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RADIOACTIVE WASTE MANAGEMENT: SPANISH EXPERIENCE

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ABSTRACT

Radioactive waste generation began in Spain during the 1950's, in association with the first applications of radioactive isotopes in industry, medicine and research. Spain's first nuclear power plant began its operations in 1968. At present, there are in operation some one thousand installations possessing the administrative authorization required to use radioactive isotopes (small producers), nine nuclear groups and a tenth is now entering the dismantling phase. There are also activities and installations pertaining to the front end of the nuclear fuel cycle (mining, milling and the manufacturing of fuel elements).

Until 1985, the research center Junta de Energía Nuclear (now CIEMAT) rendered radioactive waste removal, and subsequent conditioning and temporary storage services to the small producers. Since the beginning of their operations the nuclear power plants and fuel cycle facilities have had the capacity to condition and temporarily store their own radioactive wastes.

ENRESA (Empresa Nacional de Residuos Radiactivos, S.A.) began its operations in the second half of 1985. It is a state-owned company created by the Government in accordance with a previous parliamentary resolution and commissioned to establish a system for management of such wastes throughout Spain, being in charge also of the dismantling of nuclear power plants and other major installations at the end of their operating lifetimes.

Possibly the most outstanding characteristic of ENRESA's evolution over these last seven years has been the need to bring about a compromise between solving the most immediate and pressing day-to-day problems of operation (the first wastes were removed at the beginning of 1986) and establishing the basic organization, resources, technology and installations required for ENRESA to operate efficiently in the long term.

REFERENCE FRAMEWORK

Before going on to describe the technical activities carried out to date, I feel it would be of interest to comment, albeit briefly, on the fundamental aspects serving as an operational basis for the management system, more specifically those relating to: the definition of responsibilities and the way in which they are shared among the different participating agents and organizations; the setting up of the financing system; the process of planning and implementing strategies and activities; organization and human resources; and the generation, transfer and acquisition of the technology required for performance of the company's different technical activities.

*Assignment of the responsibilities and areas of competence of the organizations participating in the different phases of radioactive waste management (central, regional and local administrations, the regulatory body, the waste producers and ENRESA) has been gradually accomplished by way of a set of standards that in turn have gone to drawing up the applicable legal framework, which will be completed over the course of the next few years. Interfaces and the sharing of responsibilities between the different waste producers (small or large) and ENRESA have been established via specific contracts.

Activities carried out by ENRESA in relation to nuclear safety or radiological protection are subject to supervision and control by the Nuclear Safety Council, Authority independent from the State Administration which periodically reports to the Spanish Parliament.

*In order to carry out radioactive waste management it is necessary to have access to the financial resources required to cover the costs of the different activities involved. The financing system set up rests on the following basic principle: "The waste producer should bear the costs associated with safe management thereof".

In keeping with this principle, a system has been set up which has two main sources of financing:

-The small producers pay ENRESA for each service rendered, in accordance with a previously established tariffing system.

-In the case of the nuclear power plants, a percentage fee has been established on electricity sales, the aim being for each plant to generate throughout its operating lifetime sufficient funds to cover the costs associated with management of all the radioactive wastes produced by it and with its eventual dismantling and decommissioning.

This system guarantees availability within the country of the necessary financial resources.

-The planning of management strategies and the scheduling of the major activities are important actions that must be approved by Government and broadcast for the information of

the different political groups, and where applicable for debate. In keeping with this premise, the Royal Decree authorizing the creation of ENRESA imposes upon the company the obligation to draw up during the first six months of every year an Annual Report describing the actions taken during the previous financial year, and a revised version of the General Radioactive Waste Plan in force for Government approval, if the novelties and modifications included are sufficiently important to make this advisable. The Government then informs Parliament of the revised Plan.

ENRESA drew up the First General Radioactive Waste Plan, which was approved by the Cabinet in October 1987. The fourth Plan is currently in force and was approved in December 1994.

Among the other activities included are those relating to site evaluation, waste collection, transport and disposal strategies, the dismantling and decommissioning of nuclear installations, etc., as well as the corresponding economic and financial aspects.

