WHAT TO DO WITH RADIOACTIVE WASTE?

10.1 Design: ASN and IRSN Communications Departments - May 2022
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Photos: Creativemarc/IStock, Gilles Crampes/BSM International/Médiathèque IRSN

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WHAT TO DO WITH RADIOACTIVE WASTE?

THE DIFFERENT TYPES OF **RADIOACTIVE WASTE**

Radioactive waste is waste from nuclear power generation, but also industry, research and medicine, for which **no further use is planned**. It presents risks of varying degrees.

VERY SHORT-LIVED WASTE (VSLW):
Radioactive waste with a half-life of less than 100 days. A large proportion of this comes from the medical applications of radioactivity (diagnosis or therapy).

HIGH LEVEL WASTE (HLW):
This waste results from the processing of nuclear fuel and produces heat. It has to be cooled in pools for years before its permanent disposal.
In France, high-level residues are calcined and then incorporated into molten glass. They are then cast into a stainless steel package.

VERY LOW-LEVEL WASTE (VLLW):
This waste comes from the nuclear industry, in particular from dismantling operations.
It mainly consists of parts of equipment that has been cut up and very slightly contaminated rubble.

INTERMEDIATE-LEVEL WASTE, LONG-LIVED (ILW-LL):
This mainly consists of hulls and end caps from the processing of nuclear fuel and of waste from the operation and maintenance of power plants.

LOW AND INTERMEDIATE LEVEL WASTE, SHORT-LIVED (LILW-SL):
This is essentially waste associated with the maintenance and operation of nuclear installations (clothing, tools, gloves, filters, etc.). This waste also comes from research laboratories, hospitals, universities, etc.
It can be incinerated, melted, coated in a matrix (cement, for example) or compacted. It is usually cemented in metal or concrete containers.

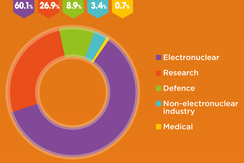
LOW-LEVEL WASTE, LONG-LIVED (LLW-LL):
This is mainly:
- waste contaminated by radium which was once used by the watchmaking industry;
- waste from the dismantling of first-generation nuclear reactors;
- waste from the processing of minerals such as rare earths used in electronics.

WHO MANAGES WASTE?

The French national radioactive waste agency, Andra. French law prohibits the disposal of foreign radioactive waste in France.

ORIGIN OF WASTE

Breakdown by economic sector of the volume of waste (in conditioned equivalent) already disposed of or destined to be taken over by Andra, by the end of 2020.
(source: Andra, Essentiels 2022)



The PNGMDR
Scan the QR code to find out more about the national radioactive materials and waste management plan (PNGMDR).

10.2 Design: ASN and IRSN Communications Departments - May 2022
Design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: Andra - Photos: H. Samson/ASN, Orano, Frédéric Dano, P. Lesage/Orano, Andra, EDF

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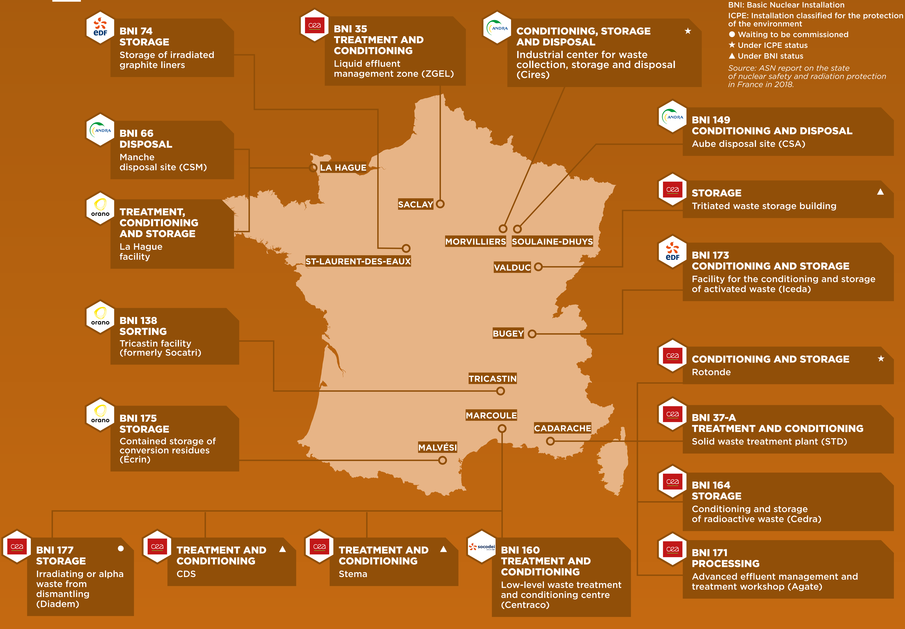
WHERE IS THE WASTE TODAY?

