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1. INTRODUCTION

This research brief is addressing the governance issues associated with the practical implementation of long-term environmental surveillance systems on the one hand, and the health impact assessment related to radioactive waste disposal installations on the other hand. Based on feedback experiences associated with the surveillance of nuclear installations, the analysis is focused on governance stakes (how to involve local stakeholders, which information is meaningful, how to transfer the surveillance system between generations...) according to the expectations of the local stakeholders.

1.1 Long-term environmental surveillance

The first part of this cooperative research deals with long-term environmental surveillance. It mostly consists of a descriptive analysis of the current surveillance system set up for the French disposal for low and intermediate level radioactive waste in operation: the “Centre de l’Aube.” This description is focused on the current system based on information provided by the operator. It entails :

- Obligations of the operator
- The surveillance plan outlining a description of the monitoring and surveillance of installations
- Information given by the operator to competent authorities and representatives of society (type of documents, recipients…)

This investigation is completed by a reflection on the practical implementation of the surveillance (which types of indicators can be followed? How to implement this surveillance?) with considerations on historical radiological impact and problems of detection limits.

Beyond this operational system for the surveillance, the second part of this analysis deals with the feedback experience provided by local stakeholders involved in the “Commission locale d’information”[1] (CLI) around the Centre de l’Aube.

1.2 Health impact assessment

[1] A CLI is equivalent to a Local Liaison Committee

The second part of this research deals with health impact assessment associated with radioactive waste disposal. The key issue addressed refers to the expectations of the local population on the follow-up of the health status of the people living in the vicinity of the installation.

This analysis mainly consists of outlining out the questions local actors are especially interested in.

Three levels of investigation have to be considered for addressing health issues: cancer registry, epidemiological study and risk assessment analysis. After a brief description of these types of investigation, lessons drawn from the experience of stakeholders' involvement on the issue of health impact are discussed based on the feedback experience of the pluralistic group of Radioecology around the nuclear installations of North Cotentin (GRNC).

On this basis, it was proposed to elaborate, with the Romanian stakeholder group, a proposal and recommendations for the involvement of local stakeholders in the follow-up of the health status of the population living around radioactive waste disposal facilities, from a local governance perspective. These recommendations include the following issues:

- The articulation of the different types of investigations according to the expectations of the local stakeholders on health assessment
- The access to information for local stakeholders
- The need for training and for external support on specific expertise
- The time-schedule for developing the different types of investigation
- The considerations of the global environmental and health context of the local population and its evolution in time
- The capacity to involve local stakeholders in the definition and the follow-up of the investigations to be performed on health impacts

2. LONG-TERM ENVIRONMENTAL SURVEILLANCE

2.1 Centre de l'Aube (CSFMA) experience on environmental surveillance

2.1.1 Description of CSFMA

The centre de l'Aube (CSFMA) [1] has been designed, built and operated by Andra since 1992 in the village of Soulaines d'Huys (303 inhabitants[2]). This centre hosts low and intermediate level radioactive waste. The waste mainly comes from nuclear industries (97 %[3]), but also from small producers like research laboratories, universities (3 %). One hundred and fifty-eight people were employed in 2007.

[2] INSEE January 2008

[3] 43% of the total packages come from EDF, 35% from CEA and 19% from AREVA NC

The operational phase is planed to last 60 years. After the final closure of the disposal facility, a 300-year surveillance phase is planed.

The total area of the site represents 95 ha (30 of which are dedicated to storage itself). The Centre de l'Aube has a 1,000,000 m^3 authorized storage capacity. In May 2008, waste which has already been disposed of represents 21 % (212,750 m^3 of packages) of the total capacity. In 2007, 11,700 m^3 were delivered. The volume of delivered packages in 2007 was 13 % lower than in 2006. The decrease of volume has been regular since 2004. This is partly due to the better management by the waste producers and a more efficient sorting of waste between LILW and VLLW[4]. At the end of 2007, 92 cells were closed. Four hundred cells are planned to be closed by 2050, *i.e.* date of the definitive closure of the centre.

The initial investment in the centre, taking into account the preliminary geological studies and the construction, amounted to 221.5 M€. The annual functioning cost represents approximately 33 M€ (2007).

The corporate tax is one of the four local direct taxes collected by local authorities in France. It only applies to private companies. It represents 50 % of the local authorities 'fiscal resources. It can be used for financing the budget of villages, counties and regions, as well as some organizations, such as chambers of commerce or professional associations. The tax is calculated from the investment, the park land and value-added businesses. The property and corporate taxes levied by the centre respectively represent 2 M€ and 4.4 M€ for 2007.

2.1.2 Practical environmental surveillance of CSFMA: regulatory elements

Safety authorities set safety requirements for the operators of nuclear installations. The French Nuclear Safety Authority (ASN) regularly checks if these rules are followed and are in line with the legislation.

Referring to the decrees of September 4th, 1989 [2], March 24th, 1995 [3] and August 21st, 2006, [4] the operator of the site has to:

- Ensure the surveillance of the installation and its environment
- Set up a surveillance plan under its responsibility and fund it. The operator has a responsibility to support the "self-surveillance activities," and the external controls (see appendix 1 for more details) required by ASN.
- Inform competent authorities and representatives of the civil society. The operator has regularly to publish a safety analysis report and environmental impact report resulting from centre's activities.

[4] A Very low level waste Storage (CSTFA), close to the CSFMA, hosts since 2004 very low level waste

2.1.2.1 Practical environmental surveillance of CSFMA: environmental surveillance plan

The surveillance plan defines the measures taken to monitor the centre and the surrounding areas [5].

- Surveillance of the installation

The surveillance of the installation consists of:

- Checking for good functioning of the disposal facility, the measurement system as well as the alarm system.
- Ensuring the safety of its staff members. The centre's staff members have regular check-ups. Radiation protection, first-aid training…and safety drill are organised to ensure safe operating practices and protection of the workers.
- Analysing the evolution of the future repository cover[5]
- Checking leaks and transfer of effluents (all the reservoirs, vats…)
- Controlling waste packages. Waste producers have special responsibilities: before they are given the authorisation to send their waste to the repository operated by Andra, they must provide that agency with data about the origin of the waste, its nature, quantity, the radioactive elements contained and the conditioning method. That is the traceability principle. Once the waste has been checked for compliance, Andra authorises the delivery: this procedure goes by the name of "approval". If the wastes do not correspond to Andra'd standards, waste producers have to finance the removal of their waste, *i.e.* the "polluter pays" principle.

- Radiological surveillance

In the framework of its mission of environmental surveillance, Andra performs more than 20,000 assessments on the site and the surrounding areas each year at different frequencies (annually, biannually, weekly…). In 2007, 20,000 assessments on 5,300 samples were made by an internal laboratory. These assessments are related to:

- Atmospheric analysis: radioactivity of ambient air of the centre, tritium radioactivity analysis
- Water analysis: ground water, radioactivity of the water of Noues d'Amance river[6], upstream and downstream of the disposal system
- Stream sediments analysis: Noues d'Amance upstream and downstream of the disposal system, far away rivers
- Analysis of vegetables and plants: internal and external plants

[5] Research is ongoing in order to prepare for the post closure phase. Thus, an experimental cover has been instrumented since 1995 to follow the way it evolves with time, quantify the flow and its operation. This observation is scheduled to last 5 years. The analysis of this coverage is still far from the concerns of the local population. These investigations aim at demonstrating the feasibility on an industrial scale of a repository cover.

