This chapter deals in a general way with management of objects and sites after they have been used for an activity involving radioactive substances, when their owner intends to abandon them or wishes to alter their utilisation.

This chapter therefore deals with:
- how radioactive waste is managed in operational activities;
- how clean-up of sites and installations is regulated, to prevent pollution;
- how past or current pollution (polluted sites) is dealt with to guarantee protection of the environment and the public.

Finally, certain installations designed for radioactive waste disposal concentrate intentionally radioactivity in a single place; how the surrounding public and environment are protected falls within the domain of waste repository safety, which must be dealt consistently with polluted site practices.

1 RADIOACTIVE WASTE MANAGEMENT PRINCIPLES

Like any human activity, nuclear activities produce waste. This waste is of two types, depending on whether or not it can be considered liable to have been contaminated by radionuclides. Waste containing high levels of natural radioactivity, sometimes resulting from use of a process leading to concentration of this radiation, can be produced by non-nuclear activities, in which the radioactive substances are not used for their radioactive or fissile properties.

Certain industrial waste, considered to be hazardous, must be managed in specific channels.

Radioactive waste management begins with the design of installations using radioactive substances, and proceeds during the operating life of these installations through concern for limitation of the volume of waste produced, of its harmfulness and of the quantity of residual radioactive materials contained. It continues through identification, sorting, treatment, packaging, transport and interim storage and final disposal. All operations associated with management of a category of waste, from production to disposal, constitute a waste management channel, each of which must be appropriate to the type of waste concerned.

The operations within each channel are interlinked and all the channels are interdependent. These operations and channels form a system which has to be optimised in the context of an overall approach to radioactive waste management addressing safety, radiation protection, traceability and volume reduction issues. This management must also be completely transparent to the public.

1 | 1 Radioactive waste management channels

Radioactive wastes vary considerably by their activity level, their half-lives, their volume or even their nature (scrap metal, rubble, oils, etc.). The treatment and long-term management solution must be appropriate to the type of waste in order to overcome the risk involved, notably radiological hazards.

The latter can be assessed on the basis of two main parameters: the activity level, which contributes to the toxicity of the waste, and the radioactive half-life, which depends on the radioactive decay periods of the radioelements it contains. Therefore, on the one hand we have very low, low, intermediate or high level waste and, on the other hand, waste known as very short-lived, resulting mainly from medical activities (activity level halved in less than 100 days), short-lived (activity level halved in less than 30 years) and long-lived, containing a large quantity of long-lived radioelements (activity level halved in more than 30 years).

The table below shows the stage reached in implementation of the different waste management channels, notably the final disposal channel adopted. It shows that for certain waste, there is at present no final disposal solution.

Table 1: Existing or future disposal channels for the main radioactive solid wastes

<table>
<tr><th>Period
Activity</th><th>Very
short-lived</th><th>Shot-lived</th><th>Long-lived</th></tr>
<tr><td>Very low level</td><td rowspan="4">Management
by
radioactive decay</td><td colspan="2">Dedicated surface disposal
Recycling channels</td></tr>
<tr><td>Low level</td><td rowspan="2">Surface disposal
(Aube repository)
except tritiated waste, sealed sources (under study)</td><td>Dedicated sub-surface disposal under study</td></tr>
<tr><td>Moyenne activité</td><td>Channels under study under article L. 542.3 of the Environment Code (law of 30.12.1991)</td></tr>
<tr><td>High level</td><td colspan="2">Channels under study under article L. 542.3 of the Environment Code (law of 30.12.1991)</td></tr>
</table>

- Very short-lived waste

Medical uses of radioactivity, whether for diagnostic or therapeutic purposes, generally involve very short-lived radioelements (their radioactivity is halved in less than a few days). The waste produced by these diagnostic or treatment activities is collected and stored for a time enabling virtual disappearance of the radioactivity, generally about ten times the half life of the radioactive element. This waste, now conventional, is then disposed of as such in the conventional hospital waste disposal channels.

- Very low-level waste (VLL)

Apart from the waste originating from former operation of uranium mines in France, most very low-level waste today comes from nuclear installation dismantling, from conventional industrial or research sites which use low-level radioactive substances, or from clean-up of sites polluted by radioactive substances. The quantity produced will grow considerably when the time comes for the large-scale complete dismantling of the power reactors and plants currently in operation. Radioactivity of this waste is about a few Becquerels per gram.

- Short-lived intermediate and low level waste

The activity of short-lived intermediate and low level waste is mainly due to radionuclides emitting beta or gamma radiation, with a half-life of less than 30 years. In this waste, long-lived radionuclides are strictly limited. This type of waste comes from nuclear reactors, fuel cycle facilities, research centres and university laboratories and hospitals. It consists mainly of manufacturing waste and used equipment and materials, sealed sources, cleaning rags and protective clothing. This category also includes products from gaseous and liquid waste treatment at nuclear installations.

The technical solution generally adopted for this type of waste is its removal, either directly or after incineration or fusion, to a surface repository, where the waste packages are stored in concreted structures. This provides for containment of the radionuclides for a sufficient length of time to take full advantage of the radioactive decay phenomenon (see point 6|1). This disposal channel has been operational since 1969, when France decided to cease its participation in the VLL waste immersion operations organized by the OECD. At that time, 14,300 m³ of radioactive waste of French origin had already been immersed in the Atlantic Ocean.

– Special case of short-lived intermediate and low-level waste for which no disposal channel is currently available

Short-lived intermediate and low-level waste includes certain categories which have characteristics making them currently unsuitable for acceptance at the Aube repository in Soulaines, without additional authorisation from the ASN.

Some sealed sources fall into this category: in industrial or medical activities, the radioactive elements used are frequently contained in perfectly leaktight containers. The tightness of the container is guaranteed by periodic leak tests and by a strictly limited source operational life. After use, the sources must be returned to their manufacturer.

A specific feature of these sources is that they contain often highly concentrated radioactivity. Consequently, even when the radioactive elements concerned have a relatively short life, they cannot always be accepted as such by a surface waste repository, because even after 300 years, they would still have significant radioactivity. In addition, their envelope is often made of stainless metals, making them tempting for people digging into the repository. The future of used sources is being reviewed by a special working group headed by the ASN with the aim of drafting the national radioactive waste and reusable materials management plan.

In addition, some waste contains significant quantities of tritium, a short-lived radionuclide but one that is hard to confine owing to its mobility, unlike the other radionuclides.

– Long-lived low-level waste

This waste usually comes from industrial activities leading to concentration of naturally occurring radioactive materials (NORM) (the former radium industry for example), or from the nuclear industry (such as the irradiated graphite contained in the structures of the old gas cooled reactors (GCR).

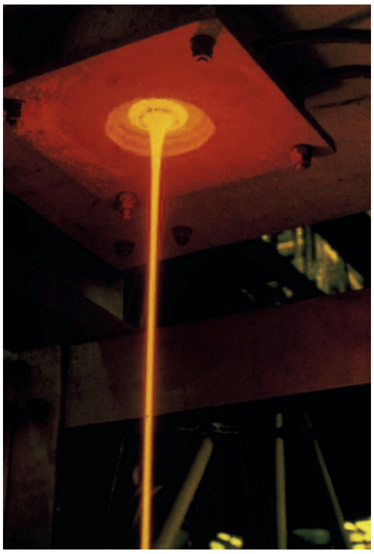
Owing to its long life, this waste cannot be disposed of in a surface repository as it is impossible to take advantage of its radioactive decay within a time-frame compatible with permanent institutional surveillance. However, its low intrinsic hazard could enable it to be disposed of in a subsurface repository about fifteen metres deep.

– High-level waste and long-lived intermediate level waste

This waste contains long half-life radionuclides, notably alpha emitters. The vast bulk of it comes from the nuclear industry. It comprises both intermediate level and high-level waste.

The intermediate level waste is mainly process waste (spent fuel hulls and end-pieces, effluent treatment sludge) and in-service maintenance waste from spent fuel reprocessing facilities and research centres, or certain activated waste from the dismantling of nuclear installations. In this waste, the alpha emitters can often reach significant quantities.

The high level waste generally originates from fission and activation products deriving from spent fuel processing. Vitrified waste is characterised by significant release of heat (up to 4 kW per 150-litre container), making the use of cooling systems necessary. This high level waste also includes fuel irradiated in CEA research reactors, together with EDF spent fuel which is not to be reprocessed.



Vitrification of a solution of fission and activation products

At present, there is no disposal channel for this waste, which is for the time being stored in the nuclear installations. Research into possible disposal is being conducted along the lines defined by Article L. 542-3 of the Environment code (see point 6|2).

1|2

The regulatory framework for radioactive waste management

Radioactive waste management falls within the general scope of law 75-633 of 15 July 1975 and its implementation decrees, concerning waste disposal and the recovery of materials. The basic principles of this law are the prevention of waste production, the responsibility of the waste producers, the traceability of this waste and the need to inform the general public.

– Production of radioactive waste in basic nuclear installations

Management of radioactive waste from basic nuclear installations is structured within a strict regulatory framework, defined by a ministerial order of 31 December 1999 stipulating the general technical regulations intended to prevent and limit the detrimental effects and external hazards resulting from the operation of basic nuclear installations. This order requires drafting of a study specifying how the waste produced in basic nuclear installations is to be managed. One part of this study is submitted for approval to the Director General for Nuclear Safety and Radiation Protection.

– Production of radioactive waste in other activities using radioactive substances

The provisions mentioned in the decree of 4 April 2002 concerning the general protection of persons against ionising radiation have been incorporated into the public health code. Article R.1333-12 of this code states that management of waste contaminated by radioactive substances originating in any activity comprising a risk of exposure to ionising radiation must be reviewed and approved by the public authorities, in conditions and according to technical rules which have yet to be defined.

Circular 2001/323 of 9 July 2001 sets the technical aspects to be taken into account when ensuring good management of radioactive waste, mainly in health institutions, but also in biomedical research laboratories. This circular requires that each institution draw up an individual on-site management plan for radioactive waste, based on the following main principles: sorting of the waste as early as possible in the process, separate storage areas according to the type of waste, disposal of the waste through identified channels.

Since July 2003, presentation of the institution's waste management plan has been a pre-requisite to renewal of the radioelement possession licences.

– Radioactive waste generated by clean-up of polluted sites

When clean-up of a polluted site is justified in terms of protection against ionising radiation, the waste resulting from the work must be correctly characterised in order to determine which disposal channels are necessary. The ANDRA in general takes part in these rehabilitation operations and conducts these investigations directly.

– Waste management channel supervision

Supervision of the waste management channels requires on the one hand traceability of radioactive waste treatment and disposal operations, and on the other detection of the presence of radioactive waste upstream of any treatment in installations not authorised to receive them.

As regards waste traceability, whether the waste is radioactive or not, decree 2005-635 of 30 May 2005 concerning the monitoring of waste treatment channels aims to ensure improved supervision and monitoring of the waste throughout the processing and disposal channel. It requires the creation of traceability systems (registers, periodic declaration to the Administration and waste trace sheets).

With regard to waste treatment or disposal installations not authorised to receive radioactive waste, the action taken by the authorities led to radioactivity detection systems being installed at the entrances to the sites (landfills, foundries, incineration plants, etc.). These systems constitute an extra line of defence in the supervision of radioactive waste management channels.

1 | 3

European regulation harmonisation work by WENRA

The Western European Nuclear Regulators' Association (WENRA) was created in 1999. It originally consisted of the heads of the nuclear safety authorities of the member countries of the European Union, plus Switzerland.

It initially provided the expertise for reviewing the safety of the reactors in the eastern European countries applying for membership of the European Union. The authorities of the eastern European countries have since then joined WENRA.

One of the key WENRA missions is to develop a joint approach to nuclear safety and regulation. WENRA therefore implemented a procedure designed to draft reference safety levels for harmonising nuclear safety practices.

Working groups were set up in 2002 in order to draft these reference levels. One of them, the WGWD (Working Group on Waste and Decommissioning) was more specifically tasked with defining reference levels concerning the safe interim storage of radioactive waste and spent fuel and nuclear installation dismantling operations.

