OSPAR COMMISSION

Implementation of PARCOM Recommendation 91/4 on liquid discharges

Report from France

Radioactive Substances Series

2010

REPORT ON THE IMPLEMENTATION OF PARCOM 91/4 ON RADIOACTIVE DISCHARGES

Submitted by FRANCE under application of the OSPAR Convention for the protection of the marine environment of the North East Atlantic

April 2010

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l’Espagne.

EXECUTIVE SUMMARY

Since 2006, the Law No. 2006-686 of June 13, 2006 concerning transparency and nuclear safety, known as the TSN law, caused a comprehensive reform of the organization of nuclear safety and radiation protection regulation in France. The TSN Law creates an integrated system to regulate nuclear installations based on a broadened conception of nuclear safety, covering both the prevention of accidents and the protection of human health and of the environment. It takes into account lessons drawn from an examination of foreign legislation.

France has fully incorporated the best available techniques (BAT) into its legislative and regulatory texts. The best available techniques appear in the front rank of the principles that control nuclear activities in France.

Even if the radiological impact associated with liquid radioactive discharges is very low, France is determined that its regulatory framework and operator practices will lead, through the application of the best available techniques, to achieve a high level of control over radioactive discharges and to obtain reductions in discharges, in line with the OSPAR strategy. France will ensure that this approach is applied in a fully transparent manner, and will involve the various stakeholders. Although that in general effluents discharges decrease, France consider that the reduction of radioactive discharges continues in line with technical progress. This is realised by proceeding with the overhaul of the discharges permits of the basic nuclear installations. France requires that the limits be set as low as the best available techniques will allow, taking into account feedback from experience with the discharges produced at the facilities.

France has set up a system for monitoring environmental radioactivity that meets the objectives of the OSPAR strategy both in terms of coverage of the French portion of the OSPAR area, and of the quality of the monitoring data provided under the agreement concerning the program for monitoring radioactive substances in the marine environment.

- **Application of the BAT (Best Available techniques) to the radioactive discharges of AREVA NC LA HAGUE facilities.**

The methods selected by the operator to minimise the radioactive discharges and emissions from the AREVA NC La Hague site are based upon a continuous approach. The foundations of this are the technical and economic evaluation of the new solutions offered by research developments, for both processes and technology. The management methods for liquid discharges have been reviewed, with the introduction inter alia of the “new effluent management”, which is based on using evaporators that concentrate radioactivity sent to vitrification and purify the distillate that is either recycled In the process or discharged practically free of radioactivity.

The records of the period show the validity of the arrangements implemented, such as:

- The replacement of UP2-400 units by more sophisticated and modern facilities (R4 being the last example), with the replacement of pulsed columns or mixers-settlers by centrifugal extractors that induces a lower degradation of the solvent, resulting in less effluent.
- The complete implementation of the NGE (New effluent management) that sorts aqueous effluents in function of their acidity before evaporating them.
- The continuous purification of solvent and diluent in the TEO (Organic Effluent Treatment) units by distillation under vacuum.
- The discharges to the sea are still lowering as well as the impact on the reference group that is at a very low level.

Extensive R&D is ongoing to develop more improvements in several fields, inter alia:

- Chemical treatment of alkaline effluents in order to vitrify their concentrates;
- Increase of reagent quantities in STE3 in order to get better decontamination factors,
- Use of TIS filters to trap solid 60-Co from storage pool effluents;
- Microfiltration to reduce the alpha content of the "V" effluents;
- Periodic review of tritium abatement techniques and conditioning of resulting waste;
- Retrieval and conditioning of legacy sludges of STE2;
- Retrieval and conditioning of legacy metallic structural waste from LWR fuels;
- Retrieval and conditioning of legacy magnesium and graphite waste from natural uranium fuels.

The same methods and processes as well as the same equipment are used for the reduction of the discharges resulting from exceptional operations such as dismantling and reconditioning of legacy waste. Those that have been undertaken during the period (rinsing of HAO, HA, PF, MAU and MAPu workshops and preliminary operations of reconditioning sludges from STE2) have thus generated very little radioactive discharges.

These accomplishments show how the best technologies are continuously developed and used on the AREVA NC La Hague plants to improve the process and the abatement techniques as soon as they become available, with reductions in the volume and the activity of the effluents as well as in the corresponding impact.

➢ Application of the BAT (Best available techniques) to the radioactive discharges of the French CNPEs (EDF)

The renewal of release permits of the French nuclear power plants (CNPEs) has continued over the 2006-2009 period, with the renewal of the permits of the CNPEs of Golfech, Penly, Civaux and Chooz. The French administration has taken advantage of these renewals to strongly lower the limits concerning radioactive liquid discharges, for beta and gamma emitters except tritium.

In addition, EDF has continued to implement operating practices that have allowed to lower radioactive discharges, with a reduction of more than one hundred times for liquid activity discharges over 20 years for all radionuclides except tritium and carbon 14. Among these practices, it can be noted a better selection of effluents at the source so that they can be sent for appropriate treatment, the increase in the treatment of effluents by evaporation and optimisation of effluents recycling.

As regards tritium, because there is no industrial method for trapping it (given the large volumes of water to be processed and the corresponding low activity), EDF has conducted a feasibility study of reducing releases of tritium into the sea by storing the tritium in tanks and waiting for the radioactivity to decay before discharge. The conclusion from this study is that this option is neither technically nor economically viable and that it therefore does not represent a best available technique.

Eventually, the studies of the radiologic impact of the CNPEs have been improved since 2006 by the update of the transfer functions between activity released and dose, calculated to the population of the reference group. These annual calculations have been broken down radionuclide by radionuclide since 2009 and the total results always remain below 10 microSieverts per year for the reference group.

- *Application of the BAT (Best available techniques) to the radioactive discharges of the CEA centers (French Alternative Energies and Atomic Energy Commission).*

Even if the CEA's discharges cannot be detectable in the marine environment, due to the distance and to the fact they have been already diluted before arriving in the Seine, France is very attentive to the application of the BAT to deal with these discharges.

The programme of denuclearisation of the centre of Fontenay-aux-Roses, which is currently in progress, will include the cleanup and complete dismantling of the nuclear installations. This process will be accompanied by ever smaller liquid discharges. Since the start of the 1990s, there has been a net reduction in liquid discharges of the centre of Saclay, which varies from a factor 5 to 30 depending on the radionuclide or groups of radionuclides considered.

Radioactive liquid discharges to the environment have very low radiological activity and their characteristics are within authorised limits. Prior to the discharge, this effluent is treated to reduce its radioactivity. The most active liquid waste from the installations is always in dedicated tanks specific to its nature and activity. It is then transferred towards one of three treatment stations of the CEA. Its subsequent treatment in a dedicated treatment plant concentrates a large part of radioactive material into solid waste.

In the centre of Saclay, the radioactive liquid effluent treatment installation has benefited from a major renovation program which will permit the treatment of approximately 1500 m3 of effluent per year. This installation benefits from best available technologies. It is equipped on one hand with a new evaporator benefiting from the last technical progress and from the acquired experience and on the other hand from the new process of solidification of the evaporation concentrates by concreting to guarantee a better safety towards the risk sets by fire. The factors of decontamination of the radioactive effluents already high with the current installation will be still improved (more than 10 000 for the main alpha, beta or gamma radionuclide emitters, except the tritium and the carbon 14).

The remainder whose activity is within authorized limits can be ultimately discharged to the environment, a number of tests are performed before during and after the discharge. The continuous improvement of the performance of the installations and processes has permitted the reduction of discharges to the environment over a number of years.

The liquid discharge authorisation of the Saclay centre has been recently modified end of 2009. Depending on the category of radionuclides, the reduction factor of new regulations on discharges, compared to those previously in force, lies between 4 and 30.

The exposure to annual liquid discharges for the reference group of every site is estimated for several scenarios every year and ends in very low doses locally (of the order at most of 3 µSv/year).

PART I: general informations

1. Purpose of the Report

This report is submitted as part of an examination of the implementation of PARCOM Recommendation 91/4 on radioactive discharges, concerning which the contracting parties agreed: "*To respect the relevant Recommendations of international organizations and to apply the Best Available Technology to minimize and, as appropriate, eliminate any pollution caused by radioactive discharge from all nuclear industries, including research reactors and reprocessing plants, into the marine environment.*"

According to Appendix 1 of the OSPAR Convention, for the purposes of OSPAR the best available techniques are defined as follows:

BEST AVAILABLE TECHNIQUES

1. The use of the best available techniques shall emphasise the use of non-waste technology, if available.

2. The term "best available techniques" means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration shall be given to:

(a) comparable processes, facilities or methods of operation which have recently been successfully tried out;

(b) technological advances and changes in scientific knowledge and understanding;

(c) the economic feasibility of such techniques;

(d) time limits for installation in both new and existing plants;

(e) the nature and volume of the discharges and emissions concerned.

3. It therefore follows that what is "best available techniques" for a particular process will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding.

4. If the reduction of discharges and emissions resulting from the use of best available techniques does not lead to environmentally acceptable results, additional measures have to be applied.

5. "Techniques" include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

This report applies to a situation in which the regulation of nuclear safety and radiation protection in France has been completely revised.

1.1. French facilities in the OSPAR area

As of January 1, 2010, France had 124 basic nuclear installations, distributed over about forty sites. These include the following facilities discharging radionuclides within the OSPAR area:

- The La Hague nuclear fuel reprocessing plant;
- 15 nuclear power plants on 19 sites, thus including 44 of the 58 operating pressurised-water reactors in France;
- The nuclear research facilities at Fontenay-aux-Roses and Saclay.

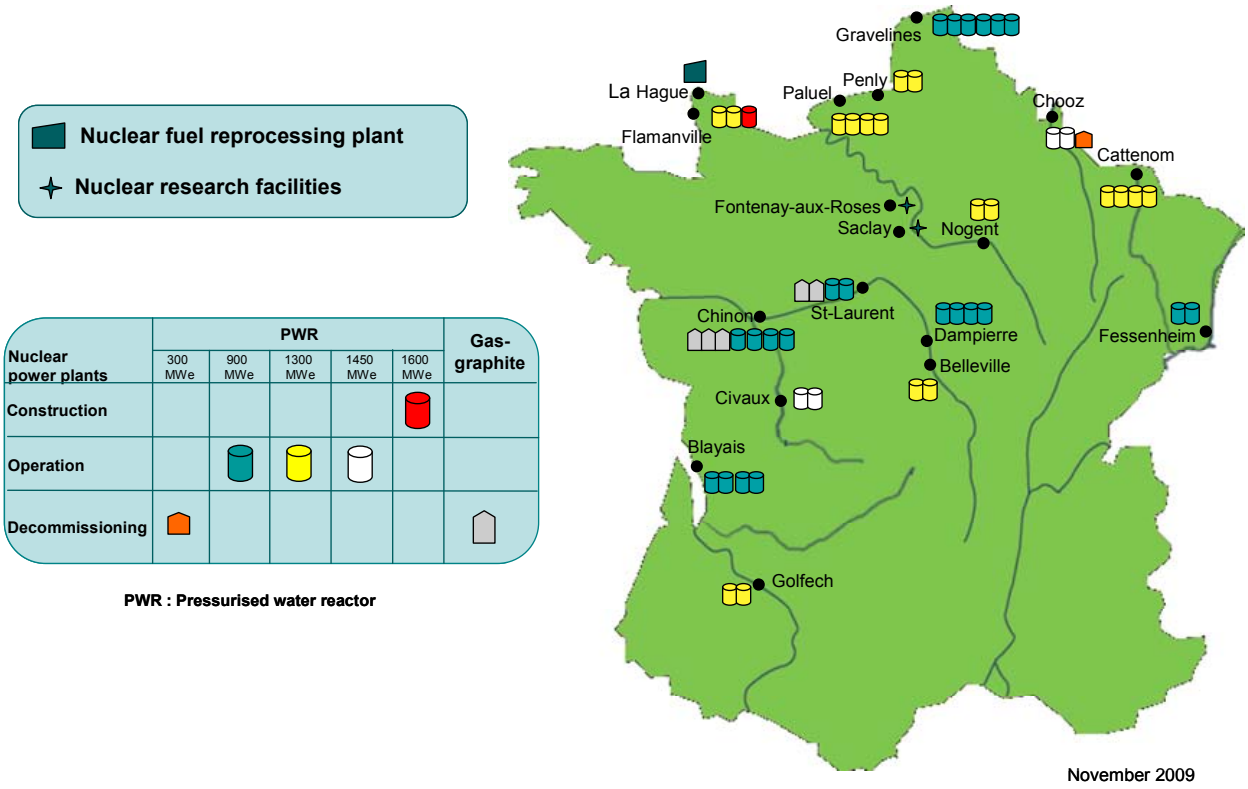


Figure 1: French facilities in the OSPAR area

2. The organization of nuclear safety and radiation protection regulation in France

Law No. 2006-686 of June 13, 2006 concerning transparency and nuclear safety, known as the TSN law, caused a comprehensive reform of the organization of nuclear safety and radiation protection regulation in France. It relies on a variety of actors: State structures, bodies for information and debate, and technical support organizations.

2.1 State structures

The regulation of nuclear safety and radiation protection involves all of the State's structures:

- Parliament, to define the major long-term options;
- The Government, especially the ministers responsible for nuclear safety and radiation protection, who have been assigned the power for overall regulation and for matters concerning the desirability of creating a basic nuclear installation;
- The prefects, responsible for protecting the population;
- Advisory structures, which provide an outside view on significant decisions regarding nuclear safety and radiation protection;
- The Nuclear Safety Authority (ASN), which is the regulatory authority.

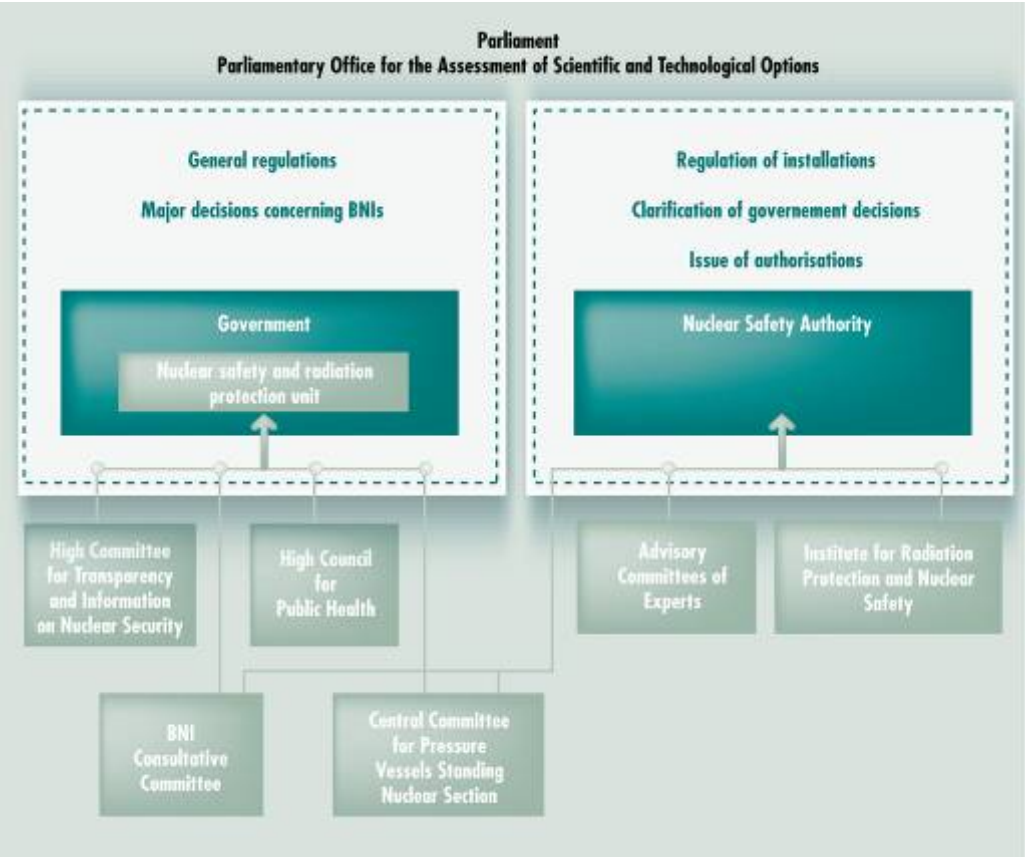


Figure 2: The organization of nuclear safety and radiation protection control in France

2.1.1 Parliament

In 2006 two major laws in the area of nuclear safety and radiation protection were approved by Parliament: the above-mentioned TSN Law and Law No. 2006-739 of June 28, 2006 concerning a program for the sustainable management of radioactive materials and wastes. Parliament's decisions are facilitated by the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST), whose mission is to inform Parliament about the consequences of choices of a scientific and technologic nature - which include nuclear safety and radiation protection matters. For this purpose it gathers information, implements research programs, and conducts evaluations. Its work is available on the OPECST's website (http://www.senat.fr/opecst/).

2.1.2 The Government

The Government is responsible for enacting general technical regulations concerning nuclear safety and radiation protection. It is also responsible under the TSN Law for taking major decisions concerning basic nuclear installations, in particular permits for construction and dismantling. In doing so it may request proposals or advice from the ASN. It can also use the services of advisory bodies such as the Advisory Commission for Basic Nuclear Installations, the High Committee for Transparency and Information on Nuclear Safety, and the High Council for Public Health. The Government is responsible for civil protection in emergency situations.

2.1.3 Ministers responsible for nuclear safety and radiation protection

The ministers responsible for nuclear safety, as indicated in the TSN Law of June 13, 2006, are the Minister of State, Minister for the Ecology, Energy, Sustainable Development, and the Sea, and the Minister of the Economy, Industry, and Employment. They define the general regulations applicable to basic nuclear installations, making use of recommendations from the ASN where necessary. They take a limited number of major individual decisions concerning:

- The design, construction, operation, final shutdown, and dismantling of basic nuclear installations;
- The final shutdown, maintenance, and monitoring of radioactive-waste storage facilities;
- The construction and use of pressure equipment specially designed for these facilities.

If a facility presents serious dangers the above-mentioned ministers may suspend its operation after receiving advice from the ASN.

The ministers responsible for nuclear safety and radiation protection approve ASN regulatory decisions of a technical nature. **In this capacity the ministers approve discharge limits**. In addition, the Minister of Health is responsible for radiation protection. He/she rules on general regulations concerning radiation protection, making use of recommendations from the ASN where necessary. Regulations on radiation protection for workers are the responsibility of the Minister of Labor.

2.1.4 The High Committee for Transparency and Information on Nuclear Safety

The TSN Law created a High Committee for Transparency and Information on Nuclear Safety (HCTISN), a forum for information, consultation, and debate concerning the risks connected to nuclear activities and their impact on human health, on the environment, and on nuclear safety. The High Committee offers a center for debate and assists in informing the public at the national level. Membership is open to all: its members notably include parliamentarians, representatives of Local Information Committees (CLIs), associations, and union organizations, as well as other qualified figures.

The High Committee may issue an opinion on any matter within these areas, and on related controls and information. It may also take up any matter concerning access to information on nuclear safety, and recommend any measure likely to ensure or improve transparency on nuclear issues.

Any question concerning nuclear safety and its control may be referred to the High Committee by the ministers responsible for nuclear safety, the presidents of the relevant commissions of the National Assembly and the Senate, the president of the Parliamentary Office for the Evaluation of Scientific and Technological Choices, the presidents of Local Information Committees, or the operators of basic nuclear installations.

All of this work is available on its website: http://www.hctisn.fr.

2.1.5 Prefects

The Prefect is the State's representative in the *Département*. In particular, he/she plays a major role in the event of a crisis, by being responsible for preventive measures concerning the population.

The Prefect is involved in the licensing procedures for basic nuclear installations. Specifically, regarding the requirements for water taking, for discharges, and for other nuisances caused by basic nuclear installations, he/she seeks the advice of the Departmental Council for the Environment and for Health and Technological Risks.

2.1.6 Nuclear Safety Authority (ASN)

The TSN Law creates an independent administrative authority, the ASN, responsible to the State for the regulation of nuclear safety and radiation protection. The ASN is responsible for the regulation of nuclear activities arising mainly from the nuclear industry, from non-nuclear industries using sources of ionizing radiation, from the research sector, the medical sector, and from the radioactive-substance transportation sector.

The ASN examines requests for basic nuclear installations (INBs) licenses for the construction or dismantling and makes recommendations to the Government on the decrees to be issued in these areas. It establishes the requirements applicable to these facilities regarding risk-prevention, pollution, and nuisances. It authorizes the commissioning of these facilities and rules on their declassification after dismantling. Certain ASN decisions are subject to the approval of the ministers responsible for nuclear

safety. The ASN also issues the authorizations for small-scale nuclear facilities requested by the Public Health Code.

Its officers include designated nuclear-safety inspectors, radiation-protection inspectors, and officers responsible for checking on compliance with the provisions concerning equipment under pressure. It issues the required approvals to the bodies which take part in the controls and in the monitoring of nuclear safety and radiation protection. It may impose penalties, and in particular suspend the operation of a facility.

The ASN contributes to informing the public in its areas of specialization.

The ASN is involved in the management of radiologic emergency situations resulting from events liable to threaten personal and environmental safety by exposure to ionizing radiation that occur in France or that are likely to affect French territory.

2.2 Technical support organizations

On the technical level the ASN relies on the expertise provided by the Institute of Radiological Protection and Nuclear Safety (IRSN) and Advisory Expert Groups (GPE).

2.2.1 Institute of Radiological Protection and Nuclear Safety (IRSN)

The IRSN, created by Law No. 2001-398 of May 9, 2001 and by Decree No. 2002-254 of February 22, 2002, is a public industrial and commercial institution. It brings together public expertise and research resources in the fields of nuclear-safety and radiation-protection regulation. The IRSN is responsible to the individual ministers for the environment, health, research, industry, and defense.

The Institute conducts and implements research programs, so as to ground its position as a public expert in the latest scientific knowledge from the fields of nuclear and radiologic risk, on both the national and international level. It is responsible for providing technical support to the relevant public authorities concerning safety, radiation protection, and security, both in the civil sphere and in that of defense. Lastly, it performs a number of public-service missions, particularly as regards monitoring of the environment and of persons exposed to ionizing radiations. In this context the IRSN manages national databases (national accounting of nuclear materials, national inventory file of radioactive sources, file concerning the monitoring of the exposure of workers subjected to ionizing radiations, etc.), as well as contributing to informing the public about the risks related to ionizing radiation.

2.2.2 Advisory Committee of Experts (GPE)

In preparing its decisions, the ASN relies on the advice and recommendations of Advisory Committee of Experts. These groups consist of experts selected on the basis of their specializations. They come from industry, the universities, and associations. They investigate the technical problems raised in the area of safety by the creation, commissioning, operation, and shutdown of nuclear facilities and their ancillaries, and by the transport of radioactive materials. GPEs are consulted by the ASN's Director General on the safety and radiation protection of facilities and activities within their fields of specialization. In particular, they examine the safety reports - preliminary, provisional, and final - from each of the INBs. They are provided with reports giving the results of analyses carried out by the IRSN, and issue an opinion together with recommendations.

Each GPE may call on any recognized persons for their individual specialties. It may arrange a hearing for the operator's representatives. Participation by foreign experts enables the group to take a varied approach to problems and to benefit from experience acquired on the international scene.

Since the submission of the last French report in 2006, the Advisory Committee of Experts have addressed a number of subjects involved in the implementation of OSPAR's objectives. The various meetings are shown in the table below.

Year	Topic
2006	EPR - Further safety evaluation of the EPR reactor project
2007	Saclay INB 35 and STELLA - Safety review of the liquid-effluent management area
2007	AREVA, La Hague - Safety review of INB 118 (facility for the processing and discharge of liquid effluents)
2009	PWR - Examination of the radioactive and chemical effluents management from Électricité de France power plants

Table 1: Meetings of the Advisory Committee of Experts on the management of effluent discharges at nuclear facilities in the OSPAR area

3. The legislative and regulatory framework for applying the best available techniques in France

France has fully incorporated the best available techniques (BAT) into its legislative and regulatory texts and has the tools to control their application in the various phases of the lives of its facilities.

Implementation of the best available techniques in France is based on the various laws and regulations established for the regulation of nuclear safety and radiation protection, namely:

- The Environmental Code, which defines the principles and general rules applicable to environmental protection;
- The TSN law and its implementing regulations.

3.1 BAT in the Environmental Code

The best available techniques constitute one of the pillars that underpin the requirements regarding protection of the environment and sustainable development. In this regard, the best available techniques are introduced at the highest level of French legal texts, which provide, through the Environmental Code, that actions for the protection, development, restoration, rehabilitation, and management of the environmental heritage must comply **with the principle of preventive and corrective action, preferably at the source, against attacks on the environment, by using the best techniques available at an economically acceptable cost**.

This requirement is imposed along with the following three other major principles:

- **The precautionary principle**, according to which a lack of certainty, in light of current scientific and technical knowledge, should not delay the taking of measured and effective steps aimed at preventing a risk of serious and irreversible damage to the environment, at an economically acceptable cost;
- **The polluter-pays principle**, under which the costs resulting from measures to prevent or reduce pollution and to combat it should be borne by the polluter;
- **The participatory principle,** according to which everyone has access to information about the environment, including information about hazardous substances and activities, and the public is involved in the process of developing projects having a significant effect on the environment or on land-use planning.

3.2 BAT in the TSN Law and regulations

3.2.1 The major principles of the TSN law

The Law of June 13, 2006 concerning transparency and nuclear safety, known as the "TSN Law", produced a comprehensive reform of the legal framework applicable to nuclear activities and their regulation. The law also contains advances in the area of transparency. In particular, it takes into account lessons drawn from an examination of foreign legislation.

The TSN law established a new system to regulate nuclear installations and introduced new provisions regarding information. It was supplemented by various implementing regulations.

The TSN Law provides that the best available techniques, along with the other major principles in the area of environmental protection (see 3.1) apply to nuclear activities. It also reaffirms the major principles in the area of radiation protection. It sets out the fundamental principle of the primary responsibility of the operator as regards the safety of its facility, written into international law, to be applied every day, and essential in order that each person, both operator and regulatory authority, have a clear understanding of their responsibilities.

Accordingly, the best available techniques appear in the front rank of the principles that control nuclear activities in France.

3.2.2 General technical regulations

General technical regulations include all of the measures of general application concerning nuclear safety. The best available techniques were imposed in a Ministerial Order dated November 26, 1999 establishing the general technical requirements concerning the limits and methods of water takings and discharges subject to permitting that are carried out by basic nuclear installations.

In particular, this Order requires that the limits for discharges must be established on the basis of the best available techniques.

In French regulations the best available techniques are to be understood in the sense of Directive No. 96/61/CE of 9/24/96 concerning the combined prevention and reduction of pollution (Point 11 of Article 2 and Appendix IV), thereby fully encompassing the definition given in the OSPAR Convention:

"best available techniques" means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole:

(a) "techniques" shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(b) "available techniques" means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;

(c) "best" means most effective in achieving a high general level of protection of the environment as a whole.

In determining the best available techniques, special consideration should be given to the items listed in Annex IV;

Annex IV: Considerations to be taken into account generally or in specific cases when determining best available techniques, as defined in Article 2(12), bearing in mind the likely costs and benefits of a measure and the principles of precaution and prevention:

1. the use of low-waste technology;

2. the use of less hazardous substances;

3. the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;

4. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;

5. technological advances and changes in scientific knowledge and understanding;

6. the nature, effects and volume of the emissions concerned;

7. the commissioning dates for new or existing installations;

8. the length of time needed to introduce the best available technique;

9. the consumption and nature of raw materials (including water) used in the process and energy efficiency;

10. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;

11. the need to prevent accidents and to minimise the consequences for the environment;

12. the information published by the Commission pursuant to Article 17(2), second subparagraph, or by international organisations.

The Ministerial Order of November 26, 1999 made certain improvements, particularly:

- In the regulatory framework for issues concerning water takings, discharges of effluents, environmental monitoring, and information provided to the State structures responsible for regulation and to the public;
- In the application of regulatory principles concerning environmental protection, and in particular the setting of limits for discharges based on the use of the best available techniques at an economically acceptable cost.

In accordance with the TSN Law and following the adoption of the Decree of November 2, 2007, a program to overhaul the general technical regulations was undertaken by the ASN in 2008. A new order known as the "INB system" will include the basic provisions of the orders currently in force, and make the adjustments rendered necessary in application of the TSN Law and the Decree of November 2, 2007; the regulations will also take into account the reference levels employed by WENRA (Western European Nuclear Regulators' Association). After the necessary dialogues and consultations, this order should be adopted in 2010.

4. Radioactive discharges from nuclear facilities

In France there is very little radiologic impact from radioactive discharges produced by the nuclear industry, medical activities, or other industrial and research activities.

Nevertheless, although effluent discharges are broadly declining, France believes it is necessary in light of the objectives set by the OSPAR strategy to continue to reduce radioactive discharges in France, in line with technical advances. It contributes to these goals by setting limits for discharges and by requiring operators to use the best available techniques, while providing a fully transparent control process.

The ASN checks that the operators fulfill their responsibilities, starting with the design of the facility and continuing throughout its operation. It is vigilant concerning the optimization of discharges and the reduction of their impact.

4.1 Regulating of discharges from INBs

4.1.1 The new INB system

The TSN Law creates an integrated system based on a broadened conception of nuclear safety, covering both the prevention of accidents and the protection of human health and of the environment. It defines the conditions for the issuance of a license to build or to dismantle a nuclear installation, giving measures concerning prevention and limits the importance they deserve. In particular, it recognizes the fact that in this area as in all others risk cannot be completely eliminated, and that the measures adopted are aimed at preventing or limiting the risks, in light of current scientific knowledge and techniques.

The INB regulating system is governed by Decree No. 2007-1557 of November 2, 2007 concerning nuclear installations and the regulation, as regards nuclear safety, of the transport of radioactive substances; it is known as the "INB procedures" decree, adopted in application of Article 36 of the TSN Law.

The "INB procedures" decree repeals Decree No. 95-540 of May 4, 1995 concerning discharges of liquid and gaseous effluents and water taking by nuclear installations. It defines the new framework that will henceforth govern the procedures concerning INB and covers the full life cycle of an INB, from its construction license to its final shutdown and dismantling. Lastly, it describes the relationships between the ministers responsible for nuclear safety and the ASN in the area of INB safety. The INB system, which dates from 1963, has thus been completely revised.

The new system provides that permits for the construction, final shutdown, and dismantling of basic nuclear installations, which are issued as decrees, incorporate all of the issues, whether they concern nuclear safety, radiation protection, or protection of the environment, using an integrated approach. These authorizing decrees will therefore now include the authorization of discharges from the INB.

These authorizing decrees are supplemented by individual stipulations based on ASN decisions which set out in particular, where needed, the requirements regarding water taking by the INB and the discharge of radioactive effluents produced by the INB. The specific stipulations setting the limits for discharges from the INB into the environment are subject to approval by the ministers responsible for nuclear safety.

The integrated approach required by this new system also applies to changes in the facilities and to reassessments of the facilities' safety. For these reassessments, Article 29 of the TSN Law stipulates that "the operator of a nuclear installation must periodically undertake a safety review of its installation, in light of the best international practices". In addition, the TSN Law provides that safety review take place every ten years, subject to an exemption provided in the authorizing decree and justified by the particular features of the installation. Implementation of the new INB system enables problems related to effluent discharges to be considered during safety review.

4.1.2 Setting limit values

The first limits for discharges from French nuclear facilities had been set on the basis of an impact lower than the current thresholds for effects on health. It was then found that the regulatory limits established in the past were not representative of actual discharges.

This finding was all the more blatant in that the optimization efforts required by the authorities and implemented by the operators had led to a substantial reduction in the discharges. By way of example, the liquid effluents from the Flamanville power plant for activation and fission products went from 151 GBq in 1986 to 0.641 GBq in 2007.

To establish regulatory limits that encourage operators to reduce their discharges, France requires that the limits be set as low as the best available techniques will allow, taking into account feedback from experience with the discharges produced at the facilities. In recent years the ASN has undertaken an approach to revising the discharge limits such that they are close to actual discharge figures, thus encouraging the operators to keep up their efforts to reduce and control their discharges.

The lowering of discharge limit values is expressed in a reduction by the factor shown in the table below.

	AREVA NC La Hague plant	Nuclear power stations	
		900 MWe	1300 MWe
Activation products/Fission products (excluding tritium)	12	2.3	2.6
Alpha emitters	10		

Table 2: Reduction factors for the radioactive liquid discharge limits defined in discharge permits since 1995

Updating of the requirements concerning discharges according to the principles described above for all the sites requires a sustained effort over several years (70% of French facilities are currently fully regulated by provisions made in application of the above-mentioned Decree No. 95-540 or of the TSN Law). The improvements caused by the application of these provisions provide justification for continuing this approach.

4.2 The radiological impact of nuclear activities

In application of the optimization principle, the operator must reduce the radiological impact of its facility to values that are as low as reasonably possible, taking into account the economic and social factors.

The operator is required to evaluate the dosimetric impact caused by its activity. This obligation arises either from Article L1333-8 of the Public Health Code or from the regulations concerning discharges from INBs, depending on the case.

This evaluation covers discharges from identified outlets (stack, and discharge outfalls into the fluvial or marine environment). It also includes diffuse emissions and sources of radiological exposure to ionizing radiation present in the facility. The impact is estimated for identified reference groups. These are homogeneous groups of persons receiving the highest average dose among the entire population exposed at a given facility, under realistic scenarios This approach enables a comparison between the total dose and the acceptable annual dose limit for a member of the public (1 mSv/year) defined in Article R1333-8 of the Public Health Code.

Prior to authorization, the impact is evaluated on the basis of the required annual limit, considering the radionuclides likely to be discharged. This evaluation is reassessed each year, based on the activity of the radionuclides measured in the discharges, to which must be added the radiation exposure (due in particular to the storage of wastes).

The determination of doses due to INBs is shown in the portions of this report concerning sites. In France, liquid radioactive discharges produced by the nuclear industry have very little radiological impact.

4.3 Control of radioactive discharges

Monitoring of the discharges from a facility is primarily the operator's responsibility. The provisions regulating discharges provide for controls that the operator must implement. These controls particularly address effluents (monitoring of the discharges' activity, characterization of certain effluents before discharge, etc.) They also include provisions concerning monitoring of the environment (checking in the discharge stream, sampling of air, milk, grass, etc.) Lastly, measurements of related parameters are required where necessary (especially meteorology). The results of regulatory measurements must be recorded in registers which, in the case of INBs, are sent to the ASN each month for checking.

In addition, INB operators must regularly send a certain number of samples collected from the discharges to an independent laboratory for analysis. The results of these controls, called "cross" analyses, are sent to the ASN. The cross-analysis program defined by the ASN is designed to provide grounds for believing that the

results obtained by the operators are accurate. In 2008 cross-analysis control programs were established for the majority of facilities.

Lastly, ASN uses unscheduled inspections to ensure that operators comply with regulatory provisions. During these inspections, the inspectors, who may be assisted by technicians from a specialized independent laboratory, check that the regulatory requirements are being met, have samples collected in the effluents and the environment, and have them analyzed by this laboratory. Since 2000 the ASN has carried out from 10 to 20 inspections with sampling per year.

4.3.1 Accounting for INB discharges

The reduction in the activity of radioactive effluents discharged by INBs, the changes in the categories of radionuclides regulated under discharge permits, and the need to be able to calculate the dosimetric impact of discharges on the population led the ASN to make changes in 2002 to the accounting rules for radioactive discharges.

The principles underlying the accounting rules are the following:

- For each of the regulated categories of radionuclides, the activities discharged are based on the specific analysis of radionuclides and not on overall measurements;
- The detection limits to be complied with are defined for each type of measurement;
- For each INB and each type of effluent, a so-called "reference" spectrum is defined, i.e., a list of radionuclides whose activity must be systematically accounted for, whether or not it is greater than the decision threshold. These reference spectra, which are subject to change, are based on feedback from experience with previous analyses. When the activity is less than the decision threshold, the threshold figure is used in the accounting.
- Other radionuclides that may be locally present are included when their activity concentration is greater than the decision threshold.

As their discharge permits are renewed, these regulations have been progressively applied to almost all of the French nuclear facilities in the OSPAR area.

4.3.2 Tritium

Tritium discharges from nuclear facilities are subject to permitting via the decree authorizing the construction of a nuclear installation. Their direct and indirect effects are evaluated during the impact study that accompanies the application for a permit submitted by the operator. Up to now, the medical authorities in France and abroad, as well as international health organizations, have agreed in considering that tritium has a low radiotoxicity. It is also accepted that it is not concentrated in food chains (no bioaccumulation) when found in the form of tritiated water.

France nevertheless considers that its radiotoxicity and the technical possibilities for treating it should continue to be investigated periodically, which is fully consistent with the conclusions published by ICG Bremen. For this reason the ASN wished to have a measured analysis of existing studies on this subject. The ASN therefore decided, at the end of 2007, to establish two independent discussion groups, bringing together scientists, operators, and associations, including French experts but also foreign ones:

- The "tritium impact" group, responsible for establishing an inventory of the scientific knowledge concerning tritium's impact on health;
- The "defense in depth" group, responsible in particular for investigating the state of the art regarding the technical possibilities for treating tritium and establishing an inventory of knowledge concerning its environmental impact.

Their first meetings were held in May 2008. It was planned to close this first cycle of discussions by publishing a white paper in 2010.

4.4 Informing the public about discharges

The ASN considers that an essential issue in the regulation of discharges is to provide a suitable forum for the stakeholders.

The public is consulted during the permitting procedures, by means of a public inquiry. The ASN ensures that the implementation of the public inquiry process allows the public and the associations involved to make their views known.

In addition, in the event of a minor change in a facility leading to an increase in the limit value of the discharges, the Decree of November 2, 2007 provides for local meetings of the Local Information Committee (CLI) and of the Departmental Council on Environment and Health and Technologic Risk (CODERST) concerning the new regulations, and does not require direct consultation of the public. In 2008 ASN therefore decided to recommend to the operators, as an experiment, the establishment of a procedure for consulting the public in certain cases, and to have the operator make its project impact study available.

Over the lifetime of the facility, the ASN ensures that the operators submit an annual report concerning the impact of their facility on the environment. This report (whose content is defined in the Ministerial Order of November 26, 1999 establishing the general technical requirements concerning the limits and methods of sampling and the discharges subject to permitting that are made by basic nuclear installations) presents full information on discharges of effluents for the preceding year. It is sent to the Local Information Committee (CLI) for study.

In conclusion, although the radiologic impact associated with liquid radioactive discharges is very low, France is determined that its regulatory framework and operator practices will led, through the application of the best available techniques, to achieve a high level of control over radioactive discharges and to obtain reductions in discharges, in line with the OSPAR strategy. France will ensure that this approach is applied in a fully transparent manner, and will involve the various stakeholders.

5. Monitoring radioactivity in the environment

The monitoring of radioactivity in the environment is an international concern, operating within two agreements:

- The Euratom Treaty which, in its Article 35, requires Member States to establish permanent control structures for radioactivity in the atmosphere, waters, and the soil, in order to ensure checks on compliance with basic standards for the protection of the health of populations and workers against the dangers resulting from ionizing radiation.
- The OSPAR Convention, whose strategy for a Joint Assessment and Monitoring Programme (JAMP) provides for the establishment of a program of monitoring for radioactive substances in the marine environment.

In this regard, the monitoring of radioactivity in the environment is particularly focused on:

- Monitoring carried out around nuclear facilities by the operators, as part of their discharge permits;
- Monitoring of radioactivity in the environment within the national territory, performed by the Institute for Radiation Protection and Nuclear Safety (IRSN).

5.1 Monitoring of environmental radioactivity by the operators

Generally speaking, the regulatory provisions regarding environmental monitoring by operators are related to concerns about the safety of the facilities and the prevention and mitigation of accidental pollution. This environmental monitoring by operators is performed as part of their primary responsibility.

This environmental monitoring enables:

- The acquisition of knowledge about the state of the environment before and during the operation of the facility;
- Confirmation of the absence of substances whose emission is not permitted;
- Confirmation that the facility's impact remains below the impact estimated in advance, when the facility was being authorized;
- The raising of an alert in the event of a malfunction of the facility, for example by checking on the groundwater.

All French nuclear facilities are subject to systematic environmental monitoring. The nature of this monitoring is adjusted to the risks and disadvantages that the facility might present for the environment, as described in the permitting documents and especially in the impact study.

Regulatory monitoring of the environment around INBs is adapted to each type of installation, according to whether it is a nuclear power reactor, a plant, or a laboratory. The nature of the environmental monitoring associated with liquid discharges that must be laid down in the Authorizing Order is defined in Articles 14, 22, and 23 of the Ministerial Order of November 26, 1999.

Each year the operators thus obtain nearly 200,000 results of environmental-monitoring measurements of all categories.

5.2 Monitoring of environmental radioactivity on the national territory

Environmental monitoring is carried out by the IRSN via measurement and sampling networks dedicated to:

- Monitoring of the air (aerosols, rainwater, and ambient gamma activity);
- Monitoring of surface waters (rivers and streams) and underground water (water tables);
- Monitoring of the human food chain (milk, cereals, food intake);
- Monitoring of land areas (reference stations far from any industrial facility);
- And monitoring of the seacoast.

Each year the IRSN carries out more than 50,000 measurements in the environment, of all categories (excluding telemetry networks).

Monitoring of the Atlantic, Manche, and North Sea coasts involves OSPAR regions I, II, and III, as defined by the RSC.

The selection of environmental sampling stations and measurements is based on the following objectives:

- To contribute to an assessment of the environmental impact of various sources of radioactivity (evaluate the levels of radioactivity, monitor its development in space and time, and identify and characterize the sources of the radionuclides);
- To contribute to an evaluation of human radiologic exposure (in particular, to quantify radioactivity levels in foodstuffs);
- To contribute to the detection and monitoring of a possible radiologic event and to informing the public authorities;
- To contribute to compliance with the regulations (checking the conformance of practices with respect to the regulatory framework, and cross-checking the operator's own monitoring)

In light of these objectives, the seacoast monitoring plan comprises:

- Reference stations enabling characterization of the background noise and pollution sources other than the discharges from major nuclear facilities, and monitoring the contributions of major rivers;
- Stations within the area of influence of nuclear facilities located on the coast, enabling a monitoring of the spatial distribution and development over time of the radiologic state of the marine environment.

Optimization of the monitoring program relies on knowledge acquired from radioecologic studies, feedback from experience with the monitoring networks, and use of dispersion models developed by the IRSN.

