Reference Series

2006 | EDITION

Radioactive waste and recoverable material in France

2006

Summary of the National Inventory

ANDRA
Agence nationale
pour la gestion des déchets radioactifs

Contents

Inventorize - the route to management

Thorough knowledge is needed if the various types of radioactive waste are to be managed openly, consistently and in a safe manner. All French radioactive material users have subscribed to this process for many years.

Under the terms of the French Act of Parliament of 30 December 1991, the Government commissioned the French National Agency for Radioactive Waste Management (or Andra) to carry out a survey of all the radioactive waste present on French Territory.

Through its efforts to collect and confirm information from many sources **over the years**, that is mainly from statements made by waste producers and handlers, **Andra has built up a database on existing waste and its geographical location**. This constantly updated resource has been regularly circulated.

At the beginning of the century the Government decided to extend the areas covered by this database, in response to the recommendations made by the National Review Board (CNE) and the Parliamentary Office for Evaluating Scientific and Technology Options (OPECST). This is how the first edition of the National Inventory, published in 2004, came about.

The National Inventory of Radioactive Waste and Recoverable Material, presents a full panorama of radioactive waste that it groups into waste families that present homogenous characteristics. It describes the state of the waste that may be conditioned (that is, in its final form) or may not be conditioned (that is, has not been put through sufficient treatments to arrive at its final form) **at the end of 2004**.

Furthermore it presents not only a statistical and geographical summary, but a **predictive summary, as it provides waste quantity forecasts for 2010, 2020 and beyond**.

The Inventory also includes **recoverable materials** that contain radioactivity. They **are always accounted for separately** because of their special nature.

The data is presented in a synthesis report. This summary is the general public version of the report. The synthesis report offers more in-depth information for those readers who request it. There is also a technical document that presents the waste families in detail, a brochure describing the geographical locations of the radioactive waste on French territory, and a CD-ROM that includes all the publications that make up this edition of the National Inventory.

The 2006 edition of the National Inventory has the benefit of readers' comments on the previous edition and moreover presents more in-depth coverage on decommissioning and waste recovery operations together with a clearer link between geographical accounting and the waste families. This new edition also puts forward waste production assessments that cover the whole service life of current installations, using contrasting hypotheses on nuclear power plant reactor renewal.

Finally **readers are again invited to contribute their comments and suggestions on the Andra web site**, **www.andra.fr** to take the National Inventory, which is already considered as a valuable reference tool, further forward.

This Inventory, produced by Andra with the help of the waste producers under the supervision of the public authorities, will be regularly updated every three years.

Marie-Claude DUPUIS,
Director-General, Andra

1 Radioactive waste classification

1.1 The rationale behind classifying radioactive waste

There are many characteristics that distinguish one type of waste from another, such as their physical and chemical nature and the level and type of radioactivity. Each type of waste calls for specific treatment and management appropriate to the risk it represents.

Classification is of the essence. Radioactive waste classification in France is based on **two parameters**: the radiation level and half-life of the radionuclides contained in the waste.

- **The radioactivity level** is generally expressed in Becquerels (Bq) per unit mass. The level of radioactivity, also known as **activity, is the quantity of radiation emitted** by the radioactive elements contained in the waste.

- The **radioactive period** is expressed in years, days, minutes or seconds. It is also called **half-life**, and expresses the amount of time it takes for the initial activity of a radionuclide to be halved.

A **classification system by radioactive waste category** is arrived at by combining half-life and activity.

Distinction is made between waste whose main radionuclides are short-lived (less than or equal to 30 years) and those with long-lived radionuclides (over 30 years). Conventional wisdom is that the former no longer present any risk after 300 years.

"Very short-lived" radionuclides used for **medical diagnosis purposes**, whose half-life is less than a 100 days, are a **special case**. In a short time (several half-lives), their radioactivity drops to such low levels that the notions of "very low-, low- and intermediate-level activity" are fairly meaningless for waste of this kind.

[Table 1.1] French classification of radioactive waste

<table>
<tr><th colspan="4">FRENCH CLASSIFICATION OF RADIOACTIVE WASTE
AND RELATED LONG-TERM MANAGEMENT SOLUTIONS
(EXISTING OR BEING CONSIDERED)</th></tr>
<tr><th>Half-life
Activity</th><th>Very short-lived
<100 days</th><th>Short-lived (SL)
<30 years</th><th>Long-lived (LL)
>30 years</th></tr>
<tr><td>Very low level waste (VLLW)</td><td rowspan="4">Waste managed by allowing the radioactivity to decay in situ</td><td colspan="2">The Aube VLLW disposal facility*</td></tr>
<tr><td>Low-level waste (LLW)</td><td rowspan="2">> The Aube LILW disposal facility

> Being considered for tritiated waste</td><td>Being considered (radium-bearing and graphite waste)</td></tr>
<tr><td>Intermediate-level waste (ILW)</td><td>Being considered within the framework of articles L.542-1-14 of the Environment Code (Act of 30 December 1991)</td></tr>
<tr><td>High-level waste (HLW)</td><td colspan="2">Being considered within the framework of articles L.542-1-14 of the Environment Code (Act of 30 December 1991)</td></tr>
</table>

* A VLLW waste disposal facility does not accept waste residue from uranium ore processing, which has its own specific disposal facilities provided for in the vicinity of the production sites.

THREE MAIN KINDS OF RADIATION

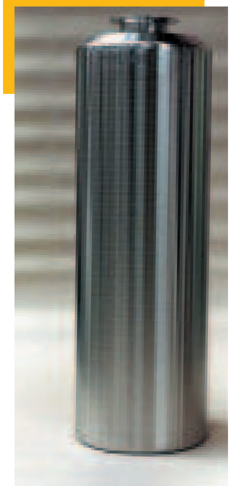
ALPHA RADIATION:
Emission of particles comprising helium atom nuclei, that have a range of a few centimetres in the air. These particles can be stopped by a single sheet of paper.

BETA RADIATION:
Emission of electrons that penetrate several metres of air.
A sheet of aluminium or a pane of glass can stop them.

GAMMA RADIATION:
Much more penetrating electromagnetic radiation, of the same type as X-rays. Several centimetres of lead or several tenths of metres of concrete are generally required to stop them.

1.2 Five major categories of radioactive waste

1.2.1 [High-level waste (HLW)]



Standard container for vitrified waste

Its mean activity is over one billion Becquerels per gram.
Most of this waste comes from the nuclear power industry and comprises the radioactive elements that cannot be recovered from spent fuel. After reprocessing operations this waste is conditioned in the form of a vitrified matrix poured into stainless steel containers. This type of waste releases heat because of its high concentration of radioactivity in a very small volume.

1.2.2 [Long-lived intermediate-level waste (ILW-LL)]

This waste presents a mean activity of over one million Becquerels per gram. Most of it comes from spent fuel structures (cladding hulls and end-fittings) or residue from nuclear facility operations (waste from effluent treatment, equipment, etc.). It is characterized by a significant presence of long-lived radionuclides.

Hulls and end-fittings, Cogema Compacting Facility, La Hague

Most French waste-related radioactivity - a comparatively small volume - is accounted for by HLW taken together with ILW-LL.

1.2.3 [Long-lived low-level waste (LLW-LL)]

Its mean activity varies from several tens of Becquerels to several hundreds of thousands of Becquerels per gram. It covers two types of waste: known as "**radium-bearing**" and "**graphite**" waste.

Radium-bearing waste contains a considerable amount of radium and/or thorium. It comes from the use of naturally-occurring radioactive material in industrial processes. Natural radioactivity is thus concentrated in the ore extraction residue.
Old luminous paint, lightning rod heads and some cleanup waste from polluted sites may also be included in this type of waste.

Radium-bearing waste (Rhodia plant)

The fuel in the first power plants, known as gas cooled reactors, was surrounded by **graphite** elements ("sleeves", "stacks"), the source of today's graphite waste. These power plants have now been shut down.

Graphite sleeve surrounding "natural uranium" GCR fuel

1.2.4 [Short-lived low- and intermediate-level waste (LILW-SL)]

Its mean activity varies from hundreds to one million Becquerels per gram.
The long-lived radionuclides (with a half-life of over 30 years) are limited in this waste, primarily those that emit alpha radiation, with a statutory limit of 3700 Becquerels per gram.
This is essentially waste from nuclear facility maintenance (clothing, tools, filters...) and operation (liquid or gaseous effluent treatments). It may also come from decommissioning operations.

