RADIOACTIVE WASTE AND POLLUTED SITES

CHAPTER 16

This chapter covers the way in which radioactive waste and sites that are contaminated by radioactive materials are managed in order to guarantee protection of the environment and of the public.

Radioactive waste means radioactive materials for which no subsequent use is planned or envisaged. The waste may arise from nuclear activities or non-nuclear activities in which the radioactivity naturally contained in the materials, not used for their radioactive or fissile properties, may have become 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 Material and Waste Management Plan (PNGMDR). The purpose of the PNGMDR, developed jointly by ASN and the ministry for energy, is to ensure the existence of safe disposal routes for each category of radioactive waste, to identify foreseeable needs for storage or disposal facilities and to establish the actions needed to bring about coherent and structured progress in the management of radioactive waste. The second edition of the PNGMDR was sent to Parliament at the start of 2010. The decree for its application, to be published in 2011, will stipulate the actions to be performed in compliance with the orientations indicated by the plan.

ASN dedicated issue 190 of its "*Contrôle*" magazine to the subject of radioactive waste management, in order to present the issues and points of view of the different stakeholders regarding management of radioactive waste in France.

Management of sites contaminated by radioactive substances consists in establishing and implementing rehabilitation of sites on which an activity has led to contamination of the environment or to radiological pollution (sometimes a legacy) after handling of radioactive materials or use, without the intention to make use of their radioactive properties, of naturally radioactive materials.

1 RADIOACTIVE WASTE MANAGEMENT PRINCIPLES

Like any human activity, nuclear activities generate 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 routes.

The basic principle enacted by current regulations is to optimise the quantity and nature of the waste produced by 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 further continues through identification, sorting, processing, packaging, transport, interim storage and final disposal. All of the operations associated with the management of a given category of waste, from its production through to final disposal, form a "route" Each route must be appropriate to the nature of the waste handled.

The operations within each route are interlinked and all the routes are interdependent. These operations and routes 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 a nuclear activity;
- waste from activities employing radioactivity, but formerly exempted from regulations, comprising sufficiently significant concentrations of radioactivity, or from items that 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 as regard to radiation protection;
- uranium ore processing residues disposed of in classified installations.

The PNGMDR also defines the status of recoverable materials (uranium, thorium, plutonium) and requires that this status be periodically reviewed.

1|1 Radioactive waste management channels

Radioactive waste varies considerably by activity level, half-life, volume or even nature (scrap metal, rubble, oils, etc.) depending on the type. Each type of waste requires treatment and a long-term management solution that is appropriate, 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. A distinction is

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

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

therefore made between very low, low, intermediate and high level wastes on the one hand, and between 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 routes: it shows that for certain wastes there is, at present, no final disposal solution.

Very short-lived waste

Medical uses of radioactivity, generally, involve very short-lived radioelements. The waste resulting from these diagnostic or care activities is collected and stored for a time, allowing the radioactivity to decay sufficiently (generally by about ten half-lives) before it is disposed of via the conventional hospital waste disposal systems.

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 level of this waste is about a few Becquerels (Bq) per gram. The management solution adopted for it is disposal in a very low level radioactive waste disposal facility (repository). This disposal route was created to apply the management strategy adopted for this very low level waste and which is specific to France. This represents a rejection of the concept of unconditional clearance of wastes, even the least radioactive.

Short-lived intermediate and low level waste

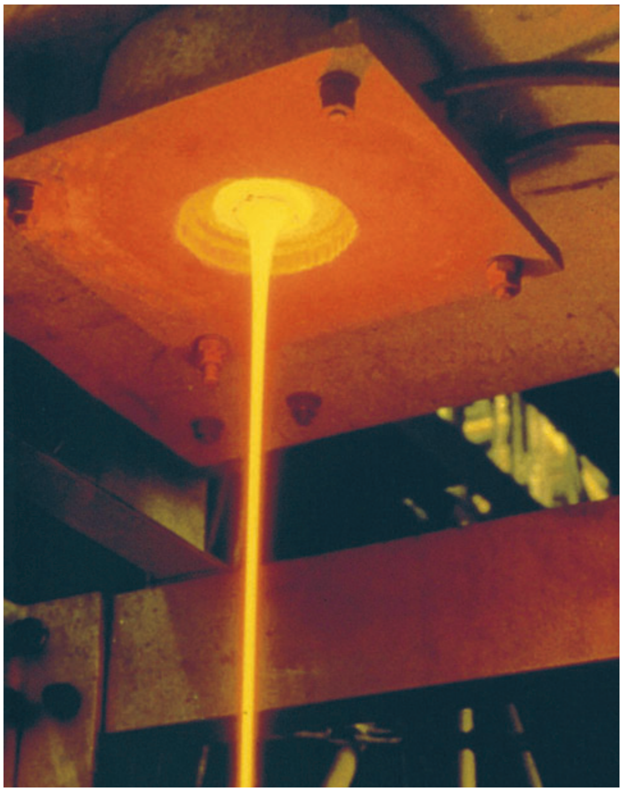
The activity of short-lived intermediate and low level waste is mainly due to radionuclides emitting beta or gamma radiation, with a half-life of less than 30 years. The activity of this waste is between a few hundred Bq per gram to 1 million Bq per gram. In this waste, long-lived radionuclides are strictly 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 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 route has been operational since 1969, when France was the first country to decide to cease its participation in the VLL waste immersion operations organised by the OECD. At that time, 14,300 m^3 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 route 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 because the radioactivity they contain is often highly concentrated and in spite of the relatively short lives of the radioactive elements they contain, they cannot always be accepted in surface storage facilities. This is because, given their initial levels of activity, they may retain a significant level of radioactivity which must be taken into account in a scenario for the potential recovery of such objects from a repository after 300 years. Furthermore, their cladding is often made from inoxidisable metals that could be attractive to people digging in the repository.

However, since 2007, it has been possible to dispose of certain sources in low and intermediate level waste disposal facilities (CSFMA). These are short-lived sources with a half-life of 30 years or less, with activity levels below certain thresholds determined on the basis of the radionuclides concerned. For other sources, the French National Agency for Radioactive Waste Management (ANDRA) released a study on the sustainable management of used sealed sources establishing the different disposal solutions that could be envisaged and the associated criteria (notably activity and nature of radionuclides) for acceptance of the different categories of sources. In 2009, ASN



Vitrification of a solution of fission and activation products in the La Hague plant

approved the broad outlines of this strategy but issued a number of additional requests. In compliance with the recommendations issued by ASN, the 2010–2012 PNGMDR requires studies to be conducted to establish the processes that will allow appropriate packing of sources before their storage (with prior treatment if necessary).

In addition, some wastes contain significant quantities of tritium, a short-lived radioelement, that is difficult to contain owing to its mobility. In the light of the acceptance criteria for ANDRA's repositories, this waste cannot be accepted owing to its tritium content. The management routes chosen consist in storing it for a long enough period to allow radioactive decay (the half-life of tritium being nearly 12 years) before disposal. As required by decree 2008-357 of 16 April 2008 applying article L. 542-1-2 of the Environment Code and setting requirements relative to the PNGMDR, the French Alternative Energies and Atomic Energy Commission (CEA) produced a study inventorying the tritiated waste produced in France and proposing options for the design and sizing of future installations per family of waste (six in all) to allow storage for several decades. In particular, the PNGMDR incorporates the recommendations made by ASN in its report on these studies and its decree of application will stipulate both the need for creation of such storage facilities and the conducting by ANDRA of a study to specify the procedures for management of solid tritiated wastes from activities other than the nuclear industry.

Long-lived low level waste

This waste usually comes from industrial activities leading to concentration of naturally occurring radioactive materials (the former radium industry for example), or from the nuclear industry (such as the irradiated graphite contained in the structures of the former 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 level 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 monitoring. However, its low level of intrinsic hazardousness could lead to subsurface disposal being envisaged at a depth of at least fifteen metres. ANDRA is studying the disposal concepts for these wastes and is pursuing the search for a repository site on the basis of the safety orientations defined by ASN for search for a disposal site for waste with low specific activity and long life.

Intermediate level long-lived waste 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, effluent 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. These wastes, which are vitrified, are characterised by the high levels of residual heat (as much as 4 kW per 150-litre container). This high level waste also includes fuel irradiated in CEA research reactors, together with EDF spent fuel which is not to be reprocessed. The activity level of this waste is of several billion 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 in chapter I of part IV of the Environment Code and its implementation decrees, concerning waste disposal and recovery of materials. The basic principles enacted by the Code are the prevention of waste production, the responsibility of the waste producers up until disposal, the traceability of this waste and the need to inform the general public. The Code was supplemented by act 91-1381 of 30 December 1991 on research into radioactive waste management, known as the "Bataille" Act, which established a framework for research into long-lived high level waste and by the act of 28 June 2006. 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

UNDERSTAND

Definitions

Among radioactive substances, some are considered to be recyclable while others are considered as waste. Thus, in the sense given in the Environment Code, "radioactive materials" are radioactive substances for which a subsequent use is planned or envisaged, after processing if applicable. In the nuclear electricity production process, for example, the spent fuel still contains materials that can be used. These materials are treated to extract uranium and plutonium in particular from them. "Radioactive wastes" are "radioactive substances for which no subsequent use is planned or envisaged".

research into long-lived high level and intermediate level waste. It reaffirms 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 act of 28 June 2006 augments ANDRA's duties, in particular the public service requirement to rehabilitate sites contaminated by radioactive substances and to collect waste for which the responsible party has defaulted. Finally, the act of 28 June 2006 sets a clear legal framework for securing the funds necessary for decommissioning and for the management of radioactive waste (see chapter 15).

