RADIOACTIVE WASTE, CLEAN-OUT AND POLLUTED SITES

CHAPTER 16

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

This chapter therefore deals with:

- how radioactive waste is managed in operational activities;

- how clean-out of sites and installations is regulated, to prevent pollution;

- how past or current pollution (polluted sites) is dealt with to guarantee protection of the environment and the public.

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

2006 was marked by the adoption of the programme act of 28 June 2006 on the sustainable management of radioactive materials and waste. This act was one of the milestones set by the "Bataille act" of 30 December, which aimed to ensure that Parliament would be able to examine a bill on this subject, after 15 years of research into 3 areas - separation and transmutation of radionuclides, deep geological disposal and long-term interim storage. The preparation of this act was itself preceded by a public debate on the management of radioactive waste and the submission of opinions by the national assessment committee and the Nuclear Safety Authority (ASN). The fundamental role of the Parliamentary office for the assessment of scientific and technological options must also be mentioned as, for the duration of this fifteen year period, it constantly supervised the management of radioactive waste, carried out public hearings in early 2005 and published a report in March 2005 which proved to be key factors in the debate.

This act continues the principles which led to the adoption of the Bataille act, by recommending that research be pursued in the 3 areas initiated in 1991. The act now stipulates that ultimate waste will be disposed of in deep geological formations, which will remain reversible for at least 100 years. The process for examination of such a repository is specified, the authorisation decree will thus be preceded by a further public debate, by an act setting the conditions for reversibility of the repository and by wide-ranging consultation of local elected officials.

The act of 28 June 2006 also specifies the conditions for return to the producers of waste from foreign fuel reprocessed in France, restating the ban on the disposal of this radioactive waste in France.

The 28 June 2006 act provides for adoption every 3 years of a national radioactive materials and waste management plan (PNGMDR), an initial draft of which was prepared by ASN as part of a multidisciplinary working group. This plan should provide a clear framework for all radioactive waste. The first PNGMDR was drawn up by the government. It also includes a part devoted to research concerning long-lived high level and intermediate level waste.

The 28 June 2006 act reinforces ANDRA's duties, in particular the public service duty to rehabilitate sites contaminated by radioactive materials and to collect waste for which the party responsible has defaulted, as proposed in the draft plan prepared in 2005.

Finally, the 28 June 2006 act sets a clear legal framework for securing the funds necessary for decommissioning and for the management of radioactive waste.

1 Radioactive waste management principles

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

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

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

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

1 | 1

Radioactive waste management channels

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

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

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

<table>
<tr><th>Period / Activity</th><th>Very short-lived < 100 days</th><th>Short-lived < 30 years</th><th>Long-lived > 30 years</th></tr>
<tr><td>Very low level</td><td rowspan="4">Management by radioactive decay</td><td colspan="2">Dedicated surface disposal
Recycling channels</td></tr>
<tr><td>Low level</td><td rowspan="2">Surface disposal
(Aube repository)
except tritiated waste
and certain sealed sources</td><td>Dedicated subsurface disposal under study</td></tr>
<tr><td>Intermediate level</td><td>Channels being examined under article 3 of the act of 28 June 2006</td></tr>
<tr><td>High level</td><td colspan="2">Channels being examined under article 3 of the act of 28 June 2006</td></tr>
</table>

in less than 30 years) and long-lived, containing a large quantity of long-lived radioelements (activity level halved in more than 30 years).

Table 1 shows the stage reached in implementation of the different waste management channels, notably the final disposal channel adopted. It shows that for certain waste, there is at present no final disposal solution.

Very short-lived waste

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

Very low-level waste (VLL)

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. Radioactivity of this waste is about a few Becquerels per gram.

Short-lived intermediate and low level waste

The activity of short-lived intermediate and low level waste is mainly due to radionuclides emitting beta or gamma radiation, with a half-life of less than 30 years. The activity of this waste is between a few hundred Bq per gram to one million Bq per gram. In this waste, long-lived radionuclides are strictly limited. This type of waste comes from nuclear reactors, fuel cycle facilities, research centres and university laboratories and hospitals. The technical solution generally adopted for this type of waste is its removal, either directly or after incineration or fusion, to a surface repository, where the waste packages are stored in concreted structures. This provides for containment of the radionuclides for a sufficient length of time to take full advantage of the radioactive decay phenomenon (see point 6.1). This disposal channel has been operational since 1969, when France was the first country to decide to cease its participation in the VLL waste immersion operations organized by the OECD. At that time, 14,300 m of radioactive waste of French origin had already been immersed in the Atlantic Ocean.

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

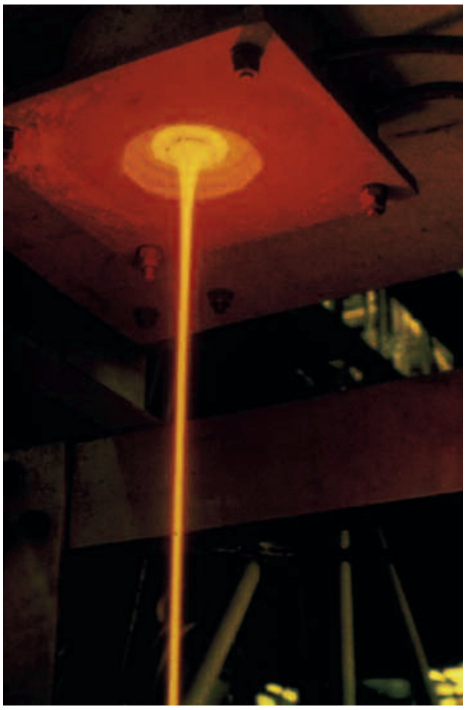
Short-lived intermediate and low-level waste includes certain categories which have characteristics making them currently unsuitable for acceptance at the Aube repository in Soulaines, without additional authorisation from ASN.

Most sealed sources fall into this category: a specific characteristic of these sources is that the radioactivity they contain is often highly concentrated. Consequently, even when the radioactive elements concerned have a relatively short life, they cannot always be accepted as such by a surface waste repository, because even after 300 years, they would still have significant radioactivity. In addition, their envelope is often made of stainless metals, making them tempting for people digging into the repository. The fate of used sources is dealt with in article 4 of the act of 28 June 2006 which provides for "finalisation by 2008 of processes allowing the disposal of spent sealed sources at existing or to-be-built centres". In addition, some waste contains significant quantities of tritium, a short-lived radionuclide but one that is hard to confine owing to its mobility, unlike the other radionuclides.

Long-lived low-level waste

This waste usually comes from industrial activities leading to concentration of Naturally Occurring Radioactive Materials (NORM) (the former radium industry for example), or from the nuclear industry (such as the irradiated graphite contained in the structures of the old Gas Cooled Reactors (GCRs). The activity level of graphite waste is between ten thousand and one hundred thousand Bq per gram, primarily long-lived beta-emitter radionuclides. Radium-containing waste mainly consists of long-lived alpha-emitter radionuclides with an activity of from a few tens of Bq per gram to several thousand Bq per gram.

Owing to its long life, this waste cannot be disposed of in a surface repository as it is impossible to take advantage of its radioactive decay within a time-frame compatible with permanent institutional surveillance. However, its low level of intrinsic hazardousness could lead to subsurface disposal being envisaged at a depth of at least fifteen metres.



Vitrification of a solution of fission and activation products

High-level waste and long-lived intermediate level waste

This waste contains long half-life radionuclides, notably alpha emitters. The vast bulk of it comes from the nuclear industry. It comprises both intermediate level and high-level waste. The intermediate level waste is mainly process waste (spent fuel hulls and end-pieces, effluent treatment sludge) and in-service maintenance waste from spent fuel reprocessing facilities and research centres, or certain activated waste from the decommissioning of nuclear installations. The activity of this waste is about one million to one billion Bq per gram.

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

At present, there is no disposal channel for this waste, which is for the time 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 6|2).

