Andra

All you need to know about radioactive waste management

ANDRA
Agence nationale pour la gestion des déchets radioactifs

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Disposal of waste packages at the Aube Waste Disposal Facility

ANDRA

French National Agency for Radioactive Waste Management

Andra is a state-owned undertaking of an industrial and commercial nature created by the law of December 30, 1991. Its mission was extended by the framework act of June 28, 2006 governing the sustainable management of radioactive materials and waste, then clarified by the 2016 law on reversibility and the terms of creation of Cigéo.

Whilst independent of the radioactive waste producers, Andra is placed under the supervision of the ministers for Energy, Research and the Environment.

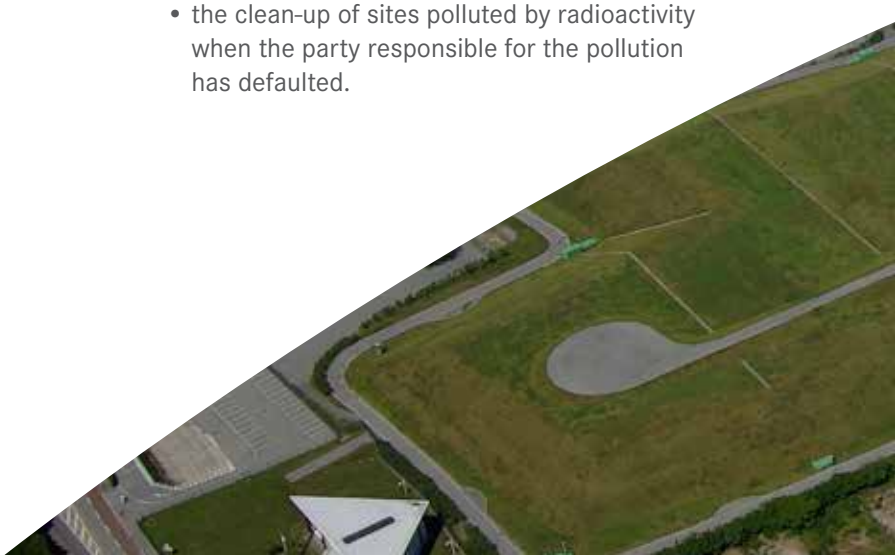
Its mission

Andra is commissioned by the French state to assiduously and responsibly fulfil a public interest mission on behalf of the French people: handle the radioactive waste produced by past and present generations and make it safe for future generations.

Its activities

To fulfil its mission, Andra accomplishes several activities:

- **Operate the two existing surface disposal facilities,** in the Aube department: the Aube Disposal Facility (CSA) dedicated to mainly short-lived low- and intermediate-level waste (LILW-SL) and the Industrial Facility for Nuclear Waste Collection, Storage and Disposal (Cires) dedicated to very low-level waste (VLLW).
- **Monitor** the Manche Disposal Facility (CSM), the first French surface storage facility for low- and intermediate-level waste, is now closed.
- **Inform, dialog and co-build with the general public**
- **Preserve the memory of its facilities**
- **Share and publicize its know-how abroad**
- **Engineer and design the disposal facilities** for the waste which does not have any yet, namely:
  - long-lived low-level waste (LLW-LL),
  - high-level waste (HLW) and long-lived intermediate-level waste (ILW-LL): the Cigéo project;
- **Accomplish a public interest mission for:**
  - the three-yearly generation of the National Inventory of Radioactive Materials and Waste on French territory and the annual updating of the stocks. The last edition was published in 2018;
  - the collection of legacy radioactive objects owned by private individuals;
  - the clean-up of sites polluted by radioactivity when the party responsible for the pollution has defaulted.



Its financing

Andra's financing comes from:

- **commercial contracts with radioactive waste producers** (EDF, Orano, CEA, hospitals, research centers, etc.) for disposal of their radioactive waste;
- **a "research" tax** collected by the Nuclear Safety Authority (ASN) from the radioactive waste producers for research and studies on the interim storage and disposal of high-level and long-lived intermediate-level waste. It is paid into a "research" fund;
- **a special contribution paid into a "design" fund** by the radioactive waste producers to finance the design studies of the Cigéo installations and the pre-startup works of the construction phase for these installations;
- **a subsidy** granted by the State for its public interest missions (generation of the national Inventory, collection of radioactive objects from private individuals, clean-up of radioactively polluted sites where the responsible party has defaulted).