The radiologic monitoring program for the marine environment implemented by France on its seacoast provides a comprehensive response to the objectives set forth by the RSC under the OSPAR Convention. In particular it leads to the acquisition of extended time series of measurements, which are made available to the RSC for the preparation of periodic assessment reports

France thus annually provides the RSC with the following environmental measurements:

OSPAR Region	STATION	Environmental and radionuclide categories				
		Seawater (surface)			Mollusks	Algae
		^{3}H	^{137}Cs	$^{239.240}Pu$	$^{239.240}Pu$	^{137}Cs
I	Roscoff	A	A			W
	Brest	Q	Q			
	Concarneau	A	A			W
	Pornichet	Q	A			
	Oléron	Q	A			W
	Arcachon	A	A			
II	Carteret	Q			W	Q
	Goury	Q	Q	A	W	Q
	Cherbourg	Q				
	Barfleur	Q			W	Q
III	Honfleur	Q				W
	Wimereux	A	A			W

A: Annual, Q: Quarterly, W: Weekly

Table 3: Sampling and measurements from monitoring of the French seacoast, representing the concentration data sent to RSC OSPAR

The sampling stations are shown on the following map:

Figure 3: Sampling stations on the French seacoast sending measurements to RSC OSPAR

Twelve stations are distributed along the French seacoast, with a higher density in Manche where the majority of the coastal nuclear facilities are located.

This effort to optimize the collection of concentration data for OSPAR is accompanied by an effort to develop methods to make use of them as part of the RSC's work. In fact, France has played a key role in leading the Inter-sessional Correspondence Group (ICG-Stats) in recommending the statistical methods to be employed by RSC in compiling its periodic assessment reports on the implementation of the OSPAR strategy for radioactive substances. In particular, it has suggested rigorous methods for conducting statistical tests while taking into account the presence in the data series of values lower than the detection limits (Fiévet and Della Vedova, Journal of Environmental Radioactivity, 101:1-7, 2010). France has also played a key role in the application of these data for estimating the impact on the biota. These methods have been employed by the RSC since its third periodic assessment report.

The national network for environmental radioactivity measurement

As part of the implementation of the Euratom 96/29 directives (basic standards for the protection of the health of the population and workers against ionizing radiation) and the 2003/4/CE directives (public access to information concerning the environment), France has established a national network for measuring radioactivity in the environment, designed to provide the public with the results of the monitoring of environmental radioactivity and with information concerning the nuclear industry's impact on health throughout France. This database is intended to contribute towards informing the public through the development of an internet portal enabling access to radioactivity measurements and their interpretation in

terms of radiologic impact. The development and validation of the portal's contents were completed in 2009, and it was opened to the public in 2010 (http://www.mesure-radioactivite.fr/).

The public availability of the results from monitoring of environmental radioactivity, and information concerning the nuclear industry's impact on health throughout France, is ensured by the regulatory obligation imposed on institutional actors and on nuclear operators to publish the results of mandatory environmental monitoring on the national network's website. The regulations require that the mandatory monitoring measurements of radioactivity in the environment are carried out in approved laboratories.

Non-mandatory measurements carried out in approved laboratories (including the laboratories of associations) may also be published on the national network's website.

5.3 Quality of measurements in the environment

Besides making information about environmental radioactivity available to the public, France believes that the issue of the quality of the information is a primary concern, particularly in a context as sensitive as that of radioactivity in the environment. The importance of this matter becomes apparent when a comparison is made of the results obtained by the various actors supplying data to the national environmental radioactivity network. It is therefore essential to begin by ensuring the technical and organizational abilities of the laboratories.

This approach is very much in line with the quality objectives set by the strategy for a Joint Assessment and Monitoring Programme (JAMP).

In order to pursue a policy aimed at guaranteeing the quality of measurements of environmental radioactivity, a system for approving laboratories was introduced.

The approvals cover all of the environmental matrices: water, soils and sediments, biologic matrices (fauna, flora, and milk), aerosols, and atmospheric gases. The measurements include the principal artificial and natural radionuclides, alpha, beta, and gamma emitters, and ambient gamma dosimetry.

In total, some fifty types of measurement can be covered by an approval. There are a corresponding number of inter-laboratory comparison trials. These trials are organized by IRSN over a five-year cycle, corresponding to the maximum duration of an approval's validity.

5.3.1 A new procedure for approving laboratories

In 2008 an ASN decision established new approval procedures for laboratories that measure environmental radioactivity.

In particular, the approval procedure includes:

- The submission of an application by the laboratory in question, after taking part in an inter-laboratory trial (EIL);
- Its investigation by the ASN;
- Consideration of the applications by a pluralistic approval committee, which issues recommendations on anonymous applications.

The laboratories are approved by a decision of the ASN, published in its Official Gazette.

The Approval Committee is the authority within the National Network for the Measurement of Environmental Radioactivity which is responsible for ensuring that measurement laboratories have the organizational and technical abilities to provide the network with quality measurement results. The committee is responsible for recommending approvals, rejections, or suspensions of approval to the ASN.

5.3.2 Terms of approval

Laboratories that wish to be approved must establish an organization that meets the stipulations of Standard EN ISO/CEI 17025 concerning the general requirements for the capacities of calibration and testing laboratories.

In order to demonstrate their technical skills, they must take part in inter-laboratory trials (EILs) organized by the IRSN. The EIL program, which now covers five years, is updated annually. It is the subject of an investigation by the Approval Committee and is published on the national network's website (www.mesure-radioactivite.fr).

Out of a concern for transparency on the terms of laboratory approval, specific evaluation criteria are employed by the Approval Committee. These criteria are published on the national network's website.

In 2008 the ASN issued 136 approvals and extended 6, rejected 59 requests, and suspended 17 approvals. At the end of 2008 the total number of approved laboratories was 39, for a total of 535 currently valid approvals.

From 2003 to the end of 2009, the IRSN organized 29 inter-laboratory trials covering 41 types of approval. By way of example, the approvals in the area of water during 2008 and 2009 covered:

- Uranium isotopes, the gravimetric determination of uranium, and radium-226 and its daughters, as well as radium-228;
- Indices of overall alpha and beta activity, of tritium activity, and potassium content;
- Artificial gamma emitters with energy E > 100 keV and E < 100 keV;
- Technetium-99 activity.

Monitoring the radioactivity of water attracts the largest number of approved laboratories, with 56 laboratories holding up to 12 different approvals for the monitoring of this medium. About forty laboratories hold approvals for measurements of biologic matrices (food chain), atmospheric dust, and ambient gamma dosimetry. There are about 25 laboratories with approvals for soil monitoring. Although most of the laboratories are able to measure gamma emitters in all environmental matrices, only about ten of them are approved for the measurement of carbon-14, the transuranium elements, and radioelements in the natural decay chains of uranium and thorium in water, soil, and biologic matrices.

In 2009 the ASN issued 398 approvals and extended about one hundred. On January 1, 2010, the total number of approved laboratories was 60, for a total of 718 currently valid approvals. The ASN may find it necessary to reject or suspend approvals for one measurement in a given matrix. In this event the laboratories may re-acquire their approvals after the conduct of a new trial and the implementation of corrective actions. Moreover, these suspension and rejection decisions do not call into question the quality of the other radioactivity-measurement services provided by these laboratories.

A detailed list of the approved laboratories and their areas of technical expertise is available on the ASN's website (www.asn.fr).

In conclusion, France has set up a system for monitoring environmental radioactivity that meets the objectives of the OSPAR strategy both in terms of coverage of the French portion of the OSPAR area, and of the quality of the monitoring data provided under the agreement concerning the program for monitoring radioactive substances in the marine environment.

PART II: APPLICATION OF THE B.A.T. TO THE RADIOACTIVE DISCHARGES OF THE AREVA NC LA HAGUE FACILITIES

SITE-SPECIFIC INFORMATION

1. Site characteristics

1.1 Name of site

Établissement AREVA NC de La Hague, formerly Établissement COGEMA de La Hague.

Aerial view of the site

1.2 Type of facility

Spent nuclear fuel reprocessing facility and associated functions: interim storage pools, liquid effluent treatment unit, plutonium recovery unit in wastes, waste conditioning units, fission products vitrification units, interim storage for wastes before return to foreign customers or disposal in France, discharge control laboratory and environmental control laboratory.

1.3 Year of commissioning/licensing/decommissioning

The first reprocessing plant on the La Hague site, UP2, designed for the French natural uranium gas graphite reactor fuels with a capacity of more than 600 tU/y, came into operation in 1966 with the corresponding effluent treatment plant STE2 very soon after.

Faced with the development of reactors using enriched uranium oxide and ordinary water (known as "light water reactors"), France proceeded to adapt its reprocessing plants to deal with the fuels used in the reactors of these series. It was in response to this requirement that a new "High Activity Oxide" head-end of UP2 (HAO) was brought into service in 1976 to carry out the preliminary operations of shearing and dissolution of "light water" fuels, with a corresponding reference capacity of 400 tU/y.

The later development in France and in the world of these light water reactors led COGEMA to increase the reprocessing capacity. First, extensive modifications were planned to increase UP2-HAO plant reference capacity from 400 to 800 tU/y for light water reactor fuel. The implementation of these modifications, under the designation UP2-800, was completed in 1994. Secondly, a completely new plant, with the same reference capacity (around 800 tU/y of light water reactor fuel), was designed and built on the same site,

intended to be used solely for the reprocessing of foreign reactor fuels during the first ten years of its operation. This plant came into operation in 1990.

These new plants were accompanied by a new effluent treatment plant, named STE3, which came into operation in 1987. For the first time, STE3 allowed the direct conditioning of waste resulting from the treatment of the effluents of the reprocessing operations.

The oldest units of UP2 being nearly 30 years old when UP2-800 started in 1994, some of them have been subject to refurbishment and a completely new plutonium tail end (purification, conversion and conditioning) using new process equipment, named R4, was built and came into operation in 2002.

In addition, a new facility called ACC (hulls compaction facility), was set up and started in 2002 in order to decrease the volume of conditioned solid waste of both UP2-800 and UP3-A. This facility allows reducing the volume of technological and structural (hulls and end-pieces) waste by a factor of five.

COGEMA has submitted in September 1999 for a revision of the decrees concerning UP2-800, UP3-A and STE3; the aim of the submission being essentially to give some operational flexibility to the plant. The submission asked to increase the authorized capacity limit of the storage pools, to bring the allowed production limit of each plant (UP2-800 and UP-3A) up to the usable capacity of 1,000 tU/y, the total production limit of the site being set at 1,700 tU/y. It also asked for the authorisation of the industrial reprocessing of MOX fuels and new fuels (such as higher burn-up fuels as well as MTR fuels), and the treatment of products coming from outside the site, provided they are compatible with the facility process.

Consequently, on January 10th 2003, new authorisation decrees were published for STE3, UP2-800, and UP3-A. Considering that none of the changes induced significant modifications of the facilities, or any increase of the discharges, to take into account the progress of the techniques, apply the BAT principles and encourage the continuous improvement performed by the operator, the authorisation limits of the associated discharge application order (also published on January 10th 2003) were lowered for most of the nuclides, and applied to a finer cutting out of the types of discharges and radionuclides.

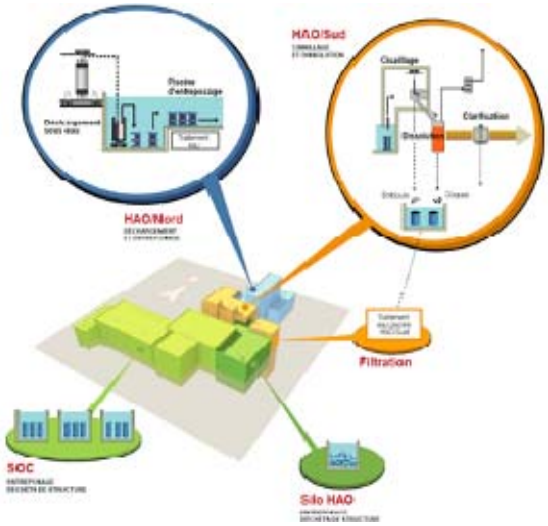
In compliance with the discharge order of January 10th 2003, which states that the discharges authorisation limits were to be reviewed after four years, a complementary ministerial order was set in force on January 8th 2007. It brought another set of significant reductions of the authorisation limits (presented in §2.5).

Concerning decommissioning, it has been undertaken on two pilot plants belonging to the French CEA, a small industrial isotope production plant, and one for the reprocessing of fast neutron reactor fuels, 1 kg/day capacity (decommissioning completed). The operation of this plant has ceased in 1979, the equipment has been rinsed from 1979 to 1981, then the equipment has been removed from 1989 to 1995 and the premises cleaned up from 1996 to 2001. The premises are now free of radiological control. One can enter them in civilian clothes, without the requirement of any monitoring. In several other buildings, the premises have been cleaned up and reused to install the equipment used in more elaborated processes.

The plants that came into operation in 1966 and 1976 have been submitted since 2003 to CDE standing for “Cessation Définitive d’Exploitation”, that is to say final stop of operation. It consists, using the normal process and maintenance equipment as well as the usual operating team, in removing as much as possible radioactive substances and contaminated equipment and sending them to their normally used destination, either in the process for reusable substances or to the waste for the others. Since this phase uses only the means intended for the normal operation, it does not require a specific ministerial decree, only a decision of the French Nuclear Safety Authority (Autorité de Sûreté Nucléaire – ASN) that checks the current safety file applies to the operation.

The next stages, the MAD, standing for “Mise à l’Arrêt Définitif”, that is to say final cessation of operation, and the DEM, standing for Démantèlement (decommissioning) are of a different nature, requiring specific means for example for the decontamination of the structure of the buildings and other competences than

those of the usual operating team. It thus requires a specific safety file and a new ministerial decree. For this purpose, AREVA NC has submitted in February 2008 a file requiring such an order for the MAD/DEM of the HAO workshop, this one comprising a transportation cask unloading facility, a fuel storage pond and its filtering unit, a fuel shearing and dissolution unit, a clarification unit and two storage units for the structural debris of fuel. The setting of such a decree requires a public enquiry that has taken place in November 2008.



The HAO workshop

Apart from the decommissioning activities, the other exceptional type of operation is RCD, standing for “Reprise et Conditionnement des Déchets” meaning retrieving and conditioning of legacy waste. Up to 1990 around, some by-products that had no agreed disposal channel have been either stored in silos or conditioned in provisional form. For safety and consistency reason, it is important that these by-products are retrieved and conditioned in forms that allow them to be directed to agreed disposal channels.

1.4 Location

The plant is located on the northwest tip of the Cotentin peninsula, 6 km from the Cap de la Hague, 270 km west from Paris and 20 km west of the Cherbourg conurbation (92,000 inhabitants). The plant is located in the central part of the Jobourg plateau, at the highest point reaching 180 m above sea level. It covers an unbroken area of 2.3 square km.

1.5 Receiving waters and catchment area

Receiving water is the Channel, 1.5 km west from the Cap de la Hague at a place selected as the one where the tidal streams have the highest velocity (up to 10 kt, that is to say around 5 m/s). Discharge is carried out during a relatively short time, beginning at a precise moment before the high tide, to ensure the best dilution. The dilution rate is around 500,000 at a distance of 1 km from the end of the discharge pipe, and 1,000,000 in the vicinity of Goury, nearest fishing harbour. The diluted activity is then transported to the North Sea by residual tidal currents.

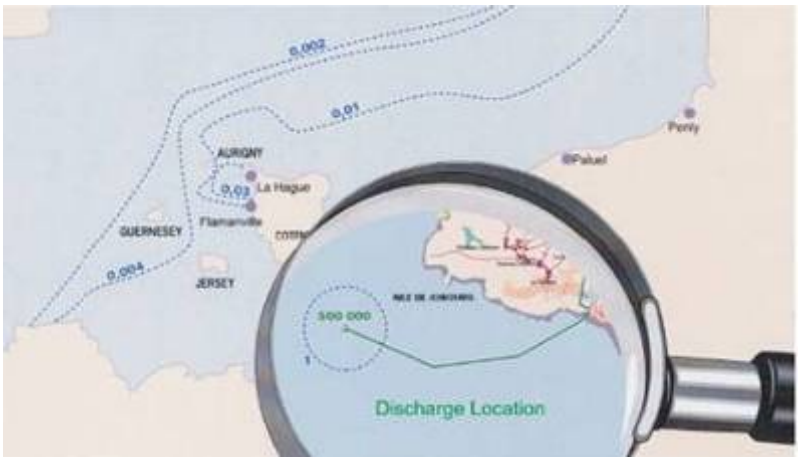
The order of November 26th 1999, taken in application of the decree N° 95-540 of May 4th 1995 that sets the technical specifications applicable to the limits of the discharges submitted to authorisations, requires that the operator monitors radioactive discharges before and during the emission. It prescribes before discharge monitoring aimed at:

- Verifying that the limits set for the discharge of the effluents are complied with, and, if these limits are not complied with, that the effluents are sent to appropriate treatment equipment;

- Determining the parameters of the discharges (agenda and flow), taking into account the regulations set in order to insure the optimal dispersion of the discharges, and particularly the limits set by the discharge authorisations.

Several types of monitoring must be performed during the discharge:

- Continuous monitoring of the flow and the radioactivity at the pipe level, before any mixing with other categories of effluent;
- Monitoring of the radioactivity flow at the discharge point for the categories of the most significant radionuclides.



The discharge point location

Thus, each emission is performed after the analysis of representative samples by the operator. The volume and radioactivity discharged are transcribed on a monthly register communicated inter alia to the ASN.

A large number of streams having their source on the plateau flows the northeast and southwest slopes to the sea. An important part of southwest basin is collected in the Moulinets valley, in an impoundment built by the coast to hold 400,000 m3 of fresh water used for supplying the plant process. All these streams are submitted to the January 8th 2007 French ministerial order prescriptions (that complements the January 10th 2003 ministerial order), defining radioactive and physicochemical concentration limits, and are carefully monitored. No radioactive effluent is discharged by the AREVA NC plant in these streams.

1.6 Production

Annual production over the reporting period is displayed in Table 1 below. Also displayed is the equivalent electrical energy delivered during their use in reactor by the spent fuel elements that have been reprocessed during the considered year.

This indicator is more relevant than the mere tonnage of uranium treated, because:

- It represents the service rendered by the reprocessed fuel, and can then be used as a reference for the normalisation of the data, which are then freed from the variability of the service rendered,
- It is practically proportional to the fission products content of the spent fuel, which contains the most part of the radioactivity, and represents then the radioactive input to the process, i.e. the reference for the global decontamination factor of the plant.

These points are dealt with in § 2.3.2 below.

Tons of initial uranium	2003	2004	2005	2006	2007	2008
UP2-800	707	461[I]	683	317[II]	458[III]	299[IIII]
UP3-A	408	640	429	698	490	638
SITE TOTAL	1,115	1,101[I]	1,113	1,015[II]	948[III]	937 [IIII]
Equivalent Energy (GW.y)	37.50	39.25	41.43	38.97	38.25	31.31

[I] including 10.6 tons of MOX.
[II] including 16 tons of MOX.
[III] including 31.5 tons of MOX.
[IIII] including 5 tons of MOX.

Table 1. Annual site production during the reporting period

It can be remarked on Table 1 that the equivalent energy may grow more with years than the production in tons, which is the case up to 2007. This evolution reflects the more efficient use of the fuel performed in the reactors: average burn-up encountered a more than 20 % increase between 2003 and 2007, from 37.2 GWd/t to 44.7 GWd/t (it was only 34.4 GWd/t in 2000).

It is also worth noting that a significant part of the equivalent energy displayed corresponds to a service that has been rendered to some other contracting parties to OSPAR than France.

2. Discharges

2.1 Description of systems in place to reduce, prevent or eliminate discharges of radioactive substances to the marine environment

2.1.1 General principles

The general principles applied for the design and operation are the following ones:

- Use of a very stringent system of containment to prevent losses, a minimum of two complete physical barriers being installed between the radioactive material and the environment.
- Use of the natural radioactive decay as a basis principle, in order to substantially decrease the activity of the short half-life radionuclides. Fuel, after reception, is driven towards storage pools, where it stays for an average period of around 5 years (as an example the ruthenium 106 residual activity is then reduced by a factor of 32 between the fuel arrival and the beginning of the reprocessing step).
- Optimisation of the destination of by-products (washing solutions, hulls rinsing effluents, solvent washing), the first priority being to recycle them as much as possible into the process.
- Second priority, for the by-products that cannot be recycled, being to send them as much as reasonably possible to the solid wastes (with a preference for vitrification, and to compaction and/or grouting if it is not possible to vitrify). The remainder is discharged in either the atmosphere or the sea, according to the technical possibilities, in order to minimise the impact on the reference groups.
- Exposure of workers and risks for population and workers are taken into account to balance the options, in consistency with the ICRP principles.

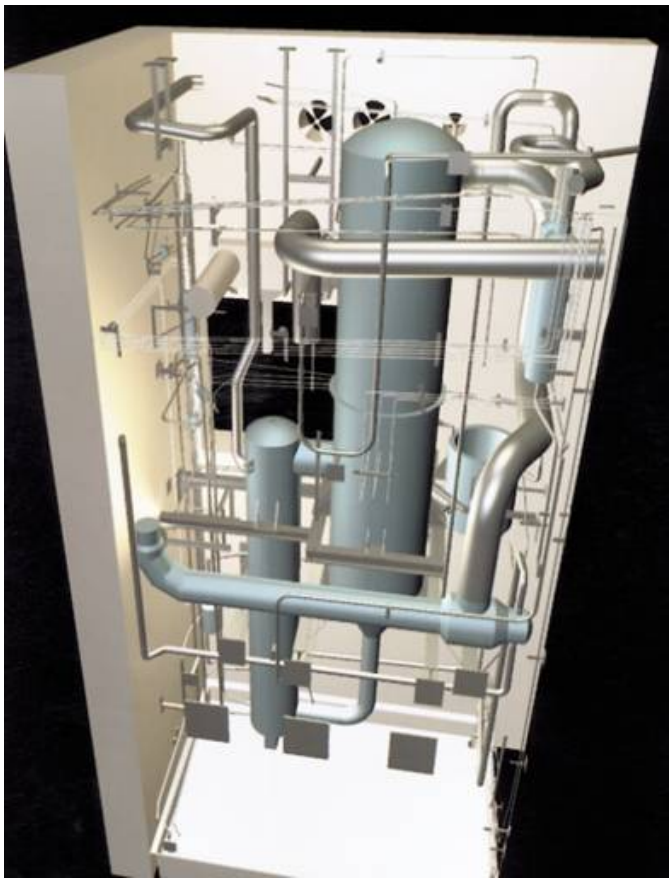
Consequently, the effluents are collected, then treated as much as possible to recover all reagents, which are purified and if necessary converted in order to recycle them into the process. The remainder is

concentrated in such a way that the radioactive elements contained can be sent to solid waste, most of them to vitrification, which is the most compact and efficient way of conditioning radioactive elements in terms of material containment. Some processes that used to generate effluents that could not be concentrated or vitrified (such as some laboratory analyses effluents) have been substituted for other ones in order to withdraw some active flows.

Major fluxes concerned by recycling are vacuum groups condensates, washing or decontamination effluents, pool effluents, evaporator distillates, and solvent treatment effluents.

For instance, all aqueous solutions used to rinse structural elements (end-pieces and debris of cladding called hulls) are recycled to prepare the dissolution reagent from highly concentrated nitric acid, itself coming from recycling, concentrated and purified by evaporation after that other products (fission products, uranium and plutonium) have been removed from its flow in the process. This is also the case for spent solvent and diluent, which are purified from the radioactivity and the degradation products they contain by distillation under vacuum in a specific evaporator. The remaining fraction, in this case, cannot be vitrified and it is grouted as solid waste after calcination in a dedicated unit. This recycling principle is a first and very important mean of reducing the discharges.

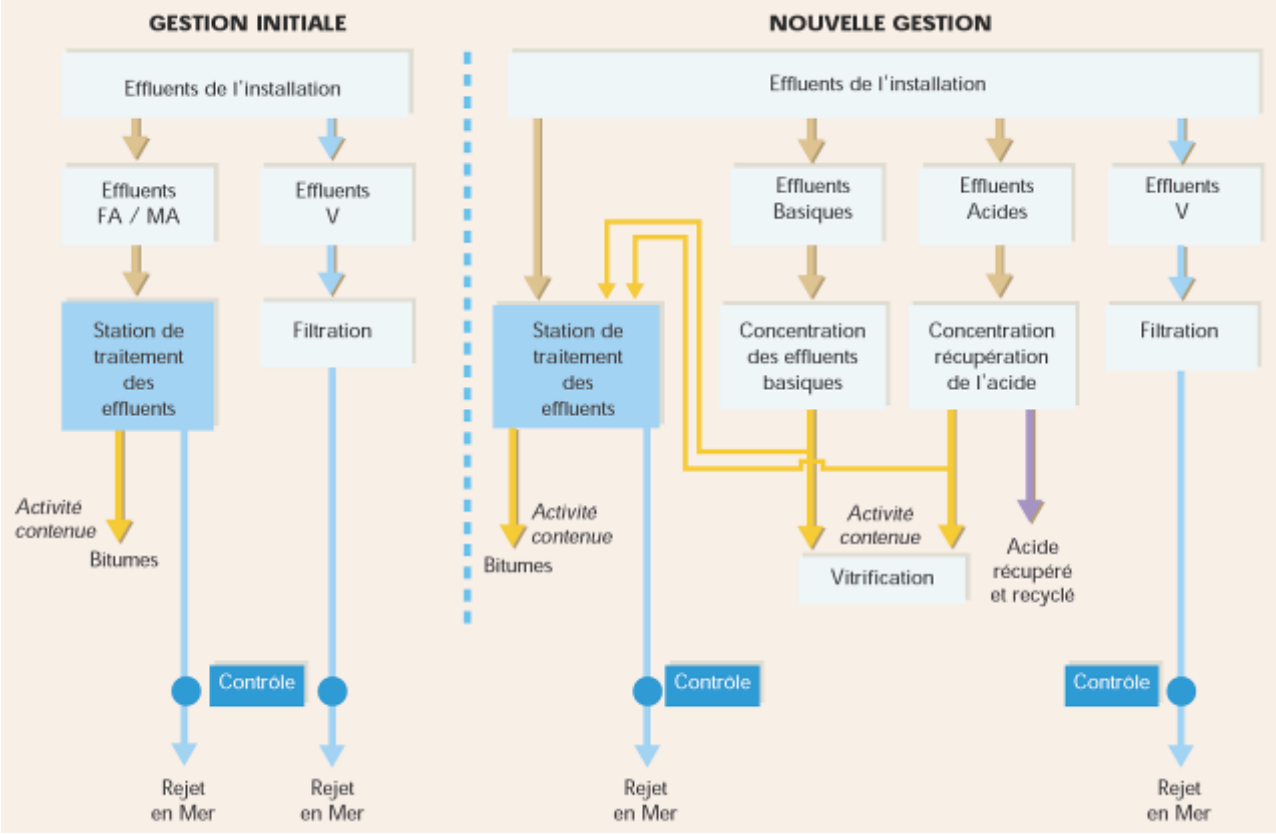
For the solutions that cannot be recycled, previous liquid effluents management was based on an activity level sorting out. High activity effluents were all sent to vitrification, medium and low activity effluents were collected and sent separately to the effluent treatment station STE3, in the same batches whatever their origin, their acidity and their chemical content (provided they could be accepted by STE3 equipment and process). Very low activity effluents, in fact those which receive no activity in normal operation, called “V” effluents, meaning “to be verified”, were stored, controlled by batches to check that their activity was below the prescribed limit, then filtered and discharged to the sea between the active effluents discharges which take place during the high tidal stream periods.



An evaporator for effluents

2.1.2 The "new effluent management"

In 1996, a "new effluent management" system has been introduced. The high activity effluents are still regularly sent to vitrification. The medium and low activity effluents are now collected separately on an acidity basis, the acid ones on one side, and the alkaline ones on the other side. Instead of being sent to the effluent treatment unit to be sorted out according to their activity level, they are concentrated in dedicated evaporators, for acidic effluents and for alkaline effluents respectively, which were installed in 1998 in UP3-A. The main part of the feed of the acidic and alkaline evaporators comes out as distillates, practically free of contamination, which are sent to the "V" effluents and discharged with them. The remaining concentrates take the whole radioactivity, becoming thus high activity effluents (of very little volume compared to the original ones) and are then sent to vitrification with these ones. This is a second and also very important mean not only of reducing effluents, but also of reducing solid waste volume, which contributes to the safety of the disposal.



The former and new effluent management

These technical developments became possible in UP2-800 and UP3-A because of the significant improvements brought by the new implementation of the process in these plants. This one led to substantial reduction of the quantity and of the activity (better Decontamination Factors) of the effluents. Consequently, this permitted to concentrate the effluents in evaporators of reasonable size which were possible to install in free spaces of the plants.

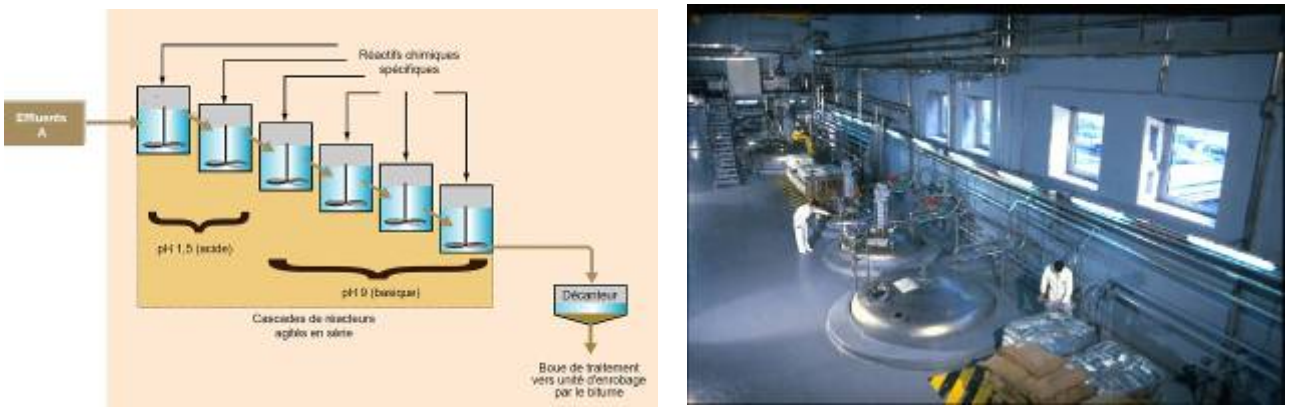
The resulting effects of New Effluent Management implementation can be seen in Table 5 below.

2.1.3 Other improvements

The case of the analytical laboratory analysis effluents is a specific one. The activity they contained represented a significant part of the alpha emitters and a minor part of the other emitters in the discharged liquid effluents before volume reductions began. After most of the volume reduction measures had been implemented, the other emitters' proportion became also significant. Most of them could not be recycled because the reagents used for the analysis led to compounds which were not compatible with the necessary

treatments. The most important measures taken were to develop new technologies of automated on line measures which do not need to take samples from the process, thus suppressing an effluent flow, and also to develop the use of the technology of plasma torch spectrography. This technology needs only very small samples and does not use unusual reagents, suppressing the corresponding effluent flow. Some of the remaining plutonium solutions analyses were the cause of the high alpha activity content of the effluents coming from the analytical laboratory. Since 2001, a new plutonium recovery management on this flow allows a significant reduction of the alpha activity driven to the effluents from all of the laboratories and the sampling units of the AREVA NC La Hague site.

Following the implementation of the better controlled process of STE3 (as described in previous BAT application Reports) since 1989, which led to substantial reductions of the activity of the discharges, the implementation of the principles described above brought new significant reductions, moreover with a lesser volume of solid waste. The radioactive elements instead of being bituminised or cemented, are sent to vitrified wastes accepting much higher activity concentrations. Thus, the substantial decrease of the discharges is not obtained at the detriment of the volume of solid waste, but together with a better compactness of these (3,000 bitumen drums have been replaced by less than one glass canister).



STE3. The process and the reagents preparation room

In 2002, the two workshops of UP2-400 that were still operated, MAU and MAPu (Medium Activity Uranium and Plutonium) have been replaced respectively by a part of T3 and the new R4 workshop. The replacement of pulsed columns or mixers-settlers by centrifugal extractors induces a lower degradation of the solvent, resulting in less effluent. Process improvements in relation to discharges affect the management of the diluent and solvent, and the management of aqueous effluents.

The replacement of UP2-400 units by more sophisticated facilities (R4 as the last example) led then to a significant reduction in beta emitters discharges to the sea, these decreased by a factor of two between 1999 and 2004.

Solvent and diluent are now continuously purified in the TEO (Organic Effluent Treatment) units, by distillation under vacuum. Aqueous effluents are sorted out according to their acidity, following the principles of the NGE (New effluent management) implemented in the UP3-A plant, and concentrated in dedicated evaporators. The concentrates that gather most of the radioactivity are to be dried and incorporated in the vitrified waste, the clean distillates are as much as possible recycled into the process. This allows the reduction of both the volume and activity of both the alpha and beta liquid discharges.

One point of the New Effluent Management has not been implemented. Since the beginning of the tests in 1996, it has appeared that sending the concentrates of the alkaline effluents concentration unit (CEB) to T7 (vitrification workshop of the UP3-A plant) was inducing foaming and plugging of the feeding unit of the vitrification workshop. These tests have been halted in January 2007. While awaiting a solution the concentrates are sent to STE3 for chemical precipitation treatment.

This treatment being then the main remaining source of ruthenium discharges to the sea, extensive R&D has been launched to reduce these discharges. The source of the problem encountered in T7 has been

identified as the presence of traces of degradation products of the solvent used in the process (organic-phosphoric compounds). The solution selected for further investigation is a chemical treatment of the concentrates in order to completely oxidise these compounds with hydrogen peroxide in presence of nickel (Fenton reagent) after acidification of the concentrates (see Chapter 5, Additional Information, for the detail of the other solutions explored).

The formal qualification of this process was achieved in 2004, after:

- Tests of industrial feasibility of the process;
- Optimisation of the process with inactive simulated solutions;
- Validation tests at laboratory scale with real solutions taken from the T2 workshop;
- Qualification of the reference process, by comparison between inactive and active tests;
- Assessment of the impact of the process implementation, in terms of by-products, residual hydrogen peroxide, corrosion, radiolysis, criticality, calcination and vitrification.

The complementary equipment to be installed in T7 has then been designed, the administrative authorisation for its installation and active use required and obtained, the equipment installed and started. Several test campaigns have been performed in 2008, with a satisfactory performance level.

The results of these campaigns are under detailed analysis, in order to determine the optimum industrial production parameters and then to accordingly design the modifications to be installed in R7.

2.1.4 Results

These items show how the best techniques, concerning as well processes as abatement systems, are developed and used on the AREVA NC La Hague plants as soon as they become available (that is to say *inter alia* once they have been qualified and authorised), and how they induce reductions in the volume and the activity of the effluents, which appear clearly in Table 5, and in the corresponding impact.

Other modifications are being studied but not yet installed, as detailed in Chapter 5, Additional Information.

Several radionuclides have been pointed out of particular interest in the framework of the OSPAR strategy. Their management led to a dramatic reduction of their impact on the reference group. It is addressed here:

- Technetium 99 is a fission product emerging during the dissolution step, and mainly routed towards liquid form. After a double extraction process, 99 Tc follows the solvent with the plutonium flux. A reinforced washing has been set up in 1998 on UP3-A. It induced an increase of the decontamination factors of the washing unit by a factor of 4 to 5. A specific treatment is then applied in evaporators. Consequently, this nuclide has been sent to the vitrified waste for its major part since 1996. 99 Tc discharges have been cut by a factor of ten between 1989 and 2004, with the improvement of the global decontamination factor from 10 to 3 500 over the same period. Mean value of the DF on the 1996-2003 period is around 1,600.
- Concerning discharges to the sea of caesium 137, a reduction of more than a decade was reached in ten years. A noticeable increase of the decontamination factor through the improvement of the chemical treatment in STE3 has been obtained in 2003.
- Plutonium 239-240: alpha emitter of very high toxicity, this radionuclide is totally produced artificially. Sea concentrations show a marking essentially attributable to former reprocessing operations. Plutonium discharges have been reduced by a factor of 10 between 1989 and 1999, and keep following a decreasing trend since then, by a factor of 2, testifying to the improvements in liquid effluents management.

2.2 Efficiency of abatement systems

Global efficiency of the system, relative to discharges, is measured through a transfer function Fn, which is the ratio of the outgoing activity to the activity of the same nuclide in the fuel entering the process. One often uses Decontamination Factor (DF), which is the reverse of the transfer function. Transfer functions for the marine pathway and for the radionuclides quoted above are shown in Table 2 below:

	F sea
137Cs	10^{-7}
99Tc	10^{-4}
Pu	$<10^{-7}$

Table 2. Transfer functions of nuclides in 2008

An overall transfer function for total alpha can be estimated at about 10-7 over the period.

Concerning total beta, no global transfer function can be drawn since abatement techniques do not have the same efficiency over the range of radionuclides covered.

Details about abatement techniques are given in Appendix 1. They reflect the current situation, with the improvements obtained upon STE3 chemical treatment, and the technical achievements since the setting up of new evaporators in R2/T2.

2.3 Annual liquid discharges

2.3.1 Nuclide-specific data (OSPAR Annual Report on Liquid Discharges)

The so-called exceptional operations are those that the ministerial order of January 8th 2003 attributes to final cessation of operation and dismantling (MAD/DEM) and reconditioning of legacy waste (RCD).

Monitored discharge values are reported annually to OSPAR through OSPAR Annual Report on Liquid Discharges. The 2007 declaration has not distinguished between routine and exceptional discharges, because the OSPAR template did not allow for these. Comprehensive values are presented in Table 3 for 2007 and in Table 4 for 2008. The equivalent electrical energy produced for 2007 is 38.25 GWye and for 2008 is 31.3 GWye.

Radionuclide	Discharge limit for exceptional operations TBq / annum	Discharges from exceptional operations TBq / annum	Discharge limit for routine operation TBq / annum	Discharges from routine operation TBq / annum	TOTAL discharges TBq / annum	Normalised discharges from routine operation TBq / GW.y
Tritium			1.85E+04	1.2E+04	1.2E+04	
Total-□	7.0E-02	4.4E-03	7.0E-02	1.7E-02	2.13E-02	4.44E-04
Total-□		4.0E-01		4.4E+00	4.8E+00	1.15E-01
C 14			4.2E+01	7.1E+00	7.1E+00	
S 35						
Mn 54				1.3E-02	1.3E-02	
Fe 55						
Co 57				3.9E-04	3.9E-04	
Co 58				8.1E-04	8.1E-04	
Co 60	5.0E-01	3.9E-01	9.0E-01	4.7E-01	4.7E-01	
Ni 63				9.7E-02	9.7E-02	
Zn 65				ND	ND	
Sr 89				ND	ND	
Sr 90	9.8E+00	8.0E-03	1.2E+00	1.1E-01	1.2E-01	
(Sr 90 + Cs						
(Zr + Nb 95)				ND	ND	
Tc 99				6.1E-02	6.1E-02	
Ru 103				ND	ND	
Ru 106			1.5E+01	2.2E+00	2.2E+00	
(Ru + Rh) 106				4.5E+00	4.5E+00	
Ag 110m				ND	ND	
Sb 124				ND	ND	
Sb 125				7.4E-02	7.4E-02	
I 129			2.6E+00	1.4E+00	1.4E+00	
Cs 134			5.0E-01	6.8E-02	6.8E-02	
Cs 137	6.0E+00	4.5E-01	2.0E+00	5.6E-01	1.0E+00	
Ce 144						
(Ce + Pr) 144				3.2E-03	3.2E-03	
Pm 147						
Eu 152						
Eu 154				7.1E-04	7.1E-04	
Eu 155				1.8E-04	1.8E-04	
Np 237				1.3E-04	1.3E-04	
Pu 241				1.2E-01	1.2E-01	
Am 241				2.8E-03	2.8E-03	
Cm 242				3.5E-05	3.5E-05	
Cm 243+244				1.5E-03	1.5E-03	
Uranium in kg				2.65E+01	2.65E+01	

ND : not detectable

Table 3. OSPAR annual discharges in 2007

Radionuclide	Discharge limit for exceptional operations TBq / annum	Discharges from exceptional operations TBq / annum	Discharge limit for routine operation TBq / annum	Discharges from routine operation TBq / annum	TOTAL discharges TBq / annum	Normalised discharges from routine operation TBq / GW.y
Tritium			1.85E+04	8.2E+03	8.2E+03	
Total-	7.0E-02	3.1E-03	7.0E-02	1.7E-02	2.03E-02	5.49E-04
Total-		2.1E-01		6.37E+00	6.6E+00	2.03E-01
C 14			4.2E+01	6.2E+00	6.2E+00	
S 35						
Mn 54				2.3E-03	2.3E-03	
Fe 55						
Co 57				7.3E-05	7.3E-05	
Co 58				6.4E-05	6.4E-05	
Co 60	5.0E-01	2.1E-02	9.0E-01	9.7E-02	1.2E-01	
Ni 63				6.4E-02	6.4E-02	
Zn 65				ND	ND	
Sr 89				ND	ND	
Sr 90	9.8E+00	1.0E-02	1.2E+00	1.6E-01	1.7E-01	
(Sr 90 + Cs						
(Zr + Nb 95)				ND	ND	
Tc 99				7.4E-02	7.4E-02	
Ru 103				ND	ND	
Ru 106			1.5E+01	3.4E+00	3.4E+00	
(Ru + Rh) 106				6.7E+00	6.7E+00	
Ag 110m				ND	ND	
Sb 124				ND	ND	
Sb 125				3.8E-01	3.8E-01	
I 129			2.6E+00	1.0E+00	1.0E+00	
Cs 134			5.0E-01	7.5E-02	7.5E-02	
Cs 137	6.0E+00	1.8E-01	2.0E+00	8.9E-01	1.1E+00	
Ce 144						
(Ce + Pr) 144				1.5E-04	1.5E-04	
Pm 147						
Eu 152						
Eu 154				5.6E-04	5.6E-04	
Eu 155				8.1E-05	8.1E-05	
Np 237				4.3E-04	4.3E-04	
Pu 241				1.2E-01	1.2E-01	
Am 241				2.7E-03	2.7E-03	
Cm 242				1.1E-05	1.1E-05	
Cm 243+244				1.3E-03	1.3E-03	
Uranium in kg				1.93E+01	1.93E+01	

ND : not detectable

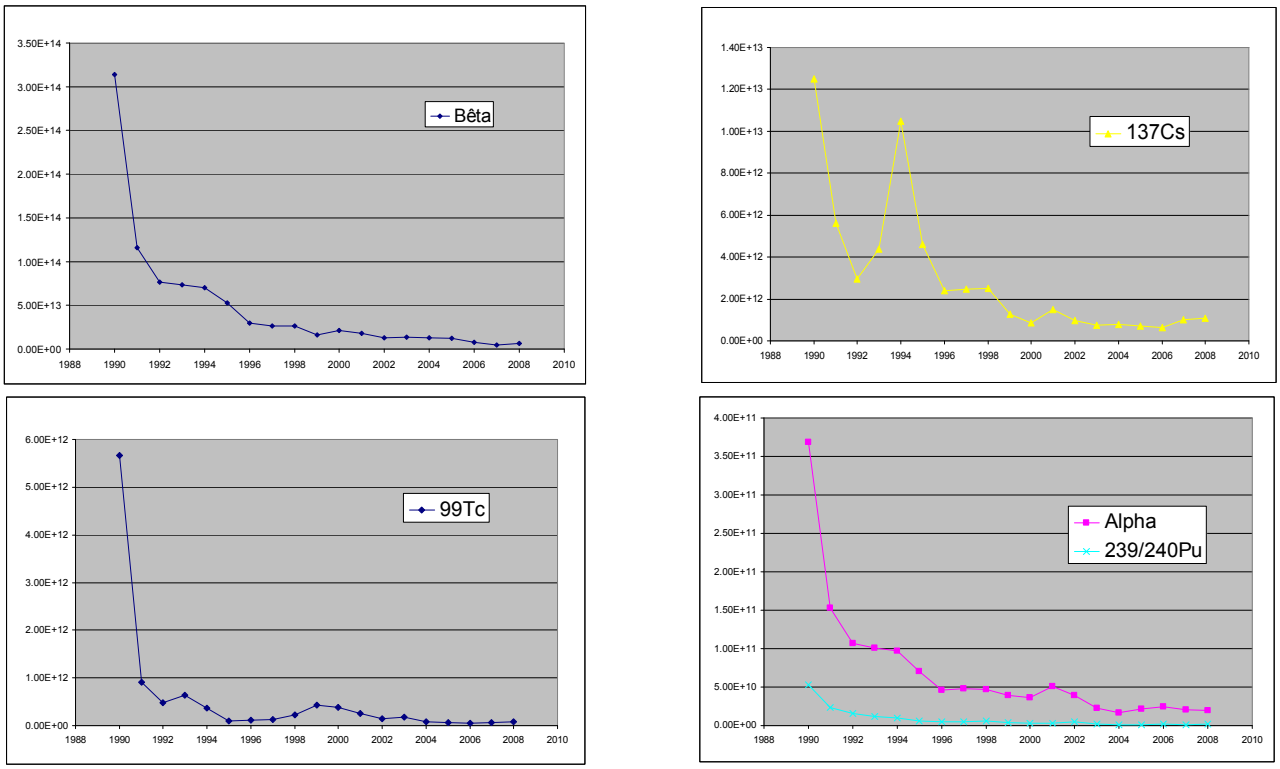
Table 4. OSPAR annual discharges in 2008

Annual liquid discharges for the last two periods and back to 1995 are displayed in Table 5 below. The operator's library comprises every element effectively measured and notified to the ASN. The status of the annual discharges can be found since 2004 in the annual report of environment monitoring which is required by the §c) of the 32nd article of the 8th January 2007 ministerial order that complements the January 10th 2003 ministerial order.