Lowering a concrete shell into a repository structure (the Aube LILW disposal facility)

1.2.5 [Very low-level waste (VLLW)]

Its mean activity is generally less than 100 Becquerels per gram.
It basically comes from decommissioning nuclear facilities or from conventional industries that use naturally-occurring radioactive material. It generally occurs in the form of inert waste (concrete, rubble, earth).
By applying the principle of precaution and in contrast to most other countries, France has a specific management system dedicated to this type of waste.

Unloading big-bags (the Aube VLLW disposal facility)

2 Where radioactive waste comes from

Every year since the beginning of the 20th century, the use of radioactive material has been generating radioactive waste.
Most of it comes from the nuclear power industry. Radioactive waste is also produced on a smaller scale by research facilities, nuclear medicine departments, national defence activities and some isolated industries.

The Inventory has opted to classify the origin of radioactive waste into **12 categories** of industrial activity likely to lead to the **production**, **conditioning**, or **storage or disposal of radioactive waste**.

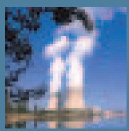
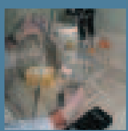
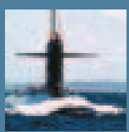
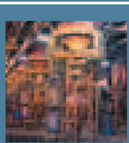
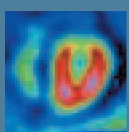
[Table 2.1]

	THE 12 RADIOACTIVE WASTE PRODUCER OR STORER CATEGORIES
1	Front end* of the Fuel cycle
2	Nuclear power plants
3	Back end* of the fuel cycle
4	Waste treatment or maintenance facilities
5	Civilian R&D centres of the CEA, Commissariat à l'Energie Atomique
6	Research establishments other than CEA centres (physics, chemistry, biomedical research)
7	Medical activities: diagnostics, therapeutics, analyses
8	Miscellaneous industrial activities: manufacture of sources, monitoring, special items
9	Non-nuclear industries using naturally-occurring radioactive material
10	Research, production or experimentation centres working for the deterrent forces
11	Defence, DGA, SSA, Army/Air Force/Navy/ Gendarmerie facilities
12	Interim storage, disposal facilities

Category 12 is not really a "waste-producing activity". It covers sites where waste from all sources is temporarily stored or disposed of. Even if the operation of certain relevant facilities may produce radioactive waste, they are mentioned in this summary basically because they constitute holding areas.

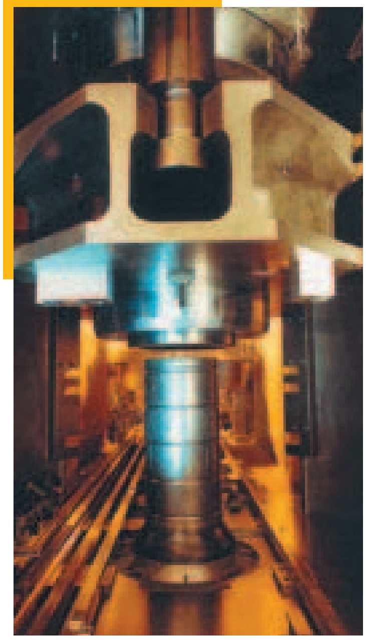
* Notion explained in the glossary

[Table 2.2] The economic sectors that produce radioactive waste

ECONOMIC SECTORS	PRODUCER OR HOLDER CATEGORY
 NUCLEAR POWER INDUSTRY	Front end of the fuel cycle Nuclear power plants Back end of the fuel cycle Waste treatment or maintenance facilities Storage and disposal facilities
 RESEARCH	Back end of the fuel cycle (marginal) Waste treatment or maintenance facilities Civilian R&D centres of the CEA Research establishments (other than CEA centres) (physics, chemistry, biomedical research) Storage and disposal facilities
 DEFENCE	Front end of the fuel cycle (marginal) Back end of the fuel cycle (marginal) Waste treatment or maintenance facilities Research, production or experimentation centres that work for the deterrent forces Defence establishments, DGA, SSA, Army/Air Force/Navy, Gendarmerie Storage and disposal facilities
 NON-NUCLEAR INDUSTRY	Miscellaneous industrial activities: manufacture of sources, monitoring, special items Non-nuclear industries using naturally-occurring radioactive material Storage and disposal facilities
 MEDICAL	Diagnostics, therapeutics, analyses Civilian R&D centres of the CEA Research establishments (other than CEA centres) (physics, chemistry, biomedical research) Storage and disposal facilities

3 Waste treatment and conditioning

Waste compacting (COGEMA La Hague)



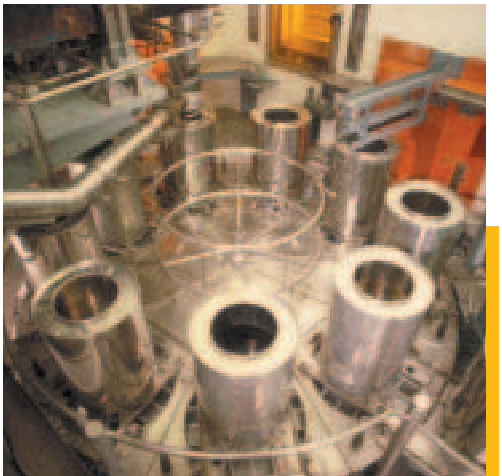
Radioactive waste must present specific characteristics that makes it conducive to being accommodated in a given storage or disposal facility. It thus undergoes prior **treatment**, to transform the initial waste into waste that presents characteristics that are more appropriate for management, primarily with a view to **reducing volumes** and **stabilizing** the products. The highly varied treatment techniques include compaction, incineration, evaporation and flocculation.

Following treatment the waste is **conditioned**. It is in a form conducive to long-term management. The waste is often embedded in a solid, stable matrix generally placed in metal canisters or concrete containers. The waste, matrix and container taken together form what is commonly known as the waste **package**.

Waste conditioning is tailored to its characteristics:

- radioactive (level and type of radiation emitted, half-life),
- physical (solids, liquids or mixed),
- chemical.

The volumes presented in the Inventory are those of the packaged waste after conditioning or that make allowance for the intended conditioning. Thus the figures are given as equivalent conditioned volume in m^3.



Drum filling carousel.
STE 3 effluent treatment station (COGEMA La Hague)

Most of the unconditioned waste was produced in the 1950's to 1970's by the major nuclear power plant operators. Whatever the case, it must be collected and conditioned: either to meet the safety requirements for interim storage, or, more generally, to work towards a final management solution. The post-conditioning volume estimates are based on the processes envisaged by the industry.

Disposal of metal drums (the Aube LILW facility)

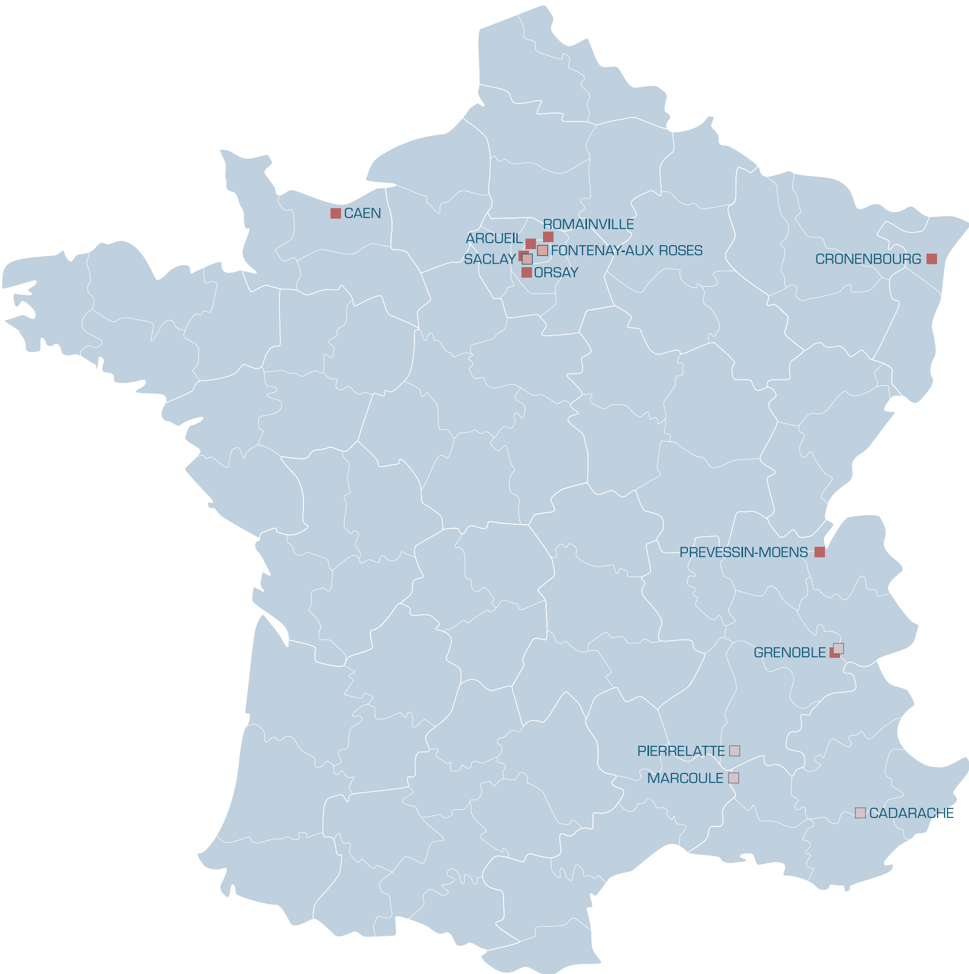
4.1 Geographical inventory

The National Inventory has surveyed 899 sites. The main sites listed are presented on the following maps.

