ORGANIZATION OF LOW-LEVEL WASTE MANAGEMENT WITHIN ANDRA, FRANCE

Principles of waste management

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ABSTRACT

Short-lived waste contains relatively small quantities of radioelements with half-lives of no more than 30 years, and only trace amounts of long-lived radioelements, if any. Cobalt-60, produced by the activation of structural steel in nulcear power plants, accounts for approximately half the radioactivity in waste managed by ANDRA, yet it has only a 5-year half-life. For this reason protection from radiation emitted by this type of waste is not difficult; and the waste will become harmless in less than 300 years.

In terms of disposal safety, the guiding principle is simply to isolate the radioactive materials from the environment by disposing of only stabilized waste packages and protecting the packages from outside forces, especially water and human intrusion.

Some countries, particularly those that have elected not to sort waste into long-lived and short-lived categories, like Germany and Switzerland, plan to dispose of all waste in deep underground repositories. This approach is sometimes a matter of convenience, as is the case for countries like Sweden and Finland, which have built repositories in the Scandinavian granite shield at nulcear power plant sites. France, Spain, the United States, Great Britain, Japan, and others dispose of short-lived waste in near-surface disposal facilities. The safety of the disposal system depends on its three fundamental building blocks: the waste package, the disposal facility, and the site.

Introduction

The dawning realization that human activities generate waste and that this waste has potential impacts on our environment is a trend that has had important implications for the twilight years of the 20th century. Radioactive waste in particular is a matter of considerable concern to the public, with emotional debate often clouding the public's legitimate need for information on the subject.

In France, the magnitude of the nuclear power program and the widespread use of radioelements by the medical profession, industry and the research community called for a radioactive waste management program that was national in scope. Only a public entity can be expected to exist for the time periods required for effective radioactive waste management, and is capable of reconciling short-term goals with long-term responsibility while providing technical guarantees and maintaining objectivity in the decision-making process. Accordingly, in 1979 the French Government created a new entity within the French Atomic Energy Commission—ANDRA, the National Radioactive Waste Management Agency. By law and in accordance with the Government's policy, ANDRA was given complete responsibility for radioactive waste disposal,

including the design, siting, construction, and operation of waste disposal facilities.

A major parliamentary debate was held on the program to select a long-lived waste repository, resulting in passage of legislation on December 30, 1991. The Waste Law turned ANDRA into a public service company reporting to the Ministries of Industry, of the Environment, and of Research. At the same time, the law reaffirmed ANDRA's principle functions, particularly the development of waste form specifications with which all generators must comply. The Waste Law also extended the Agency's responsibilities through the creation of the National Waste Observatory within ANDRA, whose mission is to establish and maintain a current inventory of all radioactive waste storage and disposal sites on French territory.

Generation of Short-Lived Waste in France

Nearly 20,000 m^3 of immobilized waste were shipped to ANDRA's disposal facilities in 1991. Electricité de France's 58 nuclear power reactors, representing an installed capacity of 58.5 GWe, generated nearly 315 TWh of electricity and accounted for approximately one third of the total volume of waste shipped. Light water reactors generate two types of waste:

- *process waste* is waste generated by the treatment of primary coolant (such as ion exchange resins and water filters), liquid effluent (such as evaporator concentrates and ion exchange resins with very low activity levels), and gaseous effluent (such as preliminary filters, absolute filters, and iodine traps); and
- *plant waste* is waste generated primarily by maintenance operations, such as rags, paper, cardboard, vinyl sheets and bags, pieces of wood and metal, debris, gloves and maintenance clothing.

The activity of the EDF waste, expressed in gigabecquerel, is shown below:

Total alpha activity	6.7
Total beta activity	619,895
including:	
cobalt-60	295,549
cesium-137	25,637
strontium-90	4,058
carbon-14	3,497
tritium	353

In addition, the La Hague and Marcoule reprocessing plants shipped 7,500 m^3 of waste to ANDRA's disposal facilities in 1991, consisting exclusively of plant waste from operations and maintenance activities. The activity of the reprocessing plant waste, expressed in gigabecquerel, is provided below:

Total alpha activity	6,570
including:	
americium-241	2,299
plutonium-239	395
plutonium-238	717
plutonium-240	342

Total beta activity 865,490
including:
cobalt-60 2,864
cesium-137 386,790
strontium-90 268,111

Nearly 5,000 m^3 of waste from plant operations in the front end of the fuel cycle and from all of the major nuclear research centers were also shipped.

Total alpha activity 1,899
including:
americium-241 505
plutonium-238 56
plutonium-239 759
plutonium-240 277
radium-226 206

Total beta activity 141,091
including:
cobalt-60 3,641
cesium-137 128,644
strontium-90 4,558
carbon-14 464
tritium 1,517

The 1,200 users of radioelements all over France — hospitals, medical research laboratories, universities, industry, etc. — generated approximately 250 m^3 of waste, primarily waste contaminated with a few gigabecquerel of tritium and carbon-14.