1 | 2

The regulatory framework for radioactive waste management

Radioactive waste management falls within the general framework defined by act 75-633 of 15 July 1975 codified in chapter I of part IV of the Environment Code and its implementation decrees, concerning waste disposal and recovery of materials. The basic principles of this act are the prevention of waste production, the responsibility of the waste producers, the traceability of this waste and the need to inform the general public. In 1991, it was supplemented by the Bataille act, which set a framework for the research into long-lived high level waste and conferred the status of independent establishment on ANDRA, which was in charge of research into geological disposal. The act of 28 June 2006 gives a legislative framework for management of all radioactive waste and materials. It provides for the production of a national radioactive materials and waste management plan, updated every 3 years and specifies measures for radioactive waste financing (see chapter 15). The act also sets the new schedule for research into long-lived high level and intermediate level waste (see point 6|2). Finally, it recalls the ban on final disposal on French soil of foreign waste, by providing for the adoption of rules specifying the conditions for return of waste resulting from reprocessing in France of spent fuel or waste from abroad.

Production of radioactive waste in basic nuclear installations

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

Production of radioactive waste in other activities using radioactive materials

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

Circular 2001/323 of 9 July 2001 sets the technical aspects to be taken into account when ensuring good management of radioactive waste, mainly in health institutions, but also in biomedical research laboratories.

Waste management channel regulation

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

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

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

1 | 3

European regulations harmonisation work within WENRA

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

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

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

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

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

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

The reference levels concerning the safety of decommissioning operations require that the nuclear licensees produce decommissioning strategies for their sites, draft decommissioning plans, that the more important decommissioning phases be submitted to the safety authority and that decommissioning be designed into the nuclear installation in order to facilitate all the operations as and when the time comes.

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

1 | 4

Organisation and responsibilities

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

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

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

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

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

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

In this context, ASN drafts regulations governing radioactive waste management, regulates the safety of the basic nuclear installations which give rise to this waste or play a part in its disposal and conducts inspections in the facilities of the various waste producers (EDF, COGEMA, CEA, hospitals, research centres, etc.) and of ANDRA. It regulates the ANDRA's overall organisational provisions for acceptance of waste from the producers. It assesses the waste management policy and practices of the radioactive waste producers.

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

1 | 5

ANDRA national inventory of radioactive waste and reusable materials

In January 2006, ANDRA published the latest version of the national inventory of radioactive waste and reusable materials. This inventory is an exhaustive list of the waste identified as radioactive throughout France. It also includes a forward-looking part which proposes estimates for the quantities of waste that will be produced by 2010 and by 2020. ASN is a member of the steering committee for the national inventory of radioactive waste and reusable materials, a new version of which is expected for early 2009.

The following tables present some data extracted from the national inventory published in 2006. The largest volumes (< 92% of the total volume) concern very low level or short-lived low and intermediate level waste, representing only a few teraBecquerels, which is a minute fraction of the total activity. On the other hand, long-lived, high-level waste will in 2020 represent more than a billion teraBecquerels, for a total volume of a few thousand cubic metres, or ˜ 2% of the total volume and ˜ 96% of the total activity.

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

Waste categories	Existing volumes in 2004 disposed of or stored (m^3)	Anticipated volumes in 2010 disposed of or stored (m^3)	Anticipated volumes in 2020 disposed of or stored (m^3)
Very low level	144,498	300,279	581,144
Low and intermediate level short-lived	793,726	928,989	1,193,001
Low level – long-lived	47,124	48,432	104,997
Intermediate level – long-lived	45,518	49,464	54,884
High level	1 851	2 511	3 611

Types of fuels	Existing quantity in 2004 (t)	Existing quantity in 2010 (t)	Existing quantity in 2020 (t)
EDF uranium oxide spent fuel waiting for processing	10,700	11,250	10,850
PWR reactor MOX fuels	700	1300	2350

(source: national inventory of radioactive waste and reusable materials – ANDRA 2006)

1 | 6

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

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

In response to a request from the Parliamentary office for the assessment of scientific and technological options in 2000, the Nuclear Safety Authority has since 2003 been overseeing the preparation of a national radioactive waste and reusable materials management plan within a wide-ranging working group. At the meeting of the French cabinet on 4 June 2003, the Minister for Ecology and Sustainable Development officially confirmed his intention to draw up such a plan.

The waste producers (all sectors), the waste disposal facilities, ANDRA, the departments of the ministries concerned, environmental protection associations and representatives of elected officials are invited to take part in these meetings. An initial draft of the national radioactive waste and reusable materials management plan was published on ASN website for consultation purposes on 13 July 2005, and will be available until the end of 2005. In its opinion to the Government dated 1 February 2060, ASN had recommended adoption of the principle of such a plan as part of the draft act required by the Bataille act in 1991, and formulated a certain number of concrete recommendations for certain waste categories.

The act of 28 June 2006 requires that the Government draw up a national plan for the management of radioactive materials and waste every 3 years. The provisions of the plan are specified by a decree. The first edition of the PNGMDR was drawn up at the end of 2006. The decree stipulating its provisions should be published in the Official Gazette in the first quarter of 2007. It should be noted that some of the recommendations in the ASN opinion of 1 February were incorporated into article 4 of the act of 28 June 2006.

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

Article 6 of the programme act of 28 June 2006 on the sustainable management of radioactive materials and waste

I. - After article L. 542-1 of the Environmental Code, an article L. 542-1-2 is inserted, drafted as follows:

Art. L. 542-1-2. - I. – A national plan for the management of radioactive materials and wastes appraises the existing management modes of radioactive materials and wastes, identifies the foreseeable needs for storage or disposal installations, states the necessary capacities for these installations and the storage timeframes and, for radioactive wastes which are not yet the subject of a definitive management mode, determines the aims to be reached.

In accordance with the guidelines defined in articles 3 and 4 of programme act 2006-739 of 28 June 2006 on the sustainable management of radioactive materials and wastes, the national plan organises the implementation of research and studies on the management of radioactive materials and wastes by setting dates for the implementation of new management modes and the creation of installations or the modification of existing ones so as to meet the needs and aims defined in the first paragraph.

The plain comprises, in an appendix, a summary of achievements and research conducted in foreign countries.

II. - The national plan and the decree establishing its stipulations comply with the following guidelines:

1) Reduction of the quantity and toxicity of radioactive wastes is sought in particular by treating spent fuels and by treating and conditioning radioactive wastes;

2) Radioactive materials awaiting treatment and ultimate radioactive wastes awaiting disposal are stored in specially laid out installations;

3) After storage, ultimate radioactive wastes, which cannot for nuclear safety or radiation protection reasons be disposed of at the surface or at a low depth, are disposed of in deep geological formations.

III. – The national plan is established and updated every three years by the Government. It is transmitted to Parliament, which brings it before the Parliamentary office for the assessment of scientific and technological options, and disclosed.

IV. – The decisions taken by the administrative authorities, especially the authorisations mentioned in article L. 1333-4 of the Public Health Code, must be compatible with the stipulations of the decree set forth in II of this article."

II. – The national plan set forth article L. 542-1-2 of the Environmental Code shall be drawn up for the first time before 31 December 2006.

2 MANAGEMENT OF VERY LOW LEVEL WASTE

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

2 | 1

VLL waste management principles

Some European countries have adopted a policy of exempting VLL waste on the basis of an activity threshold, an option that is allowed by European Council radiation-protection Directive 96/29/Euratom of 13 May 1996. French policy does not provide for unconditional discharge of VLL waste simply on the basis of universal thresholds. This leads to specific management of this waste and disposal of it in a dedicated repository.

Waste management in the BNIs is mainly regulated by the order of 31 December 1999. Pursuant to said order, each licensee of a basic nuclear installation must therefore send ASN a "waste study" presenting the risk of contaminated, activated, or non-radioactive waste being produced in the installation. This installation "zoning", subject to ASN approval, thus enables a distinction to be made between two types of zones. The zones likely to lead to the production of radioactive waste are referred to as "nuclear waste zones". The waste originating from nuclear waste zones has to be managed in dedicated channels. The waste from the other zones is, after checking that there is no radioactivity, routed to conventional waste channels (non-specific or special industrial waste). ASN has published a guide, revised in September 2002, for the production of BNI waste studies. It is available from ASN website.

