RADIOACTIVE WASTE AND POLLUTED SITES

CHAPTER 16

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

This chapter looks at how radioactive waste is managed for activities still in operation and how past or confirmed pollution (polluted sites) is managed in order to guarantee protection of the environment and the public.

Some installations intended for the disposal of radioactive waste intentionally concentrate the radioactivity in a single place, but their primary goal must nonetheless be to guarantee the protection of the public and the surrounding environment.

Radioactive waste is radioactive materials for which no subsequent use is planned or envisaged. It may stem from nuclear activities or may be produced by non-nuclear activities in which the radioactivity naturally contained in the materials, not used for their radioactive or fissile properties, may have been concentrated by the processes employed.

The management of radioactive waste is governed by the 28 June 2006 Act on the sustainable management of radioactive materials and waste. This Act defines a roadmap for management of all radioactive waste, in particular by requiring the updating every 3 years of a French National Radioactive Materials and Waste Management Plan (PNGMDR). The purpose of the PNGMDR is to produce an inventory of the existing management methods for radioactive materials and waste, to identify the foreseeable needs for storage or disposal facilities, to clarify the necessary capacity of these installations, the length of the storage periods and, for the radioactive waste for which there is as yet no final management solution, the PNGMDR defines the objectives to be met. Decree 2008-357 of 16 April 2008, implementing the 28 June 2006 Act, clarifies the requirements concerning the PNGMDR.

Clean-out of polluted sites consists in rehabilitating those sites on which a nuclear activity took place and which may potentially have led to contamination of the environment or on which radiological pollution has been observed due either to handling of radioactive materials (possibly some time in the past), or the utilisation of naturally occurring radioactive materials (NORM), albeit with no intention to exploit their radioactive properties.

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.

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

The basic principle laid out in the regulations in force is to optimise the quantity and nature of the waste produced by the installations. Radioactive waste management begins with the design of installations using radioactive materials, 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, 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.

Within the framework of the PNGMDR, the following are considered to be radioactive waste:

– waste from nuclear activities (activities regulated owing to the radioactivity they involve), which have been or are liable to have been contaminated by radioactivity or activated by the nuclear activity;

– waste from activities employing radioactivity, but which are exempted by the regulations, comprising significant concentrations of radioactivity, or which exist in very large quantities and require specific measures (the case of smoke detectors, for example);
– waste containing NORM, possibly enhanced by a human activity (TENORM) although not necessarily using the radioactive properties of the materials, and in which the radioactivity concentration is such that it cannot be ignored in radiation protection terms;
– uranium ore processing residues disposed of in classified installations.

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 risks.

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 radionuclides 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 radionuclides (activity level halved in more than 30 years).

Table 1 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.

Very short-lived waste

Medical uses of radioactivity, whether for diagnostic or therapeutic purposes, generally involve very short-lived radionuclides (their radioactivity is halved in less than a few days). The waste generated by these diagnostic or therapeutic activities is collected and stored for a time allowing the radioactivity to decay by a factor of 1000 after waiting for about ten half-lives. This waste is then disposed of in the conventional hospital waste disposal channels.

Very low level waste

Apart from the waste originating from former operation of uranium mines in France, most very low level waste today comes from nuclear installation decommissioning, from conventional industrial or research sites which use low level radioactive materials, or from clean-out of sites polluted by radioactive materials. The quantity produced will grow considerably when the time comes for the large-scale complete decommissioning of the power reactors and plants currently in operation. The 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. The activity of this waste is between a few hundred Bq per gram to one million Bq per gram. 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. 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

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

Activity \ Period	Very short-lived	Short-lived	Long-lived
Very low level	Management by radioactive decay	Dedicated surface disposal Recycling channels	
Low level		Surface disposal (Aube repository)	Dedicated subsurface disposal under study
Intermediate level		except tritiated waste and certain sealed sources	Channels being examined under Article 3 of the Act of 28 June 2006
High level		Channels being examined under Article 3 of the Act of 28 June 2006	

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. This disposal channel has been operational since 1969, when France was the first country to decide 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.

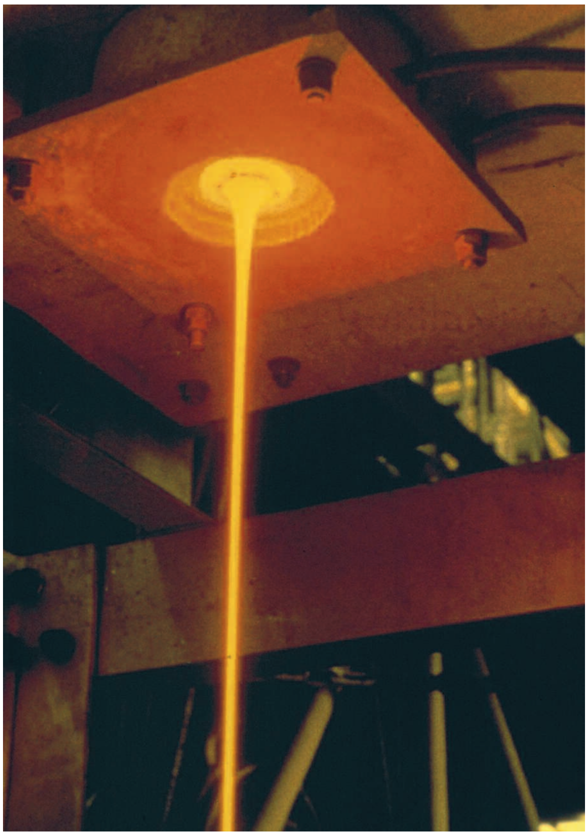
Short-lived intermediate and low level waste includes certain categories which have characteristics making them currently unsuitable for acceptance at the Aube repository in Soulaines, without additional authorisation from ASN.

Most sealed sources fall into this category: a specific characteristic of these sources is that the radioactivity they contain is often highly concentrated. 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 fate of used sources is dealt with in Article 4 of the act of 28 June 2006 which provides for "finalisation by 2008 of processes allowing the disposal of spent sealed sources at existing or to-be-built centres". 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 (GCRs). The activity level of graphite waste is between ten thousand and one hundred thousand Bq per gram, primarily long-lived beta-emitter radionuclides. Radium-containing waste mainly consists of long-lived alpha-emitter radionuclides with an activity of from a few tens of Bq per gram to several thousand Bq per gram.

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 level of intrinsic hazardousness could lead to subsurface disposal being envisaged at a depth of at least fifteen metres.



Vitrification of a solution of fission and activation products at La Hague (Manche *département*)

Long-lived intermediate level and high 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, effluents treatment sludge) and in-service maintenance waste from spent fuel reprocessing facilities and research centres, or certain activated waste from the decommissioning of nuclear installations. The activity of this waste is about one million to one billion Bq per gram.

The high level waste generally originates from fission and activation products deriving from spent fuel processing. This waste, which is vitrified, 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 (French Atomic Energy Agency) research reactors, together with EDF spent fuel which is not to be reprocessed. The activity level of this waste is of several thousand Bq per gram.

For the time being, this waste is being stored in the nuclear installations. Research is being carried out into disposal in accordance with Article 3 of the act of 28 June 2006 (see point 3|4).

1 | 2 The legal and regulatory requirements for radioactive waste management

Radioactive waste management falls within the general framework defined by Act 75-633 of 15 July 1975 codified in chapter I of part IV of the Environment Code and its implementation decrees, concerning waste disposal and recovery of materials. The basic principles of this act 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. In 1991, it was supplemented by the Bataille Act, which set a framework for research into long-lived high level waste and conferred the status of independent establishment on ANDRA, which was in charge of research into geological disposal.

The 28 June 2006 Act sets the legal requirements for management of all radioactive waste and materials. It provides for the drafting of a National Plan for management of radioactive materials and waste, to be updated every 3 years. The act also sets the new schedule for research into long-lived high level and intermediate level waste. It recalls the ban on final disposal on French soil of foreign waste, by providing for the adoption of rules specifying the conditions for return of waste resulting from reprocessing in France of spent fuel or waste from abroad. The 28 June 2006 Act reinforces ANDRA's duties, in particular the public service duty to rehabilitate sites contaminated by radioactive materials and to collect waste for which the party responsible has defaulted. Finally, the 28 June 2006 Act sets clear legal requirements for securing the funds necessary for decommissioning and for the management of radioactive waste (see chapter 15).

Production of radioactive waste in basic nuclear installations

Management of radioactive waste from basic nuclear installations is structured within strict regulatory requirements, 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 recalls the need for the licensee to take all necessary steps in the design and operation of its installations in order to guarantee optimum management of the waste produced, in particular taking account of subsequent management routes. It 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 to ASN for approval.

As part of the renovation of the BNI regulations following on from the Nuclear Transparency and Security Act, known as the "TSN" Act of 13 June 2006, this order will soon be revised and the requirements concerning waste management in BNIs will be grouped within a new order. An ASN decision will supplement the requirements concerning the management of waste produced in basic nuclear installations.

Production of radioactive waste in other activities using radioactive materials

The provisions mentioned in the decree of 4 April 2002 concerning the general protection of persons against ionising radiations have been incorporated into the Public Health Code. Article R. 1333-12 of this Code states that the management of effluents and waste contaminated by radioactive materials originating from all nuclear activities related to medicine, human biology, or biomedical research and entailing a risk of exposure to ionising radiations must be examined and approved by the public authorities. The ASN decision of 29 January 2008, approved by the ministers responsible for the environment and health, implementing the provisions of Article R. 1333-12 of the Public Health Code, sets the technical rules applicable to the disposal of effluents and waste contaminated by radionuclides, or liable to have been contaminated owing to a nuclear activity.

Waste management channel regulation

Regulation 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.

