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Institutional framework for long term management of high level waste and/or spent nuclear fuel

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INSTITUTIONAL FRAMEWORK FOR LONG TERM MANAGEMENT OF
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FOREWORD

One of the objectives of the IAEA is to accelerate and enlarge the contribution of nuclear energy to peace, health and prosperity throughout the world. The IAEA seeks to achieve this objective by fostering the exchange of information concerning peaceful uses of nuclear energy through various means, e.g. organizing international conferences and meetings; undertaking technical co-operation with countries seeking to improve their understanding and use of nuclear energy; and providing educational and reference information and material.

Appropriate technologies and standards of safety must be employed for any application of nuclear energy to ensure that it can be used with no unacceptable effects on mankind and/or the environment. This precept applies to the management of radioactive waste, as it does to all other aspects of the use of nuclear energy.

For radioactive waste management in the long term, national governments may be required to play a major role, not only with respect to safety, protection of public health and the environment, but also for instance, with regard to institutional and economic aspects of waste management, evaluation of long term options and selection of technologies for the waste disposal.

National approaches for defining and classifying radioactive waste, siting and designing waste management facilities, implementing institutional measures to ensure safe disposal, and obtaining public acceptance of waste management operations and facilities, vary considerably. Also, the present status of the development of the institutional framework for the management of high level waste (HLW) and/or spent nuclear fuel (SNF) differs considerably from country to country. Nevertheless, many common elements are also present.

This publication provides a compilation of information on the institutional aspects of national programmes for long term management of HLW and/or SNF, such as implementing, regulatory and oversight activities, definition of responsibilities, repository site selection processes, management costs and financing schemes. This publication does not contain information relating to nuclear safety requirements or the safeguards requirements that are applied to ensure the accountability and physical security of the nuclear materials present in HLW and/or SNF, except as references to the roles played by various parties involved in the management of HLW and/or SNF.

It should be noted that the policy of many Member States regarding the long term management is just being established or modified, and the information contained in the publication reflects the current status and may change in accordance with the policy changes. The exchange of information among countries, in particular by studying the institutional frameworks in the Member States proceeding succesfully in HLW and/or SNF management, may enable to identify useful models for their potential use by countries on the way of establishing their infrastructures or modifying them.

The IAEA wishes to express its gratitude to J.R. Williams (chairperson) and the other participants in the consultants meetings on the Institutional Framework for Waste Management and Disposal. Through participation in these meetings, they provided substantive guidance and input that was invaluable to the successful completion of the study whose results are presented in this report.

The IAEA officer responsible for this report was H. Yamachika of the Division of Nuclear Fuel Cycle and Waste Technology. V. Tsyplenkov of the same Division finalized the report for publication.

EDITORIAL NOTE

The use of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries.

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1. INTRODUCTION

1.1. Background

Radioactive waste is generated as the result of numerous activities that are part of day-to-day life, including electrical power generation, industrial processes (weld inspection, measurement of material transfer operations, well logging, etc.), medical diagnosis and treatment, and research. In accordance with the provisions of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, Member States have agreed to establish an objective to ensure that during all stages of spent nuclear fuel (SNF) and high level waste (HLW) management there are effective measures against potential hazards. This objective serves to protect individuals, society and the environment from the harmful effects of ionizing radiation, now and in the future, in such a way that the needs and aspirations of the present generation are met without any compromise.

Different approaches and programmes for the long term management of SNF and HLW arising from reprocessing of SNF are being considered in various countries. Some countries have already sited, or are in the process of siting, geological repositories for the disposal of SNF and/or HLW. Other countries are expected to initiate similar siting processes in the near future. Many countries are currently initiating studies of policies and strategies aimed at determining the most appropriate means for long term management of their HLW and/or SNF. Although each country is in a different stage or phase of the HLW and/or SNF management process (even when they have selected similar policies and programmes), they are all undertaking a stepwise approach to solving the problem of HLW/SNF management. Furthermore, one aspect of the SNF/HLW long term management process appears to be common to all countries: *Inventories of SNF and HLW are growing and require immediate attention by national decision makers.*

With these facts in mind, it seems timely and useful for the IAEA Member States involved in development of programmes for management of HLW and/or SNF to share information on their experiences, the progress they have made, and their plans for the future; and for the IAEA to compile this information for use by all interested parties. It is possible, and even likely, that as various countries proceed with implementation of their programmes, their plans and approaches will evolve to take account of later information and developments. Nevertheless, the information presented in this publication is current as of the time when this report was prepared.

1.2. Objectives

The objective of this publication is to provide information on the institutional framework that has been, or is being, established for the long term management of HLW and/or SNF in the selected Member States, and to provide this information to all interested Member States. Information on the amounts of HLW and SNF that are expected to be generated, and on the geological repositories that are being considered for disposal of this waste is also provided to help put the institutional framework into perspective (e.g. regarding the scale of the programmes).

1.3. Scope

The scope of this publication includes the institutional and financial arrangements that have to be used for the long term management of HLW and/or SNF. For the purpose of this report, the institutional framework for the long term management of HLW and/or SNF is defined to include the following elements:

- A consistent set of requirements for the technical and legal infrastructure including: funding, liability, institutional control, records management, and research activities,
- An organizational structure with clearly defined responsibilities, and
- Provisions for participation by interested parties in decisions and outcomes.

There are many different possible institutional and financial arrangements that could be established for radioactive waste and spent fuel management. This publication makes no presumption that any of these arrangements is more desirable than any other. In fact, the differences in the approaches taken in various countries are likely to have resulted from different conditions (including the legislative framework) that exist in those countries, and represent selection of the steps that are appropriate and necessary for use in those countries. Nevertheless, consideration of all the approaches currently being taken should prove useful in assisting countries who have not established programmes for disposal of HLW and/or SNF in defining their own programmes. This information might also prove useful in assisting countries that have HLW and/or SNF disposal programmes in place in resolving difficulties that might be encountered in execution of their programmes by showing them alternate approaches that have worked elsewhere.

The focus of this publication is on geological disposal of HLW and/or SNF from commercial nuclear power reactors. Nevertheless, in cases where national programmes include plans for geological disposal of HLW and/or SNF from sources other than commercial nuclear power generation (e.g. research, defence, medicine, industry, agriculture), information pertaining to long term management of the waste from such activities is also included.

The major topics addressed in this report are as follows:

- Organizational structure for HLW and/or SNF long term management
- Legislative framework
- Waste streams and proposed repositories
- Siting of geological repositories
- Public involvement and transparency
- Waste management costs
- Financing systems
- Other considerations.

The majority of the information presented in this report was collected in 2001. Nevertheless, to the extent possible, progress since 2001 has also been included.

1.4. Methods used

The IAEA determined that this publication would be most useful if it focused on countries in which a notable inventory of HLW and/or SNF exists, leading to the potential for public concern regarding their long term management and an associated need for careful attention to be paid by the authorities cognizant of such matters in those countries. As a result, Member States with more than two commercial nuclear power reactors in operation were invited to participate in the study.

At the initiation of the study, the IAEA submitted a questionnaire to knowledgeable members of the nuclear community in Member States satisfying the criterion discussed above, and received and analysed their responses. Where appropriate, existing documents were referenced and supplementary questions and responding answers were utilized, to complement the responses received from individual countries.

1.5. Structure of the publication

The TECDOC is divided into two main parts: a summary overview and comparison of the approaches selected by Member States for the HLW and/or SNF long term management in their countries, and an Annex presenting more detailed information on the status of institutional development in the participating Member States. The summary overview was written under the guidance of, and was reviewed by, the participants in the Consultants Meetings on the Institutional Framework for Waste Management and Disposal. Descriptions of the individual institutional frameworks are based on information submitted by one or more representatives of the Member State concerned. The representatives of the Member States also reviewed the national frameworks to ensure their accuracy.

The Member States that responded to the questionnaire and are addressed in this publication are as follows:

Belgium	Hungary	South Africa
Bulgaria	Japan	Spain
Canada	Korea, Republic of	Sweden
Czech Republic	Lithuania	Switzerland
Finland	Netherlands	United Kingdom (UK)
France	Russian Federation	United States of America (USA)
Germany	Slovakia	

The report as a whole addresses several different aspects of the institutional framework for the long term management of HLW and/or SNF, ranging from technical topics to administrative/legal provisions and financial arrangements. It is recommended that individuals who are interested in any particular subject should first address the summary observations in the main part of the report, and then refer to the appropriate parts of Annex for more details.

2. REVIEW OF WORLDWIDE ACTIVITIES

2.1. Organizational structure

Member Countries were requested to provide a simplified organizational chart depicting the various legislative, regulatory, implementing and oversight bodies that are involved in the long term management of HLW and/or SNF. The structures of the charts provided by the countries vary considerably. For that reason, it is difficult to make comparisons between the countries, based on the charts originally provided by Member States. In order to allow such comparisons, the charts presented in Annex have been modified from those originally submitted by Member States to highlight the organizations involved in conducting the following functions:

Policy/legislation	Organizations responsible for policy-making, legislation and other decisio that require involvement of government officials (often elected officials) the national level.
Regulatory authorities	Organizations (government agencies) responsible for regulation of HL and/or SNF management.
Implementing organization	Organization (governmental or others) responsible for implementing HLW and/or SNF management tasks.
Advisory (oversight) body	Organization nominated by the government to advise to policy-makers or to supervise technical and scientific activities of the implementi organization
Fund management body	Organization responsible for the management of HLW/SNF funds.

Analysis of the national situations clearly shows that, for management of HLW and/or SNF, the principle of separation between (1) policy-making and legislation, (2) regulatory activities and (3) implementing activities has been established in most of the participating countries. The organizational arrangement for radioactive waste management has recently been or is presently being revised in some countries (e.g. Bulgaria, Canada and the UK) to better respond to policy considerations regarding how to handle these issues in the future. Current indications are that the changes in these countries are all likely to go in the direction of a more distinct separation between the three levels mentioned above. Also, when applicable, the charts indicate the existence of separate and independent oversight bodies, as well as the existence of separate financial resource management bodies.

Oversight bodies, where they exist, have been assigned the task of providing advice to policy-makers and/or the implementing organization on the radioactive waste management programme as a whole, or on separate activities within the programme. The attention of such bodies has been directed both

toward plans and programmes on a strategic level, and toward implementation aspects of plans and programmes. Such oversight bodies may also act as advisors to regulatory authorities.

Financial resource management bodies, where they exist, are a supplement to the basic structure comprising policy-making, regulatory and implementing activities, and are used specifically to deal with long term financial management issues. For more detailed information concerning the existence of such bodies, see Section 2.7 and the national frameworks.

2.1.1. Functions of the implementing organizations

Most of countries that responded to the questionnaire have established separate implementing organizations for the management of HLW and/or SNF. However, the functions and responsibilities of the implementing organizations vary between countries.

The following examples show the range of these differences. In some countries, an implementing organization has been established specifically for disposal of HLW and/or SNF (e.g. Finland, Japan and the USA). In other countries, an implementing organization has been established with a broader responsibility, including such tasks as the long term storage of SNF pending development of a geological repository, and disposal of long lived low and intermediate level radioactive waste, including future wastes arising from decommissioning of nuclear power plants (NPPs), along with disposal of HLW and/or SNF (e.g. Belgium, France, Spain and Sweden). In the Russian Federation, radioactive waste disposal tasks are divided among several different organizations that have been nominated by the responsible Ministry depending on the task involved.

2.1.2. Types of the implementing organizations

There are three types of implementing organizations in different countries as described in Table I.

The Republic of Korea and the United Kingdom have not yet decided on whether their implementing organizations will be governmental organizations or not.

TABLE I. TYPES OF THE IMPLEMENTING ORGANIZATIONS

Implementing organizations	
Established already	To be established in the future
Part of the national or central government administration	
Germany (BfS subcontracted to DBE)	
USA *(OCRWM)*	
South Africa *(NECSA)*	
Government owned companies	
Belgium (ONDRAF/NIRAS)	Bulgaria
Czech Republic *(RAWRA)*	
France *(ANDRA)*	
Lithuania *(RATA)*	
Hungary *(PURAM)*	
Russian Federation *(Minatom institutions)*	
Private companies (some are partly privately owned)	
Finland (Posiva Oy)	Canada
Japan *(NUMO)*	
Netherlands *(COVRA)*	
Slovakia *(Slovak Electric plc.)*	
Spain *(ENRESA)*	
Sweden *(SKB)*	
Switzerland *(NAGRA and ZWILAG)*	

2.2. Laws and regulations

Different countries have adopted different ways to solve their need for necessary provisions in laws and regulations in connection with radioactive waste and spent fuel management. In some countries such provisions are parts of more inclusive legislation (e.g. Sweden) covering most aspects within the nuclear field, or even legislation covering the whole area of environmental protection. In other countries (e.g. France, Japan, Lithuania, USA), there are laws and regulations that particularly apply to management of HLW and/or SNF. One country (Canada) is currently considering legislation. On this topic in particular, there is no single way in which to accomplish the task. The approach in any country is likely to depend completely on conditions that are unique to that country.

2.3. Waste stream assumptions

The national situations presented in the Annex provide estimates of the types and amounts of material that each Member State will have to deal with in long term, along with the assumptions on which those estimates are based (e.g. the number of reactors, the total power output of the nuclear reactors, lifetime assumptions). For countries having a once-through policy[1], amounts of SNF are shown in weight units that specify the number of metric tonnes of uranium metal[2] that were placed into the fuel when it was manufactured. Due to differences in HLW canister capacity, the specifications for the material generated by various reprocessing facilities, and the amount of radioactive nuclei in SNF (which depends on the SNF burnup), it is not possible to specify in general the amount of HLW that would be generated from reprocessing a given amount of SNF. As a result, for countries pursuing a closed nuclear fuel cycle[3], amounts of HLW are shown either in terms of the volume of HLW or in terms of the number of canisters that contain vitrified HLW.

Among the countries covered by this publication, eight countries (i.e. Belgium, France, Germany, Japan, The Netherlands, Russian Federation, Switzerland, and the UK) currently reprocess on their territories or abroad at least a portion of their SNF. Switzerland also plans to directly dispose of a part of their SNF. In Germany, SNF generated after January 2005 will be directly disposed of under an agreement reached in 2000 between the government and major utilities in the country, while SNF generated prior to 2005 will be reprocessed.

The data available regarding the estimated amounts of HLW and/or SNF to be disposed of in the countries covered by this publication are summarized in Table II. (The amounts of other wastes to be disposed of are provided in some cases in the national frameworks.)

2.4. Proposed repositories

Most of the Member States addressed in this publication plan to eventually construct a geological repository in which their HLW and/or SNF will be disposed of, but they are in widely differing stages of the process of implementing their plans.