[Map 4.1a] Main nuclear power industry sites

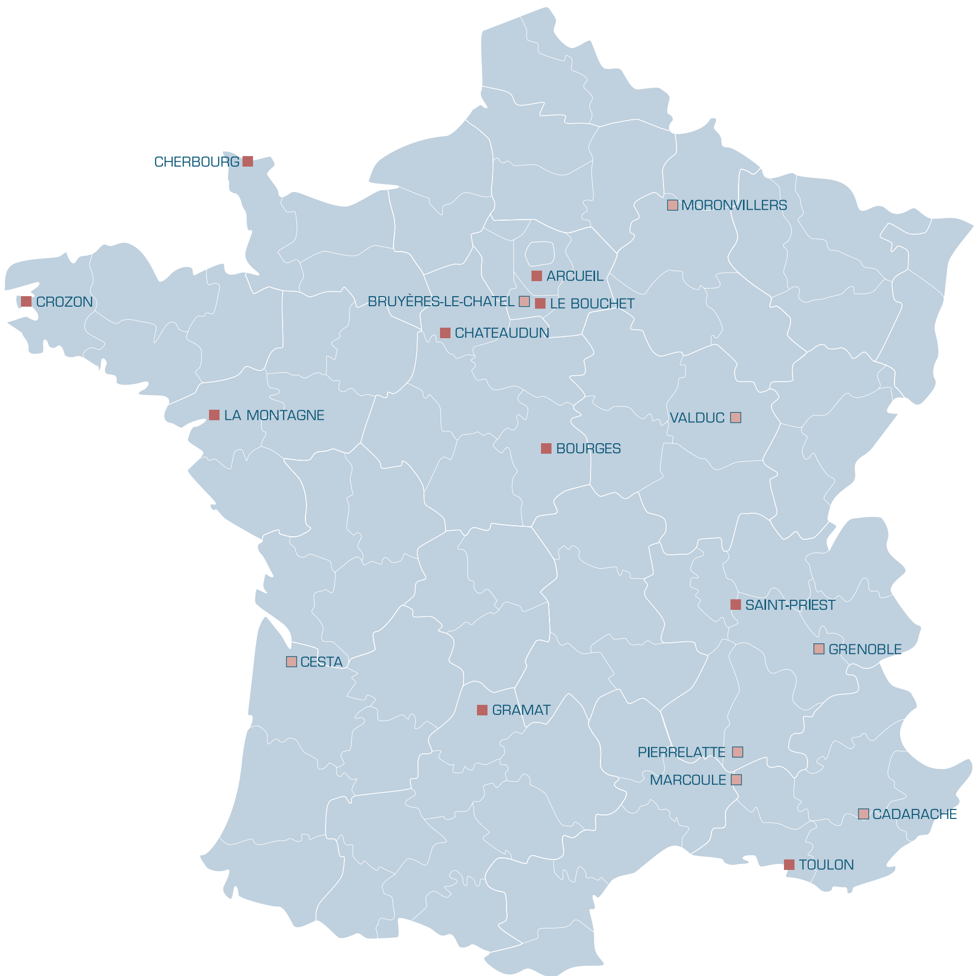
- Front end of the fuel cycle
- Nuclear power plants
- Back end of the fuel cycle
- Waste treatment or maintenance facilities

[Map 4.1b] Main Research sites



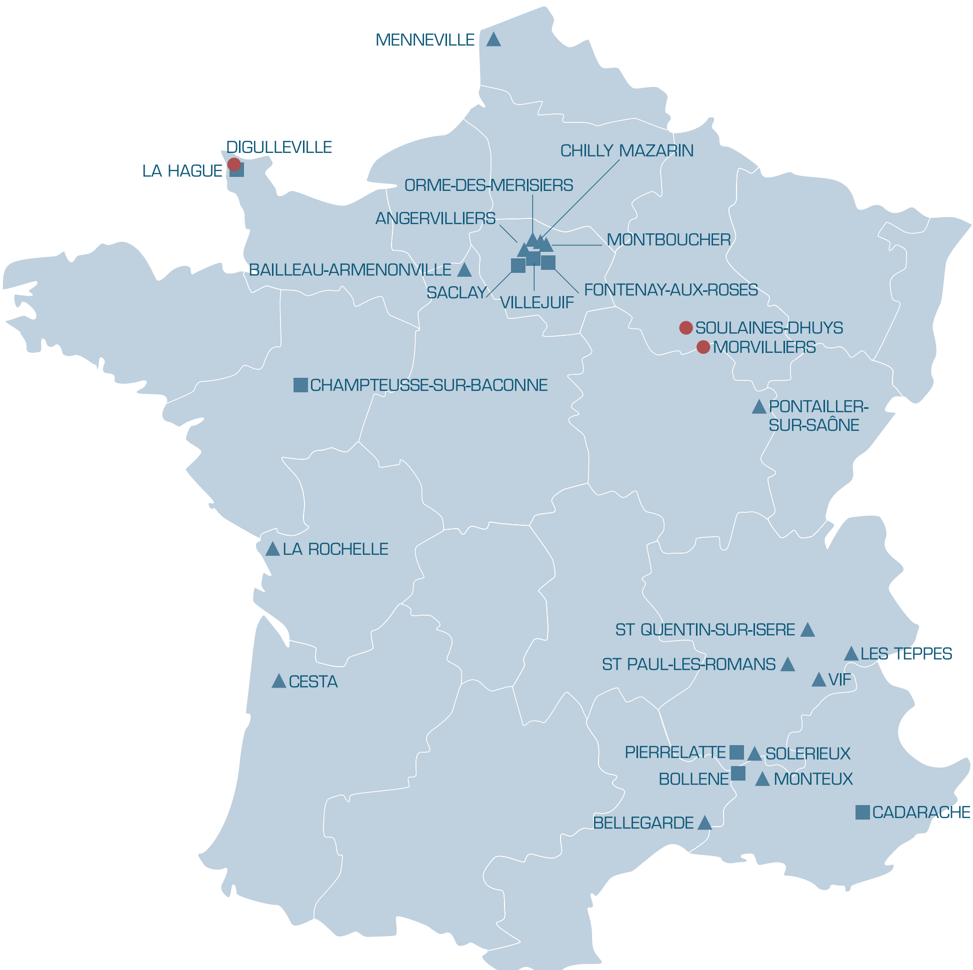
Civilian R&D centres of the CEA
Main research sites (other than CEA centres)

[Map 4.1c] Main Defence sites



Research, production or experimentation centres working for the deterrent forces
Main Defence facilities: DGA, SSA, Armies

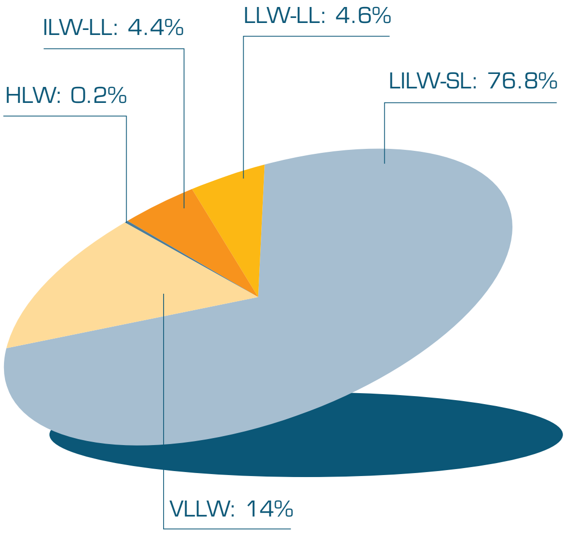
[Map 4.1d] Main storage and disposal sites



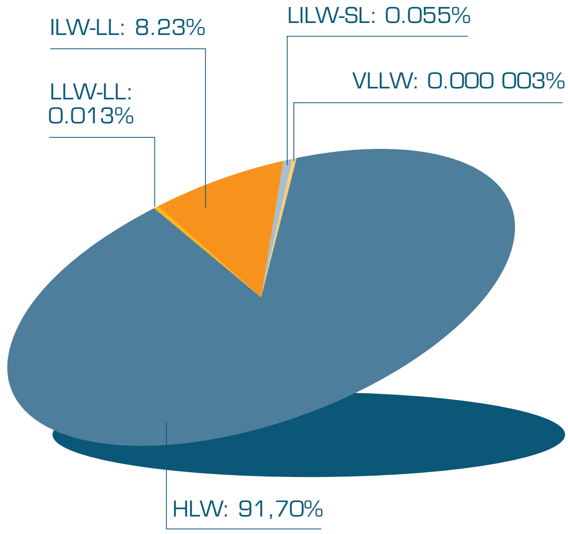
● Andra disposal facilities
■ Storage sites
▲ Other sites (landfills, backfill...)