French Policy on Short-Lived Waste Disposal

Some countries, particularly those that have elected not to sort waste into long-lived and short-lived categories, like Germany and Switzerland, plan to dispose of all waste in deep underground repositories. This approach is sometimes a matter of convenience, as is the case for country like Sweden and Finland, which have built repositories in the Scandinavian granite shield at nuclear power plant sites. France, Spain, United States, Japan, and others dispose of short-lived waste in near-surface facilities.

France has elected to dispose of short- and intermediate-lived solid radioactive waste with low- and medium- activity levels in near-surface facilities using multiple-barrier concepts in accordance with national safety regulations. Near-surface disposal methods have gradually evolved since 1969, when the first French radioactive waste disposal facility at the Centre de la Manche began operating, and have reached maturity with the design and construction of the Centre de l'Aube.

The underlying principle of near-surface radioactive waste disposal is to protect the waste from human intrusion and from exposure to water for as long as it takes for its radioactivity to decline, through the natural process of decay, to levels that are no longer harmful to the environment. The disposal facility will be monitored for the duration of the institutional control period, not to exceed the 300 years mandated by the regulatory authorities. The institutional

control period requirement is accompanied by site-specific acceptance limits for mass and total activities for both long- and short-lived emitters.

Operation and Closure of the Centre de La Manche

The Centre de la Manche, located 400 km northwest of Paris on a 12-hectare site on the tip of the Cotentin peninsula near Cherbourg, is France's first near-surface disposal facility. The CEA contracted with Infratome for site operations from 1969 to 1978.

Initially, the Centre de la Manche was designed and operated as a shallow land burial site, with trenches that were covered with a plastic liner and a bitumen-impregnated membrane. After ANDRA took over site operations in 1979, the Centre de la Manche disposal concept was gradually revised to include modular disposal units made of reinforced concrete and discrete rainwater and infiltration water collection systems.

As of December 31, 1991, a total of 484,345 m^3 of waste had been disposed of at the Centre de la Manche. Waste shipments to the Manche are scheduled to stop in mid-1994, at which time the maximum capacity of 525,000 m^3 will have been reached.

Site closure operations, which began in the summer of 1991 in the northern section, will continue in 1993 on the central section, with the southern section to be completed in 1995. In addition to dismantling facilities used in site operations, closure consists primarily of revamping rainwater and infiltration water collection systems, and especially placement of the final disposal cap to protect the disposal units from rainwater for the duration of the institutional control period.

Special attention was given to the design and placement of the disposal cap. A multiple-layer design was selected whose layers are, from bottom to top, as follows:
- a level sub-grade and a series of sloped panels in the form of a roof,
- a draining layer,
- a bitumenous membrane,
- another draining layer,
- a layer of schist designed to protect the membrane from roots and burrowing animals, and
- a layer of seeded topsoil.

The total cost of closure operations is estimated at FF 435 million in 1991 French francs, or approximately $ 87 million.

Design and Construction of the Centre de L'Aube

ANDRA submitted a national radioactive waste management program to the French Government in 1984 which recommended the construction of a second disposal facility for short-lived low- and medium-level waste. The program was approved by the government, and the decision to construct the facility was announced by the Secretary of State for Energy on June 19, 1984.

By October 1984, site selection activities had begun in the Aube and Indre Departments, and later in the Vienne Department, all of which had been determined to be suitable based on site screening studies begun in 1981.

In July 1985, following submittal of a preliminary site characterization report, the government approved ANDRA's request to continue site characterization work in the Aube Department to

gather information needed to apply for a Declaration of Public Utility — similar to eminent domain — and to prepare a license application for creation of a Basic Nuclear Facility at the Pli site. ANDRA submitted both applications toward the end of July 1986, and public hearings were held on them from September 29 to November 10, 1986.

In the meantime, the Standing Committee on Radioactive Waste Disposal met on January 26 and February 4, 1987, and approved ANDRA's Preliminary Safety Analysis Report on February 11, 1987.

The Prime Minister signed a decree proclaiming the public utility of the project on July 22, 1987, which was published under docket 168 in the July 23, 1987 edition of the *Journal Officiel* of the French Republic.

During the preliminary phase of the project, a major public information campaign was launched and the conceptual design of the facility was finalized.

Land for the site was purchased in August 1987. A site clearing permit was granted by the Ministry of Agriculture on August 24, 1987, and tree felling began immediately. ANDRA also purchased a 98-hectare site in the township of La Chaise for a reforestation project to compensate for the loss of trees at the Aube site.

A construction permit for the non-nuclear portions of the Centre de l'Aube was granted on October 11, 1988, and the construction permit for the rail terminal at Brienne le Château was granted on January 9, 1989.

