



## THE RADIOACTIVE WASTE MANAGEMENT PROGRAMME IN SPAIN

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### ABSTRACT

In 1984 the Empresa Nacional de Residuos Radiactivos (ENRESA) was set up in order to be responsible for all radioactive waste management activities in the country. ENRESA is a state-owned company, the shareholders of which are CIEMAT (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, formerly (JEN) and SEPI (Sociedad Estatal de Participaciones Industriales), both institutions dependent on the Ministry of Industry and Energy.

ENRESA has a broad scope of responsibilities, including not only the management of L/ILW, HLW and spent fuel but also the decommissioning of nuclear installations, as well as the rehabilitation of uranium mining and milling facilities when required. The policy on radioactive waste management is defined by the Government, and the strategies are developed by ENRESA in accordance with the General Radioactive Waste Management Plan. This Plan is a strategic document which must be submitted yearly by ENRESA to the Government, for its approval when the Ministry of Industry and Energy decided so. The plan, in general terms, contains the main aspects related to waste generation and forecasts, as well as the strategies and technical solutions to be prepared, along with the associated economic and financial aspects.

ENRESA's activities are financed by the waste producers. On the one hand the nucleoelectric sector pays a percentage fee on all the electricity sales, while small producers pay tariffs according to the services provided, both are approved by the Government.

The fifth General Radioactive Waste Plan, approved by the Government in July 1999, is currently in force and contains the strategies for the management of radioactive wastes and decommissioning of nuclear installations in Spain.

## ORGANISATIONAL FRAMEWORK AND FINANCING SCHEME

From the institutional viewpoint, in Spain the Ministry of Industry and Energy (MIE) plays the leading role in controlling nuclear activities, since it is the body responsible for awarding licenses and permits for installations and activities within the framework of the existing nuclear legislation. The Nuclear Safety Council (CSN) was created in 1980 as the sole body with responsibility for nuclear safety and radiological protection. This body is independent of the State Administration and reports directly to Parliament. For any license to be granted by the MIE it requires the mandatory and binding report issued by the CSN. The Ministry of Environment (MIMA) is the authority for environmental issues, and participates in the licensing of nuclear installations and activities in collaboration with the CSN, in relation specifically to the Environmental Impact Assessment.

As regards installations potentially generating radioactive wastes, the Spanish legislation contemplates two major categories: the nuclear installations (nuclear power plants and reactors, stores of nuclear substances, etc.) and the radioactive installations.

In 1984, a major reorganization of the back-end nuclear fuel cycle activities took place with the creation of the Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA), thus concentrating all radioactive waste management activities under the responsibility of only one Agency. ENRESA was set up as a state-owned limited liability company, independent of waste producers, in order to be responsible for all waste management activities in the country, including the decommissioning of nuclear installations. The company is supervised by the Government through the MIE, to whom is obliged to submit an Annual Report of Activities and a proposal for a General Radioactive Waste Plan on a yearly basis.

In accordance with the Royal Decree authorizing the constitution of ENRESA, the costs of activities deriving from the management of radioactive wastes are to be borne by the producers of such wastes. The system established for the nuclear power plants consists of applying a percentage fee based on the billing of electricity sales by the entire electricity industry, while for other producers payment for the services rendered is based on tariffs, billed at the moment of waste collection.

For the nuclear electric sector a system of payments on account is established, such that the income collected through the application of the percentage fee is accumulated for financing of costs that will normally occur years later. In order to ensure automatic financing in accordance with the system established, ENRESA will transfer to a provision those funds which are to be collected through billing on electricity sales throughout the operating lifetime of nuclear power plants. It should also be pointed out that the final

economical balance of the management performed by ENRESA should be zero. Both the income from the quota and that arising as a result of the financial yield of net surpluses should be set aside for the creation of a special fund. This fund may be used only for compliance with the objectives for which ENRESA was created and therefore for financing of the costs of waste management. The supervision, control and qualification of the financial investments of the fund is the responsibility of the MIE Tracking and Control Committee.

For the rest of the radioactive waste producers, other than the nuclear power plants (CIEMAT, ENUSA, hospitals, industry, etc.), the financing system is based on economic consideration for the services rendered, through payment of the established tariffs. The prices are drawn up in accordance with the criteria established in the Standard Contract approved by the MIE.

## **GENERAL RADIOACTIVE WASTE PLAN**

In accordance with the Royal Decree regulating its foundation, ENRESA is due to draw up a General Radioactive Waste Plan (PGRR) every year to be submitted to the MIE for Government approval. This Plan is a basic document which outlines the strategies and main lines of action projected to accomplish the defined objectives in the different areas of responsibility.