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

2 | 2

The particular case of clean-out when decommissioning installations

The problem of the safety of final shutdown and decommissioning of nuclear installations is dealt with in chapter 15. The following section only deals with operations designed to separate the nuclear parts (which could have been activated, extensively contaminated, or in contact with radioactive materials) from conventional parts (which could not have been in contact with radioactive materials).

Basic nuclear installations

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

With regard to complete post-operational clean-out operations on civil engineering structures constituting nuclear waste zones, guide SD3-DEM-02 of 27 March 2006 was published by ASN. “Complete” clean-out of a nuclear installation consists in total removal of the civil engineering structures considered to be nuclear waste, including inside the thickness of the structures (concrete shells for example). In this case, the installation’s waste zoning must be updated, in order to take account of the activation or migration phenomena likely to have occurred in the civil engineering structures. A new limit between nuclear waste zone and conventional waste zone must be defined, using an approach based on successive and independent lines of defence.

The first line of defence to be employed must be based on an in-depth review of the state of the installation and an understanding of the physical phenomena involved (activation, migration of contamination, etc.). Modelling these phenomena will define a minimum clean-out thickness, to which a fixed safety margin must be added to cover any calculation uncertainties. The total clean-out thickness thus obtained then corresponds to the limit between a nuclear waste zone and a conventional waste zone.

After the clean-out operations, the licensee then removes all nuclear waste from the nuclear waste zones, before implementing an appropriate inspection programme on the remaining elements, to confirm that there is no contamination or activation (2nd line of defence). It then submits a proposal to ASN for final delicensing of this zone so that it becomes a conventional waste zone. After approval of this final waste zoning modification, the remaining conventional waste is disposed of in conventional channels and can be dealt with in the same way as normal industrial waste.

In 2006, ASN examined the first files from the nuclear installation licensees presenting the clean-out methodologies used for final shutdown and decommissioning operations.

Furthermore, in the current context of managing industrial sites being decommissioned, the need became apparent for conservation of a trace of the past existence of a basic nuclear installation on a site, along with any utilisation restrictions appropriate to the final condition of the site following decommissioning. At present, prior to administrative delicensing of a nuclear installation, an easement on behalf of the State is established by ASN, jointly with the local authorities concerned, and is proposed to the land owner. This constraint is recorded in the mortgage register to guarantee its permanence. Easements of this type were systematically used for the recent nuclear installation delicensing operations (FBFC facility in Pierrelatte in 2003, BNI 48 in 2005, BNI 43 and 121 in 2006). The act of 13 June 2006 on nuclear transparency and safety now offers the possibility of a public interest easement following delicensing or removal of a basic nuclear installation. These new procedures will be implemented for the forthcoming delicensing operations.

Medical, industrial and research installations

There are as yet few dossiers concerning clean-out of medical, industrial and research installations. In 2004, a dossier for complete decommissioning of a former pharmaceutical laboratory owned by Aventis-Pharma was submitted to ASN for its opinion by the *préfet*[1] of Seine-Saint-Denis. From 1956 to 2003, this laboratory carried out radioactive labelling of molecules for pharmaceutical research, using carbon 14 and tritium. The clean-out and decommissioning methodology chosen is similar to that used for nuclear installations: the premises were divided into waste zones, mainly based on the history of activities on the site, allowing differentiation between nuclear and conventional waste. On the basis of the clean-out objectives set by ASN, the clean-out operations were carried out and some of the waste removed to authorised disposal channels. The preliminary studies and the operations themselves are carried out together with ANDRA, which provides the owner with assistance. After a joint inspection to confirm that the final state envisaged by the licensee has actually been achieved, the building will be demolished and the remaining waste disposed of through a conventional waste management channel.

2 | 3

Morvilliers VLL waste repository

The move to rationalise management of VLL waste initiated by ASN in 1994 showed that it was necessary to create a repository for this type of waste. At the request of the nuclear licensees, technical studies had been conducted by ANDRA and by the "ultimate" waste and polluted earth processing and disposal company (SITA FD) as of 1996 with a view to creating a repository intended for very low level radioactive waste. The site finally chosen is not far from the Aube waste repository. The *préfet* authorised the installation on 26 June 2003. This installation classified on environmental protection grounds (ICPE), with a capacity of 650,000 m^3, has been operational since August 2003. After two years of operation, ANDRA asked the Aube *préfet* for authorisation to increase its annual disposal capacity volume from 24,000 m3 to 37,000 m3 and to change some of the operating conditions (slope of the covering, leachate pumping rule). This application was granted by order of the *préfet* on 21 July 2006 and should enable ANDRA to accept the flow of VLL waste which is rising year on year, owing to the decommissioning work currently in progress.

3 MANAGEMENT OF RADIOACTIVE WASTE BY THE PRODUCERS

3 | 1

Waste management in basic nuclear installations

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

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

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

3 | 1 | 1

CEA waste management

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

CEA also possesses legacy solid and liquid waste for which there can be certain treatment difficulties, or for which there is no operational disposal channel. Nuclear fuel without further use from the civil sectors of CEA is placed in interim storage, either dry (in a decay pit) or in a pool, pending definition of a disposal channel (reprocessing or storage).

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

ASN observes that CEA is experiencing persistent problems in successfully replacing certain waste management channels, particularly with regard to the new safety rules. ASN regrets an overall lack of forward planning during the periodic safety reviews on this type of installation, which led to commitments being made even though the necessary financing had not been secured in advance. CEA was thus forced to abandon certain interim storage or reprocessing installations such as ECUME or ATENA in 2003.

For 2006, ASN notes the following points:
- some projects have regularly progressed in accordance with the commitments made in 2005 (particularly commissioning of CEDRA unit 1, see point 4|1 below),
- some projects, for which a change in strategy had been announced in 2005, were clarified (AGATE project, organic liquid treatment),
- however, in certain fields, the strategy was once again called in question. ASN therefore asked CEA to rapidly redefine a new and clear strategy in these areas (for example, recovery of the BNI 56 pits, which had been postponed for economic reasons).

Management of the CEA civil waste and spent fuels was examined in 1999 on the occasion of a meeting of the advisory committees for plants and waste. In the light of recent developments, both in terms of organisation (decommissioning of the UP1 plant in Marcoule and abandonment of certain projects), ASN wishes to examine all CEA activities linked to its BNI and secret BNI waste and to spent fuels. Together with the Delegate for Nuclear Safety and Radiation Protection for National Defence Installations and Activities (DSND), ASN asked CEA to forward a file concerning its management strategy for 2008. ASN and the DSND would then be able to adopt a joint stance on management of the CEA waste and spent fuel following examination of the file by the advisory committees of experts and the secret BNI supervisory bodies, by the year 2009.

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

3 | 1 | 2

Management of COGEMA waste

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

The waste produced at La Hague comprises on the one hand the waste resulting from reprocessing of spent fuel for the nuclear power plant licensees and on the other, the waste linked to operation of the installations. Most of this waste is the property of the plant licensees.

The waste generated by the spent fuels includes:

– Fission products and minor actinides (high level)

The solutions of fission products and minor actinides resulting from spent fuel reprocessing, are calcined then vitrified in the R7 and T7 facilities. The vitrified waste is poured into stainless steel containers. After the glass has solidified, the containers are transferred to an interim storage installation pending availability of a long-term management solution or until they are sent to COGEMA's 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 temporarily stored on the site.

Fuel assembly hulls, ACC shop at COGEMA La Hague

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 effluent used to be treated by chemical co-precipitation (and still is in the STE3, but in small quantities owing to the change in process used for effluent at La Hague). The sludges produced in STE3 are evaporated and encapsulated in bitumen, with the final encapsulated product then being poured into stainless steel drums in this facility. The drums are then stored on the site. The licensee envisages using the STE3 bituminisation process for packaging the legacy sludges from STE2.