The systems for traceability of waste, whether or not radioactive (registers, periodic notification to the administration and waste monitoring statements) are defined by decree 2005-635 of 30 May 2005 concerning regulation of the waste treatment circuits. The order of 30 October 2006, implementing the above decree, more specifically targets radioactive waste.

To avoid radioactive waste being introduced into waste treatment or disposal facilities that are not duly authorised, the steps taken by the authorities have led to the installation of radioactivity detection systems at site entrances (landfills, foundries, incinerators, etc.). These systems constitute an extra line of defence in the regulation of radioactive waste management channels.

1 | 3 Very low level radioactive waste management principles

Some European countries have adopted a policy of exempting VLL waste on the basis of an activity threshold, an option that is allowed by European Council radiation-protection Directive 96/29/Euratom 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 amended order of 31 December 1999. Pursuant to said order, each licensee of a basic nuclear installation must therefore send ASN a "waste study" which presents the risk of contaminated, activated, or non-radioactive waste being produced in the installation. This installation "zoning", subject to ASN approval, thus enables a distinction to be made between two types of zones. 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). ASN has published a guide, revised in September 2002, for the production of BNI waste studies. It is available from the ASN website.

ASN has at present no plans to propose a draft order to the Minister for Health allowing reuse of contaminated or potentially contaminated waste in consumer goods or construction materials. Waste from nuclear waste zones may only be reused in a nuclear installation.

1 | 4 European regulations harmonisation work within 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 decommissioning operations.

The reference levels for the interim storage of radioactive waste and spent fuel and for the decommissioning of nuclear installations were published on the websites of the WENRA member authorities at the beginning of 2006, in order to collect the opinions of the stakeholders before they are enshrined in national regulations by 2010. The comments received led the WGWD working group to revise these levels in order to deal only with the aspects more specific to the topic considered (interim storage and decommissioning) ensuring that a graduated approach was used in relation to the reference levels drafted by WENRA for reactors.

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 decommissioning operations require that the nuclear licensees produce decommissioning strategies for their sites, draft decommissioning plans, that the more important decommissioning phases be submitted to the safety authority and that decommissioning be designed into the nuclear installation in order to facilitate all the operations as and 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 decommissioning of nuclear installations will have to be updated. The new regulatory texts currently being prepared already include the WENRA reference levels whenever possible. 2008 was devoted to reviewing the incorporation of these reference levels into the regulations of the WENRA member authority States, with a view to ensuring the applicability of the recommended requirements and a common reading of this reference level by the member safety authorities of WENRA. This exercise initially concerned the reference systems relating to the storage of radioactive waste and spent fuels and will in 2009 be extended to the reference systems for BNI decommissioning.

1 | 5 Stakeholders and responsibilities

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. Each producer is responsible for the waste until disposal in a duly authorised installation. However, various stakeholders are also involved in the waste processing, transport, storage or disposal process. Each party along the waste management chain is responsible for the safety of its installations and activities. This concerns:

– companies responsible for transporting waste between production and processing or storage sites (AREVA NC Logistics, BNFL SA, etc.);
– waste processing contractors (SOCODEI, AREVA NC) who sort and package the waste (for example by compacting and then vitrification) in order to make disposal or storage conditions safer. They can also use a variety of methods for recycling certain radioactive materials or eliminating certain waste (in particular by incineration);
– managers of the storage or disposal centres (CEA, EDF, AREVA NC, ANDRA). The Act gave ANDRA a duty of long-term management of the disposal centres. 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);
– research and development organisations such as CEA or ANDRA, which also take part in technical optimisation of radioactive waste management, with regard to both waste production and the development of packaged waste processing, packaging and characterisation. Efficient coordination of the research programme is necessary to ensure overall safety optimisation in this area.

In this context, ASN drafts regulations governing radioactive waste management, regulates 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, AREVA NC, CEA, hospitals, research centres, etc.) and of ANDRA. It regulates ANDRA's overall organisational provisions for acceptance of waste from the producers. It issues opinions on the waste policy and management practices of the radioactive waste producers.

ASN has three main concerns:
– safety at each stage in radioactive waste management (production, treatment, packaging, interim storage, transport 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 | 6 ANDRA national inventory waste and reusable materials

In January 2006, ANDRA published the latest version of 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. 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 2009.

The following tables present some data extracted from the national inventory published in 2006. The largest volumes (92% of the total volume) 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, or less than 2% of the total volume and less than 96% of the total activity.

1 | 7 The national plan for the management of radioactive materials and waste (PNGMDR)

The preceding paragraphs show the various technical and regulatory aspects of radioactive waste management: categories (according to the disposal method), inventory, regulation at source, and role of the various stakeholders. These elements were gradually implemented over the years, as and when inadequacies in various areas were highlighted. The need for an overall framework became apparent because, for all the radioactive waste and regardless of the producer, this would guarantee safe and coherent management and financing, in particular with definition of priorities.

In response to a request from the Parliamentary Office for the Evaluation of Scientific and Technological Choices in 2000, ASN 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 working group meetings. An initial draft of the national radioactive waste and reusable materials management plan was published on ASN's website for consultation purposes on 13 July 2005, and will be available until the end of 2005. In its opinion to the Government dated 1 February 2006, ASN had recommended adoption of the principle of such a plan as part of the draft act required by the Bataille Act in 1991, and formulated a certain number of concrete recommendations for certain waste categories.

The act of 28 June 2006 requires that the Government draw up a National Plan for the Management of Radioactive Materials and Waste every 3 years. The provisions of the plan are specified by a decree. The first edition of the PNGMDR was produced at the beginning of 2007 and transmitted to the Parliamentary Office for the Evaluation of Scientific and Technological Choices, for its opinion.

The OPECST published its evaluation report on the National Plan for the Management of Radioactive Materials and Waste in April 2007, and made a number of recommendations, some of which were implemented in 2008. In particular, a summary of the PNGMDR was produced and sent out to the Local Information Committees, to the High Committee for Transparency and Information on Nuclear Security, to the administrations concerned, to the licensees and to all members of the working group responsible for monitoring implementation of the PNGMDR.

Decree 2008-357 of 16 April 2008 was also published and set out requirements concerning the National Radioactive Materials and Waste Management Plan. The decree specifies the precise management models for the various waste categories: from very low level and very short-lived waste (less than 100 days) to intermediate or high level, long-lived waste (more than 31 years). The management solutions developed for the various waste categories, in particular listing the waste processing, storage or disposal installations, are described in it.

ASN is therefore responsible for determining the conditions in which very short-lived radioactive waste is managed, in order to ensure that its activity has decayed enough for it to be dealt with in channels not specifically authorised for radioactive waste. ASN will also be consulted by the ministers for its opinion on the various analyses and additional studies entrusted to AREVA NC, ANDRA and CEA. Finally, in accordance with the "Waste Act", ASN will by 30 June 2009 produce a summary of the management solutions used for TENORM waste and will submit a proposal to the ministers responsible for health and the environment concerning all regulatory measures designed to improve the radiation protection aspects of management of this category of waste.

In 2008, the pluralistic working group responsible for drafting the PNGMDR, chaired by ASN, met four times and in particular examined the following subjects: the planned long-lived low level waste repository, tritiated waste, former waste storage facilities, the waste stored by Comhurex in Malvési and the waste stored by Rhodia in La Rochelle.

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

Waste categories	Existing volumes in 2004 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	144,498	300,279	581,144
Low and intermediate level short-lived	793,726	928,989	1,193,001
Low level – Long-lived	47,124	48,432	104,997
Intermediate level – Long-lived	45,518	49,464	54,884
High level	1,851	2,511	3,611

Types of fuels	Existing quantity in 2004 (t)	Existing quantity in 2010 (t)	Existing quantity in 2020 (t)
EDF uranium oxide spend fuel waiting for processing	10,700	11,250	10,850
PWR reactor MOX fuels	700	1,300	2,350

(source: National Inventory of Radioactive Waste and Reusable Materials – ANDRA 2006)

2 MANAGEMENT OF RADIOACTIVE WASTE BY THE PRODUCERS

2 | 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 possible, 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.

ASN asks that in the design of new installations, the licensees meet an objective to reduce the quantity of waste produced.

The following sections examine the situation of the basic nuclear installations.

2 | 1 | 1 CEA waste management

CEA's waste management strategy

CEA has treatment, packaging and interim storage facilities for most of the waste its activities produce. In general, each CEA site has treatment and packaging installations for the waste and radioactive effluents it produces (see chapter 14). The solid wastes for which there are operational channels (reprocessing, elimination by incineration or melting, disposal in approved surface repositories) are removed accordingly (CEA installations, Centraco, repository, etc.). Long-lived intermediate and high level waste is generally stored by CEA in installations with a lifespan limited to a few decades, pending creation of a long-term disposal channel. Very low level waste, a significant volume of which is generated by CEA, particularly owing to decommissioning of its former installations, is stored on site and then taken away to the Morvilliers VLL waste repository. Liquid waste is treated, solidified and packaged in drums. Depending on their activity, the resulting packages are either disposed of in ANDRA's Aube waste repository, or stored by CEA pending final disposal.

CEA also possesses legacy solid and liquid waste for which there can be certain treatment difficulties, or for which there is no operational disposal channel. Nuclear fuel without further use from the civil sectors of 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).

The two main issues for CEA with regard to radioactive waste management are:

- bringing new processing installations on-line within a time-frame compatible with its commitments to cessation of activities in old installations, in which safety no longer complies with modern requirements;
- running projects for removal of certain legacy waste from storage.

As in previous years, ASN observes that CEA is experiencing persistent difficulties with managing these two issues.

