L&ILW Disposal in Spain - Licensing and Safety Aspects

Part I. Regulatory Framework
Part II. Safety Assessment

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L&ILW DISPOSAL IN SPAIN
LICENSING AND SAFETY ASPECTS

PART I – REGULATORY FRAMEWORK

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1. BACKGROUND

This seminar constitutes phase 1 of the TACIS Project "Improvement of non NPP Radioactive Waste Management in the Moscow Region" developped by CASSIOPEE consortium and by RADON Moscow NPO.

The aim of the seminar is to expose the experience in the management of this category of wastes in a country of the European Union. Spain was selected and thus the Seminar is to be organized by ENRESA and held in Madrid and El Cabril (Spain). Nevertheless it was considered useful to include in the Seminar a presentation from each of the other Western European countries participating in the Project (ANDRA, COVRA, ONDRAF).

A proposal of seminar content was sent to RADON NPO, as shown in Table 1, with a duration of 8 working days. After the coments of the Russian counterparts the dates were changed and the total duration was fixed in 7 days, including a 2 days stay at El Cabril Facility to get a deeper knowledge of the Operational procedures. The final Seminar Schedule is given in Table 2.

This document includes the different lessons as were originally foreseen some of the lessons have been melt in one to fulfill the schedule requirements.

2. GENERAL ASPECTS

In 1951, the Junta de Energía Nuclear (JEN, Nuclear Energy Board) was set up as the first specialized body, with full powers over all nuclear matters.

Since the early 1970's the Spanish authorities have been amending the previous legal and institutional regime, and the JEN has relinquished its duties concerning the different aspects of the nuclear fuel cycle.

The Empresa Nacional del Uranio, S.A. (ENUSA, National Uranium Enterprise) was set up with the purpose of assuming responsabilities in industrial activities of the nuclear fuel cycle, except for radioactive waste management.

The Consejo de Seguridad Nuclear (CSN, Nuclear Safety Council) was founded in 1980 as an independent body, generally responsible for regulation and supervision of nuclear installations in matters of nuclear safety and radiation protection.

The Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA, National Radioactive Waste Company) was set up in 1984 as an state company, responsible for all activities related to the management of radioactive wastes, including spent fuel.

The JEN, currently Centro de Investigaciones Energéticas y Medioambientales y Tecnológicas (CIEMAT), remains nowdays as a research centre in matters of energy and environment.

3. RADIOACTIVE WASTE MANAGEMENT

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 operation 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 power reactors 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) (figure 1).

3.1. EMPRESA NACIONAL DE RESIDUOS RADIACTIVOS, S.A. (ENRESA)

The Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA) was set up in 1984 by Royal Decree 1522/1984, to undertake the responsibility of all activities related to radioactive waste management in Spain, thus concentrating these activities in only one Agency. Its main mission is to ensure the safety of the population against the potential risks associated to the radioactive wastes, and to adopt the most convenient solutions for this purpose.

The political decision to create ENRESA arose from debates in Congress relating to the 1983 National Energy Plan (PEN 1983), one of whose parliamentary resolutions established that the Government would create a company to take charge of nuclear and radioactive wastes.

3.1.1. Responsibilities

The Royal Decree by which ENRESA was founded also defined its functions, which can be summarized as follows:

- Handling and conditioning of wastes in some specific cases.
- Siting, design, construction, operation and long term management of centralized storage and disposal facilities.
- Setting up of the necessary systems for collection, transfer and transport of radioactive wastes.
- Management activities derived from the decommissioning of nuclear installations.
- Conditioning of the uranium mining and milling tailings, when required.
- Support to civil protection services in cases of nuclear emergency.

3.1.2. Organization

ENRESA is a state – owned limited liability company, the shareholders of which are the CIEMAT (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas – formerly JEN) and TENEO (State Industrial Holding). Both institutions depend on the MIE (Ministerio de Industria y Energía) (Figure 2). It has been conceived to operate as a management company, the policy being the analysis, definition and control of those activities needed to achieve the objectives, which in turn will be developed by other companies, mainly services and engineering firms, under its direction and supervision.

The fulfilment of its objectives is largerly dependent on three factors: an efficient organization structure, a highly qualified staff and a solid funding system. The Directing Bodies of the company are, apart from the Shareholders General Meeting and the Board of Directors, both preceptive, the Presidency, the General Manager and the Directors of the different areas. Besides, there exists a Committee of Directors with an advisory capacity.

3.1.3. General Radioactive Waste Plan

In accordance with the Royal Decree of its creation, ENRESA shall draw up, within the first six month of each year an Annual Report, which shall contain at least the following:

- Operation carried out during the previous financial year.

- The General Radioactive Waste Plan, which shall include a revision of all necessary actions required and technical solutions applicable over the timescale of activity of the radioactive wastes; the updated economic-financial study should include the cost of the aforementioned activities.

This Annual Report shall be submitted by the Ministry of Industry, to the Government for approval, which shall be given where applicable, and shall then be presented to the Parliament:

As may be appreciated, the document known as the General Radioactive Waste Plan is the essential planning instrument in this area. Although to date ENRESA has presented a project for this Plan every year, in some cases the modifications with respect to the previous year have been so minor that the MIE as not considered it necessary to undertake a complete modification of the Plan. To date there have been three General Radioactive Waste Plans: the first published in October 1987, the second in January 1989 and the third, which is currently in force, in July 1991.

This Plan is analyzed by the Government, along with ENRESA's activities in each financial year; following approval, a report is presented to the Parliament, normally via the Congress's Commission for Industry and Energy.

The basic content of the Plan consists of an analysis of the situation in those countries which have the most important nuclear programmes, and continues with a definition of the radioactives wastes, generated and stored in Spain and forecasts for future generation, as well as a description of the management strategies for each radioactive waste type existing in Spain.

As a result of development of the management strategy for low and intermediate level wastes, described in the first Plan published in 1987, the El Cabril facility, the key element for management in Spain of this type of waste, was constructed and licensed. Strategies have also been defined for the temporaty storage of spent nuclear fuel and for final disposal of high level wastes.

An aspect peculiar to Spain is the fact that ENRESA is responsible also for the decommissioning of nuclear installations and for the rehabilitation of tailing dykes from mining activities.

The Plan continues by establishing basic economic hypotheses, including forecasts for waste management costs, this covering decommissioning of nuclear installations, and definition of income to be received via the electricity tariffs to cover these costs.