As part of the review of the regulatory regime applicable to BNIs, a number of technical measures concerning the production of waste in the installations, its packaging and the storage and disposal of radioactive waste will be clarified by ASN regulatory decisions.

Production of radioactive waste in basic nuclear installations

Management of radioactive waste from BNIs is established, notably by a ministerial order of 31 December 1999 establishing the general technical regulations intended to prevent and limit the detrimental effects and external hazards resulting from the operation of BNIs. This order reaffirms the need for the licensee to take all necessary steps in the design and operation of its installations to ensure optimum management of the waste produced, taking account of the subsequent management solutions. The order is currently under review. An ASN decision, placed on the ASN website for consultation in 2010, will complete the requirements relative to the modalities of management of wastes arising in BNIs.

Production of radioactive waste in other activities using radioactive materials

The provisions mentioned in decree 2002-460 of 4 April 2002 concerning the general protection of persons against ionising radiation have been incorporated into the Public Health Code. Article R. 1333-12 of this Code states that 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 radiation 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 route regulation

Regulation of the waste management routes requires on the one hand traceability of radioactive waste processing and disposal operations, and on the other detection of the presence of radioactive waste upstream from any processing 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 processing circuits. The order of 30 October 2006 establishing the content of the registers mentioned in article 2 of decree 2005-635 of 30 May 2005 on monitoring of waste treatment circuits and radioactive waste monitoring statements mentioned in article 4 targets radioactive waste more specifically.

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 routes.

1|3 Very low level radioactive waste management principles

Some European countries have implemented a policy establishing clearance thresholds for VLL waste on the basis of upper activity thresholds, an option that is allowed by Council Directive 96/29/Euratom of 13 May 1996 on radiation protection. French doctrine does not provide for unconditional clearance of VLL waste on the basis of universal threshold values, to avoid dissemination of radioactivity in manufactured products. This leads to specific management of this waste and disposal of it in a dedicated repository.

Waste management in the BNIs is, primarily, regulated by the order of 31 December 1999, amended. The order requires each BNI licensee to submit a study (known as the "waste study") to ASN stipulating the procedures for management of wastes produced in the BNIs and which addresses the risk of production of contaminated waste, activated or likely to become so. "Zoning" of the installation is therefore established, subject to approval by ASN. Two types of zone can be distinguished. 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 via routes specific to radioactive waste. The waste from the other zones is, after checking that there is no radioactivity, sent to conventional waste routes (non-specific or special industrial waste). A guide for drafting of the BNI waste studies is available on the ASN website. Reuse of wastes from the nuclear waste zones is only possible in nuclear installations: for example, in the form of shielding inside waste packages.

1|4 European regulations harmonisation work within WENRA

The Western European Nuclear Regulators' Association (WENRA) was created in 1999.

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 (see chapter 7).

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) is more specifically tasked with defining reference levels concerning the safe interim storage of radioactive waste and spent fuel and nuclear installation decommissioning operations. In 2010, it extended its work to include definition of the reference levels applicable to the disposal of radioactive waste in repositories.

Draft versions of 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 members at the beginning of 2006, in order to collect the opinions of the stakeholders before they were enshrined in national regulations. The comments received led the WGWD to revise these reference safety levels. A new version of the reference levels for storage of radioactive waste and spent fuels was thus made available for consultation in 2010. The main requirements concern the necessity of stipulating the responsibilities of owners of wastes or fuels and of storage facility licensees, ensuring that storage is reversible, and monitoring of the wastes and fuels to detect any degradation and take appropriate action.

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 nuclear regulator and that decommissioning be designed into the nuclear installation in order to facilitate all the operations as and when the time comes. In 2010, the WGWD's efforts concentrated on updating of the reference level for decommissioning.

The new regulatory texts currently being prepared (order and ASN decisions) already include the WENRA reference levels whenever possible.

1|5 Stakeholders and responsibilities

Waste producers must also constantly endeavour to minimise the volume and activity level of their waste, at the front-end through design and operating provisions and at the back-end through appropriate waste management. Each producer is responsible for the waste until disposal in a duly authorised installation. However, other 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);
– licensees of storage or disposal centres (CEA, EDF, AREVA NC, ANDRA). The act of 28 June 2006 tasked ANDRA with the long-term management of the repositories. ANDRA also has a public service obligation to store waste for which no disposal route 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, notably with regard to processes of characterisation, treatment and packaging of waste.

In this context, ASN drafts regulations governing radioactive waste management, regulates the safety of the BNIs 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, processing, packaging, interim storage, transport and disposal);
– safety of the overall radioactive waste management strategy, ensuring overall consistency;
– the setting up of routes adapted 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.

In the performance of its duties, ASN calls, in particular, on the services of IRSN.

Other parties are involved in evaluating the implementation of radioactive waste management policy, particularly the National Review Board (CNE), created by the act of 30 December 1991. This group of scientific personalities was initially tasked with reviewing the findings of research into the management of high level, long-lived radioactive waste. The act of 28 June 2006 confirmed that the second National Review Board (CNE2) had all of the duties of the first Board. The act also extended its duties by including in its evaluations the sustainable management of radioactive materials and wastes, in line with the orientations established by the PNGMDR. In addition, the COSRAC (Committee for the Monitoring of Research on the Cycle Back-End) comprising the various research and industrial parties involved (CEA, ANDRA, CNRS, AREVA, EDF) and the ministries concerned, is coordinating the research being done on radioactive waste.

1|6 ANDRA national inventory of radioactive waste and reusable materials

Article L.542-12 of the Environment Code, as amended by the act of 28 June 2006, tasks ANDRA with "establishing, updating every three years and publishing the Inventory of radioactive materials and waste present in France, along with their location on the national territory".

The 2009 national inventory, published in June 2009, presents the stocks of waste and materials as at the end of 2007, plus the forecasts for the end of 2020, the end of 2030 and at the end of the lifetime of the existing facilities. The inventory also lists the storage capacity for HLW, ILW-LL, LLW-LL, radium and tritiated waste, as well as the storage capacity needs for disposal of HLW and ILW-LL waste in deep underground repositories. Finally, the inventory presents the stocks of radioactive materials, information about sites polluted by radioactivity and mining residue disposal sites. ASN takes part in the steering committee of the national inventory of radioactive waste and recoverable materials. The national inventory is a source of information for drafting the PNGMDR.

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

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 requirements concerning wich are established by decree.

In 2009, ASN, working with the General Directorate for Energy and Climate (DGEC), co-directed the drafting of a second PNGMDR for the 2010–2012 period; a summary was disseminated and published on the ASN's website, as recommended by the French Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPESCT). The new edition of the PNGMDR has been updated on the question of recoverable materials (see box in point 1.2) and regarding the overall coherence of the nuclear fuel cycle. A decree and application order will stipulate the actions to be taken in line with the orientations established in the 2010-2012 PNGMDR. Orientations are based mainly on the opinion communicated by ASN to the minister in charge of ecology on 25 August 2009 concerning the studies undertaken to respond to the recommendations of the first plan. In this context, ASN, in July 2009, sent the ministers in charge of health and ecology a round-up of the management solutions put in place for wastes containing enhanced naturally radioactive substances as well as proposals to improve waste management from the radiation protection point of view.

TO BE NOTED IN 2010

The European Commission adopts a draft directive on management of radioactive waste and spent fuel

On 3 November 2010, the European Commission officially adopted a draft directive on the management of radioactive waste and spent fuel. The document will now be submitted to the European Council and to the European Parliament which will study the terms of the proposal.

In line with the Commission, ASN is of the opinion that there is a need to establish a European regulatory framework devoted specifically to management of radioactive waste and spent fuel. It therefore supports the steps undertaken at the European Community level aimed at the adoption of a directive in this area.

The Authority considers that the directive proposed to the Commission constitutes real progress by defining a binding legal framework within the EU that is based on internationally recognised safety standards. In this regard, ASN has been closely involved in the preparatory work carried out within the European Nuclear Safety Regulators' Group (ENSREG) and which led to the proposal to the Commission of a draft directive on management of radioactive waste and spent fuel.

ASN feels particularly that the setting up in each Member State of a competent regulatory authority in the field of safe management of waste and spent fuel with sufficient financial and human resources to achieve its ends, would be an important step forward. Similarly, the conditions relating to transparency and peer review, and to the establishing of a national radioactive waste management plan would represent progress for the EU. On this latter point, ASN, which participates in the drafting of the national plan for radioactive waste and spent fuel management (PNGMDR), is of the opinion that the introduction of such a plan in each Member State would be a major development.

The 27 Member States and European Parliament are now beginning negotiations on the text in Brussels. ASN, whose competence in the area of safety of management of waste and spent fuels is recognised by the act of 28 June 2006 (known as the "Wastes" Act) will follow developments closely.

ASN views the PNGMDR as a veritable control tool and a roadmap for management of all radioactive wastes, regardless of their level of activity or their type. The PNGMDR also allows meaningful dialogue on these issues and contributes to transparency and availability of information. ASN thus notes with satisfaction that the draft European directive on radioactive waste management requires each Member State to develop such a plan.