Key figures

as of 31/12/2020

674 employees

5 sites, including:

- **the headquarters** at Châtenay-Malabry (92);
- **2** operating industrial facilities in the Aube: **Cires** and **CSA**;
- **1** storage facility in the closure phase in the Manche department: **CSM**;
- **1** facility in Meuse/Haute-Marne (CMHM) composed of:
  - **an underground Laboratory,**
  - **a technological space,**
  - **an Ecotheque.**

Aerial view of the Manche Disposal Facility (CSM)

RADIOACTIVITY
and radioactive waste

Radioactivity

A natural phenomenon, radioactivity is the property of certain unstable atoms, called radionuclides, to spontaneously change into another atom, while emitting radiation.

The radioactivity of an element decreases naturally with time, more or less rapidly depending on the nature of the radionuclides.

Since the discovery of radioactivity, its properties have been used in many applications: power generation, chemistry, biology (study of cells), geology, archaeology (dating), agriculture, medicine (diagnostic and treatment of cancers), etc.
It also has many uses in industry, for food preservation (ionization), weld inspection in metallurgy, the sterilization of medical equipment or fire detection, for example. All these activities produce waste, some of it radioactive.

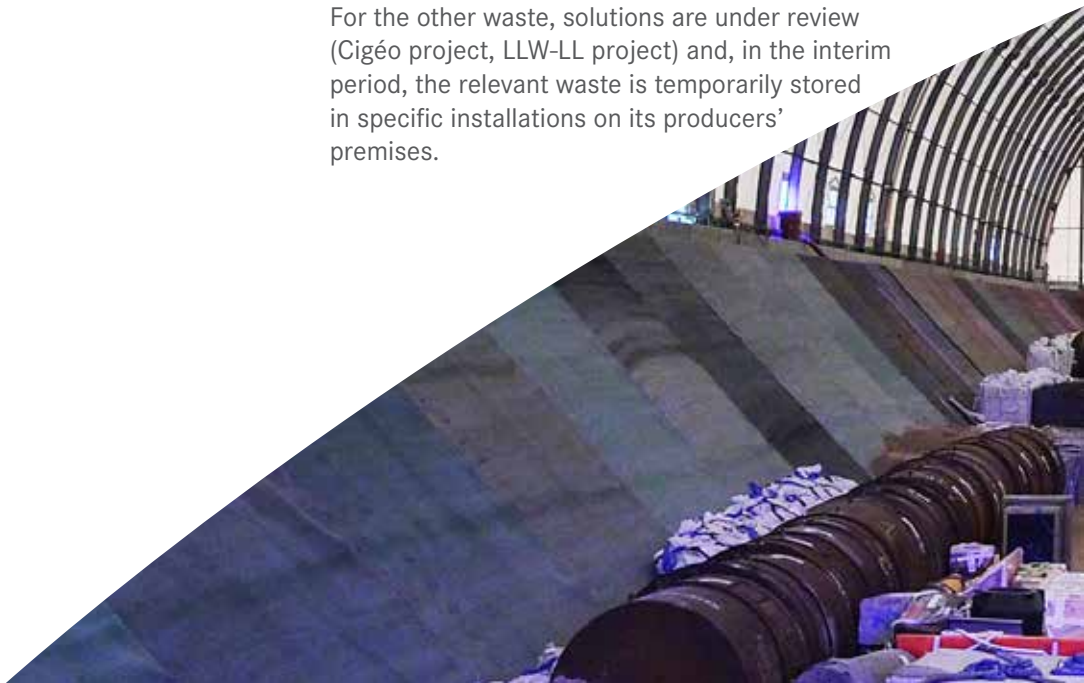
Radioactive waste and disposal

“Radioactive waste” means radioactive substances which cannot be re-used or reprocessed and must be managed in a specific manner. It has a wide variety of origins: rubble, scrap metal, gloves, filters, resins, gowns, pipettes, flasks, needles or other objects in daily use such as alarm clocks, fountains or lightning conductor heads.