Depending on its type, radioactive waste is either stored on the site where it was produced or in dedicated facilities, pending a management solution, or disposed of in specialised facilities.



VERY SHORT-LIVED WASTE:

This waste is stored at the production site for the time necessary to allow the radioactivity to decay before it can be eliminated.

VERY LOW-LEVEL:

Volume already produced: 586,000 m³*
This waste is disposed of in a specialised site at Morvilliers (Aube), operated by Andra. The total volume, after decommissioning of the fleet of nuclear power plants, is estimated at around 2.2 million m³.

LOW AND INTERMEDIATE LEVEL WASTE, SHORT-LIVED:

Volume already produced: 971,000 m³*
They are disposed of in two surface repositories: one in La Manche, which closed in 1994, and one in Aube, which opened in 1992 and is operated by Andra.

LOW-LEVEL WASTE, LONG-LIVED:

Volume already produced: approximately 93,800 m³
Most LLW-LL waste has already been produced or will be produced during the decommissioning of first-generation nuclear power plants. Today, this waste is disposed on its production sites, on sites that have historically hosted radioactive activities, or at Morvilliers.

INTERMEDIATE-LEVEL WASTE, LONG-LIVED:

Volume already produced: approximately 42,900 m³*
Pending the creation of a deep disposal facility, this waste is most commonly stored on the sites where the packages are produced.

HIGH-LEVEL WASTE:

Volume already produced: approximately 4,190 m³*
Pending the creation of a deep disposal facility, this waste is usually stored on the sites where the packages are produced.

** In 2020 (source: Andra, Essentiels 2022).*

STORAGE OR DISPOSAL?

Storage and disposal are two different activities.

DISPOSAL IS DEFINITIVE

Waste must be able to remain safe in its disposal space indefinitely, without human intervention.

STORAGE IS TEMPORARY

Waste is placed in a facility for a set period of time. It requires upkeep and human intervention. The waste is stored to be put on hold, grouped together, or to wait for its radioactivity or temperature to decrease.

Andra

Find out more about Andra's national inventory by scanning the QR code.

DEBATE
WHAT TO DO WITH WASTE?

According to a study carried out in 2019 by IRSN, only 9% of French people would agree to live near a radioactive waste disposal facility, compared with 28% who would agree to live near a mobile phone base station and 13% in a flood zone.

Nuclear waste exists today and every effort must be made to design the safest solution for its disposal.

The waste produced today needs to be managed so that the problem is not passed on to future generations.

10.3 Design: ASN and IRSN Communications Departments - May 2022
Design and production: www.kezoar.fr - Pictograms: Freepik, Kezoar

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WHAT TO DO WITH RADIOACTIVE WASTE?

DISPOSAL
OF HIGH AND INTERMEDIATE-LEVEL LONG-LIVED WASTE

The Cigéo project (Industrial center for geological disposal) is dedicated to the deep geological disposal of high and intermediate level long-lived radioactive waste, in **order to protect human health and the environment** from the radiological and chemical risks associated with this waste for hundreds of thousands of years. The chosen site is located on the border between the Meuse and Haute-Marne, where a research laboratory already exists.

HOW WILL CIGÉO WORK?