Table 2: volumes of radioactive waste stored or disposed of as at end of 2007, in equivalent packaged m³

Waste categories	Volumes (m³)
Very low level	231,688 (including 89,331 disposed of)
Low and intermediate level - short-lived	792,695 (including 735,278 disposed of)
Low level – long-lived (LLW-LL)	82,536
Intermediate level– long-lived (ILW-VL)	41,757
High level waste (HLW)	2,293 (including 74 of spent fuel)
Management route to be defined	1,564
Total	1,152,533 (including 824,609 m³ disposed of)

Table 3: anticipated quantities of radioactive waste stocks as at end of 2020 and 2030, all sectors

(in equivalent packaged m³)	Existing volumes as at end of 2007	Existing volumes as at end of 2020	Existing volumes as at end of 2030	"Committed waste"[1]
HLW	2,293	3,679	5,060	7,910
ILW-LL	41,757	46,979	51,009	65,300
LLW-LL	82,536	114,592	151,876	164,700
LILW-SL	792,695	1,009,675	1,174,193	1,530,200
VLLW	231,688	629,217	869,311	1,560,200
TOTAL	**1,150,969**	**1,804,142**	**2,251,449**	**3,328,310**

Tables 2 and 3 are taken from the National Inventory of radioactive materials and waste published by ANDRA, 2009 edition.

1."Committed waste" is the waste that will be produced by all the current installations up to the end of their lives, assuming the continued production of nuclear generated electricity.

2 MANAGEMENT OF RADIOACTIVE WASTE BY THE PRODUCERS

2|1 Waste management in basic nuclear installations

Once produced and before final disposal, certain categories of radioactive waste undergo treatments to reduce the volume or harmfulness of the waste 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 a reduction target for the quantity of waste produced.

The following sections examine the situation of BNIs.

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 routes (reprocessing, elimination by incineration or melting, disposal in approved surface repositories) are removed accordingly (installations of the CEA, Centraco, repository, etc.). Long-lived intermediate and high level waste is generally stored by CEA in installations with a lifespan limited to a few decades, pending creation of a long-term disposal route. 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 level, 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 difficulties as regard to their treatment, or for which there is no operational disposal route. Nuclear fuel without further use from the civil sectors of CEA is placed in interim storage, either in dry storage or in a pool, pending definition of a management route (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 shut down 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 2010, ASN noted, however, that there had been occasional progress with some projects, in line with the licensee's commitments and especially concerning the licensee's "major commitments" on nuclear safety and radiation protection (see chapter 14). ASN observed, for example, that action had been taken to recover waste from the BNI 56 at Cadarache but also noted that delays with these operations have nonetheless accumulated for technical reasons.

ASN also underscored the difficulties experienced by CEA in implementation of new installation projects or projects for upgrading of existing installations dedicated to radioactive waste management. For instance, commissioning of the Stella installation, is already delayed, will only be accomplished in stages owing to difficulties relating to production of waste packages; the request for authorisation to create the Diadem installation, dedicated to handling of irradiating or alpha-emitting waste and waste from decommissioning, was postponed by CEA. Commissioning of the installation will now take place by mid-2016 at the earliest. ASN has also noted delays in commissioning of the Agate installation at the Cadarache centre.

ASN is also concerned by the future of the Cadarache effluent and waste treatment plant (BIN 37 STED). CEA is considering extending operation of the BIN 37 STED by implementing a safety improvement programme (work to bring the facility into compliance, especially with regard to seismic risk, clean-out and decommissioning of parts not used for production). A part of the STED and STEL installations will be decommissioned. Given the central role of BIN 37 in CEA's radioactive waste management strategy, the proposed improvements to the installation's safety will be the object of particular attention on the part of ASN, as well as of examination by the Advisory Committee of Experts (GPE) in 2012.

CEA also informed ASN that there would probably be a delay in removal from storage of the drums containing plutonium in the PEGASE facility, owing to problems with manufacturing of the repackaging containers for this waste.

Interim storage hall of BNI 72 (Saclay)

Given the developments in CEA's waste management strategy, both in terms of organisation and projects for new or upgraded installations, ASN expressed the wish to re-examine all of CEA's activities relating to management of wastes from its BNIs and SBNIs, of spent fuels and used sealed sources. Accordingly, in March 2010, CEA forwarded its strategy for management of solid wastes, liquid effluents and spent fuel from civil CEA. ASN, jointly with the authority for defence-related nuclear safety (ASND), will decide, by the first quarter of 2012, on its position on management of CEA wastes and spent fuel, after examination of the file by the relevant Advisory Committees, paying particular attention to the orientations adopted for key waste management installations.

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 has initiated a waste recovery program as part of the delicensing of 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 STAR 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 Aube waste repository. The waste is stored there in pits, in warehouses and, for the VLL waste, in a dedicated area. Operation of the CEDRA installation (radioactive waste packaging and interim storage unit), for which creation on the Cadarache site was authorised by decree[2] in 2004, will make it possible to empty the recent pits in BNI 56 and the warehouses, and to retrieve waste stored in older pits.

On 20 April 2006, the Ministers for Industry and the Environment authorised start-up of Cedra unit 1.

At Cadarache, CEA also operates the Pegase and Cascad installations, making up BNI 22.

Pegase is an installation mainly storing irradiated fuel elements and radioactive materials 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 ensure compliance to allow continued operation of this installation, CEA, in December 2004, proposed final shutdown of the installation; this should take place 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 drums of plutonium-bearing materials for storage in Cedra. On 28 January 2008, CEA notified ASN of installation of the recovery equipment. This project, which began in 2009, should allow CEA to finalise removal of the plutonium containing drums from the Pegase installation.

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. This file was reviewed by IRSN. Further to this technical review, ASN established its position at the end of 2009 on continued operation of the installation, on condition of compliance with requirements, notably concerning acceptance in the installation of certain type of fuels.

In November 2007, CEA sent a safety option report 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 report on 1 July 2008, indicating that it had no objection to continuation of the process leading to creation of the installation, subject to the provision of a certain amount of additional information.

CEA informed ASN of a delay in submission of the request for authorisation file for DIADEM, which should take place at the end of 2011.

Recovery of CEA legacy waste

A part of the Cadarache interim storage facility consists of five 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.

CEA will resume the work to recover the waste from Trench T2 at the start of 2011, after interruption due to doubts about the stability of the mound's foundations and walls. To protect operations in trenches, CEA is to install a geotextile to protect against rock falls or localised slips.

Finishing of extraction of the legacy waste from Trench 2 is postponed until the end of 2011.

For the other trenches, CEA's approach is to reduce human intervention in the trenches and to favour a single, fixed packaging unit for the other four trenches. However, ASN notes that CEA's initial aim of completion of work in 2013 will probably not be achieved, as recovery from trenches T1, T3, T4 and T5 is planned after the work on T2, in order to benefit from the operating feedback from T2.

In its old pits, BNI 56 also stores intermediate level waste in conditions which no longer meet current safety standards. In April 2009, ASN also approved the recovery operations from pits F5 and F6, provided that certain reservations are taken into account.

Recovery of waste from older pits, some of which contain alpha-emitting radionuclides, is technically fairly complex. ASN

2. Decree n° 2004-1043 of 4 October 2004 authorising CEA to create a BNI known as CEDRA in the municipality of Saint-Paul-lez-Durance, France.

Interim storage hall of the vitrification facility R7, on the La Hague spent fuel reprocessing site

will pay particular attention to the quality of the technical solutions used on the site to recover the waste from pits F1, F2 and F4, for which it already appears evident that major technical resources will have to be used.

2|1|2 AREVA NC waste management

Description of waste produced by AREVA

The spent fuel reprocessing plant at La Hague produces most of AREVA's radioactive waste.

The waste produced at La Hague comprises on the one hand the waste resulting from reprocessing of spent fuel from the nuclear power plant licensees and on the other, the waste linked to operation of the installations. Most of this waste remains the property of the licensees of nuclear power plants (French, such as EDF, or foreign) which have their spent fuel processed. 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 incinerated 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 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 effluent treatment
The La Hague site has two radioactive effluent treatment stations (an older one, STE2, and the more recent one, STE3). The effluents are treated there by chemical co-precipitation. 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. In September 2008, subsequent to the meeting of the Advisory Committee to deal with the BNI 118 safety review, ASN issued a decision banning bituminisation of the STE2 sludges and asked AREVA to continue to look for an alternative process to bituminising for sludge recovery. These sludges, representing 3,400 tons of salts, were produced between 1966 and the late 1990s in the UP2 400 plant and the CEA research centres. After technical studies, AREVA selected the C5 standard package as an alternative to the bituminisation process. This package should be able to meet the requirements of the act of 28 June 2006 requiring recovery of the IL-LL legacy waste by 2030. It should also enable the final volume of the waste to be reduced by comparison with the bituminisation protection. The package consists of compressed pellets placed in a container in which the remaining void is filled with an inert material (sand). Manufacture of this package will require ASN approval. ASN will first of all rule on whether or not any aspects disqualify the C5 package in terms of safe storage and disposal. This opinion will be required before detailed design studies can start on preparation of the facilities for the alternative process to bituminisation.

– 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 meet the criteria for the Aube repository. Production of the packages was suspended in 2007, after ANDRA found a fault in their quality. The appraisal carried out by AREVA showed a modification to the process was the reason for the anomalies detected. Changes were made, enabling production to resume. During suspension of production, effluents were stored in tanks provided for the purpose, their capacity and safety conditions having been judged satisfactory by ASN. ASN reminded the licensee of the need to carry out impact assessments on the effect of the modifications on the quality of the waste packages.

– 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.

