## The Spanish General Radioactive Waste Management Plan

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## ABSTRACT

This paper mainly describes the strategies, the necessary actions and the technical solutions to be developed by ENRESA in the short, medium and long term, aimed at ensuring the adequate management of radioactive waste, the dismantling and decommissioning of nuclear and radioactive facilities and other activities, including economic and financial measures required to carry them out. Starting with the Spanish administrative organization in this field, which identifies the different agents involved and their roles, and after referring to the waste generation, the activities to be performed in the areas of LILW, SF and HLW management, decommissioning of installations and others are summarized. Finally, the future management costs are estimated and the financing system currently in force is explained. The so-called Sixth General Radioactive Waste Plan (6<sup>th</sup> GRWP), approved by the Spanish Government, is the "master document" of reference where all the above mentioned issues are contemplated.

## INTRODUCTION

Since ENRESA was constituted in 1984 as responsible for the radioactive waste management and the decommissioning of installations in Spain, there have been six General Radioactive Waste Plans (GRWP) that have served to map out the courses of actions, programmes, objectives and technical and economic or financial resources that the company has implemented and used to develop an integrated waste management system in the country.

The 6<sup>th</sup> GRWP was approved during the Cabinet Meeting held on June 23<sup>rd</sup> 2006, on the basis of a proposal submitted by ENRESA in response to a request from the Ministry of Industry, Tourism and Commerce (MITYC), after having participated the Autonomous Communities and a process of public information having been applied for the first time. The plan is needed in order to comply with a resolution issued by the Spanish Congress in December 2005, as a result of submittal of the annual report by the Nuclear Safety Council (CSN), as well as because of new legislative developments and a series of technical and economic issues.

#### Administrative organisation

The main parties involved in Spain, from administrative point of view, in the field of radioactive waste are: the Government, through the MITYC, which defines policies and grants the corresponding permits and licenses; the CSN, as the sole responsible for nuclear safety and radiation protection, which reports to Parliament; Enresa, as the entity responsible for radioactive waste management; and the waste producers, particularly significant among which are the six nuclear power plants in operation (8 reactors), the Juzbado fuel assembly manufacturing facility and some 1,300 authorised radioactive facilities.

Among the responsibilities of ENRESA the following items could be pointed out:

- Site selection and the design, construction and operation of centers for the storage and disposal of the radioactive wastes generated in Spain.

- Establishment of systems for the collection, transfer and transport of radioactive wastes.
- Management of operations arising from the decommissioning of nuclear and radioactive installations.
- Conditioning of tailings arising from uranium mining and milling, when required.
- Providing support to civil defense services in the event of nuclear emergencies.

### Waste generation

In Spain radioactive wastes are generated at what are known as *nuclear facilities*, such as the nuclear power plants (NPP's) and the fuel assembly manufacturing facility at Juzbado (Salamanca), and at the so-called *radioactive installations*, as a result of the applications of radioisotopes in medicine, industry, agriculture, research, etc. (see Fig. 1.). They may occasionally be generated at other installations or in specific activities such as those performed as a result contamination incidents.

In view of their activity and half-lives, most of these wastes may be disposed of at the El Cabril facility (Córdoba) and are referred to in the GRWP as *low and intermediate activity waste* (LILW).

In addition to the radioactive waste produced during their operation and subsequent dismantling, the nuclear power plants generate smaller quantities of spent fuel (SF), which is managed as waste since it is not subjected to any treatment to recover the non-burned uranium and plutonium. This reprocessing has been carry out as a technical strategy in the past only, while the spent fuel from the Vandellós I NPP, in France, and done until 1983, as part of a research programme, for the spent fuel from the José Cabrera and Santa María de Garoña plants, in UK.



Fig. 1. Nuclear fuel cycle and radioactive installations in Spain

According to the best estimates, based on a reference scenario of 40 years of service lifetime for the Spanish reactors currently in operation, followed by their subsequent complete dismantling (and no reprocessing of the spent fuel), the waste generation forecasts point to a volume of radioactive wastes to be managed in Spain – conditioned and open to disposal at the ENRESA facility at El Cabril – of 176,900 m<sup>3</sup>. According to current estimates, the volume of wastes not eligible for disposal at this facility is 12,800 m<sup>3</sup>; the destiny of these wastes would *a priori* be the Centralized Temporary Storage (CTS) facility and finally a planned Deep Geological Disposal (DGD) facility. Of these materials, approximately 70% will be spent fuel (6,690 Ut) and the rest other intermediate or high level wastes (see Table I.)

