is monitored inside the La Hague Site and at the fence perimeter by many dosimeters, which are read every month (11 locations along the fence: exposure range between 60 and 80 nGy/h), supplemented by eight stations along the fence that monitor dose rates on a continuous basis. Lastly, continuous measurements are taken in five neighbouring villages. All continuous measurements are transmitted to the Environmental Control Station of the site.

Radioactive discharges have decreased sharply over the last 30 years. The radiological impact of the La Hague Site dropped by a factor of 5 and the impact on the reference group, which stood at about 70 µSv/a in 1985 has stabilised at around 10 µSv/a. Thanks to those efforts, it is now possible to anticipate the strengthening of regulatory standards within the European Union (as transposed into French law) that currently sets at 1 mSv/a the maximum limit for the added efficient dose per year for the public, compared to the average natural exposure in France (2.4 mSv/a) and its variants throughout the world (between 1 and 10 mSv/a). AREVA, however, is continuing its studies on the feasibility of reducing further the radioactive discharges of the La Hague Plant, notably in the framework of the Order for plant discharges.

Impact of discharges

Reducing discharges and their impact has always been one of the prime concerns of the CEA and later of AREVA, in consultation with authorities. Site selection, in particular, has always been guided by that concern.

Discharge licences have always been issued based on practical dose constraints that are far lower than regulatory limits, considering the application of the best available techniques and aiming to set limit values as close as possible to the actual discharge levels of the facilities in their normal operating conditions. Furthermore, processing facilities may only be licensed if they are shown to be sufficiently reliable in ensuring that any risk of uncontrolled discharges is kept to a strict minimum. Nevertheless, very unlikely events must be considered as part of a beyond-design-basis approach, whenever their consequences are potentially high, and measures must be taken to limit them. Under those conditions, the risk of exposing an individual to doses exceeding the national regulatory limits due of a discharge may be considered as extremely low.

The following principles were adopted:

- The use of a rigorous containment system to prevent losses, as mentioned above.
- The optimisation of the destination of by-products resulting from effluent processing, with the main priority being focused on recycling those products to the maximum extent possible of the process, and the second priority being centred on sending non-recyclable products for treatment as solid waste (preferably by vitrification, or failing that, by compacting and/or cementing). The remainder is discharged after processing either into the atmosphere or into the sea, depending on what is technically feasible, preferably in a place where the impact on the environment and reference groups is minimal.
- The due consideration of worker exposures, as well as to public and occupational risks in the assessment of the various options.

In application of those principles, the effluents are collected, treated to the maximum extent possible in order to recover all reagents, purified, and, if necessary, converted for recycling purposes in the process, with the rest being concentrated and sent with any contained radionuclides for solid-waste disposal, mostly by vitrification, which is the most compact and effective means of packaging radionuclides. Some parts of the process producing unsuitable effluents for vitrification or concentration (such as certain laboratory analyses) were modified in order to eliminate active effluents.

For instance, all aqueous solutions being used to rinse the structural elements of fuel assemblies (top and bottom end-pieces and cladding debris) are recycled in a dissolution solution prepared with highly concentrated nitric acid, which has been recycled, concentrated and purified by evaporation after extraction of other products (fission products, uranium and plutonium) during the process. The same applies to solvents and thinners, which are purged of their radioactivity and of the decay products they contain by vacuum distillation within a special evaporator. In that case, the residue is impossible to vitrify and is packaged as solid waste by embedding it in cement, after calcination in a dedicated unit. That method is a primary and extremely important means for reducing the volume and activity of effluents.

As for non-recyclable solutions, HL effluents are vitrified. Based on their acidity, LIL effluents are collected and sorted into acid and alkali effluents. Instead of being sent to the effluent-treatment station for sorting according to their radioactivity level, they are concentrated in dedicated evaporators, which have been installed in such a way that operation never stops. Most of the products fed into the acid and base evaporators come out in the form of distillates, which are virtually free of contamination, then directed towards "V" effluents and discharged as such. The residual concentrate contains all existing radioactivity and, thus, becomes an HL effluent (but of far smaller volume than the initial effluent), and is sent for vitrification with other HL effluents. That method is a second and very important means of reducing the activity and volume of effluents, as well as of solid waste.

It was impossible to use that type of arrangement in old plants that called upon less efficient processes and process equipment.

Effluents from the analytical laboratory constitute a special case. The most significant steps taken to reduce the radioactivity of that type of effluents were to develop new on-line analysis techniques that no longer require that samples be collected from the process, thereby eliminating one source of effluent, and also to develop plasma-torch chromatography, which requires only very small samples and uses no unusual reagent, thus eliminating another fraction of the effluent stream.

Some analyses of residual plutonium solutions have caused the high alpha radioactivity of the analytical laboratory's effluents. The installation of a special plutonium recovery unit on that stream led to a significant reduction in the alpha energy discharged by the laboratory.

The implementation of the principles described above has led to significant discharge reductions concurrent with a reduction in the volume of solid waste, because, instead of being embedded in bitumen or cement, radionuclides are sent for vitrification, a process that is compatible with far higher activity levels. Hence, reducing discharges was not achieved to the detriment of an increased volume of solid waste, but rather simultaneously with improved compaction.

The result of the steps being taken is particularly visible for discharges into the sea, which had risen appreciably during the period in which LWR fuels were being treated in the old facilities.

AREVA is implementing significant means to control its discharges and to keep regulatory registers, which are transmitted every month to ASN. The measurements of those discharges are also subject to crossed controls by independent laboratories and unscheduled inspections by ASN.

The impact of those discharges is currently very low, well below that required by international regulations or recommendations and by health considerations. In any case, the impact corresponding to gaseous and liquid discharges has never exceeded the current dose limits for member of the public (and therefore certainly never the applicable limits at the time). However, applying the best-available technology (BAT) principle means that the reduction process must be continued, taking into account the progress made in similar processes or operations, advances in scientific and technological knowledge, the economic feasibility of new techniques and the implementation time required, as well as the nature and volume of the relevant discharges.

Radioactive discharges have greatly decreased over the last 30 years. The radiological impact of La Hague has been reduced by a factor of 4: the impact on the reference group has stabilized below 20 µSv/a compared with a level of about 70 µSv/a in 1985. These efforts have anticipated the reinforcing of the regulatory standards in the European Union, transposed into French law, which currently sets the maximum cumulative effective dose per year on the general public at 1 mSv, in comparison with the average natural exposure in France which amounts to 2.9 mSv/a according to IRSN[17].

The calculated impact values were confirmed by a particularly exhaustive study conducted by the expert group *Nord-Cotentin Radioécologie* which, at the government's request, examined all discharge values, plus more than 50,000 reports of samples taken by various bodies. The Nord-Cotentin exercise in 2000, which revealed that environmental markings from the plant discharges were insignificant when compared to natural radioactivity and the fallouts from the Chernobyl accident and atmospheric testing of nuclear weapons, all levels which were already very low.

4.2.3.2. ENVIRONMENTAL MONITORING

Upstream from the controls conducted by competent authorities and by the EC (Article 35 of the Euratom Treaty), AREVA is implementing significant environmental-monitoring means.

In the framework of the National Network of Radiological Measurements in the Environment (*Réseau national de mesures de la radioactivité de l'environnement* – RNME), the Group's six laboratories concerned (AREVA NC La Hague, AREVA NC Pierrelatte, AREVA NC Malvési, EURODIF-Production, AREVA NP Romans and SEPA Bessines) obtained from ASN the approvals associated with their analyses.

The report presenting the radiological summary of the RNM for the period 2011-2014 concludes that *"the doses liable to be received by the population living in the vicinity of the French nuclear facilities, estimated from the results of the measurements taken during the various environmental monitoring programmes are low, 100 to 10,000 times lower than the public exposure limit set at 1 mSv/year. […] These doses tally well with those estimated..."* This validates the overall consistency of the monitoring system and the impact estimation models, with regard to the annual discharge reports.

4.2.3.3. PUBLIC INFORMATION

AREVA reports on its undertakings through a policy of information transparency by making the discharge values and environmental monitoring results available to the public regularly via the website www.areva.com as well as via the French national network of environmental radioactivity monitoring www.mesure-radioactivite.fr.

In addition, every nuclear site of the AREVA Group issues every year the following reports.

[17] IRSN's Repères magazine no 29, April 2016.

- Pursuant to its discharge-licence order or ASN resolution setting the prescriptions about discharges, a public report presenting notably the status of water intakes and the status report of the control of intake media, the status of discharges, the estimated doses received by the population due to the activity conducted during the past year. This report is issued before 30th June of the following year to ASN, to the national and local government administrations concerned and to the Local Information Committee (CLI).
- In accordance with L.125-15 of the Environment Code, a report describing the measures taken with regard to nuclear safety and radiation protection, incidents, the nature and the measurement results of radioactive and non-radioactive discharges, the nature and quantity of radioactive waste being stored on the site of the facility, as well as all measurements being taken in order to limit the waste volume and impact on human health and the environment, especially soils and waters. This report must be issued before the 30th June of the following year. It is presented to the CHSCT (Committee for Health, Safety and Working Conditions) of the site concerned, and addressed to the HCTISN (French High Committee for Transparency and Information on Nuclear Security), to the ASN and CLI representatives, and to a wide audience of external and internal stakeholders (elected officials, journalists, suppliers, etc.). It is also posted on line on the AREVA website, (www.areva.com).

Each year the AREVA group also publishes the reference document, the annual report and the report on the safety of the nuclear installations. All these documents are available on its website.

In France the Local Information Committees foster direct interchange between the principal local stakeholders (elected officials, associations, experts, etc.), mainly through regular meetings. These meetings, to which the press is also invited, provide the opportunity to present the current news of the AREVA sites and to assess the actions taken with respect to the environment, security and nuclear safety.

4.2.4. Radiation protection and effluent limitation at EDF

4.2.4.1. RADIATION PROTECTION OF WORKERS

Any action taken to reduce occupational doses starts with a thorough knowledge of risks that can lead to an internal or external exposure to radiation. Thanks to EDF's "radiological cleanliness" policy and the systematic use of respiratory equipment in case of suspected risk of internal contamination, cases are rare or not serious.

Since most doses are due to external exposures, EDF is focusing its efforts on reducing them. That policy and its results form a whole and it is impossible to isolate what is strictly associated with spent-fuel management or waste management. Consequently, the following paragraphs will address the overall operation of nuclear-power reactors.

In order to optimise and to reduce further the doses of exposed individuals, EDF launched the ALARA-1 policy as early as 1992, thus leading to significant improvements in terms of collective and personal dosimetry. To continue making progress, EDF launched a new ALARA initiative in 2000 applying the optimisation principle as a whole and aiming to reduce the collective dosimetry. This initiative is based on three lines of progress:

- reduced contamination in systems (zinc injection, decontamination work, filtration optimisation, optimisation of cold shutdowns etc.);
- dose optimisation in work planning (dose forecasts, optimisation analysis in relation to dose targets, real-time monitoring of collective and individual doses, analysis of deviations, etc.);
- experience feedback, analysis of deviations and good practices.

Between 2003 and 2016, these efforts reduced the number of workers with an annual individual dose of between 14 and 20 mSv from 322 down to 0, and the average individual dose from 1.93 to 1 mSv. Likewise, the collective dosimetry per plant unit continued to drop and reached 0.76 man.Sv/unit in 2016. It is noteworthy that a slight rise and fluctuation of the collective dose has been observed for 5 years. This is due to the variation in maintenance volumes from one year to another.

In addition, EDF has undertaken actions to ensure better control of the risk situations represented by radiographic exposures, prohibited areas (red) and limited stay areas (orange) by:

- reducing the repeat exposure situations and drawing the lessons from events involving jammed sources,
- continuing the proactive procedure for identifying, counting, protecting and reducing the hot points and by reinforcing the preparation and inspection of activities, particularly when they can lead to exposure levels exceeding 2 mSv/h, in close collaboration with the industrial gamma radiography service providers.

The activity preparation, which ranges from initial assessment to final optimisation and ends with the integration of experience feedback, is carried out using a computer application, PREVAIR, which is shared by all nuclear sites and corporate engineering groups. This application is also used for the preparation of activities entrusted to contractors.

During an intervention, PREVAIR allows for the automated collection and tracking of doses per intervention. In addition, since the system is coupled with new dosimeters equipped with alarms, it reinforces the protection of individual workers by adapting the alarm thresholds of their electronic dosimeters to the dose forecast for their intervention.

Once the intervention is over PREVAIR allows experience feedback to be built up by archiving the doses per intervention. The operational-dosimetry process is designed to monitor occupational doses in real-time during interventions and to display deviations to set objectives.

Use and dissemination of experience feedback

In order to limit occupational doses, EDF took proactive steps to reduce the annual exposure limit from 50 to 20 mSv as early as 2000. In addition, alarm thresholds have been implemented in the management of operational doses used on all EDF nuclear sites. These thresholds of 16 mSv as a first step, and then replaced by a unique threshold of 14 mSv since spring 2012. Monitoring of occupational doses upon entry into a controlled area takes into account not only their doses over the past 12 months, but also their dose forecast. If this value is reached, special consultations involving radiation-protection experts are held in order not only to assess and to refine the optimisation of subsequent doses, but also to improve monitoring practices and prevent any violation of statutory limits. Crafts identified as receiving the highest exposure levels (insulation fitters, welders, mechanical-maintenance technicians and logisticians) are subject to specific monitoring procedures that have proven effective, since individual doses, although still high, have decreased considerably over the past 10 years, as mentioned earlier in the report.

Implementation of an ALARA approach to shipments

In order to optimise doses associated with shipments of radioactive materials, EDF extended its ALARA approach to the case of spent-fuel shipments: all available data are used not only by operators in charge of removal operations, but also by designers to define appropriate tools for new packages.

4.2.4.2. EFFLUENT DISCHARGES

Discharges of radioactive effluents are subject to a general regulation which provides:

- the relevant procedures for obtaining discharge licences;
- discharge standards and conditions;
- the role and responsibilities of nuclear-site managers.

In addition, ministerial orders or ASN resolutions for each site include specific requirements regarding:

- limits not to be exceeded in the form of regulatory annual limits, or of additional or total maximum concentrations of the receiving environment (the concentration limits are associated with annual total activity limits set to ensure good management);
- discharge conditions;
- the modalities for discharge control and of the environmental-monitoring programme.

Concentration limits are associated with annual total-activity limits set for sound-management purposes.

That regulatory framework also involves the implementation of the optimisation principle, the aim of which is to reduce the impact of radioactive discharges to a level that is compatible with the ALARA principle. It was integrated into the facility design through the use of effluent-treatment capabilities, etc., and has resulted in a rigorous management of effluents during operation.

This procedure was integrated into the facility design (installation of effluent treatment capabilities, etc.) and has resulted in the setting up of rigorous effluent management during operation with the aim of mitigating the environmental and dosimetric impacts. Efforts are therefore being made to limit discharges by improving the effluent collection and treatment channels and by reducing their production at source.

Those measures have led to a drastic reduction in liquid effluent discharges, except for tritium and carbon-14 (proportionate to electricity production), which, in fact, were originally the prevailing contributor to environmental and health impacts (dose).

The substantial reduction in liquid discharges (except for tritium and carbon-14), which has been observed for a number of years (100 times less since 1984), means that the current dose impact of discharges from an NPP is governed chiefly by tritium and carbon-14 discharges.

However, the dose impact of radioactive discharges remains extremely low, in the order of one or a few microsieverts per year, as calculated for the reference group living close to an NPP. That value is well below the natural exposure level in France (2,400 µSv/a) and the exposure limit for the members of the public (1,000 µSv/a), excluding exposure to natural radiation and excluding medical practices).

Environmental monitoring

In order to check on compliance with the regulatory provisions, EDF implements a programme for monitoring effluent discharges and the environment. This programme, established in agreement with ASN, is conducted under the licensee's responsibility.

In addition to the monitoring and measurements carried out on the effluent discharges, EDF deploys substantial resources to measure the radioactivity in the periphery of the BNIs to detect any abnormal change in environmental radioactivity levels near the NPPs. These surveillance measures cover the various external and internal human exposure pathways (inhalation, ingestion):

- atmospheric radioactivity measurements (dust and gas) and the ambient gamma dose rate,
- measurements on environmental matrices taken from terrestrial and aquatic environments and on consumer products.

EDF's monitoring of the environment around the NPPs fulfils three separate but complementary functions:

- An alert function, through a network of radiation meters set up in the vicinity of the installation. By forwarding the alert to the control room, any abnormal change in the ambient radioactivity level near the site is detected in real time.
- A routine surveillance function that concerns the daily to monthly analyses (essentially overall beta and tritium activity measurements) performed on atmospheric dust, rainwater, groundwater, plants, milk, etc.
- A scientific monitoring and studies function which corresponds to the radioecological measurement campaigns, usually carried out between April and October. It aims at making a highly precise evaluation of radionuclide activities in the terrestrial and aquatic ecosystems and any spatial and temporal changes thereto.

In addition to those technical functions, the communication function encompasses contacts with the authorities and the general public. The keeping of regulatory records (effluents and environment) sent annually to ASN is entrusted upon a single and independent unit from the services responsible for requesting discharges licences or conducting discharges.

Following the creation by the French authorities within the National Network of Measurements (*Réseau national de mesures* – RNM, see § F.4.1.4.1), all environmental laboratories at EDF's NPPs embarked on a process of gaining ASN approval for the different measurements contributing to the network, and, in parallel, accreditation to the NF EN ISO/CEI-17025 standard.

Furthermore, a decennial assessment of the radiological state of the site and its environment, similar to the baseline measurements, must also be performed when commissioning the first unit at a site. All sites have now conducted their first decennial review. Third decennial reviews began with Fessenheim in 2009 and are scheduled according to a planning, which is established with the laboratory in charge of that study and site involved.

Each year EDF thus takes more than 40,000 regulatory samples to which it voluntarily adds hundreds of annual analyses to determine more precisely the radiological and radioecological status of the environment. All these measurements confirm the very low environmental impact of radioactive discharges from the NPPs and a general reduction in the activity of artificial gamma-emitting radionuclides measured in the monitored environmental matrices.

It is to be noted that specific surveillance actions can also be implemented further to certain events that could lead to one-off contamination situations. In the context of the post-Fukushima follow-up for example, nearly 500 gamma spectrometry analyses on aerosol filters and nearly 200 on iodine traps were carried out over a seven-week period in addition to the monitoring of the installations required by the regulations. All the results were transmitted daily to ASN and to the IRSN emergency centre, which thus had a constantly updated map of the air masses above France.

4.2.5. Radiation protection and limiting of effluents at the ILL

The average individual dose for the ILL is very low and continuously decreasing, at 0.011 mSv/a. The maximum individual dose (1.01 mSv/a) was received by a person carrying out mechanical maintenance work. The dose record is likely to increase in the coming years given the numerous programmed work on the reactor block. For information, the zero doses indicated by the approved dosimetry laboratories correspond to doses that are below the dosimeter recording threshold, that is to say 0.05 mSv.

With regard to internal exposure, only exposure to tritium may be above the detection limits and the collective dose is of 1 mSv divided among about 30 persons at the ILL.

	ILL	Experimenters	Companies	Total
Number of persons monitored	378	1506	339	**2 223**
Number of zero doses	316	1454	314	**2 084**
Collective dose [Man.mSv]	13.63	8.31	2.68	**24.62**
Maximum individual dose [mSv]	1.01	0.65	0.22	**1.01**
Average individual dose [mSv]	0.036	0.006	0.008	**0.011**

TABLE 21: DOSES RECEIVED IN 2015 BY PERSONS WORKING AT ILL

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. Such emergency plans should be tested at an appropriate frequency.

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.

5.1. General emergency preparedness in BNIs

The organisation of the response by the public authorities in a nuclear or radiological emergency situation is a particular case of the government's organisation for dealing with major emergencies, as presented in circular 5567/SG from the Prime Minister dated 2nd January 2012. This circular describes the role and the responsibilities:

- at government level (ministries and interministerial crisis committee);
- at defence and security zone level (zone operations centre);
- at *département* level (departmental operations centre);
- of the various stakeholders and regional agencies taking part in the response to a major emergency.

The management of a radiological emergency situation is covered by the "national response plan for a major nuclear or radiological accident of February 2014 and by the interministerial directive of 7th April 2005 concerning the organisation of the response by the public authorities to a nuclear or radiological emergency.

International notification of the emergency situation is the subject of the interministerial directive of 30th May 2005 relative to the application of the international convention on the early notification of a nuclear or radiological accident and the decision of the council of the European Communities concerning the community procedures for the rapid exchange of information in the event of a nuclear or radiological emergency situation.

Information exchange protocols are in place with France's neighbours liable to be affected by a nuclear or radiological emergency situation in a facility close to a border.

FIGURE 11: CRISIS ORGANISATION IN THE EVENT OF AN ACCIDENT

5.1.1. Local provisions

In a nuclear or radiological emergency situation liable to have an impact outside a BNI, the Prefect of the *département* where this facility is situated takes charge of the emergency response operations. He or she implements the provisions of the off-site emergency plan (PPI) and orders population protection measures.

To ensure local management of the emergency, he or she activates and utilises the emergency management centre (departmental operations centre), which comprises representatives from all the response services (police, gendarmerie, civil protection), the decentralised regional agencies of ASN and IRSN. He or she is also responsible for communication with the media and information of the general public and elected representatives.

The licensee of the BNI affected by the accident must deploy an organisation and means for controlling the accident, assessing it and mitigating the consequences, for protecting the persons on the site and alerting and regularly informing the public authorities. These arrangements are determined beforehand in the on-site emergency plan (PUI) that the licensee is required to prepare.

5.1.2. National provisions

In the event of a major crisis requiring the coordination of numerous players, a governmental crisis organisation is set up, under the supervision of the Prime Minister, with the activation of the interministerial crisis committee (CIC). The purpose of this committee is to centralise and analyse information in order to prepare the strategic decisions and coordinate their implementation at interministerial level. It comprises:

- all the ministries concerned, or their representatives;
- the competent safety regulator and its technical support organisation (IRSN);
- the representatives of the licensee;
- the administrations or public institutions providing assistance, such as Météo-France.

In a radiological emergency situation, each ministry - together with the decentralised State services – is responsible for preparing and executing national level measures within their field of competence.

The ministries concerned also work together with ASN in order to advise the Prefect on the protection measures to be taken. They provide the Prefect with the information and advice such as to enable him or her to assess the state of the facility, the seriousness of the incident or accident and its possible developments.

5.1.2.1. THE EMERGENCY PLANS

The licensee of a BNI is obliged by the regulations to draw up a nuclear or radiological emergency response plan. This plan is called the “on-site emergency plan (PUI)” and its purpose is:

- to return the facility to a stable, controlled state;
- to prevent, mitigate or delay the consequences of the accident outside the facility;
- to alert the response services outside the facility and facilitate their response actions on the site;
- to alert and protect the persons on the site;
- to alert the public authorities;
- to take the steps provided for in the off-site emergency plan which are under the responsibility of the licensee.

For certain BNIs, such as NPPs or research reactors, the public authorities in the *département* are required by the regulations to draw up a contingency plan for the population living within a specified area around the facility. This plan is called the “off-site emergency plan” (PPI) and its purpose is to protect populations in the short term from the threat of radioactive releases and provide the licensee with outside emergency response resources. It defines the duties of the various services concerned, the ways of broadcasting the alert and the material and human resources.

At the Government level, the national "major nuclear or radiological accident" plan published in February 2014 covers the major radiological emergency situations concerning BNIs or the transport of radioactive materials. It details the national emergency management organisation, the response strategies and principles and contains a decision support guide that is available to the ministerial authorities. This plan is implemented nationwide (defence and security zones and *départements*) to supplement the off-site emergency plans.

5.1.2.2. COUNTERMEASURES IN THE EMERGENCY PLANS

In the event of a major nuclear or radiological accident, a number of measures can be envisaged by the Prefect in order to protect the population:

- sheltering and waiting for instructions: when alerted by a siren, the persons concerned take shelter at home or in a building, with all openings completely closed (and ventilation equipment switched off) and wait for instructions from the Prefect over the radio;
- taking stable iodine tablets: when ordered by the Prefect, the persons liable to be exposed to releases of radioactive iodines are instructed to take the prescribed dose of potassium iodide tablets;
- evacuation: in the event of a threat of large-scale radioactive releases, the Prefect may order evacuation. The populations are then asked to prepare a bag, secure their home, leave it and then evacuate by their own means or go to the nearest assembly point.

The Prefect may also take measures to ban the consumption of foodstuffs liable to have been contaminated by radioactive substances as of the emergency phase (until the facility has been restored to a controlled and stable state).

The dose levels triggering implementation of population protection measures in a radiological emergency situation are defined by ASN resolution 2009-DC-0153 of 18th August 2009:

- an effective dose of 10 millisieverts (mSv) for sheltering;
- an effective dose of 50 mSv for evacuation;
- an equivalent dose to the thyroid of 50 mSv for the administration of stable iodine.

The predicted doses are those that it is assumed will be received until releases into the environment are brought under control, generally calculated over a period of 24 hours for a one year old child (age at which sensitivity to ionising radiation is highest) exposed to the releases.

In the event of the release of radioactive substances into the environment, measures are decided on to prepare for management of the post-accident phase; they are based on the definition of area zoning to be implemented as of the end of the releases on exiting the emergency phase and including:

- a population protection zone (ZPP) within which action is required to reduce both the exposure of the populations to ambient radioactivity and the consumption of contaminated food, as far as is reasonably possible (for example a ban on consumption of produce from the garden, restrictions on access to wooded areas, ventilation and cleaning of homes, etc.);
- a heightened territorial surveillance zone (ZST), which is larger and more concerned with economic management of the regions, within which specific surveillance of foodstuffs and agricultural produce will be implemented;
- as necessary, within the ZPP, an evacuation perimeter defined according to the ambient radioactivity (external exposure); the residents must be evacuated for a length of time that will vary according to the level of exposure in their living environment.

5.2. ASN's role and organisation

5.2.1. ASN's duties in the event of an emergency

In a nuclear or radiological emergency situation, ASN, with the support of IRSN, has the following four duties:

- to check and ensure the validity of the nuclear safety measures taken by the licensee;
- to advise the Government and its local representatives;
- to help disseminate information;
- to act as competent Authority within the framework of international conventions.

5.2.2. ASN organisation with regard to nuclear safety

The ASN emergency response organisation set up for a nuclear accident in a BNI more specifically comprises:

- participation by ASN staff in the various CIC units, the zone emergency centre and the departmental operations centre;
- at the national level, an emergency centre in Montrouge, consisting of three command posts (PC):
    - a strategy command post, set up by the ASN Commission, which can be called on to issue resolutions and impose prescriptions on the licensee of the installation concerned in an emergency situation;
    - a technical command post (PCT) that is in constant contact with its technical support organisation - IRSN, and with the ASN Commission. Its role is to adopt positions to advise the Prefect, who is the emergency operations director;
    - a communication command post (PCC), situated close to the PCT. The ASN Chairman or his representative acts as the spokesperson, separately from the duties of head of the PCT.

The operation of the emergency centre is regularly tested during national emergency exercises and is activated for actual incidents or accidents. At the local level, ASN representatives visit the *département* and zone Prefects to help them with their decisions and their communication actions. ASN inspectors may also go to the site affected by the accident; others take part in emergency management at the headquarters of the regional division involved.

Experience feedback from the Fukushima Daiichi accident may also lead ASN to envisage sending one of its representatives, if necessary, to the French embassy in the country where an accident occurred.

During exercises, or in the event of a real emergency, ASN is supported by an analysis team located at IRSN's technical emergency centre (CTC).

ASN's alert system allows mobilisation of its emergency centre staff and those of the IRSN. This automatic system sends an alert signal to the staff equipped with appropriate reception devices, as soon as it is remotely triggered by the BNI licensee originating the alert. It also sends the alert to the staff of the SGDSN, the DGSCGC, the interministerial emergency management operations centre (COGIC), Météo-France and the ministerial operational monitoring and alert centre of the Ministry of the Environment, Energy and the Sea.

The severity of the situation is evaluated by the various parties, who if necessary decide to activate their own emergency management centres to manage the situation.

Table 22 shows the positions of the public authorities (Government, ASN and technical experts) and the licensees in a radiological emergency situation. These players each operate in their respective fields of competence with regard to assessment, decision-making, action and communication, for which regular audio-conferences are held. The exchanges between parties lead to decisions and orientations concerning the safety of the facility and the protection of the general public. Similarly, relations between the communication units and the spokespersons of the emergency centres ensure that the public and media are given coherent information.

	DECISION	EXPERTISE	INTERVENTION	COMMUNICATION
Authorities	Government (CIC) Prefect (COD, COZ)	/	Prefect (PCO) Civil Security	Government (CIC) Prefect (COD)
	ASN (PCT)	IRSN (CTC) Météo-France	IRSN (intervention units)	ASN IRSN
Operators	Local and national levels	Local and national levels	Local level	Local and national levels

TABLE 22: POSITIONNING OF THE DIFFERENT RADIOLOGICAL EMERGENCY STAKEHOLDERS

CIC: Interministerial Crisis Centre, COD: Département Operational Centre, PCO: Operational Control Centre, CTC: Technical Crisis Centre

5.2.3. Role and organisation of operators in case of emergency

The operator's emergency response organisation is designed to support the operation team in the event of an accident and must ensure the following tasks:

- on site, triggering the PUI;
- off site, mobilising accident experts from national emergency response teams (*équipe nationale de crise* – ENC), in order to help site managers, and
- informing public authorities that may, depending on the gravity of the situation, trigger the PPI.

5.2.4. The role of ASN emergency situation preparedness

5.2.4.1. APPROVAL AND OVERSIGHT OF ON-SITE EMERGENCY PLANS (PUI)

In accordance with article L. 1333-6 of the legislative part of the Public Health Code, decree 2007-1557 of 2nd November 207 and the BNI order of 2nd February 2012, along with the safety analysis report and the general operating rules, the on-site emergency plan must be one of the safety documents that the licensee must submit to ASN at least six months before the use of radioactive materials in a BNI. In this context, the PUI undergoes in-depth analysis by IRSN.

ASN ensures proper implementation of the on-site emergency plans in particular by means of inspections.

5.2.4.2. PARTICIPATION IN OFF-SITE EMERGENCY PLAN (PPI) PREPARATION

Pursuant to the decree of 13th September 2005 concerning off-site emergency plans and the ORSEC plan (emergency response organisation), implementing article L741-6 of the domestic security code, the Prefect of the *département* is responsible for drafting and approving the PPI. ASN assists the Prefect by analysing the technical data to be provided by the licensees, in order to determine the nature and scope of the consequences outside the nuclear facility. This analysis is performed jointly with the technical support organisation, IRSN.

ASN also gives its opinion on the part of the ORSEC plans drafted by the Prefects concerning the transport of radioactive materials.

5.2.4.3. THE STEERING COMMITTEE IN CHARGE OF POST-ACCIDENT ASPECTS (CODIRPA)

The "post-accident" phase concerns the handling over a period of time of the consequences of long-term contamination of the environment by radioactive substances following a nuclear accident. It includes dealing with varied consequences (economic, health, social), by their very nature complex, which need to be addressed in the short, medium or even long term, with a view to restoring a situation considered to be acceptable.

The conditions for reimbursement for the damage resulting from a nuclear accident are currently covered by Act 68-943 of 30th October 1968, amended, concerning civil liability in the field of nuclear energy. France has also ratified the protocols signed on 12th February 2004, reinforcing the Paris convention of 29th July 1960 and the Brussels convention of

31st January 1963 concerning civil liability in the field of nuclear energy. These protocols and the measures necessary for their implementation are codified in the Environment Code (section I of chapter VII of title IX of book V). These provisions and the new liability thresholds set by the two protocols entered into force in February 2016, pursuant to the 17th August 2015 Act on energy transition for green growth (TECV Act). An order of 19th August 2016 sets the list of sites with more limited risks which benefit from a reduced liability amount.

Pursuant to the interministerial directive of 7th April 2005, and in association with the ministerial departments involved, ASN was tasked with establishing the framework, and defining, preparing and taking part in implementing the necessary provisions in response to post-accident situations following a nuclear accident. In order to draw up the corresponding aspects of doctrine, ASN in June 2005 created the steering committee for managing the post-accident phase of a nuclear accident or radiological emergency situation (CODIRPA), for which it acts as Chair and technical secretary. ASN's mandate was updated in a letter from the Prime Minister of 29th October 2014.

Numerous elements of the doctrine drawn up by the CODIRPA were incorporated into the "Major nuclear or radiological accident" national response plan, sent out in January 2014, for example post-accident zoning.

The CODIRPA is currently continuing with work to take account of the lessons learned from the post-accident management carried out in Japan following the Fukushima Daiichi disaster, but also experience feedback from emergency exercises. A new working group was set up in 2015 on waste management in a post-accident situation, involving members of the CODIRPA and of the National Radioactive Materials and Waste Management Plan (PNGMDR) working group. Finally, work on the management of manufactured products, water and marine environments will be started in 2017.

5.2.4.4. EMERGENCY EXERCISES

The main aim of these nuclear and radiological emergency exercises is to test the planned response in the event of a radiological emergency in order:

- to ensure that the plans are kept up-to-date, that they are well-known to those in charge and to the participants at all levels and that the corresponding alert and coordination procedures are effective;
- to train those who would be involved in such a situation;
- to implement the various aspects of the organisation and the procedures set out in the interministerial directives: the emergency plans, the contingency plans, the local safeguard plans and the various conventions;
- to develop a general public information approach so that everyone can, through their own individual behaviour, make a more effective contribution to civil protection.
- to build on emergency situation management knowledge and experience.

These exercises, which are the subject of an annual interministerial review, involve the licensee, the ministries, the offices of the Prefect and services of the *départements*, ASN, ASND, IRSN and Météo-France, which can represent up to 300 people when resources are deployed in the field. They aim to test the effectiveness of the means of assessing the situation, the ability to ensure that the facility or package is brought to a controlled state, to take appropriate measures to protect the population and set up satisfactory communication with the media and the populations concerned.

5.3. Emergency response organisation for accidents outside BNIs

In addition to incidents or accidents which could affect nuclear facilities or a radioactive substances transport operation, radiological emergency situations can also occur:

- during performance of a nuclear activity for medical, research or industrial purposes;
- in the event of intentional or unintentional dissemination of radioactive substances into the environment;
- following the discovery of radioactive sources in places not designed to accommodate them.

It is then necessary to intervene to limit the risk of exposure of individuals to ionising radiation. Together with the ministries and the stakeholders concerned, ASN thus drafted interministerial circular DGSNR/DHOS/DDSC n° 2005/1390 of 23rd December 2005. This supplements the provisions of the interministerial directive of 7th April 2005 presented in F 5.1 and defines the organisation of the State's departments for these radiological emergency situations, more specifically:

- the context of the intervention;
- the responsibilities of the various parties;
- the methods for alerting the public authorities;
- the intervention principles;
- the departments liable to provide their assistance.

Given the large numbers of those who could possibly issue an alert and the corresponding alert circuits, all the alerts are centralised in a single location, which then distributes them to all the stakeholders: this is the fire brigade's centralised alert processing centre CODIS-CTA (operational *département* fire and emergency centre – alert processing centre), that can be reached by calling 18 or 112.

The management of accidents of malicious origin occurring outside BNIs are not covered by this circular, but by the Government's NRBC plan (nuclear, radiological, biological and chemical).

6 | DECOMMISSIONING (ARTICLE 26)

Each Contracting Party shall take the appropriate steps to ensure the safety of 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.

6.1. ASN's requirements concerning BNIs

6.1.1. Definitions

The following definitions are those presented in ASN Guide No. 6 "Final shutdown, decommissioning and delicensing of basic nuclear installations in France", updated in 2016.

Decommissioning

Decommissioning involves all the technical operations carried out with a view to reaching an end state enabling delicensing. The decommissioning phase follows the operating phase of the installation and ends at the end of the delicensing process of the installation. This definition is close to that given by IAEA in its glossary.

Clean-out

Clean-out corresponds to the operations undertaken in order to reduce or to eliminate any residual radioactivity or any other residual dangerous substance.

Delicensing

Delicensing is an administrative procedure that consists in deleting the installation from the list of "basic nuclear installations" (BNIs). In this case the installation is no longer subject to the legal and administrative system of the BNIs. Delicensing lifts part or all of the regulatory controls applicable to a BNI. It can only be carried out after completion of the decommissioning work and the justification of the achievement of the final state sought.

6.1.2. Decommissioning policy and strategy

The challenges

Since a large number of BNIs were built in France between 1950 and 1990, many of them have been shut down over the last 15 years or so and have entered into their decommissioning phase or have been decommissioned. As mentioned in Chapter D.6, more than 30 facilities of all types (nuclear power or research reactors, laboratories, fuel-processing plants, waste-management facilities, etc.) were already shut down or undergoing decommissioning in 2016. In that context, the safety and radiation protection of decommissioning operations have gradually become major topics for ASN.

The general principles

At the international level, three main decommissioning strategies have been defined by the IAEA:

- delayed decommissioning;
- safe confinement;
- immediate decommissioning.

In accordance with IAEA recommendations, French policy requires operators to adopt a strategy for decommissioning in as short a time as possible and to evacuate all hazardous substances during this phase. This strategy notably makes it possible not to place the burden of decommissioning on future generations, both technically and financially. It also makes it possible to benefit from the knowledge and skills of the teams present during the operation of the installation which is essential during the first decommissioning operations.

This principle - which appeared in Article 8.3.1 of the BNI Order and was included since 2009 in ASN's doctrine on decommissioning and delicensing - was adopted at the legislative level in the TECV Act of August 2015 which introduces it in the Environment Code. The Decree of 28 June 28 2016, amending the "BNI Procedures" Decree of 2nd November 2007, also updated the procedures governing the final shutdown and dismantling of BNIs

These changes to the regulatory framework have made several important changes, detailed in § E 2.2.4.4, the principles of which are set out in the following guides:

- Guide no 6 “Final shutdown, decommissioning and delicensing of nuclear facilities in France”, updated in 2016;
- Guide no 14 “Improvement of structures in BNIs”, updated in 2016;
- Guide no 24 “Management of soil polluted by the activities of a BNI” published in 2016.

Overview of the decommissioning of an installation

In accordance with legislation and regulations, ASN requires a clear distinction between the operating and decommissioning phases (see § E.2.2.4.4). Indeed, the decommissioning phase presents specificities in terms of risks and radiation protection in the context of rapid technical evolution in the installation. It must therefore be carried out within the framework of a specific safety reference system, after authorization issued by decree. Some preparatory or pilot operations may nevertheless be carried out between the shutdown of the installation and the obtaining of the decree, but they must be compatible with the authorization decree and remain limited.

The decommissioning file - submitted no later than two years after the declaration by the operator of its intention to shutdown permanently its installation - must explicitly describe all the work envisaged from the final shutdown until the desired final state has been reached, and explain, for each stage, the nature and the extent of the risks presented by the installation and the means used to control them. This dossier defines the major technical and administrative stages of the decommissioning envisaged.

This procedure avoids project fragmentation and promotes overall coherence of operations.

According to the regulations (see F.6), as soon as a BNI is finally shut down, it must be decommissioned and its purpose therefore changes with respect to that for which its creation was authorised, with the creation authorisation decree notably specifying the operating conditions of the facility. Furthermore, the decommissioning operations involve a change in the risks presented by the facility. Consequently, these operations cannot be performed without modifying the framework set by the creation authorisation decree. In accordance with the provisions of article L.593-25 of the Environment Code, decommissioning of a BNI is prescribed by a new decree, issued on the advice of ASN following the decommissioning file review process.

The decommissioning decree does not revoke the creation authorisation decree, but modifies it, notably by:

- revoking the provisions relating to operation, which are no longer applicable;
- prescribing decommissioning operations and the essential aspects of these operations with regard to protection of the interests mentioned in article L. 593-1 of the Environment Code.

The operations prior to decommissioning thus take place within the framework created by the facility’s creation authorisation decree and may be completed after entry into force of the decommissioning decree. These operations are authorised on a case-by-case basis in accordance with article 26 of the “BNI Procedures” decree of 2nd November 2007 or, as necessary, notified pursuant to above-mentioned article 27, taking into account the particularities of the installation concerned.

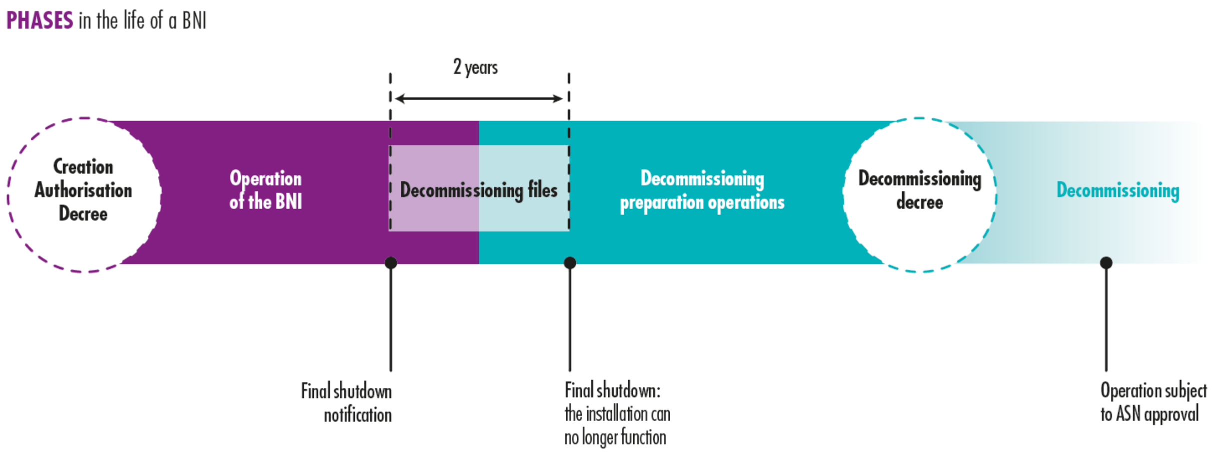

FIGURE 12: PHASES IN THE LIFE OF A BASIC NUCLEAR INSTALLATION

Two assessment levels

The licensees are subject to two assessment levels.

The first level concerns the *overall decommissioning strategy* adopted by a licensee with numerous installations to be decommissioned (EDF, CEA, AREVA). In addition to the general principles proposed, its main purpose is to examine:

- the priorities to be considered, given the status of the facilities and their level of safety;

- the management policy for the waste and effluents generated by decommissioning and, more particularly, the availability of the associated disposal routes;
- the technical feasibility of the scenarios presented for ongoing or future decommissioning;
- the particular organisation put into place to manage these decommissioning operations.

The second level of assessment concerns each facility to be decommissioned and more particularly the safety and radiation protection of the operations to be performed. Its aim is to assess the provisions proposed by the licensee in the file enclosed in support of the decommissioning application for the facility concerned (or during the periodic safety reviews of the facility).

The importance of an overview of all of a licensee’s facilities

ASN considers that it is impossible to examine the overall strategy adopted by a licensee if its BNI and SBNI are separated. This is so that an overview can be obtained of the prioritisation of the operations envisaged and the human and financial resources deployed to perform them.

In 2016, CEA and AREVA thus presented ASN and ASND with their strategy for decommissioning and waste management (and materials management for CEA), including BNIs and SBNIs.

The importance of waste management

ASN considers that management of the waste generated by decommissioning operations is a key factor which determines the smooth running of the decommissioning programmes in progress. This is because the decommissioning of a nuclear facility necessitates the availability of a management route for the removal of all the waste resulting from the decommissioning operations, or at least its storage in suitable conditions of safety.

The overall decommissioning strategy of the licensees is thus examined along with their overall waste management strategy.

It should be recalled that there is no clearance level for waste that is or could be contaminated. The CIRES disposal facility for very low level (VLL) waste accepts the least radioactive waste coming from potential radioactive waste production areas (in accordance with the facility’s "waste zoning plan"). Particular attention must however be paid to the optimisation of VLL waste management to avoid prematurely reaching saturation of the CIRES facility’s capacity.

ASN encourages approaches designed to reutilise VLL waste, notably rubble or metal waste, including studies into possible recycling of rubble as infill materials for the voids in CIRES vaults, or by melting for metal. These possibilities are covered by Decree 2017-231 of 23rd February 2017 establishing the prescriptions of the PNGMDR 2016-2018 (see F.6.3.2).

Need for particular vigilance

ASN considers that decommissioning work sites require particular vigilance in terms of worker radiation protection. This is because the change, sometimes rapid, in the physical state of the installation and the risks it presents raises the constant question of the appropriateness of the means of surveillance deployed. It is often necessary to replace, either temporarily or lastingly, the centralised means of operating surveillance by other more appropriate means of surveillance.

Funding

ASN also considers that the financial aspect of the future decommissioning activities and the implementation of dedicated assets contribute to the safety of future decommissioning activities (see F.2.3.2).

6.1.3. Regulatory requirements

Specific regulatory requirements for decommissioning are mentioned in § E.2.2.4.4. Readers are reminded that they figure chiefly in the *Environment Code*, the BNI Procedures Decree of 2nd November 2007 and the BNI Order of 7 February 2012.

Guides No. 6, 14, 23 and 24 accompany the regulatory provisions. As indicated in § E.2.2.5.2, the ASN guides contain recommendations that define safety objectives and describe practices ASN considers to be satisfactory to achieve them.

The following paragraphs clarify a few significant issues.

6.1.3.1. DECOMMISSIONING PLAN

The regulations require that the licensee provide a decommissioning plan for all BNIs as of their creation authorisation application. This plan must be regularly updated, notably:

- when the installation is commissioned;
- when the creation authorisation decree is modified in any way;
- if necessary, on the occasion of modifications to the facility as stipulated in article 26 of the “BNI procedures” decree of 2nd November 2007;
- each time a periodic safety review report is submitted;

- at notification of final shutdown (at least two years before the shutdown date envisaged) as set out in article L. 593-26 of the Environment Code, constituting an item of the decommissioning file. The final shutdown notification is submitted at least two years before the envisaged shutdown date. The time between submission of the decommissioning file and publication of the decree shall not exceed three years, except in special cases. The effective entry into force of the decree when ASN approves the revision of the facility's general operational rules (RGEs) shall take no longer than one year.

For installations whose authorisation preceded this requirement, the BNI order requires creation of this plan no later than the next 10-year periodic safety review.

The plan must describe notably the following, with the necessary justifications:

- the measures taken at the design stage in order to facilitate decommissioning, together with the measures to preserve the history of the facility and the accessibility to data, and to maintain skills and the knowledge of the facility;
- *the planned operations,* the methodology and the decommissioning steps, the equipment, the schedules;
- *the safety and radiation protection objectives;*
- *the waste management procedures, taking account of the existing or projected management solutions, and the effluent management procedures*;
- *the final status after decommissioning*, the projections for the future use of the site, the assessment of the impact of the installation and the site after reaching the final state and the potential modalities to monitor it.

It is similar to the plan described by the IAEA in Document WS-R-5.

A typical summary is proposed in the above-mentioned Guide No. 6.

6.1.3.2. LICENSING DECREE

Regulatory aspects are detailed in § E.2.2.4.5. It should be noted here that, according to the Environment Code, the decommissioning of any BNI are subject to a prerequisite licence, to be delivered by decree of the ministry in charge of nuclear safety after a public inquiry has been held and after ASN has issued its opinion.

The case submitted by the operator with his licence application for the decommissioning of his facility must describe the overall work being planned until the final state reached. It must detail the scheduled work over the short term (few years). The other activities to be carried out at a further date have to be presented, possibly with fewer details, but will be subject to a deadline in the decree, if the stakes warrant it.

In the supporting case of his licence application for final shutdown and decommissioning (with the understanding that it must notably update the report referred to the Environment Code concerning his long-term costs for decommissioning and radioactive-waste management), the operator must include an updated overview of his technical and financial capabilities, including its experience, resources and the envisaged organisation.

The decree must specify which final state to be reached, the timeframe to achieve it and the potential steps and hold points requiring a pre-agreement for launching the corresponding works.

Prescriptions to be issued by ASN complete the decree and address topics, such as incident and accident prevention and the mitigation of their impact, discharges, as well as the information modalities for ASN and the public.

6.1.3.3. ASN LICENCES AND DECLARATIONS

For hold points concerning major activities as set in the licensing decree for decommissioning, the operator must submit a case to ASN in order to obtain its prerequisite approval for the work to be done. In the case where the work would constitute a significant change in the elements presented in support of the licence application, an amendment to the decree would be required.

Over and above those hold points, the operator must declare to ASN all modifications (steps, works, procedures, etc.) that may have potential consequences on safety and provide the necessary justifying documents and updates, pursuant to Article 26 of the “BNI Procedures” Decree of 2 November 2007 amended by Decree of 28 June 2016.

Under Article 27 of the aforementioned Decree, the modifications of the facility that do not significantly call into question the safety report nor significantly increase the impact on public safety, health and welfare or the protection of the environment are subject only to declarations to the ASN. If the Nuclear Safety Authority considers that the declared modification falls under Article 26 or II of Article L. 593-14 of the Environmental Code, it shall invite the operator to file the corresponding application for authorization.

6.1.3.4. PERIODIC SAFETY REVIEWS

For every BNI undergoing decommissioning, a safety review must be prepared every 10 years (unless otherwise prescribed), as in the case of BNIs in service (see § E.2.2.3.1).

6.1.3.5. DELICENSING

As decommissioning operations progress, nuclear-waste zones are cleaned-out and may be entitled for delicensing in conventional-waste zones. The operator must declare to ASN any zone he wishes to delicense and must submit in support of his application a justifying case including a status report on the clean-out of the zone involved. Guide No. 14 provides a standard summary of such status report. ASN maintains the right to carry out an inspection with intakes and measurements before granting its approval.

Once all zones have been cleaned up and when the final state targeted has been reached, the operator may apply for his facility to be delicensed. The legal and regulatory aspects concerning such delicensing are detailed in § E.2.2.4.5.4. ASN is responsible for verifying through spot checks on site that the objectives have actually been met.