– 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 did not permit this

restriction to be lifted. AREVA sent ASN a further authorisation application for introduction of dissolver bottom debris into CSD-C packages, together with the justification file. ASN should establish its position on this file in the first half of 2011.

– Other technological waste
The technological waste is sorted, compacted and encapsulated or immobilised 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 Mélox plant, AREVA NC proposes introduction of a compacting process and creation of an installation in addition to the existing one. This strategy also includes the use of STE3 disposal cells for this type of drum, pending the availability of the new installation. In early 2009, AREVA sent a draft specification for the S5 package for packaging in compressed form of technological wastes coming mainly from the La Hague and Mélox plants. In its decision 2010-DC-0176 of 23 February 2010, ASN considered that the S5 package did not offer a sufficient guarantee for long-term storage and for deep geological formation disposal. ASN has asked AREVA to carry out studies that should lead to a physical-chemical form and resistance to leaching that comply with repositories' safety requirements.

ASN also noted recurring delays in recovery of older wastes from La Hague and the lack of an integrated view for the ranking of projects for recovery of these wastes in light of the safety issues surrounding storage. At the end of 2010, the Authority therefore asked AREVA to draw up and present to ASN a consolidated and binding schedule for recovery of these wastes that encompasses both compliance with storage safety requirements and the necessity for recovery of ILW-LL by the end of 2030 at the latest.

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 sent ASN Specification 300 AQ 59 Rev. 0A, applying to the vitrified packages referred to as CSD-U. This is a package used to contain fission product solutions from processing on the La Hague site between 1966 and 1985 of GCR fuels of the UMo (molybdenum alloy) and MoSnAl (molybdenum, tin and aluminium alloy) types. 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. ASN's decision on the CSDU waste package should be given in the first half of 2011.

Specification 300 AQ 60 Rev. 00 applies to CSD-V packages with high actinide content produced using "hot crucible" technology. AREVA has obtained ASN's agreement on production of this package, pending the results of studies to characterise the behaviour of the glass. In July 2008, AREVA sent ASN additional information in order to obtain authorisation to continue production beyond 31 December 2008. ASN issued the authorisation in a decision of 16 December 2008. Production of the CSD-V using the cold crucible process will be the subject of a new authorisation request that will be forwarded to ASN in 2011.

Specification 300 AQ 061 Rev. 0A applies to the CSD-B package resulting from packaging using vitrification of intermediate level effluents, resulting primarily from rinsing operations carried out for 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. AREVA sent ASN a production authorisation application for this package so that it could begin active production testing. ASN authorised production of this package at the end of 2009.

The COMURHEX waste installation in Malvési

The waste produced by the installation is stored on the Malvési site in former settling ponds named B1 and B2. This waste primarily contains natural radionuclides. Nonetheless, some traces of artificial radionuclides, resulting from the spent fuel reprocessing which took place in the installation until 1983, were detected in the ponds. The presence of artificial radionuclides in the waste implies that storage is covered by the BNI regime.

In compliance with the ASN Commission's decision of 22 December 2009, the COMURHEX company submitted license application for the creation of a BNI at the end of 2010. A safety options file was submitted by the licensee on 1 March 2010. The perimeter of this new BNI, proposed at this stage by the licensee, follows the foot of the bund wall around ponds B1 and B2. In the file, the licensee also presents the works that will be carried out beyond the BNI perimeter (of which the purpose is to limit releases of radioactivity into the environment) and the project for covering of ponds B1 and B2. In a letter of 13 September 2010, ASN indicated to the licensee that it saw no objection to continuation of the work, but that additional information and justification concerning the stability of the block, control of underground flows, covering of the ponds and monitoring of the BNI should be provided when submitting the file requesting authorisation for creation.

Ponds B1 and B2 are already subject to ASN regulation. Two inspections were carried out in 2010, of which one addressed environmental monitoring. The organisation put in place by the licensee was deemed globally efficient, with an approach to improvement regarding monitoring that is in line with the development of knowledge.

2 | 1 | 3 EDF waste management

Description of waste produced by EDF

The waste produced by EDF nuclear power plants is 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.

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 produced in small quantities.

It is currently stored in the plant pools pending interim storage in the future ICEDA centralised installation on the Bugey site. Decree 2010-402 of 23 April 2010 authorised EDF to create the ICEDA installation. The draft authorisation decree for ICEDA received a favourable opinion from the ASN Commission at the end of September 2009. The function of this installation will be to process and store activated waste from the BNIs currently being operated by EDF, from the decommissioning of the first generation reactors and from decommissioning of the Creys-Malville plant. In 2010, ASN carried out inspections of the site to ensure satisfactory execution of some important operations relating to the civil engineering work.

Construction progress on the waste packaging and interim storage site (ICEDA) at Bugey – October 2010

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; in particular, low level waste is stored in the Morvilliers 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 former gas-cooled reactors (GCRs). This is low level, long-lived waste which is eventually to be disposed of in the corresponding ANDRA repository currently being planned. This waste is primarily stored in semi-buried silos at Saint-Laurent-des-Eaux.

Dismantling waste from plants being decommissioned

This is, essentially, very low level waste (metals or rubble) but also graphite waste (from stacks still present in GCRs).

EDF waste management strategy

EDF fuel use policy (see chapter 12) has consequences for the fuel 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 at the end of 2001 and early 2002.

ASN asked that the "cycle consistency" file be updated. The revised file was sent by EDF to ASN at the end of 2008. The file was examined on 30 June 2010 by the Advisory Committees for laboratories and plants and for waste, on the basis of a report presented by IRSN. Subsequent to this examination, ASN introduced two-yearly update notes to strengthen monitoring of the cycle and of developments in it, and required EDF to provide a "cycle" file updated to 2016.

The Saint-Laurent-les-Eaux silos

The Saint-Laurent-des-Eaux (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, as well as 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 route for the graphite waste by 2010, however the delay in the search for a host site is likely to put this deadline back to at least 2019. In response to ASN's request for development of an alternative strategy pending the availability of a disposal facility for graphite waste, EDF proposed, in July 2009, the introduction of a containment barrier around the silos. In July 2008, ASN approved the principle of the geotechnical containment proposed by EDF, provided that EDF submitted additional data, which it did in 2009. The geotechnical containment installation work was carried out in 2010. On 4 January, EDF provided ASN with a safety review file for this modified installation; this will be examined in 2011. Examination will include, notably, verification of the performance of the geotechnical containment.

2|1|4 Management of waste from other licensees

Examination of the waste management strategy of other BNI licensees is carried out by ASN on the basis of their waste studies (see point 1.3).

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, and notably 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 half-lives 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 gives rise to the production of solid waste: small items of laboratory equipment used to prepare sources (tubes, multiwell plates, gloves, etc.), medical equipment used to administer treatment (syringes, needles, cotton swabs, compresses which could be soiled with biological products, etc.), remains of meals consumed by patients having received diagnostic or therapeutic doses, etc. Liquid radioactive effluents also arise from source preparation (radioactive liquid residues, contaminated material rinsing water, scintillating products used to count certain radionuclides, etc.), as well as from the patients who excrete the radioactivity administered to them.

2|2|2 Management and disposal of radioactive waste and effluents

Faced with this problem of health care waste contaminated by radionuclides, which appeared with the growth of nuclear medicine, the public authorities have initiated a process of 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 2001/323 of 9 July 2001) 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.

The order of 23 July 2008 was published on 2 August 2008, concerning approval by the Ministers 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 management 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 the

Solid waste containers in the interim storage area of the nuclear medicine department – Nancy CHU – December 2010

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

circular of 9 July 2001 and contains measures with regard to:
– the development and approval of effluent 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 their 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 has finalised the drafting of guidelines for application of this decision, which will specify good practices for the management of waste and effluents resulting from nuclear activities outside BNIs. The guidelines were published on the ASN website at the start of 2011, to allow consultation by stakeholders.

2|3 Management of waste containing natural radioactivity

There is measurable natural radioactivity in the environment due to the presence of radionuclides that have been or are still being produced by various physical processes. As a general rule, this radioactivity leads to no significant risk. In France, exposure to natural radioactivity varies from region to region but is about 2.5 mSv/year on average.

2|3|1 Uranium mining waste

Uranium mines were worked in France between 1948 and 2001, producing 76,000 tons of uranium. Exploration, mining and processing work was carried out on about 210 sites in France spread over 25 *départements*. Ore processing however was only carried out in 8 plants. The management strategy currently being used is in-situ management given the very large quantities of waste produced; the current approach for improvement of this management consists in taking steps to reduce the long-term risk.

The uranium mine workings produced two categories of products:
– static or dynamic processing residues, which are the products remaining after extraction of the uranium from the ore. Such residues correspond to process waste (as defined by the Environment Code);
– mining waste rock, comprising the soil and rock excavated to access the minerals of interest. The waste rock with an average uranium content corresponding to the characteristic natural background level is differentiated from the barren rock consisting of the mineralised rock excavated when working a field, but which has insufficiently high content to allow processing at an economically acceptable cost.

From amongst the processing residues, two categories can be distinguished, in terms of their specific activity levels:
– 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 corresponding residues, produced by static leaching (about 20 Mt), are placed either in stockpiles, or in open-cast mines, or used as the first covering layer in dynamic processing residue disposal sites;
– 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, produced by dynamic leaching (about 30 Mt) are either placed in former 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 mining processing residues account for 50 million tons spread over 17 disposal sites, regulated as installations classified on environmental protection grounds.

The national inventory of uranium mine sites is part of the MIMAUSA programme (history and impact of uranium mines, summary and archives), overseen by the Ministry for Ecology. ASN is a member of the programme's steering committee.