– Waste from organic effluent

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

– Ion exchanger resins

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

– Technological waste not handled by the ACC

The technological waste is sorted, compacted and encapsulated or blocked in cement in the AD2 facility. The packages complying with ANDRA technical specifications for surface disposal are sent to the Aube repository. Those that do not, are temporarily stored on the site.

Legacy waste is also present on the La Hague site. It is generally stored in tanks or in concrete compartments called HAO silos (oxide high activity facility).

At the request of ASN, the advisory committee for laboratories and plants, accompanied by experts from the advisory committee for waste, met on 16 November 2005 to look at COGEMA's policy for managing the waste produced by its La Hague establishment. On 11 January 2006, ASN sent COGEMA a letter subsequent to this examination. Its requests with regard to this waste are detailed in chapter 13, point 3|2|1.

Concerning the waste stored in building 119 and that from the MELOX plant, COGEMA proposes using a compacting process, with an installation in addition to the existing one. This strategy also includes the use of STE3 disposal compartments for this type of drum pending the availability of the new installation. ASN and its technical support organisation (Institute for Radiation Protection and Nuclear Safety - IRSN) took part in a working group in 2006 to look at the characteristics of the packages that would result from the proposed process. ASN concluded that, given the inventory of waste to be compacted, COGEMA would need to revise its waste management strategy, in particular owing to the high level of hydrogen production by the envisaged package.

3 | 1 | 3

EDF waste management

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

It should be noted that EDF is also the owner of long-lived high level and intermediate level waste from its share of the spent fuels reprocessed in the COGEMA plant at La Hague. This is described in point 3|1|2 above.

Activated waste

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

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

Operating and maintenance waste

This concerns ion exchanger resins (water treatment), filters, evaporator concentrates, servicing waste (rags, vinyl sheets and bags, gloves, and so on). Some refit and maintenance waste can consist of large items (vessel heads, steam generators, fuel interim storage racks, etc.).

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

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

This waste is stored in the Aube waste repository and some particularly low level waste in the VLL waste centre. It contains beta and gamma emitters but few or no alpha emitters.

EDF legacy waste

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

This waste is primarily stored in semi-buried silos at Saint Laurent des Eaux. The improved safety of these silos and the long-term management of this type of waste are mentioned in point 4|2 below.

Dismantling waste from plant being decommissioned

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

EDF waste management policy

EDF fuel use policy (see chapter 12) has consequences for the cycle installations (see chapter 13) and for the quantity and quality of the waste produced. This subject was examined by the advisory committees for reactors, for plants and for waste from the end of 2001 to early 2002. ASN asked that the file be updated by mid-2007.

With a view to ensuring general use of M5 alloy and zirlo fuel cladding, ASN asked EDF for information about the impact of such a move on the characteristics of the resulting waste.

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

In 2004, EDF forwarded a clarification of its waste management organisation. It also carried out waste management safety analyses in its nuclear auxiliary and effluent packaging and treatment auxiliary buildings, and forwarded them to ASN (see chapter 12 point 4|3).

The following should be noted with respect to the other requests made by ASN in 2002:
- EDF requested the creation of a centralised interim storage facility for its activated waste in 2005 (ICEDA),
- for the Saint Laurent graphite sleeves, ASN asked EDF to improve the safety of the interim storage silos pending the construction of a final disposal facility (see points 4|2 and 6|4 below).

3 | 1 | 4

Other licensees

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

3 | 2

Radioactive waste management in medical, industrial and research activities

3 | 2 | 1

Origin of waste and radioactive effluent

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

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

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

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

3 | 2 | 2

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

Faced with this problem of health care waste contaminated by radionuclides, which appeared with the growth of nuclear medicine, the public authorities 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. First, a circular from the Minister for Health (2007/323 of 9 July 2001) therefore clarified the provision of the 30 November 1981 order on the conditions for the use of artificial radionuclides used in unsealed sources for medical purposes. This circular established recommendations for management and disposal of hospital radioactive effluent.

The collection and management of radioactive waste and effluent produced by biomedical research and nuclear medicine activities are based on 4 principles, which must be incorporated into the management plan which has been mandatory since July 2003:
- the waste is sorted and packaged as soon as possible in the cycle in the producer units, so that separation can take account of the type of waste, the radionuclides it contains as well as their level of activity and half-life. Waste originating from use of radionuclides with a half-life of less than 100 days will be separated from the other waste;
- effluent and waste are stored following this preliminary sorting, for either local disposal (waste marked only by radionuclides with a half-life of less than 100 days), or collection by ANDRA (presence of radionuclides with a half-life of more than 100 days);
- the radioactivity of the waste and effluent is systematically checked before disposal;
- removal of waste and effluent through the appropriate channels. The waste originating from the use of radionuclides with a half-life of less than 100 days can be eliminated, after decay, in the household waste channel, provided that there is no infectious or chemical risk. Otherwise, the waste from health care activities is routed to a specialised channel. Aqueous liquid effluent containing radionuclides with a half-life of less than 100 days may, after decay, be sent to the public sewerage network.

a) With regard to solid waste, it must be collected from the units that produce it in specially reserved containers, designed to counter any radioactive, infectious and chemical hazard (dedicated packaging). This waste is then temporarily stored, pending local disposal after radioactive decay, or recovery by ANDRA.

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

b) For liquid effluent, there are 3 main types of controlled discharges:
- waste from laboratories handling and preparing unsealed sources from mother solutions. Only aqueous effluent from handling of radionuclides with a half-life of less than 100 days can be discharged into the sewerage system. Marked non-aqueous effluent (scintillation liquid, etc.) must be collected and follow a dedicated disposal channel involving ANDRA;

Buffer tanks

- sanitary facilities of protected rooms reserved for hospitalisation of patients who have received therapeutic doses of iodine 131 of up to 4000 MBq. These patients will eliminate in their urine 60 to 80% of the radioactive iodine administered to them;
- sanitary facilities of the nuclear medicine department used by patients who have received therapeutic or diagnostic doses. In this latter case, the levels administered do not exceed 740 MBq per application.

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

As with solid waste, the disposal of radioactive liquid effluent is only possible after a check on its residual radioactivity. This check is conducted after analysing a sample of effluent taken from the tank to be drained. The effluent collection and inspection procedures are as follows:
- effluent from the laboratories is routed to a series of 2 buffer tanks operating alternately with one being filled and the other used for decay storage. This arrangement avoids direct radioactive effluent discharge into the main sewerage system. The capacity of these tanks must be determined such as to allow storage for a time long enough to obtain clean-out of the effluent compatible with its discharge into the main waste water network (see following table presenting maximum activity concentration values on leaving the tanks). The activity concentration requirement for tank drainage is 7Bq/l;
- liquid effluent from the sanitary facilities in protected rooms is also collected in a series of buffer tanks with the same characteristics as those described above and operating in the same conditions. The activity concentration requirement for tank drainage is 100 Bq/l;
- discharges from the sanitary facilities reserved for injected patients must pass through a septic tank type decay pit, before being sent to the main sewerage system. Given the short half-life of the radionuclides contained in this effluent (primarily technetium 99m which has a half-life of 6 hours) passing through this tank contributes to their radioactive decay.

Activity concentration guideline values are given for effluent at the outflow from the health establishment; these values are 1000 Bq/l of 99mTc and 100 Bq/l of 131I.

An order concerning waste and effluent produced outside BNIs must be issued to implement article R 1333-12 of the Public Health Code. A working group supervised by ASN was active from the end of 2004 until 2006 to examine more closely how the two-fold infectious and radioactive risk was taken into account in the management of waste and effluent, along with experience feedback to be gained from enforcement of the above-mentioned circular and the regulatory requirements to be put into place. This working group comprised representatives from the health authorities (DGSNR, DGS, DHOS), from public health and research institutions (Paris public hospitals, Paris municipal hygiene laboratory, INSERM, etc.) and private pharmaceutical laboratories.

