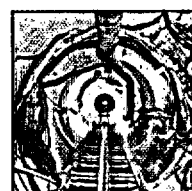
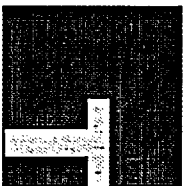


Technological
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ENRESA
Emilio Vargas nº 7
28043 MADRID - Spain
Tel.: 34 91 566 81 00
Fax: 34 91 566 81 63
www.enresa.es

Design and production: TransEdit

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The Spanish national radioactive waste company (Empresa Nacional de Residuos Radiactivos - ENRESA) was set up in 1984, and has its headquarters in Madrid.

ENRESA is a public company belonging to the Centre for Energy-Related, Environmental and Technological Research (CIEMAT) and the Spanish public industrial holding (SEPI), both reporting to the Ministry of Industry and Energy.

ENRESA is responsible for the management of all the radioactive wastes produced in Spain, this mandate being the result of a parliamentary decision. This commission includes also other activities relating to manage-

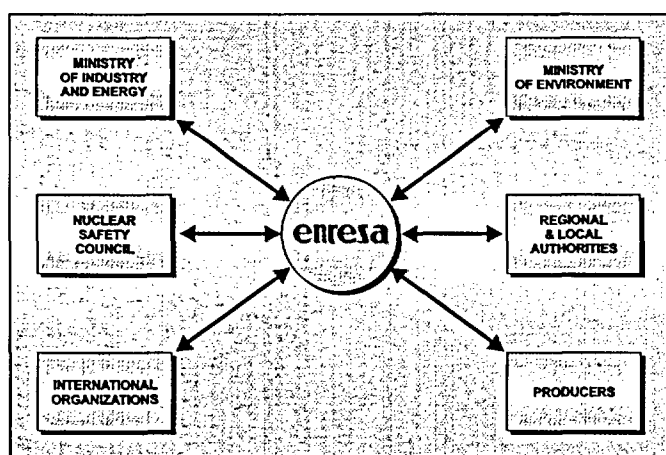
ment, such as support in the event of nuclear emergencies and the dismantling of nuclear power plants and other nuclear fuel cycle installations whenever this is required.

ENRESA currently manages a system including more than 500 waste producers and operates two facilities:

- The El Cabril Facility for the Treatment and Disposal of Low and Intermediate Level Wastes.
- The Vandellós I Nuclear Power Plant (500 MW), which was decommissioned in 1990 and is currently in the dismantling process.

The design of the Spanish radioactive waste management system and the need to identify solutions for the management of spent fuel, have implied an important experience in the implementation of projects in the different areas involved in this field:

- Development of the Spanish systems and projects.
- Continuous and systematic collaboration with technicians from other countries involved in waste treatment and disposal.
- Collaboration with the international organisations in this field.



The management of radioactive waste in Spain

In Spain, radioactive waste management is defined in the General Radioactive Waste Plan (GRWP), a Government document which is reviewed periodically in the light of technological, economic and financial changes. The strategies contained in the GRWP are binding as regards the definition and performance of ENRESA's tasks.

- ❑ Conception, design, construction and operation of installations for the storage and disposal of radioactive waste.
- ❑ The establishment of radioactive waste collection, transport and transfer systems.
- ❑ Management of nuclear and radioactive installation dismantling operations.
- ❑ Conditioning of uranium mine and mill tailings dykes.
- ❑ Support for the Civil Defense services in the event of a nuclear or radiological emergency.