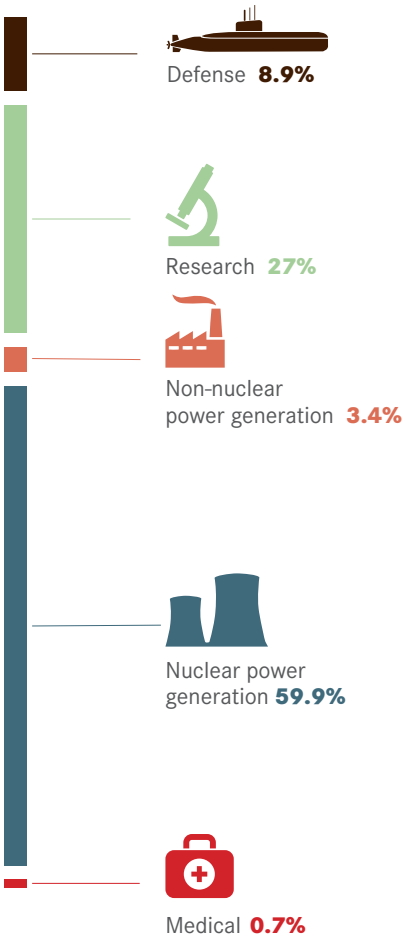
The radioactive waste may be generated by the maintenance and operation of the nuclear installations and their decommissioning, the reprocessing of the spent fuel from nuclear power plants, the clean-up of legacy sites polluted by radioactivity, research activities, industrial processes, medical examinations and healthcare, or by private individuals in possession of legacy objects from the inter-war period.

To protect people and the environment from the risks incurred by radioactive waste, France, like most countries, has opted for disposal in industrial installations tailored to each type of waste. The objective is to isolate the waste until the radioactivity has sufficiently decreased, owing to natural decay, and no longer raises risks.
In France, there already exist disposal facilities managed by Andra, which accommodate more than 90% of the radioactive waste produced each year nationwide.

For the other waste, solutions are under review (Cigéo project, LLW-LL project) and, in the interim period, the relevant waste is temporarily stored in specific installations on its producers’ premises.

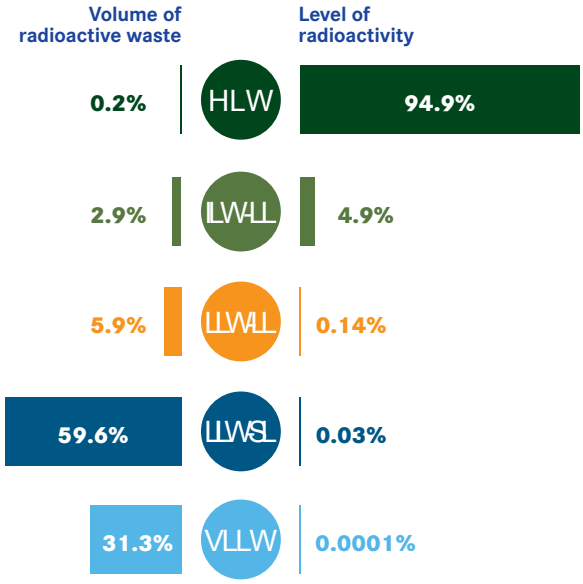


Breakdown of the existing radioactive waste per economic sector *(Source: National Inventory of Radioactive Materials and Waste, end-2019 figures)*