[6] The river of Noues d'Amance is very close to the center

- Analysis of food chain: milk, mushrooms, fish, cereals…
  (details in Appendix 1)

For very low dose measurements, external controls are made by IRSN's laboratory . The operator has to fund theses external controls.

- Physicochemical follow-up

More than 3,000 physicochemical assessments are made each year by an external laboratory in order to control the quality of surrounding watercourses. The operator has to fund theses assessments.

- Ecological follow-up

Ecological follow-up consists of studying fauna (insects, batrachians), flora and aquatic habitat of a nearby river. The results of this follow-up are sent each year to ASN.

- Protection of staff member

Particular attention is paid to staff protection. The radiological surveillance of the staff members is very rigorous. The maximal dose received in 2007 was 1.45 mSv *i.e.* 7,3 % of the maximal authorized dose (20 mSv). Information on radiation protection, mandatory for entering a regulated zone, has been given to 328 employees.

1.1.1.1. Focus on discharges

- **Regulation:**

Regulation of basic nuclear installations using radiation sources or radioactive elements evolved in the late 1990s with the publication of the Decree of November 26th, 1999 laying down the general requirements on limits and procedures for sampling and discharges (liquid and gaseous).

Following this new legislation, the Centre of the Aube made a request for an authorization for gaseous and liquid discharges, to account, among others, for discharges from the return air ventilation of the conditioning workshop (compacting and cooling shroud). This application was investigated by ASN. It led to the publication of a decision on August 21st 2006 authorizing Andra to discharge liquid and gaseous effluents and to perform water sampling for the Centre of Aube. Before this decree, the gaseous discharges from the centre, seen as low, did not require any authorization. The decree creating the centre (Decree of September 4th, 1989) stated that the air extracted from the ventilated parts of the facility presenting a risk of dissemination of radioactivity should be filtered through a system of high efficiency which has to be controlled continuously. The records of inspections of discharge points have to be sent annually to the radiation protection authority.

Even if no specific limit was fixed in the decree for these gaseous radioactive discharges, special attention has been focused on tritium discharges.

It should be noted that the adoption of these limits does not require any changes in the facility given the relatively low levels of current emissions. A prescription given by the authority has framed, from the creation of the centre, the liquid discharge of the tank and also set limits for discharges into the storm basin.

The centre has been monitoring the gaseous and liquid discharges from the operation of installations.

- **Management of discharges**

The operators of CSFMA are particularly attentive to the liquid and gaseous discharges. Each quarter, an estimate of discharges is performed for the facility and sent to the ASN and the President of the CLI.

Liquid discharges
These releases come from the cleaning water of the facilities and the circuit of vessel injection (concreting). Effluents from the compaction of the packages also called press juice (compaction) are considered as liquid waste. These effluents are collected in separate vats. None of the effluent is discharged into the environment. The tanks are sent to an approved treatment centre (agreement with AREVA).

Tritium discharges
Since the application for authorization for chronic discharges of the chimney (1992), two releases have been recorded: in 1995 and 2003. In 1995, the increase was due to the presence of a bulb with tritium from a small producer. In 2003, a discharge of tritium exceeding the permitted limits was also found. This was due to a small quantity of waste from a plant decommissioning. The certification of the waste producer was suspended. It should be noted that for the approval of the waste packages from producers, a degassing test for tritium is made beyond a certain activity because tritiated wastes have the specificity of releasing gaseous tritium in the form of steam in ambient air.

Since 1997, the center has a tool to detect the presence of tritium in the chimney. Since 2004, a more powerful tool allows the supervisory staff to be informed promptly and to stop as soon as the tritium is detected, in order to isolate the package and the lot affected by this abnormal discharge. This tool allows the facility to become more proactive. Since 2004, three stops and insulation of packages were made. This allowed producers to take corrective actions.

1.1.1.2. Obligation to inform

Referring to the decree of September 4th 1989, the operator has to provide regular

reports providing the results of controls. The operator has to issue some reports to the competent authorities and civil society (CLI), like annual reports, in case of an incident or accident (reservoir leaks, uncontrolled rejection, abnormally high radioactivity… details in appendix 4). Besides regulatory obligations, the operator sends regular reports to the CLI about discharges.

2.2 Feedback experience: an independent environmental impact study designed by a "Commission locale d'information"

2.2.1 Local Context

In 2006, the CLI attached to Soulaines' CSFMA launched an independent study designed to evaluate the environmental impact of the storage facility on its surroundings.

About 10 years ago, questions from local people prompted the CLI to undertake a first campaign of analysis of fish and game initiated by the local committee. A few years later, the CLI devised an environmental surveillance project which was put into action in cooperation with a local high school. Samples were taken by the students and analyzed by the Andra laboratory as well as by an independent laboratory, so as to compare the results.

The 2006 study was conceived at a bigger scale. Its aim was still to address the local population's concerns which arose in two stages. First, in 2004, a change in discharges regulations regarding the CSFMA created worries among the local community as to the impact of the nuclear waste on the surroundings of the site. Then, in 2006, concerns arose regarding the potential effect of the radioactive waste on local products like Champaign, wood, etc.

At the time, the CLI found itself in the middle of a polarised field: those in favour of nuclear energy on one side, those against, on the other side, each side giving figures supporting its theory. When the populations concerns reached the CLI, its members looked at the figures at hand and noted that no independent data was available to rely on. This observation sparked off the desire to make independent data available to the public, not the desire to draw conclusions and settle the question once and for all, but to give access to "untainted" figures. Hence the idea to commission an independent fact-finding study.

2.2.2 The process: how did the local committee proceed?

First, the local committee created a steering committee of 7 to 8 people to follow the prospective study. In its entirety, the LLC gathers about 80 persons, which was too big a number to work effectively as a task force on the project. Among the members were

pro, neutral and anti nuclear power persons. Some were elected officials, others members of NGOs and environmental organisations. Within the group, a nucleus of 3 to 4 people participated actively.

Second, the CLI selected an independent laboratory (ACRO, Association for the Control of Radioactivity in the West) to perform the analysis and interpret the results. Once the CLI was sure of the scope of the study, it consulted a couple of potential laboratories and selected the ACRO. The choice was motivated by two main reasons: cost, and neutral stance. The approximate cost of the study, entirely financed by the CLI, was of 20,000 euros.

Third, a cooperative process was put into action. Before performing its technical role as a sample analysis laboratory, the ACRO helped the Committee to express its expectations, choosing where to take the samples, etc. The aim was to take samples in the places where radionuclides would most likely be found if there was anything to be found. In addition to that, one objective was to take samples in places where ANDRA didn't take any, and to look during the analysis for radionuclides that ANDRA doesn't pay attention to. The ACRO then provided the expertise needed by the Local Committee to perform the analysis. There was a constant "back and forth" dynamic between the ACRO and the CLI's steering committee.

Fourth, the local committee asked for and obtained assistance from the operator. ANDRA was informed of the study before its beginning, and took part in the process. ANDRA allowed the ACRO to take samples on the storage site itself. It also analysed some of the samples in its laboratory.