For 2008, ASN observes that certain projects continued to make regular progress in line with the commitments (STELLA, PEGASE, AGATE). However, CEA continues to encounter problems with recovering waste from the trench in Cadarache BNI 56, and in evacuating organic liquid waste from the Cadarache effluents and waste treatment station (BNI 37).

Management of CEA civil waste and spent fuels was examined in 1999 on the occasion of a meeting of the Advisory Committees for plants and waste. In the light of recent developments, both in terms of organisation (decommissioning of the UP1 plant in Marcoule and abandonment of certain projects), ASN wishes to examine all CEA activities linked to its BNI and secret BNI waste and to spent fuels. Together with the Delegate for Nuclear Safety and Radiation Protection for National Defence Installations and Activities (DSND), ASN asked CEA to forward a file concerning its management strategy for 2010. ASN and the DSND would then be able to adopt a joint stance on management of CEA waste and spent fuel following examination of the file by the Advisory Committees of experts concerned, by the year 2011.

Storage of CEA waste

The waste treatment stations on the CEA sites at Saclay (BNI 72), Fontenay-aux-Roses (BNI 73) and Grenoble (BNI 79) (see chapters 14 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 73 and 79, CEA is involved in a programme to recover this waste as part of the process to delicense the Grenoble and Fontenay-aux-Roses sites. In BNI 72, fuel is stored in concreted fuel blocks. Recovery of this fuel is currently being reviewed, for subsequent reconditioning in the START installation in Cadarache and then interim storage in the CASCAD installation, also in Cadarache.

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 decommissioning 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 (radioactive waste packaging and storage) makes it possible on the one hand to empty the recent pits in BNI 56 and the warehouses, and on the other to recover waste stored in the old pits (FOSSEA project).

BNIs 37 and 56 will eventually be replaced by the CEDRA installation, for which creation on the Cadarache site was authorised by decree 2004-1043 of 4 October 2004. On 20 April 2006, the Ministers for Industry and the Environment authorised start-up of CEDRA unit 1.

CEDRA unit 1 will in particular be used to store:
– waste packages resulting from recovery of packages currently stored in the BNI 56 warehouses and pits, in order to improve their storage conditions;
– packages arising from routine BNI 37 production.

With regard to unit 2 (intermediate building) CEA decided on a change of direction for the project. The "PbSO4 hull" type waste containing radium, will be repackaged in order to limit the release of radon gas. The results of the studies into unit 2 configuration and repackaging of the hulls containing radium are expected in early 2009. CEA plans commissioning units 2 and 3 in 2014.

At Cadarache, CEA also operates the PEGASE and CASCAD installations, 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.

Given the scale of the work needed to continue with operation of PEGASE, CEA in December 2004 proposed final shutdown of the installation, which should close in 2010.

Removal from storage began in January 2006 with OSIRIS type fuel being sent to the CARES store (INBS). Removal of the OSIRIS silicide elements from storage for transfer to La Hague then began. All the OSIRIS fuels have now been evacuated. The remaining fuels are currently the subject of requests to ASN for repackaging and then evacuation, particularly to CASCAD.

2006 also saw the creation of a project for recovery of the plutonium-containing drums for storage in CEDRA. On 28 January 2008, CEA notified ASN of installation of the recovery equipment. The file is currently being reviewed. This project, which is running according to schedule, should enable CEA to meet its commitment to remove the plutonium-bearing drums from the PEGASE installation no later than the end of 2010 (action considered to be a priority by ASN).

The CASCAD installation is dedicated to dry storage of spent fuel. The fuel is placed in containers before being stored in sealed pits located in a concrete structure and cooled by natural air convection. In 2008, CEA launched a periodic safety review of the CASCAD installation.

In November 2007, CEA sent a safety option file to ASN concerning a new irradiating waste storage project for Marcoule, called DIADEM (a French acronym for decommissioning irradiating or alpha waste). ASN issued its position on this file on 1 July 2008, stating that it had no objection to continuation of the process leading to

Metal drums containing low level waste stored at CEA in Saclay (Essonne *département*) creation of the installation, provided that a certain amount of additional work was carried out.

Recovery of CEA legacy waste

The Cadarache interim storage facility partly consists of 5 trenches which, between 1969 and 1974, were filled with a variety of low and intermediate level solid waste, then covered with earth. The facility was at the time an experimental waste disposal facility.

Recovery of the waste from the trenches, which started in 2005 as part of the installation clean-out process, was suspended in September 2006 for safety reasons.

After consolidation of the walls, CEA intends to finish waste recovery from trench T2. For the other trenches, a new process will be used.

In its old pits, BNI 56 also stores intermediate level waste in conditions which no longer meet current safety standards. The FOSSEA project provides for the recovery and repackaging of all packages stored in the pits, for interim storage in CEDRA, after additional characterisation and repackaging when necessary. After deciding to halt the recovery project started in 2004, CEA examined a new recovery and processing scenario for this waste. A new file concerning pit F3 was submitted to ASN in 2007. ASN returned a favourable opinion on this new recovery scenario in July 2008, although with a number of reservations.

2 | 1 | 2 AREVA NC waste management

Description of waste produced by AREVA

The AREVA 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 for the nuclear power plant licensees and on the other, the waste linked to operation of the installations. Most of this waste is the property of the plant licensees. The issue of recovering the legacy waste stored at La Hague is dealt with in chapter 13.

The waste generated by the spent fuels includes:

– Fission products and minor actinides (high level)
  The solutions of fission products and minor actinides resulting from spent fuel reprocessing are calcined then vitrified in the R7 and T7 facilities. The vitrified waste is poured into stainless steel containers. After the glass has solidified, the containers are transferred to an interim storage installation pending availability of a long-term management solution or until they are shipped to AREVA's foreign customers.

– Long-lived intermediate level structural waste
  This chiefly consists of fuel metal cladding (called "hulls") and metal structures such as fuel assembly

Operators working on the recovery of waste from the trenches of BNI 56 in Cadarache (Bouches-du-Rhône *département*)

end-pieces. The packaging process consists in compacting the waste and placing it in a stainless steel container in the ACC facility. The final package can also contain metal technological waste. The packages are stored on the site or shipped to AREVA's foreign customers.

Waste linked to operation of the installations comprising:

– Waste from radioactive effluents treatment

The La Hague site has two radioactive effluents treatment stations (an older one, STE2, and the more recent one, STE3). The effluents used to be treated by chemical co-precipitation (and still is in the STE3, but in small quantities owing to the change in process used for effluents at La Hague). The sludges produced in STE3 are evaporated and encapsulated in bitumen, with the final encapsulated product then being poured into stainless steel drums in this facility. The drums are then stored on the site. Further to a request from the licensee, ASN in 2007 authorised the production of 108 drums for packaging the STE2 sludges using the STE3 process. After an inspection, ASN then temporarily suspended this authorisation. This suspension became final following an ASN decision subsequent to a meeting of the Advisory Committee to deal with the BNI 118 periodic safety review.

ASN asked AREVA to continue to look for an alternative to bituminisation. In 2007, AREVA carried out an analysis of the value and the technical risks inherent in the packaging method. At the same time, a 1/10th scale inactive pilot was used to test the alternative process to bituminisation and to validate certain design data. Of the 6 standard packages examined, the C5 type package was adopted as an alternative solution to the bituminisation process. It comprises compacted pellets immobilised in a cement grout. On the basis of these results, AREVA carried out an internal design review to authorise kick-off of the draft pre-project (APS). At the beginning of 2008, the results already obtained were presented to ASN, which stated that the approach adopted by AREVA could continue.

– Waste from organic effluents

The La Hague plant has an installation for interim storage of organic effluents (MDSA). The effluents stored there are subsequently treated using a mineralisation process involving pyrolysis in the MDSB facility. This installation produces cemented packages that can be disposed of in the Aube repository.

– Ion exchanger resins

The water in the fuel unloading and interim storage pools is continually purified by means of ion exchanger resins. Once used, these resins constitute waste that is treated using a cementation process.

Fuel assembly hulls, ACC facility – AREVA NC at La Hague (Manche *département*)

– Technological waste in the ACC (hulls and end-pieces)

On 27 November 2001, ASN authorised the production of CSD-C packages. This authorisation carried a restriction banning the introduction of organic technological waste and dissolver bottom debris into the primary drum.

At the end of 2007, AREVA forwarded a safety analysis file to obtain lifting of the restriction on the introduction of organic technological waste. Analysis of the data transmitted does not permit this restriction to be lifted.

In order to lift this restriction on the introduction of dissolver bottom waste into the CSD-C, AREVA in 2008 sent ASN a further authorisation application accompanied by a backup file. This file is currently being reviewed and the ASN decision should be issued during the first half of 2009.

– Other technological waste

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. Those that do not, are temporarily stored on the site.

With regard to the waste stored in building 119, and the waste from the MELOX plant, AREVA NC proposes building a compacting process and installation in addition to the existing one. This strategy also includes the use of STE3 disposal compartments for this type of drum pending the availability of the new installation. In spring 2006 a working group consisting of AREVA, ANDRA, ASN and its technical support organisation (IRSN) was set up to examine the characteristics of the packages that would be produced by the proposed process. The working group is examining all the design parameters (criticality, gaseous releases (hydrochloric acid and hydrogen), containment, void fraction) both in the light of current knowledge and with regard to continued study of the phenomena.

At the 9th meeting of the working group, held in September 2008, ASN asked AREVA to consider an industrial strategy for controlling the hydrogen release rate if the assessments, albeit conservative, were to confirm that the release rate did not allow disposal without prior storage for several decades. At the beginning of 2009, AREVA will transmit a file reviewing the studies conducted to date on the S5 package, justifying the degassing rate contemplated and detailing the methodology used and the experimental results obtained in the GANIL. The file will also review the storage capacity for organic waste contaminated by alpha emitters from the La Hague and Melox plants. ASN will issue a decision in mid-2009 on the continued production of this package.