The information received from the Member States indicates that the repository would be constructed within their territory and that the repository capacity would generally be based on the waste streams described in Section 2.3. The capacity of the proposed repositories in most countries will be sufficient to accept the HLW and/or SNF already generated or expected to be generated by the existing nuclear facilities in those countries[4].

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[1] The term “once-through policy” means that SNF is directly disposed of after being irradiated once in a reactor, and is not reprocessed.

[2] “Metric tonnes of uranium metal” are often referred to in practice as “metric *t*onnes of *h*eavy *m*etal” or t HM.

[3] The term “closed nuclear fuel cycle’’ means that reprocessing is used to separate fission products from fissile material in the SNF. The fissile material is then manufactured into new fuel elements, thus completing a circle and “closing” the fuel cycle.

[4] In the US, the capacity of the first repository is restricted by law to 70 000 t HM. A decision regarding a second repository is expected by 2010.

TABLE II. AMOUNTS OF HLW AND/OR SNF TO BE DISPOSED OF

Country	Number of nuclear power reactors *	**	Reactor operating lifetime (years)	SNF (t HM, unless other units are specified)	HLW (units as specified below)	Notes
Belgium	7		40	70 (MOX) 4320 (SNF) 70 (MOX)	2200 m^3 4700 m^3	Complete reprocessing option Direct disposal option
Bulgaria	6		Not determined at this time.	n.a.	n.a.	Amounts cannot be estimated until the lifetime of Bulgaria's reactors is determined
Canada	14	8	Various	3.6 M bundles (CANDU) 76000 bundles (others)	0	Projection of generation through 2035.
Czech Republic	6		40	3724	0	Projection of generation through the end of reactor life.
Finland	4		40-60	2600 to 4000	0	Projection of the total amount expected to be generated by the Finnish programme.
France	59	11		15 000	3500 m^3	Amount to be produced by current reactors and other fuel cycle facilities.
Germany	19	18	Various	9000	22 000 m^3	Projection of generation through the end of reactor life. The HLW amount includes the overpacks.
Hungary	4		30			See Annex.
Japan	51	1		0	~ 40 000 canisters	Amount equivalent to the SNF accumulated by 2020 (in the past, 1 canister ~ 1.35 tHM)
Korea, Republic of	16		~40	34 000	0	Projection of generation by 2040
Lithuania	2		22 & 30	~3000	0	Projection of generation until NPP shutdown in 2017
Netherlands	1	1		~40 m^3	~70 m^3	Projection of generation over the next 100 years.
Russian Federation	30		30–40	n.a.	n.a.	
Slovakia	6	1	Up to 35	~2500	0	Projection of generation through the end of NPP life
South Africa	2		40 or 50	~1900	0	Projection of generation through the end of NPP life
Spain	9	1	40	~6750	~ 80 m^3	Projection of generation through the end of NPP life. Spain adopted an open fuel cycle in 1983.
Sweden	11	1	Various	~9000	0	Projected total amount expected to be generated by the Swedish programme.
Switzerland	5		40 or more	~1800	~1000 m^3	Projection of generation through the end of NPP life.
United Kingdom	35	10	30 to 45		~1890 m^3	Projection of generation through 2013.
USA	103	15	Up to 40	83 500 (from commercial reactors), 2100 (from other reactors)	640 t HM (commercial) 5000 waste packages with 4 to 5 canisters each (defence)	Projection of generation from the present to the time of shutdown of all existing NPPs. 105 000 tHM are expected to be generated from current NPPs, if life extensions are included in the projection.

* Operating nuclear power reactors. ** Shutdown nuclear power reactors. n.a. information not available.

On the other hand, Japan proposes to build a repository whose capacity would be based on economic considerations. Specifically, the Japanese legislation requires to set the capacity of their repository at the point where the disposal cost per unit volume of waste would no longer be reduced if additional capacity were to be added to the repository (i.e. at the limit of economy of scale).

In parallel with efforts to develop their own geological repositories, the Member States are keeping in mind that, in certain circumstances, safe and efficient disposal of SNF and/or HLW might be fostered through agreements among Member States to use facilities in one of them for the benefit of the other Member States, particularly where the waste originated from joint projects.

In most countries, the implementing organization is expected to develop the proposed repository concept and capacity, followed by review and approval by the government. On the other hand, the repository capacity is stipulated by law in the USA, and both the repository capacity and concept are stipulated by legislation in Japan.

The countries in which a repository site or specific candidate site have been specified are Belgium, Finland, the Russian Federation[5], Sweden and the USA.

2.5. Management time schedule

Due in part to the fact that all countries are in an early stage of implementing the programmes for the long term management of their HLW and/or SNF, there are considerable differences between the countries regarding the schedule for implementing HLW and/or SNF disposal. Emplacement of the waste is expected to begin in about 2010 in the earliest case, while some countries have decided to store their HLW and/or SNF until as late as the latter part of the 21st century. The following points summarize the situation in all the participating countries:

- Countries with concrete time schedules (Finland, Japan, Russian Federation, Sweden, USA),
- Countries planning to establish HLW and/or SNF disposal policies, including a schedule, within approximately 10 years (Belgium, Canada, Czech Republic, France, Germany, Hungary, Republic of Korea, Slovakia, Spain, Switzerland),
- Countries that have decided to extend the HLW and/or SNF disposal planning process for a few decades and to store HLW and/or SNF in the meantime (Bulgaria, Lithuania, Netherlands, South Africa, United Kingdom).

There are also variations from one Member State to another regarding the organization responsible for establishing a time schedule. In some countries, the government is responsible for establishing milestones for the disposal programme (including by legislation in some cases), while in other countries the time schedule is developed by an implementing organization, subject to review and approval by the government.

2.6. Siting of geological repositories

2.6.1. Site selection process

Most countries are using or planning to use a site selection process in which several potential candidate sites are initially identified and the number of sites under consideration is reduced as more detailed information is gathered to describe the characteristics of the candidate sites, generally as described in IAEA Safety Series No.111-G-4.1 “Siting of Geological Disposal Facilities”. IAEA Safety Series No. 111-G-4.1 describes a process typically consisting of four stages (i.e. conceptual studies and planning, area survey, site characterization, and site confirmation). However, the approaches actually being taken in the Member States are not always divided into the four stages specified in IAEA Safety Series No.111-G-4.1, and the definition of the stages varies considerably from country to country. In some countries (e.g. Japan, USA), the site selection approach is stipulated

[5] The Russian Federation has identified the multiple sites.

in legislation. In other countries (e.g. Finland, Sweden, and Switzerland) the strategies for siting were developed by the implementing organization and reviewed or approved by the government.

Several Member States are either planning to use, or are already using, an Underground Research Laboratory (URL) in the process of site selection. These URLs are planned to be utilized in two basic ways:

- ***Methodological facilities*** – Some countries are using or planning to use a URL to conduct R&D, evaluate technologies for geological repositories and to demonstrate the viability of geological disposal to the public (e.g. Canada, Japan, Sweden, Switzerland). In these cases, the URL is not always constructed at a repository candidate site.
- ***Site characterization facilities*** – Most countries that have specified site selection plans are planning to utilize a URL for characterization of the candidate site[6], to confirm that a repository built at the site could be operated safely. Japan plans to conduct site characterization investigations in underground facilities to provide final confirmation of the adequacy of their proposed repository, in addition to the work they will do in a methodological facility. Similar site characterization activities have already been conducted in the USA prior to selection of the Yucca Mountain site. In Finland and Sweden, investigations leading to selection of candidate sites were performed through use of boreholes, with further investigations in tunnels at the site of the proposed repository. The Russian Federation also plans to conduct investigations in URLs before site selection, unless sufficient information is found to already be available from activities completed earlier in the siting process. France is conducting an R&D programme in the Bure URL.

2.6.2. Development of siting criteria

The responses provided in Annex demonstrate that the siting criteria differ from country to country. Furthermore, several of the participating countries have not progressed far enough to describe the process they will use. Nevertheless, the countries having site selection processes defined appear to be taking one of three general approaches, as summarized below:

- ***Approach 1*** – The governments (in particular, regulatory authorities) are generally responsible for developing siting criteria in every stage or phase (Czech Republic, France, Germany, Hungary, Japan, Lithuania, Switzerland),
- ***Approach 2*** – Implementing organizations are responsible for developing siting criteria during the initial stage or phase of site screening (e.g. during the stage or phase prior to final determination of a candidate site). The government may review these criteria, as well as the results of investigations that are carried out based on the criteria (Belgium, Finland, Sweden),
- ***Approach 3*** – Regulatory authorities are responsible for developing the siting criteria and an implementing organization is in charge of preparing guidelines for use of the criteria. The criteria and the guidelines are coordinated between the organizations (USA).

In general, the criteria and guidelines that have been considered in many countries address such issues as characteristics of the geological formation (size and depth), tectonic activity (e.g. volcanism, earthquakes or fault movement), radionuclide transport mechanisms (e.g. ground water), environmental impacts, underground natural resources, proximity to nuclear fuel cycle facilities upstream of disposal, and proximity to densely populated areas. Some countries include requirements for acceptance by local populations in the siting criteria. Others cover this consideration at other times in their repository approval processes.

In most countries, decision makers and affected and interested parties are informed of the potential for repository acceptability at each stage of the siting process by the results of repository performance assessments.

[6] Such facilities are not necessarily referred to as URLs in the countries that use them.

2.6.3. General procedures for decision making in each phase and stage

The site selection procedures differ so widely from country to country that it is not feasible to present a single explanation that would represent all of them. Nevertheless, the decision on whether to proceed further after each stage or phase is generally made by the government, including participation by the Minister responsible for disposal of HLW and/or SNF, after comprehensive investigations of information gathered by an implementing organization. In some countries, such as Finland, France, Hungary, Switzerland, and the USA, the Parliament (or its equivalent) is involved as one of the entities responsible for the final decision on site selection, or approval.

In many countries, opportunities are provided for members of the public and representatives of affected local governments to express their opinions and provide comments on the site selection process. Canada, Japan, Switzerland and the USA are examples of countries that provide such opportunities at each stage or phase of the siting process, often including public hearings and/or presentations by the implementing organization, followed by opportunities for public and local governments to express opinions and provide comments[7]. Countries such as the Czech Republic, Finland and Sweden provide similar opportunities for public and local government to comment at the stage or phase before initiation of physical investigations at a proposed site (via either surface or borehole examinations).

2.6.4. Role of local governments

Local governments (authorities) are considered to be any level of government lower than the federal or central government of a Member State (i.e. the Bundesländer in Germany; a prefecture or city in Japan; a community or canton in Switzerland; a municipality in Sweden; and a state or county in the USA)[8].

Prior to construction of a repository for disposal of HLW and/or SNF, numerous licenses and permits must be obtained, not only from the federal/central government, but also from local governments. These permits and licenses address both nuclear safety and other topics (e.g. regional land use planning).

The role of local governments in the decision making process for waste disposal varies significantly from country to country. In some countries, local governments have roles that are specifically defined by legislation. In other countries, the interactions with local governments are left in the hands of the implementing organizations.

One common generic mechanism used for interfacing with local governments is through preparation of an environmental impact assessment (EIA). Local government involvement in the environmental impact assessment process generally consists of requiring the implementing organization to request representatives of local government(s) to review and make comments on the study. These comments are then considered by the implementing organization and/or government organizations in deciding whether and how to proceed with development of a repository. Members of the public often also participate in the environmental impact assessments.

On the other hand, in the countries that have laws applicable specifically to HLW and/or SNF disposal, additional opportunities for local government involvement are often specified. These include interactions such as the following:

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[7] Many countries provide such opportunities for public and stakeholder involvement in later stages of the repository development process as well.

[8] In countries with Federal Governments (e.g. Germany, Russia, Switzerland, the USA), the “State” level of government (between the municipality and national levels) plays a significant role and is often not considered to be a “local” government. However, in this discussion, the State government level has been considered along with the lower levels of government because there are many similarities between the roles played by the combination of State and lower level governments in countries with Federal Governments and the roles played by the local governments in countries that do not have Federal Governments.

- Allowing local governments to conduct independent scientific and technical reviews of studies carried out by the implementing organization and submit comments to the implementing organization and the final decision maker, such as the federal/central government (USA),
- Requiring the implementing organization to obtain local government concurrence on decisions to proceed to the next stage or phase, and to the decision of the final decision maker on a candidate site (Finland, Sweden),
- Allowing the local government to conduct a repository safety assessment, under delegation from the federal/central government (Germany).

In the case of the USA, the host State government is allowed to veto the site selection made by the central government, and has done so. However, the US Congress also has the right to override this State government veto. In Finland and Sweden, the siting process could not have moved forward if the local municipalities had not approved the selection of candidate sites.

2.6.5. Financial assistance

Many governments of the countries that are conducting repository-siting investigations provide financial assistance to local governments and communities. This financial assistance is used differently from country to country, but is generally used to support activities to promote public understanding and public involvement in the disposal project (e.g. review of studies and environmental impact assessments prepared by the implementing organization, participation in public hearings and consultations). However, in France and the USA, for example, there are also cases in which financial assistance is provided for "regional development" or as "payments in lieu of taxes". Local governments are allowed to use such financial assistance for whatever purpose they determine to be appropriate, even if such uses have nothing to do with development of a geological repository. Since the approach taken is different in each of the Member States that participated in this study, please refer to the national frameworks for more detailed descriptions of the specific actions taken on this subject.

None of the participating Member States have defined the processes that might be used to provide financial assistance to local governments and communities for the time period after completion of repository site selection. This topic will be considered in more detail and implemented later in the geological repository life cycle. Nevertheless, there is a general expectation that both financial assistance and public involvement and transparency activities will continue in later stages of the SNF and/or HLW disposal process (e.g. after completion of the siting process). As an example, some countries, the USA in particular, are planning to provide financial assistance to local governments to assist them in preparing SNF and/or HLW for transportation through their jurisdictions on the way to their geological repositories.

2.7. Management costs

The estimates of the cost of HLW and/or SNF management vary from country to country, and are difficult to compare. This is mainly due to differences in the elements included in the cost estimates (e.g. R&D, storage, transportation, conditioning, disposal), as well as differences in key assumptions and boundary conditions used for calculating the waste management costs (e.g. assumed operational lifetime of the nuclear power reactors, period for storage and operation of the disposal facility, degree of closure and surveillance activities). Some countries include the cost of low and intermediate level waste management, as well as the cost for decommissioning of nuclear power reactors in their general cost estimate, while others do not. The price-basis (e.g. year 2000 US$, 1998 CHF) must also be considered for comparison of the various cost estimates, as well as the assumptions made regarding inflation and the time value of money. Finally, there are differences in the ways various countries handle the costs of preliminary R&D and the costs of the early stages of developing their HLW/SNF long term management programmes. These costs may or may not be included in the total programme cost estimates. For countries with large programmes, this could result in a large change in the cost estimate.