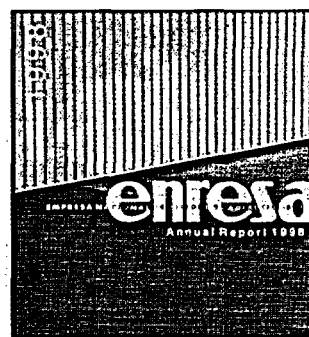
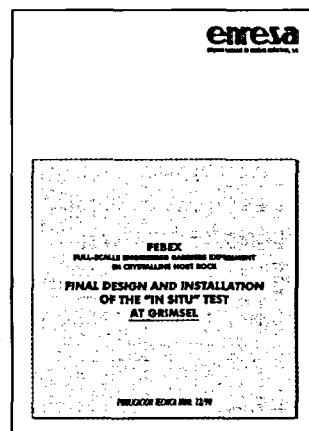
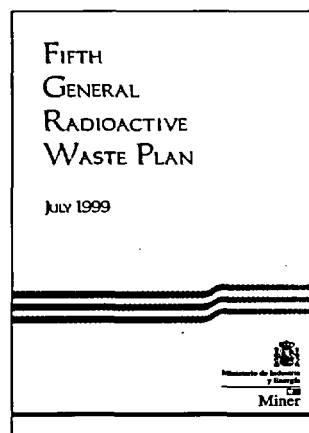
In performing these tasks, ENRESA is supervised by

the Nuclear Safety Council (CSN) and the Ministry of Industry and Energy.

The Ministry of Industry and Energy is responsible for energy policy, and consequently draws up the GRWPs in response to proposals by ENRESA and awards licenses for new and existing installations.

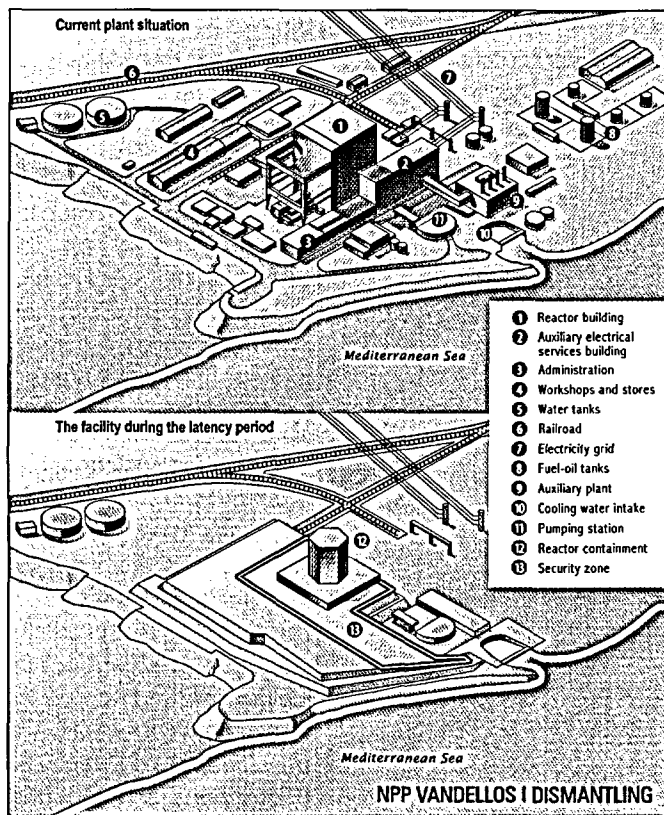
The CSN is the regulatory authority for nuclear safety issues. Its reports are prerequisites for all installation licenses and are binding. The Nuclear Safety Council also tracks and inspects the operation of all nuclear installations and proposes appropriate corrections and penalties, as required. The CSN reports only to Parliament, reporting periodically.

ENRESA is a company whose capital is fully public and independent from the waste producers. Financing is secured through the application of tariffs in the case of the "small producers" and of a fee on electricity consumption in other cases.