Cold crucible technology

In partnership with CEA, AREVA has completed the development of cold crucible direct induction furnace technology. This technique offers advantages over the existing hot crucible method for producing glass. First of all, the cooling of the melting furnace allows the formation of a fine layer of solid glass, which protects the crucible and prevents it from being corroded by the molten glass. Then, direct induction heating allows far higher production temperatures and therefore the design of new matrices.

AREVA therefore sent new specifications to ASN for the production launch authorisation. AREVA in particular sent ASN the results of its research into packaging of Umo (Uranium/Molybdenum) solutions. Similarly, borosilicate type glass formulations which can be produced at very high temperature and be used to contain a higher waste mass content, are being studied.

Specification 300 AQ 59 rev. 0A applies to the CSD-U. This is a package for fission product solutions resulting from reprocessing on the La Hague site between 1966 and 1985 of the UMo (molybdenum alloy) and MoSnAl (molybdenum, tin and aluminium alloy) type GCR reactor fuels. In order to minimise the number of packages that need to be produced, the composition of the CSD-U must maximise the level of incorporation of molybdenum (Mo) and phosphorus, which are two limiting factors for the glass formulation. The cold crucible technology enables this optimisation process to take place. Given that the radiological activity levels of these solutions are low when compared to the fission product solutions packaged in glasses produced in accordance with specifications 300 AQ 16 or 300 AQ 60, they should not constitute a limiting design factor for the CSD-U. The constraints linked to the packages are more chemical in nature. Specification 300 AQ 59 rev. 0A is currently under review at ASN.

Specification 300 AQ 60 Rev. 00 only concerns the CSD-V with enhanced actinide levels, produced using the hot crucible method. AREVA obtained temporary approval from ASN pending the results of the characterisation studies into the behaviour of the glass. In July 2008, AREVA provided ASN with all the additional information required for granting of the authorisation to continue with this production beyond 31 December 2008, in current conditions, and until such time as the cold crucible technology is implemented. ASN issued the authorisation in a decision of 16 December 2008. The specification associated with the CSD-V produced using the cold crucible process will be replaced by a new specification to be sent to ASN for approval.

Specification 300 AQ 061 Rev. 0A applies to packages CSD-B constituting the end-product of packaging by vitrification of medium-level effluents mainly from rinsing operations involved in the final shutdown of the UP2-400 plant. The solutions to be vitrified are characterised by their high sodium content. Therefore, in order to optimise the number of packages to be produced, the composition of the CSD-B must maximise the incorporation of sodium into the glass. For the same reason as for the CSD-U package, the main constraint is chemical in nature.

2 | 1 | 3 EDF waste management

Description of waste produced by EDF

The waste produced by EDF nuclear power plants comprises the following: activated waste (from reactor cores) and waste resulting from plant operation and maintenance. To this can be added the legacy waste and the waste from dismantling of power plants being decommissioned.

It should be noted that EDF is also the owner of long-lived high level and intermediate level waste from its share of the spent fuels reprocessed in the AREVA plant at La Hague.

Activated waste

This waste comprises control rod assemblies and poison rod assemblies used for reactor operations. This is long-lived intermediate level waste and the quantities produced are small.

It is currently stored in the plant pools pending interim storage in the future ICEDA centralised installation.

Operating and maintenance waste

This consists of ion exchanger resins (water treatment), filters, concentrates, evaporators, sludges, cleaning and upkeep waste (rags, vinyl sheets and bags, gloves, etc.). Some waste comes from replacement and maintenance operations and can be of large size (vessel heads, steam generators, fuel storage racks, etc.).

Some of the 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 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 waste repository and some particularly low level waste in the VLL waste centre. It contains beta and gamma emitters but few or no alpha emitters.

Legacy waste

This is structural waste (graphite sleeves) from fuel used in the old gas cooled reactors (GCRs). This is long-lived low level waste.

This waste is primarily stored in semi-buried silos at Saint Laurent des Eaux. The improved safety of these silos and the long-term management solution for this type of waste (project for disposal of low level long-lived waste (LLW-LL).

Dismantling waste from plants being decommissioned

This is mainly very low level waste. There will also be graphite waste (stacks still present in the GCRs).

EDF waste management strategy

EDF fuel use policy (see chapter 12) has consequences for the cycle installations (see chapter 13) and for the quantity and quality of the waste produced. This subject was examined by the Advisory Committees for reactors, for plants and for waste from the end of 2001 to early 2002. ASN asked that the “cycle consistency” file be updated for mid-2007. After a review and two meetings with AREVA, ANDRA and EDF, the revised file was transmitted by EDF to ASN at the end of 2008.

ASN confirms that the exercise covers a period of ten years but does not rule out the possibility of increasing this time-frame for certain points. Given the changes in the supply markets, the fabrication of fuel based on natural uranium will be removed from the exercise, except for the waste generated and eventual decommissioning of the installations. ASN asked for the “discharges” issue concerning the La Hague site to be included in the file.

The Saint-Laurent (BNI 74) silos

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 GCRs, plus technological waste.

As this installation no longer complied with current safety criteria, ASN asked EDF to empty the silos before 2010. The solution proposed by EDF was based on the availability of a final disposal channel for the graphite waste as of 2010, however the delay in the search for a host site is likely to put this deadline back to 2019. After examining alternative strategies, at the request of ASN, pending the availability of a disposal facility for graphite waste, EDF proposed building a containment barrier around the silos in a file transmitted to ASN in July 2007. In July 2008, ASN approved the principle of the geotechnical containment proposed by EDF, subject to EDF providing a certain amount of additional data.

2 | 1 | 4 Management of waste from other licensees

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

2 | 2 Radioactive waste management in medical, industrial and research activities

2 | 2 | 1 Origin of waste and radioactive effluents

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 effluents.

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. These sealed sources are not likely to produce radioactive effluents in normal conditions of use and storage.

The use of unsealed sources in nuclear medicine, biomedical and industrial research is the reason for the production of solid waste: small laboratory equipment items used to prepare sources (tubes, multiwell plates, 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 comes 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.

2 | 2 | 2 Management and disposal of radioactive waste and effluents produced by biomedical research and nuclear medicine

Faced with this problem of health care waste contaminated by radionuclides, which appeared with the growth of nuclear medicine, the public authorities first of all initiated a process of regulation of the activities and information of both patients and practitioners concerning good practices to be observed in managing this waste. A circular from the Minister for Health (DGS/DHOS 2007/323 of 9 July 2001) therefore clarified the provisions of the 30 November 1981 order on the conditions for the use of artificial radionuclides used in unsealed sources for medical purposes.

On 2 August 2008 the order of 23 July 2008 was published, concerning approval by the ministers responsible for health and the environment of ASN decision 2008-DC-0095 of 29 January 2008 setting out the technical rules to be followed for the disposal of effluents and waste contaminated or likely to have been contaminated by radionuclides as the result of a nuclear activity. This decision was taken pursuant to Article R-1333-12 of the Public Health Code. It includes the broad outlines of circular DGS/DHOS 2001/323 of 9 July 2001 and contains measures with regard to:
– the drafting and approval of effluents and waste management plans;
– the creation of contaminated waste zones;
– waste storage conditions;
– the conditions for decay management of waste and effluents contaminated by radionuclides with a half-life of less than 100 days and its discharges;
– the conditions for management and disposal of waste and effluents contaminated by radionuclides with a half-life of more than 100 days;
– installation discharge outlet monitoring conditions;
– conditions requiring use of a radioactivity detection portal at site exits.

ASN is now working on drafting a guide for implementation of this decision, which will specify good practices for the management of waste and effluents resulting from nuclear activities outside BNIs.

2 | 3 Management of Technologically Enhanced Naturally Occuring Radioactive Materials (TENORM) waste

In the environment, there is already measurable background radiation due to the presence of radionuclides which have been or are still being produced by various physical processes. As a general rule, this radioactivity leads to no significant risk, which means that there is no point in taking any particular precautions. In France, exposure to natural radioactivity varies from region to region but is about 1 mSv/year.

Some professional activities using raw materials which naturally contain radionuclides but which are not used for their radioactive properties, may lead to an increase in the specific activity of the radionuclides present. We then talk of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM). Waste containing TENORM may be accepted in various types of installations, depending on its specific activity:
– in a disposal centre authorised by order of the *préfet*[1], if it can be proven that its activity is negligible from a radiation protection viewpoint. The DPPR circular of 25 July 2006 clarifies the conditions for acceptance of this waste. This circular is accompanied by a methodological guide drafted by IRSN under the supervision of a steering committee made up of representatives of industry, disposal centre operators, environmental protection associations, experts and the Administration. The DPPR stated that the provisions of the circular should not result in the disposal centres authorised by order of the *préfet* becoming disposal channels for TENORM waste.
– in ANDRA's very low level waste disposal facility,
– in an interim storage facility. Some of this waste is waiting for a disposal channel, in particular the commissioning of a long-lived very low level waste disposal centre. ANDRA is currently looking for a site for this disposal facility, which should enter service by 2020.

2 | 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. This consists of mine tailings comprising crushed rock which was not used,

1. In a *département*, representative of the State appointed by the President.

because of its low ore content, and uranium mine processing residues. These residues fall into two categories:

– low-content ore (about 300 to 600 ppm) with a total average specific activity of 44 Bq/g (including 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;
– ore with a high average content (about 1% ‰ to 1% in French mines) having a total average specific activity of 312 Bq/g (including 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 installations classified on environmental protection grounds (ICPE). The national inventory of uranium mining sites is a part of the MIMAUSA (History and impact of uranium mines: Summary and Archive) programme, under the supervision of the Ministry for Ecology, Energy, Sustainable Development and Spatial Planning. ASN is part of the steering committee for this programme.

