INDUSTRIAL LONG TERM RADIOACTIVE WASTE MANAGEMENT IN FRANCE

by

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SCOPE OF THE PROBLEM

Any human activity, whatever it may be, involves wastes production; it is the same for nuclear energy. The long term management of radioactive wastes raises fears in the public, whereas, paradoxically, their relatively small volume and the reliability of the management techniques available as compared to wastes coming from other sources, put the nuclear energy in a very good position as regards environmental protection.

Some figures are sufficient to be convincing: France produces about 1 000 000 tonnes of wastes of any kind per day. The volume of all radioactive wastes produced by the electronuclear power plants up to the year 2000 will be less than 1 000 000 m^3, including 2 000 m^3 of vitrified high level wastes. The repurification of water alone produces, per year and per inhabitant, 700 kg per year and per inhabitant can hardly be compared to one liter of radioactive waste and to the few grams of vitrified wastes caring per year and per inhabitant fully supplied with nuclear electricity.

THE NATIONAL RADIOACTIVE WASTES MANAGEMENT AGENCY

The development of the French electronuclear program incited the authorities to intensify the effort regarding the wastes management and to set up a suitable industrial structure. This is the role of the National Radioactive Wastes Management Agency (ANDRA) established within the CEA by a Ministerial Decision (Arrêté Ministériel) dated November 7, 1979. ANDRA goals are, mainly,

to design, locate and build long term radioactive wastes storage centers and to manage those centers.

The structures set up express the will of the Authorities:

- on the one hand, to have the most recent development of science and technics applied to radioactive waste management: it is the role of the "Conseil Scientifique et Technique" (Scientific and Technical Council) of ANDRA, chaired by the Haut-Commissaire a l'Energie Atomique,

- on the other, to bring together high ranking persons and the main wastes producers: this is the purpose of the "Comité de Gestion" (Management Committee) of ANDRA, chaired by the Administrateur Général du CEA.

ANDRA is entrusted with a long term mission: man must be protected today and in the future, and with the respect of the environment and of the possibility to exploite natural resources in the future.

The half-life of some radioisotopes exceeds by far the human life. Therefore, containments must not allow nuisances for future generations that we ourselves do not accept now.

Thus, the necessity to apply storage and containment methods assuring that this acceptability condition for very long periods inspired the Authorities in their decision to separate regulation and control bodies for which the Government is responsible and to entrust a true public service with the operations of long term management of wastes. The procedure relating to the authorization of creation of a storage center is the same as that for a basic classified (Fig. 1).

INDUSTRIAL APPROACH

The development of nuclear power stations makes more than urgent the industrial approach of the long term management of wastes, often called disposal, which with processing and conditioning of those wastes, including liquid wastes, form the two parts of waste management. In fact, it appeared very soon, right after the start of the nuclear power programs, that if the disposal cost stricto sensu was only a part of about 10 to 20% of the total cost of waste