The Plan finishes by dealing with the research and development activities required for implementation of the strategies defined, including a summary of the contents of the ENRESA Research and Development Plan contemplating the activities to be carried out in this area during the period 1990 to 1994.

The most outstanding characteristic of the ENRESA planning systems is the mechanism used for annual correction, which includes the experience of both the company itself and other countries, thus providing the system with the flexibility required to take the fullest possible advantage of whatever technology breakthroughs might be made.

3.1.4. Financing System

In accordance with Royal Decree 1522/1984, authorizing the constitution of ENRESA, the costs of all radioactive waste management activities are to be financed by those responsible for generating the wastes.

The system established for the nuclear power plants consists of establishing a fee based on a percentage of the total billing of electrical energy sales by the entire electricity sector, this serving to generate up – front funds, while in the case of other producers (small producers) payment of services is by a tariff applied when the wastes are actually removed.

The aim of the financial system is that the electricity consumer should pay the costs involved in treating and disposing of the wastes generated today, final management of which will take place may years into the future. This system rules out any excuses by those responsible on the grounds of incapacity to meet these responsibilities due to lack of financial resources.

More specially, this system includes collection by ENRESA of a percentage of total electricity billing, regardless of the origin of the electricity in question, a percentage which currently stands at 1.2%. The accumulated funds, the difference between income and current costs, are administered by ENRESA and a supplemented by the corresponding financial yield. ENRESA is a non-profit making organization, since the dividends on the company's very small share capital (600 million pesetas) are purely symbolic.

4. INSTITUTIONAL AND REGULATORY FRAMEWORK

In Spain, the Ministerio de Industria y Energía (MIE, Ministry of Industry), plays a major role in the control of nuclear activities, since it is generally responsible for enforcing nuclear legislation. The CSN was founded as the only competent body in matters of nuclear safety and radiological protection, and is generally responsible for the regulation and supervision of nuclear installations. The State Secretary for the Environment, under the Ministry of Public Works, Transport and Environment participates in the licensing process, in collaboration with the CSN, in the Environment Impact Assessment.

4.1. NUCLEAR SAFETY COUNCIL (CSN)

The CSN was set up under the Act of 22nd April 1980, and is generally responsible for the regulation and supervision of nuclear installations.

This body, governed by public law, is independent of the State Administration and reports directly to Parliament. It consists of a Chairman and a Board composed of four members. The Chairman and the Board members are appointed for a period of six years, renewable by the Government, after consultation of the Minister of Industry, and on a favourable opinion of a least three – fifths of the members of the competent Committee of the Chamber of Deputies.

The Council's funds come from appropriations under the general State budget and from the Council's own resources. The Counsil obtains funds through a special charge for services, rendered, which has been established especially for this purpose. It is also levied on the issue or renewal of licenses for operating staff at nuclear and radioactive facilities.

In regulatory matters, the CSN cooperates with the Government to draw up or review rules concerning nuclear safety or radiation protection.

In the licensing process, the CSN submits reports to the MIE on the issuing of the licenses required for nuclear and radioactive installations, the transport of nuclear substances and radioactive materials and the manufacturing of nuclear and radioactive components.

In the field of radiation protection, the CSN has the power to supervise, nuclear or radioactive installations, component manufacturing plants and transport, in order to ensure that the safety requirements are complied with.

4.2. NUCLEAR AND RADIOACTIVE INSTALLATIONS

Two broad categories of installations are contemplated in the Spanish legislation: the nuclear installations, comprising the nuclear power plants and nuclear reactors, facilities using nuclear fuels either to produce nuclear substances or where nuclear substances are treated, and facilities to store nuclear substances.

The radioactive installations, in which three different categories are included.

Category 1: Facilities for the production of uranium or thorium, natural uranium fuel fabrication plants and industrial irradiation facilities.

Category 2: Those installations where nucleides with total radioactivity over certain limits are stored or handled, x-ray apparatus (> 200 Kv), accelerators and installations to store neutron sources.

Category 3: Those installations, to store or handled nuclides with a total radioactivity under certain limits and x-ray apparatus (< 200 Kv).

4.3. LICENSING PROCESS

All nuclear and radioactive installations require authorizations, to be granted by the MIE (Figure 3). Depending on their nature, these installations are subjected to different licensing procedures, which are conducted by the MIE. Any license granted by the MIE has to incorporate the corresponding preceptive and legally binding report of the CSN, as well as the "Environment Impact Statement" of the Directorate General for the Environment, under the Ministry of Public Works, Transport and Environment.

The nuclear and radioactive installations falling within the first category require: a preliminary license for site approval, a construction license and an operating license.

The various types of licenses required for nuclear and radioactive installations falling within the first category are issued by the MIE, subject to any special rules laid down by the Autonomous Communities.

Prior to issuing the preliminary license for site approval, the Minister consults the local authorities concerned and the Autonomous Bodies, whose opinions are forwarded to the CSN. The later draws up a report for the MIE. Construction and operating licenses are granted by the MIE according to a technical report by the CSN.

All licenses required for radioactive installations falling within the second and third category are granted by the Directorate – General for Energy, unless otherwise required by the Autonomous Communities.

In addition, a separate construction license is required from the local authorities (Municipal Council of the site). This license needs previous report form the Provincial Land Planning commission when –as usual- the site is not placed in an Industrial Qualified Area.

5. LEGAL ASPECTS

Spanish nuclear legislation is based fundamentally on two standards having the formal status of law, these being analyzed below. One of these standards dates back to before the 1978 Constitution, while the other is subsequent to the Constitution and consequently more coherent with its contents.

The Spanish Nuclear Energy Act, which was passed in 1964, may be considered as being obsolete. This Act related fundamentally to organizational aspects, and regulated the JEN "Nuclear Energy Board", a body which has sinve disappeared as such; as will be seen below, all the aspects have been modified without any modification to the Law in question, as a result of which it is now in disuse. Aspects relating to research and the exploitation of radioactive ores have also been substantially modified by the legislation governing mining.

The only aspects of the Law currently survirving are those which refer to the safety and licensing of installations; consequently, the Regulations governing the licensing of nuclear and radioactive facilities and the protection of workers and the public against ionizing radiations, and the standards regulating insurance against and compensation of nuclear damage, continue in force. Although certain of these Regulations were modified during the 1980's, they continue to formally regulate the original stipulations of the 1964 Law.