Interim storage of low-level waste packaged in metal drums pending reprocessing (CEA/Saclay)

The WGWD working group submitted the final version of the reference levels in December 2005. They had been approved by the members and were published on the websites of the WENRA member safety authorities in early 2006, so that the stakeholders could submit their comments prior to incorporation into national regulations by 2010.

With regard to the reference levels for interim storage of radioactive waste and spent fuel, the main recommendations concern the need to identify the owner of the waste or fuel, to ensure that storage is reversible and to monitor the waste or fuel, so that it can be recovered if damage is confirmed, and to prefer passive safety protection devices, in other words, requiring no human intervention.

The reference levels concerning the safety of dismantling operations require that the nuclear licensees prepare dismantling strategies for all of their sites, draft dismantling plans, that the most important dismantling phases be submitted to the safety authority and that dismantling be taken into account as of the design of the nuclear installation, so that all the operations involved can be made easier when the time comes.

If the WENRA members are to adopt the reference levels, French regulations concerning interim storage of radioactive waste and spent fuel and dismantling of nuclear installations will have to be updated.

1 | 4

Organisation and responsibilities

The waste producer remains responsible for the waste produced until its disposal in an installation authorised for this purpose (in the case of a polluted site, the owner of the land is considered to be the producer of the waste). However, many different organisations also play an active part in waste management: the carriers (COGEMA Logistics, BNFL SA), the processing contractors (SOCODEI, COGEMA), the interim storage or disposal centre licensees (CEA, COGEMA, ANDRA), the organisations responsible for research and development to optimise these activities (CEA, ANDRA...). Each is responsible for the safety of its activities.

Waste producers must also constantly endeavour to minimise the volume and activity of their waste, upstream through design and operating provisions and downstream through appropriate waste management. Packaging quality must also be assured.

The waste treatment (compacting, incineration, melting, etc.) contractors may act on behalf of the producers, who remain the owners of their waste. The contractors are responsible for the safety of their installations.

The interim storage or repository licensees are responsible for the medium and long-term safety of their installations.

The ANDRA has a long-term assignment to manage repositories. The ANDRA also has a public service duty to store waste for which no disposal channel is available and whose owners cannot safely store it, or for which the owner cannot be identified (see point 4|4).

Research organisations (CEA, ANDRA) contribute to the technical optimisation of radioactive waste management, with regard to both production and development of treatment, packaging and characterisation processes. Efficient coordination of the research programme is necessary to ensure overall safety optimisation in this area.

In this context, the Nuclear Safety Authority (ASN) drafts regulations governing radioactive waste management, supervises the safety of the basic nuclear installations which give rise to this waste or play a part in its disposal and conducts inspections in the facilities of the various waste producers

(EDF, COGEMA, CEA, hospitals, research centres, etc.) and of the ANDRA. It supervises the ANDRA's overall organisational provisions for acceptance of waste from the producers. It assesses the waste management policy and practices of the radioactive waste producers.

The ASN has three priorities:
- safety at each stage in radioactive waste management (production, treatment, packaging, interim storage, transportation and disposal);
- safety of the overall radioactive waste management strategy, ensuring overall consistency;
- the setting up of channels tailored to each category of waste. Any delay in identifying waste disposal solutions increases the volume and size of the on-site interim storage facilities, and the inherent risks.

1 | 5

ANDRA national inventory of radioactive waste and reusable materials

In November 2004, ANDRA published the national inventory of radioactive waste and reusable materials. This inventory is an exhaustive list of the waste identified as radioactive throughout France. It also includes a forward-looking part which proposes estimates for the quantities of waste that will be produced by 2010 and by 2020. The ASN is a member of the steering committee for the national inventory of radioactive waste and reusable materials, a new version of which is expected for early 2006.

The following tables present some data extracted from the national inventory published in 2004. The largest volumes concern very low level or short-lived low and intermediate level waste, representing only a few teraBecquerels, which is a minute fraction of the total activity. On the other hand, long-lived, high-level waste will in 2020 represent more than a billion teraBecquerels, for a total volume of a few thousand cubic metres.

Tables 2 et 3: stocks of waste and spent fuels, both existing and anticipated by 2010 to 2020 as a result of operation of the installations

Waste categories	Existing volumes in 2002 disposed of or stored (m^3)	Anticipated volumes in 2010 disposed of or stored (m^3)	Anticipated volumes in 2020 disposed of or stored (m^3)
Very low level	108,219	247,981	515,991
Low and intermediate level short-lived	778,322	913,900	1,196,880
Low lelvel – long-lived	44,559	46,581	87,431
Intermediate level – long-lived	45,359	50,207	54,509
High level	1,639	2,521	3,621

	Existing quantity in 2002 (t)	Existing quantity in 2010 (t)	Existing quantity in 2020 (t)
EDF uranium oxide spent fuel waiting for processing	10,350	11,250	10,850
PWR reactor MOX fuels	520	1,300	2,350

(source: national inventory of radioactive waste and reusable materials – ANDRA 2004)

1 | 6

The national radioactive waste and reusable materials management plan (PNGDR-MV)

The preceding paragraphs show the various technical and regulatory aspects of radioactive waste management: categories (according to the disposal method), inventory, regulations at source, and role of the various players. These elements were gradually implemented over the years, as and when inadequacies in various areas were highlighted.

It is clearly obvious that a general framework is needed which, for all radioactive waste and whatever the producers, would guarantee safe and consistent management with the corresponding financing, in particular by defining priorities.

In response to a request from the Parliamentary Office for the assessment of scientific and technological options in 2000, the Nuclear Safety Authority has since 2003 been overseeing the preparation of a national radioactive waste and reusable materials management plan within a wide-ranging working group.

At the meeting of the French cabinet on 4 June 2003, the Minister for Ecology and Sustainable Development officially confirmed his intention to draw up such a plan.

The waste producers (all sectors), the waste disposal facilities, ANDRA, the departments of the ministries concerned, environmental protection associations and representatives of elected officials are invited to take part in these meetings. An initial draft of the national radioactive waste and reusable materials management plan was published on the ASN website for consultation purposes on 13 July 2005, and will be available until the end of 2005.

The plan is based on work designed to identify the waste that exists throughout the country. This mainly concerns the ANDRA national inventory. Interfaces with existing work to designate management channels for long-lived high-level waste, in accordance with the provisions of article L. 542-3 of the Environment Code, are also specified.

The PNGDR-MV project therefore proposed a certain number of actions and the corresponding deadlines

1) Revive the search for a disposal site for low-level long-lived waste, so that such a repository would be available in 2012.

2) Those in possession of reusable materials will be required to carry out precautionary studies by 2010 into possible management channels, if these materials were subsequently to be reclassified as waste. A review will be carried out by 2008 by those in possession of reusable materials for which the reuse procedures are still being studied and have never been implemented. These studies will be the subject of a joint analysis by the DGEMP and the ASN.

3) Continue studies into disposal of used sealed sources and their possible reprocessing, so that a management scheme is available by 2008.
The impact of the disposal of used sealed sources with a half-life longer than that of Cs137 in a LL-LL type repository will need to be reviewed by ANDRA by 2007.
Interim storage solutions could be necessary to manage the long-lived sealed sources, in particular for the programme to phase out ion detector use.
The conditions for extension of the sealed source possession period beyond the 10 years set in the Public Health Code will be clarified in 2006, in order to limit the number of scrapped sealed sources.

4) A study will be carried out onto the long-term management of tritiated waste. Together with ANDRA, the CEA will look for the best solutions for the necessary interim decay storage prior to disposal, with proposal of a management strategy by 2008.

5) ANDRA will propose criteria in 2006 for providing aid to a defaulting owner of waste so that it can be recovered and sent either for interim storage, or for disposal.
The conditions for allocation of public funding for these public service duties will be clarified in 2006, in accordance with the requirements of the service level and resources contract between the State and ANDRA for the period 2005-2008. The Government's commissioner (DGEMP) will coordinate the work to be done on this subject between the various administrations concerned and the establishment.
ANDRA will review the conditions in which recovery of radioactive lightning conductors could be accelerated by mid-2006. An estimate of the available storage capacity and qualified personnel requirements for speedier recovery of these radioactive items will be made by ANDRA. This recovery could require regulations which will be specified by the authorities.
By 2007, an estimate will be made of the number of used sealed sources which, for historical reasons, cannot be returned to their supplier. Sources for which possession has been authorised and for which the owners are experiencing temporary difficulties concerning their recovery are not concerned by this measure.
An information campaign targetting the potential holders of these sources could be organised in conditions yet to be defined.

6) By 2008, review the status of the short and long-term management solutions for TENORM (Technologically Enhanced Naturally-Occurring Radioactive Materials) waste.

7) Analyses of the long-term impact of uranium mining residue disposal will be carried out by the repository licensees in conformity with the applicable regulations. An assessment of the results of this study will be made by 2008.

8) The producers of mixed radiological and chemical waste will be required to continue to stabilise and process this waste, relying on ANDRA assessments with regard to any possible disposal.

2 MANAGEMENT OF VERY LOW LEVEL WASTE

The level of risk from radioactivity is very hard to determine for very low level (VLL) waste. In addition, this level of risk from the waste can be very close to that inherent in its chemical toxicity or possible infectiousness. The procedures for managing VLL waste must therefore take account of this difficulty.

2 | 1

VLL waste management principles

Some countries, such as Germany, have implemented a policy for the discharge of VLL waste based on activity thresholds. The German administration has therefore put into practice an option offered by European Council directive Euratom 96/29 of 13 May 1996.

French policy does not provide for unconditional discharge of VLL waste simply on the basis of universal thresholds. This leads to specific management of this waste and disposal of it in a dedicated repository.

Waste management in the BNIs is mainly regulated by the order of 31 December 1999. Any basic nuclear installation must be mapped out, with "zoning" of its buildings in which there is a risk of contaminated, activated or non-radioactive waste being produced. The zones likely to lead to the production of radioactive waste are referred to as "nuclear waste zones". The waste originating from nuclear waste zones has to be managed in dedicated channels. The waste from the other zones is, after checking that there is no radioactivity, routed to conventional waste channels (non-specific or special industrial waste). The ASN has published a guide, revised in September 2002, for the production of BNI waste studies. It is available from the ASN web site.

ANDRA – receipt of packages at the Morvilliers very low level waste repository

Recycling of waste from nuclear waste zones is possible. However it would be preferable for such recycling to take place in a channel that is already nuclear, such as the lead recycling from the Marcoule installations to produce biological protections. The reuse of recycled materials in consumer goods and construction products may be authorised by waiver to article R 1333-3 by order of the Minister for Health. Various projects were presented to the nuclear safety authority in 2004 and 2005: recycling of scrap decontaminated by the SOCATRI company and machined by Feursmétal to produce industrial parts, recycling in road-building of the concrete generated by nuclear installation dismantling, recycling of contaminated molybdenum and zircalloy items. The ASN does not at present envisage any waiver to article R. 1333-3 of the Public Health Code and is not favourable to use outside nuclear installations of materials or waste originating from nuclear activities and liable to have been contaminated. The Feursmétal company announced that it intended to give up reusing scrap decontaminated by Socatri in February 2005. Since then, the ASN has suspended investigation of the other dossiers.

2 | 2

The particular case of clean-up when dismantling installations

Dismantling operations can pose safety issues dealt with in chapter 15. This section only deals with operations designed to separate the nuclear parts (which could have been in contact with radioactive substances) from conventional parts (which could not have been in contact with radioactive substances).

2 | 2 | 1

Basic nuclear installations

The clean-up method today preferred by the ASN for nuclear installations is based on a waste zoning methodology. Using a demonstration based on the design of the installation, its operating methods, an analysis of its history (incidents, modifications, periodic radiological checks, etc) or any other empirical type of demonstration, the licensee must determine the waste zoning in its installation by accurately defining the boundary between conventional waste zones and nuclear waste zones.

