INDUSTRIAL RADIOACTIVE LOW-LEVEL WASTE MANAGEMENT IN FRANCE

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HISTORY

Early history of low-level waste management in France is similar to that of other countries. Nuclear wastes were first stored in the vicinity of laboratories or at nuclear power plant sites.

Responsible persons were designated who developed ways of temporarily conditioning these wastes in order to assure safe stock piling.

Later, as the volume of waste increased, there was a lack of storage capacity at nuclear facilities and it was decided to solve the problem at an industrial level.

The French CEA (Commissariat a l'Energie Atomique) established in 1969 a shallow land burial ground at "La Hague" close to the second French reprocessing plant. The idea was not only to clear out the provisional storage, but also to study conditions for ultimate disposal. This CSM (Centre de Stockage de la Manche) was operated by a private company, a subsidiary of the CEA, but many national laboratories (especially the radiological health and safety laboratories of nuclear centers) worked on waste management problems: conditioning of different kinds of wastes, pretreatment operations, immobilization processes, containment... etc.

With the growth of waste production (see Fig. 1) in connection with the development of the French power reactors program, it became obvious that a new step had to be taken. A new body, called l'Office de Gestion des Dechets (OGD: Waste Management Office) was established within the CEA in 1978.

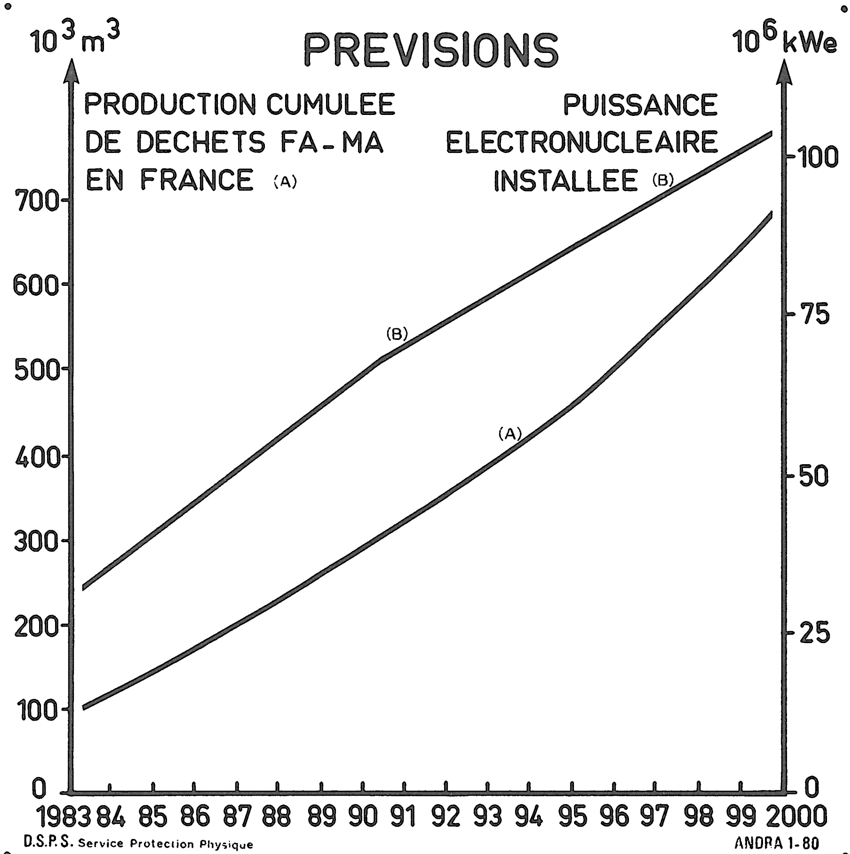

Fig 1. Prévisions

The idea was to create a nonprofit body, able to contribute to all the aspects of waste management: industrial management, general policy, research and development. This office was supposed to prefigure a national body established in November 1979 and called ANDRA (Agence Nationale pour la gestion des Dechets Radioactifs: National Waste Management Agency).

ORGANIZATION

ANDRA has the same goals as OGD but is a national establishment with personnel coming from EDF (Electricite de France: French Electricity Board), and CEA and its subsidiary companies.