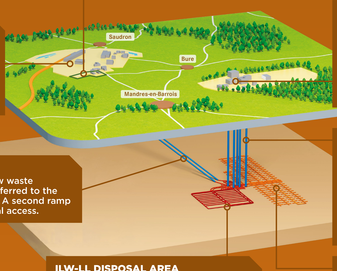
Cigéo will comprise surface facilities and one underground facility. The surface facilities will mainly be used to receive and inspect waste packages. The underground facility, planned at a depth of around 500 metres, will cover an area of around 15 km², in which the waste packages will be placed in their disposal locations using robotic devices in horizontal tunnels called "cells", dug into the heart of a layer of argillite.

These disposal areas will be developed in a modular fashion over a period of over a hundred years to enable the progressive construction of the cells into which the waste packages will be placed. The waste packages represent a volume of 85,000 m³. Once all the waste packages have been disposed of, the underground facility will be closed and the surface installations dismantled. A monitoring phase lasting several hundred years will then be put in place.

THE CIGÉO PROJECT IN DETAIL

UNDERGROUND LABORATORY
The Cigéo underground facility will develop gradually over a period of centuries.

RAMP AREA
This area, a few kilometres away from the work area, will contain buildings where waste packages will be received, checked and prepared before being transferred to the underground facility.



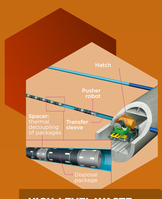
SHAFT AREA
This area, located directly above the underground facility, will be used to support the excavation and construction of the underground structures. Excavated material of these structures will be stored in this area.

SHAFTS
Five vertical shafts will link the underground facility to the area dedicated to underground works, to allow the transfer of personnel, equipment and machinery, the raising of excavated material and the ventilation of the underground facility.

DOUBLE RAMP
A first ramp will allow waste packages to be transferred to the underground facility. A second ramp will serve as technical access.

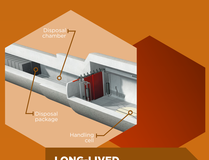
ILW-LL DISPOSAL AREA
Packages of long-lived intermediate-level waste will be placed in horizontal disposal cells several hundred metres long and around ten metres in diameter.

HLW DISPOSAL AREA
The high-level waste (HLW) packages will be placed in steel-lined disposal cells around 100-meter long and 80 cm in diameter.



HIGH-LEVEL WASTE PACKAGES
These packages will be stored in metal-lined disposal cells around 100-meter long and 80 cm in diameter.

UNDERGROUND FACILITY
The Cigéo underground facility will develop as the operation progresses, according to need, and will be made up of different zones.



LONG-LIVED INTERMEDIATE-LEVEL WASTE PACKAGES
These packages will be stored in horizontal storage cells several hundred metres long and around ten metres in diameter.

A HIGHLY CONTROLLED PROJECT

ASN is involved in drawing up regulations on radioactive waste management, and controls the safety of disposal facilities from design to decommissioning.

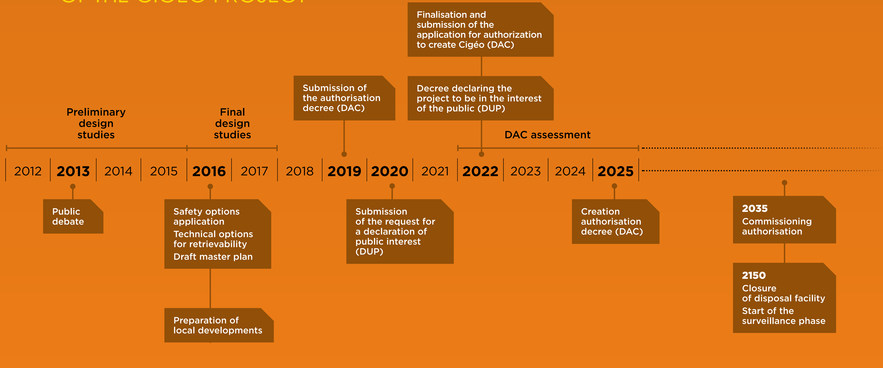
Upon request of ASN, IRSN assesses the applications submitted under the law or the PNGMDR (National Plan for the Management of Radioactive Materials and Waste) by Andra, the project owner, as the project progresses.