With regard to complete clean-up of the structures in the nuclear waste zones, a policy note was prepared by the ASN in 2005. The first line of defence to be used must be based on a comprehensive picture of the condition of the installation and an understanding of the physical phenomena involved (activation, migration of contamination for example). Modelling of these phenomena enables a minimum clean-up thickness to be defined, with addition of a fixed safety margin. The total clean-up thickness thus obtained then corresponds to the limit between a nuclear waste zone and a conventional waste zone. The licensee then removes all nuclear waste from the nuclear waste zones, before implementing an appropriate inspection programme on the remaining elements, to confirm that there is no contamination or activation (2nd line of defence). It then proposes to the Director General of the ASN, that this zone be downgraded to a conventional waste zone. After approval of this final waste zoning modification, the remaining conventional waste is disposed of in conventional channels and can be dealt with in the same way as normal industrial waste.

On the basis of this policy, the licensee of the Monts d'Arrée plant in Brennilis defined a general clean-up methodology based on determination of a minimum depth of concrete to be removed from the walls of the building, by analysing the operating history of this building, combined with modelling of migration of radionuclides through the concrete. After removal of this concrete thickness, a programme to confirm the conventional nature of the remaining walls was implemented.

In 2003 and 2004, EDF used this methodology to clean-up several nuclear buildings: the spent fuel building (BCI) and the effluent treatment station (STE) on the Monts d'Arrée site and all the hillside buildings at Chooz A. The requests for downgrading the nuclear waste zones in these buildings to conventional waste zones were approved by the ASN in 2004. These buildings were demolished using conventional demolition techniques and the resulting products are considered as conventional waste. Furthermore, in the current context of managing industrial sites being dismantled, the need became apparent for conservation of a trace of the past existence of a basic nuclear installation on a site, along with any utilisation restrictions appropriate to the condition of the site. A conventional encumbrance on behalf of the State is established by the ASN, together with the local State representatives concerned, and proposed to the owner of the land. This constraint is recorded in the mortgage register to guarantee its permanence. These procedures were implemented for the first time in the case of the FBFC installation in Pierrelatte in 2003: the licensee and state representatives signed a conventional encumbrance on behalf of the state, affecting the land within the BNI boundary, at the same time as the decision was signed to remove the installation from the list of BNIs. The same type of encumbrance was put in place in 2005 at delicensing of the SATURNE installation (BNI 48) in the CEA Saclay centre.

2 | 2 | 2

Medical, industrial and research installations

There are as yet few dossiers concerning clean-up of medical, industrial and research installations. In 2004, a dossier for complete dismantling of a former pharmaceutical laboratory owned by Aventis-Pharma was submitted to the ASN for its opinion by the prefect of Seine-Saint-Denis. From 1956 to 2003, this laboratory carried out radioactive labelling of molecules for pharmaceutical research, using carbon 14 and tritium. The clean-up and dismantling methodology chosen is similar to that employed for nuclear installations: the premises are defined according to waste zoning, based primarily on the history of activities on the site and differentiating between nuclear waste and conventional waste. The clean-up targets were set and the waste will be removed to duly authorised channels. The preliminary studies and the operations are carried out in cooperation with the ANDRA.

2 | 3

Morvilliers VLL waste repository

The move to rationalise management of VLL waste initiated by the ASN in 1994 showed that it was necessary to create a repository for this type of waste. At the request of the nuclear licensees, technical studies had been conducted by the ANDRA and by the "ultimate" waste and polluted earth processing and disposal company as of 1996 with a view to creating a repository intended for very low level radioactive waste. The site finally chosen is not far from the Aube waste repository. The Prefect authorised the installation 26 June 2003. This installation classified for environmental protection purposes (ICPE), with a capacity of 650,000 m^3, has been operational since August 2003. In 2005, the installation received 15,000 m^3 of VLL waste. ANDRA plans to increase the monthly input of waste to 2000 m^3 in the coming years.

3 MANAGEMENT OF RADIOACTIVE WASTE BY THE PRODUCERS

3 | 1

Waste management in basic nuclear installations

Once produced and before final disposal, certain radioactive waste undergoes treatments to reduce its volume or harmfulness and, whenever possibly, to recover exploitable materials. These treatments can produce secondary waste. After processing, the waste is packaged and then, depending on its nature, placed in an interim storage facility or sent to a waste repository.

The following paragraphs present the situation in basic nuclear installations.

3 | 1 | 1

CEA waste management

The CEA operates treatment, packaging and interim storage facilities for the main types of waste it produces through its research and dismantling activities as well as through its industrial activities (manufacture of sources). In general, each CEA site has treatment and packaging installations for the waste and radioactive effluent it produces (see chapter 13). The solid wastes for which there are operational channels (reprocessing, elimination by incineration or melting, disposal in approved surface repositories) are removed accordingly (installations of the CEA, Centraco, repository, etc.). Long-lived intermediate and high level waste is generally stored by the CEA in installations with a lifespan limited to a few decades, pending creation of a disposal channel. Very low level waste, a significant volume of which is generated, particularly owing to dismantling of CEA former installations, are stored on site and then taken away to the VLL waste repository. Liquid waste is treated, solidified and packaged in drums. Depending on their activity, the resulting packages are either disposed of in the ANDRA's Aube waste repository (CS-FMA), or stored by the CEA, pending availability of a final disposal channel.

The CEA also possesses solid and liquid legacy waste for which there could be treatment problems (technical difficulties due to problems with bulk collection of effluents from their storage tanks and lack of constituent chemical product characterisation or for which there is no operational disposal channel. The ASN ensures that treatment of this waste is one of CEA's priorities within its waste management policy and that adequate surveillance is maintained on the storage facilities pending treatment.

Nuclear fuel without further use from the civil sectors of the CEA is placed in interim storage, either dry (in a decay pit) or in a pool, pending definition of a disposal channel (reprocessing or storage).

One of the challenges for the CEA in radioactive waste management will be to commission new treatment installations within a time-frame compatible with its commitments to shutting down the older installations, which no longer meet modern safety standards.

The CEA strategy was seriously compromised by the decisions taken in 2003 to abandon the new installation projects such as ECUME for interim storage of spent fuel and irradiating solid waste, and ATENA for treatment of contaminated sodium waste.

In 2005, the CEA also announced a modification of the AGATE project on the Cadarache site, entailing treatment of the concentrates produced in AGATE by the Marcoule effluent treatment station. The ASN will be particularly vigilant concerning shared effluent management by the Marcoule and Cadarache centres, as proposed by the CEA. The ASN contemplates having the CEA's waste and spent fuel management strategy reviewed again by the members of the Advisory Committee for waste.

Aware of the fact that the CEA's decisions to abandon these installation projects were made in a context of budget restrictions, the ASN nonetheless considers that efforts must continue to maintain the aim of removal of waste from interim storage and cessation of treatment activities in the older installations.

3 | 1 | 2

Management of COGEMA waste

The COGEMA spent fuel reprocessing plant at La Hague produces most of this company's radioactive waste. The waste produced at La Hague comprises on the one hand the waste resulting from reprocessing of spent fuel and on the other, the waste linked to operation of the installations.

The waste generated by the spent fuels includes:

– Fission products and minor actinides (high level):

After a decay period in stainless steel tanks, the fission product and minor actinide solutions resulting from spent fuel reprocessing are calcined then vitrified. The resulting molten glass, which contains the fission products and minor actinides, is poured into stainless steel containers. After the glass solidifies, the containers are transferred to an interim storage facility pending disposal or until they are sent to the customer.

This waste contains most of the radioactivity in the waste produced in France.

The annual volume of vitrified waste packages corresponding to reprocessing of EDF fuels, amounts to about 100 m^3.

– Long-lived intermediate level structural waste:

This chiefly consists of fuel metal cladding (called "hulls") and metal structures such as fuel assembly end-pieces. The packaging process consists in compacting the waste and placing it in a standard container. The final CSD-C package can also contain metal technological waste.

The authorisation for precommissioning of the hull compacting facility (ACC) and the unit for interim storage of CSD-C containers in E EV south-east was the subject of a ministerial authorisation in 2002.

Fuel assembly hulls, COGEMA La Hague ACC shop

2004 production on behalf of all COGEMA customers, amounted to 1050 CSD-Cs (or about 180 m^3), comprising both line production and recovery of legacy waste stored under water. This waste recovery process should continue in the coming years.

Waste linked to operation of the installations comprising:

– Waste from radioactive effluent treatment

The La Hague site operates two radioactive effluent treatment stations (STE 2 and STE 3). The effluents were treated in them by coprecipitation (still the case for the STE3, but in small quantities). The resulting sludge (STE 3) is evaporated, bitumen encapsulated and then poured into stainless steel drums in the most recent of these installations (STE 3). The drums are then stored on the site. Activity at these two installations has considerably lessened in recent years since most acid effluents are now evaporated in the various fuel reprocessing facilities and the concentrates are vitrified.

– Waste from organic effluent

COGEMA also operates an organic effluent storage installation (MDSA). The effluents stored there are subsequently treated using a mineralisation process by pyrolysis in the MDSB facility. This installation produces cemented packages suitable for surface disposal.

– Ion exchanger resins

The water in the fuel unloading and interim storage pools is continually purified by means of ion exchange resins. Once spent, these resins become process waste which must be treated. In September 2000, COGEMA was authorised to start operating the resin solidification facility (ACR), which uses a cementing process.

_ Technological waste not handled by the ACC

The technological waste is sorted, compacted and encapsulated or blocked in cement in the AD2 facility. The packages complying with ANDRA technical specifications for surface disposal are sent to the Aube repository. If this can not be the case, they are kept in interim storage pending a final disposal solution.

The volume of waste delivered in 2004 from the La Hague plant to the Aube LL-IL waste repository was about 1880 m^3, with a beta activity of about 60TBq (18% of the activity delivered to this centre in 2004) and an alpha activity of about 3TBq (38% of the activity delivered in 2004). The volume of waste from the La Hague plant delivered in 2004 to the VLL waste repository was 20 m^3.

Legacy waste is also present on the La Hague site. It is generally stored in tanks or in concrete compartments called silos.

Some of these storage areas do not meet currently required safety standards and waste will therefore have to be recovered from them, which could be very expensive.

A review of these interim storages was conducted in 1998 by the Advisory Committees for laboratories and plants and for waste.

Following this review, the ASN asked COGEMA to make provision for extra resources to package and retrieve the waste, as the initial times proposed by COGEMA were felt to be too long.

In 2003, the ASN asked COGEMA to send it a dossier concerning its management policy for the waste produced by the La Hague facility, including new elements and progress made in the recovery and dismantling programmes since the 1998 meeting of the Advisory committees. COGEMA submitted this dossier in 2004.

The Advisory Committee for laboratories and plants, accompanied by experts from the Advisory Committee for waste, met on this subject on 16 November 2005. The ASN in particular noted the following points following the group's review of the dossier:

On the whole, the present resources of the COGEMA La Hague facility would seem to be sufficient for reprocessing, packaging and storing the waste involved in all the programmes to be carried out in this facility in the coming years (fuel reprocessing, recovery and packaging of legacy waste and programme for final shutdown of UP2400).

However, the situation of the HAO silo and the 130 silo is unsatisfactory because, even though the safety level in these interim storage areas was felt to be inadequate, waste recovery operations have still not started.

Moreover, removal of the drums stored in building 119 needs to begin very soon, given the insufficient level of safety of this building.

With regard to the sludges from past operation of effluent treatment station no. 2 (STE2), the reference solution put forward by COGEMA for their treatment/packaging is bituminisation in STE3 using the existing installations.

A solution such as this would entail verification of the safety of the STE3 installations and setting up the specifications for the future packages.