Breakdown of volume and level per type of radioactive waste

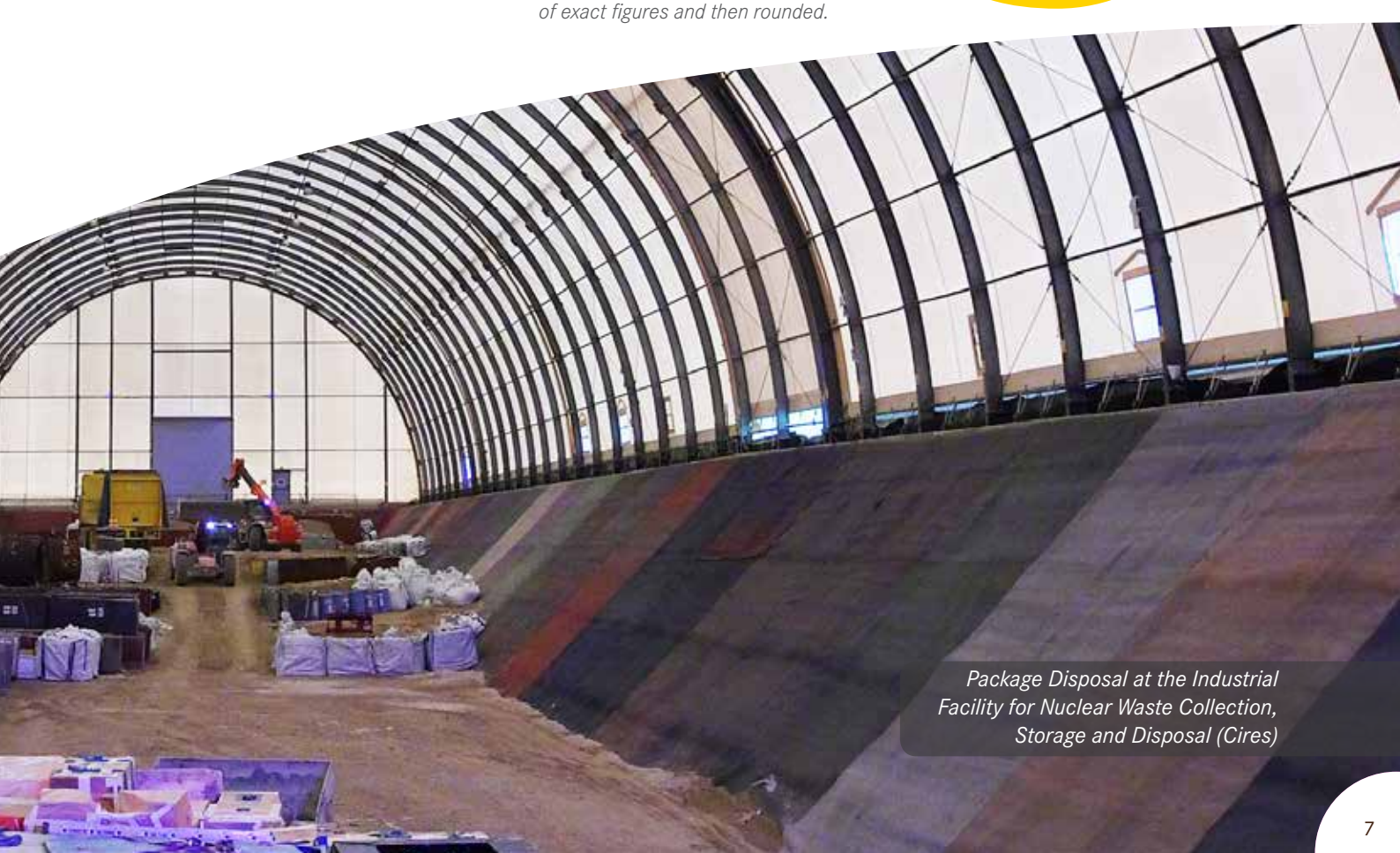
(Source: National Inventory of Radioactive Materials and Waste, end-2016 figures)



1,670,000 m³
of radioactive waste produced as of end 2019.

These figures are for the radioactive waste handled or earmarked for handling by Andra. Other waste streams, subjected to specific management modes, are itemized in the *National Inventory of Radioactive Materials and Waste*.

Source: National Inventory of Radioactive Materials and Waste
Percentages have been calculated on the basis of exact figures and then rounded.