The fifth General Radioactive Waste Plan, approved by the Government in July 1999, is currently in force. It basically contains the current generation and forecast of radioactive wastes and spent fuel in Spain, as well as the management strategies for low and intermediate level waste, spent fuel and high level waste and for decommissioning of nuclear installations, including the related economic and financial aspects.

For the purposes of economic calculations and waste generation and planning, the present PGRR is based on a reference scenario including the following hypotheses:

**- Nuclear power plants (NPPs)**

The full nuclear complement is made up of the 7 plants currently in operation (9 reactors) which together have an installed capacity of 7.6 GWe. The future incorporation of new reactors is not considered.

**- NPP service lifetime**

The value of forty years is established.

**- Fuel cycle**

The so-called open cycle is maintained as the basic option: in other words the option of reprocessing is not contemplated.

- Decommissioning of operating NPPS.

It is assumed that all the NPPs currently in operation will be completely dismantled (Level 3) at the end of their service lifetime, the operations commencing 3 years after definitive shutdown and following removal of the fuel from their pools and of operating L/ILW.

## **GENERATION OF RADIOACTIVE WASTE AND SPENT FUEL**

The total estimated volumes of radioactive wastes and spent fuel to be managed in Spain are shown in Table 1.

The total equivalent volume of the spent fuel generated, on the basis of the type of capsule assumed for definitive disposal, would be some 10.000 m<sup>3</sup>. To this amount should be added, by way of a conservative approach, the technological wastes arising from dismantling of the nuclear power plants and others which, in view of their characteristics, it would not be possible to store along with the L/ILW, such as the intermediate level wastes arising from the reprocessing of Vandellós I NPP, certain sources, etc. Consideration should also be given to the minor quantities of fissionable materials recovered during reprocessing of the fuel from Santa María de Garoña plant, sent to the United Kingdom prior to 1983. For the purposes of calculation, the total estimated volume of these other wastes amounts to some 5000 m<sup>3</sup>.

As of the end of 1998 some 25.500 m<sup>3</sup> of low and intermediate conditioned waste and some 2250 tU have been generated in the country. It is worth noting the significant reduction of L/ILW arising from nuclear power plants operation achieved over the years, fundamentally as a result of the measures adopted by the plant owner utilities, with support and collaboration from ENRESA. The annual average generation of such wastes per unit of power went from 440 m<sup>3</sup>/GWe in the first Plan (1987) to 140 m<sup>3</sup>/GWe in this fifth Plan (1999).

## **MANAGEMENT OF LOW AND INTERMEDIATE LEVEL WASTE (L/ILW)**

The final aim in the management of L ILW is their safe disposal. This step guides and orients all prior steps involved in the management process.

In Spain, the fundamental basis for the management of low and intermediate level wastes is the El Cabril Centre. This facility provides an integrated management system that includes waste collection, transport, treatment and conditioning, as well as accurate information on the waste inventory, radiological characterization and quality assurance, all of which is compatible with the type of disposal applied.

Except in the case of radioactive installations, the preliminary treatment and conditioning of low and intermediate level wastes is the responsibility of the

producer, who is required to generate waste packages meeting the acceptance criteria defined by ENRESA, for subsequent conditioning and definitive disposal at El Cabril. In the case of radioactive installations, waste treatment and conditioning is carried out at the El Cabril facilities, since given the small volume generated, the large number of producers and their different characteristics there would be no justification for each such producer having the necessary installations.

Waste transport is performed by ENRESA, as the responsible operator. This is accomplished either using the Company's own resources in the case of wastes generated by the radioactive installations or by way of specialist companies in the case of conditioned wastes.

The contracts signed between ENRESA and the waste producers include the technical specifications and criteria to be considered in relation to the characterization and acceptance of wastes, for their subsequent disposal at El Cabril. Waste characterization is an important stage in management, since it allows quality to be verified, through tests. In this respect, the Quality Verification Laboratory existing at El Cabril is a very important piece in the whole process.

### **El Cabril Centre**

Since the end of 1992, the L/ILW generated in Spain have been disposed of at the El Cabril near-surface disposal facility in accordance, with the limits and conditions established in the facility's operating permit.

El Cabril is located in the northwest of the Province of Córdoba, some 130 Km from the capital city, in an area of very low population density, in a region of moderate seismicity. The facilities are located on a geological formation of gneisses and mica schists. The centre houses two main areas, one for waste disposal and the other for conditioning and for the auxiliary buildings, including the waste quality verification laboratories.