The procedure ends after the case has been transmitted to the Prefect, once the opinions of the communes and of the CLI gathered, by an ASN's resolutions, which has been validated by the Minister in charge of nuclear safety. It appears necessary to preserve the memory of the past existence of BNIs after their delicensing and to set in place, if need be, any restrictions of use adapted to the final state of the site. Two cases may occur as follows:

- either the operator is able to demonstrate that the decommissioned facility and its footprint involve no risk, or in other words, that they are exempt from any radioactive or chemical and, in such case, a conventional easement in favour of the State is systematically instituted. The purpose of the easement is to preserve the information concerning the presence of an older BNI on the concerned parcels, thus informing the successive buyers;
- or the operator is not able to demonstrate the absence of any residual radioactive or chemical pollution, and, in such case, public-utility easements are set in place and may contain a certain number of site-use restrictions or monitoring measurements to be made. In that case, a public inquiry may be necessary.

6.1.4. Clean-out of structures and soils

The decommissioning and clean-out operations for a nuclear installation must progressively lead to the elimination of the radioactive substances resulting from the activation phenomena and/or of any contamination deposits or migrations, in both the structures of the installation premises and the soil of the site.

The structure clean-out operations are defined on the basis of the prior updating of the facility's waste zoning plan which identifies the areas in which the waste produced is, or could be, contaminated or activated. As the work progresses (for example after cleaning the walls of a room using appropriate products), the "possible nuclear waste production areas" are downgraded to "conventional waste areas".

In accordance with the provisions of article 8.3.2 of the order of 7th February 2012, "the final state reached on completion of decommissioning must be such that it prevents the risks or inconveniences that the site may represent for the interests mentioned in article L. 593-1 of the environment code, in view more particularly of the projections for reuse of the site or buildings and the best post-operational cleanout and decommissioning methods available under economically acceptable conditions".

In line with its decommissioning policy defined in 2009, ASN therefore recommends that the licensees adopt clean-out and decommissioning practices taking account of the best scientific and technical knowledge of the time and in economically acceptable conditions, such as to achieve a final state in which all dangerous and radioactive substances have been removed from the BNI. ASN considers this to be the reference approach. If, depending on the characteristics of the pollution, this approach were to pose implementation difficulties, ASN considers that the licensee must go as far as is reasonably achievable in the post-operational clean-out process. It must in any case provide technical or economic data to demonstrate that the reference approach cannot be used and that the clean-out operations cannot be taken further with the best available post-operational clean-out and decommissioning methods and techniques in economically acceptable conditions.

In 2016, ASN thus updated and published the technical guide for post-operational clean-out of structures (guide n° 14). In 2016, ASN also published a guide on the management of contaminated soils in nuclear facilities (guide n° 24).

6.1.5. Financing of decommissioning

In addition, the Environment Code requires BNI operators to assess the decommissioning charges of their facilities and the management charges for their spent fuel and radioactive waste. Furthermore, they must constitute the accruing provisions for those overall charges and allocate sufficient exclusive assets to cover those provisions. In order to ensure compliance with those requirements, specific controls are prescribed by law (see B.1.7 and F.2.2).

6.2. Steps taken by BNI operators

6.2.1. Clean-out and decommissioning of CEA facilities

The rising number of clean-out/decommissioning worksites and the corresponding waste recovery and packaging (RCD) work has become a serious constraint which weighs on the scheduling and performance of clean-out and decommissioning projects. CEA was thus required to conduct an in-depth review of the prioritisation of all of its clean-out/decommissioning and RCD projects, the overall management strategy for wastes, materials and traffic, as well as the organisation put into place for running these projects.

This prioritisation more specifically takes account of the potential source term (TSM), the other nuclear and non-nuclear risks, the state of progress of the worksites, the state of knowledge, the monitoring costs and other fixed costs and the robustness of the scenarios.

At the end of 2016, CEA sent a file specifying these aspects and answering the July 2015 request from the nuclear safety regulators to review the overall decommissioning strategy, to review the radioactive materials and waste management strategy, to prioritise the operations, to reinforce the organisation and staff and to examine the pertinence of the financial resources devoted to the operations.

Following on from the previous years, but with a more precise breakdown of the operations, the priorities concern the decommissioning of the Marcoule and Fontenay-aux-Roses facilities and the waste recovery and packaging operations at Cadarache and Marcoule.

In accordance with the strategy adopted in France, CEA opts for immediate dismantling, which consists in initiating the dismantling of a facility as rapidly as possible after final shutdown. However, faced with the complexity of some of the operations involved and the fact that the operations can last several years or even decades, CEA in certain cases proposes the option of a two-phase decommissioning process. Use of this option is justified on a case by case basis. CEA may in particular adopt this option when the potential source term (TSM) has been completely removed and only a low level of risk, radiological in particular, remains in the facility.

With regard to the final state, the main principles of the CEA strategy are as follows:

- the priority target is always delicensing of the BNIs for which shutdown has been decided and for which the shutdown decision has been notified;
- as a priority and whenever possible, CEA aims to keep the buildings standing for possible reuse or because of their location in a Centre scheduled to remain in operation, and primarily seeks to obtain unrestricted delicensing.

Facility by facility, CEA proposes adopting an approach proportionate to the issues, which is the result of a search for technical, economic, environmental protection and waste production optimisation. When implementing this approach, clean-out must be taken as far as is reasonably achievable in the light of the technical, economic, health and social constraints, the quantity of resulting waste and the best available techniques. Following these operations, CEA will determine the radiological impact of any residual contamination depending on the future usage, which varies from one site to another (continued nuclear site, site closed to the public, possible industrial reutilisation).

6.2.2. Steps taken by AREVA

All nuclear facilities that the operator intends to shut down definitely are covered by specific programmes consisting in:

- preparing the final shutdown via the facility’s safety reference system in service, which may require specific licences, and
- cleaning out and dismantling the equipment and structural elements in the framework of a reference system relating to the final shutdown and decommissioning of the facility.

The necessary costs for the performance of decommissioning operations, as well as those associated with the processing of the waste generated by those operations and with their management, are covered by financial provisions (see F.2.2.3) and a decommissioning plan, which will be developed henceforth as early as the preliminary phases of the facility.

The final goal of decommissioning and post-operational clean-out is to reach a final state 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 planned reuse of the site or buildings and the best post-operational cleanout and decommissioning methods available under economically acceptable conditions. AREVA implements a policy of reusing the sites concerned by looking for and promoting reutilisation projects in accordance with the conditions set by their final state and the applicable regulations.

As at the end of 2016, the clean-out and decommissioning projects for the Group's French installations concerned were at varying degrees of advancement:

- the last stage of administrative delicensing is being completed for SICN Annecy (ICPE) and Veurey (BNI 65 and 90);

- for the BNIs making up the UP2 400 plant at La Hague: BNI 80 obtained its final shutdown/decommissioning (MAD/DEM) decree in 2009, BNIs 33, 38 and 47 obtained their MAD/DEM decrees in November 2013, some of which are partial. Two new complete MAD/DEM decree applications for BNIs 33 and 38 were filed in June 2015. The creation authorisation decree (DAC) for BNI 118 was modified by the decree of 31st January 2016 authorising modification operations for processing of sludges from BNI 38;
- for the Georges Besse plant of EURODIF-Pro (BNI 93), the equipment rinsing and hydrolysis operation, called PRISME, was completed in 2016. The MAD/DEM authorisation application file submitted in March 2015 is currently being examined. The public inquiry file was submitted at the end of 2016;for the AREVA NC Pierrelatte plant (BNI – formerly COMURHEX), the MAD/DEM authorisation application file, completed in February 2014, is currently being examined and the public inquiry file was submitted at the end of 2016. Refurbishment of the structure 300 ICPE was completed in 2014.

The main missions of BU "Decommissioning and Services" are the clean-out and decommissioning of the AREVA installations and offering industrial operator services to French customers. This organisation incorporates in particular the Group's clean-out and decommissioning service tasks forces. This is in line with AREVA's choice to favour the decommissioning of its shut-down installations in as short a time as possible.

6.2.3. Steps taken by EDF

The objective of the EDF's current deconstruction programme is to complete the decommissioning of the following 10 BNIs:

- 9 first-generation reactors (six GGRs at Chinon, Saint-Laurent-des-eaux[18] and Bugey, the Brennilis HWR jointly built and operated with the CEA, and the Chooz-A PWR reactor) and the Superphénix fast-neutron reactor in Creys-Malville;
- the graphite-sleeve interim-storage facility at Saint-Laurent-des-Eaux and the irradiated material facility in Chinon (AMI).

That programme includes also the construction and operation of a conditioning and storage facility for activated waste (ICEDA) that will accommodate IL-LL deconstruction waste, pending the commissioning of the final outlet for that waste (Waste Act).

Type of facility	Unit	Power (MWe)	Commissioning year	Shutdown year	BNI number
6 GGR units	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 HWR	Brennilis	70 MWe	1967	1985	**162**
1 PWR	Chooz A	300 MWe	1967	1991	**163**
1 FNR (Superphénix)	Creys-Malville	1 240 MWe	1986	1997	**91**
2 silos at Saint-Laurent-des-Eaux	Silos	-	1971	-	**74**
Irradiated material facility at Chinon	AMI	-	1963	2015	**94**
1 Conditionning and storage facility (ICEDA) under construction	ICEDA	-	-	-	**173**

TABLE 23: EDF FACILITIES INVOLVED IN THE DECOMMISSING PROGRAMME

Until 2001, the preferred scenario was to dismantle immediately power reactors up to Level 2 (removal of special fissile materials and readily-dismantled parts, maximum reduction of the contained zone and adjustment of the outside barrier) and to transform it into a basic nuclear storage facility (*installation nucléaire de base et d'entreposage* – INBE). The so-called "Level-3" complete decommissioning was envisaged after several decades of containment.

Since the 2001 decision to speed up the deconstruction programme, the current choice is to deconstruct them as soon as possible.

[18] A single BNI groups both SLA1&2 reactors

Facility	Submission of case for final shutdown and decommissioning decree (DAD[19])	Beginning of public inquiry	CIINB[20]	Publication of decree for final shutdown and decommissioning
Creys Malville	**06/05/03**	**01/04/04**	**11/05/05**	21/03/06
Brennilis	**22/07/03**	**NA**	**06/07/05**	12/02/06
Chooz A	**30/11/04**	**28/08/06**	**08/12/06**	29/09/07
Bugey 1	**29/09/05**	**13/06/06**	**22/02/08**	20/11/08
Saint-Laurent A	**11/10/06**	**26/01/07**	**09/09/09**	20/05/10
Chinon A3	**29/09/06**	**02/03/07**	**09/09/09**	20/05/10

TABLE 24: ADMINISTRATIVE DEADLINES FOR A FULL-DECOMMISSIONING DECREE

The dismantling strategy for the GCR reactors was revised by EDF in 2015. This scenario is currently being examined by ASN. The schedule is built around the following principles:

- dismantling under air of a first-off reactor (Chinon A2) as of 2030 – Over the coming 10 years, this operation will require an industrial demonstrator to test the remote-manipulator tools needed to carry out these operations;
- for the other 5 reactors: dismantling after the first-off reactor (in about 2060) – In the coming 15 years, considerable work will be done to place these reactors in a safe configuration: early dismantling of all reactor peripheral buildings / work to ensure the strength of the vessels (cladding, monitoring systems, etc.).

To successfully complete all the dismantling programmes, the Dismantling and Waste Projects Department (DP2D) was created in 2016 comprising a project team dedicated to each of the structures currently being dismantled (Chooz A, Creys-Malville, Brennilis, Bugey 1, Saint Laurent A (including units A1 / A2 and the graphite sleeves silos), Chinon A comprising the three reactors A1, A2 et A3 and the AMI). A project team is also dedicated to the ILW-LL waste packaging and storage facility (ICEDA) currently under construction.

The corresponding human and financial resources have been mentioned in § F.2.2.4.

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

6.3. ASN analysis

ASN considers that the current regulations enable the nuclear facility decommissioning programmes to be carried out in good conditions. These regulations are based on the Environment Code, on the “BNI Procedures” decree of 2nd November 2007 and on the BNI order of 7th February 2012. It was supplemented in 2015 by the TECV Act and in 2016 by the modification to the “BNI Procedures” decree by a decree of 28th June 2016. It includes the essential requirements for guaranteeing the safety of the corresponding operations and the pertinence of the final state of the facilities after decommissioning. At the same time, it offers the flexibility needed for carrying out this type of operation (a single authorisation decree for a given BNI, but with possible hold points and the possibility of using a system of internal authorisations for minor operations).

ASN contributed to this overhaul of the regulatory framework and in 2017 updated and published guides n° 6, n° 14, n° 23 and n° 24 concerning BNI decommissioning and waste management.

6.3.1. Licensee policy and strategy

6.3.1.1. CEA POLICY AND STRATEGY

ASN and the Defence Nuclear Safety Authority (ASND) have observed:

- significant delays in the performance of decommissioning operations and the recovery and packaging of CEA legacy waste;
- extremely significant increases in the envisaged duration of the decommissioning and legacy waste recovery operations (about fifteen years for the Fontenay-aux-Roses facilities and for the UP1 plant of the Marcoule SBNI for example);
- as well as significant delays in the transmission of the decommissioning files.

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[19] Decommissioning licensing decree (*Décret d’autorisation de démantèlement* – DAD).

[20] CIINB: *Commission interministérielle d’information relative aux INB* (Interministerial Information Commission on BNIs). It was cancelled in 2010 (see § E.3.4.3.1).

ASN and the ASND thus asked CEA to present them in 2016 with an overall review of its strategy for decommissioning of nuclear facilities and management of radioactive waste, with regard to all the BNIs and SBNIs. This review more specifically concerns the prioritisation of the operations, the human resources and the effectiveness of the organisation in place to perform them, as well as the pertinence of the financial resources devoted to these operations.

The file was received in December 2016 and will be examined by ASN and ASND.

6.3.1.2. AREVA GROUP POLICY AND STRATEGY

With regard to AREVA, ASN and the ASND have requested an update of the decommissioning strategy applicable to all the Group's facilities, along with that relative to radioactive waste management, more particularly given the scale of the forthcoming legacy waste retrieval and decommissioning operations. The file was received in June 2016. It was jointly examined by ASN and the ASND and the results are expected in early 2018.

ASN resolution 2014-DC-472 of 9th December 2014 set prescriptions concerning the strategy for recovery and packaging of legacy waste (RCD) from the La Hague site, comprising a large number of deadlines. AREVA then transmitted its RCD strategy on 12th May 2015.

6.3.1.3. EDF POLICY AND STRATEGY

The first decommissioning strategy for the shutdown EDF reactors was sent in 2001 at the request of ASN. This strategy has been regularly updated more specifically to adjust the decommissioning schedule for the shutdown EDF reactors, to incorporate the additional studies requested by ASN and the elements concerning the future decommissioning of the NPP fleet in service. Until now, the updates called into question neither the decommissioning scenarios, nor the pace of decommissioning.

At the end of 2013, EDF submitted a file presenting its waste management strategy. It was reviewed by the Advisory Committee in 2015 with the main issues being as follows:

- the adequacy of the local and national organisation for waste management and the corresponding safety issues, in particular the definition of the roles of each of the EDF entities;
- the pertinence with regard to the issues and safety requirements for the management of the waste resulting from the operation of the NPPs and the decommissioning projects, from production up to disposal, or storage if there is no operational disposal route, taking account of the history and operating conditions and the available routes;
- the measures for reduction at source of the quantity and harmfulness of the waste produced, with a view to optimising the waste management routes;
- the management of waste for which there is no route (asbestos, lead, WEEE, etc.) according to its nature and quantity;
- the management solutions (and in particular recycling or reutilisation) envisaged for the management of large components (steam generators and pressure vessel closure heads) and the waste produced in large quantities (rubble, scrap, etc.) including from decommissioning operations;
- the management of LLW-LL type waste already produced and still to be produced by decommissioning of the first generation of GCR reactors, in particular its characterisation and the processing/destruction possibilities being envisaged by EDF;
- the availability of transport packagings given the scheduling constraints for handling of the various types of waste or spent fuels.

In March 2016, EDF informed ASN of a complete change in its strategy for the GCR reactors, entailing a decommissioning postponement of several decades. This change in strategy is linked to major technical difficulties in decommissioning of the reactors “under water”, as had been initially planned. The alternative use of decommissioning “under air” is accompanied by changes to the reactor decommissioning order and the scheduling.

EDF therefore abandoned the decommissioning approach based on opening of the vessels one after the other, with extraction of the graphite blocks and is looking at complete dismantling of one reactor before beginning to dismantle the others, in order to benefit from exhaustive operating experience feedback. EDF stated that it will however decommission all the installations peripheral to the reactor vessels within the next fifteen years.

This new strategy means that the decommissioning of certain reactors will be pushed back by several decades with respect to the strategy announced by EDF in 2001 and updated in 2013.

ASN asked EDF to send it a number of files to demonstrate that this change still meets the regulatory requirements for decommissioning as rapidly as possible and for examination of this new strategy in the light of the safety requirements applicable to these installations. These files are expected for the end of March 2017 and the end of December 2017. ASN will then issue a position statement on this new strategy for the GCR reactors.

The decommissioning strategy for the other reactors, Chooz A, Brennilis, or Creys-Malville has not however been significantly modified.

6.3.2. Reuse of very low level (VLL) materials

Ongoing and future facility decommissioning operations will generate a very large amount of VLL waste. For example, the decommissioning of the EURODIF-Pro Georges Besse plant should generate about 130,000 metric tons of metal waste.

The CIRES, which is the only facility today authorised for disposal of VLL waste, will not be able to absorb all the VLL radioactive waste produced by the decommissioning operations.

In 2015, within the context of the PNGMDR 2013-2015, ANDRA submitted an overall industrial scheme meeting the need for new VLL waste disposal capacity. This scheme was examined by ASN, which sent the Government an opinion on 18th February 2016 concerning the management of VLL waste.

These recommendations were taken up in the PNGMDR 2016-2018 which requests that:

- ANDRA and the licensees must continue their efforts to reduce the quantities of waste and more specifically by examining the possibility of recycling certain VLL waste:
  - reutilisation of VLL rubble as in-fill material for the voids in the CIRES vaults is being examined,
  - similarly, the melting of VLL metal materials would enable them to be decontaminated to radioactivity levels removing all risk and enabling reutilisation within the nuclear sector, among others, to be envisaged,
  - for incinerable VLL waste, a comparison of the environmental impacts of management by direct disposal and management by industrial incineration is also requested,
- The licensees are required to consolidate their VLL waste production estimates;
- ANDRA must confirm the possibility of increasing CIRES storage capacity without increasing the ground footprint (see D.3.2.2.3);
- the possibility of creating a new VLL waste disposal facility to take over from the CIRES must be studied;
- the waste producers must examine the feasibility of creating disposal facilities on their sites appropriate for certain types of VLL waste.

6.3.3. Internal authorisations

The system of internal authorisations is regulated by the “BNI Procedures” decree of 2nd November 2007 and by the resolution of 11th July 2008. The purpose of implementing the internal authorisations system in the BNIs is to confirm the prime responsibility of the licensee for nuclear safety and radiation protection. For operations of minor importance it introduces flexibility in the updating of the baseline safety requirements of the facilities, whose status changes rapidly during decommissioning.

ASN approved the system of internal authorisations in certain CEA facilities and that of AREVA NC La Hague, followed by those of the AREVA NC MELOX plants and the Tricastin site, in the resolutions of March 2010, December 2010 and September 2014 respectively.

In 2004, ASN authorised EDF to implement a system of internal authorisations for the installations undergoing decommissioning. In order to comply with the BNI procedures decree and the ASN resolution of 11th July 2008, EDF submitted a file in October 2009 presenting the update of its internal authorisations system. The discussions with EDF are now finished and the internal authorisations system proposed by EDF for its installations undergoing decommissioning was approved by the ASN resolution of 15th April 2014.

Following the publication of the decree of 28th June 2016 amending the “BNI Procedures” decree of 2nd November 2007 and the implementation of the notification system in accordance with article 27, ASN will before January 2018 initiate a definition of the criteria for notifying modifications without requiring ASN consent. This resolution should supersede the internal authorisations system authorisation resolutions.

6.3.4. On-site works

6.3.4.1. EDF / BRENNILIS NPP

The Brennilis NPP on the Monts d’Arrée site, called EL4-D, is an industrial prototype for a heavy water moderated and carbon dioxide cooled NPP, finally shut down in 1985. After the cancellation of the decommissioning authorisation decree in 2006, a new file was submitted in 2008 and underwent a new public inquiry. In its opinion to the Government, ASN recommended that EDF be authorised to carry out the operations mentioned in the report by the board of inquiry and that it initiate a new procedure for complete decommissioning. A partial decommissioning decree was published in July 2011. On the advice of ASN, the decree of 16th November 2016 extended the time to perform the decommissioning operations authorised by the decree of 27th July 2011, more specifically:

- the dismantling of the exchangers, which had been interrupted since 23rd September 2015 owing to a fire;
- the clean-out and demolition of the effluent treatment station.

These operations must be completed before 28th July 2018. EDF is also required to submit a complete decommissioning file for the facility by 31st July 2018.

During the course of 2016, EDF on the one hand continued with the operations to clean and repair the equipment present in the reactor containment following the fire of September 2015 on the exchangers decommissioning worksite and, on the other, with the effluent treatment station decommissioning operations.

In 2017, the major issues are linked to finalisation of the decommissioning operations for the exchangers and the effluent treatment station and performance of the periodic safety review, the conclusions of which are expected for the end of 2018.

ASN will thus examine the safety review guidance file transmitted at the end of 2016.

6.3.4.2. EDF / GAS-COOLED REACTORS

Bugey 1, Saint-Laurent A1 and A2 and Chinon A1, A2 and A3, are the reactors of the GCR series. These first-generation reactors functioned with natural uranium as the fuel and graphite as the moderator. They were cooled by gas. The last reactor of this type to have been shut down is Bugey 1 in 1994.

The Bugey 1 reactor (BNI 45)

This plant series includes reactors said to be “integrated”, where the heat exchangers are under the reactor core inside the vessel, and reactors said to be “non-integrated”, where the heat exchangers are situated on either side of the reactor vessel.

Complete decommissioning of the facility, which was finally shutdown in 1994, was authorised by the decree of 18th November 2008. The corresponding scenario is “under water” dismantling of the reactor vessel. In the event of a change in scenario (“under air”) as envisaged by EDF, the present decree would need to be modified.

ASN considers that the current decommissioning work on the Bugey 1 reactor is taking place in satisfactory conditions of safety. The licensee has a robust organisation and ensures rigorous monitoring of decommissioning equipment and works.

In 2017, ASN will also examine the periodic safety review guidance file transmitted by Bugey 1, for which the conclusions report shall be transmitted before the end of 2018.

The Chinon A1, A2 and A3 reactors (BNI 133, BNI 153, BNI 161)

The Chinon A1, A2 and A3 reactors are “non-integrated” GCR reactors. They were shut down in 1973, 1985 and 1990 respectively.

EDF has changed its decommissioning strategy and postponed the decommissioning completion date for the Chinon A reactors. These reactors should be the last GCRs to be decommissioned. The new strategy would involve decommissioning one of these reactors first (Chinon A2 or A3) because decommissioning of a “non-integrated” GCR reactor would be less difficult than that of an “integrated” GCR reactor. On receipt of the requested files, ASN will examine the acceptability of this new EDF strategy for decommissioning of its GCR reactors.
Reactors A1 and A2 were partially decommissioned and transformed into storage facilities for their own equipment (Chinon A1 D and Chinon A2 D). These operations were authorised by the decrees of 11th October 1982 and 7th February 1991 respectively. Chinon A1 D is currently partially decommissioned and houses the IEG Intra (robots and intervention machines for damaged nuclear facilities). Article 15 of the decree of 28th June 2016 tasks ASN with defining the time-frame for submission of the decommissioning files for the Chinon A1 D and A2 D reactors.

The removal of the components of the Chinon A2 systems, already dismantled, is being prepared following the first tests. Remediation of the chemically polluted soils will be carried out. Measures to reinforce monitoring of the groundwater and additional characterisation of the gaseous discharges are in progress, in accordance with the regulatory provisions.

In this context, ASN will be vigilant with regard to the short-term performance of the actions in progress or started, to operational rigour and to monitoring of outside contractors.

Finally, ASN will monitor the periodic safety review of the Chinon A1 and Chinon A2 reactors, for which the conclusions report is expected at the end of 2017.

Complete decommissioning of the Chinon A3 reactor was authorised by the decree of 18th May 2010, with a dismantling “under water” scenario. The change in scenario envisaged by EDF will require a change in the decommissioning decree. The operations to decommission the exchangers (first step in decommissioning of the facility) on the Chinon A3 reactor began several years ago. However, this programme is temporarily halted owing to the discovery of asbestos in certain parts of the exchangers.

The Saint-Laurent-des-Eaux A1 and A2 reactors (BNI 42)

Complete decommissioning of the facility, which comprises two reactors and for which final shutdown was pronounced in 1994, was authorised by the decree of 18th May 2010. The prescriptions regulating water intake and effluent discharge are set by ASN resolutions published in 2015.

The change in EDF decommissioning strategy for the GCRs (see above) would put back the end of decommissioning of the Saint-Laurent A reactors to 2100.

Pending the dismantling of the reactor vessels, other operations are being performed, outside the vessel or to prepare its dismantling.

Thus, in 2016, several operations to remove liquid and solid waste were carried out. However, all of the work programmes (vessel emptying, sludge characterisation, removal of source term from the Saint-Laurent A2 pool) were interrupted following the discovery of internal contamination of some of the personnel involved.

Finally, ASN will examine the conclusions of the periodic safety review of the Saint-Laurent A1 and A2 reactors, for which the report is expected at the end of 2017.

6.3.4.3. EDF / CHOOZ A (PWR TYPE REACTOR)

The Chooz A reactor located in the Ardennes was shut down in 1991. Its decommissioning authorisation decree was published on 27th September 2007.

Chooz A is the first pressurized water reactor built in France. The decommissioning of this power plant is considered to be a precursor for the future decommissioning of the pressurised water reactors, the technology used in the French nuclear power reactors currently in operation.

The dismantling operations per se on the primary system (apart from the dismantling of the reactor vessel) required authorisation, as they represented a hold point specified in the above-mentioned decree. The corresponding file was accompanied by an update of the safety analysis report and the general operating rules. In a resolution dated 7th December 2010, ASN authorised the beginning of these works provided that a certain number of technical prescriptions were followed.

The dismantling operations per se on the primary system (apart from the dismantling of the reactor vessel) were carried out from 2011 to 2013.

The four steam generators in the plant were removed and decontaminated and are now disposed of in the CIRES.

Dismantling of the reactor vessel requires prior authorisation from ASN. This was given by the ASN resolution dated 3rd March 2014, under the conditions defined in the file appended to the EDF application and in accordance with the prescriptions set in the ASN resolution of 25th February 2014.

In 2016, the decommissioning work on the reactor vessel started with opening of the closure head and continued with work to prepare for immersion of the vessel prior to cutting.

With regard to the environment, nuclear safety and radiation protection, ASN considers that the decommissioning operations are being carried out satisfactorily.

The periodic safety review conclusions report for the Chooz A reactor is expected for September 2017.

6.3.4.4. EDF / SUPERPHENIX (FAST NEUTRON REACTOR) AND THE APEC

Superphenix (BNI 91) is an industrial prototype sodium-cooled fast neutron reactor located in Creys-Malville. It was finally shut down in 1997.

The decommissioning decree was published in March 2006.

This facility is associated with another BNI, the fuel evacuation facility (APEC, BNI 141), which consists primarily of a storage pool in which the spent fuel removed from the Superphenix reactor vessel is stored, and storage for packages of soda concrete from the sodium treatment installation (TNA).

Despite three significant environmental events and four significant safety events, ASN considers that the safety of the decommissioning work on BNIs 91 and 141 is satisfactory.

ASN nonetheless wishes to see improvements, including in management of retentions and the correct performance of the periodic tests and modification work.

The periodic safety review was carried out by EDF on the two facilities. The conclusions reports were received at the end of December 2015 for the APEC and at the end of March 2016 for Superphenix. The examinations are in progress.

6.3.4.5. EDF / IRRADIATED MATERIAL FACILITY (AMI)

The irradiated material facility (AMI, BNI 94), notified and commissioned in 1964, is located on the Chinon nuclear site and operated by EDF. This facility (BNI 94) is not yet being decommissioned even if operations have been shut down. It was primarily intended for examination and appraisal of activated or contaminated materials from the PWR reactors.

With a view to the decommissioning of the facility, the activities in the AMI are now mainly operations to prepare for decommissioning and monitoring.

The decommissioning file was submitted in June 2013. Further to the requests made by ASN in 2014, EDF was required to supplement its file in order to specify the initial state of the facility at the time of publication of the decommissioning decree, with a target date of 2018. The additions were made by the licensee in 2016. The decommissioning file was the subject of a public inquiry at the beginning of 2017. The review of the draft decree is ongoing.

Within the framework of the operations to prepare for decommissioning, specific packaging and storage measures for certain waste are being adopted. This concerns legacy waste for which appropriate management routes are pending.

ASN will be attentive to recovery and packaging operations for this legacy waste, given the delays accumulated over the last few years.

The operation of the AMI is marked by a number of shortcomings in monitoring of contractors and in control of the operations. Improvements are needed in how operating experience feedback is taken into account and how deviations are assessed. In a context in which the organisation of the facility should change significantly at the beginning of 2017, ASN will be particularly vigilant with regard to licensee compliance with the facility's baseline safety requirements and operating rigour.

ASN will check the performance of the periodic safety review of the facility, the conclusions of which are expected in 2017.

6.3.4.6. CEA / FONTENAY-AUX-ROSES AND GRENOBLE CENTRES

The two centres at Fontenay-aux-Roses and Grenoble are in the process of delicensing.

In the case of Fontenay-aux-Roses, the decommissioning of two facilities, the PROCÉDÉ facility (BNI 165)[21] and the SUPPORT facility (BNI 166)[22], was authorised by two decrees dated 30th June 2006. These facilities ceased their activities in the years 1980-1990. The initially planned duration for the decommissioning operations was about ten years but, owing to the high probability of contamination under one of the buildings and difficulties not anticipated by the licensee, this duration will be prolonged beyond the originally planned date, at least until 2023 for PROCÉDÉ and 2019 for SUPPORT. In June 2015, CEA submitted an application to modify the final shutdown and decommissioning decree, more specifically regarding the deadlines and final state.

ASN considered that the first versions of these files were not acceptable, mainly for reasons concerning waste management.

The Grenoble site comprised six nuclear facilities:

- the SILOETTE reactor (BNI 21), which was delicensed in 2007;
- the MELUSINE reactor (BNI 19), which was cleaned-out and then delicensed in 2011;
- the LAMA[23] laboratory (BNI 61) for which decommissioning was authorised by the decree of 18th September 2008 and for which post-operational clean-out is nearing completion. In 2016, CEA submitted an application for delicensing of the facility, comprising a soil status diagnosis. The stakeholders information and consultation procedures are in progress;
- the radioactive waste treatment station and the interim radioactive waste decay storage facility (BNIs 36 and 79), for which the final shutdown decree was published in 2008. The decree of 18th September 2008 prescribes a period of eight years for completion of the work concerned. The main operations still to be carried out concern decontamination of the ground. The technical exchanges between ASN and CEA are continuing on this subject;
- the SILOÉ reactor (BNI 20) which was delicensed by the resolution of 9th January 2015.

ASN considers that the safety of the decommissioning and post-operational clean-out of the installations in the Grenoble centre was on the whole satisfactory in 2016.

6.3.4.7. CEA / CADARACHE CENTRE

The RAPSODIE reactor

The RAPSODIE experimental reactor (BNI 25) is the first sodium-cooled fast neutron reactor built in France. It functioned until 1978. A reactor vessel tightness flaw led to its final shutdown in 1983.

Decommissioning operations have been undertaken since its final shutdown but were partly stopped further to a fatal accident that occurred in 1994.

In December 2014, CEA sent ASN its complete decommissioning authorisation application and the periodic safety review file for the facility in May 2015. Requests for additional information were made in October 2015 by the Ministry in charge of nuclear safety. The licensee replied to these requests in 2016. The technical review then started and will continue in 2017. The operations currently being carried out by CEA are mainly the removal of waste containing sodium.

The fuel assembly shearing laboratory (LDAC)

The purpose of the LDAC, located within BNI 25, was to perform inspections and examinations on irradiated fuels from the fast-neutron reactors. This laboratory has been shut down since 1997 and partially cleaned out. The licensee aims to carry out operations in preparation for decommissioning. These operations are currently being examined by ASN. Its decommissioning is planned for in the decommissioning project for the entire BNI.

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[21] R&D on the reprocessing of nuclear fuels, transuranic elements, radioactive waste and examination of irradiated fuels took place in the PROCÉDÉ facility.

[22] The SUPPORT facility is designed for characterisation, processing, repackaging and storage of legacy radioactive waste and waste from the decommissioning of the PROCÉDÉ facility.

[23] Until 2012, tThe LAMA laboratory conducted post-irradiation studies of uranium and plutonium based nuclear fuels, and structural materials from nuclear reactors.

The enriched uranium processing facilities (ATUE)

Until 1995, the ATUE (BNI 52) converted uranium hexafluoride from the enrichment plants into sinterable oxide, and ensured the chemical reprocessing of waste from the manufacture of fuel elements. The facility comprised an incinerator for low-contamination organic liquids. The production activities in the facilities ceased in July 1995 and the incinerator was shut down at the end of 1997.

The ATUE facility's final shutdown and decommissioning decree was published in February 2006 and prescribed completion of the work in 2011. After observing that the decommissioning operations were stopped and that CEA had not followed up its request to submit a new authorisation application file to complete decommissioning, ASN served CEA with formal notice on 6th June 2013 to submit a new file. CEA submitted the file in question at the end of February 2014. The environmental authority will issue its opinion on this file at the beginning of 2017. The technical review by ASN will continue in 2017, more specifically with the public inquiry.

Plutonium technology facility (ATPu) and chemical purification laboratory (LPC)

The ATPu (BNI 32) produced plutonium-based fuel elements intended for fast neutron or experimental reactors and then, as of the 1990s, for pressurised water reactors using MOX fuel. The activities of the LPC (BNI 54) were associated with those of the ATPu: physico-chemical inspections and metallurgical examinations, processing of contaminated effluents and waste. The two facilities were shut down in 2003.

The final shutdown and decommissioning decrees for the ATPu facility and the LPC laboratory were published in March 2009. The decommissioning of the two facilities – which was the subject of the corresponding resolutions of 26th October 2010 – continued in 2016 with a large volume of operations, which enabled the source term to be reduced significantly. For some of them, the licensee submitted modification notifications, examined by ASN, such as the sorting, repackaging and transfer of metal scrap operations, or organisational changes to maintain sub-criticality.

CEA is the nuclear licensee for these facilities. Areva NC has been the industrial operator responsible for operation of the facilities since 1994 and is also responsible for their decommissioning until CEA takes over complete responsibility for this activity.

In 2017, ASN will remain vigilant with regard to the situation of these two BNIs concerning social, organisational and human factors, in particular when CEA resumes decommissioning activities when the industrial operator departs and will ensure that the progress made is sustained over the long-term.

6.3.4.8. CEA / SACLAY SITE

The decommissioning operations performed on the Saclay site concern two BNIs finally shut down and three BNIs in operation, parts of which have ceased activity and on which operations in preparation for decommissioning are being carried out. They also concern two ICPEs (EL2 and EL3), which were previously BNIs but which have not been completely dismantled.

On 31st December 2017, CEA also notified shutdown of BNI 72. The decommissioning authorisation application file submitted in December 2015 is currently being examined by ASN.

High activity laboratory (LHA)

The LHA (BNI 49) comprises three buildings housing several laboratories which were intended for research into or production of various radionuclides. For the LHA laboratory, the final shutdown and decommissioning decree was signed on 18th September 2008.

Following work, only two laboratories should eventually remain under the ICPE system. ASN considers that the level of safety of BNI 49 undergoing decommissioning is satisfactory. Despite the satisfactory progress being made in the operations, it will not be possible to treat the radioactive contamination of the soil in certain interior courtyards before the 18th December 2018 deadline set by the decree. In 2017, CEA will transmit a file for postponement of the deadline.

The ULYSSE reactor

The ULYSSE reactor (BNI 18) was a French university reactor, shut down in February 2007.

Its final shutdown and decommissioning authorisation application was submitted by CEA in 2009. The final shutdown and decommissioning authorisation decree was published on 18th August 2014 and provides for a decommissioning period of five years.

BNI 18 is a facility with limited safety implications.

6.3.4.9. CEA / MARCOULE SITE

The PHENIX reactor (BNI 71), built and operated by CEA, is a sodium-cooled fast neutron reactor demonstrator. It was finally shut down in 2009.

The decree prescribing that CEA carry out decommissioning operations was published on 2nd June 2016. The ASN resolution of 7th July 2016 supplemented the provisions of the above-mentioned decree.

In addition to specifying the prescriptions concerning the decommissioning of the BNI and its periodic safety review and imposing an update of the baseline safety requirements and on-site emergency plan, the resolution also defines the expected content of the commissioning authorisation application file for the future NOAH facility, the function of which is to transform into sodium hydroxide the sodium from PHENIX and other CEA facilities and which is currently being built.

ASN regularly monitors the progress of the review of the answers to its requests provided during the periodic safety review of 2014 and the construction of NOAH.

6.3.4.10. AREVA NC/LA HAGUE

The UP2-400 assembly comprises the former reprocessing plant UP2-400 (BNI 33) and the corresponding facilities, shut down since 2004:

- the STE2A effluent treatment station (BNI 38);
- the HAO oxide high activity facility (BNI 80);
- the ÉLAN IIB facility (BNI 47), which manufactured caesium 137 and strontium 90 sources until 1973.

BNI 80 carried out the first stages of the reprocessing of spent oxide nuclear fuels (reception, storage then shearing and dissolution). The dissolution solutions produced in BNI 80 were then transferred to the UP2-400 industrial plant in which the subsequent reprocessing operations took place.

Decommissioning of the HAO facility was authorised by the decree of 31st July 2009.

The waste recovery and packaging project (RCD) currently under way in the HAO silo and the organised disposal of hulls (SOC), represents the first hold point in the decommissioning of the installation. The civil engineering work for construction of the recovery and packaging facility authorised by the ASN resolution of 10th June 2014 continued in 2016 and is almost completed. In 2017, the licensee will install equipment in this facility.

BNI 80 also underwent a periodic safety review, for which ASN will complete its examination in early 2017.

In October 2008, AREVA NC submitted three authorisation applications for final shutdown and decommissioning of the other facilities in the UP2-400 plant: BNI 33 (UP2-400), BNI 38 (STE2 and AT1 facility) and BNI 47 (Élan IIB).

Following the examination of the files submitted in 2008, ASN considered that the provisions defined by AREVA NC for the decommissioning of BNIs 33 and 38 comprised nothing unacceptable from the point of view of safety, radiation protection or the management of waste and effluents. Nevertheless, this examination did reveal the necessity for the licensee to provide a large number of additional studies. Consequently, for BNIs 33 and 38, only those operations for which the information in the safety cases provided was considered to be sufficient could be authorised.

The three decrees authorising the start of final shutdown and decommissioning operations for the three BNIs date from 8th November 2013. The decrees concerning BNIs 33 and 38 only authorise partial decommissioning, whereas the decree concerning BNI 47 authorises complete decommissioning of the installation.

In accordance with the decrees for BNIs 33 and 38, AREVA NC submitted new complete decommissioning files for BNIs 33 and 38 in July 2015. The periodic safety review files for BNIs 33, 38 and 47 were also transmitted. The examination of the periodic safety review files jointly with that of the decommissioning file will provide the opportunity to check that the measures to control ageing are compatible with the decommissioning strategy envisaged by the licensee, and in particular with the projected duration of the entire decommissioning project.

The licensee has begun to carry out decommissioning operations, more specifically in BNI 33, as well as work in preparation for decommissioning in BNIs 38 and 47. ASN notes that the difficulties encountered on the decommissioning sites are mainly linked to uncertainties regarding the initial states and the presence of asbestos. The licensee focuses on defining action plans to control the schedule slippages that are liable to result from this.

More specifically with regard to the recovery of legacy waste on the La Hague site, which is a major safety issue, ASN carried out an in-depth inspection in October 2016 on the licensee's organisation and the progress made in the top priority projects. ASN found that even though efforts have been made to prevent certain operations falling even further behind schedule, sticking points could penalise the progress of other operations. ASN also found that the first recovery deadline prescribed by the resolution of 9th December 2014, concerning waste in silo 130, had not been met, even though noteworthy efforts had been made to recover these wastes.

ASN will pay particularly close attention to analysing the situation of the various projects, in order to identify areas for improvement so that the regulation deadlines can be met, including those of the resolution of 9th December 2014, which are of major importance for the safety of these older facilities.

6.3.4.11. AREVA NC PLANT IN TRICASTIN

The AREVA NC plant in Tricastin (BNI 105) operated by AREVA NC mainly produced uranium hexafluoride (UF_6) for the fabrication of nuclear fuel. The part of the plant manufacturing UF_6 from natural uranium is covered by the ICPE regulations. That manufacturing UF_6 from reprocessed uranium is covered by the BNI regulations.

In February 2014, AREVA NC submitted a decommissioning decree application. The technical review was completed in May 2016 and the environmental authority issued its opinion on the file in September 2016. Examination will continue in 2017, the year in which the public inquiry is to be held. Inspections revealed organisational shortcomings and ASN will ensure that the facility improves on this point.

6.3.4.12. EURODIF-PRO PLANT IN TRICASTIN

The Georges Besse I facility operated by EURODIF-Pro (BNI 93) consisted of a plant separating uranium isotopes using the gaseous diffusion process, which ceased production in May 2012.

The decommissioning of EURODIF presents major challenges with regard to the volume of VLL waste produced and the reduction in the decommissioning period, which must be as short as possible (currently estimated at 30 years).

The licensee submitted its final shutdown and decommissioning application in March 2015. The assessment of its acceptability revealed the need for additional data before its review could be continued. These requests concern general aspects of the decommissioning strategy adopted (waste management, description of initial and final states). The environmental authority issued its opinion on 23rd November 2016 and the examination will continue in 2017, the year in which the public inquiry is to be held.

For the activities already in progress, ASN noted that EURODIF-Pro must aim to improve its control of subcontracted activities.

6.3.4.13. SICN PLANT IN VEUREY-VOROIZE

The former nuclear fuel fabrication plant in Veurey-Voroize, operated by the Société industrielle de combustible nucléaire (SICN – AREVA Group) consists of two nuclear facilities, BNIs 65 and 90. Fabrication work ceased in the early 2000s. The decrees authorising the decommissioning operations date from 15th February 2006. The decommissioning work having been completed, delicensing of the facilities can now be envisaged. The site nevertheless displays residual though limited contamination of the soil and groundwater, the impact of which is acceptable for its envisaged future use (industrial). Therefore, as a prerequisite to delicensing, ASN has asked the licensee to submit an application for the implementation of institutional controls designed to restrict the use of the soil and groundwater and to guarantee that the land usage remains compatible with the state of the site. SICN submitted this file to the Isère *département* Prefect's office in March 2014 and sent the delicensing application file for the two BNIs to ASN. It will not be possible to declare this delicensing until these active institutional controls have been effectively put into place by the Prefect of the Isère *département*, following the examination procedure which notably includes a public inquiry.

6.3.5. Experience feedback from the Fukushima nuclear accident

The experience feedback from the Fukushima nuclear accident for the facilities under decommissioning is presented in A.3.5.

6.4. State control for securing decommissioning funds for BNIs

State-control procedures for securing BNI- decommissioning funds are the same as those applicable to those for securing the funding of “long-term charges”, such as those described in § F.6.4. In fact, *Environment Code* provides for a financial-securisation mechanism covering the management of radioactive waste and spent fuel, as well as the decommissioning charges for BNIs.

6.5. ICPEs and mines

6.5.1. ICPEs

Site-clean-out conditions after the final shutdown of ICPEs may be included in the licensing decree, In the case of facilities subject to a declaration, site-clean-out conditions after operation must be specified in the impact statement supplied with the declaration.

According to ICPE Regulations, any operator who intends to cease his activities must give the Prefect at least one month’s notice of the end of operations. In the case of waste-storage facilities that are licensed for a limited term, notice must be given at least six months before the expiry date of the licence.

For facilities subject to a declaration, the notice must indicate the nature of site-clean-out steps been taken or planned. The site has to be returned in a state such that is compatible with any future industrial or commercial activity.

For licensed facilities, the operator must enclose with the notification an updated map of the facility’s footprint and a memorandum on the site status, which must specify which steps have been taken or planned to ensure environmental protection.

The memorandum must also cover the following topics:

- the removal or disposal of all hazardous products; the elimination of fire and explosion hazards, as well as the removal of all waste present on the site;
- the decontamination of the facility site and of any polluted groundwater;
- the landscaping of the facility site into the surrounding environment;
- if necessary, the monitoring of the facility’s impact on the surrounding environment.

The operator must return the site to a condition such that there is no more hazard or inconvenience for the neighbourhood or the environment. If the rehabilitation work has not been included in the licence order or requires clarification, the former operator and the mayor of the relevant commune must enter into negotiations in order to determine the future use of the site. Failing a favourable outcome of those negotiations, the Prefect is responsible for deciding about the fate of the site in relation to the last operating term, except if it is not compatible with valid urban-planning documents at the time when operations stopped. The ICPE Inspectorate may suggest to the Prefect to issue a complementary order setting the requirements for the rehabilitation of the site.

The Prefect must be kept informed about the clean-out work as prescribed by the licensing order or any complementary decree. The ICPE inspector confirms the conformity of the work in a follow-up report.

If the ownership of the land is transferred, the buyer must be informed not only that an ICPE subject to a licence has been operated on the land, but also of any residual-pollution issues on the site.

It should be noted that the Prefect can issue an order imposing on the prescriptions necessary for protection of the environment at any time, even after the site has been cleaned out.

6.5.2. Mines

The end of a mining operation is marked by a dual procedure: the final cessation of work to be declared to the Prefect and a claim waiver to be validated by the Minister in charge of mines. The purpose of those procedures is to release the operator from the jurisdiction of the mine police, provided that he has met all his obligations.

If the formal acknowledgment of the declaration for final cessation of work, followed by a claim waiver, do not allow for the operator to be tracked back through the special mining police, the third-party liability of operators and claim holders still remains permanent. Since the *30 March 1999 Law*, with regard to the disappearance or default of any responsible party since the *1999 Law*, the State assumes the full role of guarantor for repairing damages and, henceforth, replaces the responsible party in any legal action taken by the victims. On completion of the work stoppage 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 10 year period.

In most cases, the formal acknowledgement of the declaration for the final cessation of mining activities involving radioactive substances requires the operator to monitor the overall former parameters prescribed for the operating lifetime. If monitoring detects no disturbances, complementary orders may lift any or all monitoring requirements. Since ICPEs represent the prevailing source of radioactive pollution, mine-police orders merely accompany related ICPE orders.

Section G | Safety of Spent Fuel Management (Art. 4 to 10)

1 | GENERAL SAFETY REQUIREMENTS (ARTICLE 4)

Each Contracting Party shall take the appropriate measures to ensure that all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In so doing, each Contracting Party shall take the appropriate measures:

i) to ensure that criticality and removal of residual heat generated during spent fuel management are adequately assessed;

ii) to ensure that the generation of radioactive waste associated with spent fuel management us kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

iii) to take into account interdependencies among the different steps in spent fuel management

iv) to 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 as due regard to internationally endorsed criteria and standards;

v) to take into account the biological, chemical and other hazards that may be associated with spent fuel management;

vi) to strive to avoid actions that impose reasonable predictable impacts on future generations greater than those permitted for the current generation, and

vii) to aim to avoid imposing undue burdens on future generations.

1.1. Legal framework and ASN oversight

In France, most of the spent fuel management facilities are either a BNI or form part of a BNI. In this respect, the fuel management facilities are subject to the BNI authorisation and oversight system built around the provisions of chapters III, V, VI of title IX of book V and the provisions of chapter II of title IV of book V of the Environment Code (see § E.2.2).

This system is said to be "integrated", because it aims to prevent or manage all risks and detrimental effects a BNI is liable to create for humans and the environment, whether or not these are radioactive. Radiological, biological, chemical and other risks are addressed in terms of protection of the interests mentioned in article L. 593-1 of the Environment Code (security, public health and safety, or protection of nature and the environment).

Issued pursuant to article L. 593-4 of the Environment Code, the order of 7th February 2012 defines the essential requirements applicable to the BNIs in order to protect the above-mentioned interests throughout their lifetime, from design to delicensing. Article 1.2 of the order of 7th February 2012 states that the licensee must ensure that its activities related to the safety case, the management of detrimental effects and the impact on health and the environment, or waste management, take account of the state of the art and current practice at the time of design and manufacture. Article 3.4 also stipulates that management of nuclear chain reactions, the removal of heat from radioactive substances and nuclear reactions, the containment of radioactive substances, the protection of persons and the environment against ionising radiation must be taken into account in the safety case. Finally, article 6.1 requires that the licensee take all necessary measures as of the design stage to prevent and reduce, particularly at source, the production and the harmfulness of the waste generated by its installation.

Article L.542-1 of the Environment Code stipulates that means to ensure the definitive safeguarding of radioactive waste must be sought and implemented in order to prevent or minimise the burdens to be borne by future generations. For this purpose, article L. 542-1-2 of the Environment Code requires that every three years, a national radioactive and materials and waste management plan (PNGMDR) be drawn up to inventory the existing management methods for radioactive materials and wastes and the technical solutions adopted, identifying the foreseeable need for storage or disposal facilities and specifying the capacity necessary for these installations and the storage durations. The TECV Act of 17th August 2015 requires that for their shutdown facilities, the licensees aim for decommissioning as rapidly as possible, which also tallies with the goal of mitigating the burden placed on future generations.

The Environment Code also defines requirements concerning the evaluation of long-term costs, the provisions to be taken into account by the licensees and their coverage by dedicated assets (see § B.1.7.1 and § F.2.3.2). These requirements concerning the financing of long-term costs apply to the management of radioactive waste and of spent fuels and to the decommissioning of all the facilities.

One important aspect of fuel cycle safety is the required consistency between changes to the envisaged NPP fuel management and the characteristics and possible changes to the cycle facilities (back end and front end of the cycle and management of radioactive waste). This consistency must be checked, taking account of the texts applicable to the fuel cycle facilities and to the transport of radioactive and fissile materials, more specifically: the facility creation authorisation decrees, the liquid and gaseous effluent discharge and water intake license orders and the associated ASN resolutions, and the technical prescriptions and regulations on the transport of radioactive materials.