2.2.3 The output of the study

The main output of the study is a 43-page report [6] including:

- Explanations on the sampling process: where, how, when and why the samples were taken
  Example regarding trees: « On April 4th 2007, young oaks approximately as old as the disposal facility were taken down in the vicinity of the nuclear installation: 550m North of the waste compacting facility's chimney, under prevailing winds; 1.6km South-East, nearby Quails' Pond, afar from the « referent » waste discharges. »

- Explanations on the radioactivity measurement process

- Results of samplings on trees, water, sediment, soil, grass, vegetables and vineyards
  Example regarding soil analysis: « No matter where the samples were taken, artificial radioactivity measured with gamma spectrometry is limited to 137Cs. In all cases, this 137Cs results from the radioactive distribution that followed either Chernobyl's accident or nuclear bomb tests that occurred mainly during

the 1950s and 1960s. Measured mass activities never exceed 10Bq/dry kg and are equivalent to those measured in Normandy. »

Once the study was completed, the results were made available to the public by the CLI, the ACRO and ANDRA. A special meeting of the local committee was organized to explain the methods used and share the results.

2.2.4 Lessons learned by the CLI

The results of this independent study can be seen as three-fold from the local committee's point of view.

First, the process itself was interesting and positive. It allowed the steering committee to work along with the ACRO as well as with the operator, at times. The steering committee's members acquired a technical capacity, which was sufficient in the end to have a good understanding of the results. The process allowed a technical discussion between the local committee and the operator.

Second, as it was sought from the start, one of the outputs was the "untainted" facts on radioactivity levels in the environment which were made available to the public.

Third, this study was conceived as a one-time project designed to address specific concerns, not a long-running one. It may nevertheless be renewed if the need arises at some point in the future.

2.2.5 Local actors and the conception of the surveillance plan: an upstream participation?

It may make sense to include local actors in the conception of the surveillance plan, notably in order to address questions regarding:

- The access to information envisioned in the surveillance plan for local actors
- How to bring technical indicators into general use?
- The definition and operation of the surveillance plan
- The place of some sample taking referring to the expectation of local actors
- The access of local people to independent experts
- How to set up and follow a meaningful reference of the local environment (including the different types of installations) and ensuring long-term monitoring?

3. HEALTH RISK ASSESSMENT CONCERNING NUCLEAR INSTALLATIONS: FEEDBACK EXPERIENCE

Living around nuclear installations frequently leads to a concern in the local population about the potential health impact associated with the presence of radioactivity in the

environment. Nevertheless, the analysis of the current health situation of the population living in the vicinity of nuclear installations is not straightforward.

Furthermore, the prediction of future potential health effects relies on a series of assumptions among which dose estimates and the dose-effect relationship for low dose. These assumptions are subject to uncertainties and in this context, the capacity for the experts and the local population to appreciate the potential health effects associated with radiation exposure is tricky.

First of all, it seems useful to outline the meaning of some concepts and methods:

3.1 Dosimetric quantities and ICRP approach

The ICRP system of radiological protection at low doses is based on the linear non-threshold model (LNT) which links the dosimetric quantities to the health effects [7]. This model assumes that a given increment in dose will produce a directly proportionate increment in the probability of incurring diseases (*i.e.* cancer and heritable effects) attributable to ionising radiation. The model is mainly – but not exclusively - based on the follow-up of the survivors of the atomic bomb explosions in Japan in 1945. For this population, the level of exposure has been assessed with reasonable accuracy.

The fundamental physical quantity in radiation protection is the "**absorbed dose**", which corresponds to the mean energy imparted to the mass of a specified organ or tissue. The absorbed dose is a measurable quantity ($J.kg^{-1}$ and is expressed in gray).

In order to take into account of the ***biological effectiveness*** of the different types of radiation and the ***sensitivity of organs and tissues to these radiations*** weighted quantities are introduced ("e*quivalent*" and "e*ffective*" dose, $J\ kg^{-1}$ expressed in sievert). On the basis of the LNT model low doses (< 100 mSv) can be added linearly whatever the radiations and the organs involved in the exposure.

3.2 Equivalent and effective dose are not directly measurable quantities.

- The evaluation of equivalent doses is carried out through "idealised" individuals with specified characteristics, which are sex and age averaged, called "reference person" (male and female) based on anthropomorphic models (phantoms). Such computational representations are used to compute the mean absorbed dose in an organ or a tissue. These organ and tissue doses are weighted with the radiation weighting factor to yield the corresponding equivalent doses in the organs and tissues for the reference male and female.

- As far as the effective dose is concerned, for the purpose of radiological protection, tissue weighting factors are applied to sum up the equivalent doses to obtain the whole body effective dose. "This averaging implies that the

application of this approach is restricted to the determination of effective dose in radiological protection and, in particular, cannot be used for the assessment of individual risk" (ICRP, Publication 103, §132, underscore added). Thus "In its general application, effective dose does not provide an individual-specific dose but rather that for a Reference Person under a given exposure situation." In practice, "In practical radiological protection applications, effective dose is used for managing the risks of stochastic effects in workers and the public." (both quotes are from ICRP-103, Section 4.4.6, §154).

- Estimation methods: different approaches are available for estimating the potential health impacts but are subject to uncertainties due to statistical power.

– **Epidemiological studies**: there are two types of epidemiological studies. On one hand, descriptive studies which consist of describing evolution and dispersion of diseases (these studies do not allow to identify a link between exposure and disease) and on the other hand, analytical studies which consist of identifying risk factors for diseases. The second type of study requires a significant number of individual data notably health, demographic and exposure data. The interest in this type of study is that it is a relevant tool for studying stochastic effects of ionising radiation, but there are limitations due to capacity to the ability toobserve the effects.

– **Quantitative health risks assessment**: this approach consists of assessing statistical probability to identify health effects according to the estimated levels of exposure. The risk assessment consists of 4 stages, that is to say hazard evaluation, estimation of link between exposures and number of individuals who present health effect, estimation of exposure and characterisation of risks. Results should be cautiously interpreted because of many uncertainties around dose, dose-response relationship and around the characterisation of the population.

Therefore, before making any decision, there is a need to clearly identify the aim of the study to be performed in order to select the appropriate approach.

3.3 Follow-up of cancer registry

3.3.1 Definition of a cancer registry

A register is designed to collect information about the occurrence (incidence) of cancer, the types of cancers that occur, the extent of cancer at the time of diagnosis (disease stage), and the kinds of treatment that patients receive. This data comes from different sources like laboratories of anatomy pathology, cancer therapy centres, research institutes, hospitals… Data collected by state cancer registries enables public health professionals to better understand and address the cancer burden. Registries are critical

for targeting programs focused on risk-related behaviours (*e.g.* tobacco use and exposure to the sun) or on environmental risk factors (*e.g.* radiation and chemical exposures). Such information is also essential for identifying when and where cancer screening efforts should be enhanced and for monitoring the treatment provided to cancer patients. In addition, reliable registry data is fundamental to a variety of research efforts, including those aimed at evaluating the effectiveness of cancer prevention, control, or treatment programs.

This collection must be continuous, exhaustive with an objective of public health and managed by a team with relevant skill. So it generally claims important means, time and efforts.

3.3.2 Cancer registry of Manche

In the 1980's, a network of local physicians requested the creation of a cancer registry to answer local concerns in the Manche county[7]. In 1994, the association for the cancer registry in the Manche (ARKM) was created. This registry has collected all cases of cancer diagnosis regarding inhabitants of the county of Manche since 1994.