The Law does, however, address in great detail the issue of liability and indemnity for nuclear damage.

The Law passed in 1980, subsequent to the Constitution, created the Nuclear Safety Council as a body under public law and independent from State Administration. As established in article 1 of the aforementioned Law, the Nuclear Safety Council is the only competent authority for matters relating to nuclear safety and radiological protection.

As a result of this, the report issued by this body, which is binding when its findings are negative, is a mandatory step in the process of licensing of all nuclear and radioactive installations.

Another highly important consequence of this Law, contemplated under heading 4 of article 3 there of, is that any authorizations of licenses relating to nuclear or radioactive installations and to be awarded by a public administration cannot be denied or conditioned on grounds of nuclear safety, since all determinations in this area correspond exclusively to the Nuclear Safety Council.

This Law reinforces the aforementioned general conclusions, since a single administrationally independent State organization reporting directly to Parliament, assumes all the authority for nuclear safety and radiological protection, and is therefore assigned ample attibutes and responsibilities and provided with the human and financial resources required for performance of its functions.

Finally, it should be pointed out that the main regulatory provisions specific to the nuclear sector, as regards the licensing of radioactive installations, are the following:

- The Regulations governing nuclear and radioactive installations (Decree 2869/1972, of 21st.July).

- The regulations governing protection against ionizing radiations (Royal Decree 53/1992, of 24th January).

- The Royal Decree on Environmental Impact (Royal Decree Law) 1302/1986, of 28th June).

With regard to standards coming into force since ENRESA was created, it would be interesting to mention the Ministerial Order passed on 30th December 1988, which established economic compensations for municipal areas housing disposal facilities, this possibly being a positive factor as regards social acceptance of potential sites.

With the exception of the above, no specific standards applicable to radioactive waste disposal facilities have been developed up to date.

Table 3 shows a summary of the main Regulations applicable to Waste Management.

6. SEMINAR ORGANIZATION

As mentioned in section 1, Table 2 shows the Seminar Program.

The first day is intended to introduction and the waste management plan which resumes the inventory and general policy of the country.

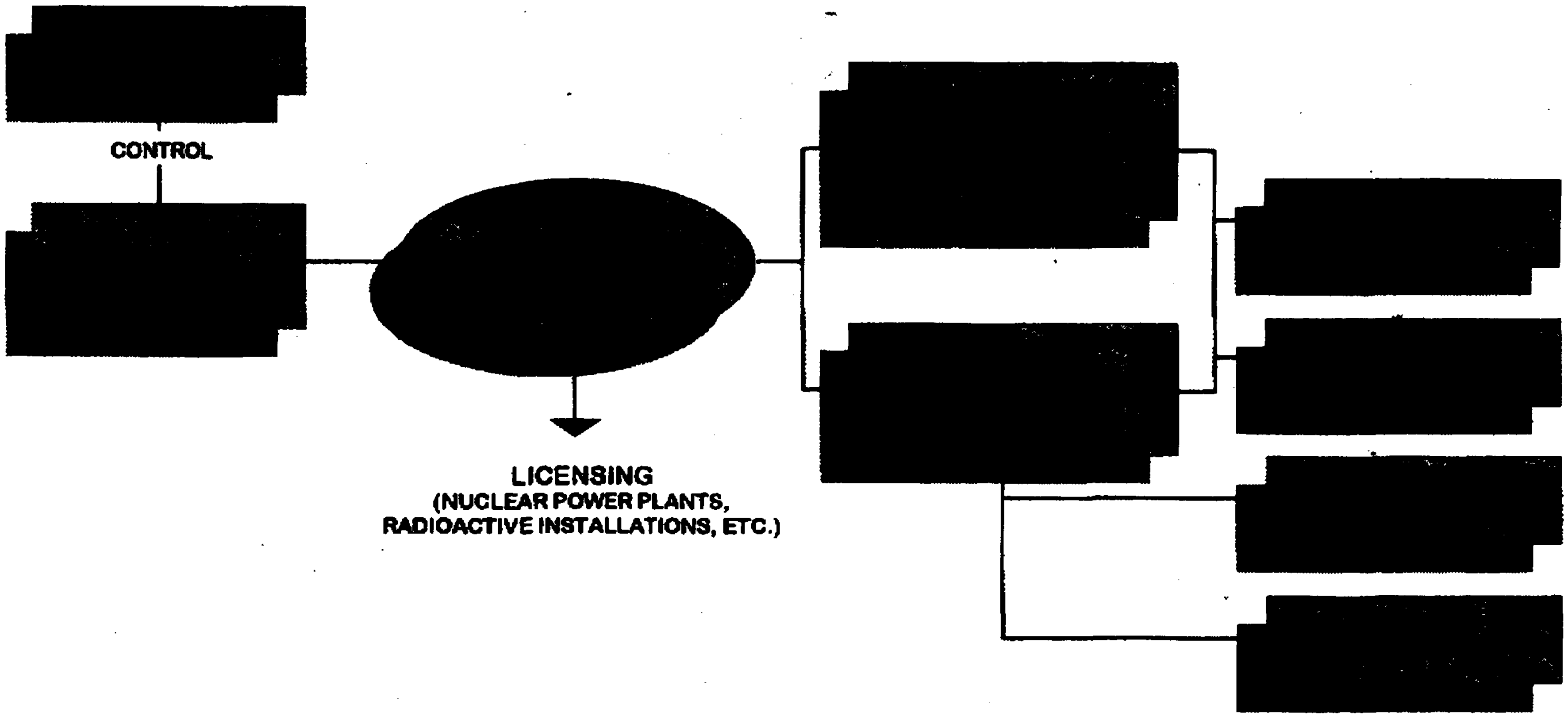
Second and third days are spent in the visit to El Cabril Facility, including the visit itself, presentations on design siting and performance assessment of the facility and on public information aspects and an open discussion about operating procedures with the operations staff.

In Fourth, Fifth and Sixth days the different theoretical and practical aspects of the waste management in Spain are reviewed: Inventory, Retrieval, Transport, Waste acceptance criteria for delivery and for disposal, administrative aspects, treatment, storage, radiological protection and surveillance, quality assurance, tracking, licensing, exemptions policy, etc.