The inventory is available from the following website: www.irsn.fr. An e-mail contact address (mimausa@irsn.fr) was created at the end of 2007. An updated version of the MIMAUSA inventory (version 2, September 2007) was published on 4 December 2007. The modifications concern the addition of a glossary and a chapter covering topical events (the Act of 28 June 2006, the revision of the ICPE list, the mining risk prevention plan, the Limousin region pluralistic experts group (GEP), improvements to pictograms and to mapping of sites, enabling them to be more easily situated, along with clarification of the site administrative sections.

The next step is to set up a MIMAUSA IT application for the Government's departments and for the public.

Article 4 of Act 2006-739 of 28 June 2006 requires that by the end of 2008, an inventory be produced of the long-term impact of uranium mining residue disposal sites and the implementation if necessary of a reinforced radiological surveillance plan for these sites. The third section of Article 10 of decree 2008-387 of 16 April 2008, concerning the National Radioactive Materials and Waste Management Plan, specifies the requirements to be met by the licensee (AREVA):

– a study of changes in the mechanical and geochemical behaviour of the stored residues,
– an analysis of the long-term performance of the disposal site retention dykes,
– a study of the long-term impact of the residue disposal sites, taking account of both a normal development scenario and degraded development scenarios.

Analysis of these studies could lead to a tightening up of the public exposure risk prevention measures being recommended.

For the purposes of these studies, meetings were held between ASN, AREVA and IRSN. ASN in 2008 validated the modelling methodology chosen by AREVA for assessing the long-term impact of the residue disposal facilities, with a normal evolution scenario and four altered evolution scenarios dealing with loss of the covering, construction of homes above the disposal site, construction of a road, presence of a child playing on the backfill. This modelling concerns 9 former mining sites in the final report submitted by Areva at the beginning of 2009.

The method presented by AREVA NC represents a significant step forward in assessing the long-term impact of uranium ore treatment residue disposal. The work done represents the first real application by a licensee of the approach officially set out in the circular from the minister responsible for the environment on 7 May 1999 concerning the rehabilitation of uranium ore treatment residue disposal sites. The study of the nine sites selected will give a precise assessment of the long-term impact of mining residues around the country and enable the public to be informed of these results. This method is felt to be consistent with the principles contained in the strategy, in particular with regard to the definition of the reference scenarios, the altered scenarios, the reference groups or the performance of sensitivity studies. It is important to point out that it is also consistent with the approach adopted for Andra's surface repositories, particularly with regard to the altered scenarios involving the construction of roads or homes over the disposal site.

A generic modelling study of the potential impacts in order to assess exposure linked to the use of tailings in the public domain was also transmitted by AREVA at the end of 2008.

In 2009, ASN will be reviewing the files transmitted by AREVA at the end of 2008.

2 | 3 | 2 Waste resulting from other activities

Other activities, particularly those leading to mining treatment residues (mines operated for the extraction of rare earths, phosphate ore treatment residues from the superphosphate fertiliser industry, and so on), can lead to problems similar to those from uranium mine treatment residues (point 2|3|1): large quantities of waste produced, often managed in-situ, and for which no appropriate disposal channel is currently available.

Site of the former Bois Noirs treatment plant (Loire *département*)

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. ASN is working together with the competent departments of the classified installations inspectorate. ASN's aim is to ensure that this waste is managed in such a way that it is systematically sent to the appropriate disposal channels. 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, ASN asked the *Robin des Bois* association to conduct a study into the effects of naturally occurring radioactivity enhanced by human activities, and the correspondingly polluted sites in France. This study covers industrial activities involving 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. The final version of the study report was submitted to ASN in December 2005.

This extremely comprehensive report provides detailed information on the potential sources of exposure of workers and the public to ionising radiations and was transmitted to the local, regional and national administrations. In 2008, ASN continued to work with the *Robin de Bois* association on the subject of TENORM, as required by the PNGMDR (see point 1|7) which stipulates that ASN must produce a study of the solutions for management of TENORM waste by 2009. ASN therefore entrusted the Robin des Bois association with a new study into legacy stores of TENORM waste, more particularly of phosphogypsum and ashes.

2|4 Management of incidental contamination

The obligation of systematic installation of radioactivity detection systems in the "conventional" waste disposal or recycling centres authorised by order of the préfet, 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 operating feedback from the incidents that have occurred since 2003, involving radioactive contamination in establishments in which no radioactivity is normally used, revealed the need to be able to inform the head of the establishment rapidly of his responsibilities and the risks regarding radioactive contamination.

Therefore in 2003, ASN drafted a guide which is to be quickly sent out to all heads of establishments in which unexpected radioactive contamination is detected. ASN has also extended to the small-scale nuclear activities sector the principles of notification of the public authorities concerning significant events involving safety, radiation protection or the environment, which already apply to the BNI and radioactive material transport sectors. ASN thus defined a certain number of criteria which should lead to the notification of significant events in the field of radiation protection, along with the corresponding notification form.

Case of the Limousin region uranium mining sites

On 24 December 2004, the DRIRE received AREVA NC's operating results, which although they meet all the requirements nonetheless need some additional work. The DRIRE therefore asked the licensee to have a third-party assessment carried out. In order to intensify the dialogue and debate concerning the Limousin region uranium mining sites, the minister responsible for ecology, the minister responsible for industry and the minister responsible for health, decided to set up a pluralistic experts group (GEP) for regular supervision and oversight of third-party assessment. ASN contributes to funding the working of the GEP. Three working sub-groups have been set up: source term and discharges, environmental and health impacts, and long-term legal and regulatory requirements. In January 2007, IRSN submitted a report corresponding to the 1st step in its third-party assessment and the GEP submitted the interim report on the first phase of its work (June to December 2006). Work continued on the other sites and river basins and a 2nd interim report was submitted at the end of 2007. These reports are available on IRSN's website. The GEP report was presented to the CLIS on the Bellegarde site on 14 March 2007 and to the Haute-Vienne CODERST on 16 March 2007. AREVA took due note of the recommendations and created an action plan. Work continued in 2008 and the GEP final report should be submitted in 2009.

The former mining site at Bellezane (Haute-Vienne *département*) before its redevelopment)

The former mining site at Bellezane after its redevelopment

3 LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

3 | 1 Long-term management of very low level (VLL) waste

The VLL waste management rationalisation process, initiated by 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 ANDRA and by the "ultimate" waste and polluted earth processing and disposal company (SITA FD) as of 1996 with a view to creating a repository intended for very low level radioactive waste. The Morvilliers site, not far from the Aube repository, was therefore chosen. This installation classified on environmental protection grounds (ICPE), licensed by order of the *préfet* dated 26 June 2003, offers a disposal capacity of 650,000 m³ and has been in service since August 2003.

After two years of operation, ANDRA applied to the Aube *préfet* for modification of the operating conditions. This concerned modifications to the architecture of the disposal cells (increasing the surface of the two face-to-face cells with a unit area of 10,000 m² each, to a single cell of 24,000 m²), the slope of the covering and the leachates pumping rule. This application, which was approved by a supplementary order of the *préfet* on 21 July 2006, enables ANDRA to take account of operating feedback from the actual conditions of operation of the disposal centre.

3 | 2 Long-term management of low level and intermediate level short-lived waste

Most intermediate and low level waste with a short half-life (less than 30 years) is sent for final disposal to ANDRA's surface waste repositories. These repositories operate on a principle whereby waste is confined and sheltered from hazards, notably water circulation, during what is known as the surveillance phase, fixed by convention to last 300 years, until such time as their activity level has decayed sufficiently to become negligible. There are two such repositories in France.

3 | 2 | 1 The Manche repository

The Manche radioactive waste repository (CSM) currently occupies an area of about 15 hectares at the end of the La Hague peninsular. It was commissioned in 1969 and was the first radioactive waste repository to be operated in France. The CSM was initially managed by CEA but was transferred to ANDRA responsibility on 24 March 1995. CSM operations ceased in July 1994. It entered the surveillance phase in January 2003 (decree n° 2003-30 of 10 January 2003).

Isolated problems with the repository covering were identified a few years ago and required limited consolidation work. In January 2009, ANDRA transmitted a file on the benefits of fitting a new covering to ensure the long-term passive safety of the repository. At the same time, ANDRA submitted the final safety report concerning the installation as a whole. These files are undergoing close scrutiny by ASN.

In addition, for a number of years, tritium has been persistently detected in the groundwater and the Grand Bel stream. In response to the CSM local monitoring committee which, since it was created in 1996, comprises representatives of the State, local elected officials and

Operations to close cells and move the mobile roof on the Morvilliers site (Aube *département*) environmental protection associations, ANDRA presented a study in May 2008 concluding that pumping of the groundwater to reduce the tritium activity concentration in the Grand Bel was impractical. This point will be explained and justified in the revised environmental surveillance plan to be analysed by ASN at the beginning of 2009.

In accordance with the recommendations of the "Turpin" commission, ANDRA in March 2008 produced an interim version of the "Concise history", the purpose of which is to preserve essential information about the CSM for future generations.

3 | 2 | 2 The low and intermediate level short-lived waste (LL-ILW-SL) repository

In 1992, the low and intermediate level waste repository (CSFMA) took over from the Manche repository, taking full advantage of operating feedback gained from it. This installation, located in Soulaines-Dhuys (Aube *département*[2]) was licensed by a decree of 4 September 1989 and offers a capacity of 1,000,000 m^3 of waste located in 400 structures. 111 structures have been built so far. The service includes packaging of the waste sent by the producers, either by injecting mortar into the 5 or 10 m^3 metal containers, or by compacting the 200 litre drums.