Bq/annum	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3 H	9.6E+15	1.1E+16	1.2E+16	1.1E+16	1.3E+16	1.1E+16	9.6E+15	1.2E+16	1.2E+16	1.4E+16	1.4E+16	1.1E+16	1.2E+16	8.2E+15
14 C		9.9E+12	9.7E+12	9.8E+12	9.9E+12	8.5E+12	7.2E+12	7.9E+12	8.7E+12	8.9E+12	8.3E+12	7.5E+12	7.1E+12	6.2E+12
54 Mn	3.1E+10	1.5E+10	4.8E+10	4.2E+10	1.2E+10	9.0E+09	9.2E+09	1.1E+11	8.9E+09	1.2E+10	6.6E+09	7.5E+09	1.3E+10	2.3E+09
57 Co	7.7E+08	8.5E+08	1.4E+09	9.0E+08	3.8E+08	3.6E+08	/	2.9E+08	3.8E+08	3.9E+08	2.2E+08	2.8E+08	3.9E+08	7.3E+07
58 Co	1.5E+10	1.8E+10	1.7E+10	6.1E+09	1.4E+09	9.3E+08	2.3E+08	6.6E+08	7.1E+08	9.9E+08	4.0E+08	4.5E+08	8.1E+08	6.4E+07
60 Co	5.5E+11	3.9E+11	4.9E+11	5.1E+11	3.2E+11	3.0E+11	3.6E+11	3.8E+11	3.6E+11	2.6E+11	2.3E+11	2.1E+11	4.7E+11	1.2E+11
63 Ni			1.3E+11	9.7E+10	8.6E+10	6.8E+10	8.0E+10	5.3E+10	1.2E+11	3.9E+10	2.7E+10	6.2E+10	9.7E+10	6.4E+10
65 Zn	7.9E+07	2.7E+09	1.7E+09	2.2E+09	2.4E+08	1.2E+08	/	2.6E+07	3.4E+08	3.5E+07	3.2E+08	4.2E+07	/	/
89 Sr	2.9E+11	9.4E+10	3.7E+10	2.4E+10	3.2E+10	1.2E+10	/	/	/	/	/	/	/	/
90 SrY	3.0E+13	1.1E+13	3.7E+12	2.5E+12	1.7E+12	1.0E+12	7.1E+11	9.0E+11	1.0E+12	2.8E+11	9.9E+11	4.3E+11	2.4E+11	3.4E+11
95 ZrNb	/	1.7E+08	3.9E+08	/	/	/	/	/	/	/	/	/	/	/
99 Tc	1.0E+11	1.2E+11	1.3E+11	2.2E+11	4.3E+11	3.9E+11	2.5E+11	1.4E+11	1.8E+11	7.9E+10	6.0E+10	4.5E+10	6.1E+10	7.4E+10
103 Ru	/	/	/	/	/	/	/	/	/	/	/	/	/	/
106 RuRh	1.5E+13	1.7E+13	2.0E+13	2.3E+13	1.4E+13	2.1E+13	1.7E+13	1.1E+13	1.4E+13	1.3E+13	1.2E+13	9.6E+12	4.5E+12	6.7E+12
110 mAg	1.4E+07	/	/	/	/	/	/	/	/	/	/	/	/	/
124 Sb	/	3.9E+08	6.9E+07	/	/	/	/	/	/	/	/	/	/	/
125 Sb	3.0E+12	2.0E+12	1.3E+12	8.3E+11	5.1E+11	3.5E+11	3.8E+11	5.1E+11	3.4E+11	1.6E+11	1.7E+11	9.6E+10	7.4E+10	3.8E+11
129 I	1.5E+12	1.7E+12	1.6E+12	1.8E+12	1.8E+12	1.4E+12	1.2E+12	1.3E+12	1.3E+12	1.4E+12	1.4E+12	1.3E+12	1.4E+12	1.0E+12
134 Cs	3.6E+11	1.7E+11	2.1E+11	1.5E+11	5.8E+10	4.7E+10	4.0E+10	6.5E+10	4.2E+10	6.4E+10	6.1E+10	6.1E+10	6.8E+10	7.5E+10
137 Cs	4.6E+12	2.4E+12	2.5E+12	2.5E+12	1.3E+12	8.7E+11	1.5E+12	9.6E+11	7.6E+11	7.9E+11	7.1E+11	6.2E+11	1.0E+12	1.1E+12
144 CePr	8.5E+08	3.0E+08	2.9E+09	1.2E+09	1.8E+09	1.8E+09	1.5E+07	1.6E+09	1.0E+09	1.6E+09	1.5E+09	1.1E+09	3.2E+09	1.5E+08
154 Eu	6.5E+09	4.6E+08	4.1E+09	8.8E+08	4.7E+08	8.3E+08	8.6E+08	6.0E+08	7.2E+08	7.1E+08	8.7E+08	1.6E+09	7.1E+08	5.6E+08
155 Eu	2.6E+09	/	2.3E+08	2.4E+08	8.9E+07	1.9E+08	/	1.6E+08	1.2E+08	2.6E+08	2.8E+08	4.6E+08	1.8E+08	8.1E+07
238 Pu	1.1E+10	8.9E+09	1.0E+10	1.5E+10	1.2E+10	1.0E+10	8.3E+09	8.3E+09	4.8E+09	4.8E+09	4.2E+09	6.1E+09	5.0E+09	5.4E+09
239/240 Pu	5.7E+09	4.6E+09	5.4E+09	6.0E+09	4.0E+09	3.3E+09	3.4E+09	4.6E+09	2.2E+09	1.4E+09	1.1E+09	1.8E+09	1.4E+09	1.7E+09
241 Pu	4.8E+11	2.2E+11	2.1E+11	2.3E+11	2.2E+11	2.8E+11	2.1E+11	2.3E+11	1.5E+11	1.3E+11	1.1E+11	1.5E+11	1.2E+11	1.2E+11
241 Am	9.5E+09	4.6E+09	6.1E+09	3.8E+09	3.5E+09	7.3E+09	2.1E+10	1.4E+10	5.7E+09	2.5E+09	2.5E+09	3.0E+09	2.8E+09	2.7E+09
242 Cm	/	5.6E+05	/	1.6E+06	/	2.4E+07	1.6E+07	1.2E+07	1.7E+07	1.6E+07	1.7E+07	2.4E+07	3.5E+07	1.1E+07
244 Cm	7.1E+09	1.9E+09	2.6E+09	1.8E+09	1.2E+09	1.5E+09	2.2E+09	1.2E+09	1.0E+09	1.1E+09	1.7E+09	2.6E+09	1.5E+09	1.4E+09
Alpha total	7.0E+10	4.6E+10	4.8E+10	4.7E+10	4.0E+10	3.7E+10	5.1E+10	3.9E+10	2.3E+10	1.7E+10	2.2E+10	2.5E+10	2.1E+10	2.0E+10
Beta total	5.3E+13	2.9E+13	2.7E+13	2.7E+13	1.6E+13	2.1E+13	1.8E+13	1.3E+13	1.4E+13	1.3E+13	1.2E+1	7.5E+12	4.8E+1	6.6E+12

'/' means result below measure threshold

Table 5. Detail of total marine discharges over 1995-2008



Evolution of the discharges of some nuclides between 1990 and 2008 (Bq)

2.3.2 Normalised data

As introduced in § 1.6, routine discharge data have been normalised against the equivalent energy produced by the reprocessed fuel elements that represent the service rendered by this fuel. This method provides freedom from the variability due to the variations of the services rendered. The normalised data are proportional to the output/input ratio of radioactivity in the plant, i.e. its transfer factor to discharges (reciprocal of the decontamination factor). They thus characterise the global efficiency of the plant, comprising both the process efficiency and the abatement systems efficiency, as considered in § 2.2.

Normalised values against equivalent energy (in GW.y) for total alpha and total beta in routine marine discharges for the last two periods and back to 1995 are given in Appendix 2.

The global downward trends that can be observed show that the mastering of the processes and the facilities by the operator is practically continuous and progressively going on.

2.4 Systems for quality assurance in relation to discharges

The Établissement AREVA NC of La Hague has an environmental management system that complies with the ISO 14001:2004 standard. This means that the environmental impact of the activities is systematically assessed and that there is a general commitment, including at the highest management level, to reduce the impact on the environment (See Appendix 4 for more details about the environmental management system).

The AREVA NC La Hague plants received in 2005 (renewed in 2007) the AFAQ's tri-certification for their activities of storage and nuclear fuel reprocessing, waste and recyclable product treatment and conditioning, flasks maintenance: ISO 9001:2000, ISO 14001:2004 and OHSAS 18001 (Occupational Health and Safety Assessment Series, 1999).

That is to say that amongst other activities, the ones relative to the discharges are subject to a documented quality system ensuring a high degree of confidence in their results. Moreover the theme of the radioactive liquid discharges is one of the main themes set as a priority by the Environment Management System.

AFAQ certifications are subject to regular recertification processes and regulatory orders are under permanent inspection.

2.5 Site specific limit discharge values

The official authorisation limit values apply to the whole site. They are shown in Table 6 below for the 2003 and 2007 orders.

Discharges to the sea TBq/y	2003 Order	2007 Order
Tritium 3H	18 500	18 500
Iodines	2.6	2.6
14 Carbon	42	42
90 Strontium (1)	12	11
137 Caesium (1)	8	8
134 Caesium	2	0.5
106 Ruthenium	15	15
60 Cobalt	1.5	1.4
Other β–γ emitters	60	60
Alpha emitters (1)	0.17	0.14

Specific limits are prescribed for the discharges from the so-called exceptional operations – those caused by final cessation of operation and dismantling (MAD/DEM) and reconditioning of legacy waste (RCD). Displayed values include routine and exceptional discharges, split as follows in the 2003 Order (modifications of the 2007 Order between brackets):

- 90 Strontium: 2 TBq/y for routine discharges, 10 TBq/y for exceptional operations (1.2 / 9.8),
- 137 Caesium: 2 TBq/y for routine discharges, 6 TBq/y for exceptional operations,
- 60 Cobalt: 1 TBq/y for routine discharges, 0.5 TBq/y for exceptional operations (0.9 / 0.5),
- Other □□□ emitters: 30 TBq/y for routine discharges, 30 TBq/y for exceptional operations,
- Alpha emitters: 0.1 TBq/y for routine discharges, 0.07 TBq/y for exceptional operations (0.07 / 0.07).

Table 6. Authorization limits of marine discharges set by the January 10th 2003 and January 8th 2007 ministerial orders

The 2007 Order features reductions for routine discharges of 40 % for 90 Strontium, 75 % for 134 Caesium, 10 % for 60 Cobalt and 30 % for alpha emitters.

2.6 Description of on-going or planned activities

As said previously, a major planned operation consisting in the conditioning of alkaline effluents concentrates coming from the solvent regeneration, which was intended to reduce the discharge activity of beta emitters after industrialisation in 2006, has not been found workable the way it was planned, because of foaming and clogging problems in the vitrification workshop. The discharge reduction will take place from 2009-2010 on, thanks to extensive R&D and modifications. The detail of these is given in § 2.1 above.

Regarding exceptional operations, the ministerial order of January 10th 2003, completed by the January 8th 2007 order, sets separate bounds for routine discharges from exceptional operations namely final cessation of operation and dismantling of former facilities or retrieval and conditioning of legacy waste.

Regarding waste treatment, the best practice nowadays is to promote direct waste conditioning in-line with the treatment. This allows the sorting out at the source, an easier traceability, the transfer of surface storage compatible waste towards the existing disposal facilities and the local safe storage of other wastes.

Historically, conditioning of waste generated by the first spent fuel reprocessing operations has been delayed, considering the technologies unavailability and the required time to develop conditionings, set up storing systems and lay out investments.

These wastes have been stored safely in silos or pits, waiting to be retrieved and definitively conditioned.

The planning of the retrieval and conditioning of legacy wastes involves:

- Retrieval of sludges (generated by coprecipitation) from the STE2 effluent treatment station, which should start in 2014 and scheduled to end after 2028, significant actions being already carried out since 2001 (research and development programs, inactive and active tests),
- Retrieval of metallic structural waste from spent fuel processed in UP2-HAO, planned to start in 2015 and to end around 2025.
- Retrieval of structural waste of magnesium and graphite type resulting from the processing of metallic uranium fuel in UP2-400, in two successive phases (concerning two distinct facilities), one planned to end around 2022 and the second one before 2030.

During the period, several pilot campaigns of STE2 sludge conditioning have been performed from different tanks filled at different periods, in order to qualify the equipment and the processes of retrieval, transfer and characterisation of the sludges. A substitute to the bitumen conditioning has been developed since 2005 (drying of the sludges and compacting in order to substantially reduce the volume of solid waste bound to a future storage). The process and the final conditioning as planned are under the process of a regulatory authorization.

Some operations have generated specific by-products in 2007 and 2008. They are as much as possible applied the same abatement techniques as those used for the routine discharges. This is the case for practically all the rinsing operations of the equipment performed in the HAO workshop prior to its MAD/DEM quoted in §1.3, as well as those of the MAU, MAPu, HA and PF workshops. Taking into account the efficiency of these techniques, these operations generated practically no discharges. Only those by-products that could not, because of their physical or chemical composition, be sent to distillation have been treated by the co-precipitation process in STE3 and generated discharges.

The operations that generated most of the discharges in 2007 are:

- the retrieval and conditioning of the solvent used in the UP2 plant before 1990 and stored in vessels of the PF workshop, accounting for 40 % of the alpha activity and 75 to 80 % of the beta activity;
- the tests for the retrieval of the sludges of STE2 quoted above, accounting for 30 % of the alpha activity and 15 to 20 % of the beta activity;
- The cleaning of the STE2 workshop (sumps and vessels), accounting for 30 % of the alpha activity and a negligible part of the beta activity.

In 2008, the specific discharges are almost totally attributable to the retrieval and conditioning of the solvent used in the UP2 plant.

These preliminary operations have generated discharges representing only a small part of the authorization pertaining to these operations.

2.7 Summary evaluation for discharges

Table 7 below summarizes the evaluation concerning BAT/BEP indicators of the site-specific information on discharges from the AREVA NC La Hague site.

Criteria	**Evaluation**
The BAT/BEP indicators	
Relevant systems in place	Yes, Management and technical systems improved since the start of the plants
Abatement factor	High factors
Downward trend in discharges	Constant or downwards
Downward trend in normalized discharges	Mainly downwards

Comparison with UNSCEAR data	No available comparative UNSCEAR data
Relevant and reliable quality assurance	Yes
Relevant site specific discharge values	Yes
Data completeness	Complete
Causes for deviations from indicators	None
Uncertainties	No influence on the conclusions
Other information	R&D for other improvements in progress

Table 7 Summary Evaluation for Discharges

3. Environmental impact

3.1 Concentration of radionuclides of concern in environmental samples

A pluralistic committee of international experts, the GRNC (Groupe Radioécologie Nord-Cotentin), comprising stakeholders such as local associations or non-governmental organisations, has been created in 1997 by the ministers in charge of the environment and health with the mission to assess the total impact of the nuclear facilities of the North-Cotentin on the potentially most exposed populations as well as the associated risks.

The GRNC has grounded its work on the results of some 80,000 analyses a year carried out from around 25,000 samples, taken in different places and media. The GRNC analysed more than 500,000 results and its Report [1] gives many detailed figures on this subject.

The reported elements come from the regulatory registers, sent monthly to the ASN. Monthly regulatory registers indicate the activities asked for in the order, for various bio-indicators such as ground, herbs, vegetation, milk, fruits, vegetables, meat for terrestrial compartment and coastal and deep sea water, sand, sediments, seaweeds, limpets and fishes for the marine compartment. The summary of these measurements can be found in the annual report of environment monitoring which is required by the §d) of the 32nd article of the 8th January 2007 ministerial order that complements the January 10th 2003 ministerial order.

Sampling of limpets and algae

Annual mean concentrations in coastal waters, fucus, limpets and fishes are given in Appendix 3, for 1995 and 2000 to 2008.

A comprehensive assessment of marine biota doses [1][2] was conducted in 2003 by an environmental-expert consulting firm, SENES, managed by recognized Canadian experts. Key results show that the radiation dose rates to marine biota arising from the AREVA NC La Hague facilities were at that time at least 2-3 orders of magnitude lower than the lowest guidance values for the protection of the populations of marine biota (UNSCEAR, IAEA) and at least 1-2 orders of magnitude lower than those from the background radiation in the region.

The consensus appraisal of this study by a group of international experts came to the major conclusion that "the predicted dose rates to marine biota attributable to the radioactive discharges to the sea from the AREVA NC La Hague facilities are small, and in general, well below the comparison guidance levels at which deleterious and observable effects to populations of marine biota might, according to current knowledge, be expected".

3.2 Nuclide libraries used

This subject is treated in § 2.3

3.3 Environmental monitoring program

The detailed environmental monitoring program is established every year and communicated to the ASN in consistency with the ministerial order. Types of measurements, frequencies and associated sampling and analysis methods are defined in the January 10th 2003 ministerial order, completed by the January 8th 2007 ministerial order.

Delayed monitoring is performed in different environmental compartment. About 25,000 samples are taken every year, leading to nearly 80,000 analyses every year. Samples are taken in every compartment of the environment participating in the potential pathways of the radionuclides to man: marine, terrestrial and hydrogeological compartments. Feedback from experience helps to choose the place and number of measurement points guaranteeing that the whole process is thoroughly controlled.

The results of the program allow assessing permanently the real impact of the AREVA NC La Hague site on the environment.

- Marine monitoring is an important part of monitoring. It is performed through discontinued measurements with time-shifted analysis. It ranges from Granville to the Bay of river Seine (near Le Havre). The sampling in the marine component comprises coastal samples (sand, seaweeds and limpets), deep sea samples (water, sediments), flat and round fishes, scallop shells, crabs, oysters, mussels, lobsters. Detailed content of the marine monitoring program is detailed in Appendix 5.
- Terrestrial monitoring is performed on rainwater, vegetation, milk and other foods, which are regularly sampled and analysed.
- Hydrologic monitoring includes drinking waters, small streams and the ground waters, to verify hydrologic and hydrogeologic dispersion.

Sampling is performed by AREVA NC employees, except for the off-shore sampling in the high sea, which is performed by the French Navy.

Some independent complementary sampling is performed by the IRSN's LRC (Cherbourg-Octeville Radioecological Laboratory) that has extensively studied the water movements in the North Sea, using 125 Sb discharged by the AREVA NC La Hague site as a quite perfectly conservative tracer during sampling campaigns in 1986 and 1994. Conversely, the result of these studies is used to determine the dilution of the AREVA NC La Hague site effluents in the sea, in view of the impact assessments.

The sampling and measurements performed by the LRC complement those performed by the IRSN on behalf of the ASN.

The North Cotentin Radio Ecology Group too has made an important use of the LRC results in its independent first assessment of the AREVA NC La Hague site impact.

COGEMA's then AREVA NC's monitoring results have been compared with the LRC measurements every year until 2006 within the context of the GRNC impact assessment required by the January 10th 2003 ministerial order. The advice resulting from this assessment for 2006, last year considered by this request, is presented in Appendix 7.

3.4 National target levels of radioactive substances in environmental samples, and/or doses to marine organisms

No national target levels are prescribed, but UNSCEAR and IAEA guidance values, as said in § 3.1, are set as reference values.

3.5 Systems for quality assurance of environmental monitoring

The Environmental Laboratory activity, as part of the activities of the AREVA NC Établissement de La Hague, complies with the ISO 14001 environmental standard, as included in the jointed certifications ISO 14001:2004, ISO 9001:2000 and OHSAS 18001 (1999) obtained in 2005 and renewed in 2007. Concerning the analyses and measures for fresh and waste waters for alpha, beta, gamma, tritium and 90 strontium, and sea water for beta and gamma, the COFRAC accreditation (French national accreditation organism) has been renewed in 2003 and 2008 (first obtained in 1996), as meeting the requirements of the ISO 17025 standard. This accreditation, delivered by an independent organism, results from the assessment of the quality system and of the management of analysis methods in term of adequacy of materials, equipments used and staff qualification.

The environment laboratory

This involves regular calibration of detectors with secondary standards traceable to primary standards and intercomparisons exercises with other laboratories, both national and international, such as the one of the IAEA. (In addition to the regulatory intercomparisons with IRSN). The intercomparison tests consist in the measurement of a sample by about fifty laboratories and the comparison of the results by the test organizer.

The AREVA NC laboratory participates to ISO standards working-out.

The laboratory has been granted the ministerial agreement for the measurement of a certain number of radionuclides in the environment, in accordance with articles R. 1333-11 and R. 1333-11-1 of the public health regulations. Most of these agreements, for those related to the marine environment, can be seen in the marine environment monitoring program presented in Appendix 5.

The ASN requires that the operators follow a program of cross measurements, aimed at guarantying the quality of the results of the analysis performed by the operators. The operator has to provide samples of the discharged effluents to a laboratory that has been agreed by the ASN. Some of these samples are analysed according to a program defined by the ASN. The operator has to check the consistency of the results of these measurements with those that it has himself obtained. L'Établissement AREVA NC of La Hague has selected for this cross measurements the laboratories of the environment and intervention directorate of the IRSN (IRSN/DEI/SESURE/LVRE and IRSN/DEI/STEME/LTE-LMN-LEI).

3.6 Summary evaluation of environmental impact

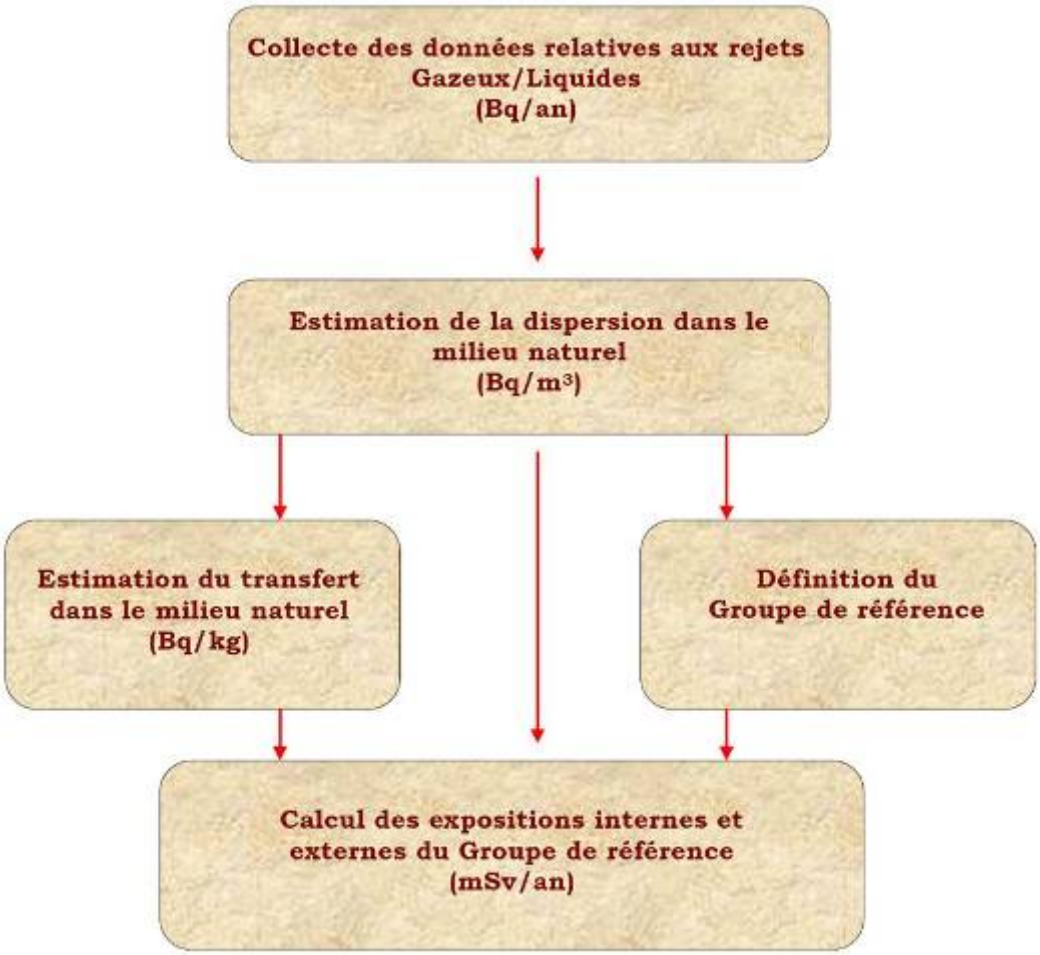
Table 8 below summarizes the evaluation concerning BAT/BEP indicators of the site-specific information on Environmental Impact from the AREVA NC La Hague site.

Criteria	**Evaluation**
The BAT/BEP indicators	
Downward trends in concentrations	Yes
Relevant environmental programme	Yes
Relevant quality assurance programme	Yes
Data completeness	Yes
Causes for deviations from indicators	No deviations
Uncertainties	Low because many samples
Other information	None

Table 8 Summary Evaluation for the Environmental Impact

4. Radiation doses to the public

4.1 Average annual effective doses



The principle of the impact assessment

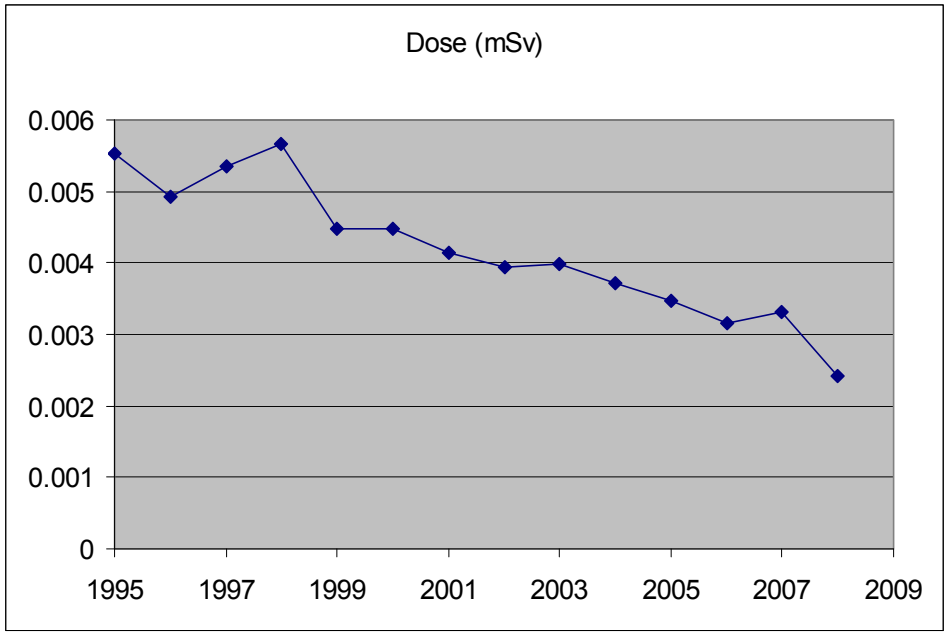
An impact assessment method has been derived from the GRNC method, and a software, named ACADIE (Internal and External Dose Calculation Application) has been developed jointly by the IRSN, the ASN and AREVA NC, based on the work of the GRNC and agreed by this committee.

Operator discharges values have been used in the impact assessment. La Hague area specific parameters for dietary and living habits, derived from inquiries or specific studies performed within the context of the 1998 impact study, have been implemented in the ACADIE software. ACADIE is used to assess the impact of annual discharges. This assessment has been until 2006 submitted to the GRNC appraisal, through the 32nd article of the January 10th 2003 ministerial order.

Annual effective doses computed with the latest version of ACADIE on the marine reference group for marine discharges are shown in Table 9 below:

Year	Dose (mSv)
1995	0.0055
1996	0.0049
1997	0.0053
1998	0.0057
1999	0.0045
2000	0.0045
2001	0.0041
2002	0.0040
2003	0.0040
2004	0.0037
2005	0.0035
2006	0.0032
2007	0.0033
2008	0.0024

Table 9. Evaluation performed with the ACADIE software of the doses to individuals of the Goury reference group related to marine discharges during the 1995-2008 period[1]



Evolution of the annual dose to the individuals of the Goury reference group from 1995 to 2008

For the marine pathway related impact to the Goury fishermen reference group, it can be seen that the doses resulting from the actual discharges since 1995 and during the period are practically constantly lowering and have always stayed more than two orders of magnitude below the dose limit of 1 mSv set by the French regulations (April 04th 2002 decree setting the limit of dose added by nuclear activity for the public).

Analysis confirms that the dose caused by tritium is negligible besides the one resulting from the other radionuclides (< 1%).

4.2 Total exposures

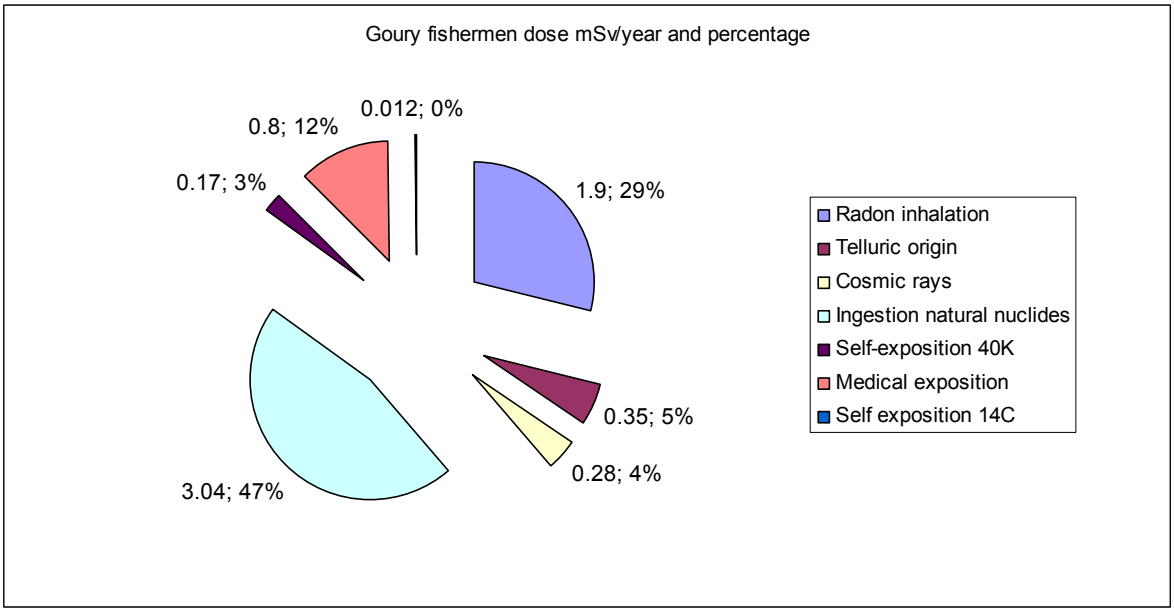
The other sources of exposure can be found in publications [3]. The main one in this region is the inhalation of radon emitted by the granitic bedrock. IRSN studies consider that the average exposure estimated from mean values of measured radon concentrations indoor and outdoor in Cotentin is 1.9 mSv/y. Telluric

1 The 1995-2004 values are around 0.001 mSv above the corresponding values presented in the 2006 BAT implementation report. This is due to the taking into account of the sea spray and the use of algae as manure, and the update of some dose coefficients agreed by the GRNC in the latest version of ACADIE.

exposure (from natural nuclides in the ground) is estimated at 0.35 mSv/y, and exposure due to cosmic rays at 0.28 mSv/y. Specific local measurements of 210 Po[2] made by the IRSN in 1990-1994 have been carried out in sea food. The recorded concentrations, with the selected diets, lead to an exposure due to the ingestion of natural nuclides of 3.04 mSv/y for the Goury fishermen. It has indeed to be noted that the ingestion of mussels or other shells, moderate but above the average, can very easily bring this value above 1 mSv/y (regulatory limit for the dose added by nuclear activities to the public), only through the natural 210 Po they contain. This is the case for the Goury fishermen. Internal self-exposure due to natural 40 K can be estimated at 0.17 mSv/y, and due to 14 C, mainly of natural origin, to 0.012 mSv/y. No local estimation figure could be found for the exposure due to medical care, but the French average of 0.8 mSv/y in 2006 can be retained. The values are summarized in Table 10 below.

mSv/y	Goury fishermen
Radon inhalation	1.90
Telluric origin	0.35
Cosmic rays	0.28
Ingestion natural nuclides	3.04
Self-exposure 40K	0.17
Self exposure 14C	0.012
Medical exposure	0.8
TOTAL	6.55

Table 10. Exposure of the fishermen of the Goury reference group, all sources except nuclear facilities[3]



Breakdown of the exposure of the fishermen of the Goury reference group, all sources except nuclear facilities

[2] The results of these measures do not prejudge the origin of such 210Po.

[3] The values of this table, when ingestion and medical exposure have been removed, are consistent with the generally agreed level of natural radiation in the North-Cotentin region of 2.7 mSv/y, value consistent with the factor 400 applied to 0.007 mSv/y by the GRNC, see Appendix 7, since the remaining total is exactly 2.712 mSv/y.

The total values are above France average (around 3.2 mSv/y in 2006) due to the nature of the ground that generates direct external exposure and indirect internal exposure through the inhalation of the radon it generates, and particularly because of the local diet which brings above the average quantities of 210 Po in the seafood.

Neighbouring nuclear facilities of the reference groups of the AREVA NC La Hague site bring very little exposure to these ones: surface disposal centre for low activity wastes of ANDRA is estimated to bring around 0.000,65 mSv/y (all paths considered) to its own reference groups in 2008 [4]. The nuclear power plant pair of Flamanville brought around 0.000,16 mSv/y through its liquid discharges on its own reference group in 2008 [5]. The conservative summing up of these values[4] would bring 0.000,81 mSv/y, that is to say it adds 0.012 % to the exposure of Goury fishermen that are submitted to 6.55 mSv/y from other sources.

The addition of the exposure due to the 2006 global dose (atmospheric and marine) of the AREVA NC La Hague site, conservatively assessed by the GRNC in its 4th mission at 0.007 mSv for the more penalizing reference group, brings only another 0.11 % to the preceding total.

The influence of all neighbouring nuclear facilities, including the AREVA NC La Hague site, estimated in a conservative way by summing all the values at 0.007 81 mSv/y is then 0.12 % of the exposure due to other sources. The additional value of 0.007 81 mSv/y is much below the dose limit of 1 mSv set by the French regulations (April 04th 2002 decree setting the limit for the dose added by nuclear activity for the public).

4.3 The definition of the critical groups

The process of definition of the critical group follows EURATOM Directive 96/29. This Directive states that the reference group is composed of individuals whose exposure to a given source is relatively uniform and representing the one of individuals who, among the population, are more particularly exposed to the said source through their usual domestic, occupational or leisure activities.

A group of experts committed by the French Ministry in charge of the health [6] has recommended in 1996 to chose, among real groups of persons, those which can be used as a reference (farms, villages and towns), all impact pathways having to be taken into account. This recommendation excludes purely hypothetical groups.

The reference group relative to the marine pathway is the Goury fishermen group. Fishermen have the longer lasting contact with the sea and its sprays and they have a proven above the average consumption of seafood. The small village of Goury, almost at the tip of the Cap de la Hague, was identified as the coastal point where radionuclides concentrations are the highest (two times lower at Barfleur, east of Goury on the north coast, three times lower at Blainville, south of Goury on the west coast).

It is assumed, in a conservative way, that all the seafood of local origin ingested by the fishermen of the reference group lived in the concentrations encountered in the vicinity of Goury.

4.4 The information on exposure pathways considered

The discharged effluents disperse into the environment. Transfer to man comes through two compartments of the biosphere, the terrestrial compartment (through atmospheric discharges), and the marine compartment. In the marine compartment, most of the nuclides are released in a soluble form, but some of them can form colloids, polymers, or be adsorbed on solid particles. Nuclides are more or less assimilated by marine species, function of the metabolism of the species itself, and of the chemical and physical properties of the nuclide.

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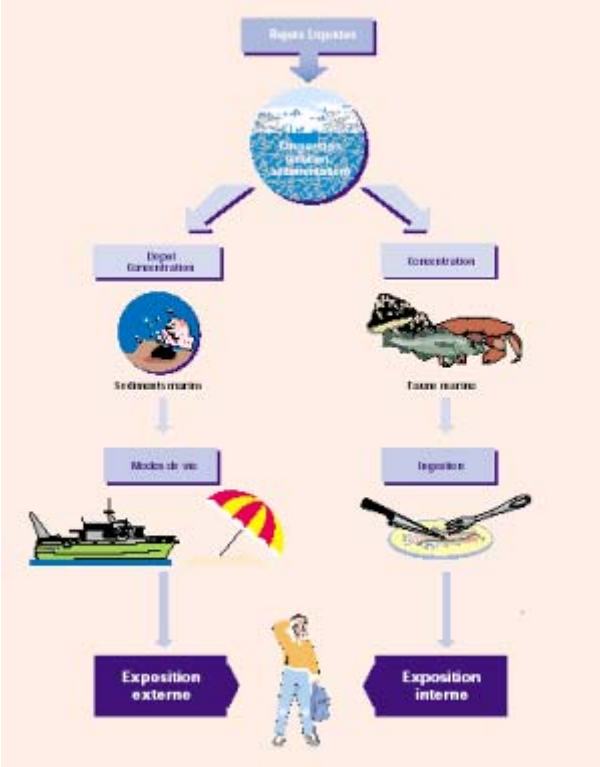
[4] The reference groups of the three quoted sites (AREVA NC La Hague, EDF Flamanville and ANDRA Disposal Center) being different, with different locations, none of these reference group is exposed to the sum of the doses assessed for each of these groups. Any kind of summing up of the doses relative to different reference groups leads to a value higher than the actual one.

Pathways to man from radioactive elements in the marine environment include the ingestion of seafood and external exposure, which depends on the local habits. For the general population, only leisure activities on the beaches have to be considered. The contamination of soil and shore vegetation resulting from the spray of seawater, which can be observed in bioindicators such as gorse is light and does not constitute a significant pathway to man.

The contribution of external exposure, whatever the activity, is much lower than the contribution of the ingestion of seafood.



The exposure pathways for liquid discharges

4.5 Basis for methodology to estimate doses

Since 2003, methodology (modelling) is that of the GRNC, defined during its first mission about the 'Estimation of exposure levels to ionizing radiation and associated risks of leukaemia for populations in the Nord Cotentin' (July 2000 report) [1], later finalised as the ACADIE software.

Specific parameters entering the model are drawn from dedicated studies, such as local diet and living habits inquiries or concentrations monitoring campaigns.

Dispersion factors in the sea are derived from initial experiments with buoys and tracers, and from many measures performed during more than 40 years, in particular by the IRSN, interpreted and validated by the work of the GRNC.

Concerning the external exposure of fishermen, exposure time has been conservatively taken at 7 hours a day, 365 days a year [7].

The diet has been defined from the enquiry made by the CREDOC, in April-May 1998, in four zones over Cap de La Hague, Cherbourg city area, West and North coast, Centre, and East coast [7]. Seafood diet of the marine reference group is conservatively taken as the one of the 95th percentile, that is to say the one of the 5 % of people having the highest consumption of seafood. Total annual sea food consumption is taken at about 127 kg, of which more than 70 kg are from local origin (supposed to live precisely in Goury waters); the rest of the food represents about 236 kg of which more than 67 kg are from local origin.

Concentration factors in fauna and sediments are taken from measurement results (IRSN/LRC experimental campaigns) interpreted by the GRNC [1] to define the coefficients, when measurable, and from EU publication (1979) for others, 14 C for instance.