As the main ordering customer, EDF must identify and characterise the technical and regulatory constraints of the fuel cycle in order to make it possible to adequately anticipate the dependency between the various steps: processing of the materials to be utilised, fuel fabrication, introduction into the reactor, transport of materials, removal of spent fuel, receipt and storage of spent fuels, possible reprocessing of spent fuels and management of the waste.

In order to verify compliance with these requirements, ASN's duties consist in:

- authorising the major steps in the life of the nuclear fuel cycle facilities and the modification requests;
- monitoring compliance with the prescriptions applicable to these facilities; this includes ASN monitoring of the organisation of the licensees in order to ensure that satisfactory account is taken of SOHF and operating experience feedback;
- verifying the actual overall consistency of the fuel cycle mentioned above.

ASN does not monitor the defence-related nuclear installations (secret BNIs or SBNI) and certain radioactive waste management facilities which do not meet the conditions defined in decree 2007-830 of 11th May 2007 relative to the BNI nomenclature. In the first case, the SBNIs are monitored by the defence nuclear safety authority (ASND) (for the fuel cycle, this concerns materials storage areas and support facilities). The facilities which are neither BNI nor SBNI may have the status of installations classified on environmental protection grounds (ICPE) and are then placed under the control of the Prefects, or may be licensed by ASN pursuant to the Public Health Code.

1.2. Safety policies of BNI operators

1.2.1. CEA's safety policy

The CEA's safety policy is to prevent the risk of dissemination of radioactive materials and to limit occupational exposures to ionising radiation. It consists in preventing the dispersal of radioactive materials and in minimising occupational radiation exposures. In order to achieve that goal, successive lines of defence, such as actual physical barriers (equipment, containments, etc.) and organisational resources (control resources, procedures, etc.) are used to isolate radioactive substances from staff and the environment.

Nuclear safety is one of the CEA's top priorities. The implementation of this priority must guarantee that the corresponding appropriate decisions and steps are taken. This attitude is what constitutes the "safety culture". The CEA's nuclear-safety structure relies on an unbroken line of accountability.

The Chairman is responsible for taking any measures required to implement any legislative, regulatory and specific provisions and requirements applicable to all activities involving a nuclear risk, and for organising nuclear safety at the CEA.

He is assisted by the Director of the Nuclear Safety and Protection Division and relies on the other functional directors, who are in charge of preparing corporate decisions and on the Nuclear Safety Strategy Committee, the body responsible for preparing corporate decisions relating to objectives, strategic development and operations in the area of nuclear safety.

Under the Chairman's authority, the CEA's skills and responsibilities with regard to nuclear safety are divided between line managers, support resources and inspections.

Line managers are supported by a network of experts in the different areas of safety, logistic support and methodological and operational support available on every CEA site.

By delegation, facility managers are responsible for nuclear safety regarding the activities, facilities and materials placed under their jurisdiction.

With reference to current nuclear-safety objectives, the Level-2 inspection function consists in checking the efficiency, appropriateness and internal control of the structure, resources and actions implemented by line managers. The inspection function is performed by other entities than those involved in line management and operates at the level of the CEA's Directorate-General and of each site directorate.

The CEA has developed an internal-authorisation system which fits into the ASN's declaration system and is based on the submission of a licence-application case (*dossier de demande d'autorisation*) by the relevant line manager to the site director of the facility involved. In turn, the site director requests approval from the inspection section of his site and, if necessary, from a safety Committee he convenes and which consists of permanent members and experts appointed by the Chairman regarding the specific needs of the operation involved.

1.2.2. AREVA's safety policy

The integration of nuclear safety is also a priority for AREVA. It is involved in formal commitments in nuclear safety and radiation protection in a *Nuclear Safety Charter,* as mentioned in § F.3.2.3*,* seeking at ensuring a high level of safety during all lifetime phases.

The primary responsibility of the operator is clearly mentioned in that charter**:** the director of every establishment is liable for safety and radiation protection on his own premises. The levels for responsibility delegation are set within every entity in connection with the operational line of management and within the limits of the attributed skills. The organisation in place is able to meet legal and regulatory requirements, notably in the fields of nuclear safety, radiation protection and transport security.

Internal controls, over and above the technical controls, are carried out by independent staff members from the operating teams, as follows:

- Level-1 controls are performed on behalf of the director of the entity and consist mostly in verifying that the safety reference system and the delegation system are applied correctly;
- Level-2 controls are performed by the team of safety inspectors duly designated by the Director general.

The defence-in-depth concept is the basic principle for the safety of nuclear facilities. It is characterised by the implementation of a large number of protection levels, based on preliminary risk analyses. Those levels rely on technical specificities, a structure, procedures, operating modes and relevant skills. Any industrial project, evolution in operations or change in an existing facility must be the subject of a preliminary analysis as associated risks.

The lessons to be learnt from experience feedback are developed at different levels and their dissemination for the benefit of all entities within the group is the responsibility of the specialist network of the Central Directorate Safety Health Security Environment.

Any person working in those facilities, whether a paid employee or one of its subcontractors, must be informed of the risks associated with his/her workstation and of the measures being taken with regard to risk prevention and control. Any such person has an alert duty, if he/she notes any characterised malfunction or a violation of any legal obligation. He/she benefits from the same forms of protection, irrespective of his/her statute. He/she must be trained and order to intervene in the implementation of actions involving risk prevention and safety improvements.

The protection of workers against ionising radiation is a clearly-stated priority, not only for the paid employees of the group, but also for external interveners.

Nuclear events are assessed in accordance with the INES scale and are made public in France, as soon as their level on the scale is equal or higher than Level 1.

The management of emergency situations is organised in order to ensure the largest reactivity and the best efficiency as close as possible to the theatre of operations. Regular exercises are organised to train the intervention teams and to draw lessons in terms of organisation, skill improvement, communications and stakeholder implications in order to achieve the best control level over altered situations or exceptional events.

AREVA seeks to provide reliable and relevant information in order for any person to appreciate objectively the state of safety in AREVA facilities. In accordance with the provisions of the Environment Code, sites must establish and distribute every year a report on nuclear safety. That report must be submitted to the Committee for Hygiene, Security and Working Conditions (*Comité d'hygiène, de sécurité et des conditions de travail* – CHSCT) of the facility before publication. Furthermore, in accordance with the provisions of the *Nuclear Safety Charter*, the General Inspectorate must prepare the annual report on the state of safety of the group's facilities, which is presented to the General Management (*Direction générale*) and to the Board of directors (*Conseil d'administration*) of the Group, and make it public.

The soundness of the principles defined by AREVA's Nuclear Safety Charter and the efficiency of the actions to which they led remain fully adapted and were rarely questioned with regard to experience feedback over the last six years and to stakeholders' expectations. A new edition of the *Charter* including notably the organisational changes that occurred within the Group in the meantime is in preparation.

1.2.3. EDF's safety policy

Scope

The safety policy mentioned is that applied to the BNIs in operation and those undergoing decommissioning. As holder of the authorisation or decommissioning decrees, EDF SA is the nuclear licensee.

In accordance with the legislative and regulatory provisions in force, EDF SA establishes and undertakes to implement a policy clearly confirming:

- the priority given to the protection of the interests of public health and safety, nature and the environment, primarily by preventing accidents and mitigating their consequences with regard to nuclear safety;
- the constant search for improvements in the measures taken to protect these interests.

Chair of EDF SA

The CEO has all the necessary powers to enable EDF SA to carry out its duties as nuclear licensee. He delegates nuclear licensee responsibilities to the Group's Executive Director in charge of the Nuclear and Thermal NPP fleet.

The Group Executive Director in charge of the Nuclear and Thermal NPP fleet is the ASN point of contact and may ask the Director of the Nuclear Generating Division (DPN) to represent him in this role for the BNIs in operation or the Director of the of Dismantling and Waste Projects (DP2D) for the BNIs undergoing decommissioning. He may also ask the Director of the Nuclear Fuel Division (DCN) for the purposes of his nuclear cycle integration duties.

Entities in charge of BNI operation and BNI design and modification at EDF SA

The Directors of the DPN, the DIPDE and the DP2D develop a Management System contributing to compliance with the rules of nuclear safety and radiation protection in the organisation and working of their entity. In this respect, they ensure that priority is given to protection of the abovementioned interests and its constant improvement, principally by preventing accidents and mitigating their consequences in terms of nuclear safety.

The Group Executive Director in charge of the Nuclear and Thermal NPP fleet appoints the Fleet Engineering, Dismantling and Environment Division (DIPDE) as the Design Authority for BNIs in operation and undergoing decommissioning. In this respect, the Director of the DIPDE guarantees that the design status of the facilities and their developments throughout their life cycle are in conformity with the baseline safety requirements in force. In so doing, the Design Authority draws on the expertise of the engineering centres designated as "Responsible Designers".

The Site

The NPP Director or the Site Director is the representative of the nuclear licensee EDF SA with regard to the installations for which he has received delegation from the DPN Director for the NPPs in operation, or the Director of the DP2D for the sites undergoing decommissioning. More particularly:

- He proposes and implements the principles of organisation and operation that ensure compliance with nuclear safety and radiation protection rules, and allow the effective exercise of the responsibilities of the nuclear licensee, EDF S.A.
- He relies on an Integrated Management System and has compliance with the requirements verified through appropriate internal monitoring. He aims to ensure the development of continuous improvement and the adoption of best practices, including those identified internationally.
- He reports the information relating to nuclear safety and radiation protection to the Director of the DPN, for the BNIs in operation, or to the Director of the DP2D, for facilities undergoing decommissioning. He is the chief point of contact for the national and local competent regulatory authorities for the aspects specific to the facilities under his responsibility.

The Independent Safety Team (FIS)

Each level of the company calls on the services of an Independent Safety Team (FIS) providing an independent opinion of how the nuclear licensee performs its duties. The FIS ensures that priority is given to nuclear safety by exercising a role of verification and support for the management. At each level of the company, the FIS reports to the manager of the level concerned. In the event of any serious breach of the nuclear safety rules, the FIS is duty bound to sound the alert which may, if necessary, be sent to the higher management level.

1.2.4. ILL's Safety Policy

As far as the ILL is concerned, the smooth running of activities consists in preventing the dispersal of radioactive materials and in limiting occupational radiation exposures.

The Institute carries out risk analysis to develop adequate steps to prevent or limit the consequences of hypothetical accidents; it also monitors the quality of the implemented steps.

The nuclear-safety structure at the ILL is based on accountability, inspections and simple decision-making processes. The ILL also relies on outside competences and expertise in that area. All employees in charge of safety and radiation protection report directly to management, and inspections are carried out by the Co-ordination and Quality Assurance

Office (*Bureau de coordination et d'assurance de la qualité* – BCAQ). The Risk Quality Unit, reporting directly to the management, maintains the IMS in accordance with the requirements of the Management Board. This unit devotes 10% of its resources to overseeing implementation of the various IMS processes, more specifically through audits and spot checks. However, this unit above all provides assistance to all the units in order to guarantee that the objectives defined in the processes are achieved. It thus provides support for all the units and independent monitoring on behalf of the Management Board. Following these independent verifications, the Management Board decides on the action plans.

With regard to spent-fuel management, fuel elements may be shipped to La Hague. The stress tests conducted in 2011 demonstrated the robustness of the HFR to external hazards and there are still two lines of defence (prevention and mitigation) to avoid these hazards and limit their consequences. Thanks to the steps provided for further to these stress tests, all the accident scenarios including these external hazards, regardless of the operating situation, are contained within the 500 m radius safety perimeter. The programme of works ran until mid-2017.

1.3. ASN analysis

As mentioned in section G.1.1., ASN also monitors the overall consistency of the industrial choices made with respect to spent fuel management, in terms of safety and the regulatory framework[24].

To do this, on the basis of a "Cycle Impact" file transmitted by EDF and jointly drafted every ten years with the French fuel cycle stakeholders, that is AREVA and ANDRA, ASN examines the consequences on the various steps of the fuel cycle of EDF's strategy of using new fuel products and new fuel management processes in its reactors. In 2015, ASN asked EDF for an overall revision of the "Cycle Impact" file to be carried out in 2016 in order to obtain a robust and long-term overview of the changes that could affect all cycle activities and the consequences of these changes on the facilities and transport activities.

The purpose of this file will be to show that the changes in fuel characteristics or in irradiated fuel management and the developments to the fuel cycle facilities made or envisaged by the industrial players concerned are in no respect unacceptable, over the coming fifteen years, whether with regard to the operating safety of the NPPs, the operation of the front-end and back-end plants in the cycle or the medium and long-term management of the waste. It shall also demonstrate long-term management of traffic and stocks of materials, fuels and waste and anticipate difficulties or contingencies in the operation of the fuel cycle.

The 2016 update of the "Cycle impact" file comprises a number of innovations with respect to the previous approaches initiated in 1999 and 2006:

- the study period, which habitually covered ten years, is increased to fifteen years, in order to take account of the time actually observed in the nuclear industry to design and build any new facilities identified as being necessary further to the assessment carried out;
- radioactive substances transport contingencies are explicitly incorporated into the assessment;
- nuclear reactor closure scenarios are studied for the period of time considered, in particular assuming stable electricity demand until 2025, to take account of the planning provisions included in the Energy Transition Act;
- the strategy for managing and storing spent fuels pending reprocessing or disposal is part of the scope of the assessment.

EDF submitted the updated "Cycle impact" file to ASN on 30th June 2016. This file is currently being examined by ASN, which will issue its position statement in 2018.

With regard to AREVA, ASN and the ASND sent several letters in June 2014 to its Chairman and to the directors of the La Hague and Tricastin sites, asking them to transmit the group's national strategy and the local strategy for the sites with regard to decommissioning and waste management. The files, received in June 2016, are currently being examined.

With regard to CEA, ASN and the ASND sent a letter on 21st July 2015 to its Chairman, asking for its updated management strategy for radioactive waste (solid and liquid) and civil radioactive materials, including spent fuels. The file, received in December 2016, is currently being examined.

[24] The other types of checks listed in section G.1.1 are dealt with in sections F.3.3 (monitoring of quality management), F.6.3 (monitoring of decommissioning strategies), G.2.3 (examination of review of fuel cycle facilities) and H.1.3 (monitoring of waste management strategies).

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 facility.

2.1. Legislative framework and ASN requirements

In order to take into account facility ageing and changes in safety expectations, the law requires every operator not only to analyse experience feedback on a continuous basis, but also to re-examine periodically the safety aspects of his BNIs.

The purpose of such provision is to ensure the constant improvement of safety in facilities and leads often to changes in the facility or in the scope of its operation. For instance, issues relating to behaviour in case of earthquake often lead to recognise the need for reinforcing facilities, the feasibility assessment of which may encourage the operator to shut it down over the more or less short term.

2.2. Safety review of facilities by BNI operators

2.2.1. CEA's safety review

The structure implemented at the CEA for safety-reassessment purposes takes the form of a project. Given the stakes involved and the resources needed to perform them, all safety reassessments, whether scheduled or under consideration, are covered in a multi-year plan, which, in theory and for each facility, should be performed every 10 years. It should also include any major planned changes and, where appropriate, the provisional date for the end of the facility's lifetime.

The primary objective of the periodic safety review is to assess the safety of the facility and identify any deviations from the baseline safety requirements in force and from the current safety and radiation protection regulations and practices.

Before reassessment, the CEA must specify its strategy for each of its facilities with regard to the nature and sustainability of the future operating functions and missions of the facility.

The second objective is to take adequate compensatory steps in order:

- to bring the facility up to the highest safety level reasonably possible, in view of the remaining timescale of its operating life, and depending on the estimated cost of any safety-related changes;
- to reduce future occupational exposures during the operating phase in accordance with the ALARA principle, focusing as a priority on the most exposed workstations, and
- to reduce nuisances on the environment (discharges and waste) according to the ALARA principle, focusing especially on eliminating the production of waste for which there is no processing technology available, minimising discharges into the environment, encouraging internal recycling procedures and improving safety in integrated storage areas within the facility.

The CEA proposes a number of steps designed to upgrade safety in its facilities, by reinforcing certain lines of defence or adding others, as reflected in requirements regarding key safety factors or equipment important for the protection of interests (systems and equipment or operating rules).

Those steps are then submitted to a safety analysis. The conclusions of the reassessment are presented to ASN, which in turn provides its opinion, before any change is made and before any safety demonstration of the upgraded facility is conducted. The facility's safety reference system is then updated.

Hence, the safety reassessment may result in changes (structures, equipment, operating rules, etc.), maintenance and clean-out activities, as well as the revision of operating documents.

2.2.2. AREVA's safety review

The periodic safety reviews are a continuous and highly demanding process. The ten-yearly safety review is an important milestone in terms of the safety of the facilities and its benefits are widely recognised internationally. It participates in and explicitly determines the continuous measures taken to maintain and improve the level of safety in nuclear facilities.

Within the Group, this today requires permanent action, on the one hand owing to the annual number of facilities being reviewed or for which the file is under examination and, on the other, to the implementation of improvement measures resulting from the review.

This process has been regulated for several years in France and is based on two strong technical components: the conformity check and the safety reassessment.

Emphasis is first of all placed on the conformity check. The conformity check on a facility consists in ensuring that the regulatory changes and the changes to the facility and its operations, as a result of modifications (technical, process, production, organisation, etc.) or its ageing, do not compromise the design safety analyses and remain in conformity with the authorised operating range. This conformity check is based on the facility's baseline requirements, which are permanently kept up to date. These baseline requirements comprise texts at several levels: regulatory texts both general and specific to the facility, licensing decrees for discharges and water intake, codes and standards, letters and correspondence with the Authorities (ASN prescriptions, Advisory Committee follow-up, licensee undertakings, etc.) directives, standards and requirements from the group, facility baseline requirements (safety report, general operating rules, on-site emergency plan, waste study, decommissioning plan, impact assessment, etc.).

A programme of physical verification of the facility, in addition to permanent measures in this field, is defined and implemented. The licensee gives priority to equipment and elements important for protection (EIP) which take part in controlling the BNI's safety functions. The licensee also demonstrates its management of facility ageing. It proposes adaptations to its maintenance or monitoring programmes and the implementation of compensatory measures, based on studies of ageing phenomena and the lessons it has learned from operating experience feedback.

A plan to check the conformity of operating practices with the documents of the applicable safety baseline requirements is also defined and implemented.

A plan to restore conformity is defined and implemented as applicable.

The safety reassessment is an opportunity to reanalyse the safety of the facility in the light of current safety and radiation protection regulations and practices (in particular, guides, standards and basic safety rules), incorporating all operating experience feedback from the facility (dosimetry, effluents, waste, anomalies and incidents, etc.) as well as from accidents which affected similar facilities in France or abroad. It leads to the identification of areas for improvement of the facilities or their operations.

2.2.3. EDF's safety review

2.2.3.1. EDF'S SAFETY REASSESSMENT PROCESS OF EXISTING FACILITIES

EDF conducts regular safety reassessments per technical series. The interval between two reassessments is of 10 years at maximum, in accordance with the French regulations on BNIs (Environment Code).

The process is divided into three phases:

- A description of the safety reference system, consisting of a set of rules, criteria and specifications applicable to a plant series.
- A compliance demonstration of the standard state of each unit series with the safety reference system, followed by a compliance check of all reactor units with the reference state.
- A reassessment of the safety requirements, based on the examination of all major safety-related feedback, followed by the potential identification of any changes that need to be brought to the standard state of the plant series. Because of the large amount of work this reassessment is performed during the decennial inspection which is a long shutdown.

The process ensures the conformity of reactors with the current reference system. It also highlights any safety aspect requiring further analysis, particularly on the basis of French or foreign experience feedback and changing knowledge. The analysis may lead to changes in the reference system, corresponding to a new reference status, together with an update of the safety analysis report presenting the safety demonstration.

Probabilistic safety studies are conducted when relevant, especially when searching for and analysing accident-warning signs, or when ranking main risk components and assessing the safety level as well as for the assessment of the value of certain modifications with regard to their safety stake and the difficulty of their implementation.

Following each ten-yearly outage inspection and periodic safety review, the baseline safety requirements for each plant series changes by incorporating the improvements made. Following this work on each unit, a report is sent to ASN so that it can rule on the conditions for continued operation for a further period of 10 years. At present, following the third ten-yearly outage inspections and the periodic safety review of the 900 MW plant series, ASN issued a favourable opinion for continued operation for a further ten years, in certain conditions, concerning the units of the 900 MWe PWR plant series at Tricastin 1, Fessenheim 1, Bugey 2 and Fessenheim 2.

Changes following implementation of the post-Fukushima measures

Following the nuclear accident in the Fukushima nuclear power plant (see A.3), a stress tests procedure was initiated. In September 2011, EDF presented ASN with the stress test reports for the units in extreme situations, for each site. This approach (i) consolidated the existing margins of the NPP units with regard to external hazards included in the current baseline requirements and (ii) defined a first batch of proposed modifications to be implemented in the short and medium term, designed to deal with extreme situations.

In June 2012, ASN issued a number of technical prescriptions concerning the implementation of additional measures to deal with extreme external natural hazards and prevent accidents and, were an accident to occur, to mitigate its effects and prevent long-term off-site contamination. These initial prescriptions were added to by ASN in January 2014 with resolutions setting additional requirements to be met by the structures, systems and components of the "hardened safety core".

For EDF's nuclear reactors, these new requirements correspond to major works and investments, which started in 2012 and will continue for several years and which entail:

- the implementation of a programme to improve coverage of total loss of water and electricity supply situations, consisting in:
  - providing all sites with new means, first of all mobile and then fixed, to increase their autonomy with regard to water and electricity,
  - reinforcing robustness to total loss of electrical power situations by installing a new ultimate backup diesel generator set (DUS) on each unit that is robust to extreme hazards,
  - improving emergency management, notably by setting up new local emergency management centres (CCL),
  - reinforcing and training the shift crews,
- as of 2012, the gradual deployment of the "Nuclear Rapid Intervention Force" (FARN), an internal EDF national intervention force comprising specialised teams (about 300 staff) and equipment, capable of taking over from the teams of a site affected by an accident and implementing additional emergency response means within 24 hours, with operations beginning on the site within 12 hours following mobilisation. This arrangement consisting of national and regional bases may be common to several nuclear sites. The arrangement has been fully operational since the end of 2015;
- a new on-site emergency plan (PUI) baseline has been deployed on all EDF sites since 15th November 2012. It takes into account accident situations simultaneously affecting several facilities on a given site;
- for the reactor fuel storage pools, reinforced measures to reduce the risk of uncovering of the fuel, including an ultimate make-up system, which is to be installed on all sites from 2017 to 2021, together with installation of the ultimate back-up diesel generator sets in the plant units;
- the implementation of a "hardened safety core" of material and organisational measures to control the fundamental safety functions in extreme situations. Its aim is to prevent or limit the spread of a severe accident, to minimise large-scale radioactive releases and – even in extreme situations – to enable the licensee to carry out its emergency management duties. The equipment to be included in this hardened safety core shall be designed to withstand major events (earthquake, flooding, tornado, etc.), on a scale greater than those considered in the current baseline requirements for determining the level of resistance of the facilities.

The EDF post-Fukushima programme is on the one hand a response to the Fukushima Daiichi accident in Japan (phases 1 and 2) and on the other addresses the safety goals for EDF reactors with regard to the "operating duration" dossier (phase 3).

In an extreme situation (i.e. natural hazard significantly beyond the design basis), the hardened safety core will:

- prevent reactor melt by prioritising cooldown by the secondary systems (ultimate secondary cooldown by the steam generators);
- remove residual power from the reactor containment without opening the containment venting system. This system consists of a new hardened safety core pump and an exchanger allowing long-duration operation in recirculation on the reactor building sumps;
- prevent containment basement melt-through by installing a corium dry spreading system and passive reflooding with water from the sumps;
- prevent uncovering of the spent fuel assemblies stored or being handled (ultimate make-up, robustness of pools and connected systems, etc.) and prevent the risk of falls by spent fuel packagings and fuel assemblies being handled.

  This is in line with EDF's NPP operating duration objective, which – for the current fleet – is to aim to meet the safety objectives of the generation 3 reactors (EPR-FLA3 in France) and minimise the risk of cliff-edge effects (large-scale, long-term radioactive releases into the environment), in the event of hazards significantly beyond the initial design-basis scenarios, by implementing the hardened safety core.

These new material and organisational provisions, which represent an industrial programme and level of investment on an unprecedented scale, will be deployed on the occasion of the 4th periodic safety review of the 900 and 1300 MWe PWR plant series and as of the 3rd periodic safety review of the N4 plant series.

2.2.3.2. APPLICATION TO THE SAFETY OF ON-SITE SPENT-FUEL COOLING PONDS AND TO SPENT-FUEL STORAGE AND DISPOSAL OPERATIONS

The safety review encompasses the safety the fuel building and spent-fuel cooling pond (seismic resistance, cooling capacity and limitations, monitoring, incidental operating procedures).

The scenarios examined include the risks of rapid emptying of the spent fuel pits and the loss of cooling. The modifications to be implemented are designed to prevent the uncovering of the fuel assemblies: e.g., automatic shutdown of the pit cooling system pumps when the very low level is reached and measurement of the emptying rate.

As mentioned above, the design and the strength of spent fuel pits in the NPPs were examined during the stress tests performed following the accident to the Fukushima Daiichi NPP (see above).

In particular, in response to the ASN prescriptions concerning the provisions designed to reinforce prevention of the risk of accidental emptying of the fuel building pool, EDF presented its studies and the changes to be made to its facilities:

- re-sizing of the siphon-breaker on the cooling system discharge line in order to prevent complete and rapid emptying of the pool by siphoning in the event of a connected line rupture;
- automation of isolation of the cooling system intake line, thus avoiding gravity emptying of the pool by the suction line;
- studies of seismic resistance of the transfer tube significantly above the design level with implementation of a double wall if necessary;
- prevention of the risk of rapid loss of water inventory in the BK pool’s storage compartment in the event of hypothetical transfer tube or drain line leak situations in the transfer compartment or the BR pool compartments;
- robustness of the pool instrumentation to ensure management of the situation and in particular management of water make-up;
- ultimate emergency make-up system which should be installed as of 2017 to 2021, jointly with installation of an ultimate back-up diesel generator set on the units (see above);
- finally, with regard to the increase in the level of defence in depth, EDF will be deploying an additional cooling system for the BK pool by the time of the 4th periodic safety review of the 900 MWe PWRs, ensuring a resilient system subsequently improving the robustness of the reactors to loss of coolant situations.

2.2.3.3. TRANSPORT SAFETY

EDF has taken into account the experience feedback concerning the cleanliness limits for the shipment of radioactive materials and waste, as well as of spent fuel, by abiding to a set of good-practice rules completing official regulations and constituting the “Shipment Reference Framework” (Référentiel transport), as follows:

- the responsibility of consignors, particularly for the quality of checks and shipment documents;
- the qualification of the carriers hired by EDF;
- the declaration, analysis and experience feedback from shipment incidents in case of deviations and analysis of “weak signals”;
- the creation of local shipment-security advisers, in accordance with regulations, and on the national level, in order to provide expertise, assistance and advice;
- the requirement for carriers to implement an emergency plan;
- the realisation of periodic crisis exercises dedicated to radioactive material transport with, at least, the participation of the sites, the central services and the carriers.

2.2.4. Safety review by the ILL

For the safety review scheduled in 2017, the ILL must specify its strategy for the definition and long-term continuity of the future functions and operational missions of the facility.

The ILL takes appropriate measures to:

- bring the facility to a level that is as safe as reasonably achievable;
- reduce subsequent exposure to ionizing radiations of the operating personnel to a level that is as low as reasonably achievable;
- reduce environmental harm (discharges and waste) to a level that is as low as reasonably achievable.

The ILL takes measures to reinforce the lines of defence (prevention, mitigation) or add extra lines, taking the form of requirements concerning elements important for protection.

The ILL implements its safety analysis methodology recently evaluated by IRSN, to deduce these reinforcement measures. The EIP and AIP are the result of this analysis, along with their defined requirements. The ILL also conducts a conformity assessment, both regulatory and technical.

The conclusions of the review are presented to ASN, which issues a position statement, before the modifications are made and the modified facility’s safety demonstration is carried out. The facility’s baseline safety requirements are then updated.

Thanks to the regular investments made on the HFR, the periodic safety review should lead to a very limited number of modifications (structures, equipment, operating rules, etc.) and limited maintenance and upgrade work.

2.3. ASN analysis

AREVA carried out a periodic safety review for some of its facilities in order to check that both their ageing and the changing safety requirements have been taken into account. These facilities should all have been reviewed before 3rd November 2017. This series of initial periodic safety reviews is a major challenge for the facilities of the AREVA group.

In April 2016, ASN issued a position statement on the orientation of the programme of generic studies to be carried out in preparation for the fourth periodic safety reviews on the nuclear reactors, after consulting the public on the draft requests for additional information to be sent to EDF concerning the studies and verifications to be carried out.

With the support of IRSN, ASN is currently examining the generic studies linked to this review. In 2019, Tricastin reactor 1 will be the first 900 MWe reactor to undergo its fourth ten yearly outage inspection. The fourth ten-yearly outage inspections for the 900 MWe reactors will continue until 2030.

At the beginning of 2015, ASN issued its opinion on the generic aspects of the continued operation of the 1300 MWe PWR reactors beyond thirty years of operation. ASN considers that the steps taken or being envisaged by EDF to assess the condition of its 1300 MWe PWR reactors and manage their ageing up until the periodic safety review associated with their fourth ten-yearly outage inspections are acceptable. ASN also considers that the modifications identified by EDF following this study phase will help to significantly improve the safety of these installations. Paluel reactor 1 was the first 1300 MWe PWR reactor to carry out its third ten-yearly outage inspection, in 2016. These third ten-yearly outage inspections for the 1300 MWe PWR reactors will continue until 2023.

In February 2015, ASN ruled on the orientations of the periodic safety review associated with the second ten-yearly outage inspections of the 1450 MWe PWR reactors. ASN more specifically considers that the safety objectives to be considered for the VD2 N4 safety review must be defined in the light of the objectives applicable to the new reactors and asked EDF to study the measures liable to comply with this requirement as rapidly as possible, so that they can be implemented as of the second ten-yearly outage inspections on the 1450 MWe PWR reactors. With the support of IRSN, ASN is currently examining the generic studies linked to this review. The second ten-yearly outage inspections for the 1450 MWe PWR reactors are scheduled to start in 2018 with the Chooz B2 reactor and will run until 2022.

2.3.1. The AREVA NC La Hague reprocessing plants in operation

In 2008, ASN examined the conclusions of the periodic safety review of BNI 118 which includes the effluent treatment station (STE3), the solvents mineralisation facility (MDS/B) and the sea discharge pipe. ASN is particularly attentive to compliance with the undertakings made by the licensee during this periodic safety review. ASN observes that, on the whole, AREVA NC is late in meeting its initial undertakings, in particular concerning the performance of conformity examinations on the facility and the processing of legacy waste.

The periodic safety review for the UP3-A plant (BNI 116) at La Hague was transmitted to ASN in 2010. At the request of ASN, the French institute for radiation protection and nuclear safety (IRSN) assessed this report and presented the results of its analysis to the Advisory Committee for laboratories and plants (GPU) on the occasion of six meetings held between mid-2012 and March 2015:

- the first meeting of the GPU, on 27th June 2012, examined the method and data used by AREVA NC to carry out this review, as well as the approach adopted to identify elements important for safety and its application to the UP3-A plant;
- the second meeting, on 13th June 2013, examined operating experience feedback, more specifically concerning the incidents affecting UP3-A;
- the third meeting, on 14th January 2014, was devoted to the safety provisions for on-site radioactive transport packagings;
- the fourth meeting of the GPU on 26th March 2014 was devoted to reviewing the conformity of BNI 116 with its baseline safety requirements, the satisfactory control of the ageing of this facility and the safety of maintenance operations;
- the fifth GPU meeting of 18th March 2015 was devoted to the safety reassessment conducted by the licensee, in particular in the light of changing regulations and best practices in the field of safety and radiation protection as well as the lessons learned from operating experience feedback from the facility;
- the sixth GPU meeting of 25th March 2015 was devoted to the programme of measures defined by the licensee to improve the safety of its facility, in order to rule on the level of safety of the UP3-A plant both now and for the next ten years.

Following this examination, ASN prescribed safety improvements for AREVA NC in its resolution of 3rd May 2016. This review showed the need for an improvement in the protection of the installation against the risk of fire and against the lightning risk. ASN also considers that the checks must be reinforced on the equipment designed to concentrate the fission products in the facility (the “evaporators”). This equipment is corroding faster than anticipated in the design.

As the maintained integrity of these items has major safety implications, the ASN Commission gave a hearing to the AREVA CEO on 11th February 2016. In its resolution of 23rd June 2016, ASN stipulated the conditions to be met by AREVA NC for continued operation of the fission products concentration evaporators in the La Hague plants. ASN is particularly attentive to the development of corrosion in this equipment.

In 2016, AREVA NC submitted a request to ASN for its opinion regarding the safety options for the new fission product concentration installations, with a view to commissioning them in 2021.

The examination of the methodology and the conclusions of the review of the UP3-A facility on the La Hague site presented by the licensee must be an opportunity for AREVA to improve its process for the future periodic safety reviews, including for the examination of the guidance file for the review of plant UP2-800 (BNI 117). When examining each new file, ASN will be attentive in ensuring that the experience feedback from the previous files is correctly integrated. ASN will in particular ensure that lessons are learned from the safety review of UP3-A, with regard to identification of the EIP and the corresponding defined requirements, in accordance with the BNI order.

The periodic safety review file for the UP2-800 plant was submitted by AREVA NC at the beginning of January 2016 and is currently being examined. A first meeting of the GPU is scheduled for the first quarter of 2018 and will primarily concern the reassessment with regard to the most recent requirements and the conformity and ageing review of the cutting and dissolving facility.

2.3.2. The AREVA NC MELOX MOX fuel fabrication plant

The MELOX BNI, situated on the Marcoule site and operated by AREVA NC, is today the world’s only nuclear installation producing MOX fuel, which consists of a mixture of uranium and plutonium oxides.

Its periodic safety review file was transmitted by the licensee on 21st September 2011. One of the main issues which came out of the review was management of worker exposure to ionising radiation and the adaptation of the facility and its organisation to changes in the composition of the materials used. The ASN resolution of 15th July 2014 subjects continued operation of the plant to compliance with the prescriptions concerning control of the risk of worker exposure to ionising radiation, the criticality risk and the risk of fire.

In 2016, ASN observed that the safety situation in the facility is on the whole satisfactory.

On the other hand, ASN observes failures to comply with the time-frame for performance of the prescribed work to reinforce control of the fire risks and delays in meeting the licensee’s undertakings with regard to monitoring of subcontracted operations.

2.3.3. Taking into account the feedback from the Fukushima accident

ASN’s position concerning the stress tests following the Fukushima Daiichi accident is given in Chapter A.3.

3 | SITING PROJECTS (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 date relating to the facility to enable them to evaluate the likely safety impact 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.

All facilities involved in spent-fuel management are BNIs or part of BNI.

Hence, any new facility is subject to the general BNI regulations, which, with regard to siting, are detailed in § E.2.2.2.

There is currently no siting project for any spent-fuel management facility in France.

4 | FACILITY DESIGN AND CONSTRUCTION (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 BNI general regulations apply to spent fuel management facilities. They are described in Chapters E.2 and F.4 (see § E.2.2.3 for the procedures, § E.2.2.5 for the technical rules and § F.4.1.4 for discharges).

The technologies used for design and construction are based in particular, on experience feedback, the implementation of periodic tests or analyses, in accordance with the legislation and the regulations.

The steps taken by the licensees in terms of safety are presented in G.2.2.

ASN ensures implementation of the regulations through the instruction of technical files, analyses of significant events and inspections it conducts in accordance with procedures presented in § E.2.2.6 and § E.2.2.7. ASN actions concerning the periodic safety reviews performed by AREVA, EDF and CEA are presented in G.2.3.

Finally, with regard to the technical provisions for delicensing of a BNI, title IV of the BNI Procedures Decree stipulates that, for a BNI, the facility decommissioning plan included in the creation authorisation application file must be updated in the decommissioning application file (see § F.6.1.3.1).

5 | SAFETY ASSESSMENT OF FACILITIES (ARTICLE 8)

Each Contracting Party shall take the 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 paragraph i).

The BNI general regulations described in Chapter E.2 apply to spent fuel management facilities.

All measures to be taken by operators are described in G.2.2, which deals with existing facilities.

The regulations concerning the safety evaluation are presented in § E.2.2.3.1, E.2.2.3.2, E.2.2.3.3, E.2.2.4.1, E.2.2.4.2, E.2.2.4.3 and E.2.2.4.4 concerning the safety assessment, creation authorisations, commissioning authorisations, substantial or notable modifications to the facilities, monitoring of incidents and final shutdown and decommissioning of the facilities, respectively.

ASN must ensure the actual implementation of those regulations through the analyses and inspections it carries out according to the modalities described in § E.2.2.6 and E.2.2.7.

6 | OPERATION OF FACILITIES (ARTICLE 9)

Each Contracting Party shall take the appropriate steps to ensure that:

i. the licence 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 licence 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 spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of the facility, and are renewed by the regulatory body.

6.1. Licensing process

The general BNI regulations, which include spent-fuel management facilities, are described in E.2.2 with regard to the operating licence.

6.2. BNI operators' practices

6.2.1. CEA's operational safety practices

Licences are issued to the CEA in accordance with the procedures described in Chapter E.2. Operational safety is ensured in accordance with general and specific regulations; it also includes regular reassessment (see G.2.2).

The quality and sustainability of technological and engineering support means are ensured by the quality-assurance initiatives described in § F.3.2.2 and by human and physical resources described in § F.2.2.2. Insofar as decommissioning is concerned, practices are described in § F.6.2.1

The safety reference systems for CEA facilities are drawn up within the framework of the commissioning-licence application and updated either in the event of any change or during periodic reassessments. They consist of a safety report, general operating rules, also drawn up by the licensee, and technical prescriptions imposed by ASN. Those reference systems determine the operational uses licensed by ASN.

The documents constituting the safety reference systems are completed by a set of procedures and operating methods drawn up by the operators with a view to ensuring that all operating procedures performed at the facility are consistent with the safety reference systems and their scope.

Any significant event occurring at a CEA facility must be notified to ASN. These events are analysed to identify the root causes and to define any corrective and preventive action to be taken to avoid any recurrence. A significant event report must be prepared and sent to ASN within two months.

In 1999, the CEA has set up a Central Experience Database (*Fichier central de l'expérience*), which provides all parties concerned with information on events, together with an event analysis guide, designed to harmonise the drafting of significant event reports, to improve their evaluation and to codify results.

By drawing on those event reports, the CEA is able to gather invaluable lessons for improving safety at its facilities, identifying generic safety-related weaknesses, defining targeted improvement areas and ensuring the broadest possible dissemination of such information.

6.2.2. AREVA's operational safety practices

Operations comply with the facility's baseline requirements described in § G.2.2.2. During the periodic safety reviews, a plan to check the conformity of operating practices is drawn up and implemented. It takes account of the permanent or temporary operating instructions, the main operating procedures, the main maintenance procedures and the operating instructions in degraded situation. Particular attention is given to ergonomics and to the availability of documentation at the workstations as well as consideration of changes to the operating rules and the organisation. The licensee's processes concerning deviation management, change management and documentary modifications and management, which take part in keeping the baseline requirements up to date, are described and analysed. Their effectiveness is also justified.

Outside these review periods, support for the operators and a regular check on the application of or familiarity with any new procedure by the management and/or head of the facility are essential in order to manage particular workplace situations. This support is also important on decommissioning worksites, in which the environment and working conditions are constantly changing, as equipment dismantling progresses. Risk management is frequently based partly on operating rules, which must minimise the potential risk of human error. It is then important that the understanding and justification of the operating constraints be perceived to be commensurate with the issues and stakes by those responsible for implementing them. Training, competence assessment and information measures are taken at all hierarchical levels.

6.2.3. EDF's operational safety practices

Licences are issued to EDF in accordance with the procedures described in Chapter E.2. Operation is conducted in accordance with general and specific regulations, as described in § G.2.2.2. The quality and sustainability of technological and engineering support means are guaranteed by the quality dispositions described in § F.3.2.4 and by the human and physical resources described in § F.2.2.4. With regard to decommissioning, practices are described in § F.6.2.3.

6.2.4. ILL operational safety practices

The HFR safety baseline requirements are defined in the commissioning authorisation application and updated in the event of modifications or during the periodic safety reviews. These baseline requirements define the operating range authorised by ASN.

These baseline safety requirements are supplemented by a range of procedures and operating methods drafted by the licensees, generally by the operators; their purpose is to allow performance of operations in the field consistently with the baseline safety requirements and their operating range.

ASN is notified in real time of any incidents which have occurred. These incidents are then analysed in order to identify their underlying causes and define the corrective and preventive measures to be taken to prevent them from happening again. The incident report is produced and transmitted to ASN within 2 months.

Based on an analysis of the incident reports, ILL learns the lessons of use for improving the safety of its facilities, identifies generic safety weaknesses, defines targeted areas for progress and ensures the broadest possible dissemination.

6.3. ASN analysis

ASN is tasked with contributing to the preparation of the general regulations for BNIs and thus for spent fuel management facilities, the operation of which is presented in E.2.2.4. ASN also checks compliance with the rules and prescriptions applicable to these facilities, notably during the file reviews or performance of inspections on the sites.

Article 20 of the decree of 2nd November 2007 requires ASN authorisation for commissioning of a BNI. The file to be transmitted to ASN by the licensee notably comprises a summary report on the facility commissioning tests and a summary of the acquired operating experience with regard to protection of the interests.

The regulations also require that by means of its reviews and inspections, ASN ensures that the operating limits and conditions resulting from tests and operating experience are clearly defined and revised if necessary and that the licensee's activities are carried out in accordance with the established procedures.

In addition, title II of the order of 7th February 2012 prescribes requirements to be met by the licensee in terms of organisation and responsibility. Article 2.1.1 states that the licensee must have adequate technical capability to manage its activities, either in-house or through agreements with third parties. It must thus receive safety-related engineering and technology support for the duration of the operation of its BNI. Article 2.4.1 requires that the licensee's integrated management system must notably include provisions enabling the licensee:

- to identify and process deviations and significant events which, pursuant to article 2.6.4, must be reported to ASN as rapidly as possible;
- to collate and capitalise on experience feedback;
- to define appropriate effectiveness and performance indicators with regard to the targeted objectives.

As mentioned in section F.3.3, the TECV Act also introduces the possibility of managing or limiting the use of contractors or subcontractors for the performance of certain AIP. Thus, article 63-2 of the "BNI Procedures" decree of 2nd November 2007, amended by the decree of 28th June 2016, states that when the licensee entrusts the performance of services or work important for the protection of interests to an outside contractor, within the perimeter of its facility either in operation or undergoing decommissioning, they may be performed by subcontractors of no more than tier two. The TECV Act also makes it possible to manage and monitor the performance of AIP outside the perimeter of a BNI.

With regard to decommissioning, article 8 of the “BNI Procedures” decree of 2nd November 2007 requires that as of its creation authorisation application, the licensee must present a decommissioning plan containing the methodological principles and the steps envisaged in the decommissioning of the facility and the remediation and subsequent surveillance and monitoring of the site. This approach helps to ensure that the decommissioning of the facilities is taken into consideration as of the design stage and that it is taken into account in the operating conditions.

This decommissioning plan, which must be updated at submission of the commissioning authorisation application (article 20), is reviewed periodically and must be supplemented and detailed on the occasion of the decommissioning authorisation application (see § F.6.1.3).

7 | FINAL 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.

Spent fuels are not at present intended for direct final disposal, except for a few experimental spent fuels. Spent fuels are either reprocessed (UOX), or stored pending deployment of a fleet of generation IV fast neutron reactors (MOX and URE).

For UOX reprocessing and in accordance with the plutonium traffic balancing principle applied by EDF, the annual reprocessing flow is calculated so as to obtain no more than the precise quantity of plutonium necessary for fabrication of the MOX fuel.

If these fuels were to be reclassified as waste at some time in the future, they would need to be accepted in the CIGEO project deep disposal facility.

On 31st May 2016, ASN issued an opinion on the notion of reversibility of the deep geological disposal facility, entailing adaptability and recoverability requirements. These two notions are present in the 25th July 2016 Act which supplements article L. 542-10-1 of the Environment Code, for definition of the notion of reversibility.

The adaptability requirement implies that the facility must take account of possible changes to energy policy or industrial choices, for example leading to direct disposal of spent fuels. The PNGMDR 2016-2018 requires that in 2017 ANDRA must propose the types and quantities of waste to be included in the CIGEO reserve inventory.

In its opinion of 10th February 2015 concerning the evaluation of the cost of the CIGEO project, ASN estimated that the adaptability inventory should be used by ANDRA as an input data for its cost calculations. On this subject, the PNGMDR 2016-2018 recommends that before 30th June 2018, ANDRA must send the Minister responsible for energy a cost evaluation for the direct disposal of spent fuels from the operation of NPP reactors or experimental reactors.

SECTION H | SAFETY OF RADIOACTIVE WASTE MANAGEMENT (ART. 11 TO 17)

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

i. ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;

ii. ensure that the generation of radioactive waste is kept to the minimum practicable;

iii. take into account interdependencies among the different steps in radioactive waste 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 radioactive waste management;

vi. strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current practices;

vii. aim to avoid imposing undue burdens on future generations.

1 | GENERAL SAFETY REQUIREMENTS (ARTICLE 11)

1.1. ASN requirements

A BNI (basic nuclear installation) that produces or manages waste is subject to the BNI system and to the provisions of chapters III, V, VI of title IX of book V and to the provisions of chapter II of title IV of book V of the Environment Code, of the Decree of 2nd November 2007 and the order of 7th February 2012. The Environment Code and the Decree of 2nd November 2007 were recently modified by the TECV Act of 17th August 2015, by the Ordinance of 10th February 2016 and by the Decree of 28th June 2016 (see § E.2.2 and G.1.1).

Articles 1.2, 3.4 and 6.1 of the order of 7th February 2012 stipulate respectively that:

- "*the licensee must ensure a level of risks and adverse effects mentioned in article L. 593-1 of the Environment code that is as low as possible under economically acceptable conditions for its activities of design, construction, operation, final shutdown and decommissioning, maintenance and monitoring of its basic nuclear installations, given the state of knowledge, practices and environmental vulnerability*";
- "*the control of nuclear chain reactions, the removal of thermal power, the containment of radioactive substances, the protection of persons and the environment against ionising radiation must be taken into account in the safety case*";
- "*the licensee shall take all necessary measures from the design stage to prevent and reduce, particularly at source, the production and the harmfulness of the waste produced in its installation*".

With regard to radioactive waste, article 542-1 of the Environment Code stipulates that:

- *"the sustainable management of radioactive material and waste of any kind (…) it ensured in such a way as to protect individual health, safety and the environment";*
- "*the search for and the deployment of the means necessary for the definitive safeguarding of radioactive waste are undertaken in order to prevent or limit the costs that will be borne by the future generations*".

To this end, article L. 542-1-2 of the Environment Code stipulates that a National Plan for the Management of Radioactive Material and Waste (PNGMDR) shall be drawn up, defining the "*general objectives, the main time frames and the calendars for meeting these time frames while taking into account the priorities it defines*".

This same article stipulates that *"the reduction in the quantity and harmfulness of the radioactive waste is sought in particular by reprocessing the spent fuels and processing and packaging the radioactive waste;*

The decree of 2nd November 2007 amended and the order of 7th February 2012 also specify requirements in this area:

- article 8 of the decree of 2nd November 2007 amended, stipulates that the file submitted by the licensee when filing a BNI creation application must include an impact study of which the scope, detailed in article 9 of the abovementioned decree, comprises:
    - proof of the compatibility of the installation "*with the radioactive waste intended to be produced by the installation, or stored or disposed of in it with the National Plan for the Management of Radioactive Material and Waste (PNGMDR)",*
    - "*the solutions adopted to avoid, reduce or, when possible, compensate for the impact of the installation's water intakes and emissions, the volume and the radiological, chemical and biological toxicity of the waste produced and optimise the management of the installation's waste and emissions by promoting their recycling and processing"*,
- article 20 of the decree of 2nd November 2007 stipulates that any BNI licensee shall, when making the installation commissioning application, provide "*a waste management study for the installation setting out the licensee's targets for limiting the volume and radiological, chemical and biological toxicity of the waste produced in its installations and to reduce, by the recycling and processing of the said waste, the final disposal volumes reserved for ultimate waste"*;
- articles 37 and 37-1 of the decree of 2nd November 2007 also stipulate that, as part of the BNI final shutdown and decommissioning procedures, the waste management plan shall be updated and supplemented;
- pursuant to article 6.8 of the order of 7th February 2012, licensees shall ascertain, when packaging "*their waste […], that the waste packages produced are compatible with the planned conditions for their subsequent management"*. In this way the licensees take into account the links of interdependency that exist between the different stages in the management of radioactive waste.

The obligations of licensees of BNIs or future BNIs with regard to the control of safety for the management of radioactive waste are thus defined by acts, decrees and ministerial orders, as well as by resolutions and prescriptions issued by ASN (see section E).

ASN has thus published resolutions concerning:

- in 2013: control of detrimental effects and the impact of BNIs on health and the environment,
- in 2015:
    - the content of the safety analysis report,
    - the waste management study and the assessment of the waste produced in the BNIs,
- in 2016: modifications to the resolution of 2013 on the control of detrimental effects and the impact of BNIs on health and the environment.

In 2017, ASN will finalise its resolution relative to the packaging of radioactive waste and the conditions of acceptance of the radioactive waste packages in the disposal BNIs.

Complementing this, the ASN guides (see § E.2.2.5.2) define safety objectives and describe practices that ASN considers suitable for achieving them.

In 2016, ASN published a guide to the establishing and modification of the installations waste zoning plan (No. 23) to detail the conditions of application of it resolution of 2015 on the management of waste and the assessment of the waste produced in the BNIs.

1.2. Steps taken by BNI operators

1.2.1. Steps taken by waste producers CEA, AREVA, EDF and ILL

Waste-management activities in BNIs must include the following major phases:

- “waste zoning” (see § B.5.2.1);
- collection;
- sorting;
- characterisation;
- treatment and conditioning;

- storage;
- shipment.

Collection and sorting constitute sensitive phases in waste-management activities in BNIs.

Waste is collected selectively, either directly during normal operations or by staff on worksites.