The disposal system has to comply two fundamental objectives: on the one hand to ensure immediate and deferred protection for both human beings and the environment and, on the other hand to allow the site to be used freely and without radiological limitations after a maximum period of 300 years.

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, the whole constituting a concrete solid block. These containers are piled up in vaults distributed in two different platforms. The base slab of each of these platforms, on which the disposal vaults rest, 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, channelling it to a network of pipes installed in accessible galleries located beneath the disposal platforms, this constituting a control network.

The capacity of the disposal structures constructed will be sufficient to meet Spain's needs until 2016. As of December 1998 some 12.000 m<sup>3</sup> of conditioned waste have already been disposed of in this facility.

## **MANAGEMENT OF SPENT FUEL AND HIGH-LEVEL WASTE**

In Spain, basically the following has to be managed: the spent fuel generated by the nuclear power plants and, for historical reasons, the high level vitrified wastes from reprocessing in France of the fuel from the Vandellós I plant, along with minor quantities of fissionable materials recovered during reprocessing in the United Kingdom of the fuel from the Santa María Garoña plant, prior to 1983. Furthermore, consideration is required to be given to other wastes that, in view of their activity and half-life, cannot be disposed at the El Cabril centre.

In the current strategy as addressed in the fifth Radioactive Waste Plan, a distinction is made between the temporary and definitive technological solutions to be applied, which to some extent defines a different approach to previous plans, in particular as concerns the time schedule in the decision – making process. In principle, no decision for the final solution will be taken before 2010.

### **Temporary Solutions**

Historically, the National Energy Plans and consequently the Radioactive Waste Plans have considered the direct disposal of fuel irradiated in Light Water Reactors. Accordingly the basic strategy has been to provide sufficient storage capacity for the spent fuel until a definitive solution is available. Due to the fact that no decision for the definitive solution will be taken before 2010, the fifth Plan, currently in force, emphasizes the importance of providing sufficient storage capacity for a longer time, not only for the spent fuel but also for the high level vitrified waste to be returned from France and fissionable material to be returned from the United Kingdom, as well as for other wastes and spent sealed sources not amenable to be disposed of at El Cabril.

With these considerations in mind the present strategy can be summarized in the following steps:

- Increasing the storage capacity at the reactor pools by means of reracking.
- Providing flexible complementary solutions, to be applied when needed.

- Providing a centralized interim storage facility by the year 2010.

Currently the operation of reracking has already been performed at all the nuclear power plants, given result to the following situation as of the end of 1998 in Table 2.

It is worth noting that 4 NPPs have sufficient capacity for their whole lifetime, while Trillo NPP will become saturated in 2003, and the rest will experience the same problem progressively as from the year 2013.

In order to provide complementary capacity for the out of pool storage at the reactor sites ENRESA had decided to design a dual-purpose metal cask (storage/transport) in the early nineties. These casks would serve for the storage of spent fuel at-reactor to transport it to the Centralized Interim Storage Facility whenever available. To solve the problem of the Trillo NPP a temporary storage facility is to be built on the plant site, which will house the spent fuel in dual – purpose metal casks, which should be available by the year 2002. This facility has already been designed and the cask has been licensed by the Spanish authorities, the manufacturing of the first units having begun in 1998.

Finally, the basic strategy contemplates to make available a centralized interim storage facility by 2010, in order to provide a solution to the problem of storage of the vitrified wastes and fissionable materials from reprocessing. This installation will also be required to store wastes other than spent fuel and HLW which cannot be stored at El Cabril, as well as the spent fuel itself, as the storage capacity of the nuclear power plants decreases or their dismantling is addressed. Although this strategy is considered to be basic for the purposes of economic calculation and planning, it might be complemented with the construction of individual temporary storage facilities at certain of the nuclear power plants.

### **Definitive Solutions**

The strategy adopted to date by ENRESA for the definitive management of spent fuel and HLW has been based exclusively on ensuring the availability of the scientific and technological know-how and capacity required for definitive disposal in deep geological formations, since this option was considered the only one feasible. The work performed up to now has led to the following:

- The identification of a large number of zones in the national geography which from the geological point of view, might be valid, pending in-situ confirmation.

- Significant progress in the generic and specific designs of the disposal system in each geological medium studied (granite, clay and salts), as well as in the development and preliminary applications of the tools and methodologies required for the assessment of the long-term behaviour and safety.
- Partial development, through the R + D Plans, of basic technologies for site characterization and modelling of the most relevant processes taking place in the different confining barriers, for application in safety assessment.