3 | 1 | 3

EDF waste management

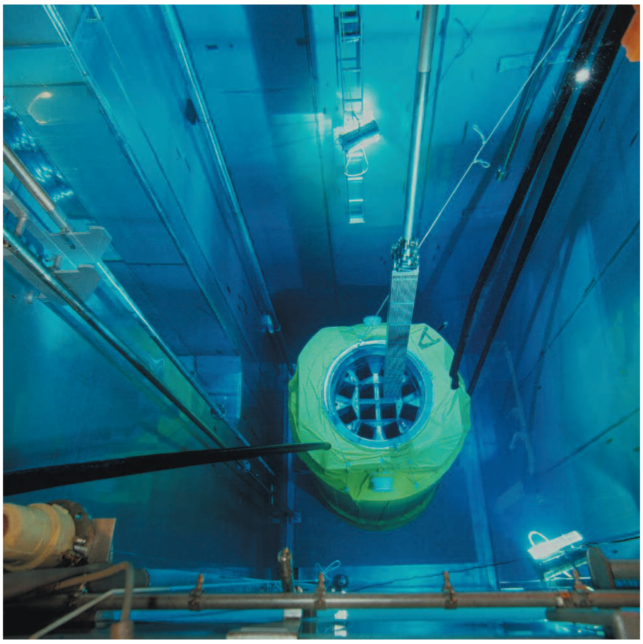
EDF waste comprises the following:

- ultimate waste from spent fuels after reprocessing in the COGEMA plant at La Hague and the share of fuels which are not to be reprocessed (high-level waste), activated waste, including rod control clusters and poison rod assemblies used for reactor control operations (long-lived intermediate level waste);
- waste resulting from plant operation and maintenance (low and intermediate level short-lived waste, and even some very low level waste);
- legacy waste, such as structural waste (graphite sleeves), waste from the former gas cooled reactor technology (GCR), which is long-lived low level waste;
- waste resulting from current dismantling of power plants (primarily very low level);
- the high-level and intermediate level long-lived waste from spent fuel after reprocessing in the COGEMA La Hague plant is described in point 3|1|2 above.

Activated waste, at present stored in pools, represents relatively small quantities and its long-term management is currently the subject of research by the CEA and ANDRA under the terms of the law of 30 December 1991 (articles L. 542-13 and L. 542-14 of the Environment Code).

Waste resulting from nuclear power plant operation and maintenance includes:

- waste from gaseous or liquid effluent treatment used to reduce the activity level prior to discharge. This includes ion exchange resins, water system filters, evaporator concentrates, liquid sludge, pre-filters, absolute filters and iodine traps;
- waste from maintenance operations. It may be solid (rags, paper, cardboard, vinyl sheets or bags, wooden or metal parts, rubble, gloves, protective clothing, etc.) or liquid (oils, decontamination effluents, etc.);
- special waste from exceptional replacement and maintenance operations (vessel heads, steam generators, fuel assembly storage racks, etc.).



Unloading of spent fuel, EDF Chinon

Some of the untreated waste produced is dealt with in the CENTRACO plant in Marcoule (metal melting or incineration of liquids, resins or other incinerable materials), in order to reduce the volume of ultimate waste.

For the other types of operating and maintenance waste, various packaging methods exist, in particular:
- solid waste compacting in the Aube LL-IL waste repository, followed by packaging in metal drums filled with a cement-based material;
- resin encapsulation in a polymer, inside a concrete container;
- filter encapsulation in a cement-based material, inside a concrete container.

This waste is stored in the Aube LL-IL waste repository and some particularly low level waste in the VLL waste centre.

Waste considered to be special owing to its dimensions and weight is also stored in the Aube LL-IL waste repository. This is in particular the case of the vessel heads (see point 6|1|2 below). All this operating and maintenance waste contains beta and gamma emitters and little or no alpha emitters.

It accounts for most of the beta activity delivered to the Aube LL-IL waste repository every year (in 2004, 258 TBq for beta emitters, or 77% of the delivered activity) and a very small amount of the alpha emitters (0.6%), with the total waste delivered amounting to 8520 m^3. Most of the activity is concentrated in the ion exchanger resins used to purify the water systems (pool water treatment system, primary water treatment systems, waste water treatment system) and in the primary coolant systems filters.

Waste from EDF past practices (graphite sleeves) is at present mainly stored at Saint-Laurent. The long-term management solution for this type of waste, as well as for the graphite stacks still in the shutdown GCR reactors, is covered in point 6|1|4 below.

Waste from plants currently being dismantled is mainly very low level waste.

In 2004, about 6870 m^3 of EDF VLL waste were delivered to the VLL waste repository.

The EDF fuel utilization policy, regarding both in-pile irradiation conditions and spent fuel management (see chapter 12), has repercussions on the fuel cycle installations (see chapter 14) and on the quantities and quality of the secondary waste produced. This subject was reviewed by the Advisory Committees for plants and for waste in late 2001 and early 2002.

In July 2002, the ASN asked EDF for additional information concerning the envisaged future management methods of the fuel and the consequences for the fuel buildings in the NPPs, the MELOX plants in Marcoule, FBFC in Romans-sur-Isère and COGEMA La Hague. In 2004 and 2005, the ASN asked EDF for additional data concerning the impact of the new “MOX parity” and “Galice” fuel management systems on the waste package specifications, on management of the waste and organic effluents produced in the various fuel cycle installations and on the “long-duration” dry interim storage project for MOX fuel. The answers are as yet incomplete and further details are required.

In 2002, the waste management policy developed by EDF, both centrally and in the NPPs, both for operating and legacy waste, was jointly reviewed by the Advisory Committees for reactors and for waste. On the basis of this review and the findings made during its own inspections in 2000 and 2001, the ASN asked EDF in December 2002 to improve the safety of the NPP buildings in which most waste management takes place, to start treatment and disposal of used steam generators, to look for channels for disposal of the activated waste stored in the pits, of chemical waste and of graphite waste. The ASN also asked EDF for clarification of its waste management organisation.

In 2004, EDF forwarded a clarification of its waste management organisation. EDF also carried out safety analyses on waste management in the nuclear auxiliary, packaging auxiliary and effluent treatment buildings. It transmitted the results to the ASN.

However, the ASN considers that the improvements required will have to be based on a better definition of the scope of operation for each site and on the measures envisaged by the fire action plan and needed to ensure conformity with the order of 31 December 1999. EDF was asked for additional data in 2005.

The following should be noted with respect to the other requests made by the ASN in 2002:
- EDF submitted a file for creation of a centralised interim storage facility for its activated waste;
- for the Saint-Laurent graphite sleeves, EDF must look for solutions to remedy the delay in the search for a graphite waste disposal site, given the current conditions of storage (see point 4|2 below).

3 | 1 | 4

Other licensees

The waste management by other BNI licensees is reviewed by the ASN on the basis of their waste surveys (see point 1|2).

3 | 2

Radioactive waste management in medical, industrial and research activities

3 | 2 | 1

Origin of waste and radioactive effluent

Many areas of human activity use radioactive sources; this is particularly the case with diagnostic and therapeutic activities. This activity may lead to the production of radioactive waste and effluent.

Sealed sources are mainly used for radiotherapy (telegammatherapy and brachytherapy) and for measurement. Given their characteristics (usually radionuclides with periods of several years and high activity levels) these sources must be recovered by their supplier once they are no longer needed, or by their manufacturer in the event of defaulting by the supplier. Decree 2002-460 of 4 April 2002 reinforced the sealed source recovery requirements previously adopted by the CIREA. These sealed sources are not likely to produce radioactive effluent in normal conditions of use and storage.

The use of unsealed sources in nuclear medicine, biomedical and industrial research is the reason for production of radioactive solid waste and liquid effluent: small laboratory equipment items used to prepare sources (tubes, gloves, etc.), medical equipment used for administration (syringes, needles, cotton swabs, compresses which could be soiled with biological products, etc.), remains of meals consumed by patients who had received diagnostic or therapeutic doses, and so on. The radioactive liquid effluents also come from source preparation (liquid radioactive residues, contaminated material rinsing water, scintillating products used to count certain radionuclides, and so on), as well as from the patients who naturally eliminate the radioactivity administered to them.

To the radioactive risk can be added the chemical and infectious risks, in particular in the biomedical field. The infectious risk is due to pathogens (viruses, bacteria, parasites) contained in certain waste and effluent produced by the health care activities. If this risk is to be controlled, then specific handling rules must be followed and appropriate packaging used, failing otherwise it nosocomial diseases (secondary infections contracted in the health care establishments) are possible.

Faced with this problem of health care waste contaminated by radionuclides, which appeared with the growth of nuclear medicine, the public authorities have initiated a process of supervision of the activities and information of both patients and practitioners concerning good practices to be observed in managing this waste. First, a circular from the Minister for Health (2007/323 of 9 July 2001) therefore clarified the provision of the 30 November 1981 order on the conditions for the use of artificial radionuclides used in unsealed sources for medical purposes. This circular established recommendations for management and disposal of hospital radioactive effluent. Since then, the Ministry for the Environment (DPPR) in 2003 sent the managers of landfills and incineration plants recommendations stating what to do if the alarms are triggered on the radioactivity detection gates now installed in all such installations. The Minister for Health issued a new article on 21 January 2004 instructing nuclear medicine practitioners to advise their patients returning home on how to properly dispose of any radioactive waste they may produce. After publication of this ministerial order, a working group was set up to harmonise practices and accompany the dissemination of these new measures.

3 | 2 | 2

Management and disposal of radioactive waste and effluent produced by biomedical research and nuclear medicine

The disposal of radioactive effluent and waste produced when handling radioactive sources must comply with the provisions of point 1.2 of this chapter, in particular circular 2001/323 of 9 July 2001.

An order concerning waste and effluent produced outside BNIs must be issued to implement article R 1333-12 of the Public Health Code. A working group coordinated by the ASN was set up in September 2004 to make a particularly close review of how the infectious and radioactive risk is dealt with in waste and effluent management, as well as of the regulatory requirements to be established. This working group comprises representatives from the health authorities (DGS, DDASS), from public health and research institutions (Paris public hospitals, Paris municipal hygiene laboratory, INSERM, etc.) and private pharmaceutical laboratories.

The working group reviewed the following:
– drafting and approval of the waste and effluent management plans;

- management using zoning or exemption thresholds;
- the possibility of discharging effluent contaminated with carbon 14 or tritium;
- installation discharge outlet monitoring conditions;
- study of impact of discharges;
- conditions requiring use of a radioactivity detection portal at site exits;
- consistency between requirements applicable to the infection risk and those applicable to the radioactive risk, in particular the conditions for storage and biocidal treatment of waste before it is sent for disposal (incineration).

The collection and management of the radioactive waste and effluent produced by biomedical research and nuclear medicine activities is based on 4 principles:
- the waste are sorted and packaged as soon as possible in the cycle in the producer units, so that separation can take account of the type of waste, the radionuclides it contains as well as their level of activity and half-life. Waste originating from use of radionuclides with a half-life of less than 100 days will be separated from the other waste;
- effluent and waste are stored following this preliminary sorting, for either local disposal (waste marked only by radionuclides with a half-life of less than 100 days), or collection by the ANDRA (presence of radionuclides with a half-life of more than 100 days);
- the radioactivity of the waste and effluent is systematically checked before disposal;
- the waste and effluent are disposed of using appropriate disposal channels. Waste originating from the use of radionuclides with a half-life of less than 100 days may be disposed of - after decay - in the household waste channel, provided that there is no chemical or infectious hazard. If there is, then waste resulting from medical care activities is sent to a specialised disposal channel. Aqueous liquid effluent containing radionuclides with a half-life of less than 100 days may, after decay, be sent to the public sewerage system.

a) With regard to solid waste, it must be collected from the units that produce it in specially reserved containers, designed to counter any radioactive, infectious and chemical hazard (dedicated packaging). This waste must then be routed to an area specially set aside for its storage, pending local disposal after radioactive decay, or collection by the ANDRA. This area must be specifically laid out to ensure secure access and containment of the radioactive materials.

After an interim storage period taking advantage of natural radioactive decay (as a general rule at least 10 half-lives of the radionuclides concerned), waste originating from medical activities can be disposed of in conventional or hospital waste channels, provided that the level of irradiation is low enough (about 1.5 to 2 times the background level) and there is adequate waste traceability. A gate type radiation detection system can be installed by the licensee to ensure compliance with the requirements mentioned above.

b) Handling of radioactive sources may also lead to the release of liquid effluents. There are 3 main types of releases monitored:
- waste from laboratories handling and preparing unsealed sources from mother solutions. Only aqueous effluent from handling of radionuclides with a half-life of less than 100 days can be discharged into the sewerage system. Marked non-aqueous effluent (scintillation liquid, etc.) must be collected and follow a dedicated disposal channel involving the ANDRA;
- sanitary facilities of protected rooms reserved for hospitalisation of patients who have received therapeutic doses of iodine 131 of up to 4000 MBq. These patients will eliminate in their urine 60 to 80% of the radioactive iodine administered to them;
- sanitary facilities of the nuclear medicine department used by patients who have received therapeutic or diagnostic doses. In this latter case, the levels administered do not exceed 740 MBq per application.

