# NUCLEAR WASTE PRODUCTION AND MANAGEMENT IN FRANCE: A STRINGENT REGULATORY FRAMEWORK CONTRIBUTING TO PRODUCER'S EFFICIENCY HOW IT APPLIES FOR A PRODUCER

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## ABSTRACT

Nuclear waste production and management in France is governed by safety requirements imposed to all operators. In France, nuclear safety relies on two basic principles:

- Responsibility of the nuclear operator, which expands to waste generated
- Safety basic objectives issued by national safety authority

French nuclear safety is under the responsibility of the Ministries in charge of Environment and Industry, represented by a safety authority, which is called DSIN: Safety Directorate of Nuclear Installation. Safety authority carry out numerous regulatory controls and actions: to elaborate the regulations for reaching safety targets, to annualize safety files submitted by plant operators, to control effective implementation of safety measures and to inform the public. The operators should demonstrate they reach the safety targets which are defined in "fundamental safety rules". There are specific fundamental safety rules for waste management. The administrative authority DSIN is advised by a technical institute (IPSN) and by expert groups for technical assessments.

On December 30$^{th}$ of 1991, the French government issued a law defining the framework of nuclear waste management. The law redefined the vocation and status of the ANDRA agency created in 1979 for waste management and disposal. The goal was to promote ANDRA as an independent body in the process. Additionally, the law assigned three axes of research to optimize long lived waste management (HLW and ILW): underground disposal, long lived radionuclide separation and transmutation conditioning and long term storage of waste. The 1991's law also created a national advisory committee (CNE: Commission Nationale d'Evaluation) in charge of an annual public report to the parliament reviewing research actions and provided recommendations. The location of the first inactive underground laboratory to be operated by ANDRA has been issued in July 1999 by a decree of the State Council, after public inquiry and consultation of involved public and administration. The next step referring to regulatory framework evolution is planned in 2006 when the parliament will have to debate about the opening of an active underground disposal site.

ANDRA has established acceptance criteria for LLW waste to be disposed of in their surface repository sites. But, up to now, no acceptance criteria exist for HLW and ILW in underground repositories. For the HLW and ILW separated by reprocessing from spent fuel, COGEMA has developed specified process prescriptions for production of conditioned waste which are audited both internally by a quality assurance plan and externally, on one hand by an independent quality company (The Bureau Véritas),

and on the other hand by ANDRA. Final residues as glass canisters, compacted or cemented hulls and end-fittings and technological waste from reprocessing have to comply with technical specifications approved by the French safety authority and several foreign safety authorities. Taking into account existing waste, the producer's specifications are a practical basis for designing the underground repository and drawing up the future related acceptance criteria.

As a whole, the French regulatory framework for waste management combines stringent regulatory conditions with sufficient operators' initiative to ensure efficiency.

## INTRODUCTION

Nuclear waste production and management in France is governed by safety requirements imposed to all operators. French nuclear safety relies on two basic principles:

- Responsibility of the nuclear operator, which expands to waste generated
- Safety basic objectives issued by national Safety Authority.

For a long time the regulatory framework for waste production and management has been satisfactorily applied and has benefited to each actor of the process. LLW/MLW and HLW nuclear waste are currently conditioned in safe matrices or packages either likely to be disposed in surface repositories or designed with the intention to be disposed underground according to their radioactive content. France is looking into the case of VLLW and has already carried out a design for future disposal, the design being in the pipe. Other types of waste (i.e. radium bearing waste, graphite, and tritium content waste) are also considered in the whole framework of French waste management.

## RESPONSIBILITIES AND ORGANISATION OF MAIN ACTORS

Industrial nuclear operators are responsible of their waste management: EDF (Electricité de France) for power production, COGEMA (Compagnie Générale des Matières Nucléaires) in the front end and back end of fuel cycle and CEA (Commissariat à l'Energie Atomique) for nuclear research. For waste disposal management, the government has created ANDRA (Agence Nationale pour la Gestion des Déchets Radioactifs) by an order of law in November 1979. The legal status of this company has been modified by the nuclear law of December 1991, establishing an industrial and commercial public company placed under the supervision of the three Ministries of Environment, Industry and Research (order of law of December 1992). ANDRA is in charge of waste disposal and operates two surface sites: the Soulaines site (CSA) in the Aube Département which is in full operation and the Centre de La Manche site (CSM), which has stopped operation since 1994 and is now in the surveillance phase. Concerning underground disposal, the missions of ANDRA have been defined by the law of December 1991 on possible waste management options in the French nuclear fuel cycle which will be specified hereafter.