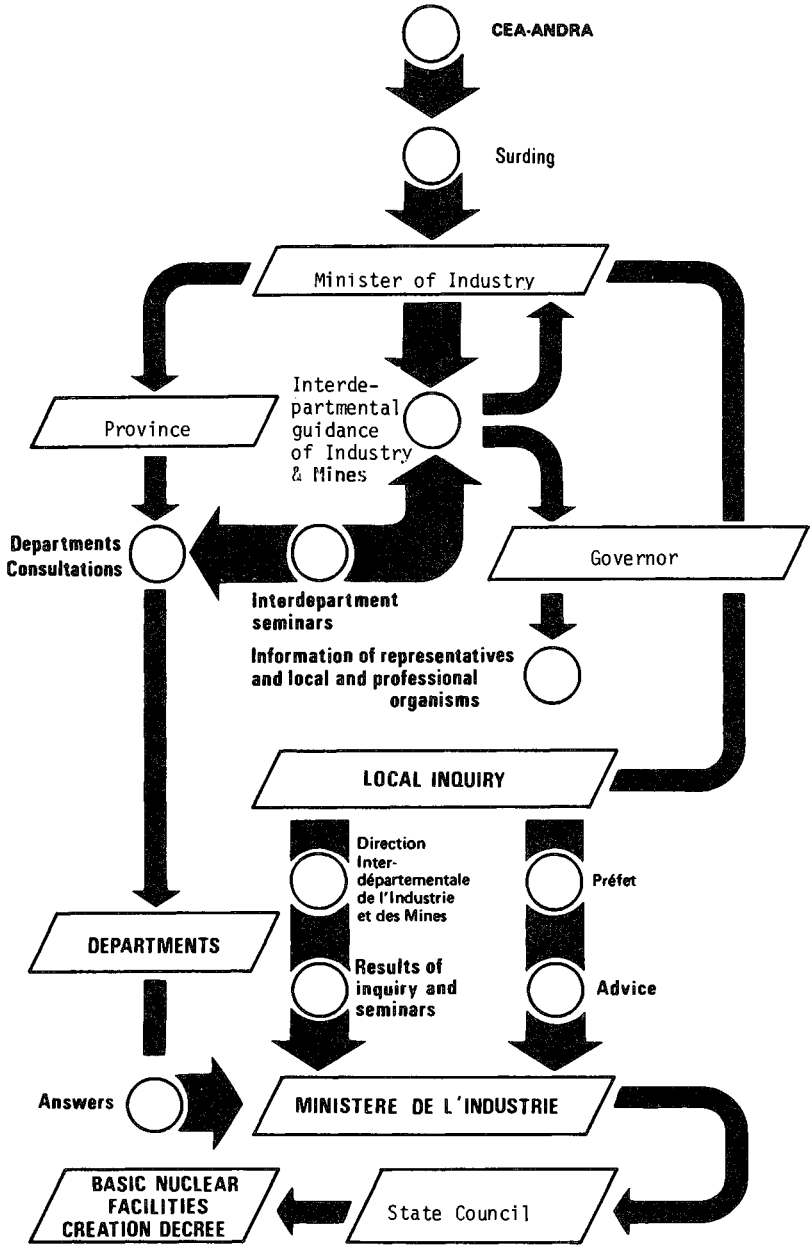

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Fig. 1. Scheme of the Procedure Related to Creation Authorization of Basic Nuclear Facilities.

management (processing, conditioning and disposal), this last cost was directly connected to the disposal concepts envisaged. Hence, it is necessary to make an optimal choice among the available techniques in order to set more efficiently and more economically the first parts of management (processing and conditioning), particularly at reprocessing plants and nuclear power plants.

Hence, it is necessary and urgent to have an optimized industrial approach covering the whole of the waste management problem. Its optimization at the economical and safety levels requires an homogeneous approach and must involve plans of storage centers as well as plan for processing and without a knowledge of the storage sites characteristics. A preview is then necessary. ANDRA, which is the subject of precise questions from EDF[a] and COGEMA[b], to which it must answer, tries to harmonize the different parts of the nuclear waste management. ANDRA's industrial approach means a coherent policy of optimized integration of all the different factors intervening in the waste management - from their primary origin to the long term storage site.

RADIOACTIVE WASTES

In terms of disposal, radioactive wastes, an overall view, may be classified in three large categories: (Fig. 2)

- low and medium activity wastes (LMA), consisting, for the main part, in short lived radionuclides. They represent 99% of the volume of radioactive wastes, but include less than 1% of the total radioactivity of these wastes. Their annual production, now of about 20 000 m^3 per year, i.e. that is less than a half liter per inhabitant in France, will rise to 70 000 m^3 in the year 2000. About 10% of that volume consists in wastes coming from the use of radionuclides in hospitals, research and industry.

- the wastes including mainly long-lived emitters such as radium and plutonium, of which annual production, now of about a few hundred cubic meters, will reach some thousands cubic meters in 2000.

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[a] EDF: Electricité de France - French Electricity Board

[b] COGEMA: Compagnie Générale des Matières Nucléaire covering the whole nuclear fuel cycle.

	1980	1992	1995	2000
FMA	20 000 / 20 000	50 000 / 500 000	65 000 / 650 000	70 000 / 900 000
ALPHA	270 / 270	2 000 / 9 000	3 000 / 18 000	3 000 / 35 000
GLASS	0 / 0	380 / 380	175 / 850	190 / 1 650

ANNUAL DELIVERIES TOTAL ACCUMULATED

Fig. 2. Expected Delivery of Wastes.

- lastly, the vitrified wastes or very high activity wastes, including long-lived emitters and very active radionuclides. They come for the main part from nuclear fuel reprocessing plants. Their cumulated production up to the year 2000 will be less than 2000 m^3. They contain 99% of the radioactivity generated by the electronuclear industry.