The waste is sorted according to its nature (physico-chemical state) and dose equivalent rate.

Once sorted, the waste must be characterised qualitatively and quantitatively with regard to mass, physico-chemical properties and composition, potential radioactive content, etc. Such characterisation must be consistent with existing regulations and technical specifications, notably concerning treatment, conditioning, elimination or recovery processes.

In the framework of elimination or recovery systems, waste may only be shipped to industrial facilities that are licensed to receive such waste. The purpose is to ship those residues through those systems as soon as possible in order to minimise interim storage on production sites. The transport of radioactive waste is carried out in accordance with regulations in force.

Traceability of waste-management steps is guaranteed, from their origin (waste zoning) up to their elimination or recovery site.

Lastly, the management of each waste category must be described and analysed in the “waste management studies” to be conducted by each production site in order to seek improvement and optimisation venues and to establish a reference system.

All “waste management studies” prepared by the CEA, AREVA, EDF and ILL are updated on a regular basis and transmitted to ASN.

On the basis of that reference system, every operator must prepare an annual management report of his waste, according to a specified format described in an ASN decision, and send it to ASN and to all competent territorial authorities. All information contained in that report must be accessible to the public, unless protected by trade or defence secret.

For each of their sites, EDF, AREVA, ILL and the CEA prepare, pursuant to article L.125-15 of the Environment Code, annual reports describing the steps that were taken with regard to safety and radiation protection, events, measured discharges into the environment, as well as stored waste in their BNIs.

1.2.2. Waste disposal process towards CENTRACO and ANDRA

The constitution and follow-up of radioactive-waste shipment programmes are drawn up after consultation between all entities concerned and notification of the carriers, with due regard to the different disposal systems available: fusion and incineration at CENTRACO, disposal at the CSA and the CIRES. The quality of those shipments must be monitored.

1.2.3. Steps taken by ANDRA

ANDRA’s radiation-protection goals are described in § F.4.2.1.1.

With regard to risks associated with the potential chemical toxicity of the waste and in accordance with RFS III.2.e and the ASN safety guide dedicated to the definitive disposal of radioactive waste in deep geological formations, ANDRA requires producers to quantify the amount of radionuclides that are present in the waste and are subject to the regulations for hazardous waste or for water quality. Those radionuclides are submitted to impact assessments of the disposal facilities involved. Specific actions are also undertaken to reduce their quantities in delivered packages, especially in the case of lead.

Reducing the volume of delivered waste is a common objective for all waste producers and ANDRA. It reduces the footprint requirements of the disposal facility. It is achieved chiefly through efficient packaging processes (compacting, incineration) and through a strict control of the materials brought into the controlled areas of the facilities. Figure 8 shows the evolution of deliveries of LIL-SL packages since 1969.

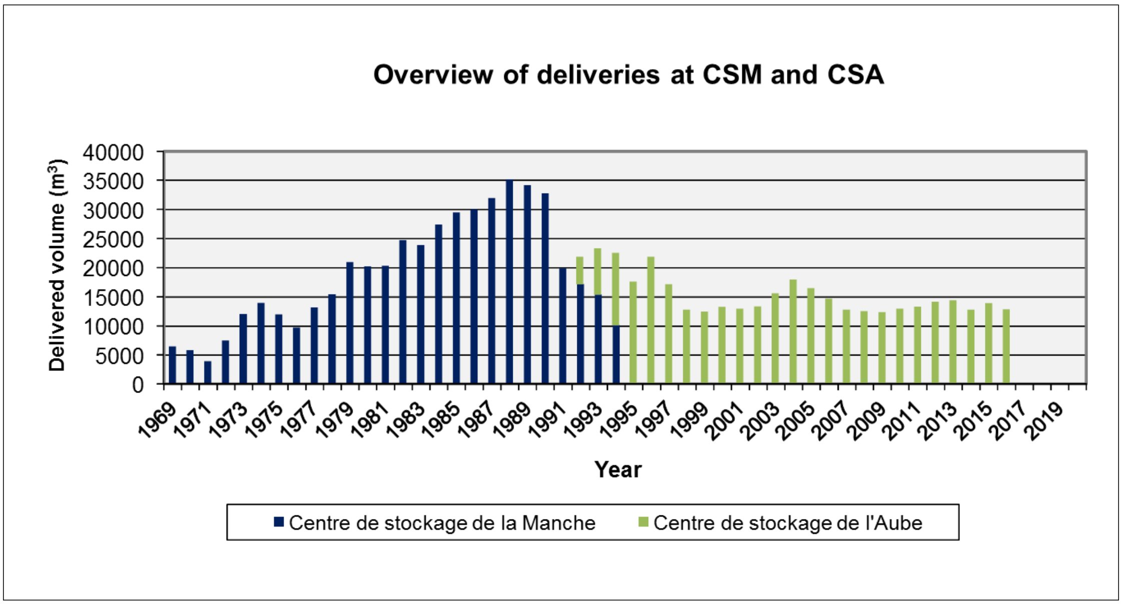

FIGURE 13: DELIVERED VOLUMES OF LIL-SL-WASTE PACKAGES SINCE 1969

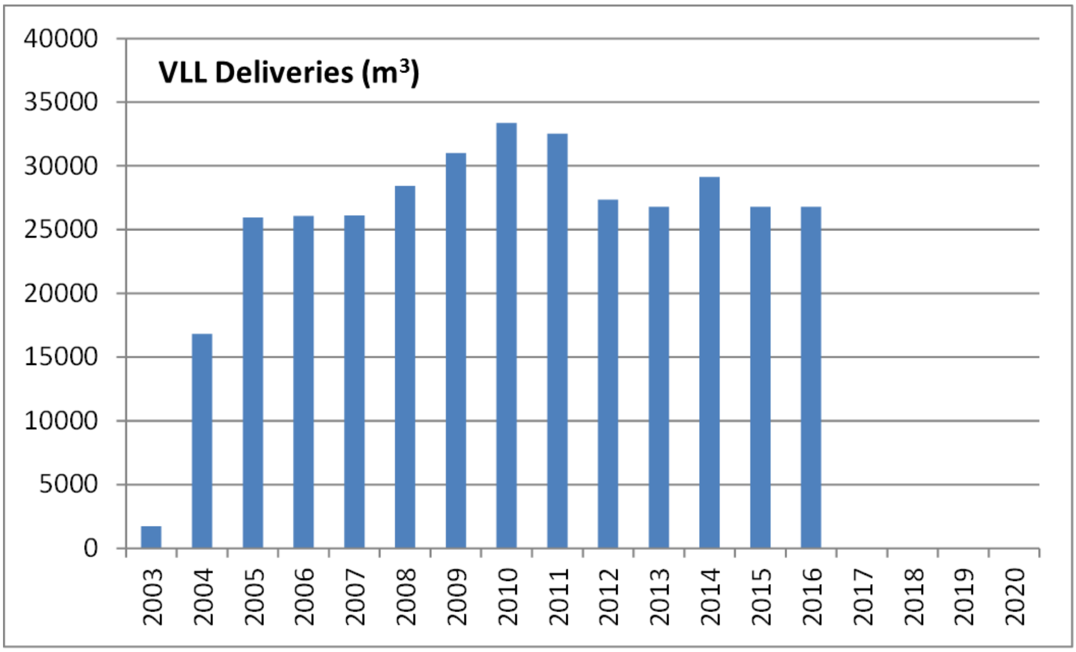

FIGURE 14: DELIVERED VOLUMES OF VLL--WASTE PACKAGES

The short, medium and long-term safety management of waste disposal facilities requires control of the quality of the waste packages they accept. This quality is described in specifications which set the conditions to be met by the waste and the waste packages in order to be admitted in such facilities. These specifications constitute a reference system for nuclear operators producing waste packages. More specifically, they concern the prevention of radiological, chemical, fire and criticality hazards. During the operation of the facility, an acceptance process called the “certification process” run by ANDRA is applied for each waste-package type proposed by the producer, in order to guarantee that it complies with ANDRA specifications.

That approach is now used at the CIRES.

In the case of HL-IL/LL waste for which investigations are under way for their deep geological disposal, packages were designed in accordance with the safety guide dedicated to the disposal of radioactive waste in deep geological formations. In accordance with the Waste Act of 28 June 2006, ANDRA is also responsible for providing its opinion to administrative authorities on new conditioning projects.

As regards the planned shallow disposal facility for radium-bearing, graphite and other LL-LL waste awaiting conditioning, ANDRA is not only investigating the most appropriate packaging means with nuclear operators who own radioactive waste, but also developing disposal concepts in parallel.

1.3. ASN's analysis for BNIs

ASN controls the steps taken by operators in order to comply with regulatory requirements (see section E and chapters H.2 to H.7). This control concerns all their obligations concerning the protection of interests mentioned in Article L.593-1 of the Environment Code. Pursuant to Article 1.2 of the Order of 7th February 2012, this control covers operators' activities related to all steps in the life of the facilities (design, construction, commissioning, operation, final shutdown and decommissioning, maintenance and monitoring for disposal facilities). It applies to the existing and planned facilities as well as to waste packaging modes:

- ASN reviews from a technical standpoint all cases and supporting documents submitted by operators, notably in accordance with the "BNI Procedures" Decree of 2nd November 2007 (creation authorisation application file, final shutdown and decommissioning file, closure and monitoring, modifications, periodic safety review files, etc.);
- ASN carries out inspections on the operator's sites and services. This includes inspections at ANDRA to ensure correct implementation of approval issue processes for packages which are to be delivered to its disposal centres.

This control entails prescriptions, follow-up letters, additional assessments, administrative and penal sanctions (see E.2).

ASN also examines reports, studies and proposals made by the licensees in order to meet the requirements of the decrees establishing the prescriptions of the PNGMDR, issued pursuant to Article L. 542-1-2 of the Environment Code. At the beginning of 2016, ASN issued 7 opinions on the studies submitted in application of the PNGMDR 2013-2015, in view of preparation of the PNGMDR 2016-2018, on the management of VLL, LLW-LL, HLW/ILW-LL waste, the former mines, the legacy situations, waste necessitating specific work and the reusable nature of radioactive materials.

ASN can also propose recommendations to the Government. In 2015 it thus published an opinion relative to the cost of the implementation of long-term management solutions for high-level and intermediate-level long-lived radioactive waste. This subject was subsequently taken up in the order of 15 January 2016 on the cost of the CIGÉO project. Likewise, ASN made a statement on the reversibility of deep geological disposal of radioactive waste in its opinion of 31st May 2016, a subject which was addressed by the act of 25th July 2016 supplementing article L. 542-10-1 of the Environment Code on the subject.

In addition to this, ASN considers it important to examine the overall policy and strategy of each of the major nuclear licensees for the management of radioactive waste and decommissioning (see § F.6.3.1 and G.1.3 concerning the licensees' decommissioning policy and strategy and the overall coherence of the cycle). EDF, CEA and AREVA NC are thus asked periodically to produce a file setting out their policy and strategy so that ASN can:

- have an overall and forward-looking view of their strategy that goes beyond 10 years;
- check the coherence of these strategies and the degree to which the licensees anticipate the necessary actions to implement them under optimum conditions.

A revision of EDF's file on its waste management policy was transmitted to ASN which examined it in 2014. The file was then examined by the Advisory Committees of Experts in 2015. This file was examined at the same time as that concerning EDF's decommissioning strategy (see § F.6.3.1.3). In 2015, ASN also asked EDF for an overall revision of the "Cycle impact" file to be carried out for 2016 in order to present the way in which the changes in fuels or the management of irradiated fuels will be taken into account in the next fifteen years for, among other things, the medium and long-term management of waste (G.1.3).

With regard to the AREVA group, the waste management strategy of the La Hague site was examined by the Advisory Committee of Experts brought together by ASN in 2005. In 2006, ASN made a position statement on this strategy by letter. The waste management strategy over the perimeter of the AREVA NC SBNI at Tricastin was also examined in 2012 by the safety commission for laboratories, plants and waste brought together by ASN. In December 2012, ASND informed AREVA NC of its position concerning this strategy. In June 2014, ASN and ASND asked AREVA to send them its national strategy concerning waste management and decommissioning. The file was received in June 2016 and is currently being examined.

Concerning CEA, the strategy review has been held and the Advisory Committee issued its opinion in February 2012 It deals mostly with the CEA's structure to ensure the sound management of all waste being generated by those facilities (including historical waste) and the existence of suitable means to achieve that goal: new waste-processing or storage facility projects, renovation of existing facilities, development of conditioning processes and development of transport packages. Progress with respect to the previous review in 1999 was noted. Nevertheless, very significant increases in the projected duration of decommissioning operations and the quantity, non-standard nature and difficulty in characterising certain substances or waste that will be produced by these operations have led ASN and ASND to jointly ask for an overall review in 2016 of the decommissioning and waste management strategies for the next 15 years. This report was received in December 2016 and is currently being examined.

Lastly, in the context of decree 2007-243 of 23rd February 2007, ASN gives the DGEC its opinion on the three-yearly reports and annual updating notes on the long-term financing of nuclear expenses submitted by the licensees (see B.1.7 and F.2.3.2).

1.4. Case of ICPE Facilities and Mining Waste

As has already been mentioned in this report, radioactive waste from ICPE facilities is managed in the same routes as that from BNIs. Management safety is therefore identical.

In France, the last uranium mine closed down in 2001. Hence, the mining industry no longer produces new waste, but the public and the environment must continue to be protected from historical waste, particularly in the case of mine and ore-processing disposal sites, which are classified as ICPEs. With regard to mine tailings, the 22 July 2009 Circular requires explicitly the operator to draw an inventory of all mine tailings that have been reused in the public field. Following that inventory, the operator must also verify that the proposed uses of the soil are acceptable on environmental and hygienic grounds. In case of incompatibility, remediation actions will need to be implemented in connection with public authorities. In the event of any incompatibility, remediation measures will be taken together with the public authorities. The Ministry for Ecology issued an instruction under signature of the Prefects on 8 August 2013, with regard to its services in the DREAL, in order to manage this operation. This instruction manages the process of inventorying and removing the waste rock reused in the public domain. It more specifically clarifies the conditions for information of the public concerning the results of the inventory, defines the methodology for performance of the work and specifies the memory conservation process. This action is overseen by the administrative authority (Prefect) with the support of the regional directorates for the environment, land-planning and housing (DREAL) in collaboration with ASN and the local regional health agencies (ARS).

1.5. Case of industrial activities outside the nuclear field, research activities and medical activities

The case of industrial activities outside the nuclear field, of research activities and of medical activities, is dealt with in B.6.2.

2 | EXISTING FACILITIES AND PAST PRACTICES (ARTICLE 12)

Each Contracting Party shall in due course take the appropriate steps to review:

i) the safety of any radioactive waste management existing at the time the Convention enters in to 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.

2.1. Requirements from regulatory authorities

A periodic safety review of BNIs is undergone at least every 10 years (see § E.2.2.3.1).

If necessary, ASN requires the operator to take all appropriate measures to improve safety. That is normally the case for certain old storage facilities. COGEMA (now AREVA NC), the CEA and EDF used to store radioactive waste on certain sites (e.g., La Hague, Saclay, Marcoule, Cadarache, Saint-Laurent-des-Eaux) according to the regulations and state-of-the-art techniques of the time. The absence or obsolescence of conditioning of the stored waste and the original expected lifetime of those storage facilities, associated with the increase in safety requirements since then, now require that safety-improvement actions be implemented. In these conditions this legacy waste generally has to be retrieved and packaged so that it can be taken away either to existing disposal facilities or to storage facilities with a satisfactory level of safety.

In this respect, according to Article L. 542-1-3 of the Environment Code, the owners of intermediate level, long-lived waste produced before 2015 must package it no later than 2030.

In its resolution 2014-DC-0472 of 9th December 2014, ASN prescribed provisions concerning AREVA NC's legacy waste retrieval and packaging (RCD) operations on its La Hague site. This resolution sets some sixty milestones governing the RCD operations for the projects concerned. ASN also conducted an in-depth inspection of the RCD projects in October 2016, focusing on the licensee's organisation and the progress of the top priority projects. ASN noted a number of points hindering the progress of the operations.

In some cases, the time frames of the RCD operations and the level of safety of storage are such that ASN is obliged to demand that the safety of the installation be reinforced (as was the case for the Saint-Laurent silos, for example).

Moreover, AREVA NC, CEA and EDF, within the framework of the PNGMDR 2013-2015, have continued investigations relative to the search for legacy disposal sites containing radioactive waste. This concerns more specifically:

- thirteen conventional waste disposal facilities which received VLL waste from conventional or nuclear industries;
- waste in disposal sites near BNIs, SBNIs or SIENIDs (experimental nuclear installations concerning defence);
- waste depots with high natural radioactivity which are not subject to the regulations of classified installations.

The PNGMDR 2016-2018 asks for these investigations to be completed.

2.2. Steps taken by BNI operators

2.2.1. Steps taken by ANDRA

The CSM was in service from 1969 to 1994. During that period, both regulations and safety principles evolved. The first editions of RFS I.2 and III.2.e date back to 1982 and 1985, respectively. ANDRA concentrated its efforts on adapting its operating methods to the changes in the regulations. For past practices, which no longer comply with current regulations, ANDRA checks that they are still compatible with the safety objectives. The measures regarding the CSM are described in § D.3.2.2.1 and H.7.

2.2.2. Steps taken by CEA

Historical waste includes all residues resulting from various former practices at a time when current technological solutions were not available. It is often similar to current waste but, given the diversity of storage solutions and changes in waste-management conditions and processes, it raises specific problems relating to recovery, characterisation and treatment.

The waste involved includes mainly the following:

- liquid aqueous and organic waste, contained in tanks, carboys or drums;
- solid waste placed generally in drums, which are stored in pits, cells or ditches;
- solid waste buried in open ground under various forms (in bulk wrapped in vinyl, in metal drums or concrete casks).

CEA's objective is to retrieve and package this waste with appropriate treatment so that it can be sent to existing routes or routes currently being created.

In this approach, among that waste, priority is given to the recovery of liquid organic and aqueous waste; in 10 years' time, the percentage of recovered old organic effluents that used to be stored on sites is above 80%.

CEA is also continuing with the reduction of the source term of its facilities resulting from solid waste. After sorting, this waste is either sent to the ANDRA CSA or CIRES, or stored in the centres, pending ANDRA's definition of the ILW-LL and LLW-LL disposal packages. The αcontaminated waste is packaged in cement-encapsulated packages for storage in BNI 164 (CEDRA). The highly radioactive waste should, as of mid-2019, be stored in a future dedicated facility in the Marcoule centre (DIADEM). When ANDRA has defined the acceptance specifications for the ILW-LL and LLW-LL packages, CEA will build specific packaging units for the primary packages of LLW-LL waste and, to a lesser extent, ILW-LL primary packages, for direct packaging in disposal containers and shipment to the future disposal centres.

It should be noted that, in the framework of the denuclearisation of the Grenoble Centre, all historical waste being stored on site were characterised, recovered and evacuated. The recovery programme for such waste is continuing on the other CEA sites, especially at Fontenay-aux-Roses and Marcoule (UP1 Plant), and at Saclay and Cadarache as well. The objective is, once the waste is sorted, to direct it either towards ANDRA.

2.2.3. Steps taken by AREVA: recovery of La Hague's historical waste

Part of the waste resulting from the operation of the UP2-400 Plant is stored at La Hague pending the commissioning of compatible final-storage facilities with their radiological and physico-chemical characteristics. Those residues are the topic of a recovery and reconditioning programme (*Programme de reprise et reconditionnement* – RCD) with a view for subsequent evacuation. The project management of MAD/DEM and RCD operations is carried out by the DM2D project management department, which delegates operational management to the Decommissioning and Services (D&S) business unit. The large developments for the recovery of old waste are managed by DM2D through the Direction des Grands Projets (DGP).

The waste generated by the UP2-400 plant will be processed and conditioned either in existing facilities (UP2-800/UP3), which are already in service, or in new facilities to be built.

Almost all fission products have already been vitrified. The vitrification of solutions with high molybdenum concentrations, which are not compatible with the current vitrification solution in hot crucible (corrosion aspect), has been initiated early 2013 thanks to the new vitrification process in cold crucibles (see B.6.1.3).

Recovery of technological waste contaminated with α radiation, which had been stored in steel drums and placed in Building 119 has been completed in 2015. These historical waste resulting from the UP2-400 Plant have been transferred to the UCD in order to be processed mechanically (sorting and conditioning) and chemically (decontamination by leaching), then to AD2 to be conditioned into cemented packages. More recent waste originating from the AREVA NC MÉLOX plant or the ATPu facility at Cadarache have been transferred to the STE3 Workshop pending their processing.

The sludge, which have been stored in the STE2 Workshop should be recovered starting in 2020 in order to be treated through a new process under study as a substitute for bitumisation, as originally planned.

During their recovery, all waste contained in the HAO silo will be sorted in a new cell under construction, whereas structural waste (hulls and end-pieces) will be transferred to the ACC Workshop for compacting purposes; technological waste (aluminium covers) will be sheared and stored in cursors within the SOC pools before being conditioned in CBF-K fibrous packages; the filler fines and resins will be recovered and transferred in a new cementation cell beside the recovery cell in order to be cemented into drums. The cursors that are stored in pools of the SOC will be transferred to the HAO silo's sorting and recovery cell, where they will be emptied, while the hulls and end-pieces they contain will undergo the same treatment as the structural waste of the HAO silo, whereas technological waste (empty cursors, covers, etc.) will be conditioned in CBF-K packages, after shearing and decontamination, if need be.

GCR waste from silos 115, the SOD and silo 130 will start in 2018 in a facility under construction.

It will be temporarily stored in DE/EDS.

2.2.4. Steps taken by EDF

2.2.4.1. WASTE CONDITIONING AND DISPOSAL ON EDF OPERATING SITES

Each nuclear power plant (NPP) has premises allowing the management of different types of waste:

- the LLW/ILW-SL waste intended for the CSA repository is stored in premises designed for this purpose (the NPP BAC/BTE buildings);
- the VLL waste to be disposed of in CIRES is stored in dedicated regulated areas for the storage of very low level waste (VLL areas) pending removal.

The EDF NPPs can be obliged to store certain types of waste, packaged or not, in their facilities pending the development of a suitable processing route.
This situation has evolved positively thanks in particular to the commissioning of the SOCODEI's CENTRACO plant (see § B.6.1.1), the CIRES managed by ANDRA and the policy of on-line removal and just-in-time management of waste adopted by EDF.

Various ongoing actions have ended up in concrete results, such as:

- the reduction in the quantities of concrete casks and drums present in BACs and BTEs, by optimising the entire "shipping" process, with due account of the need for prompt disposal at the CSA;
- the decrease in the quantity of non-conforming packages that may delay their shipment;
- the development of a metal container type package appropriate for repackaging certain non-conforming concrete hulls;
- the reduction at the production source (ion-exchange resins, water filters, technological waste);
- the optimisation of treatment or disposal options by broader sorting (VLL/low-level, compactable, incinerable/non-incinerable waste, etc.);
- the incineration of larger volumes of evaporation concentrates;
- "waste zoning".

Those actions are ongoing and are consistent with the application on sites of the operating rules for the management of radioactive waste in their facilities.

2.2.4.2. WASTE CONDITIONING AND EVACUATION ON EDF DECOMMISSIONING SITES

All waste resulting from decommissioning operations is managed as any other operating waste from NPPs in service. They are characterised, sorted and conditioned before being shipped towards compatible storage facilities in service or towards CENTRACO's fusion and incineration facilities.

IL/LL waste will be stored pending the availability of the deep geological repository prescribe by the Waste *Act*.

According to current studies, the ongoing deconstruction of 10 BNIs, including nine Generation-1 reactors and the graphite-sleeve storage facility at Saint-Laurent-des-Eaux will generate a total of approximately 1 million tonnes of waste, of which the radioactive share represents about 20% (by weight) as follows:

- 800,000 t of "conventional" waste, containing no radioactive element and most of which consisting of concrete and cleaned-up rubble to be used to fill holes left by the deconstructed facilities on the site;
- 250,000 t of mostly SL radioactive waste, intended for permanent storage after packaging, and for which the procedures exist or remain to be created.

Those radioactive residues are divided as follows:

- VLL waste includes concrete, rubble and earth; it represents about 118,000 t and will be disposed eventually at the CIRES.
- LIL-SL waste consists mostly of equipment that was used to contain or to transport radioactive fluids (pipes, valves, tanks, etc.) and represents about 53,000 t. ANDRA's CSA is a safe and permanent disposal solution for this type of waste.
- IL-LL waste is made up of metal parts that became radioactive under the action of neutrons from the reactor core (about 120 t). While waiting for solutions proposed by the Waste Act to come into operation (deep geological repositories being the benchmark solution, for commissioning by 2030), EDF must package IL-LL waste and set up a temporary storage solution. Such is the purpose of the ICEDA Project at the Bugey NPP, Ain département, before transferring the waste to ANDRA's deep geological repository prescribed by the Waste Act, when available.
- LL-LL radioactive waste from GGRs (around 17,000 t), for which the Waste Act provides for the commissioning of a waste repository. These are, on the one hand, graphite sleeves which are currently stored and, on the other hand, graphite structures, in particular stacks, which are still in place in the former UNGG reactors.

The sodium from the Creys-Malville NPP (around 5,900 t of sodium from the reactor vessel and the non-radioactive secondary systems) will be converted into sodium hydroxide, via an industrial process developed by the CEA, then safely packaged by placing it in concrete blocks. Those VLL radioactive concrete blocks (about 67,000 t) will then be stored on site for about 30 years, during which their radioactivity level will decrease close to that of natural radioactivity.

2.3. ASN analysis on BNIs

2.3.1. Existing facilities

As mentioned above, the existing facilities undergo periodic safety reviews. In accordance with Article L. 593-19, after each review, the licensee sends ASN a report comprising the conclusions and, as necessary, the steps it envisages taking to remedy the anomalies found and to improve the safety of its facility. ASN sends the Minister responsible for nuclear safety its opinion on this report and issues a position statement concerning continued operation. It sends the licensee special requests with a schedule for the expected answers. New prescriptions to be implemented by the licensee may be set. ASN also conducts inspections which are followed up by a letter to the licensee concerned. In 2017, all BNIs operating for at least 10 years are to submit a review report. This is the first such report for most off-reactor installations.

2.3.2. Legacy waste

Most of the waste produced to date is packaged. However, some waste, known as legacy waste, is not packaged or is inadequately packaged (deterioration of the containers for instance) and is incompatible with the subsequent management procedures as required in Article 6.7 of the BNI Order of 7th February 2012.

Although progress has been observed in the retrieval of legacy waste, ASN had to ask the licensees to step up their efforts to meet the deadlines necessary to ensure the safety of the legacy waste storage sites and achieve the 2030 goal set by Article L. 542-1-3 of the Environment Code for the end of packaging operations for ILW-LL waste produced before 2015.

The following significant examples are detailed below:

- graphite sleeves stored by EDF (Saint-Laurent-des-eaux);
- sludge resulting from the processing of UP2-400 effluents at La Hague (AREVA NC, La Hague);
- tritiated waste (CEA and others);
- waste from BNI-56 (CEA Cadarache);
- waste from BNI-72 and BNI-35 (CEA Saclay).

2.3.2.1. GRAPHITE SLEEVES STORED BY EDF

This is fuel structure waste from the old gas-cooled reactor (GCR) series. Its long-term management is being studied by EDF and by ANDRA under the LLW-LL type waste disposal project (see section B). In the meantime, this waste is stored, mainly in the Saint-Laurent-des-Eaux silos. The tonnage is about 2,000 t (as compared with the 970 t stored at La Hague and the 760 t stored in Marcoule). The Saint-Laurent-des-Eaux silos consist of two semi-buried reinforced concrete bunkers, with a steel lining. They were filled in 1994.

Given the delay in the graphite waste disposal project and in response to ASN's request for improved safety concerning the Saint-Laurent silos, EDF presented a solution in July 2007 consisting in installing a containment barrier around them. Following examination by ASN, additional requests and then approval, work to install a geotechnical containment acting as a barrier was carried out in 2010. The licensee sent the periodic safety review file in early 2010 and the examination of this file more specifically concerned the data concerning this containment and the associated equipment. ASN then informed EDF that the use of the facility thus reinforced and monitored (under surveillance since 1994) as a storage centre could continue provided that EDF met the undertakings it made at the examination of the periodic review file.

Operation of the site used for storage is limited to monitoring and maintenance measures. In 2015, ASN finished examining the commitments made by EDF in the context of the periodic safety review of the installation which ended in 2014 and is waiting for additional studies requested on completion of the examination. The stress tests file is currently being examined.

In the context of its new decommissioning strategy for the gas-cooled reactors (GCR), EDF has announced its decision to start removing the graphite from the silos without waiting for the graphite waste disposal route to become available.

2.3.2.2. SLUDGES RESULTING FROM TREATMENT OF UP2-400 EFFLUENTS IN LA HAGUE

From 1966 to the end of the 1990s, the effluents from the UP2-400 plant were treated in the STE2 facility by chemical co-precipitation. The sludge resulting from this process (a volume of 9,300 m^3 representing about 3,400 t of salts) were stored in buried silos as and when they were produced.

The main risk consists in the dissemination of radioactive substances due to the single containment barrier formed by the silo walls, whose current state is not well known and whose evolution over time is not easily foreseeable.

Over the last few years, the operator has set and tested the sludge-recovery and transfer modalities as a prerequisite for any processing and conditioning.

The scenario presented in 2010 for the retrieval and packaging of sludge from the STE2 plant comprises three steps:

- retrieval of the sludge stored in silos in STE2 (BNI 38);
- transfer and processing by drying and compacting in STE3 plant (BNI 118);
- packaging of the resulting pellets in "C5" packages for deep geological disposal.

ASN authorised the first phase of the sludge retrieval work in STE2 in 2015.

The creation authorisation decree for effluent treatment station STE3 was modified by decree of 29th January 2016 to allow the implementation of the STE2 sludge treatment process. Through a resolution of 4th January 2011, ASN also subjected to its prior agreement the acceptability of the C5 package in the deep geological disposal:

- to the demonstration that the integrity of the package is maintained during the period of deep disposal reversibility with regard to the risks of corrosion and hydrogen release;
- the production of other elements allowing the acceptability of deep disposal to be analysed, particularly with regard to:
    - the feasibility of its integration in the disposal project,
    - its behaviour in a disposal situation, particularly with respect to the release of radioactive substances and its impact on the performance of the other components of the disposal system.

AREVA NC however informed ASN at the end of 2016 that the process adopted for the treatment of the sludge in STE3 renders the conditions of operation and maintenance of the facilities more complex. The licensee is considering an alternative scenario.

ASN will be particularly vigilant to ensure that AREVA NC does everything in its power to meet the prescribed deadlines for retrieval of the STE2 sludge.

2.3.2.3. OTHER AREVA NC'S LEGACY WASTE

Unlike the direct on-line packaging of the waste generated by the new UP2-800 and UP3-A plants at La Hague, most of the waste generated by the first UP2-400 plant was stored in bulk without permanent packaging. The operations to retrieve this waste are technically delicate and necessitate substantial means.

The difficulties associated with the age of the waste, in particular the need for characterisation prior to any retrieval and processing, require the licensees to assess, for any project, the corresponding production of waste and plan for processing and packaging as and when the waste is produced. Retrieval of the waste contained in the old storage facilities on AREVA's La Hague site is also a precondition for the decommissioning and clean-out of these storage facilities.

ASN therefore monitors the retrieval of legacy waste from the La Hague site with particular attention because of the strong safety and radiation protection implications associated with it. Furthermore, it is an important commitment on the part of the AREVA group.

The initially-planned calendar for the retrieval of this waste has drifted off target in the last few years. ASN considers that the deadlines must no longer be pushed back because the buildings in which this legacy waste is stored are of an old design and do not comply with current safety standards. ASN considers in particular that AREVA NC must start the retrieval of the legacy waste produced by operation of the UP2-400 facility as early as possible. This concerns, in addition to the sludge in STE2, the waste from the HAO and 130 silos and the fission product solutions stored in the SPF2 unit.

ASN has subjected all the legacy waste retrieval and packaging programmes to prescriptions by a resolution of 9th September 2014. This resolution defines the priorities of the RCD operations in terms of safety and sets milestones for each programme concerned.

2.3.2.4. THE LEGACY WASTE OF CEA CADARACHE

The legacy waste of CEA Cadarache is stored in BNI 56, the "*Parc d'entreposage*" (Storage yard). Part of this installation is made up of 5 trenches filled between 1969 and 1974 with varied types of solid waste of low and intermediate level activity, then covered with earth. At the time this was an experimental waste disposal facility.

The ILW-LL waste comes from the operation or decommissioning of CEA installations and cannot be disposed at the CSA. The installation also comprises storage areas of legacy very low level (VLL) waste compatible with disposal at the CIRES facility.

The waste present on the installation must be retrieved as soon as possible, packaged and stored in appropriate facilities (CEDRA in particular). Retrieval of the waste from the pits and trenches requires the setting up of new processes. The VLL waste is characterised and packaged in the STARC ICPE before being transferred to the CIRES.

The CEA also sent ASN the report presenting the conclusions of the periodic safety review of the installation in March 2017. The procedure for registering the BNI perimeter of the installation will be carried out at the same time as the safety review. CEA plans to submit the installation decommissioning file at the end of 2017.

Delays are noted in the waste retrieval and packaging projects linked to project management and the development of retrieval solutions that take into account all the requirements concerned. CEA was unable to meet its commitment to retrieve the waste from pits 5 and 6 of BNI 56 in 2016.

2.3.2.5. THE LEGACY WASTE OF CEA SACLAY

BNI 72 is used for the storage, characterisation and packaging of the waste produced at the Saclay centre. The installation also collects the CEA disused sources. The legacy waste and the spent fuels are stored there in wells, pools or blocks.

In early 2009, at the request of ASN, the competent Advisory Committee of Experts examined the periodic safety review file submitted by the licensee. In this context the CEA made a number of commitments, including that of stopping the processing units and removing the waste stored in the pool and in the storage blocks, all within 10 years.

These waste retrieval and packaging projects require substantial technical and human resources in order to set priorities, comply with the ASN prescriptions and meet the licensee's commitments. CEA has for example started removing the facility's waste, spent fuel and sources from storage. The ongoing emptying of storage block 116 has been disturbed several times by the discovery of content that did not correspond to what was expected.

The storage facility emptying operations are falling behind schedule. Several operations, such as draining of the water potentially contained in the spent fuel cans, have not started. Compliance with certain deadlines prescribed by ASN seems compromised, which should lead CEA in 2017 to request a modification of the resolution of 2010. ASN shall be attentive to the justification of the new time frames requested and the plan of action proposed by CEA to complete the removal from storage operations in a schedule compatible with maintaining the facility in suitably safe conditions.

The decree of 8th January 2004 authorising the creation of STELLA required CEA to remove old effluents stored in tanks MA500 and HA4 of BNI 35 within ten years. CEA was unable to meet this deadline due to technical difficulties in the retrieval and packaging of this waste. In effect, only half of the initial source term had been removed (19,256 GBq in 2004) by the 8th January 2014. Nevertheless, all the radioactive organic effluents contained in tank HA4, which presented the greatest risks for safety, had been removed by the end of 2013. By a resolution of 15th July 2014, ASN prescribed new retrieval deadlines for these effluents and obliged the CEA to have them removed by the end of 2018 with intermediate deadlines at the end of 2014, 2015 and 2016. The CEA continued the removal from storage operations in 2016. It must complete the draining of the last tank before the end of 2018.

2.3.2.6. ASN CONCLUSIONS CONCERNING LEGACY WASTE

The various preceding examples show the difficulties inherent in retrieving and packaging legacy waste. The problems encountered are notably the following:

- the data concerning legacy waste are imperfect. When it was stored, the conditions of traceability and quality assurance were not the same as today. Its characterisation prior to retrieval is therefore based on the available records of its production, on a few samples and, as necessary, by calculation and can only be accurately determined once the waste has been retrieved for treatment/packaging;
- legacy waste is often heterogeneous (this is more specifically the case with the waste in silos 115, 130, HAO);

- the licensees have to deal with treatment/packaging problems with this waste and must often develop specific processes, in a context which is made difficult by the fact that the specifications for acceptance in the planned disposal routes have not yet been defined;
- the licensees have to deal with technical retrieval difficulties;
- the licensees use industrial strategies which have undergone significant changes and these subjects were given no appropriate prioritisation in the licensees' overall strategy.

All these problems often lead to delays and cost overruns. Solving the problems posed by the legacy waste and removal from storage means that the projects have to be taken into consideration very early on in the process, with particularly close monitoring on the part of ASN.

ASN is particularly attentive to compliance with the deadlines for the waste retrieval and packaging programmes implemented by the licensees.

The challenges for the three major licensees are the following:

- For EDF, the main challenge is the management of graphite waste. Given the new dismantling strategy for the UNGG reactors, EDF is involved in the RCD operations of the silos' graphite sleeves in Saint-Laurent-des-Eaux and is considering the creation of a storage facility.
- For AREVA NC, the retrieval of legacy waste is an important AREVA undertaking. The initial schedule has drifted and the deadlines can no longer be pushed back because the buildings in which the waste is stored are old and no longer provide comfortable margins with regard to current safety standards. With its resolution on the waste retrieval and packaging programme (RCD), ASN provided a regulatory framework for the progress and performance of the AREVA RCD programme according to the safety issues of the operations.
- For CEA, the two main issues are on the one hand the deployment of new waste treatment and storage facilities within a time-frame compatible with the shutdown programme for old facilities in which the level of safety no longer complies with current requirements and, on the other, running legacy waste storage removal projects. ASN observed that CEA is experiencing difficulties with managing these two issues, even if certain projects have made progress. ASN is monitoring the progress of CEA's programmes very closely and asked the CEA to present its overall strategy for waste management and decommissioning. This strategy is currently under examination.

The Decree of 27 December 2013 establishing the provisions of the PNGMDR 2013-2015 required that EDF, AREVA and CEA present by 31 December 2014 the state of progress of the characterization of ILW-LL waste and the consolidated design options for new packages appropriate for the disposal route as envisaged. The PNGMDR 2016-2018 requests to continue these studies concerning the conditioning of ILW-LL waste and its suitability with the storage facility being studied.

2.3.3. Tritiated waste

The majority of the tritiated waste produced in France is operational and decommissioning waste from facilities associated with the CEA's military applications (98%), while the remainder comes from small producers other than nuclear power production (research, pharmaceutical and hospital sector, etc.). At the end of 2013, the volume of tritiated waste represented some 5,900 m^3. A significant increase in the inventory of tritiated waste produced in France is projected, associated with the commissioning of the ITER fusion facility. Thus, for the producers as a whole, the inventory of tritiated waste requiring storage before disposal is forecast to reach a volume of about 30,000 m3 by 2060, for a tritium radiological activity of about 35,000 TBq. However, commissioning of ITER is falling behind schedule, pushing back the production of waste by the same amount of time.

The operational solutions for the long-term management of tritiated waste are:

- currently limited in terms of storage capacity: the majority of the waste is stored on the CEA sites, particularly Valduc and Marcoule;
- complex, involving, depending on the case:
    - a heat treatment by melting for the metallic waste and by baking for the organic waste in Valduc,
    - incineration of the liquid waste at CENTRACO,
    - decay storage for the waste which cannot go to CENTRACO or ANDRA centres,
    - disposal for the tritiated waste with low degassing levels.

As a complement to the storage on the Marcoule and Valduc sites, a storage facility project -INTERMED - associated with the ITER project is currently being studied (see B.6.1). A safety options file for this facility was submitted to ASN in 2014.

With regard to the defining of management routes, the PNGMDR 2016-2018 requires ANDRA, SOCODEI and CEA to present an analysis of the various options (direct disposal, storage, incineration with or without storage) by the end of 2017, so that the subsequent PNGMDR can adopt a position in this respect.

For the waste from small non-nuclear producers, the chosen solution is mutualised storage in INTERMED.

Pending the commissioning of INTERMED, ANDRA and the CEA have jointly studied, under the PNGMDR 2013-2015, the possibilities of accepting tritiated waste from a defaulting responsible entity. In such cases the waste could be accepted by the Valduc storage facilities subject to conditions. The delay in the availability of INTERMED resulting from the delayed commissioning of ITER will make it necessary to review the management strategy for the tritiated waste from small producers.

2.3.4. Technological alpha waste from AREVA NC and CEA not acceptable for surface disposal

Technological alpha waste from AREVA NC comes mainly from the La Hague and MELOX plants. In accordance with an ASN resolution dated 23 February 2010, AREVA NC presented the progress of its work to define an alternative package to the compacted waste package. The new treatment and packaging mode proposed by the licensee is based on an incineration/fusion/vitrification process enabling packages to be manufactured on the basis of principles more conducive to safe storage and disposal.

In application of the provisions of the decree of 27th December 2013 establishing the prescriptions of the PNGMDR 2013-2015, AREVA and the CEA transmitted an interim report in December 2014 concerning the chosen process. Specific difficulties in the process remain to be resolved and will be worked upon to determine the process feasibility by the end of 2019.

2.4. Historical waste from non-BNIs

The current policy and practices regarding historical waste from non-BNIs are described in the general framework appearing in B.5 and B.6.

In the case of ICPEs, regulations allow competent authorities to review licences in order to improve the operation of older facilities, such as mine-tailing storage facilities.

Inventory of polluted sites by radioactivity is detailed in § D.3.1.4.

The management of polluted sites has been the subject of continuous measures by the public authorities for several years.

The circular of 17 November 2008, intended for the Prefects, describes the administrative procedure applicable to the management of radioactive polluted sites subject to the ICPE system or the Public Health Code system, whether the party responsible is solvent or has defaulted. This circular thus allows treatment of legacy radioactive contamination on sites caused by past craft or industrial activities involving radioactivity (often radium), these sites not generally being ICPEs.

Sites contaminated by radioactive substances are managed on a case-by-case basis, requiring a precise diagnosis of the site and the contamination. Article L.125-6 of the Environment Code, amended on 26th March 2014, provides for the State to create Soil Information Sectors (SIS) in the light of the information at its disposal. These sectors must comprise land areas in which the knowledge of soil contamination justifies (particularly in the case of change of use) carrying out soil analyses and taking contamination management measures to preserve public health and safety and the environment. The decree of 26th October 2015 defines the conditions of application. The Regional Directorates for the Environment, Planning and Housing (DREAL) coordinate the SIS development process under the authority of the Prefects. The ASN regional divisions contribute to the process by naming the sites they know to be contaminated by radioactive substances.

The Prefect calls on the opinions of ASN and the classified installations inspectorate (when these latter are concerned) to validate the site remediation project and oversees the implementation of remediation measures by means of a prefectural order. In the event of residual pollution after the work, he may implement normal restrictions or institutional controls.

The methodological guide for management of industrial sites potentially contaminated by radioactive substances, which appeared in 2011, describes the applicable approach for dealing with various situations liable to be encountered when remediating sites potentially contaminated by radioactive substances. It aims to provide the various actors with a common methodological base for simultaneous, joint management of all the risks presented by such a site. It in particular specifies the necessary justifications to be provided by the party responsible for remediation of the site to the competent authorities. In accordance with the radiation protection principles specified in Article L1333-1 of the Public Health Code, the cost-benefit analysis specified in Chapter 5 of the guide must first of all aim to reduce exposure of individuals to ionising radiation as a result of the use of the site and the remediation operations as far as is reasonably achievable. This cost-benefit analysis must also take into consideration the robustness of the envisaged management solutions. Thus, the removal of as much pollution as possible, in order to aim for complete clean-up, is the reference approach in order to avoid having to resort to subsequent additional pollution clean-up operations.

For specific cases duly justified the decision may be taken not to carry out maximum remediation. It is then requested, to implement restrictions of use and take all steps to conserve the memory of the site and ensure appropriate public information.

If the party responsible has defaulted, decontamination of the site is carried out as part of ANDRA’s public interest duties as defined by the Waste Act.

ANDRA then coordinates the clean-out of the contaminated sites under a mandate from the prefects of the regions in which the sites are situated. A National Commission of Radioactivity Aids (CNAR) chaired by the Director-General of ANDRA gives an opinion on ANDRA's proposals for the clean-up scenarios to be implemented and on the use of public funds to assist them. This commission comprises representatives of the ministries responsible for financing the operations and for nuclear safety and radiation protection, of ASN, of environmental protection associations, of competent personalities and an elected official.

In all cases the clean-out objectives are submitted to ASN for its opinion and achievement of the site clean-out objectives may be verified after completing the decontamination operations. In October 2012 ASN published the basic principles of its doctrine regarding sites and soils contaminated by radioactive substances, principles it applies when forming its opinions.

This doctrine is founded on four basic principles. Firstly, the positions ASN adopts with regard to a contaminated site are "*duly justified, traced and presented to the stakeholders and audiences concerned in complete transparency*". Secondly, the stakeholders and audiences concerned "*must be involved at as early a stage as possible in the process to rehabilitate a site*".

The second principle relies on involving the stakeholders and audiences concerned as early as possible in the site rehabilitation process.

The third principle is the "polluter pays" principle. The last principle indicates that "*pursuant to the Public Health Code, the exposure of individuals to ionising radiation during and after operations to manage sites contaminated by radioactive substances must be kept as low as reasonably achievable in the light of current technology and of economic and social factors".*

The doctrine also points out that "*from an operational point of view (…) the reference procedure to adopt, when technically possible, is to completely clean out sites contaminated with radioactivity, even if the human exposure induced by the radioactive contamination appears limited*."

3 | SITING PROJECTS (ARTICLE 13)

Each Contracting Party shall take all 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 the 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 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 11.

3.1. Regulatory framework and ASN requirements for BNI projects

The siting procedure for any future BNI is detailed in § E.2.2.2.

More particularly with regard to the implementation of a disposal facility, ASN has published the following RFS and safety guide:

- RFS I-2 (published in 1982 and revised in 1984), for surface storage facilities for LIL/SL waste;
- a safety guide published in February 2008 for the deep geological disposal of HL radioactive waste.

Concerning LL-LL waste, ASN published in June 2008 a general safety orientation notice for the siting of the of a relevant storage facility.

These documents, the role of which is specified in § E.2.2.5.2, define the objectives to be adopted for radioactive waste disposal facilities, as early as the site investigation and facility design phases, to ensure safety after closure. They in particular deal with the geological medium and the technical siting criteria.

A legislative mechanism may prove necessary to implement any new storage facility. It is notably the case for a deep geological repository and its prerequisite facility, which consists in a URL. The *1991 Law* had prescribed that any project for a URL be the subject of a consultation mission with elected officials and the populations. That mission was set by decree. According to the same law, the licence should be granted to build and to operate the URL by decree on the basis of a technical application to be submitted by ANDRA, after public inquiry and opinion of stakeholders. In practice, ANDRA submitted in 1996 three applications, each corresponding to a different site. Only the creation of the Eastern Laboratory Site, at Bure, was licensed in 1999.

Article L. 542-10-1 of the Environment Code prescribes a certain number of specific requirements concerning the creation application for a deep geological formation repository which requires that such application refer a given deep geological formation, which has been investigated through a URL.

The procedures concerning any BNI creation authorisation application are indicated in sections E.2.2.3.1 and E.2.2.3.2. They are detailed and supplemented by article L. 542-10-1 of the Environment Code for the deep geological disposal authorisation, procedures which were clarified by the act of 25th July 2016 defining the notion of reversibility and introducing more specifically the concept of industrial pilot phase.

Filing of the creation authorisation application for the centre is thus preceded by a public debate as defined in article L. 121-1 on the basis of a file produced by ANDRA. The five-year time frame mentioned in article L. 121-12 is extended to ten years. The creation authorisation application for the centre also gives rise to a report from the national commission mentioned in article L. 542-3, to an ASN opinion and the gathering of the opinions of neighbouring regional authorities.

This application is then sent to the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST), which assesses it and reports on its work to the competent commissions of the National Assembly and the Senate.

The authorisation sets the minimum period during which reversibility of disposal must be ensured as a precautionary measure. This period cannot be less than one hundred years. The creation authorisation for the centre is delivered by decree in *Conseil d'Etat* (Council of State).

The commissioning authorisation is limited to the pilot industrial phase, for which the results give rise to a report by ANDRA, an opinion from the commission mentioned in article L. 542-3, an opinion from ASN and opinions from the neighbouring regional authorities. These documents are sent to the OPECST which assesses them and reports on its work to the competent commissions of the National Assembly and the Senate.

The Government then presents a bill adapting the conditions of exercise of disposal reversibility taking into account, if applicable, the OPECST's recommendations, and ASN issues the complete commissioning authorisation for the facility.

In the event that a project is likely to have an impact on the environment of another State, Article R. 122-11 of the French Environment Code and Article 13-II of “BNI Procedures” Decree of 2nd November 2007 provide for information and consultation measures with the involvement of the State. In addition, the same decree specifies that “*the licence to create a facility likely to discharge radioactive effluents in the environment shall only be delivered after reception of the opinion of the Commission of European Communities taken in accordance with Article 37 of the Euratom Treaty or, in the absence of such opinion, after six months of the request to the Commission*”.

3.2. Steps taken by BNI operators

3.2.1. Steps taken by ANDRA

In the context of the investigations conducted under the *Waste Act,* ANDRA is in charge of the R&D Programme for the implementation of the deep geological repository to be commissioned in 2025, subject to the creation authorisation application acceptance. The Programme monitors the investigations and studies that were carried out under the *1991 Law* and integrated in ANDRA’s *2005 Clay Report* (*Dossier Argile 2005* - www.andra.fr).

The 2005 Clay Report contains notably a description of the acquired knowledge at and around the MHM-URL, a summary of all design studies for a deep geological repository until then (including reversibility aspects).

Thanks to the research results achieved by the MHM-URL, it was possible to demonstrate in 2005 that a deep geological repository for HL/IL-LL waste was feasible within the Callovo-Oxfordian argillite layer under review.

In 2009, ANDRA presented the safety, reversibility and design options. These were examined by ASN and its technical support organisation, IRSN, in 2010, more specifically to identify the main elements to be supplemented for the creation authorisation application.

In 2010, ANDRA carried out a detailed geological survey of the zone studied for siting of the repository, using underground three-dimensional seismic means. In its November 2011 assessment report, the National Review Board (CNE) stressed the point that the new seismic campaign confirms the excellent homogeneity of this zone. The CNE also considers that ANDRA now has a geological model justifying the transposition of the data produced from the information acquired in the underground laboratory to the zone being studied for siting of the repository.