-The objectives underlying the organizational framework of ENRESA are efficiency and agility, this suggesting the need for a small structure limited to the basic and essential functions of planning, establishing of specifications, management and control of projects and operations, and the generation and assimilation of technology. The company's operations are based on a corporate information system developed in-house and on a rigorous quality system.. This organizational model has the effect of multiplying efforts, through the participation of engineering, services and construction companies, research centers and universities in the activities directed by ENRESA, and of increasing efficiency as a result of the specialization of these external organizations in different areas. ENRESA currently has a highly qualified staff of 250 people, of whom 140 work in the company's head offices.

-In order to make performance of its technical activities possible, ENRESA has had to establish appropriate mechanisms for technology generation and assimilation. In the case of short-term activities, the mechanism normally used has been technology transfer and acquisition and direct support from Spanish or foreign companies capable of participating. As regards longer term activities, an ambitious R&D program has been set up, the aim of which is to share research efforts with other companies and organizations, the work being carried out by Spanish and overseas research bodies and universities. In this respect, I feel it is important to underline the positive attitude of frank and open collaboration in the field of technology that has been shown to ENRESA by most of the organizations in charge of radioactive waste management in different countries, especially the members of the European Community, this being favoured in part by the continuous dialogue and scientific and technological interchange promoted by the Community's research program.

-In going over the basic aspects conditioning the company's technical and operating performance, I should like to mention the importance of achieving a level of public acceptance sufficient to allow the different activities involved in radioactive waste management to be carried out. Communication and public information activities have always played an important role, accompanying and in preparation for technical activities. In many cases the results of these efforts have been positive, facilitating the acquisition of the permits and authorizations required for subsequent technical activities. Nevertheless, success has not always been forthcoming, and in certain cases we have had difficulty in putting our message across, in particular in relation to certain R&D activities which, in view of their harmless nature, we had not imagined would require overmuch effort in communication.

LOW AND INTERMEDIATE LEVEL WASTES

The key aim in the management of low and intermediate level wastes is their final disposal. The disposal conditions and orients all the other tasks involved in the management process: Both the typology of the wastes and their conditioning will be defined by the acceptance criteria to be met by the conditioned waste packages in order for them to satisfy the safety requirements applicable to final disposal.

Following evaluation of the different alternatives available, near-surface disposal with engineered barriers was chosen as the method best covering Spanish needs. The way in which the producers are to prepare their wastes, and the acceptance criteria these must satisfy in order to be removed are specified in the contract drawn up between each producer and ENRESA. In the case of the small producers, who do not possess conditioning facilities the criteria refer mainly to the way in which the wastes are separated and presented to ENRESA, while for the nuclear power plants having the capacity to treat and condition their wastes the requirements contemplate the characteristics to be met by each type of conditioned waste, and refer to due compliance by the plant of the waste treatment and conditioning procedure agreed on with ENRESA. The process of waste acceptance and verification of quality is completed by way of a checking system based on audits and destructive and non-destructive control tests carried out in laboratory.

The El Cabril Facility

The keystone on which the entire low and intermediate level waste management system rests is the new facilities at El Cabril.

El Cabril is located in the north-west of the province of Córdoba, some 130 kilometers from the capital, in an area of very low population density and to the south of the central zone of the Iberian Massif, in a region of moderate seismicity. The facilities are located on a geological formation of gneisses and mica schists of a thickness of more than 300 meters. The site characterization process, which lasted five years, included important research efforts that have allowed detailed knowledge to be gained of the area. To describe these tasks in detail would be beyond the scope of this paper; suffice it to say that more than 100 boreholes were made and that the characterization and modeling process included perforating some 8,000 meters.

The project got under way at the beginning of 1986, construction began in January 1990 and authorization for start-up was received in October 1992.

The Spanish contribution to the project and to construction of the facilities is estimated at 95% of the total. Special mention should be made of the collaboration provided by the French agency ANDRA during the phase of preliminary engineering, and of the consulting services provided by TECHNICATOME for the project developed by INITEC.

The El Cabril Center has two main areas, one for waste disposal and the other for conditioning and for the auxiliary buildings, including the waste quality verification laboratory.

Disposal system

The installations have been projected in such a way as to allow for the disposal of low and intermediate level wastes. In this respect they have to meet two fundamental objectives: on the one hand to ensure immediate and deferred protection for both human beings and the environment, and on the other to allow the site to be used freely and without radiological limitations after a maximum period of 300 years. It is this limitation that distinguishes the short-lived low and intermediate level wastes that may be disposed of near the surface from those other categories which have to be disposed of deep underground.