4.2 Inventory by category

The breakdown of radioactive waste volumes by category (chart 1) and distribution of radioactivity by category (chart 2) was as follows on the cut-off date, **31 December 2004**:

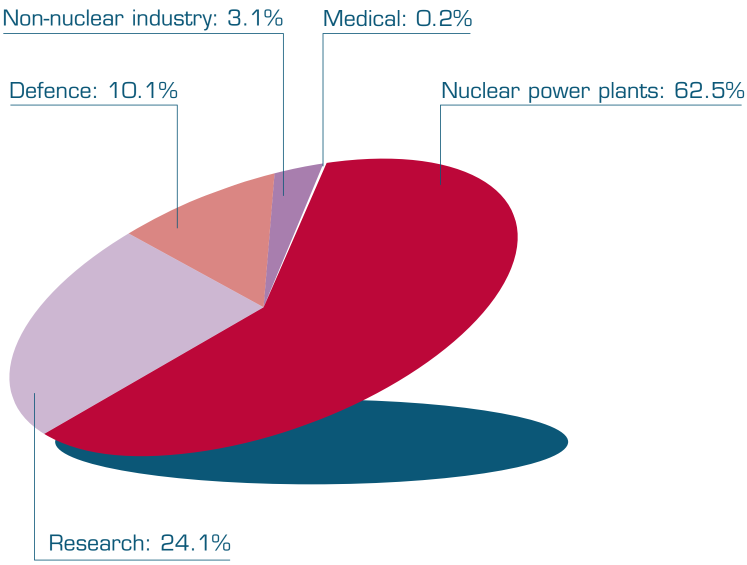


Volumes by category



Radioactivity by category

The breakdown of radioactive waste volumes by economic sector was as follows on the cut-off date, **31 December 2004**:



Breakdown by economic sector year end 2004

[Table 4.1] Distribution by economic sector in equivalent conditioned volume in m³

	Nuclear power industry	Research	Defence**	Non-nuclear industry	Medical	Total
HLW	1,462	150	239	0	0	**1,851**
ILW-LL	27,766	11,710	5,917	125	0	**45,518**
LLW-LL	10,780	19,808	625	15,891	20	**47,124**
LILW-SL	550,350	160,731	66,519	14,276	1,850	**793,726**
VLLW*	55,656	56,396	30,505	1,941	0	**144,498**
TOTAL	646,014	248,795	103,805	32,233	1,870	**1,032,717**

* When the producers declare their VLLW in tonnes, the corresponding volumes are calculated on the basis of ratios defined by Andra.
** The Defence economic sector includes the waste from military applications division of Commissariat à l'Energie Atomique (CEA/DAM) together with the waste from French national defence-related activities (DGA, SSA, Army/Air Force/Navy, Gendarmerie).

4.2.1 [HLW]

On **31 December 2004**, the stock of HLW stood at **1,851 m³**.
It is stored at the La Hague and Marcoule facilities. Most of this waste is conditioned in the form of a vitrified matrix poured into stainless steel canisters. HLW waste is covered by the Act of 30 December 1991, that entrusted Andra and the CEA with the task of following several lines of research for ultimate management solutions.

HLW represents **91.70%** of the radioactivity and **0.2%** of the volume accounted for in the National Inventory.

R7 - UP2-800 vitrification plant storage hall (COGEMA La Hague)

4.2.2 [ILW-LL]

On **31 December 2004**, the stock of ILW-LL stood at **45,518 m³**.
Most of it is stored at the La Hague and Marcoule facilities.
Only **36%** of ILW-LL is **conditioned**. This is because most of the legacy waste that was stored back in time without any treatment is awaiting retrieval and treatment.
ILW-LL waste is covered by the Act of 30 December 1991, that entrusted Andra and the CEA with the task of following several lines of research for ultimate management solutions.

ILW-LL accounts for **8.23%** of the radioactivity and **4.4%** of the volume accounted for in the National Inventory.

View of the multi-purpose storage facility (COGEMA Marcoule)

4.2.3 [LLW-LL]

On **31 December 2004**, the stock of LLW-LL stood at **47,124 m^3**. This total includes the **radium-bearing (35,876 m^3)** and **graphite** waste that has already been removed from the decommissioned reactors **(11,248 m^3)**, the remainder awaiting decommissioning has been accounted for in future stocks. According to EDF's conditioning assumptions, the volume of all present and future **graphite** waste packages taken together will amount to **70,078 m^3**. This waste is awaiting an ultimate management solution.
In the framework of their studies, Andra's research teams have recommended sub-surface disposal in a clay layer fifteen meters below ground level. No decision has been made on the siting of this facility to date.

LLW-LL accounts for **0.013%** of the radioactivity and **4.6%** of the volume accounted for in the National Inventory.

4.2.4 [LILW-SL]

On **31 December 2004**, the stock of LILW-SL stood at **793,726 m^3** (drums containing the waste immobilized in a hydraulic binder, concrete containers, metal canisters...). Of this quantity, **695,048 m^3** is already in surface repositories.
Since 1992, this waste has been disposed of at the Andra **waste disposal facility in the Aube** where the waste packages are disposed of in vast concrete repository structures. This Facility had already accommodated 167,823 m^3 of waste by the end of 2004 and has a total capacity of one million m^3, that is an active lifetime of about 50 years. It takes over from the Manche waste disposal facility which received waste packages amounting to over 500,000 m^3 between 1969 and 1994.

The Aube LILW disposal facility

LILW-SL accounts for **0.055%** of the radioactivity and **76.8%** of the volume accounted for in the National Inventory.

Some of the waste accounted for as LILW-SL can be stored by the producers without being delivered to the LILW waste disposal facility in the Aube, either because Andra has concluded that they could not be admitted in their current state - which is the case for CEA/DAM* **tritiated waste** that amounts to **2,143 m^3** for which specific solutions are being examined - or because research into their management solutions was unfinished at the end of 2004 - which is the case of some of the legacy **drums of bitumen-embedded** materials at Marcoule for example, which account for **42,200 m^3**.

*Commissariat à l'Energie Atomique/Military Applications Division

4.2.5 [VLLW]

On **31 December 2004**, the stock of VLLW stood at **144,498 m³**. For the most part it is kept on the nuclear facility sites.

An industrial surface disposal solution exists for this waste in the form of metal canisters, big-bags full of rubble, metal drums, massive metal parts, etc. After treatment as appropriate (compacting or transforming into an inert form), they have been placed in cells excavated into the surface clay, at the **VLLW disposal facility in the Aube** operated by Andra since August 2003. The VLLW disposal facility has a capacity of 650,000 m³, and should be able to accommodate waste for thirty years. It has already accepted **16,644 m³** of waste for disposal.

VLLW accounts for **0.000 003%** of the radioactivity and **14%** of the volume accounted for in the National Inventory.

The **residue left over from uranium ore processing** that has a similar level of activity is not accounted for in the VLLW figures and **is disposed of on the mining sites**. It amounts to **about 50 million tonnes**.

The Aube VLLW disposal facility

Bellezane uranium mine following site reclamation

An ultimate industrial solution has been found for roughly 84% of the volume of waste already produced. Andra and the CEA submitted a report to the public authorities in June 2005 on the fifteen-year research program into an ultimate solution for HLW and ILW-LL in application of the Act of 30 December 1991 (transcribed in article L542 of the Environment code, paragraphs 1-14) to provide the basis for a Parliamentary debate in 2006. Furthermore a sub-surface disposal facility is planned for radium-bearing and graphite waste. Other waste that is either non-approved or pending approval for acceptance by Andra's disposal facilities in the Aube, is subject to specific case-by-case study and as it stands, cannot be accounted for together with the waste that has an ultimate management solution.