For all nuclear operators of the fuel cycle, nuclear safety is under the responsibility of the Ministries in charge of Industry and Environment. A safety authority represents the Ministries: the DSIN (Safety

Directorate of Nuclear Installations) advised by a technical institute (IPSN) and by expert groups for technical assessments. This presentation does not include the military nuclear centres, which depend on the High Commissioner of the CEA, for safety aspects.

Apart from these main actors, the Ministries are likely to consult the High Committee of Nuclear Safety and Information (CSSIN) and the Interministerial Committee of Basic Nuclear Installations. Concerning the 1991 law on long lived nuclear waste, the parliamentary office for scientific choices and technologies assesses the present studies and evaluates the different options: underground disposal, separation and transmutation, conditioning and long term storage.

DSIN carries out numerous regulatory controls and actions: to elaborate the regulations for reaching safety targets, to analyse safety files submitted by plant operators, to control effective implementation of safety measures and to inform the public. The operators should demonstrate that they reach the safety targets, which are defined in the "safety fundamental rules" by the DSIN. Specific fundamental safety rules exist for waste management through which we will go further in this presentation.

## REGULATORY FRAMEWORK FOR WASTE DISPOSAL

General laws and regulations for nuclear industry apply to nuclear waste disposal. Additionally, DSIN has issued recommendations for safety in its "RFS" (Safety Fundamental Rules) and some of them applied specifically to waste. To satisfy a fundamental rule is equivalent for an operator to be in good agreement with the common regulatory practice. The safety fundamental rules draw up the safety objectives without imposing the way they can be reached. It is on the responsibility of the operator to show evidence of conformity with the safety fundamental rules. The seven fundamental rules currently applying to waste disposal are mentioned in the table hereafter and may be divided in two groups: those for conditioning of waste to be disposed (RFS III-2-e and III-2-a to III-2-d) and those for surface and underground disposal sites (respectively RFS I-2 Rev.1 and III-2-f).

**Table of safety fundamental rules for waste disposal**

| Number | Purpose | Date of issue |
|---|---|---|
| I-2 Rev.1 | Surface site safety objectives and design bases for long term storage of solid radioactive waste of short or medium half-life and of low or mean specific activity | 05/19/1984 |
| III.2.a | Production, control, treatment, conditioning and storage of waste resulting from irradiated fuel from Pressurised Water nuclear Reactors: general measures | 09/24/1982 |
| III.2.b | Id :particular measures applying to high active vitrified waste | 10/12/1982 |
| III.2.c | Id :particular measures applying to low and medium active waste embedded in bitumen | 04/05/1984 |
| III.2.d | Id :particular measures applying to waste embedded in cement | 02/01/1986 |
| III.2.e | Preliminary requirements for agreeing embedded solid waste packages to surface disposal | 10/31/1986 |
| III.2.f | Definition of prescribed objectives in designing and working a disposal of radioactive waste in deep underground repositories to ensure safety after the operating period | 06/10/1991 |

## The recommendations for surface disposal sites

For surface disposal, the RFS I-2 Rev.1 stipulates the three phases of the life of the disposal site (operating phase, surveillance phase and common site phase). It also quotes the duration of the surveillance phase fixed at about 300 years based on the half-life of significantly present radionuclides and social considerations on archive durability (about ten times the Caesium 137 decay period).
This recommendation establishes also low limits of specific activity for alpha emitter waste likely to be disposed relying on dust inhalation in case of accidental intrusion in the disposal.

The RFS specifies that the containment relies on the maintain in safe state of three successive barriers:

- The geological medium
- The structure of the covered disposal and the water collecting system
- And finally the package.

The safety assessment evaluates the design and operating of the disposal and should ensure that the disposal impact is acceptable. The assessment is realised on a deterministic approach of risks, which leads to limit the radionuclide total content for the site.

Quality of conditioning, surveillance of disposed waste and design of the building are also addressed in the recommendations. The safety rule RFS III.2.e describes the objectives of characterisation for packages to be disposed at the surface.

## The recommendations for deep geological disposal sites

In the way of minimising constraints for future generations, the underground disposal option is currently under development to safely contain long-lived and high radioactive waste.

Since the debate on energy in autumn 1981, the thought process for designing and settling an underground disposal is being progressing. The first action of the Government was to nominate a working group directed by the professor Castaing. As a first step, the group submitted a report in 1982 on possible options for irradiated fuel management. The second task of the group was to look over the nuclear waste management programme presented in 1982 by the CEA. This work has resulted in publication of a second report in April 1983, which has recommended necessary research in different host rocks (granite, clay and salt). A third task, which has led to another report in 1984, was attributed to the working group: it has consisted in notifying the urgency to start up the geological prospecting and to define criteria for site study. In 1985, the Government has asked professor Goguel, a worldwide known geologist to lead a scientific working group on these subjects and to provide a report.