The inventory is available from the following website: *www.irsn.fr.*

The inventory will be completed by an inventory of mining waste rock by 2014.

Article 4 of act 2006-739 of 28 June 2006 required that by the end of 2008, an inventory be produced of the long-term impact of uranium mining residue disposal sites, with the implementation if necessary of an enhanced radiological monitoring plan for these sites. 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. Nine mine sites were modelled in the study provided by AREVA at the start of 2009. ASN made known its opinion to the minister on 25 August 2009 (see ASN Opinion 2009-AV-0075). ASN considers that the study submitted by AREVA on the long-term impacts on health and on the environment of the disposal sites for mining residues resulting from former uranium ore extraction and processing installations constitutes a crucial milestone for verification of the safety of these disposal sites. However, ASN is also of the opinion that further analyses are needed to ensure a more robust long-term safety case for these sites. This work represents the first real application by a licensee of the approach officially set out in the circular from the Minister for the Environment on 7 May 1999 concerning the rehabilitation of uranium ore processing residue disposal sites. The study of the nine sites selected gives an initial quantified assessment of the long-term impact of mining residues on national territory and informs the public of these results. From the results of this study, the additional exposure of the population, assuming these disposal sites evolve normally, is less than 1 millisievert/year in the active surveillance phase. The conceivable exposure for scenarios with significant deterioration of the sites remains below a few tens of millisieverts/year.

The 2010–2012 PNGMDR specifies the additional analyses to be conducted by AREVA in the coming years, relative to:
– characterisation studies for mining residues from disposal sites other than those studied;
– the geomechanical assessment of the strength of the embankments surrounding the mining residue disposal sites, specifying the requirements for checking the long-term safety of these sites;
– the analysis of the results of the dosimetric impact assessment performed in 2008, in particular to study the feasibility and relevance of increasing the quality of the covering on all mining residue disposal sites;
– assessment of the dosimetric impact of the mining waste rock.

Moreover, subsequent to these studies and in line with the commitments made, AREVA has begun looking into the possibility of replacing the water covering at the Bois Noirs Limouzat site by a solid cover and has presented its action plan for monitoring former uranium mines.

Further to these actions, in a circular dated 22 July 2009, the ministry responsible for sustainable development and ASN established an action plan covering the following areas of work:
– controlling the former mining sites;
– improving understanding of the environmental and health impact of the former uranium mines and their surveillance;
– waste rock management: achieving a better understanding of its uses and reducing its impacts if necessary;
– improving information and dialogue.

At the end of 2009, AREVA began steps to consolidate the inventory of places where waste rock is reused, in order to detect any incompatibilities that might need to be remedied.

AREVA accordingly made measurements from a helicopter around the former mine sites in France.

A first fly-over stage took place in the Limousin region between November 2009 and end of April 2010. The second fly-over, in other regions, began in May 2010 and was completed by the end of 2010. The areas concerned are the *départements* of Saône-et-Loire, Allier, Puy-de-Dôme, Lozère, Loire, Nièvre, Morbihan and Vendée.

The data has to be subjected to statistical processing to identify the geographical areas that require ground verification. The first maps of Limousin were obtained at the end of September 2010. The results for Limousin are being processed and interpreted.

The ground reconnaissance and verification phase will continue until 2013.

The numbers of places where waste rock have been used will only be known after completion of all of the ground reconnaissance. ASN is particularly attentive to follow-up of these different phases and to any emergency situation that may be revealed.

The final report from the pluralistic expert group of the Limousin mining sites (GEP Limousin) was submitted to the ministry in charge of ecology and to the Chair of ASN on 15 September 2010, and a joint ministry and ASN press conference was held on 17 September 2010. The GEP Limousin's approach was to use detailed analysis of some sites in the Limousin area to develop a broader vision of the situation of former uranium mining sites in France. The GEP Limousin became aware of the difficulties arising from the legacy management of this file and of the considerable progress made in recent years to find solutions to those difficulties both for the Limousin area and nationally. The Group is of the opinion that progress should continue and be broadened in order to develop a clear perspective on the sustainable management of these sites over the next decade. The strategy to be implemented to achieve this must encompass the different aspects of the issue (technical, institutional, social) and must be supported by an effort to follow-up on actions. The strategy must be shared with local people and must allow for the specific nature of each area.

The ASN Chair and Ministry for Ecology have made a commitment to the GEP to examine the ways and means for implementation of these recommendations and to ensure follow-up as part of the remit of the working group on the PNGMDR.

2 | 3 | 2 Waste resulting from other activities

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. This is known as enhanced natural radioactivity. Most of these activities are (or were) regulated under the legislation on installations classified for the purposes of environmental protection (ICPE) (under Part I of Book V of the Environment Code).

Waste containing enhanced natural radioactivity can be accepted in various types of facilities, depending on its specific activity:
– in a waste disposal centre authorised by order of the *préfet*, if it can be proven that the waste activity level is negligible from a radiation protection viewpoint. The circular from the Directorate for the Prevention of Pollution and Risks (DPPR) of 25 July 2006 stipulates the conditions for acceptance of waste containing enhanced natural or concentrated radioactivity in disposal facilities. This circular comes with a methodological guide drafted by IRSN under the supervision of a steering committee made up of representatives of industry, disposal centre licensees, environmental protection associations, experts and Government departments. This circular states that enhanced natural waste must not constitute a majority of the waste received by the disposal centre;
– in ANDRA's very low level waste disposal facility;
– in a storage facility. Some of this waste is waiting for a disposal route, in particular the commissioning of a disposal centre for long-lived very low level waste. ANDRA is currently seeking a site for this disposal centre.

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 sites polluted as a result 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.

This extremely comprehensive study allowed refinement of the identification of potential sources of exposure of workers and the public to ionising radiation and was sent to the local, regional and national administrative bodies. In 2008, ASN continued to work with the Robin de Bois association, asking it to carry out a new study on the stores of legacy waste containing enhanced natural radioactivity and more particularly the stores of phosphogypsum and coal ash.

Under the terms of the PNGMDR, ASN, in July 2009, forwarded its report on the management solutions for waste with enhanced natural radioactivity to the Ministers for Environment and Health. The conclusions of this report do not call into question the existing management solutions. However, ASN also made recommendations for improvement of management of disposal of this type of waste. Most of the recommendations target ICPEs. On these matters, ASN is working with the relevant departments of the Ministry for Environment, notably regarding the uptake of these recommendations.

2|4 Management of incidental contamination

The obligation for systematic installation of radioactivity detection systems in disposal or recycling centres for "conventional" waste authorised by order of a *préfet* enables detection of the presence of radioactivity in the waste.

Initial feedback on the incidents that have occurred since 2003 led ASN, in 2003, to draft guidelines intended to be disseminated rapidly to all licensees of establishments in which the presence of radioactive elements had been found. These situations are to be the subject of a declaration to the relevant authorities.

ASN has also extended to the small-scale nuclear activities the principles of notification of the public authorities concerning significant events involving safety, radiation protection or the environment that already apply to BNIs and radioactive material transport. ASN thus defined a number of criteria which should lead to the notification of significant events in the field of radiation protection, along with the corresponding notification form. In particular, anomalies in waste management must lead to the declaration of significant events.

UNDERSTAND

Mining residue disposal sites

Mining residue storage sites have been set up near uranium ore treatment facilities in former open-cast mines or in basins closed by an encircling dyke or behind a dyke blocking off a thalweg. These storage sites can cover surface areas varying from a few hectares to several tens of hectares, and enclosing from a few thousand to several million tonnes of residues.

Following the gradual closure of the mining works, the redevelopment of these sites consisted in placing a solid cover over the residues to provide a geomechanical and radiological protection barrier to limit the risks of intrusion, erosion, dispersion of the stored products and the risks relating to internal and external exposure (radon) of the neighbouring populations. The radioactivity measurements carried out on the storage sites give values of the same order as the measurements taken in the environment of the site.

3 LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

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

The VLL waste management streamlining process initiated by ASN in 1994 indicated the necessity for the creation of a disposal site for this type of waste. At the request of the nuclear licensees, technical studies were 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 chosen. This 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 authorisation, granted by a supplementary order of the *préfet* on 21 July 2006, enables ANDRA to take account of experience 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. The principle underlying operation of these repositories is the confinement and protection of the waste from hazards, notably water circulation, during what is known as the surveillance phase (by convention 300 years) until such time as its 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) occupies an area of about 15 hectares at the end of the La Hague peninsula. 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 placed under ANDRA's responsibility on 24 March 1995. CSM operations ceased in July 1994. The repository entered the surveillance phase in January 2003 (decree 2003-30 of 10 January 2003 authorising ANDRA to modify the Manche radioactive waste repository – BNI 66, located within the municipality of Digulville-Manche to allow it to enter the surveillance phase).

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. ANDRA also submitted the final safety report as well as the surveillance plan for the facility.

In accordance with the recommendations of the commission assessing the situation of the Manche repository (known as the "Turpin Commission"), in March 2008, ANDRA drafted an interim version of the "Concise History" intended to preserve essential information about the repository for future generations.

Aerial view of the Manche repository

These documents were presented to the Advisory Committee for waste in December 2009. At the beginning of 2010, ASN established its position on the additional measures to be taken by ANDRA for step-by-step installation of the new covering layer, but also for enhancing the environmental monitoring of this centre and consolidating the work being done on preserving records about the repository.