Corrective factors have been affected to the transfer factors to the marine compartment by the GRNC experts in order to take into account the actual results of measurement in the environment (more than 500,000 results used).

External exposure factors are taken from the September 1st 2003 ministerial order for krypton, and Federal Guidance 12 from US-EPA for other radionuclides.

Whole body dose coefficients for inhalation and ingestion are also taken from this same order, which is the transposition to French law of EURATOM Directive 96/29.

More details on ACADIE are given in Appendix 6.

4.6 Site specific factors for significant nuclides

Site-specific factors appear in § 4.5.

4.7 Site specific target annual effective dose

French regulations do not consider targets for the annual effective dose. The limits apply only to the discharges. Nevertheless, the effective doses to the reference groups are assessed every year.

4.8 Systems for quality assurance of processes involved in dose estimates

As any other activity of the Établissement, the processes involved in dose assessment comply with the ISO 9001:2000 quality standards, as part of the jointed certification of integrated management ISO 14001:2004, ISO 9001:2000 and OHSAS 18001 (1999). That is to say, in particular, that they are traceable and subject to verifications. Independent verifications are performed by the technical support of the ASN, IRSN. The initial work of the GRNC [1], as ordered by the government, constitutes also a very extensive verification of all the work performed relative to the discharges, including the dose assessment.

Within the context of the Sustainable Development Approach, launched by the AREVA Group in 2001, the radiological impact on the public living in the vicinity of nuclear facilities was chosen as an environmental indicator of major interest.

4.9 Summary evaluation of radiation doses to the public

Table 11 below summarizes the evaluation concerning the BAT/BEP indicators of the site-specific information on radiation doses to the public from the AREVA NC La Hague site.

The methods for estimating the doses, agreed by the GRNC and the IRSN, are relevant for judging the exposure of the population and to check the compliance with the dose limits and constraints. The doses are decreasing due to managerial and technical improvements continuously implemented on the AREVA NC La Hague site.

Table 11. Summary Evaluation for Radiation Doses to the Public

Criteria	Evaluation
The BAT/BEP indicators	
Downward trend in radiation dose	Yes
Relevant critical group	Yes
Reliable dose estimates	Yes
Relevance of target dose	No target dose for the site
Relevant quality assurance systems	Yes

Data completeness	Data are complete
Causes for deviations from indicators	No deviations
Uncertainties	Low
Other information	Assessment method based on the work of the GRNC, pluralistic expert group

5. Summary – BAT

From the evaluations of the BAT/BEP indicators for discharges, environmental impact and radiation doses to the public it is concluded that the BAT have been applied at the AREVA NC La Hague site during the time period covered by this report as well as before.

6. Additional information

One of the main goals of the AREVA NC La Hague plants operators has always been to control the discharges and their impact, aiming at an industrial activity without harm, neither for the workers nor for the population. Since the creation of the site, the operators keep continuously investing in the evolution of the industrial units, in order to integrate progress achieved in processes, technologies and impacts knowledge. This is clearly apparent in the evolution of the doses to the workers, of the waste volume production and of the discharges that have been continuously decreasing since the beginning of operation and are still decreasing. The impact for the reference group is low and the efforts are nevertheless still going on.

It should not be forgotten, however, that as new improvements are implemented, the expected impact gains will get lower and lower and the corresponding expenses will have to be evaluated in regard to the prevention costs usually accepted against all the domestic, industrial, technological and dietary risks to which the population is exposed, in a consistent way with the ICRP statement: ("If the next step of reducing the detriment can be achieved only with a deployment of resources that is seriously out of line with the consequent reduction, it is not in the society's interest to take that step, provided that individuals have been adequately protected.").

This point being recalled, several directions of progress are envisaged. Those concerning liquid effluents are exposed hereafter.

In addition to the process improvements already in use in UP3-A and UP2-800 (including the R4 workshop), the preferred orientation of liquid effluents towards vitrification, by concentrating them, will continue to be extended in the following years to the effluents resulting from the shutdown and the decommissioning programs of the UP2-400 plant, in consistency with the constant research of the Best Available Techniques for these operations.

Concerning the reduction of the 106 Ru discharges from the alkaline concentrates, the chemical pre-treatment before vitrification that is presented in § 3.1 will be implemented in 2009-2010 in UP-3A and later in UP2-800, it will lead to a decrease of the discharge of 106 Ru and other beta emitters. Other studies have been undertaken on the same subject, such as the improvement of the treatment in STE3 that is presented below, and another option based on the relatively low half-life of 106 Ru (around 1 year). It consists in increasing as much as possible the average residence time of the concentrates in the existing buffer storages before the standard treatment in STE3. The normal process already allows for a residence time of around one year. In a reference scenario featuring the maximum capacity of the site, a little less than another year could be added. The gain on the impact would be of the order of 0.001 mSv/y (which is less than for the other options), with no investment, but this option establishes a direct link between the main process and the effluent treatment station process. At the present time, if the effluent treatment station cannot receive the concentrates, because of a failure or maintenance, for instance, the operation of the main process can go on during a reasonable time by filling the buffer tanks, which are progressively emptied when the operation of STE3 has resumed. With the maximum residence time option, any stop of STE3 or of

the transfer will oblige to stop the main process. This is an important drawback, and, for this reason, this option ranks after the chemical pre-treatment of the concentrates and after the improvement of the STE3 process.

At the same time, studies are conducted in collaboration with the CEA (Commissariat à l'Énergie Atomique), in order to improve the chemical treatment of the liquid effluents treatment unit STE3 by increasing the reagent quantities up to the theoretical maximum. Laboratory experiments showed that significant gains might be reached on the decontamination factors over major beta emitters. Industrial tests have been performed in 2007, validation campaigns performed in November 2008, to be continued in 2009. The results are satisfactory relative to the radioactive discharges. The drawback is that the production of sludge is twice the one resulting from the standard treatment, leading to a production of bituminised drums that is also twice the one resulting from the standard treatment. A balance has to be found between the reduction of the discharges and the production of solid waste. The last and the next campaigns are aimed at the definition of an optimum between these two requirements. It has to be noted that this modification brings almost no discharge reduction if the vitrification of alkaline concentrates is implemented, it is studied only in case it is not possible to send the alkaline effluents to vitrification.

Extensive R&D has been performed since 2006 to find a way of trapping 60 Co that is under solid form. 60 Co comes essentially from the corrosion products of the primary circuits of reactors that are deposited on the cladding of the fuel assemblies, are then freed in the AREVA NC La Hague site storage pools and reach the effluents under the form of soluble complexes or very fine particles. One of the main problems encountered is the quick clogging of the filters. TIS filters (tangential microfiltration on ceramic membrane) that are less prone to clogging are being tested, but there are yet numerous issues to be solved:

- The proportion of insoluble vs. soluble seems to vary in large proportions, it has to be better known before the efficiency of the process can be determined;
- Clogging time must be reduced;
- Declogging efficiency must be brought to a sufficient level;
- A disposal path for the solid filtrates, that are high-energy gamma emitters, has to be determined, qualified and authorised.

Microfiltration (with the same type of filter or with other types) could also be used to reduce the alpha activity of the “V” discharges, which is supposed to be mostly under solid form. The issues are the same as for cobalt 60 filtration except that the solid waste is not irradiating and, from a practical point of view, that the flows to be treated are considerably higher than the storage pools ones. Laboratory tests are being performed.

In accordance with the BAT philosophy, a periodic review of the processes that could be used to reduce the tritium discharges to the sea is performed. In that framework, a distillation process has been selected as possibly bringing a discharge reduction of the highly diluted tritium effluents discharge. A summary design study has shown that for a 2000 tU/year capacity plant, this process would require 18 units of 2 distillation columns of 3 m diameter and respective height of 32 m and 12 m, requiring no less than 5,700 m3 of packing and 130 MW of thermal power. These parameters, particularly the required thermal power, seem quite unrealistic, particularly when one remembers that:

- It would save at most 0.000,01 mSv/y to the reference group for marine discharges (hundred thousands times less than the agreed public dose limit of 1 mSv/y);
- There are absolutely no safe and qualified conditioning and disposal processes for the by-product of this process.

The present conclusion is that the only available technique for the tritiated effluents of the AREVA NC La Hague site remains the physical dispersion and isotopic dilution to the sea.

The implementation of some of the envisaged progresses could lead in OSPAR time scale to further reduction of impact to the marine pathway reference group, that are already at levels considered by the

radiological protection specialists as being insignificant from the radiological aspect. The objective of an industrial activity without harm, neither for the workers nor for the population, that can be considered as reached, could then be comforted.

Bibliography

[1]. Estimation des niveaux d'exposition aux rayonnements ionisants et des risques de leucémies associés de populations du Nord-Cotentin, Groupe Radioécologie Nord-Cotentin, Rapport de juillet 2000.

[2]. Assessment of marine biota doses arising from the radioactive sea discharges of the COGEMA La Hague facilities, SENES Consultants Limited, March 2003.

[3]. Comparing the dose contributions from man-made and from natural radioactivity, D. Beutier, N. Dellero, J. Pradel, IRPA-10 congress, Hiroshima, April 2000.

[4]. Centre de Stockage de la Manche - Rapport Annuel 2008 - ANDRA

[5]. Rapport national français de mise en œuvre de la Recommandation PARCOM 91/4 sur les rejets radioactifs – OSPAR - 2010

[6]. Avis du Conseil supérieur d'hygiène publique de France, section de la radioprotection, concernant le rapport intitulé "Évaluation de l'impact sanitaire des installations nucléaires en fonctionnement normal",

http://www.sante.gouv.fr/adm/dagpb/bo/1998/98-48/a0483043.htm.

[7]. Dossier d'enquête publique, étude d'impact, Publications COGEMA, Décembre 1998.

[8]. « Année 2006 - Appréciation par le GRNC de l'estimation des doses présentée dans le rapport annuel de surveillance de l'environnement d'AREVA NC La Hague – quatrième avis du GRNC – rapport de synthèse ».

Complementary information on the GRNC:

http://www.irsn.fr/FR/base_de_connaissances/Environnement/surveillance-environnement/GRNC/Pages/Radioecologie-nord-cotentin.aspx?DossierGuid=b41f42b5-7ff1-402d-bf21-cd266f8732c2&DossierWebGuid=da5ae901-2367-41f6-aa7e-cf5c9aed8f60

Appendix 1: System(s) in place to reduce, prevent or eliminate discharges and their efficiency

Abatement system/ Management	Into operation (Year)		Efficiency of abatement system		Comments
	Existing	Planned	Decontamination Factor DF or purification factor FE[5]	Other measure of efficiency	
Recycling:					
Acidic washing of hulls and end-pieces	1990			100 %	After distillation
Water washing of hulls and end-pieces	1990			100 %	After distillation
Water washing of vitrified waste canisters				100 %	After distillation
Water washing of compacted waste canisters				Around 50 %	Function of operating conditions
Condensates from vacuum generation				100 %	After distillation
Recovered tritiated acid	1990			100 %	After distillation
Recovered non-tritiated acid	1990			100 %	After distillation
Recovered solvent	1990			100 %	After distillation, liquid concentrate is grouted
Distillation:					
Acidic effluents	1996		FE=10^3 à 10^5		Distillates discharged to the sea, concentrates vitrified
Alkaline effluents	1996		FE=10^4		Distillates discharged to the sea, chemical precipitation of concentrates before discharge
Recovered tritiated acid	1990		FE=10^3 à 10^5		
Recovered non-tritiated acid	1990		FE=10^3 à 10^5		
Oxalic mother liquors	1990		FE=10^6 à 10^7		

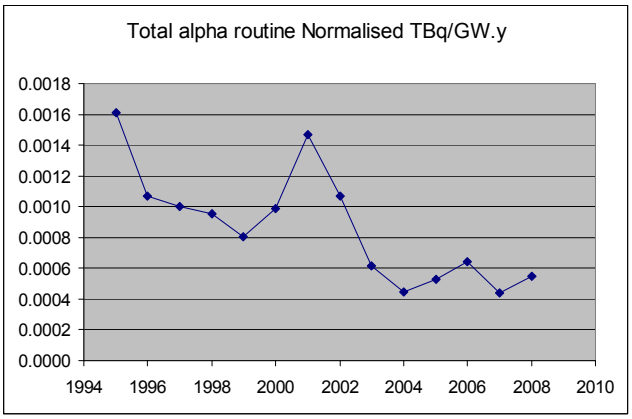
[5] Decontamination factor FD= Activity flow of the feed divided by activity flow of the distillate
Purification factor FE= Specific activity of the concentrate divided by specific activity of the distillate.

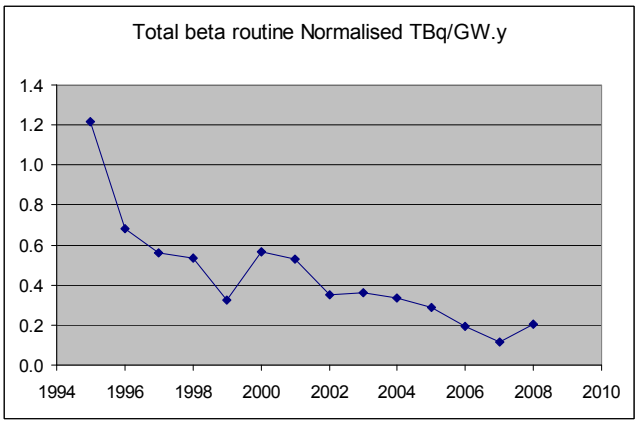
Process improvements:					
Continuous monitoring of the pH of precipitation process	1987		FD for □=400 □=4 125 Sb=1,1 106 Ru=4 137 Cs=100 90 Sr=5		STE3 with separate reactors
Separate reactors for the introduction of each reagent	1987				STE3
Use of pulsed columns in place of mixers-settlers	1990				UP3-A first and second separation cycles
Use of centrifugal extractors in place of mixers-settlers	2002				R4 plutonium purification
Optimisation of the solvent path in the whole process	1990				UP3-A
Reinforcement of 99 Tc washing	1998			FD increased 4 to 5 times	UP3-A
Change of analysis methods	2000				Laboratory, with no reagent preventing the distillation
Replacement of laboratory analysis by on-line continuous measurement requiring no sampling	2000			100 %	UP3-A, UP2-800
Installation of a Pu recovery unit on the laboratory effluents	2000				UP3-A, UP2-800
Finer adjustment of STE3 process regarding 137Cs removal	2003		?	?	
ultrafiltration	1990		□=600 □□□=1.5		Laboratory effluents
vitrification		2009-2010	106Ru=2		Integration of alkaline effluent concentrates in vitrified waste
Radioactive decay:					
Fuel elements are “cooled” in storage pools during an average period of 5 years after extraction from reactor core before processing	1990			Radioactive decay of 106Ru	DF=32 for 5 years delay
Fission products solution cannot be processed for vitrification before 6 years after extraction from reactor core	1990			Radioactive decay of 106Ru	DF=64 for 6 year delay (does not cumulate with preceding one)

Appendix 2: Normalised routine marine discharges since 1995

TBq/y	Equiv. Energy GW.y	Total alpha routine		Total beta routine	
		Absolute	Normalised / GW.y	Absolute	Normalised / GW.y
1995	43.45	7.01E-02	1.61E-03	5.29E+01	1.22E+00
1996	43.14	4.61E-02	1.07E-03	2.94E+01	6.82E-01
1997	47.49	4.77E-02	1.00E-03	2.66E+01	5.60E-01
1998	49.36	4.72E-02	9.56E-04	2.65E+01	5.37E-01
1999	49.19	3.95E-02	8.03E-04	1.59E+01	3.23E-01
2000	37.19	3.67E-02	9.87E-04	2.10E+01	5.65E-01
2001	34.64	5.09E-02	1.47E-03	1.83E+01	5.28E-01
2002	36.64	3.92E-02	1.07E-03	1.28E+01	3.49E-01
2003	37.5	2.30E-02	6.13E-04	1.36E+01	3.63E-01
2004	39.25	1.74E-02	4.43E-04	1.31E+01	3.34E-01
2005	41.43	2.2E-02	5.31E-04	1.2E+01	2.90E-01
2006	38.97	2.5E-02	6.42E-04	7.5E+00	1.92E-01
2007*	38.25	1.69E-02	4.42E-04	4.4E+00	1.15E-01
2008	31.31	1.72E-02	5.49E-04	6.37E+00	2.03E-01

*2007 values take into account exceptional discharges that have not been reported separately to OSPAR in 2007.





Appendix 3: Annual mean concentrations of nuclides in the marine environment over the 2000-2008 period

The table is complemented by the 1995 values as a reference.

Coastal waters (Bq/l)	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
125 Sb	< 0.11	< 0.32	< 0.63	< 0.62	< 1.21	< 1.20	< 0.74	< 0.75	< 0.81	< 0.79
106 Ru	< 0.32	< 0.97	< 1.98	< 1.94	< 4.42	< 4.40	< 5.31	< 5.45	< 5.7	< 5.74
137 Cs	< 0.04	< 0.13	< 0.24	< 0.24	< 0.54	< 0.53	< 0.33	< 0.33	< 0.35	< 0.34
60 Co	< 0.06	-	-	< 0.24	< 0.67	< 0.67	< 0.4	< 0.41	< 0.42	< 0.42
239/40 Pu	< 3.76E-05	< 2.82E-05	< 7.02E-05	< 8.61E-05	< 1.06E-04	< 5.75E-05	< 7.51E-05	< 5.91E-05	< 7.10E-05	< 6.44E-05
238 Pu	< 5.27E-05	< 4.60E-05	< 7.62E-05	< 9.41E-05	< 9.67E-05	< 6.53E-05	< 7.55E-05	< 3.89E-05	< 5.50E-05	< 3.63E-05
Potassium 40	12.50	12.20	12.50	12.10	12.80	12.70	13	12.3	13	12.5
Beta activity	13.80	-	-	-	-	-	11.4	12.6	13	12.6
3 H	-	< 11.20	< 9.72	< 12.10	< 11.50	< 14.60	< 12.7	< 9.55	< 9.5	< 8.05

Fucus (Bq/kg fresh)	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
125 Sb	< 0.40	-	-	< 0.57	< 0.26	< 0.25	< 0.25	< 0.24	< 0.25	< 0.24
137 Cs	< 0.22	< 0.18	< 0.34	< 0.28	< 0.13	< 0.12	< 0.12	< 0.11	< 0.12	< 0.12
129 I	-	8.10	5.37	7.52	6.40	7.25	7	5.36	6.5	5.25
131 I	-	-	-	-	0.23	-		-	-	-
60 Co	2.43	< 0.97	< 0.79	< 0.60	< 0.53	< 0.37	< 0.35	< 0.29	< 0.67	< 0.42
106 Ru	< 1.66	< 1.30	< 2.31	< 2.20	< 1.14	< 1.04	< 2.1	< 2.1	< 2.3	< 1.94
241 Am	< 0.35	< 0.10	< 0.15	< 0.17	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.12
239/40 Pu	< 0.06	< 0.06	< 0.08	< 0.07	< 0.07	< 0.07	< 0.06	< 0.06	< 0.05	< 0.05
238 Pu	< 0.06	< 0.04	< 0.07	< 0.06	< 0.06	< 0.07	< 0.047	< 0.039	< 0.051	< 0.042
Potassium 40	257.00	268.00	251.00	252.00	271.00	289.00	290	266	280	299
14 C (natural and artificial)	-	37.60	32.60	33.50	31.80	32,.0	35	36.9	38	39

- result of analysis not available < result below measurement threshold

Limpets (Bq/kg fresh)	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
125 Sb	< 0.17	-	-	< 0.33	< 0.35	< 0.34	< 0.34	< 0.34	< 0.36	< 0.35
110 mAg	< 0.48	0.23	0.23	0.21	-	-	-	-	-	-
137 Cs	< 0.10	< 0.10	< 0.16	< 0.14	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
129 I	-	< 0.47	< 0.43	< 0.44	< 0.26	< 0.33	< 0.31	< 0.26	< 0.31	< 0.24
60 Co	0.77	0.36	< 0.24	< 0.21	< 0.24	< 0.22	< 0.21	< 0.21	< 0.26	< 0.23
106 Ru	< 1.20	< 0.99	< 1.26	< 1.25	< 1.40	< 1.35	< 3.00	< 2.65	< 2.9	< 2.7
241 Am	< 0.39	< 0.15	< 0.17	< 0.19	< 0.13	< 0.13	< 0.14	< 0.14	< 0.14	< 0.13
239/40 Pu	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.02	< 0.02	< 0.03	< 0.02	< 0.023
238 Pu	< 0.03	< 0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.015	< 0.02	< 0.014	< 0.013
Potassium 40	60.90	68.50	68.10	69.60	65.90	70.50	72	68.7	73	78
14 C (natural and artificial)	-	61.40	56.10	54.10	53.30	54.00	59	58.1	61	60

.

Fishes (Bq/kg fresh)	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
125 Sb	< 0.14	-	-	< 0.24	< 0.26	< 0.27	< 0.27	< 0.29	< 0.28	< 0.29
137 Cs	< 0.45	0.26	< 0.24	0.24	< 0.20	< 0.19	< 0.24	< 0.19	< 0.17	< 0.17
129 I	-	< 0.22	< 0.44	< 0.35	< 0.11	< 0.11	< 0.11	< 0.11	< 0.1	< 0.1
60 Co	< 0.08	< 0.06	< 0.12	< 0.12	< 0.16	< 0.16	< 0.16	< 0.17	< 0.16	< 0.17
106 Ru	< 0.44	< 0.41	< 0.83	< 0.87	< 1.01	< 1.01	< 1.99	< 2.21	< 2.11	< 2.22
241 Am	-	-	-	< 0.14	< 0.10	< 0.11	< 0.11	< 0.12	< 0.1	< 0.11
239/40 Pu	-	-	-	< 0.02	< 0.01	< 0.01	< 0.011	< 0.01	< 0.01	< 0.01
238 Pu	-	-	-	< 0.02	< 0.01	< 0.01	< 0.014	< 0.012	< 0.012	< 0.01
Potassium 40	97.30	101.00	103.00	104.00	105.00	107.00	109	110	120	124
14 C (natural and artificial)	-	51.30	47.30	39.80	38.30	39.80	39	46	41	47

- result of analysis not available < result below measurement threshold

Appendix 4: the environmental management system of the AREVA NC La Hague facility

The ISO 14001:2004 Standard

This international standard defines the arrangements to be implemented by an organisation, in order for this one to manage the impact on the environment of its activities and products. The implementation of this standard enables any organisation to:

- identify and control the **environmental impact** of its activities, products or services;
- **improve** its environmental performance continually;
- implement a **systematic approach** to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

This brings to external stakeholders (authorities, representatives, inhabitants, communities, etc.) of the organisation confidence in:

- Its commitment to respect its policy;
- The implementation of preventive rather than corrective actions;
- The conformity to legal and regulatory requirements;
- A process of continuous improvement of the significant environmental impacts.

The environmental management system

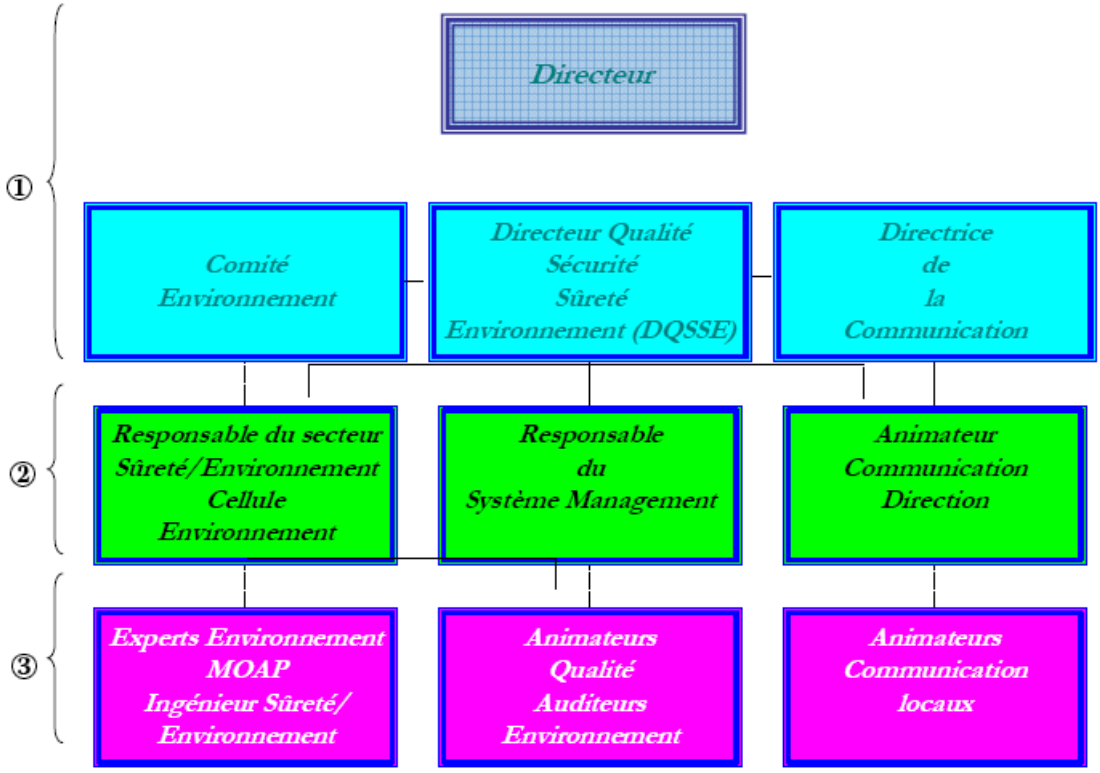
Perimeter

The environmental management system is implemented in compliance with the ISO 14001:2004 Standard.

It applies to all the activities controlled by the Établissement AREVA NC de La Hague that may have an environmental impact, that is to say the treatment of nuclear fuel and nuclear substances and all the associated activities on the site of the facility.

The geographical perimeter is defined by the limits of ownership of the facility, to which are associated the five measurement stations in neighbouring villages and all the piezometers that are managed by the facility.

The organisation



①A decisional structure, the Environment Committee.

It defines the axis for improvements, validates the program of environmental management, follows the progression of the actions and examines the environmental indicators.

②An operational structure

It is the Nuclear Safety – Environment sector, in which an Environment Section is specifically in charge of animating the environment management system and to check the compliance with the regulations.

③Relays on the field

Environmental experts: they update the environmental analysis of their competence, propose improvement actions and give an advice on the modifications.

Managers for objectives and progress actions (MOAP): they stimulate the workers of their sector, manage the follow up of the action of the Environmental Management Program and update the environmental indicators of their sector.

Safety/Environment Engineers and their Manager: they check, with the MOAP, the compliance of the equipment with the regulations and assess the environmental impact of their operation.

Environmental auditors: they perform the internal audits required by the Environmental Management System.

The selected themes

- Atmospheric discharges of non-nuclear facilities
- Atmospheric discharges of nuclear facilities
- Chemical pollution of ground and subsoil
- Conventional waste
- Energy management
- Liquid discharges in streams
- Liquid discharges of nuclear facilities
- Nuisances
- Radioactive pollution of ground and subsoil
- Reagents and chemical products
- Solid nuclear waste
- Transport of nuclear substances
- Water management

Appendix 5: Marine monitoring near the AREVA NC La Hague facility

The following elements are taken from the internal procedure that defines the regulatory controls allowing the monitoring of the environment of the AREVA NC La Hague facility during the year 2008: type of sampling to be taken, location and periodicity of the sampling as well as the radionuclides to be measured.

The measurements that are described are performed by the laboratory of the Service de Prévention et de Radioprotection (Department for prevention and health physics).

1. Coordinates of the sampling points

The sampling is to be performed at a maximum distance of 200 m from the exact location displayed.

Sampling on the shore (sand, algae, limpets) Art. 27

Sampling location	North latitude	West longitude
Anse des Moulinets	49°40.00	1°53.85
Granville	48°49.80	1°35.60
Barneville-Carteret	49°21.80	1°46.50
Siouville-Hague	49°33.30	1°53.85
Herquemoulin	49°39.90	1°53.85
Écalgrain	49°41.17	1°56.47
Goury	49°43.58	1°56.67
Anse Saint Martin	49°42.82	1°52.16
Urville-Nacqueville	49°40.98	1°43.38
Querqueville	49°39.83	1°40.60
Anse du Brick	49°40.26	1°29.15
Barfleur	49°41.00	1°16.00
Vauville	49°38.35	1°51.20

Sampling on the open sea (water, sediments) Art. 27

Sampling location	North latitude	West longitude
Nez de Jobourg	49°40.70	1°58.00
Cap de La Hague	49°44.80	1°55.70
Pointe de Jardeheu	49°44.00	1°51.10
Anse des Moulinets	49°38.5	1°52.2
Sciotot	49°29.5	1°51.8
Écalgrain	49°41.5	1°56.5
Anse Saint Martin	49°43.0	1°53.0
Grande rade Cherbourg	49°39.9	1°39.4
Anse du Brick (cap Lévi D1)	49°40.7	1°31.5
Anse du Brick (cap Lévi D2)	49°40.9	1°31.6
Barfleur	49°40.6	1°15.6

Nota: sampling on the open sea is performed by Marine Nationale (French Military Navy).

2. Sea water

The locations of the sampling points are marked on the map below.

Near the coastline *(Art.27.I)*

Sample	Amount sampled	Analyses	Period
Anse des Moulinets Sea water	10 litres	Tritium Gamma spectrometry **(1)**	Daily
Anse des Moulinets Monthly aliquot*	/	Gamma spectrometry **(2)** Beta counting Tritium Potassium ^{90}Sr Alpha spectrometry	Monthly
Goury Sea water	10 litres	/	Daily
Goury Monthly aliquot*	/	Gamma spectrometry **(2)** Beta counting Tritium Potassium ^{90}Sr Alpha spectrometry	Monthly

* Monthly aliquot is made up by PR/E/L service personal, from daily samples

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, ^{106}RuRh, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

(2) beta-gamma emitters by direct measurement - specific measurement of iodine 129 by radiochemical analysis

On the open sea *(Art.27.I)*

Sample	Amount sampled	Analyses	Period
Jobourg	5 litres	Gamma spectrometry **(1)** Beta counting Tritium Potassium	January April July October
Cap de La Hague	5 litres		February May August November
Jardeheu	5 litres		March June September December

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, ^{106}RuRh, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

Diagram of sea water sampling points locations

3. Marine sediments

The locations of the sampling points are marked on the map on next page, with the identifiers corresponding to the following list. (Art.27.I)

The sampling is performed on each location every quarter.

Sampled amount is 4 kg per location.

<table>
<tr><th>Location</th><th>Month of sampling</th><th>Measurements on each sample</th></tr>
<tr><td>Anse des Moulinets</td><td rowspan="3">January
April
July
October</td><td rowspan="8">Gamma spectrometry (1)
90 Strontium
244 Curium
Alpha spectrometry</td></tr>
<tr><td>Écalgrain</td></tr>
<tr><td>Anse Saint Martin</td></tr>
<tr><td>Grande rade Cherbourg</td><td rowspan="2">February
May
August
November</td></tr>
<tr><td>Sciotot</td></tr>
<tr><td>Anse du Brick (cap Lévi D1)</td><td rowspan="3">March
June
September
December</td></tr>
<tr><td>Anse du Brick (cap Lévi D2)</td></tr>
<tr><td>Barfleur</td></tr>
</table>

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, ^{106}RuRh, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

The results of the measurements defined in the tables are transcribed in the corresponding register.

Diagram of marine sediment sampling points locations

4. Shore sampling at low tide

Beaches selected for low tide sampling are marked on the map below.

The agenda of the sampling is given in § 4.4 below.

4.1 Beach sand

Sampling is performed on each location every quarter. *(Art.27.I)*
Sampled amount is 2 kg per location.

Location	Measurements on each sample
Granville	Gamma spectrometry **(1)**
Siouville	
Herquemoulin	
Écalgrain	
Anse saint Martin	
Anse du Brick	
Vauville	
Anse des Moulinets	
Barneville	
Goury	
Urville	
Querqueville	
Barfleur	

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, ^{106}RuRh, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

4.2 Algae

Fucus
Sampling is performed on each location every quarter. *(Art.27.I)*
Sampled amount is 3 kg per location.

Location	Measurements on each sample
Granville	Gamma spectrometry **(1)**
Siouville	
Herquemoulin	
Écalgrain	
Anse saint Martin	
Anse du Brick	
Vauville	
Anse des Moulinets	Gamma spectrometry **(1)** 14 Carbon Alpha spectrometry
Barneville	
Goury	
Urville	
Querqueville	
Barfleur	

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, $^{106}RuRh$, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

Other Algae (non regulatory analysis)

Other kinds of algae are sampled on a bi-annual basis
Sampled amount is 3 kg for chondrus and 4 kg for kelp.

Species	Location	Measurements on each sample
Chondrus	Herquemoulin	Gamma spectrometry (1)
	Anse des Moulinets	
	Écalgrain	
	Goury	
	Anse Saint Martin	
Kelp	Anse des Moulinets	
	Anse Saint Martin	

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, $^{106}RuRh$, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

4.3 Limpets

Sampling is performed on each location every quarter. *(Art.27.I)*
Sampled amount is 6 kg per location.

Location	Measurements on each sample
Granville	Gamma spectrometry **(1)**
Siouville	
Herquemoulin	
Écalgrain	
Anse saint Martin	
Anse du Brick	
Vauville	
Anse des Moulinets	Gamma spectrometry **(1)** Carbon 14 Alpha spectrometry
Barneville	
Goury	
Urville	
Querqueville	
Barfleur	

(1) beta-gamma emitters by direct measurement, in particular for ^{60}Co, $^{106}RuRh$, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am

Location diagram of low tide sampling points

4.4 Agenda of the low tide sampling

"Coeff" refers to the tide coefficient

First quarter

Date	Coeff	Local time	Location
Thursday January 10	82	15:43	Siouville
Tuesday January 22	87	15:19	Urville
Tuesday January 22	87	15:19	Querqueville
Wednesday January 23	93	15:03	Écalgrain
Thursday January 24	95	15:45	Moulinets
Thursday February 07	86	14:44	Goury
Friday February 08	93	15:22	Herquemoulin
Wednesday February 20	87	14:18	Barneville
Thursday February 21	94	15:37	Anse saint Martin
Thursday March 06	81	15:16	Anse du Brick
Friday March 07	93	14:25	Granville
Thursday March 20	86	15:48	Barfleur
Friday March 21	92	14:29	Vauville

Second quarter

Date	Coeff	Local time	Location
Friday April 04	82	15:09	Urville
Friday April 04	82	15:09	Querqueville
Monday April 07	108	16:09	Moulinets
Monday April 07	108	16:09	Écalgrain
Friday April 18	80	14:23	Siouville
Monday May 05	100	15:11	Barneville
Monday May 05	100	15:50	Anse saint Martin
Tuesday May 06	103	15:46	Herquemoulin
Wednesday May 07	102	16:30	Goury
Monday June 02	84	15:19	Anse du Brick
Tuesday June 03	91	14:42	Barfleur
Tuesday June 03	91	16:36	Granville
Wednesday June 04	95	15:34	Vauville

Third quarter

Date	Coeff	Local time	Location
Wednesday July 02	83	15:26	Querqueville
Thursday July 03	90	15:18	Goury
Friday July 04	94	16:10	Moulinets
Friday July 04	94	16:10	Écalgrain
Thursday July 31	80	14:23	Siouville
Thursday July 31	80	15:21	Urville
Friday August 01	90	15:12	Herquemoulin

Friday August 01	90	16:01	Anse saint Martin
Monday August 18	91	16:29	Barneville
Friday August 29	81	15:47	Anse du Brick
Monday September 15	92	17:15	Barfleur
Tuesday September 16	99	15:58	Vauville
Monday September 29	96	15:21	Granville

Fourth quarter

Date	Coeff	Local time	Location
Monday October 13	84	14:02	Siouville
Tuesday October 14	94	15:48	Querqueville
Wednesday October 15	101	15:24	Goury
Thursday October 16	103	16:04	Écalgrain
Thursday October 16	103	16:04	Moulinets
Tuesday October 28	87	13:58	Barneville
Thursday October 30	85	15:56	Urville
Wednesday November 12	90	15:14	Barfleur
Thursday November 13	97	14:05	Vauville
Friday November 14	100	14:45	Herquemoulin
Friday November 14	100	15:34	Anse saint Martin
Thursday December 11	82	14:23	Anse du Brick
Friday December 12	90	13:46	Granville

5. Marine fauna

5.1 Species by location

Quarterly sampling of marine fauna species is performed on 3 sectors near the East, North and West coasts. (Art.27.I)

The amounts required for analysis are the following ones:

Species	Required amount
Flat and round fishes	5 kg
Scallops	17 kg
Crab	10 kg
Oyster	30 kg
Mussel	20 kg
Lobster	7 kg

Each sample is measured for:

- beta-gamma emitters by direct measurement, in particular for ^{60}Co, ^{106}RuRh, ^{125}Sb, ^{129}I, ^{134}Cs, ^{137}Cs, ^{241}Am,
- 14 carbon,
- alpha emitters of plutonium by alpha spectrometry.

East coast	North coast	West coast
Flat fishes Round fishes Oysters Mussels	Flat fishes Round fishes Crabs Scallops	Flat fishes Round fishes Crabs Oysters Mussels Lobsters

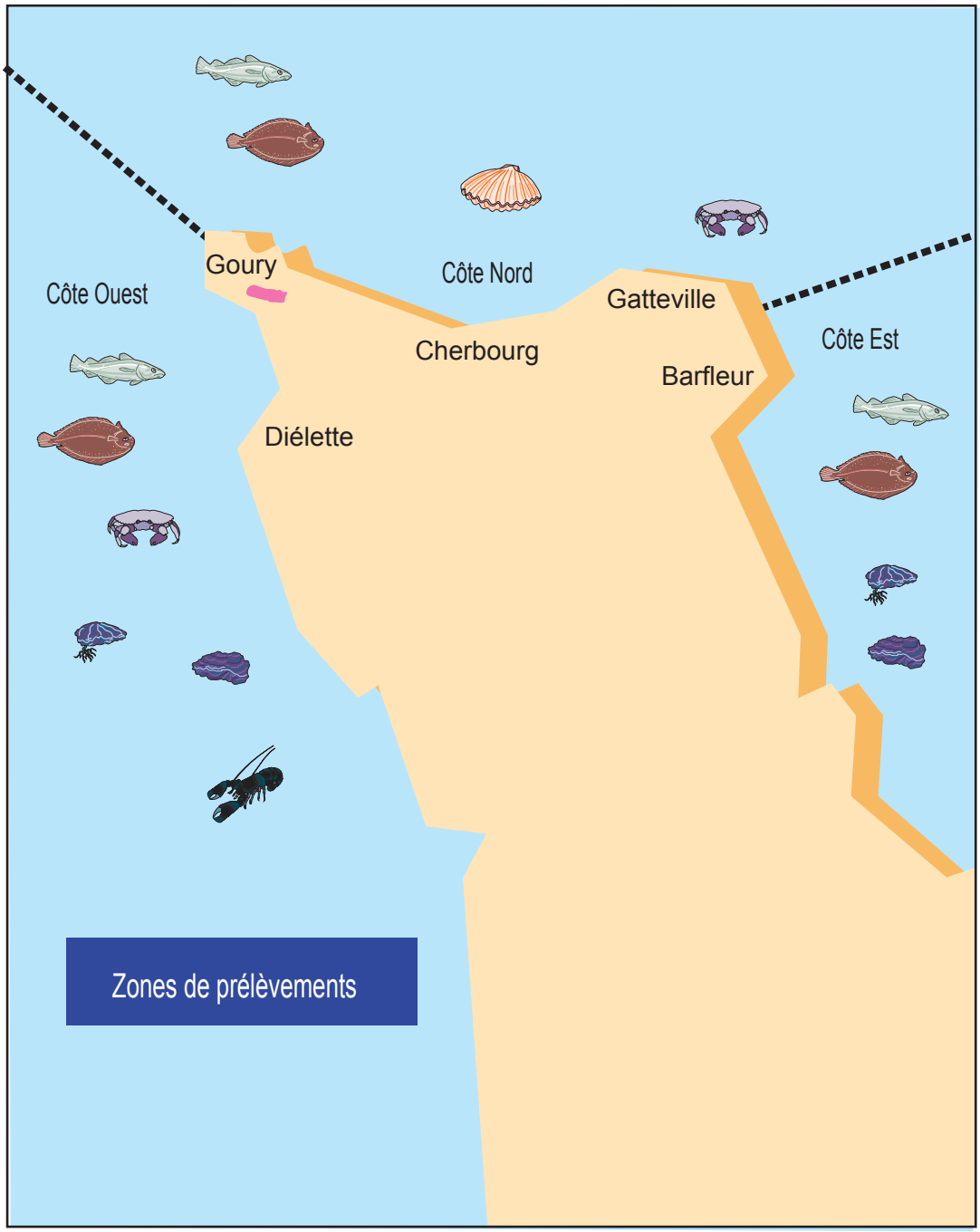
The agenda of the sampling is given in § 5.2 below (meteorological hazards not taken into account).

The results of the measurements defined in the tables are transcribed in the corresponding register.