The wastes coming from the future dismantling of nuclear power plants or nuclear facilities must be added to these volumes.

THEIR INDUSTRIAL MANAGEMENT

The problems raised by the long term industrial management of radioactive wastes are not different from those raised by the management of all the other wastes, however, with two important advantages for the radioactive wastes: their radioactive decay and the reference to natural radioactivity that may be favorable compared to the number of toxic chemical wastes entirely new on the earth.

The basic rules concerning the long term management are to protect human beings, today and in the future, to preserve his environment and his resources and to limit the burden of future generations.

That means: at prevention level, a limitation of the production to the strict minimum, by their sorting and their volume reduction; at protection level, the placing of barriers between the environment and these wastes.

At practical and industrial levels, after eventual processing of the liquid wastes, the wastes are most often neutralized then coated in a matrix (cement, bitumen, resins or vitrified), then packaged in a container before being disposed of.

Low and medium activity wastes are stored on the ground or at shallow depth (concrete coated trenches), then covered with clay and earth, at the Centre de Stockage de la Manche (CSM), created on June 19, 1969 and managed by ANDRA. The other european countries dispose of their low and medium activity wastes by sea dumping in the Atlantic Ocean, under OECD control.

The wastes containing long-lived radionuclides are either stored temporarily on the ground production site, or stored at the CSM. In the coming years, they will be stored at medium depth on continental sites.

As for the vitrified wastes, stored temporarily on the ground on production sites, ANDRA carries on studies to determine the most adequate storage from the point of view of safety as well as economy, in the most suitable geological formation and at the right depth.

THE PRESENT FACILITIES

With CSM, ANDRA disposes of an area of about 30 acres (Fig. 3 and 4), able to receive and store on the ground about 300 000 m^3 of low and medium activity wastes, of which about 120 000 m^3 have already been used. At the increasing rate of delivery of 20 000 m^3 per year, the CSM would be saturated in 1985-86, as it seems desirable to spare the remaining capacity to receive the wastes coming from the adjoining COGEMA plant and from the nearly electronuclear power plants. Therefore, it will soon be necessary to create a second storage center for low and medium activity wastes, if possible in the center of south-east of France (Fig. 5), able to receive several hundreds of cubic meters.

For that reason, the Government has decided, when ANDRA was created, to open a second storage center. The Bois Noirs site in the Forez (Figs. 6 and 7) has been selected and the project made public in the fall of 1979. The application for authorization of creation has been deposited on March 30, 1980. The opening is planned for the beginning of 1983, subject to obtaining the creation authorization. The local inquiry, opened on May 19, 1980, has been closed without any noticeable incident on June 13. That center would receive only low and medium activity wastes for final storage.

COST OF WASTE DISPOSAL

What is the cost of radioactive waste disposal? Can it endanger the profitability of the electronuclear industry? The convergent conclusions of the economic studies carried out reassure us that

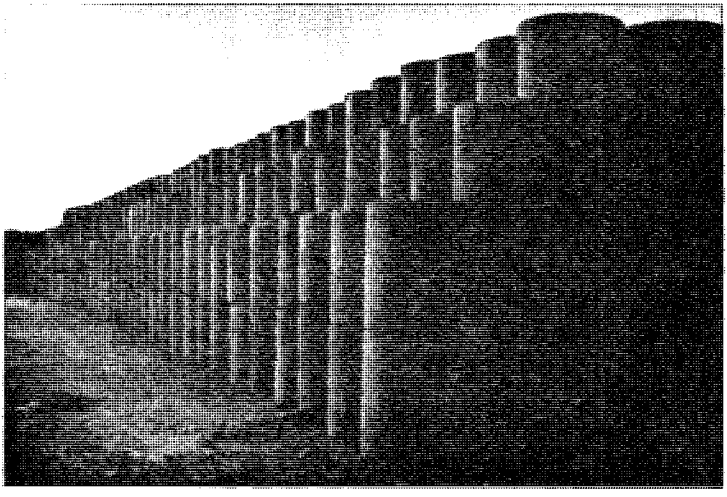

Fig. 3 . Concrete containers stored at the le Manche center. The empty spaces between the containers are gradually filled by a pliable substance to keep them in place. Then the containers are recovered with an impermiable layer of clay and with a second layer of earth planted with Genista. At St. Priest-la-Prugne, a similar storage will be effected. It will be done in such a manner as to not pose any danger to man or his environment, and also it will be aesthetically acceptable.