To these controlled releases can be added the diffuse radioactivity from the patients, whether hospitalised in the establishment (outside protected rooms), or out-patients.

The procedures for collection of these effluents are as follows:

- effluent from the laboratories is routed to a series of 2 buffer tanks operating alternately with one being filled and the other used for decay storage. This arrangement avoids direct radioactive effluent discharge into the main sewerage system. The capacity of these tanks must be determined such as to allow storage for a time long enough to obtain clean-up of the effluent compatible with its discharge into the main waste water network (see following table presenting maximum activity concentration values on leaving the tanks);
- liquid effluent from the sanitary facilities in protected rooms is also collected in a series of buffer tanks with the same characteristics as those described above and operating in the same conditions. However, given the high activity concentration of this effluent, these tanks must be separate from those collecting laboratory effluent;
- releases from the sanitary facilities reserved for injected patients must pass through a septic tank type decay pit, before being sent to the main sewerage system. Given the short half-life of the radionuclides contained in this effluent (primarily technetium 99m which has a half-life of 6 hours) passing through this tank contributes to their radioactive decay.

Maximum activity concentration values on leaving the tanks

Activity concentration check-points	Activity concentration value adopted	Observations
Diagnostic buffer tanks	7 Bq/l	Tanks for effluent originating primarily in the preparation and administration premises of diagnostic or therapeutic activities (< 740 MBq) using radionuclides.
Therapy buffer tanks	100 Bq/l	Tanks connected to the sanitary facilities for patients receiving therapy > 740 MBq of iodine 131.
Septic tank	–	Septic tank connected to the nuclear medicine department sanitary facilities reserved for patients who have received diagnostic or therapeutic doses (< 740 MBq). As the septic tank functions on a continuous basis, there are no activity concentration values for the effluent output.
Hospital outlet	1,000 Bq/l of ^{99m}Tc 100 Bq/l of ^{131}I	These are reference guide values for checks to be regularly performed (at least 4 times per year, over a minimum period of 8h) or continuously with a device on the outlet. If the values are exceeded, a more complete review over a longer period is required in order to determine an average activity concentration which, if higher than the guide values, will require that the establishment look at ways of improving its effluent release methods.

Buffer tanks

As with solid waste, the disposal of radioactive liquid effluent is only possible after a check on its residual radioactivity. This check is conducted after analysing a sample of effluent taken from the tank to be drained. The different activity concentration values to be used for drainage of the buffer tanks or at the establishment outlet are given above.

3 | 3

Management of technologically enhanced naturally occuring radiation (TENORM) waste

In the environment, there is already a measurable background radiation due to the presence of radioelements which have been or are still being produced by various physical processes. Their concentration does not in general lead to any major hazard, obviating the need to take particular precautions against the radioactivity hazard. In France, exposure to natural radioactivity varies from region to region but is about 1 mSv/year.

Definition of enhanced natural radioactivity: all materials naturally contain radionuclides. Some, such are rare earths, are particularly rich in uranium and thorium. Handling or transforming them can lead to expose the workers or the population. We then talk of enhanced natural exposure, insofar as the radionuclides are naturally present in the raw materials and are not used for their fissile, fusible or fertile properties, but the industrial activities then enhance exposure of the persons. The raw materials liable to lead to significant doses are commonly called NORM (Naturally-Occurring Radioactive Materials) or TENORM (Technologically Enhanced Naturally-Occurring Radioactive Materials) if the industrial process concentrates the radionuclides.

3 | 3 | 1

Uranium mining waste

Uranium mines handle large quantities of raw materials and thus generate large quantities of VLL waste with enhanced natural radioactivity. These are the uranium mine residues, of which 2 categories must be distinguished:
- low-content ore (about 300 to 600 ppm) treated by static leaching and from which the residues take the form of rocky blocks of varying dimensions with a total average specific activity of 44 Bq/g (about 4 Bq/g of radium 226). These residues are placed either in stockpiles, or in open-cast mines, or used as the first covering layer for disposal of dynamic treatment residues;
- medium content ore (about 1 ‰ to 1% in French mines) processed by dynamic leaching and from which the residues take the form of clayey sand with a total average specific activity of 312 Bq/g

(about 29 Bq/g of radium 226). These residues are either placed in old open cast mines, sometimes with an additional dyke, or in pools with a surrounding dyke, or behind a dyke damming a thalweg.

In France, the treatment residues represent 49 million tons (31 million tons of dynamic treatment residue and 18 million tons of static treatment residue) spread over 17 disposal sites, run as ICPE. The national inventory of uranium mining sites, produced as part of the MIMAUSA programme (Memory and Impact of Uranium Mines: Summary and Archive) run by the Ministry for Ecology and Sustainable Development, can be accessed on the www.irsn.fr website.

Thinking about the safety review of former mining sites and the disposal of mining treatment residues, their long-term surveillance and the consequences of inappropriate future use of the land concerned is ongoing.

Case of the Limousin region uranium mining sites:

To encourage dialogue and debate around the Limousin region's uranium mining sites, the Haute Vienne prefect decided in April 2005 to set up a local information committee (CLI). The process to appoint the chairman and members of this CLI is ongoing.

On 24 December 2004, the Regional Directorate for Industry, Research and the Environment (DRIRE) received Cogema's operating results, which although they meet all the requirements nonetheless need some additional work. The DRIRE therefore asked the licensee to have an external peer-review carried out. At the same time the Minister for Ecology and Sustainable Development, the Minister Delegate for Industry and the Minister for Solidarity, Health and the Family decided to set up a pluralistic expert group (GEP) to regularly monitor the third-party assessment and take part in its coordination (reviewing the rehabilitation of the various sites with a view to their future use and control of short and long term risks, site surveillance procedures, the possible use of materials outside mining sites, and so on). This GEP will consist of about ten French and foreign experts, who should be appointed in the first half of 2006. This GEP's mission will last a limited period of time and should end in early 2007.

3 | 3 | 2

Waste resulting from other activities

The Public Health Code requires that industrial activities which are likely to enhance natural ionising radiation must conduct "exposure supervision [of persons] and a dose estimation". The order of 25 May 2005, concerning professional activities using raw materials containing NORM and which are not used owing to their radioactive properties, lists the professional activities concerned by the provisions of this order and within the next 2 years will lead to a precise inventory of the industries concerned throughout France. However, it should take somewhat longer to complete the assessment required by the order of the doses received by workers exposed to this radiation, as well as the population.

These activities are likely to generate waste which has concentrated the natural radioactivity and may therefore trigger the radiation alarm at the entrance to technical landfills.

For some of these activities, and in particular those leading to mining treatment residues (mines operated for extraction of rare earths, phosphate ore treatment residues produced by the superphosphated fertiliser industry, etc), the same problem can occur as for uranium mine processing residues (see point 3|3|1) concerning the large quantities of waste produced, often managed on-site, and for which there is today no appropriate disposal channel.

Some of these installations are not currently active, however most of them are (or were) regulated by part 1 of book V of the Environment Code. The ASN is cooperating with the relevant classified installations inspection services and in particular is taking part in the working group dealing with the acceptability of enhanced natural radioactivity waste, for which the activity level and concentration could be neglected from the radiation protection standpoint in landfills. The ASN aims to ensure that this waste is sorted and packaged as far upstream as possible, so that it is always routed to the appropriate channel. It should be noted that given the absence of a long-lived low level waste repository, the only channel currently available for the most active waste is interim storage.

In 2004, the ASN asked the Robin des Bois association to conduct a study into the effects of natural occurring radioactivity enhanced by human activities, and the correspondingly polluted sites in France. From 2004 to about mid-2005, the Robin des Bois association therefore sent out about 2300 questionnaires (including reminder letters) to the companies or administrations concerned by TENORM (technologically enhanced naturally-occurring radioactive materials). Each activity sector concerned had a specific questionnaire. These areas involve phosphates, monazite, rare earths, ilmenite, zirconium (refractories, abrasives, sanding, ceramics, foundries), ferrous and non-ferrous metals, mineral and spring waters, drinking water, spas, wells, geothermal activities, oil and gas, coal (combustion ashes), wood (combustion ashes) and papermaking. Finally, a standard questionnaire was also sent out to companies managing class I and II landfills in order to define a typology of the events which triggered the access portal detectors in 2004. These questionnaires are part of the precautionary approach designed to identify the potential sources of exposure to ionising radiation of workers and the public and aimed at providing the public with better protection should they be exposed to significant radiation without being aware of it. The study report was submitted to the ASN at the end of August 2005. This extremely complete report is currently being analysed. It comprises a certain number of recommendations which could be incorporated into the PNGDR-MV.

4 INTERIM STORAGE OF RADIOACTIVE WASTE AND SPENT FUEL

4 | 1

Basic nuclear installations intended for interim storage of radioactive waste and spent fuel

4 | 1 | 1

Solid waste treatment stations

The waste treatment stations on the CEA sites at Saclay (BNI 72), Fontenay (BNI 74) and Grenoble (BNI 79) (see chapters 13 and 15) also provide interim storage capacity for fuel elements or high level waste in pits and/or fuel blocks. The waste is packaged in containers and stored in radioactive decay pits. For BNIs 74 and 79, the CEA is involved in a programme to recover this waste as part of the process to denuclearise the Grenoble and Fontenay-aux-Roses sites.

In BNI 72, fuel is also stored in concrete blocks and is currently being recovered for reconditioning in the STAR facility at Cadarache prior to interim storage in the CASCAD facility in Cadarache.

The radioactive waste storage yard

The main role of the radioactive waste storage yard (BNI 56) in Cadarache is to provide interim storage of radioactive solid waste (IL-LL waste) from the operation or dismantling of CEA installations and which cannot be stored in the CSA.

The waste is stored there in pits, in warehouses and for the VLL waste, in a dedicated area. The start of operations at CEDRA makes it possible on the one hand to empty the recent pits in BNI 56 and the hangars, and on the other to recover waste stored in the old pits (Fosséa project). The ASN will be vigilant concerning implementation of these storage removal programmes.

4 | 1 | 2

CEDRA

Decree 2004-1043 of 4 October 2004 authorised the CEA to create the CEDRA basic nuclear installation (packaging and storage of radioactive waste) on the Cadarache site. CEDRA Unit 1 should enter service in 2006, and will comprise an interim storage unit for low-level packages, an interim storage unit for intermediate level packages and a technical station, which will be delayed for a few years (interim storage unit). This installation will eventually replace some of the CEA's existing installations, in particular BNI 37 for waste treatment, and BNI 56 for interim storage of low and intermediate level packages.

4 | 1 | 3

PEGASE/CASCAD

PEGASE and CASCAD are two installations at CEA Cadarache making up BNI 22.

PEGASE mainly stores spent fuel elements and radioactive substances and materials, either under water or dry. Drums of plutonium-containing by-products are stored in the PEGASE premises pending recovery for treatment.

On the occasion of the PEGASE periodic safety review, the CEA made a commitment to final shutdown of PEGASE operations no later than 2015. The PEGASE periodic safety review in 2003 did not enable the ASN to reach a final decision on continued operation of PEGASE and additional studies into the installation's earthquake resistance and justification of reinforcement works are to be supplied.

Given the scale of the work needed, the CEA preferred in December 2004 to propose final shutdown of the installation, which should close in 2010. In 2005, the CEA transmitted the safety case for the recovery and repackaging of the drums containing plutonium-bearing residues. After repackaging, this waste will be stored in CEDRA.

Total removal of waste from storage in PEGASE over the next five years is felt to be a priority by the ASN, which will be particularly vigilant with regard to compliance with the time-frame announced by the CEA.

The CASCAD installation is dedicated to dry storage of spent fuel. The fuel is placed in containers before being stored in pits, where it is cooled by natural convection.