5.2 Agenda of the sampling

East Coast	North Coast	Species	West Coast
March June September December	February May August November	Flat fishes	January April July October
March June September December	February May August November	Round fishes	January April July October
February May August November		Oysters	January April July October
		Mussels	February May August November
	February May August November	Crabs	January April July October
	February May August November	Scallops	
		Lobsters	February May August November

Diagram showing sampled species in each sector



6. Preparation and analysis methods

SEA WATER SAMPLES

(Art.27)

Preparation of the sample
No specific preparation. ***OPERATING METHOD REF. HAGSRER056***

Type of analysis	Chemical preparation	Physical measurement	Reference text and/or recognition
Gamma Spectrometry (QUALITATIVE AND QUANTITATIVE)	Filtering (7 µm) Acidification Conditioning in measurement geometry	γ spectrometry on hyperpure germanium detector	ISO 10703 standard COFRAC n°1-0721 accreditation 135, ED203 programme Interministerial agreement valid until 31 March 2010
Index of global beta radioactivity	Filtering (7 µm) Evaporation of 30 ml of water on crucible	Counting of the crucible with low background noise counter	Interministerial agreement valid until 28 April 2009
Potassium	Filtering (7 µm) Dilution of the sample to 1/50th	Spectrophotometry by flame emission	NF T 90-019 standard
Tritium	Filtering (7 µm)	Direct measurement by liquid scintillation on 10 ml of water added with INSTAGEL	NF M 60-802-1 standard Pr NF 60-802-3 COFRAC n°1-0721 accreditation 135, ED205 programme Interministerial agreement valid until 28 April 2009
90 Strontium	Acidification of the sample Addition of catching agent (stable yttrium oxide) to 30 l of sample Liquid-liquid extraction of yttrium with HDEHP Purification of extracted phase with TOM Precipitation of yttrium oxalate Recovery then calcination of the precipitate at 900°C Verification of the absence of interfering beta emitter by checking of the decay of yttrium 90	Counting of the precipitate in a stainless steel crucible on low background noise counter Determination of the chemical efficiency by weighting of the precipitate	NF M 60-806-2 standard Interministerial agreement valid until 26 May 2008

SEA WATER SAMPLES (continuation)			
Type of analysis	**Chemical preparation**	**Physical measurement**	**Reference text and/or recognition**
129 Iodine	Filtering (0.45 µm) Addition of tracer ^{131}I to 30 litres of sample Reduction of the iodines to I^- Precipitation of silver iodide Solubilisation of the precipitate and elimination of silver Liquid-liquid extraction of I_2 with chloroform Re-extraction of iodine in aqueous, alkaline and reducing medium	X-γ spectrometry on hyperpure germanium detector in G5065 geometry Determination of the chemical efficiency from the tracer	LERFA (IRSN) type method Interministerial agreement valid until 31 March 2010
Plutonium (ALPHA-EMITTING ISOTOPES)	Filtering (7 µm) Acidification (destruction of hydrolyse products and complexes, solubilisation of Pu) Addition of tracer ^{236}Pu to 50 litres of sample Co-precipitation of hydroxides Oxidation of Pu to valence IV Separation of Pu on anionic resin Electro deposition on stainless steel crucible Φ 19mm	α Spectrometry on silicon detector	NF M60-804-2 standard Interministerial agreement valid until 29 January 2011

BEACH SAND AND MARINE SEDIMENT SAMPLES

(Art.27)

Preparation of the sample
Oven drying in aluminium vat (at constant temperature 65°C up to constant weight), sieving (stainless steel sieve with square 1 mm mesh), conditioning of the dry product in the geometry required by the measurement. *OPERATING METHOD REF. HAGSRER049, HAG055200110002*

Type of analysis	Chemical preparation	Physical measurement	Reference text and/or recognition
Gamma Spectrometry (QUALITATIVE AND QUANTITATIVE) & IODINE 129		direct γ spectrometry on hyperpure Germanium detector in required geometry	NF M 60-790-6 standard COFRAC n°1-0721 accreditation 135, code S.403 programme
Plutonium (ALPHA-EMITTING ISOTOPES)	Addition of tracer ^{236}Pu Calcination at 600°C of 10 g of dry product Mineralisation of the ashes Co-precipitation of hydroxides Oxidation of Pu to valence IV Separation of Pu on anionic resin Electro deposition on stainless steel crucible Φ 19mm	α Spectrometry on silicon detector	NF M60-790-8 standard and IAEA Technical Reports n°295.

BEACH SAND AND MARINE SEDIMENT SAMPLES (continuation)

Type of analysis	Chemical preparation	Physical measurement	Reference text and/or recognition
90 Strontium	Calcination at 600°C of 20 g of dry product Addition of catching agent stable Sr^{2+} and of tracer ^{85}Sr **Mineralisation of ashes** Purification of strontium by precipitation Waiting t>15 days for the balance ^{90}Sr - ^{90}Y to be reached Addition of catching agent (stable yttrium oxide) Precipitation of yttrium hydroxide Precipitation of yttrium oxalate Recovery then calcination of the precipitate at 900°C Recovery on stainless steel crucible Φ 50mm Verification of the absence of interfering beta by checking the decay of yttrium 90	Counting of the precipitate in a stainless steel crucible on low background noise counter Determination of the chemical efficiency of Sr purification by γ spectrometry on hyperpure germanium detector in SG50 geometry Determination of the chemical efficiency by weighting of the precipitate	LMRE (IRSN) type method
Americium / Curium	Addition of tracer ^{243}Am and ^{236}Pu and first part of preparation common with Pu analysis Recovery of the eluate and washing with HCl 9M Separation Am/Cm in TRU-SPEC column Elimination of rare earths on anionic resin Electro deposition on stainless steel crucible Φ 19mm	α Spectrometry on silicon detector	NF M60-790-8 standard and IAEA Technical Reports n°295.

ALGAE SAMPLES

(Art.27)

Preparation of the sample
Oven drying in aluminium vat (at constant temperature 65°C up to constant weight), mechanical crushing, conditioning of the dry product in the geometry required by the measurement. ***OPERATING METHOD REF. HAGSRER050***

Type of analysis	Chemical preparation	Physical measurement	Reference text and/or recognition
Gamma Spectrometry (QUALITATIVE AND QUANTITATIVE) & IODINE 129		Direct γ spectrometry on hyperpure germanium detector	NF M 60-790-6 standard COFRAC n°1-0721 accreditation 135, code S.403 programme Interministerial agreement valid until 11 September 2009
14 Carbon (fucus)	Calcination of 0.5 g of dry sample with "OXIDIZER" Recovery of CO_2 in a mixture of 8 ml CARBOSORB and 12 ml PERMAFLUOR	Measurement by liquid scintillation	NF M 60-812-6 standard COFRAC n°1-0721 accreditation 135, code S.406 programme Interministerial agreement valid until 11 September 2009
Plutonium (ALPHA-EMITTING ISOTOPES) (fucus)	Addition of tracer ^{236}Pu Calcination at 450°C of 10 g of dry product Mineralisation of ashes Co-precipitation of hydroxides Oxidation of Pu to valence IV Separation of Pu on anionic resin Electro deposition on stainless steel crucible Φ 19 mm	α Spectrometry on silicon detector	NF M60-804-2 standard and IAEA Technical Reports n°295. Interministerial agreement valid until 26 May 2008

SHELLFISH, CRUSTACEAN AND MOLLUSC SAMPLES (limpets, oysters, mussels, scallops, crabs, lobsters)

(Art.27)

Preparation of the sample
Dipping in boiling water up to separation of flesh and shell, draining of water and separation of the flesh from the shells, drying of the flesh in oven in aluminium vat (at constant temperature 65°C up to constant weight), mechanical crushing of the dry product, conditioning of the dry product in the geometry required by the measurement. *OPERATING METHOD REF. HAGSRER051 and HAGSRER052*

FISH (round and flat) SAMPLES

(Art.27)

Preparation of the sample
Separation of edible part from the viscera and the head, drying of the flesh in oven in aluminium vat (at constant temperature 65°C up to constant weight), mechanical crushing of the dry product, conditioning of the dry product in the geometry required by the measurement. *OPERATING METHOD REF. HAGSRER051*

Type of analysis	Chemical preparation	Physical measurement	Reference text and/or recognition
Gamma Spectrometry (QUALITATIVE AND QUANTITATIVE) & IODINE 129		Direct γ spectrometry on hyperpure germanium detector in geometry GX200	NF M 60-790-6 standard COFRAC n°1-0721 accreditation 135, code S.403 programme Interministerial agreement valid until 11 September 2009
14 Carbon	Calcination of 0.5 g of dry sample with "OXIDIZER" Recovery of CO_2 in a mixture of 8 ml CARBOSORB and 12 ml PERMAFLUOR	Measurement by liquid scintillation	NF M 60-812-6 standard COFRAC n°1-0721 accreditation 135, code S.406 programme Interministerial agreement valid until 11 September 2009
Plutonium (ALPHA-EMITTING ISOTOPES)	Addition of tracer ^{236}Pu Calcination at 450°C of 50 g of dry product Mineralisation of ashes Co-precipitation of hydroxides Oxidation of Pu to valence IV Separation of Pu on anionic resin Electro deposition on stainless steel crucible Φ 19mm	α Spectrometry on silicon detector	NF M 60-804-2 standard and IAEA Technical Reports n°295. Interdepartmental Interministerial agreement valid until 26 May 2008

FRESH WATER SAMPLES
(brooks, rain water, underground water and drinkable water)

(Art.2)

Preparation of the sample
No specific preparation. *OPERATING METHODS REF. HAGSRER055, HAGSRER076, HAGSRER072, HAGSRER047*

Type of analysis	**Chemical preparation**	**Physical measurement**	**Reference text and/or recognition**
Gamma Spectrometry (QUALITATIVE AND QUANTITATIVE) & IODINE 129	Acidification Conditioning in measurement geometry	γ spectrometry on hyperpure germanium detector	ISO 10703 standard COFRAC n°1-0721 accreditation 135, code S.403 programme Interministerial agreement valid until 31 March 2010
Index of global alpha radioactivity	Evaporation on crucible	Counting of the crucible on low background noise counter	NF M 60-801 standard COFRAC n°1-0721 accreditation Programme 135, ED201 Interministerial agreement valid until 28 April 2009
Index of global beta radioactivity	Evaporation on crucible	Counting of the crucible on low background noise counter	NF M 60-800 standard COFRAC n°1-0721 accreditation Programme 135, ED201 Interministerial agreement valid until 28 April 2009
Potassium		Spectrophotometry by flame emission	NF T 90-019 standard COFRAC n°1-0721 accreditation 100-1, ED140-10 programme
Tritium	Distillation or treatment in columns ^{3}H resin (EICHROM) if the sample is heavily sludged or coloured	Direct measurement by liquid scintillation of 10 ml of water added with 10 ml INSTAGEL	NF M 60-802-1 standard NF M 60-802-3 standard COFRAC n°1-0721 accreditation 135, ED201 programme Interministerial agreement valid until 28 April 2009

90 Strontium	Addition of catching agent stable Sr^{2+} to 100 to 500 ml of sample Acidification of the sample Separation of Sr on Sr SPEC resin (EICHROM) Evaporation of the eluted Sr on a stainless steel crucible Φ 50mm Verification of the quality of the extraction process by checking of the radioactive growth of yttrium 90	Counting of the crucible on low background noise counter Determination of the chemical efficiency by atomic absorption	NF M 60-806-3 standard COFRAC n°1-0721 accreditation 135, code X.01 programme Interministerial agreement valid until 26 May 2008

BROOK SEDIMENT SAMPLES

(Art.27)

Preparation of the sample
Drying in oven in aluminium vat (at constant temperature 65°C up to constant weight), sieving (stainless steel sieve with square 1 mm mesh), and conditioning of the dry product in the geometry required by the measurement. *OPERATING METHOD REF. HAGSRER054*

Type of analysis	Chemical preparation	Physical measurement	Reference text and/or recognition
Gamma Spectrometry (QUALITATIVE AND QUANTITATIVE)		Direct γ spectrometry on hyperpure germanium detector	NF M 60-790-6 standard COFRAC n°1-0721 accreditation 135, code S.403 programme Interministerial agreement valid until 10 July 2011
Plutonium (ALPHA-EMITTING ISOTOPES)	Addition of tracer ^{236}Pu Calcination at 600°C of 10 g of dry product Mineralisation of ashes Co-precipitation of hydroxides Oxidation of Pu to valence IV Separation of Pu on anionic resin Electro deposition on stainless steel crucible Φ 19mm	α Spectrometry on silicon detector	NF M60-804-2 standard Interministerial agreement valid until 10 July 2011

Appendix 6: ACADIE impact assessment model

I - Dispersion

Dispersion of liquid effluents discharged to the sea can be modelled by dilution factors. These dilution factors are ratios averaged on the year scale of the measured activity of the sea water, from which the background level is derived, to the flow of radioactivity discharged by the considered facility. The GRNC has assessed dilution factors from activity measurement results that have been obtained on a large time scale and for different sampling points. A hydrodynamic model of residual currents has also been used.

The selected dilution factors are indicated on the map below. They are expressed in relative value to the dilution factor assessed by the IRSN for Goury (selected reference group for the impact of the discharges to the sea of the AREVA NC La Hague facility).

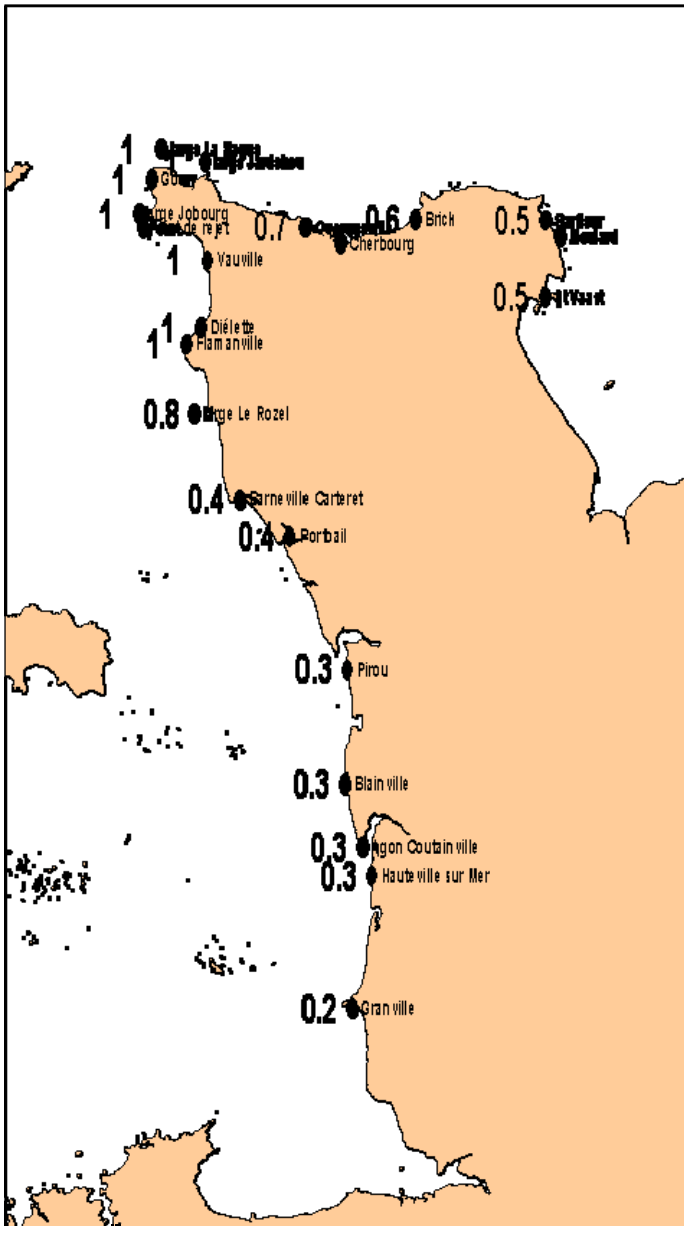


Figure 1: Dilution factors of the discharges of the AREVA NC La Hague reprocessing plants – Reference value (unit at Goury) correspond to 0.76 Bq.m^{-3} for 1 TBq discharged per year.

II - The transfer in the various compartments of the marine environment

The activity of the sea water in the different coastal sectors of the North-Cotentin is computed from the dilution factors as defined above and the activities of the various radionuclides annually discharged under liquid form by the reprocessing plant of AREVA NC La Hague, following formula below:

$$A\ sea\ water = Fd \times Q$$

With:
A sea water: activity of the sea water ($Bq.m^{-3}$)
Fd: dilution factor ($Bq.m^{-3}$/Bq discharged.y^{-1})
Q: discharge rate (Bq discharged.y^{-1})

It is possible to estimate the activity content of marine species (algae, fishes, shellfishes and molluscs) and sediments on the basis of a steady state at year's scale. In a steady state, the mass specific activity of living species and sediments is supposed to be proportional to the volumetric activity of the sea water at the place where they are sampled.

Corresponding proportionality factors are named concentration factors (FC) for marine species and distribution factors (Kd) for the sediments. The assumption of proportionality implies that a balance is obtained between the different compartments of the medium (algae, marine species and sediments). When this condition is not reached, the measured radioactivity of marine species is different from the one computed using the FCs and Kds. The GRNC has compared the model and the measurement results for the indicators and the radionuclides for which measures were available spread over a long time. In some cases, corrective factors have been integrated into the model of the transfer to the environment.

The values of the corrective factors are shown in Appendix I to this document, those of the concentration factors in Appendix II and those of the distribution coefficients in Appendix III.

III – Marine species

Six indicators have been selected:
- Algae (a);
- Fishes (f);
- Crustaceans (c);
- Filtering molluscs (m1);
- Non-filtering molluscs (m2);
- Sediments.

The activity of marine species is calculated from the following formula:

$$A\ (a,f,c,m1,m2) = A\ sea\ water \times FC\ (a,f,c,m1,m2) \times 0.001 \times Fcorrect.$$

With:
A (a,f,c,m1,m2): activity in the algae, fishes, crustaceans and molluscs ($Bq.kg^{-1}$ fresh),
A sea water: activity in the sea water ($Bq.m^{-3}$),
FC (a,f,c,m1,m2): concentration factor for algae, fishes, crustaceans and molluscs ($l.kg^{-1}$ fresh),
0.001: conversion factor,
Fcorrect.: corrective factor (dimensionless).

The GRNC has selected the concentration factors recommended by the IRSN for living species, because they reflect more particularly the behaviour of the radionuclides in the species living in the English Channel. When there was no IRSN value, the GRNC has selected the IAEA values.

For some radionuclides, there is no concentration factor value available. The concentration factors of the chemical analogs have been selected. Thus beryllium has been taken as cobalt, rubidium as caesium, rhodium as ruthenium and praseodymium as cerium.

IV – Sediments

The activity of the sediments is calculated from the following formula:

$$A\ sed = A\ seawater \times Kd \times 0.001 \times Fcorrect$$

With:
A sed: activity in the sediments ($Bq.kg^{-1}$ dry)
A seawater: activity in seawater ($Bq.m^{-3}$)

Kd: distribution coefficient ($l.kg^{-1}$ dry)
0.001: conversion factor
Fcorrect: corrective factor (dimensionless)

For 244 Cm, the Kd value selected by the GRNC was the value set forth by the IAEA, i.e. 2,000,000 l/kg dry [2]. In February 2002, IRSN has published the results of a study on the behaviour of radionuclides in the environment [3]. One of the conclusions of this study is that the Kd of 244 Cm in the considered sediments is lower than the one selected by the GRNC (by a factor of 100); adequate value is around 20,000 l/kg dry. GRNC has selected this new value and an assessment of the hazards associated to 244 Cm has been performed [4].

Bibliography

[1] Groupe Radioécologie Nord-Cotentin, Volume 3 : Modèles de transfert des radionucléides dans l'environnement, Institut de Protection et de Sûreté Nucléaire, Fontenay-aux-Roses, 1999.

[2] IAEA, Sediments Kds and Concentration Factors for Radionuclides in the Marine Environment, Technical reports Series n°247, Vienne 1985.

[3] Germain P, M. Masson (2002), Étude du comportement des radionucléides rejetés dans l'environnement par l'usine de La Hague, rapport IPSN/DPRE/SERNAT/2002-02, Institut de Protection et de Sûreté Nucléaire, Fontenay-aux-Roses, février 2002.

[4] Ringeard C., Réexamen des risques associés aux rejets de Cm-244 dans les effluents liquides de l'usine COGEMA La Hague et à l'ingestion de sable par les enfants de 0 à 2 ans – Réponse à la saisine DSSQ-2002-37 de COGEMA en date du 4 février 2002, Fiche Technique 02/22-bis, Institut de Radioprotection et de Sûreté Nucléaire, Fontenay-aux-Roses, 2002.

APPENDIX I.-. CORRECTIVE FACTORS

	Algae		Fishes		Crustaceans		Filtering molluscs		Non-filtering molluscs		Sediments	
	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->
3H	1	1	1	1	1	1	1	1	1	1	1	1
10Be	0.6	1.1	0.8	2	0.5	1.3	0.5	2	0.5	1.2	0.04	0.04
14C	1	1	1	1	1	1	1	1	1	1	1	1
36Cl	1	1	1	1	1	1	1	1	1	1	1	1
41Ca	1	1	1	1	1	1	1	1	1	1	1	1
54Mn	1.1	1.1	1	1	1	1	1	1	1	1	1	1
55Fe	1	1	1	1	1	1	1	1	1	1	1	1
57Co	1	1	0.8	2	0.5	1.3	0.5	2	1	1	0.04	0.04
58Co	0.7	0.7	0.8	2	0.5	1.3	0.5	2	0.5	0.5	0.04	0.04
60Co	0.6	1.1	0.8	2	0.5	1.3	0.5	2	0.5	1.2	0.04	0.04
59Ni	1	1	1	1	1	1	1	1	1	1	1	1
63Ni	1	1	1	1	1	1	1	1	1	1	1	1
65Zn	9	9	1	1	1	1	1	1	0.35	0.35	1	1
75Se	1	1	1	1	1	1	1	1	1	1	1	1
79Se	1	1	1	1	1	1	1	1	1	1	1	1
87Rb	0.7	0.7	0.2	0.2	0.4	0.4	0.5	0.5	0.6	0.6	0.2	0.2
89Sr	0.4	0.4	0.6	1.2	1.3	1.3	1	1	0.4	0.4	3	3
90Sr	0.4	0.4	0.6	1.2	1.3	1.3	1	1	0.4	0.4	3	3
91Y	1	1	1	1	1	1	1	1	1	1	1	1
93Zr	1	1	1	1	1	1	1	1	1	1	1	1
95Zr+Nb	1	1	1	1	1	1	1	1	1	1	1	1
94Nb	1	1	1	1	1	1	1	1	1	1	1	1
93Mo	1	1	1	1	1	1	1	1	1	1	1	1
99Tc	1.9	1.9	1	1	1	1	1	1	1	1	1	1
103Ru	0.7	0.7	3.9	3.9	0.5	0.5	0.2	1	0.4	0.4	0.05	0.2
106Ru	0.7	0.7	3.9	3.9	0.5	0.5	0.2	1	0.4	0.4	0.05	0.2
107Pd	1	1	1	1	1	1	1	1	1	1	1	1
110mAg	1	1	1	1	1	1	1	1	1	1	1	1
113mCd	1	1	1	1	1	1	1	1	1	1	1	1

	Algae		Fishes		Crustaceans		Filtering molluscs		Non-filtering molluscs		Sediments	
	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->
121Sn	1	1	1	1	1	1	1	1	1	1	1	1
121mSn	1	1	1	1	1	1	1	1	1	1	1	1
126Sn	1	1	1	1	1	1	1	1	1	1	1	1
124Sb	0.9	0.9	3.8	3.8	1.4	1.4	0.5	0.5	1.2	1.2	0.2	0.6
125Sb	0.9	0.9	3.8	3.8	1.4	1.4	0.5	0.5	1.2	1.2	0.2	0.6
126Sb	0.9	0.9	3.8	3.8	1.4	1.4	0.5	0.5	1.2	1.2	0.2	0.6
127Te	1	1	1	1	1	1	1	1	1	1	1	1
127mTe	1	1	1	1	1	1	1	1	1	1	1	1
129I	1	1	1	1	1	1	1	1	1	1	1	1
131I	1	1	1	1	1	1	1	1	1	1	1	1
134Cs	0.7	0.7	0.2	0.2	0.4	0.4	0.5	0.5	3.4	3.4	0.2	0.2
135Cs	0.7	0.7	0.2	0.2	0.4	0.4	0.5	0.5	1	1	0.2	0.2
137Cs	0.7	0.7	0.2	0.2	0.4	0.4	0.5	0.5	0.6	0.6	0.2	0.2
144Ce	0.5	0.5	1	1	1	1	1	1	3.1	3.1	1	1
147Pm	1	1	1	1	1	1	1	1	1	1	1	1
151Sm	1	1	1	1	1	1	1	1	1	1	1	1
152Eu	1	1	1	1	1	1	1	1	1	1	1	1
154Eu	1	1	1	1	1	1	1	1	1	1	1	1
155Eu	1	1	1	1	1	1	1	1	1	1	1	1
232U	1	1	1	1	1	1	1	1	1	1	1	1
233U	1	1	1	1	1	1	1	1	1	1	1	1
234U	1	1	1	1	1	1	1	1	1	1	1	1
235U	1	1	1	1	1	1	1	1	1	1	1	1
236U	1	1	1	1	1	1	1	1	1	1	1	1
238U	1	1	1	1	1	1	1	1	1	1	1	1
237Np	1	1	1	1	1	1	1	1	1	1	1	1
236Pu	1	1	1	1	1	1	1	1	0.6	0.6	1	1
238Pu	1	1	1	1	1	1	1	1	0.6	0.6	1	1
239,240Pu	1	1	1	1	1	1	1	1	0.6	0.6	1	1
241Pu	1	1	1	1	1	1	1	1	0	0	1	1
242Pu	1	1	1	1	1	1	1	1	0	0	1	1
241Am	1	1	1	1	1	1	1	1	1	1	1	1

	Algae		Fishes		Crustaceans		Filtering molluscs		Non-filtering molluscs		Sediments	
	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->	FC ->90	FC 91->
242Am	1	1	1	1	1	1	1	1	1	1	1	1
242mAm	1	1	1	1	1	1	1	1	1	1	1	1
243Am	1	1	1	1	1	1	1	1	1	1	1	1
242Cm	1	1	1	1	1	1	1	1	1	1	1	1
243Cm	1	1	1	1	1	1	1	1	1	1	1	1
244Cm	1	1	1	1	1	1	1	1	1	1	1	1
245Cm	1	1	1	1	1	1	1	1	1	1	1	1
246Cm	1	1	1	1	1	1	1	1	1	1	1	1
133I	1	1	1	1	1	1	1	1	1	1	1	1

APPENDIX II.-. CONCENTRATION FACTORS

	Algae	FC ($l.kg^{-1}$ fresh)
H	Tritium	1
C	Carbon	5,000
I	Iodine	10,000
Ru	Ruthenium	300
Sb	Antimony	20
Sr	Strontium	40
Cs	Caesium	50
Co	Cobalt	6,000
Tc	Technetium	30,000
Pu	Plutonium	4,000
Am	Americium	400
Cm	Curium	400
Mn	Manganese	5,000
Ag	Silver	5,000
Fe	Iron	20,000
Mo	Molybdenum	100
Ce	Cerium	5,000
Zn	Zinc	2,000
Zr	Zirconium	2,000
Cl	Chlorine	0.05
Ca	Calcium	6
Ni	Nickel	2,000
Eu	Europium	3,000
Se	Selenium	1,000
Np	Neptunium	50
Y	Yttrium	1,000
Nb	Niobium	3,000
Pa	Palladium	100
Cd	Cadmium	5,000
Sn	Tin	20,000
Te	Tellurium	10,000
Pm	Promethium	3,000
U	Uranium	100
Be	Beryllium	
Rb	Rubidium	
Sa	Samarium	3,000
Pr	Praseodymium	

	Fishes	FC ($l.kg^{-1}$ fresh)
H	Tritium	1
C	Carbon	5,000
I	Iodine	15
Ru	Ruthenium	2
Sb	Antimony	20
Sr	Strontium	5
Cs	Caesium	400
Co	Cobalt	200
Tc	Technetium	80
Pu	Plutonium	100
Am	Americium	100
Cm	Curium	100
Mn	Manganese	1,000
Ag	Silver	4,000
Fe	Iron	1,000
Mo	Molybdenum	20
Ce	Cerium	100
Zn	Zinc	5,000
Zr	Zirconium	30
Cl	Chlorine	0.05
Ca	Calcium	2
Ni	Nickel	1,000
Eu	Europium	300
Se	Selenium	6,000
Np	Neptunium	10
Y	Yttrium	20
Nb	Niobium	30
Pa	Palladium	50
Cd	Cadmium	1,000
Sn	Tin	50,000
Te	Tellurium	1,000
Pm	Promethium	500
U	Uranium	1
Be	Beryllium	
Rb	Rubidium	
Sa	Samarium	500
Pr	Praseodymium	

	Crustaceans	FC (l.kg^{-1} fresh)
H	Tritium	1
C	Carbon	5,000
I	Iodine	100
Ru	Ruthenium	300
Sb	Antimony	10
Sr	Strontium	5
Cs	Caesium	100
Co	Cobalt	5,000
Tc	Technetium	1,300
Pu	Plutonium	500
Am	Americium	1,000
Cm	Curium	1,000
Mn	Manganese	5,000
Ag	Silver	3,000
Fe	Iron	5,000
Mo	Molybdenum	100
Ce	Cerium	1,500
Zn	Zinc	4,000
Zr	Zirconium	500
Cl	Chlorine	0.05
Ca	Calcium	5
Ni	Nickel	1,000
Eu	Europium	1,000
Se	Selenium	5,000
Np	Neptunium	100
Y	Yttrium	1,000
Nb	Niobium	200
Pd	Palladium	10
Cd	Cadmium	10,000
Sn	Tin	50,000
Te	Tellurium	1,000
Pm	Promethium	1,000
U	Uranium	10
Be	Beryllium	
Rb	Rubidium	
Sm	Samarium	1,000
Pr	Praseodymium	

	Molluscs	FC ($l.kg^{-1}$ fresh)
H	Tritium	1
C	Carbon	5,000
I	Iodine	100
Ru	Ruthenium	600
Sb	Antimony	20
Sr	Strontium	10
Cs	Caesium	50
Co	Cobalt	2,000
Tc	Technetium	400
Pu	Plutonium	3,000
Am	Americium	1,000
Cm	Curium	1,000
Mn	Manganese	10,000
Ag	Silver	40,000
Fe	Iron	20,000
Mo	Molybdenum	100
Ce	Cerium	1,500
Zn	Zinc	80,000
Zr	Zirconium	1,000
Cl	Chlorine	0,05
Ca	Calcium	1
Ni	Nickel	2,000
Eu	Europium	7,000
Se	Selenium	6,000
Np	Neptunium	400
Y	Yttrium	1,000
Nb	Niobium	1,000
Pa	Palladium	500
Cd	Cadmium	20,000
Sn	Tin	50,000
Te	Tellurium	1,000
Pm	Promethium	5,000
U	Uranium	30
Be	Beryllium	
Rb	Rubidium	
Sa	Samarium	5,000
Pr	Praseodymium	

APPENDIX III. DISTRIBUTION COEFFICIENTS

	Sediments	Kd ($l.kg^{-1}$ dry)
H	Tritium	1
C	Carbon	2,000
I	Iodine	500
Ru	Ruthenium	5,000
Sb	Antimony	400
Sr	Strontium	30
Cs	Caesium	1,000
Co	Cobalt	40,000
Tc	Technetium	100
Pu	Plutonium	10,000
Am	Americium	30,000
Cm	Curium	20,000
Mn	Manganese	1,000
Ag	Silver	1,000
Fe	Iron	50,000
Mo	Molybdenum	
Ce	Cerium	20,000
Zn	Zinc	2,000
Zr	Zirconium	3,000
Cl	Chlorine	0.03
Ca	Calcium	500
Ni	Nickel	100,000
Eu	Europium	500,000
Se	Selenium	100,000
Np	Neptunium	1,000
Y	Yttrium	10,000,000
Nb	Niobium	500,000
Pa	Palladium	5,000,000
Cd	Cadmium	2,000
Sn	Tin	1,000
Te	Tellurium	1,000
Pm	Promethium	2,000,000
U	Uranium	1,000
Be	Beryllium	
Rb	Rubidium	
Sa	Samarium	2,000,000
Pr	Praseodymium	

Appendix 7: Advice of the GRNC Groupe Radioécologie Nord Cotentin : Appraisal by the GRNC of the Assessment of the doses presented in the annual report of monitoring of the environment of AREVA NC – La Hague – Fourth advice of the GRNC – Synthesis report year 2006

The following text is a courtesy translation of an extract from the report "Année 2006 - APPRECIATION PAR LE GRNC DE L'ESTIMATION DES DOSES PRESENTEE DANS LE RAPPORT ANNUEL DE SURVEILLANCE DE L'ENVIRONNEMENT D'AREVA NC LA HAGUE - QUATRIEME AVIS DU GRNC - RAPPORT DE SYNTHESE" sent to the authorities in 2007.

The dose values that are quoted in the text represent the total dose received by the selected populations, that is to say the sum of the dose due to the discharges to the sea and the one due to the atmospheric discharges. They thus cannot be directly compared to the doses due only to the marine discharges that appear elsewhere in the present report.

Advice of the GRNC

In order to formulate its advice, the GRNC has answered the following questions:

1 – The quantification of the discharged activities is it accurate?

In its three preceding advices, the GRNC has evidenced some differences between the activities computed with transfer functions (ratio of the activity of a given nuclide in the discharges to the activity of this same nuclide in the spent fuel) and the activities measured and reported by AREVA NC, for three nuclides that are discharged to the sea (tritium, 14-carbon, and 238-plutonium).

In 2006, some differences can still be observed for tritium and 238-plutonium. On the contrary, concerning 14 carbon, the GRNC notices a measured activity that is for the first time consistent with the activity in the spent fuel. The GRNC Working Group has questioned the operator about a possible modification of the parameters of the CESAR software in 2006; this hypothesis has been denied by AREVA NC. Consequently, the GRNC WG does not know why the balance of the discharges has gone back to consistency in 2006.

Though these differences do not influence the dosimetric impact, the GRNC has done its best to understand their origin. The questions raised by the GRNC are the subject of an internal AREVA NC working group, whose outcome of the on-going work has been presented to the GRNC WG in 2007. On-going CEA research concerns among others the assessment of the repartition of tritium between the fuel itself and the structure. Concerning 238-plutonium, the differences could be, for part of them, explained by the treatment of batches of legacy solvent used years before. GRNC would have wished to know the isotopic repartition of plutonium in these batches in order to validate this hypothesis, but these data have not been made available. However the WG notices that this isotope has displayed a lower activity than expected since it is measured (for 21 years). The difference has been observed before significant quantities of solvent have been treated.

The GRNC wishes to validate the hypothesis expressed up to now by AREVA and the GRNC WG experts in view of explaining the various differences observed.

The GRNC has also evaluated the situation relative to the comparison between the discharged activity measured by the IRSN and the one reported by AREVA NC.

The GRNC considers that the quantification of the discharged activities, for those of the nuclides that contribute predominantly to the dose, is accurate.

Conclusion of the four assessments performed by the GRNC on the 2003 to 2006 period: the GRNC observes that the quantification of the discharges cannot be performed solely by the analysis of the source term via transfer functions. Indeed, for the four years under study, the operation of the plant has not only been fuel treatment, but also legacy solvent treatment. In the lack of a precise description of the operations performed during the last year, the quantification of the discharges is difficult. The members of the GRNC WG in charge of the determination of the source term stress the importance of the availability of experts having a good knowledge of the operation of the plant.

2- The modelling of the transfers to the environment does it reliably takes into account the local conditions?

The GRNC has evaluated the situation relative to the comparison between the levels of activity measured in the environment (as indicated previously, more than 1,000 samples have been the object of around 15,000 analysis whose results have been communicated to the GRNC) and those resulting from the modelling applied to the discharged activities. The ratios model/measurement computed for the year 2006 are similar to those of the three preceding years.

(paragraph concerning only the terrestrial compartment omitted).

Concerning the marine compartment, the ACRO had put forward in the preceding advice of the GRNC the hypothesis of a bioaccumulation of tritium, phenomenon that is not presently taken into account by the GRNC. The GRNC WG has done its best to evaluate the situation of the present knowledge on the phenomena of bioaccumulation of tritium in the environment and to check the relevance of taking them into account in the conditions of dispersion of La Hague. The study previously quoted concludes on the basis of the research performed by the IRSN that the concentration factor of the tritium in various marine species of La Hague ecosystem is near 1, at the difference of the one observed in ecosystems such as those of the Bristol Channel or of Sellafield because of the chemical forms discharged.

The GRNC takes notice of this study and will continue its reflection on this subject, by integrating among others the results of the work performed in the framework of the working group installed in 2008 by the ASN on the impact of tritium (bioaccumulation and effects of tritium on living organisms).

The doses assessed by the GRNC from the results of measurements in terrestrial and marine foods are globally of the same order of magnitude than those computed from the modelling applied to the discharged activities. The nuclides for which there are significant differences between the results of modelling and the measurements in the environment are not significant contributors to the total dose, except for 129-iodine.

By comparing it with the modelling performed by the GRNC, it appears that the modelling performed by AREVA NC to take into account the transfers of nuclides in the environment is indeed representative of the local conditions.

Conclusion of the four assessments performed by the GRNC on the 2003 to 2006 period: each year, the GRNC WG collects all the information issuing from the various protagonists of the monitoring of the nuclear operation: IRSN, ASN, AREVA NC, laboratories, etc., this representing each year around 15,000 measurements. It results from this a strong reactivity in

front of questions formulated by the authorities or the local stakeholders via the CSPI (case of the 90 strontium raised by the ACRO), or when an incident takes place (case of the untimely discharges of 106 ruthenium that allowed the ACRO to detect an underestimation of the source term by AREVA), or during the examination of consistency or discrepancy between the measurements of various participants. As an example of this last point an error concerning the balance of the 2005 discharges of 14 carbon has been detected by the GRNC in September 2006. This example underlines the interest of this "critical cross examination" that proves to be an excellent verification tool. The experience gained from these four years of measurement collect can be translated under the form of recommendations for the national monitoring network:

- **Necessity to harmonize the practices of the laboratories;**
- **Definition of a minimal set of information to be transmitted with each measurement result;**
- **Pluralistic dialog on the basis of the gathered data in order to obtain an understandable presentation.**

The GNRC WG recommends not to stop this collection of data and the associated treatments when the present exercise is over. The advantage of having performed a model/measurement comparison during four years is to allow the proposition of a modification of the values of the correction factors, data introduced in the modelling by the GRNC to take into account the large series of measurements performed from 1966 to 2006 in the marine environment. Cobalt is concerned by this modification since it has been observed that the model systematically over assesses its activity in all the compartments of the environment. Concerning the sediments, the ratios model/measurement are systematically lower than 1. This can be explained by the fact that the phenomena of accumulation of deposits from the historical discharges are not modelled. (Sentence concerning only terrestrial compartment omitted).

3- The choice of the groups of population for the assessment of the doses to the public and the assessment of the level of exposure are they adequate?

The GRNC has gone on considering that it is important, on the one hand, to make sure that the choice of the so-called reference groups, defined by the regulations as likely to be the most exposed to the discharges, and the corresponding doses as assessed by AREVA NC, are correct, and on the other hand, to identify, as the basis of sensibility analysis, other populations whose living habits, either chronic or specific, could be more penalizing in terms of received dose.

Concerning the selection of the reference groups, AREVA NC and the GRNC use two different approaches: AREVA NC assesses the conditions of atmospheric dispersion on the basis of meteorological data averaged on several years, in accordance with the recommendations of the Experts Group of the article 31 of the EURATOM treaty (RP 129). Moreover, as indicated before, AREVA NC has on its own performed a sensitivity analysis whose results range from 2 to 10 µSv. For its part, the GRNC has used for the year 2006, as it had done for the year 2005, the continuous monitoring of 85 krypton in order to determine an average atmospheric transfer coefficient (ATC) specific of the meteorological conditions of the year under examination. Thus, the GRNC has concluded that for 2006 the most exposed group to gaseous effluents was located at Digulleville.

On another hand, the GRNC, in relation with the sensitivity analysis, has taken into account various scenarios. The selection of some groups identified by the GRNC has been approved by all of its members, while some others have been criticised because considered as unrealistic.

On the whole, GRNC results are the following ones:

- two scenarios defined as reference groups in accordance with the regulations and validated by all the members of the GRNC (Goury and Digulleville) result in doses ranging from 4 to 7 µSv (around).
- six chronic scenarios also validated by all the members of the GRNC result in doses ranging from 4 to 17 µSv.
- four scenarios that did not receive a unanimous validation because considered as unrealistic (population fed at 100 % from local terrestrial food at Digulleville or from local sea food at Goury) result in doses ranging from 6 to 16 µSv (around).

To sum it up, the dose resulting from the discharges of the La Hague plant as assessed by the GRNC for the more penalizing reference group for the year 2006 (adult at Digulleville – 7 µSv) is consistent with the one assessed by AREVA NC. It is lower by a factor 3 than the one assessed from the discharge limits set by the Order of January 10, 2003, by a factor of around 140 than the regulatory dose limit for the individuals of the public, and by a factor 400 than the exposure of natural origin in the North-Cotentin region.

Conclusion of the four assessments performed by the GRNC: the GRNC has evidenced the interest not to limit the assessment to the reference groups as defined by the regulations, but to perform a sensitivity analysis using various scenarios taking into account the variability of the atmospheric conditions and of the living habits of the local population.

PART III: Application of the BAT to the Radioactive discharges of the French CNPE's (EDF)

Nuclear reactors

1. Characteristics of French nuclear production sites in the OSPAR area

1.1 Nuclear Power Production Plants (CNPEs) in the OSPAR area

Map reference	Name of Nuclear Power Production Plant	Destination of discharges	Number and type of units	Installed capacity (MWe)	Date of first divergence
F1	Belleville-sur-Loire	Loire	2 PWR	2600	1987
F2	Le Blayais	Gironde Estuary	4 PWR	3600	1981
F3	Cattenom	Moselle	4 PWR	5200	1986
F4	Chinon	Loire	4 PWR	3600	1982
F5	Chooz	Meuse	2 PWR	2900	1996
F15	Civaux	Vienne	2 PWR	2900	1997
F6	Dampierre-en-Burly	Loire	4 PWR	3600	1980
F7	Fessenheim	Rhin	2 PWR	1800	1977
F8	Flamanville	North Sea (Channel)	2 PWR	2600	1985
F9	Golfech	Garonne	2 PWR	2600	1990
F10	Gravelines	North Sea	6 PWR	5400	1980
F11	Nogent-sur-Seine	Seine	2 PWR	2600	1987
F12	Paluel	North Sea (Channel)	4 PWR	5200	1984
F13	Penly	North Sea (Channel)	2 PWR	2600	1990
F14	Saint Laurent des Eaux	Loire	2 PWR	1800	1981

Note : The power produced by each CNPE is shown in the table in Section 0.

1.2 French regulatory structure

French regulations concerning water withdrawals and discharges at Basic Nuclear Installations (INBs) comprise an assemblage of texts developed both on the international level (agreements, protocols,

etc.), and within the Community (directives, regulations, etc.). They comprise general texts (laws, decrees, orders, circulars, etc.) as well as texts covering each individual nuclear installation.

As regards the texts covering each facility, the permits for water intakes and non-radioactive discharges were regulated by prefectorial orders for a specific period (generally from 15 to 18 years), while permits for liquid and gaseous radioactive discharges were issued as interministerial orders of unlimited duration.

Beginning with Decree 95-540 of May 4, 1995 concerning liquid and gaseous effluents and water withdrawals at Basic Nuclear Installations (INBs), the procedures for requesting permits have been examined at the interministerial level, and give rise to a single order. The authorizing order for each INB is issued for an unlimited term but is reviewable at any time.

In addition, the Order of November 26, 1999, issued in application of the 1995 decree, established the general technical requirements concerning the limits and methods for withdrawals and discharges made by INBs that are subject to permitting.