The disposal system is made up of a set of multiple barriers, within which the waste packages are immobilized by means of mortar and stored inside concrete containers measuring 2.25 x 2.25 x 2.20 meters, the whole constituting a block weighing some 24 tons.

These containers will be piled in 28 cells, distributed between two platforms. Each cell houses 320 containers and measures approximately 24 x 19 x 10 meters.

The base slab of each of these platforms, on which rest the disposal cells, constitutes the main element of the overall assembly. Its functions are to provide mechanical support and to collect whatever water that could hypothetically enter the system by filtration, channeling it to a network of pipes installed in accessible galleries located beneath the storage structures, this constituting a control network..

Even though in the disposal near the surface the waste retrievability is always possible, the system employed at El Cabril, without cutting containers, complies with the Regulatory Authorities requests about easy retrievability.

It is foreseen that the capacity of the disposal facilities constructed will be sufficient to meet Spain's needs until the year 2010 (approx.). As of December 1995 some 5200 m3 of conditioned waste were already disposed of at El Cabril, thus representing a degree of occupation of 12% of the installation available capacity.

Waste conditioning

The operations carried out in the Conditioning building may be grouped into five major areas:

*Wastes from small producers. Among the main systems are those used for classification, crushing, segregation and packaging of the wastes, and a 50 kg/h incinerator for the treatment of biological and organic wastes.
*Compactable wastes. A 1,200 ton drum compactor has been installed which provides average volume reduction factors of more than 3.

*Conditioned wastes. Wastes arriving on site already conditioned in a solid matrix as well as compacted wastes are introduced in the concrete containers to be transferred to the mortar injection station placed in the container handling area.

*Inorganic liquid wastes. The liquid wastes which may be expected to arrive on site are aqueous solutions having low levels of activity and concentrations. Following analysis, these liquid wastes are incorporated in the immobilizing mortar used to fill in the spaces between drums inside the concrete containers. This serves not to reduce the capacity and, since the amount of water required for preparation of the mortar is much higher than the expected quantity of liquid effluents, altos the zero release objective to be met.

*Injection of mortar. Following positioning of the cover plate all the concrete containers are transferred to the immobilizing mortar injection station. Following the setting process the containers are transported to the disposal cells.

Both the waste conditioning systems described above and the disposal systems, including the one used for positioning the containers in the cells, are remotely controlled from the control room by means of programmable automata. The only exception to this is the handling of certain wastes from the small producers with very low contact dose rates, and operation of the incinerator.

Conditioned waste quality control laboratory

This facility is used for the performance of tests designed to determine the characteristics of the different types of waste packages, using active test specimens and actual packages, and for the technical verification of some of the packages arriving at the Center.

It is foreseen that this building will be used also for the performance of research and development tasks aimed at optimizing the waste solidification process.

DISMANTLING

Curiously, among the first tasks that ENRESA has had to address have been those relating to the dismantling of installations, such as the Vandeilós 1 nuclear power plant, a 500 MWe graphite-gas unit that operated from 1973 to 1989, the Andújar Uranium Mill, which generated 1.2 million tons of tailings during its operational lifetime, from 1959 to 1981, and other less far-reaching interventions relating to installations associated with the front end of the fuel cycle and small research reactors.

With respect to the Vandellós I nuclear power plant, ENRESA has already submitted the Decommissioning and Closure Plan to the Safety Authorities in 1994, and the detailed engineering project is nearly completed now. The dismantling authorization is expected for the end of 1996. The main immediate objectives for this project can be summarized as follows:
- Dismantling of the nuclear power plant to level 2.
- Release 80% of the site.
- Maintain the remaining 20% as a restricted area with a new building to be constructed for the reactor box.
- Complete the dismantling program in 5 years.

In 1986, ENRESA was commissioned to dismantle the disused Andújar uranium mill and to undertake reconditioning of the tailings dykes generated during the operational lifetime of the facility.

This project, including environmental evaluation and the safety study was performed under the direction of ENRESA by INITEC, with consulting in certain specific areas from Jacobs Engineering (the engineering firm for the US Department of Energy's UMTRA project), The licensing process, with its corresponding stipulations regarding public information allowed the works to begin in 1990, following issuing of the necessary permits by the central and local administrations.