5 What about tomorrow?

5.1 Forward-looking scenarios for the period 2005-2020

Assumptions and scenarios of future requirements need to be formulated if future volumes of waste produced are to be defined. They are based on the assumption that current industrial activities will continue without major interruption. Nonetheless they take into account potential developments envisaged by industry, such as changes to the processes implemented for conditioning waste.

[Table 5.1] The main assumptions used to estimate future waste production

Nuclear power plants	Assumptions take into account current nuclear power plants The power plants have a forty-year service life Gradual increase in fuel burnup Continued use of current proportions of mixed uranium-plutonium oxide (MOX) fuel
Fuel reprocessing	Continued operation of the La Hague reprocessing plant Clean-up of shutdown plants (UP2-400 at La Hague, UP1 at Marcoule)
Defence	Nuclear defence program to be kept up on a similar scale Submarine propulsion program to be pursued
Research and development	Research to be continued in the field of nuclear energy with current facilities
Medical and industrial usage	Use of radioactivity to be continued generally at current levels

5.2 Forecasts of waste production

5.2.1 [HLW]

The HLW production rate is regular and is directly related to spent fuel reprocessing. Andra has adopted the figure of **0.13 m³** of waste per tonne of reprocessed fuel for forecasting purposes.

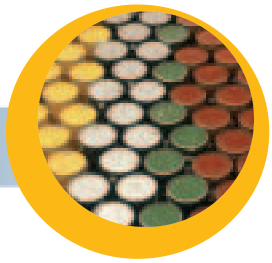
5.2.2 [ILW-LL]

The ILW-LL production rate (leaving aside legacy waste retrieval) will tend to remain steady from now until 2020. Andra has adopted the figure of **0.183 m³** of waste from cladding hulls and end-fittings per tonne of spent fuel unloaded by the French nuclear power plant industry for forecasting purposes.

5.2.3 [LLW-LL]

The graphite waste products originate from dismantling decommissioned power plants.

The small amount of radium-bearing waste still produced comes from cleaning up disused sites and non-nuclear industry.



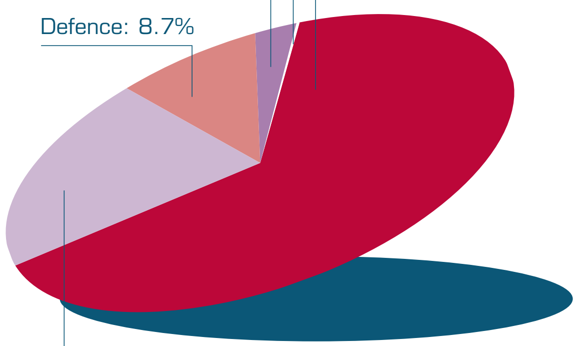
5.2.4 [LILW-SL]

The LILW-SL production rate appears to be stable over the period in question. The volumes being produced should start increasing after 2010, as decommissioning operations of old facilities are stepped up.

5.2.5 [VLLW]

The growth in volumes of VLLW matches the implementation of programs to cleanup and decommission facilities once they have been shut down. This waste is gradually disposed of in Andra's purpose-built facility. The demand for facility decommissioning operations should pick up from 2010 onwards, accelerating the growth in VLLW volumes.

Breakdown by economic sector in 2020 (volume)



[Table 5.2] Forecasts for the period 2005-2020 in equivalent conditioned volume in m³

	EXISTING VOLUMES 2004 DISPOSED OF OR IN STORAGE	FORECAST VOLUMES 2010 DISPOSED OF OR IN STORAGE	FORECAST VOLUMES 2020 DISPOSED OF OR IN STORAGE
HLW	1,851	2,511	3,611
ILW-LL	45,518	49,464	54,884
LLW-LL	47,124	48,432	104,997
LILW-SL	793,726	928,989	1,193,001
VLLW	144,498	300,279	581,144
TOTAL	**1,032,717**	**1,329,675**	**1,937,637**

5.2.6 [Decommissioning waste after 2020]

Decommissioning the Brennilis power plant

The forecasts for decommissioning waste for 2010 and 2020 are based on the facilities currently shut down.
The Inventory can only provides a ballpark forecast of waste volumes, given the uncertainties that surround the implementation rate beyond the year 2020.

These assumptions will naturally be revised if either technical or economic strategy changes, or alternatively for reasons of public policy.

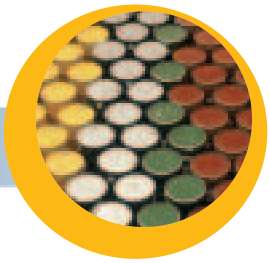
Facility decommissioning waste is accounted for as follows:
Before 2020, it is counted together with other waste, primarily from operations, as and when decommissioning takes place.
Beyond 2020, it has been singled out in the producers' statements. The following table gives the corresponding volumes.

[Table 5.3] Decommissioning waste after 2020 : equivalent conditioned volumes in m³

	FRONT END AND BACK END INSTALLATIONS OF THE FUEL CYCLE	CURRENT NUCLEAR POWER PLANT UNITS	CIVILIAN CEA RESEARCH INSTALLATIONS (decommissioning up to 2050)	CEA/DAM* INSTALLATIONS
ILW-LL	3,000	6,000	1,000	0
LLW-LL	0	4,000	0	5,100
LILW-SL	55,000	250,000	24,000	26,000
VLLW**	73,000	300,000	120,000	71,500

*Commissariat à l'Energie Atomique/Military Applications Division.
** When the producers declare their VLLW in tonnes, the corresponding volumes are calculated on the basis of ratios defined by Andra.

How will this inventory develop?



THE « EARMARKED » WASTE TOTAL

Andra has made an assessment of all the waste « earmarked » by the current nuclear power plants, including the previously presented waste (up to 2020 and for decommissioning, beyond 2020) together with an assessment of the operating waste volumes produced beyond 2020. These volumes are governed by hypothesis on France's future energy policy. Thus Andra has envisaged two contrasting scenarios (renewal or otherwise of the current nuclear power plants) for illustrative purposes only. The figures should be taken as orders of magnitude, in the light of the uncertainties surrounding calculations of this type.

[Table 5.4] Total waste produced by current installations up to their end of service life (including decommissioning) in a scenario involving no renewal of current nuclear power plants

	Waste produced in equivalent conditioned volume in m³
HLW (spent fuel)	70,000 assuming conditioning in disposal containers
HLW (Vitrified waste)	3,300
ILW-LL	65,400
LLW-LL	115,000
LILW-SL	1,645,000
VLLW	1,176,000

To this quantity must be added 444,000 tonnes of depleted uranium and unused recycled uranium (likened to LLW-LL in terms of radioactivity content).

[Table 5.5] Total waste produced by current installations up to their end of service life (including decommissioning) in a scenario involving renewal of current nuclear power plants

	Waste produced in equivalent conditioned volume in m³
HLW (spent fuel)	0
HLW (Vitrified waste)	6,800
ILW-LL	70,300
LLW-LL	115,000
LILW-SL	1,700,000
VLLW	1,218,000

The detail of the envisaged scenarios and their underlying hypotheses are given in the National Inventory synthesis report. The reader is invited to refer to the document to understand these figures properly. These scenarios are just two of many other possibilities.

6 Sites contaminated by radioactivity

6.1 What is a site contaminated by radioactivity?

According to the interministerial circular of 16 May 1997, « *a site polluted by radioactive substances is any site, abandoned or in use, on which natural or man-made radioactive substances, have or are being used or stored* ***in such a way that the site presents health and environmental risks***. »

Thus the main characteristic of a **site contaminated** by radioactivity is the **uncontrolled dispersal of radioactive substances** whose effects are incompatible with the current regulations governing public health and environmental protection or the current or planned re-use of the site. Generally either the site owner or the public authorities demand a cleanup operation, which may produce a volume of radioactive waste that will need to be treated, conditioned and directed to a suitable management channel.

Furthermore, a **site** may simply by **marked** by radioactivity, that means that it presents traces of natural or man-made radionuclides that while detectable, are so low risk that there is no need for any particular action. There are various causes for environmental marking by radioactive elements that may be due to industrial or small-scale activities carried out on the site, or alternatively contamination from quite external sources. These marked sites are identified and monitored by the public authorities.