Conclusion has been drawn up in 1987 and two main criteria have appeared:

- The geological stability of the storage
- The draining pathways and flowrates of underground water which finally springs to the surface.

Finally one should notice that the professor Castaing's group has established the safety principles of a disposal site and that the safety requirements have been set up by the professor Goguel's group.

As a consequence, the DSIN issued in 1991 a safety fundamental rule (RFS III-2.f) on deep geological disposal. The same year, a parliamentary debate was organised on a future law that was considering different options of waste management from the nuclear fuel cycle. This law, issued on December 31$^{st}$, 1991 defines the framework of research aiming at optimising waste management. According to the law, research work has to be implemented in three different purposes:

- To study different concepts of geological disposal
- To study separation and transmutation of long lived waste
- To study waste conditioning processes and long term storage.

Additionally, the 1991 law requires that the Government will sent to the Parliament an annually public report for assessment of the research state and progress until 2006 when a decision should be taken on siting, designing and operating a disposal site.
On December 9$^{th}$, 1998, the Government decided to choose a reversible solution for disposal and to look for two types of soil: clay and granite. Three sites for establishing an inactive underground research laboratory were then investigated and a first one was chosen after public inquiry in 1999: the "Bure" clay site in the Meuse Département, Northeast of France. The decree authorising ANDRA to operate on-site inactive research at Bure has been issued in July 1999. A granite site is now searched and the associated process is described in the decree of August 3$^{rd}$, 1999: three experts are now in charge of preliminary consultation aiming at licensing another research laboratory site.

## REGULATORY FRAMEWORK FOR WASTE CONDITIONING

Production of radioactive waste packages is driven by safety rules for nuclear installations and integrates rules for waste disposal.
The French producer elaborates specifications for waste packages, which are then approved by the Safety Authority. These specifications describe the packages and constitute a design basis for the operating phase of the conditioning facility, for storage and transport. They constitute also one of the reference documents in the process of the repository designs.

### ANDRA's agreement process

Outside the specifications of the producer, ANDRA has elaborated acceptance criteria for LLW packages and verifies that the packages comply with the criteria to give an agreement for their disposal in the surface repository of Soulaines.
For the HLW, the definition and establishment of the system is under progress and depends on the acceptation by the Parliament in 2006 to dispose off waste underground. In that way, ANDRA has already defined three levels of agreement, while the design of the underground repository was progressing:

- In the level 1 agreement ANDRA verifies that the knowledge on the package is sufficient related to process specification, nuclear material content declaration, description of the process of production, Quality assurance planning, feedback experience gained during production and collected in files, data concerning the long term behaviour in conditions specified by ANDRA.

- The level 2 agreement will verify that the packages comply with a first set of general requirements imposed by ANDRA on the basis of experience on first series of produced packages. All the waste described in files sent to ANDRA initially (1998-2001) should automatically satisfy these requirements because they are at the origin of the first designs.

- The level 3 agreement will rule on the compatibility of each type of package with each of the disposal design defined and specified by ANDRA.

### COGEMA's experience in HLW/ILW conditioning

After extracting uranium and plutonium as valuable material from nuclear fuel, COGEMA conditions remaining ultimate waste those are fission products and hulls and end-fittings. These two categories are not likely to be disposed off at surface according to their high active and long lived radionuclides content.

Fission products are conditioned in a long-term glass matrix and poured in canisters called CSD-V: they constitute the vitrified residues. Specifications of production for vitrified waste have been set up by COGEMA (300AQ016) and approved by the DSIN on July 21$^{st}$, 1986. They have been then approved later by several base load customers of COGEMA: Japan, Germany, Belgium, Switzerland

and Netherlands. COGEMA benefits from a 20 years feedback experience of vitrification operating. In effect, the first French vitrification started in 1978 at the CEA-MARCOULE site, in the south of France well known as the AVM facility. This pilot facility has produced up to now about 856 tons of glass embedding 15 millions of TBq in 2412 canisters. Then two other facilities have been built on the Reprocessing LA HAGUE site, T7 and R7 facilities respectively en 1989 and 1992. The LA HAGUE facilities have presently produced about 7,000 canisters.

Hulls and end-fittings are planned to be compacted soon in the ACC facility that will start operating in 2000. At present, the specification is expected approval from the French safety authority with favourable advice from ANDRA.