All the seminar is focused in non NPP waste, but a more general view of all Low & Intermediate Level Waste, including NPP waste, management has been taken into consideration.

The last day is intended for the presentations on the experience in France, Belgium and the Netherlands and for discussion on phase 2 of the Project.

ADMINISTRATIVE ORGANIZATION



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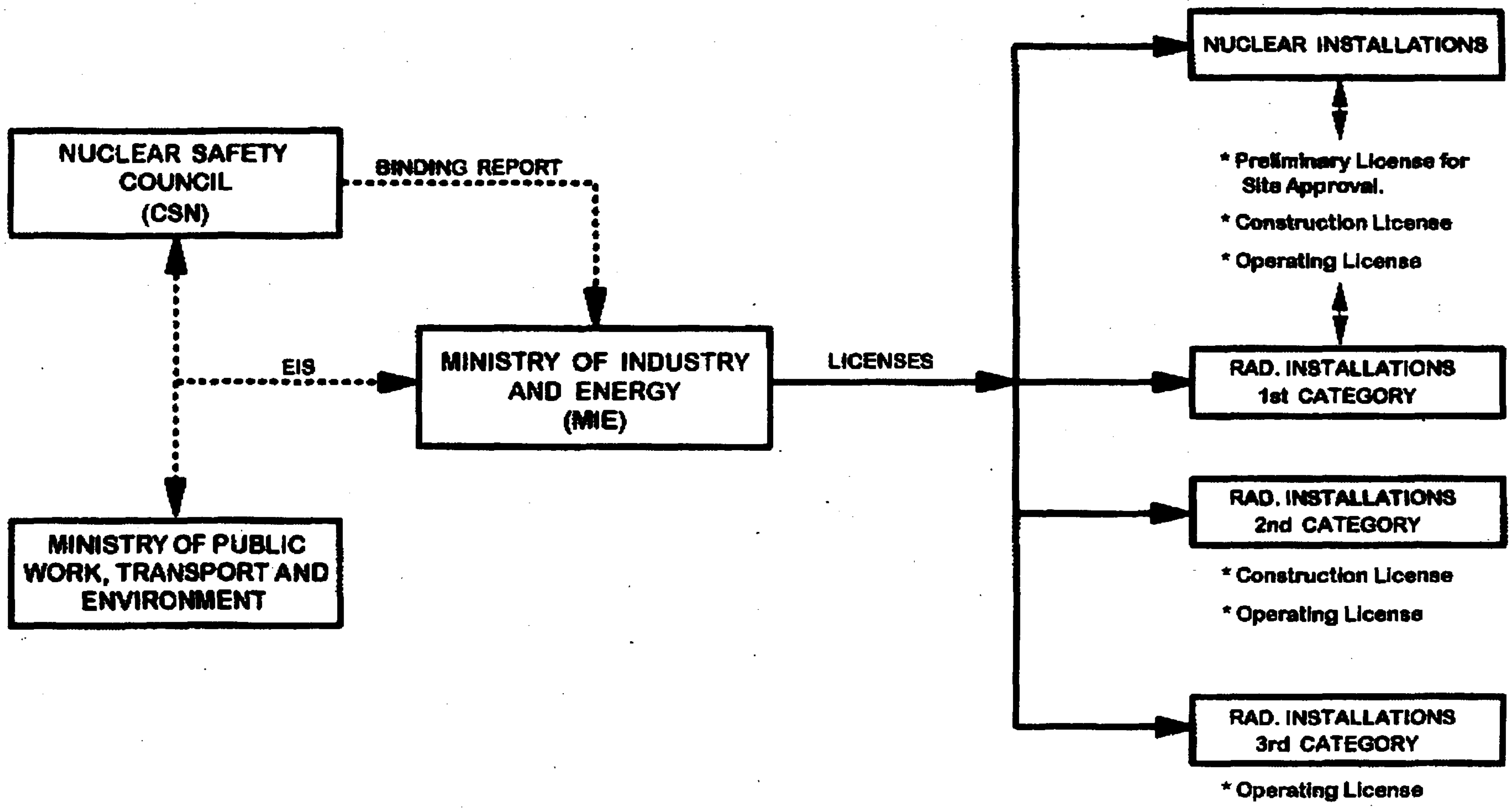
REGULATORY AND LICENSING FRAMEWORK



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LEGISLATION
SUMMARY OF LEGAL PROVISIONS IN FORCE

RANK	APPLICATION		TITLE	O.S.G.
LAW	GENERAL		• LAW 25/1964. NUCLEAR ENERGY	04th MAY 64
			• LAW 25/1980. CONSTITUTION OF CSN	25th APR 80
			• LAW 40/1994. LAW GOVERNING NATIONAL ELECTRICITY SYSTEM	31st DEC 94
DECREE/ ROYAL DECREE	M. INDUST. & ENERGY		• R.D. 1889/1996. BASIC ORGANIZATIONAL STRUCTURE MIE	08th AGO 96
	GENERIC TO NUCLEAR ENERGY		• D. 2177/1967. REG. COVERAGE OF NUCLEAR RISK	18th SEP 67
			• D. 2869/1972. REG. COVERING NUCLEAR AND RADIOACTIVE INSTALLATIONS	24th OCT 72
			• R.D. 1157/1982. STATUTES OF NUCLEAR SAFETY COUNCIL (CSN)	07th JUN 82
			• R.D. 53/1992. REG. PROTECTION AGAINST IONIZING RADIATIONS	12th FEB 92
	REF. FUEL CYCLE	FRONT END	• R.D. 2967/1979. ORDERING C.C.N. ACTIVITIES	14th JAN 80
			• R.D. 1611/1985. MODIFICATION PREVIOUS R.D.	11th SEP 85
			• R.D. 813/1988. MODIFICATION PREVIOUS R.D.	27th JUL 88
		BACK END	• R.D. 1522/1984. CONSTITUTION OF ENRESA	22nd AUG 84
			• R.D. 1899/1984. DEVELOPMENT OF ENRESA ACTION PLAN	27th OCT 84
			• R.D. 404/1996. DEVELOPMENT OF LAW 40/1994 AND AMENDMENTS TO THE R.D. 1522/84	22nd MAR 96
	TRANSPORT		• R.D. 1749/1984. AIR TRANSPORT (UPDATED BY M.O. 28/12/90. O.D.G. 23/1/91)	31st DEC 84
			• R.D. 879/1982. RAIL TRANSPORT	18th JUL 89
			• R.D. 74/1992. NATIONAL REG. ROAD TRANSPORT OF HAZARDOUS MATERIALS (TPC)	14th SEP 92
			• R.D. 2088/1994. TRANSP. CEC DIRECTIVE 92/3/EURATOM. SURVEILLANCE AND CONTROL TRANSFER RW BETWEEN MEMBER STATES AND ORIGIN OR DESTINATION	26th NOV 94
MINISTERIAL ORDERS	ENRESA	INSTALLATIONS	• ORDER MIE 13/12/85. TRANSFER TO ENRESA OF JEN INSTALLATIONS AND PERSONNEL	—
			• ORDER MIE 31/10/89. AUTHORIZ. ENRESA CONSTRUCTION OF EXTENSION TO SOLID RW DISPOSAL FACILITY IN SIERRA ALBARRANA (EL CABRIL)	02nd NOV 89
			• ORDER MIE 08/10/96. EXTENSION TO THE PROVISIONAL OPERATING PERMIT FOR SIERRA ALBARRANA NUCLEAR RW DISPOSAL FACILITY	22nd OCT 96
		FINANCING	• ORDER MIE 12/05/83	18th MAY 83
		COMPENSATIONS COUNCILS	• ORDER MIE 20/12/94. ASSIGNMENT OF FUNDS FOR RW DISPOSAL FACILITIES OR NPP's. EXTENSION TO R.D. 1522/1984	28th DEC 94