Most of the polluted sites are home to **activities that are not related to nuclear industry** but that handle naturally-occurring radioactivity. A few exceptions involve man-made radionuclides, for example the manufacture of marked molecules or former defence tests on civilian or military land.

6.2 Predictions for the period 2005-2020

Andra estimates radioactive waste production at **100-200 m³ p.a.** of radioactive waste from cleanup operations of polluted sites, split half-and-half between VLLW and LLW-LL from the list of currently identified sites and preliminary studies, which are in turn dependent on the cleanup level demanded by the authorities.

[Table 6.1] List of polluted or formerly polluted sites, all activities taken together

ENVIRONMENT	NAME OF THE SITE	2004	OWNER
> Derelict industrial land	• Ganagobie (04)	A	Isotopchim
	• Pargny-sur-Saulx (buildings) (51)	A	Orflam Plast
	• Pargny-sur-Saulx (river banks) (51)	C	Orflam Plast
	• Saint-Nicolas-d'Aliermont (76)	C	Bayard
	• Le Bouchet (former INB) (91)	A	Former CEA plant
> Industrial land partly or totally occupied by operating facilities	• Boucau (64)	A	Reno
	• Colombes (92)	A	Sol essais
	• Romainville (93)	A	Aventis
	• Beauchamp (95)	C	Lumina
	• Les Roches (38)	B	Rhodia chimie
	• La Rochelle (17)	C	Rhodia Electronics
	• Serquigny (27)	B	Atofina
	• Saint-Nicolas-d'Aliermont (76)	C	Couaillet Mauranne
	• Besançon (25)	C	Lipp
	• La Roche de Rame (05)	C	Planet
	• Pierrelatte (26)	C	Radiacontrole
	• Wintzenheim (68)	B	Jaz
	• Valognes (50)	C	COGEMA
	• Donges (44)	C	Total Fina Elf
	• Bonneuil-sur-Marne (94)	C	Port authority
	• Rogerville (76)	B	Le Havre Port Authority
	• Grand-Couronne (76)	C	Grande Paroisse
> Legacy radium production/processing sites	• Nogent-sur-Marne (94)	A	School complex
	• Gif-sur-Yvette (91)	A	Housing estate
	• Ile-Saint-Denis (93)	A	Charvet + VNF
	• Arcueil (94)	A	University of Paris VI
	• Clichy (92)	A	Port authority + Departmental Facilities Directorate
	• Aubervilliers (93)	A	AFTRP
	• Paris 7e	C	private address
	• Paris 8e	C	private address
	• Paris 8e	A	private address
	• Paris 8e	C	private address
	• Paris 10e	A	private address
	• Paris 16e	A	private address
> Private house or property	• Nogent-sur-Marne (94)	A	Yab
	• Gif-sur-Yvette (91)	A	Federal Mogul
	• Asnières (92)	A	private address
	• Bandol (83)	A	private address
	• Paris 15e	A	private address
	• Colombes (92)	C	private address
	• Annemasse (74)	A	private address
	• Salagnac (33)	C	Clairvivre estate
	• Paris 14e	A	private address
Military land	• Arcueil (94)	A	DGA
	• Vaujours (93)	C	CEA/DAM
Miscellaneous	• Aubervilliers (93)	A	Société Budin
	• Marseille (13)	A	private address
	• Marnaz (74)	A	private address
	• Gruissan (11)	C	INRA
	• Le Bouchet-Ile verte (91)	C	CEA
	• Opoul Perillos (66)	C	Town Hall
	• Basse Ham (57)	C	Ets Wittman

A: sites awaiting cleanup or where cleanup is in progress - B: cleaned-up sites with waste stored in situ awaiting removal - C: cleaned-up sites with or without right of way.

The geographical brochure gives detailed fact sheets on some of these sites.

7 Recoverable radioactive material

Some radioactive material has a recoverable potential and thus is not considered as waste. It is recycled in various ways: plutonium is reused in MOX fuel (mixture of plutonium and uranium oxides), manufacture of recycled uranium fuel...

It is important to emphasise two points:

- Accounting measures already exist for so-called "nuclear" material, that is sensitive material in national defence terms that France has undertaken to survey by way of non-proliferation monitoring. Some of the material identified as recoverable is in this category (for instance, enriched uranium, plutonium). Accurate accounting is made at each individual facility under the supervision of government services. The National Inventory has not set itself the same objectives, but aims to give the reader some simple orders of magnitude. Therefore it gives round figures, incorporating the main stocks as declared by the storers.

- The materials used to manufacture arms or held as strategic stocks are covered by the French official secrets act. Consequently they are not included in the National Inventory.

The main survey findings and forecasts for 2010 and 2020 are given in the following table.

[Table 7.1]

	2004	2010	2020
Stock of depleted uranium from enrichment plants	240,000 t	280,000 t	350,000 t
Uranium hexafluoride in process in enrichment plants	3,100 t	Decreasing	Less than 40 t
Fuel in use in EDF nuclear power plants (all types), in tonnes of heavy metal	4,955 t	4,955 t	4,955 t
Spent uranium oxide fuel from EDF awaiting treatment, in tonnes of heavy metal	10,700 t	11,250 t	10,850 t
Other temporarily stored PWR reactor fuels: • Enriched recycled uranium	200 t	350 t	700 t
Other temporarily stored PWR reactor fuels: • Mixed Uranium - Plutonium oxides (MOX)	700 t	1,300 t	2,350 t
Recycled uranium (of French origin: EDF, AREVA, CEA property)	18,000 t	21,200 t	26,400 t
SUPERPHÉNIX fast breeder reactor fuel (of French origin) [1]	75 t	75 t	75 t
Brennilis EL4 reactor fuel (CEA and EDF property)	49 t	49 t	49 t
Non-irradiated plutonium of nuclear power industry or research origin (of French origin) [2]	48,8 t	Stock generally stable	Stock generally stable
Fuel from CEA Civilian research	63 t	37 t	18 t
Fuel from Defence	35 t	50 t	70 t
Thorium (CEA and RHODIA stocks in the form of nitrate and hydroxides)	33,300 t	33,300 t	33,300 t
Suspended particles (RHODIA stock)	19,585 t	26,185 t	37,185 t

((1) This tonnage does not include the fertile assemblies (51 tonnes) that EDF considers unrecoverable.
(2) This figure includes the plutonium that is separated out or present in new MOX fuel. However it does not include the plutonium contained in spent fuel. By way of illustration, uranium oxide spent fuel contains 1% mass of Pu, whereas MOX spent fuel contains 4-5% Pu.

7.1

Main recoverable materials accounted for and their respective storage sites

Storage of depleted uranium containers - COGEMA Pierrelatte, Tricastin Site

Most of the depleted uranium, produced by the industrial process that manufactures nuclear fuel is stored at Pierrelatte (26) and Bessine-sur-Gartempes (87).

Recycled uranium, separated from spent fuel during reprocessing operations, is stored at Pierrelatte and Marcoule.

Plutonium, also extracted during spent fuel reprocessing, is mainly stored at La Hague and in CEA facilities.

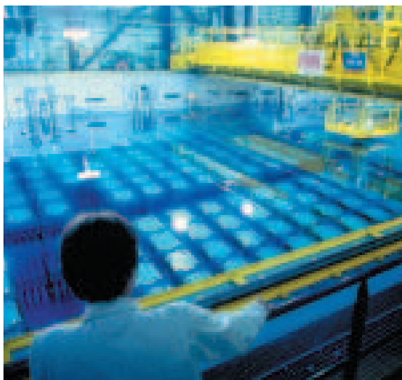
Spent fuel of various types:
After use in reactors, uranium oxide-bearing fuels are removed and stored in the nuclear power plant « pools » to cool down to a suitable temperature prior to reprocessing at La Hague.
Enriched recycled uranium and mixed uranium oxide/plutonium oxide (MOX) fuels are placed in interim storage and will be reprocessed after 2020.
Other spent fuels originate from earlier types of reactors, Research or Defence use.

Carousel of plutonium boxes Mox Melox fuel manufacturing plant COGEMA Bagnols-sur-Cèze

7.2

Beyond the year 2020: spent fuel production

Beyond the year 2020, the annual quantity of spent fuel unloaded from EDF reactors will amount to 900 tonnes compared with today's figure of 1,150 tonnes. This reduction is due to the introduction of so-called high burnup fuels.
The theoretical quantity of fuel unloaded between 2020 and the end of current nuclear power plant lifetimes is 7,000 tonnes assuming a hypothetical service life of 40 years for each facility. This does not in any way pre-empt the energy choices that will be made to take over from current electricity-generating facilities.