ANDRA is responsible:

-- for managing long term storage establishments,
-- for planning and building new storage facilities in connection with waste production forecasts,
-- for preparing, in connection with wastes producers, specifications for storage and conditioning of wastes,
-- for contributing to R and D in long-term waste management.

Two boards are controlling ANDRA (see Fig. 2):

-- The Management Board chaired by the CEA Chief Manager assisted by the CEA High Commissioner, EDF Director General, and representatives of waste producers, regulatory authorities, and hospitals.

   This board is responsible for financial and administrative matters, especially budgeting and tariffing.
-- The Scientific Board, chaired by the CEA High Commissioner assisted by scientists from CEA and other national scientific bodies. This board gives advice on technical and scientific aspects of waste management, examines the R and D program, and makes recommendations on ANDRA missions.

ANDRA works in close connection with:

-- regulatory authorities responsible for the safety of nuclear facilities: siting, safety of conditioning, monitoring, transport, waste producers,
-- CEA departments and bureaus, in particular the DPI (Departement des Procedes Industriels: Department of Industrial Processes) and BECC (Bureau d'Etude et de Controle des Confinements) which are responsible for preparing operating manuals and testing methods of conditioning.

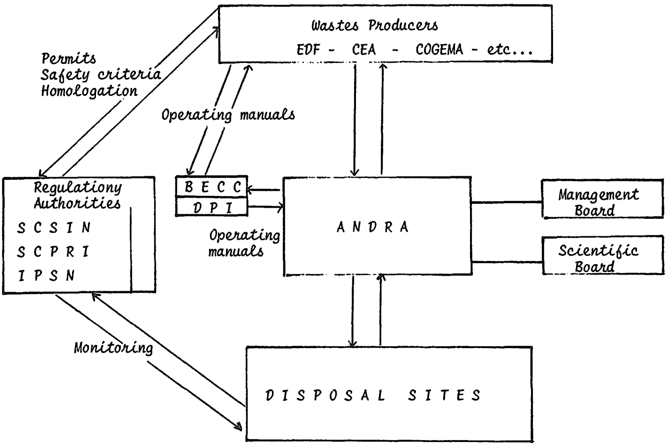

Fig. 2. Waste Management

EDF : Electricité de France
CEA : Commissariat à l'Energie Atomique
COGEMA: Compagnie Générale des Matières Nucléaires
IPSN : Institut de Protection et de Sûreté Nucléaire
SCPRI : Service Central de Protection contre les Rayonnements Ionisants
BECC : Bureau d'Etude et de Contrôle des Confinements
DPI : Département des Procédés Industriels
SCSIN : Service Central de Sûreté des Installations Nucléaires

PHILOSOPHY

A waste cannot be separated from its disposal site. Prior to receiving any waste, a site has to be investigated as is any Installation Nucleaire de Base (INB: Basic Nuclear Facility). The procedure of authorization has often been described (1). In the particular case of a low-level burial ground, the basic philosophy is somewhat different from that for other nuclear facilities where reactors, reprocessing plants, accelerators, etc., are considered.

Except in the case of low probability accidents such as volcanic eruptions or falling meteorites, disturbances may come from man or from underground water.

Barriers have to be built in order to avoid such disturbances and, if the wastes have been disturbed, in order to limit the consequences.

For $\beta\gamma$ bearing wastes, it is assumed that, according to their half-lives, they will have decreased and disappeared after 600 years. During this period, man will probably not forget the existence of a radioactive disposal: the French cathedrals are older than 600 years.

Surface or subsurface repositories seem convenient and the total stored activity is the factor to be considered.

But underground waters could penetrate the deposit so the barriers have to act in a double way:

-- to prevent watering by utilizing water-proof materials,
-- to prevent diffusion of radionuclides by utilizing proper components.

α wastes half lives are so long that it is not possible to assume a perfect containment. Yet, while the barriers are not totally impervious, they are efficient enough to keep the discharge to the environment at negligible levels.

After thousands of years, it is possible that man will have forgotten the existence of a burial ground. So the limit of waste activities are set so that a man using different kinds of tools and working on the deposit would be prevented from receiving present dose limits. A typical example is the bulldozer driver working eight hours/day in the dust rising from the burial ground.

Volumic activity is the factor to be considered. According to it, a threshold is defined for surface, subsurface or deep storage.