PEN-83: "CREATION OF A PUBLIC COMPANY IN CHARGE OF THE TRANSPORT, DISPOSAL AND SURVEILLANCE OF NUCLEAR AND RADIOACTIVE WASTES" (PLAN CURRENTLY IN FORCE PEN 1991-2000)

GRWP: "REVISION OF ALL NECESSARY ACTIONS AND TECHNICAL SOLUTIONS APPLICABLE OVER THE TIMESCALE OF RW ACTIVITY".

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L&ILW DISPOSAL IN SPAIN.
LICENSING AND SAFETY ASPECTS

PART II – SAFETY ASSESSMENT

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1. INTRODUCTION

"El Cabril" facility, owned by ENRESA, is in operation since 1992. It resolves the storage of low and intermediate level radioactive waste in Spain up to 2010 approximately. Wastes produced by the operation of Spanish nuclear power plants, the nuclear fuel factory of Juzbado, the CIEMAT and waste generated by medical, research and industrial activities (minor producers) are disposed of in "El Cabril".

The center includes a conditioning building, with compactation and incineration systems, a laboratory for waste quality verification, as well as the necessary auxiliary building.

As it is known the licensing process of a nuclear installation requires to carry out the evaluation of the radiological impact. The evaluation should allow to assure that the safety and radiological objectives of the center will be met.

Hereafter are presented, on the one hand, the safety and operating requirements contained in the operating permit, derived from the safety evaluation performed by the Nuclear Safety Council (CSN); and on the other hand, the radiological impact assessment contained in the Final Safety Analysis Report presented by ENRESA.

2. PARTS OF SAFETY ASSESSMENT

The safety and radiological requirements contained in the operating permit have been derived from the safety evaluation performed. This assessment is divided in two different parts.

The first one is related to the facility active systems during the operational phase (including organisation, management, control and surveillance programs). The second one related to the long-term performance of the disposal system includes the institutional, or control and monitoring period and the post-institutional phase where it is assumed any activities to take place at the site is performed without restriction.

The first part has been developed by the application of the usual regulations and standard an nuclear facilities, considering the specific characteristics if this facility.

The development of the second part has been based on the radiological impact assessment contained in the Final Safety Analysis Report, taking into account the recommendations and methodologies of international organisations. The requirements promulgated in other countries and the long-term radiological acceptance criteria defined by the Spanish Nuclear Safety Council (CSN).

3. SAFETY ASSESSMENT BASES

Safety assessment of "El Cabril" facility presented in the safety analysis report is based on:

- Safety and radiological protection goals.
- Radiological limits and regulatory conditions.
- Characteristics of waste to be stored.
- Facility design and operation.
- Site characteristics.

Each of these items are developed in the following paragraph. The first two subjects are described in detail. On the contrary, a brief description of the last third subjects is presented since, although they are related to safety assessment, they are not the main objective of the lesson.

3.1 Safety and radiological protection goals

"El Cabril" has been planned to provide a long term storage for low and intermediate-level radioactive waste. Consequently the disposal system must satisfy two basic safety objectives:

- Ensure the immediate and deferred protection of any member of the public, and of the environment, as well as the workers in operational phase.

- Allow the free use of the site after a maximum period of 300 years without any radiological limitation.

Immediate protection does not pose any particular problems and in this regard it is similar to other nuclear installations. However, long term protection implies the use of a system of multiple barriers.

The maximum period of 300 years was taken from the French Fundamental Safety Rule, RFS-I.2, which have been used as a reference, and correspond to a period during which it is reasonable to assure that construction may be prevented on the site, and at the end of which, it is supposed that all artificial construction will be totally degraded.

This objective involves the limitation of total activity of radionuclides to be disposed of in the facility, as well as the concentration of radionuclides in the waste.

Besides, a third objective have been adopted in the "El Cabril" project:

- To facilitate the recoverability of the waste if circumstances were to make it advisable.

The original design was modified in order to incorporate this concept, based on the use of disposal units for the emplacement of the waste packages inside the disposal cells.

3.2 Radiological limits and regulatory conditions

In order to achieve the safety and radiological protection goals, the following radiological limits and conditions were established:

- The total activity to be disposed of in the facility will be lower than the reference inventory.

Nuclide	Reference Inventory. (TBq)
H-3	2.00E+02
C-14	2.00E+01
Ni-59	2.00E+02
Ni-63	2.00E+03
Co-60	2.00E+04
Sr-90	2.00E+03
Nb-94	1.00E+00
Tc-99	3.20E+00
I-129	1.50E-01
Cs-137	3.70E+03
Pu-241	1.15E+02
Alfa Total 300 a (Bq/g)	3.70E+02

Activity limitations are derived from the radiological impact assessment of the facility in the post-operational phases (institutional control period and free use phase) using long-term radiological acceptance criteria. The procedure involves the consideration of ground water migration scenarios and human intrusion scenarios. The first are highly site-specific and in related to total activity limits of the facility. Intrusion scenarios, which may occur once the surveillance period is over, are practically independent on the site and are related to the limits of the radionuclide concentration in the waste, which are generally more restrictive than limits of total activity.