The data collected includes:
- Individual characteristics: name, forename, profession at the time of diagnosis, sex, date and place of birth, and place of residence.
- Diagnosis: date, mode of discovery, topography, morphology…
- Surveillance: health status of the patient, date of death or last news…

The Association of Cancer Registry of Manche (ARKM) made a cancer registry of Manche (see Appendix 5) [8]. This summary of the cancer registry shows an increase in the number of cases per year can be seen from 1994 (with a number of detected cancers of 2589) to 2003 (with 3238 detected cancers). It has to be noted that it is not possible to establish causality between exposure and ionizing radiation. There is notably a need to put the results into perspective with national trends and to test different assumptions with further investigations with epidemiological studies in order to further analyse these data.

3.4 Pluralistic risk assessment: Group Radioecology North Cotentin, France (GRNC)

3.4.1 Context

[7] The county of Manche comprises a peninsula named Nord-Contentin, located at the extreme north-west tip of Normandy. This peninsula and the town of Cherbourg form one of the major economic areas of la Manche county. The nuclear energy industry makes an overriding contribution to its industrial activities. Indeed, most large companies working in the region are associated with the civil and military use of nuclear energy (Cherbourg Arsenal, La Hague reprocessing plant, La Manche low and medium radioactive waste storage centre and Flamanville nuclear power plant.

In 1995 and 1997, the results of an epidemiological study realised by Jean-François VIEL, Professor of the University of Besançon (France) and his team were published. These results suggested a causal relation between the development of leukaemia in children in the region of Nord-Cotentin and exposure to radioactive discharge from the various nuclear installations located in the Cotentin Peninsula. These publications caused strong local reactions, especially among mothers of children living near nuclear installations who published a manifesto asking for "clear and objective information" about discharges from installations in the region and their potential health effects.

A nation-wide debate developed around the work done by Professor VIEL involving scientists, experts, operators and NGOs. In order to contribute to the questions raised by the conclusions of this work, the Minister of the Environment and Secretary of State for Health and Social Security set up in February 1997 a Scientific Committee (named "Souleau Committee") to propose a «new epidemiological study in the Nord-Cotentin ». The "Souleau Committee" included scientists, mainly epidemiologists, among which was Professor Jean-François VIEL.

The Committee set up two working groups, the first one concentrating on epidemiological aspects, the other on radioecological aspects. Concerning the radioecological aspect, the Scientific Committee started from an evaluation based on models used by operators for the purposes of authorizations procedures for discharges from the COGEMA - La Hague reprocessing plant.

In the report's conclusions, in June 2007, the Scientific Committee recommended that this work be pursued, and in particular that the results of measurements made in the environment be systematically used in comparison with evaluations made based on real discharges and the model for their transfer through the environment. It was found that a pluralist expertise was necessary to confirm confidence in the results of such a critical evaluation process. Hence the decision to set up in August 1997 a pluralistic group of expertise, to pursue the reflection on the procedure for monitoring the effects of ionising radiation in France and the continuation of studies of the Nord-Cotentin, *i.e.* the GRNC [9, 10, 11]. The GRNC was set up to satisfy the objective of creating a tool for in-depth critical analysis of available data about the Nord-Cotentin situation. Considering the participation of experts from associations and foreign experts, it was agreed that the objective of the group was not necessarily to lead to a consensus, but to perform the most exhaustive possible critical analysis emphasizing uncertainties and points of disagreement between experts whenever necessary.

The initial task assigned to the GRNC was to reconstruct doses received from all industrial, medical and natural sources in order to estimate the risk of leukemia associated with ionising radiation for young persons less than 25 years old. This was done assuming as a precautionary measure that a risk exists regardless of the level of the dose i.e. using a linear no-threshold relationship between the dose and the risk. Much of the critical effort was made for sources from the nuclear industry present in the Nord-Cotentin, and particularly the La Hague reprocessing plant. The group developed a retrospective analysis to estimate the risk associated with ionising radiation, based on an inventory of discharges from Nord-Cotentin nuclear installations, and radioactivity

measurements made essentially to satisfy the requirements of the regulatory environmental monitoring.

3.4.2 Methodology

The GRNC[8] was composed of experts from French, British, German and Swiss institutes, from NGOs and from the nuclear industry, who all worked together to build a methodology.

Four specialized task forces were formed, each being made responsible for a specific step in the general procedure adopted for the evaluation of exposures and risks. These task forces were the following:

- Reconstruction and critical analysis of radioactive discharges from installations
- Inventory, appraisal and analysis of environmental measures
- Comparison between model results and measurements
- Dose and risk calculations

This type of pluralistic approach raised new questions. Members of the GRNC quickly realized that traceability of its activities and availability of information were the first prerequisites for a transparent debate and credibility of the group's work. As soon as the GRNC was created, it was agreed that any member of the group would be free to provide any information about the state of progress of the studies provided that she or he did not give any conclusions about the work being done before they had been scientifically validated. It was decided that members of the GRNC would not be governed by any type of confidentiality obligation. The GRNC has been in regular contact with local organizations and populations concerned by its task.

3.4.3 Results of epidemiological study

In parallel to the work developed in the GRNC, an epidemiological study was performed in order to further investigate the previous studies. The aim was to estimate the number of cases that can be attributed to exposure to ionizing radiation in the cohort of young people from 0-24 years who resided in the Canton Baumont-Hague. The radiation risk in the cohort is estimated for the period 1978-1996 because this is the only period for which epidemiological data on the incidence of leukaemia among existing youth 0-24 years of the township exists. The risk of leukaemia has also been

[8] The characteristics of this group concerning the nature of its participants and its operating method are significantly different from the characteristics of a similar group previously in the UK, the Committee On Medical Aspects of Radiation in the Environment Committee (COMARE). This Committee was set up in November 1985 to advise the British Government about effects on health from natural and artificial radioactivity in the environment. It was composed of scientists and professors from universities, mostly working in the fields of radiobiology and cancerology.

considered in relation to the distance between the geographic location and nuclear facilities.
The main results are presented on Appendix 6, Table 1.

For the evaluation of exposure, the values of the parameters characterizing the dose-relevant habits of people in the exposed cohort were discussed and then validated, giving priority to realism. These values were adjusted to local habits based on enquiries on consumption and input from GRNC experts familiar with local habits and customs. Then, for the evaluation of the risk of leukaemia, the group adopted the internationally recognized models for dose-effect relationships without any threshold.

Considering all investigations and results, the main conclusions on epidemiological studies were that they have shown that the total number of cases of leukaemia expected in the Beaumont-Hague canton from 1978 to 1992 would be of the order of 1.4, and from 1978 to 1996 of the order of 2 if the occurrence rate of this disease was the same as the value observed nationally. Four cases were observed during the first period and no additional case occurred during the second one. Because of the small number of cases, the sensitivity of the variation for observed cased is very high. Therefore, for the reference period (1978-1992), the comparison between observed cases and expected cases leads to the conclusion that it may be possible that there is a excess of cases with statistical significance, while it is no longer the case for the longer period (1978-1996).
This illustrates the limitation of this epidemiological approach if one would like to conclude with certainty on the attributability of occurrence of leukaemia. Therefore, there is a need to use with caution the values derived from such studies.

3.4.4 GRNC's results

Two years later the GRNC publicized the results of its assessment of the exposure levels of children (0-24 years old) together with reservations expressed by some NGO members (see appendix 6 for the protocol and details about results).

The GRNC's results were that 99 % of the radiation-induced risk of leukaemia could be attributed to sources other than discharges from nuclear installations, including almost 75 % due to natural radioactivity, 24 % due to medical exposure and 1 % to fallout from atmospheric testing of nuclear weapons and the Chernobyl accident.