4 | 2

Legacy waste

4 | 2 | 1

Recovery of waste from trenches in the CEA BNI 56

The Cadarache interim storage area (see point 4|1) is equipped with trenches filled between 1969 and 1974 with low and intermediate level solid waste, before being covered with earth. At the time, this installation was an experimental storage installation for this type of waste. This waste was packaged in various ways (drums, vinyl bags, etc.). Operational recovery of this legacy waste began in 2005 and should progress at an estimated rate of one trench per year. There are a total of 5 trenches.

The trenches site will then be handled using the methodology employed for sites polluted by radioactive substances.

Waste recovery from pits

BNI 56 also contains old pits in which intermediate level waste is stored in conditions which no longer meet current safety requirements (some waste is not contained in packages appropriate for recovery in normal pit operating conditions and waste characterisation is inadequate or even non-existent). The CEA has initiated the FOSSEA project for recovery and repackaging of all the packages stored in the pits. Eventually, all the waste stored in the pits will be stored in CEDRA, after additional characterisation and repackaging as necessary.

Trench emptying worksite, BNI 56

4 | 2 | 2

The EDF Saint-Laurent silos (BNI 74)

The Saint-Laurent (BNI 74) silos consist of 2 semi-buried reinforced concrete bunkers. They are made tight by steel plating.

From 1971 to 1994, waste was stored in bulk in the silos. This waste was mainly graphite sleeves containing fuel elements from the nearby GCR reactors, plus technological waste.

There is only one containment barrier between the waste and the environment means. Therefore, this installation does not meet current safety criteria. The ASN asked EDF to empty the silos by 2010.

In 2005, EDF presented the ASN with the silo dismantling file for silo emptying operations. However, the solution proposed by EDF requires the availability of a final solution for graphite waste disposal as of 2010. It would however appear that such an installation could not be available before 2013, given the delay in the search for a host site.

Based on the assumption that the silos could not be operated beyond 2010 given their condition and the absence of any guarantee that the integrity of the silo steel plating barrier could be retained in the event of flooding, the ASN asked EDF to look at alternative strategies. The studies conducted by EDF indicate three possible options for which the ASN asked EDF to continue to review the technical feasibility:
- silo emptying deferred until graphite waste disposal facility becomes available, with silo operation beyond 2010, subject to improved surveillance of the installation and implementation of remedial measures;
- silo emptying and graphite disposal in the Aube repository (CSA);
- silo emptying and interim storage on the Saint-Laurent site in a dedicated installation, pending availability of a final disposal solution.

The ASN considers that it is up to EDF to find a satisfactory solution for the safety of its graphite waste.

4 | 3

Management of radioactive waste for which the producer is unknown or insolvent: a public service duty

Every year, radioactive objects for which there is no known owner are found, often when they trigger the radioactivity detection gates in waste disposal facilities and landfills. The objects concerned frequently contain small quantities of radium, a radioactive element commonly used in the early 20th century for its luminescent properties. Localised contamination of the sites following radioactive source handling incidents are also declared to the authorities. The waste management law of 15 July 1975 makes the producer responsible for the disposal of waste liable to harm public health or the environment. However, some of those in possession of radioactive objects or waste are not able to finance the relatively high cost of their disposal in a relevant channel. In such cases the owner of the waste is said to be defaulting.

4 | 3 | 1

Organisation of the public authorities and their various responsibilities

Jointly with the DGS, IPSN and OPRI, the DPPR drafted a circular dated 16 May 1997 on the management of sites contaminated by radioactive substances. The clean-up of these sites can lead to the production of radioactive waste. The DRIREs enforce the arrangements of this circular on behalf of the prefect.

Furthermore, the public authorities, more particularly the prefects, can ask the ANDRA, CEA or IRSN to take charge, at least temporarily, of radioactive waste. The conditions in which the prefects refer matters to these organisations must be specified in a draft circular prepared by the ASN, as regards radiological emergencies outside those about basic nuclear installations. Waste for which the owner defaults and for which responsibility is assumed by the State, will naturally be sent to ANDRA.

4 | 3 | 2

The types of waste concerned and special actions in progress

The waste concerned stems primarily from the widespread use at the beginning of the 20th century of radioactive products, such as radium for its luminescence or its medical applications (needles) and industrial properties (lightning conductors). This use may have led to contamination of land which is no longer used for industrial purposes.

The public authorities created several financing systems to help those in possession of this type of waste (private individuals in particular):

- the radium fund: this fund was set up in June 2001 and is used to provide up to half the cost of clean-up and recovery of waste from sites contaminated by past activities which used radium. The maximum value of the aid was revised at an interministerial meeting on 31 March 2005 and is capped at 75% for the entire clean-up process and 100% for making sites contaminated by radium safe;
- the agreement between the nuclear power sector producers and the ANDRA: this is implemented in order to secure a site contaminated by radioactive substances in accordance with the provisions of the circular of 16 May 1997 aforesaid.

These two measures cannot guarantee the medium-term financing needed to deal with waste for which the licensee is defaulting.

The radium fund was in fact set up for specific cases and can only be used when the contaminating radionuclide is radium. The agreement between ANDRA and the producers in the nuclear electricity generating sector also came to an end in May 2005. Discussions are under way to obtain another operational agreement between the producers in the nuclear electricity generating sector and ANDRA in 2006.

Under the terms of the 2005-2008 four-year services and resources contract which was signed on 1 August 2005 between the State and ANDRA, ANDRA's duties of general public interest will be financed by the Agency from its own resources, topped up as necessary by a subsidy from the Ministry of Industry's budget. The duties of general public interest benefiting from this subsidy are in particular certain activities relating to the collection of dispersed radioactive waste and depollution of contaminated sites entrusted to Andra by the authorities. By the end of 2005, Andra will submit appropriate management and financing arrangements to its supervisory ministries.

4|3|3

Public service storage facilities

The ANDRA does not operate storage facilities. It concludes agreements with other nuclear licensees so that they provide it with interim storage capacity.

The Socatri Company was thus authorised by decree to store low-level long-lived waste on behalf of the ANDRA in 2003. Radium lightning conductors are stored on behalf of the ANDRA in BNI 56 on the CEA's Cadarache installation. The CEA also stores used sources for which there are currently no disposal channels, in BNI 72 in Saclay.

ANDRA and the CEA signed an agreement in 2005 to clarify the conditions in which all the waste stored by the CEA is to be taken over by ANDRA (including radioactive sealed sources).

5 SITES POLLUTED BY RADIOACTIVE SUBSTANCES

5|1

The legal framework of action by the public authorities

5|1|1

Interministerial circular of 16 May 1997

According to this circular, a site polluted by radioactive substances is any site, either abandoned or in operation, on which natural or artificial radioactive substances have been or are employed or stored in conditions such that the site constitutes a hazard for health and the environment.

This circular, for the prefects, describes the administrative procedure applicable to sites polluted by radioactive substances and specifies that the treatment and rehabilitation operations are performed and financed directly by those responsible, as defined by the law of 19 July 1976 concerning installations classified for environmental protection purposes. In the absence of an identified or solvent person responsible, the ANDRA at the request of the ministries concerned, may oversee operations within the framework of procedures to finance rehabilitation of polluted sites defined in this circular. Non-renewal of the agreement covering polluted sites for which the owner has defaulted (see point 4|3|2) at the end of its period of validity, undermines the financing of operations under application of the circular of 16 May 1997. The Directorate for the Prevention of Pollution and Risks (DPPR) is currently looking at ways of updating this circular.

The methodology guide for management of industrial sites potentially contaminated by radioactive substances, which was published in October 2000 (version 0), describes the applicable approach for dealing with the various situations likely to be encountered in the rehabilitation of sites (potentially) contaminated by radioactive substances and explains the circular of 16 May 1997. This guide should be updated soon.

5 | 1 | 2

The law of 30 July 2003

Law 2003-699 of 30 July 2003 concerning industrial hazards updates the legislative framework for operation of an installation classified on environmental protection grounds and also applies to basic nuclear installations. It provides new tools for dealing with and preventing soil pollution and financing de-pollution. It therefore reinforces the regulations about site rehabilitation, including the obligation of information when selling land polluted by an industrial activity.

The 1 March 2005 circular concerning the inspection of classified installations - polluted sites and soils, as a result of the order by the European Court of Justice, referred to as the "Van de Valle" order of 7 September 2004, recalls that regardless of the action taken further to this order and whether or not materials are classified as waste, it appeared vital to preserve the principles of polluted soil management according to the use and the actual risk.

5 | 2

The inventories of polluted sites in France

Several complementary inventories are available to the public.

5 | 2 | 1

The ANDRA national inventory

Since 1993, the ANDRA has published a national inventory of radioactive waste giving information on the condition and location of radioactive waste around the country, including on sites identified as being polluted by radioactive substances. The November 2004 edition is available on the ANDRA website, www.andra.fr.

A new edition is planned for early 2006.

5 | 2 | 2

Databases of the Ministry for Ecology and Sustainable Development

The Ministry for Ecology and Sustainable Development set up a web portal dedicated to polluted or radiation contaminated sites and soils (www.sites-pollues.ecologie.gouv.fr). This portal gives access to two databases, according to the nature (chemical or radioactive) of the polluted site. They are:

• "BASOL" which is an inventory of the sites polluted or likely to be polluted and requiring preventive or remedial action on the part of the public authorities. In 2004, it contains about 3660 sites and is updated on a quarterly basis. A summary of the inventory is accessible on the Ministry for Ecology and Sustainable Development web site, www.ecologie.gouv.fr.

• "BASIAS" which is a record based on regional historical inventories of former industrial sites, a trace of which must be retained. Its purpose is to maintain inventoried site records in order to provide information of use for town planning, land transactions and environmental protection. This inventory should be completed for most departments by 2005/2006 and should contain between 200,000 and 300,000 sites. The information collected is input into a data base managed by the BRGM and available on the website, www.basias.brgm.fr.

5 | 3

Actions performed and dossiers in progress

5 | 3 | 1

General

The action diversity carried out by the ASN since 2002 as regards sites polluted by radioactive substances illustrates the great variety of situations encountered. The pollution can be due to former activities for which the industrial operator has disappeared (radium industry), "declining" economic activities (uranium mines, rare earths extraction sites) or new industrial activities. The health and environmental impacts also vary widely and the de-pollution targets to be defined depend on the future use (industrial, housing estate, school, park, etc.) chosen for the site concerned. After checking the de-pollution of the site and in order to preserve a history of the location, constraints must be put in place to confirm the possible uses and set utilisation restrictions as necessary.

5 | 3 | 2

Action taken

The "Radioactive contamination: how to deal with polluted sites? " symposium on 4 May 2004 in Paris.

On 4 May 2004, the ASN and the DPPR organised a symposium on the subject "Radioactive contamination: how to deal with polluted sites?", which brought together some 200 people and led to an exchange of views by the public authorities, industry, environmental protection associations and departmental and regional local government; it concerned general policy and the legal framework, hazard assessment, cleanup objectives and methodologies, real estate consequences, media coverage of both polluted site discovery and clean-up. It was an opportunity for presentation of a first inventory of radioactive polluted sites in France and how they are managed, with experience feedback on the management of radioactive polluted sites abroad, in order to compare the treatment of chemically polluted sites with those affected by radioactive pollution.

The collection of the papers submitted on this occasion constitutes an initial "white paper" on the management of polluted sites in France and abroad. The papers and proceedings of the symposium are available on the ASN web site. The ASN also devoted its magazine "Contrôle" issued on December 2004 to the follow-up on this 4 May symposium.