- The long-term radiological criterion defined by the CSN is a risk of 10^{-6}/year or the equivalent dose associated with this risk (0.1 mSv/year).

- The collection, treatment and conditioning waste systems have been designed to meet the objective of "zero discharge". In order to implement this requirement, the radioactive waste collected in the tank of radioactive liquid effluent system and of the infiltration control network will be utilised to produce the filling mortar of the disposal units.

- By considering the expected material evolution of disposal facility, the annual effective dose via groundwater must not be greater than 0.1 mSv, either short-term or long-term.

- The channels for radioactive gaseous release are the outlet of the controlled ventilation system and the incinerator stack. Both systems have been designed and operate in such a way that the doses to a hypothetical member of the public at the limit of the restricted are, due to all gaseous discharges to the atmosphere and considering all exposure pathways, be as low as reasonable achievable and lower than 0.01 mSv/y.

- The dose to any member of public due to any accidental situations must be lower than 5 mSv/y and in any case lower than 1 mSv/y averaged through the individual life.

- Doses to workers due to normal operation activities must be lower than the limits of Spanish radioactive health physics regulation and ALARA.

  With a view to achieve this objective, optimum technical options were selected during the project conceptual design phase, with remote control of operations involving radioactive materials whenever possible. A highly accurate method for dividing the facility into zones was devised, and maximum external and inhalation exposure dose rate values were assigned to each such zone, depending on the residence time foreseen, for both normal operation and maintenance activities. The design objective adopted was a maximum dose per worker of 5 mSv/y. The ventilation and biological shielding system were designed to comply with the aforementioned criteria.

- Dose to an intrudent derived from the postulated intrusion scenarios considered in the French Fundamental Safety Rule, RFS I-2, must be lower than the limits mentioned above for the case of accidental scenarios, 1 mSv/y.

There was not discussion about the probabilities of these scenarios as in the RFS I-2, it is assumed that this intrusion occurs 300 years after the end of the operation period.

- A further, more realistic, intruder scenario was also considered, where a lapse of 500 year after the end of the operation period is assumed, on account of the actual, specific disposal system. A smaller limit (0,1 mSv/y) must be fulfilled in this case.

- Duplicate archives in two different places will be maintained during the operational phase in order to keep all the necessary information at the moment of the closure. Such information shall include at least: a) the data related to the waste containers (including manufacture, identification, location in the storage cells, waste origin, type and conditioning process, as well as radionuclide content), b) the information related to each storage cell (including design and manufacturing data, chronological and technical data of the cell occupation, results of the infiltration control network surveillance and potential anomalies) and c) the results of the site and environmental surveillance programs.

Moreover, it has been required that the computerised system shall have capacity to provide information, on the waste received, treated, conditioned and disposed, as well as the total activity disposed at the time.

- The following experimental studies have been required to know the long term actual performance of the disposal system: a) a radioactive waste characterisation program, including the necessary tests to verify the lixiviation rate, b) an investigation plan on the durability of engineered barriers, c) an experimental erosion study to provide the necessary information for the final design of the cover, d) the update of the flux and transport hydrologic model with the obtained experimental data.

Finally, the organisation structure for operation includes a quality assurance group and a radiological protection group. The staff has the required qualifications and a training program has been established. All activities involved in the operation of the facility are carried out according to the approved Quality Assurance program and the Radiological Health Physics Manual. Besides, Emergency and Physical Security Plans are arrange, and Environmental Monitoring Program to be performed during the operation phase will be submitted for approval every year.

3.3 Characteristics of waste to be stored

In order to guarantee compliance with safety criteria, the "El Cabril" disposal facility has imposed a series of waste acceptance criteria limiting both total activity and the activity per waste package, beta and gamma, and a very low limit for activity concentrations from long-lived alpha emitters.

Qualitative and quantitative acceptance criteria on physical and chemical characteristic of the wastes have been developed by ENRESA and approved by the CSN. Any change in the origin, type, or conditioning process of the waste considered up to now will be subject to the elaboration of the specific acceptance criteria and their approval.

Solid and solidified wastes to be disposed of in the facility are defined as those whose activity comes mainly from short-lived radionuclides ($T_{1/2}$ < 30 years) with very limited content of long-lived alpha emitters.

All radioactive waste packages must be immobilised inside disposal units prior to their disposal. The use of these disposal units will have to be approved by the CSN after passing the structural test as well as the transport regulations for A type packages.

Waste packages are classified in two levels according to the activity content. Waste packages are of level 1 if the specific activity when generated is lower than the values:

Total alpha specific activity (long-lived emitters)	1,85 E+2 Bq/g
Beta-gamma specific activity by isotope with half-life > 5 years, except Tritium	1,85 E+4 Bq/g
Total beta-gamma specific activity due to half-life > 5 years emitters	7,40 E+4 Bq/g
Tritium specific activity	7,40 E+3 Bq/g

Waste packages whose activity go beyond this limits are classified as level 2. The specific activity of these waste packages should be lower than the specific activity defined for the disposal unit.

Nuclide	Disposal Unit (Bq/g)
H-3	1.00E+06
C-14	2.00E+05
Ni-59	6.30E+04
Ni-63	1.20E+07
Co-60	5.00E+07
Sr-90	9.10E+04
Nb-94	1.20E+02
Tc-99	1.00E+03
I-129	4.60E+01
Cs-137	3.30E+05
Alfa Total 300 a (Bq/g)	3.70E+03

The distribution of the waste packages inside the disposal unit and of those in the storage cells must be carried out in order to obtain a good homogeneous activity distribution. With this objective additional limits of activity for the disposal units and storage cells have been approved.

In application of the ALARA criteria, the peripheral places inside each storage cell will be occupied by waste disposal units with dose rates in surface lower than 200 mR/h. Additionally, it has been required that only disposal units with level 1 wastes can be located on the upper layer of each storage cell. This provision ensure, according to the evaluation of human intrusion scenarios, the compatibility with the long-term radiological protection objectives and criteria.

3.4 Facility operation and design

The facility is divided in two zones: the disposal zone, and the conditioning and auxiliary buildings zone.