At this time, there are basically three types of cost estimates:

- Estimates by countries that include primarily the cost of disposal (Czech Republic, Japan) or that plan to reprocess their SNF abroad and therefore only include the cost of storage and transportation (Bulgaria).
- Estimates by countries that have broader programmes, and thus must include the costs of additional stage(s) of the waste management process (Finland, Hungary, Lithuania, Slovakia, Spain, Sweden, Switzerland, the USA).
- Estimates by countries that have not yet made a decision on their approach for long term management of HLW and/or SNF, but have nevertheless prepared the cost estimates based on concepts they have studied (Belgium, Netherlands).

Table III summarizes the cost data obtained from the Member States.

In most countries, the organization responsible for preparation of the cost estimate is specified by legislation. There are two primary approaches for developing the cost estimates:

- The waste generators (reactor operators) and/or the implementing organizations prepare the cost estimates, which may be reviewed by the government (Ministries, Regulator, Safety authority). In some cases, the government review is supported by reviews by external experts (Czech Republic, Finland, Hungary, Lithuania, Slovakia, Spain, Sweden, and the USA),
- A competent body prepares the cost estimate, which may be submitted to the government for approval, or subjected to an independent review (Bulgaria, Germany, Hungary, Japan, Netherlands, Switzerland).

2.8. Financing system

Since many of the activities associated with long term management of HLW and/or SNF will take place several decades (or more) into the future (possibly after the generators of the waste have gone out of business), it is prudent to collect the financial resources that will be needed for future operations while the waste generators are still in operation. The Member States indicated that they use various financial systems to ensure the long term availability of financial resources for their geological disposal programmes. Funds and reserves are the two most common financing systems. In the former, the financial resources are usually maintained by organizations independent from the waste generators. In the Russian Federation, financing is obtained from the national budget.

The scope of Member States' programmes for management of HLW and/or SNF differs from country to country (e.g. some include such activities as decommissioning of nuclear facilities, and management of low level waste, while others do not). Accordingly the activities covered by the funds vary from country to country, as follows:

- Only HLW and/or SNF disposal (Czech Republic, Japan, the USA)[9]
- Interim storage and disposal of SNF: (Belgium, Finland*)*
- Decommissioning of nuclear power plants, as well as storage and disposal of HLW and/or SNF (Hungary, Lithuania, Spain, Sweden, Switzerland[10]).

The annual fees that are widely used to obtain the resources kept in the funds are generally calculated and determined based on the amount of electricity or waste generated in a certain year (i.e. on the basis of the future liability associated with the waste generated in that year).

[9] Early in the US programme, a small fraction of the programme budget (a portion of which was obtained from annual appropriations instead of the Waste Fund) was spent on SNF storage planning and research and development.

[10] The financial resources that will be required for decommissioning are maintained in a separate fund.

TABLE III. ESTIMATED COST OF HLW/SNF MANAGEMENT

Country	Total estimated cost	Notes
Belgium (2000 MEURO)	290–580	Complete reprocessing option
	590–1500	Direct disposal option
Bulgaria (2000 US $M)	234	This estimate includes the cost of SNF storage and equipment to transport the SNF to Russia. Additional US $68M is needed every year until 2008 to pay for export of the SNF to Russia.
Czech Republic (1999 MCZK)	46 942	This estimate includes the costs of R&D, repository and associated programmes (e.g. public relations).
Finland (2000 MEURO)	1287	This estimate includes the costs of SNF storage and transport, repository and associated programmes (e.g. licensing) in the future.
Hungary (2000 billion HUF)	359.3	This estimate includes the costs of R&D, SNF storage and transport, repository and associated programmes.
Japan (2001 billion yen)	2891.2	This estimate is an average based on analysis of sedimentary rock and granite options. The estimate includes the costs of R&D, a repository with the capacity to dispose of 40 000 canisters of vitrified HLW, management and tax. The costs were estimated in 2001 Yen, based on the assumption that the disposal programme began in 2000 (when NUMO was established), construction of the repository will start in 2025, and it will close in 2095 with monitoring thereafter for 300 years.
Lithuania (2001 MEURO)	1600–2100	This estimate includes the costs of SNF storage and a repository.
Netherlands (1999 MEURO)	1358	This estimate includes the costs of SNF and HLW storage and a repository.
Slovakia (2000 MSk)	~75 200	This estimate includes the costs of SNF storage and a repository.
Spain (1999 MEURO)	10 000	This estimate includes the costs of SNF/HLW and LILW management and decommissioning.
Sweden (2001 MSEK)	58 180	The total estimated cost includes expenditures of 13 063 MSEK from 1982 through 2000 and estimated costs of 45 117 MSEK for 2001 through 2065. For a breakdown of the estimated costs for 2001 through 2065, see Annex. The estimated future costs include 13 509 MSEK for decommissioning of NPPs. The expenditures from 1982 through 2000 consisted mainly of administration, R&D, transportation system costs, and storage (in CLAB).
Switzerland (1998 MCHF)	11 227	This estimate includes costs for transport, storage and management of the amount of SNF discussed in Section 2.3, and disposal of L/ILW. Approximately 1748 MCHF were spent by the end of 2000, out of a total L/ILW disposal cost of 3400 MCHF.
USA (2000 US $M)	57 520	This represents the Department of Energy's May 2001 total system life cycle cost estimate to dispose of all planned SNF expected from currently operating and shutdown nuclear power plants (~ 83 500 t HM), as well as HLW from defence activities. The total amount of SNF to be disposed of results from the reactors operating to the end of their original licensed lifetime and does not include life extensions. The total cost estimate includes the costs of repository, transportation, and other associated programmatic costs. It does not include utility costs to store SNF on site prior to waste acceptance by DOE or the cost to decommission NPPs.*

* The figures in the table represent historical costs, both in year-of-expenditure and constant 2000 dollars, and all future costs in constant 2000 dollars. The share of costs associated with commercial SNF and HLW is approximately 72.8% of the total, or $41.8 billion. The share of cost associated with disposal of defence related wastes is approximately 27.2% of the total or $15.7 billion. Historical costs total $6.7 billion in year-of-expenditure dollars.

In general, two methods are used to collect financial resources: (1) a levy on electricity rates or (2) a contribution from the waste generator (who collected financial resources through electricity rates). The amount of the contribution is generally calculated and determined by agencies of the national governments. In most cases, levies are applied only to income derived from electricity generated at nuclear power plants. However, in Spain, the levy is imposed on income derived from all electricity sales, regardless of the origin of the electricity.

In most countries that have established funds, the government itself, or a high level organization within the government, is designated as the financial resource management organization. However, there are some exceptions. For example, in Spain the implementing organization manages the funds, and in Japan a non-profit, third party body designated by the Minister performs this function. In every case, the government is responsible for developing criteria or guidelines for management of the funds. On the other hand, in the countries where the financial resources are retained internally by the waste generators, the waste generators are responsible for management of the resources. The annual amount deposited to such reserves is primarily determined by the waste generators themselves.

The funds are usually managed in a low risk manner (e.g. by depositing them in the national account or investing them in government bonds or according to a financing strategy established by the competent body). Finland has a unique system in which the waste generators (nuclear power plant operators) may borrow up to 75% of the accumulated funds.

In addition to collecting funds as waste is generated, any liability associated with management of waste generated prior to establishment of the financing system must also be covered. The fees for waste generated prior to establishment of the financing systems have been collected as one-time-fees upon establishment of the financing systems (in Finland and Sweden), through a series of payments over time (in Japan and Switzerland), or as a combination of both (in the USA).

2.8.1. Waste management fee

The fee is defined as a price per kW•h in some countries, where it is collected as a levy on the income derived from electricity sales. In other countries, the fee is calculated and allocated on other bases. As a result, it is difficult to compare the fees charged in different countries. The fact that the cost elements covered by the fund differ from country to country, as mentioned in previous section, makes it more difficult to compare the fees on a common basis. Nevertheless, based on rough calculations, the fee per kW•h generated at nuclear power plants has been summarized as follows by most of the countries that participated in preparation of this report (The countries not listed below are either in the process of revising the plans for their HLW and/or SNF disposal programmes, or did not estimate an equivalent of a disposal fee for their programmes).

The waste management fees in various countries are given in Table IV.

In some countries (e.g. Sweden, USA), there are legal requirements mandating that an annual analysis be performed to assess the adequacy of the fee.

2.8.2. Withdrawal

In most countries maintaining funds for HLW and/or SNF disposal, the budget for the activities of the implementing organization is approved, and then funds are withdrawn according to the budget.

The organizations responsible for approval of the budget vary from country to country, as shown below:

- The Parliament or Congress (Hungary, Russian Federation, USA),
- The government or government agencies (Bulgaria, Czech Republic, Finland, Japan, Slovakia, Spain, Sweden, Switzerland),
- Board of the implementing organization (Canada[11]).

[11] As specified in draft legislation being considered in Canada.

TABLE IV. WASTE MANAGEMENT FEES

Country	Fee per kW•h
Fees covering only HLW and/or SNF disposal	
Czech Republic	0.05 CZK
Japan	about 0.13 yen
USA[12]	US $0.001
Fees covering storage and disposal of SNF	
Finland	0.0023 Euro
Fees covering decommissioning, disposal and storage of HLW/ SNF and disposal of other wastes	
Bulgaria	3% of electricity sales (nearly US $0.9/MW·h)
Hungary	1.18 HUF
Lithuania	6% of the wholesale price of electricity (nearly 4.9 Litas/MW·h)
Slovakia	6.8% of the sale price of electricity (nearly 0.13 Sk/kW•h)
Spain	0.8% of the retail price of electricity generated by all power stations
Sweden	0.01 SEK
Switzerland	0.01 CHF

In countries where financial resources are kept in reserve by the waste generators, payments are made from the reserves to the implementing organization upon its request.

In some countries, withdrawals have been or are being made as a combination of the approaches discussed above, generally with withdrawals from funds planned for use in conjunction with (or in preparation for) long term programme activities and withdrawals made from other reserves (or from appropriations) used for short term activities.

2.8.3. Auditing the financing system

In countries where a fund has been established and money are paid or withdrawn through national accounts, the organization responsible for auditing government finances also audits the financing system for long term waste management. In addition, there are cases in which arrangements are made to have independent auditors also verify that the fund is being managed properly (Switzerland, the USA).

In the countries where the financial resources are maintained in reserve by the waste generators, professional auditors under contract with the nuclear power plant operators audit the reserve, in accordance with the rules for private enterprises.

2.8.4. Revenues and expenditures

Due to the significantly different approaches that different countries are taking in tracking and presenting data regarding revenues and expenditures, it is more appropriate to refer to the data in Annex separately than to attempt to summarize the data here.

2.9. Public involvement and transparency

The information submitted by the Member States demonstrates that each of the Member States recognizes that involvement of the public and ensuring transparency are activities that must be included by any HLW and/or SNF disposal programme that hopes to be successful. The Member

[12] If centralized storage is authorized, the fee in the USA would be required to cover that expense as well.

States are conducting public outreach programmes not only to involve the public in the site evaluation and decision making process, but also to facilitate public understanding and to build public confidence by various means (e.g. distributing materials, establishing exhibition and explanatory facilities, arranging visits to nuclear facilities and meetings with programme staff).

There are two basic approaches being taken by the Member States on this issue. In Bulgaria, the Czech Republic, Lithuania, Netherlands and Slovakia, public involvement is to be conducted as a part of the process of preparing an environmental impact assessment. In other countries, the public is requested to participate in the HLW/SNF management process at several different steps in the programme as specified in legislation. Sweden is an example of using both approaches.

The USA is an example of the second group of countries. In the USA, the public was consulted regarding development of siting guidelines, criteria and recommendations, participates in environmental impact assessments, conducts co-operative research activities through a university located near the proposed repository site, is represented by an agency of the State government that continually monitors the repository development programme, and participates in the repository licensing process.

Other examples of the second group are Finland, France, Switzerland and Hungary, where committees consisting of residents, communities and representatives of municipalities and the implementing organization are organized to provide timely information to the public regarding the status of investigations conducted by the implementing organization and to respond to public concerns. In Canada, the current plan is to name representatives of Aboriginal people as members of the implementing organization's Advisory Council (if the draft legislation currently under consideration is enacted).

2.10. Other considerations

2.10.1. Liability

The lifetimes of implementing organizations responsible for geological disposal of HLW and/or SNF will be far shorter than the period over which the HLW and SNF will remain radioactive. As a result, there are concerns regarding how liability issues (e.g. related to harm that might be caused by a repository) would be handled after liquidation of the implementing organization, as well as during the period when disposal is being carried out.

For most countries, the liability systems for a geological repository require the operator to be responsible (i.e. to have the liability) for any damage or harm to other parties that occurs for the time period during which the repository operator is managing the repository. For the time period after closure of the repository and liquidation of the repository operating organization, Finland is studying whether the central government will assume all liability.

In other countries (e.g. the USA) protection is provided by law (i.e. the Price-Anderson Act for US Department of Energy contractors). In this case, the implementing organization and its contractors would be indemnified (i.e. protected from liability), and the Federal Government would pay any valid claims up to the limits specified by law. These provisions would also apply to the period after repository closure.

2.10.2. Retrievability and institutional controls

This portion of the publication is intended primarily to address HLW and SNF retrievability and institutional control after closure of a repository.

The requirements for repositories in Germany and Sweden currently do not include provisions mandating retrievability of HLW and/or SNF. However, these countries are currently considering whether to establish such a requirement. Finland currently requires that retrievability of SNF from a geological repository must be ensured. Switzerland and the USA require that retrievability of SNF and/or HLW disposed of in a geological repository must be maintained for a certain period of time

after emplacement. France is conducting a study evaluating disposal options in geological formations, with and without reversibility.

Specification of the institutional controls (including monitoring and required funding) to be applied after repository closure is a task that is planned to be carried out in the future. However, in some countries, the applicable requirements specify that a repository shall be designed to function safely without monitoring.

2.10.3. Records keeping

The countries with currently active repository siting programmes generally have regulations or policies in place that specify requirements for maintenance of records during the period when the disposal project is being carried out. In general, the requirements specify that the operator of the disposal facility must maintain records during the period of conducting repository operations. Certain countries specify that the government must also maintain records of HLW and/or SNF disposal operations.

A few countries have already issued policies for records keeping needed after the disposal project has been completed and the implementing organization has been liquidated. In these cases, the government is required to assume responsibility for records management indefinitely. However, in all cases, the details regarding exactly which records must be kept, where they shall be kept and how have not been specified yet. These requirements will be developed in detail as the various geological repository programmes proceed and approach the time for repository closure. This time will be decades from now, at the earliest.