ASN therefore requested that the surveillance effort be maintained and knowledge of the long-term behaviour of the repository be further developed. A progress report on engineering of the repository cover is to be presented to ASN within 5 years. In addition, ANDRA will organise exercises to test the system for maintaining the site history.

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 experience feedback gained from it. Licensed by decree in September 1989[3], this installation, located in Soulaines-Dhuys (Aube *département*) offers a storage capacity for 1,000,000 m^3 of waste located in 400 storage units. Operations performed comprise packaging of the waste sent by its producers, either by injecting mortar into the 5 or 10 m^3 metal containers, or by compacting the 200-litre drums.

Waste containment is achieved by three consecutive barriers: the package, the covering and the ground in which the repository is engineered. The repository's activities therefore generate a very small quantity of radioactive effluents. These are regulated by the order of 21 August 2006 authorising ANDRA to discharge liquid and gaseous effluents and to abstract water for the Aube repository (BIN 149).

In 2006, ASN issued an opinion in favour of extension of the disposal activities to the zone not yet used and asked for additional safety studies on the risks of explosion and fire, and for estimation and monitoring of the impact of long-lived radionuclides and chemically toxic substances. In August 2008, ANDRA sent ASN its response to the recommendations made by the Advisory Committee and to ASN's requests. The general operating rules were revised in 2009 to take account of modifications made following the revision of the safety report and were approved by ASN in March 2010, after IRSN had made known its recommandations.

After approval by ASN of the design modifications, ANDRA, in 2009, began the construction of a new Tranche (Tranche 8) consisting of seven lines of structures. The extension of the disposal area required adaptation of the radiological, physico-chemical and piezometric monitoring of the groundwater in the Aptian sands. At the end of 2010, the situation in terms

3. Draft decree amending the decree of 4 September 1989 authorising the Commissariat à l'énergie atomique (i.e. ANDRA) to create a radioactive waste disposal facility at Soulaines-Dhuys and La Ville aux Bois (Aube *département*).

of operation of the repository was as follows: 120 storage structures have been built, of which:
– 104 are completely filled with packages,
– 6 are in use,
– 110 are awaiting use.

In addition, 33 structures are being built in Tranche 8. In 2010, a health investigation was carried out around the repository by the Health Monitoring Institute (InVS) at the request of the "Citoyens du Coin" interest group and local elected officials. The results of the study were communicated to the Soulaines CLI at the end of October 2010. In view of the results, which did not indicate any link between the repository and any possible effects on health, it was decided not to push this investigation any further. Conversely, to respond to the population's concerns, trends in incidences of cancer, especially lung cancer, will continue to be monitored.

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 rule establishes the roles of waste producers and of ANDRA, the main requirements for waste packages as well as the procedures for approval of waste packages by ANDRA.

As part of this, ANDRA draws up general and specific specifications for each type of package (dimensional, physical, chemical, radioactive and other characteristics). For their part, waste producers justify the measures taken to comply with specifications by means of technical tests and organisational procedures. This system undergoes initial assessment, followed by periodic assessment by the producer, ANDRA and ASN, which may lead to approval suspension or revocation. A report on the quality of waste packages received at the repository is forwarded each year to ASN, which is also informed systematically of measures taken by ANDRA when the quality of packages is such that they cannot be accepted.

As part of the review of the safety of CSA, conducted in 2006 by the Advisory Committee for waste, ANDRA has made a commitment to ASN to revise the specifications for acceptance of packages. This revision, initially planned for 2010, should be completed in 2011.

ASN is particularly attentive to the strategy implemented by ANDRA to check the quality of the packages accepted in its repositories. In addition to traditional quality control, ASN also reaffirmed the need for ANDRA to continue to conduct "super-inspections" (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 relatively 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 for this type of waste are thought to be not very 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, also 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* which in principle offer potentially favourable geology. This type of sub-surface disposal centre (several tens of metres deep) 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 planned repository. As part of the site selection process, the Government consulted ASN and the National Review Board about the analysis methodology adopted by ANDRA. ASN had analysed this methodology in light of the general safety guidance memorandum for the LL-LL waste disposal site search which it published in June 2008, and it sent the minister its opinion on 15 January 2009. ASN stated that there was nothing, from a geological standpoint, to rule out continued investigation into the siting of a LL-LL waste repository on one of the sites classified by ANDRA as geologically "very interesting" and that the capacity of the sites to host a disposal facility should be confirmed on the basis of the results of detailed investigations.

In June 2009, ANDRA announced the Government's decision to conduct detailed investigations on two *communes* in the Aube *département* Auxon and Pars-lès-Chavanges, and thus check the feasibility of siting a shallow depth disposal centre for LL-LL waste. The municipal councils of the two above-mentioned *communes* decided to withdraw from the project in the summer of 2009. ANDRA will therefore have to find new potential sites. A public debate will be held before the final site is chosen, following the detailed investigations phase. The pre-selected communes will be asked to delibarate on the matter again, before the site is chosen, in order to confirm whether or not they are candidates.

The waste to be accepted in this repository will mainly be graphite and radium-containing waste but, as requested by the decree 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. The quantified inventory and waste characterisation work should also be pursued so that ANDRA can propose a model inventory for repository sizing design. ASN considers it important, from the point of view of safe management of LL-LL waste, to find a disposal solution for this waste in the near future. Furthermore, ANDRA should pursue the process of searching for a site while strengthening the dialogue and cooperation with stakeholders.

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

3|4|1 Separation/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. 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 on the impact of this transmutation on deep disposal. The determining parameter for the determination of the space required for a repository is the thermal capacity of the glass packages (closely associated with the presence of minor actinides): the greater the heat given off by the packages, the greater the space must be between them in the repository, and therefore the greater the footprint of the repository.

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 light of other, essentially economic, criteria.

The separation-transmutation strategy can only be implemented in a facility that includes fast neutron reactors, critical (RNR) or sub-critical (Accelerator Driven System – ADS). Current work on the subject is therefore aiming to anticipate reactor development.

The act of 28 June 2006 and the PNGMDR orient studies and research towards the industrial possibilities for transmutation of minor actinides.

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 TSN 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 by 2020.

3|4|2 Long-term storage

The purpose of research into long-term 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 findings. 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".

Storage and placing of HL and IL-LL waste in repositories complete one another so as to optimise waste management. The needs to extend the creation of interim storage facilities must be surveyed to ensure provision of adequate storage capacities for waste before its final disposal. Once final disposal repositories are functioning, storage will allow better organisation of their operation and the construction of new repository tranches. Some wastes need to be placed in storage for a period while their radioactivity declines before they can be placed in a repository.

As regard to these considerations an IL-LL and HL-LL waste storage programme must accompany the future disposal of waste. The programme is covering:
– identification of the storage needs, according to various disposal scenarios. An initial inventory was supplied at the end of 2009;
– production of storage concepts, giving details on their feasibility, durability and performance. Options were 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 Disposal in deep geological formations

The Programme Act of 28 June 2006 on the sustainable management of radioactive materials and waste 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 2007-2014 to meet the objectives of the act of 28 June 2006. 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, occupational 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-disciplinary activity is described in a document giving the input data, the deliverables, the interfaces with the programmes and the other cross-disciplinary activities.

The PDD was presented to the Advisory Committee for waste in December 2007. In June 2010, ANDRA forwarded the updated 2008–2014 scientific programme, the results of which are used to support the safety case.

The project milestones are as follows:
– in 2012, public debate file;
– in 2014, authorisation decree application file;
– Act on reversibility;
– in 2025, commissioning.

To date, the studies for waste disposal in deep formations are carried out in the Bure underground laboratory, authorised by the decree of 3 August 1999 authorising ANDRA to install and operate an underground laboratory within the municipality of Bure.

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:
– 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 (zone in which the repository could be located);
– 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.

In 2009, study and research continued on the choice of a site and the repository design. Among the experiments carried out by ANDRA, 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. At the end of 2009, a 30 km² zone of interest for detailed geological investigations (ZIRA), with a view to siting the underground facilities of the future repository, and zones for installation of surface facilities (ZIIS) was proposed to the ministers in charge of energy, research and the environment. On 5 January 2010, ASN communicated its favourable opinion on the choice of the ZIRA to the Government.

ASN inspection to the Bure laboratory – November 2009

After government approval of the ZIRA, ANDRA undertook detailed reconnaissance (notably 3D seismic survey) in the ZIRA of which the results should be available by the end of 2011. Working with local authorities, ANDRA will also examine the surface development areas in the ZIIS allowing it, by 2012 at the latest, to forward the file necessary for organisation of the public debate, and to propose a site for the future repository (surface and underground).

In 2009, in Saudron near Bure, ANDRA inaugurated a technology demonstration and information centre for the disposal and reversibility concepts. This centre hosts prototypes and technology demonstrators built to test and validate the industrial concepts contemplated for the nuclear installations in the repository.

At the end of 2009, ANDRA forwarded a file presenting an update of safety and reversibility options for disposal in the repository, of the model inventory for waste packages used for design of the repository and the main design solutions for the surface facilities envisaged. The file was examined on 30 November 2010 by the Advisory Committees for waste and for laboratories and plants, on the basis of the report presented by IRSN. ASN will decide on its position on this file at the start of 2011. It has already accepted that the files examined allow identification of the important points for the safety case for a future deep underground repository in the formation selected. It has also observed that some subjects require more investigation by ANDRA before submission of a request for authorisation to create a repository, for both the operating phase and the period after closure of the repository.

ASN has verified, by inspections at ANDRA's head office and on site at Bure, that the experiments are conducted in accordance with processes ensuring the quality of results obtained.