Within the areas of competence assigned to it, ENRE-SA has carried out the following activities:

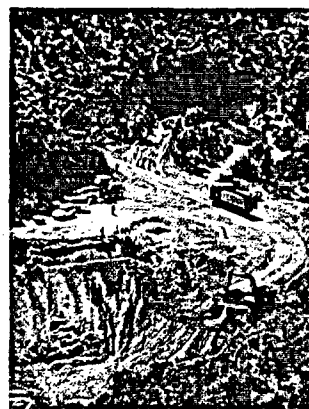
- ❑ Characterisation of the site for the El Cabril Low and Intermediate Level Waste Disposal Facility.
- ❑ Planning, design, safety assessment, licensing, construction and operation of El Cabril.
- ❑ Planning, design and performance of the decommissioning and dismantling project of the Andújar uranium mill and its site.
- ❑ Design, development, construction and licensing of a dual-purpose (storage and transport) metallic cask for the dry storage of spent nuclear fuel.
- ❑ Extension of the storage capacity of Spanish nuclear power plant fuel pools by reracking.
- ❑ Implementation of an integral management sys-



tem for the collection of radioactive wastes from small producers (hospitals, industries, research centres), with more than 500 clients and for the collection of wastes

from 9 nuclear power stations.

- ❑ Planning, organisation and performance of the removal of more than 20.000 radioactive light-

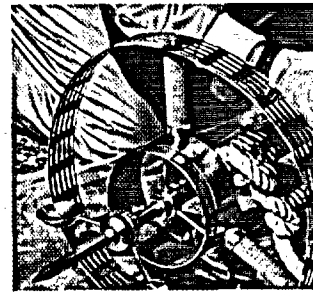
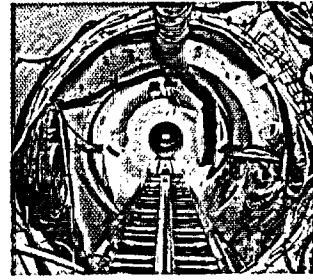


ning rods throughout Spain.

- ❑ Strategy development, project implementation and performance of the Vandellós I NPP (500 MW) dismantling program.
- ❑ Preparation and coordination of three four-yearly R&D Plans.
- ❑ Planning, project development and performance of an Environmental Restoration Plan for 19 Disused Uranium Mines.

- ❑ Development of the capabilities required for site characterisation, basic design and systems safety assessment of the deep geological disposal system for spent nuclear fuel, in three types of host rock (granite, salt and clay).

- ❑ Planning, design, construction and operation of a network of five public information centres illustrating radioactive waste management and dismantling projects.



international cooperation

ENRESA collaborates with the International Organizations most closely linked to the issue of Radioactive Waste management through participation in international projects, studies and technical assistance to countries implementing management programs. The following are among the most relevant.

For the European Commission (DG XI):

- ☐ Safety Study and Assessment of a geological disposal facility in granite and clay media.
- ☐ Environmental Impact Assessment of a Deep Geological Disposal Facility.
- ☐ Comparative analysis of the financing schemes used for radioactive waste management in various Western countries.
- ☐ Preparation of a CD-ROM explaining waste management in the countries of the European Union.

For the European Commission (TACIS and PHARE programs):

- ☐ Improvement of radioactive waste management in the Moscow region.
- ☐ Possibilities for radioactive waste management on the Kola peninsula (Russia).

- ☐ Assessment of sites for repositories in Ukraine.
- ☐ Study of the situation in Bulgaria.
- ☐ Technical assistance in site selection in Hungary
- ☐ Study of management schemes in Slovenia
- ☐ Technical assistance in creating an Agency for radioactive waste management in the Czech Republic.
- ☐ Assistance to the European Commission in defining technical assistance and bid evaluation projects.
- ☐ Study of management schemes in Latvia.

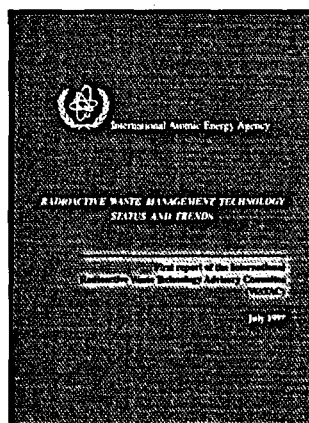
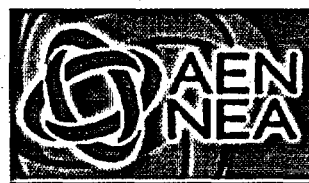
For the IAEA:

- ☐ Technical assistance missions in Chile, Brazil, Mexico, Romania, Bulgaria, Russia, Hungary, Uruguay, Croatia, Ecuador and several Central and Eastern European countries.