3. CONCLUSION

The overview clearly demonstrates that, at a detailed level, no two countries have developed, or are proposing, identical institutional frameworks for HLW and/or SNF management. The most likely reason for these differences is that the systems in each of the countries have been developed in the context of the customs, precedents and history of nuclear energy development and use in those countries. In some countries, specific legislation dictates the institutional framework.

Nevertheless, if the institutional frameworks are viewed in a more global context, many similarities become apparent. In all countries, the national government has a vital role in implementing programmes for long term management of SNF and/or HLW. In addition, all of the Member States are taking a stepwise approach to development of their programmes for long term management of HLW and/or SNF. All of the Member States have legal and regulatory frameworks to govern SNF and/or HLW management activities, and most have established (or assigned duties to) specific organizations to implement, regulate and provide oversight of these activities. Many of the Member States have established funds to ensure that the financial resources that will be needed in the future for long term management of HLW and/or SNF are available when needed, and all recognize the need to establish records keeping systems for the period after closure of their geological repositories.

Several countries are currently reviewing their policies and strategies for long term HLW/SNF management, and plan to develop new institutional frameworks for their use. Other countries have not yet established such policies and strategies. Every country, even those with well established institutional frameworks, should pay careful attention to countries where HLW and/or SNF management is proceeding successfully, and the manner in which the institutional frameworks function in those countries. Even countries with well-established institutional frameworks may, in the future, find it necessary to review and modify their systems, and may be able to identify useful models for their potential use from the study of systems that have worked in other countries.

In particular, the exchange of information among countries regarding the institutional framework for HLW and/or SNF long term management will be most beneficial and fruitful if special attention is paid to societal elements and the history of nuclear development and application in those countries.

Annex

NATIONAL INSTITUTIONAL FRAMEWORKS FOR HLW AND/OR SNF LONG TERM MANAGEMENT

A-1. BELGIUM

A-1.1. Organization and legislation

A-1.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.

Government

Ministry of the Economy,
Ministry of the Interior,
Ministry of Justice

- Establish policies.
- Grant licenses.

REGULATION

Regulatory Authority

Federal Agency for Nuclear Control (FANC)

- Is responsible for nuclear safety and radiation protection regulation.

IMPLEMENTATION

Implementing Organization

National Agency for Management of Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)

- Is responsible for management of all radioactive wastes.

Financial Resources Management Body

ONDRAF/NIRAS

- Is responsible for management of the funds provided by the waste generators.

The interactions between the governmental bodies, the implementing organization and the nuclear utilities involved in the HLW and/or SNF long term management in Belgium are shown in Fig. A-1.1.

A-1.1.2. Implementing organization

The Belgian National Agency for Radioactive Waste and Fissile Materials (Organisme National des Déchets Radioactifs et des Matières Fissiles/Nationale Instelling voor Radioactief Afval en Splijtstoffen or ONDRAF/NIRAS) was created as a public agency by the law of 8 August 1980. ONDRAF/NIRAS is responsible for developing a safe, coherent management policy for all the radioactive waste in Belgium. Their responsibilities also include preparation and maintenance of a quantitative and qualitative inventory of radioactive waste, removal and transport of the waste, its treatment and conditioning, and its storage and long term management. Other missions are related, in particular, to the decommissioning of shutdown nuclear facilities.

A-1.1.3. Laws and regulations

Major laws and regulations applicable to the management of high level waste and spent nuclear fuel are as follows:

- Law of 8 August 1980 (establishment of ONDRAF/NIRAS);
- Royal Decree of 30 March 1981 and 16 October 1991, and Laws of 11 January 1991 and 12 December 1997 (establishment and amendment of mission and function of ONDRAF/NIRAS);
- Royal Decree of 20 July 2001 (establishment of the Federal Agency for Nuclear Control [FANC] and Regulation of the Protection of the Population and the Workers against Ionizing Radiation).

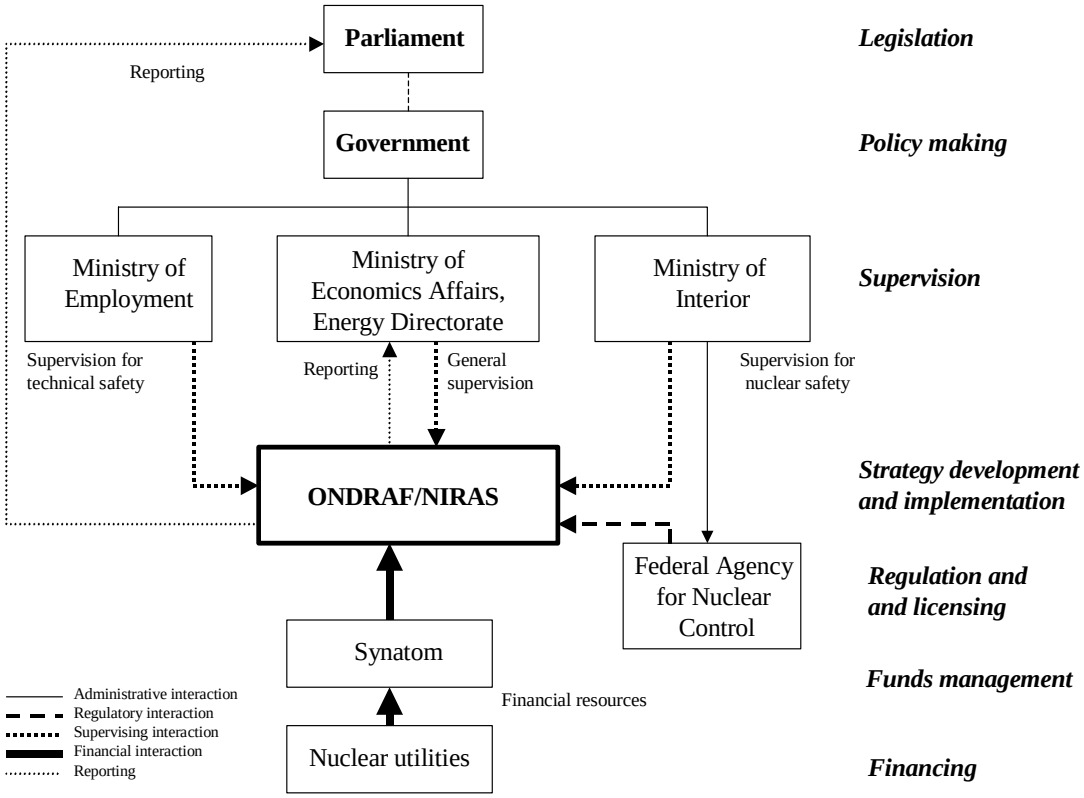

Fig. A-1.1. Organizational structure.

A-1.2. Waste streams and proposed repositories

A-1.2.1. Waste stream assumptions

There are 7 PWR type power reactors in operation in Belgium, with a total capacity of about 5.7 GW(e). The government decided in 2002 that the existing nuclear reactors will be shut down after their 40-year operating lifetime (i.e. between 2015 and 2025).

Two distinct options for final disposition of the waste streams resulting from operation of these nuclear power reactors are being considered: (1) An option in which all spent fuel is reprocessed, and (2) Another option in which the spent fuel is disposed of without reprocessing. These two options are based on the same assumptions regarding the fuel that has been or will be used, i.e.:

- Initial enrichment of 4.0% ^{235}U for the UOX fuel and of 4.93% ^{239}Pu + ^{241}Pu for the mixed oxide fuel;
- The fuel (uranium or MOX) is irradiated for 1450 days and its reference burnup is 45 GWd/t HM.

Based on these assumptions, the total consumption of conventional uranium fuel is estimated to be 4860 t HM of PWR SNF, plus approximately 70 t HM of MOX SNF. As a result, the total inventories for the two options are as follows:

- ***Complete reprocessing option*:** Reprocessing of all 4860 t U. This option involves production of 3920 containers of vitrified HLW and 6410 containers of structural waste (hulls and end pieces) from spent fuel assemblies, plus some 70 t HM of existing MOX.
- ***Direct disposal option***: Reprocessing stops after reprocessing of the 630 t U under existing contracts. This option entails production of 420 containers of vitrified HLW and 820 containers of structural waste from spent fuel assemblies (hulls and end pieces), plus about 4230 t U of non-reprocessed spent fuel and the existing 70 t HM of MOX.

Up to now, 227 m³ of the foreseen 4300 m³ of SNF has already been vitrified.

The forecasts of waste production (based on the two options and information about the other waste streams) indicate a sharp reduction in the waste volume intended for deep disposal. This volume stood at approximately 27 000 m^3 in 1989, but is now only about 10 000 m^3 for the complete reprocessing option and some 12 500 m^3 for the direct disposal option.

A-1.2.2. Proposed repositories

Following international recommendations, ONDRAF/NIRAS is examining final disposal in a suitable geological formation as the main solution for long term management of HLW/SNF.

All attention has been focused on poorly indurated argillaceous media, i.e. the Boom Clay (Rupelian) and the Ypresian Clays (Ypresian) as host geological formations. Reference repository designs have been developed for the Boom Clay under the Mol-Dessel nuclear zone (NE Belgium). The Boom Clay beneath the Mol-dessel has been analysed as a reference, but has not been designated as a disposal site.

The following tables summarize the characteristics of these reference designs:

For HLW (complete reprocessing option):

Capacity:	3915 canisters – (420 canisters to be generated under existing contracts, 3495 canisters to be generated under possible new contracts).
Depth:	240 m below ground level in Boom Clay beneath the Mol-Dessel nuclear zone. (0.224 km² would be occupied by a facility to receive HLW).
Engineered barriers:	Primary canister – A watertight, corrosion resistant package to ensure confinement during the thermal period of the repository. Disposal tube – A watertight, corrosion resistant tube to facilitate HLW emplacement.

For SNF (direct disposal option):

Capacity:	9859 SNF assemblies and 420 HLW canisters.
Depth:	240 m below ground level in Boom Clay (approximately 1.3 km² would be occupied by a SNF and HLW receipt facility).
Engineered barriers:	Primary canister – A watertight, corrosion resistant package for SNF. Disposal tube – A watertight, corrosion resistant tube to facilitate SNF and HLW emplacement.

A-1.2.3. Management time schedule

Based on the present national nuclear programme, all of the HLW and SNF to be managed in Belgium will have been generated by around 2025. Since a final long term management policy for this radioactive waste has not been established, it is difficult to provide a detailed time schedule for disposal of these wastes. In any case, the thermal output will require that the HLW and SNF be stored for a 50 to 60 year cooling period. Another key issue in definition of the schedule is the siting process.

A-1.3. Siting of geological repositories

A-1.3.1. Siting process

ONDRAF/NIRAS has been conducting research activities since the early 1980s to provide the authorities with technical and scientific information for assessment of long term management options for HLW/MLW in Belgium. (These studies were started in 1974 by SCK•CEN.)

In 1984, ONDRAF/NIRAS decided to prepare a report that would systematically present and analyze the results of all of the studies carried out concerning deep disposal between 1974 and 1989 in Belgium, including an assessment of long term radiological safety. This was in line with recommendations made by the Evaluation Commission for Nuclear Energy created in 1975 by the Minister of the Economy and charged with responsibility for developing an energy policy for Belgium. The recommendations stated that "*...the high-level waste should remain accessible and under control until a final solution or a solution that is sufficiently safe is found.*" The commission also noted that "*On the basis of current knowledge, it is important to undertake a ten-year assessment of the problems linked to use of nuclear energy before proceeding down this route, particularly since a solution that is final or at least sufficiently safe has not actually been implemented for the high-level waste or for the control of tritium, inert gases, carbon-14, and iodine-129.*"

The safety and feasibility report, known as the "*SAFIR Report*" (prepared jointly with SCK•CEN and Belgatom), was submitted by ONDRAF/NIRAS to its supervising minister, the Secretary of State for Energy, in May 1989. ONDRAF/NIRAS hoped that the authorities would provide their initial views on the acceptability of the Boom Clay layer beneath the Mol-Dessel nuclear zone as a potential host formation for disposal of Category B and C radioactive waste, and would approve the continuation of an R&D programme.

A commission, called the "SAFIR Evaluation" (composed of Belgian and foreign experts), was established in 1989 by the Secretary of State for Energy to evaluate the SAFIR report. The evaluation confirmed the conclusions of the SAFIR report and concluded that the poorly indurated clays[1] (i.e. the Boom Clay under the Mol-Dessel nuclear zone) could be considered suitable for disposal of HLW and medium level waste (MLW) because the Boom Clay could offer an effective, long term protection capacity, very low hydraulic conductivity, a plastic character having good self healing properties, the capacity to contain radionuclides for a long period of time and, hence, the capacity to delay their migration towards the biosphere. It also expressed the view that the R&D programme proposed by ONDRAF/NIRAS in conjunction with SCK•CEN for the period 1989–1994 was coherent and represented a logical follow-up to the work done since 1974. Finally, it recommended that work on certain aspects of the long term safety and geology of the host formation should be expanded and the research programme should include research activities on (i) other host formations and locations, with particular attention to the study on the Ypresian Clays beneath the Doel nuclear zone as an alternative, (ii) SNF.

Having received approval to continue its work on the deep disposal of HLW/MLW/SNF in 1990, ONDRAF/NIRAS reassessed its R&D programme to bring it into line with the recommendations of the SAFIR Evaluation Commission. The nature of the programme was, and still is, *methodological research*. Its prime aim is to establish whether it would be feasible, both technically and financially, to design and build on Belgian territory a deep disposal repository for HLW/MLW/SNF that is safe, without specifying a particular site.

Given its methodological nature, the ONDRAF/NIRAS work programme was developed to characterize argillaceous formations at the following two sites:

- *Boom Clay and the Mol–Dessel nuclear zone*: Reference host formation and site[2];
- *Ypresian Clays and the Doel nuclear zone*: Alternative host formation and site.

The ONDRAF/NIRAS programme, which has focused on a study of the Boom Clay beneath the Mol-Dessel nuclear zone, also gave priority to investigation of disposal solutions for waste classes seen as being the most demanding in terms of radiation and heat emission (i.e. vitrified HLW or SNF).

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1 "Indurate" means "to make hard, as to make into a compact hard rock mass by the action of heat, pressure, or cementation" (Merriam-Webster's Unabridged Dictionary). "Poorly indurated" clays would not have these characteristics. They generally display, under saturated conditions, plastic and self heating properties as well as a non-brittle behaviour. Their water content is generally high (i.e. around 30 to 40% vol.).

2 Since Belgium has not yet selected a disposal site, use of the word "site" does not imply selection of any specific radioactive waste disposal location.