3.4.1 Disposal zone

In the disposal zone there are 28 storage cells grouped in two platforms: the north platform with 16 cells, and the south platform with 12. In each of these platforms, the cells are laid out in two rows, each of which are served by a slinging roof which moves along rails.

The storage cells have approximate external dimension of 24 x 19 x 10 m. The main element is the bottom slab. This slab form a horizontal surface on which the containers are placed. The bottom slab is linked to a network of pipes. This network is called "The Infiltration Control Network" and makes the monitoring of the disposal system possible.

The waste packages, to be disposed of in the storage cells, most of them 0.22 m^3 drums, are immobilised previously inside concrete containers, called disposal units, with external dimensions of 2.25 x 2.25 x 2.20 m.

The disposal unit are stored in piles of four levels in the storage cells, with a capacity for 320 disposal unit each.

When the waste emplacement operation are finished, the project foresees the burial of the disposal cells under a low permeability cover, made up of alternate layers of impermeable and drainage materials.

In summary, "El Cabril" is a type of disposal facility based on the concept of a multi-barrier system. Three barriers constitute this system:

- The first barrier consist of the waste immobilisation matrix and the concrete storage container.

- The second, made up by the bottom slab of the cells, the cover and the infiltration control network, limits the ingress of water and allows whatever water might have come into contact with the waste packages to be controlled and possibly treated, if necessary.

- The third is the geological barrier, or the surrounding terrain which limit the impact of any potential leaching in the eventually of the degradation of the two first barriers, which are assumed to be completely degraded in the free use phase.

3.4.2 Building zone

The building zone houses the installations for waste treatment and conditioning and their control, as well as the auxiliary services needed for the operation and maintenance of "El Cabril" Center. The involved buildings directly in the waste management are the following:

- Transitory Reception Building
- Conditioning Building
- Active Laboratory for Waste Quality Verification

3.5 Site characteristics

3.5.1 Physical environment

The site is located in the south-west part of Spain, in an area of moderate seismicity. The facility covers an area of 20 Ha located in the north part of the country estate named "El Cabril", property of ENRESA, with a total area of 1126 Ha.

The cells have been built in a geologic formation called "Cabril", basically composed of gneisses and mica schists.

Monthly average temperatures vary from 7 ºC (January) to 27 ºC (July and August). Annual average precipitation is 653 mm, quite regularly distributed among spring, autumn and winter.

The location of the facility up on a hill, at higher elevation than near fluvial streams, makes the probability of flooding negligible.

Main conclusions from the hydrogeological studies indicate that the materials over which the facilities are erected can be considered as a continuous, heterogeneous, anisotropic and low-permeability medium. Average permeability in the most transmissive area is 2×10^{-5} cm/s. Infiltration has been estimated to vary between 10 and 43 mm/a. Maximum groundwater table is at least 4 m under the base of the storage cells. The area drains to the "Montesina" brook through two transfer pathways, one straight and one through the "Morales" brook.

The annual average volumetric flow of "Montesina" brook is 0.45 m^3/s. This brook meets the "Bembézar" river, that has an annual average flow of 6.07 m^3/s, that finally reaches the "Bembézar" reservoir. Both streams flow through narrow ravines.

3.5.2 Biologic and human environment

The population density in the area is very low, with 35 people living in a radius of 10 km. In the last decades the population in a 50 km radius area has dropped, and industrial or urban factors capable to change the trend are not expected.

The site area is rather steep, what precludes important agricultural activities. When it exists, agriculture is traditional, extensive and little efficient.

There are enclosed land for hunting, but there are no water collecting from “Montesina” and “Bembézar” rivers upstream of the “Bembézar” reservoir.

4. EXPOSURE SCENARIOS

During the lifetime of the disposal facility, a number of scenarios (assuming a set of conditions or events already taken into account in the facility planning and design) has been considered as radionuclides may be released from the disposal facility and potentially cause radiological impacts on individuals or the environment.

The radiological impact assessment of “El Cabril” includes two group of scenarios. The former is relating the facility operational phase and the later refer to the long term performance of the disposal system.

The exposure scenarios considered relating to the parts of safety assessment are:

a) Facility operational phase:

- Air and external exposure pathways both for normal evolution and accidental condition.
- Water exposure pathway is included in long-term evaluation since a conservative assumption as control of liquid effluents meets the criterion of "zero discharge".

b) Long-term performance of the disposal system:

- Radionuclide migration water pathway both for normal evolution and accidental condition.

- Inadvertent human intrusion.

  According to the French Fundamental Safety Rule, RFS I-2, three scenarios are considered:

  - Road construction
  - Residence
  - Residence and sport activities practise

  Besides, agreeing with OECD/NEA methodology another scenario is evaluated:

  - Permanent residence

In general the particular hypothesis for each considered scenario have been assumed to assess the biggest doses to a critical individual, so that these scenarios can be considered those that penalise the radiological impact, settling an upper bound.

The radiological consequences of the postulated scenarios are lower than the radiological limits and regulatory conditions.

4.1 Facility operational phase

4.1.1 Air pathway scenarios

During normal evolution the operation of two systems which are involved in gaseous release to the atmosphere is evaluated in order to ascertain that the dose to a hypothetical member of the public at the unrestricted areas is below the acceptable limits. These two systems are:

- Controlled ventilation system and
- Incineration stack

Gaseous effluents come mainly from:

- Compacting process of compactable wastes coming from nuclear power plants.
- Extraction of samples of active packages in the laboratory.

- Incineration of waste coming from minor producers, which cannot be conditioned otherwise.
- Incineration of liquid organic waste originated in the compacting process.

In accidental conditions the postulated scenarios are

- Drum handling incident causing drum integrity loss.
- Waste fire outside the incinerator.
- Confinement loss during the compacting process or abnormal operation of controlled ventilation system.
- Abnormal operation of incineration system.

4.1.2 External exposure scenarios

During normal evolution the dose rate is assessed for exposition to

- The disposal unit located in the storage platform.
- The transport lorries loaded with drums and placed in car park near the interring reception building.
- The drums inside buildings (interring reception building, conditioning building, active laboratory for waste quality verification, etc.).

4.2 Long-term performance of the disposal system

4.2.1 Water pathway radiological impact

The disposal system evaluation involves the simulation of the disposal facility, the geosphere, and the biosphere. The evaluation performed is deterministic and the upper estimated methodology is used.