GRNC's recommendations: concluded that the "*work done (epidemiological and radioecological) cannot explain the relatively high observed number of cases of leukaemia, but does not disprove the basic working assumption that there is no threshold in the dose/effect relationship, in other words low doses are related to a low risk rather than a zero risk. However as a result of this work, it is recommended that priority should be given to carrying out a more detailed study of exposures due to medical and natural sources in the Nord-Cotentin, and that in any case, exposures of*

the public to all sources should be minimized (as required by the regulations)".

Several experts from associations explicitly expressed reservations about the final conclusion. They noticed that the wide composition of the GRNC was beneficial, because it increases the range of the debates and that type of method should be extended to other nuclear related contexts. Nevertheless, they expressed that it is impossible to do all the necessary work to improve the efficiency of independent expertise unless sufficient human and financial resources are provided (financial support for associations). They also quoted that there were still uncertainties about many calculations carried out by the working groups: validity of models selected for the dispersion of the radionuclides in the environment, identification of different causes of leukaemia, all other possible causes of leukaemia should be further investigated. This approach and all these results were largely discussed with members of the local population through the CLI around LA Hague reprocessing plant (namely CSPI) and with the group of mothers “les Mères en colère”.

It has to be mentioned that the GRNC still exists in 2009 and now has new missions in order to follow regularly the evaluation of the impacts associated with the discharges of nuclear installations in the Nord Cotentin region.

4. PROPOSALS AND RECOMMENDATIONS

It was proposed to elaborate with the Romanian stakeholder group proposals and recommendations for the involvement of local actors in the practical implementation of surveillance and in the follow-up of the health status of local populations living around radioactive waste disposal facilities, from a local governance perspective.

4.1 Issues at stake

The local population is particularly concerned about potential health impacts around nuclear waste installations and difficulties appear to put these estimated impacts into perspective. Some questions emerged, like:

- How to estimate the long-term evolution of environment and health (taking into account statistical limitation)?
- How to set up a global approach on health impacts including the other nuclear installations and the other exposures to ionising radiation (natural sources and medical exposures)?
- How to put these estimated impacts into perspective with the regional, national and international situation concerning evolution of health?

4.2 Establishment of partnership

The local stakeholders expressed a clear interest to establish cooperation / partnership with national institutes in charge of health and environmental surveillance but they are facing difficulties to find a good process, resources and to deal with technical and

scientific matter.

The creation of these partnerships would contribute to address questions of concern for the local stakeholders and to find a mutual understanding of the issues at stake, to favour the confidence on the surveillance system and to identify potential improvements in the surveillance system and management of the nuclear waste installations.

4.3 Interest and organisation of the vigilance

A demand on the part of local actors emerged concerning the development of a surveillance system on health and the environment in order to create vigilance on the long-term evolution and to be able to have a reference in case of incidental situation.

It is important to favour a continuous vigilance but with different levels of involvement for the local stakeholders according to the stage of development and operation of the nuclear waste installation. The local stakeholders should participate in the definition of the reference point before the creation of the installation. It would be necessary to identify key milestones in the long term programme for which the local stakeholders may develop more intensive actions.

Reflections have to be engaged concerning the organisation of the sustainable vigilance and the transfer of information among the local stakeholders (notably the identification of relevant indicators for the local stakeholders for the long term follow-up of health and the environment).

4.4 Means for organising the vigilance

For ensuring efficient partnerships, means and resources are needed. The local actors should have easily access to information concerning environmental and health impacts of the disposal and a reflection has to be engaged on their access to dedicated training. In fact, in order to be able to understand information transmitted by operator and to express their expectation, local stakeholders should have required competence. A reflection on financial mechanisms is essential to put in place this type of actions.

There is a key interest in sharing international experiences on health and environmental surveillance (expressed by the local stakeholders and the national organisations). A willingness of local stakeholders emerged for external expertise to characterise the reference level of radioactivity, improving the level of confidence in the surveillance system.

4.5 Global perspective on health and environment

The aim of improving the health and environmental situation of the local population has to be linked with the request for "compensation" associated with the waste installation. By this demand, local stakeholders expressed needs for organising partnership focus on

the vigilance on environmental and health evolution. It would be necessary to set up a development project including the aim of improving the health status of the population and the environmental situation in a global perspective.

APPENDIX 1. DESCRIPTION OF SURVEILLANCE SYSTEM OF FRENCH DISPOSAL FOR LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTE, THE "CENTRE DE L'AUBE"

- Date of operation: January 1992
- Total area: 95 hectares
- Disposal area: 30 hectares
- Geological structure: impervious clay layer, sand over clay ensures the flow of rainwater into the River of Noues d'Amance.
- Storage capacity: 1 million m^3 of waste packages
- Operating duration: approximately 50 years before a surveillance phase of 300 years
- Annual storage: in 2007, 11700 m^3 of delivered waste packages and 212 750 m^3 of stored waste packages (21% of the total storage capacity)
- Origin of waste: nuclear industry (98% filters, resins for water treatment, tools, gloves ...) 2% of these waste come from small producers (research laboratories, universities, hospitals ...)
- Levels of radioactivity of the waste: Low and Intermediate Level Waste (ILW), short-lived may contain long-lived elements. These wastes are solid radioactive waste and do not contain significant quantities of biological substances or chemicals.
- Initial investment in the Centre (geological studies prior to construction + construction): 221.5 million euros.
- Number of employees during the operation phase: 170 people
- Miscellaneous: Takes over from the disposal of centre Manche.

APPENDIX 2. : SOME RESULTS OF ENVIRONMENTAL REVIEW PUBLISHED BY THE "CENTRE DE L'AUBE" OPERATOR FOR 2007[9]

Atmospheric analysis (*mean value milli-becquerels per cubic meter*)

	Alpha	**Beta**
Ambient air	<0.04	0.49
Reference state (March 1987)[10]	<0.10	0.06

Water analysis (Bq/L)

	Alpha	**Beta**	**Tritium**
Ground waters in the centre	<0.08	0.13	<5.8
Reference state (December 1987)	<0.11	<0.24	4.3
Downstream waters	<0.08	<0.13	<5.9
Reference (1985)	<0.11	<0.11	5.7

Stream sediments analysis (*Bq/dry Kg*)

	Cesium 137	**Cobalt 60**
Downstream center	<1.2	<1.3
Far away river	10	<1.6

[9] Ref. Bilan 2007 des centres de stockage de l'Aube, ANDRA, Website: www.andra.fr

[10] The reference states have been made by Andra before the construction of the site

Plants analysis (Bq/dry Kg)

	Cesium 137		**Cobalt 60**	
	Internal	External	Internal	External
Plants	<3.0	<4.1	<3.4	4.5
Reference state (Sept.1990)	0.9		No measure	

Food chain (mean value Bq/L)

Milk	**Cesium 137**	**Cobalt 60**
Milk (5 Km from CSFMA)	<0.18	<0.20
Reference state (Sept. 90)	0.9	No measure

	Periods	**Cesium 137**	**Cesium 134**	**Cobalt 60**	**Potassium 40**
Mushrooms	August 2007	1.8	<0.14	<0.14	110
Fishes	July 2007	<0.08	<0.07	<0.09	110
Cereals	Wheat, July 2007	<0.21	<0.20	<0.23	170
	Corn October 2007	<0.15	<0.16	<0.19	73