In view of the generalized delay affecting the programmes of other countries, the uncertainties regarding definitive solutions and the availability of temporary solutions, it has been considered appropriate to postpone decisions regarding definitive solutions until the year 2010. This will allow studies to be made of the feasibility and possible influence of the new technologies such as Separation and Transmutation. In this new timeframe, the following lines of action are foreseen:

- The geological studies for the siting process will be limited to maintaining the existing information and to ensuring its value, such that it be of use in an eventual selection process and for the safety assessment when a decision is finally taken.
- Additional work for the existing preliminary designs will be limited to incorporate the criteria of retrievability, the importance of which is increasingly underlined in the international context.
- The Safety Assessment capabilities developed should be maintained in the future through exercises incorporating the experimental data and models of the research groups susceptible to standardisation at international level.
- The R + D Plan will be oriented within the next five years to complete the efforts initiated in previous years, in relation to both resources and infrastructures for the development of characterisation techniques and methodologies. With this aim in mind, ENRESA will participate in the overseas underground laboratories projects within the EU R + D programme (1999-2003), taking advantage of their infrastructure and consequently reducing costs. In view of the importance of the new technologies, such as S/T, ENRESA will initiate a research and development programme in accordance with its possibilities and infrastructure available, in close connection with other European countries. The effect of these new technologies on definitive management should be periodically analyzed.



## **DECOMMISSIONING OF INSTALLATIONS**

From the waste production and technological viewpoints, the decommissioning of nuclear power plants is the most relevant, particularly outstanding at present is the closure of Vandellós I plant, with the remainder of the operating plants constituting an activity for the longer term.

There are, however, other installations relating to the front-end of the nuclear fuel cycle, such as disused uranium mines, the Andújar Uranium Mill and the La Haba uranium concentrates production facility, which are currently in different stages of activity. In addition, consideration should also be given to the dismantling of experimental reactors and research facilities.

### **Dismantling of Vandellós I NPP**

Vandellós I, a graphite gas-cooled reactor, was definitively shutdown in 1990, after a fire incident in the turbine building, the plant being at present in the dismantling process.

The alternative chosen was immediate dismantling to Level 2, followed by a period of waiting for completion of total dismantling of the remaining parts of the plant (Level 3).

In January 1998, the MIE, following the favourable report of the CSN and of the Environment Impact Assessment by the Ministry of the Environment, issued its authorization for the performance of dismantling activities at the plant and transferred ownership from the utility, HIFRENSA, to ENRESA. The first work began in February 1998, and the period required to complete the dismantling contemplated in the project is estimated at 5 years. Following dismantling to Level 2 there will be a waiting period-although not defined yet, this period is estimated at some 30 years – followed by total dismantling of the remaining parts of the plant (Level 3). This will leave the site completely free for subsequent unrestricted use.

### **Decommissioning of the other NPPs**

The alternative considered, for the purposes of calculation and planning, for the other plants currently in operation is total dismantling (Level 3), to be initiated three years after definitive shutdown of the reactors and following removal of the spent fuel from their pools. According to the hypotheses contemplated in the Radioactive Waste Plan as regards the foreseen lifetime of these plants (40 years), it will not be necessary to address their dismantling in the near future.

**TABLE 1****TOTAL ESTIMATED VOLUMES OF RADIOACTIVE WASTES AND SPENT FUEL TO BE MANAGED IN SPAIN**

<b>CONDITIONED LOW AND INTERMEDIATE LEVEL WASTES</b>	<b>(m<sup>3</sup>)</b>
Manufacturing of fuel elements	1,400
Nuclear Power Plant Operation	43,800
Research Activities and Radioisotope Application	8,300
Nuclear Power Plan Dismantling	135,100
Dismantling of Other Installations	1,100
Others	3,900
<b>Total (m<sup>3</sup>)</b>	<b>193,600</b>
<b>SPENT FUEL AND HIGH LEVEL WASTES</b>	
Spent Fuel (tU)	6,750
Spent Fuel (Num. of elements)	19,680
Vitrified wastes from Vandellós (m <sup>3</sup> )	80

**TABLE 2****SPENT FUEL ON STORAGE AS OF 31 DECEMBER 1998**

<b>NPP</b>	<b>tU</b>	<b>Degree of Occupation</b>	<b>Forecast Date of Saturation</b>
José Cabrera	55	43	
Sta. M <sup>a</sup> de Garoña	229	58	
Almaraz I	318	42	2020
Almaraz 2	314	41	2022
Ascó 1	297	51	2013
Ascó 2	258	44	2016
Cofrentes	364	50	2014
Vandellós 2	210	32	2021
Trillo	204	69	2003