The limits of waste activities increase with depth because it is assumed that a civilization able to dig at depths more than 50 meters will be able to recognize odd matters and possibly to measure radioactivity.

For all kinds of wastes, as we ignore the behavior of barriers after a long period of time, we dispose several barriers each of them able, in principle, to work in the proper and complementary way.

In fact, ANDRA has to integrate technical and economic factors taking into account safety considerations.

PROCEDURES

When a new method of waste disposal is proposed, a procedure has to be followed in order to test the method and to demonstrate its innocuity.

Specifications have been listed: they are criteria (see Table I) which characterize the waste. Figures have to be given for each criteria in the operating manual.

This first step is the characterization of the waste.

If the producer is unable to characterize the waste, the BECC can make the characterization at the producer's cost.

The second step is the qualification. When a waste has been characterized, tests are undertaken using random samples in order to verify that the figures associated with the criteria are correct.

Qualification affects immobilized products as well as containers.

The third step is the homologation by regulatory authorities. According to the characteristics of the disposal site, the regulatory authorities, on the advice of the Institut de Protection et de Surete Nucleaire (IPSN), give permission to dispose of the waste.

TABLE 1

Characteristics	Qualities and Phenomena to investigate
Physical and Mechanical	-Density of packaging, container -Homogeneity of contents -Filling in rate -Impact resistance -Hardness, extrusion -Contraction, cracking -Behavior when freezing
Chemical	-Matrix-waste compatibility -Chemical stability -Action of water at a given temperature - inflation - solubility -Container - immobilization product compatibility -Interaction between container and module -Interaction between immobilization product and module -Resistance to corrosion
Thermosensibility	-Action of temperature on mechanical characteristics -Action of temperature on chemical stability -Cracking, gas production -Autocombustion -Behavior against fire
Radiosensibility	-Action of radiations on mechanical characteristics -Action of radiations on chemical characteristics -Gas production
Biodamage	-Action of microorganisms: gas emission and microbial attack from outside
Confinement	-Life of container -Porosity -Permeability - gases water -Lixiviation - renewed water - stagnant water - action of Ph - action of temperature - chemical forms of lixiviated products - oxygen content - ionic strength - action of pressure.

The last step is ANDRA's agreement. Factors such as economic aspects, easy handling and transportation, shapes of wells or trenches, etc., have to be considered by ANDRA.

In fact, this procedure is iterative; prior to each step ANDRA is consulted in order to avoid dead-ends or duplication of work.

When a method of conditioning is agreed upon, ANDRA is authorized to check from time to time to see that the criteria are actually met. A team of controllers visits the nuclear facilities, checks the quality assurance of conditioning processes, and selects containers which will be tested by destructive or non-destructive methods.

INDUSTRIAL PROBLEMS

In order to illustrate the above philosophy, it is possible to give examples from the Centre de Stockage de la Manche (Fig. 3 and 4).

Containment barriers are shown on Fig. 5; they are:

- -- the chemical form of the waste,
- -- the immobilization material,
- -- the container, filling in material and modules, and
- -- the soil.

Figure 6 shows the disposition of a tumulus for $\beta\gamma$ low-level wastes.

Figure 7 shows a special concrete trench to store medium activity $\beta\gamma$ wastes.

FINANCIAL ASPECTS

Cost of waste management is very hard to analyze: up-stream process is often more expensive than storage. In many cases, 90% of the money is spent in preparing and conditioning the wastes prior to storage operations.