APPENDIX 3. : COMPARISON BETWEEN THE "CENTRE DE L'AUBE" DISPOSAL[11] AND CRUAS NUCLEAR POWER PLANT DISCHARGES [12][12] IN 2007

Liquid discharges CSFMA	Discharges in GBq observed	Annual limit in GBq	Part of the annual limits
Tritium	$5.3.\ 10^{-3}$	5	0.11%
Carbon 14	$4.5.10^{-4}$	0.12	0.38 %
Other alpha-beta particles	$1.1.\ 10^{-4}$	0.1	0.11%
Gamma particles	$2.3.\ 10^{-6}$	4.10^{-4}	0.58%

Liquid discharges NPP Cruas	Discharges in GBq observed	Annual limit in GBq	Part of the annual limits
Tritium	$35.5.\ 10^{3}$	80.10^{3}	44.38%
Carbon 14	35.10^{3}	$600.\ 10^{3}$	5.83%
Total alpha-beta	0.03	0.6	5%

[11] See "Bilan 2007 des centres de stockage de l'Aube", ANDRA, Website: www.andra.fr

APPENDIX 4. : SURVEILLANCE PLAN OF "CENTRE DE L'AUBE" DISPOSAL

1. Decree of 4 September 1989 (including the amendments made by the Decree n°2006-1006 of 10 August 2006)[13]:

This decree authorizes the Atomic Energy Commission to establish, on the municipalities of Soulaines-Dhuys and Ville-aux-bois (Aube county), a surface storage installation for solid, short and long-lived radioactive waste, called the "Centre de l'Aube" disposal.

Stored in this facility are packages of radioactive waste awaiting packaging or emplacement in the disposal facility and waste generated by operations, awaiting tranfer to an authorized site. At the end of the period of operation, no radioactive waste packages should remain in the store.

- Self- monitoring

During the phases of operation and monitoring, inspections are carried out at the facility and in its environment to detect any failure of containment of radioactive substances stored. If such a failure was detected, the necessary actions to restore the integrity of containment would be made.

After the operation phase, the facility will continue to be controlled for a certain period of time in order to allow the radioactive decay of short and medium lived radionuclides to a non-significant level of radiological risk.

- **Obligations of the operator**

During operation and surveillance phases, controls are regularly made in the installation and its environment in order to detect any failure of containment of radioactive substances stored. If such a failure was detected, the necessary actions to restore the integrity of containment would be made. Audits conducted by the operator include air, surface water, groundwaters, soil, plants and the ambient gamma radiation.

Tasks	Approbation – Recipient organism	Frequency
Setting the radiological capacity of the facility for each radionuclide not referred in Article 5 of this decree and which are present in the waste	Ministers responsible for industry and prevention of major technological risks.	

[13] JORF, September the 6th, 1989 p.11253 and JORF n°185 August the 11th, p. 11945

Surveillance and control of the suppliers and manufacturers activities for design and implementation of storage structures and equipment installation	Inventory has to be sent to the central protection against ionizing radiation	Annually
Protection against the risk of release into the air of radioactive substances: Monitoring of ventilation devices and filters efficiency	Reports of control points of air discharge have to be sent to the central service of protection against ionizing radiation	Annually
Environmental Protection: If there is any modification to the environment compared to authorization decree, the operator has to present a report detailing the consequences of this modifications	Dossier submitted to the central safety of nuclear installations and central service of protection against ionizing radiation	Immediate statement
Radiological monitoring of the site and environmental controls: - Air - Surface waters - Groundwaters - Soil - Plants - Ambient gamma radiation	Results transmitted to the central service of protection against ionizing radiation from the Ministry of Health	Immediate statement

- Specifications linked with the approval of the introduction of the first packages of radioactive waste and continuance of operation:

Schedule	**Reports, informations to present**	**Informations about the content of reports**	**Recipients**
6 months before the approval demand	All elements ensuring that the requirements of this decree have been or will be respected	-	-Central services of safety of nuclear installations - Minister of Health
After approval demand	File describing the provisions for the end of the facility operation and to ensure the surveillance -Update the safety report and general rules of operation	Documents must specify: - Future of factory floor and equipment used during the operational phase - Detailed inventory of radioactive stored waste -Time-effective proposed for the surveillance phase - Measures taken to maintain the safety of structures during the storage phase of operation in terms of containment of radioactive substances stored to protect against the risk of intrusion and radiological monitoring of the site.	Ministers responsible for industry and the prevention of major technological risks.

- Obligation of information

The operator must notify ASN of any changes which update the facility security reports: reports of safety, operating rules, internal emergency plan.

- In case of anomaly:

Regulated zones	Frequency

If the operator detects an abnormal level of radioactivity, he shall without delay notify the central service of safety of nuclear installations and the central service of protection against ionizing radiation.
Any accident or incident, nuclear or not, having or being likely to have serious consequences for the security of the facility has to be immediately reported by the operator to the head of the central safety of nuclear installations which shall inform the head of central service for protection against ionizing radiation. The Minister of Health will consult when necessary the national committee of medical experts on issues related to the radiological risk that the population may suffer.

The deadline for commissioning of the basic nuclear installation is 10 years from the publication of this decree.

2. Decree of 24 March 1995

This decree authorizes ANDRA (National Agency for management of radioactive waste) to operate the storage of radioactive waste of the municipalities of Soulaines-Dhuys and La Ville-aux-Bois previously operated by the Atomic Energy Commission.

3. Decree of 21 August 2006

This decree authorizes ANDRA to discharge liquid and gaseous effluents and water withdrawals for the CSFMA. This decree also applies to classified installations for environmental protection included in the scope of the basic nuclear installation.

- Self- surveillance:

  - Discharges of radioactive effluents

Only authorized discharges of effluents by the chimney in the floor of waste compaction are allowed. The activity of radioactive effluents discharged into the atmosphere as a gas or solid or liquid aerosols to the chimney of the ACD should not exceed the following limits:

Parameters	Annual discharged activity (GBq/year)
Tritium	50
Carbone 14	5
Iodines	2.10-2
Other beta-gamma emitters	2.10-4
Alpha emitters	2.10-5

Effluent flow	Continuously
Analysis of the components of gaseous discharges in the following conditions:	Four-monthly periods: 1 to 7, from 8 to 14, from 15 to 21 and 22 at the end of the month

- Alpha-emitters samples on a filter with determination of global alpha activity - Alpha-spectrometric analysis on the filters - Tritium and carbon 14 samples - Iodine samples on specific adsorbents (gamma spectrometry analysis, analysis iodines 125, 129 and 131) Other beta-gamma emitters: - Continuous sampling with global beta measure - Gamma spectrometric analysis on filters	- End of each p - End of month -4 periods -4 periods - End of each period - Monthly
Estimated atmospheric emissions: diffusion of discharges of waste packages (tritium)	Quarterly
Control of conduits	Annually
- Checking equipment and associated alarms - Calibration	- Monthly - Regularly
Monitoring of environmental radioactivity: - Integrated measure of ambient gamma radiation (20 points on the fence of the site + 1 point in the forest) - 2 points on the centre (1 point under the prevailing winds), measures of global alpha and beta activity + Analysis of halogen and gamma spectrometry + Continuous sampling of air with atmospheric tritium measurements + Continuous sampling of precipitation with determination of global alpha, beta and tritium + Samples of plants for gamma spectrometric analysis and complement with 1 point outside the centre + Analysis of the content of tritium and carbon 14 + Sample of topsoil (global alpha/beta activity and alpha/gamma spectrometry) - 2 points in the vicinity of the centre (including 1 point under the prevailing winds), gamma spectrometry measurement on a sample of milk, tritium and carbon 14 analysis. - Samples of mushrooms and main agricultural products (zone under the prevailing winds) measurements of global alpha/beta activity, gamma spectrometry and determination of tritium and carbon 14 content.	- Monthly - Daily (working days) - End of each period - End of each period - End of each period - Monthly (and quarterly) - Annually - Annually - Quarterly (and annually) - Annually