Practically, the ONDRAF/NIRAS methodological R&D programme was intended to develop any method and to gather any knowledge needed to undertake an in-depth assessment of the safety and feasibility of the deep disposal of HLW/MLW/SNF in poorly indurated clay. The aim of the research included characterization of the waste to be disposed of, characterization and assessment of the host formations and their environment, design of a repository, investigation of interactions within the disposal facility, development of a methodology for assessing the long term performance and radiological safety of such a facility, development of a methodology for assessing the cost of deep disposal, and preparation of a full scale experiment to demonstrate the feasibility of deep disposal.

The *SAFIR 2 Report*, published in December 2001, discussed the results gained during the second phase of its methodological research and development programme (1990–2000). The report had three objectives:

- To provide the authorities and all the other parties concerned with a structured synthesis of the available technical and scientific information concerning the disposal of HLW/MLW/SNF in a poorly indurated argillaceous formation, to enable them to assess the progress made regarding technical feasibility and assessment of long term radiological safety;
- To promote interaction with the nuclear safety authority (FANC) with the intent of reaching closer agreement on the research efforts still required and on the principles of safety assessments, and to specify the modes of enforcement of the regulations that are applicable to the specific case of a deep repository; and
- To provide one of the technical and scientific bases for a broad dialogue with all of the parties concerned regarding the long term management of radioactive wastes.

To assist in conducting this research, Belgium has developed a methodological, underground research laboratory at Mol.

A-1.3.2. Development of siting criteria

Since Belgium has not decided on a policy for long term management of radioactive waste, no siting criteria have been developed at this time.

Nevertheless, SCK•CEN began to study the deep disposal of HLW in Belgium in the mid-1970s with the Geological Survey of Belgium. Research in the Boom Clay beneath the Mol-Dessel nuclear zone was encouraged by the Evaluation Commission for Nuclear Energy, which noted in its final report of March 1976 that, for Belgium, the deep argillaceous layers appeared to offer the best solution for the final disposal of this waste.

In the same year, the European Commission began to draw up, on a bibliographical basis, a European inventory of geological formations that might have characteristics favourable for the deep disposal of HLW. Selection was made solely by applying exclusion criteria concerning lithology (clay, salt, or granite) and the depth and thickness of the formations. In Belgium, only argillaceous formations were selected. These formations can be divided into two main groups:

- Formations consisting of hard Paleozoic rocks (shale) (e.g., in the Cambro-Silurian massifs of Brabant and the Ardennes), and
- Formations consisting of poorly indurated, plastic Cenozoic rocks (Ypresian Clays and Boom Clay).

As for the hard rocks, little relevant information about their properties at depth was available at the time. On the other hand, the very encouraging preliminary results on the lithology and containment capacity of the Boom Clay beneath the Mol-Dessel nuclear zone led SCK•CEN and then ONDRAF/NIRAS to intensify research in this formation.

Fifteen years later, the SAFIR Evaluation Commission (1990) concluded that the decision to study the Boom Clay beneath the Mol-Dessel nuclear zone was justified, but that it might also be worthwhile if other locations were considered, e.g. the Doel nuclear zone with its underlying Ypresian Clays. Following these conclusions, ONDRAF/NIRAS embarked on a research program into the clays at Doel in the early 1990s.

When it is time to establish siting criteria for a HLW/SNF disposal facility, Belgium expects to use a global approach involving assessment and optimisation of the performance and safety of the disposal system as a whole, rather than using exclusion criteria linked to various characteristics of the geosphere.

A-1.3.3. General procedures for decision making in each phase or stage

Since Belgium has not decided on a policy for long term management of radioactive waste, a general procedure for decision making in each phase or stage of the siting process has not been developed yet.

A-1.3.4. Role of local governments

Since Belgium has not decided on a policy for long term management of radioactive waste, the role to be played by local governments in the long term management of HLW and long lived radioactive waste has not been specified. However, it is expected that an approach will be developed that will be similar to the open decision making process that is being used to reach a decision regarding disposal of low level radioactive wastes. This approach includes establishment of local partnerships in which local residents play a key role.

A-1.3.5. Financial assistance

Since Belgium has not decided on a policy for long term management of radioactive waste, no decision has been made regarding financial assistance during the various phases or stages of the siting process.

A-1.4. Management costs

A-1.4.1. Total estimated cost and its breakdown

ONDRAF/NIRAS has carried out a detailed assessment of the cost of implementing geological disposal for HLW/SNF based on the reference designs mentioned in Section A-1.2.2. This cost assessment has, however, been undertaken on the assumption that a common repository will be developed for all types of radioactive waste that are suitable for geological disposal. In particular, for the cases analysed, repositories would be constructed and operated in two stages. MLW and moderately heat-emitting HLW would be disposed of first. Then, HLW and SNF would be disposed of.

The costs were estimated at the end of 1997, ranging from 290 to 580 million EURO for the complete reprocessing option, and ranging from 590 to 1500 million EURO for the direct disposal option (both at year 2000 economic conditions). These estimates include no R&D. However, approximately 150 million EURO were spent for R&D over the 1974–2000 period. The cost estimates will be reviewed as knowledge evolves.

A-1.4.2. Organization responsible for cost estimation

ONDRAF/NIRAS is responsible for estimating costs for management of all radioactive waste in the country, including the cost of managing HLW and SNF.

A-1.5. Financing system

A-1.5.1. Overview of the financing system

The activities required to properly manage HLW/SNF will be conducted over several decades. As a result, ONDRAF/NIRAS has developed a tariff (fee) based financing system for waste that is to be transferred to ONDRAF/NIRAS. Waste producers will pay the tariff into a special fund, called the *long term fund*, established within ONDRAF/NIRAS. The financial resources collected in the long term fund will be used to guarantee that the financial resources needed to implement the selected long term management solution(s) will be available when they are needed. The amount of the tariff is calculated through use of objective allocation criteria, based on the three following principles:

Reservation of capacity: Every major waste producer informs ONDRAF/NIRAS of its planned total waste production programme, thereby enabling ONDRAF/NIRAS to calculate the fixed costs among the producers.
Tariff payment: Each waste producer pays into the long term fund a contribution that corresponds to their pro rata share of the costs of the long term management of the waste the producer plans to transfer to ONDRAF/NIRAS.
Contractual guarantee: Each major waste producer commits to paying to the long term fund the balance of any fixed costs that are attributable to his waste and that are not already covered by the tariff payments.

[There is a second fund, informally called the *insolvancy fund*, created as a result of a supplementary mission entrusted to ONDRAF/NIRAS by the Royal Decree of 1991, to cover expenses that ONDRAF/NIRAS may incur to manage radioactive wastes from small producers that have become insolvent. Resources for this fund are obtained by adding a small percentage to the invoices that ONDRAF/NIRAS submits for services performed for radioactive waste producers.]

A-1.5.2. Waste management fee

Information on the amount of the waste management fee (i.e. tariff) is not available. These fees are specified in commercial contracts with the utilities and are therefore confidential.

A-1.5.3. Withdrawal

The mechanism to be used to withdraw funds from the long term fund is one of the topics to be covered by a study to be conducted as part of the framework of the next R&D-programme (for the period 2004-2008). It will be necessary to consult with the various waste producers involved regarding the funding withdrawal mechanism.

A-1.5.4. Auditing the financing system

The Board of Directors of ONDRAF/NIRAS has established a Financial Auditing Committee, composed of four directors, with responsibility for auditing the organization's financial policy. The Financial Auditing Committee's responsibilities include both present and long term waste management activities.

A-1.5.5. Revenue and expenditure of financial resources

Waste disposal fees are paid in Belgium at the time the radioactive wastes are transferred to ONDRAF/NIRAS. Only a small part of the total expected revenue has been collected at the present time. In fact, for the HLW/SNF, transfers and payments are expected to take place until around 2040 under the current Belgian nuclear programme. As a result, information on revenues and expenditures

is not currently available. Estimates regarding this information are expected to be developed in the framework of future R&D programme activities.

A-1.6. Public involvement and transparency

In the past, members of Belgian society have not had many opportunities to interact with the organizations and institutions involved in the management of radioactive waste regarding options for long term management of HLW/SNF/MLW. Although ONDRAF/NIRAS has routinely used the ISOTOPOLIS information centre as a channel for communication with both the public at large and local communities, this has only been a first step toward involving the public in the decision making process. However, considering the large number of people who visit the underground laboratory (HADES) on the days that it is open to the public, it is apparent that members of the public desire information on Belgian radioactive waste management activities and plans.

In keeping with principles of good governance, members of society must be allowed to participate in decisions made by their government through a true dialogue that is open to all stakeholders. Establishment of a genuine dialogue and a climate of mutual listening between stakeholders and within society is necessary to build the confidence that will be required to allow decisions regarding disposal of HLW/SNF.

The following three key elements are being considered and will have to be implemented with utmost care to ensure that the dialogue that is to be conducted has the potential to result in a constructive outcome:

- Clear definition of the parties to be involved in the dialogue (i.e., the stakeholders),
- Establishment of the organization and terms of the dialogue,
- Specification of the aims of the dialogue.

An integrated action programme is being considered, composed of several stages, as described below. The intent of the programme is to ensure that all stakeholders are provided with the information they need, to conduct a dialogue that allows all parties to be on the same footing, and to promote a culture of transparency and openness.

First stage – A transitional stage: Foundations must be laid for a constructive social dialogue, while simultaneously continuing the technical initiatives currently underway.

Second stage – Dialogue underpins research: A dialogue will be conducted with the various stakeholders, also at a local level on the basis of mutually accepted structures. This stage will continue until the methodological aspect has been completed. The aim by the end of this stage will be to achieve an initial agreement concerning the site or sites at which the preliminary studies for the following stages would be conducted.

Subsequent stages – Towards a solution: After the methodological activities are completed, these stages will correspond to specific activities at one or more sites directed toward implementation of the solution decided upon by all involved parties. The activities to be conducted during these stages will be determined during the preceding stages.

A-1.7. Other considerations

Policies and strategies for nuclear liability, waste retrievability, institutional controls and records keeping with regard to HLW/SNF long term management will be developed in the process of conducting future R&D programmes.

A-2. BULGARIA

A-2.1. Organization and legislation

A-2.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts law.

Government

- Establishes policies.
- Makes decisions on whether to construct national radioactive waste storage and/or disposal facilities.
- Determines whether to declare that SNF is radioactive waste (requiring disposal).

REGULATION

Regulatory Authority

Nuclear Regulatory Agency

- Develops requirements and criteria.
- Is responsible for nuclear safety regulation.

IMPLEMENTATION

Implementing Organization

Radioactive Waste Management Organization (WMO)

- Is responsible for radioactive waste management, including disposal
- Is responsible for construction, operation, maintenance, modernization and closure of waste management facilities.

Financial Resources Management Body

Ministry of Energy & Energy Resources

- Is responsible for management of the funds.
- Prepares cost estimates.

The interactions between the government, the regulatory authority, the waste generators and the implementing organization involved in the HLW and/or SNF long term management in Bulgaria are shown in Fig. A-2.1.

A-2.1.2. Implementing organization

The Radioactive Waste Management Organization (WMO) will be established on 1 April 2004 as a state owned enterprise according to the new Law on Safe Use of Nuclear Energy (LSUNE). The major mission of WMO is as follows:

- Management of radioactive waste including handling, pre-treatment, treatment, conditioning, storage and/or disposal of and closure of disposal facilities;
- Construction, operation, rehabilitation and modifications of radioactive waste management facilities;
- Transportation of radioactive waste - if holding a permit or license for transport as required by LSUNE.

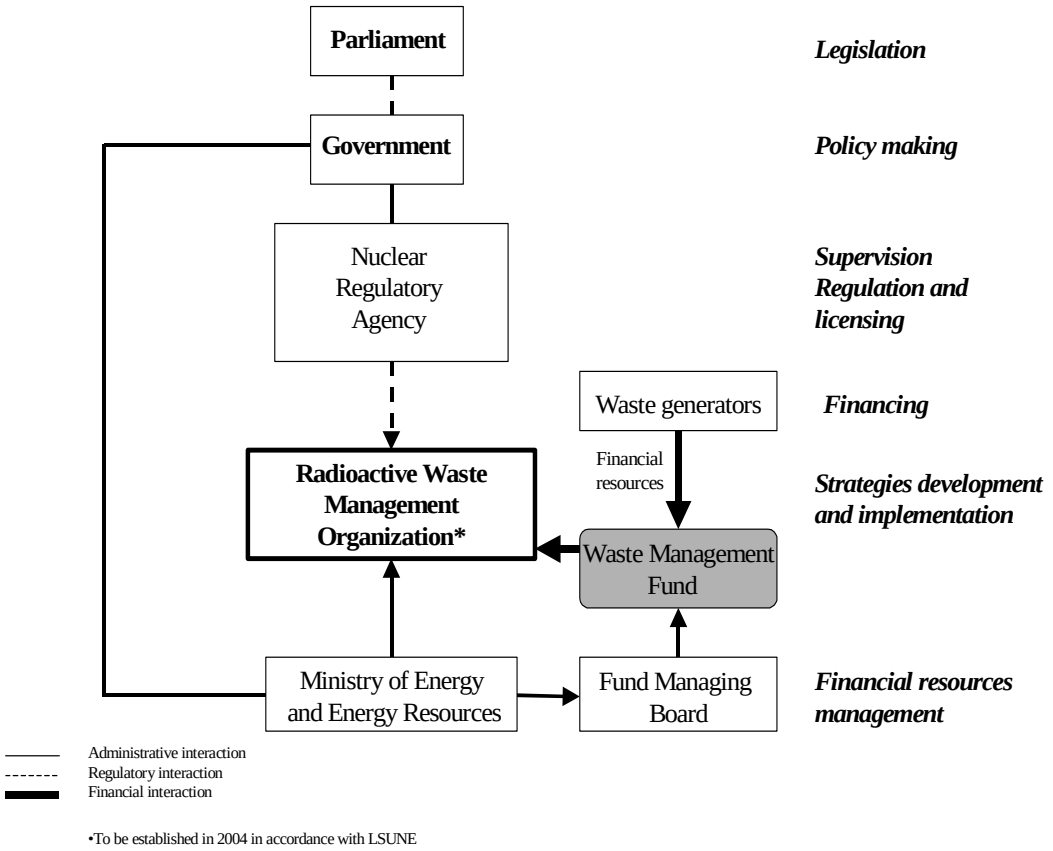


Fig. A-2.1. Organizational structure.

The scientific and technical validity of activities to be undertaken by the WMO will be monitored through the use of a process of authorization. According to LSUNE, the authorization process will be implemented by requiring WMO to obtain a license for operation of each radioactive waste management facility as well as permits for such stages as site selection, design, construction and commissioning. These licenses and permits must be obtained from the new Nuclear Regulatory Agency, which will conduct the required monitoring of the WMO activities for ensuring they are in line with the conditions of the license(s) and the safety requirements.