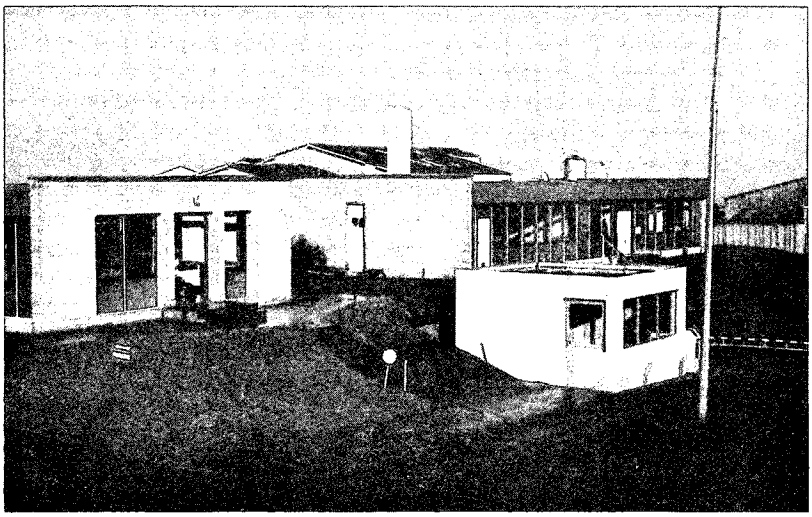

Fig. 4. Reception and control station for packing at the storage center of la Manche. The wastes are conditioned at the sites where they are produced. They are immobilized there by cement, asphalt or resin, and enclosed in a container. The packages which will be delivered to the storage center at St. Priest-la-Prugne will contain only low and intermediate level wastes.

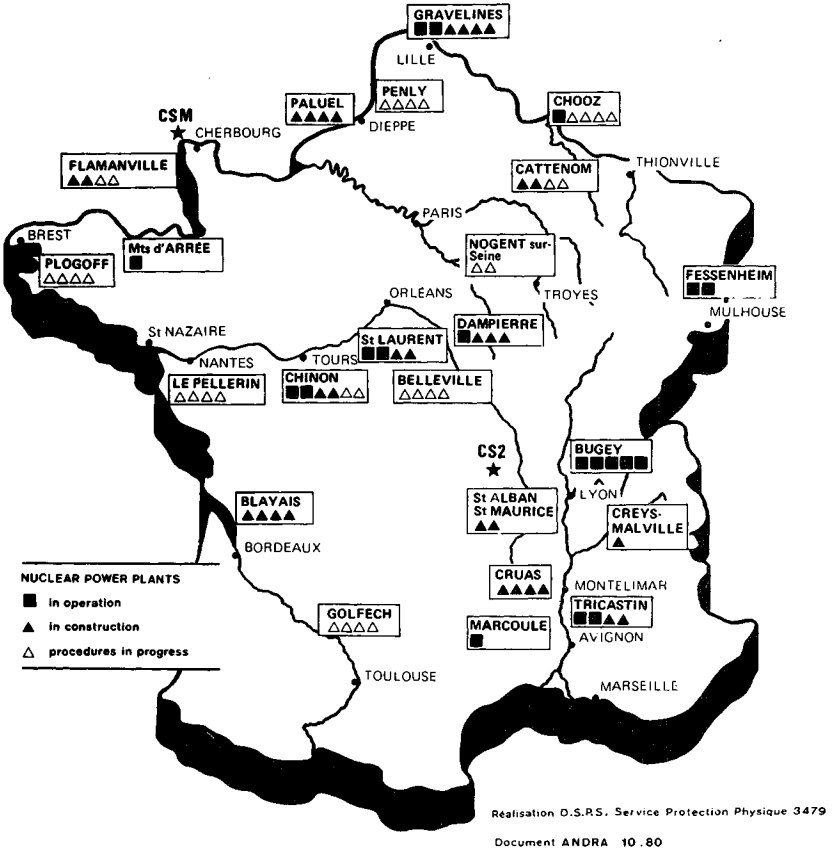

Fig. 5. Nuclear Reactors in Operation, In Construction and Planned, September 1, 1980.

Fig. 6. The north face of the quarry where the storage will be done. There will be only low and intermediate level wastes stored at St. Priest-la-Prugne.