In February 2007, ASN published the safety guide for final disposal of radioactive waste in deep geological formations, replacing the Basic Safety Rule III.2.f., following the favourable opinion given by the Advisory Committee for waste. In response to questions by the Advisory Committee experts, in 2008, ASN set up a working group for more in-depth consideration of the subjects of values for radiation protection and for the safety case over long time scales. The conclusions of these considerations were presented in March 2010 to the Advisory Committee on waste. ASN observed, in particular, that the approach described in the safety guide is consistent with the doctrine applied internationally where these subjects are concerned.

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

ANDRA, together with the waste producers, chose a gradual approach 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 design specifications for deep geological formation disposal) 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.

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

The regulatory context has changed since 2006, owing to:
– the fourth paragraph of Article 14 of Programme 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 an opinion concerning the waste packaging specifications;
– the guide published by ASN "on final disposal of radioactive waste in deep geological formations", which presents the safety functions relating to the packages and, in its Appendix 1, the main principles for packaging.
– work undertaken by ASN on regulations, especially with a view to revision of the general regulations applying to BNIs.

In order to take account of these changes, ASN resumed work on the conditions for approval of changes to packages production 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, describing the package approval process and the roles of the different parties;
– harmonisation of all practices; in the current situation, the packaging conditions for 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.

ASN therefore undertook the drafting of a decision on the waste packaging authorisation procedures. A first draft was published in 2010 to be viewed on ASN's website. The decision will be published after entry into force of the future order on the general regulations applying to BNIs.

The draft decision aims to establish requirements in the area of waste packaging and the process of validation of these types of packaging, while providing a framework for the procedures for reception of waste packages at the repository site.

4 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 on the sustainable management of radioactive materials and waste (article L 542-12 of the Environment Code) states that ANDRA has particular responsibility for the collection, transport and handling of radioactive waste and the rehabilitation of sites polluted by radioactive materials, on request, and at the expense of the parties responsible, or further to 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.

4|2 Abandoned radioactive objects

The Government circular of 17 November 2008, co-signed by the General Directorate for Risk Prevention (DGPR), the General Directorate for Health (DGS), the General Directorate for Energy and Climate (DGEC) and ASN, explains ANDRA's public service duties, the responsibility it assumes for certain types of radioactive waste and the management of sites polluted by radioactive materials.

Furthermore, the public authorities, more particularly the *préfet*s, can ask ANDRA, CEA or IRSN to take charge, at least temporarily, of radioactive waste. The conditions in which the *préfet*s refer to these organisations are specified in Government circular DGSNR/DHOS/DDSC 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 takes charge of wastes when the parties responsible have defaulted.

4|3 Sites polluted by radioactive substances

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 *préfet*s, describes the applicable administrative procedure for managing sites polluted by radioactive substances covered by the ICPE regime or the Public Health Code, whether the party responsible is solvent or defaulting. This 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 ICPEs.

The methodology guide for management of industrial sites potentially contaminated by radioactive substances, which was published in October 2000 (version 0), describes the applicable approach for dealing with the various situations likely to be encountered in the rehabilitation of sites (potentially) contaminated by radioactive materials.

A working group comprising representatives from IRSN, INERIS, the Ministry for Ecology and ASN, was set up in 2009 to further develop this guide and to, notably, allow an approach that is consistent with the general doctrine on management of sites and soils contaminated by chemicals and to foster public involvement throughout rehabilitation projects.

In 2009, the public authorities (DGPR and ASN) felt that it was important to set up a pluralistic working group to determine clean-up objectives for sites contaminated by radioactive substances. This group comprises the regulatory authorities (ASN, DGPR, DGS, the Regional Directorate for the Environment, Planning and Housing, the French Health Monitoring Institute), licensees (CEA, AREVA, ANDRA), associations (CRIIRAD, Robin des Bois), representatives of the public (local elected officials, OPECST) and French and foreign experts (IRSN, FANC). The outcome of the work done by this group was used in drafting of the guide. The group's work was presented by ASN at the 5-day event organised by the French Society for Radiation Protection (SFRP) on optimisation of radiation protection in the areas of nuclear electricity generating, industry and the medical sector, on

Derelict industrial site of the Bayard company in Saint-Nicolas d'Aliérmont

TO BE NOTED IN 2010

Operation Radium Diagnosis

Operation the Radium Diagnosis was launched in Ile-de-France in October 2010.

The State has decided to carry out free diagnoses in order to detect and if necessary treat any radium pollution resulting from past activities. This operation concerns 84 sites in the Ile-de-France region and 50 sites in the provinces that have accommodated activities associated with radium, and necessitating diagnosis.

Discovered by Pierre and Marie Curie in 1898, radium has been used in certain medical (the first cancer treatments) and craftwork activities (clock-making until the 1950s, due to its property of radioluminescence; manufacture of lightning arresters and cosmetic products, etc.).

These medical or craftwork activities, which are not attached to the nuclear industry, can have left traces of radium on certain sites.

The diagnosis of the sites having accommodated an activity that used radium is a continuation of the many actions engaged by the State in recent years, such as the rehabilitation of sites on which research and radium extraction activities were carried out at the beginning of the 20th century, or the recovery of radioactive objects from private households, etc.

This operation is performed with rigour and is free of charge for the occupants of the places concerned: the diagnosis consists in taking systematic measurements to detect the presence of any traces of radium or to confirm the absence of radium.

The diagnoses are carried out by a team of specialists from the French Institute for Radiation Protection and Nuclear Safety (IRSN), accompanied by an ASN referral agent who will have contacted the occupants beforehand to tell them about the operation. On completion of the diagnosis, the occupants are informed verbally of the results, with subsequent written confirmation by post.

If traces of pollution are found, rehabilitation operations are carried out free of charge by ANDRA, the French National Agency for Radioactive Waste Management, in agreement with the owners.

Ultimately, each person concerned is given a certificate guaranteeing the results of the operation.

At the end of 2010 seven sites representing 42 premises or houses had undergone diagnosis. Nine of the premises revealed traces of pollution and have'been or are currently being rehabilitated. ASN will see to it that ANDRA carries out the rehabilitation work as required.

30 September 2010. The approach presented was judged relevant and consistent with ICRP recommendations.

Following on from this work, in November 2010, ASN, DGPR and IRSN provided a draft of the methodological guide entitled "gestion des sites potentiellement pollués par des substances radioactives " (management of sites potentially contaminated by radioactive substances). Publication of the guide is planned for the first half of 2011.

In 2010, ASN also continued its work with a view to formalising the basic principles of its doctrine in the area of management of sites polluted by radioactive substances. ASN already believes that the solution involving the contamination being maintained in-situ should not be considered the reference solution for management of sites polluted by radioactive substances and that this option can only be an interim solution or reserved for cases in which complete clean-out cannot be contemplated owing, in particular, to the volume of waste to be excavated.

4 | 3 | 2 The polluted sites inventories

Several complementary inventories are available to the public.

• The ANDRA national inventory
Since 1993, ANDRA has been publishing 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 June 2009 edition is available on the ANDRA website, *www.andra.fr*.

• The Ministry of Ecology's databases
The MEEDDM has created a web portal specifically for polluted 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 kept. 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

Coudraies area in Gif-sur-Yvette (Essonne)

Review of the files on the properties in the Coudraies district in Gif-sur-Yvette, which began in 2002, enabled the Essonne *préfet* to propose allocation of technical and financial aid for clean-out of contaminated sites, for the simpler cases. The aim is to clean out land that can be cleaned and to demolish the two houses that cannot be subject to this type of work.

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 demolition of the house should be undertaken at the start of 2011. Two properties were cleaned-out in 2008 and early 2009. ANDRA purchased a second property in June 2010. A public meeting was held on 22 September 2010 at the town hall of Gif-sur-Yvette, attended by the mayor, ANDRA, ASN and representatives of the *sous préfecture* to consider the fate of the properties purchased.

Sanitary requirements for the Coudraies district were incorporated in May 2007 into the local development plan for Gif-sur-Yvette.

Following a request by a local resident and after analysis of the history of the district, ASN also initiated a process to clear up any ambiguity concerning a few plots of land in the Clos Rose district of Gif-sur-Yvette. The results were presented to the inhabitants in the last quarter of 2010 and at the CNAR of 7 December 2010. Of 11 plots investigated, two houses have radium activity concentrations above 400 Bq/m^3. Additional investigations are to be carried out to identify the radon transfer pathways in the houses and to indicate the steps necessary to reduce these radon activity concentrations.

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

From 1987 to the end of 2000, the Isotopchim Company was involved in carbon 14 and tritium labelling of molecules intended for medical applications in Ganagobie (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. ANDRA has been cleaning out the site since December 2002, notably sending the flasks containing concentrated solutions to the appropriate disposal routes. This priority waste was packaged and removed to CEA's Marcoule centre from March to June 2008. Continuation of clean-out and rehabilitation work is now being examined by the CNAR. Greater security (installation of an operational fire detection system and replacement of the fence) was put into place in July 2009. Additional analysis of the remaining liquid waste was initiated in order to define the disposal routes. Removal of the remaining VLL solid waste was validated by the CNAR and has started. ANDRA is also looking for an interim storage solution for the liquid waste pending availability of a disposal route for all of this waste.

Rehabilitation of the site of the former Pierre et Marie Curie school at Nogent-sur-Marne (Val-de-Marne département)

The Pierre et Marie Curie school was built on a former radium extraction site. The land is currently fallow.