View of the Manche repository

Waste containment is built around a system of three consecutive barriers: the package, the covering structure and the geological formation. The centre's activities therefore generate a very small quantity of radioactive effluents. These discharges are regulated by the order of 21 August 2006, leading to a modification of the authorisation decree dated 10 August 2003.

In May 2007, the CLI organised a programme of sampling and environmental radioactivity measurements at the CSFMA, using the resources and expertise of the ACRO (Association for the Control of Radioactivity in the West). The results of this study were presented to the Local Information Committee in February 2008. They corroborate those produced by ANDRA and show that the centre's impact on the environment is negligible.

In June 2006, the Advisory Committee of experts for waste evaluated the repository's operating conditions and declared itself in favour of continued operation and extension to the zone not yet in service (known as zone B). In 2006, ASN issued an opinion in favour of extension of the disposal activities to the zone not yet used and asked that additional safety studies be conducted into the risks of explosion and fire, and that the impact of long-lived radionuclides and chemically toxic substances be estimated. In August 2008, ANDRA sent ASN the answers to the recommendations made by the Advisory Committee and the subsequent requests from ASN. After analysis by ASN and IRSN, the general operating rules will be modified to take account of the changes made further to the revision of the safety analysis report.

3 | 2 | 3 Package acceptance rules

In May 1995, ASN defined requirements for approval of radioactive waste packages intended for the surface repository (RFS III.2.e). This basic safety rule determines the roles of the producers and of ANDRA, the radioactive or non-radioactive content requirements for each package, the approval procedures and the required characteristics.

In this respect, ANDRA draws up general and particular specifications specific to each type of package (dimensional, physical, chemical, radioactive and other characteristics). For its part, by means of technical tests and organisational procedures, the producer demonstrates the measures taken to ensure compliance with these specifications. This system undergoes initial evaluation, followed by periodic assessment by the producer, ANDRA and ASN, which may lead to approval suspension or revocation.

2. Administrative region headed by a *Préfet*.

Disposal structures in the Aube repository

In 2008, ANDRA redefined the waste package specifications to take account of operating feedback acquired since the surface repository was opened.

ASN is particularly attentive to the strategy implemented by ANDRA for checking the quality of the packages accepted in its repositories: at the request of ASN, ANDRA in 2008 drew up a document presenting its strategy on this subject. ASN considers that this document is on the whole satisfactory, but asked ANDRA to supplement it with a file to define its strategy, presenting the more operational aspects of its approach and giving a clearer justification of the link between the safety analysis report / waste acceptance specifications and the checks carried out. In addition to traditional quality control, ASN also recalled the need for ANDRA to continue to conduct "super-checks" (package destruction to verify its content), which means that it needs appropriate installations for this type of inspection.

3 | 3 Long-term management of long-lived low level waste

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 current interim storage facilities are not felt to be particularly satisfactory. 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 decommissioning, produce waste containing graphite and significant quantities of long-lived radionuclides. This waste consists mainly of graphite stacks and sleeves, activated by neutron irradiation.

In June 2008, ANDRA issued an information file about its search for a site to host a low level long-lived radioactive waste repository, to those *communes*[3] which in principle offer potentially favourable geology. This type of subsurface disposal (several tens of metres depth) could be located in a hillside, or excavated. A number of repository design options could be contemplated and their technical feasibility is currently being examined. Studies and research are also under way to gain a clearer understanding of the nature of this waste (inventory and behaviour of very long half-life radionuclides, understanding of radionuclide release mechanisms, etc.) and to determine its compatibility with the characteristics of the repository. The candidate *communes* had until the end of October 2008 to make themselves known. The minister responsible for the environment will at the beginning of 2009 select 2 or 3 sites on which additional investigations are to be carried out, leading to a final choice in 2011 of the site selected to host the repository.

The waste to be accepted in this repository will mainly be graphite and radium waste but, as requested by decree 2008-357 of 16 April 2008, ANDRA is also examining the possibility of taking other types of low level long-lived waste, such as objects containing radium, uranium and thorium, and used low level long-lived sealed sources, as well as other waste from the processing of liquid effluents incorporated into bitumen by an encapsulation process and then packaged in metal drums.

To facilitate the final siting choice for the repository, the ASN website in June 2008 published "general safety

3. Smallest administrative subdivision administered by a mayor and a municipal council.

guidelines for the siting of a low level long-lived waste repository site", produced jointly with IRSN. It contains guidelines for the safety of the repository design, as well as its safety following closure.

3 | 4 Long-term management of long-lived high and intermediate level waste

3 | 4 | 1 Seperation/Transmutation

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

Separation covers a number of processes, the purpose of which is to separately recover certain long-lived radionuclides, minor actinides and fission products. Once repackaged, these species are intended to be transmuted either by fission, for the minor actinides, or by neutron capture, for the fission products, resulting in short-lived nuclides or stable atoms. The studies conducted on this subject complement those carried out by ANDRA into a deep disposal concept. The footprint of the HL-LL waste repository in fact depends on the thermal properties of the glass packages and, generally speaking, any increase in the interim storage time helps to reduce the footprint of the facility. The heat released is primarily due to the minor actinides after 300 years, in particular in the presence of americium 241. In the absence of these minor actinides, the package cooling time (a few decades in interim storage) and the footprint of the HL-LL waste disposal installations would be reduced by about 30%. The length of the thermal phase would then be shortened to about a hundred years, owing to the fission products alone.

Operators constructing a graphite assembly in a reactor

The relationship between the minor actinides content, the length of the interim storage period and the underground footprint of the repository, means that combinations are then possible in order to optimise the storage/disposal arrangement, in the light of other, essentially economic, criteria.

Furthermore, the radiotoxicity inventory of the glass packages is correlated with the presence of minor actinides after several hundred years. For the impact assessment of an altered scenario such as intrusion into the repository, the radiological impact would be reduced.

The 28 June 2006 Act directs studies and research towards the industrial transmutation of minor actinides in fast neutron reactors, whether critical (FNR) or sub-critical (Accelerator Driven System – ADS) in conjunction with the research being conducted into the new generations of nuclear reactors.

The first deadline is 2012 when, according to the Act, CEA is required to "submit a report assessing the prospects of the various industrial separation-transmutation technologies", in particular comprising a part dealing with the benefits of separation-transmutation for geological disposal.

After the 28 June 2006 Act was passed, the following strategic decisions were taken by CEA on 20 December 2006. Studies and research into critical reactors will concern sodium-cooled (FNR-Na) and gas-cooled (FNR-He) fast neutron reactors. For the first technology, priority is given to designing and producing a prototype for 2020. The technologies and operating principles of a gas-cooled fast neutron reactor will be examined at a European level, leading to a technological design and development demonstrator for the gas-cooled fast neutron reactor technology (REDT) for which a construction decision could be reached in about 2012. ADS studies will be carried out under an international programme.

Given the scale of the research still to be carried out, ASN considers that no industrial application of these processes could be possible before about 2040.

3 | 4 | 2 Long-term storage

The purpose of the research into long-term storage is to design a system guaranteeing long-term containment of radioactivity, while also allowing retrieval of the packages and ensuring compatibility with possible subsequent disposal.

The function of interim storage is to allow the safe management of waste packages between their production and their final disposal. In the case of thermal packages, it also allows cooling under surveillance. Throughout the storage phase, it must be possible to recover the packages.

CEA in 2005 sent the Government its report on the packaging and long-term storage of high level, long-lived waste. The report presents the research work carried out along with the results.

The Act of 28 June 2006 now gives ANDRA responsibility for continuing interim storage studies.

The Act no longer considers storage to be a final management solution but stipulates that studies must be carried out into storage so that "no later than 2015, new interim storage installations can be created, or existing installations modified, in order to meet the requirements, particularly in terms of capacity and duration".

The storage programme comprises three parts, covering the following respectively:
– identification of the storage needs according to various storage scenarios, with a first inventory to be provided in 2009;
– production of storage concepts, specifying their feasibility, durability and performance (options to be proposed in 2009);
– preparation of new storage capacities, for implementation in 2015 and for which the projects must be described in 2011.

3 | 4 | 3 Deep geological disposal

The Sustainable Management of Radioactive Materials and Waste Act of 28 June 2006 sets a schedule prior to the 2025 commissioning, subject to authorisation, of a reversible deep geological repository. ANDRA has drawn up a development plan (PDD) for the HL-LL waste project, which presents the project research and studies strategy for the period 2007-2015, in response to the objectives of the 28 June 2006 Act. The development plan is divided into 8 thematic programmes (experimentation, reconnaissance, phenomenology, simulation, engineering, information, surveillance, transport) and 5 cross-disciplinary activities (safety, reversibility, cost, conventional health and safety, impact assessment). The cross-disciplinary activities consolidate the data obtained by the programmes at the different stages of the project and give an overall, complete picture of the performance of the project. Each cross-functional activity is described in a document giving the input data, the deliverables, the interfaces with the programmes and the other cross-functional activities.

The PDD was presented to the Advisory Committee for waste (GPD) in December 2007.

The project milestones are as follows:
– in 2009, presentation of the reversibility and safety options, proposal of a restricted area of about 30 km², within the transposition zone;
– in 2012, public debate file;
– in 2014, authorisation decree application file;
– in 2025, commissioning.

Work to examine the disposal of waste in deep geological formations is currently being done in the Bure underground laboratory (Meuse *département*), authorised by decree in 1999.