The tasks of demolishing, decontaminating, dismantling the mill and the remodeling of the dykes and positioning of the covering layers are in an advanced stage of development have been completed in mid 1994. It resulted in the definitive stabilization of the dykes and factor 20 reduction in radiological impact, despite the fact that the initial situation was, in any case, within the limits established by the applicable standards.

HIGH LEVEL WASTES

In view of the evolution in perspective of the uranium market, the Spanish Government decided in 1983 not to reprocess the irradiated fuel from light water nuclear power plants.

This decision implies the need to increase the long-term capacity for temporary storage of spent fuel, until such time as this material may be transferred to a future geological disposal facility, In this respect, appropriate agreements have been reached between ENRESA and the nuclear plants in order to increase the storage capacity of these installations, using the technology best suited to the characteristics of each. As a result of these agreements, re-racking has been completed in the spent fuel pools of both groups of the Almaraz and Ascó plants, this having increased the storage capacity of the four groups to such an extent that their needs will be covered practically to the end of their estimated operating lifetime. The feasibility analysis for the rest of the nuclear power plants has also been performed. This process of increasing the capacity for temporary storage will continue in the future, through re-racking or through the use of metallic casks, either for storage (some of which have already been constructed in Spain) or for storage and transport (through licensing process with the US NRC and the Spanish Nuclear Safety Council). Also, the preliminary design of a centralized interim storage facility for spent fuel with capacity to store the whole generation of the Spanish nuclear power plants, started in 1995. Once the final revision of this preliminary design be completed, the detailed engineered design will begin.

These solutions allow sufficient time for development of the geological disposal program for long-lived wastes. This program, initiated in 1987, includes three main activities:

1. Gaining of geological knowledge with a view to identifying salt, granite and clay formations possibly suitable as hosts for the geological disposal facility. This task should culminate

tentatively in the next decade with presentation to the Government of a set of candidate sites (foreseeable from one to four) which, because of their interest, might be characterized.

2. Establishment of an ambitious R&D program, aimed mainly at providing the technical capacity required to design, license and construct the geological disposal facility within the established schedule.

In order to carry out this research Program, ENRESA is based on the collaboration of research centers and universities, Spanish as well as foreign, mainly from the E.C. countries. To give an idea about the size of the works it may be useful to know that the number of researchers involved in the different projects is close to 300.

3. With a view to orienting and prioritizing the activities referred to in the previous two points, a basic design has been drawn up for a geological disposal facilities in a granite, clay and in salt. This work has been especially useful in two ways:

-For updating of available knowledge regarding the main parameters of the waste disposal facility and its safety.

-For underlining the parameters having the greatest impact on the safety and cost of such a facility.

CONCLUSIONS

Since ENRESA began its activities, now eleven years ago, the following main results have been achieved:

*The establishment and start-up of the low and intermediate level waste management system (waste acceptance criteria and laboratories for their verification, waste collection and transport systems and facilities for conditioning, temporary storage and disposal), which is capable of managing the wastes belonging to these categories forecast for production in Spain up to the year 2010.

*The capacity to temporarily store spent fuel on site at the operating nuclear power plants is being increased, practically to the end of these plants' operating lifetime. This is being achieved through the re-racking of spent fuel pools and the use of metallic casks, depending on the technical possibilities of each plant.

This increase in the capacity for temporary storage of spent fuel will allow work to progress over the next two decades on geological prospecting and technology development, prior to construction of a geological disposal facility. All these tasks are being carried out in accordance with the established program,, initiated in 1987, which is requiring important technological, financial and communication-related efforts.

The financial, technological and waste management means required for dismantling of nuclear installations at the end of their operating lifetime have been established; thus, for example, the works involved in dismantling and tailing dyke remodeling at the disused uranium mill in Andújar were completed. The engineering project for the dismantling of the Vandellós I nuclear power plant is going ahead according to schedule, and was submitted to the Authorities during the first half of 1994, the starting of work being expected for the end of 1996.

This overall set of results represents an appreciable improvement in Spain,s capacity to solve environmental problems and a substantial reduction in the potential risk associated with the existence of radioactive wastes.