In 2012, ANDRA initiated industrial design studies for the repository. These studies are based on the main principles adopted following 20 years of research, to ensure the long-term safety of the repository. The results of the preliminary studies were assessed in 2013 by ASN and the CNE and were presented to the public debate. ANDRA’s follow-up to the public debate and the recommendations of the CNE will be taken into account in the subsequent studies. After having drawn up a Preliminary Design Study in 2014-2015, ANDRA submitted a safety options file and a retrievability technical options file to ASN in 2016 in preparation for the examination of the CIGÉO creation authorisation application. An international peer review mandated by ASN was held under the aegis of the IAEA at the end of 2016: A team of 9 international experts from the safety authorities of the countries requested to participate examined the safety options file and formulated opinions and recommendations. On the basis of the feedback from the examination of this safety options file, planned for mid-2017, and the definitive preliminary design studies, ANDRA will finalise the creation authorisation application in mid-2019.

In accordance with the provisions of the Euratom treaty, the European Commission will be involved in the authorisation process. More specifically, ANDRA will send the European Commission a file concerning radioactive effluent discharges; the CIGÉO creation authorisation may only be granted after the Commission has issued its opinion on this file.

ANDRA is also in charge of the disposal project for LLW-LL waste for which there is at present no solution, such as graphite waste (stacks and sleeves) and radium-bearing waste.

In 2008, the siting process for a repository able to accept LLW-LL type waste was unsuccessful. Further to the guidelines given in the 2010-2012 PNGMDR and the recommendations of the High Committee for Transparency and Information on Nuclear Security (HCTISN) which analysed the lessons learned from the siting process, ANDRA submitted proposals to the Government in 2012 for continuation of the project. In 2013, the Ministry in charge of energy asked ANDRA to continue the siting work, both on sites already housing nuclear facilities and in areas where communes had submitted their candidacy in 2008, as recommended by the HCTISN. In 2013, geological investigations were carried out in the vicinity of ANDRA's existing disposal centres in the Aube département, jointly with local actors. In mid-2015, ANDRA gave the Government its interim report on the near-surface disposal of LLW-LL waste for the investigated site. This report enabled the lessons to be drawn from the first geological investigations and from the progress in the studies and research into waste conducted by ANDRA and the producers. Preliminary design studies of the disposal facility have been carried out and undergone a first safety assessment. ASN has been asked to give an opinion on this report.

3.2.2. Steps taken by the CEA

CEA is building its new nuclear facilities only on its centres which already host other nuclear facilities. In practice, the host sites are now almost exclusively Cadarache and Marcoule, which are remote from urban areas and offer intrinsic characteristics that are favourable to the siting of such facilities. In the Saclay centre, new facility projects can occasionally be initiated, but they generally either replace older facilities that are hard to maintain to current safety standards (this was the case with the Centre's Stella liquid effluent treatment plant), or facilities with low potential impact dedicated to post-operational radioactive clean-out of facilities that have been shut down.

The general waste management strategy at CEA therefore aims, following initial packaging in their production centre, to send to Cadarache or Marcoule waste that requires more extensive treatment, packaging and possible storage pending opening of a disposal route. The corresponding facilities are built in compliance with the regulations and the local residents are both informed and consulted, more specifically through public inquiries. At the end of the public inquiry, the CEA obtained, in 2016, the decree authorizing the creation of the DIADEM storage facility dedicated to irradiating radioactive waste in Marcoule.

3.3. ASN analysis for BNIs

ASN ensures compliance with the regulations by reviewing the files presented by the licensees and by carrying out inspections.

With regard to the deep geological disposal project, ASN sent the Government the following opinions in recent years:

- in early 2010 a positive opinion on ANDRA's proposal for a zone of interest favourable for siting of such a repository, in which additional geological investigations will be carried out;
- on 10 May 2011 an opinion concerning the benefits to be gained from continuing research and experimentation work in the Meuse/Haute-Marne underground laboratory;
- on 26 July 2011 an opinion on the file transmitted in late 2009 by ANDRA, more specifically presenting an update of the safety and reversibility options for the disposal facility and the inventory of waste adopted for the design of the facility;
- on 16 May 2013 an opinion on the documents produced by ANDRA since 2009. In this opinion, ASN recalls certain principles which as project manager, ANDRA must follow, notably the need to maintain the radiological impact as low as possible in the light of current scientific knowledge, current technology and economic and social factors. While underlining the quality of the work done by ANDRA, ASN makes a number of recommendations for the future studies and work. ASN specifies the principles it adopts for the waste inventory, with a view to the future review of the repository creation authorisation application and any modification requests made during operation.
- on 10th February 2014, an opinion on the project cost evaluation; further to this opinion, on 15th January 2016 the Minister responsible for energy set the reference cost of the project at €25 billion (cost as at 31st December 2011);

- on 25th February 2016, an opinion on the management of HLW/ILW-LL waste under the PNGMDR 2016-2018 asking the licensees to study the consequences of pushing back the commissioning of CIGÉO beyond the planned date of 2030;
- on 31st May 2016, an opinion on reversibility taken up in the act of 25th July 2016.

Lastly, ASN has published several position statement letters addressed to ANDRA:

- in December 2013 further to the examination of a file entitled "CIGÉO Project Outline Jesq03 (2012)". This file provides a synthesis of the "overall architecture adopted for the design studies" and details more specifically the project design changes and their impacts on safety, with respect to the file submitted at the end of July 2009;
- in October 2014, on the closing engineering structures;
- in December 2014, on the requirements of the project safety options file;
- in April 2015, on the control of risks in operation;
- in June 2016, on the project development plan.

Examination of the safety options file submitted by ANDRA began in Spring 2016 and formed the subject of an international peer review organised by the IAEA from 7th to 15th November 2016. ASN is to give its opinion on this file in 2017.

Through follow-up visits to the underground laboratory, ASN ensures that the experiments carried out in accordance with the Waste Act follow processes guaranteeing the quality of the results obtained.

3.4. ICPEs and mine tailings

Environmental acceptability is the founding principle of ICPE regulations.

In accordance with European directives for all facilities subject to licence, any application must comprise a study analysing the impact of the project on the environment. Its content must be commensurate with the scale of the planned work and the foreseeable consequences. The impact assessment must include:

- an analysis of the initial state of the site and of the environment, particularly with regard to natural resources, tangible assets and the cultural heritage likely to be affected by the project;
- an analysis of the direct and indirect, temporary and permanent effects of the facility on the environment;
- an analysis of the environmental effects in combination with other projects;
- the reasons for which, particularly in terms of environmental concerns, the project was selected among possible solutions;
- the measures planned by the applicant to eliminate, to restrict and, if possible, to compensate any inconvenience induced by the facility.

The licence application must also include a risk analysis, consisting of a description of likely accidents to occur due to potential external causes, with due account of the planned location involved, as well as an overview of the potential hazards of the facility in case of accident.

The content of the hazard and impact assessments, and all aspects of the licence application case, must be made public and submitted to the populations concerned for comments through the framework of a public inquiry.

The general regulations for mining industries set specific rules for the management of ore-tailing and waste disposal sites, if the uranium concentration exceeds 0.03%.

A management plan for those disposal sites must be established and specify appropriate steps to be taken to limit the radiological impact on the environment.

Those disposal sites must be monitored by their operators until such time when their radiological impact on the environment is acceptable.

4 | FACILITY DESIGN AND CONSTRUCTION (ARTICLE 14)

Each Contracting Party shall take the 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 a 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.

4.1. BNIs

The general regulations for BNI design and construction are described in § E.2.2.3 with regard to procedures, in § E.2.2.5 with regard to technical rules and in § F.4.1.4.1 with regard to discharges. Over and above general regulatory requirements, ASN may issue technical prescriptions pertaining to the design, construction or operation of any planned facility. These prescriptions thus supplement the facility's creation authorisation decree.

For a disposal facility and in accordance with the *BNI Order*, the choice of geological medium, the design and construction of a radioactive waste disposal facility, its operation and its transition to the monitoring phase are defined in order to provide passive protection for persons and the environment from the radioactive substances and the toxic chemicals contained in the radioactive waste. This protection should not require any intervention after a monitoring period, determined according to the radioactive waste emplaced and the type of repository. The licensee shall demonstrate that the design meets these objectives as well as its technical feasibility.

The technologies used in the design and construction of a radioactive waste management facility must draw on experience, tests and analyses. This is notably the case with the deep geological disposal project, thanks to the underground laboratory. This is also the case of waste treatment/packaging, storage or disposal BNIs, for which the processes and equipment which are elements important for protection, must be based on proven technologies or, in the case of a prototype, must be the subject of qualification files, for which tests are systematically performed in the facility before it is commissioned.

For other facilities than disposal facilities, the operator must take all necessary measures as early as the design stage in order to facilitate its decommissioning and to limit the production of resulting waste.

According to the Environment Code, the operator must demonstrate, as early as his creation-licence application, that his proposed general decommissioning principles are able to prevent or to limit potential risks or inconveniences of the facility; similarly, he is required to demonstrate that his proposed method for maintaining and monitoring his radioactive-waste disposal facilities after closure are also able to prevent or to limit such risks or inconveniences. The BNI Procedures Decree specifies that the creation-licence application must include a decommissioning plan. It presents the proposed principles and phases for the decommissioning of the facility, as well as for the rehabilitation and subsequent monitoring of the site. It must also justify the timeframe between the final shutdown and the dismantling of the facility.

In accordance with international standards (IAEA, WENRA) ASN feels that the following items are especially important as early as the design and construction phases of any new facility:

- the selected materials;
- effective measures to facilitate decommissioning operations;
- circuit-related measures in order to prevent active deposits, in order to limit any extension of contamination and to facilitate not only the decontamination of premises and equipment, but also the electrical shut-off of the buildings;
- the collection and archiving of necessary documents and data.

The description of the steps taken during the design stage in order to facilitate decommissioning and to limit the production of resulting waste used to be rather brief in the past. At present, owing to the new regulatory requirements (decommissioning plan, waste studies), this is more detailed for new BNIs.

For a waste disposal facility, Article 42 of the BNI Procedures Decree requires that, in the creation authorisation application, the decommissioning plan be replaced by a document presenting the means envisaged, as of the design stage, for final shutdown and subsequent monitoring of the facility. This document must include an initial safety analysis of the facility following final shutdown and transition to the monitoring phase. This plan must include:

a) "the forecast duration of the phases of decommissioning, closure and monitoring of the facility;

b) "the methods envisaged for the phases of decommissioning, closure and monitoring of the facility;

c) the methods envisaged for the conservation and transmission of the memory of the facility during and after the monitoring phase;

d) 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;

e) a description of the engineering structures in place for closure;

f) a description of the various work steps necessary for the accomplishment of all the closure operations and subsequent monitoring, justifying their respective durations."

4.2. ICPEs

For radioactive-waste management facilities constituting ICPEs, the general ICPE regulations apply, as described in § E.2.3.1 with respect to design and construction.

The regulatory body (the Prefect in each *département*) ensures that those regulations are duly enforced through the analyses and inspections it conducts according to the modalities described in § E.2.3.3.

5 | SAFETY ASSESSMENT 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 paragraph (i).

5.1. Regulatory Framework and ASN requirements

The BNI general regulations apply to radioactive waste-management facilities pertaining to that category, set by decree, due to their radiological content.

Requirements and modalities for safety-assessment purposes were described in § E.2.2.3.1 and E.2.2.4, whereas the general principles are reiterated below.

In order to apply for a licence to create a disposal facility, the applicant must provide a certain number of data and studies (see § E.2.2.3.2). The content of the file is detailed at Article 8 of the BNI Procedures Decree. All lifetime phases of the facility must be reviewed (including its decommissioning or, in the case of a disposal facility, the subsequent period after shutdown). ASN reviews the preliminary safety report and forwards its opinion to the Minister for the drafting of the decree licensing or denying the creation of the facility.

The main requirements concerning the preliminary safety report are defined in Article 10 of the BNI Procedures Decree and the BNI Order. Among other things, this latter specifies the principles and procedures relating to the safety case. The licensee must in particular apply the principle of defence in depth. The safety case must be based on a cautious deterministic approach and present the way in which the following functions are ensured:

- control of nuclear chain reactions;
- evacuation of the thermal power produced by the radioactive substances and nuclear reactions
- containment of radioactive substances;
- protection of persons and the environment against ionising radiation.

The ASN resolution of 17 November 2015 defines the requirements concerning the BNI safety reports. This resolution specifically stipulates the elements to be included in the safety report. Furthermore, as mentioned in H.3.1, ASN has issued basic safety rules and safety guides to define the objectives to be adopted from the outset, to ensure the safety of the facility, including safety after closure when dealing with a repository.

It should be noted that the operator may, even before initiating the licensing procedure, request ASN's opinion on all or part of his selected options for the safety of the future facility. That preparatory procedure does not replace any of the subsequent regulatory reviews, but is consistent with a process aiming at clarifying, from the early stages of the studies, the basic safety principles for the future facility.

Once the facility is built and for the facility commissioning, hence for the first introduction of radioactive substances, the operator must submit a specific report to ASN as specified in § E.2.2.4.1 and described at Article 20 of the BNI Procedures Decree of 2 November 2007.

Once the case reviewed and, if the conclusions of that review are favourable, ASN may license the commissioning of the facility. In its Resolution, ASN then must set the deadline after which the operator must submit an end-of-commissioning report for the facility (see. E.2.2.4.2).

Licences do not include any time limit. However, periodic safety reviews must be carried out every 10 years. It should be noted that the implementation decree may set a different timescale, if the specificities of the facility warrant it and ASN may suspend the license in the event of imminent danger.

Some clarifications concerning the safety assessment and the environmental assessment of the disposal facilities, for the period following closure, are given below. Two types of situations are to be considered:

- the reference situation, based on a scenario involving the normal evolution of the disposal facility, and
- so-called “altered evolution” scenarios, resulting from uncertain events that are more or less likely, whether they are natural or associated with human actions.

The impact assessment under normal-evolution conditions must be based on a deterministic approach with reasonably conservative models and parameters. Uncertainty studies must be conducted. If the assessment involves a value above 0.25 mSv/a, it would be appropriate either to reduce uncertainties by an adapted research programme or to revise the design of the facility. In the case of a deep geological repository, the quoted value of 0.25 mSv/a would be maintained as a reference value for any timescale above 10,000 years.

With altered situations, assessments may lead to exposures in excess of 0.25 mSv/a, in which case the criteria to judge whether the impact is acceptable or not refer to the exposure mode and time, as well as to the conservative aspect of the selected assessment hypotheses (as specified in § D.3.2.2.2).

For instance, in the case of the CSA in the Aube *département*, the following altered scenarios have been selected for the phase following the 300-year monitoring period:

- conventional intrusion scenarios leading to air transfer (road works, homes, children’s playgrounds);
- various scenarios leading to a water transfer in the aquifer (barrier failure, water feed wall).

With regard to the project for deep geological disposal of radioactive waste, its procedures are governed by article L. 542-10-1 of the Environment Code (see § H.4.1 for the regulatory details) which prescribes a pilot industrial commissioning phase prior to operation. In addition, the ASN Guide dedicated the final geological disposal of radioactive waste provides for an initial period of 500 years corresponding to the memory preservation of the repository, thus allowing very little probability for human intrusions in the disposal area.

5.2. Steps taken by BNI operators

5.2.1. ANDRA practices

For the creation of the CSA, the safety and environmental assessments dealt not only with the operating phase, but also with the 300-year monitoring phase, and the subsequent post-monitoring phase, which rests on the implementation of passive safety measures. The design of the disposal structures and the specifications applicable to CSA waste packages take into account all lifetime phases mentioned before. In addition, preparations for the CSM’s closure were made by applying the same conditions as for the creation of a new BNI.

Concerning the CIRES, which is subject to ICPE rather than BNI regulations, a comparable scheme was followed, with the production of safety studies and environmental impact assessments, concerning not only construction and operation, but also the long-term future of the facility after closure. These studies are updated each time the facility is modified.

5.2.2. Practices of other operators (CEA, AREVA, EDF)

The CEA, AREVA and EDF practices are identical to those implemented for spent-fuel management facilities as described in G.2.2.

5.3. ASN analysis for BNIs

The deep geological disposal project is still at a phase which precedes the creation authorisation application. The ASN analysis is described in H.3.3.

Existing disposal facilities are for their part periodically reviewed.

ANDRA sent ASN the periodic safety review file for the CSA in August 2016. The examination of this file will focus in particular on evaluating the safety of the facility with regard to the planned development of its activities over the next ten years. It will also enable the strategy for decommissioning, closing and monitoring the facility once it has stopped receiving waste to be detailed. In 2016 ANDRA continued deployment of the package inspection facility aiming to give the site more efficient means for checking the quality of the packages received at the CSA. ASN is currently examining the commissioning authorisation application for this facility (see H.6.3).

As for the CSM, it is dealt with in H.7.1.

5.4. ICPEs and mine tailings

Assessing the design choices made by the applicant and the impacts and hazards relating to an ICPE that is subject to licensing or to a mine-tailing disposal facility must be analysed during the review of the impact assessments and risk study (see E.1.2. and H.3.4).

The objective of the operators and agents responsible for the administrative monitoring is to determine proportional constraints to the risks and hazards involved in the long-term site management and monitoring of the sites.

6 | OPERATION OF FACILITIES (ARTICLE 16)

Each Contracting Party shall take the appropriate steps to ensure that:

i) the licence 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 the 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.

6.1. Regulatory framework and ASN requirements

The requirements referred to in Article 16 of the Joint Convention are consolidated in the French regulations.

The licence to operate any disposal facility for radioactive waste may only be granted in accordance with the procedure referred to § E.2.2.4 and reiterated in H.5.1.

The general operational rules (RGE) established by the operator, in accordance with the BNI Procedures Decree, must describe the operating limits and conditions of the facility involved. Those RGEs must be revised periodically in order to take into account the evolution of the facility and of the acquired experience.

Quality-assurance rules determine the quality requirements for the operation, maintenance, monitoring and inspection of the facility (See Title II of the Order of 7th February 2012). More particularly, the operator must have all necessary skills for carrying out all safety-related activities concerned. However, he may call upon external support with regard to engineering and technology in all safety-related fields.

In accordance with the Environment Code and Article 2.6.4 of the Order of 7th February 2012, all significant incidents or accidents for nuclear safety or radiation protection must be declared to ASN as soon as possible and to the State representative in the *département* in which the incident or accident took place (see § E.2.2.4.4 and E.2.2.7.2).

In application of Article 2.6.4 of the Order of 7th February 2012, the operator must provide a detailed report, including a technical analysis, a human-factor report and a cause tree. ASN must check the thoroughness of the report and use it for a cross-functional analysis between the various operators.

Furthermore, in application of the order of 7th February 2012, the licensee must maintain a continuous improvement approach. Articles 2.7.1 and 2.7.2 of the abovementioned order thus stipulate respectively that:

- in addition to the individual handling of each deviation, the licensee periodically reviews the deviations to assess the cumulative effect of as-yet uncorrected deviations on the installation, and to identify and analyse trends concerning the recurrence of similar deviations;
- the licensee takes all necessary measures, including with respect to outside contractors, to systematically collect and analyse information that could enable it to improve the protection of the interests mentioned in article L. 593-1 of the environment code, whether the information results from the experience of the activities mentioned in article 1.1 on its own installation or on other installations - similar or not - in France or abroad, or from research and development activities.

A decommissioning plan must also be submitted by the applicant as early as his licence application to create a BNI other than a disposal facility for radioactive waste (see H.4.1). In the case of a disposal facility, the decommissioning plan is replaced by a decommissioning, closure and monitoring plan (see H.4.1).

Waste packaging is an essential aspect of radioactive waste management, because the package is the first of the three containment barriers in a disposal facility and, in the case of storage, plays an important role in both containment and possible retrieval.

In accordance with Article L. 542.12 of the Environment Code, ANDRA is in charge of drafting specifications for disposal of radioactive waste and for giving the competent administrative authorities an opinion on the waste packaging specifications.

The BNI Order specifies the following points:

- waste intended for facilities with acceptance specifications stipulated in Article L. 542.12 of the Environment Code is packaged in accordance with these specifications;
- the packaging of radioactive waste intended for facilities currently being studied and for which there are no acceptance specifications requires prior approval by ASN.

The ASN resolution 2017-DC-0587 of 23 mars 2017 specifies the requirements of the BNI Order.

For the CSA, ANDRA has set in place a series of procedures (specifications, certification procedure, verification and computerised monitoring, visual control and dose rate upon arrival, audits and inspections on waste production sites, destructive or non-destructive testing of packages upon delivery at disposal sites, procedures for non-conformities treatment). As mentioned in § D.3.2.2.2 above, the criteria for package acceptance in the centre are the result of the operating and long-term safety assessments. Each producer designs and develops its processing/packaging projects (per type of final package) and submits them to ANDRA for a check on conformity with the specifications issued by this organisation and to obtain final approval. It should be remembered that the CSA can only accept for disposal packages approved beforehand by ANDRA.

For certain radioactive waste, and notably HL/IL-LL waste, a repository is under review, but its commissioning is not planned before 2025 (industrial-pilot phase), according to the necessary authorisations. In the context of the PNGMDR 2016-2018, ANDRA has been asked to draw up as soon as possible a preliminary version of the CIGÉO facility acceptance specifications so that the producers can assess the acceptability of their waste.

In the meantime - as is the case for the other disposal facilities being studied - the production of waste packages they will receive is subject to ASN authorisation, after packaging approval on the basis of a file called "Packaging baseline requirement" demonstrating that on the basis of existing knowledge there is nothing to prevent disposal of the packages on site.

AREVA NC thus produces "production specifications" for the waste packages produced in the La Hague plant since 1991.

In November 2015, EDF submitted to ASN an approval application file for packaging ILW-LL waste in C1PGSP packages in the ICEDA facility. This file was supplemented in May 2016 and is currently being examined.

At the end of 2015, CEA transmitted a packaging approval application for packages from BNI 37 A, and this file is currently being examined.

6.2. Steps taken by BNI operators

6.2.1. ANDRA operational safety practices

For its facilities, ANDRA follows the procedures described in E.2.2, especially with regard to commissioning and to the declaration of safety-related events.

General operational rules (*Règles générales d'exploitation* – RGE) and General Monitoring Rules (*Règles générales de surveillance* – RGS) describe the normal operating mode for disposal facilities. Established by ANDRA, they are consistent with general regulations, each facility's specific regulations (especially the creation-licence decree) and the technical requirements notified by ASN. RGEs and RGSes are subject to the formal approval of ASN.

Environmental-monitoring plans are also drawn up by ANDRA and prescribe the qualitative and quantitative nature, as well as the frequency, of measurements to be taken in or around the disposal facilities in order to meet the objectives of the decree on the transition unto the monitoring phase and to the order for licensing discharges. They are also subject to ASN's critical review prior to their implementation.

Those steps are taken not only at the CSA in service, but also at the CSM, now in its monitoring phase.

In the case of the CIRES, ANDRA complies with the requirements of the ICPE regulatory framework, as described in E.1.3.

Generally speaking, all ANDRA activities, especially the operation, maintenance and monitoring of disposal facilities, are carried out in accordance with established procedures that are consistent with ANDRA's quality system (see § F.3.2.1). The structure of the Agency is designed to maintain the necessary scientific and technical skills in all areas relating to the safety of its facilities (see § F.2.2.1).

6.2.2. Operational safety practices of CEA, AREVA and EDF

Radioactive-waste and spent-fuel management facilities all constitute BNIs. Consequently, the operational-safety practices of the CEA, AREVA and EDF are identical to those applicable to spent-fuel management facilities, as described in G.6.2.

6.3. ASN analysis for BNIs

As mentioned above, the purpose of the provisions described in E.2.2 concerning BNI regulations is to comply with the objectives of Article 16 of the Joint Convention. Controlling the steps taken by operators, particularly through frequent inspections and periodic safety reviews, ensures that the regulations are applied properly.

In 2011, ANDRA submitted an application for modification of the facilities, so that in addition to the non-destructive checks already performed (visual, X-ray, sizing, gamma spectrometry) they could carry out X-ray imaging checks, tritium degassing checks and destructive inspections (core sampling of low radioactivity packages). ASN is in favour of ANDRA having its own advanced inspection resources in order to check the quality of the packages received in its facilities, including by means of spot checks. The work was completed in 2015. Coming into service is subject to approval by the ASN.

In addition, ASN receives every year ANDRA's status reports on the quality of the packages received at the CSA, from every major waste producer. ASN conducts inspections in order to verify the soundness and efficiency of the system set in place by ANDRA.

6.4. ICPEs and mine tailings

In the case of ICPEs, the steps to be taken with regard to the operation, maintenance, monitoring, and ultimately upon termination of activity, are prescribed through technical requirements to be incorporated into the relevant prefectoral order (see § E.1.2), taken in application of the *Environment Code,* notably of its Book V, as described in Section L. With regard to mine tailings, since all facilities are no longer in operation, practices with regard to closure are described in H.7.2.

7 | INSTITUTIONAL MEASURES AFTER CLOSURE (ARTICLE 17)

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

i) records of the location, design and inventory of that facility required by the regulatory body 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.

7.1. Waste generated by BNIs or ICPEs

7.1.1. Legislative framework

The legislative framework applicable to radioactive waste disposal BNIs for the period following their closure is governed by article L. 593-31 of the Environment Code which stipulates that:

- the prescriptions applicable to the phase after closure of the installations, qualified as monitoring phase, are defined by the decommissioning decree;
- the delicensing decision can be made once the installation has entered the monitoring phase.

The BNI procedures decree specifies that the decommissioning file contains more specifically:

- the duration and envisaged methods for the phases of decommissioning, closure and monitoring of the facility;
- a description of the engineering structures in place for closure;

- a description of the various work steps necessary for the accomplishment of all the closure operations and subsequent monitoring, justifying their respective durations;
- the general monitoring rules;
- a detailed file on the memory of the installation;
- and, if necessary, active institutional controls that the administrative authority can apply under article L. 593.5 of the Environment Code.

Lastly, the order of 7th February 2012 provides in particular that the protection of the interests mentioned in article L. 593.1 of the Environment Code (i.e. public health and safety, protection of nature and the environment) must be ensured passively and not require human intervention beyond a limited monitoring period, stipulating that the licensee must provide justification for the chosen design and the technical feasibility of meeting these requirements.

The closure of the facilities and entry into monitoring phase are subject to the prior consent of ASN which rules in the light of the decommissioning file and, more specifically, the demonstration of the effectiveness of the planned monitoring measures.

7.1.2. The Centre de stockage de la Manche (CSM)

In France, the CSM is the only facility to have moved unto its monitoring phase (final shutdown according to the definition given by the Joint Convention). Waste reception operations stopped on 30 June 1994 but the facility entered into its monitoring phase in January 2003 (see decree for moving in monitoring phase on 10 January 2013).

The different characteristics of the CSN shutdown are detailed above in § D.3.3.1 and in § F.4.2.1.3 for liquid discharges.

The monitoring phase is the period during which the disposal facility must be controlled (access restriction, with monitoring and repairs, if need be).That phase is due to last for at least 300 years, with due account of the fact that the number of required actions will decrease over time. The said Decree of 10 January 2003 specifies that the monitoring plan throughout that period is revised every 10 years, at the same time as the safety report, the RGEs and the emergency plan. Those documents are submitted to ASN for review and take experience feedback into account. Similarly to the CSM case, the approach must be gradual and cautious.

During the procedure which authorised the CSM to enter the monitoring phase, a certain number of recommendations were issued, notably by the Manche repository situation review board, known as the “Turpin Commission” (1996), such as:

- to assess the durability of the installed cover and estimate the benefits of replacing it by a new one in order to facilitate the control programme;
- to optimise the control programme, in order for monitoring to become increasingly passive;
- to hand over all required information to future generations (plans, data, summary report and detailed case, transmission support, etc.), and
- to inform and to involve the public throughout the monitoring phase.

With regard to the durability of the cover, during the last periodic safety review ASN considered that ANDRA should continue its efforts to reinforce the stability of the cover and resolve the problems of stormwater infiltrations. In accordance with the commitment made during this safety review, ANDRA sent ASN on 16th February 2015 an interim review of the work carried out on the repository cover. Technical complements were requested in September 2016 and will in particular enable the requirements concerning the dimensioning of the long-term cover to be clarified. These factors will also be addressed in the examination of the periodic safety review initiated when ANDRA submitted the safety review guidance file (DOR) in July 2016. Nevertheless, in application of the decree of 28th June 2016 following on from the TECV act, the CSM is administratively no long considered to be in the monitoring phase but in the decommissioning phase, as the closure operations have not all been carried out. ASN has asked ANDRA to indicate the duration of the long-term cover installation operations before the CSM is closed and enters the monitoring phase. On the basis of this information, ASN will issue a resolution setting the date by which the closure and entry-into-monitoring-phase application file must be submitted, and the duration of the CSM monitoring phase.

The years of operation of the CSM repository were marked by tritium contamination of the water table discovered in 1976. The waste that caused this contamination was removed in 1977 and 1978, but the groundwater contamination is still significant. In 2016 ANDRA continued taking tritium activity measurements in the water table at the CSM. These measurements reveal a reduction in the average tritium-marking of the water table which is consistent with the radioactive half-life of tritium. In its opinion of 23rd February 2016, ASN considers that the regulatory monitoring plan for the CSM is appropriate for monitoring the tritium contamination of the ground and surface waters. ANDRA will continue taking five-yearly measurements of the tritium stratification in the piezometers of the initial study and in new sectors to consolidate the observed trends and map the various sectors of the CSM. These data should provide a better understanding of the hydrogeological mechanisms at the CSM.

7.1.2.1. LONG-TERM ARCHIVAL AND CONSERVATION OF MEMORY

Archival

Long-term archiving also constitutes a significant component. The technical prescriptions set by ASN for the monitoring phase require that the following information be archived over the long term.

In order to retain the memory of the Centre and encourage its transmission over several centuries, ANDRA has taken a number of steps, which were mentioned in § D.3.2.2.1 and which are specified below.

ANDRA has set up a so-called "passive" memory comprising a detailed memory and a summarised memory. This is a long-term memory (spanning a time scale of a few centuries to a thousand years):

- All the documents constituting the detailed memory are printed on permanent paper in two copies, one kept on the site, the other in the National Archives. In accordance with the recommendations of the "Turpin Commission", ANDRA produced an intermediate version of the "summarised memory" intended to conserve the essential information concerning the CSM for the future generations. Following an exercise carried out in 2012 to examine the relevance of the data contained in the detailed memory, ANDRA conduct in 2016 an exercise to prioritise the data figuring in it. ANDRA has undertaken to transmit a consolidated version in 2019;
- The summarized memory is contained in a single volume. It is intended to be distributed to decision-makers, whether local (prefects, mayors, notaries, etc.) or national (ministers, etc.) and to broader audiences (associations, national and international bodies (NEA, IAEA, etc.) and the general public). It provides a record of the most important information on the disposal facility to enable decisions to be taken with full knowledge of the facts.

Ultimately, ANDRA also envisages producing a simplified memory (some thirty pages) and an ultra-simplified memory (1 page printed on both sides)

Furthermore, the existence of the disposal centre is recorded in the land registry so that any possible future utilisation of the site and the neighbouring land is done knowledgeably.

In addition, ANDRA also deploys an "active" memory based on communication with the public and regular relations with the Local Information Committee (CLI) and based on a short and medium-term memory (spanning from a few decades to about a century).

It is based on two principles:

- informing the public (site newsletter, receiving visitors, website, etc.) in order to make the memory last as long as possible after the end of operation of the facility;
- keep track of the functioning of the centre and inform the local populations through the CLI.

The memory project

With CIGÉO, ANDRA wants the time scale of the memory to cover several thousand years.

Consequently, in 2010, ANDRA decided to launch a memory project with a two-fold goal:

- increase the robustness of the reference solution;
- develop the reflections and studies on the several-thousand year memory.

For each of the three components that constitute the memory (message, physical medium and relaying mechanism), ANDRA is conducting complementary research combining landscape archaeology, linguistics, ageing of materials, archival, and social sciences and the humanities.

Studies of a completely different nature have also been initiated on the following subject.

Permanence:

- of languages and symbols, in order to determine the reasonable period for which current or dead languages can be known, and what the communication solutions might be once these languages are no longer known;
- of institutional conservation of writing, audio, objects, etc., by the specialised French but also international organisations, to analyse the preventive measures taken to limit deterioration over time and encourage assimilation and transmission by future generations;
- of long-duration digital archival, notably by organising an intelligence watch in this field which is beginning to develop and which, within the time frame of a few decades, could open up new prospects for the long term.

Temporality and vestiges:

- archaeology of techniques and landscapes, incorporating man-made and geodynamic changes and the possibility of memory within human creations (use of the infill of surface-ground connections as a memorisation tool);
- memory of “legacy” disposal sites not managed by ANDRA, which exist at various locations in France (uranium mines, nuclear test sites, etc.).

The societal aspect of the problem:

- perception of long time scales (several millennia and more) by the public, within a grouping of human and social sciences laboratories;
- three main orientations (regression, stagnation, progress) for the possible societal changes in science, technology, humanity, etc.;
- integration of the preservation of the memory of disposal facilities into nuclear, heritage and memory teaching programmes;
- transmission of memory between generations via the social networks on the web, to provide worldwide information about the memory of the disposal centres.

7.2. Mine tailings

The uranium mines and their annexes, and their conditions of closure, are covered by the mining code. The disposal facilities for radioactive mining tailings are governed by section 1735 of the ICPE nomenclature.

A plan of action was also defined in 2009, comprising the following themes:

- monitor the former mining sites;
- improve the understanding of the environmental and health impact of the former uranium mines and their monitoring;
- manage the mining tailings;
- reinforcing information and consultation.

After shutdown, mining sites must undergo work in accordance with the Prefect’s decisions in order to control long-term hazards by selecting robust and durable structures.

First of all, the Prefect requires the implementation of a reliable active monitoring system guaranteeing that any impact remains acceptable.

On the basis of experience feedback from that control, active monitoring may be scaled down to passive monitoring. Long-term acceptability is examined in the light of realistic scenarios of degraded situations (loss of embankment impermeability, cover degradation, mining works, residential homes, etc.).

One major aspect of the monitoring system is institutional control, the aim of which is to ensure that any changes brought to the land will not affect risk control. The institutional control of lands and waters consists of the following:

- restrictions on the occupation or use of the site (irrigation, agriculture, breeding, home building, swimming, etc.);
- mandatory actions (monitoring, maintenance, etc.);
- required precautions (excavation work, pipe laying, etc.);
- access restrictions.

Information must be accessible to the public and certified by a notary (contract lawyer). In the event of a major hazard, the Prefect may decide to implement a mining risk prevention plan.

Mining site rehabilitation has been designed and then carried out with a view to scaling down the monitoring of those sites to a very slight level, once an active monitoring phase of a few years is set in place. The objective of operators and agents responsible for administrative monitoring was to avoid excessive site-monitoring or maintenance constraints over the long term.

However, checks and even modifications proved to be necessary for the disposal sites used for treatment residues from uranium-bearing ore and mining waste rock, and measures are currently ongoing (see B.6.3).

Studies on the long-term behaviour of tailings disposal sites have been submitted under the PNGMDR 2013-2015 and will be continued under the PNGMDR 2016-2018.

SECTION I | TRANSBOUNDARY MOVEMENT (ART. 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 relevant binding international instruments. In so doing:*

   i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorised and takes place only with the prior notification and consent of the State of destination;

   ii) a transboundary movement through States of transit shall be subject to those international obligations, which are relevant to the particular modes of transport utilised;

   iii) 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;

   iv) a Contracting Party which is a State of origin shall authorise a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary movement, and

   v) 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 radioactive waste is exported for processing to return, or provide for the 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 processing, and

   iv) the rights of a Contracting Party to which spent fuel is exported for processing to return, or provide for the return of, radioactive waste and other products resulting from processing operations to the State of origin.

1 | LICENSING OF TRANSBOUNDARY TRANSPORT

France advocates the principle whereby every NPP operator is liable for the waste he generates. That principle is integrated in the Environment Code which prohibits the disposal of any radioactive waste in France that originates from abroad or results from the processing of spent fuel and radioactive waste produced abroad. The same Article specifies that the introduction of any radioactive substance or equipment on French soil for treatment purposes is conditional upon intergovernmental agreements, setting a mandatory date for the return of the ultimate treatment waste to the country of origin (see B.1.4).

Radioactive waste is conditioned in a form that guarantees their most secure transport and storage possible for the environment and public health. France ensures that the countries of destination of that waste comply with the obligations set by § 1 of Article 27 of the Joint Convention.

With regard to the organisation of transboundary movements, France applies all international, European and national safety, transport, security, physical-protection and public-order regulations, including the prescriptions of 2006/117/Euratom Council directive of 20 November 2006 concerning the monitoring and control of radioactive-waste and spent-fuel transfers, as transposed in internal law by Decree No. 2008-1380 of 19 December 2008 and codified in Articles R. 542-34 to 66 of the Environment Code.

Transboundary movements of spent fuel and radioactive waste between France and third-party countries involve mainly spent-fuel processing operations, that are performed at the La Hague Plant on behalf of Belgian, Dutch, German, Italian, Japanese and Swiss customers.

Most transboundary movements between European countries are made by rail. Sea routes are used for Japan-bound shipments, since suitable port infrastructures meeting the required nuclear-safety level have been built at both ends of the itinerary. No significant incident compromising safety, security or radiation protection has been notified in recent years during those shipments.

In accordance with § 2 of Article 27 of the Joint Convention, France has never authorised any spent-fuel or radioactive-waste movement towards a destination located south of 60° latitude South.

Since French authorities are truly committed to fulfilling the transport provisions of Article 27 of the Joint Convention, they readily supplement them through a transparency policy, based on information exchange and dialogue, particularly with the public at large and civil society. More specifically, they apply those sea-transport provisions to coastal States along the sea routes and conduct diplomatic information campaigns.

2 | CONTROL OF TRANSPORT SAFETY

2.1. Organisation of safety control for the transport of radioactive substances

Since 12 June 1997, ASN has been responsible for regulating and controlling the safe transport of radioactive and fissile materials for civilian uses. Its powers in that field are mentioned in the Environment Code.

It should be noted that transport regulations for radioactive substances have two separate objectives, as follows:

- security, or physical protection, consists in preventing any loss, disappearance, theft and fraudulent use of nuclear materials (usable for nuclear weapons production), for which the Senior Defence and Security Official (*Haut fonctionnaire de défense et de Sécurité* – HFDS) reporting to the Minister in charge of Ecology, is, per delegation of the Ministries of Defence and Energy, the competent authority;
- safety consists in controlling the irradiation, contamination and criticality risks relating to the transport of radioactive materials, in order to protect human beings and the environment against their ill effects. Safety control is the responsibility of ASN.

Pursuant to the Defence Code, control of the transport of radioactive substances relevant to national defence is the responsibility of the Delegate for nuclear safety and radiation protection for activities and facilities involving defence (DSND).

In the oversight of the safety of transport of radioactive and fissile substances, ASN is tasked with:

- contributing to the preparation of the technical regulations and monitoring their application;
- carrying out the licensing procedures (approval of packages and organisations);
- receiving the notifications prior to the shipping of higher-risk radioactive substances and receiving the notifications from companies whose activity involves the transport of radioactive substances;
- organising and supervising inspections;
- taking enforcement measures (serving compliance notices, financial deposit, compulsory work performance, suspension of transport, etc.) and the necessary sanctions;
- contributing to informing the public.

In addition, ASN would provide the public authorities with technical support in the event of an accident involving radioactive substances.

2.2. Regulation of the transport of radioactive substances

Unlike the technical regulations governing the safety of installations, which are specific to each country, international bases have been developed by the IAEA for the safety of transport and constitute the regulations for the safe transport of radioactive material, reference SSR-6 (2012 edition).

It must be noted that the term "radioactive material" used in the regulations specific to transport designates all radioactive substances, including waste.

The IAEA bases are taken up in the international modal regulations:

- the ADR agreement (European Agreement concerning the International Carriage of Dangerous Goods by Road) which governs road transport;
- the RID regulations (Regulations concerning the International Carriage of Dangerous Goods by Rail) which governs rail transport;
- the ADN agreement (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways) which governs inland waterway transport;

- the IMDG (International Maritime Dangerous Goods) code which governs maritime transport, and;
- the technical instructions of the ICAO (International Civil Aviation Organisation) which governs air transport.

These modal regulations are integrally transposed into French law and rendered applicable by European or French legislation (Directive 2008/68/EC, Commission Regulation (EU) 965/2012, TMD Order of 29th May 2009, RSN Order of 23rd November 1987, etc.). To this end, ASN is in contact with the Administrations responsible for the various modes of transport (General Directorate for Risk Prevention (DGPR), General Directorate for Infrastructure, Transport and the Sea (DGITM), General Directorate for Civil Aviation (DGAC) and sits on the Interministerial Commission on the Transport of Hazardous Materials (CITMD).
Safety of transport is based on the principle of defence in depth and three complementary levels of protection:

- the robustness of the packages, which enables the safety functions to be maintained, including in the event of a severe accident (if the risks so justify);
- the reliability of the transport operations, which reduces the occurrence of anomalies, incidents and accidents;
- emergency situation management, which makes it possible to mitigates the consequences of incidents and accidents.

The IAEA document Regulations for the Safe Transport of Radioactive Material SSR-6 specifies the package performance criteria. The package must fulfil the safety functions of containment, radiation protection, prevention of thermal risks and criticality.

The level of safety of the package is appropriate for the potential danger that the transported material represents. For each type of package (excepted packages, industrial packages, type-A, type-B, type-C packages, etc.), the regulations define the safety requirements which aim to maintain the safety functions when the packages is subjected to certain test conditions.

ASN is the competent authority for the safe transport of radioactive materials. It participates in the drafting of the technical regulations and verifies their application. ASN endeavours to be involved as early as possible in the preparation of the regulations, in collaboration with IRSN, by participating more specifically in the various international or multinational working groups that exist for the transport of dangerous goods and radioactive materials.

In this context, ASN is a member of the IAEA TRANSSC (Transport Safety Standards Committee) and is represented in numerous working groups relative to the transport of dangerous goods, as an expert when the case of radioactive substances is addressed. It also participates in the European Association of Competent Authorities (EACA).

With regard to spent fuel and waste transport operations, the French regulations impose the same safety rules whether the transport operations involve border crossings or not. All these transport operations must therefore comply with the international modal regulations, in particular the ADR agreement for transport and the RID agreement for rail transport.

As regards security, the Defence Code contains provisions aiming to prevent the theft of nuclear material during transport or malicious acts directed against them. This applies in particular to spent fuel and high-level waste transport operations.

To this end, the Defence Code stipulates that the carriers must obtain an authorisation from the HFDS (Senior Defence and Security Official). They are required in particular to take measures to protect the items they collect or transport and to comply with the inspection requirements.

The HFDS relies on the assistance and technical expertise of the IRSN in the accomplishment of this task. IRSN is more specifically tasked with monitoring nuclear transport operations.

In this context, a duly authorised carrier must provide IRSN with a notice describing the conditions of each transport operation, indicating the nature and quantity of material transported, the places of departure and arrival, the itinerary and schedule and border crossing points. On the basis of this file, IRSN or the HFDS, as the case may be, will issue an authorisation to carry out the transport operation or not.

2.3. The inspection in the transport of radioactive materials

ASN has implemented an inspection structure involving its local divisions and is working in a similar way with existing procedures for BNIs.

A sound organisation is sought from the regulatory and practical standpoints with the other regulatory authorities responsible notably for transport means, labour inspection in the transport sector or the protection of nuclear materials. Those regulatory authorities may prohibit a shipment after detecting non-conformities with regulations. In addition, the Energy Transition for Green Growth Act of 17 August 2015 reinforces the powers of ASN inspectors, especially in relation to violations and penalties.

2.4. Radioactive substance transport events

The recording and analysis of transport events provides ASN with information on the problems encountered by the transport actors and any risks for safety, in order to improve practices and identify any needs for changes in the regulations.

In accordance with the provisions of the TMD order of 29th May 2009 and the requirements of the international modal regulations and the Environment Code, any deviation from the regulations or requirements of the safety case, and any event actually or potentially affecting safety, must be notified to ASN within four working days. In addition to this notification, a detailed report of the incident must be sent to ASN within two months.

In the transport of radioactive substances, 58 events rated level 0 and 5 events rated level 1 were notified to ASN in 2016.

A guide addressed by ASN to all the consignors and carriers, and which is available on its website (www.asn.fr), defines the classification criteria for events involving transport and the procedures for notifying ASN of them. A revision of this guide (ASN Guide no 31) was published in May 2017.

SECTION J | DISUSED SEALED SOURCES (ART. 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 safe 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 source.

1 | REGULATORY FRAMEWORK

The general regulatory framework for sources is described in § F.4.1.2.4. Any user to whom a sealed source has been delivered must have them collected by the supplier as soon as it is out of use and no later than 10 years after the initial approval appearing on the corresponding supply form. Those provisions relating to the recovery of sources and to financial responsibilities apply in France since the early 90s.

Studies on suitable solutions for eliminating disused sources are also under way in the framework of the PNGMDR.

ASN has authorised that sealed radioactive sources with a shorter half-life than caesium-137 (i.e., about 30 years) be disposed of at the CSA, in accordance with activity limits per source and per source package. Since that management system concerns only about 10% of disused sources, it will not allow for the overall long-term management of all sources.

In order to control and to limit the number of radioactive sources to be recovered, the extension of the operating lifetime of some sources is contemplated. A technical Resolution by ASN specifying the conditions under which such extension may be granted was ratified by the *Order of 23 October 2009* (*ASN Resolution No. 2009-DC-0150*). Such extension needs to be assessed particularly on the basis of the construction process of the source, the quality of its fabrication, its past operating conditions and the extent to which its state and impermeability may be controlled. The results of periodical technical controls throughout the operating lifetime of the source are also examined.

2 | CEA'S ROLE

Under French regulations, since 1989, sealed source suppliers are responsible for recovering disused sealed radioactive sources (DSRS) if requested by the user. This obligation now figures in the Public Health Code (Article R.1333-52 III).

The CEA and CISBIO, its former subsidiary, were major manufacturers and suppliers of a very large variety of sealed sources (all isotopes, all applications). Recovery of the DSRS's is therefore a statutory obligation for the CEA, resulting from its past activities as a sealed source supplier. Furthermore, given the special status of the CEA with regard to the management of its own sources until April 2002, the CEA manages the DSRS's acquired before that date, whoever the initial supplier was.

It is in this context that the CEA has set up a system for collecting and storing DSRS's and is seeking disposal routes. This system was finalised in 2008/2009 with the creation of:

- the HL Sources GIP (high-level sources Public Interest Grouping), between CEA and CISBIO, for the retrieval of high-level cobalt and caesium sources ;
- the Sources Mission, responsible for strategic coordination of the entire DSRS programme.

The programme scope includes:

- collection and management through to disposal of DSRS's which were supplied by the CEA or CISBIO and all the DSRS's used by the CEA and acquired before April 2002;
- management of the sources already retrieved in the past by the CEA or CISBIO through to their disposal;
- collaboration with the IAEA in international operations to retrieve or make safe radioactive sources within the framework of the agreement signed by France and the IAEA in 2011 ("support-plan").

At the end of 2008, ANDRA issued a study on the sustainable management of disused sealed radioactive sources under the waste act, and the 2009 version of the PNGMDR took the management of DSRS's into account. The CEA used these bases to revise its DSRS management strategy in order to systematically include not only their retrieval and storage but also their disposal. This strategy was approved by ASN in the first half of 2012.

The CEA and CISBIO have stopped their sealed source supply activities (CEA in 1999 and CISBIO in 2006). Consequently, the CEA's DSRS management programme aims at achieving its objectives within a limited time frame. The end of the regulatory obligations of the CEA (and CISBIO) resulting from their statuses as former suppliers and manufacturers of sealed sources, which is the fundamental objective of the Sources mission, implies:

- keeping the various retrieval routes available for the time necessary to finalise the collection of disused or still-used sources;
- creating disposal routes and keeping them available for the time necessary to ensure the disposal of the stocks of sources already retrieved and those still to be retrieved;
- close or transfer to ANDRA the developed disposal routes by 2023.

3 | DISPOSAL OF DISUSED SEALED SOURCES

3.1. Stock of disused sealed sources

In late 2011, ANDRA updated an inventory of the stocks of disused sealed sources considered as waste, together with the entities in possession of them, pursuant to decree 2012-542 of 23 April 2012 setting out the requirements of the PNGMDR 2010-2012. 3.5 million disused sealed sources have been declared to ANDRA. The companies in the French grouping of electronic fire safety industries (GESI) hold about 74% of all disused sealed sources (smoke detectors), the French armed forces hold about 23% (scrapped military equipment such as compasses, instrument dials, etc.) and industrial and medical sources represent about 3% (including the sources at CEA, the *Compagnie pour l'Etude et la Réalisation de Combustibles Atomiques* - CERCA, EDF, etc.).

3.2. Overview of the conditions of disposal of sealed sources

On account of their properties, disused sealed sources lie within the categories of radioactive waste that require special management routes.

The specificity of sealed sources is their concentrated activity and their potential attractiveness. In the event of human intrusion following the loss of all recorded memory of a repository, this attractiveness could lead to used sealed sources being retrieved by individuals unaware of the hazards. If the impact that would result from this retrieval were considered to be excessive, the used sealed sources would not be considered acceptable in the repository. The repository acceptance conditions for sources are therefore the subject of specifications, on the one hand with an activity criterion concerning the packages and structures, called “specific activity limit” (LAM) and on the other an activity criterion per radionuclide in each source, called the “source activity limit” (LAS). This source activity limit is estimated in order to limit exposure in the event, for example, of a package falling during repository operation or humans intruding after the monitoring period and taking away a disused sealed source (scenarios considering the potentially attractive nature of the source).

The CSA today, and the CIRES since 2015, have acceptance specifications for the disposal of radioactive packages containing sealed sources.

The CSA accepts sources comprising a single radionuclide whose half-life is less than that of caesium-137, that is to say 30 years, and with activity levels below given thresholds[25]. Lastly, mixed packages containing both disused sealed sources and waste are not authorised. For the CIRES, the accepted sources are those whose activity 30 years after their arrival will be less than 1 Bq. 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 type waste repository. Used sealed sources not acceptable in surface or sub-surface repositories were allocated to deep geological disposal, along with ILW-LL waste for disused sources having low exothermal properties and with HLW waste for the most exothermal disused sources.