A-2.1.3. Laws and regulations

The following laws and regulations specify the requirements applicable to HLW and/or SNF management in Bulgaria:

- Law on the Safe Use of Nuclear Energy (LSUNE);
- The Regulation No. 7 on Collection, Storage, Treatment and Disposal of Radioactive Waste in the Territory of the Republic of Bulgaria;
- The Regulation on Determining the Amount of the Contribution and the Order for Collecting, Spending and Control over the Financial Resources in the " Safety and Storage of Radioactive Waste" Fund. (Degree of the Council of Ministers).

LSUNE entered in force at the end of June 2002, however most of its provisions for management of radioactive waste will be in force with a delay of several years. For example, WMO will be established in 2004, and new financial arrangements for radioactive waste management will enter in force in 2003. LSUNE requires new secondary legislation (regulations) to be created for regulating specific areas of the nuclear and radiological safety and the management of radioactive waste and spent nuclear fuel. Therefore significant changes are expected to take place in the infrastructure for the

management of radioactive waste and SNF during the following two-three years. This profile reflects rather the future infrastructure as provided for in LSUNE, and which in many cases is not yet actually created.

A-2.2. Waste streams and proposed repositories

A-2.2.1. Waste stream assumptions

Bulgaria has one nuclear power plant (Kozloduy NPP) with six WWER type nuclear power reactors in operation, with a total capacity of about 3.8 GW(e). There are three waste streams for HLW and SNF:

- SNF from the above NPP,
- HLW arising from reprocessing of SNF,
- SNF and/or HLW from reprocessing of SNF from the IRT-2000 research reactor[3].

Since the decisions on the lifetime of Bulgaria's nuclear power reactors, and on the nuclear fuel cycle policy, have not yet been made, the information on the total amounts of anticipated SNF and HLW is not available.

A-2.2.2. Proposed repositories

There is no proposal for a repository for HLW and/or SNF in Bulgaria. The concept of the repository is expected to be a subject of a new strategy for HLW/SNF management, which according to LSUNE, will be proposed by the Minister of Energy and Energy Resources and adopted by the Council of Ministers.

A-2.2.3. Management time schedule

Presently SNF is being stored in the in-reactor storage pools and in the storage facility located on the NPP site. Storage of the SNF is expected to take place for several decades (30-50 years). There are plans for building a new SNF store (dry type) at the NPP site. The new store should be commissioned before 2006 when the capacity of the existing store will be insufficient due to the SNF arising from decommissioning of units 1 and 2.

Since a decision for disposal of HLW and/or SNF has not yet been taken, the time schedule for the disposal has not yet been developed. The time schedule should be proposed in the above-mentioned strategy for HLW and/or SNF management.

A-2.3. Siting of geological repositories

A-2.3.1. Siting process

The draft Regulation on Safety of Radioactive Waste Management defines that the siting process shall be in compliance with IAEA Safety Series No.111-G.4.1, Safety Series No. 99 and IAEA Safety Series No. 63, which include four general stages in the siting process, as follows:

- Conceptual and planning stage,
- Area survey stage,
- Site characterization stage,
- Site confirmation stage.

[3] IRT-2000 is not currently in operation. Current plans are to replace it with a new research reactor located at the same site (using the same building). The SNF unloaded from this new reactor may be reprocessed abroad.

A-2.3.2. Development of siting criteria

The draft Regulation on Safety of Radioactive Waste Management defines that the siting criteria shall be in compliance with IAEA Safety Series No.111-G.4.1, Safety Series No. 99 and IAEA Safety Series No.63.

A-2.3.3. General procedures for decision making in each phase or stage

LSUNE states that the Council of Ministers will decide on the facilities to be used for disposal of radioactive waste in general, and for disposal of HLW/SNF in particular.

The draft Regulation on Safety of Radioactive Waste Management states that authorization (licenses and permits) is required for siting (including each stage mentioned above), design, construction, commissioning and operation of the facilities.

A-2.3.4. Role of local governments

In accordance with the Law on Environmental Protection, local governments will be invited to participate in the siting process by submitting comments on the environmental impact assessment (EIA). Local government representatives may also be invited to participate as members of the Commission under the Ministry of Environment and Water, which reviews the EIA.

LSUNE requires the Minister of Energy and Energy Resources to organize a discussion with a number of interested parties, among them the local authorities, of the draft strategy for HLW/SNF management before it has been submitted for approval by the Council of Ministers.

A-2.3.5. Financial assistance

This aspect has not been addressed in the legislation.

A-2.4. Management costs

A-2.4.1. Total estimated cost and its breakdown

A cost estimate has been prepared for storage of SNF but not for disposal. The costs were estimated to be 234 million US $ for storage of SNF from 1999 to 2010. In addition, 68 million US $ would be needed every year until 2008 to transport 600 SNF assemblies of WWER-440 and WWER-1000 to Russia.

A-2.4.2. Organization responsible for cost estimation

The Ministry of Energy and Energy Resources is responsible for preparing the cost estimation, subject of approval by the government.

A-2.5. Financing system

A-2.5.1. Overview of the financing system

As required by the Law on the Use of Atomic Energy for Peaceful Purposes, the “Safety and Storage of Radioactive Waste Management Fund” was established in 1999 to cover the costs for storage and management of radioactive waste, including disposal.

The operators of nuclear power plants are required to pay to the Fund an amount calculated by the following formula (this amount is being collected as a levy on the electricity rate):

$$\frac{3 \times A \times B}{100}$$

where:

A is the electricity 'adjusted rate'[4] excluding VAT,
B is the sum of electricity generated by NPPs.

Other organizations (e.g. research institutes, hospitals) that generate radioactive wastes are also required to pay tariffs as specified in the regulation.

The funds received are deposited on the Bulgarian National Bank accounts and are dispensed for use in the projects and programmes approved by the Board. If there is a surplus at the end of any year, it will be carried over to the following year.

The financial resources are managed by the Managing Board of the Fund consisting of the chairman, the Minister of Energy and Energy Resources and nine other members who are representatives of the relevant Ministries and other organizations.

The Fund covers the waste management including disposal of all radioactive waste generated in the country and does not cover the management of SNF. LSUNE gives the Council of Ministers the authority to decide whether the SNF is radioactive waste under certain conditions. One of the preconditions for declaring the SNF as waste by the Council of Ministers is that the generator of the SNF has made a payment to the Fund; in such case the Fund will finance the disposal of the SNF.

In addition to the Waste Management Fund, the Decommissioning of Nuclear Facilities Fund was established to cover the decommissioning cost of nuclear facilities. A similar Board was organized to manage the Decommissioning Fund.

The issues of financing the radioactive waste management are properly addressed in LSUNE. Some changes have been made in the managing structures, the financing mechanism, etc. The Law requires the Minister of Energy and Energy Resources to propose new regulations for the two funds. The provisions of LSUNE concerning the financing of radioactive waste management will enter into force on 1 January 2003.

A-2.5.2. Waste management fee

The NPP operators are required to pay 3% of the income received from electricity sales to the "Safety and Storage of Radioactive Waste Fund". The operators also are required to pay 15% of electricity sales to the "Decommissioning of Nuclear Facilities Fund" (this amount was raised recently from 8%).

A-2.5.3. Withdrawal

Withdrawal will be made based on appropriations approved by the Managing Board.

A-2.5.4. Auditing the financing system

The Ministry of Finance regularly audits the financial operations of the Fund.

An independent auditing organization designated by the Managing Board will also audit the financial system and report the results to the Board.

A-2.5.5. Revenue and expenditure of financial resources

In the past, financial resources have been contributed mainly by the Kozloduy NPP as follows:

[4] The term 'adjusted rate' means the price agreed upon between the NPP operator and the electricity distribution company. It is calculated on the basis of the produced energy and the available (installed) electrical power generation capacity (in reserve). The 'adjusted rate' varies over time. Its value for the first three months of 2002 was 0.0312 BLev/kW•h (1 US $ ~ 2.22 BLev).

- Funds available as of 13 April 2002: about 39.3 million lev
- Revenues in 2001: about 31.8 million lev
- Expenditures in 2001: about 10.7 million lev

During the period from 1999 to 2001, the funds were spent on reconstruction and upgrading of the near surface repository (Novi Han), and on construction of the treatment and storage facility at the Kozloduy site.

Revenues and expenditures in 2002 are expected as follows:
- Revenues: about 31.5 million lev
- Expenditures: about 10.7 million lev

With regard to the "Decommissioning of Nuclear Facilities Fund", revenue and expenditure is expected to be as follows:

Funds available as of 13 April 2002	about 39.3 million lev
Revenues in 2001	about 100.5 million lev
Expenditures in 2001	about 1.8 million lev
Planned revenues in 2002	about 137.2 million lev
Planned expenditure in 2002	about 4.2 million lev

A-2.6. Public involvement and transparency

The public will be involved in the siting process during the environmental impact assessment, as provided for by the Law on Environmental Protection.

LSUNE and the draft Regulation on the Safety of Radioactive Waste Management envisage additional requirements for public involvement. For example, LSUNE provides for public hearings of the draft national strategy for the management of radioactive waste and SNF and public consultation on a decision for a radioactive waste repository, and the Regulation requires that, in addition to the main report, a summary of the safety analysis reports for waste management facilities shall be prepared for public and non-specialized organizations.

A-2.7. Other considerations

A-2.7.1. Nuclear liability

Third party liability is subject to the Vienna Convention on nuclear liability. Liability of the operator of a nuclear installation for nuclear damage shall be absolute and limited.

A-2.7.2. Institutional controls

The draft Regulation on Safety of Radioactive Waste Management requires institutional control for a geological repository, the details of which will be developed by the Radioactive Waste Management Organization.

A-2.7.3. Records keeping

LSUNE requires that the organizations managing radioactive waste shall maintain a system for control of and accounting for the radioactive waste in their possession, and shall keep records. The draft Regulation establishes the detailed requirements for the records and the records keeping.

A-3. CANADA

A-3.1. Organization and legislation

A-3.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts law.

Government

- Establishes policies, i.e. an approach for waste management.

Ministry of Natural Resources

- Monitors activities of the Waste Management Organization
- Approves a formula on annual deposits to the fund.

REGULATION

Regulatory Authority

Canadian Nuclear Safety Commission (CNSC)

- Establishes radiological and environmental safety requirements.
- Is responsible for granting a construction license.

IMPLEMENTATION

Implementing Organization

Waste Management Organisation (WMO)

- Submits options for waste management.
- Is responsible for implementation of spent nuclear fuel disposal.
- Is responsible for developing cost estimates and the formula for annual deposits to the fund.

Financial Resources Management

Energy Corporations and Atomic Energy of Canada Ltd.* (*AECL)

- Are responsible for maintaining funds (at present).

The interactions between the government, Ministry of Natural Resources, AECL, the regulatory authority, the implementing organization and the energy corporations involved in the SNF long term management in Canada are shown in Fig. A-3.1. Planned financial interactions are shown in more detail in Section A-3.5.1.

A-3.1.2. Implementing organization

The Nuclear Fuel Waste (NFW) Act states that long term management of nuclear fuel waste will be implemented by a waste management organization (WMO) that is to be formed as a legal entity separate from the main waste owners in the country.

Under the NFW Act, government oversight activities are to be administered by the federal Minister of Natural Resources.

A-3.1.3. Laws and regulations

The framework for nuclear safety of waste management is provided under the Nuclear Safety and Control (NSC) Act, along with requirements applicable to other nuclear activities. The Nuclear Fuel Waste Act is dealing with siting, financing, and implementing organization. The NFW Act came into force on 15. November 2002.

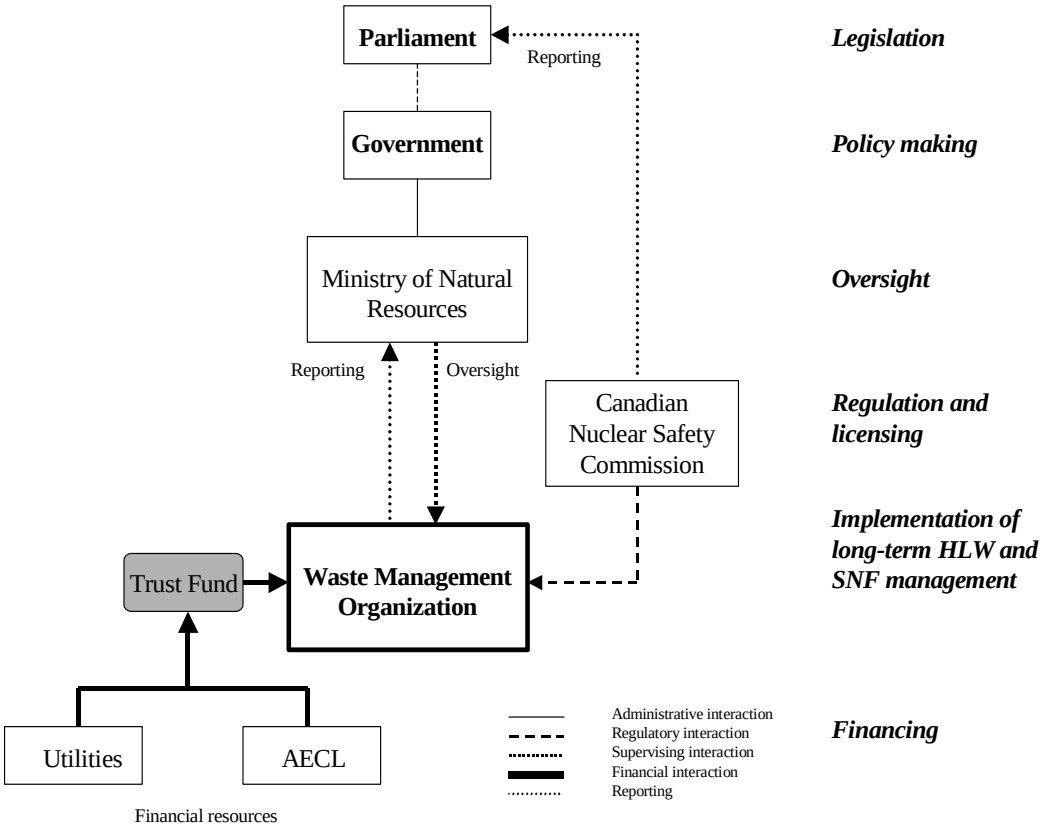


Fig. A-3.1. Organizational structure.

A-3.2. Waste streams and proposed repositories

A-3.2.1. Waste stream assumptions

Nuclear fuel waste results mainly from the CANDU power reactors and nuclear power demonstration reactors.