As of the end of 2006 there were a total 38,580 m3 of conditioned low and intermediate level wastes generated in Spain and 3,514 tons of spent fuel.

	m <sup>3</sup>		
Low and Intermediate Level Wastes	as of Dec 06	from Jan 07	Total
Manufacturing of fuel elements	470	180	650
Nuclear Power Plant Operation	27,685	10,396	38,081
Research Activities and Radioisotopes Application	3,908	960	4,868
Nuclear Power Plant Dismantling	3,401	119,293	122,694
Dismantling of Other Installations	0	983	983
Others	3,112	3,513	6,625
TOTALLILW	29 576	125 225	172 001
	30,370	135,325	173,901
High Level Wastes			
Spent Fuel	5,380	4,770	10,150
	(3,514 Ut)	(3,176 Ut)	(6,690 Ut)
Vitrified wastes from reprocessing Vandellós I NPP	81		81
ILW from reprocessing of Vandellós I NPP	666		666
Nuclear Power Plant Dismantling	0	1,055	1,055
Others	0	850	850
	6 4 0 7	6 675	12 902
	0,127	C10,0	12,802

Table I. Total estimates volumes of radioactive wastes to be managed in Spain

# ACTIVITIES WITH LOW AND INTERMEDIATE LEVEL WASTES

The fundamental element for the management of low and intermediate level waste is the El Cabril centre (see Fig.2.). Operating around this waste disposal facility there is an integrated management system that includes the collection, transport, treatment and conditioning of the wastes, along with the necessary information on the waste inventory, radiological characterisation and quality verification, all compatible with the type of disposal performed.



## Fig.2. Aerial view of El Cabril

According to the estimates regarding the generation of this type of waste, the current El Cabril installations and the temporary storage facilities of the waste producers guarantee sufficient capacity for the management of all the operating wastes arising from the nuclear power plants, the previous treatment and conditioning of which is the responsibility of the producer. They also guarantee the capacity required for the management of the wastes arising from dismantling of the plants – the dismantling of Vandellós I NPP has already been completed to Level 2– and of those generated by the radioactive installations, the responsibility for treatment in this case being to Enresa.

The central axis of the fundamental activities relating to the management of this type of waste in the coming years will be the rationalisation and possible improvement of the different processes involved in their management. Likewise, work will be carried out within the associated R&D projects and activities and on the analysis of aspects such as waste volume reduction at the nuclear power plants, an area in which highly satisfactory results have already been obtained.

Approximately 60% of the LILW might be considered as very low level wastes. For these work has already started on a complementary installation to those already in place at El Cabril, which will provide an additional capacity of some 120,000 m<sup>3</sup> (four security cells), which would guarantee the safe disposal of this type of waste in Spain. The first cell of these new modular installations, for which the appropriate authorisations have already been obtained, are scheduled to enter into service by the end of 2007, with a capacity of 35,000 m<sup>3</sup>.

### MANAGEMENT OF SPENT FUEL AND HIGH LEVEL WASTE

Different alternatives might be used for the management of spent fuel and high level waste. Firstly, in the case of spent fuel, it might be managed directly as waste or reprocessed in order to recover the fissile material for reuse as new fuel. In this respect, and as pointed out above, Spain previously sent spent fuel for reprocessing in France and the United Kingdom but, although the option cannot be considered to be closed, it implies very high costs and the problem of the surplus wastes and other materials deriving from treatment being returned to Spain.

Two aspects may be distinguished in the direct management of spent fuel: temporary storage and long-term disposal.

The availability of safe temporary storage systems for spent fuel based on different technologies – which are already in operation internationally – provides time for studying the possible alternatives to final management to be addressed, consequently delaying the need for decision-making in this respect.

In Spain measures have been taken to increase the capacity of the nuclear power plant pools in which the spent fuel is initially stored. In 1998 all these pools were re-racked and the projects for designing metallic casks suitable for the transport and dry storage of the fuel assemblies were developed.

Nevertheless, despite this increase in storage capacity, the pools of certain of the nuclear power plants will become saturated before the end of the service lifetime of the facilities. This problem was going to occur most quickly at the Trillo nuclear power plant (Guadalajara), as a result of which the construction of an Individual Temporary Storage (ITS) facility was authorised so that the plant could continue to operate after the pools had become saturated. The Trillo ITS installation, which is being in operation since 2002, is located on the plant site and the waste is being stored in dual purpose (for transportation and storage) metallic casks licensed and manufactured in Spain.

As a result of the early shutdown of the José Cabrera nuclear power plant in April 2006, this installation is being provided with a Individual Temporary Storage (ITS) for its spent fuel, combining metallic materials and concrete for containers.

In the medium term, and bearing in mind that the rest of the plants would begin to see their pools saturated towards the end of the present decade, the priority option contemplated in the 6<sup>th</sup> GRWP is the construction of a Centralized Temporary Storage (CTS) facility servicing all the plants. This facility (modular, dry storage system, vault type, see Fig. 3) would also allow for the management of reprocessing wastes and others not eligible for disposal at El Cabril.

Given that most of the temporary storage needs will arise around the period 2009-2014, the date of startup of this facility should be before 2011. On July 7<sup>th</sup> 2006, and in order to facilitate compliance with this objective, the Government set up an inter-ministerial commission to manage and supervise site selection, design the process of public participation and information and drive the public policies and legal arrangements that might need to be applied at the site selected.

There are examples of facilities similar to the CTS already in operation in the world, as a result of which the experience, technology and resources required for the performance of this project are available.