Within the framework of the PNGMDR 2013-2015, on the basis of the previous PNGMDRs, a working group - the "Sources WG" - jointly chaired by the Director General for Energy and Climate and the Director General for the Prevention of Risks, or their representatives, continued the analysis of the situation and the needs in order to define procedures for the management of disused sealed sources if they are intended for recycling or considered as waste. The CEA, which is a stakeholder in the management of disused sealed sources and ensured the secretariat of the working group, submitted the WG recommendations in a report distributed on 19th December 2014.

The PNGMDR 2016-2018 thus recommends primarily that ANDRA:

- examines the possibility of reassessing the acceptance criteria for the CIRES and the CSA;

[25] Activity per source < source activity limit (LAS), depending on the radionuclide concerned; maximum activity of package < 270 TBq; Specific activity of package < 1/10 of the maximum acceptable limit (MAL).

- develops - as part of the project for a disposal facility for LLW-LL waste currently under design - preliminary acceptance criteria for disused sealed sources;
- integrates, for the HLW and ILW-LL waste, the case of disused sealed sources in the preparation of preliminary acceptance specifications for the CIGEO project transmitted as part of the project safety options;
- presents at the end of 2017 a track record for the deployment of the management routes for disused sealed sources considered as waste in order to assess the implementation of the preceding recommendations.

3.3. Retrieval of disused sealed sources

The holders of sealed sources are required under article R. 1333-52 of the Public Health Code to have their sources retrieved after ten years of possession, unless a holding extension authorisation is issued.

The supplier of sealed radioactive sources is for its part obliged to retrieve, unconditionally and on simple request, any sealed source it has supplied.

Since 1st June 2015, this article provides for the possibility of retrieval by any sealed radioactive source supplier (and no longer only the original supplier or its successor) and by ANDRA if, and only if, the original supplier has not been able to be identified or if there is no possibility of recycling these disused sealed radioactive sources under the prevailing technical and economic conditions.

The PNGMDR 2016-2018 asks ANDRA to evaluate, taking this modification in to account, the inventory of disused radioactive sealed sources likely to be collected in the next 5 years and to check that its storage capacities are compatible with that inventory.

SECTION K | GENERAL EFFORTS TO IMPROVE SAFETY

1 | NATIONAL MEASURES

In order to guarantee and maintain a high level of nuclear safety for the nuclear installations in France, the French authorities carry out their duties on the basis of various principles.

Among these principles, a priority is the continuous improvement of nuclear safety, using the best available techniques.

1.1. ASN Objectives

Under article L. 592-1 of the environment code, ASN participates in the oversight of nuclear safety and radiation protection and informing the public in these areas (see § E.3.1).

ASN is involved in all aspects of radioactive waste management, fuel management and decommissioning, either directly as the installations oversight authority or within the framework of the PNGMDR.

1.1.1. Objectives concerning the regulatory framework

Continuation of the overhaul of the regulatory framework applicable to BNIs

Since 2013 ASN has been pursuing its overhauling of the regulatory framework applicable to BNIs.
In 2015, the promulgation of the "TECV" Act 2015-992 of 17th August 2015 relative to energy transition for green growth marked a new state in the legislation concerning nuclear activities. The modifications introduced stem firstly from the TECV Act itself and from Ordinance 2016-128 of 10th February 2016 adopted in application of this act. These two texts have amended the Environment Code and the "BNI Procedures" decree of 2nd November 2007 on the basis of experience acquired in application of the framework put in place in 2006 and the harmonisation of practices at European level, a task in which France was a major contributor. The licensing system has, among other things, evolved to give a system that is more graded and proportionate to the risks. Decree 2016-846 of 28th June 2016 relative to the modification, final shutdown and decommissioning of basic nuclear installations and to subcontracting has also changed the regulatory framework governing these subjects:

- with regard to the BNI final shutdown and decommissioning system, the principle of decommissioning the BNIs in the shortest possible time frame is written into the Environment Code;
- with regard to closure and entry into monitoring phase of disposal facility BNIs, which are subject to the consent of ASN and for which the conditions and duration must be described in the decommissioning, closure and monitoring plan;
- the use of outside contractors and subcontracting is also more tightly regulated.

Ordinance 2016-128 of 10th February 2016 also allowed the transposition of Council Directive 2011/70/Euratom of 19th July 2011 for the responsible and safe management of spent fuel and radioactive waste.
ASN also continued its work on preparing regulatory resolutions aiming to detail the "BNI Procedures" decree or the BNI order with, among other things:

- in 2013, resolutions relative to :
    - control of detrimental effects and the impact of BNIs on health and the environment;
- in 2014, resolutions relative to :
    - control of the criticality risk in BNIs;
    - physical modifications;
    - control of the fire risk;
- in 2015, resolutions relative to:
    - the study of waste management and the assessment of the waste produced in the BNIs;
    - the content of the safety analysis report.

ASN also continued preparing guides presenting recommendations detailing the safety objectives and describing the practices that ASN deems satisfactory. An exhaustive list of the published guides is provided in the appendix in section L.5.2.
ASN continued this work in 2017, applying Guide No. 25 published in 2016 on the conditions for consulting stakeholders and the public in the preparation of regulatory resolutions or ASN guides.
In this respect, in 2017 ASN will finalise the resolution relative to the packaging of radioactive waste and will produced draft resolutions relative to radioactive waste disposal and storage facilities.
In 2017 ASN also plans preparing a joint guide detailing the structuring and the requirements associated with BNI decommissioning plans and starting the drafting of guides developing specific points stemming from Guides No. 14 and No. 24 relative to the management of polluted soils, and in particular a guide relative to radioactivity measurements in order to verify achievement of the clean-up objectives for a site.
In 2017 ASN will also start revising the safety guide on the disposal of low-level long-lived radioactive waste.
ASN will also keep track of the work to transpose Directive 2013/59/Euratom of 5th December 2013 setting the basic standards for radiation protection.

Involvement in international working groups

Lastly, ASN will remain strongly involved in international work by maintaining its active participation in international working groups.
More specifically, ASN participates in:

- the WGWD (Working Group on Waste and Decommissioning) of WENRA (Western European Nuclear Regulators Association) tasked with developing reference levels relative to the management of radioactive waste and spent fuels;
- the WASSC (Waste Safety Standards Committee) of the IAEA (International Atomic Energy Agency) whose role is to draw up international standards, particularly for the management of radioactive waste;
- Working Group 2 (WG2) of ENSREG (European Nuclear Safety Regulators Group) tasked with subjects relating to the management of radioactive waste;
- the meetings of the International Working Forum on Regulatory Supervision of Legacy Sites (RSLS) organised by the IAEA to discuss the management and prevention needs of legacy sites;
- other projects such as SITEX-II[26] conducted with the European Union, or GEOSAF-Part II[27] and HIDRA[28] of the IAEA.

1.1.2. Objectives concerning radioactive material and waste

1.1.2.1. THE FINDINGS

ASN considers that the French radioactive waste management system, built around a specific body of legislative and regulatory texts, a national radioactive materials and waste management plan (PNGMDR) and an agency dedicated to the management of radioactive waste (ANDRA), is capable of regulating and implementing a structured and coherent national waste management policy. All waste must ultimately have access to safe management routes, and more specifically to a disposal solution. ASN will monitor the progress of the studies submitted under the PNGMDR 2016-2018, more specifically within the PNGMDR working group that it co-chairs with the DGEC.

1.1.2.2. THE ISSUES

Deep geological disposal of high and intermediate level, long-lived waste (HLW/ILW-LL);

With regard to the CIGÉO project for the disposal of high and intermediate level, long-lived waste, 2017 will be marked by the drafting of the ASN opinion on the CIGÉO safety options file submitted by ANDRA in 2016 and containing more specifically the project’s safety options, the technical retrievability options, a preliminary version of the waste acceptance specifications and a project development plan. This file is the first overall file on the safety of the facility since 2009. It underwent an international peer review under the aegis of the IAEA in November 2016. The ASN opinion, based on an analysis of the safety options file by the competent Advisory Committees of Experts and on the report of the IAEA experts, will indicate in particular its expectations regarding the content of the CIGÉO creation authorisation application that ANDRA plans submitting in mid-2018.

ASN underlines the importance it attaches to the progress that the waste producers must make in packaging their waste, particularly the waste resulting from waste repackaging operations and notes that the preparation of a preliminary version

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[26] "*Sustainable network for Independent Technical EXpertise of radioactive waste disposal - Interactions and Implementation*", Horizon 2020 Project

[27] "*GEOSAF Part II provides a forum to exchange ideas and experience on the development and review of an integrated operational and post-closure safety case for geological disposal facilities. It also aims to provide a platform for knowledge transfer.*"

[28] "*Human Intrusion in the context of Disposal of Radioactive Waste*"

of waste acceptance specifications for CIGÉO by ANDRA will enable the requirements concerning the future waste packages to be detailed.

Disposal of low level, long-lived waste (LLW-LL)

The LLW-LL waste essentially comprises graphite waste from the gas-cooled reactors, radium-bearing waste and bituminised waste from the treatment of radioactive liquid effluents on the Marcoule site. ASN considers it vital to move forward in the setting up of management routes for this waste. The analysis of the file submitted by ANDRA in 2015 has shown that it will be difficult to demonstrate the feasibility - in the investigated area on the land of the community of Soulaines - of a disposal facility for all the LLW-LL waste. In its opinion of 29th March 2016, ASN asked ANDRA to submit by mid-2019, a report presenting the technical and safety options for this disposal facility, the inventory of the waste likely to be disposed of in it and an industrial scheme for managing the LLW-LL waste established through consultation with the producers of this waste.

Depending on the results of this report, the waste producers may have to firstly deploy new storage capacities to avoid delaying the decommissioning operations, and secondly speed up the deployment of alternative strategies if their waste is not compatible with ANDRA's project.

The packaging of the waste, and legacy waste in particular

ASN considers that research must be continued and intensified in the coming years in order to define and implement appropriate packaging methods for irradiating ILW-LL waste containing organic matter and for legacy waste, so that the waste produced before 2015 is packaged before 2030 in accordance with the law.

As the level of safety of certain legacy waste storage facilities is unsatisfactory, ASN asks the licensees concerned to rapidly retrieve and package this waste with a view to storing it in safe facilities. In this respect, an ASN resolution concerning the retrieval and packaging of the legacy waste at the La Hague site was issued on 9th December 2014.

In 2017 ASN will continue to closely monitor the legacy waste and spent fuel retrieval and packaging operations, focusing on those presenting the most significant risks for safety.

ASN will also give an opinion on the studies and the strategies demanded of the licensees under the PNGMDR for the retrieval and packaging of waste produced before 2015 to be packaged before 2030.

The radioactive waste management strategies

ASN periodically assesses the strategies implemented by the licensees to ensure that each type of waste has an appropriate management route and that the various routes are mutually coherent. ASN in particular remains attentive to ensuring that the licensees have the necessary treatment or storage capacity to manage their radioactive waste and anticipate sufficiently far in advance the construction of new facilities or renovation work on older facilities.

In this respect, ASN and ASND are assessing the waste management strategy of AREVA, submitted in mid-2016, and that of the CEA submitted at the end of 2016. ASN and ASND will issue their conclusions in 2018.

In 2017 ASN will ensure in particular that the CEA meets its commitments concerning its old installations which no longer comply with current safety requirements. ASN will also keep track of the progress of the CEA's strategic waste management projects (DIADEM, BNI 37-A, solid and liquid waste management on the Saclay site) and the preparation of the decommissioning files for the old storage facilities (BNI 56, PEGASE, BNI 37B).

ASN will ensure that the main recommendations of the PNGMDR 2016-2018 are implemented by the radioactive waste producers and the material owners. The general objectives of these recommendations are to:

- reinforce the management route approach by recommending the setting up or the updating of associated overall industrial schemes by checking, more specifically, the coherence of the waste management strategy with the decommissioning programmes;
- consolidate the radioactive waste production forecasts, particularly for very low level waste, and reduce the waste produced at source;
- adopt an approach considering the long-term harmfulness of the radioactive waste in a global environmental perspective;
- reinforce the prospects for long-term reutilisation of certain radioactive materials, or the storage strategies adopted by the licensees pending the availability of final management solutions.

The other objectives of ASN

In 2017, ASN will continue examining the commissioning authorisation applications for the storage BNIs ECRIN at Malvési (AREVA) and ICEDA near the Bugey NPP (EDF). It should also start reviewing the commissioning authorisation application for the DIADEM storage facility in Marcoule (CEA).

In 2017 ASN will continue examining the periodic safety review of ANDRA's CSA disposal facility and will start examining the periodic safety review files of several CEA treatment, storage and packaging facilities which are to be received before the start of November 2017.

Management of the former uranium mining sites and polluted sites and soils

With regard to the former uranium mining sites, in 2017 ASN will endeavour to address the concerns of the DREALs (Regional Directorates for the Environment, Planning and Housing) regarding the AREVA Mines action plan for the management of mining waste rock. It will focus in particular on the management of potentially sensitive situations, especially with regard to the radon risk. It will ensure that the measures are taken in complete transparency and with the involvement of local stakeholders and it will continue its work in collaboration with the Ministry responsible for the environment.

As far as the polluted sites and soils are concerned, ASN will continue in 2017 to state its position on the projects for the rehabilitation of polluted sites on the basis of the principles of the doctrine it published in October 2012 and will work with the Ministry responsible for the environment on the revision of Circular of 17th November 2008 relative to the management of certain types of radioactive waste and sites displaying radioactive contamination. In 2017 ASN will adopt a position on the draft decree for the transposition of Directive 2013/59/Euratom which should be adopted the same year. It will also maintain its investment in the operational management of the Radium Diagnosis operation. It will pursue its action in collaboration with the government departments concerned and the other stakeholders.

1.1.3. Objectives concerning decommissioning

In 2016, some thirty nuclear installations of all types (power and research reactors, laboratories, fuel reprocessing plants, waste treatment facilities, etc.) were shut down or undergoing decommissioning in France, which corresponds to about one third of the BNIs in operation other than the power reactors. The decommissioning operations are most often long and costly, involving the removal of massive amounts of waste and representing challenges for the licensees. The current size of the French nuclear fleet, of which the oldest plants and research installations are today definitively shut down or undergoing decommissioning, makes this stage in the life of an installation a major challenge for the future.

ASN's main actions in 2017 will concern the monitoring of the examination and progress of the decommissioning projects (examination of the decommissioning files for: AMI (Chinon), COMURHEX, EURODIF, UP2-400, STE2, ATUE, RAPSODIE, the SUPPORT and PROCÉDÉ BNIS, the solid radioactive waste management zone). This must be carried out with appropriate waste management strategies. ASN will be particularly attentive to the projects for retrieval and packaging of the legacy waste from CEA and AREVA, where the delays are highly detrimental for the safety of the sites concerned. As indicated above, the strategy files submitted by these two licensees in June and December 2016 respectively shall undergo in-depth examination.

ASN will also make a position statement on EDF's request to change the decommissioning strategy for its gas-cooled reactors (GCR).

The periodic safety reviews of the installations undergoing decommissioning, for which the majority of the conclusions files will be submitted by the licensees in 2017, will undergo attentive examinations tailored to the risks and inconveniences these installations represent.

ASN will also continue its oversight actions to get the licensees to devote the necessary means to ensure decommissioning in as short a time as possible and achieve a final state in which the maximum possible amount of hazardous substances, radioactive substances included, has been removed.

1.1.4. Objectives concerning the fuel cycle

1.1.4.1. CROSS-DISCIPLINARY ASPECTS

ASN will continue its review of several of the AREVA group’s BNIs and will extend this process to new facilities at La Hague and Romans-sur-Isère in particular, but also on EDF's inter-regional fuel stores (MIR) for storing fresh fuel with enriched natural uranium (at Chinon and Bugey).

ASN will continue to monitor implementation of the additional safety measures requested following the stress tests (see § A.3).

With regard to the current AREVA group, ASN will be particularly attentive to ensuring that the future BNI licensees resulting from the ongoing split-up of the group are in full possession of the capabilities needed to meet their responsibilities as licensees. In particular, two groups resulting from AREVA as it currently stands must have sufficiently credible capabilities to make any necessary changes to the facilities concerned and manage any emergencies in them.

1.1.4.2. CONSISTENCY OF THE CYCLE

In 2016 ASN began examining the new “Cycle impact” file, covering the 2016-2030 period which aims at anticipating the various emerging needs in order to manage the nuclear fuel cycle in France. ASN will focus in particular on monitoring the level of occupancy of the spent fuel underwater storage facilities (AREVA and EDF). It has asked EDF, as overall ordering customer, to examine the impact of the shutdown of a reactor or a possible change in the spent fuel reprocessing streams on the forecast saturation dates for these storage facilities, along with solutions for delaying these dates. ASN considers that AREVA and EDF must very rapidly define a management strategy that goes beyond 2030. The "Cycle impact" file submitted in 2016 is currently being examined and will undergo a joint review by the Advisory Committees of Experts for laboratories and plants, waste, reactors and transport in early 2018.

1.1.4.3. TRICASTIN SITE

ASN will continue its examination of the modification of the SOCATRI facility under the Trident project. ASN will be particularly attentive to the reorganisation of the site for the management of nuclear waste pending construction of the Trident facility which should begin in 2017.

ASN shall keep a close watch over the commissioning of the ATLAS facility which is to replace several run-down laboratories.

ASN will continue to monitor the reorganisation of the Tricastin platform to ensure that these major organisational changes have no impact on the safety of the various BNIs on the site. It will also ask the platform's licensees to either complete the unification process initially planned for 2012 or that they ensure their independence by abandoning the sharing of equipment and entities they need today.

ASN will start examining the periodic safety reviews of BNIs 93 (Georges Besse enrichment plant) and 105 (uranium conversion plant), for which the files must be submitted in November 2017 at the latest.

Jointly with ASND and the Minister responsible for nuclear safety, ASN will define the final breakdown into BNIs resulting from the ongoing process to declassify the site's SBNI.

1.1.4.4. MELOX PLANT

ASN will continue monitoring compliance with the licensee's commitments and the prescriptions it issued further to the periodic safety review of the plant carried out in 2011, particularly with regard to the fire risk and the monitoring of outside contractors.

In addition, the changes in fuel management for power reactors, which will necessitate adaptation of the characteristics of the MOX fuel, will be a subject of interest for ASN. AREVA NC will effectively have to demonstrate that these changes have no impact on the safety of the facility and it will, if need be, submit the necessary modification files.

The licensee has stated its intention to manufacture, on an experimental basis, fuel compatible with the ASTRID project.

1.1.4.5. LA HAGUE SITE.

ASN will be particularly attentive in 2017 to any development in the corrosion of the fission product evaporator-concentrators. AREVA NC must consolidate its methods of inspecting these items of equipment and its corrosion development forecasts. AREVA NC has undertaken to replace these items with commissioning staggered between 2020 and 2021. ASN will examine the corresponding applications.

In the context of the periodic safety reviews, ASN will monitor the conformity work on the UP3-A plant and compliance with the prescriptions of the resolution of 3rd May 2016. Particular attention shall be paid to application of the identification methodology for equipment important for protection and the reassessment of the control of fire-related risks. The examination of the periodic safety review file for the UP2-800 plant will give rise to the first review by the Advisory Committee of Experts for Plants at the end of 2017.

With regard to the forthcoming process changes in the La Hague facility, ASN attaches particular importance to the TCP (specific-fuel processing) project, which will make it possible to process several fuel assemblies which at present cannot be processed and thus push back the point at which the storage pools reach capacity. Among other things, ASN will have to supervise commissioning of pit 40 of the E/EV-LH building for the storage of CSD-V packages by Autumn 2017.

ASN will also ensure that all the fuels received at the AREVA NC plant are received with a view to processing in accordance with the plant's authorisation decrees.

With regard to the retrieval and packaging of legacy waste, ASN considers that efforts must be maintained. It will be careful to ensure that the changes in AREVA's industrial strategy do not lead to noncompliance with the prescriptions concerning the retrieval and removal of the waste from silo 130 and the sludge from STE2 and HAO. ASN has already issued prescriptions in this respect, in 2010 for silo 130 and in 2014 for the RCD (waste retrieval and packaging) programme as a whole.

1.1.4.6. ROMANS-SUR ISÈRE SITE

AREVA NP still needs to carry out major conformity work on several buildings.

Given the malfunctions observed in recent years, ASN will continue the tightened monitoring of the site in 2017 in order to ensure that this licensee’s nuclear safety performance is improved. It will be attentive to compliance with the deadlines for performance of the work defined in the facility’s safety improvement plan and the revision of its safety baseline requirements. It will also be attentive to the implementation of the improvements planned as part of the stress tests (see § A.3).

The report presenting the conclusions of the ten-yearly safety reviews carried out on BNI 63 (CERCA) submitted in late 2015 will be examined to enable ASN to reach a conclusion with regard to the conditions for authorisation of possible continued operation of these facilities for the next ten years.

1.2. Objectives of the licensees

1.2.1. Objectives of ANDRA

The Waste Act and the putting in place of the PNGMDR have extended and reinforced the remit of ANDRA, which acts as a State operator. A contract defining ANDRA's objectives for the 2013-2016 period was signed with the State in 2013. A new 5-year contract is currently being prepared. It is the subject of numerous discussions with ANDRA's various contacts (waste producers and stakeholders).

This contract hinges around strategic priorities which make safety the focal point of ANDRA's actions, and in particular:

- industrial excellence, with involvement in the management of decommissioning waste and the search for a balance between the safe operation of the centres and the producers' constraints;
- the success of the CIGÉO project, in the context of an approach subtending project optimisation, incremental development and reversibility, resulting in a creation authorisation application based on optimised detailed preliminary project studies;
- an action governed by societal, environmental and ethical responsibility, through the implementation of innovative systems of dialogue and constantly endeavouring to integrate (environmentally and societally) the activities in the regions through consultation and co-construction;
- a position as a public agency constituting the reference and authority in managing waste safely and proportionally to the risks, integrating the complexity of these risks, and guiding more specifically the deployment of solutions for the management of waste from the decommissioning work sites.

1.2.2. CEA Objectives

Maintaining its BNIs at the optimum level of safety remains a major priority for CEA.

On this account, CEA performs periodic safety reviews of its installations every ten years. The lessons drawn from the accident that hit the Fukushima-Daichii nuclear power plant in Japan in 2011 have also given rise to a plan of actions to reinforce the protection of the installations against natural phenomena of high intensity, not taken into consideration in the installation design basis due to their very low probability of occurrence.

CEA is also conducting a major programme to renovate its transport packages to meet its needs and changes in regulations.

Training and awareness-raising actions continue to be implemented to reinforce the security, radiation protection and nuclear safety culture of the personnel. Likewise, the entire chain of command is mobilised in the progress approach on which the safety policy of the installations is founded, and which implies its commitment and accountability as regards defining objectives and allocating resources.

In the area of radiation protection, CEA, which considers the health of its personnel and outside contractors a priority, is stepping up its action for exposure reduction and forward-looking management, in which the employees concerned are fully involved.

CEA is implementing a major radioactive clean-out and decommissioning programme on those of its installations whose maintained operation is no longer justified, whether this is because they no longer meet CEA's R&D requirements or because they do not meet current safety standards. In this programme, CEA is endeavouring to minimise the resulting waste production and ensure that the waste is correctly categorised to avoid overloading existing management routes as a result of systematic conservative classification.

CEA also contributes to the studies called out in the PNGMDR, particularly in the areas of waste disposal, storage and packaging, the management of disused sealed sources and the recycling of radioactive waste.

1.2.3. EDF Objectives

EDF aims at having optimised management routes for all its waste and is working, within the framework of the PNGMDR and in collaboration with ANDRA and the other waste producers, on the development of these routes through its technical and financial participation.

EDF’s other objective is to make the best use possible of current disposal facilities in service in order to extend their operating lifetime by limiting the volumes intended for disposal.

With regard to disposal-facility projects, EDF and the other waste producers are financing ANDRA’s overall actions concerning HL-LL and IL-LL waste.

1.2.4. AREVA 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 installations by applying techniques identified within the framework of the period safety reviews,
- taking into account an event and the lessons learned from it, which can result in modifications to the installations or equipment or changes in work methods and procedures,
- reducing worker dosimetry by optimising or reorganising the working environments,
- integrating regulatory changes,
- improving prevention of the criticality risk by checking the effectiveness of the measures taken, by upgrading the computerised management systems and by improving the ergonomics of the human/machine interfaces,
- the actors, taking into account, for example, the analysis of risks associated with the organisational and human factors in the safety-related activities and the decommissioning activities.
- the collective work approach by developing or simplifying the organisational structures,
- training and skills development, notably to fulfil a work function,
- dissemination of the safety culture with collective self-assessment tools,
- reductions in consumption and the production of waste, such as studying the implementation of additional management routes or treatment methods that reduce the environmental and radiological impacts of radioactive waste management, reductions in energy consumption and the production of conventional waste and the optimisation of valorisation by material recycling,
- measures to enhance transparency and communication of information, particularly with local authorities and the local actors.

The AREVA group moreover continues to invest in:

- the creation of new units such as conversion plants and waste treatment units,
- the renovation and compliance upgrading of installations and equipment,
- the retrieval and packaging of waste, and in decommissioning and the management of waste from shut down installations,
- the implementation of emergency situation management and mitigation measures defined within the framework of the post-Fukushima stress tests
- and lastly in the R&D actions to develop new processes and more resistant materials, to use less polluting reagents and acquire a better understanding of certain risks and phenomena.

2 | INTERNATIONAL CO-OPERATION MEASURES

2.1. Institutional co-operation

2.1.1. ASN co-operation measures

ASN's international activities are carried out within the legislative framework defined by Article L. 592-28 of the Environment Code.

ASN also aims to promote a high level of safety and the reinforcement of the nuclear safety and radiation protection culture across the world.

Lastly, ASN considers that international relations should enable it to consolidate its skills in its areas of activity.

2.1.1.1. 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 work respectively on nuclear safety - including waste management, and radiation protection.

ASN has invested itself in the work of WENRA, whose missions include developing reference safety levels in order to harmonise nuclear safety practices in Europe. Working groups were set up in 2002 to develop these reference levels. One of these groups, the WGWD (Working Group on Waste and Decommissioning) was tasked with developing reference levels relative to the safety of radioactive waste and spent fuel storage facilities, of radioactive waste disposal facilities and of decommissioning operations. The WENRA member countries must produce national action plans for the transposition of these reference levels. ASN is thus drafting an action plan to meet WENRA's requirements. These reference levels are valuable input data for the ASN resolutions detailing the provisions of the BNI Order.

In the area of radiation protection, ASN is a member of the association HERCA; four working groups are currently addressing the following themes: workers and dosimetric passport, justification and optimisation of the use of radioactive sources in the non-medical sector, medical applications, and emergency situation preparedness and management.

ASN is also participating in projects under the 7th Euratom R&D Framework Programme, such as the SITEX project (dedicated to the technical support anticipations and needs of a nuclear safety authority in the examination of a file concerning a deep geological disposal facility) and PREPARE project (concerning emergency situations and post-accident management in the field of radioactive substance transport).

2.1.1.2. RELATIONS WITH THE IAEA

ASN actively participates in the work of the IAEA Commission of Safety Standards (CSS) which draws up international standards for the safety of nuclear installations, waste management, radioactive substance transport and radiation protection. It is a member of the four safety standards Committees (NUSSC for the safety of nuclear installations, RASSC for radiation protection, TRANSSC for the safety of radioactive material transport and WASSC for the safety of radioactive waste).

It also participates in GEOSAF (IAEA project on the safety of a deep geological repository during the operating phase) and HIDRA (IAEA project on the unintentional impacts of human activities on deep geological repositories once the memory of the repository has been lost. The discussions on this theme, which explores time scales of up to a million years, go beyond the bounds of conventional technical subjects and address issues such as the societal impacts).

ASN is also a member of the International Decommissioning Network (IDN) coordinated by the IAEA and as such keeps itself informed of the international projects. It contributed in particular to the CIDER (constraints to implementing decommissioning and environmental remediation programmes) project, which aims to identify and develop aids to overcome the difficulties that member countries can encounter in site decommissioning and rehabilitation projects, and which held its first plenary meeting in March 2013.

2.1.1.3. RELATIONS WITH THE NEA

Within the NEA (Nuclear Energy Agency), ASN participates in the work of the CNRA (Committee on Nuclear Regulatory Activities) which is chaired by the ASN Director-General. ASN also participates in the work of the Committee on Radiation Protection and Public Health (CRPPH), the Radioactive Waste Management Committee (RWMC) and some of the working groups of the Committee on the Safety of Nuclear Installations (CSNI).

2.1.1.4. BILATERAL RELATIONS

Bilateral relations between ASN and its foreign counterparts represent an essential vector for international actions. They allow interactions on topical subjects and the rapid implementation of cooperation measures, useful in particular for informing the countries concerned if events occur on nuclear installations situated close to national borders.

2.1.1.5. PEER REVIEWS

IRRS

ASN hosted an IRRS - Integrated Regulatory Review Service - mission in November 2014. As part of this mission, ASN initiated a self-assessment in 2013, the findings of which were sent to the auditors.

The ASN was first evaluated by its peers in 2006 when it was set up as an independent authority. This mission covered all areas of nuclear safety and radiation protection. In 2009, a follow-up IRRS mission was organized. To undergo such audits at least once every ten years has become an obligation under the European Nuclear Safety Directive in 2009.

The good practices identified by the IRRS team during its mission in 2014 are detailed in E.3.1.3.2.

The final report of the mission was handed over to the French Government within three months. This report has been made public. The follow-up mission is scheduled for 2 to 9 October 2017.

The reports of the three IRRS missions can be consulted on www.asn.fr.

ARTEMIS

At the request of France, an ARTEMIS mission, the IAEA's integrated peer review service on radioactive waste, spent fuel, dismantling and remediation, was scheduled from 14 to 24 January 2018 .The ASN is associated with the reception of the mission, which is managed by the DGEC.

Accreditation NF EN ISO/CEI 17020

Since 1 July 2013, the ASN Nuclear Pressure Equipment Department has been accredited in compliance with standard NF EN ISO/CEI 17020 as a type A organisation for manufacturing inspection and in-service monitoring of nuclear pressure equipment (No. 3-1018 available from the COFRAC site). This is not the result of a regulatory requirement but of a recommendation from an IAEA experts group, during an Integrated Regulatory Review Service (IRRS) audit of ASN performed in late 2006.

2.1.2. IRSN's co-operation programmes

With regard to the safe management of radioactive waste and to the safe management of spent fuel, the IRSN's international relations revolve mainly around the following development areas:

- the understanding of the processes regulating the transfers of radioactive materials in geological media and the development of states of art and elements of doctrine on scientific and technical issues;
- research on deep earthquakes and their impact on rock fracturing and groundwater circulations and studies on seismic forecasts;
- studies on the applicability of instrumentation means, notably on investigation techniques for disposal sites and auscultation of underground work behaviour;
- modelling of overall significant phenomena for the safety of disposal facilities, and of the potential dosimetric consequences of those facilities;
- specific risk studies associated with the operation of deep geological disposal facilities for HL/IL-LL waste;
- safety studies on fuel treatment and waste management in the framework of the development scenarios for a nuclear fleet of Generation-IV reactors;
- assistance to safety authorities of Eastern European and former Soviet Union countries (Armenia, Bulgaria, Georgia, Lithuania, Russia and Ukraine) through various European projects, such as the International Nuclear Society Council (INSC) and Instrument for Pre-accession Assistance (IPA) together with the projects of the European Bank for Reconstruction and Development (EBRD) concerning the safe decommissioning of nuclear facilities and the safety of storage and disposal facilities for radioactive waste;
- safety-training actions for waste management actions (decommissioning, waste treatment facilities, disposal) for the representatives of the civil society, experts or foreign safety authorities, through programmes managed by ENSTTI (training and tutorials modules).

The IRSN's major partners include the following:

- GRS from Germany and Bel V from Belgium, for safety analyses of disposal facilities and the modelling of their behaviour over the long term;
- JNES and JAEA from Japan and SwRI from the USA, for safety interventions in waste disposal facilities;
- SSTC from Ukraine and both SEC-NRS and IBRAE from Russia for improving waste and spent-fuel management and corresponding safety assessments;
- CNSC from Canada and FANC from Belgium for the study of key mechanisms for the safety of deep geological repositories.

Work on furthering knowledge and improving assessment tools is also conducted within the international organisations. In that context, the IRSN has participated or is participating in the following EC programmes:

- FORGE (European Commission) regarding the study of the impact of gas formations within deep geological repositories, and
- SITEX (European Commission) regarding the governance of research and expertise for geological disposal.

In addition, the IRSN partakes in the studies being conducted at the Mont Terri Laboratory, Switzerland, on the safety of deep geological repositories for HL-LL waste.

IRSN is also a member of various international working groups involved in the drafting of technical recommendations, guides and standards on decommissioning radioactive waste and spent fuel, and notably in the preparation of IAEA's safety documents.

The Institute also leads or participates, under the aegis of the IAEA, in projects aiming at harmonizing practices for the safety of geological repositories (GEOSAF2, PRISM2, HIDRA), facility decommissioning (FASA, DRIMA) and the management of the resulting waste (SADRWMS and SAFRAN). Furthermore, it is also involved in the activities of the NEA expert groups on radioactive-waste management and deep geological repositories (RWMC).

Lastly, IRSN has helped to create a working group within the ETSON association which is intended to enhance the interactions and the networking of the TSOs (Technical Safety Organisations) in the research into and appraisal of the safety of radioactive waste.

2.1.3. Participation of France in ENSREG

The European Nuclear Safety Regulators Group (ENSREG) was created by decision of the European Commission on 17 July 2007 (2007/530/Euratom) in order to advise and to assist the Commission in the progressive development of a common vision and, ultimately,, of new European rules with regard to the safety of nuclear facilities and the safe management of spent fuel and radioactive waste. The Group constitutes an exchange platform between national regulatory authorities.

France is represented through ASN and the DGEC. More particularly, ASN participates in ENSREG's Working Group on the Safety of Nuclear Facilities; the DGEC and ASN are also involved in the Working Group on Spent Fuel and Radioactive Waste Management.

On 19 July 2011, the Council of the European Union adopted the directive 2011/70/Euratom for the management of spent fuel and radioactive waste (see § A.2.1.1).

2.1.4. ANDRA's international co-operation

The international aspect is an important part of ANDRA's activities. The Waste Act entrusted the Agency with an outreach mission of its know-how abroad. Its other mission is to make available to the public useful information relating to radioactive-waste management and to participate in the dissemination of the scientific and technological culture in that field, which should not be limited to a strictly domestic context.

It is also essential to compare ANDRA's approaches with foreign ones and, hence, to benefit from the experience feedback of foreign partners, which naturally leads to international co-operation initiatives, especially with its counterparts, and to mobilise a scientific expertise about the Agency's programmes and projects. In that respect, ANDRA has set the following goals:

- To promote contacts and co-operation projects with its foreign partners. ANDRA seeks to present its projects and approaches at the international scale in order to compare them with those in other countries concerned by the topic. In that context, ANDRA has played a significant role in the preparation and implementation of the Implementing Geological Disposal Technology Platform (IGD-TP) and took an active part in the development of the Strategic Agenda for Research (*Agenda stratégique des recherches*) and its Deployment Plan (*Plan de déploiement*). ANDRA currently contributes to the JOPRAD (*Towards joint programming on radioactive waste disposal*) project. It opens up to its foreign partners its programmes and facilities, such as the Meuse/Haute-Marne URL for studies on the deep geological disposal of HL-LL waste.
- To sit on leading international bodies, such as European co-ordinating bodies, the OECD/NEA and the IAEA. At present, several representatives of ANDRA participate in the work of the offices of various NEA bodies. ANDRA is also represented on WATEC (International Radioactive Waste Technical Committee) which meets annually to determine the orientation of IAEA's work in the technical side of radioactive waste management. It is also active in the IAEA's DISPONET disposal centres network and in other networks organised by IAEA.
- To conduct a scientific, technical and economic watch, which forms a structured activity within ANDRA.
- To organise occasional outreach missions with a view to participating in foreign studies and the development of radioactive-waste disposal projects abroad.
- To distribute free of charge paper copies of the English version of its publications and documents and to make them available on its website (*www.andra.fr*).

As part of the European Commission's Framework Programme for Research and Development (FPRD), ANDRA participates actively in projects devoted to the management of HL radioactive waste, and more particularly, to the issues involving deep geological disposal.

2.2. Co-operation programmes of waste and spent-fuel producers

2.2.1. CEA's international co-operation programmes

As a scientific and technical research organisation specialising in nuclear technology, the CEA extends its activities to all related fields, especially, the field of safety. Those activities entail many international co-operation programmes.

Regarding safety at its own facilities, the CEA is involved in the EC Research Programme and in projects co-ordinated by the OECD/NEA and the IAEA on spent-fuel and radioactive-waste management. It has also developed regular exchanges with several foreign counterpart organisations, namely on the operating experience with British and Belgian facilities, the lessons to be learnt from incidents that occurred in Belgium, Japan, the United Kingdom and the USA, together with research on the long-term conditioning and behaviour of waste packages.

In the area of Post-operational clean-out / Decommissioning, the CEA is at once licensee, owner of the operations and also conducts R&D programmes to control the work performance times and costs and the volumes of waste, to improve safety and guarantee full compliance with radiation protection requirements under optimum economic conditions.

The CEA's international relations in this area are directed towards:

- finding synergies to develop solutions to shared problems;
- exchanging experience feedback with other projects;
- contributing to international standards;
- supporting our industrial partners in their export activities.

The CEA thus pursues its approach to direct the legacy bipartite collaborations in A&D operations and waste management towards joint co-funded projects, and participates in various calls for proposals for Euratom or Fukushima on subjects useful for its own A&D projects.

It has thus been chosen to coordinate the INSIDER project (sampling and characterisation methodology for intermediate and high-level activity) and will participate in the THERAMIN (heat treatment of waste) and TRANSAT (cross-discipline subjects/tritiated waste) projects.

The CEA also participates in the CHWM (Center for Hierarchical Waste Form Materials) project conducted by the University of South Carolina in response to a U.S. Department Of Energy (DOE) Energy Frontier Research Centre (EFRC) call for proposals, and is also developing the technique of remotely operated laser cutting to retrieve fuel debris on the Fukushima site.

It also participates actively in the working groups of international organisations in the field of A&D:

- participation in the Steering Group and member of the IDN (International Dismantling Network) of the IAEA;
- participation on the board and French representation in the CPD (Cooperative Program on Decommissioning);
- CEA representation in the WPDD (Working Party on Decommissioning and Dismantling);
- participation in the EGFWMD (Expert Group on Fukushima Waste Management and Decommissioning) R&D (2015/2016), etc.

2.2.2. AREVA's international co-operation programmes

With regard to facilities dealing with the fuel cycle and radioactive waste management, international exchanges an co-operation programmes in which AREVA is involved may be divided into three main areas, as follows:

- relations with international institutions participating in the development of safety and radiation protection standards,
- relations with countries in which AREVA is operating one or several facilities or is performing transport activities, and
- international projects.

In the framework of the activities conducted in Europe regarding safety and radiation protection, AREVA participates in the European Nuclear Installations Safety Standards (ENISS), an association of European operators that has been created with a view to establishing a dialogue with the WENRA in the context of the harmonisation approaches within the European Union and particularly on topics, not only like the storage of waste and spent fuel, but also as the decommissioning of BNIs. AREVA participates also in the work of the European Nuclear Energy Forum (ENEF), which groups stakeholders in the nuclear sector and whose work seals also with safety and waste.

AREVA also provides its expertise by taking part in assessments of strategies, nuclear sites and installations at the request of and to assist IAEA, as well as in the regular technical meetings to prepare or revise the IAEA technical documents, guides and safety standards, or via various inter-professional associations, such as the World Association of Nuclear Operators (WANO), of which it became a full member in 2012 as licensee of the nuclear fuel recycling plant in La Hague.

AREVA carries out a significant part of its activities outside France by operating fuel-cycle facilities and by providing transport or storage services to foreign customers, thus leading to a large number of exchanges with the relevant entities. Those exchanges exist also about the knowledge of the waste packages that are produced by AREVA and shipped back to original customers. Hence, such packages constitute international "standards" in the sense they are given as basic data in the numerous concepts of deep geological repositories, notably in Belgium, Germany, Japan, Switzerland, etc.

Over and above those co-operation efforts, AREA partakes in international actions and projects with a view to improving not only the management of waste and spent fuel, but also the safety of storage facilities.

Together with the Shaw Company, AREVA is involved in the construction of MOX-fuel fabrication plant in South Carolina (USA) in order to reduce the inventory of military plutonium by recycling it in the form of MOX fuel to be used American NPPs. That reduction of inventories is carried out in the framework of the Russian-American disarmament agreements and according to the technologies of the AREVA Group.

In addition, AREVA is at the stage of advanced discussions for a recycling plant project in China, in combination with an ambitious national nuclear-energy development programme that will ensure the responsible management of spent fuel at the end of the cycle, according to the nuclear development of China.

2.2.3. EDF's international co-operation programmes

EDF's international activities concern a number of key areas, in all activity domains of EDF:

- international activities within the EDF Group and foreign nuclear development projects (United-Kingdom with EDF Energy, China, Poland, South Africa, United States of America, etc.);

- bilateral exchanges of experience, mainly via twinning agreements and co-operation agreements;
- participation in international organisations which enhances experience feedback exchanges, including secondment of experts from the World Association of Nuclear Operators (WANO) and peer reviews, IAEA and Operational Safety Review Team (OSART), Institute of Nuclear Power Operations (INPO), Electric Power Research Institute (EPRI), ENISS within the European Atomic Forum (FORATOM), World Nuclear Association (WNA) etc.;
- contract-based advice and service activities (Daya Bay, Koeberg, etc.);
- preparation and planning for future reactors, and technology-watch activities (EUR, etc.);
- decommissioning and environment.

The first area for EDF's international co-operation is exchange of experience. Twinning operations between French and foreign NPPs and co-operation agreements with operators having NPPs under decommissioning constitute the main framework for those exchanges and allow direct information exchanges between operators of different cultures working in different environments.

A second area concerns collaboration with international institutions. At the IAEA, EDF takes part in the work performed on safety standards and guides and on incident analysis (IRS); it also participates in OSART delegations to assess the safety of nuclear facilities, both in France and abroad. With WANO, EDF is involved in a number of programmes and peer reviews (both in France and abroad) as well as in other programmes, particularly those concerning assistance visits, experience feedback, technical meetings and performance indicators, which includes sharing databases. EDF also follows the work of the OECD/NEA, EPRI, INPO, NRC, and WNA, in particular through its participation in the working groups on spent fuel management, waste management and decommissioning.

A third area concerns consulting and service activities to other operators, co-operation agreements (China, South Africa), assistance in various technical fields (training, engineering, chemistry, etc.,) and partnerships (Eastern Europe, Russia, etc.).

Of the facilities concerned by radioactive-waste management for spent-fuel management, as presented in Section D, the more important ones belong to the BNI category, as defined in § E.1.1, and are scattered throughout France, as shown in the following figure:

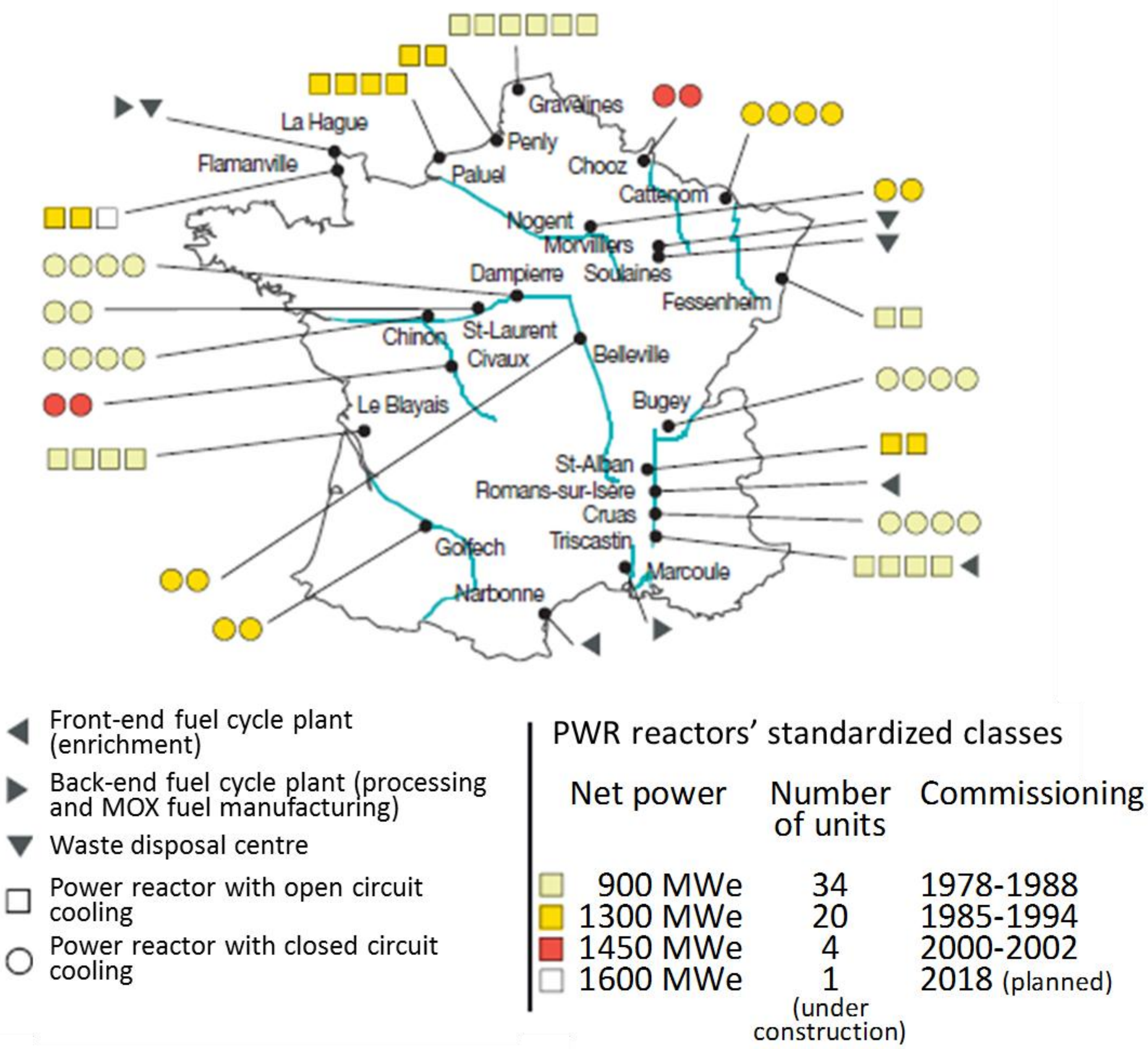

FIGURE 15: LOCALISATION OF FUEL CYCLE FACILITIES IN FRANCE ON 31 DECEMBER 2016 [29]

[29] It should be noted that the CEA sites in Saclay and Cadarache also have waste management facilities, not shown in this figure.

1 | SPENT FUEL GENERATING OR MANAGEMENT FACILITIES

1.1. Spent fuel generating facilities

Spent fuel is generated or likely to be generated in the BNIs shown below.