Study of the rock enables its physical-chemical properties to be determined in terms of repository safety. Scientific experiments are also designed to enhance the available knowledge concerning:
– understanding the geology of the region and its history, with the possibility of predicting its future behaviour;
– the regularity of the clay layer in the transposition zone (on which the repository could potentially be sited);
– water circulation in the limestone and marl terrain above and below the clay layer;
– the impact of excavation of the underground structures and the possibility of mitigating or cancelling out the effects;
– the performance of argillites in containing the radioactive elements and delaying their migration.

Among the experiments carried out by ANDRA in 2008, the surface reconnaissance campaign allowed examination of the lateral continuity and spatial variability of the properties of the formations studied, in order to obtain exhaustive information about the transposition zone. This acquisition was based on the collection of seismic data over 176 km, on drilling 14 boreholes divided among 6 platforms, including the Trias deep bore, along with surface mapping operations.

By means of inspections at ANDRA head office and on the Bure site, ASN ensures that all quality assurance steps are taken so that the experiments performed provide the expected results.

In 2008, ANDRA also undertook work to create a demonstration and information centre on the disposal and reversibility concepts in Saudron, near Bure. This centre will host prototypes and technology demonstrators built to test and validate the industrial concepts contemplated for the nuclear installations in the repository. It is scheduled to open in June 2009.

In February 2007, ASN published the safety guide for final disposal of radioactive waste in deep geological formations, in place of Basic Safety Rule III.2.f., following the favourable opinion given by the Advisory Committee for waste (GPD). However, during the course of the debates, members of the GPD raised questions concerning the radiation protection criteria values and the problem of providing a safety case for such very long time-scales. The Advisory Committee thus considered that further work was needed to examine the criteria, the time-scales for which they apply and how they can be interpreted. Against this backdrop, ASN decided in 2008 to convene a working group comprising experts on these subjects. The conclusions of their deliberations will be available in 2009.

3 | 4 | 4 Specifications and approval certificates for waste packages unsuitable for surface disposal

ANDRA, together with the waste producer, has chosen a progressive procedure whereby initially, and until 2001, the only specifications required were those related to knowledge. It also defined requirements concerning qualification of the process and management of production applicable to all waste producers, so that surveillance can be implemented and nonconforming packages identified. In 2003, most level 1 approvals (compliance with first package requirements for inclusion in the deep geological formation disposal design specifications) were granted. The performance specifications for level 2 waste packages stipulate the package properties which, as things currently stand, would seem to determine the design or impact assessment of a possible repository. ANDRA anticipates a change in this approach in order to link the specifications drafting process to that for production of an application for authorisation to create a geological repository, which could be submitted in 2014.

The setting up of this procedure is being closely followed by ASN, in particular through inspections at ANDRA and on the premises of the waste producers.

In 2006 and 2007 the regulatory context changed owing to:
– the fourth paragraph of Article 14 of planning Act 2006-739 of 28 June 2006 on the Sustainable Management of Radioactive Materials and Waste, which specifies that, in compliance with nuclear safety rules, ANDRA must submit specifications for radioactive waste disposal and provide the competent government authorities with a recommendation concerning the waste packaging specifications;
– guide published by ASN "on final disposal of radioactive waste in deep geological formations", chapter 4.2 of which presents the safety functions relating to the packages, along with guidelines in its appendix 1.

In order to take account of these changes, ASN resumed work on the conditions for approval of changes to the production of packages for waste that cannot be disposed of in surface or sub-surface repositories (known as "N3S" packages). The aim of this work is to meet a two-fold objective:
– operational implementation of the changing context, by describing the package approval process and thus explicitly describing the role of the parties involved at each stage in the process;
– harmonisation of all practices; in the current situation, the packaging conditions for the packages produced at La Hague are subject to ASN approval. The packages produced on the other sites are not explicitly bound by such a requirement.

In 2008, ASN produced a draft decision concerning the waste packaging approval procedures. This draft was sent to a working group comprising ANDRA, IRSN, DSND and ASN. It will be transmitted to the producers in 2009, for their opinion.

4 ABANDONED RADIOACTIVE OBJECTS AND SITES POLLUTED BY RADIOACTIVE MATERIALS

4 | 1 The organisation and regulation of action by the public authorities

Article 14 of Act 2006-739 of 28 June 2006 Act on the Sustainable Management of Radioactive Materials and Waste (Article L 542-12 of the Environment Code) states that ANDRA is particularly responsible for the collection, transport and handling of radioactive waste and the rehabilitation of sites polluted by radiation, on request, and at the expense of the parties responsible, or further to public requisition when the parties responsible for this waste or these sites have defaulted. The last paragraph of Article 15 stipulates that ANDRA shall receive a subsidy from the State, which contributes to funding the missions of general interest entrusted to it. For this purpose, ANDRA's board in April 2007 set up a National Funding Commission for Radioactive Matters, CNAR. This arrangement replaces the two financial systems that previously existed: the radium fund and the agreement between producers in the nuclear power generating sector and ANDRA.

The Government circular of 17 November 2008 co-signed by the DGPR, DGS, DGEC and ASN explains ANDRA's public service role, the handling of certain radioactive waste and the management of sites polluted by radioactivity, abrogating the Government circular of 16 May 1997 on the management of sites contaminated by radioactive materials.

Furthermore, the public authorities, more particularly the *préfets*, can ask ANDRA, CEA or IRSN to take charge, at least temporarily, of radioactive waste. The conditions in which the *préfets* refer to these organisations are specified in government circular DGSNR/DHOS/DDSC n° 2005/1390 of 23 December 2005 concerning the principles for intervention in the case of an event liable to lead to a radiological emergency, outside the situations covered by an emergency or response plan. ANDRA is the natural destination for waste for which the party responsible has defaulted and which is handled by the State.

4 | 2 Abandoned radioactive objects

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.

In 2007, the CNAR validated the policy of funding the recovery of radioactive objects as required by the Act of

Radium emanator

28 June 2006. In order to inform those in possession of these objects, who can be extremely diverse: private individuals (sometimes as a result of an inheritance), teaching institutions, local authorities, fire brigades, etc., an ANDRA information guide on the "identification and collection of radioactive objects in the home" was drafted in 2008 with the CNAR. This guide presents the various objects (natural radioactive salts, ore samples, radium based objects for medical uses, alarm clocks, compasses, radioactive lightning conductors, radium fountains, etc.) and the risks associated with them. It also specifies the conditions in which they can be taken away free of charge.

4 | 3 Sites polluted by radioactive materials

4 | 3 | 1 General

A site polluted by radioactive materials is any site, either abandoned or in operation, on which natural or artificial radioactive materials have been or are employed or stored in conditions such that the site constitutes a hazard for health and the environment. The circular of 17 November 2008, intended for the *préfets*, describes the applicable administrative procedure for managing sites polluted by radioactive materials covered by the classified installations regime or the Public Health Code, whether the party responsible is solvent or defaulting. This new circular is thus able to deal with legacy radioactive contamination of sites caused by past craft or industrial activities involving radioactivity (see the radium clock making industry, radium extraction workings of the 1920s to 1930s, the laboratories of the early 20th century which discovered radioactivity, and so on). These sites are not generally classified installations. For installations classified on environmental protection grounds, this new circular also refers to that published on 8 February 2007 by the Minister for Ecology and entitled "Cessation of activity by a classified installation – Chain of responsibility – Defaulting by the parties responsible".

ASN considers that the new regulations on sites polluted by radioactive materials enables a clear and applicable context to be given to the inspectors in charge of supervising these sites, ensuring compliance with international recommendations (IAEA) on the subject.

The methodology guide for management of industrial sites potentially contaminated by radioactive materials, 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 materials. This guide was revised in particular to take account of abrogation of the circular of 16 May 1997 and to allow an approach consistent with that for the management of sites and soils polluted by chemicals. The DGPR and ASN thus called on IRSN on 9 July 2008 to draft this new guide, scheduled for release at the beginning of 2010. A monitoring committee comprising ASN, DGPR and IRSN was set up and met for the first time on 2 October 2008. This committee defined the working procedures and schedules. A working group will initially collate the feedback from the old guide and consult all the stakeholders.

4 | 3 | 2 The polluted site inventories

Several complementary inventories are available to the public.

- The ANDRA national inventory
  Since 1993, 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 materials. The January 2006 edition is available on the ANDRA website, www.andra.fr. The next edition is planned for June 2009.

- The databases of the Ministry for Ecology, Energy, Sustainable Development and Spatial Planning
  The Ministry for Ecology, Energy, Sustainable Development and Spatial Planning has 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, whatever 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;
  – "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.

4 | 3 | 3 Some of the files 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 *préfet* to propose allocation of technical and financial aid for the simpler cases. A property was purchased at the end of 2005, with the site being made safe by ANDRA in 2006 and 2007. Surveillance was put into place in 2008 and the house will eventually be demolished. The CNAR considered that financing of other files took priority, which explains why the demolition work was not scheduled for 2008. Two files should be resolved at the end of 2008 while a particularly complex one is still being examined.

The Essonne *sous-préfet* for his part sent the Gif-sur-Yvette town hall a document in mid-2005 as part of the revision of the local urban development plan, which specifies the health requirements concerning the Coudraie district. This document was submitted to ASN for its opinion. The Mayor of Gif incorporated these provisions into the update of the town's Local Urban Development Plan (PLU) approved by the Town Council on 9 May 2007. The CNAR confirmed financial coverage of the radiological checks defined in the PLU on behalf of the former owners (before May 2007).

b) 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

The National Funding Commission for Radioactive Matters (CNAR)

On 24 April 2007, the board of Andra created a National Funding Commission for Radioactive Matters (CNAR). This commission is required to issue an opinion on the use of the public subsidy mentioned in Article 15 of the 28 June 2006 Act, concerning both the funding priorities and the strategy for treatment of polluted sites and the principles governing the procedures for taking charge of the waste. This commission also issues an opinion on individual matters brought before it.