## Authorisation of operating licenses and qualification of the process and the installation

### *General procedures for a BNI operating licensing*

The general procedure for the creation of a BNI (Basic Nuclear Installation) is governed by the decree 63-1228 of December 11$^{th}$, 1963 modified by the decrees of March 27$^{th}$, 1973 and April 23$^{rd}$, 1985 and January 19$^{th}$, 1990. For this purpose, a public inquiry is launched and the safety authority (DSIN) considers a preliminary safety report. The safety report is examined by the IPSN (advisory institution for the DSIN) as well as the general conditions of operations and the emergency internal plan. An expert group is consulted. With the agreement of all the actors, the DSIN prepares a project of operating licensing decrees which should receive approval from the Ministry of Health and a special commission (CIINB), and finally from the Ministries of Industry and Environment before to be issued. After delivering the authorisation of active operating, the safety report of the BNI that deals with all the related facilities is finalised and sent to the DSIN for definitive approval. The general operating conditions and the emergency internal plan, integrating the prescriptions of the DSIN are also finalised in accordance with the safety report.

### *Application to the LA HAGUE vitrification facilities*

The R7 and T7 facilities that are part respectively of UP2-800 and UP3 have been licensed by decree in May 1981 and their safety reports have been approved. For these waste treatment facilities, another process concerning the specification of produced residue has been driven in parallel at the same time of the licensing phase.

## QUALITY ASSURANCE AND QUALITY CONTROL IN THE PRODUCTION

The QA/QC system comprises several independent parts implying the implementation of quality assurance in each step and level.
The Quality Assurance (QA) accounts for the provisions taken in order to carry out the quality assurance and the Quality Control (QC) accounts for the controls which allow to verify that the provisions have been achieved.

## Quality assurance

Quality Assurance requirements implemented by COGEMA for any produced residue are defined on the basis of the ISO 9002 standards and imply:

- A structure of Quality Assurance Managers and Correspondents, reporting to various hierarchical levels
- Documentation which describes the systems in place and provisions taken to control the manufacturing process and to guarantee the quality of the products and provided services
- Verification of the actual implementation of these provisions by means of checks, inspections and audits.

COGEMA can thus demonstrate the quality of each residue and the mastery of the conditioning process, verifying the compliance of operating parameters with the values quoted in the reference document of specifications. In that way, the Quality Assurance Plan (QAP) sets forth provisions and measures implemented to ensure conformity of the residues or products to specifications.

## Quality control

The QC system comprises an organisation and a series of controls realised by the operator and independent bodies.
The La Hague reprocessing plant has its own quality control system (COGEMA MQ/CQ) but it is controlled independently by DSIN, ANDRA and by the Bureau Véritas on the behalf of the customers.
The Bureau Véritas finally establishes the waste compliance certificates. In addition, foreign Safety Authorities (e.g. PKS and TUV, in case of German Safety Authority or the RWMC in case of the Japanese Safety Authority) implement technical visits and checking at the COGEMA facilities. For the operating surface disposal, ANDRA has set up a system of acceptance criteria and an acceptance process based on package specifications with which the conditioned residues must comply.
In that way, the Quality Control Program (QCP) is set up to define inspection arrangements that guarantee correct processing of the residues.

Raw materials and manufactured product quality provisions as well as process control are associated to the Quality Control Programme (QCP) and QAP. The quality organisation assessment and monitoring system of COGEMA supplier's are also assessed. Parameters relating to product quality are checked and modifications in the facilities are assessed to guarantee that facility characteristics are in compliance with. The results are presented in several periodical reports (internal quality reports and meeting, reports of independent control bodies).

## CONCLUSION

In France, ANDRA has established acceptance criteria for LLW to be disposed off in their surface repository sites. These waste category resulting from reprocessing industry are conditioned by COGEMA under its QA framework and transferred on line to the surface repository site of Soulaines.

For the HLW and ILW conditioned through reprocessing, COGEMA has developed specified process prescriptions for production which are audited both internally by a quality assurance plan and externally, on one hand by ANDRA and DSIN, and on the other hand by an independent quality company (The Bureau Véritas). Final residues as glass canisters, compacted or cemented hulls and end-fittings and technological waste are produced in the QA framework and have to comply with technical specifications approved by the French safety authority and several foreign safety authorities. Taking into account existing waste, the producer's specifications are a practical basis for designing the underground repository and drawing up the future related acceptance criteria.

As a whole, the French regulatory framework for waste management combines stringent regulatory conditions with sufficient operator's initiative to ensure efficiency.