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of Licensing	Date of publication in J.O.	Remarks
24	CABRI and SCARABÉE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactors	27.05.64			Modification decree
39	MASURCA (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		14.12.66	15.12.66	
40	OSIRIS - ISIS (Saclay) 91191 Gif-sur-Yvette	CEA	Reactors		08.06.65	12.06.65	
42	EOLE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		23.06.65	28 et 29.06.65	
67	HIGH-FLUX REACTOR (HFR) 38041 Grenoble	ILL	Reactor		19.06.69 05.12.94	22.06.69 06.12.94	Modification decree
75	FESSENHEIM NPP (reactors 1 & 2) 68740 Fessenheim	EDF	Reactors		03.02.72	10.02.72	Modification decree
78	BUGEY NPP (reactors 2 & 3) 01980 Loyettes	EDF	Reactors		20.11.72	26.11.72	Modification decree
84	DAMPIERRE NPP (reactors 1 & 2) 45570 Ouzouer-sur-Loire	EDF	Reactors		14.06.76	19.06.76	
85	DAMPIERRE NPP (reactors 3 & 4) 45570 Ouzouer-sur-Loire	EDF	Reactors		14.06.76	19.06.76	
86	BLAYAIS NPP (reactors 1 & 2) 33820 Saint-Ciers-sur-Gironde	EDF	Reactors		14.06.76	19.06.76	
87	TRICASTIN NPP (reactors 1 & 2) 26130 Saint-Paul-Trois-Châteaux	EDF	Reactors		02.07.76	04.07.76	Modification decree
88	TRICASTIN NPP (reactors 3 & 4) 26130 Saint-Paul-Trois-Châteaux	EDF	Reactors		02.07.76	04.07.76	Modification decree
89	BUGEY NPP (reactors 4 et 5) 01980 Loyettes	EDF	Reactors		27.07.76	17.08.76	Modification decree
92	PHÉBUS (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		05.07.77	19.07.77	Modification decree
95	MINERVE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		21.09.77	27.09.77	
96	GRAVELINES NPP (reactors 1 & 2) 59820 Gravelines	EDF	Reactors		24.10.77	26.10.77	Modification decree
97	GRAVELINES NPP (reactors 3 & 4) 59820 Gravelines	EDF	Reactors		24.10.77	26.10.77	Modification decree
100	SAINT-LAURENT DES EAUX NPP (reactors B1 & B2) 41220 La Ferté-St-Cyr	EDF	Reactors		08.03.78	21.03.78	

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of Licensing	Date of publication in J.O.	Remarks
101	ORPHÉE (Saclay) 91191 Gif-sur-Yvette	CEA	Reactor		08.03.78	21.03.78	
103	PALUEL NPP (reactor 1) 76450 Cany-Barville	EDF	Reactor		10.11.78	14.11.78	
104	PALUEL NPP (reactor 2) 76450 Cany-Barville	EDF	Reactor		10.11.78	14.11.78	
107	CHINON (reactors B1 & B2) 37420 Avoine	EDF	Reactors		04.12.79	08.12.79	Modification decree
108	FLAMANVILLE NPP (reactor 1) 50830 Flamanville	EDF	Reactor		21.12.79	26.12.79	
109	FLAMANVILLE NPP (reactor 2) 50830 Flamanville	EDF	Reactor		21.12.79	26.12.79	
110	BLAYAIS NPP (reactors 3 & 4) 33820 Saint-Ciers-sur-Gironde	EDF	Reactors		05.02.80	14.02.80	Modification decree
111	CRUAS NPP (reactors 1 & 2) 07350 Cruas	EDF	Reactors		08.12.80	31.12.80	Two modification decrees
112	CRUAS NPP (reactors 3 & 4) 07350 Cruas	EDF	Reactors		08.12.80	31.12.80	Modification decree
114	PALUEL NPP (reactor 3) 76450 Cany – Barville	EDF	Reactor		03.04.81	05.04.81	
115	PALUEL NPP (reactor 4) 76450 Cany – Barville	EDF	Reactor		03.04.81	05.04.81	
119	SAINT-ALBAN - SAINT-MAURICE NPP (reactor 1) 38550 Le Péage-de-Roussillon	EDF	Reactor		12.11.81	15.11.81	
120	SAINT-ALBAN - SAINT-MAURICE NPP (reactor 2) 38550 Le Péage-de-Roussillon	EDF	Reactor		12.11.81	15.11.81	
122	GRAVELINES NPP (reactors 5 & 6) 59820 Gravelines	EDF	Reactors		18.12.81	20.12.81	Two modification decrees
124	CATTENOM NPP (reactor 1) 57570 Cattenom	EDF	Reactor		24.06.82	26.06.82	
125	CATTENOM NPP (reactor 2) 57570 Cattenom	EDF	Reactor		24.06.82	26.06.82	
126	CATTENOM NPP (reactor 3) 57570 Cattenom	EDF	Reactor		24.06.82	26.06.82	
127	BELLEVILLE NPP (reactor 1) 18240 Léré	EDF	Reactor		15.09.82	16.09.82	
128	BELLEVILLE NPP (reactor 2) 18240 Léré	EDF	Reactor		15.09.82	16.09.82	Modification decree
129	NOGENT SUR SEINE NPP (reactor 1) 10400 Nogent-sur-Seine	EDF	Reactor		28.09.82	30.09.82	Modification decree

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of Licensing	Date of publication in J.O.	Remarks
130	NOGENT SUR SEINE NPP (reactor 2) 10400 Nogent-sur-Seine	EDF	Reactor		28.09.82	30.09.82	Modification decree
132	CHINON NPP (reactors B3 et B4) 37420 Avoine	EDF	Reactors		07.10.82	10.10.82	Modification decree
135	GOLFECH NPP (reactor 1) 82400 Golfech	EDF	Reactor		03.03.83	06.03.83	Modification decree
136	PENLY NPP (reactor 1) 76370 Neuville-lès-Dieppe	EDF	Reactor		23.02.83	26.02.83	
137	CATTENOM NPP (reactor 4) 57570 Cattenom	EDF	Reactor		29.02.84	03.03.84	
139	CHOOZ B NPP (reactor 1) 08600 Givet	EDF	Reactor		09.10.84	13.10.84	Deferment of commissioning: Decrees of 18.10.1993, J.O. of 23.10.93 and of 11.06.99, J.O. of 18.06.99
140	PENLY NPP (reactor 2) 76370 Neuville-lès-Dieppe	EDF	Reactor		09.10.84	13.10.84	
142	GOLFECH NPP (reactor 2) 82400 Golfech	EDF	Reactor		31.07.85	07.08.85	
144	CHOOZ B NPP (reactor 2) 08600 Givet	EDF	Reactor		18.02.86	25.02.86	Deferment of commissioning: Decrees of 18.10.93, J.O. of 23.10.93 and of 11.06.99, J.O. of 18.06.99
158	CIVAUX NPP (reactor 1) BP 1 86320 Civaux	EDF	Reactor		06.12.93	12.12.93	Deferment of commissioning: Decree of 11.06.99, J.O. of 18.06.99
159	CIVAUX NPP (reactor 2) BP 1 86320 Civaux	EDF	Reactor		06.12.93	12.12.93	Deferment of commissioning: Decree of 11.06.99, J.O. of 18.06.99

TABLE 25: SPENT FUEL GENERATING FACILITIES ON 31 DECEMBER 2015

1.2. Spent fuel storage or processing facilities

Spent fuel is stored or processed in the BNIs as shown below (it should be noted that spent fuel is also stored on the nuclear power plant (NPP) sites).

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of licensing	Date of publication in J.O.	Remarks
22	TEMPORARY DISPOSAL FACILITY PEGASE/CASCAD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Disposal of radioactive substances	27.05.64	17.04.80	27.04.80	Former reactor shut down on 19.12.75. Modification (creation of CASCAD): decree of 04.09.89, J.O. of 08.09.89
33	SPENT FUEL PROCESSING PLANT (UP2-400) (La Hague) 50107 Cherbourg	AREVA NC	Transformation of radioactive substances	27.05.64			Final shutdown and decommissioning decree of 08.11.13, J.O. of 10.11.13

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of licensing	Date of publication in J.O.	Remarks
38	EFFLUENT AND SOLID WASTE PROCESSING STATION (STE2) AND OXIDE NUCLEAR FUEL PROCESSING FACILITY (AT1) (La Hague) 50107 Cherbourg	AREVA NC	Transformation of radioactive substances	27.05.64			Final shutdown and decommissioning decree of 08.11.13 J.O. du 10.11.13
50	SPENT FUEL TEST LABORATORY (LECI) (Saclay) 91191 Gif-sur-Yvette	CEA	Use of radioactive substances	08.01.68			Modification decree
55	LABORATOIRE D'EXAMENS DES COMBUSTIBLES ACTIFS (LECA/STAR) (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Use of radioactive substances	08.01.68			Extension (STAR creation): decree of 04.09.89, J.O. of 08.09.89
72	SOLID RADIOACTIVE WASTE MANAGEMENT ZONE (Saclay) 91191 Gif-sur-Yvette	CEA	Disposal or storage of radioactive substances		14.06.71	22.06.71	
80	HIGH LEVEL OXIDE FACILITY (HAO) (La Hague) 50107 Cherbourg	AREVA NC	Transformation of radioactive substances		17.01.74	05.02.74	Final shutdown and decommissioning decree of 31.07.09, J.O. of 04.08.09
94	IRRADIATED MATERIALS FACILITY (Chinon) 37420 Avoine	EDF	Use of radioactive substances	29.01.64			Modification decree
116	REPROCESSING PLANT FOR SPENT FUEL ELEMENTS FROM LIGHT WATER REACTORS (UP3-A) (La Hague) 50107 Cherbourg	AREVA NC	Transformation of radioactive substances		12.05.81	16.05.81	Several modification decrees
117	REPROCESSING PLANT FOR SPENT FUEL ELEMENTS FROM LIGHT WATER REACTORS (UP2 800) (La Hague) 50107 Cherbourg	AREVA NC	Transformation of radioactive substances		12.05.81	16.05.81	Several modification decrees
141	ATELIER POUR L'ÉVACUATION DU COMBUSTIBLE (Creys-Malville) 38510 Morestel	EDF	Disposal or storage of radioactive substances		24.07.85	31.07.85	Several modification decrees
148	ATALANTE CEN VALRHO Chusclan 30205 Bagnols-sur-Cèze	CEA	R&D laboratory and study on actinide production		19.07.89	25.07.89	Deferment of commissioning: Decree of 22.07.99 J.O. of 23.07.99

TABLE 26: SPENT FUEL PROCESSING OR STORAGE FACILITIES ON 31 DECEMBER 2016

2 | RADIOACTIVE WASTE GENERATING OR MANAGEMENT FACILITIES

2.1. BNIs generating radioactive waste different from those listed in L1, L.2.2 and L.3 on 31 December 2016

The following BNIs produce radioactive waste, as do the BNIs that manage spent fuel (see L1), the radioactive waste storage and treatment BNIs (see L.2.2) and the BNIs undergoing decommissioning (see L.3.).

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of licensing	Date of publication in J.O.	Remarks
18	ULYSSE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Reactor (under decommissioning)	27.05.64			Final shutdown and decommissioning decree no 2014-906 of 18.08.14 (JO of 21.08.14)
29	ARTIFICIAL RADIONUCLIDES PRODUCTION FACILITY (Saclay) 91191 Gif-sur-Yvette Cedex	Cis Bio International	Transformation or production of radioactive substances	27.05.64			Modification decree (change of operator)
53	ENRICHED URANIUM AND PLUTONIUM WAREHOUSE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	08.01.68			
63	FUEL ELEMENTS FABRICATION PLANT 26104 Romans-sur-Isère	AREVA NP	Production of radioactive substances	09.05.67			Three modification decrees
68	DAGNEUX IONISATION PLANT Z.I. Les Chartinières 01120 Dagneux	IONISOS	Use of radioactive substances		20.07.71	25.07.71	Two modification decrees
77	POSEIDON – CAPRI IRRADIATION FACILITIES (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Use of radioactive substances		07.08.72	15.08.72	
98	NUCLEAR FUELS FABRICATION UNIT 26104 Romans-sur-Isère	AREVA NP	Production of radioactive substances		02.03.78	10.03.78	Two modification decrees
99	CHINON INTER-REGIONAL WAREHOUSE 37420 Avoine	EDF	Fresh fuel storage		02.03.78	11.03.78	Modification decree
102	BUGEY INTER-REGIONAL WAREHOUSE 01980 Loyettes	EDF	Fresh fuel storage		15.06.78	27.06.78	Modification decree
113	LARGE NATIONAL HEAVY ION ACCELERATOR (GANIL) 14021 Caen Cedex	G.I.E GANIL	Particle accelerator		29.12.80	10.01.81	Modification decree. Creation authorisation decree for Spiral 2/phase 1 extension
123	LABORATORY FOR THE EXPERIMENTAL DESIGN AND FABRICATION OF ADVANCED NUCLEAR FUELS (LEFCA) (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Production of radioactive substances		23.12.81	26.12.81	
138	URANIUM CLEAN-UP AND RECOVERY FACILITY (Tricastin) 26130 Saint-Paul-Trois-Châteaux	SOCATRI	Plant		22.06.84	30.06.84	Two modification decrees
143	NUCLEAR MAINTENANCE FACILITY (SOMANU) 59600 Maubeuge	SOMANU	Nuclear maintenance		18.10.85	22.10.85	
146	POUZAUGES IONISATION PLANT Z.I. de Monlifant 85700 Pouzauges	IONISOS	Ionising facility		30.01.89	31.01.89	Modification decree (change of operator)
147	GAMMASTER IONISATION PLANT - M.I.N. 712 13323 Marseille	ISOTRON France	Ionising facility		30.01.89	31.01.89	
151	NUCLEAR FUELS FABRICATION PLANT (MELOX) 30200 Chusclan	AREVA NC	Production of radioactive substances		21.05.90	22.05.90	Several modification decrees
154	SABLÉ-SUR-SARTHE IONISATION PLANT Z.I. de l'Aubrée 72300 Sablé-sur-Sarthe	IONISOS	Ionising facility		01.04.92	04.04.92	Modification decree (change of operator)

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of licensing	Date of publication in J.O.	Remarks
155	TU 5 and W FACILITIES (Tricastin) 26701 Pierrelatte	AREVA NC	Transformation of radioactive substances		07.07.92	11.07.92	Modification decree
156	CHICADE (Cadarache) 13108 Saint-Paul-lez-Durance Cedex	CEA	Research and development laboratory		29.03.93	30.03.93	
157	TRICASTIN OPERATIONAL HOT UNIT (BCOT) 84504 Bollène	EDF	Nuclear maintenance		29.11.93	07.12.93	Modification decree
168	GEORGES-BESSE II PLANT FOR THE SEPARATION OF URANIUM ISOTOPES BY CENTRIFUGATION 26702 Pierrelatte	SET	Transformation of radioactive substances		27.04.07	29.04.07	
169	MAGENTA 13115 Saint-Paul-lez Durance (Bouches-du-Rhône)	CEA	Receipt and shipping of radioactive substances		25.09.08	27.09.08	Decree published in JO of 27.09.08 ASN Resolution of 27.01.11 for commissioning
176	ATLAS 26702 Pierrelatte	AREVA NC	Research and development laboratory		30.09.15	02.10.15	
178	TRICASTIN URANIUM STORAGE AREAS 26702 Pierrelatte	AREVA NC	Storage				Declined from the SBNIs by decision of the Prime Minister on 20 July 2016. Registered as BNI by ASN resolution of 1st December 2016

TABLE 27: BNIS PRODUCING RADIOACTIVE WASTE DIFFERENT FROM BNIS LISTED IN L.1 AND L.2.2 AND THE BNIS UNDERGOING DECOMMISSIONING LISTED IN L.3. ON 31 DECEMBER 2016

2.2. Main BNIs managing radioactive waste on 31 December 2016

The main BNIs managing radioactive waste (processing, storage, and disposal) are listed in the table below. It should nevertheless be noted that the BNIs listed in L.1 and L.2.1 and the BNIs undergoing decommissioning figuring in L.3 also include radioactive waste processing and storage facilities. More particularly, BNIs 116 and 117 (La Hague plants) which figure in section L.1.2 have extensive facilities for processing and storing waste, particularly HLW and ILW-LL waste.

It is to be noted that ANDRA's CIRES facility, which ensures the sorting and processing of waste from small producers and the disposal of very low level waste, is subject to the regulations for ICPEs (Installations Classified on Environmental Protection Grounds).

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of licensing	Date of publication in JO	Remarks
22	PÉGASE & CASCAD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	27.05.64			
35	LIQUID EFFLUENT MANAGEMENT AREA (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Transformation of radioactive substances	27.05.64			Modification decree
37A	WASTE TREATMENT STATION (STD) (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Transformation of radioactive substances	27.05.64		06.08.15	Split of BNI 37 into two entities following the ministerial order of 9 June 2015. Decision CODEP-DRC-027225 of the President of the ASN of 09.07.15 recording BNI No. 37-A
37B	EFFLUENT TREATMENT STATION (STE) (Cadarache) 13115 Saint-Paul-lez-Durance Cedex (Bouches-du-Rhône)	CEA	Transformation of radioactive substances	27.05.64		06.08.15	Decision CODEP-DRC-027232 of the President of the ASN of 09.07.15 recording BNI No. 37-B
56	RADIOACTIVE WASTE STORAGE AREA (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Disposal of radioactive substances	08.01.68			
66	CENTRE DE STOCKAGE DE LA MANCHE (CSM) 50448 Beaumont-Hague	ANDRA	Radioactive-waste surface disposal facility		19.06.69	22.06.69	Changeover to monitoring phase: Decree of 10.01.2003, J.O. of 11.01.2003

BNI No	Facility's name and location	Operator	Type of facility	Date of declaration	Date of licensing	Date of publication in JO	Remarks
72	SOLID RADIOACTIVE WASTE MANAGEMENT AREA (Saclay) 91191 Gif-sur-Yvette	CEA	Disposal or storage of radioactive substances		14.06.71	22.06.71	Final shutdown notified by CEA for 31 December 2017
74	STORAGE OF IRRADIATED GRAPHITE SLEEVES (SAINT LAURENT DES EAUX) 41220 La Ferté-St-Cyr	EDF	Disposal or storage of radioactive substances		14.06.71	22.06.71	Modification decree (change of operator
118	LIQUID EFFLUENTS AND SOLID WASTE TREATMENT STATION (STE3) La Hague 50107 Cherbourg	AREVA NC	Transformation of radioactive substances		12.05.81	16.05.81	Several modification decrees
149	CENTRE DE STOCKAGE DE L'AUBE (CSA) Soulaines-Dhuys 10200 Bar-sur-Aube	ANDRA	Surface storage of radioactive substances		04.09.89	06.09.89	Two modification decrees
160	CENTRACO Codolet 30200 Bagnols-sur-Cèze	SOCODEI (EDF Group)	Transformation of radioactive waste and effluents		27.08.96	31.08.96	Two modification decrees
164	CEDRA (Cadarache) 13113 St Paul lez Durance	CEA	Packaging and storage of radioactive substances		04.10.04	05.10.04	
171	AGATE – Advanced Management and Effluent Treatment Facility (Cadarache) 13113 St Paul lez Durance	CEA	Transformation of radioactive effluents		25.03.09	28.03.09	
173	ICEDA – activated waste conditioning and storage facility	EDF	Packaging and storage		23.04.10	25.04.10	Pending commissioning
175	ECRIN – Conversion waste contained storage (Malvési) 11100 Narbonne (Aude)	AREVA NC	Storage of radioactive substances		20.07.15	22.07.15	Pending commissioning
177	DIADEM Irradiating or alpha waste from decommissioning (Marcoule) Chusclan	CEA	Storage of radioactive substances			14.06.16	Pending commissioning

TABLE 28: MAJOR BNIS MANAGING RADIOACTIVE WASTE ON 31 DECEMBER 2016

Note: CIRES (very low level waste repository) is classified as an ICPE (installation classified on environmental protection grounds) and therefore does not figure in this list.

3 | FACILITIES DECOMMISSIONED OR UNDERGOING DECOMMISSIONING

3.1. Decommissioned reactors or in the process of being decommissioned on 31 December 2016

Facility's name and location	BNI No	Date of commissioning	Final production shutdown	Thermal power (MW)	Last regulatory actions	Remarks
NEREIDE Fontenay-aux-Roses	(ex BNI 10)	1960	1981	0.5	1987: Cancelled from BNI list	Decommissioned, delicensed
TRITON Fontenay-aux-Roses	(ex BNI 10)	1959	1982	6.5	1987: Cancelled from BNI list, classified as an ICPE	Delicensed, classified as ICPE
ZOÉ Fontenay-aux-Roses	(ex BNI no 11)	1948	1975	0.25	1978: Cancelled from BNI list, classified as an ICPE	Contained (Museum), delicensed, classified as ICPE
MINERVE Fontenay-aux-Roses	(ex BNI no 12)	1959	1976	0.0001	1977: Cancelled from BNI list	Dismantled at FAR and rebuilt at Cadarache
EL2 Saclay	(ex BNI no 13)	1952	1965	2.8	Cancelled from BNI list	Partially dismantled, remaining parts contained.
EL 3 Saclay	(ex BNI no 14)	1957	1979	18	1988: Cancelled from BNI list, classified as an ICPE	Partially dismantled, remaining parts contained.
MELUSINE Grenoble	(ex BNI 19)	1958	1988	8	2011: Cancelled from BNI list	Cleaned-out
SILOETTE Grenoble	(ex BNI 21)	1964	2002	0.100	2007: Cancelled from BNI list	Cleaned-out - easements
PEGGY Cadarache	(ex BNI no 23)	1961	1975	0.001	1976: Cancelled from BNI list	Decommissioned, delicensed
CESAR Cadarache	(ex BNI no 26)	1964	1974	0.01	1978: Cancelled from BNI list	Decommissioned, delicensed
MARIUS Cadarache	(ex BNI no 27)	1960 in Marcoule, 1964 in Cadarache	1983	0.0004	1987: Cancelled from BNI list	Decommissioned, delicensed
HARMONIE Cadarache	(ex BNI 41)	1965	1996	0.001	2009: Cancelled from BNI list	Building demolished, easements
Strasbourg University reactor (RUS) Strasbourg	(ex BNI 44)	1967	1997	0,100	2012: Cancelled from BNI list	Cleaned-out – memory easements
SILOE Grenoble	20	1963	1997	35	2015: Cancelled from BNI list	Cleaned-out
RAPSODIE Cadarache	25	1967	1983	20 then 40		Preparation to final shutdown
BUGEY 1 Lagneu	45	1972	1994	1 920	1996: Final shutdown decree 2008: Decree authorizing operations for complete decommissioning	Under decommissioning
SAINT-LAURENT DES EAUX A1 La Ferté-Saint-Cyr	46	1969	1990	1 662	1994: Final shutdown decree 2010: Decree authorizing operations for complete decommissioning	Under decommissioning
SAINT-LAURENT A2 La Ferté-Saint-Cyr	46	1971	1992	1 801	1994: Final shutdown decree 2010: Decree authorizing operations for complete decommissioning	Under decommissioning
PHÉNIX Marcoule	71	1969		350	2016: Decommissioning decree	Under decommissioning
SUPERPHENIX Creys-Malville	91	1985	1997	3 000	1998: Final shutdown decree 2009 : Final shutdown (last stage) and complete decommissioning decree	Under decommissioning

Facility's name and location	BNI No	Date of commissioning	Final production shutdown	Thermal power (MW)	Last regulatory actions	Remarks
Chinon A1D (ex-Chinon A1) Avoine	133 (ex BNI 5)	1963	1973	300	1982: Decree for Chinon A1 containment and creation of the storage BNI Chinon A1D	Partly decommissioned, modified as storage BNI for waste let on site (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 the storage BNI Chinon A2D	Partly decommissioned, modified as storage BNI for waste let on site
CHINON A3D (ex-Chinon A3) Avoine	161 (ex BNI 7)	1966	1990	1 360	2010: Decommissioning decree	Partly decommissioned, modified as storage BNI for waste let on site
EL-4D (ex-EL4) Brennilis Huelgoat	162 (ex BNI 28)	1966	1985	250	1996: Decree for decommissioning and creation of the storage BNI EL-4D Various decrees including the decree for final shutdown and complete decommissioning cancelled by State Council decision on 06.06.07, decree for final shutdown and complete decommissioning of 27.07.11	Under decommissioning
CHOOZ AD (ex-Chooz A) Givet	163 (ex BNI A1, 2, 3)	1967	1991	1 040	1999: Decree of partial decommissioning of Chooz A and creation of the storage BNI Chooz AD Decree of final shutdown and decommissioning of 27.09.07, J.O. of 29.09.07	Partly decommissioned, modified as storage BNI for waste let on site

TABLE 29: DECOMMISSIONED REACTORS OR IN THE PROCESS OF BEING DECOMMISSIONED ON 31 DECEMBER 2016

3.2. Other decommissioned facilities or in the process of being decommissioned

Facility's name and location	BNI No	Type of facility	commissioning	Final production shutdown	Last regulatory actions	Current status
LE BOUCHET	(ex BNI 30)	Ore processing	1953	1970	Cancelled from BNI list	Decommissioned
GUEUGNON	(ex BNI 31)	Ore processing	1965	1980	Cancelled from BNI list	Decommissioned
STED Fontenay-aux-Roses	BNI 34	Treatment of solid waste and effluent	Avant 1964	2006	2006: Cancelled from BNI list	Integrated to BNI 166
ALS Saclay	(ex BNI 43)	Particle accelerator	1965	1996	2006: Cancelled from BNI list	Cleaned-out, easements
SATURNE Saclay	(ex BNI 48)	Particle accelerator	1958	1997	2005: Cancelled from BNI list	Cleaned-out, easements
ATTILA Fontenay-aux-Roses	(ex BNI 57)	Processing pilot in 1 cell of the BNI	1966	1975	2006: Cancelled from BNI list	Integrated to BNI 165 and 166
LCPu Fontenay-aux-Roses	(ex BNI 57)	Plutonium chemistry laboratory	1966	1995	2006: Cancelled from BNI list	Integrated to BNI 165 and 166
BAT. 19 Fontenay-aux-Roses	(ex BNI 58)	Plutonium metallurgy	1968	1984	1984: Cancelled from BNI list	Decommissioned
RM2 Fontenay-aux-Roses	(ex BNI 59)	Radio-metallurgy	1968	1982	2006: Cancelled from BNI list	Integrated to BNI 165 and 166
LCAC Grenoble	(ex BNI 60)	Analyse de combustibles	1968	1984	1997: Cancelled from BNI list	Decommissioned
STEDS Fontenay-aux-Roses	(ex BNI 73)	Radioactive waste decay storage	1989		2006: Cancelled from BNI list	Integrated to BNI 166
ARAC Saclay	(ex BNI 81)	Fabrication of fuel assemblies	1975	1995	1999: Cancelled from BNI list	Cleaned-out

Facility's name and location	BNI No	Type of facility	commissioning	Final production shutdown	Last regulatory actions	Current status
IRCA Cadarache	(ex BNI 121)	Irradiator	1983	1996	2006: Cancelled from BNI list	Cleaned-out - easements
FBFC Pierrelatte	(ex BNI 131)	Fuel fabrication	1983	1998	2003: Cancelled from BNI list	Cleaned-out - easements
MIRAMAS URANIUM WAREHOUSE Istres	(ex BNI 134)	1964	2004		2007: Cancelled from BNI list	Cleaned-out - easements
SNCS Osmanville	(ex BNI 152)	Ioniser	1983	1995	2002: Cancelled from BNI list	Cleaned-out - easements
ATPu Cadarache	32	Fuel fabrication plant	1962	2003	2009: Decree for final shutdown and decommissioning	Under decommissioning
UP2-400 plant La Hague	33	Transformation of radioactive substances	1964	2004	2013: Decree for final shutdown and partial decommissioning	Under decommissioning
STED and HL-waste storage unit Grenoble	36 and 79	Waste treatment station and storage	1964/ 1972	2008	2008: Decree for final shutdown and decommissioning	Under decommissioning
STE2 et AT1 La Hague	38	Effluent processing station	1964	2004	2013: Decree for final shutdown and partial decommissioning	Under decommissioning
ELAN II B La Hague	47	Fabrication of Cs-137 sources	1970	1973	2013: Decree for final shutdown and decommissioning	Under decommissioning
LHA (High activity laboratory) Saclay	49	Laboratory	1960	1996	2008: Decree for final shutdown and decommissioning	Under decommissioning
ATUE Cadarache	52	Uranium processing	1963	1997	2006: Decree for final shutdown and decommissioning	Under decommissioning
LPC Cadarache	54	Laboratory	1966	2003	2009: Decree for final shutdown and decommissioning	Under decommissioning
LAMA Grenoble	61	Laboratory	1968	2002	2008: Decree for final shutdown and decommissioning	Cleaned-out - Under decommissioning
SICN Veurey-Voroize	65 and 90	Fuel fabrication plants	1963	2000	2006: Decree for final shutdown and decommissioning	Decommissioned
ATELIER HAO La Hague	80	Transformation of radioactive substances	1974	2004	2009: Decree for final shutdown and decommissioning	Under decommissioning
Georges-Besse plant Tricastin	93	Transformation of radioactive substances	1978	2012		Preparation to final shutdown
AREVA NC Pierrelatte	105	Uranium chemical transformation plant	1979	2008		Preparation to final shutdown
LURE Orsay	106	Particle accelerators	From 1956 to 1987	2008	2015: Cancelled from BNI list	Cleaned-out - easements
PROCEDE Fontenay-aux-Roses	165	Grouping of former process facilities	2006		2006: Decree for final shutdown and decommissioning	Under decommissioning
SUPPORT Fontenay-aux-Roses	166	Waste packaging and processing	2006		2006: Decree for final shutdown and decommissioning	Under decommissioning

TABLE 30: OTHER DECOMMISSIONED FACILITIES OR IN THE PROCESS OF BEING DECOMMISSIONED ON 31 DECEMBER 2016

4 | COMPLEMENTARY SAFETY ASSESSMENTS OF NUCLEAR INSTALLATIONS IN THE LIGHT OF FUKUSHIMA ACCIDENT – LIST OF INSTALLATIONS AND SITES CONCERNED

The Fukushima accident in Japan has led the French safety authorities, in response to the Prime Minister's referral, to ask the licensees to carry out stress tests on their installations and their support functions.

Based on the specifications drawn up by the French safety authorities, the stress tests consist in analysing the beyond-design-basis safety margins of nuclear installations with respect to extreme natural phenomena (earthquakes, floods, etc.). They involve a deterministic approach that consists in increasing the level of aggression in question to assess the resistance of the installation to extreme situations and the current measures to counter them. The postulated successive losses of safety functions (electrical power supplies, cooling systems, etc.), and the management of accidents resulting from these situations are examined.

The aim is to identify any situations that could lead to a sudden deterioration of the accident sequences (“cliff-edge effect”) and propose additional measures to prevent such situations and to increase the robustness of the installation with regard to defence in depth.

After a first series of stress tests carried out in 2011 on those installations considered as priorities by the safety authorities (batch 1), a second series of stress tests was carried out in 2012 on other CEA installations and on the resources shared by the Cadarache and Marcoule centres (batch 2). These stress tests were supplemented in 2013 by stress tests on the shared resources of the Saclay centre and on other CEA installations for which stress tests results are to be transmitted to the authorities when the periodic safety review of the installation becomes due (batch 3).

See chapter A.3 for the stress test follow-ups.

4.1. Installations and sites identified as priority to be assessed in 2011

4.1.1. Installations operated by Électricité de France – NPPs

- Belleville NPP (BNI 127 et 128)
- Blayais NPP (BNI 86 et 110)
- Bugey NPP (BNI 78 et 89)
- Cattenom NPP (BNI 124, 125, 126 et 137)
- Chinon B NPP (BNI 107 et 132)
- Chooz B NPP (BNI 139 et 144)
- Civaux NPP (BNI 158 et 159)
- Cruas NPP (BNI 111 et 112)
- Dampierre NPP (BNI 84 et 85)
- Fessenheim NPP (BNI 75)
- Flamanville NPP, including Flamanville 3 (BNI 108, 109 et 167)
- Golfech NPP (BNI 135 et 142)
- Gravelines NPP (BNI 96, 97 et 122)
- Nogent NPP (BNI 129 et 130)
- Paluel NPP (BNI 103, 104, 114 et 115)
- Penly NPP (BNI 136 et 140)
- Saint-Alban-Saint-Maurice NPP (BNI 119 et 120)
- Saint Laurent B NPP (BNI 100)
- Tricastin NPP (BNI 87 et 88)

4.1.2. Installations operated by CEA

Cadarache site	• Réacteur Jules Horowitz (réacteur expérimental et d’irradiation) (BNI 172) • Masurca (maquette critique) (BNI 39) • ATPu (laboratoire en démantèlement) (BNI 32)
Saclay site	• OSIRIS (réacteur expérimental) (BNI 40)
Marcoule site	• Phénix (BNI 71)

4.1.3. Installations operated by AREVA

La Hague site **AREVA NC**	• UP3-A (BNI 116) • UP2 800 (BNI 117) • UP2 400 (BNI 33) • STE2 AT1 (BNI 38)	• HAO (BNI 80) • Elan IIB (BNI 47) • STE3 (BNI 118)
Marcoule site	• AREVA NC : Usine MELOX (BNI 151)	
Tricastin site	• EURODIF-Pro: Georges-Besse plant and its annex (BNI 93) • SET: Georges-Besse II plant and its annex RECII (BNI 168) • AREVA NC: TU5 W plant (BNI 155) • AREVA NC Pierrelatte – Tricastin (BNI 105) • SOCATRI – Plant (BNI 138)	
Site de Romans	• AREVA NP: (BNI 98) (ex FBFC plant)	

4.1.4. Installations operated by Institut Laue Langevin

Grenoble site	• High flux reactor (HFR) (BNI 67)

4.2. Installations and sites assessed in 2012

4.2.1. Installations operated by CEA

Cadarache site	• Rapsodie (BNI 25) • MCMF (BNI 53) • LECA (BNI 55) • CHICADE (BNI 148)	• Cabri (BNI 24) • PEGASE (BNI 22) • Storage area (BNI 56) • Site support functions
Saclay site	• Orphée (BNI 101)	
Marcoule site	• Atalante (BNI 156) • Site support functions	

4.2.2. Installations operated by AREVA

Romans site	• AREVA NP (BNI 63) (ex CERCA plant)

4.2.3. Installations operated by Cisbio International

Saclay site	• Cisbio plant (BNI 29)

4.2.4. EDF installations being decommissioned

Creys Malville site	• Superphénix including TNA (BNI 91) • APEC (BNI 141)
Bugey NPP site	• Bugey 1 (BNI 45)
Chinon NPP site	• Chinon A1 (BNI 133) • Chinon A2 (BNI 153) • Chinon A3 (BNI 161)
Saint-Laurent NPP site	• Saint-Laurent A1 (BNI 46) • Saint-Laurent A2 (BNI 46)
Chooz NPP site	• Chooz A (BNI 163)
Brennilis site	• Monts d'Arrée - EL4-D (BNI 162)

4.2.5. Installation under construction ITER Organization

Cadarache site	• ITER

4.3. Other installations of lower priority to be assessed according to specific ASN requests, including by anticipated periodic safety reviews

4.3.1. Installations operated by CEA

Cadarache site	• Phébus (BNI 92) • EOLE (BNI 42) • MINERVE (BNI 95) • STAR (BNI 55) • Magenta (BNI 169) • CEDRA (BNI 164) • LPC (BNI 54) • LEFCA (BNI 123) • CASCAD (BNI 22) • AGATE (BNI 171) • STEDS Treatment (BNI 37)
Saclay site	• LECI (BNI 50) • Poséidon (BNI 77) • ZGDS Storage (BNI 72) • ZGEL Treatment and storage (BNI 35)

The following BNIs are not concerned by the stress tests: ATUe (BNI 52) on the Cadarache site, Ulysse (BNI 18) and LHA (BNI 49) on the Saclay site, STED (BNI 36), LAMA (BNI 61), STED (BNI 79) and Siloé (BNI 20) on the Grenoble site.

4.3.2. Installations operated by IONISOS

- Dagneux site (BNI 68)
- Pouzauges site (BNI 146)
- Sablé sur Sarthe site (BNI 154)

4.3.3. Installations operated by ANDRA

- Centre de stockage de la Manche - CSM (BNI 66)
- CSA (BNI 149)

4.3.4. Installations operated by Électricité de France

Tricastin site	• Tricastin operational hot unit (BCOT) (BNI 157)
Chinon site	• Irradiated materials facility (AMI) (BNI 94) • Inter-regional warehouse (MIR) (BNI 99)
Bugey site	• Fuel inter-regional warehouse (MIR) (BNI 102) • ICEDA (BNI 173)
Saint- Laurent site	• Interim storage facility of irradiated graphite sleeves (BNI 74)

4.3.5. Installations operated by AREVA

Narbonne site	• AREVA NC Malvési (ECRIN)

4.3.6. Other operators

SOCODEI	**Marcoule site**	• CENTRACO (BNI 160)
SOMANU	**Maubeuge site**	• Atelier de maintenance nucléaire (BNI 143)
GIE GANIL	**Caen site**	• GANIL (BNI 113)
ISOTRON		• GAMMASTER - Marseille (BNI 147) • GAMMATEC – Chuslan (BNI170)

The following BNIs are not concerned by the stress tests: the Strasbourg university reactor (BNI 44) – Louis Pasteur University, the LURE (BNI 106), SICN (BNI65 and BNI90).

5 | MAJOR LEGISLATIVE AND REGULATORY TEXTS

5.1. Laws and regulations in force

Environment Code (Chapter II of Title IV of Book V and Title IX of Book V – Lesgislative and regulatory parts)

Public Health Code (Chapter III of Title III of Book III of First Part - Lesgislative and regulatory part)

Labour Code

Act no 2006-686 of 13 June 2006 (known as "TSN Act")
On transparency and security in the nuclear field

Act no 2006-739 of 28 June 2006 (known as "Waste Act")
On the Sustainable Management of Radioactive Materials and Waste

Act no 2015-992 of 17 August 2015 (known as "TECV Act")
Related to energy transition for green growth (in particular Title VI)

Ordonnance no 2016-128 of 10 February 2016
Pertaining to various provisions in the nuclear field

Act no 2016-1015 of 25 July 2016
Specifying the modalities for the creation of a reversible deep geological repository for long-lived and high-level radioactive waste

Decree no 2006-1606 of 14 December 2006
Relating to public interest groupings governed by Article L. 542-11 of the Environment Code

Decree no 2007-150 of 5 February 2007
Defining the Perimeter of the Proximity area described in Article L542-11 of the *Environment Code*, Concerning the Meuse and Haute-Marne Underground Laboratory Designed to Study the Suitability of Deep Geological Formations for Disposing of Which Radioactive Waste.

Decree no 2007-243 of 23 February 2007
Concerning the Secure Financing of Nuclear Costs.

Decree no 2007-720 of 7 May 2007
Concerning the Membership and Operating Procedures of the Local Information and Oversight Committees Created by Article L542-13 of the Environment Code for Underground Laboratories Conducting Research into the Radioactive Waste Management and Modifying Decree No. 99-686 of 3 August 1999.

Decree no 2007-721 of 7 May 2007
Determining the Fraction of the Support Tax Paid Back to the Communes any part of which is Less Than 10 km From the Main Access to the Underground Installations of the Bure (Meuse) Research Laboratory pursuant to V of Article 43 of Act No. 99-1172 of 30 December 1999, as amended, constituting the 2000 Finance Act.

Decree no 2007-830 of 11 May 2007
Concerning the BNI Nomenclature.

Decree no 2007-831 of 11 May 2007
Concerning the Appointment and Empowerment Procedures for Nuclear Safety Inspectors.

Decree no 2007-1557 of 2 November 2007 (known as "Procedures Decree")
Concerning Basic Nuclear Facilities and the Regulation of Nuclear Safety Aspects Involved in the Transport of Radioactive Material.

Decree no 2007-1572 of 6 November 2007
Concerning Technical Inquiries on Accidents or Incidents Induced by Nuclear Activities.

Decree no 2008-209 of 3 March 2008
Concerning the Management of Foreign Waste and Processing Contracts.

Ministerial Order of 7 February 2012 (known as "BNI Order")
Setting the general rules relative to basic nuclear installations.

Decree no 2015-231 of 27 February 2015
Related to the management of used sealed radioactive sources.

Decree no 2017-231 of 23 February 2017
Taken for the application of Article L. 542-1-2 of the Environment Code and laying down the requirements of the national plan for the management of radioactive materials and waste.

5.2. Safety Guides (on 30 June 2017)

5.2.1. Basic safety rules

RFS I.1.a Inclusion of Hazards Relating to Aircraft Crashes (7 October 1992).

RFS I.1.b Inclusion of Hazards Linked to the Industrial Environment and Communication Routes (7 October 1992).

RFS 2001-01 Determination of Seismic Movements to Be Considered for Installation Safety (revision of RFS-I.1.c – 16 May 2001).

RFS I.2. Safety Objectives and Design Bases for Surface Facilities Intended for Long-term Disposal of Solid Short or medium-lived Radioactive Waste with Low or Intermediate Specific Activity (8 November 1982 – revision of 19 June 1984).

RFS I.2.d Taking into account risks related to the industrial environment and communication routes (07 May 1982)

RFS I.3.a Use of the single failure criterion in safety analyzes (05 August 1980)

RFS I.3.b Seismic instrumentation (08 June 1984)

RFS I.3.c Prevention of criticality risks (18 October 1984).

RFS I.4.a Protection against fire (28 February 1985).

RFS II.2. Design and operation of ventilation systems in BNIs other than nuclear reactors (20 December 1991).

RFS-II.4.1.a Software for electrical safety systems (15 May 2000)

RFS III.2.a General Provisions Applicable to the Production, Monitoring, Treatment, Packaging and Interim Storage of Various Waste Categories Resulting from Processing of Fuel Irradiated in Pressurised-water Reactors (24 September 1982).

RFS III.2.b Special Provisions Applicable to the Production, Monitoring, Treatment, Packaging and Interim Storage of High-level Waste Packaged in Glass and Resulting from Processing of Fuel Irradiated in Pressurised-water Reactors (12 December 1982).

RFS III.2.c Special Provisions Applicable to the Production, Monitoring, Treatment, Packaging and Interim Storage of Low or Intermediate-level Waste Encapsulated in Bitumen and Resulting from Processing of Fuel Irradiated in Pressurised-water Reactors (5 April 1984).

RFS III.2.d Special Provisions Applicable to the Production, Monitoring, Treatment, Packaging and Interim Storage of Waste Encapsulated in Cement and Resulting from Processing of Fuel Irradiated in Pressurised-water Reactors (1 February 1985).

RFS III.2.e Prerequisites for the Approval of Packages of Encapsulated Solid Waste Intended for Surface Disposal (31 October 1986 – revision of 29 May 1995).

RFS-IV.1.a Classification of mechanical equipment, electrical systems, structures and structures (December 21, 1984)

RFS-IV.2.a Requirements to be taken into account in the design of safety-classified mechanical equipment, carrying or containing a fluid under pressure and classified at levels 2 and 3 (21 December 1984)

RFS-IV.2.b Requirements to be taken into account in the design, qualification, implementation and operation of electrical equipment belonging to safety-classified electrical systems (31 July 1985)

RFS-V.1.a Determination of the activity released from the fuel to be taken into account in accident safety studies (10 June 1982).

RFS-V.1.b Meteorological means of measurement (10 June 1982).

RFS-V.2.b General rules applicable to the construction of civil engineering works (30 July 1981).

RFS-V.2.c General rules applicable to the realization of mechanical equipment (08 April 1981).

RFS-V.2.d General rules for the manufacture of electrical equipment (28 December 1982)

RFS-V.2.j General rules relating to fire protection (20 November 1988)

RFS-V.2.h General rules applicable to the construction of civil engineering works (4 June 1986)

RFS 2002-1 Development and Use of Probabilistic Safety Studies (26 December 2002)

5.2.2. Guides

ASN Guide n°3: Recommendations for writing annual public information reports concerning basic nuclear installations (20 October 2010)

ASN Guide n°6: Final shutdown, decommissioning and delicensing of basic nuclear installations in France (30 August 2016)

ASN Guide n°7: Transport of radioactive packages or substances on the public roads for civil purposes (15 February 2016)

ASN Guide n°8: Assessing the conformity of nuclear pressure equipment (4 September 2012)

ASN Guide n°9: Determining the perimeter of a BNI (31 October 2013)

ASN Guide n°10: Guide to the local involvement of Local Information Committees (CLIs) in the third 10-year outages of 900-MWe reactors (1 June 2010).

ASN Guide n°13: Protection of basic nuclear installations against external flooding (8 January 2013)

Draft ASN Guide n°14: Acceptable complete clean-out methodologies in basic nuclear installations in France (21 June 2010)

ASN Guide n°18: Disposal of effluents and waste contaminated by radionuclides, produced in facilities licensed under the Public Health Code (26 January 2008)

ASN Guide n°19: Application of Order of 12/12/2005 relative to nuclear pressure equipment (21 February 2013)

Methodological guide: Management of sites potentially polluted by radioactive substances (December 2011)

Guide indicating the conditions of application of the fire provisions of the Order of 31/12/1999 amended (1 April 2006)

Guide to the regulatory requirements applicable to the transport of radioactive materials in airports (February 2006)

Safety Guide on the final disposal of radioactive waste in deep geological formations (February 2008)

General safety orientations notice in view of the search for a site for disposal of low specific activity, long-lived waste (June 2008)

6 | STRUCTURE OF MAJOR NUCLEAR OPERATORS

6.1. Structure of ANDRA

ANDRA was created within the CEA in 1979, and became an independent entity in 1992. It is led by a Director General who has functional departments and operational departments under his authority.

6.1.1. The functional departments

- The general secretariat proposes to general management the Agency's orientations with regard to budgetary, legal, management control, purchasing and information technology matters, then implements them. It is responsible for questions relating to accounting, fiscal aspects, financing and cash flow. It prepares the meetings and ensures secretaryship of the board of directors and the finance committee. It is responsible for relations with the State comptroller and the advisory committee on contracts.
- The Human Resources Department implements the Agency's human resources policy.
- The Department of Communication and Dialogue with Civil Society proposes ANDRA's strategy regarding information, consultation and outreach with its internal and external audiences.

6.1.2. The operational departments

- The CIGÉO Project Management represents ANDRA, the owner, for the design and construction of surface infrastructures (nuclear and non-nuclear) and underground infrastructures (nuclear and non-nuclear) necessary for the general vision of deep geological disposal (CIGÉO) and the construction of its section 1.
- The Engineering Department is an operational department working for the Agency's projects and activities. The engineering department is the technical guarantor of ANDRA's acquired expertise in projects and programmes relative to the specification, design, production and qualification of disposal facility constituents.
- The research and development department (DRD) is tasked with defining and implementing the Agency's R&D work which integrates all the scientific studies and the underground laboratory experimental work. It is involved in particular in package inspection means, facility monitoring systems, new materials and alternative waste treatment processes. It carries out digital simulations for ANDRA's various activities. It defines and conducts the geological reconnaissance campaigns.
- The role of the Environmental Safety and Waste Management Strategy Department (DISEF) is to guarantee that all the facilities designed and operated by ANDRA, and the waste management methods it proposes, have a controlled impact on man and the environment today, tomorrow and over the long term. It coordinates the expertise in terms of safety and the environment, capitalisation of knowledge of packages, controlling their quality and safety, and the strategy for determining waste management routes.
- The Meuse/Haute-Marne Centre is responsible for the construction, operation and maintenance of the underground research laboratory. It also fulfils this role for the Technological Space and the "Ecotheque". It contributes to the regional development initiatives around the CIGÉO project, in close collaboration with the regional authorities and the government departments. It prepares its own local industrial presence.
- The Industrial Operations Department operates the disposal facilities and implements the industrial solutions for accepting radioactive waste. For these activities it is the chief point of contact for all waste producers for the acceptance of waste in the industrial waste management routes of the CIRES and CSA centres, and for the acceptance of waste (including LLW-LL and ILW-LL waste) from all small waste producers and holders.
- The Development, Innovation and International Relations Department coordinates innovation, and the development of industrial solutions. It showcases and capitalises on the results obtained in contractual and/or partnership contexts both nationally and internationally. It represents ANDRA in the international bodies.

6.2. Structure of CEA

The CEA is a public research organisation founded in 1945.

With the publication of the legislative section of the Research Code (Ordinance n° 2004-545 of 11 June 2004), the CEA (formerly the *Commissariat à l'Energie Atomique* - Atomic Energy Commission), which became the Alternative Energies and Atomic Energy Commission on 10 March 2010 (Supplementary Budget Act 2010-237 of 9 March 2010) now lies within the category of Industrial and Commercial Public Establishments (EPIC), in the research EPIC category.

Its status and its missions are defined in Articles L. 332-1 to L. 332-7 of the Research Code.

A major actor in the world of research, development and innovation, the CEA works in four broad areas: low-carbon energies (nuclear and renewables), information technologies, technologies for health, defence and global security. In each of these four broad areas, CEA has first-class fundamental research resources and plays a role in dynamic development through innovation in relation with industry. It coordinates and takes part in the research work conducted in the TGIRs (*Très grandes infrastructures de recherche* - Very large research infrastructures).

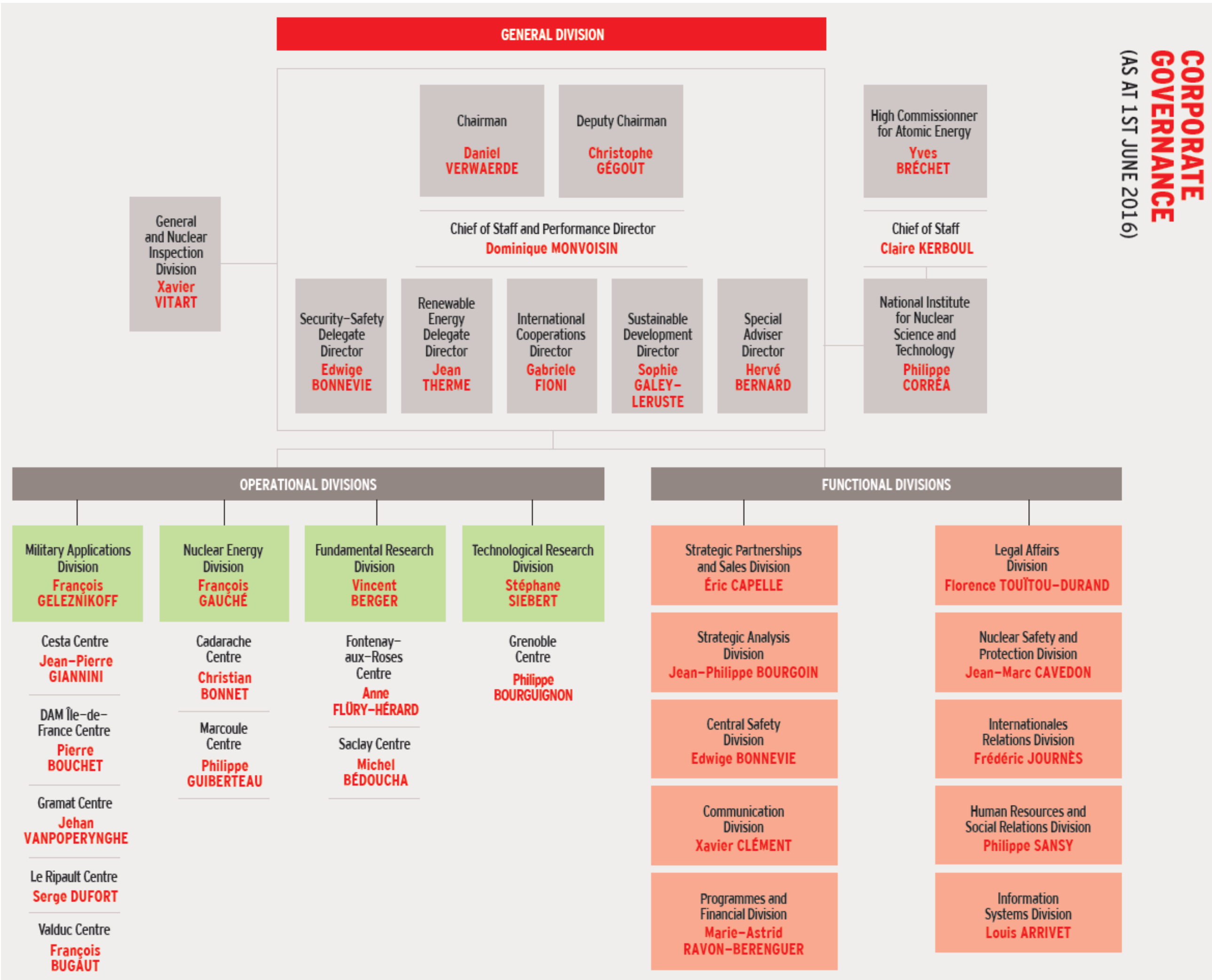

FIGURE 16: ORGANISATION CHART OF CEA

6.3. Structure of AREVA

Before 30th June 2016, AREVA had its legacy "pillar" of activity, namely its nuclear activities (Mines, Front-end, Back-end and Reactors & Services), and a second pillar, namely renewable energies (Offshore windfarms, Concentrated solar power, Biomass, Hydrogen and Energy storage).