ASN prepared the draft order sent out in 2006 for examination by the professionals concerned, and which contained provisions dealing in particular with:
- drafting and approval of the waste and effluent management plans;
- the waste and effluent decay management conditions;
- the possibility of discharging effluent contaminated with carbon 14 or tritium;
- installation discharge outlet monitoring conditions;
- conditions requiring use of a radioactivity detection portal at site exits;

This draft will be modified to take account of certain remarks made, in particular those from the *Société française de médecine nucléaire* (French society of nuclear medicine). The provisions of the order must nonetheless remain consistent with radioactive waste management in France.

Finally, it should be noted that despite increasingly stringent management procedures in the nuclear medicine departments, radioactivity detection gates situated at the entrance to conventional waste treatment installations are still frequently triggered, primarily due to the waste produced by patients returning home following treatment. The Ministry for the Environment (Directorate for the Prevention of Pollution and Risks - DPPR) in 2003 sent the managers of landfills and incineration plants recommendations stating what to do if the alarms are triggered on the radioactivity detection gates now installed in all such installations. The Minister for Health issued an order on 21 January 2004 instructing nuclear medicine practitioners to advise their patients returning home on how to properly dispose of any radioactive waste they may produce.

3 | 3

Management of Technologically Enhanced Naturally Occurring Radiation (TENORM) waste

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

Some professional activities using raw materials which naturally contain radionuclides but which are not used for their radioactive properties, may lead to an increase in the specific activity of the radionuclides present. We then talk of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM).

Waste containing TENORM may be accepted in various types of installations, depending on its specific activity:

- in a disposal centre authorised by order of the *préfet*, if it can be proven that its activity is negligible from a radiation protection viewpoint. The DPPR circular of 25 July 2006 clarifies the conditions for acceptance of this waste. This circular is accompanied by a methodological guide drafted by IRSN under the supervision of a steering committee made up of representatives of industry, disposal centre operators, environmental protection associations, experts and the Administration. The DPPR stated that the provisions of the circular should not result in the disposal centres authorised by order of the préfet becoming disposal channels for TENORM waste.
- in ANDRA's very low level waste disposal facility,
- in an interim storage facility. Some of this waste is waiting for a disposal channel, in particular the commissioning of a long-lived very low level waste disposal centre. Act 2006-739 of 28 June 2006 on the sustainable management of radioactive materials and waste sets 2013 as the time-frame for commissioning of this facility.

Act 2006-739 of 28 June 2006 requires that an inventory of short and long-term solutions for TENORM waste be produced in 2009.

3 | 3 | 1

Uranium mining waste

Uranium mines handle large quantities of raw materials and thus generate large quantities of VLL waste with enhanced natural radioactivity. These are the uranium mine residues, of which 2 categories must be distinguished:

- low-content ore (about 300 to 600 ppm) with a total average specific activity of 44 Bq/g (including about 4 Bq/g of radium 226). These residues are placed either in stockpiles, or in open-cast mines, or used as the first covering layer for disposal of dynamic treatment residues;
- ore with a high average content (about 1 ‰ to 1% in French mines) having a total average specific activity of 312 Bq/g (including about 29 Bq/g of radium 226). These residues are either placed in old

open cast mines, sometimes with an additional dyke, or in pools with a surrounding dyke, or behind a dyke damming a thalweg.

In France, the treatment residues represent 49 million tons (31 million tons of dynamic treatment residue and 18 million tons of static treatment residue) spread over 17 disposal sites, run as installations classified on environmental protection grounds (ICPE). The national inventory of uranium mining sites, produced as part of the MIMAUSA programme (Memory and Impact of Uranium Mines: Summary and Archive) run by the Ministry for Ecology and Sustainable Development, can be accessed on the www.irsn.fr website. An update of the MIMAUSA inventory should be available in the second half of 2007.

The process, which started in 2005, to examine periodic safety reviews of former mining sites and mining treatment residue disposal activities, their long-term surveillance and the consequences of inappropriate future use of the land concerned, continued in 2006.

The Bellezane (Haute-Vienne) former mining site before and after redevelopment

Case of the Limousin region uranium mining sites

To encourage dialogue and debate around the Limousin region's uranium mining sites, the Haute Vienne prefect decided in April 2005 to set up a local information committee (CLI). The CLI members are currently being appointed. On 24 December 2004, the Regional Directorate for Industry, Research and the Environment (DRIRE) received Cogema's operating results, which although they meet all the requirements nonetheless need some additional work. The DRIRE therefore asked the licensee to have an external peer-review carried out. At the same time the Minister for Ecology and Sustainable Development, the Minister Delegate for Industry and the Minister for Solidarity, Health and the Family decided to set up a pluralistic expert group (GEP) to regularly monitor the third-party assessment and take part in its coordination

The GEP, chaired by Annie Sugier, met for the first time on 29 and 30 June 2006 in Bessines (Haute-Vienne). The GEP members drew up the programme of work for the year 2006, confirmed the choice of the study sites (catchment area of the Ritord and residue disposal site in Bellezane) and defined the following three sub-groups: source term and discharges, environmental and health impact, long-term regulatory framework. The first results were delivered in November 2006. The duties of this GEP are for a limited period of time and should be completed at the end of 2007.

3 | 3 | 2

Waste resulting from other activities

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

Some of these installations are not currently active, however most of them are (or were) regulated by part 1 of book V of the Environment Code. ASN is working together with relevant departments of the ICPE (Installations Classified on Environmental Protection Grounds) inspectorate. ASN aims to ensure that this waste is sorted and packaged so that it is always routed to the appropriate channel. It should be noted that given the absence of a long-lived low level waste repository, the only channel currently available for the most active waste is interim storage.

In 2004, ASN asked the Robin des Bois association to conduct a study into the effects of natural occurring radioactivity enhanced by human activities, and the correspondingly polluted sites in France. This study covers industrial activities involving phosphates, monazite, rare earths, ilmenite, zirconium (refractories, abrasives, sanding, ceramics, foundries), ferrous and non-ferrous metals, mineral and spring waters, drinking water, spas, wells, geothermal activities, oil and gas, coal (combustion ashes), wood (combustion ashes) and papermaking. The final version of the study report was submitted to ASN in December 2005. This extremely comprehensive report provides detailed information on the potential sources of exposure of workers and the public to ionising radiation and was transmitted to the local, regional and national administrations.

4 INTERIM STORAGE OF RADIOACTIVE WASTE AND SPENT FUEL

4 | 1

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

a) Solid waste treatment stations

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 74 and 79, CEA is involved in a programme to recover this waste as part of the process to delicense the Grenoble and Fontenay-aux-Roses sites.

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

The radioactive waste storage yard

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

The waste is stored there in pits, in warehouses and for the VLL waste, in a dedicated area. The start of operations at CEDRA makes it possible on the one hand to empty the recent pits in BNI 56 and the warehouses, and on the other to recover waste stored in the old pits (Fosséa project).

b) CEDRA

Decree 2004-1043 of 4 October 2004 authorised CEA to create the CEDRA basic nuclear installation (packaging and storage of radioactive waste) on the Cadarache site. On 20 April 2006, the Ministers for Industry and the Environment authorised start-up of CEDRA unit 1.

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

The CEDRA installation will eventually replace in particular BNIs 37 and 56.

c) PEGASE/CASCAD

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

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

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

Removal from storage began in January 2006 with consignment of OSIRIS Oxydes type fuels to the CARES (secret BNI) interim storage facility, but these operations were interrupted as a result of an incident. Pending the authorisation to resume, removal from storage of the OSIRIS Siliciures elements began.

In 2006, a project to recover the plutonium-containing drums for interim storage in CEDRA should enable CEA to meet its undertaking to remove this waste no later than the end of 2010.

Total clearance of the PEGASE store over the coming five years is considered to be a priority by ASN.

The CASCAD installation is dedicated to dry storage of spent fuel. The fuel is placed in containers before being stored in sealed pits located in a concrete structure and cooled by natural air convection.