IRSN issues opinions to ASN. In some cases, it submits its expert report to the standing advisory group on waste, which reports to ASN.

This group brings together around forty specialists from a variety of backgrounds: geologists, hydrogeologists, geomechanical engineers, mining specialists, nuclear safety specialists, etc. It issues opinions and recommendations to ASN.

The Cigéo timetable
is available by scanning this QR code

STAGES IN THE CREATION OF THE CIGÉO PROJECT



10.4 Design: ASN and IRSN Communications Departments - May 2022
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THE ISSUES OF THE GEOLOGICAL DISPOSAL

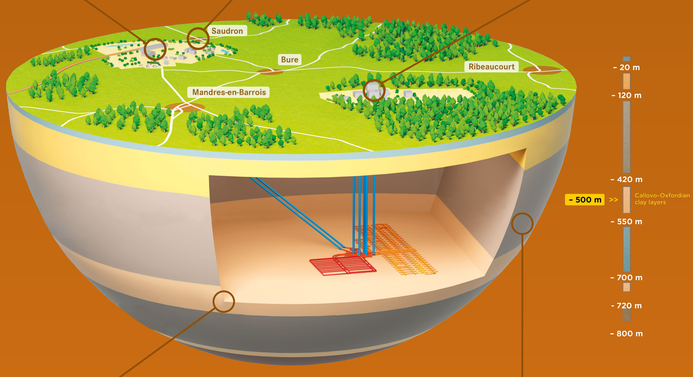
The **issue** of geological disposal is a **sensitive one because of the risks** associated with long-lived waste. The constraints are very significant, because the facility must be safe for hundreds of thousands of years.

DEBATE
THE CIGÉO PROJECT

HEAT
High-level waste produces off heat. However, above 90°C, the behaviour of rock is difficult to predict.
Under the Cigéo project, the waste will be cooled on the surface before being disposed of, so as not to exceed this temperature and to reduce uncertainties. This requires proper management of surface waste storage.

TRANSPORT
New rail and road infrastructure will be built to ensure that waste is transported from its storage sites under safe conditions.
Concentrating waste in one place will result in numerous convoys converging on the destination. This will increase the risks associated with transport.

GASEOUS EMISSIONS
Some waste releases non-radioactive hydrogen. Above a certain quantity, hydrogen presents a risk of explosion in the presence of oxygen.
Ventilation systems are planned, their design must ensure that the site is leaktight.



GROUND STABILITY AND RESISTANCE
The over 100-m thick argillite layer, in which the site will be built, was formed 150 million years ago and has changed little since then. Moreover, these argilites have impervious and resistant characteristics, making them an excellent natural shield.
Seismic events could create a set of faults that would compromise the clay's ability to confine radioactivity. But this would still require the radioactive elements to rise to the surface in a time period that is shorter than their lifespan.
The safety of the Cigéo project is based on the clay's ability to act as a barrier over a very long period of time.

WATER ISSUES
The underground strata are full of water. These aquifers are important water resources for humans. Contamination caused by the disposal facility could compromise their use.
The Cigéo site was chosen because the facility will be located in an area that has no major aquifers and is highly impermeable.

REVERSIBILITY
The disposal of waste in Cigéo must be reversible for a period of at least 100 years, i.e. it must be possible to retrieve packages during this period in the event of a problem.
While this is provided for in Andra's project, some people have doubts about the economic (and even technical) feasibility of extracting the packages once they have been disposed of.

RESOURCES
Areas of exceptional interest in terms of underground resources must be avoided. This requirement reflects the desire not to deprive local people of the benefits of a major local resource, and also to limit the risk of intrusion into the disposal facility should the memory of its existence be lost.

OPERATIONAL RISKS
The site will be in operation for around a hundred years, and the "classic" risks for a nuclear facility cannot be overlooked: criticality, fire, containment, ventilation, package drops, etc.
To design the facility, all the specific aspects are studied: depth, size, duration of operation, concurrent constructions and operations. The risks are analysed in the safety reports.

Find out more about
the project

10.5 Design: ASN and IRSN Communications Departments - May 2022
Design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: Andra

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