The Interministerial Commission on Basic Nuclear Facilities gave full approval to the project during its February 9, 1989 meeting, and the Prime Minister signed the Authorization Decree for creation of the Centre de l'Aube as a Basic Nuclear Facility on September 4, 1989, which was published under docket 207 in the September 6, 1989 edition of the *Journal Officiel* of the French Republic. The Authorization Decree allowed construction to proceed on the nuclear portions of the Centre de l'Aube. Construction at the site and at the rail terminal lasted from 1988 to 1991.

The operating license for the Centre de l'Aube was granted by the Ministries of Industry and of the Environment on December 26, 1991, and the first container of waste was delivered to the site on January 13, 1992, almost 10 years after the project was initiated.

The total cost of the project was approximately 1.3 billion 1990 francs, or about $260 million, for a total site capacity of 1,000,000 m^3 and annual waste receipts of 30,000 m^3. The cost breakdown is given below:

- Site selection and characterization	8%
- Project management	20%
- Construction of the Centre de l'Aube	38%
- Waste treatment facilities	13%
- Licensing	1%
- ANDRA overhead	11%
- Public information	2%
- Site access road	3%
- Rail terminal	2%
- Taxes	2%.

Annual operating expenses will be approximately 200 million francs, or about $40 million, and post-operating closure expenses are projected to be approximately 700 million francs, or about $140 million.

The technical requirements for the Centre de l' Aube were based on 20 years of operating experience at the Centre de la Manche, and may be summarized as follows:

- waste isolation in engineered structures built above the highest level of the water table;
- long-term protection of the disposal facility against rainwater by an impermeable cap;
- collection and monitoring of infiltration water, if any, that may have contacted the waste;
- protection of the engineered structures during operations by movable buildings until a temporary cap has been placed over them;
- development of remote operating systems to reduce personnel exposure to radiation; and
- total site management consisting of separating operating units from units under construction throughout the operating period.

Comprehensive Waste Management System and Quality Assurance

ANDRA worked with waste generators, regulatory authorities, and numerous subcontractors to streamline waste operations, both technically and economically, through the development of a comprehensive waste management system that covers all activities, including waste immobilization, transportation, and disposal. The ultimate purpose of the waste management system is to ensure safety at a reasonable cost while minimizing operating constraints and environmental impacts. Underlying the waste management system is a far-reaching quality assurance program that encompasses all areas of activity and that is flexible enough to apply to all waste management strategies and to adapt to special circumstances. The waste management system provides regulatory authorities with a means of verifying the compliance of site operations, and centralizes information that can be used to satisfy the public's need to know at the same time.

There are two basic components to the comprehensive waste management system:

- cost-benefit optimization of waste immobilization, transportation, and disposal operations; and
- waste tracking, from the point of generation to its final location in the disposal facility.

The first component calls on technical specifications which were established by ANDRA based on the regulations and technical requirements of French safety authorities. The waste generators must provide ANDRA with a Waste Acceptance File, similar to a Topical Report in the U.S., for each type of waste they plan to fabricate. The file includes the following:

- a precise description of the waste and of the immobilization process, including a description of the container;
- a description of the characterization testing program and copies of test reports;
- the quality assurance plan for waste immobilization operations; and
- the sampling and monitoring locations accessible to ANDRA in the waste immobilization process.

Waste tracking, the second component of the waste management system, is an important means of ensuring safety and offers the additional benefit of regulating transportation operations to facilitate site management. ANDRA set up a computerized network which provides a real-time link between the various waste production sites, the disposal facilities, and ANDRA's Paris headquarters. The tracking system is used to:

- identify individual waste packages;
- determine the specific characteristics of individual waste packages — type of waste, type, and concentrations of radionuclides, immobilization method, container type, etc. ;
- compare this information to waste form characteristics in the database;
- certify the compliance of the waste package to the waste acceptance file and simultaneously authorize its shipment;
- track the waste package from the generator's facility to its location in the disposal facility; and
- maintain a current inventory of total radioactivity and individual radionuclides in the disposal facility in accordance with regulations.

The radiological inventory will form the basis of the decision, to be made at the end of the operating period, on the exact duration of the institutional control period, not to exceed 300 years.

Through back-and-forth consultation with the waste generators, real progress has been made toward reducing the volumes of waste initially generated, going from 125 m^3/TWh to 40 m^3/TWh in the last 10 years.

An Active Communications Program

As a public service company, ANDRA must answer to the community. The Agency's active communications program was designed to give everyone the information he or she needs to determine ANDRA's efficacy in meeting its responsibilities. Key aspects of the program are openness and adapting the message to the audience. The program also aims at providing general information on radioactive waste management as well as at explaining ANDRA's programs and its disposal facility operations.

The selection of the Aube site and facility construction were accompanied by a locally-based public information campaign that targeted elected representatives, the media and the public at large. This voluntary policy of distributing information is being continued during the operating phase, primarily through the vector of the Local Information Commission made up of elected representatives, the media, municipal, and regional government agencies and environmental protection groups from the local community.