- ☐ Reception at its facilities of various technical visits and visiting scholars.

For NEA-OECD:

- ☐ Participation on the different Committees and working groups dealing with radioactive waste issues.



Low and intermediate level wastes

The disposal of low and intermediate level wastes has been internationally proved as an industrial solution.

Since 1986, ENRESA has organised the collection of all these wastes, from the producer to disposal at the El Cabril Disposal Facility, the Spanish repository for this type of wastes. El Cabril is of the surface type with engineered barriers.

El Cabril is the last stage of a waste collection system that includes waste inventory definition, characterization, acceptance, transport, treatment and disposal.

ENRESA has the capability of advising throughout the different phases of low and intermediate level waste management:

- The drawing up and development of strategies for the implementation of management systems.
 - ✓ Situation analysis.
 - ✓ Waste characterisation and inventory definition.
 - ✓ Formulation of management strategies.
 - ✓ Feasibility analysis.
 - ✓ Definition of waste package collection, transport and acceptance interfaces.
 - ✓ Establishment of exemption criteria.

- Design and construction of waste treatment and disposal facilities.

- ✓ Feasibility analysis.
- ✓ Technical and legal requirements.
- ✓ Acceptance criteria.
- ✓ Engineering.
- ✓ Design of remote operation systems.
- ✓ Operating practices.
- ✓ Operator training.
- ✓ Design and construction of storage-transport casks.
- ✓ Concrete durability analysis.
- ✓ Traceability systems.

- Site selection.

- ✓ Hydrogeological studies.
- ✓ Geochemical studies.
- ✓ Geotectonic studies.
- ✓ Seismic studies.
- ✓ Materials.
- ✓ Modelling.

- Long-term safety assessment.

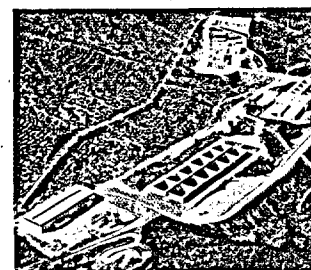
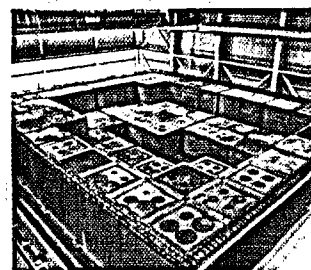
- ✓ Safety criteria.
- ✓ Calculation methodology and models.
- ✓ Licensing.

- Design and implementation of Radiological Surveillance Plans.

- ✓ Radiological surveillance.
- ✓ Conventional surveillance.

- Environmental management.

- ✓ Environmental impact studies.
- ✓ Environmental management plans.



Since its establishment in 1984, ENRESA has been working with a view to providing solutions to the storage of spent fuel at the Spanish nuclear power plants.

The possibility of some spent fuel pools becoming saturated led to a plan to replace the original racks by other, more compact devices capable of storing fuel in a denser configuration (reracking). To date, all nuclear units have implemented this solution.

In order to facilitate plant operation in those cases in which reracking does not allow for storage over the whole life of the plant, ENRESA has developed a metallic cask for dry storage of the fuel: the DPT (dual-purpose cask).

The DPT cask is designed to meet the requirements of the standards for storage and transport, and ensures greater safety and economy in these operations.

The DPT cask has been licensed by the Spanish Nuclear Safety Council (CSN).

The DPT cask is designed to house 21 fuel elements with an initial enrichment of 4% U235, a maximum degree of burnup of 41200MWd/tU and a cooldown period of just 5 years. The weight of the cask once loaded remains below 118 tons.

A study has been performed also on the feasibility of concrete casks (for storage only) and of different conceptual solutions for the centralized storage of spent fuel.