With the signing of the TSN Law of June 13, 2006 and Decree 2007-1557 of November 2, 2007, effluent release permits now comprise:

- The construction permit for the INB (unlimited term),
- An ASN decision regulating the discharges,
- An ASN decision, approved by the ministers responsible for nuclear safety, concerning the limits on releases into the environment.

The administration (ASN) has taken advantage of these changes to lower some of the limits concerning liquid and gaseous radioactive releases and to strengthen the controls on chemical discharges and the methods of environmental monitoring.

1.3 Schedule of renewals of release permits for EDF Nuclear Power Production Plants

Administrative status	Site	Date of renewal of release permit
Renewed	St-LAURENT	2/2/1999
Renewed	FLAMANVILLE	5/11/2000
Renewed	PALUEL	5/11/2000
Renewed	BELLEVILLE	11/8/00
Renewed	CHINON	5/20/03
Renewed	GRAVELINES	11/7/2003
Renewed	BLAYAIS	9/18/2003
Renewed	CATTENOM	6/24/2004

Administrative status	Site	Date of renewal of release permit
Renewed	NOGENT	12/29/2004
Renewed	GOLFECH	9/18/2006
Renewed	PENLY	2/15/2008
Renewed	CIVAUX	6/23/2009
Renewed	CHOOZ[6]	11/30/2009
In progress	FLAMANVILLE with EPR	2010 (projected)
In progress	DAMPIERRE	2011 (projected)
In progress	FESSENHEIM	2012 (projected)

1.4 Old and new limits for radioactive liquid releases

Table I - Annual limits on liquid radioactive releases for two 900-MWe units

Parameters	Old annual limits[7] (GBq)	New annual limits for two 900-MW units (GBq)
Tritium	55 000	from 40 000 to 80 000 (High Burnup Fraction fuel)
Iodines	750	0.3
Other radioelements (excluding ^{3}H, ^{40}K, and Ra)		30
^{14}C	Unregulated	130

[6] This renewal includes exceptional releases due to the dismantling of the CHOOZ A power plant.

[7] At unrenewed sites.

Table II - Annual limits on liquid radioactive releases for two 1300-MWe units

Parameters	Old annual limits[2] (GBq)	New annual limits (GBq)
Tritium	80 000	from 80 000 to 110 000 (High Burnup Fraction fuel)
Iodines	1100	0.1
Other radioelements (excluding ^{3}H, ^{40}K, and Ra)		25
^{14}C	Unregulated	190

Table III - Annual limits on liquid radioactive releases for two 1450-MWe units

Parameters	Old annual limits[2] (GBq)	New annual limits (GBq)
Tritium	80 000	from 80 000 to 90 000 (High Burnup Fraction fuel)
Iodines	222	0.1
Other radioelements (excluding ^{3}H, ^{40}K, and Ra)		5
^{14}C	Unregulated	190

2. Optimization of liquid of liquid radioactive releases from nuclear power plants

2.1 Description and performances of systems

The overall regulation of Basic Nuclear Installations (INBs) is based among other things on the so-called optimization principle.

This principle has been incorporated into the design of the structures (possibility of recycling or processing the effluents) throughout the nuclear production fleet, so as to "*reduce as far as reasonably possible and at an acceptable cost*" the discharges of effluents.

With this goal in mind, since the first commissioning of the nuclear fleet the operators have endeavored to keep discharges of effluents to a minimum. Their efforts have mainly been directed towards two kinds of action:

- Establishing a rigorous management of effluents, aimed in particular at reducing the production of effluents at the source and at recycling spent effluents (creation of a guide for research into the production of effluents, adoption of an effluent-recycling policy, etc.),
- Improvement of the systems for collecting and processing effluents.

Over twenty years, these actions have resulted in a more than one hundred-fold reduction in releases of activity by liquid effluents for all radionuclides excluding tritium and carbon 14.

Thanks to these actions, since the early 1990s the activities released by EDF's nuclear power plants (CNPEs) have reached a very low level. The controls carried out under the environmental-monitoring program show that the terrestrial ecosystem has not been affected by the radioactive releases from these plants. Only the area close to the point where liquid discharges are made is slightly influenced by certain radioelements present at trace levels.

It will be noted that the dosimetric impact due to these radioelements is less than 10 µSv/year.

However, this has not led to a slackening of the efforts being made; they are in fact being actively pursued, in order to:

- Maintain the good results obtained in the area of discharges,
- Apply an even stricter management of effluents, so as to avoid failures and deviations (preparation of a guide to good practice),
- Take actions to improve the discharges from under-performing plants (inter-comparison of results).

2.2 Characterization of liquid radioactive discharges

Liquid radioactive effluents are grouped into two families, according to their origin:

- Effluents from the reactor coolant system, which may contain dissolved fission gases (xenon, iodine, etc.), fission products (cesium, etc.), activation products (cobalt, manganese, tritium, carbon 14, etc.), and also chemical substances such as boric acid and lithium. These effluents can be recycled.
- Effluents from the auxiliary circuits, which constitute the rest of the effluents.

These include:

- Effluents that are radioactively and chemically clean,
- Effluents that are radioactively and chemically loaded,
- Weakly radioactive effluents comprising drain waters from floors and "wastewaters" (showers, laundries, and washbasins).

After systematic collection, these effluents are processed to hold back most of their radioactivity. They are then sent to storage tanks, where they are subjected to radioactive or chemical inspection before being discharged.

Before any discharge, the properties of the materials to be discharged are examined, particularly on the basis of activity checks, and if necessary they may be sent back for additional processing. Their

discharge may be postponed if the possibilities of dilution are unfavorable, e.g., for radioactive elements in rivers during low-water periods. During discharge the radioactivity is also checked in the discharge pipe. If an alarm threshold is exceeded the discharge is automatically halted. An accounting of the discharges is kept up to date and checked by the Administration.

2.3 Operational effectiveness

The performance of CNPEs depends not only on the effectiveness of their effluent-processing systems but also on their operating practices.

The management of effluents at nuclear sites is the subject of operating instructions based on principles designed to:

- Check the quality and quantity of radioactive effluents produced,
- Control the activity released.

In this regard, actions are implemented to reduce the production of effluents at the source and to optimize the collection and processing of effluents. This also requires the establishment of an organization dedicated to effluent management, and lastly a results-based management.

2.3.1 Reduction at the source

The following arrangements assist in reducing the production of effluents at the source.

- During operational inspections the main sumps are inspected to detect any significant flow of effluents.
- Plexiglass covers were installed on the inlet manifolds of some of the sumps in order to see the origin of the effluents.
- Procedures for tracing leaks were implemented.

2.3.2 Collection and processing

Spent liquid effluents are selectively collected under four categories (drain waters from floors, service-drain effluents, chemical effluents, and residual drain waters) in order to send them for the treatment that best suits their characteristics (filtration, evaporation, or demineralization).

2.3.3 Organization

The organization set up to manage effluents is designed to:

- Prevent pollution,
- Provide for full control of effluent discharges.

This organization demands the active involvement of all the personnel concerned (awareness-raising and training). It relies in particular on making use of the experience acquired on the site and in the entire production fleet, and encourages the implementation of the best practices identified by this feedback from experience.

This organization is strengthened during periods when the unit is shut down, when more effluents are produced because of the numerous maintenance activities requiring circuits to be drained.

Daily monitoring of effluent production enables discharges to be efficiently reduced during this phase of the operation.

2.4 Implementation of best available techniques and best environmental practices

As noted earlier, the activity released by nuclear power plants has greatly diminished over the last 20 years. This reduction in the activity released by CNPEs is due in particular:

- To better identification of effluents at the source, so that they can be sent for appropriate treatment,
- To an increase in the treatment of effluents by evaporation,
- To improvements in the treatment processes at certain sites, in particular the flocculation of aluminum sulfate to improve the efficiency of the demineralizer processing of silver 110 m,
- To optimized recycling of the effluents.

This involves all of the radionuclides except for tritium and carbon 14, for which the activity released is directly linked to the power produced. As regards tritium, no industrial method for trapping it exists, given the large volumes of water to be processed and the correspondingly low activity concentrations of tritium. We should also note that tritium is one of the least toxic radionuclides.

Nevertheless, EDF has carried out a number of actions to optimize releases of tritium. These actions are described in the following sections.

2.4.1 Implementation by EDF of a tritium-management policy

The first action aimed at optimizing tritium releases consisted of setting a policy for the management of tritium (July 2007). Given that tritium cannot be trapped and that its dosimetric impact is greater for releases of tritium in gaseous form than in liquid form, this policy sets out the following main recommendations:

1. Reduce atmospheric releases of tritium to a minimum and discharge tritium preferentially as a liquid.
2. Reduce the concentration of tritium in the reactor coolant system in the event of primary/secondary leaks, to limit the transfer of tritium to the secondary cooling system.
3. Avoid disseminating tritium into the tanks or pools during the shutdown of a unit, by diluting the reactor coolant system before shutdowns for refueling.

2.4.2 Feasibility studies on the storage of liquid tritium for decay

As part of the examination of release permits for the future EPR reactor at Flamanville, EDF conducted a feasibility study on the possibility of reducing releases of tritium into the sea by storing the tritium in tanks and waiting for the radioactivity to decay before discharge.

The production of tritiated effluents being about 30,000 m3/year at an average concentration of 10-8 g/L, with no possibility of concentration:

- 40 tanks of 750-m3 would have to be built each year to store all the tritium produced, or 1,200 tanks for 30 years of operation.
- 450 tanks of 750-m3 would have to be built to store 12 years of production before discharge and thereby reduce the activity of the released tritium by half. This option would cover a ground area of 45,000 m3 (excluding support systems) at a total construction cost of €785 M, for a gain of about 0.00002 mSv/year to the public.

The conclusion from this study is that this option is neither technically nor economically viable, and that it therefore does not represent a best available technique. Moreover, besides its cost, this option would introduce increased risks of pollution of the water table in the event of a leak or overflow, and would increase gaseous releases of tritium through the tanks' vents.

2.5 Performance of the future Flamanville EPR reactor

As regards the future EPR reactor now under construction at Flamanville, its design and operation are intended to further improve the best environmental performances obtained at current nuclear power plants. This reactor includes in its design the recycling and advanced selective sorting of liquid effluents, allowing optimization of their processing. These design arrangements make it possible to achieve release levels lower than those at other units of the fleet, in comparison with the power produced, except for releases of tritium and carbon 14 (because of the greater power of this reactor). The regulatory limits for releases from the EPR, which cover its normal operation and routine operational uncertainties, were established by the Administration according to current regulations, and were set conservatively in order meet environmental and health concerns. They incorporate industrial improvements from the operating nuclear fleet. They were set after an examination of the environmental impact study submitted to the public inquiry.

3. Inventory of liquid radioactive discharges

3.1 Accounting rules

By creating new categories of radionuclides, the latest discharge permits have made it necessary to alter the system of accounting for radioactive effluents. This new system was implemented on the Saint-Laurent site for the year 1999, and then on the Paluel, Flamanville, and Belleville sites according to the publication date of their discharge orders. It has been used at all of the (CNPE) power plants in EDF's nuclear fleet since January 2002.

The new accounting is based on a radionuclide-by-radionuclide analysis. In addition, liquid and gaseous discharges are increased on purpose to the uncertainty of measurement when below half of the detection limit.

The rules thus primarily rely on the definition of a reference spectrum. For liquid discharges, this spectrum consists of a list of radionuclides that must be identified by appropriate measurement methods. The second basic rule consists of a mandatory declaration of the activity released by the radionuclides belonging to the reference spectrum. Radionuclides whose measured activity is less than half of the detection limit of the apparatus are systematically recorded at a value equal to half of the detection limit. The objective is to overestimate the activity of the discharge by introducing the uncertainty of measurement. Thus certain frequently-occurring radionuclides (said to belong to the reference spectrum) are at a minimum recorded at a value equal to half of the detection limit, so as to allow for uncertainties in the measuring apparatus.

3.2 Inventory of liquid discharges

The liquid activities released by the radionuclides monitored for OSPAR, beta and gamma emitters as well as tritium, are given in the tables below for the years 2000 to 2008.

Rejets Liquides		Activités rejetées (GBq)												Total émetteurs β - γ	Energie nette	Total émetteurs β - γ normalisé
CNPE	**Année**	**3H**	**54Mn**	**58Co**	**60Co**	**110mAg**	**123mTe**	**124Sb**	**125Sb**	**131I**	**134Cs**	**137Cs**	**51Cr**	**GBq**	**MWe.an**	**GBq/GWe.a**
BELLEVILLE	2000	3,9E+04	3,9E-02	3,2E-01	6,3E-01	4,3E-01		3,4E-02	8,2E-02	1,7E-02	4,7E-02	6,5E-02		1,7E+00	1608	1,04
SUR-LOIRE	2001	4,9E+04	4,2E-02	4,3E-01	3,5E-01	6,8E-02	1,9E-02	1,7E-01	2,2E-01	3,6E-02	4,4E-02	5,9E-02		1,4E+00	2057	0,70
	2002	4,9E+04	3,7E-02	3,6E-01	1,7E-01	5,2E-02	2,8E-02	1,8E-01	2,1E-01	3,5E-02	4,1E-02	4,0E-02		1,2E+00	2162	0,53
	2003	4,1E+04	2,7E-02	2,8E-01	2,2E-01	2,9E-02	2,1E-02	4,9E-02	8,1E-02	2,8E-02	3,1E-02	3,1E-02		8,0E-01	1943	0,41
	2004	5,6E+04	1,8E-02	1,1E-01	1,0E-01	1,9E-02	1,4E-02	1,7E-02	5,1E-02	1,9E-02	2,0E-02	2,4E-02		3,9E-01	2219	0,18
	2005	6,0E+04	1,8E-02	2,9E-02	6,6E-02	1,8E-02	1,5E-02	1,7E-02	5,3E-02	2,0E-02	1,9E-02	2,5E-02		2,8E-01	2224	0,13
	2006	5,3E+04	1,0E-02	6,9E-02	4,5E-02	1,1E-02	1,1E-02	2,3E-02	6,6E-02	1,2E-02	1,1E-02	1,5E-02		2,7E-01	1900	0,14
	2007	5,9E+04	9,0E-03	3,2E-02	3,0E-02	9,0E-03	7,0E-03	1,2E-02	2,7E-02	1,0E-02	9,0E-03	1,7E-02		1,6E-01	2057	0,08
	2008	5,2E+04	9,0E-03	5,9E-02	4,1E-02	8,0E-03	6,0E-03	9,0E-03	2,9E-02	9,0E-03	8,0E-03	5,1E-02		2,3E-01	1825	0,13
LE BLAYAIS	2000	3,6E+04	4,6E-02	1,0E+00	7,6E-01	9,0E-01	1,8E-01	3,1E-01	1,1E-01	1,2E-02	2,8E-02	1,4E-01		3,5E+00	2214	1,57
	2001	4,7E+04	1,6E-02	7,2E-01	1,7E-01	9,4E-01	2,7E-01	2,3E-01		1,7E-02	1,6E-02	2,7E-02		2,4E+00	2798	0,86
	2002	5,4E+04	4,0E-02	2,8E-01	5,2E-01	2,9E-01	3,2E-01	4,2E-02	1,3E-01	2,7E-02	2,5E-02	8,0E-02		1,8E+00	2988	0,59
	2003	3,6E+04	7,9E-02	1,5E+00	4,2E-01	1,9E+00	1,7E-01	1,1E-01	1,1E-01	3,2E-02	3,1E-02	4,9E-02	7,8E-02	4,4E+00	2377	1,85
	2004	4,5E+04	3,0E-02	4,0E-01	2,3E-01	4,2E-01	1,0E-01	3,5E-02	7,0E-02	1,6E-02	2,0E-02	9,1E-02	3,0E-02	1,4E+00	2874	0,49
	2005	4,6E+04	2,4E-02	1,4E-01	1,7E-01	3,3E-01	6,6E-02	2,2E-02	4,4E-02	1,7E-02	1,7E-02	3,0E-02		8,5E-01	2865	0,30
	2006	5,1E+04	2,3E-02	1,9E-01	2,0E-01	2,1E-01	6,5E-02	3,4E-02	4,7E-02	1,5E-02	1,9E-02	3,7E-02		8,4E-01	3030	0,28
	2007	4,5E+04	2,2E-02	3,0E-01	1,6E-01	1,1E+00	4,9E-02	3,9E-02	4,8E-02	1,8E-02	1,9E-02	3,0E-02		1,8E+00	3078	0,58
	2008	4,8E+04	1,6E-02	8,3E-02	1,3E-01	5,3E-01	1,8E-02	1,5E-02	3,4E-02	1,6E-02	3,1E-02	4,9E-02		9,2E-01	3160	0,29
CATTENOM	2000	8,6E+04	5,3E-02	5,6E-01	3,6E-01	1,8E-01	1,6E-02	8,8E-02	3,7E-02	4,6E-03	2,4E-02	8,3E-02		1,4E+00	4016	0,35
	2001	1,1E+05	2,2E-02	4,5E-01	1,7E-01	5,0E-02	5,7E-02	1,1E-01	3,5E-02	5,0E-03	1,5E-02	7,2E-02		9,9E-01	3383	0,29
	2002	9,4E+04	5,1E-02	4,6E-01	3,4E-01	6,5E-02	2,2E-01	1,1E-01	1,1E-01	3,6E-02	6,3E-01	5,3E-01		2,6E+00	4170	0,61
	2003	7,3E+04	2,8E-02	7,4E-02	2,0E-01	2,6E-02	3,6E-02	2,8E-02	7,3E-02	2,6E-02	9,6E-02	1,0E-01	6,2E-03	6,9E-01	4300	0,16
	2004	1,0E+05	3,2E-02	1,6E-01	4,3E-01	3,6E-02	1,0E-01	3,1E-02	9,5E-02	2,9E-02	9,4E-02	1,2E-01		1,1E+00	4052	0,28
	2005	8,3E+04	2,0E-02	1,1E-01	3,0E-01	2,6E-02	1,3E-01	2,5E-02	4,8E-02	1,5E-02	2,7E-02	4,6E-02		7,4E-01	4366	0,17
	2006	1,3E+05	2,8E-02	2,3E-01	6,0E-01	2,6E-02	4,1E-02	3,9E-02	6,3E-02	2,2E-02	4,1E-02	7,7E-02		1,2E+00	3889	0,30
	2007	1,1E+05	2,9E-02	1,7E-01	3,5E-01	2,6E-02	6,7E-02	2,5E-02	6,3E-02	1,9E-02	3,6E-02	6,5E-02		8,5E-01	4255	0,20
	2008	1,1E+05	5,9E-02	3,4E-01	2,6E-01	3,3E-02	1,2E-01	3,8E-02	8,3E-02	3,0E-02	4,2E-02	8,6E-02		1,1E+00	3981	0,27

Rejets Liquides

		Activités rejetées (GBq)												Total émetteurs β - γ	Energie nette	Total émetteurs β - γ normalisé
CNPE	**Année**	**3H**	**54Mn**	**58Co**	**60Co**	**110mAg**	**123mTe**	**124Sb**	**125Sb**	**131I**	**134Cs**	**137Cs**	**51Cr**	**GBq**	**MWe.an**	**GBq/GWe.a**
CHINON	2000	3,8E+04	5,1E-02	8,6E-02	1,1E-01	1,8E-01	2,8E-01	6,7E-02	7,8E-02	4,9E-02	5,4E-02	7,8E-02		1,0E+00	2708	0,38
	2001	3,9E+04	3,6E-02	1,2E-01	1,4E-01	7,3E-01	1,4E-01	5,3E-02	2,4E-02	3,1E-02	3,8E-02	7,3E-02		1,4E+00	2797	0,50
	2002	4,4E+04	7,0E-02	1,3E-01	1,5E-01	5,1E-01	1,5E-01	9,9E-02	1,0E-01	6,8E-02	7,6E-02	8,3E-02		1,4E+00	2902	0,49
	2003	3,5E+04	2,9E-02	2,4E-01	1,1E-01	2,5E-01	4,0E-02	2,4E-02	6,3E-02	2,1E-02	2,3E-02	3,0E-02		8,3E-01	2643	0,31
	2004	3,9E+04	2,8E-02	1,4E-01	2,6E-01	9,3E-02	9,1E-02	4,4E-02	1,4E-01	2,0E-02	2,7E-02	6,9E-02		9,1E-01	2695	0,34
	2005	4,0E+04	1,6E-02	3,1E-02	7,5E-02	2,3E-02	2,4E-02	7,3E-02	1,6E-01	1,4E-02	1,6E-02	2,0E-02		4,5E-01	2746	0,16
	2006	4,2E+04	1,6E-02	8,8E-02	9,8E-02	3,0E-02	1,3E-02	1,7E-02	4,6E-02	1,4E-02	1,6E-02	1,9E-02		3,6E-01	2729	0,13
	2007	3,9E+04	1,6E-02	4,0E-02	3,8E-02	6,0E-02	2,5E-02	1,5E-02	4,1E-02	1,4E-02	1,5E-02	2,0E-02		2,8E-01	2628	0,11
	2008	3,2E+04	1,3E-02	7,0E-02	8,0E-02	4,5E-02	1,1E-02	1,2E-02	3,6E-02	1,1E-02	1,2E-02	1,4E-02		3,0E-01	2762	0,11
CHOOZ	2000	3,7E+04	1,5E-02	3,0E-01	0,0E+00	1,3E+00		1,0E-02		1,1E-02	1,0E-02	4,2E-02		1,7E+00	1781	0,95
	2001	3,9E+04	9,0E-03	2,3E-01	4,0E-02	3,4E-01		8,0E-03		9,2E-03	8,1E-03	1,5E-02		6,6E-01	2247	0,29
	2002	4,1E+04	2,4E-02	1,3E-01	7,2E-02	2,8E-01	1,7E-02	2,2E-02	6,6E-02	2,4E-02	2,2E-02	2,6E-02		6,8E-01	2206	0,31
	2003	2,8E+04	1,8E-02	2,7E-02	6,5E-02	4,7E-01	1,2E-02	1,6E-02	4,9E-02	1,8E-02	1,6E-02	1,9E-02		7,1E-01	2340	0,30
	2004	4,8E+04	2,2E-02	3,9E-02	1,5E-01	2,6E-01	1,6E-02	2,1E-02	6,3E-02	2,4E-02	2,1E-02	2,4E-02		6,4E-01	2358	0,27
	2005	2,8E+04	1,8E-02	1,4E-01	2,8E-01	1,2E-02	1,7E-02	4,9E-02	1,7E-02	1,6E-02	1,9E-02			5,7E-01	2207	0,26
	2006	4,9E+04	1,9E-02	4,6E-02	1,5E-01	8,1E-02	1,2E-02	1,7E-02	4,9E-02	2,2E-02	1,5E-02	2,0E-03	3,9E-01	4,1E-01	2203	0,19
	2007	4,3E+04	1,9E-02	4,4E-02	3,1E-01	9,0E-02	1,2E-02	1,6E-02	4,9E-02	1,7E-02	1,5E-02	1,8E-02	5,8E-01	5,9E-01	2443	0,24
	2008	6,0E+04	2,1E-02	2,4E-02	1,6E-01	2,2E-02	1,5E-02	2,0E-02	6,1E-02	2,2E-02	2,0E-02	2,3E-02	3,6E-01	3,8E-01	2664	0,14
CIVAUX	2000	2,6E+04	3,7E-02	8,7E-01	2,4E-02	2,3E-01		3,3E-02		2,1E-02	1,9E-02	2,3E-02		1,3E+00	1589	0,79
	2001	1,6E+04	2,3E-02	7,7E-01	2,4E-02	7,6E-01		3,2E-02		1,3E-02	1,2E-02	1,4E-02		1,6E+00	1265	1,30
	2002	1,8E+04	3,8E-02	2,4E-01	6,4E-02	5,7E-01	1,2E-02	1,6E-02	4,5E-02	1,7E-02	1,5E-02	1,8E-02		1,0E+00	2169	0,48
	2003	2,4E+04	2,2E-02	1,4E-01	5,4E-02	1,9E-01	8,4E-03	1,0E-02	2,9E-02	1,1E-02	1,0E-02	1,2E-02		4,9E-01	2283	0,21
	2004	3,2E+04	5,8E-02	1,7E-01	1,9E-01	3,0E-01	8,6E-03	2,7E-02	4,8E-02	2,2E-02	1,3E-02	1,8E-02		8,5E-01	2616	0,33
	2005	4,3E+04	1,8E-02	2,7E-02	7,0E-02	7,4E-02	7,8E-03	1,1E-02	3,3E-02	1,5E-02	1,1E-02	1,3E-02	2,6E-01	2,8E-01	2201	0,13
	2006	5,4E+04	1,6E-02	3,5E-02	3,6E-02	6,5E-02	1,1E-02	1,4E-02	3,7E-02	3,1E-02	1,3E-02	1,6E-02		2,7E-01	2450	0,11
	2007	3,2E+04	6,0E-03	8,0E-03	4,1E-02	2,0E-02	7,0E-03	8,0E-03	1,4E-02	6,0E-03	5,0E-03	6,0E-03	1,2E-01	1,2E-01	2167	0,06
	2008	4,8E+04	6,0E-03	1,9E-02	6,0E-02	4,6E-02	7,0E-03	8,0E-03	1,3E-02	5,0E-03	5,0E-03	9,2E-03	1,7E-01	1,8E-01	2412	0,07

Rejets Liquides		Activités rejetées (GBq)												Total émetteurs β - γ	Energie nette	Total émetteurs β - γ normalisé
CNPE	**Année**	**3H**	**54Mn**	**58Co**	**60Co**	**110mAg**	**123mTe**	**124Sb**	**125Sb**	**131I**	**134Cs**	**137Cs**	**51Cr**	**GBq**	**MWe.an**	**GBq/GWe.a**
DAMPIERRE	2000	3,2E+04	4,3E-02	1,1E+00	7,1E-01	6,6E-01	7,4E-02	2,0E-01	1,3E-01	1,2E-02	1,8E-02	1,2E-01		3,1E+00	2495	1,23
EN-BURLY	2001	3,5E+04	5,8E-02	7,2E-01	6,8E-01	3,0E-01	5,0E-02	8,5E-02	6,4E-02	5,1E-03	2,2E-02	2,2E-01		2,2E+00	2379	0,93
	2002	4,3E+04	4,2E-02	5,9E-01	5,7E-01	4,1E-01	1,1E-01	9,0E-02	9,5E-02	3,6E-02	3,2E-02	6,0E-02		2,0E+00	2581	0,79
	2003	3,3E+04	4,1E-02	4,2E-01	3,0E-01	2,1E-01	4,4E-02	6,0E-02	7,3E-02	3,5E-02	7,4E-02	9,2E-02	4,1E-02	1,3E+00	2612	0,52
	2004	4,5E+04	3,1E-02	2,3E-01	1,0E-01	1,1E-01	2,3E-02	2,9E-02	5,9E-02	1,9E-02	3,6E-02	6,0E-02		7,0E-01	2670	0,26
	2005	4,0E+04	2,0E-02	1,4E-01	8,8E-02	6,4E-02	1,4E-02	2,5E-02	6,1E-02	1,5E-02	5,2E-02	9,6E-02	5,7E-01	5,8E-01	2728	0,21
	2006	3,1E+04	2,1E-02	1,3E-01	1,4E-01	2,7E-01	2,1E-02	6,8E-02	4,6E-02	1,4E-02	2,0E-02	4,4E-02	7,9E-01	7,7E-01	2810	0,28
	2007	4,0E+04	1,8E-02	8,7E-02	6,0E-02	1,9E-01	2,2E-02	2,1E-02	5,1E-02	2,1E-02	2,2E-02	3,2E-02	5,0E-01	5,2E-01	2739	0,19
	2008	4,5E+04	1,8E-02	6,0E-02	6,4E-02	1,7E-01	2,0E-02	1,6E-02	4,8E-02	2,4E-02	1,8E-02	2,2E-02	4,3E-01	4,6E-01	2791	0,16
FESSENHEIM	2000	1,8E+04	2,8E-02	8,4E-01	1,9E-01	7,2E-01	1,0E-02	1,8E-01		2,6E-02	3,0E-02	5,2E-02		2,1E+00	1083	1,92
	2001	2,3E+04	5,3E-02	3,9E-01	7,6E-02	5,1E-01	1,8E-02	9,6E-02		3,3E-02	3,8E-02	5,4E-02		1,3E+00	1394	0,91
	2002	1,6E+04	2,3E-02	3,1E-01	8,7E-02	2,7E-01	5,7E-02	7,6E-02	1,4E-01	2,2E-02	2,5E-02	3,6E-02		1,0E+00	1090	0,96
	2003	2,2E+04	1,4E-02	2,5E-01	6,6E-02	1,6E-01	1,7E-02	2,2E-02	5,3E-02	1,4E-02	1,5E-02	2,3E-02		6,3E-01	1320	0,48
	2004	2,3E+04	8,4E-03	4,8E-01	4,5E-02	3,4E-01	8,2E-03	2,7E-02	7,2E-02	9,2E-03	9,2E-03	2,4E-02	9,9E-04	1,0E+00	1209	0,85
	2005	2,0E+04	6,7E-03	1,5E-01	3,6E-02	1,7E-01	1,3E-02	4,5E-02	4,5E-02	6,9E-03	7,2E-03	1,6E-02	5,0E-01	5,0E-01	1350	0,37
	2006	2,8E+04	8,0E-03	2,5E-01	3,3E-02	1,4E-01	1,0E-02	1,7E-02	2,6E-02	6,9E-03	7,2E-03	1,5E-02	5,1E-01	5,1E-01	1333	0,38
	2007	1,8E+04	7,0E-03	1,8E-01	2,1E-02	1,8E-01	9,0E-03	1,5E-02	2,6E-02	6,9E-03	7,2E-03	1,8E-02	4,7E-01	4,7E-01	1079	0,43
	2008	2,1E+04	1,5E-02	8,1E-02	1,5E-01	1,7E-01	1,8E-02	1,5E-02	2,1E-02	6,8E-03	7,7E-03	1,6E-02	4,9E-01	5,0E-01	1169	0,43
FLAMANVILLE	2000	4,7E+04	3,2E-02	6,7E-01	8,2E-01	2,8E-01		9,1E-02		2,5E-03	5,7E-02	2,3E-01		2,2E+00	2043	1,07
	2001	5,8E+04	2,2E-02	3,7E-01	3,9E-01	1,2E-01	1,1E-02	1,0E-01	5,6E-02	2,3E-02	1,5E-02	2,6E-02		1,1E+00	2124	0,53
	2002	5,9E+04	4,2E-02	3,8E-01	1,3E+00	1,4E-01	1,2E-02	6,7E-02	2,5E-01	1,7E-02	3,0E-02	1,8E-01		2,4E+00	1899	1,27
	2003	6,0E+04	3,6E-02	2,8E-01	5,0E-01	4,4E-02	8,4E-03	5,5E-02	7,1E-02	1,5E-02	1,6E-02	2,0E-02		1,0E+00	2003	0,52
	2004	5,8E+04	1,5E-02	1,0E-01	2,4E-01	7,7E-02	1,1E-02	2,8E-02	7,4E-02	1,7E-02	1,5E-02	2,3E-02		6,0E-01	2061	0,29
	2005	5,6E+04	2,5E-02	2,5E-01	3,0E-01	5,2E-02	1,3E-02	2,9E-02	7,4E-02	1,5E-02	1,6E-02	2,2E-02	7,9E-01	8,0E-01	2155	0,37
	2006	5,2E+04	2,0E-02	1,2E-01	8,0E-02	3,0E-02	1,4E-02	2,1E-02	5,8E-02	1,8E-02	1,8E-02	2,2E-02	3,8E-01	4,0E-01	2044	0,19
	2007	5,5E+04	1,8E-02	2,3E-01	8,4E-02	2,3E-02	1,2E-02	2,6E-02	6,8E-02	1,5E-02	1,7E-02	1,9E-02	5,0E-01	5,1E-01	2015	0,25
	2008	3,2E+04	1,5E-02	1,5E-01	8,9E-02	1,8E-02	1,0E-02	2,1E-02	9,8E-02	1,4E-02	1,6E-02	1,7E-02	4,4E-01	4,5E-01	1256	0,36

Rejets Liquides		Activités rejetées (GBq)												Total émetteurs β - γ	Energie nette	Total émetteurs β - γ normalisé
CNPE	**Année**	**3H**	**54Mn**	**58Co**	**60Co**	**110mAg**	**123mTe**	**124Sb**	**125Sb**	**131I**	**134Cs**	**137Cs**	**51Cr**	**GBq**	**MWe.an**	**GBq/GWe.a**
GOLFECH	2000	2,7E+04	1,8E-02	1,7E-01	2,1E-01	3,5E-02	2,2E-02	9,8E-03	7,7E-03	3,5E-03	3,0E-02	8,5E-02		5,9E-01	2009	0,29
	2001	4,9E+04	2,0E-02	2,5E-01	1,4E-01	8,0E-03	1,8E-02	9,0E-03		6,0E-03	3,5E-02	9,7E-02		5,8E-01	1880	0,31
	2002	7,0E+04	5,6E-02	1,2E-01	1,5E-01	1,6E-02	1,2E-02	1,3E-02	4,9E-02	1,3E-02	3,4E-02	5,4E-02		5,2E-01	2176	0,24
	2003	6,8E+04	4,5E-02	1,1E-01	1,8E-01	1,5E-02	2,1E-02	1,9E-02	6,8E-02	1,5E-02	3,7E-02	6,5E-02	7,6E-03	5,8E-01	2049	0,28
	2004	5,9E+04	2,4E-02	1,2E-01	2,1E-01	3,3E-02	4,9E-02	3,0E-02	1,2E-01	2,2E-02	3,7E-02	7,9E-02	3,2E-02	7,2E-01	1837	0,39
	2005	4,9E+04	1,5E-02	5,6E-02	6,9E-02	4,8E-02	1,9E-02	1,5E-02	4,4E-02	1,6E-02	1,8E-02	2,1E-02	3,0E-01	3,2E-01	2122	0,15
	2006	5,3E+04	8,0E-03	3,5E-02	4,0E-02	1,8E-02	1,4E-02	1,0E-02	2,2E-02	8,0E-03	8,0E-03	1,3E-02	2,4E-01	1,8E-01	2052	0,09
	2007	6,3E+04	6,0E-03	3,2E-02	2,9E-02	1,1E-02	9,0E-03	6,0E-03	1,8E-02	1,3E-02	6,0E-03	1,0E-02	1,3E-01	1,4E-01	2219	0,06
	2008	6,1E+04	8,1E-03	5,2E-02	4,7E-02	1,2E-02	1,4E-02	7,7E-03	2,1E-02	7,8E-03	7,6E-03	1,5E-02	1,8E-01	1,9E-01	1939	0,10
GRAVELINES	2000	4,7E+04	9,2E-02	1,6E+00	6,6E-01	5,8E-01		6,8E-02		9,7E-03	1,4E-02	9,7E-02		3,1E+00	4040	0,77
	2001	5,3E+04	8,5E-02	2,8E+00	8,9E-01	1,0E+00		3,3E-01	5,7E-01	2,3E-02	1,6E-02	9,1E-02		5,8E+00	4038	1,44
	2002	4,2E+04	1,3E-01	2,9E+00	9,1E-01	7,5E-01	5,6E-02	2,8E-01	2,5E-01	5,6E-02	6,3E-02	1,1E-01		5,5E+00	4044	1,36
	2003	5,9E+04	9,6E-02	5,2E-01	7,6E-01	5,9E-01	6,7E-02	1,0E-01	2,1E-01	8,6E-02	8,7E-02	9,4E-02		2,6E+00	4237	0,62
	2004	4,7E+04	8,7E-02	2,5E-01	7,3E-01	2,3E-01	6,2E-02	1,5E-01	1,9E-01	9,7E-02	8,7E-02	1,1E-01		2,0E+00	4406	0,45
	2005	5,3E+04	8,0E-02	3,0E-01	9,2E-01	2,4E-01	5,2E-02	1,1E-01	1,8E-01	5,4E-02	6,3E-02	9,5E-02	2,0E+00	2,1E+00	4367	0,48
	2006	4,4E+04	8,2E-02	3,4E-01	9,6E-01	4,9E-01	2,2E-02	6,6E-02	9,9E-02	4,5E-02	4,6E-02	9,4E-02	2,2E+00	2,2E+00	4389	0,51
	2007	7,4E+04	4,1E-02	2,0E-01	6,3E-01	4,6E-01	2,2E-02	6,1E-02	1,6E-01	2,4E-02	3,2E-02	7,6E-02	1,7E+00	1,7E+00	4250	0,40
	2008	6,0E+04	2,7E-02	1,6E-01	4,8E-01	1,6E-01	1,4E-02	3,2E-02	8,3E-02	1,8E-02	2,0E-02	6,6E-02	1,1E+00	1,1E+00	4285	0,25
NOGENT	2000	6,2E+04	3,0E-02	5,0E-01	6,0E-01	1,2E-01		4,3E-02	2,7E-02	9,8E-03	1,4E-02	5,2E-02		1,4E+00	2134	0,65
SUR-SEINE	2001	5,3E+04	3,3E-02	4,7E-01	7,2E-01	2,7E-01		6,3E-02	4,2E-02	6,1E-03	2,2E-02	9,2E-02		1,7E+00	2114	0,81
	2002	5,2E+04	3,9E-02	4,3E-01	7,2E-01	1,3E-01	1,5E-02	5,1E-02	4,8E-02	4,1E-02	3,5E-02	5,2E-02		1,6E+00	1963	0,80
	2003	4,8E+04	1,5E-02	1,4E-01	1,0E-01	1,7E-02	1,6E-02	1,7E-01	4,2E-02	9,4E-03	6,2E-02	7,0E-02		6,4E-01	2217	0,29
	2004	5,6E+04	1,5E-02	5,1E-01	9,0E-02	1,5E-02	2,7E-02	6,6E-02	5,1E-02	2,3E-02	2,8E-02	3,4E-02		8,6E-01	1906	0,45
	2005	5,4E+04	1,8E-02	1,7E-01	1,4E-01	2,9E-02	1,8E-02	2,1E-02	3,9E-02	1,6E-02	2,4E-02	3,8E-02	5,0E-01	5,1E-01	1927	0,27
	2006	6,7E+04	1,6E-02	1,5E-01	8,1E-02	3,2E-02	1,0E-02	1,6E-02	3,1E-02	1,2E-02	1,4E-02	2,5E-02	3,7E-01	3,9E-01	2207	0,17
	2007	6,7E+04	1,3E-02	8,0E-02	3,6E-02	1,7E-02	9,0E-03	1,4E-02	2,9E-02	1,5E-02	1,1E-02	1,6E-02	2,3E-01	2,4E-01	2365	0,10
	2008	4,9E+04	1,4E-02	9,8E-02	7,1E-02	2,0E-02	8,8E-03	1,3E-02	2,8E-02	1,4E-02	1,2E-02	1,6E-02	2,8E-01	2,9E-01	1832	0,16

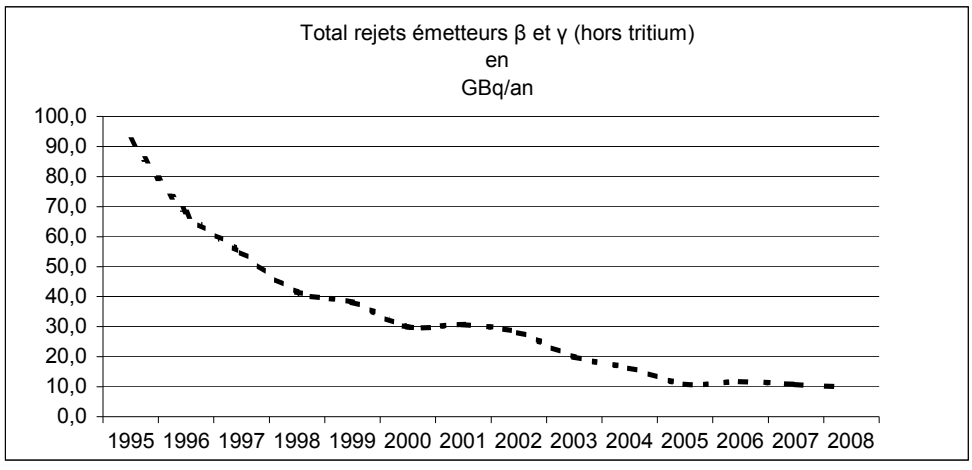
Rejets Liquides		Activités rejetées (GBq)												Total émetteurs β - γ	Energie nette	Total émetteurs β - γ normalisé
CNPE	**Année**	**3H**	**54Mn**	**58Co**	**60Co**	**110mAg**	**123mTe**	**124Sb**	**125Sb**	**131I**	**134Cs**	**137Cs**	**51Cr**	**GBq**	**MWe.an**	**GBq/GWe.a**
PALUEL	2000	1,1E+05	7,1E-02	1,5E+00	7,8E-01	3,1E-01	6,7E-03	3,2E-01	5,3E-01	1,9E-02	6,8E-02	4,0E-01		4,0E+00	4226	0,95
	2001	1,0E+05	1,7E-01	2,7E+00	1,8E+00	6,3E-01	5,1E-02	2,2E-01	8,5E-01	8,0E-02	8,0E-02	3,4E-01		6,9E+00	3880	1,78
	2002	9,4E+04	1,2E-01	1,2E+00	9,4E-01	1,7E-01	4,9E-02	1,7E-01	4,7E-01	1,1E-01	1,7E-01	2,7E-01		3,7E+00	3802	0,96
	2003	1,1E+05	9,8E-02	8,1E-01	1,0E+00	1,5E-01	3,4E-02	1,7E-01	1,9E-01	2,7E-02	6,1E-02	7,5E-02	2,7E-02	2,6E+00	3818	0,68
	2004	9,7E+04	1,2E-01	1,0E+00	1,1E+00	4,3E-01	5,4E-02	1,6E-01	1,9E-01	4,1E-02	8,1E-02	1,2E-01	8,4E-03	3,3E+00	3598	0,92
	2005	1,2E+05	7,4E-02	3,1E-01	6,4E-01	1,8E-01	3,3E-02	7,1E-02	1,2E-01	3,2E-02	4,5E-02	5,9E-02	1,5E+00	1,6E+00	4068	0,38
	2006	1,1E+05	6,3E-02	3,5E-01	3,4E-01	9,9E-02	3,1E-02	7,1E-02	1,1E-01	3,5E-02	4,0E-02	5,1E-02	1,2E+00	1,2E+00	3926	0,30
	2007	7,8E+04	7,1E-02	4,2E-01	3,6E-01	4,8E-02	6,0E-02	1,2E-01	8,8E-02	2,9E-02	3,7E-02	5,4E-02	1,3E+00	1,3E+00	3182	0,40
	2008	1,2E+05	5,3E-02	5,9E-01	3,1E-01	7,7E-02	1,8E-01	8,3E-02	1,2E-01	3,4E-02	4,6E-02	6,4E-02	1,9E+00	1,6E+00	4231	0,37
PENLY	2000	3,5E+04	2,7E-02	4,9E-01	3,2E-01	3,2E-02	1,7E-02	6,7E-02	2,3E-02	4,4E-03	4,1E-02	1,6E-01		1,2E+00	2028	0,58
	2001	4,5E+04	1,7E-02	4,0E-01	2,7E-01	1,8E-02	7,0E-02	2,1E-02	3,1E-02	6,1E-03	8,6E-02	1,8E-01		1,1E+00	2128	0,52
	2002	3,3E+04	2,7E-02	2,0E-01	4,1E-01	6,8E-02	4,0E-02	3,5E-02	1,4E-01	1,4E-02	8,7E-02	3,4E-01		1,4E+00	1780	0,76
	2003	2,6E+04	2,9E-02	5,8E-02	7,6E-01	3,7E-02	4,2E-02	2,1E-02	8,3E-02	1,6E-02	1,9E-01	4,6E-01		1,7E+00	2226	0,76
	2004	2,9E+04	3,8E-02	2,0E-01	6,1E-01	8,7E-02	4,7E-02	8,3E-02	5,6E-02	1,6E-02	6,0E-02	1,2E-01	9,2E-02	1,3E+00	2017	0,65
	2005	5,3E+04	2,8E-02	1,6E-01	4,6E-01	3,2E-02	2,4E-02	5,3E-02	5,9E-02	1,4E-02	3,7E-02	7,9E-02	9,3E-01	9,4E-01	2007	0,47
	2006	6,6E+04	2,5E-02	4,1E-01	2,5E-01	2,3E-02	1,6E-02	9,3E-02	8,4E-02	1,6E-02	3,5E-02	6,9E-02	1,0E+00	1,0E+00	2217	0,46
	2007	5,8E+04	1,8E-02	2,3E-01	1,1E-01	1,7E-02	5,7E-02	5,1E-02	5,4E-02	1,1E-02	1,8E-02	2,8E-02	5,8E-01	5,9E-01	2050	0,29
	2008	7,2E+04	1,6E-02	1,7E-01	2,1E-01	8,0E-03	4,0E-02	2,1E-02	3,3E-02	3,7E-03	5,8E-03	1,5E-02	5,2E-01	5,2E-01	2301	0,23
ST LAURENT	2000	2,3E+04	4,5E-02	6,9E-01	4,6E-01	2,6E-01	5,5E-02	9,7E-02	9,4E-03	1,5E-02	2,9E-02	7,6E-02		1,7E+00	1156	1,50
DES EAUX	2001	2,6E+04	4,7E-02	6,0E-01	2,8E-01	2,5E-01	8,0E-02	6,1E-02	2,0E-02	1,1E-02	1,7E-02	3,9E-02		1,4E+00	1468	0,96
	2002	2,5E+04	3,7E-02	6,6E-01	2,0E-01	1,7E-01	3,3E-02	8,9E-02	5,0E-02	1,6E-02	2,3E-02	4,6E-02		1,3E+00	1466	0,90
	2003	1,7E+04	4,4E-02	2,8E-01	1,6E-01	1,1E-01	3,5E-02	3,3E-02	6,4E-02	2,0E-02	2,7E-02	6,0E-02	4,0E-02	8,3E-01	1292	0,64
	2004	2,6E+04	1,9E-02	4,0E-02	7,8E-02	7,5E-02	1,7E-02	1,6E-02	3,8E-02	1,2E-02	1,5E-02	2,4E-02		3,3E-01	1459	0,23
	2005	1,9E+04	1,1E-02	6,8E-02	8,4E-02	3,5E-02	5,4E-03	9,0E-03	2,3E-02	7,7E-03	9,0E-03	1,7E-02	2,7E-01	2,7E-01	1265	0,21
	2006	2,2E+04	9,0E-03	1,0E-02	8,7E-02	1,3E-02	4,0E-03	7,0E-03	1,8E-02	6,0E-03	7,0E-03	9,0E-03	1,6E-01	1,7E-01	1475	0,12
	2007	2,0E+04	8,0E-03	3,2E-02	4,0E-02	4,9E-02	5,0E-03	8,0E-03	1,7E-02	6,0E-03	7,0E-03	1,0E-02	1,8E-01	1,8E-01	1406	0,13
	2008	2,8E+04	7,6E-03	2,6E-02	4,4E-02	2,7E-02	4,6E-03	7,8E-03	1,7E-02	6,0E-03	6,3E-03	9,0E-03	1,5E-01	1,6E-01	1534	0,10

3.2.1 Total measured releases for all CNPEs.

The table below shows the activities of releases from measured beta and gamma emitters (i.e., excluding carbon 14, which is calculated, but specifically including nickel 63 when it is measured) and excluding tritium, for all CNPEs.