The CNAR of 8 December 2009 was asked for an opinion on rehabilitation of this site. The CNAR selected a project involving partial excavation of the contaminated land and construction above this of public sports amenities. On advice from ASN, the CNAR nonetheless felt it necessary to see that development of the site should not hinder subsequent operations in areas

French National Funding Commission for Radioactive Matters (CNAR)

The meeting of the board of governors of ANDRA of 24 April 2007 created the national funding commission for radioactive matters (CNAR). This commission must give opinions on the utilisation of the public subsidy provided for in article 15 of the aforementioned act of 28 June 2006, on both the fund assignment priorities and the polluted site treatment strategies and the principles of subsidised collection and disposal of waste. This commission also delivers an opinion on the individual files submitted to it.

The commission is chaired by the executive director of ANDRA and includes representatives from the supervising ministries (DGEC, DGPR, DGS), ASN, IRSN, the Association of Mayors of France, environmental defence associations and qualified key figures.

ANDRA ensures the secretaryship of the CNAR.

The commission met quarterly in 2010, to address matters such as the attribution of public funds for the management of polluted sites considered to require priority treatment, such as Orflam-Plast, Gif-sur Yvette, Bandol, Isotopchim, Bayard in Saint-Nicolas d'Aliermont, and occasionally for the collection and disposal of certain wastes. This commission is equivalent to the Technical Commission (formerly the national funding commission) that exists within the ADEME for the management of sites polluted by non-radioactive substances.

where residual contamination may persist and recommended that the municipality evaluate the possibility of more extensive extraction of contaminated material to attain more far-reaching clean-out objectives.

ASN will be called upon to validate the various phases of this site work and hold points are planned after each phase. The first phase, which began on 19 October 2010, consists, primarily, in removal of the bulky items from the former school premises. Work to remove asbestos has also started. This first site phase should conclude with demolition of the buildings. The second of the two work phases, which consists in carrying out soil clean-up, should begin in early 2011 and be completed in September 2011.

A local information and monitoring commission (CLIS), of which ASN is a member, was established by the *préfet* for the Val-de-Marne *département* and a monitoring committee was also set up by the town hall.

Établissements Charvet *in l'Ile Saint-Denis (Seine-Saint-Denis département)*

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. Starting in 1966, they were partly occupied by various companies handling butcher's waste transit activities. The Charvet company, the current owner of the site, carried out the same activities from the 1990s to mid-2005. The site, closed since the business ceased operations, was illegally occupied from December 2005 to June 2006. Access to the site is now closed. The Charvet site has been identified as being eligible for financing under France's recovery plan, and is part of the project to rehabilitate an eco-zone on the *Ile-Saint-Denis* island. On 29 September 2009, the CNAR accepted the rehabilitation project based on a scenario involving partial excavation of the contaminated earth, allowing the creation of a park or comparable activity, taking account of possible subsequent intervention for that part of the site on which the contaminated soil and rubble would be stored.

The clean-out work will take place in two phases, the first under the responsibility of the Charvet SA company, the second after handover to the public establishment for land management of the *Ile-de-France* region (EPIC).

The first comprises sorting of the contaminated waste from conventional waste and removal from site. The waste sorting and packaging facility was inspected by ASN on 30 June 2010.

During validation of the rehabilitation scenario, the CNAR, in September 2009, decided that it was necessary to further the hydro-geological studies of the site to decide on the risk of pollution of groundwater and to stipulate appropriate management methods and procedures.

A local information and monitoring commission (CLIS) is being constituted. ASN will have a seat on this commission, alongside representatives from public administrative bodies.

Former Curie laboratories in Arcueil (Val de Marne département)

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. In September 2008, ASN 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 was held on 22 June 2009.

An ASN inspection was carried out on 16 October 2009.

After an unauthorised entry to the site in June 2010 (unauthorised entry and theft), ensuring of the safe condition of the site was reinforced. In parallel, the local education authority managing the site decided to close down the work as it had exceeded its budget. The site is therefore closed for several months.

Decontamination of the former Curie laboratories site in Arcueil

Établissements Charvet in *Ile-Saint-Denis*

The Haÿ-les-Roses sub-prefecture, in agreement with the Arcueil town council, decided to organise a public meeting in mid-December 2010 to explain the progress made on the site to the inhabitants of Arcueil as well as informing them about recently occurring events (incident and active safetying of site). ASN participated in the meeting.

Orflam-Plast in Pargny-sur-Saulx (Marne département)

In 1934, the UTM Company (UTM standing for monazite treatment unit) started to produce lighter flints by extracting the cerium contained in imported monazite ore, and then began to make lighters under the brand name ORFLAM PLAST. Using the same ore, the company also produced pure thorium nitrate for export until 1959. Direct processing of the raw material ceased in 1967, when this activity was replaced by materials that were pre-treated prior to import and free of either thorium or uranium. The Orflam-Plast company was wound up by a decision of the court of commerce in May 2006. The consequence of this judgement was to relieve the liquidator of all responsibility for the site.

In an administrative decision, the Orflam site was transferred to the State property department on 24 November 2008.

Since the beginning of 2008, rehabilitation of the site has been managed by the National Funding Commission for Radioactive Matters (CNAR). Since the end of October 2008, stores of contaminated legacy waste from the Orflam-Plast plant have been discovered and work has been done to make them safe. ASN asked IRSN to analyse the sediment, water, and aquatic fauna and the measurements obtained enabled the pond to be opened for fishing at the end of August 2009. Spectrometry mapping was carried out by a helicopter on 29 and 30 June 2009 over a 60 km² area. The active zones previously identified were confirmed and no other zone showing thorium activity significantly higher than the local natural background level was brought to light. At the end of 2009, the CNAR ruled on the rehabilitation scenarios for the contaminated areas both off and on the site, so that work could begin in mid-2010. A local information and monitoring commission (CLIS) was set up at the end of 2009. The "pond" site was completely cleaned up in 2010, and fishing activities could be re-authorised in July 2010. The rehabilitation work on the "peupleraie" site should be completed in early 2011. Work on the plant site should begin in 2011. Specific restrictions for land use will be introduced for each of the sites.

4|4 Public service storage facilities

ANDRA has a public service storage duty. So far, however, it has not operated any storage facilities, simply signing agreements with other nuclear licensees for access to their storage capacity. For example, the Socatri company was authorised by decree in 2003 to provide interim storage on behalf of ANDRA for low level long-lived 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 routes.

In September 2009, ANDRA approved the creation of a storage facility for diffuse nuclear waste, in particular low level, long-lived waste. This facility will not however be able to accept tritiated waste.

5 OUTLOOK

In 2010, ASN continued with its actions aimed at ensuring that radioactive waste is managed safely, 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. In particular, ASN remains attentive to the implementation by AREVA of its strategy for retrieval of old waste from La Hague site.

In accordance with the joint ASN and ASND request, in 2010, CEA sent a file on the management strategy for waste produced in civil nuclear installations to both of the authorities. The file presents the management strategy for waste produced and to be produced in the future, identifying the needs for facilities for treatment, packaging, transport packages and placing in storage. It will be examined by an Advisory Committe with a view to ASN establishing a position. Furthermore, ASN has observed an overall difficulty on the part of CEA to fulfil its commitment, notably in terms of meeting its deadlines, leading it to postpone the deadlines for removal from storage of waste present in the oldest installations. In addition, in 2011, ASN will continue to follow attentively the retrieval from storage of wastes presenting the greatest safety risk.

With regard to the long-term management of radioactive waste, ASN is encouraged by the way ANDRA operates its waste centres currently in service. ASN considers that there must be safe disposal routes for all waste. To this end, it is of the opinion that France should be provided with a facility to allow disposal of low level long-lived waste. ASN will therefore follow attentively the process of search for a site and development of disposal solutions.

The Authority considers that key steps will be taken to develop the disposal project in coming years. By means of the opinion that it gave on the file submitted by ANDRA in 2009, ASN will set out the main areas of focus for between now and submission of the license application for creation that should take place at the end of 2014. ASN remains vigilant to ANDRA's providing of the expected elements. It will also pursue the development of its doctrine on reversibility.

After consultation, ASN also expressed several opinions in 2010 on the strategies for management of polluted sites. Under the renewed regulations, ASN has been strengthened since 2009 and will continue its work in 2011 in collaboration with the relevant administrative departments and bodies, and with other stakeholders. In 2011, ASN intends to publish its doctrine in the area of management of sites polluted by radioactive substances. ASN restates its position that the solution involving maintaining the contamination in-situ must not be the reference solution for management of sites polluted by radioactive materials. This option can only be an interim solution or reserved for situations in which the complete clean-out option cannot be contemplated owing to the volume of waste to be excavated.

In 2011, ASN will also continue to work on revising regulations, following the publication of Act 2006-686 of 13 June 2006 on transparency and safety where nuclear matters are concerned, in particular by stipulating, via its decisions, the measures applicable to BNIs concerning the production of nuclear waste, the storage of this waste, its packaging and its disposal.

Moreover, in 2011, ASN will continue with its operations for diagnostic analysis of sites likely to have hosted activities involving handling of radium in Ile-de-France and will extend these operations to other regions.

Finally, ASN will maintain its close involvement in international work by maintaining its active participation in working groups, especially within the framework of the IAEA's Waste Safety Standards Committee (WASSC) which validates the reference standards for radioactive waste management, and within WENRA, as well as by participating in the work of the different international organisations on disposal of radioactive waste and especially on reversibility.