In parallel with temporary storage, ENRESA is working on a solution to the long-term storage or final disposal of these wastes.

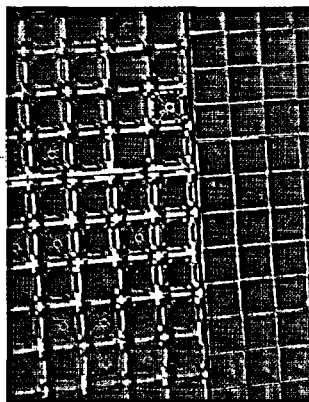
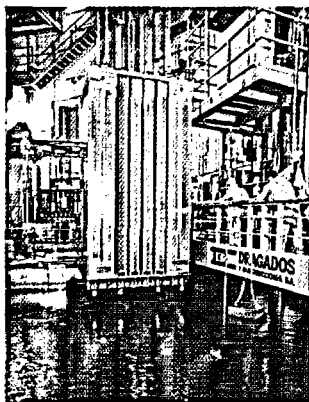
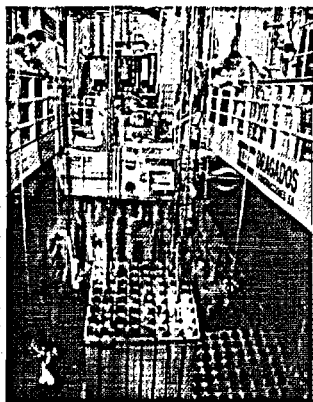
For 14 years, ENRESA has worked on development, implementation and personnel training in relation to techniques internationally accepted by countries having important nuclear programs.

The final disposal of spent fuel in deep geological facilities is a technique that ENRESA has worked on from the beginning of its activities. The company's experience focuses on site selection and characterisation techniques, the design of disposal facilities, safety assessment and management of the associated R&D.

The design of spent fuel repositories has been undertaken in Spain based on the hypothesis that the disposal would finally be performed in a granite, salt or clay formation.

The exercises performed to date include the concept and design of the surface and underground installations required for the repository, along with a sensitivity analysis relating to different spent fuel disposal scenarios.

To date, ENRESA has promoted four R&D Plans, basically oriented towards improving knowledge of fuel



disposal techniques. The R&D Plans include the participation of supranational organizations involved in radioactive waste management: European Union, NEA/OECD and OIEA.

The services of ENRESA in this field are:

□ Temporary storage of spent fuel.

- ✓ Analysis of temporary storage requirements.
- ✓ Technical and economic evaluation of solutions.
- ✓ Selection of technologies.
- ✓ Strategic planning to increase the storage capacity.
- ✓ Design, construction, licensing and supply of dual-purpose metallic casks (storage-transport).
- ✓ Design and safety assessment of storage systems.

□ Final disposal of spent nuclear fuel.

- ✓ Strategic planning of final disposal solutions
- ✓ Planning, organisation and co-ordination of final disposal facility site selection
- ✓ Design of deep geological disposal facilities (granite, salt, and clay)

- ✓ Conceptual design of packages and capsules.

- ✓ Performance of integrated safety assessments of geological disposal systems.

- ✓ Assessment of long-term performance of spent fuel and disposal capsules.

- ✓ Sensitivity and uncertainty analysis.

- ✓ Characterisation, design, construction and evaluation of clay engineered barriers.

- ✓ Solute transport models.

- ✓ Biosphere transport models and evaluation of radiological impact.

- ✓ Probabilistic techniques for analysis of evaluation results.

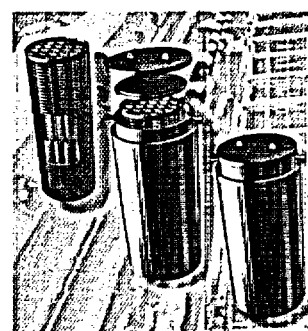
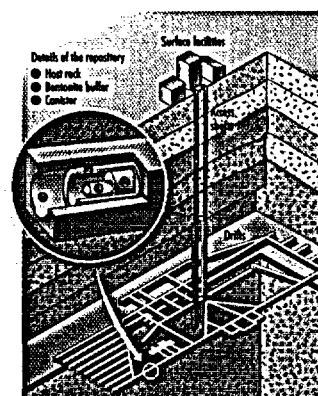
- ✓ Thermo-hydro-mechanical (THM) models.