The main analysed areas are: the assessment of source term taken into account transport inside the concrete disposal cells, the estimation of aquifer transport and the examination of the biosphere pathways.

Also, an accidental scenario is postulated assuming a partial cover fail during the surveillance and control period causing a direct exposure of the cells to the rainfall.

The general and the specific assumptions, both for normal and accidental evolution are presented following.

4.2.1.1 Simulation model - general assumptions

- The actually arrangement of the engineered barriers (long term cover, top and bottom concrete slabs of the cells, the infiltration control network and the storage unit make up of concrete container, mortar for immobilisation and waste package) is considered to simulate the disposal system.
- The evaluation is performed in two successive temporal intervals: institutional period (the first 300 years) and the post-institutional period (henceforth).
- Institutional period is characterised by the undegraded barriers multi-layer cover and concrete barriers.
- Post-institutional period is identified with the total degradation of the cover and the other engineered barriers. The infiltration control network is assumed failed.
- The two successive temporal phases are simulated through the change of the material properties (mainly hydraulic conductivity) following a step function. Temporal phases are considered stationary.
- In accidental conditions it is assumed that the cover fails. It is assumed that a 100 squared meters of surface is damaged and remaining failed for a year before remedial activities are performed. The evaluation is carried out considering that an equivalent disposal cells area is exposed to the rainfall during the year the event happens.
- The activity distribution of the waste packages inside the disposal unit and of those in the storage cells is homogeneous.
- Geosphere/biosphere interface is modelled as a river system

4.2.1.2 Simulation model - specific assumptions

- Source term.
  - The release rate during the institutional period, the first 300 years, is estimated using the diffusion mass law for conditioned waste and the surface rinse model for unconditioned waste.
  - During post-institutional period, surface rinse is assumed as the release mechanism of contaminants from unconditioned and conditioned waste. As the infiltration water reached the waste the contaminant is instantaneous release.
  - The release model does not take into account sorption on solid phase or limits on release due to contaminant solubility.
  - Transport model includes advection, diffusion-dispersion and sorption mechanism as well as decay processes. Only one dimension is considered.
- Geosphere.
  - As a conservative assumption transport through unsaturated zone is not evaluated.
  - Radionuclide migration through saturated zone is modelled in one dimension Processes as advection, diffusion-dispersion, sorption mechanism and decay are taken into account.
- Biosphere.
  - The critical group is located in the riverbank in a point downstream after the river meeting.
  - As a framework a local agricultural system is modelled where the critical individual is able to supply the food products he needs.
  - The analysed potential pathways are:
    - Drinking water.
    - Fish and invertebrates.

- Vegetable products contaminated after irrigation.
- Animal products contaminated through feeding and drinking.
- Ingestion.
- Inhalation.
- External irradiation.

4.2.1.3 Computer codes used for the evaluation

The codes employed are DUST (Disposal Unit Source Term) to evaluate the source term and contaminant migration through the geosphere, and AQUABIOS to examine biosphere exposure pathways and to assess the final dose.

Under ENRESA I+D program a code for safety evaluation for near surface radioactive waste disposal facilities, CESARR, have been developed by The Cátedra de Tecnología Nuclear (Polytechnic University of Madrid). CESARR allows to perform a probabilistic safety assessment. It is linked with SYVAC3 (System Variability Analysis Code) developed by AECL which handles the probabilistic management of the results obtained with CESARR. Besides, results obtained with CESARR can be used directly with the code MAYDAY, which performs uncertainty and sensitivity analysis.

4.2.1.4 Sensitivity analysis

The sensitivity analysis carried out consider variation of parameter related to the source term and radionuclide migration through the geosphere. Regarding biosphere any parameter variation was considered, except for those parameters which are involved at the same time in any both source term-biosphere, or radionuclide migration through the geosphere-biosphere. The hypothesis assumed regarding radionuclide transport through the biosphere, specially the assumptions on location and self-sustaining degree of the critical individual, are pessimistic enough to consider that the biosphere is treated conservatively.

The variation proposed is due, on the one hand, to the knowledge degree about the parameter; and on the other hand, to the involved uncertainties relating to the value determination.

The study was performed over the follow parameters:

- Related to source term.

  - Engineered barrier durability (multi-layer cover and concrete structures).
  - Concrete-water distribution coefficient.
  - Annual rainfall (Darcy velocity variation).

- Regarding transport through geosphere.

  - Soil-water distribution coefficient.

4.2.2 Inadvertent human intrusion.

Two different studies of human intrusion scenarios have been performed. The first one was carried out according to the French Fundamental Safety Rule, RFS I-2, and the second one according to the OECD/NEA methodology. The formed is considered hypothetical and unlikely. Because of this reason the later study was undertaken and was defined as more realistic and likely.

The general and the specific assumptions to evaluate the scenarios presented above are described below.

4.2.2.1 Simulation model - general assumptions

- It is not conserved historical memory concerning site location.
- There is no physical barrier to prevent intrusion.
- There is not activity loss due to leaching. Radioactive decay is only considered.

4.2.2.2 Simulation model - specific assumptions.

- Road construction scenario.

  - Human intrusion occur 300 years after the closure of the facility.

- A road is constructed over and a long the disposal facility.
- A depth ditch is excavated.
- Complete mix of the wastes with the non active material man made barriers and with the natural materials presented on the site.
- Doses received by workers due to external irradiation and dust inhalation are evaluated.

• Residential scenario.

- Human intrusion occur 300 years after the closure of the facility.
- Habitual presence in areas occupied by the waste coming from extensive excavation.
- Complete mix of the wastes with the non active material man made barriers and with the natural materials presented on the site.
- External irradiation and dust inhalation dose assessment.

• Residential and sport activities practise scenario.

- Human intrusion occur 300 years after the closure of the facility.
- Habitual presence in areas occupied by the waste coming from extensive excavation.
- Complete mix of the wastes with the non active material man made barriers and with the natural materials presented on the site.
- Sport activities practise.
- External irradiation and dust inhalation dose assessment.

• Residential scenario according to OECD/NEA methodology.

- Human intrusion occurs 500 years after the closure.
- Habitual presence in areas occupied by the waste coming from limited excavation.
- Food consumption produced on contaminated soil.
- External irradiation, dust inhalation and ingestion dose assessment.