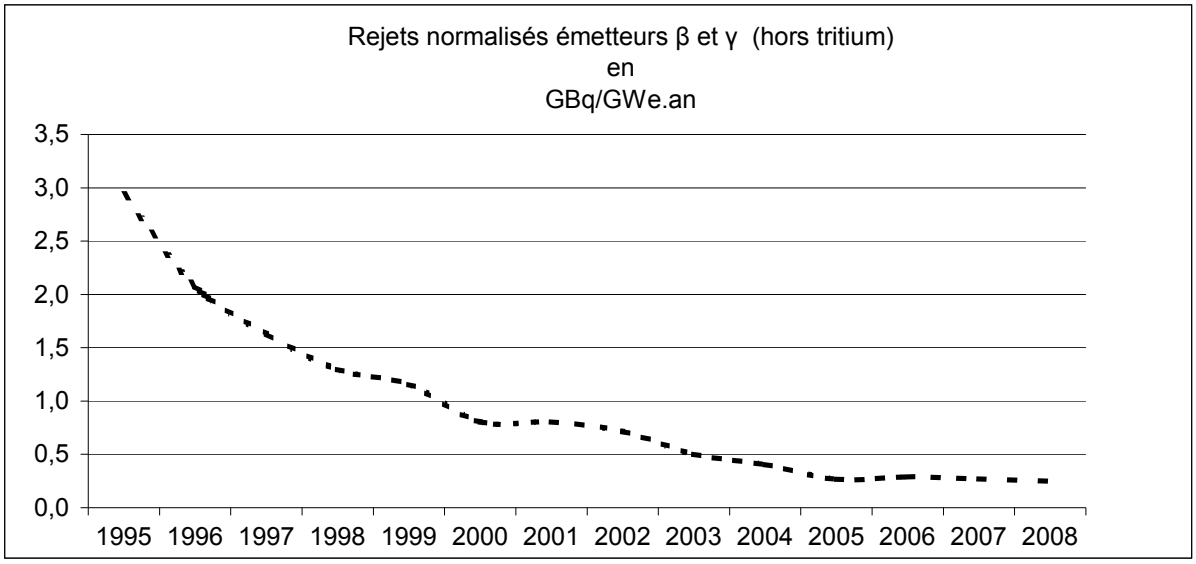
Year	Total releases of measured β and γ emitters (excluding tritium) in GBq	Total standardized releases of β and γ emitters (excluding tritium) in GBq/GWe.year
1995	92.1	2.94
1996	68.0	2.08
1997	54.6	1.63
1998	41.5	1.30
1999	38.1	1.16
2000	29.9	0.80
2001	30.7	0.81
2002	28.0	0.71
2003	19.9	0.50
2004	16.2	0.40
2005	10.9	0.27
2006	11.8	0.29
2007	10.8	0.27
2008	9.8	0.25

3.2.2 Variation of releases of measured beta and gamma emitters (excluding tritium) for all CNPEs.



3.2.3 Standardized releases

The graph of standardized releases of measured gamma and beta emitters (excluding tritium) highlights the progress achieved between 1995 and 2008, showing the activities released (divided by 10) in comparison with the power produced.



3.2.4 Comment concerning liquid releases of tritium

For tritium, the releases depend on the series (power and enrichment of the fuels). The average releases of liquid tritium per net power produced for the 2000-2008 period are:

- 15.1 TBq/GWe.year for the 900-MWe series over the 2000-2008 period.
- 25.8 TBq/GWe.year for the 1300-MWe series over the 2000-2008 period.
- 16.6 TBq/GWe.year for the 1450-MWe series over the 2000-2008 period.

3.3 Quality Assurance/Deviation Management (significant events)

The monitoring of environment-related events within the EDF is ensured by a two-level process: local (by the CNPEs) and national (by a special network). This network investigates events that are deemed to be major issues, occurring at French and foreign nuclear power plants.

Depending on their level of importance, these events are the subject of appropriate handling either at the national (generic aspect) or local level.

Each event is immediately declared to the Administration. If the event is considered to be significant, a report is prepared and sent to the Administration.

Since 2000, no event taking place at a French power station has led to a significant increase in liquid releases.

4. Control of discharges and monitoring of the environment

The operator is required to establish a program for controlling discharges and monitoring the environment. This program, defined in the discharge permit, is designed to ensure a proper management of discharges and control of their impact on the environment and on public health.

Controls on discharges are in particular designed to check on the figures stipulated in the authorizing order both for withdrawals of water and for radioactive discharges. These controls are defined for each parameter (activity, activity concentration, and emission rate) covered by a license application.

In addition to these controls, the operator performs environmental-monitoring measurements whose goal is to assess the impact of its installation's operations. This monitoring comprises:

- Periodic measurements of certain radiochemical parameters, in terms of activity concentrations or specific activities,
- Continuous monitoring of the parameters,
- Radioecologic surveys.

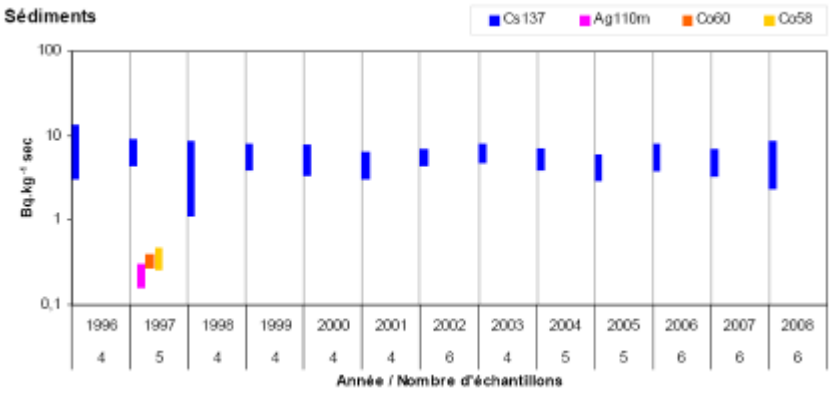
The radioecologic measurements carried out around nuclear sites allow estimates of the chronic releases from a CNPE in normal operation. These measurements, which cover both land-based and aquatic ecosystems, are performed every year (annual monitoring) and particularly address tritium and the gamma-emitting radionuclides. They are supplemented by studies carried out every ten years over the lifetime of nuclear installations (ten-year inventory), which cover a greater variety of matrices and radionuclides. These results are compared with radioecologic data collected before the startup of the facility (zero point).

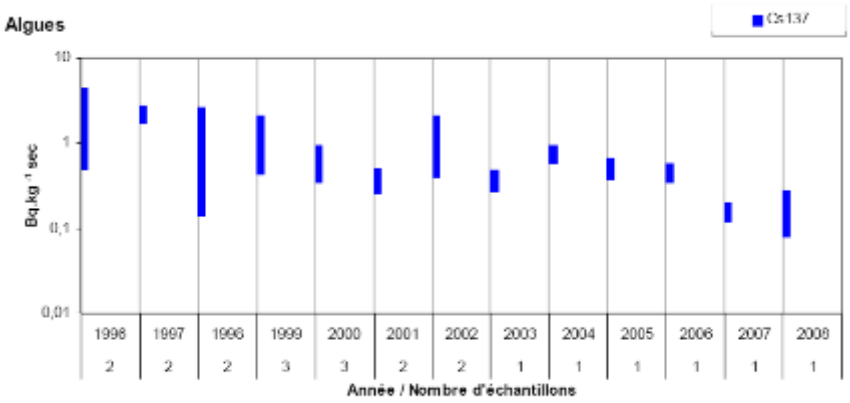
The control and monitoring procedures take into account the experience acquired since work began in this field. They represent an optimized system of control and monitoring, based on the most pertinent data and practices.

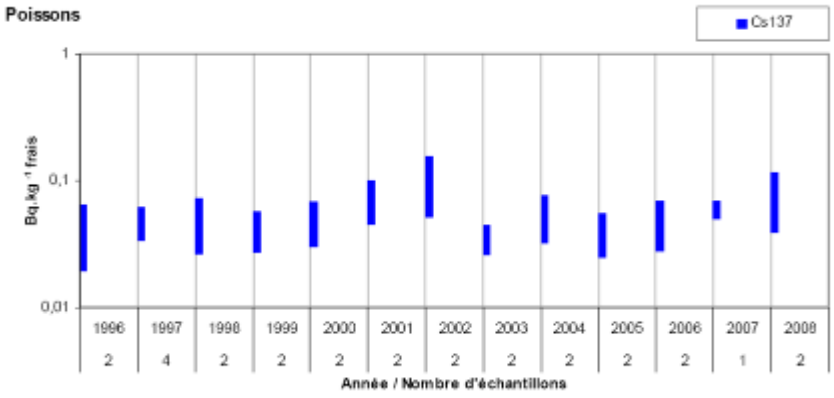
A summary of the results for the marine sites is presented in the tables below[8].

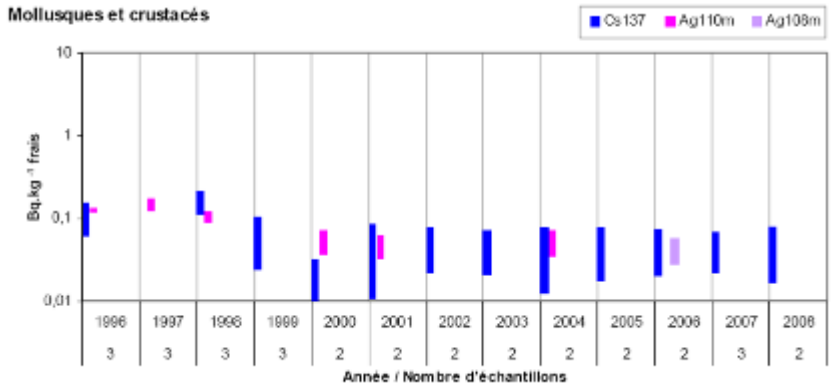
[8] NB: These data are in addition to the data that France regularly sends directly to OSPAR.

Blayais CNPE

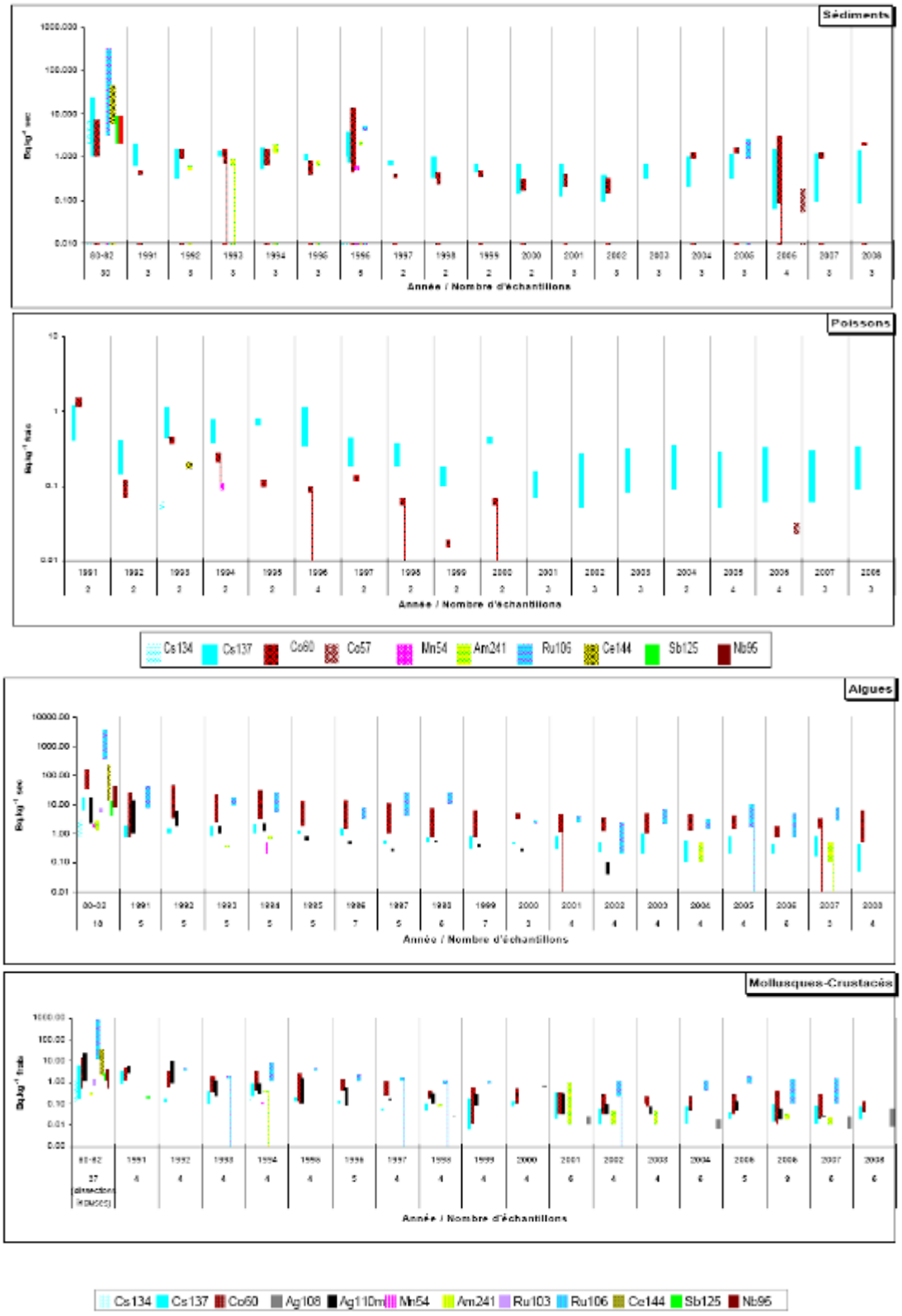




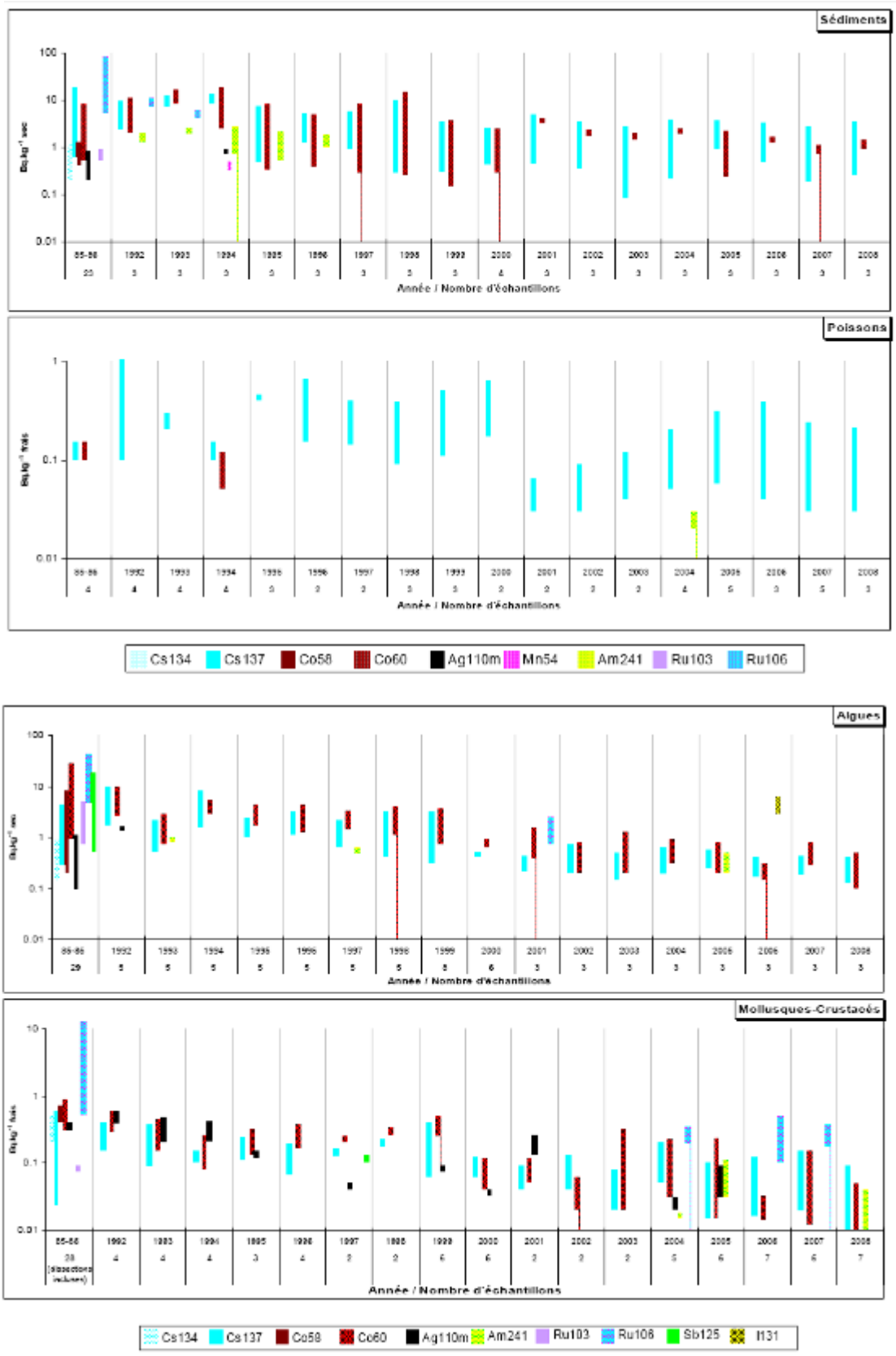




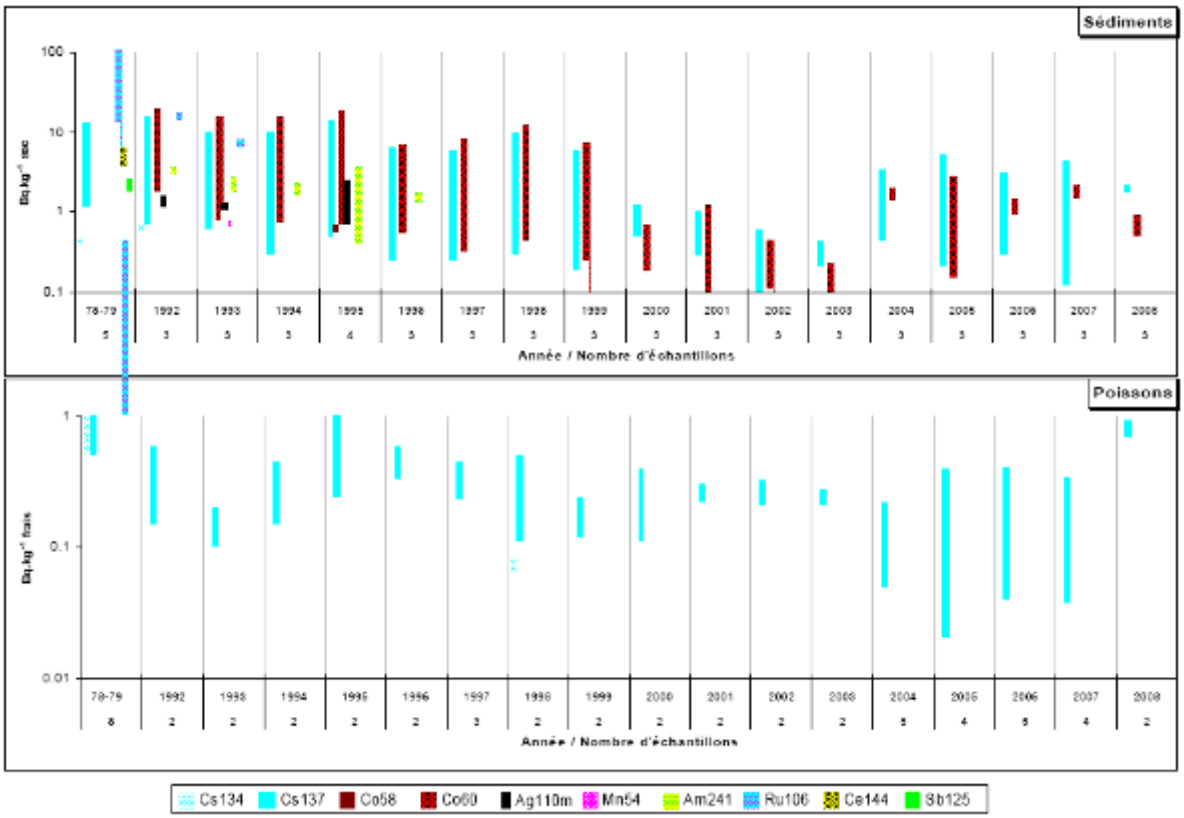
Flamanville CNPE

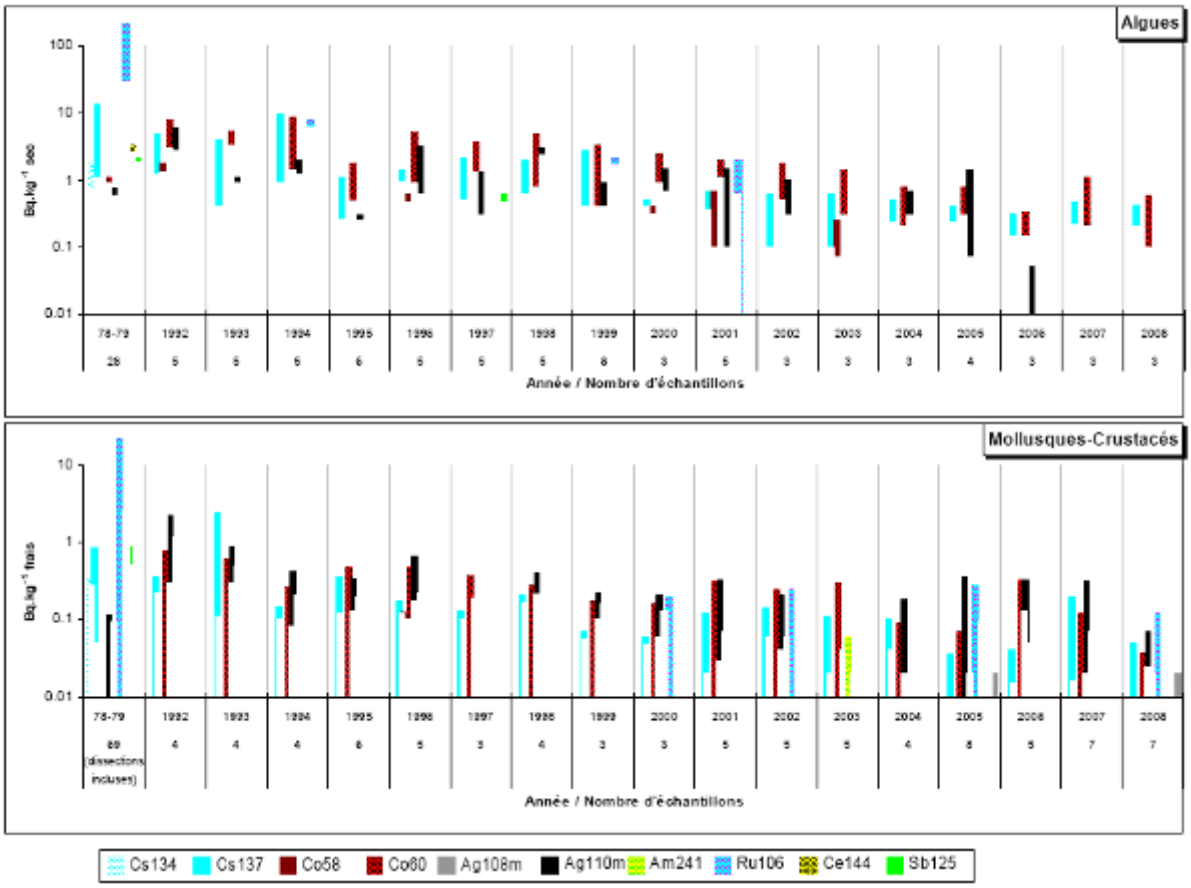


Penly CNPE

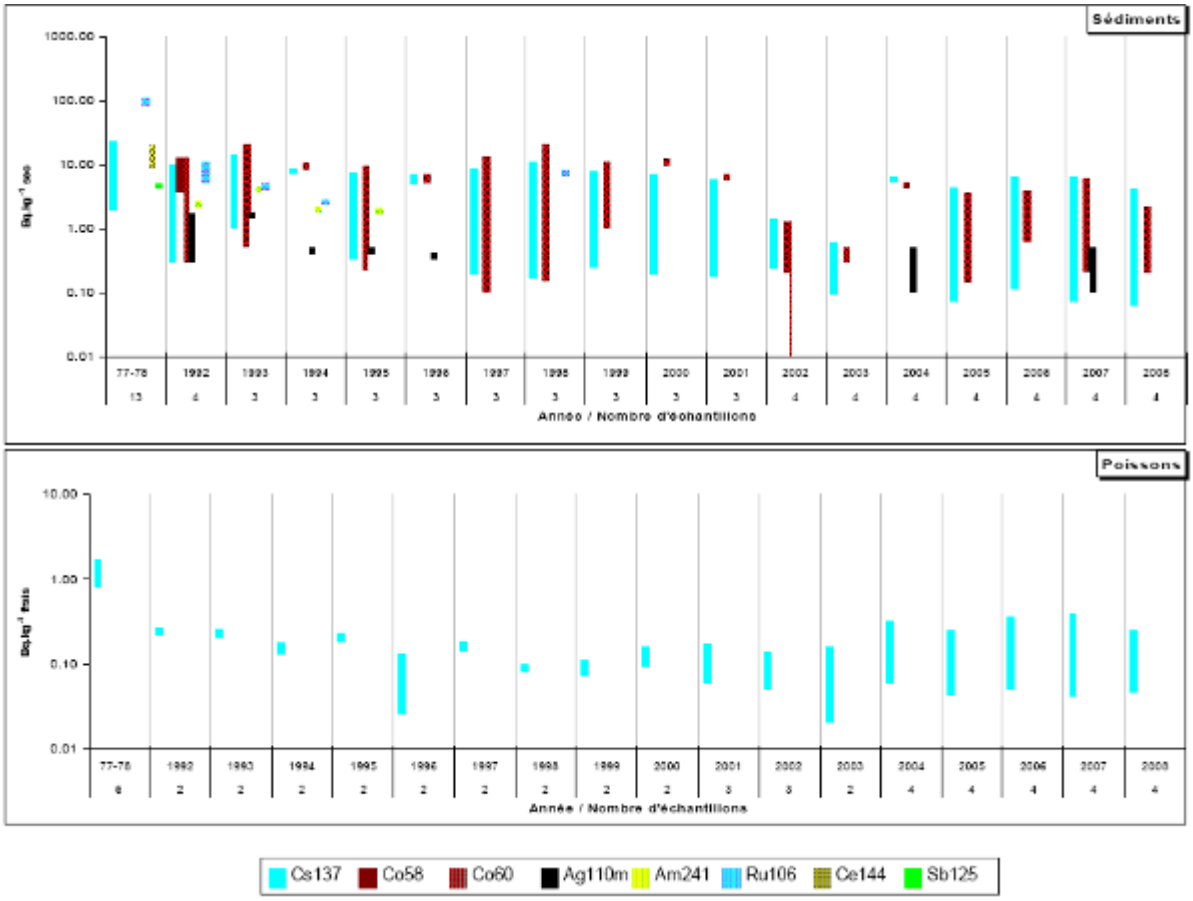

Sédiments
Bq.kg-1 sec
Année / Nombre d'échantillons
Poissons
Bq.kg-1 frais
Année / Nombre d'échantillons
Cs134 Cs137 Co58 Co60 Ag110m Mn54 Am241 Ru103 Ru106
Algues
Bq.kg-1 sec
Année / Nombre d'échantillons
Mollusques-Crustacés
Bq.kg-1 frais
Année / Nombre d'échantillons
Cs134 Cs137 Co58 Co60 Ag110m Am241 Ru103 Ru106 Sb125 I131

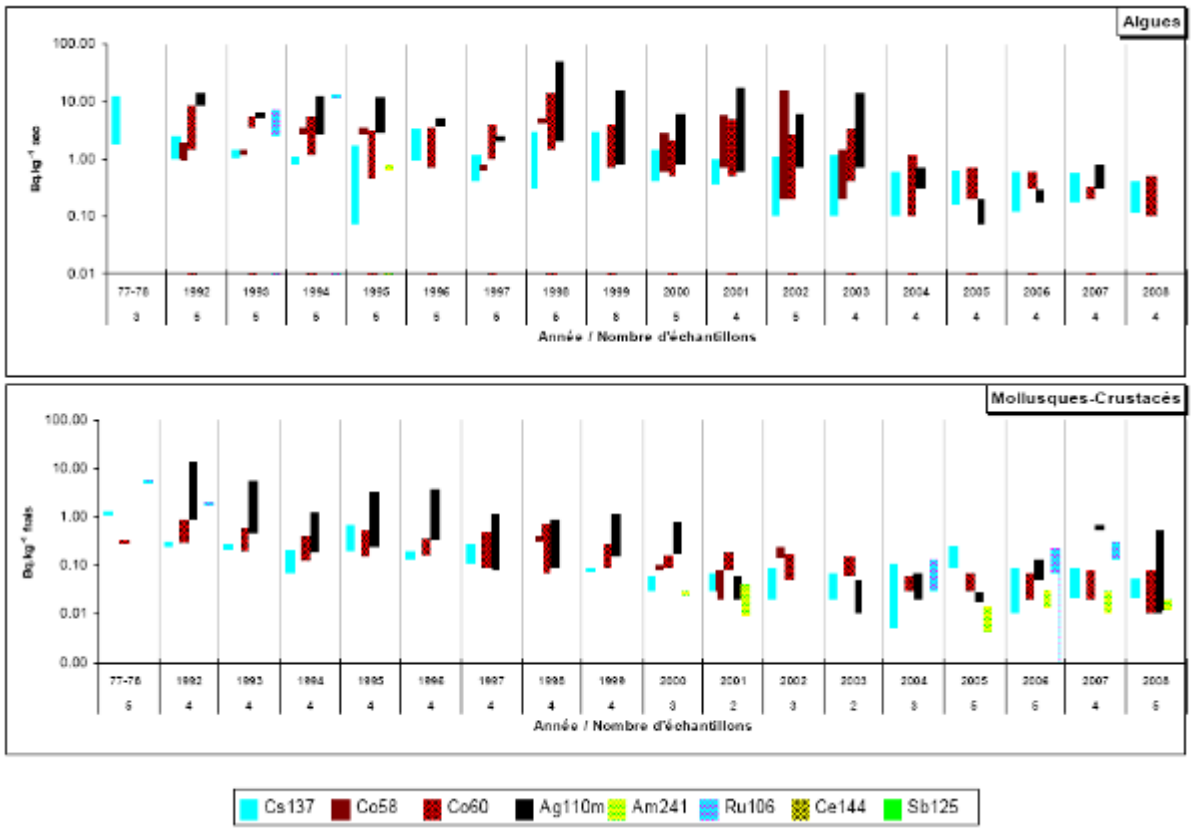
Paluel CNPE


Sédiments
Bq.kg⁻¹ sec
Année / Nombre d'échantillons
Poissons
Bq.kg⁻¹ frais
Année / Nombre d'échantillons
Cs134 Cs137 Co58 Co60 Ag110m Mn54 Am241 Ru106 Ce144 Sb125


Algues
Bq.kg⁻¹ sec
Année / Nombre d'échantillons
Mollusques-Crustacés
Bq.kg⁻¹ frais
Année / Nombre d'échantillons
Cs134 Cs137 Co58 Co60 Ag108m Ag110m Am241 Ru106 Ce144 Sb125

Gravelines CNPE





5. Radiological impact of marine sites

Studies of the radiological impact of CNPEs rely heavily on a methods manual prepared at the request of the Directorate-General for Health, and approved by France's Senior Council for Public Health. The computer tools used by EDF to calculate doses were the subject of a comparative analysis as part of the Nord-Cotentin study in 1999. The results obtained are similar to those obtained using other calculation codes. In addition to the food intake specific to each CNPE, the model for calculating the dose also includes, for marine sites, external exposures due to 100 hours of exposure on the beach and 20 hours/year of swimming with ingestion of seawater (1 L/year). Calculations of the annual dose are a recent requirement of the regulations. In accordance with the regulations they are performed annually for the adults in the reference group's population for all sites, and broken down radionuclide by radionuclide beginning in 2009.

The transfer functions between activity and dose were updated in 2006 using the properties shown in the tables below. These tables also show the total effective dose attributable to discharges of liquid radioactive effluents (including tritium and calculated carbon 14) for the years 2005-2008, at marine sites.

	Years	Annual total dose due to liquid discharges, in microSv
Le Blayais	2005	0.37
	2006	0.38
	2007	0.49
	2008	0.43

Characteristics of the "Le Bastion" Reference Group	
Food intake (kg/year):	
Root vegetables	52.5
Leafy vegetables	14.4
Fruiting vegetables and fruits	62.1
Milk	84.4
Meat	47.5
Fish	18.3
Mollusks	2.3
Crustaceans	2.3

	Years	Annual total dose due to liquid discharges, in microSv
Flamanville	2005	0.28
	2006	0.26
	2007	0.25
	2008	0.16

Characteristics of the "La Berquerie" Reference Group	
Food intake (kg/year):	
Root vegetables	31.4
Leafy vegetables	4.6
Fruiting vegetables and fruits	59.6
Milk	97.8
Meat	47.8
Fish	13
Mollusks	6.7
Crustaceans	7.1

	Years	Annual total dose due to liquid discharges, in microSv
Paluel	2005	0.65
	2006	0.60
	2007	0.49
	2008	0.65

Characteristics of the "Le Tot" Reference Group	
Food intake (kg/year):	
Root vegetables	57
Leafy vegetables	13
Fruiting vegetables and fruits	52.5
Milk	93.9
Meat	43.6
Fish	18.3
Mollusks	8.4
Crustaceans	8.4

	Years	Annual total dose due to liquid discharges, in microSv
Penly	2005	0.34
	2006	0.37
	2007	0.34
	2008	0.37

Characteristics of the "Saint Martin Plage" Reference Group	
Food intake (kg/year):	
Root vegetables	57
Leafy vegetables	13
Fruiting vegetables and fruits	52.5
Milk	93.9
Meat	43.6
Fish	18.3
Mollusks	8.4
Crustaceans	8.4

	Years	Annual total dose due to liquid discharges, in microSv
Gravelines	2005	0.24
	2006	0.26
	2007	0.25
	2008	0.23

Characteristics of the "Petit Fort Philippe Nord" Reference Group	
Food intake (kg/year):	
Root vegetables	93
Leafy vegetables	11.8
Fruiting vegetables and fruits	42.3
Milk	68.9
Meat	44.3
Fish	24.4
Mollusks	6.8
Crustaceans	6.8

Part IV: Application of the B.A.T to the Radioactive Discharges of the CEA centres

CEA FONTENAY AUX ROSES CENTER

1. Site characteristics

The site concerned is known as "CEA de Fontenay-aux-Roses".

1.1 Type of facility

The site currently consists of research laboratories (life sciences, robotics, etc.) and two basic nuclear installations (INB) in the cleanup and dismantling phase.

1.2 Start of operations and decommissioning

The French Alternative Energies and Atomic Energy Commission (CEA) Centre at Fontenay-aux-Roses, the first CEA research centre, was created in March 1946. Several generations of nuclear facility have been constructed there. They were in operation until their gradual decommissioning occurred between 1982 and 1995. Up until 2006, there were 4 INB on the site. Since then, only 2 INB remain: INB165 known as "INB procédé" (Process-INB) and INB166 known as "INB support" (Support-INB).

1.3 Location

The site is located in the district of Fontenay-aux-Roses (Department 92), several kilometres from Paris.

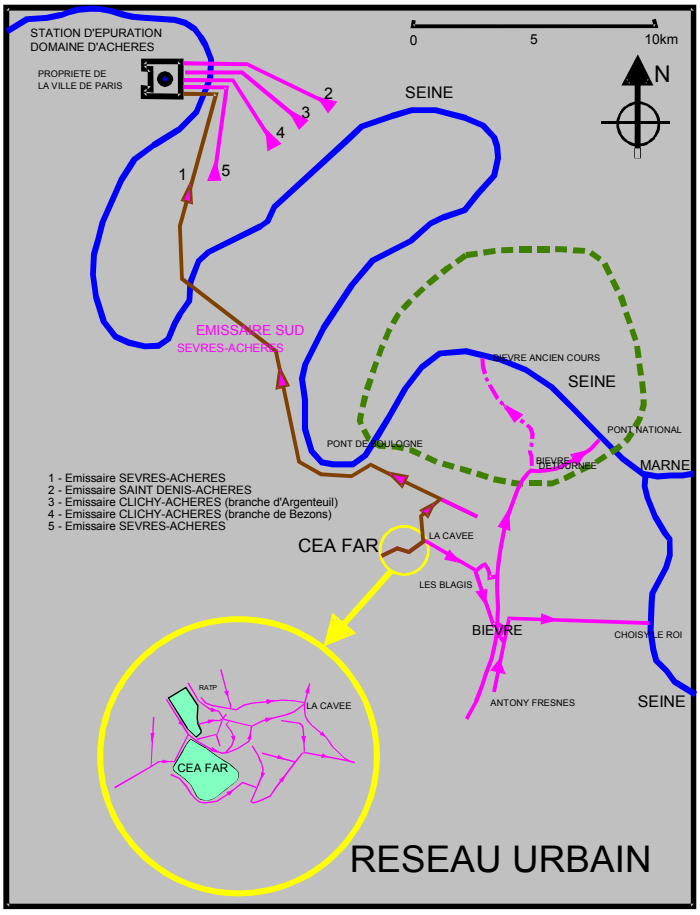
1.4 Receiving waters and catchment area

All of the radioactive effluents are stored and then evacuated following processes which depend on the specific nuclear sector concerned.