(a) CANDU spent nuclear fuel

There are twenty-two nuclear power reactors with a total capacity of 15 GW(e), owned by three provincial utilities. As of the end of 1998, fourteen reactors were operating, and eight were in extended shutdown mode. The owner utilities plan to bring the shut down reactors back into service in the 2000 - 2009 time frame, depending on economic and market conditions.

At the end of 1998, accumulated SNF amounted to 1 347 141 bundles or approximately 5389 m³, which were stored in both wet and dry storage facilities at the reactor sites.

Based on the utilities' operation plans (in which the end of operations for the nuclear power reactors ranges from 2010 to 2035), the total lifetime inventory of their SNF will be approximately 3.6 million bundles[5] (14 170 m³).

(b) Prototype/Demonstration and Research Reactor SNF

The inventory of prototype, demonstration and research reactor spent fuel amounted to 48 558 bundles (194 m³) at the end of 1998, details of which are shown as follows:

[5] One bundle of spent nuclear fuel contains about 19 kg of uranium.

The SNF of the three shutdown prototype/demonstration reactors: 30 322 bundles (121 m³)
The inventory of other research reactors: 18 236 bundles (73 m³)

The SNF inventory to 2035 for the existing prototype/demonstration and research reactors owned by AECL is projected to amount to 76 000 bundles (300 m³).

A-3.2.2. Proposed concepts

Atomic Energy of Canada Ltd proposed to the Federal Government in 1995 a concept for a deep geological repository for SNF, with a capacity ranging from 5 to 10 million bundles. The vault would be excavated at a nominal depth of 500 to 1000 m in plutonic rock of the Canadian Shield. The waste would be encased in a container, which would be surrounded by a buffer material (e.g. clay-based fill).

Two repository capacities were discussed. Under one scenario, the proposed repository would have a capacity of 5 million spent fuel bundles, based on the assumption that it would accept all of the SNF unloaded from the power reactors existing as of 31 March 1993 and that these reactors would be operated for 40 years from their commissioning. Under the second scenario, the repository would have a capacity of 10 million bundles, based on the assumption that it would accept all SNF generated by the end of 2035 under the condition that the nuclear generating capacity would increase by 3% per year after 1994. No new nuclear reactors would be constructed after 1993.

However, no decision regarding proposed repositories has yet been made by the Federal Government. The Nuclear Fuel Waste Act would provide a legal framework leading to such a decision in the near future.

A-3.2.3. Management time schedule

The Nuclear Fuel Waste Act states that, once the legislation enters into force, the WMO must submit options for the long term management of SNF within three years. The organization's report would include a proposed implementation plan for each of the options proposed, including a time schedule. Once the Federal Government selects an option, the WMO must submit information for a specific project in order to get a license from the Canadian Nuclear Safety Commission.

A-3.3. Siting of geological repositories

A-3.3.1. Siting process

Under the NFW Act, the WMO would be required to suggest long term management concept options along with siting economic regions. After the Federal Government makes a decision, the WMO would have to prepare supporting documentation for a specific project at one or more specified sites to get a license under the NSC Act. Public consultations are mandatory under both the NSC Act and the NFW Act. In addition, the Canadian Environmental Assessment Act would be triggered by a license application and the NSC Act. A full public review will likely be carried out on the specific project.

Canada has one underground research laboratory located in Pinawa, Manitoba. The URL has no role in siting a long term management facility for nuclear waste produced from either commercial or research operations, except in assisting in the demonstration of the safety of deep geological repositories in general.

A-3.3.2. Development of siting criteria

Criteria for radiological and environmental safety mostly fall under the NSC Act and pursuant regulations, and other regulatory documents. Socio-economic impacts are mostly dealt with under the NFW Act.

Basic criteria have already been developed under the NSC Act regarding the burden on future generations, health, safety, environment and radiological safety. In 1987, the criteria were presented in Regulatory Policy Statement R-104 entitled "Regulatory Objectives, Requirements and Guidelines for the Disposal of Radioactive Waste-Long Term Aspects". This document and the criteria are currently under review. There are plans to develop guidelines for qualitative assessment of detrimental socio-economic impacts and mitigation measures under the NFW Act.

A-3.3.3. General procedure for decision making in each phase or stage

The WMO is required to submit to the Federal Government options for the long term management of SNF. Upon the submission, the Government of Canada makes a decision on the long term management concept.

Thereafter, the WMO will prepare specific supporting documentation in order to get a license for construction of a repository under the NSC Act. Before a license can be granted by the Canadian Nuclear Safety Commission, the project must go through an environmental review under the Canadian Environmental Assessment (CEA) Act.

A-3.3.4. Role of local governments

There are mandatory requirements for public consultation under both the NFW Act and the NSC Act. In the former, there is a specific requirement to consult with local governments. In the latter, public consultations are triggered under the Canadian Environmental Assessment Act.

A-3.3.5. Financial assistance

The CEA Act provides for financial assistance for public participation in the processes under the Act, specifically in the review panel and mediation processes.

The Federal Government's fiduciary responsibility for Aboriginal Peoples also provides for financial assistance for Aboriginal Peoples to participate in the process throughout the duration of the project and beyond.

A-3.4. Management costs

A-3.4.1 Total estimated cost and its breakdown

Since a decision on the approach for the long term management of SNF has not been made yet, no official cost estimates are available. However, AECL, in its 1995 Environmental Impact Statement, provided cost estimation for its proposed deep geological concept (the Environmental Assessment Panel did not recommend proceeding with AECL's proposed concept at that time, due to a lack of demonstration of public support).

A-3.4.2. Organization responsible for cost estimation

The NFW Act states that the WMO is responsible for developing the cost estimate for waste management. The cost estimation will be included in a study that sets out proposed approaches for the long term management of SNF, conducted by the WMO. The study will be submitted to the Minister of Natural Resources, and then the government shall select one of the approaches.

The cost estimates provided in the 1995 EIS are summarized below:

	5 million bundles		7.5 million bundles		10 million bundles	
	Duration (years)	**Cost (MCan $ 1991)**	**Duration (Years)**	**Cost (MCan $ 1991)**	**Duration (Years)**	**Cost (MCan $ 1991)**
R&D (as spent)*		665		665		665
Interim storage		n/a		n/a		n/a
Siting	23	2140	23	2160	23	2180
Land acquisition		n/a		n/a		n/a
Design		n/a		n/a		n/a
Licensing (regulatory)		n/a		n/a		n/a
Construction	5	1520	6	1630	7	1810
Waste transportation**		869		1095		1333
Repository operation	20	4060	30	6040	41	8060
Decommissioning	13	940	15	1090	16	1250
Closure	2	30	2	30	2	30
Institutional control after closure		n/a		n/a		n/a
Other cost (such as financial assistance, etc.)		n/a		n/a		n/a
Total		**10 224**		**12 710**		**15 328**

These figures were extracted from AECL's "Summary of the Environmental Impact Statement on the concept for Disposal of Canada's Nuclear Fuel Waste" published in September 1994.

* AECL and OPG developed the concept at AECL's laboratory in Whiteshell.

** AECL estimated that transportation would cost between 3 and 16% of the cost of the disposal facility. For this exercise, transportation was estimated at 10%.

A-3.5. Financing system

A-3.5.1. Overview of the financing system

The NFW Act requires nuclear energy corporations and AECL to maintain a segregated trust fund with an independent financial institute to cover the expenses for the management of SNF, including its disposal.

Within ten days of the NFW Act coming into force, existing nuclear energy corporations and the AECL must deposit specified initial amounts into the fund. Each subsequent year, on the anniversary date of the Act coming into force, the nuclear energy corporations and AECL must make specified deposits into the fund until such time as the Federal Government makes a decision on the approach for the long term management of SNF.

Once the Federal Government makes a decision on the approach, nuclear energy corporations and AECL's annual deposits into the trust fund will be calculated by a formula which will be established by the WMO and approved by the Minister of Natural Resources on two occasions; the first time is after the Federal Government makes a decision on the long term management approach for SNF and the second time is after the Canada Nuclear Safety Commission (CNSC) issues a first license to implement the approach.

The formula to determine the annual deposit will be developed by the WMO. The NFW Act requires that certain elements shall be included in the formula, including:

- The estimated total cost of management of SNF;
- The estimated rate of return on the trust funds;
- The life expectancy of each of the nuclear reactors;
- The estimated amounts to be received by the WMO from owners of nuclear waste other than the nuclear energy corporations and AECL.

Figure A-3.2. shows the schematic of the financing approach proposed in the NFW Act.

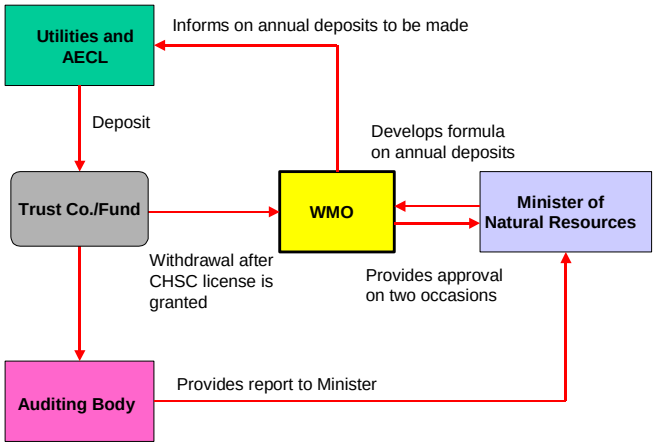


Fig. A-3.2. Schematic of the financing approach proposed in the NFW Act.

The money in the funds will be managed by the trust companies in accordance with their respective trust agreements, which will be entered into with the nuclear energy corporations and AECL.

If there are insufficient assets in the trust fund, the annual deposits to be made by the nuclear energy corporations and AECL will be increased. If there is a surplus in the trust fund after the WMO has completed implementation of the approach, the beneficiaries of the trust funds may withdraw all or part of the balance.

A-3.5.2. Waste management fee

The Federal Government has not made a decision on the preferred long term management approach for SNF. Once a decision is made, the formula to determine the annual deposits to the trust fund will be based on the cost of the method. The WMO will review the formula on an annual basis and make changes to the fee as required.

A-3.5.3. Withdrawal

The WMO is the only entity which can withdraw financial resources from the trust fund. Two conditions must be met:

4 The WMO can only withdraw financial resources to implement the approach after it has been selected by the Federal Government of Canada.
4 The WMO can only withdraw financial resources from the fund after the Canadian Nuclear Safety Commission has issued either a construction or operating license for the approach selected by the Government.

If the WMO is found to have withdrawn money from the trust fund for purposes other than implementing the approved approach, the Minister of Natural Resources has the authority to freeze the fund and require prior approval for future withdrawals.

The Board of Directors of the WMO will be responsible for approving the budget and expenditures for waste management activities. All activities prior to receiving either a construction or an operating license for the approved approach will not be paid out of the fund.

A-3.5.4. Auditing the financing system

The WMO must submit audited financial statements to the Minister of Natural Resources within three months after the end of each fiscal year. Every financial institution that holds a trust fund must submit audited financial statements for that trust fund to the Minister within three months after the end of each fiscal year. These audited statements will be made available to public.

The Minister has the right to audit the WMO, nuclear energy corporations, AECL, as well as every financial institution that holds a trust fund. The Minister may designate anyone who is considered qualified to perform an audit. The results of audits will be reported to the Minister and will be made public. It will be up to the discretion of the Minister as to the frequency of audits. At this time no decision has been made as to how the audit programme will be managed.

A-3.6. Public involvement

There are mandatory requirements for public consultation under both the NFW Act and the NSC Act. In the latter, public consultations are also triggered under the Canadian Environmental Assessment (CEA) Act.

Under the NFW Act, the WMO must establish Advisory Council that would include local and Aboriginal people's representation. In addition, the WMO is responsible for developing and proposing a public participation plan under the NFW Act that would last throughout the duration of the project and beyond. This plan has not yet been developed.

Later when a specific site is proposed, the public will participate by providing their views under the NSC Act and the CEA Act.

A-3.7. Other considerations

A-3.7.1. Nuclear liability

The Nuclear Liability Act (NLA), proclaimed in 1976, established the liability for third-party injury and damage arising from nuclear accidents in the country. It reflects the principles of absolute and exclusive liability of the operator, limited liability, and mandatory insurance.

The liability limit imposed on the operator of nuclear installations is 75 million Canadian Dollars. Operators must maintain mandatory insurance up to a specified limit, prescribed by CNSC and calculated to provide approximately the amount of compensation which would be required as a result of a nuclear incident. The amount of supplementary insurance (the difference, if any, between the basic insurance prescribed by the CNSC and the maximum liability of 75 million Canadian Dollars) would be provided by the Federal Government through a reinsurance agreement.

Although there are no nuclear fuel disposal facilities in the country, they are covered under the NLA if the CNSC determines that the nuclear materials in the facilities can achieve criticality. In addition, the basic amount of insurance that operators of disposal facilities will be required to carry will be decided by the CNSC.

A-3.7.2. Institutional controls

There will be requirements for institutional controls under both the NFW Act and the NSC Act. Provincial and Federal Government policies will also have an impact on institutional controls. Details will be decided in the future.

A-3.7.3. Records keeping

Criteria for records keeping are included in regulations pursuant to the NSC Act and under the NFW Act, including the following important points:

- Every licensee and every prescribed person shall keep the records specified by the Acts.
- Waste management organizations shall keep records for at least five years at their place of business.

A-4. CZECH REPUBLIC

A-4.1. Organization and legislation

A-4.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts law.

Government

- Approves plans and budget of the Radioactive Waste Repository Authority (RAWRA) and fees.

REGULATION

Regulatory Authorities

State Office for Nuclear Safety

- Monitors and regulates nuclear safety and radiation protection.

Czech Mining Office

- Monitors and regulates geological and mining activities.

IMPLEMENTATION

Implementing Organization

Radioactive Waste Repository Authority (RAWRA)

- Is responsible for implementation of radioactive waste disposal.
- Calculates and proposes amounts of fees.

Financial Resources Management Body

Ministry of Finance

- Is responsible for management of the Nuclear Account.

The interactions between the government, the regulatory authority and the implementing organization involved in the HLW and/or SNF long term management in the Czech Republic are shown in Fig. A-4.1.

A-4.1.2. Implementing organization

The Radioactive Waste Repository Authority was established in 1997 as a state-owned implementing organization by the Atomic Act (Act No. 18/1997 Coll.).

RAWRA's major activities are described in the Atomic Act as follows:

- Preparation, construction, commissioning, operation, closure and monitoring of radioactive waste repositories,
- Handling of radioactive waste,
- Conditioning of spent or irradiated nuclear fuel into a form suitable for its disposal or further utilization,
- Proposing fees to be paid to the Nuclear Account,
- Keeping records of accepted radioactive waste.