A 7-point plan of action for sites polluted by radioactive substances was drafted at the 4 May 2004 symposium (see above point). The action taken is listed below:

1. to consolidate and complete the inventory of potentially contaminated sites, the MIMAUSA mines inventory was distributed in April 2004, the Andra waste inventory in November 2004, and the TENORM inventory made progress following the study carried out by the Robin des Bois association and the order of 25 May 2005;

From left to right: former mining site of Bellezane (Haute-Vienne) before and after its redevelopment

Radioactive lightning conductor

2. to continue with action in progress concerning former uranium mining sites, by reviewing the safety aspect of the disposal sites, as necessary. The report by the radiation protection section of the CSHPF distributed in January 2005 gives an overview of the current situation of the uranium mining sites and presents various recommendations. The PNGDR-MV duly notes Cogema's commitments to the long-term future of its mining residue and a pluralistic expert group should be set up by the end of 2005 for the uranium mining sites in the Limousin region;

3. to increase prevention through measures requiring mandatory removal of radioactive objects (radioactive lightning conductors, radioactive smoke detectors). Technical studies into faster recovery of these objects will be reviewed by the PNGDR-MV;

4. to build channels for disposal of radioactive waste appropriate to clean-up of polluted sites: role of the National radioactive waste management plan;

5. to increase transparency by creating a dedicated web portal. A web portal dedicated to polluted or radiation contaminated sites and soils has been available since 2005 at the address www.sites-pollues.ecologie.gouv.fr;

6. to produce a method for determining action priorities for the authorities;

7. to review the applicable texts, in particular the 1997 circular, taking account of institutional changes, greater involvement by locally elected representatives, the financing mechanisms to be set up, and participation by the public as soon as possible in the process. The "methodological guide for management of industrial sites potentially contaminated by radioactive substances of October 2000 (version 0)" will have to be updated.

5 | 3 | 3

Some of the dossiers in progress

a) Coudraies area in Gif-sur-Yvette (Essonne)

Review of the files on the properties in the Coudraies area in Gif-sur-Yvette (91), which began in 2002, enabled the Essonne prefect to propose allocation of technical and financial aid for the simpler cases. Two clean-up projects were carried out in 2004. For the more complex cases, the committee in 2003 produced summary technical data sheets covering all the solutions reviewed, along with their technical and economic advantages and drawbacks, leaving it up to the ministries concerned to choose the most appropriate solution for each property, given the economic context. In 2005, the decision was made to purchase a property and make the site safe after purchase. Two dossiers are still to be dealt with.

The Essonne sub-prefecture for its part sent the Gif-sur-Yvette town hall a notification document in mid-2005 as part of the revision of the local urban development plan, which specifies the health requirements concerning the petite Coudraie district. This document was submitted to the ASN for its opinion.

Making safe the Isotopchim site in Ganagobie (Alpes-de Haute-Provence):

From 1987 to the end of 2000, the Isotopchim Company was involved in carbon 14 and tritium labelling of molecules intended for medical applications in Ganagobie (04). In 2000, the company went into liquidation, leaving a contaminated environment (incidental release of carbon 14 into the atmosphere and aqueous releases into the sewers) along with a large amount of chemical and radioactive waste on site.

Since the end of 2000, several inventories have been produced and an initial rehabilitation project reviewed. In December 2002, the ANDRA/producers programming committee for "orphan" sites, rejected funding of this project owing to the anticipated cost and the lack of any commitment from the local authority.

Since June 2003, the ASN has been associated with the search for solutions and various meetings have been held with all the stakeholders in order to make the site safe, look for appropriate disposal channels for removal of the priority waste present on the site and present this new rehabilitation project to the ANDRA/producers programming committee. A feasibility study was entrusted to ANDRA for depollution of the site. The security of the site was also improved in 2005.

b) DANNE property in Bandol (Var)

This property had been cleaned up in the past and the site is today a wasteland. The waste resulting from the decontamination operations carried out in 1992 is still on the site and residual hot spots still exist. The Var tax office is responsible for the site as administrator. In mid-2005, the decision was taken to make the site safe (brush clearance, removal of hot spots as required to allow easy maintenance of this plot, etc.). The site could be rehabilitated during a second phase, in particular through a redevelopment project.

5 | 3 | 4

Management of incidental contamination

The obligation of systematic installation of detection gantries in the industrial waste disposal or recycling centres has on several occasions in recent years revealed traces of radioactivity in the waste to be treated, leading to management of incidental radioactive contamination. Initial experience feedback from the incidents that have occurred since 2003 and which led to radioactive contamination in establishments which normally use no radioactivity (metal foundry) or in which radionuclides are not normally used in unsealed form, showed the need to be able to notify the establishment manager rapidly of his responsibilities and of the radioactive contamination hazards. The ASN drafted a memo in 2003 intended for rapid distribution to all managers of establishments in which unexpected radioactive contamination is detected.

A second memo should be sent out in 2006. It will specify the good practices to be implemented by the contractors responsible for the clean-up, decontamination and non-BNI dismantling operations.

This memo will guarantee:

- effective decontamination, consistent with clean-up policies used in installations using radionuclides in unsealed form;
- radioactive waste quality management, consistent with the existing waste disposal channels.

Situation in the Budin foundry in Aubervilliers (93) and the Métal Blanc lead treatment company in Bourg-Fidèle (08).

Following discovery of the radioactive content of the load on two lorries by the Métal Blanc company in Bourg-Fidèle (Ardennes *département*[1]), incidental uranium contamination had been revealed in the Budin works at Aubervilliers (Seine-St-Denis *département*) in 2003. Initial decontamination was carried out, but some parts of the installation retained traces of contamination. A second decontamination phase is awaiting financing.

The trailers containing radioactive substances immobilised for several months in the Métal Blanc company's car park were taken away in January 2005 after their content had been recovered. The radioactive waste resulting from these operations was managed in the authorised channels.

This type of incident raises the problem of monitoring the fate of radioactive objects contained in industrial or medical appliances which had received no specific radiation protection authorisation and which now have to be managed in authorised channels.

6 LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE BY DISPOSAL

6 | 1

Long-term management by surface or subsurface disposal of radioactive waste

Most short-lived (less than 30 years) intermediate and low level waste is sent for final disposal to the surface waste repositories owned by the ANDRA (National Agency for Radioactive Waste Management).

These repositories operate on a principle whereby waste is confined and sheltered from hazards, notably water circulation, during what is known as a surveillance period, fixed by convention to last 300 years, until such time as their activity level has become negligible. There are two such repositories in France.

Surface or subsurface storage projects are being defined for other types of low-level waste.

6 | 1 | 1

Manche waste repository

The Manche waste repository, with its 530,000 m³ capacity, was set up in 1969 at Digueville and operated until July 1994. The final covering (leaktight and grass-covered), to protect the structures containing the waste against all water infiltration, was completed in June 1997. The localised settling of this covering layer detected in September 1999 would not appear to have worsened significantly since. However, this aspect remains under close surveillance.

In September 1998 the ANDRA submitted a request, completed in 1999, for authorisation to enter the surveillance period, which takes account of the recommendations of the Turpin Commission tasked by the government in 1996 with issuing an opinion on the environmental impact of the repository. The safety documents submitted to the ASN to back up this request were formally approved by the ASN in January 1999.

At the request of the ASN, the ANDRA also submitted, in December 1997, a discharge licence application, revised in 1999.

1. Administrative division of the size of a county.

The ASN, jointly with the various ministerial departments concerned and taking into account the recommendations of the public inquiry committee, then prepared a draft authorisation to enter the surveillance period, amending the initial authorisation decree issued in 1969, together with a draft discharge licence. The regulations were published in the *Official Gazette* in January 2003.

As soon as the surveillance period decree was published, the ASN asked the ANDRA to begin to look at the future of the covering layer and the separation network designed to collect water that had penetrated the repository. The future of the covering layer should be the subject of a report into the benefits to be gained from installing a new and more durable cover, no later than 2009. In 2003, the ASN also authorised the ANDRA to modify the separation network so that it could be resized to take account of the throughput of effluent during the surveillance period. In 2004, ANDRA sent the ASN the surveillance phase safety report, which is currently being reviewed.

ANDRA – Manche waste repository

6 | 1 | 2

Aube waste repository

The low and intermediate level short-lived waste (LL-ILW-SL) repository

The low and intermediate level waste (LL-IL) repository, which until 2005 was known as the Aube repository, was created in 1989. It is located on the communes of Soulaines-Dhuys and La Ville-aux-Bois in the Aube *département*. It covers a surface area of about one hundred hectares.

Since 1992, this Centre has taken over from the Manche repository. Its design has benefited extensively from feedback relating to the construction and operation of the former plant.

ANDRA – Aube waste repository

The reduction at source in the volume of waste produced by nuclear licensees and the ramp-up of the CENTRACO facility means that the continued operation of this centre for several more decades can be envisaged.

The waste packages are stored in concrete structures connected to a drainage network for possible water infiltration (separate free-falling subsurface system), which is permanently monitored. The site capacity is 1,000,000 cubic metres of waste packages, entailing about 400 structures.

In addition to the disposal structures, the repository also has a waste packaging facility in which 2 types of operations are carried out: compacting of 200 litre drums in a 1000 ton press and grouting of the 5 or 10 m^3 metal drums containing waste.

In 2001, the ANDRA was authorised by the ASN to accept for storage 55 EDF reactor vessel heads which had been replaced. The construction of the structures designed to take the vessel heads began in 2003. The first vessel heads were stored in 2005. The LL-IL waste repository currently contains 9 vessel heads.

In December 1999, the ASN authorised the ANDRA to use the Aube waste repository to store sealed radioactive sources from the CEA, with a half-life of less than that of cobalt 60. In January 2002, the ANDRA submitted an application for generic acceptance of radioactive sources meeting certain criteria, justified by a safety analysis based on the principles of RFS III.2.e. In 2004, the ASN gave the ANDRA authorisation in principle, although this did require that additional information be forwarded, in particular with respect to the packaging of used sealed sources. This additional information was provided by ANDRA in 2005 and the ASN authorised disposal of certain sources (radioactive half-life of less than 30 years, compliance with activity limits per source and per package).

In June 2002, the ANDRA sent the ministers in charge of nuclear safety an application to modify the authorisation decree of the LL-IL waste repository and a discharge licence application for this repository, to bring it into conformity with the provisions of the Environment code and its implementing decrees. This dossier was completed in 2004, and then submitted to a public inquiry. The dossiers dealing with these applications were the subject of a public inquiry from 30 November 2004 to 8 January 2005. The regulations authorising ANDRA to discharge effluent should be published in the Official Gazette in early 2006.

6 | 1 | 3

Package acceptance rules

In May 1995, in Basic Safety Rule III.2.e, the ASN defined requirements for radioactive waste package acceptance in a surface repository.

Prior to package acceptance in a waste repository, the ANDRA, which is responsible for the long term safety of the repository, must implement an approval procedure. The file presented by the waste producer must comprise a description of the packaging process used, the technical characterisation documents, an assessment of the activity contained and the quality assurance programme. The characteristics of each package must be in compliance with the technical specifications drawn up by the ANDRA.

Within this process, the ASN carries out surveillance inspections to check that the ANDRA acceptance procedure complies with Basic Safety Rule III.2.e requirements and to ensure that the procedure is correctly implemented. Inspections also take place on the premises of the nuclear licensees to supervise the ANDRA's surveillance of waste producers considered to be ANDRA contractors, as provided for in the order of 10 August 1984.

In 1999, the ASN initiated a project to update the RFS III.2.e. This RFS project will be submitted to the Advisory Committee for waste after the Aube repository safety review by the Advisory Committee scheduled for June 2006.

6 | 1 | 4

Surface or subsurface disposal projects

Disposal of waste containing radium

Originating primarily from the radium and derivatives industries, active in the first half of the 20th century, or from certain chemical industries, waste containing radium is usually low level but very long-lived. The radioactive elements it contains, when they decay, also produce radon, a naturally radioactive gas which must not be allowed to build up.

The ANDRA is reviewing how to eliminate this waste. It is mainly working on a subsurface disposal concept (about fifteen metres below ground level).

For safety reasons, it is important to be able to dispose of this type of waste as soon as possible, as it is currently stored in unsatisfactory conditions. At the end of 2002, the ASN took a stand concerning the concepts proposed by the ANDRA. These concepts are felt to be acceptable but rely on theoretical geological models. The ASN considers that these studies can now only be taken a stage further within the framework of a study of a real site.

Disposal of irradiated graphite waste

The past operation of GCR plants (EDF Chinon, Bugey and Saint-Laurent-des-Eaux reactors and CEA G1, G2, and G3 reactors at Marcoule) and their current dismantling, produce waste containing graphite and significant quantities of long-lived radioelements. This waste consists mainly of graphite stacks and sleeves, activated by neutron irradiation.

Owing to their radiological content, notably regarding long-lived radionuclides, the ANDRA preferred to consider a subsurface repository design for this waste.