Spent fuel storage pool. Spent fuel reprocessing plant COGEMA La Hague

8 Summary and prospects

The findings for this edition of the National Inventory follow on from those of the first edition. They highlight the following points:

- **Waste can be described by a calculated number of clearly distinct families** although its physical and chemical compositions and conditioning methods may vary.

- **Waste originates from a few economic sectors**, with the highest levels being produced not only by the nuclear power production sector, of course, but also by the Research and Defence sectors. The non-nuclear industry also produces radioactive waste, but as a general rule only low- or very low-level waste, or very short-lived waste.

- **There are only a relatively limited number of sites holding waste (less than a thousand)**. The survey carried out in 2004-5 for this edition has pinpointed new sites that have been added to those already included in the survey. They are mainly small industrial concerns, research laboratories and health care centres that occasionally have radioactive waste on their premises. These specific sectors must be kept under constant scrutiny.

- **The waste held by the main producers is well accounted for**, because of the strict records that they have kept for many years, that are audited by the public authorities. Moreover, efforts are being made to characterize the legacy waste, some of which needs to be retrieved and conditioned.

- **Work on surveying "small producers"** is more recent and probably not fully completed. While the users of radioactive elements for medical purposes and establishments that handle sources tend to be well monitored, the area of conventional industries that may produce very low-level waste needs additional investigation. The public authorities have made efforts in recent years to locate legacy waste and a significant amount has been accounted for. However undiscovered waste could still turn up and modest quantities be added to the Inventory.

- **Waste is either disposed of or stored at the producer's site**. Almost all waste is covered by a defined category, for which an ultimate management solution exists or is being worked on. There are only a few isolated cases identified as not being covered by any of the current management channels or any pre-defined category, because of the chemical nature of the waste. These stocks have remained stable since the last edition was published.

- **Forward-looking research reveals that decommissioning waste - essentially very low-level or low-level waste - will assume major proportions in the future**. In the case of the waste produced by the nuclear industry, these producers of various categories have successfully reduced their waste volume. Today's volumes are much lower than in the past, particularly low and intermediate-level, short or long-lived waste. One of the major waste management issues for the next twenty years will be retrieving and conditioning operations for waste from legacy nuclear facilities.

- Beyond 2020, operating waste estimates are particularly tenuous as they are dependent on the future of the industrial sectors and in particular nuclear power production. Nonetheless, **Andra wished to illustrate the notion of "earmarked waste" for the whole lifetime of the power plant facilities**, using two assessments based on two contrasting scenarios, one involving renewal and the other non-renewal of the current nuclear power plant facilities. These assessments, that must be understood as orders of magnitude, supplement the information already presented to readers in the previous edition.

- **The survey of recoverable materials is simplified by the low number of sites involved**. Stocks are stable (for plutonium, spent fuel awaiting reprocessing) or are increasing at a steady pace (recycled uranium and depleted uranium). Business conditions and future strategic choices will dictate to what extent these materials are used. The survey that is presented in this work only intends to cover the major stocks resulting from civilian use. Military material covered by the French official secrets act, as well as buffer stocks of material held by certain facilities, have not been accounted for in detail.

The Inventory will continue its mission, that has been confirmed by the public authorities. A new edition will be published by 2009. In the intervening period, Andra will make every effort to continue its information gathering to present an even fuller panorama of radioactive waste and recoverable materials. The regular publication of editions of the Inventory will also track the progress made in conditioning waste and the retrieving-conditioning operations of legacy and decommissioning waste.

This Inventory has benefitted enormously from the suggestions contributed by readers of the previous edition. Andra will also strive to take into account those raised by the 2006 Inventory, primarily through its web site, www.andra.fr.

Glossary

TERM	DEFINITION
ACTINIDES	Natural or man-made **radionuclides** whose atomic number is in the range 89 (actinium) to 103 (lawrencium). In **spent fuel** they are formed by neutron capture from uranium, in the reactor.
ACTIVITY (NUCLEAR)	Number of spontaneous nuclear transitions of a quantity of radioactive nuclides by unit of time *Note: the unit of activity is the becquerel, the activity of a quantity of radioactive nuclides for which the number of nuclear transitions per second is equal to one. The curie and its sub-multiples are also used (1 curie = 3.7 x 10^{10} Bq).*
ACTIVITY PERIOD (OR HALF-LIFE)	As applied to a single radioactive decay process, it is the average time required for the activity of a radioactive source to reduce its original value by half.
BACK END OF THE FUEL CYCLE	All the operations that accompany nuclear-powered electricity generation, from **spent fuel reprocessing** to recycling the **plutonium** in **MOX fuels**.
BASIC NUCLEAR INSTALLATION (INB)	Defined by Decree No. 63-1228 of 14 December 1963, designates any civilian industrial installation (reactor, particle accelerator, plant, repository, storage facility...) authorised to hold radioactive substances in quantity or with total radioactivity above a threshold set by the public authorities.
BECQUEREL (Bq)	SI unit used to measure radioactivity. 1 Bq equals one radionuclide disintegration per second. This unit replaces the curie. It is more often used in its multiple forms: megabecquerel (MBq, million Becquerels), gigabecquerel (GBq, billion), terabecquerel (TBq, 10 to the power 12) or petabecquerel (PBq, 10 to the power 15).
BITUMINISED SLUDGE	Waste resulting from embedding radioactive sludge (from radioactive fluid treatment) in bitumen (tar, asphalt).
BURNUP RATE	Total energy released per unit mass of a nuclear fuel. It is commonly expressed in megawatts-day per tonne.
C WASTE (VITRIFIED)	High-level waste generated by the process of vitrifying solutions of **fission** products during **spent fuel** reprocessing.
CLADDING WASTE	Waste obtained after shearing **fuel assemblies**, that correspond to metal parts of the assembly (mainly hulls and **end-fittings**), at the time of reprocessing.
CLEANING UP RADIOACTIVITY	All the operations that aim to reduce radioactivity levels in a facility or site, primarily involving decontamination or equipment removal.
CONFINEMENT (OF RADIOACTIVE MATERIALS)	Maintaining radioactive materials inside a determined space through a set of measures aimed at preventing theses substances from being dispersed in unacceptable amounts outside that space. By extension, all the provisions made to ensure this containment.
CONTAINER	Closed recipient suitable for mechanical handling intended for transport and/or storage and/or disposal of radioactive substances.
CONTAMINATION (RADIOACTIVE)	Presence of radioactive materials in an item of equipment, on the surface of objects or in any place where this presence is undesirable or may have harmful consequences. A distinction is made between external and internal contamination when referring to human beings. In the case of internal contamination, the radioactive particles are present in the body, for example through inhalation or ingestion of solids, liquids or gases contaminated by radioactive materials. In the case of external contamination, the radioactive substances are in contact with the skin or the external parts of the body.
DECOMMISSIONING	All the technical operations that take a nuclear facility to a chosen declassification level.

TERM	DEFINITION
DISPOSAL FACILITY	Organized repository of **radioactive waste packages**, designed to be permanent.
ENRICHED RECYCLED URANIUM	**Recycled uranium** that has been enriched to be added to a nuclear **fuel**.
EQUIVALENT CONDITIONED VOLUME	Volume of a waste package, after it has been through all the treatment and conditioning stages currently envisaged by its producer.
"FAST BREEDER REACTOR" (FBR) SYSTEM	Type of reactor in which the presence of materials that could slow down the neutrons is limited, so that the **fission** is primarily induced by fast neutrons.
FISSILE	Said of a **nuclide** whose nuclei are likely to undergo **fission** through the effect of neutrons of all energies however weak they are.
FISSION	Division of a nucleus into at least two other nuclei and release of energy.
FISSION PRODUCT	Radioactive or stable **isotope** either directly from the **fission** of heavy nuclei (such as uranium or plutonium) or the disintegration of fission fragments, cesium, strontium, iodine, xenon etc.
FRONT END OF THE FUEL CYCLE	All the operations that accompany nuclear-powered electricity generation, uranium ore extraction to manufacturing **fuel**.
FUEL (NUCLEAR)	Material containing **nuclides** whose consumption by **fission** enables a chain reaction to be sustained in a nuclear reactor.
FUEL ASSEMBLY	Unit formed of **fuel rods** and loaded as a single item into a nuclear reactor.
"GAS COOLED REACTOR" (GCR) SYSTEM	Type of reactor that uses **fuel** based on natural metal uranium, with graphite as its moderator and pressurized carbon gas as its coolant. These reactors were used in France in the 1960s-1970s.
GRAPHITE WASTE	Waste essentially made up of carbon from legacy **gas-cooled reactors** being decommissioned.
HULLS AND END-FITTINGS	Respectively designate the **cladding** sections and end pieces obtained after shearing the **fuel** assembly **rods** when reprocessing.
ISOTOPES	Stable or radioactive bodies of the same chemical nature that are distinguished solely by their atomic mass.
LONG-LIVED (LL)	See: long-lived waste
LONG-LIVED WASTE	Waste containing a significant quantity of **radionuclides** whose radioactive period (half-life) is more than 30 years.
MARKED (SITE)	Site that presents traces of natural or man-made **radionuclides**, that are detectable without necessarily dictating the need for taking any particular action.
MATRIX (CONDITIONING)	Material that embeds or encapsulates the **radioactive waste**.
MINOR ACTINIDES	**Actinides** produced in irradiated **fuel** in smaller quantities than the major actinides (uranium, plutonium). Essentially neptunium, americium and curium.
MOX FUEL	Nuclear **fuel** based on a blend of uranium and plutonium oxides.
NUCLIDE	Atomic nucleus characterised by the number of protons and neutrons it contains and its nuclear energy status, provided that the average life is long enough to be observed in this state.