Any modification of measurement points has to be approved by the Managing Director of ASN

- **Liquid radioactive / not radioactive discharges**

Type of control	Control parameters	Frequency
Preliminary analysis of the radioactivity: - tritium - carbon-14 - global beta-alpha measurement - gamma spectrometry determination of the isotopic composition - Determination of the isotopic composition by alpha spectrometry		
Analysis of effluent from the basin storm	- Representative sampling of discharges: Filtered waters: global alpha and beta activities, tritium and carbon 14, potassium, global beta activity for particles in suspension - Mixing aliquot of all discharges of the month Raw water: alpha, beta-gamma emitters	- Twice a week on representative sampling of discharges - Monthly
Effluent from the restaurant, administrative buildings, guard post and the river	Measures overall alpha (<0.10 Bq/l), total beta (<0.15 Bq/l) and tritium (<10 Bq/l)	Weekly
Radioactivity of the sediment control basin storm	- Determination of alpha and beta comprehensive global analysis + alpha and gamma spectrometry - Determination of activity of main radionuclides present in the waste disposed at the centre	Monthly - Annually
Effluent from the WWTP (wastewater Treatment Plant) - Pipe discharges to the storm basin - Line-out basin storm	BOD5, COD, TSS, total and faecal coliforms, faecal streptococci -Temperature, pH, conductivity and dissolved oxygen - Temperature, conductivity, pH, dissolved oxygen, DB05, COD, TSS, total nitrogen, phenol index, total hydrocarbons (Cd, B, As, Pb, Cr, Hg, Ni, Be, Sb, U), selenium, cyanide, test on Daphnia	- Monthly - Continuous measurements - Time sample measures
Effluents discharged into “Noues d’Amance” river		Establishment of a continuously determining measure representative of the flow of the receiving environment at the point of discharge

Checking watertightness of pipelines for transferring radioactive waste or potentially contaminated effluent from the		Periodic testing (made known to the General directorate of nuclear safety and radioprotection regional

various installations on the site and the tanks		directorates of industry, research and environment and the Champagne-Ardenne)
Physico-chemical and biological surveillance:		
Verifying the operation of measuring devices and associated alarms on the pipelines	- Measures of temperature, conductivity, pH, dissolved oxygen, BOD5, COD, TSS, total nitrogen, phenol index, total hydrocarbons, total metals (Cd, B, As, Pb, Cr, Hg, Ni, Be, Sb, U), selenium, cyanide, Daphnia test	Monthly + monitoring and adjustments as necessary - Quarterly
Functioning of gates and valves		- periodic testing programme (results transmitted to the regional directorates of industry, research and environment)
-sampling during low and high water periods, surface layer water from 15 piezometers (including 13 on the center)	- Total metal (Cd, B, As, Pb, Cr, Hg, Ni, Be, Sb, U), selenium, cyanide, total hydrocarbons, nitrates and nitrites measurements.	- bi-annual
Monitoring for environment radioactivity:		
-control of aquatic plants in the Noues d'Amance river upstream and downstream from the center discharges"	- Concentration measures of the chemical cadmium, total chromium, lead, cobalt, nickel.	bi-annual
- Grab samples of Noues d'Amance waters (2 km downstream of the outfall)	For these 2 samples: pH measures, global alpha and beta, tritium, potassium, global beta activity of particles in suspension	- Weekly -bi-annual
- monitoring of benthic macrofauna at two sampling stations located upstream and downstream from the center discharges		- Monthly
- Grab samples of water Noues d'Amance upstream of the discharge point - Sample of water from the Voire river, downstream of the discharge centre	- pH measures, global alpha and beta, tritium, potassium in filtered water, beta activity of particles in suspension	- Monthly
- Time-sample of sediment of Noues d'Amance downstream releases	- Determination of global alpha and beta analysis and spectrometric gamma + alpha analysis + determination of the activity of main radionuclides present in the waste stored at the center - Determination of global alpha and beta activity and alpha and gamma spectrometry	- Monthly
- Upstream of the discharge and downstream		- Quarterly (and annually)
- Control of the groundwater surface in 8 points in the center - 14 points out of the center (including 9 in the center) - Groundwater sample in two points	-For the control of 8.14 points and groundwater: measure the water filtered (determination of total alpha, total beta, potassium, tritium, pH) and total particles in suspension (global beta activity)	- Monthly - Quarterly - Annually
- Samples of aquatic plants in Noues Amance downstream releases from the center	- Determination of alpha activity and beta comprehensive analysis alpha and gamma spectrometry	- Biannually
- Fishes samples in Noues d'Amance river at the point of discharge from the center and downstream	-	-

The frequency of sampling, the nature and number of tests defined in this article may be modified by approval of the Managing director for nuclear safety and radiation protection, in particular to take account of feedback.

- External controls

Regardless of controls and tests set out in this decree, representatives of the General Directorate of Nuclear Safety and Radioprotection, Water Police Service or Regional Directorates of Industry, Research and Environment Champagne-Ardenne may apply if necessary, unexpected (or not) sampling and analysis of liquid effluents or gaseous emission points and in the environment in order to verify compliance with the requirements of this decree. All costs will be borne by the operator.

The operator will provide, for analysis in a laboratory designated by General Directorate Of Nuclear Safety And Radioprotection, samples of which a list and conditions of sampling will be specified in advance by General Directorate Of Nuclear Safety And Radioprotection.

- Obligation of information of the operator, records various institutions, periodicity

The operator must provide regular reports for information

- **Administrative obligations of the operator:**

Content	Addressees	Frequency
Register of water sampling: results of the monitoring of water, reports the calibration of measuring devices required for control of water	Kept by the operator but can be easily accessed by the competent departments: general directorate of nuclear safety and radioprotection, regional directorates of industry, research and environment Champagne-Ardenne, water police services.	
Register of maintenance and calibration of measuring devices or non-continuous discharges and measuring apparatus testing laboratories	General directorate of nuclear safety and radioprotection, regional directorates of industry, research and environment Champagne-Ardenne	1 copy of the monthly summary sheets in by 15 of the following month.
Register of summary monthly statements for each category of discharge (continuous or discontinuous) - Number, date, duration and activity of the discharge, its volume and in the case of liquid effluents, the average flow of water in which the discharges occur. - The flow of effluent in the chimney of rejection (for exhausts) or in the pipeline (for liquid waste)	General directorate of nuclear safety and radioprotection, regional directorates of industry, research and environment Champagne-Ardenne	1 copy of the monthly summary sheets in by 15 of the following month

- The composition and activities or the quantities measured for each category of effluent before or during discharge		
Register of measurement results: For monitoring environmental radioactivity from the production and releases of radioactive effluents and environmental radioactivity from the discharge of liquid radioactive waste	General directorate of nuclear safety and radioprotection, regional directorates of industry, research and environment Champagne-Ardenne Departmental Directorate of Health and Social Affairs of Aube (copy)	-1 copy of the monthly summary sheets in by 15 of the following month -Monthly
-Detailed description of the network management of radioactive liquid effluent and the mechanisms and means of protection in place -Functions and details of officials in charge of ensuring radiation protection under the responsibility of the operator	General directorate of nuclear safety and radioprotection, regional directorates of industry, research and environment Champagne-Ardenne	2 months after the publication of this decree at the latest