As regards the final management of spent fuel and high level waste, the CTS solution would made it possible to postpone the deep geological disposal programmes to 2050, as scheduled in the Plan, and advantage will be taken of the resulting time to continue to research new technologies, such as partitioning and transmutation, which might serve to reduce radiological quantities or inventories.



# Fig. 3. Conceptual design for CTS vault type

# **DECOMMISSIONING OF FACILITIES**

Spain is at the forefront at international level in the field of facility decommissioning, thanks to projects now culminated such as those performed at the uranium concentrates mills of Andújar, in Jaén, and La Haba, in Badajoz, the rehabilitation of disused uranium mines and the dismantling of the Vandellós I nuclear power plant, a gas cooled reactor type.

The level 2 dismantling works at the Vandellós I plant finished in 2003, giving way to a 25-year waiting (dormancy) period prior to the completion of the dismantling operation with the removal of the remaining parts, basically the concrete structure or shroud surrounding the reactor. The site will then be left completely free for any subsequent use, without any restrictions (level 3).

The  $6^{th}$  GRWP considers the alternative of complete dismantling (level 3) of all the Spanish nuclear power plants currently in operation (LWR's). Once these plants have reached the end of their service lifetime (40 years), they will be shut down and, three years later, dismantled.

The dismantling of the José Cabrera nuclear power plant, which ceased to operate on April 30<sup>th</sup> 2006, will begin in 2009 following removal of the spent fuel from the pool and the operating LILW. According to the forecasts of the GRWP, the site will be released for any future use in 2015.

Other activities currently under way in this field are the definitive restoration of the former uranium mine at Saelices el Chico (Salamanca), which is scheduled for completion in 2008, and the Integrated Plan for Improvement of the National CIEMAT<sup>1</sup> Installations (PIMIC), for which all the necessary authorisations are now available, with completion scheduled for mid 2009.

<sup>&</sup>lt;sup>1</sup> Centre for Energy-related, Environmental and Technologycal Research

### **OTHER ACTIVITIES**

In addition to what has been set out thus far, centering on the activities described in the 6<sup>th</sup> GRWP, the document also includes other activities for which Enresa is responsible. One of these is the Protocol on collaboration in the radiological surveillance of metallic materials and the management of radioactive lightning rod headers and any other radioactive material that might arise outside the regulatory system.

#### **ECONOMIC-FINANCIAL ASPECTS**

In accordance with the scenario contemplated in the  $6^{th}$  GRWP and described above, the cost of radioactive waste management from 1985 to 2070 will amount to some 13,000 million euros. Practically half this sum corresponds to the management of spent fuel and the dismantling of the nuclear power plants. As of the end of 2006, approximately 25% of the costs had been incurred (see Fig. 4.)



#### Fig. 4. RW Management Cost

These costs are covered by way of the so-called Fund for the financing of activities included in the GRWP, which receives anticipated incomes throughout the operating lifetime of the facilities, from the following sources and corresponding financial yield (see Fig. 5).



Fig 5. Financing System Scheme

- *Charges to the electricity tariff.* This financing system is based on the application of percentages on the billing of electricity sales, by way of tariffs or tolls, established such that the income from this source and corresponding financial yield cover the future costs of management of the radioactive waste and spent fuel generated by the nuclear power plants, and their dismantling and decommissioning, attributable to the operation of these facilities prior to April 1<sup>st</sup> 2005.

- *Charges to the nuclear power plants.* This is the system used to finance the costs of management of the radioactive waste and spent fuel generated by the nuclear power plants, and their dismantling and decommissioning, attributable to the operation of these facilities after April 1<sup>st</sup> 2005.

- Charges to the Juzbado fuel assembly manufacturing facility. This is the system used to finance the costs of management of the operating radioactive waste and the future dismantling of the installations.

- *Charges to other facilities.* This is the system applicable to the operators of radioactive facilities generating wastes in medicine, industry, agriculture and research and to services rendered to third parties, such as Ciemat for work relating to the PIMIC or certain companies as a result of contamination incidents at their installations. All these pay directly for the services rendered, following removal of the waste.

At the end of 2007 more than 2,000 million euros were accumulated in the Fund as a result of the real incomes, expenditures and financial yield from the year 1983, when this collection system was putted in operation.

## FINAL CONSIDERATIONS

The 6<sup>th</sup> GRWP includes the strategies and actions to be performed by Enresa in the coming years. The document, revised by the Government and subject to a process of public information, underlines the fact that Spain possesses an excellent infrastructure for the safe and efficient management of radioactive waste, from the administrative, technical and economic-financial points of view.

From the administrative point of view there is an organisation, supported by ample legislative developments, that contemplates and governs the main responsibilities of the parties involved in the process (Government, CSN, ENRESA and waste producers).

As regards the technical aspect, the experience accumulated to date by Enresa is particularly significant, as are the technologies now available in the field of management and for dismantling processes.

As regards the economic-financial basis, a system is in place that guarantees the financing of radioactive waste management costs. This system is based on the generation of funds up front, during the operating lifetime of the facilities, through the application of fees established by Statutory provisions.

Finally, a mandatory mechanism of annual revision for both technical issues and economic and financial aspects, allows to have updated all the courses of action.