Glossary

TERM	DEFINITION
PLUTONIUM	Man-made, radioactive heavy metal element. Its most important **isotope** is **fissile** plutonium-239, produced by irradiating a uranium-238 nucleus in a nuclear reactor.
POLLUTED (SITE)	Any site, abandoned or in use, on which natural or man-made radioactive substances, have or are being used or stored in such a way that the site presents health and environmental risks.
"PRESSURISED WATER REACTOR" (PWR) SYSTEM	Type of reactor that uses enriched uranium **fuel** and that uses ordinary water pressurized to keep it liquid as a moderator and reactor coolant.
PRODUCER (WASTE)	Entity that technically controls the production and primary conditioning of **radioactive waste**.
RADIOACTIVE WASTE	Residue from the use of radioactive materials, that are not planned to be used in the current state of knowledge and whose **activity** level is such that they cannot be permitted to be discharged uncontrolled into the environment.
RADIOACTIVE WASTE CONDITIONING	Series of operations that consists of transforming **radioactive waste** so that it is suitable for transport, **storage** or disposal. *Note: the most common operations involve compacting, embedding, vitrification or containerizing.*
RADIOACTIVE WASTE PACKAGE	Non-recoverable **container** full of conditioned **radioactive waste**.
RADIOACTIVITY	Physical phenomenon characterised by the disintegration of unstable atomic nuclei and accompanied by the emission of an ionising ray. Distinction is made between: - alpha radioactivity (α): characterised by the emission of a helium nucleus or alpha particle (2 protons and 2 neutrons); - beta radioactivity (β): characterized by the emission of an electron (β^-) or a positron (β^+); - gamma radioactivity (γ); characterized by the emission of a high-energy electromagnetic (photon) wave (γ ray).
RADIOELEMENT	Element all of whose **isotopes** are radioactive.
RADIOLOGICAL PROTECTION	All the methods and means used to protect mankind from ionising radiation.
RADIONUCLIDE	Radioactive **isotope** of an element.
RARE EARTHS	Generic term for lanthanides and their oxides. There are about fifteen chemical elements that present similar structures and properties. They are found in varying proportions in certain ores (monazite). Applications of rare earths are electronics, magnetism (audio playback heads), automobile (catalytic converters), television screens, etc.
RECYCLED URANIUM	Uranium from **spent fuel** separated by reprocessing operations.
ROD	Small diameter tube, closed at both ends, that forms the core of a nuclear reactor when it contains a **fissile**, fertile or absorbent material. *Note: when it contains fissile matter, the rod is a **fuel** element.*
SCENARIO	A set of hypotheses on an activity that produces **radioactive waste**, on which the stock forecasts are built for the purposes of the National Inventory.
SHORT-LIVED (SL)	See: short-lived waste.

TERM	DEFINITION
SHORT-LIVED WASTE	Waste containing a majority of **radionuclides** whose radioactive period (half-life) is less than 30 years.
SPENT FUEL	Nuclear **fuel** that has been irradiated and removed from a reactor after use because it can no longer sustain the production of energy without undergoing appropriate treatment.
SPENT FUEL REPROCESSING	Process carried out on spent fuel consisting of separating out the uranium and plutonium (that account for about 97% of the mass) from the **fission** products.
STORAGE (OF RADIOACTIVE WASTE)	Temporary storage of **radioactive waste**.
TONNE OF HEAVY METAL (tML)	Unit relating to the mass of combustible metal (uranium or uranium + plutonium + americium for MOX) introduced during the manufacture of **fuel**. The notion "initial" is implicit in tML.
TOXIC CHEMICAL	Element likely to induce hazardous effect for human health in the event of ingestion and for inhalation
TREATMENT OF WASTE	Series of mechanical, physical or chemical operations aimed at modifying the characteristics of the waste. The purpose of the treatment is to make the waste suitable for conditioning.
TRITIATED WASTE	Tritium-contaminated waste.
TRITIUM	Radioactive **isotope** of hydrogen, whose nucleus is made up of two neutrons and one proton.
UOX FUEL	Nuclear **fuel** based on uranium oxide. Distinction is made between: - UOX1: Fuel manufactured out of natural uranium enriched by 3.25% U^{235} with an average **burnup rate** of 33 GWd/t; - UOX2: Fuel manufactured out of natural uranium enriched by 3.7% U^{235} with an average burnup rate of 45 GWd/t; - UOX3: Fuel manufactured out of natural uranium enriched by 4.5% U^{235} with an average burnup rate of 55 GWd/t.

The Act of 30 December 1991 now transcribed into the French Environment code (articles L. 542-1 - 14) lays down the general framework for managing radioactive waste over the long term.

The aim of the French national radioactive waste management policy and all the statutory requirements is to guarantee that human and environmental safety are upheld throughout. It promotes sustainable management methods that provide the necessary safeguards for this safety over the long term. The competent statutory authorities, primarily the French Nuclear Safety Authority (ASN) verify that these requirements are being implemented.

Under the terms of the legislative and statutory requirements, the producers are responsible for their waste and for developing their own management and conditioning strategies. They retain ownership of their waste and must finance the management procedures for this waste.

The Act of Parliament created the French National Agency for Radioactive Waste Management (or Andra) as the public industrial and commercial organization charged with working towards implementing the national policy. It is responsible for the long-term management of radioactive waste and accordingly must:

- *be involved in defining and contributing to long-term radioactive waste management research and development programs,*
- *manage the long term disposal facilities either directly or through third-party organizations acting on its behalf,*
- *design, find locations for and build new disposal facilities to cope with the long-term waste management and production projections and carry out whatever research is necessary to do so, in particular by creating and operating underground laboratories designed to study deep geological formations,*
- *define specifications for conditioning and disposing of radioactive waste, in compliance with relevant safety rules,*
- *carry out an inventory of the status and location of all radioactive waste present on French soil.*

Andra's teams were responsible for
writing this document on the basis
of the first edition written by Anita Castiel.

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The 2006 edition of the National inventory of radioactive waste and recoverable material is made up of five publications:

- Synthesis report *(Informed public)*
- Catalogue describing the families of radioactive waste *(Informed public)*
- Where is the radioactive waste in France?
  Geographical inventory of radioactive waste *(All readers)*
- **Radioactive waste and recoverable material in France**
  Summary of the National Inventory *(All readers)*
- CD-ROM *(All readers)*

All these documents are available on request from Andra either by post or through the Andra web site **www.andra.fr**

ANDRA

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The Andra Publication Series

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The short documents in the Essential series provide simple and illustrated explanations with a view to furthering knowledge on radioactive waste and Andra.

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References by way of procedures, research progress and the Agency's activities: this broad-based series offers a varied and technical array of information, such as the siting of radioactive waste stocks.

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Videos, CD-ROMs, computer-generated pictures, some pictures convey more than a thousand words can ever do. The "Discovery Series" uses illustrations to explain the principles of radioactive waste management to a broad public.

Sciences and Technology Series

Taking stock of state-of-the-art knowledge, presenting the Agency's ongoing research together with its methods and approaches. That is just what the "Sciences and Technology" Series aims to do. It is intended for an informed public and provides summaries and monographs published under the aegis of Andra and in partnership with other scientific institutions

Report Series

The "Report Series" of statements, reports and colloquium proceedings, aims to keep the informed public abreast of progress in the Agency's research program

Industrial practices

This series of documents focuses on the methods used for receiving and managing radioactive waste.

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