- ✓ Flow models.

- ✓ Geochemical models and geostatistical models and techniques.

- ✓ Techniques for the acquisition of contaminant transport parameters (tracer testing).

- ✓ "In situ" determination of hydraulic and geochemical parameters (mobile units).



ENRESA is currently carrying out the tasks of decommissioning and dismantling the Vandellós I 500 MW Nuclear Power Plant. The Vandellós plant was shut-down in 1989 following an accident affecting the conventional part of the facility.

In response to an order from the Ministry of Industry and Energy, ENRESA analysed the possible alternatives for dismantling and submitted a strategy for restoration of the site, which was approved in 1992. The project foresees dismantling to level 2 (IAEA) over a period of four years, and subsequent total dismantling (level 3) over a longer period (around 25 years).

Since then, all the fuel has been removed from the reactor and the plant pools, the latter have been decontaminated and all the plant operating wastes have been conditioned.

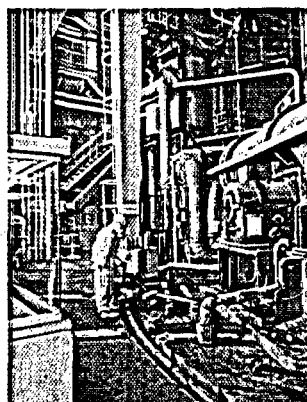
The project establishes that the structures and components external to the reactor pile will be dismantled, except those ensuring confinement of the reactor. The pile will be isolated and the different connections with the outside will be closed and sealed. The long-term

dismantling tasks include surveillance of the state of conservation of the reactor structures, the penetrations and all the other aspects considered necessary to guarantee safe isolation throughout the period.

In the short term, after four years, more than 80% of the site surface, will be cleared for any use.

Our experience comprises:

- ☐ Technical-economic analysis of alternatives.
- ☐ Strategic planning of dismantling.
- ☐ Radiological inventory of the facilities.
- ☐ Analysis of possibilities for exemption from regulatory control in the disposal of low level wastes.
- ☐ Optimisation of the radiological impact of the installation.
- ☐ Design and preparation of the Decommissioning and Dismantling project
- ☐ Project performance, ion decontamination techniques for concrete, general decontamination, cutting and melting of metallic wastes.



The immediate and longer-term safety are the basic objectives in the design of a radioactive waste repository. Long-term compliance with the safety criteria imposed by the regulatory authorities, standards and international practices requires a preliminary assessment of the conditions and processes which will affect the installations over very lengthy periods of time.

In addition to being a necessary instrument for compliance with the licensing requirements of a repository, long-term safety assessment is also a tool for acquiring in-depth knowledge of the most relevant processes taking place in disposal facilities and for identification of the most important variables impacting the behaviour of the radioelements.

The safety study also makes it possible to identify additional research requirements in relation to parameters of relevance for operation of the repository, and is consequently a basic element in the design of R&D Plans and of the characterization programs associated with the implementation of such installations.

The different performance and safety assessments have made it possible to determine the acceptability of the El Cabril solution,

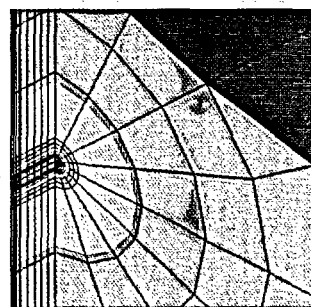
consisting of surface disposal with engineered barriers (surveillance period 300 years). They have also facilitated simulation of the conditions under which radioactive decay would take place and its impact on the biosphere, for a spent fuel geological disposal facility for in three types of host materials: granite, salt and clay.