Package Disposal at the Industrial Facility for Nuclear Waste Collection, Storage and Disposal (Cires)

CLASSIFICATION OF RADIOACTIVE WASTE

and its storage concept

In France, there exist five categories of waste, classified according to their disposal route, which particularly depends on two criteria: their level of radioactivity and their lifetime.

Very low-level radioactive waste (VLLW)

Very low-level radioactive waste is primarily produced by the operation and decommissioning of nuclear installations. Some waste is also produced by the cleanup and remediation of legacy sites polluted by radioactivity.

VLLW takes the form of inert (concrete, rubble, earth), etc. or metallic waste. It is disposed of at the surface of the Industrial Facility for Nuclear Waste Collection, Storage and Disposal (Cires), opened in 2003.

Upon arrival at the site, 30 % of the received waste is specifically treated before disposal:
- plastic waste or scrap metal is compacted to reduce its volume;
- liquid waste (polluted water, sludge) is solidified and made chemically inert. The waste is then placed in drums or big bags.

Once conditioned, these waste packages are identified and stacked in disposal cells dug several meters deep in a clay layer. When filled, the cells are covered by a capping system composed particularly of sand, a geomembrane lining ensuring water-tightness, and clay.

• Short-lived low- and intermediate-level waste (LILW-SL)

This waste is produced either by the maintenance (clothing, tools, filters, etc.) and operation of nuclear installations, or by the research or healthcare activities of laboratories and hospitals.

Containing primarily short-lived radioactive atoms, this waste has been disposed of since 1992 at the surface of the Aube Disposal Facility (CSA), which took over from the Manche Disposal Facility (CSM), in operation from 1969 to 1994.

Before disposal, some waste is compacted or solidified, then mixed with concrete before being placed in a container also made of concrete or metal.

The waste packages are composed of 15-20 % waste and 80-85 % concrete encapsulation. They are disposed of at the surface in reinforced concrete structures with 25-meter sides and a height of 8 meters.

Once filled, these structures are closed by a concrete slab sealed by a layer of water-tight resin. Lastly, a final clay layer several meters thick with a water-tight membrane is placed on the structures to provide long-term protection.

Long-lived low-level waste (LLW-LL)

This waste basically covers two types of waste referred to as “radium-bearing” and “graphite”

> **Radium-bearing waste** owes its name to the radium it contains. It mainly originates in the use of ore (extraction of rare earths) or uranium and the clean-up of legacy industrial sites which used radium or thorium from 1900 to 1960.

> **Graphite waste**, as its name indicates, contains graphite, a mineral corresponding to a very pure variety of carbon. It was produced during the operation and decommissioning of first-generation nuclear reactors (UNGG or natural uranium graphite-gas reactors), now discontinued.

> **Other types of waste** also belong to this category: radioactive lightning conductor heads, luminescent paint (formerly used in the clock-making industry for example). Certain legacy radioactive objects, no longer in production, (radium watches, radium-bearing needles) have been found at the homes of private individuals.

Andra investigates the range of possible scenarios for managing this waste, in order to propose safe and appropriate disposal solutions.

High-level waste (HLW) and long-lived intermediate-level waste (ILW-LL)

High-level waste (HLW) and long-lived intermediate-level waste (ILW-LL) is mainly produced by the nuclear power industry and the associated research activities and also, to a lesser extent, national Defense-related activities.

> **HLW** corresponds mainly to the highly radioactive residues arising from spent fuel processing (mainly those used for power generation and, to a lesser extent, those arising from national Defense-related activities).

> **ILW-LL waste** varies in origin. It corresponds to the metal structures enclosing the fuel (hulls and end-fittings) or the residues arising from the operation of the nuclear installations.

Cigeo, the deep geological disposal project for HLW and ILW-LL waste

Cigéo is an Andra-engineered French project for the disposal in a deep geological layer of high-level and long-lived intermediate-level waste (HLW and ILW-LL) produced by all the current nuclear installations until their decommissioning.

Cigéo’s basic objective is to protect people and the environment from the danger represented by this waste, while limiting the burden placed on future generations. It is the outcome of more than a quarter of a century of research, three laws and two public debates.