Annual Public Report -Reminder of the provisions of the decree of Approval (control of discharges and water, monitoring program); -State of water and annual review of environmental control sampling -State of discharges and their annual and monthly distributions (in activity and chemical concentration) and review of the monitoring carried out on the discharges and the environment. This information is accompanied by the necessary commentary for understanding it: map of monitoring program (location of stations study), location of discharges in relation to regulatory limits, comparison of environmental measurement results, initial explanations about any abnormal results, etc..; - Estimate, as realistically as possible, doses received by the population because of the activity during the past year, this estimate applies to the reference groups of the population affected by the site, the characteristics are contained in the report this estimation is based on: -Evaluation of the doses due to external radiation, with an indication, where appropriate, of the quality of the radiation in question; -Evaluation of the incorporation of radionuclides, indicating their nature and, when necessary, their physical and chemical states and determination of the activity and concentrations of these radionuclides; -Estimation of the impact of chemical waste on the environment; -Description of the maintenance operation of equipment and structures involved in water withdrawals or discharges; -Description of the incidents or malfunctions that have been the subject of an investigation under Article 32 of this decree (leakage of waste gases or liquids, uncontrolled releases, abnormal increase of radioactivity in certain facilities, deterioration of filters, failure of equipment to measure flows and activities, etc..), and corrective measures taken by the operator; -Setting multi-year perspective of the results (comparison with previous results), including those relating to the reference state's oldest known data; -Presentation of the efforts made by the operator for the protection of the environment.-Annexes: scientific reports and tables of raw data.	General Directorate of Nuclear Safety and Radioprotection, Directorate of pollution and risks prevention of Ministry in charge of Environment, DGS of Ministry in charge of health, prefect of Aube county, water police, Regional Directorates of Industry, Research and Environment Champagne-Ardenne ; Departmental Directorate of Health and Social Affairs of Aube, Regional Directorate of Environment (DIREN) Champagne-Ardenne, CLI	April 30th of the following year at the latest

APPENDIX 5. SUMMARY OF CANCER REGISTRY OF MANCHE

Years of registration: 1994-2003/on-going registration: 2004-2005

Table. Number of cases of cancers (incidence)/year from 1994 till 2003

Year	Solid tumour	Hematological malignancies	Total
1994	2352	237	2589
1995	2332	250	2582
1996	2468	300	2768
1997	2409	373	2782
1998	2564	339	2903
1999	2706	309	3015
2000	2551	313	2864
2001	2716	292	3008
2002	2633	263	2896
2003	2958	280	3238
TOTAL	**25689**	**2956**	**28645**
Current collection			
2004	2447	309	2756
2005	63		63
TOTAL	**2510**	**309**	**2819**

**Source: Cancer registry ARKM of Manche, 2006*

APPENDIX 6. Pluralistic risk assessment: Group Radioecology Nord-

Cotentin (GRNC)

- **Table. 1. Observed and expected cases of Leukaemia among youth 0-24 years residing in Baumont-Hague according within a 10 Km radius from nuclear installation**

Period	Observed cases	Expected cases
1978-1992	4	1,4
1993-1996	0	0,67
1978-1996	4	2,07

- **Risk calculation approach by the Radiological Group of Nord-Cotentin (GRNC)**

Period:

- Risk calculation 1978-1996, (0-24 years old chidren and young adults)
- To reconstruct the cohort: 1954-1996

Table 2.: Size of the reconstructed 0-24 years old cohort in the Baumont-Hague canton between 1978 and 1996:

	People born in the canton (1954 to 1996 generations)	Influx during « Major construction »phase	Total
Number of persons (reconstructed cohort)	5,506	1,150	6,656
Person.years	55,437	13,871	69,308

- **Results of GRNC study: Exposures and risks of leukaemia for the**

cohort

Table 3. Exposures and risks of leukaemia for the cohort

Exposure source	Number of cases of radiation-induced leukaemia for the cohort
Natural sources	0,62
Medical sources	0,2
Atmospheric testing of nuclear weapons and the Chernobyl accident	0,01
Nuclear installations	0,0014*
*Routine discharges**	*0,0009*
Incidents	*0,0005*
Total (rounded)	0,835

** The in utero contribution to the exposure risk should be added which is equal to 0,0003 cases, this value being calculated only for routine discharges from nuclear installations.*

(GRNC 1999): "The reconstruction of exposures from nuclear installations, as was done by the Nord- Cotentin Radioecology Group, has led to a calculated number of 0.0014 cases of radiation-induced leukaemia during the 1978-1996 period. This number is low considering the incidence of leukaemia observed by recent epidemiological studies. However, this result is an average estimate and at this stage it should be emphasized that margins of uncertainty have not been quantified. Due to these reservations, some members of the group are of the opinion that it is impossible at this stage to conclude that it is unlikely that discharges from nuclear installations contribute to the incidence of leukaemia observed in the Beaumont-Hague canton."

REFERENCES

[1] AGENCE NATIONALE DE GESTION DES DECHETS RADIOACTIFS (ANDRA) WEBSITE**: www.andra.fr/andra-aube/**

[2] JORF, September the 6th, 1989 p.11253, **www.legifrance.gouv.fr**

[3] JORF n°185 August the 11th, p. 11945, **www.legifrance.gouv.fr**

[4] JORF n°73, March the 26th 1995, p.4858, **www.legifrance.gouv.fr**

[5] ANDRA, **Bilan 2007 des centres de stockages de l'Aube, www.andra.fr**

[6] ASSOCIATION POUR LE CONTROLE DE LA RADIOACTIVITE DANS L'OUEST, **Analyse des niveaux de la radioactivité dans les environs du centre de stockage FMA-VC de l'Aube -Année 2007 - Présentation, résultats et méthodes, Commission Locale d'Information de Soulaines-Dhuys,** RAP080206(01)_CSA_v04, February 2008

[7] A. SUGIER (ICPR), T. SCHNEIDER, **Dose concepts and the achievability of protection for the disposal of long-lived solid waste according to ICPR (ICPR Publication 103, §133),** First RWMC-RF Workshop – Tokyo 20-22 January 2009

[8] ASSOCIATION DU REGISTRE DES CANCERS DE LA MANCHE, **Website: www.arkm.org**

[9] NORD-COTENTIN RADIOLOGICAL GROUP, **Estimation of exposure levels to ionizing radiation and associated risks of leukaemia for population on the Nord-Cotentin**, http:// www.irsn.org/index.php?position=radioecologie_nord_cotentin

[10] GROUPE RADIOLOGIQUE NORD COTENTIN, **Rapport détaillé du GT 4**, **Estimation des doses et risque de leucémie associé**, Juillet 1999

[11] T. SCHNEIDER, S. GADBOIS, **Comparative analysis of risk governance for radiological and chemical discharges of industrial installations, RISKGOV, Case Study Report, Dialogue process around the liquid and gaseous discharges of the COGEMA-La Hague facility in France**, CEPN/NTE/03-13, September 2003

[12] ELECTRICITE DE FRANCE**, Website: www.energies.edf.com, NPP of Cruas**