ENRESA has experience on:

- ☐ Methodological formulation of the assessment.
 - ✓ Establishment of safety criteria.
 - ✓ Determination of the basic information required (waste, engineered barriers, design of the disposal facility and site).
 - ✓ Development of scenarios (base case and alternative scenarios).
 - ✓ Determination of most adequate models.
- ☐ Performance of the exercise.
 - ✓ Development of technical and mathematical bases.
 - ✓ Assessment of consequences.
 - ✓ Definition and treatment of uncertainties.
 - ✓ Analysis of results and conclusions regarding

the performance and safety of the facility.

- ☐ Determination of additional R&D requirements.



Between 1960 and 1980, the Andújar Uranium Mill produced 1,350 tons of concentrates from 1,200,000 tons of uranium ore. As a result of this, 1,000,000 m³ of process tailings were generated. ENRESA drew up and performed the dismantling project for these installations, remodelled and stabilised the tailings dyke and finally carried out environmental restoration of the site.

The products arising from dismantling of the installations and demolition of the buildings were incorporated into the tailings dyke. Following a series of activities designed to modify its configuration, this dyke was covered with layers of natural materials protecting against the release of radon, the seepage of rain water, biointrusion, erosion and possible flooding.

Finally, the entire site was restored.

ENRESA has also drawn up the environmental restoration project for 19 sites previously used for uranium mining activities.

In these areas, the capability of the company comprises the field of environmental restoration of sites used for uranium mining and milling or for radioactive installations:

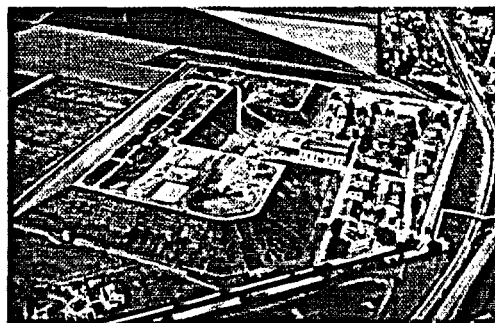
□ Dismantling of installations.

- ✓ Planning of activities.
- ✓ Radiological characterisation.
- ✓ Environmental evaluation and risk assessment.
- ✓ Project design, preparation and performance.

✓ Technical management.

□ Restoration of sites. Remodelling and stabilisation of uranium mining and milling tailings dykes.

- ✓ Planning of activities.
- ✓ Characterisation studies: demography, socio-economics, geology, hydrogeology, meteorology, ecology, geochemistry and radiometry.
- ✓ Project design, preparation and performance: general design criteria, assessment criteria, analysis of alternatives, intervention criteria, restoration plan.
- ✓ Safety and environmental impact study.
- ✓ Technical management.
- ✓ Environmental surveillance plan.



Public opinion is highly sensitive to radioactive waste management activities. For this reason it is considered essential that any action relating to the implementation of new installations or new management policies or strategies be accompanied by appropriate social communication measures favouring their understanding.

ENRESA has been carrying out such a practice since its very constitution, through the development and updating of various generic or project-specific communications plans.

Among the many examples, special mention may be made of the authorization for the construction and subsequent operation of El Cabril, the decommissioning and dismantling of the Andújar Uranium Mill, the on-going project for the dismantling of the Vandellós I Nuclear Power Plant, the decommissioning and environmental restoration of disused uranium mines, the removal of more than

20,000 radioactive lightning rods, etc.

In all these cases, suitable action in relation to public information has contributed to achieving the technical objectives in a highly rapid and efficient manner.

ENRESA currently continues to develop and implement communications programs aimed at the general public as well as various sectors of the population, teachers, university students, journalists, etc..., with a view to achieving acceptance of its objectives.

An important element of these programs are the five Public Information Centres of ENRESA (Andújar, Cabril, Córdoba, Madrid, Vandellós), which received more than 25.000 visitors during 1998. The design and operation of these centres have been undertaken by ENRESA. They are equipped with mock-ups, audio-visual materials and other informative elements designed to be interactive, such that they facilitate the understanding of the visitor in the various pro-

cesses involved in waste management.