If its construction is authorized, Cigéo will be sited in Meuse/Haute-Marne, within a clay layer situated 500 meters underground and engineered for almost 20 years by Andra, particularly by means of its underground research Laboratory.

Pending the commissioning of Cigéo, the HLW and ILW-LL packages already produced are temporarily stored under dry conditions in buildings on their production site mainly at La Hague (50), Marcoule (30) or Cadarache (13).

Andra’s underground Laboratory in Meuse/Haute-Marne

PATHWAY
of radioactive waste

Use of radioactivity properties
in five main economic sectors: nuclear power industry, national defense, non-nuclear power industry, medicine

Treatment and conditioning (*)
of most radioactive waste by the producers

Transportation of radioactive waste to Andra's industrial facilities in the Aube department

Receipt of the waste
by Andra in its dedicated disposal facilities

Sorting
of waste by the producers on their production site

Production of radioactive waste

LILW-SL and VLL waste

Very low-level waste radioactive half-life under 100 days

HL, ILW-LL and LLW-LL waste

In situ radioactivity decay
for subsequent management as conventional waste

Storage at the production site for waste generated by the nuclear power industry et **storage in the dedicated installation at Cires for waste generated by the non-nuclear power industry** *pending the commissioning of dedicated disposal facilities*

** For their packages to be accepted on the disposal sites, the producers are required to meet the requirements set by Andra: weight, contained radioactive atoms, radiological activity and risks incurred. These data are saved under a barcode identification number, which is a veritable package ID card providing traceability of the waste and determining its exact positioning in the repository. To ensure conditioning quality and compliance with these rules, inspections are regularly conducted by Andra on the producers' premises.*

Preserving the memory of the sites *and transmission to future generations*

Radiological inspections *of the packages, their contents and their compliance with Andra's requirements*

Closure of the storage facilities

Treatment of some packages before disposal *to reduce their volume (compacting, solidification for example)*

Package disposal

Monitoring of the disposal facilities and their environment *during their operation and after their closure*

Thorough inspections *of randomly sampled packages during their delivery*

Radiological wipe test on a truck upon arrival at the Aube Disposal Facility (CSA)

ANDRA'S sites

Manche disposal facility (CSM)

With a surface area of about 15 hectares, the first French disposal facility received, between 1969 and 1994, 527,225 m³ of low-and intermediate-level waste. It is currently in its closure phase.

MANCHE DISPOSAL FACILITY
BP 807 Digulleville • 50440 La Hague

To visit the facility: 0810120172
(price of a local call)

To find out more, go to:
https://manche.andra.fr/

Key figures of Andra's industrial facilities in the Aube department

as of 31/12/2021

> **412,258 m³ of waste** disposed of at Cires since 2003, which accounts for **63,4 %** of the Facility's total authorized disposal capacity.

> **353,147 m³ of waste** disposed of at the CSA since 1992, which accounts for **35.3 %** of the Facility's total authorized disposal capacity.

Andra's industrial facilities in the Aube department

> Industrial Facility for Nuclear Waste Collection, Storage and Disposal (Cires)

With a surface area of 45 hectares and an authorized disposal capacity of 650,000 m³, this facility has been used for the receiving and disposal of very low-level waste since 2003. It has also been used for the collection and storage of waste from non-nuclear power activities since autumn 2012 and for waste sorting and treatment since 2016.

> Aube Disposal Facility (CSA)

With a surface area of 95 hectares and an authorized disposal capacity of 1,000,000 m³, this facility, dedicated to the disposal of short-lived low-and intermediate-level waste, has been in use since 1992. It took over from the Manche Disposal Facility, building on the 25 years of experience already accumulated.

ANDRA'S INDUSTRIAL FACILITIES IN THE AUBE DEPARTMENT
BP 7 • 10200 Soulaines-Dhuys

To visit the facilities: 0 800 31 41 51
(Free call from a landline)

To find out more, go to:
https://aube.andra.fr/

Water quality monitoring station as part of the OPE

Andra's Meuse/Haute-Marne facility (CMHM)

> Underground Laboratory

Built in 2000 and located at a depth of 490 m, the Underground Laboratory is a unique research tool in the deep storage project called Cigéo, for high-level (HLW) and long-lived intermediate-level (IL-LLW) waste. Its underground tunnels enable *in-situ* analysis of a 160 million year old clay layer, as well as a range of concepts and techniques which will be able to be implemented in Cigéo.
If the Cigéo project is given the go-ahead, it will be sited close to the Laboratory.