4 | 2

Interim storage of legacy waste

a) Recovery of waste from trenches in the CEA BNI 56

The Cadarache interim storage facility (see point 4|1) partly consists of 5 trenches which, between 1969 and 1974, were filled with a variety of low and intermediate level solid waste, then covered with earth. The facility was at the time an experimental waste disposal facility. As part of the programme to clean-out and rehabilitate the site, recovery of the waste from the trenches, which began in 2005, continued in 2006.

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

Waste recovery from pits

In its old pits, BNI 56 also stores intermediate level waste in conditions which no longer meet current safety standards. The FOSSEA project provided for the recovery and repackaging of all packages stored in the pits, for interim storage in CEDRA, after additional characterisation and repackaging when necessary. In 2006, CEA nonetheless made it known that for economic reasons, it was unable to implement the process that had been studied for a number of years, and that it had suspended the work for an as yet unspecified period. ASN asked CEA to clarify its stance with regard to the new steps it intends to take to recover the waste from the trenches.

Trench emptying worksite, BNI 56

b) The EDF Saint-Laurent silos (BNI74)

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

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

As this installation no longer complied with current safety criteria, ASN asked EDF to empty the silos before 2010. The solution proposed by EDF in 2005 was based on the availability of a disposal channel for the graphite waste by 2010, however the delay in the search for a host site is likely to put this deadline back to 2013. ASN asked EDF to look at alternative strategies. Studies conducted by EDF show that the solution consisting in recreating a containment barrier around the silos would seem to be sufficient to improve the safety of this interim storage, pending the availability of a graphite waste disposal channel. This solution should be implemented by EDF and will require prior authorisation by ASN.

4 | 3

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

4 | 3 | 1

Organisation of the public authorities and their various responsibilities

The DPPR is responsible for drafting regulations concerning polluted sites, on the basis of the provisions concerning ICPE. It therefore published a circular on 16 May 1997 concerning the management of sites contaminated by radioactive materials. The clean-out of these polluted sites can lead to the production of radioactive waste. The DRIREs enforce the arrangements of this circular on behalf of the prefect.

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

4 | 3 | 2

The types of waste concerned and special actions in progress

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

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

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

These two measures did not guarantee the medium-term financing needed to deal with waste for which the licensee is defaulting and the agreement between ANDRA and the producers in the nuclear electricity generating sector came to an end in May 2005. The size of the radium fund had for its part been tailored to precise situations and could only be used when the contaminating radionuclide was radium. The amount of 1.5 million euros initially allocated to the ADEME is to be transferred to the fund dedicated to this task at ANDRA. Under the terms of the 2005-2008 four-year services and resources contract which was signed on 1 August 2005 between the State and ANDRA, ANDRA's duties of general public interest will therefore be financed by the Agency from its own resources, topped up as necessary by a subsidy from the Ministry of Industry's budget. The 28 June 2006 act on the sustainable management of radioactive materials and waste confirmed ANDRA's public service duty. The duties of general public interest benefiting from this subsidy are in particular certain activities relating to the collection of dispersed radioactive waste and depollution of contaminated sites entrusted to Andra by the authorities. During the course of 2006, ANDRA, its supervisory ministries and ASN examined how to carry out these new duties. A committee should be set up in 2007 to validate the technical and financial solutions chosen, which will allow allocation of a public subsidy (see 5).

4 | 3 | 3

Public service storage facilities

ANDRA does not operate any interim storage facilities. It signs agreements with other nuclear licensees so that they provide it with interim storage capacity. For example, the SOCATRI company was authorised by decree in 2003 to provide interim storage on behalf of ANDRA for long-lived low level waste, CEA at Cadarache for interim storage of radium lightning conductors, and CEA at Saclay for interim storage of used radioactive sources for which there are currently no disposal channels.

5 SITES POLLUTED BY RADIOACTIVE MATERIALS

5 | 1

The legal framework of action by the public authorities

According to the 1997 circular, 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. This circular, for the *préfets*, describes the administrative procedure applicable to sites polluted by radioactive materials and specifies that the treatment and rehabilitation operations are performed and financed directly by those responsible, as defined by the act of 19 July 1976 concerning installations classified on environmental protection grounds (ICPEs). As part of the process to overhaul polluted site regulations, the Minister for Ecology and Sustainable Development could publish a circular in 2007, inspired by the new practices applicable to sites contaminated by materials other than radioactive and tailored to the case of installations classified on environmental protection grounds.

However, certain sites suffer radioactive contamination from former small-scale or industrial activities involving radioactivity (for instance the clock-making industry using radium, the radium extraction companies of the 1920s to 1930s, the laboratories which in the early 20th century worked on radioactivity discoveries, and so on). These sites are not always ICPEs and another circular should apply to this type of site, specifying the conditions in which the ANDRA's new public service duties apply.

ASN considers that the new regulations on sites polluted by radioactive materials should enable a clear and applicable context to be given to the inspectors in charge of supervising these sites on behalf of the *préfet*, ensuring compliance with international recommendations (IAEA) on the subject. These regulations could clarify the provisions of article R. 1333.90 of the Public Health Code dealing with a confirmed risk of chronic exposure.

The methodology guide for management of industrial sites potentially contaminated by radioactive materials, published in October 2000 (version 0), describes the applicable approach to dealing with various situations liable to be encountered during rehabilitation of sites (potentially) contaminated by radioactive materials and should soon be updated to take account of the forthcoming abrogation of the circular of 16 May 1997 and to allow an approach consistent with management of chemically polluted sites and soils.

5 | 2

The inventories of polluted sites in France

Several complementary inventories are available to the public.

5 | 2 | 1

The ANDRA national inventory

Since 1993, ANDRA has published a national inventory of radioactive waste giving information on the condition and location of radioactive waste around the country, including on sites identified as being polluted by radioactive materials. The January 2006 edition is available from the ANDRA website, www.andra.fr. The next edition is scheduled for 2009.

5 | 2 | 2

Databases of the Ministry for Ecology and Sustainable Development

The Ministry for Ecology and Sustainable Development set up a web portal dedicated to polluted or radiation contaminated sites and soils (www.sites-pollues.ecologie.gouv.fr). This portal gives access to two databases, 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. A summary of the inventory is accessible on the Ministry for Ecology and Sustainable Development website, www.ecologie.gouv.fr.

– "BASIAS" which is a record based on regional historical inventories of former industrial sites, a trace of which must be retained. Its purpose is to maintain inventoried site records in order to provide information of use for town planning, land transactions and environmental protection. The information collected is input into a data base managed by the BRGM and available on the website, www.basias.brgm.fr. www.basias.brgm.fr.

5 | 3

Actions performed and dossiers in progress

5 | 3 | 1

General

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

5 | 3 | 2

Somme of the dossiers in progress

a) Coudraies area in Gif-sur-Yvette (Essonne):
Review of the files on the properties in the Coudraies area in Gif-sur-Yvette (91), which began in 2002, enabled the Essonne *préfet* to propose allocation of technical and financial aid for the simpler cases. A property was purchased at the end of 2005 and the site was made safe by ANDRA in 2006. Nonetheless, 2 dossiers have still not been resolved, even if proposals were submitted to the owners in mid-2006.
The Essonne *sous-préfet* for its part sent the Gif-sur-Yvette town hall a document in mid-2005 as part of the revision of the local urban development plan, which specifies the health requirements concerning the petite Coudraie district. This document was submitted to ASN for its opinion.

b) Making safe the Isotopchim site in Ganagobie (Alpes-de Haute-Provence):
From 1987 to the end of 2000, the Isotopchim Company was involved in carbon 14 and tritium labelling of molecules intended for medical applications in Ganagobie (04). In 2000, the company went into liquidation, leaving a contaminated environment (incidental release of carbon 14 into the

atmosphere and aqueous releases into the sewers) along with a large amount of chemical and radioactive waste on site.