It is chaired by the Director General of the Agency and comprises representatives of the supervisory ministries (DGEMP, DGPR, DGS), ASN, IRSN, the Association of Mayors of France, environmental defence associations and qualified personalities.

Members of the CNAR visiting the Coudraies district in Gif-sur-Yvette (Essonne *département*) on 9 September 2008

CNAR secretarial services are provided by ANDRA.

The commission met quarterly in 2008 to discuss operational subjects, that is the drafting of a guide for assistance with handling of waste, the management of polluted sites considered to be priorities, such as Gif sur Yvette, Bandol, Isotopchim, etc.

This commission is the equivalent of ADEME's National funding Commission dealing with management of sites polluted by non-radioactive materials.

molecules intended for medical applications in Ganagobie (Alpes de Haute-Provence *département*). 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. Since December 2002, ANDRA has been conducting site clean-out operations, in particular to remove the bottles containing concentrated solutions to an appropriate and financed disposal channel. The option of transferring these solutions, which represent a very small volume, and then treating them at CEA in Marcoule, was studied in 2006. The intervention procedures were finalised and the necessary authorisations obtained (DSND approval for treatment of the products in Marcoule, special arrangement for transport issued by ASN, etc.). ASN noted significant mobilisation by CEA since 2006 to help the public authorities rehabilitate the site. A public meeting, attended by ASN, was held on 20 March 2008 in Ganagobie Town Hall, to explain to the population the forthcoming work to package and evacuate the radioactive waste and special industrial waste considered to be a priority. Packaging and evacuation of the priority waste was carried out from March to June 2008. The rest of the site clean-out and rehabilitation work will be managed by the CNAR.

c) 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 in its capacity as trustee of an estate in abeyance. 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.). Brush was cleared, fencing repaired and the waste made safe during the summer of 2006, thanks to financing through ANDRA's public service duties. Removal of the hot spots and of the waste took place in November 2007. The next step is the possible rehabilitation of this site through a redevelopment project.

Following information of the public by ASN, the safety of a neighbouring plot of land was checked and confirmed in October 2007. Four contamination spots were also cleaned up in November 2007. ASN had an assessment made of the exposure suffered by the residents as a result

Interior of a home in the Coudraies district of Gif-sur-Yvette after clean-out

of these contamination spots. A meeting was held on 27 November 2007 at the Town Hall to envisage a more widespread reassurance programme throughout the commune. In April 2008, a number of areas of doubt were cleared up and a few points of contamination were identified as entailing no health risk. A new map of the Danne property was also produced in April 2008 and shows that on 2/3 of the land, the values are comparable to the background levels of the region. This new map will constitute the basis for the site rehabilitation projects.

d) Établissements Charvet on the Île Saint-Denis (Seine-Saint-Denis)

From 1910 to 1928, this site housed a plant extracting radium from uranium ore and a laboratory for Marie Curie. Until August 2006, buildings still existed on the site. Since 1966 they had been partly occupied by various companies handling butcher's waste transit activities. The Charvet company, which is the current owner of the site, carried out the same activities from the 1990s to mid-2005. The site, which has been closed since the business ceased operations, was illegally occupied from December 2005 to June 2006. Access to the site is now prohibited, with the entrances blocked off by demolition rubble. On 29 August 2006, ASN visited the site to decide on how to remove the waste contaminated by radium and envisage the future fate of the site. During the course of its inspection on 10 May 2007, ASN observed that the condition of the site was comparable to that observed during its visit on 29 August 2006, which is unsatisfactory. A number of letters were sent to the licensee, asking it to remedy the situation. In July 2008, *Établissements Charvet* therefore removed the big-bags containing waste that had been refused by a landfill after it was revealed that they contained waste contaminated by radium. ASN and the DGPR are remaining particularly vigilant with regard to the fate of this site and the waste sorting criteria.

Site of the Danne property in Bandol (Var *département*)

Site of former Curie laboratories in Arcueil (Val-de-Marne *département*)

e) Former Curie laboratory in Arcueil (Val-de-Marne)

By order of the *préfet* on 20 August 2004, University Paris VI, the owner of the Curie Foundation's former radioactive materials handling site *(Institut du radium)* in Arcueil was asked to carry out safeguard, surveillance and decontamination work. Since 2006, this has been the responsibility of the State. ASN therefore in September 2008 validated the objectives for sorting conventional waste from contaminated waste, in line with the waste evacuation routes. It would appear that all the waste and furniture present on this site will need to be removed before radiological characterisation of the site prior to its rehabilitation. A public meeting should be held in early 2009.

4 | 4 Public service storage facilities

ANDRA has a public service storage duty. To carry out this duty, it does not operate storage facilities itself, but signs agreements with other nuclear licensees so that they provide it with interim storage capacity. For example, the SOCATRI company was authorised by decree in 2003 to provide interim storage on behalf of ANDRA for long-lived low level waste, CEA at Cadarache for interim storage of radium lightning conductors and depleted uranium radioactive objects, and CEA at Saclay for interim storage of used radioactive sources for which there are currently no disposal channels. In 2008, ASN reminded ANDRA that it placed particular importance on there being storage installations for all the waste. ANDRA informed ASN that it was examining whether or not it would be appropriate for it to operate a storage facility itself.

5 OUTLOOK

The management of radioactive waste is governed by the 28 June 2006 Act on the Sustainable Management of Radioactive Materials and Waste. This Act defines a roadmap for management of all radioactive waste, in particular by requiring the updating every 3 years of a National Radioactive Materials and Waste Management Plan (PNGMDR). The first version of the PNGMDR, produced by a pluralistic working group co-chaired by ASN, was issued at the end of 2006 and the next version is expected for the end of 2009. ASN considers that the 28 June 2006 Act and the PNGMDR provide a clear, coherent and complete framework for the management of radioactive waste in France. It also considers that the discussion and debating arrangements put into place to deal with the subject of radioactive waste, particularly within the framework of the PNGMDR, are satisfactory. ASN attaches importance to informing its foreign counterparts of the framework created for radioactive waste management in France.

In 2008, ASN continued with its actions aimed at ensuring that radioactive waste is managed safely, right from the moment it is first produced. ASN thus regulates its management within the nuclear installations and periodically assesses the management strategies put in place by the licensees. ASN thus in 2006 took a stance on the possibility of recovering waste from past practices in the AREVA NC plant at La Hague. It would appear that even though AREVA NC has sufficient means for implementing its recovery strategy, the safety of several storage installations such as the HAO silos is unsatisfactory and ASN is attentive to ensuring that AREVA NC complies with the recovery schedules presented. ASN will take the necessary regulatory measures if any drift is observed. The safety of the CEA waste and spent fuel treatment and interim storage installations was assessed at the end of the 1990s, following which CEA envisaged creating new installations and renovating certain others. ASN observes that on the whole, CEA is experiencing difficulty in meeting its commitments, particularly in terms of completion times, with the result being that it periodically reviews its strategy.

A new summary file on CEA's waste strategy will be transmitted at the end of 2009 with the aim of conducting a joint review by the Advisory Committee for waste and the safety commission for management of defence installation waste. With regard to EDF, ASN will in 2009 be reviewing the document transmitted by EDF at the end of 2008 concerning the consistency of the nuclear fuel cycle.

ASN is closely monitoring the search for a site started by ANDRA in June 2008 for the LLW-LL repository project, pursuant to the 28 June 2006 Planning Act and the decree of 16 April 2008. The repository is designed to take graphite and radium waste and could also accept other low level long-lived waste. In 2008, with the assistance of the various organisations concerned, ASN published general guidelines for the siting of a low level long-lived waste repository. These guidelines contain the initial components of a strategy which could subsequently be included in an ASN safety guide. In 2009, ASN will be monitoring the next stages in ANDRA's siting process and will be preparing for the forthcoming examination stages with a view to the authorisation decree for the future repository.

Since 2002, ASN has been involved in regulating management of sites polluted by radioactive materials. The administrative procedures in this field are based to a large extent on the classified installations regulations. The new circular that appeared in 2008, specifying the roles and responsibilities of the various stakeholders with regard to handling of polluted sites and soils, consolidates ASN's role of providing support for the préfets. ASN also takes part in the national radioactive aid commission set up within ANDRA as part of its public service role, the aim of which is to review rehabilitation projects for contaminated sites for which the party responsible has defaulted. Within this revised regulatory framework, ASN should have a greater role to play in 2009 on the subject of polluted sites, in collaboration with the administrations concerned and the other stakeholders (ANDRA, IRSN, local authorities, associations, etc.).

Following the incident on the SOCATRI company's site in Tricastin during the summer of 2008, ASN submitted a report to the High Committee for Transparency and Information on Nuclear Security (HCTSIN) concerning the management of former radioactive waste storage sites. This report gives an inventory of the former storage sites, some of which are not basic nuclear installations, and describes the action to be taken or already in progress, in order to improve the safety of these sites. The report also covers former radioactive waste disposal sites. In 2009, under the PNGMDR, ASN will continue to be attentive to ensuring that these situations inherited from the past are cleared up as rapidly as possible.

In 2009, pursuant to the 28 June 2006 Act, ASN will submit its report on short and long-term management solutions for TENORM and will, as applicable, propose new management solutions. In 2009, ASN will also continue to work on revising the regulations, following the publication of the law on nuclear transparency and security, in particular by clarifying the measures applicable to BNIs concerning the production of nuclear waste, the storage of this waste, its packaging and its disposal in the appropriate installations. Finally, under the terms of the Joint Convention on the Safety of Spent Fuel Management and the on the Safety of Radioactive Waste Management, for which the review session will be held in May 2009, ASN will present the French report.