The ANDRA is studying the feasibility of locating on the same site two facilities of different design for graphite waste and waste containing radium respectively, with a view to reducing overall operating costs.

The search for a site announced at the 4 June 2004 meeting of the PNGDR-MV working group came to nothing, for a variety of reasons. The decision was taken to suspend this search during the debate on radioactive waste management and preparation of the bill on the management of HL-LL waste. The site search could therefore resume in 2007, so that a HL-LL waste repository could be available in 2012 - 2013.

Graphie assembly in graphite gas reactor

6 | 2

High-level long-lived waste disposal: application of the provisions of chapter II of part IV of the Environment Code as a result of law 91-1381 of 30 December 1991 concerning research into radioactive waste management

Articles L. 542-1 to L. 542-14 of the Environment Code set the broad outlines for research into radioactive waste management:

- high-level long-lived radioactive waste must be managed in such a way as to protect nature, the environment and human health, taking into consideration the rights of future generations;
- work is being conducted into:
- separation and transmutation of the long-lived radioactive elements in this waste,
- reversible or irreversible disposal in deep geological formations, the feasibility of which would notably be assessed by the construction of underground laboratories,
- processes permitting the packaging and long-term surface storage of this waste;
- before 30 December 2006, the government will submit a report to Parliament overviewing this research along with a draft law authorising as necessary creation of a long-lived high level radioactive waste repository, and setting the conditions for the constraints and restrictions relating to this repository.

Most of 2005 was devoted to preparation for this deadline.

Those involved in the research work, the CEA and ANDRA, prepared a set of dossiers summarising the fourteen years of research in their respective areas: areas 1 and 3 for the CEA, and area 2 for ANDRA. A preliminary version of these dossiers was submitted in June 2005 and the final version in December 2005.

The Parliamentary Office for the Assessment of Scientific and Technological Options (OPECST) organised a series of hearings at the beginning of 2005, to review the current state of research in the various areas. The 15 March 2005 report took a clear stance on key subjects.

The National Assessment Commission will in early 2006 submit a summary of the quality of the work done and the results obtained and will specify a number of recommendations for future areas of work.

Based in particular on a review of the above-mentioned dossiers, the ASN will be required to submit an opinion to the Government at the beginning of 2006, concerning the safety of the various management solutions for high-level, long-lived waste.

As foreseen by the OPECST, Parliament could therefore give its approval in principle for a geological disposal type solution, for which the authorisation process has yet to be defined.

The ASN would clearly have a major role to play in determining whether the repository project offered the vital safety guarantees, prior to its construction.

The debate organised from September 2005 to January 2006 by the National Public Debates Committee, convened by the ministers for Industry and the Environment, should be a means of obtaining the opinion of the public concerning the general topic of radioactive waste.

All these elements should therefore be in place by early 2006 so that Parliament can reach a decision on this subject in 2006, the deadline set by the law of 30 December 1991.

The lessons learned from reviewing the results of the research by the players concerned are presented in the following chapters.

6 | 2 | 1

Separation/transmutation

Separation/transmutation processes are aimed at isolating and transforming long-lived radionuclides in nuclear waste into short-lived radionuclides and stable elements.

Separation covers a number of processes, the purpose of which is to recover separately certain long-lived transuranians or fission products. These radionuclides, after repackaging, will be incinerated (by fission) to give short-lived nuclides, or transmuted (by capture) into stable atoms. Ongoing studies in this area are complementary to those performed by the ANDRA on a deep repository design insofar as they could lead to a reduction in the potential harmfulness of the waste placed in the repository.

Laboratory results have been obtained with separation of actinides (americium, neptunium, curium) and long-lived fission products (iodine 129, technetium 99, caesium 135). With regard to transmutation, simulations of various reactor populations were conducted, for transmutation of minor actinides: PWR, fast neutron reactors, 4th generation reactors which will be capable of producing energy by incinerating their own waste and that of the previous generation of reactors. The transmutation strategy requires access to a large nuclear installed base for long periods. The industrial feasibility of these projects still however has to be explored, in particular in the field of transmutation, in which considerable research will still be needed.

The ASN ensures that the experimentations involved in this research programme, performed notably in the Phénix and Atalante installations, are carried out under satisfactory safety conditions. With regard to Phénix, after major reactor renovation work and a final review by the Advisory Committee for reactors at the end of 2002, the ASN informed the CEA in January 2003 that it had no objections to resumption of operation, which took place in July 2003. At a later stage in this research, the implications of possible industrialisation of the separation and transmutation processes will have to be reviewed. Given the scale of the research still to be carried out, it can be assumed that no industrial application of these processes could be possible before about 2040.

6 | 2 | 2

Underground laboratories

Article L. 542-3 of the Environment Code requires that the possibility of reversible and irreversible disposal of radioactive waste in deep geological formations must be reviewed, in particular by building underground laboratories.

To date, only a single site (Bure, Meuse) has been designated for location of an underground laboratory and authorised by a decree in 1999.

On the basis of this review, the ANDRA received approval of the shaft sinking conditions on 7 August 2000 from the Ministers for Industry and the Environment. In December 2005 the two laboratory shafts reached the target depth of 490 m. In the main shaft, at a depth of 445 m, a 40-metre long experimentation niche was built and equipped starting in September 2004. It has been operational since December 2004. Since this niche was built, 40 boreholes have been made to obtain information on the mechanical behaviour of the rock and the composition of the fluids in the clay, plus an experiment on the diffusion of tracers. Sensors were also installed to monitor disturbances during excavation of the main shaft down to 490 m. The auxiliary shaft reached its nominal depth of 490m in October 2004 and in December 2005, more than 200 m of drifts had been excavated. A multi-experiment drift was equipped in October 2005 and the results of the KEY experiment into the feasibility of sealing the drift are currently being analysed. Construction of the laboratory, with the two shafts being joined up, should end in late 2006. The drilling of 5 diverted boreholes in 2003-2004 confirmed the homogeneity of the host rock.

On 24 August 2004, ministerial approval was given for construction of the experimentation niche after review of the dossiers concerning the summary of mechanical and hydraulic disturbances caused by construction of the shafts and the construction and experimentation programmes concerning this niche. Ministerial approval for construction of the laboratory drifts followed by their actual construction took place on 2 February 2005 after review of the corresponding application forwarded by the ANDRA.

Through inspections at ANDRA head office and on the Bure site, the ASN is ensuring that all quality assurance steps are being taken to make sure that the experiments carried out during excavation of the shafts and in the experimental drifts provide the hoped for results and that the steps have been taken to limit hydraulic and mechanical disturbances in the shaft environment.

The preliminary versions of the 2005 Clay and Granite Dossiers were sent to the ASN in June 2005. In the second half of 2005, these dossiers were reviewed by the IRSN and the Clay dossier was reviewed by the Advisory Committee for waste.

At the same time, a peer review of the 2005 Clay dossier was organised by OECD/NEA at the request of the ministers for the Environment and for Industry.

Bure laboratory – experimental drift at a depth of 445 metres

Bure laboratory – experimental arrangement for sealing test

As they currently stand, the results submitted by ANDRA concerning the feasibility of a repository on the Bure site, indicate that there is nothing to oppose the possible construction of a repository in the geological formation reviewed at Bure. Additional information will however be required as part of the new investigative phase after 2006.

With regard to revision of the regulatory texts, the ASN - in association with the IRSN and the ANDRA - set up a working group responsible for updating RFS III.2.f on deep geological disposal of radioactive waste. The aim is to update the specifications for deep geological disposal by 2006. This updating of Basic Safety Rule III.2.f should allow consideration of design advances obtained notably in the radiation protection field, the importance attached to the notion of reversibility, together with feedback from various modelling exercises carried out in France and abroad. This work benefits from the extensive exchanges between French and Belgian experts. Franco-Belgian collaboration in particular led to the production of a joint document on "Elements of the safety approach to deep geological storage of radioactive waste". This document was translated into English, sent out to eight European partners active in this field and debated at a seminar organised at the Paris head offices of the ASN on 5 November 2004 under the chairmanship of the ASN and the AFCN. The Franco-Belgian document was also presented to the Advisory Committee for waste on 9 November 2004 to clarify the context for updating of RFS III.2.f.

Future actions to harmonise geological disposal safety rules were discussed and a further meeting was held on 20 May 2005 in Brussels. During this meeting, the decision was taken to create a working group with responsibility for conducting a pilot study on the regulatory analysis of a safety case for a geological repository. The working group consists of representatives from 8 European safety agencies, a representative of EU-DG/TREN and a representative of the IAEA. Two meetings were held, the first in Brussels on 30 June 2005 and the second in Stockholm on 27 and 28 October 2005.

6 | 2 | 3

Long-term storage

The CEA sent the Government its report on the packaging and long-term storage of high-level, long-lived waste. The report describes the research work carried out and the results achieved. The aim of the research into long-term storage is to design a system able to offer long-duration containment of radioactivity (the CEA envisages interim storage periods of from 100 to 300 years), while ensuring that it is still possible to recover the packages and guaranteeing compatibility with possible subsequent disposal.

It would seem that long-term storage is an unavoidable stage prior to a final management solution. However, the interim storage installations must be maintained such that the integrity of the barriers confining the radioactivity in the waste packages is preserved.

6 | 2 | 4

Specifications and approval certificates for waste packages unsuitable for surface disposal

Since 1996, the ANDRA has initiated a system of specifications and approval certificates which should in 2005 result in package approval certificates indicating conformity with the preliminary design specifications of a deep geological repository.

The ANDRA, together with the waste producer, has chosen a step-by-step procedure whereby initially, and until 2001, the only specifications required are those related to knowledge. It also defined requirements concerning qualification of the process and control of production by all waste producers, so that supervision could be implemented and non-conforming packages identified. In 2003, most of the level 1 approval certificates (reply to initial requirements concerning packages for inclusion in the design specifications for deep geological disposal) were granted. The level 2 waste package performance specifications state the package properties which would currently appear to determine the sizing or impact assessment of any repository. These specifications were distributed in their entirety in 2004 and 2005.

Since 1998, the setting up of this procedure has been closely followed by the ASN, in particular through inspections at the ANDRA and on the premises of the waste producers.

Progress made on long-term interim storage work also involves the preparation of specifications indicating package conformity with the requirements of such installations. Interactions between the concepts of long-term storage and sub-surface storage, with regard to waste packaging, must be taken into account.

7 Outlook

The aim of the ASN is to ensure that radioactive waste is dealt with safely, unambiguously and exhaustively, regardless of its origin or the means of disposal. The ASN therefore prepared a National Radioactive Waste and Reusable Materials Management Plan (PNGDR-MV) with the assistance of a working group of waste producers and disposal facility managers, administrations, representatives of elected officials and of environmental protection associations. The draft plan was made available for consultation by the public on the ASN website, www.asn.gouv.fr.

With regard to management of high-level, long-lived radioactive waste, within the framework specified in the law of 30 December 1991, the parties involved in research met the deadline set by the law and submitted an initial version of their final report in June 2005. The national review board will in early 2006 submit a summary of the research done under the terms of the law of 30 December 1991 and the ASN will then submit a report on the safety and radiation protection of the various management solutions proposed.

At a parliamentary level, the Parliamentary Office for the Assessment of Scientific and Technological Options (OPECST) organised a series of hearings at the beginning of 2005 to review the current situation of the research carried out under the terms of the law of 30 December 1991 and formulated its recommendations and its stance in a report published on 15 March 2005 "For the long term: a 2006 law on the sustainable management of radioactive waste", in which the OPECST expressed clear and ambitious stances on key issues.

Finally, the public debate on the management options for high-level, long-lived radioactive waste, organised by the National Public Debates Commission from September 2005 to January 2006, at the request of the ministers for Industry and for the Environment, aimed to collect the opinion of the citizens on the general topic of radioactive waste.

On the basis of the information collected in this way, it is important for Parliament to be able to decide in 2006 on how to manage radioactive waste. So that the scope of the decision by Parliament is not limited to high-level, long-lived waste alone, the guidelines of the National Radioactive Waste and Reusable Materials Management Plan could, as recommended by the OPECST in its March 2005 report, be approved by the future bill. The PNGDR-MV would thus be recognised as a key element in radioactive waste management in France.