Since the end of 2000, several inventories have been produced and an initial rehabilitation project reviewed. Since December 2002, ANDRA has been conducting site clean-out operations, in particular to remove the bottles containing concentrated solutions to an appropriate and financed disposal channel. The option of transferring these solutions, which in fact represent a very small volume, and then treating them at CEA in Marcoule, was studied in 2006 and should take place during the course of 2007. ASN noted significant mobilisation by CEA during 2006 to help the public authorities rehabilitate the site.

c) Danne property in Bandol (Var)

This property had been cleaned up in the past and the site is today a wasteland. The waste resulting from the decontamination operations carried out in 1992 is still on the site and residual hot spots still exist. The Var tax office is responsible for the site as administrator. In mid-2005, the decision was taken to make the site safe (brush clearance, removal of hot spots as required to allow easy maintenance of this plot, etc.). Brush was cleared, fencing repaired and the waste made safe during the summer of 2006, thanks to financing through ANDRA's public service duties. Elimination of hot spots and removal of waste are still required before the site can be rehabilitated through a redevelopment project.

d) Etablissements Charvet on the Île Saint-Denis (Seine-Saint-Denis):

From 1910 to 1928, this site housed a plant extracting radium from uranium ore and a laboratory for Marie Curie. It was partially demolished in 1948, but until August 2006, buildings still existed on the site. Since 1966 they had been occupied by various companies handling butcher's waste transit activities. The Charvet company, which is the current owner of the site, carried out the same activities from the 1990s to mid-2005. The site, which has been closed since the business ceased operations, was illegally occupied from December 2005 to June 2006. Access to the site is now prohibited, with the entrances blocked off by demolition rubble. On 29 August 2006, ASN visited the site to decide on how to remove the waste contaminated by radium and envisage the future fate of the site.

5 | 3 | 3

Management of incidental contamination

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

Two particular dossiers could be mentioned:

- Following discovery of the radioactive content of the load on two lorries by the Métal Blanc company in Bourg-Fidèle (Ardennes *département*[2]), incidental uranium contamination had been revealed in the Budin works at Aubervilliers (Seine-St-Denis *département*) in 2003. Initial decontamination was carried out, but some parts of the installation retained traces of contamination. A second decontamination phase is awaiting financing.
- It should be noted that about one ton of depleted uranium was found at the Debus works in Villejuif and, even if it poses no immediate health problems, will have to be disposed of in authorised channels in accordance with radioactive waste management principles. A channel was identified by the working group initiated by ASN, as part of the PNGMDR development process, but waste handling in this channel involves high costs which will have to be financed.

6 LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE BY DISPOSAL

6 | 1

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

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

6 | 1 | 1

Manche waste repository

The Manche waste repository, with its 530,000 m3 capacity, was set up in 1969 at Diguevielle and was operated until July 1994. It entered the surveillance phase in January 2003 (decree n° 2003-30 of 10 January 2003).

ANDRA has for a number of years been detecting the persistent presence of tritium in the groundwater and in the Grand Bel. Following enquiries from environmental associations (ACRO - Association for the Control of Radioactivity in the West) and ASN, ANDRA will be examining whether or not it would be advisable to install a pumping system to divert and treat the groundwater. The results of this modelling study are expected some time in 2007.

Finally, by January 2009, ANDRA should submit the final safety analysis report concerning the installation as a whole and should decide on the benefit to be gained from installing a new cover to ensure the passive long-term safety of the repository.

ANDRA – Manche waste repository

6 | 1 | 2

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

The low and intermediate level waste (LL-IL) repository, which until 2005 was known as the Aube repository, was created in 1989. It is located on the *communes*[3] of Soulaines-Dhuys and La Ville-aux-Bois in the Aube *département*. It covers a surface area of about one hundred hectares.

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

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

ANDRA – Aube waste repository

The waste packages are disposed of in concrete structures connected to a network draining away any water that has penetrated (buried gravity separation network), subject to permanent surveillance. The site's capacity is 1,000,000 m^3 of waste packages, or about 400 structures.

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

In 2001, ANDRA was authorised by ASN to accept for storage 55 EDF reactor vessel heads which had been replaced. The construction of the structures designed to take the vessel heads began in 2003. The first vessel heads were stored in 2004. The LL-IL waste repository currently contains 12 vessel heads. A first structure dedicated to these large waste items was thus closed during the year. In December 1999, ASN authorised ANDRA to use the Aube waste repository to store sealed radioactive sources from CEA, with a half-life of less than that of cobalt 60. In January 2002, ANDRA submitted an application for generic acceptance of radioactive sources meeting certain criteria, justified by a safety analysis based on the principles of basic safety rule RFS III.2.e, available from ASN website. In January 2006, ASN modified the technical requirements of the CSFMA to allow acceptance of low level sealed source packages with a half life shorter than that of caesium 137.

In June 2002, ANDRA sent the ministers with responsibility for nuclear safety a request for modification of the authorisation decree creating the LL-IL waste repository and a request for a repository discharge license to bring it into conformity with the requirements of the Environment Code. This request, completed in 2004, underwent a public enquiry procedure from 30 November 2004 to 8 January 2005. Following the administrative procedures, ANDRA was thus authorised by decree 2006-1006 of 10 August 2006 (modifying the decree of 4 September 1989) and by ministerial order of 19 September 2006 to proceed with water intake and discharge of aqueous or gaseous effluent in certain conditions.

In accordance with basic nuclear installation practices, ANDRA carried out a periodic review of the CSFMA. This dossier was examined by IRSN and submitted to the advisory committee for waste in June 2006. On the basis of the opinion of the advisory committee, ASN declared itself to be in favour of extension of the disposal activities in the zone not yet used and asked that additional safety studies be conducted into the risks of explosion and fire, and that the impact of long-lived radionuclides and chemically toxic substances be estimated.

6 | 1 | 3

Package acceptance rules

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

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

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

ASN initiated a project to update the RFS III.2.e. This project should benefit from the discussions initiated during the advisory committee meeting of June 2006 concerning the CSFMA, with probable changes scheduled for 2007.

6 | 1 | 4

Surface or subsurface disposal projects

Disposal of waste containing radium

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

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

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

Disposal of irradiated graphite waste

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

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

Graphite assembly in graphite gas reactor

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

The launch of the EDF programme to decommission the GCRs required the creation of a management channel suitable for this waste. Article 4 of the act of 28 June 2006 stipulates “Development of disposal solutions for graphite wastes and radium-containing wastes, so that the corresponding disposal centre can be set in operation in 2013”.

During the course of 2006, ASN produced a safety guide for the safety both in operation and after closure of a repository for long-lived, low level solid radioactive waste, jointly with the relevant IRSN departments. This guide provides for a certain number of criteria applicable to the site for such a repository, which will have to be defined rapidly if the objective set by the act is to be met.

6 | 2
Disposal of long-lived high level waste

Implementation of the requirements of chapter II of part IV of the Environment Code, as a result of programme act 2006-739 of 28 June 2006 concerning the sustainable management of radioactive materials and waste, following the public debate held from September 2005 to January 2006, and taking account of the recommendations contained in the March 2005 report from the Parliamentary office for the assessment of scientific and technological options, the Government submitted a report and a bill to Parliament in the first half of 2006 concerning the management of radioactive materials and waste in compliance with the requirements of the Bataille act of 1991. The report and the bill, referring to the conclusions of the national assessment committee in its February 2006 report and of ASN in its opinion of 1 February 2006 on ANDRA research into the Bure laboratory site, confirmed the need for studies to continue in the three areas of research initiated by the Bataille act, so that in particular an operational solution for deep geological disposal is available by the year 2025. The bill also presented provisions concerning the ban in France on the disposal of foreign waste. As mentioned in point 1|6, the bill provided for adoption every 3 years of a national radioactive materials and waste management plan, which should comprise a “research” part. Finally, this bill contained provisions concerning the secure financing of radioactive materials and waste management and decommissioning of basic nuclear installations, as presented in chapter 15.

After adoption by the National Assembly on 15 June 2006, the bill passed into act on 28 June 2006.