ENRESA has experience of public information in the following areas:

- ☐ Drawing up, development and feasibility analysis of public information and communications plans.
- ☐ Design, construction, management and maintenance of public information centres.
 - ✓ Design of contents.
 - ✓ Design of systems, mock-ups and exhibition elements.
 - ✓ Visit management systems.
- ☐ Training plans in relation to radioactive waste management for university and school groups.
- ☐ Drawing up of communications plans in critical scenarios.
- ☐ Design of in-house communications plans.



B Business management support

The conception, design and implementation of the Spanish radioactive waste management system has required the availability of management systems in keeping with the company's dimensions and with the requirements of current business practices.

ENRESA is obliged to meet the Quality Assurance criteria applied in the processes of the nuclear industry. The company has obtained the ISO-9001 Quality Certification from AENOR (Spanish Standards Association) and has recently obtained conformity with ISO standard 14001 for its El Cabril facility. The company has its own Environmental Management Plan and is subject to the Environmental Auditing system.

ENRESA has experience in the different areas of corporate development, and es-

pecially in relation to the following:

- ☐ Planning of information systems.
- ☐ Planning and development of corporate systems.
- ☐ Quality management.
- ☐ Environmental management.
- ☐ Documentary management.



O ur team

ENRESA employees are some 300 people, distributed between the company's headquarters in Madrid, the El Cabril Disposal Facility and the Vandellós I Nuclear Power Plant. There are 600 specialists collaborating at engineering companies, universities, research centres and others.

The staff of ENRESA is highly professional; 60% of the personnel is made up of technicians, as demands the nature of the company's activities.

The experience has been acquired over 14 years during which projects, developments and exercises have been carried out in all areas of radioactive waste management: low and intermediate level wastes, spent fuel, decommissioning and dismantling of installations, management of special sources, decontamination of processes, public information, etc.

Such experience has also been acquired through continuous participation in the international organizations working in the fields of research and construction and operation of radioactive waste disposal installations.

ENRESA participates in the following international projects, among others:

- ☐ Research into the full-scale behaviour of a high level waste disposal facility at the Grimsel granite international laboratory (Switzerland).
- ☐ Research work at the Aspö granite rock laboratory (Sweden).
- ☐ Research at the Mol clay laboratory (Belgium).
- ☐ Research at the Mont-Terri clay underground laboratory (Switzerland).
- ☐ Participation in the various groups of the Nuclear Energy Agency of the

OECD (NEA/OECD) and the International Atomic Energy Agency (IAEA).

- ☐ Assistance to the Commission of the European Union in the Radioactive Waste Action Plan Development groups and in its third-country assistance activities.

The 600 scientists and about 30 organizations collaborating permanently with ENRESA include the following:

- ☐ CIEMAT
- ☐ Spanish Scientific Research Council (CSIC)
- ☐ Polytechnic University of Catalonia
- ☐ Polytechnic University of Madrid
- ☐ University of Oviedo
- ☐ NAGRA
- ☐ GRS
- ☐ SCK-CEN
- ☐ US Geological Survey



- ☐ LILW management systems.
- ☐ Selection and characterisation of sites for LILW repositories.
- ☐ Design, construction and operation of LILW repositories.
- ☐ Safety assessment.
- ☐ Dismantling of nuclear power plants.
- ☐ Environmental restoration of sites. Uranium mines and nuclear fuel cycle installations.
- ☐ Temporary storage of spent fuel.
- ☐ Site selection for spent fuel disposal facilities.
- ☐ Techniques for assessment of the long-term safety of disposal facilities.
- ☐ Environmental and radiological surveillance measures.
- ☐ Visitors centres.
- ☐ Business management support systems.



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Technological capabilities of Enresa

For further information, contact:

enresa

Departamento de Estudios Internacionales
C/ Emilio Vargas, 7
28043 MADRID

<http://www.enresa.es>

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