The organisation of AREVA's activities was illustrated by the diagram below:

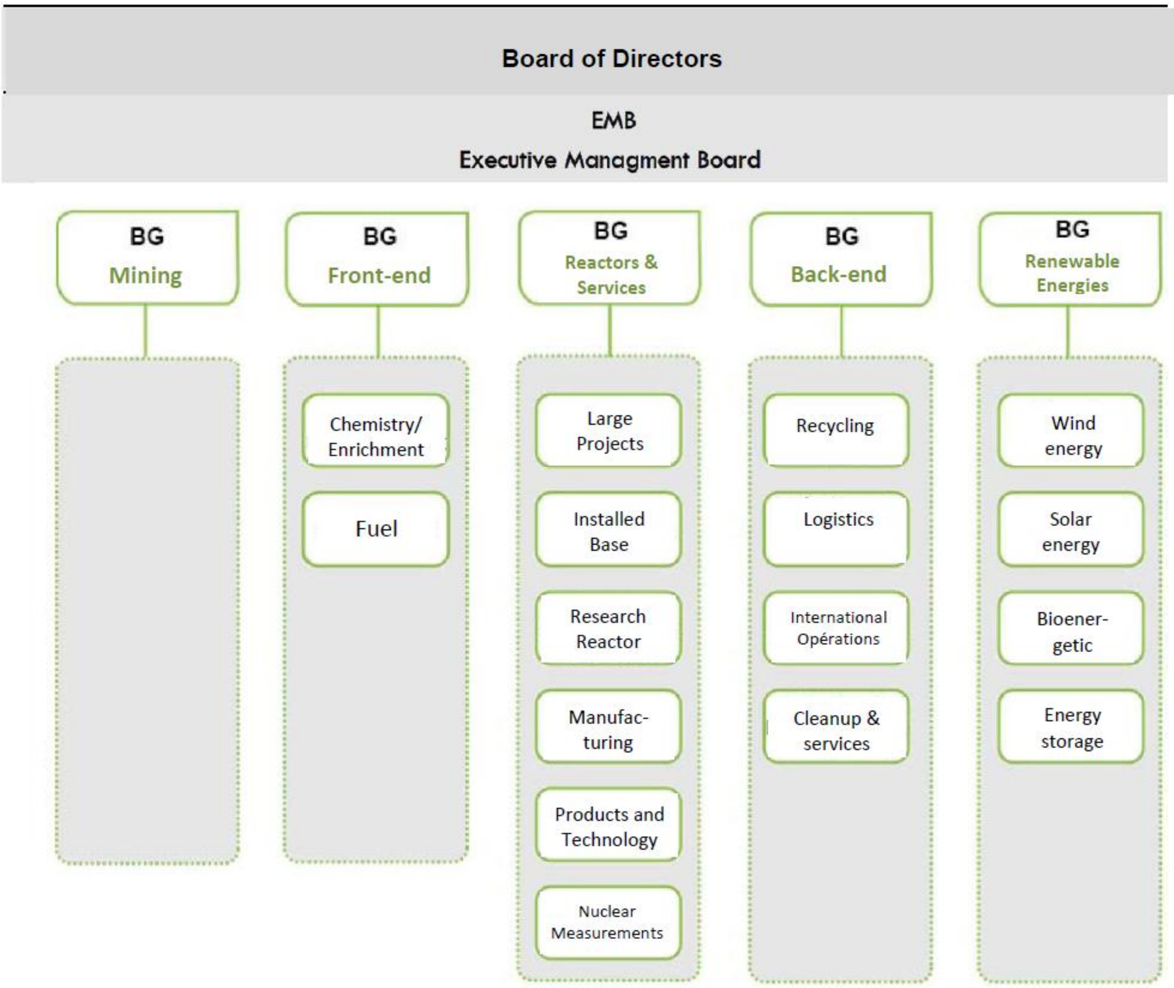

FIGURE 17: ORGANISATION CHART OF AREVA BEFORE 30 JUNE 2016.

The information provided in this report is derived from this organisation.

As from 30th June 2016, in the context of the reorganising of the French nuclear sector, AREVA will refocus its activity on the fuel cycle: mines, chemistry and enrichment, recycling, logistics, decommissioning and engineering. These activities are grouped with the entity New AREVA.

The activities relating to the design of reactors, the manufacture of components and fuel, including the Romans-sur-Isère facilities, the services to the installed base, will be kept within AREVA NP, the reference player in these areas and which will join the EDF group by the end of 2017.

The other activities (Renewables) have been sold.

The simplified diagrams of the 2 companies are shown below:

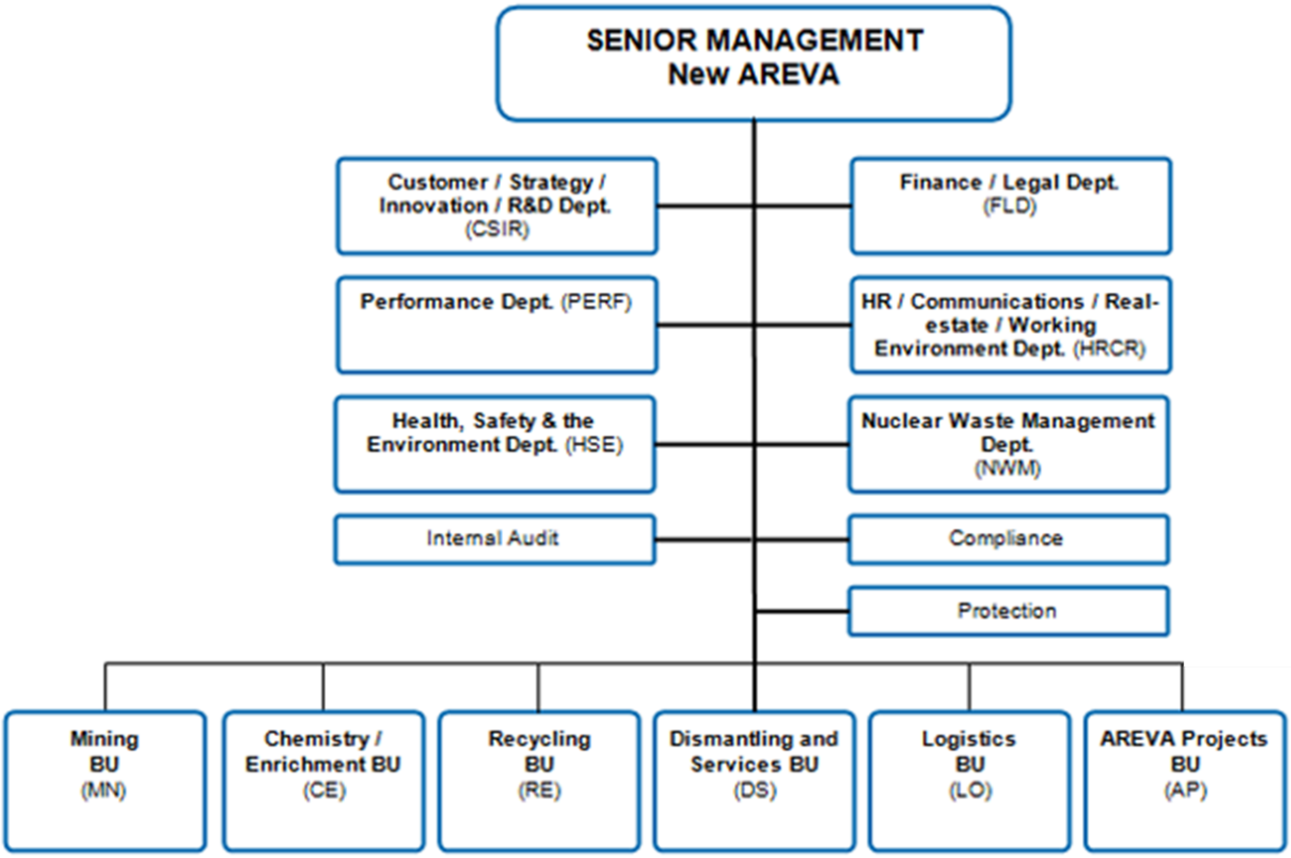

FIGURE 18: ORGANISATION CHART OF NEW AREVA.

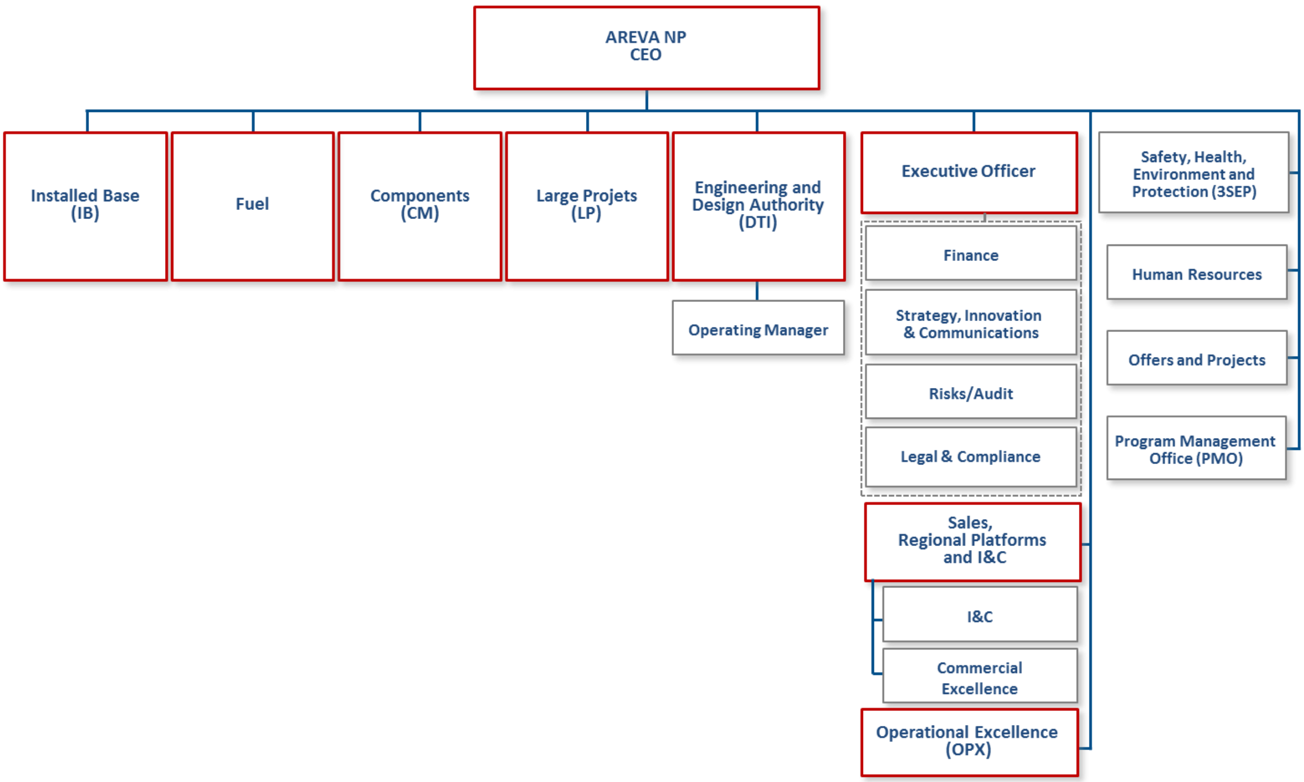

FIGURE 19: ORGANISATION CHART OF AREVA NP.

6.4. Structure of EDF

EDF is the main electricity production company in France and the only one to operate nuclear power reactors. EDF fulfils these missions directly through the various departments, divisions and entities.

The DPNT (Nuclear and Thermal Generation Division) is the centralised producer, responsible for nuclear and thermal electricity generation.

Its broad duties within EDF are:

- to maintain the safety of the nuclear fleet at the highest level while achieving the set production targets;
- ensure the success of the "Grand Carénage" Programme (extension of service life and post-Fukushima measures);
- develop an industrial route for nuclear dismantling and the management of radioactive waste ;
- have a strong, high-performance and innovative engineering base working for the Grand Carénage Programme and dismantling/waste projects;
- secure the procurement of nuclear fuel and management of the nuclear cycle;
- manage operational waste and spent fuel;
- adapt the thermal fleet and diversify the thermal engineering activity.

The DIPNN (New Nuclear Projects & Engineering Division) is:

- the architect-integrator of the New Nuclear build, working on a group of projects covering all the phases of the new nuclear build engineering;
- supporting the operating performance and the extension of the service life of the EDF nuclear power plants in France;
- responsible for the development of the EDF Group's international nuclear projects.

6.4.1. Nuclear and Thermal Generation Division (DPNT)

The missions of the main entities or organisations in the Nuclear and Thermal Generation Division having nuclear-related activities are described below.

6.4.1.1. NUCLEAR PRODUCTION DIVISION

As nuclear operator, the DPN is in charge of operational sites until their final shutdown. The DPN holds the main responsibility for all generic actions. In that respect, it bears the waste-related costs, which include especially the fixed costs for “pre-processing” (mobile packaging units and CENTRACO) and disposal (CSA and CIRES). The Director of the DPN is the main contact with the ASN Director-General, particularly in the field of radioactive waste management in operating NPPs.

6.4.1.2. POWER AND NUCLEAR POWER GENERATING STATIONS

In accordance with regulations, NPP managers are responsible for their waste (from the production site up to their final destination) and for the conformity of the packages they produce. They are required to implement the doctrine drawn up for the entire nuclear fleet and to use generic agreements of waste packages, whenever available. They ensure that the agreements are consistent with existing national provisions. They rely essentially on the support of the Corporate Technical Support Unit (*Unité technique opérationnelle* – UTO).

6.4.1.3. NATIONAL ENGINEERING UNITS

The UTO is only national engineering unit supporting NPPs for operational waste-management issues. It is responsible for:

- The development of the doctrine regarding operating waste (basic requirements, internal guidelines, etc.);
- the methodological support necessary for the implementation of the doctrine;
- the review of package agreements;
- proposing products to NPPs (packages, hulls, drums) and materials (dry loads) for waste conditioning and managing common conditioning resources (mobile units, etc.).

The Operational Engineering Unit (*Unité d’ingénierie d’exploitation* – UNIE), is also involved in waste management and specifically for the definition of “zoning” (classification of buildings and rooms according to their radiological content) and for the definition and leadership of the professional workforce and skills in charge of managing waste on nuclear sites.

6.4.1.4. THE NUCLEAR FLEET, DISMANTLING AND ENVIRONMENT ENGINEERING DIVISION (DIPDE)

The Nuclear Fleet, Dismantling and Environment Engineering Division (DIPDE) ensures the engineering of the nuclear fleet in operation and of dismantling through technical studies and works.

The DIPDE has three main partners: the Grand Carénage Programme, the DPN and the DP2D.

The DIPDE ensures the integrity of design (role of Design Authority) with respect to nuclear safety and protection of the interests in behalf of the DPN; it participates in the performance of the nuclear fleet in operation through its contribution to maintaining the production level. The DIPDE ensures the technical and financial management of the Grand Carénage Programme. The DIPDE contributes to the DP2D dismantling projects by performing technical studies and implementing modifications on the plant units in operation.

6.4.1.5. THE DISMANTLING AND WASTE PROJECTS DIVISION (DP2D)

The mission of the Dismantling and Waste Projects Division (DP2D) is to be the EDF group's integrated operator for nuclear power plant dismantling and waste management.

The DP2D was set up in response to the will to have for greater synergy between the dismantling of definitively shut down power plants and the management of radioactive waste. As a responsible industrial actor, EDF must ensure that all the waste resulting from dismantling will be able to be treated, stored and ultimately disposed of in appropriate facilities by contributing to the setting up of a true industrial waste management route in this area.

6.4.1.6. THE NUCLEAR FUEL DIVISION (DCN)

By delegation from DPNT, DCN is responsible, for EDF, for the activities associated with the fuel cycle and therefore in particular for defining and apply the management strategy for spent fuel.

It manages the contracts for uranium procurement and enrichment, manufacture of UO2 and MOX fuel, and the transport, reception, storage and processing contracts for spent fuel and induced waste.

6.4.1.7. THE GRAND CARÉNAGE PROGRAMME

The Grand Carénage Programme is a project structure tasked with modernising and extending the operating life of the fleet in service operated by the Nuclear Generation Division (DPN).

The DIPDE and the UTO (Operational Technical Unit), as engineering units, contribute to the Grand Carénage Programme in the studies and production phases.

The Production Industrial Support Division (DAIP) provides heavy maintenance services, training, exceptional transport operations, etc.

The National Centre for Electricity Production Equipment (CNEPE), the Construction and Operational Expert Appraisal and Inspection Centre (CEIDRE) and the Thermal and Nuclear Studies and Projects Service (SEPTEN), as engineering units, contribute to the Grand Carénage Programme in the studies and production phases.

6.4.2. The New Nuclear Projects & Engineering Division (DIPNN)

The missions of the main entities or organisations in the DIPNN having nuclear-related activities are described below.

6.4.2.1. NATIONAL CENTRE FOR ELECTRICITY PRODUCTION EQUIPMENT (CNEPE)

In its role as architect-integrator, the National Centre for Electricity Production Equipment (CNEPE) is responsible for the design and production engineering of the conventional part of the installations for:

- the reactor fleet in operation: improving the systems and facilities of the nuclear plant units in operation to meet the requirements for safety, security, and environmental quality;
- the New Nuclear Build: the design and construction of the new nuclear power plants (Hinkley Point C, Taishan, etc.);
- meet the demands of the DIPNN for projects under development.

6.4.2.2. THE NATIONAL CENTRE FOR NUCLEAR EQUIPMENT (CNEN)

The National Centre for Nuclear Equipment (CNEN) is responsible for the development of nuclear power in France and internationally.

Its missions:

- contribute to the new construction projects in France and coordinate the design of the EPR projects in the United Kingdom as Responsible Designer ;
- fully ensure the role of EDF as an industrial actor and designer and prepare for future operation;
- be a major actor in the EDF group's "New Nuclear Build" projects on the international scene;
- guarantee the safety, security, quality and control of the EPR projects costs and time frames.

6.4.2.3. THE THERMAL AND NUCLEAR STUDIES AND PROJECTS SERVICE (SEPTEN)

The mission of the Thermal and Nuclear Studies and Projects Service (SEPTEN) is to:

- fulfil a role of design integration and expertise;
- be the "Responsible Designer" of the safety case for the existing fleet.

The SEPTEN is responsible for the performance of the nuclear fleet in operation and for the extension of its service life.

It is involved in the Grand Carénage Programme and the new nuclear build.

6.4.2.4. THE CONSTRUCTION AND OPERATION EXPERT APPRAISAL AND INSPECTION CENTRE (CEIDRE)

The Construction and Operation Expert Appraisal and Inspection Centre (CEIDRE) is EDF's expert appraisal unit responsible for the inspection and monitoring of the manufacture of materials for the current and new nuclear build.

7 | MESUREMENTS TAKEN IN THE ENVIRONMENT

7.1. Monitoring stations

7.1.1. Radioactivity telemetry network

7.1.1.1. TÉLÉRAY (AMBIENT GAMMA DOSE RATE)

IRSN's TELERAY alert network is the French national network dedicated to the permanent watch of ambient gamma radiation levels. With a 24h/24h alert function in the event of an abnormal rise in the level of radioactivity, the network's probes are distributed over the entire French territory (mainland France and the French overseas departments, regions and *collectivités*, known by their acronym "DROM/COM") and take an equivalent dose rate measurement (in nSv/h) every ten minutes. Modernised as of 2010, this network now comprises nearly 400 fixed radiation monitors, installed in greater density around nuclear facilities. It can be supplemented on demand by some twenty mobile radiation monitors, in accident situations for example.

The information from the measurements of these radiation monitors is made public either in "real time" through the teleray.irsn.fr/ application, or in deferred time through the websites https://www.mesure-radioactivité.fr, https://sws.irsn.fr.

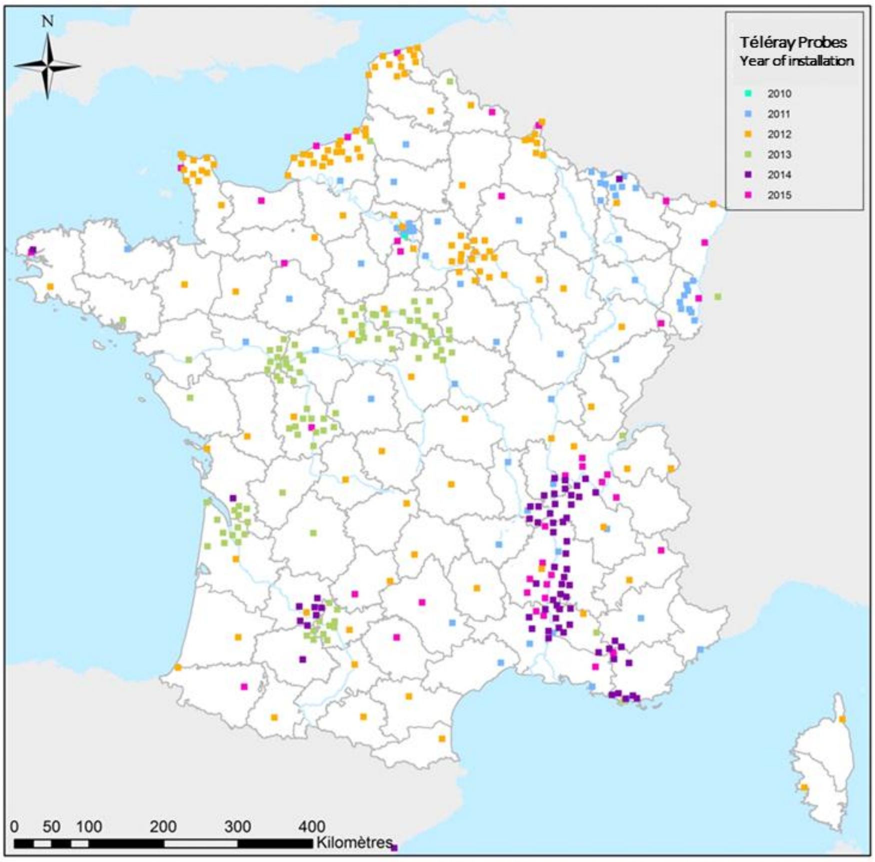

FIGURE 20: LOCALISATION OF THE TELERAY NETWORK'S PROBES IN FRANCE IN 2017

7.1.1.2. HYDROTELERAY

The Hydrotéléray network is an automated network dedicated to the real-time monitoring of the radioactivity of the major rivers downstream from all nuclear finicalities and before their discharge in the open throughout the country. It includes seven telemetry stations (Seine, Loire, Rhône, Rhine, Meuse, Moselle and Garonne. The system is equipped with a sodium-iodide (NaI) detector and is able to measure by gamma-spectrometry in situ radioactivity in water channelled from rivers in 25L leaded tanks. The network carries out more than 30,000 measurements each year, with special focus on 131 Iodine and 137 Caesium.

7.1.1. Monitoring of the atmospheric compartment

7.1.1.3. ATMOSPHERIC AEROSOLS

Monitoring of the radioactivity of atmospheric aerosols throughout France is ensured by two types of sampling stations constituting the OPERA-AIR network:

- the "medium volume" stations (80 m^3/h). Today the network counts 34 such stations, 24 of which are situated near nuclear facilities. The filters from these stations are sampled once a week and sent to a laboratory for analysis. All form the subject of a gamma spectrometry measurement. . A measurement of overall alpha activity is also carried out on the filters from the stations close to nuclear facilities that could discharge alpha emitting radionuclides.
- the "high volume" stations (700 m^3/h). There are 8 stations of this type situated at a distance from nuclear facilities. The filters from these stations are sampled once a week and sent to a laboratory for analysis. They all are subject to a measurement by gamma spectrometry and the levels of activity that these stations can measure are tiny (down to 10^{-7} Bq/m^3 for certain radionuclides).

7.1.1.4. RAINWATERS

The nuclear installations (29 stations) are monitored through collectors positioned downwind of the prevailing winds, where the rainwater is collected weekly. Apart from monitoring nuclear facilities, the rainwater-monitoring system includes 12 stations disseminated throughout the country. A total of 28 nuclear facilities are monitored through a collector network installed under prevailing winds at locations where water is collected on a weekly basis.

7.1.1.5. GASES

Atmospheric compartment monitoring is sometimes supplemented by sampling tritium in the air, achieved in particular by using bubblers installed near a few nuclear installations, and more recently by passive trapping systems. One of these aerosol sampling stations is also equipped with a system for trapping iodines on activated carbon cartridges.

Environment	Means	Measurements and analyses
Internal exposure	420 Téléray stations (continuous) > 100 integrating dosimeters (quarterly)	γ rays
Aerosols	On filter / 34 stations (weekly)	γ spectrometry (weekly) U or Pu and Am on some stations
Rainwater	29 collectors close to nuclear sites (weekly) + 14 other collectors	^{3}H (monthly) + a few γ, α total spectrometry measurements depending on station
Gases	3 bubblers (weekly to bimonthly) Passive traps (bimonthly) on activated charcoal cartridge	^{3}H (HTO form and other forms) Iodine (routinely near La Hague)

TABLE 31: MEASUREMENT PROGRAMME IMPLEMENTED BY IRSN FOR RADIOLOGIC MONITORING OF ATMOSPHERIC COMPARTMENT

7.1.2. Monitoring of the water compartment

7.1.1.6. CONTINENTAL STREAM

In addition to the Hydrotéléray continuous monitoring network, French rivers are monitored by a system of 27 stations comprising semi-automated water collectors, with devices for trapping suspended matter in 25 stations, the majority of which are located immediately downstream of the nuclear installations. The taking of samples of surface water, water from resurgences, sediments, aquatic plants and fish supplement the inland water monitoring system.

7.1.1.7. COASTAL WATERS

The marine environment is monitored from coastal sampling points scattered along all seashores of the country. The number of stations and their location are determined not only by the determination to ensure a sound geographic coverage, but also by the proximity of nuclear facilities and by the application of specific follow-up programmes (e.g., for the Mediterranean Sea). Three types of stations are found, as follows:

- hydrocollectors installed in the discharge devices of the 4 coastal nuclear power stations;

- stations submitted to the influence of the discharges made by nuclear facilities with a follow-up of evolution in space and time of the radiological stats;
- so-called “reference” stations that characterise background noise and potential pollution sources other than the discharges from coastal nuclear facilities and monitor the radionuclide input of large rivers in the sea.

Coastal monitoring includes seawater sampling points but also bio-indicators (seaweed and molluscs) that concentrate radionuclides and account for the status of the environment better that the direct measurements in seawater. Fishes are also sampled on a yearly basis.

Environments	Samplings (frequency)	Analysis plan
Groundwater	1 station (yearly)	total α, total β, K, γ spectrometry
Drinking waters	4 stations (semi-yearly to yearly)	total α, total β, K, ^{3}H, ^{90}Sr, γ spectrometry, U
River water	21 hydrocollectors (continuous) 46 stations (manual, semi-yearly)	^{3}H (monthly), total α, total β, K, γ spectrometry, ^{90}Sr (yearly) ^{3}H (monthly), total α, total β, K, γ spectrometry, ^{90}Sr (yearly)
Suspended matters	25 stations (monthly)	γ spectrometry (monthly) Pu, Am, Sr on 5 stations (yearly)
Sediments	24 stations (yearly to semi-yearly)	γ spectrometry, Pu, Am, U, ^{90}Sr
Aquatic plants	6 stations (semi-yearly)	γ spectrometry , + bound ^{3}H, ^{14}C, Sr, Pu, Am on a few stations
Sea water	4 hydrocollectors (continuous) 11 manual sampling stations	^{3}H (monthly), γ spectrometry (quarterly) ^{3}H (semi-yearly), γ spectrometry (yearly)
See Sediments	18 stations (semi-yearly to yearly)	γ spectrometry Pu, Am (16 stations), ^{90}Sr on 12 stations
Molluscs	13 stations (quarterly to yearly)	γ spectrometry + bound ^{3}H, ^{14}C, Sr, Pu, Am on a few stations
Seaweeds	15 stations (semi-yearly to yearly)	γ spectrometry + bound ^{3}H, ^{14}C, Sr, Pu, Am on a few stations
Fish	36 stations (yearly)	γ spectrometry + bound ^{3}H, ^{14}C, Sr, Pu, Am on some stations

TABLE 32: MEASUREMENT PROGRAMME IMPLEMENTED BY IRSN FOR RADIOLOGIC MONITORING OF WATER COMPARTMENT

7.1.3. Monitoring of terrestrial compartment

A sampling network was deployed throughout the country through the contribution of decentralised State services, such the Directorate-General for Foodstuffs (*Direction générale de l’alimentation* – DGAL) and Directorate-General for Competition, Consumer Affairs and Fraud Prevention (*Direction générale de la concurrence, de la consommation et de la répression des fraudes* – DGCCRF) and provides for permanent watch over the radioactivity levels in the terrestrial flora and the food chain, in both mainland France and the overseas territories.

Monitoring is ensured by taking regular samples of milk, leafy vegetables, and cereal crops in the vicinity of nuclear installations.

In addition, annual monitoring based on taking samples of fruit, vegetables, beverages, ground vegetables and meat from reared livestock or wild game, is ensured over the entire country and managed at departmental level.

The reference levels are acquired during specific studies called "radiological findings".

Element	Sampling (frequency)	Analysis plan
Milk	33 nearby nuclear sites (semi-yearly to quarterly) 9 stations under *department* monitoring (yearly)	γ Spectrometry, free ^3H + ^{14}C, bound ^3H, U on some stations γ Spectrometry, + free ^3H, ^{90}Sr on some stations
Wheat	31 nearby nuclear sites (yearly)	γ Spectrometry + bound ^3H, ^{14}C, Pu, Am, U on some stations
Vegetable-leaves	23 nearby nuclear sites (yearly) 5 for oversea monitoring	γ Spectrometry, ^3H, ^{14}C + bound ^3H on some stations γ Spectrometry + U, Th on one station
Fruits and vegetables	14 (yearly)	γ Spectrometry + free/bound ^3H, ^{14}C, Pu, Am, U on some stations
Meat	4 (yearly)	γ Spectrometry + bound ^3H, ^{14}C, ^{90}Sr depending on stations
Honey	1 (yearly)	γ Spectrometry free/bound ^3H
Drinks	1 (yearly)	γ Spectrometry, free ^3H
Plants	29 stations (yearly to semi-yearly)	γ Spectrometry, free/bound ^3H, ^{14}C, U, Sr, Pu, Am depending on stations

TABLE 33: MEASUREMENT PROGRAMME IMPLEMENTED BY IRSN FOR THE RADIOLOGIC MONITORING OF TERRESTRIAL COMPARTMENT (RADIOLOGIC CASES EXCLUDED)

7.1.4. Regional radiological findings

The purpose of the regional radiological findings is to establish over an extensive area (covering several departments) an updated baseline of the levels of radioactivity in certain environmental compartments that are characteristic of the area in question. This baseline must take into account firstly the "background radiation noise" associated with the natural radioactivity and the persistence of old atmospheric fallout (nuclear weapons tests and the Chernobyl accident) and secondly the influence of current or past discharges from any nuclear installations present in the area. In the event of incidental or accidental discharge, this baseline will serve as a comparison benchmark and help orient the deployment of reinforced monitoring.

Every report, updated approximately every five years, would include several sampling campaigns in the order of 100 to 200 between the terrestrial environment (major agricultural productions), terrestrial and sea water environment and the atmospheric environment (aerosols and gases). Depending on the scale of the findings and the studied environment, the emphasis is placed on typical agricultural crops and livestock production for the area concerned, fishery products or the natural bio-indicators.

Findings coming under a particular theme were also performed: study of areas of persistence (current radiological state of areas in which the fallout from atmospheric tests of nuclear weapons and Chernobyl had been the highest), study of mining sites (extension of the former uranium mine monitoring areas to a distance much further downstream).

7.1.5. Regulatory environmental monitoring of BNIs

Radioactive discharges around nuclear sites are monitored by the operators themselves according to the regulatory specifications described below. Those provisions represent a general minimum requirement, but, depending on the situation involved, operators are invited to take additional measurements, especially around the AREVA Site at La Hague.

The statutory environmental monitoring of BNIs is adapted for each type of facility, whether a nuclear-power reactor, a plant or a laboratory is involved. The different measurements associated with the monitored environments, are presented hereinafter.

7.1.5.1. REGULATORY ENVIRONMENTAL MONITORING OF NPPS

The different measurements associated with the NPP monitoring, are presented in the following table.

Environment	Samplings and measurements to be carried out by the operator
Air at ground level	4 stations for continuous sampling of atmospheric dust on a fixed filter with daily measurement of total α and total β if total β exceeds 2 mBq/m^3 1 continuous sample under the prevailing wind Weekly measurement of atmospheric ^{3}H
Rainwaters	1 station under the prevailing wind (monthly collector) Measurements: total β and tritium on monthly mix
Ambient γ radiation	4 stations at 1 km with continuous measurement and recording (10 nGy/h to 10 Gy/h) 10 stations around the site perimeter with continuous measurement and recording (10 nGy/h to 10 mGy/h) 4 stations with continuous measurements at 5 km (10 nGy/h to 0.5 Gy/h)
Plants	2 grass-sampling points (monthly check) with measurements: total β, γ spectrometry (+ ^{14}C and C, quarterly) Main agricultural crops (annual check) with measurements: total β, γ spectrometry
Milk	2 sampling points (monthly check) with yearly measurements: β (^{40}K excluded), K (+^{14}C,)
Environment receiving liquid discharges	Samples at mid-discharge into the river or after dilution in cooling water (case of coastal NPPs), with measurement of total β, K and ^{3}H Continuous sampling from the river or after dilution in the cooling water (case of coastal power plants) with daily tritium measurements Seawater samples (coastal NPPs only) twice a month with measurement of total β, K and ^{3}H Annual samples of sediments, aquatic fauna and flora with measurement of total β, γ spectrometry
Groundwater	5 sampling points (monthly check) with measurement of total β, K and ^{3}H
Soils	Regulatory samplings and checks to be performed by the operator

TABLE 34: REGULATORY ENVIRONMENTAL MONITORING OF NPPS

7.1.5.2. REGULATORY ENVIRONMENTAL MONITORING OF CEA OR AREVA FACILITIES

The different measurements associated with the NPP monitoring, are presented in the following table.

Environment	Samplings and measurements to be carried out by the operator
Air at ground level	4 stations for continuous sampling of atmospheric dust on a fixed filter with daily measurement of total α and total β 1 continuous sample with weekly measurement of atmospheric ^{3}H
Rainwaters	2 continuous sampling stations including 1 under prevailing wind with weekly total β and tritium measurements
Ambient γ radiation	4 stations with continuous measurement and recording 10 integrating dosimeters at site limits (monthly collecting)
Plants	4 grass-sampling points (monthly check) Main agricultural crops (annual check) with measurements: total β, γ spectrometry (+^{3}H (HTO, OBT) and ^{14}C periodically)
Milk	1 sampling point (monthly check) Measurements: total β, γ spectrometry (+ ^{3}H and ^{14}C periodically)
Soils	1 yearly sampling with γ spectrometry
Environment receiving liquid discharges	At least weekly water sampling in the environment with total α, total β, K and ^{3}H measurements Annual samples of sediments, aquatic fauna and flora with measurement of total β, γ spectrometry
Groundwater	5 sampling points (monthly check) with measurement of total α, total β, K and ^{3}H

TABLE 35: REGULATORY ENVIRONMENTAL MONITORING AT CEA OR AREVA FACILITIES

7.2. Measurements in the environment and around nuclear sites

7.2.1. Gaseous discharges from nuclear sites

Gaseous discharges from the major BNIs and the corresponding authorised limits are presented in the following tables, according to the categories of grouped radioactive products used in valid licences on 1 January 2007.

7.2.1.1. LIMITS AND VALUES OF GASEOUS DISCHARGES FROM EDF SITES

	Tritium		Carbon 14		Rare gases		Iodine		FP / AP	
	Limit	2016 disch.	Limit	2016 disch.	Limit	2016 disch.	Limit	2016 disch.	Limit	2016 disch.
	TBq	TBq	TBq	TBq	TBq	TBq	GBq	GBq	GBq	GBq
900 MWe reactors										
Le Blayais	8	1.0	2.2	0.58	72	0.49	1.6	0.027	1.6	0.0056
Le Bugey (2 to 5)	8	0.6	2.2	0.35	60	0.79	1.2	0.04	0.28	0.0028
Chinon B	8	1.5	2.2	0.56	48	0.50	1.2	0.014	0.28	0.0037
Cruas-Meysse	8	1.4	2.2	0.56	48	1.07	1.2	0.027	0.8	0.0118
Dampierre	10	1.5	2.2	0.58	72	1.66	1.6	0.043	0.8	0.0061
Fessenheim	4	0.9	1.1	0.20	24	0.13	0.6	0.008	0.14	0.0009
Gravelines	12	2.8	3.3	0.75	108	4.40	2.4	0.116	2.4	0.0126
St Laurent B	4	0.7	1.1	0.29	30	0.35	0.6	0.015	0.4	0.0018
Le Tricastin	8	1.4	2.2	0.50	72	0.79	1.6	0.024	1.6	0.0025
1 300 MWe reactors										
Belleville	5	1.6	1.4	0.40	25	0.52	0.8	0.009	0.1	0.0038
Cattenom	10	3.1	2.8	0.76	50	0.73	1.6	0.034	0.2	0.008
Flamanville	8	1.5	1.4	0.47	25	0.80	0.8	0.028	0.1	0.0026
Golfech	8	1.0	1.4	0.47	45	2.90	0.8	0.143	0.8	0.0030
Nogent	8	1.1	1.4	0.49	45	0.59	0.8	0.104	0.8	0.0062
Paluel	10	1.5	2.8	0.46	90	0.51	1.6	0.034	1.6	0.0097
Penly	8	0.9	1.4	0.43	45	0.44	0.8	0.060	0.8	0.0026
St Alban	4.5	1.5	1.4	0.41	25	0.60	0.8	0.023	0.1	0.0040
1 450 MWe reactors										
Chooz	5	0.6	1.4	0.53	25	0.36	0.8	0.017	0.1	0.0039
Civaux	5	1.9	1.4	0.43	25	1.23	0.8	0.069	0.1	0.0014

TABLE 36: LIMITS AND VALUES OF GASEOUS DISCHARGES FROM EDF SITES

7.2.1.2. LIMITS AND VALUES OF GASEOUS DISCHARGES FROM AREVA'S LA HAGUE SITE

The current licence (ASN Resolution n° 2015-DC-536 of 22 December 2015) subdivided the previous discharge categories and reduced authorised limits, as shown in the following table.

Site	Tritium		Artificial alpha-emitters		Radioactive iodine		Rare gases	
	Limit (TBq/a)	2016 discharge (TBq)	Limit (GBq/a)	2016 discharge (GBq)	Limit (GBq/a)	2016 discharge (GBq)	Limit (TBq/a)	2016 discharge (TBq)
La Hague	150	74.5	0.01	0.0004	18	6.41	470 000	320 000

Site	Carbon 14		Other beta and gamma emitters	
	Limit (TBq/a)	2016 discharge (TBq)	Limit (GBq/a)	2016 discharge (GBq)
La Hague	28	19.1	1	0.10

TABLE 37: LIMITS AND VALUE OF GASEOUS DISCHARGES FROM AREVA'S LA HAGUE SITE

7.2.1.3. LIMITS AND VALUES OF GASEOUS DISCHARGES FROM CEA SITES

Current licences cover two or four gas categories depending on the site, as shown in the following table.

Site	Rare gases		Tritium		Halogens		Aerosols	
	Limit (TBq)	2016 discharge (TBq)	Limit (TBq)	2016 discharge (TBq)	Limit (GBq)	2016 discharge (GBq)	Limit (GBq)	2016 discharge (GBq)
Grenoble	0.4	0	8.39	0.0362			0.08	0.0001
Saclay	740	36.56	555	20.13	18.5	0.173	37	0.034

Site	Rare gases + Tritium		Halogens + Aerosols	
	Limit (TBq)	2016 discharge (TBq)	Limit (GBq)	2016 discharge (GBq)
Cadarache	555	< 33.8	18.5	< 0.0093
Fontenay-aux-Roses	20		10	

TABLE 38: LIMITS AND VALUES OF GASEOUS DISCHARGES FROM CEA SITES

7.2.2. Liquid discharges from nuclear sites

Liquid discharges from major BNIs are presented in the following tables with their corresponding limits per category of radioactive product specified in current licences.

7.2.2.1. LIMITS AND VALUES OF LIQUID DISCHARGES FROM EDF SITES

	Tritium		Carbon 14		Iodine		FP / AP	
	Limits	2016 discharge	Limits	2016 discharge	Limits	2016 discharge	Limits	2016 discharge
	TBq	TBq	GBq	GBq	GBq	GBq	GBq	GBq
900 MWe reactors								
Le Blayais	80	42.6	600	43.4	0.6	0.0130	60	0.327
Le Bugey (2 à 5)	90	28.5	260	26.5	0.4	0.0160	36	1.183
Chinon B	80	43.9	260	41.9	0.4	0.0120	36	0.618
Cruas-Meysse	80	47.1	260	41.9	0.4	0.0356	36	1.409
Dampierre	100	45.5	260	43.5	0.6	0.0152	36	1.030
Fessenheim	45	16.9	130	14.9	0.2	0.0043	18	0.425
Gravelines	120	59.0	900	56.1	0.9	0.0360	90	2.563
Saint-Laurent-des-Eaux B	45	23.7	130	23.7	0.2	0.0064	20	0.345
Le Tricastin	90	42.0	260	37.2	0.6	0.0171	60	0.368
1300 MWe reactors								
Belleville	60	54.6	190	29.7	0.1	0.0159	10	0.696
Cattenom	140	122.0	380	57.1	0.2	0.0227	20	0.639
Flamanville	80	62.5	190	35.3	0.1	0.0052	10	0.373
Golfech	80	63.5	190	35.3	0.1	0.0102	25	0.243
Nogent-sur-Seine	80	72.5	190	36.6	0.1	0.0159	25	0.230
Paluel	120	52.8	800	34.8	0.2	0.0090	50	2.093
Penly	80	50.1	190	32.3	0.1	0.0052	25	0.380
Saint-Alban	60	52.7	190	30.8	0.1	0.0094	10	0.245
1 450 MWe reactors								
Chooz	80	66.3	190	39.9	0.1	0.0103	5	0.324
Civaux	80	69.6	190	69.6	0.1	0.0069	5	0.324

TABLE 39: LIMITS AND VALUES OF LIQUID DISCHARGES FROM EDF SITES

7.2.2.2. LIMITS AND VALUES OF LIQUID DISCHARGES FROM AREVA'S LA HAGUE SITE

The current licence (ASN Resolution n° 2015-DC-536 of 22 December 2015) subdivided the previous discharge categories and reduced authorised limits, as shown in the following table.

Tritium		Alpha emitters		Strontium 90		Caesium 137		Caesium 134	
Limit (TBq/a)	2016 discharge (TBq)	Limit (TBq/a)	2016 discharge (TBq)	Limit (TBq/a)	2016 discharge (TBq)	Limit (TBq/a)	2016 discharge (TBq)	Limit (TBq/a)	2016 discharge (TBq)
18 500	12 300	0.14	0.023	11	0.10	6	0.66	0.5	0.05

Carbon 14		Ruthenium 106		Cobalt 60		Radioactive iodine		Other beta and gamma emitters	
Limit (TBq/a)	2016 disch. (TBq)	Limit (TBq/a)	2016 disch. (TBq)	Limit (TBq/a)	2016 disch. (TBq)	Limit (TBq/a)	2016 disch. (TBq)	Limit (TBq/a)	2016 disch. (TBq)
42	7.55	15	1.37	1.4	0.06	2.6	1.44	55	1.52

TABLE 40: LIMITS AND VALUES OF LIQUID DISCHARGES FROM AREVA'S LA HAGUE SITE

7.2.2.3. LIMITS AND VALUES OF LIQUID DISCHARGES FROM CEA SITES

Current licences concern four sites and cover three categories of liquid discharges, as shown in the following table.

Site	Tritium		Alpha emitters		Others	
	Limit (TBq)	2016 (TBq)	Limit (GBq)	2016 (GBq)	Limit (GBq)	2016 (GBq)
Cadarache	1	0.053	0.13	0.00027	1.5	0.326
Fontenay-aux-Roses	0.2	0.000005	1	0.001	40	0.006
Grenoble	0.097	0.00068	0.022	0.0001	0.22	0.0076
Saclay	0.246	0.0147	0.01	0.044	0.54	0.024

TABLE 41: LIMITS AND VALUES OF LIQUID DISCHARGES FROM CEA SITES

Those results confirm ASN's policy to downgrade discharge licences by adapting them more strictly to the operating requirements of the facilities.

8 | BIBLIOGRAPHY

8.1. Documents

1 | Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (JC), September 1997, IAEA (JC)

2 | Guidelines regarding the Form and Structure of National Reports, INFCIRC/604/Rev.3 of 13 January 2015

3 | Public Health Code - *Code de la santé publique – Journal officiel de la République française*[30].

4 | Environment Code - *Code de l'environnement – Journal officiel de la République française.*

5 | ASN report on the state of nuclear safety and radiation protection in France in 2016, July 2017

8.2. Internet Sites

All above-mentioned documents or at least a summary of their content, as well as other relevant information on the theme of this report, may be consulted on Internet, especially on the following websites:

Legal texts	www.legifrance.fr
ASN	www.asn.fr
ANDRA	www.andra.fr
CEA	www.cea.fr
AREVA	www.areva.fr
EDF	www.edf.fr
ILL	www.ill.eu
MTES	www.developpement-durable.gouv.fr/
AIEA	www.iaea.org

[30] Legislative and regulatory texts are also available in French on: www.legifrance.fr

9 | LIST OF THE MAINS ABBREVIATIONS AND ACCRONYMS

ANDRA	*Agence nationale pour la gestion des déchets radioactifs* – National agency for radioactive waste management
ASN	*Autorité de sûreté nucléaire* – Nuclear safety authority
BNI	Basic nuclear installation
CEA	Commissariat à l'énergie atomique et aux énergies alternatives –Alternative energies and atomic energy commission
CENTRACO	*Centre de traitement et de conditionnement de déchets de faible activité* – Low-level Waste Processing and Conditioning Facility
CIC	*Cellule interministérielle de crise* - Interministerial crisis committee
CNE	*Commission nationale d'évaluation* – National assessment commission
COFRAC	*Comité français d'accréditation* - French accreditation committee
COGIC	*Centre opérationnel de gestion interministérielle des crises* - Interministerial emergency management operations centre
CSA	*Centre de stockage de l'Aube* – Aube disposal centre
CSM	*Centre de stockage de la Manche* – Manche disposal centre
CIRES	*Centre industriel de regroupement, d'entreposage et de stockage* – Industrial centre for waste grouping, storage and disposal
DGEC	*Direction générale de l'énergie et du climat* - General Directorate for Energy and Climate
DGS	*Direction générale de la santé* – General Directorate for Health
DGSCGC	*Direction générale de la sécurité civile et de la gestion des crises* - Directorate General of Civil Protection and Crisis Management
DGPR	Direction générale de la prévention des risques
EDF	*Électricité de France*
EU	European Union
GP	*Groupe permanent d'experts* – Permanent expert advisory committee
GPD	Permanent expert advisory committee on radioactive waste
GPESPN	Permanent expert advisory committee on nuclear pressurized equipment
GPMED	Permanent expert advisory committee on radiation protection in the medical field
GPRADE	Permanent expert advisory committee on radiation protection except medical field
GPR	Permanent expert advisory committee on nuclear reactors
GPT	Permanent expert advisory committee on transport of radioactive substances
GPU	Permanent expert advisory committee on laboratories and plants

HCTISN	Haut comité pour la transparence et l'information sur la sécurité nucléaire
HFDS	*Haut fonctionnaire de défense et de sécurité* - Senior Defence and Security Official
HL	High-level (waste)
HL-LL	High-level long-lived (waste)
HWR	Heavy-water reactor
ICEDA	*Installation de conditionnement et d'entreposage de déchets activés* - Conditioning and storage facility for activation waste
ICPE	Installations Classified on Environmental Protection Grounds
ICRP	International Radiological Protection Commission
IL	Intermediate-level
ILL	*Institut Laue-Langevin* – Laue-Langevin Institute
IL-LL	intermediate-level long-lived
INES	International nuclear events scale
IRSN	*Institut de radioprotection et de sûreté nucléaire* – Institute for radiation protection and nuclear safety
JO	*Journal official de la république française – French Republic's Official Journal*
LIL	Low and intermediate-level (waste)
LIL-SL	Low and intermediate-level short-lived (waste)
LL-LL	Low-level long-lived (waste)
LL-SL	Low-level short-lived (waste)
LWR	Light-water reactor
MSNR	*Mission de sûreté nucléaire et de radioprotection* - Nuclear Safety and Radiation Protection Mission
MOX	Mixed oxides nuclear fuel
MTES	*Ministère de la transition écologique et solidaire* - Ministry of Ecological and Solidarity Transition
OPECST	*Office parlementaire d'évaluation des choix scientifiques et techniques* – Parliamentary Office for the Assessment of Scientific and Technological Options
PNGMDR	*Plan national de gestion des matières et déchets radioactifs* – National plan on management of radioactive materials and waste
PPI	*Plan particulier d'intervention*- Off-site emergency plan
PPI	*Politique de protection des intérêts* – Protection of interests policy
PUI	*Plan d'urgence interne* - On-site emergency plan
PWR	Pressurized water reactor

RCD	*Reprise et conditionnement des déchets anciens* – Recovery and packaging of legacy waste
RFS	*Règle fondamentale de sûreté* – Basic safety rules
RGE	*Règles générales d'exploitation* – General Operational Rules
RGS	*Règles générales de surveillance* – General monitoring rules
R&D	Research and Development
SBNI	Secret basic nuclear installation (defence)
SGDSN	*Secrétariat général de la défense nationale* - General Secretariat for National Defence
TECV	Act n° 2015-992 of 17 August 2015 relative to energetic transition for gree growth
TMD	*Transport des marchandises dangereuses* – Order of 29th May 2009 concerning transport of dangerous goods
TSN	*Transparence et sécurité dans le domaine nucléaire* - Act n° 2006-686 of 13 June 2006 concerning transparency and security in the nuclear field
UOX	Uranium oxide nuclear fuel
UNGG	*Uranium naturel-graphite-gaz* – Natural uranium-graphite-gas reactor type
VLL	Very low level (waste)
WENRA	Western European Nuclear Regulators' Association