Articles L. 542-1 to L. 542-14 of the Environment Code were modified further to this act. They set the broad outlines for research and study into radioactive waste management:
- sustainable management of radioactive materials and waste of all types, in particular resulting from the operation or decommissioning of installations using radioactive sources or materials, and carried out with the aim of protecting human health, safety and the environment;
- the search for and implementation of the means necessary for definitively making radioactive waste safe are undertaken in order to prevent or mitigate the burden to be borne by future generations;
- the producers of spent fuel and radioactive waste are responsible for these materials, without prejudice to the liability of those in possession thereof, given their responsibility for nuclear activities.

With regard to long-lived high level waste, research and studies are being carried out into:
- the separation and transmutation of long-lived radioactive elements, so that by 2012 an assessment of the industrial prospects of these channels will be available, with commissioning of a prototype installation before 31 December 2020;
- reversible disposal in deep geological layers for selection of a site and design of a repository so that, on the basis of the results of the studies conducted, the authorisation application specified in article L. 542-10-1 of the Environment Code can be examined in 2015 and, subject to this authorisation, the facility can be commissioned in 2025;

– interim storage, so that no later than 2015, new interim storage installations can be created or existing facilities modified, in order to meet the needs, especially in terms of capacity and duration, identified by the plan specified in article L. 542-1-2 of the Environment Code.

6 | 2 | 1

Separation/transmutation

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

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

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

ASN ensures that the experimentations involved in this research programme, performed notably in the Phénix and Atalante installations, are carried out under satisfactory safety conditions. With regard to Phénix, after major reactor renovation work and a final review by the Advisory Committee for reactors at the end of 2002, ASN informed CEA in January 2003 that it had no objections to resumption of operation, which took place in July 2003. ASN however only authorised continued operation of the Phénix reactor for a period corresponding to 720 equivalent full power days, which means that the reactor will be stopped in about 2008-2009, depending on the various outages. Research into transmutation will have to be carried out on other reactors. A review should be carried out in 2012 allowing examination of the implications of possible industrial application of the separation and transmutation processes. Given the scale of the research still to be carried out, it can be assumed that no industrial application of these processes could be possible before about 2040.

6 | 2 | 2

Deep geological disposal

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

On the basis of this review, ANDRA received approval of the shaft sinking conditions on 7 August 2000 from the Ministers for Industry and the Environment. In December 2006, the access shaft and the main laboratory drifts were completed. In the main shaft, at a depth of 445 m, an experimentation niche 40 m long was built, with fitting out work starting in September 2004. It has been operational since December 2004. From this niche, 40 bores were drilled to obtain results on the mechanical behaviour of the rock and the composition of the fluids in the clay, and to carry out a tracer diffusion experiment. A multi-experiment drift was equipped in October 2005 and the results of the KEY experiment into the feasibility of drift sealing are currently being analysed. The drilling in 2003-2004 of 5 directional boreholes confirmed the homogeneity of the host rock.

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

ASN inspection of the Bure underground laboratory on 9 May 2006

Finally, ASN has prepared the draft decree authorising continued operation of the Bure laboratory beyond 31 December 2006. This decree, dated 23 December 2006 and extending the operational life by 5 years, was published in the Official Gazette on 31 December 2006 after being approved by the laboratory local information and surveillance committee in October 2006 and the Council of State in December 2006.

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

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

Future actions to harmonise geological disposal safety rules were discussed and a further meeting was held on 20 May 2005 in Brussels. During this meeting, the decision was taken to create a working group with responsibility for conducting a pilot study on the regulatory analysis of a safety case for a geological repository. The working group consists of representatives from 8 European safety agencies, a representative of EU-DG/TREN and a representative of the IAEA. This working group drafted a report presenting a common approach to examining the safety of a nuclear waste repository in a deep geological formation. The conditions in which the European authorities involved in the safety of a radioactive waste repository could work together on such a subject still need to be examined, like the work already undertaken by WENRA concerning the interim storage of radioactive waste and spent fuel and the decommissioning of nuclear installations.

6 | 2 | 3

Long-term storage

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

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

It would appear that the long-term interim storage promoted by certain stakeholders, is an essential phase prior to any final management solution. However, the interim storage installations have to be maintained in order to ensure the integrity of the barriers designed for containment of the radioactivity present inside the waste packages. ASN considers that it would not seem reasonable to count on this type of solution for managing waste over periods of time exceeding several centuries.

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

6 | 2 | 4

Specifications and approval certificates for waste packages unsuitable for surface disposal

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

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

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

7 OUTLOOK

Nuclear activities generate radioactive waste following rigorous management principles and in accordance with an international consensus. Radioactive waste is classified according to its lifetime and its activity level and is the subject of an exhaustive inventory published by ANDRA every 3 years, the latest version of which dates from 2006. This waste is managed in channels appropriate to its characteristics. Some waste, mainly from biomedical research and nuclear medicine, is managed by decay owing to its very short half-life, enabling a negligible activity level to be reached after just a few weeks. The nuclear power sector produces the largest amount of radioactive waste. The short-lived low or intermediate level waste is disposed of in the ANDRA repositories. Part of this inventory does not as yet have an operational long-term management solution and the corresponding waste is therefore stored for the time being in the nuclear installations, pending reprocessing or final disposal. This is in particular the case with long-lived high and intermediate level waste resulting from the reprocessing of nuclear power plant spent fuels, but also long-lived low level waste, some of which will be produced during decommissioning of the first generation reactors.

In 2006, ASN continued with its actions aimed at ensuring that radioactive waste is managed safely, right from the moment it is first produced. ASN thus regulates its management within the nuclear installation, but also periodically assesses the management strategies put in place by the licensees. ASN thus in 2006 took a stance on the possibility of recovering waste from past practices in the COGEMA plant at La Hague. It would seem that even if COGEMA has sufficient means to implement its recovery strategy, the safety of a number of interim storage installations such as the HAO silos (oxide high activity facility) is unsatisfactory and COGEMA will have to be attentive to complying with the recovery schedules presented. The safety of the CEA waste and spent fuel treatment and interim storage installations was assessed at the end of the 1990s, following which CEA envisaged creating new installations and renovating certain others. ASN observes that on the whole, CEA is experiencing difficulty in meeting its commitments, particularly in terms of completion times, with the result being that it periodically reviews its strategy. ASN observes that certain projects have been successfully completed, such as the CEDRA interim store or the STELLA installation, but that others are encountering difficulties, such as recovery of waste from the Cadarache interim storage area.

Since 2002, ASN has been in charge of regulating management of sites polluted by radioactive materials. The administrative procedures in this field are to a large extent based on the ICPE regulations, particularly the 1997 circular which needs to be revised to take account of the reforms made to radiation protection and the creation of the new ASN, with its radiation protection inspectors who are now able to assist the *préfets* in managing these situations, but also the experience feedback from management of the various cases encountered, often characterised by excessively lengthy examination processes and by the problem with finding a responsible party capable of financing any rehabilitation work necessary.

The year 2006 was marked by the passing of a programme act on 28 June, concerning sustainable management of radioactive materials and waste. ASN notes that this act takes account of the recommendations it made in its opinion to the Government on 1 February 2006, which was published, following a safety and radiation protection analysis of the dossiers submitted by CEA and ANDRA in mid-2005. ASN is therefore pleased to see that this act now provides a coherent and exhaustive legislative framework for all radioactive materials, such as spent fuel, and waste.

In 2007, ASN will attach particular importance to:

- helping to draft the regulations implementing the 28 June 2006 act and ensuring compliance with its requirements, in particular by continuing with co-supervision of the working group in charge of drafting and monitoring the PNGMDR;
- finalising the work to revise the regulations concerning sites polluted by radioactive materials. This revision entails the ongoing overhaul of the system for assistance with financing the rehabilitation of such sites and incorporation of international recommendations in this field, as underlined by the IRRS audit of ASN at the end of 2006;
- finalising the regulations concerning management of radioactive effluent and waste pursuant to article R. 1333.12 of the Public Health Code;
- supervising the measures taken by COGEMA to recover the legacy waste from La Hague and by CEA to create and renovate its waste and spent fuel treatment and interim storage facilities.

Chapter 16
RADIOATIVE WASTE, CLEAN-OUT AND POLLUTED SITES

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