Liquid effluents which are likely to contain traces of radioactivity are stored in the laboratory's tanks. These effluents are inspected before authorisation for discharge is granted, in accordance with the decree of March 30,1988 relating to discharges from the centre and to the authorisation of liquid and gaseous effluent discharges by the nuclear industry research centre at Fontenay-aux-Roses.

Monitoring programs for liquid effluent discharges, put in place at CEA Fontenay-aux-Roses, also comply with the regulation on authorisation of discharges of non-domestic wastewater from this establishment into the public sewage network of the Department of Hauts-de-Seine. This decree, dated 22 March 2006, was established by the Hauts-de-Seine General Council.

The characteristics of the effluents conform to the regulations in these decrees. The discharge is made directly into the communal and departmental sewerage systems, following the methods defined in the waste directives of the centre; these internal specifications define the procedures that must be followed in order that the regulations are adhered to. The waters are then transported to the purification plant at Achères (30 km from the site), which then discharges the treated effluent into the Seine.



Network of receiving waters

1.5 Production

The centre is dedicated to research. There are no research reactors active on the site.

2. Discharges

2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

In general, the methodology applied for cleanup, waste management procedures as specified in waste studies (in application of the inter-ministerial decree of 31/12/1999) and the waste directives of the centre, all contribute to the overall reduction of discharges and emissions.

With regard to liquid discharges:

- The SABINE station (Station d'Assainissement des Boues Issues du Nettoyage des Egouts - Station for the cleansing of slurry resulting from the cleaning of sewers), created in 1993, is used to treat slurry resulting from cleaning of the sewer network at the Centre, from the bottom of the tanks and the underground technical galleries. The slurry effluents are collected by hydro-cleaning and then treated by settling filtration. The dehydrated slurries and clarified effluents are then directed towards the appropriate waste management processes.
- The retention tanks were created in 2003 and 2004 in order to recover any water used for extinguishing a fire in one of the INB (the retention tanks are sized to be able to recover water used in the most serious extinguishing scenario conceivable).

The programme of denuclearisation of the centre, which is currently in progress, will include the cleanup and complete dismantling of the INB. This process will be accompanied by ever smaller gaseous effluent and liquid discharges which will remain at the current level during the cleanup phase in-order that they are subsequently abated.

2.2 Efficiency of the abatement systems

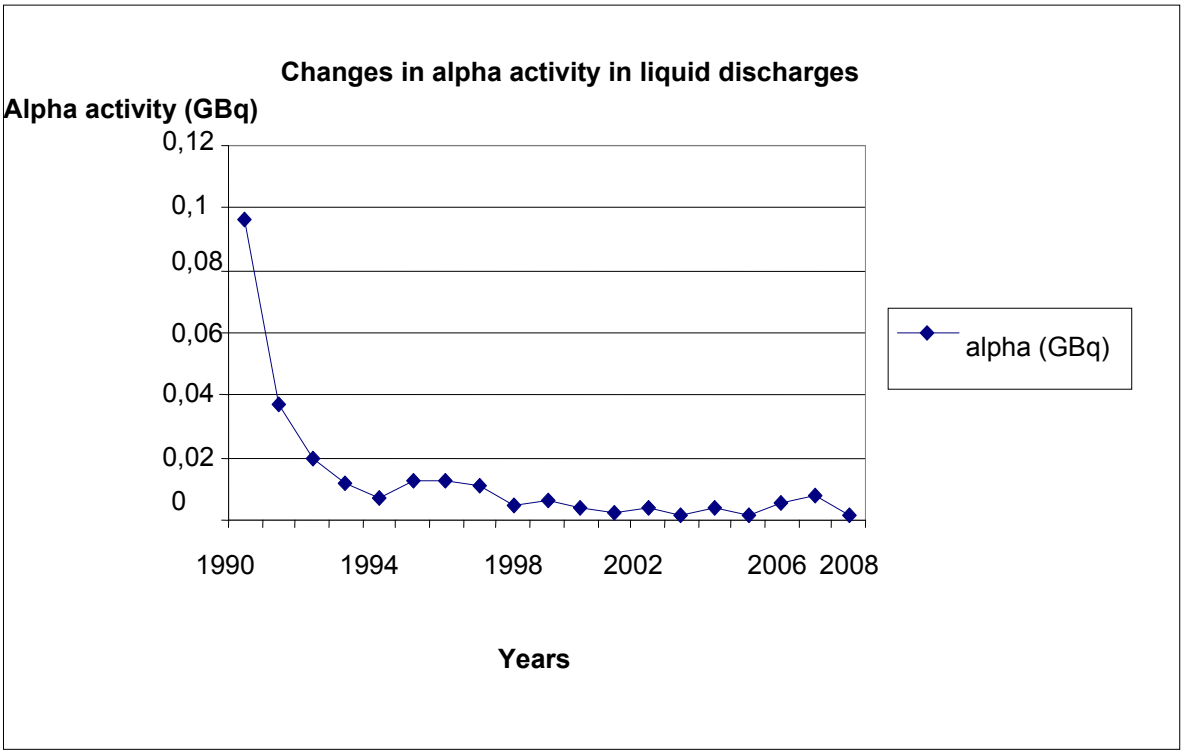
Annually, the SABINE station produces on average around 5 m^3 of very low level activity waste (dehydrated slurries) and 180 m^3 of liquid effluents which are discharged into the urban server (after inspections according to the waste directives of the centre).

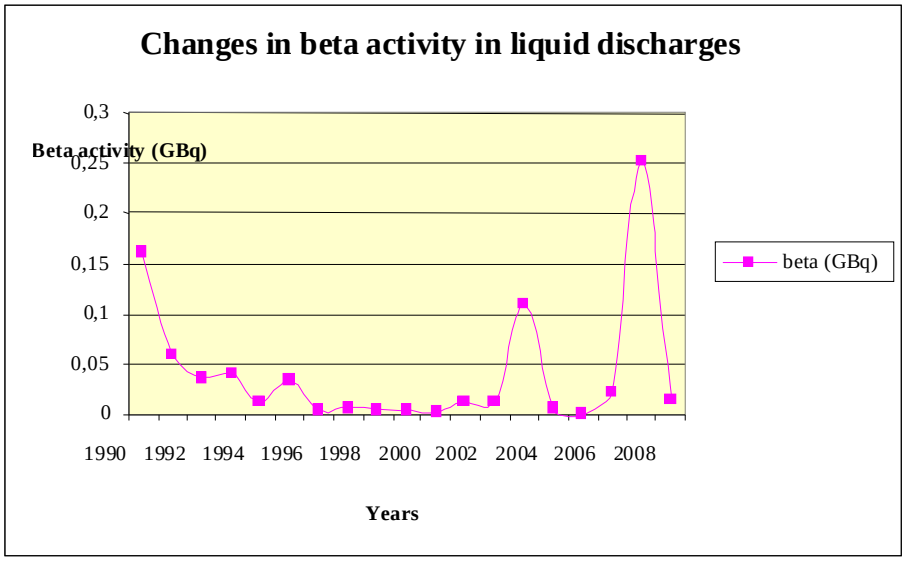
2.3 Annual liquid discharges

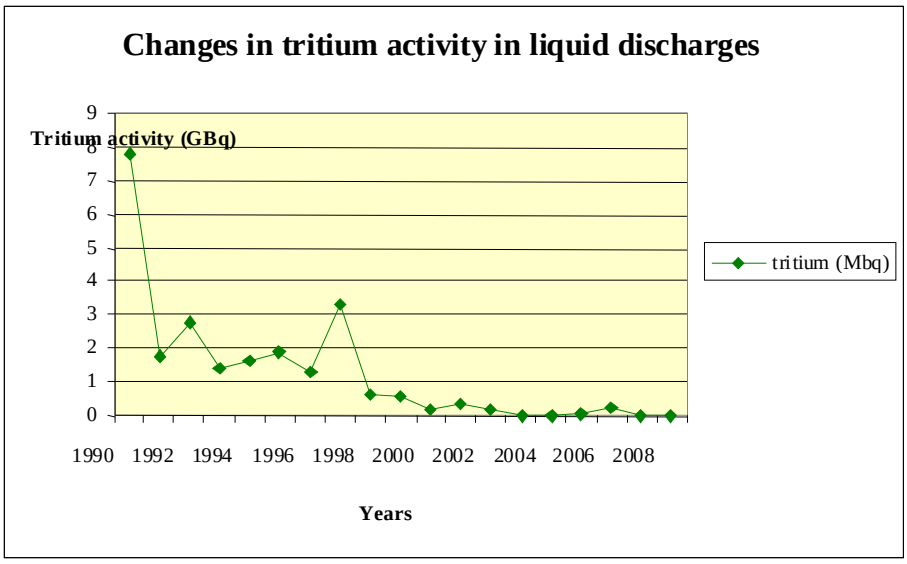
The annual liquid discharge activities are summarized in the table below:

Discharges in GBq	2000	2001	2002	2003	2004	2005	2006	2007	2008
Alpha emitters	3.6. 10^{-03}	2.7. 10^{-03}	4.6. 10^{-03}	1.3. 10^{-03}	4.3. 10^{-03}	1.7. 10^{-03}	6. 10^{-03}	8. 10^{-03}	2. 10^{-03}
Beta emitters*	2.2. 10^{-03}	1.3. 10^{-02}	1.1. 10^{-02}	1.1. 10^{-01}	5. 10^{-03}	1. 10^{-03}	2.2. 10^{-02}	2.5. 10^{-01}	1.4. 10^{-02}
Tritium	1.5. 10^{-01}	3.3. 10^{-01}	1.7. 10^{-01}	9. 10^{-03}	6.3. 10^{-03}	6.3. 10^{-02}	2.2. 10^{-01}	1.6. 10^{-02}	1.1. 10^{-02}

*The wide variations observed result from the diversity of cleanup and dismantling works for the facilities.


Changes in alpha activity in liquid discharges
Alpha activity (GBq)
0,12
0,1
0,08
0,06
0,04
0,02
0
1990
1994
1998
2002
2006
2008
alpha (GBq)
Years


Changes in beta activity in liquid discharges
Beta activity (GBq)
0,3
0,25
0,2
0,15
0,1
0,05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
beta (GBq)
Years


Changes in tritium activity in liquid discharges
Tritium activity (GBq)
9
8
7
6
5
4
3
2
1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
tritium (Mbq)
Years

2.4 Quality systems for data retention and management

The support units at the centre as well as the INB are ISO 9001 certified.

2.5 Summary evaluation

Criterion	Evaluation
MTD/MPE indicators:	
• Relevant systems put in place	Relevant systems
• Decontamination or abatement factor	Effective systems
• Downward trend in discharges	The downward trend has been significant for more than 10 years. There are no more INB in operation.
• Comparison with values recorded by similar facilities	***Not applicable***
• Relevance and reliability of the quality assurance systems	Relevant quality assurance systems
• Relevance of the target	yes
Comprehensive nature of the data communicated	yes
Reasons for variation compared to the indicators	***Not applicable***
Uncertainties	Determined
Other information	***Not applicable***

3. Environmental Impact

3.1 Concentration of radionuclides in environmental samples

The CEA centre at Fontenay-aux-Roses does not discharge directly into the marine environment, but rather into the Seine after passing through the purification station at Achères, via the water sewerage network.

The large dilution which occurs, by a factor of order 33,000, between the discharge into the urban sewage water network (7.5. 10^{-03} $m^3.s^{-1}$ on average) and discharge into the Seine (mean flow of 250 $m^3.s^{-1}$) should be noted. If the mean flow at the mouth of the Seine (2,500 $m^3.s^{-1}$) is also considered, then the dilution factor increases to 330,000.

By considering the values measured during the last four years, from 2005 to 2008, the concentration of radionuclides added to the urban sewage water network, downstream of the centre, is seen to be on average of order 20 $Bq.m^{-3}$ for alpha emitters and 300 $Bq.m^{-3}$ for beta emitters and tritium. At the mouth of the Seine, taking account of the dilution factor, the concentrations will have been of order 6. 10^{-05} $Bq.m^{-3}$ for alpha emitters and 1. 10^{-04} $Bq.m^{-3}$ for beta emitters and tritium.

3.2 Environmental monitoring program

The environmental monitoring program is described in the monitoring plan which defined the requirements of the decree of March 30, 1988.

For liquid discharges, around the clock monitoring is performed of effluents passing into the centre's two drainage channels and from these into the urban sewage downstream from all the outflow points at the centre. There are similar checks on the groundwater, re-emergence points and lakes.

Sampling frequencies are varied and range from daily sampling to annual sampling.

The number of annual samplings is around 1000; these are taken from the urban sewers, mains water, drainage channels, groundwater, re-emergence points, surface water and rainwater. The measurements performed on the samples amounted to a total of around 3200 analyses per year; these are mainly for analysis of the total alpha and beta counts as well as tritium and carbon-14 analyses.

3.3 Quality assurance systems for the environmental monitoring

The support units at the centre have obtained ISO 9001 certification (in particular, for the process of controlling the environmental impact of the centre's activities).

The analysis laboratories are COFRAC (French committee of accreditation) accredited according to standard ISO 17025 and the other technical standards in force. The Site and Environment Monitoring Laboratory has approvals delivered by the French Nuclear Safety Authority to provide environmental radioactivity measurements which are performed as part of the national measurement network (decree of July 8, 2008).

3.4 Summary evaluation

Criterion	**Evaluation**
MTD/MPE indicators:	
• Downward trends in the concentrations	Effective downward trends since the shutdown of the INB
• Relevance of the environmental monitoring programme	Relevant programme
• Relevance and reliability of the quality assurance systems	Appropriate and reliable systems
Comprehensive nature of the data communicated	Yes
Reasons for variation compared to the indicators	***Not applicable***
Uncertainties	Determined
Other information	***Not applicable***

4. Ionising radiation doses received by the public

4.1 Mean annual doses for individuals from the critical group

The annual exposure of the critical group due to liquid discharges is summarised in the table below:

Year	2003	2004	2005	2006	2007	2008
Exposure (mSv)	$7.1.10^{-7}$	$3.6.10^{-7}$	$1.4.10^{-7}$	$4.9.10^{-7}$	$1.8.10^{-6}$	$1.5.10^{-7}$

The mean value for the period 2003-2008 is $6.1.10^{-7}$ mSv per year.

The methodology is described briefly in section 4.4.

4.2 Definition of the critical group

The critical group is made up of individuals working eight hours per day in the fields fertilized with slurries from the purification centre at Achères and irrigated with water from the Seine.

4.3 Exposure routes considered

It is assumed that all radioactivity discharged by the CEA centre at Fontenay-aux-Roses arrives at the Achères purification station. The individuals in the critical group:

- exclusively consume products cultivated in these fields;
- consume fish caught in the Seine downstream from Achères;
- drink reprocessed water from the Seine.

Note: no allowance is made for any radioactivity in the Seine due to natural radioactive elements or due to radioisotopes coming from other facilities.

4.4 Methodology for estimating doses

Doses are estimated using the "ABRICOT" code, employing a source term which corresponds to the effective discharges.

4.5 Quality assurance systems for dose estimates

The CEA belongs to a centre of expertise, developed by its Analysis, Surveillance and Environment Department (DASE), at Bruyères-le-Châtel.

4.6 Summary evaluation

Criterion	Evaluation
MTD/MPE indicators:	
• Downward trends in doses	The doses are very low since the shutdown of the INB
• Lower exposure than the constraint	***Not applicable***
• Relevance of the critical group	Critical group chosen in a relevant way
• Realism and reliability of the dose estimates	The dose estimates are reliable and sufficiently realistic
• Relevance of the targets	***Not applicable***
• Relevance and reliability of the quality assurance systems	Appropriate and reliable systems are in place
Comprehensive nature of the data communicated	Yes
Reasons for variation compared to the indicators	Not applicable because of the very low doses obtained.
Uncertainties	***Not applicable***
Other information	***Not applicable***

CEA SACLAY CENTRE

1. Site characteristics

1.1 Name of site

The CEA Saclay centre, with 5000 researchers, is the largest of the CEA centres. Located on an area of around 150 hectares, it houses research and innovation of the highest quality on the national and European scales. It is characterised by a wide diversity of activities, ranging from fundamental research to applied research in very varied areas and disciplines, such as astrophysics, nuclear physics, particle physics, metallurgy, electronics, biology, nuclear medicine, pharmacology, climatology, numerical simulation, chemistry and the environment.

Five primary research directions are pursued there: research in physical sciences, nuclear applications research, health research, technological research and studies of the environment. The CEA Saclay centre also houses the National Institute for Nuclear Science and Technology (INSTN) whose mission is focused on higher education and training.

Aerial view of the centre at Saclay

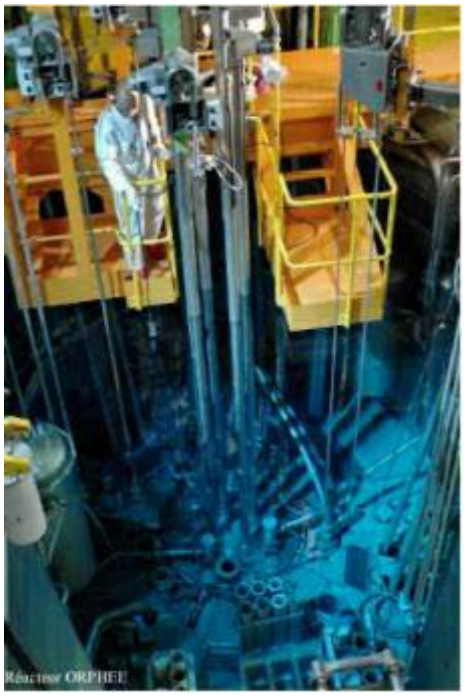
1.2 Type of facility

The CEA Saclay centre has eight basic nuclear installations (INB) and around 80 facilities classified for environmental protection (ICPE); these are the research laboratories. The 8 INB are the following:

- two open pool-type research reactors and a teaching reactor, the latter being permanently shut down,
- two high-level activity laboratories for the study of irradiated materials, of which one is now in the dismantling phase,
- two reprocessing facilities for radioactive liquid effluent and solid radioactive waste,
- an irradiation facility with a mission to study radiosterilisation of products intended for medical use.

The company IBA/CIS Bio International is situated on the edge of the site. It manufactures and sells radiopharmaceutical products for medical use and contains an INB.

The CEA's OSIRIS reactor



The CEA's ORPHEE reactor

1.3 Dates of commissioning/ granting of a licence/ decommissioning

Research was first performed at CEA Saclay at the start of the 1950s. The key dates for the 8 INB at the centre are the following:

- the two, open pool type research reactors achieved criticality on September 8, 1966 for the OSIRIS reactor (INB 40) and on December 19, 1980 for the ORPHEE reactor (INB 101),
- the teaching reactor ULYSSE (INB 18), of the Argonaut type, achieved criticality on July 23, 1961 and its final shutdown was pronounced on February 9, 2007,
- the high-level activity laboratory (LHA – INB 49) gradually increased its operations from 1954 to 1960 and its final decommissioning took place on September 18, 2008,
- the irradiated fuel research laboratory (LECI – INB 50) was commissioned in November 1959; a second line of shielded cells was commissioned in 1970 and an extension with a third line of shielded cells became operational in October 2005,
- the radioactive liquid effluent reprocessing and management area (INB 35) has been in existence since 1958. Its last major overhaul consisted of constructing a new evaporator and a workshop for cementation of concentrates which will be commissioned in 2010,
- the solid radioactive waste management area (INB 72) was authorised in June 1971,
- and finally, the irradiation facility POSEIDON (INB 77) was authorised in August 1972.

1.4 Location

The CEA Saclay centre is located around 20 km south-west of Paris, with average coordinates of latitude 48°43’ North and longitude 2°09’ East (see map in appendix A).

1.5 Receiving waters and catchment area

The industrial waste water produced by the CEA Saclay Centre is sent, after treatment, into the Saclay ponds, from where the waters flow on into the ru de Vauhallan and then into the Bièvre and the Seine before finally reaching the English Channel. The dilution factor at the mouth of the Seine, when compared to the mean flow of industrial water produced, is around 50,000.

Aerial view of the Saclay centre and the ponds

1.6 Production

The OSIRIS reactor has a thermal power of 70 MW(th) and the ORPHEE reactor has a power five times less, 14 MW(th). At decommissioning, the teaching reactor, ULYSSE, had an almost zero power output. No energy production (heat or electricity) is coming from these reactors.

1.7 Other relevant information

Radioactive liquid effluent, produced by the various facilities at CEA's Saclay centre, is collected exclusively in dedicated tanks, or drums in the case of small producers. For this type of effluent, there is no network of channels on the site which could carry it to a direct or indirect discharge point. Rather, these effluents are transported in special road tankers to the radioactive liquid effluent treatment centre, which is part of INB 35 known as STELLA, and are treated there. After a very major renovation programme including, in particular, the commissioning of a new evaporator and a new cementation workshop, the facility will reopen in 2010 for radioactive effluent treatment. The volumes treated will rise gradually to between 1000 and 1500 m^3 per year.

View of the STELLA facility

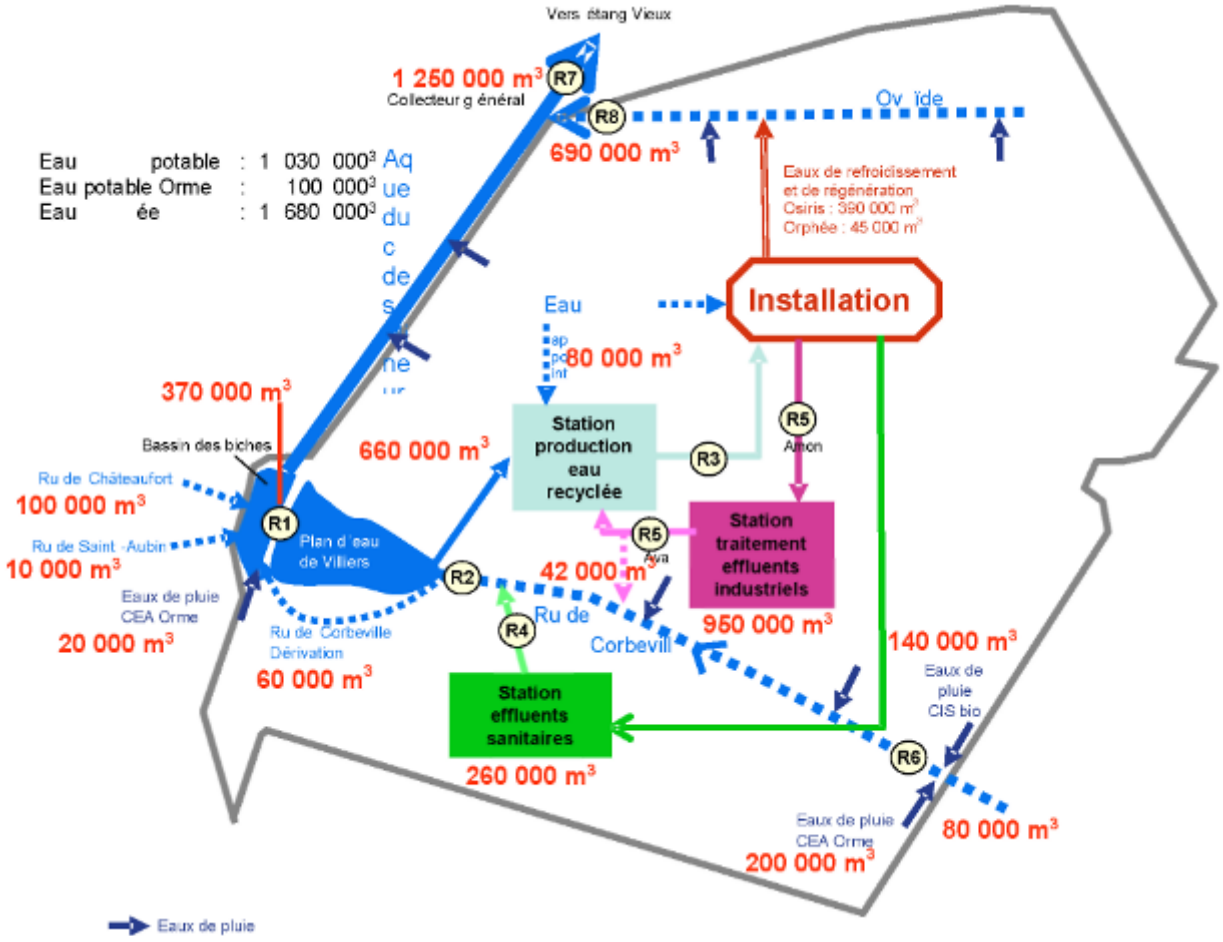
The evaporator at the STELLA facility

2. Discharges

2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

Apart from the radioactive liquid effluent treatment station referred to in 1.7 above, which has units for distillation of effluents and cementation of salts which have concentrated the radioactivity, the CEA Saclay centre also possesses:

- a station which includes processes of neutralisation, settling, pre-chlorination, coagulation, filtration through sand, neutralisation by sodium hydroxide and post chlorination. The station treats industrial effluents coming from the various laboratories and for produces recycled water starting with the majority of these processed effluents, which is intended to reduce consumption of drinking water by supplying the cooling circuits of the research reactors and the various facilities;
- an effluent cleaning treatment station (settlement, digestion, biological treatment, clarification) which will be replaced in 2012 by a new station, probably of the membrane type, in order to significantly reduce discharge of nitrate and phosphates. Furthermore, this commitment by the CEA has been written into the prefectural decree of 25 September 2009, regulating liquid discharges from the centre both for radionuclides and for physical-chemical and chemical parameters.



Water cycle at CEA-Saclay (2008 data)

2.2 Efficiency of the abatement systems

The decontamination factor for radioactive liquid effluent is around 104, except for tritium and carbon-14. Tritiated and/or carbon effluents, separately collected, can be added to the cement after distillation. The cement fixes the radioactive concentrates.

Ultimately, the waste water discharged into the natural environment adheres to the radioactivity limits defined by European directive 98/83 on water intended for human consumption.

2.3 Annual liquid discharges

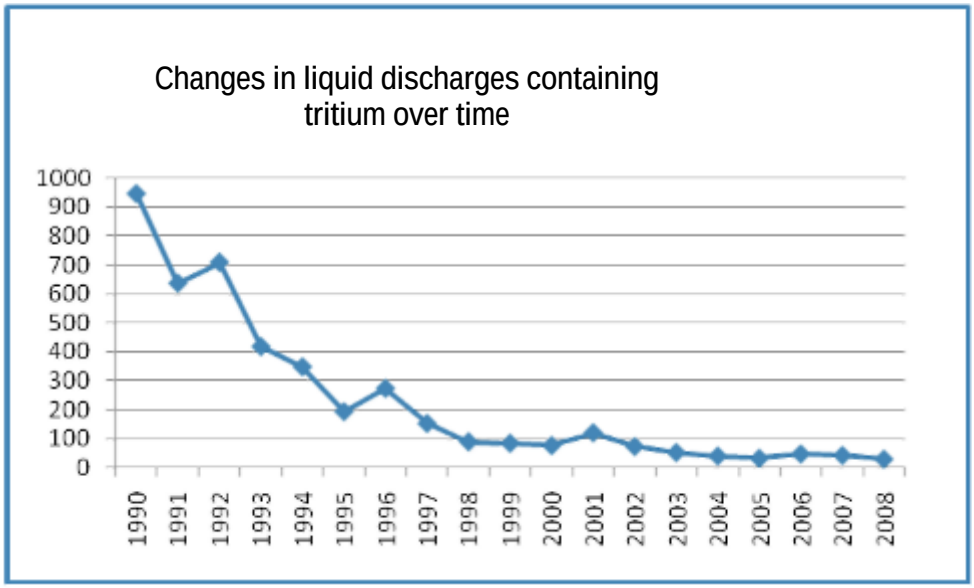
The total annual liquid discharges from the CEA Saclay Centre (including those from IBA/CIS Bio International) are presented in the table below for the period 2000-2008.

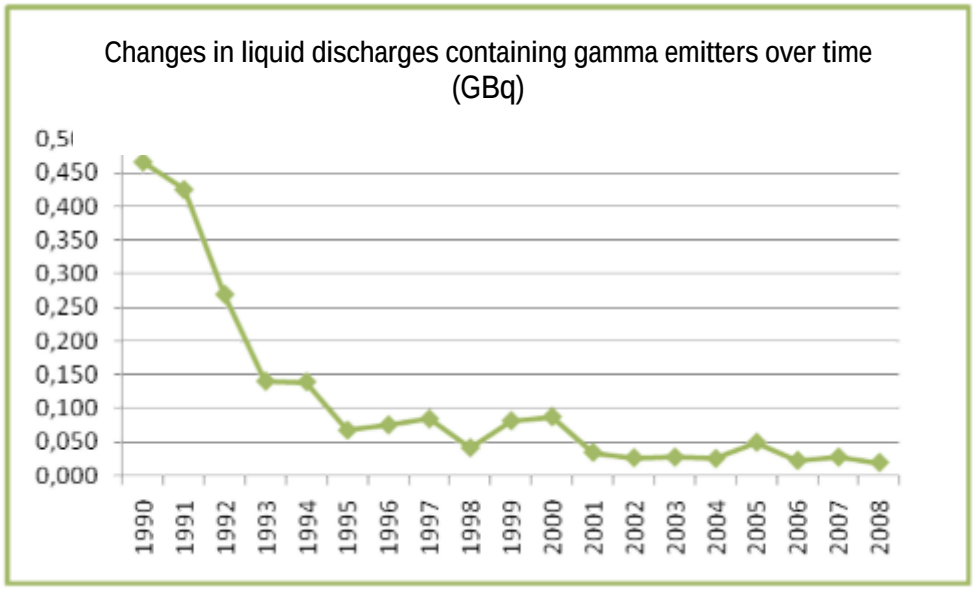
Discharges in GBq	2000	2001	2002	2003	2004	2005	2006	2007	2008
H-3	77	121	74	53	41	33	48	43	30
Alpha-emitters*	< 0.16	< 0.16	< 0.13	< 0.10	< 0.10	<0.09	<0.10	<0.11	<0.06
Gamma-emitters	0.087	0.034	0.026	0.027	0.025	0.049	0.022	0.027	0.019
Pure beta (without H-3)	1.42	1.44	1.00	0.87	0.83	0.78	1.09	1.19	0.72

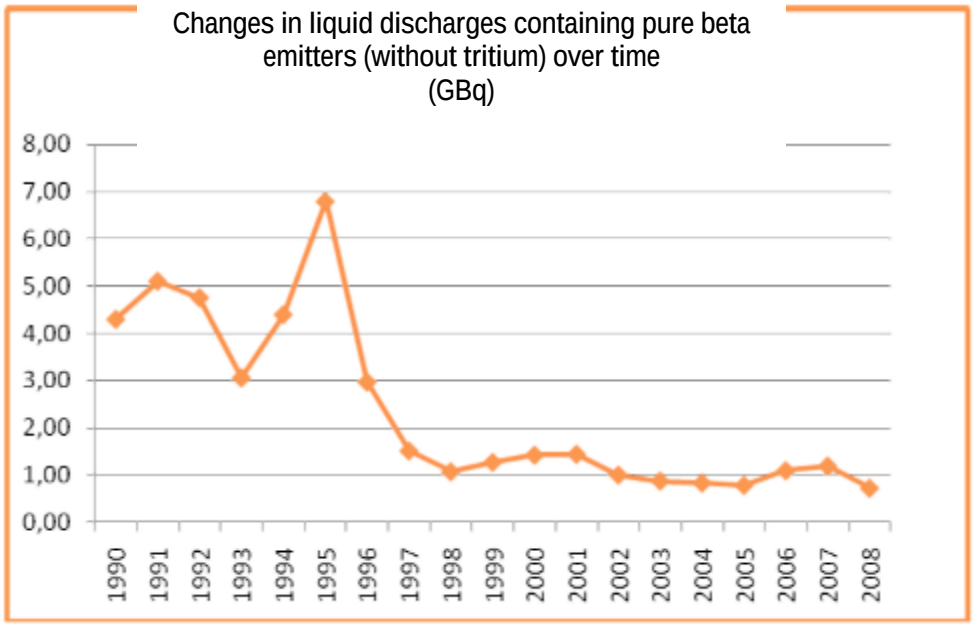
* The actual discharges of α-emitters are very low: Pu-238+239+240 of order 10^{-5} GBq in 2008.

Pure beta emitters essentially consist of carbon-14, discharges of which were responsible for 0.7 GBq in 2008.

As demonstrated by the plots showing the monitored changes in discharges over time of tritium, gamma emitters and pure beta emitters, it can be seen that since the start of the 1990s there has been a net reduction in liquid discharges which varies from a factor of 5 to 30 depending on the radionuclide, or groups of radionuclides, considered.







2.4 Quality systems for data retention and management

The CEA Saclay Centre is

- ISO 9001-2008 certified for technical support, logistics and administrative activities, and in the areas of safety, health and the environment (AFAQ no. QUAL/2004/23042);
- and ISO 14001-2004 certified for all its facilities (AFAQ no. ENV/2004/23050).

2.5 Target values for releases from the site

The CEA Saclay centre requires authorisation for its liquid discharges, which was recently modified. The table below shows the annual authorised liquid discharges from CEA Saclay in force before 25 September 2009, and those in force after that date.

Depending on the category of radionuclides, the reduction factor of the new regulations on discharges, compared to those previously in force, lies between 4 and 30.

<table>
<tr><td rowspan="5">Liquid releases</td><td colspan="2" rowspan="2">Radionuclides</td><td colspan="2">Annual authorisations</td></tr>
<tr><td>Before 25/09/09</td><td>After 25/09/09</td></tr>
<tr><td colspan="2">H-3</td><td>7,400 GBq</td><td>250 GBq</td></tr>
<tr><td colspan="2">Alpha emitters</td><td>0.74 GBq</td><td>< 0.20 GBq</td></tr>
<tr><td rowspan="2">Beta-gamma</td><td>Carbon-14</td><td rowspan="2">37 GBq</td><td>2 GBq</td></tr>
<tr><td>Other emitters</td><td>0.5 GBq</td></tr>
</table>

Annual authorisations of liquid discharges from CEA Saclay

2.6 Summary evaluation

Criterion	Evaluation
MTD/MPE indicators	
• Relevant systems put in place	Relevant systems
• Decontamination or abatement factor	Effective systems
• Downward trend in discharges	The downward trend is significant: depending on the radionuclide, reductions by a factor of between 10 and 100 over 30 years, and between 5 and 30 since 1990.
• Comparison with values recorded by	Not applicable
• Relevance and reliability of the quality assurance systems	Relevant quality assurance systems
• Relevance of the target	yes
Comprehensive nature of the data communicated	yes
Reasons for variation compared to the indicators	Not applicable
Uncertainties	Determined
Other information	Not applicable

3. Environmental impact

3.1 Concentration of radionuclides in environmental samples

The water from CEA Saclay discharged into the natural environment after treatment, flows into the old and new ponds at Saclay, and then along the ru de Vauhallan into the Bièvre, before flowing into the Seine. Their radionuclide concentration is very low, as shown in the following table. The levels of Sr-90, Cs-137 and Pu-239+240 are comparable, moreover, to those observed in the North Atlantic.

Concentrations in Bq/l	**H-3**	**C-14**	**Cs-137**	**Pu-239+240**
Water flowing into the ponds at Saclay (annual average 2007)	35 (24 in 2008)	< 0.7	$5{,}5.10^{-3}$	$4{,}9.10^{-6}$
Surface waters of the North Atlantic Ocean (samples 1992-1993)	-	-	Between $1.6.10^{-3}$ and $2.6.10^{-3}$	Between 10^{-6} and 12.10^{-6}

3.2 Environmental monitoring program

Considering the very low environmental impact of the activities at CEA Saclay, monitoring of the physical environment and the local biotope is carried out over a radius of around 5 km.

This closer monitoring produces around 9000 samples annually requiring more than 24,000 radiological measurements.

Only a light tritium effect is perceptible locally.

3.3 Quality assurance systems for the environmental monitoring

The analysis laboratories at CEA Saclay which carry out the environmental monitoring are accredited by COFRAC (French accreditation committee) according to standard ISO 17025. They are approved by the French Nuclear Safety Authority to perform environmental radioactivity measurements as part of the National measurement network (decree of July 8, 2008).

Furthermore, CEA Saclay has had an environmental management system in place since 2002, based on continuous improvement of environmental performance, which includes a sustainable development approach, and it has had ISO 14001 certification since 2004.

3.4 Relevant information not covered by the preceding headings

In response to the law requiring transparency in nuclear safety matters (law no. 2006-686 of June 13, 2006), the CEA Saclay Centre compiles an annual public report containing, in particular, the provisions for safety and radiological protection in the INB, as well as the results of measurements of discharges and their impact on the environment. This report is presented annually at a plenary meeting of the local information commission (CLI), an authority for information, dialogue and follow-up, chaired by the President of the Essonne General Council.

3.5 Summary evaluation

Criterion	Evaluation
MTD/MPE indicators	
• Downward trends in the concentrations	Effective downward trend
• Relevance of the environmental monitoring programme	Relevant programme redefined by a prefectural decree of 25/09/09
• Relevance and reliability of the quality assurance systems	Appropriate and reliable systems
Comprehensive nature of the data communicated	Yes
Reasons for variation compared to the indicators	Not applicable
Uncertainties	Determined
Other information	Not applicable

4. Ionising radiation doses received by the public

The local impact of liquid discharges is very low.

It is estimated from several scenarios:

- it would be of order 1 µSv/year for individuals from a local company who consumed 2 litres of underground water each day in which the tritium concentration had attained a value of order 100 Bq/L because of former contamination. However, no underground water has been captured for human consumption since October 2006;
- it would be of order 3 µSv/year, essentially due to the carbon-14 concentration in fish, for fishermen who consumed 8 kg annually of fish caught in the new pond at Saclay. However, all fishing is forbidden in the adjoining pond (the old pond at Saclay) which is an ornithological reserve;
- and it would be less than 0.1 µSv/year for farmers who consumed cultivated products that were irrigated using the subterranean groundwater.

The impact of these liquid discharges for the English Channel is even less. Given that the mean flow entering the ponds at Saclay is order 0.05 m^3/s and that the mean flow at the mouth of the Seine is around 2500 m^3/s, it can be deduced that there is a dilution factor of order 50,000. The effect on concentrations of radionuclides discharged by the CEA Saclay centre is therefore very low compared to the concentrations of the same radionuclides already present in the waters of the North Atlantic, which come from the fallout of worldwide airborne nuclear tests.

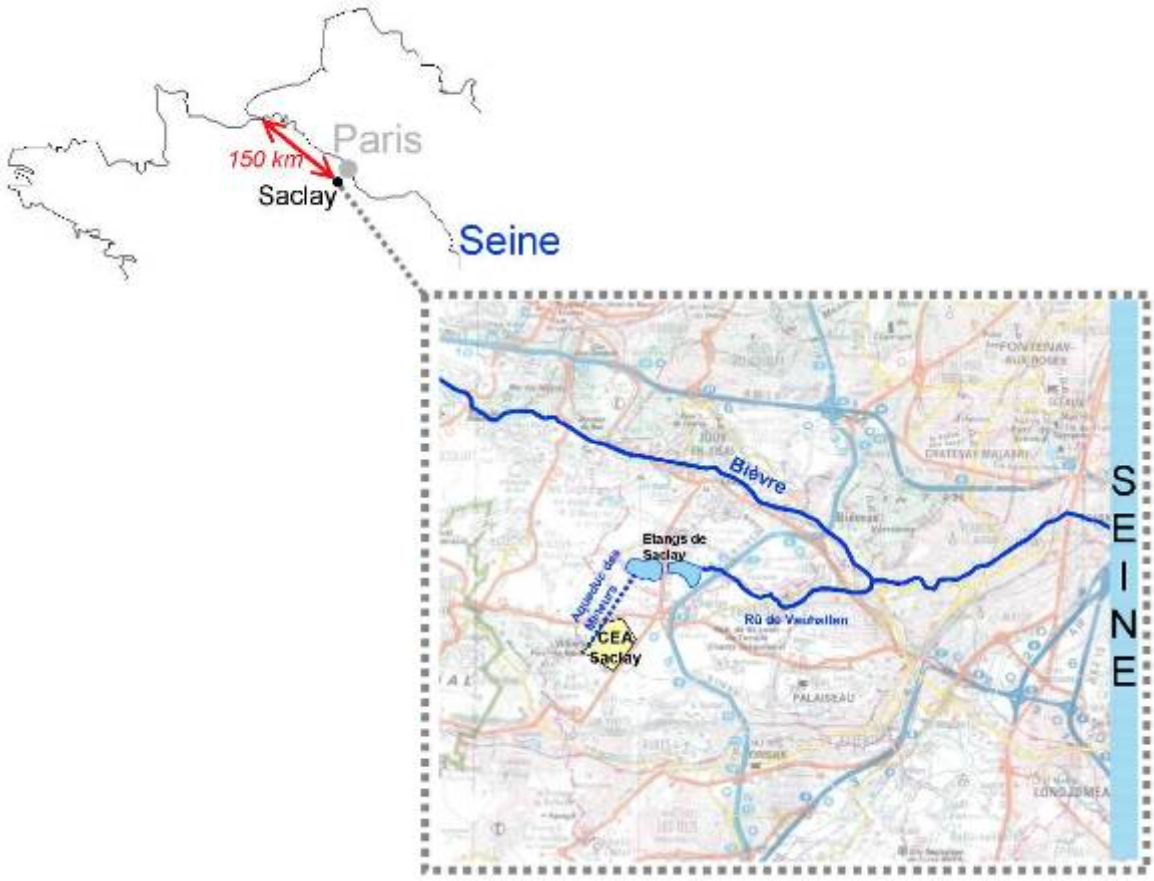
Radionuclides	Order of magnitude of CEA Saclay contribution to levels in the Channel	Order of magnitude of the concentrations found in the North Atlantic	Fractional contributions from CEA Saclay up to the point of their dilution by the Seine into the Channel
H-3	≈ 5.10-^{4} Bq/L	≈ 0.1 Bq/L	≈ 1/200th
Cs-137	≈ 10^{-7} Bq/L	≈ 10^{-3} Bq/L	≈ 1/10,000th
Pu-239+240	≈ 10^{-10} Bq/L	≈ 10^{-6} Bq/L	≈ 1/10,000th

This demonstrates that there is a non-detectable and completely negligible impact from CEA Saclay on the waters of the Atlantic.

Furthermore, based on a hypothetical consumption of 2 litres of water daily, taken from the Seine as it flows into the English Channel, the increased impact due to liquid discharges from CEA Saclay would be less than 0.0001 µSv/year.

APPENDIX A

LOCATION OF THE CEA SACLAY CENTRE



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OSPAR's vision is of a healthy and diverse North-East Atlantic ecosystem used sustainably

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