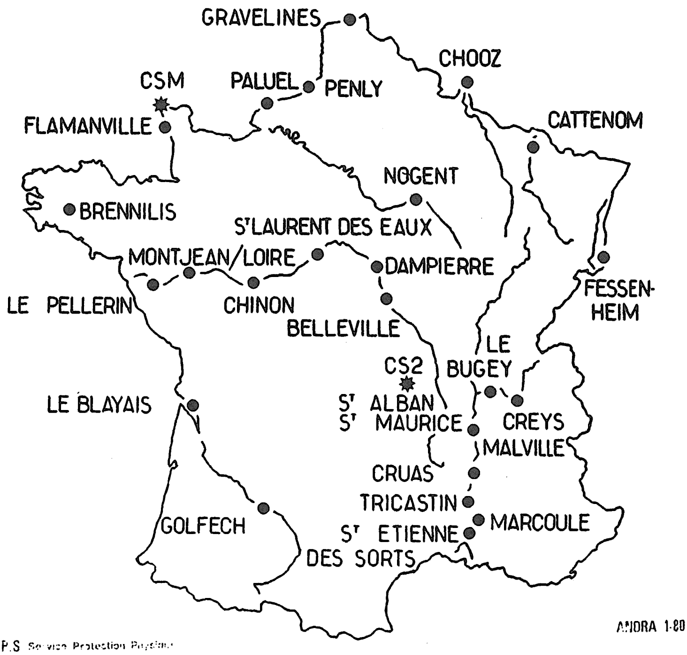

Fig. 3. Centrales Nucléaires prévues ou existantes

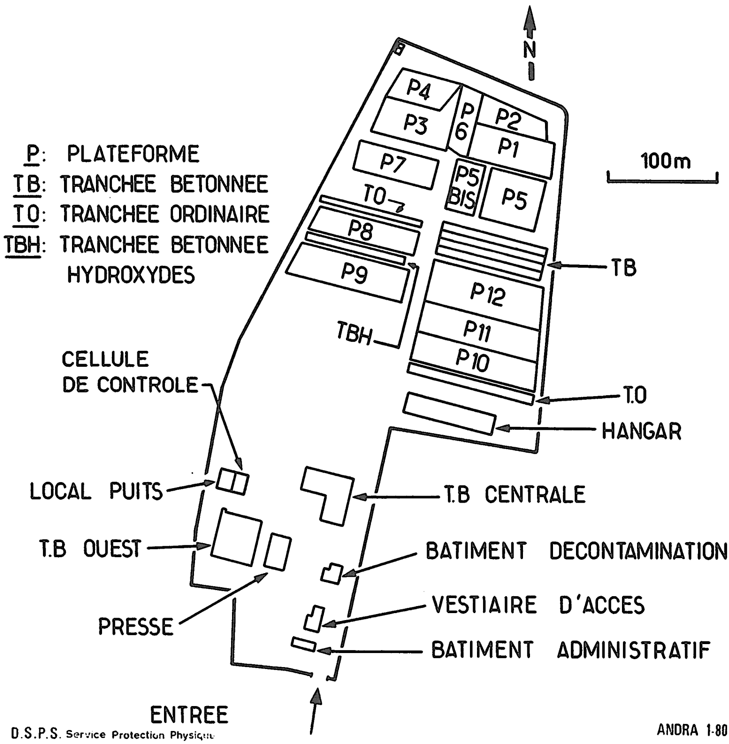

Fig. 4. Centre de Stockage de la Manche

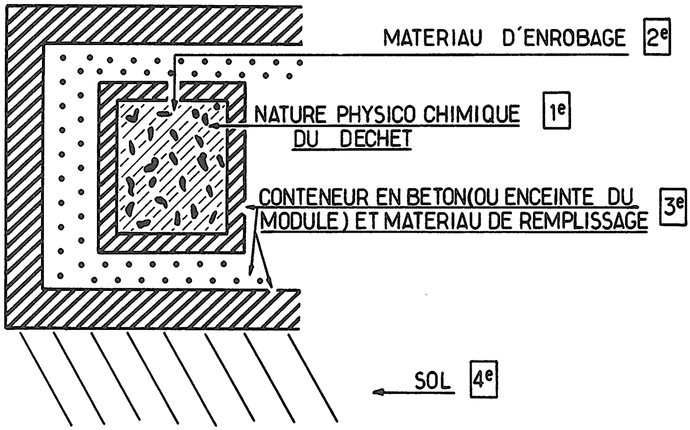

Fig. 5. Barrières de Confinement

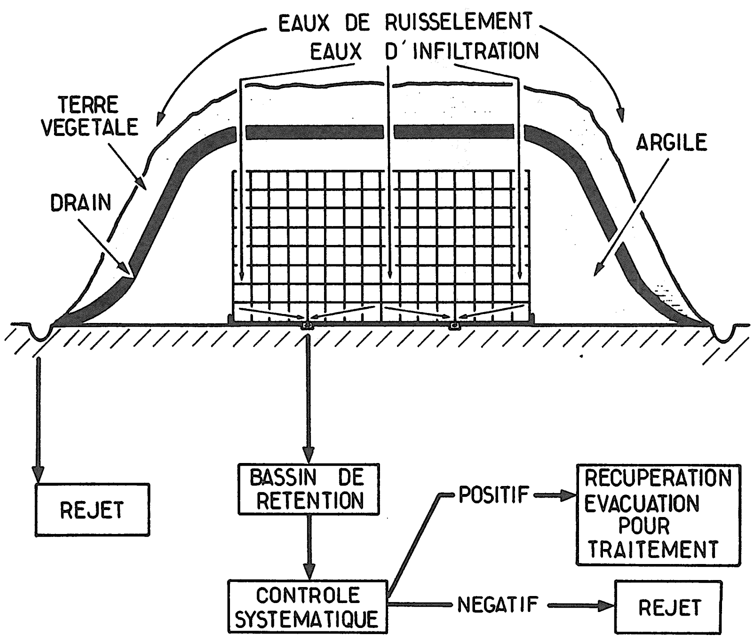

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Fig. 6. Principe des réseaux de drainage

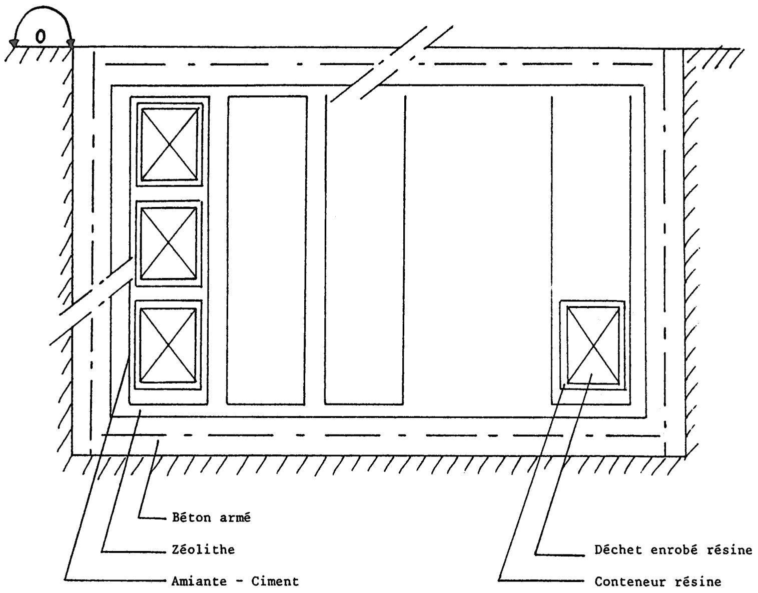

Fig. 7. Concept de stockage

The economic study of an integrated method of waste disposal has started in order to analyze the relative importance of all the involved factors and to minimize the costs.

ANDRA budget is about $25 million. Research and development studies are financed currently by the CEA Deputy Director for Safety at a level of $14 million. Technical and scientific studies are financed by wastes producers.

ANDRA balances its budget on a yearly basis by invoicing its services to wastes producers.

CONCLUSION

The short history of low-level waste management in France is long enough to bring some experience.

Procedures have been defined which seem suitable for siting and managing low-level burial grounds.

A basic philosophy exists which hopefully envisages the main aspects and consequences of the ultimate storage of low-level wastes.

An organization has been created which is able to coordinate the actions of scientific laboratories, waste producers, and operators of repositories and to take into account scientific, technical, health and economic aspects.

Ten years of storage at the CSM show that it is possible to safely store low-level wastes without major problems.

A permanent work is necessary to study the technicals aspects of the storage of new kinds of wastes, but the philosophy and the organization seem able to solve the health and safety problems and to guarantee a safe solution.

The volume of low-level wastes is far more important than that that of high-level wastes; that is the reason why it has been studied in the first place. But, at the present time, the fate of high-level waste is being considered thoroughly by CEA laboratories and commissions in order to be able to present a proper solution to the French nuclear industry in the near future.

REFERENCES

1. Decret N° 63-1228 - 11 decembre 1963 relatif aux Installations Nucleaires (Journal Officiel du 14 decembre 1963).