Laboratory key figures

More than ***2 km of test tunnels***
80 experiments set up in the underground tunnels.
13 partnering bodies or ***university establishments***.
7 laboratory consortiums combining more than ***80 laboratories and research bodies.***

Andra's sites are open free of charge to the public the whole year round.

MEUSE/HAUTE-MARNE FACILITY
(Underground Laboratory, Technological Space, Ecotheque)
Department road 960 • BP 9 • 55290 Bure

To visit the facility: 03 29 75 53 73
(Free call from a landline)

To find out more, go to:
https://meusehautemarne.andra.fr/

> Technological Space

The Technological Space presents Cigéo through the exhibition of mock-ups and various robots and industrial prototypes built by Andra. The objective is to test and validate the technological concepts of this repository: concrete package container, handling system, etc.

> Ecotheque

Andra possesses a 1400 m² ecotheque built in 2013 in the locality of Bure. It preserves during one century all the environmental samples taken as part of the Permanent Environment Observatory (OPE), which covers a surface area of 900 km² between the Meuse and Haute-Marne departments. A unique infrastructure in France, Andra's ecotheque is an outgrowth of the most highly-developed ecotheques in the world and is integrated into the international network of ecotheques.

Facility environment monitoring

Before commissioning its sites, Andra generated an initial status report describing their main features and their environment. This status report serves as a baseline for the analyses conducted during operation and during the site closure and monitoring phases, enabling Andra to verify that the environmental impact of its activities is very slight by means of many samples and quality analyses on the water, air, soil, fauna and flora. **In 2020, about 1500 radiological analyses were conducted in the Cires environment; about 15,570 radiological and physical-chemical analyses and about 2320 samples on and around the CSA; 2170 samples and 12,000 analyses were carried out on and around the CSM.**
If it is given the go-ahead, a monitoring plan will also be set up around Cigéo under the control of the French Nuclear Safety Authority. This regulatory monitoring will be reinforced by the observations carried out as part of the Permanent Environment Observatory, which groups together a range of environment observation, testing and conservation resources. This certified observatory is registered in a large number of national and international scientific networks.

GLOSSARY

A

Activity: level of radioactivity. Measured in becquerels.

Atom: the basic building block of matter (composing air, water, earth, living beings, etc.). Each atom is formed of a nucleus (the protons and neutrons) and electrons which gravitate around it.

B

Becquerel (Bq) : unit of measurement of the radioactivity level, from the name of Henri Becquerel who discovered radioactivity at the end of the XIXth century.

D

Disposal: Long-term solution for the industrial management of radioactive waste.
Disposal safety relies upon three components: the packages containing the waste, the storage structures in which the packages are placed and the site geology, which forms a natural barrier.

Disposal structure: structure for disposing of the waste packages.

I

Interim storage: temporary solution for managing radioactive waste before disposal.

P

Package: container for placing radioactive waste generally immobilized in a “matrix” (concrete or glass).

R

Radiation: radioactive atoms emit radiation at widely differing energies.
There exist three main types of radiation, which differ in their penetrating power. Alpha radiation, whose range in air is a few centimeters, is stopped by a simple sheet of paper.
Beta radiation can travel several meters through the air. It is stopped by a sheet of aluminum or a glass window.
Gamma radiation, of the same nature as X rays but with higher energy, is stopped by several centimeters of lead or several decimeters of concrete.

Radioactive period or half-life: mean time after which a radioactive atom naturally loses half of its activity. The activity of a radioactive product is divided by four after two periods and by eight after three periods. At the end of ten periods, activity is divided by 1000.
A distinction is made between the waste whose main radioactive atoms have a short half-life (no longer than 31 years) and those with a long half-life (no shorter than 31 years). The 31-year limit was determined by the radioactive half-life of caesium 137. The former are generally considered to no longer raise radiological hazards after 300 years.