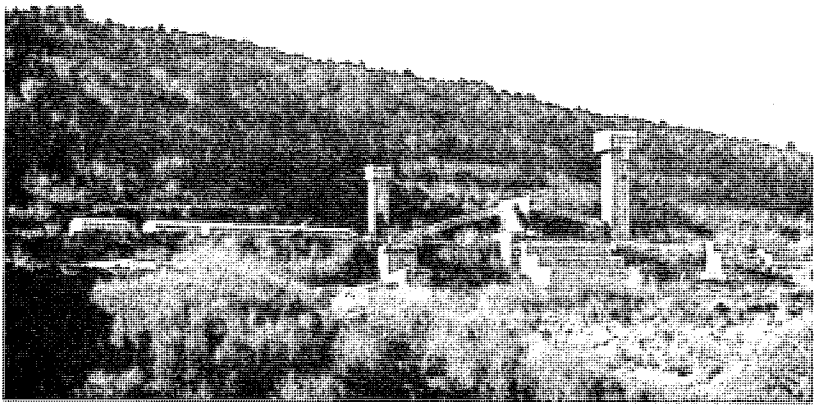

Fig. 7. A view of the facilities of the mine at St. Priest-la-Prugne. On the first level of the building is the workshop where the ores are prepared and which protects certain auxillary facilities at the storage center.

cost does not exceed a few percent of the cost of the nuclear KWH. This low and reassuring percentage shall nevertheless hide that in absolute value, because of the preponderant part of electronuclear energy in the future energy production, it leads if applied to the cost of the cumulated energy production up to 2000, to very large sums of the order of several billions Francs. Moreover, the disposal charge represent only a part of the total cost of waste management (processing, conditioning and disposal), which explains the importance and urgency to develop disposal concepts from which the design and cost of the upstream management are directly dependent.

FINANCING OF ANDRA ACTIVITIES

Financing of ANDRA activities, ANDRA being a public utility service, is provided in the following way by the waste producers:

- operating charges of the storage centers and operation of ANDRA are charged directly to the bodies delivering the wastes,

- specific investments, i.e. those concerning the storage of very special wastes, whose owners are precisly identified, are prefinanced by the last ones,

- lastly, other investments, called common investments, are financed by loans, whose service is annually covered by the bodies at the origin of the wastes, in the framework of contracts for taking charge of their wastes.

It goes without saying that, as the electronuclear industry development is increasing, the cost of radioactive waste disposal will soon be connected with cost of the KWH, which militates in the future in favor of a solution of the tax type to assure that financing.

As an order of magnitude, the budget of ANDRA for 1980 was 70 MF, of which 40 MF of investments, the budget for 1981 is 120 MF, of which 80 MF of investments. As for the 5 year plan, it foresees an amount of expenses of about 700 MF, of which 400 MF of investments for the period 1980-1984.

THE INDUSTRIAL STRUCTURE

ANDRA, a light structure (about twenty people), focusing its activity on a management at a high level with a view of optimization in the field of economy and safety, entrusts an operator, under its control, with the management of its storage centers.

Since January 1981, ANDRA's operator is the Société Industrielle de Stockage et d'Assainissement (SISA) (Industrial Society for Storage and Cleansing) grouping CEA (34%), ECOPOL (Ecologie et Pollution) (32%), EMC (Entreprise Minière et Chimique) (34%). On the other hand, in addition to its operator SISA, ANDRA calls in the operational units of the Commissariat à l'Energie Atomique, in particular the Institut de Protection et de Sûreté Nucléaire, the Division d'Etudes de Retraitement et des Déchets et de Chimie Appliquée, the Division de Metallurgie et d'Etudes des Combustibles Nucleaires; the Division d'Etudes de Retraitement et des Dechets et de Chimie Appliquee has created for that purpose a conditioning and containment research bureau. ANDRA also calls its external bodies, the Bureau de Recherches Géologiques et Minières as well as different research departments or industrial firms.

CONCLUSIONS

This short description of the frame in which the long term industrial management of radioactive wastes takes place allows to delimit its industrial and economical dimensions, as well as its political dimensions. In particular, and immediately, ANDRA must try to convince the public that the setting of these industrial means based on management techniques studied and developed since the very beginning of the nuclear era, alows, now and in the future, to solve the problem of the radioactive wastes disposal in safe conditions widely compared with those of the disposal of all other industrial wastes.