Radioactive waste: radioactive substances for which no further use is foreseen or planned.

Radioactivity: most atoms (like hydrogen for example) are stable and not radioactive. Others, like plutonium, are unstable and spontaneously change to other atoms (stable or not). When changing, they release surplus energy in the form of radiation, until they recover their stability: this is the phenomenon of radioactivity.

Reversibility: according to the law of June 28, 2006, the deep disposal of high-level and long-lived intermediate-level waste must be reversible during at least 100 years. And, according to that of July 25, 2016, reversibility is the capacity for successive generations either to continue the construction then the operation of the successive phases of disposal, or to re-assess the previously defined choices and to upgrade the management solutions.

S

Sievert (Sv): the unit of measurement of the biological effects on people due to exposure to radioactivity. According to the regulations, the annual dose caused by the activities of the nuclear industry must be as limited as possible and may not exceed 1 mSv for the population. AS a comparison, in France, mean annual exposure to naturally occurring radioactivity is 2.4 mSv and 1,1 mSv for artificial radioactivity (medical exposure).

A dose of 1 mSv is equivalent to: 17 months in the Paris region, 7 Paris-San Francisco return plane trips and the mean annual number of medical radiological procedures in France per inhabitant.

THE KEY DATES

of radioactive waste management in France

1969
Manche Disposal Facility (CSM) opened under the CEA's responsibility.

1979
Andra created within the CEA.

1991
Law of December 30th, the first in France on the receiving and management of radioactive waste. It conferred on Andra its status as a state-owned undertaking of an industrial and commercial nature, independent of the radioactive waste producers.

1992
Facility for the disposal of short-lived low-and intermediate-level waste (CSA) opened in the Aube department.

1994
Last package disposed of at the Manche Disposal Facility.

1998
Authorization to install and operate the Meuse/Haute-Marne underground laboratory, which analyzes the feasibility of deep disposal for long-lived high-level and intermediate-level waste.

2000
Start of construction of the Meuse/Haute-Marne underground laboratory.

2001
First State/Andra four-year contract defining the Agency's missions.

2003
> Commissioning of the Disposal Facility for Very Low-level Waste (Cires).

> French government decree authorizing the transition to the monitoring phase of the Manche Disposal Facility.

2005
Submittal to the authorities of a summary report *(Dossier 2005)* on the feasibility and safety of deep reversible disposal for long-lived high-level and intermediate-level waste.

2005/2006
Public debate on the management of HLW and ILW-LL radioactive waste.

2006
Debate in Parliament and then vote on the June 28 2006 law extending Andra's missions and establishing deep reversible disposal as the reference solution for long-term management of HLW and ILW-LL.

2007
Set-up of the Permanent Environment Observatory.

2008
Call for applications from local authorities for the siting of a disposal facility for long-lived low-level waste (forty or so applications received within the year). Two localities were to be selected, but were to withdraw their application under pressure from opponents in 2009.

2010
Government approves the zone of about 30 km^2 proposed by Andra to conduct the studies for the siting of Cigéo, the deep disposal facility for long-lived high-level and intermediate-level waste.

2011
> Launch of the Cigéo industrial design.

2012
Commissioning of the interim storage and grouping installations for the non-nuclear power waste at Cires in the Aube department.

2013
Public debate on the Cigeo project organised by the National Public Debate Commission.

2015
Submittal to the Government of a status report on the LA-LLW project.

2016
> July 25 law stating the terms of creation of a reversible disposal installation in a deep geological layer of long-lived high-and intermediate-level radioactive waste.

> Andra submits the Cigéo safety option files to the French Safety Authority.

> Sorting, treatment commissioned at Cires.

2018
> Package inspection installation (ICC) commissioned at CSA.

> New edition of the*National Inventory of Radioactive Materials and Waste published.*
(**www.inventaire.andra.fr**).

2020
> Inception of Cigeo licencing process (Declarattion of Public Utility – DUP).

AGENCE NATIONALE POUR LA GESTION
DES DÉCHETS RADIOACTIFS

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