The Ministry of Industry and Trade nominates the Director and the Board of RAWRA, and ensures communication of RAWRA with the Government.

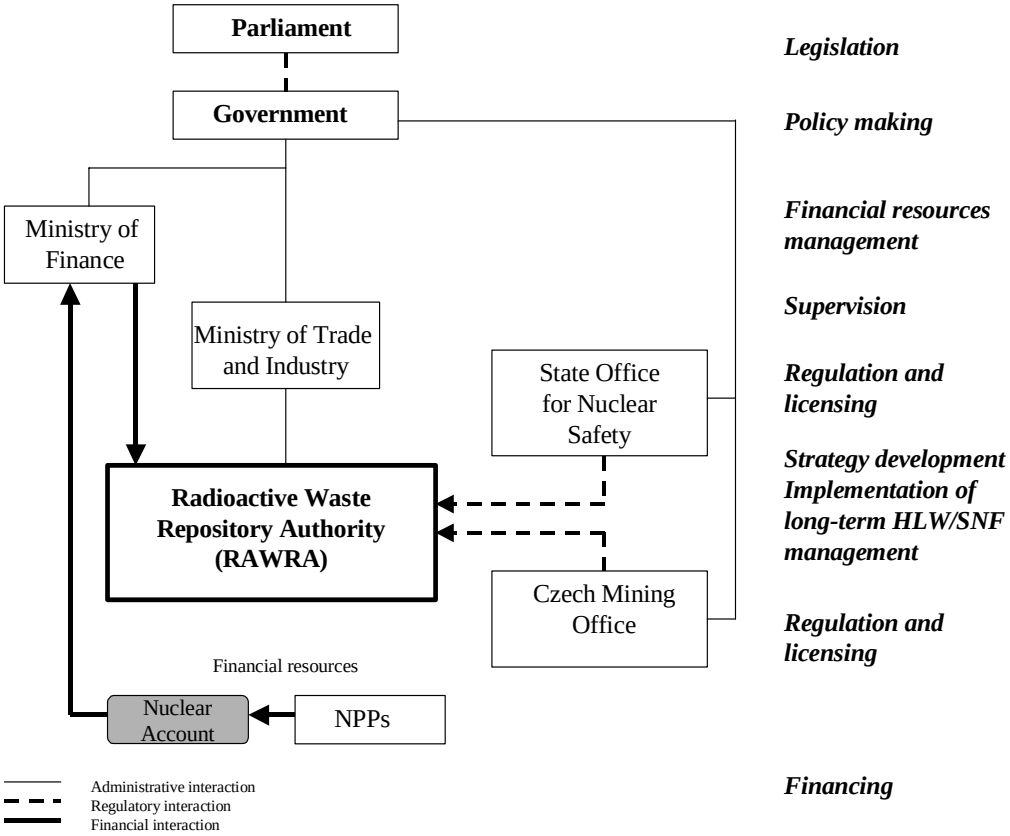


Fig. A-4.1. Organizational structure.

A-4.1.3. Laws and regulations

The fundamental institutional framework for radioactive waste disposal (such as the financing system, implementing body, and requirements) is stipulated in the Atomic Act (No. 18/1997 Coll.) as amended by the Act No. 13/2001 and other decrees of the State Office for Nuclear Safety, along with requirements applicable to other nuclear activities.

A-4.2. Waste streams and proposed repositories

A-4.2.1. Waste stream assumptions

The Czech Republic has four WWER-440 type nuclear power reactors with a total capacity of about 1.6 GW(e) in operation at the Dukovany site, and two WWER-1000 type power reactors with a total capacity of about 1.8 GW(e) in operation at the Temelin site.

In accordance with the Atomic Act, spent nuclear fuel is not considered radioactive waste. However, the SNF is managed in accordance with the requirements of the regulations for management of radioactive waste. The owner of the SNF or the State Office for Nuclear Safety, will decide in the future whether to reprocess the SNF, or dispose of it directly.

Assuming the reactor lifetime of forty years and the period of several decades between closure and decommissioning of the nuclear power reactors, the inventory of anticipated LL-LILW[6] and SNF is as follows:

[6] LL-LILW – Long lived low and intermediate level waste.

Source*	LL-LILW** from operations (m³)	LL-LILW from decommissioning (m³)	SNF (t HM)
Dukovany NPP (1985-2025)	50	-	1937
Dukovany NPP (2085-2094)	-	2000	-
Temelin NPP (2000-2042)	50	-	1787
Temelin NPP (2090-2095)	-	624	-
Total, NPPs	**2724**		**3724**
Institutions (1958-2000)	80	5	0.2
Institutions (2000-2050)	150	50	0.3
Total, institutions	**285**		**0.5**

* Data in the table do not include either wastes arising from potential new power reactors, or HLW that may be generated from reprocessing. Spent fuel generated at the Training Critical Assembly (training reactor operated by the Faculty of Nuclear Engineering), and at the Zero Power Reactor (NRI Rez) is included in the column "Institutions".

** LL-LILW includes waste arising from maintenance of reactors (e.g. metallic parts of the primary circuit, control and handling rods), waste arising from decommissioning of nuclear reactors (e.g. long lived ILW metallic and constructional materials), and transuranic waste from institutions and industry.

A-4.2.2. Proposed repositories

In the RAWRA's report entitled "Reference Design of a Deep Geological Repository" (published in 1999), the characteristics of a proposed repository are presented as follows:

Surface area:	up to 0.3 km²
Underground area (including buffer zone):	2–2.5 km²
Depth:	500–1000 m
Host rock:	granite
Excavation volume:	up to 1.5 million m³
Engineered barrier system:	steel container, clay/bentonite based sealing

RAWRA plans to dispose of, in a single facility, all radioactive waste, including low level waste, after the existing repository for low level waste is filled up.

A-4.2.3. Management time schedule

RAWRA is responsible for developing the time schedule for radioactive waste disposal. The time schedule below is taken from the "Concept of Radioactive Waste Management" that was submitted by RAWRA to the Ministry of Industry and Trade and approved by the government of the Czech Republic in May 2002.

Investigation of eight sites	by 2005
Proposal of two final sites (including a regional plan)	by 2015
Confirmation of the site	by 2025
Permit for characterization in an underground laboratory	by 2030
Licensing of construction	by 2045
Commissioning of repository	2065

A-4.3. Siting of geological repositories

A-4.3.1. Siting process

The siting process proposed by RAWRA and approved by the government is as follows:

4 Siting screening – The geological setting was studied by the Czech Geological Survey. The study was completed in 1992. Consequently, 27 promising areas were selected in different host rocks.

- Site selection – This study was conducted through the critical evaluation of pre-existing geological information and numerous existing reports, and was concluded in 1998. Consequently, eight sites were selected in 1998.
- Site investigation - Various explorations, such as surface surveys and boreholes, will be carried out. RAWRA expects that, as a result, two sites will be recommended for characterization.
- Site characterization - Extensive explorations, such as boreholes, will be conducted, and the number of candidate sites will be narrowed to one.
- Site confirmation – Studies to confirm the suitability of the selected site will be carried out in an underground research laboratory (called the "confirmation URL").

RAWRA has placed a priority on international co-operation at the existing URLs in foreign countries in order to facilitate and accelerate research activities in support of the siting process described above.

A-4.3.2. Development of siting criteria

Siting criteria for a geological repository have been proposed by RAWRA on the basis of existing nuclear, environmental and geological legislation (i.e. "Criteria for Siting of Nuclear Facilities and Very Important Ionizing Radiation Sources" (No. 215/1997 Coll.). These proposed siting criteria are subject to approval by the State Office for Nuclear Safety.

The criteria in the regulation consist of exclusion and conditional criteria, which are defined as physical criteria pertaining to issues such as volcanic activity, seismic activity, and mining activities.

A-4.3.3. General procedures for decision making in each phase or stage

An annual report and plans that include conclusions of the investigations and proposals for the siting are submitted and approved by the government. The decision on whether to proceed further is subject to approval by the government.

A license must be granted by the State Office for Nuclear Safety prior to construction of nuclear facilities, and an Environmental Impact Assessment also has to be cleared. Then various permits must be obtained, from local authorities prior to construction of the surface facilities, and from the regional mining office prior to construction of underground facilities.

A-4.3.4. Role of local governments

In addition to a license from the State Office for Nuclear Safety, an approval for construction of the above mentioned ground nuclear facility must be obtained from the local construction office. On the other hand, for an underground facility, construction must be approved by the Czech Mining Office. A set of specialized licenses (including a license from the State Office for Nuclear Safety) must be obtained before the Czech Mining Office will grant its approval.

As part of the site approval process, the Environmental Impact Assessment (EIA) procedure must be completed. This procedure includes the review of the draft EIA by local governments and incorporation of their comments in the final EIA, and conducting public hearings. The Ministry of the Environment will issue a final statement specifying the actions to be taken in response to the EIA.

A-4.3.5. Financial assistance

At present, no financial assistance is provided to local communities. However, in January 2002, the Parliament approved an amendment to the Atomic Act, which came into force in July 2002. The provisions of this amendment will enable provision of financial assistance from the Nuclear Account to communities in the vicinity of radioactive waste repositories in operation. The level of financial assistance will be determined by a regulation, which is still under preparation.

A-4.4. Management costs

A-4.4.1. Total estimated cost and its breakdown

The latest cost estimation is as follows:

Cost element	Cost*(million CZK 1999)
R&D	5240
Public relations, legislation	200
Designing support and studies	620
Total building cost	7517
Operation	23 065
Closure	300
Total	**46 942**

* The costs specified above do not include any compensation for local communities or costs of transportation and storage of SNF. Storage and transportation of SNF is included in the operational costs of NPPs.

A-4.4.2. Organization responsible for cost estimation

The cost estimate for radioactive waste disposal in the Czech Republic is to be developed by RAWRA, and is not subject to any particular independent review.

A-4.5. Financing system

A-4.5.1. Overview of the financing system

According to the Atomic Act, the "Nuclear Account" was established in 1997 to ensure that funds are available in the future to cover the costs of radioactive waste disposal (e.g. costs for site survey and characterization, costs of design, construction and operation of the disposal facilities, costs for R&D). However, the Nuclear Account does not cover the costs of transportation and storage of SNF, and decommissioning of nuclear power plants.

RAWRA is responsible for developing a methodology for calculation of fees, including use of a discounting method. The fee calculated by RAWRA must be approved by the government. Fees are paid into the Nuclear Account as levies from NPP operators and as tariffs from small waste generators.

The Ministry of Finance is responsible for management of the Nuclear Account. Financial resources in the Nuclear Account are kept in the National Bank, and are invested only in securities having, at least, the same rate of return as National Bonds. If there is a surplus or deficit in the Fund, fees will be adjusted by the government decree.

A schematic representation of the radioactive waste financing arrangements in the Czech Republic is provided in Fig. A-4.2.

A-4.5.2. Waste management fee

Currently 50 CZK/MW·h is charged for all electricity produced by the NPPs as the levy to fund waste management activities. The charge is calculated every year and must be paid annually.

A-4.5.3. Withdrawal

Financial resources are transferred from the Nuclear Account to the RAWRA account annually based on the RAWRA plans and the budget approved by the government.

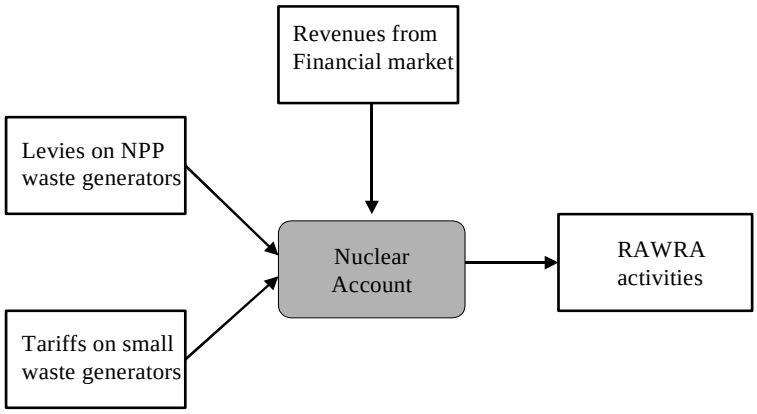


Fig. A-4.2. Financing arrangements.

A-4.5.4. Auditing the financing system

The financial system is subject to regular auditing by the government. The Supreme Auditing Office has the right to audit the management of financial resources from the Nuclear Account, and RAWRA assures annually the audit of its accounting by the authorized auditor.

A-4.5.5. Revenue and expenditure of financial resources

The revenues to and expenditures from the Nuclear Account, beginning with establishment of the Account and running through 2000, are shown in the following table:

Account elements	**Funds (million CZK)**			
Year	**1997**	**1998**	**1999**	**2000**
Income	157	696	725	722
Expenditure	4	38	72	340
Balance	154	812	1465	1848

The RAWRA's plan of activities, budget and annual report are subject to approval by the government.

A-4.6. Public involvement and transparency

In 2001, the basic strategic document ("Concept of Radioactive Waste and Spent Fuel Management in the Czech Republic") was the subject of an environmental impact assessment process (in compliance with Act No. 244/1992). Public hearings were held in September 2001 in Prague. Representatives of several environmental groups and communities near the sites identified as potentially suitable for use as a geological disposal facility, and others, participated in these hearings.

In the autumn of 2000, RAWRA established contacts with communities in 8 regions that had been selected during the siting process and recommended as subjects of geological research activities. In the spring of 2001, RAWRA initiated establishment of 4 Boards, whose membership includes the mayors and chairmen of local elected councils from the regions that include sites being studied. The purpose of these Boards is to involve local representatives in the siting process.

In addition, public hearings concerning the site selection will be conducted as part of the preparation of the environmental impact assessment, as required by the Environmental Impact Assessment Act.

Finally, RAWRA has carried out various following activities to enhance understanding of media, central and local administrations and professionals and residents in the regions:

- Meetings and seminars,
- Technical visits to nuclear facilities,
- Short TV documentaries,
- Establishment of an information centre in the capital city.

A-4.7. Other considerations

A-4.7.1. Nuclear liability

The Atomic Act specifies that the Vienna Convention on Civil Liability for Nuclear Damage and the Joint Protocol Relating to the Application of Vienna and Paris Convention shall be applied to civil liability associated with accidents involving nuclear facilities, including repositories. The liability of the operator of the nuclear installation for damage caused by a nuclear accident is absolute and limited.

A-4.7.2. Institutional controls

The safety authority's decree states that post-closure institutional control shall be provided for a certain period of time after closure of a repository. However, the period and scope of long term institutional control are not yet defined.

A-4.7.3. Records keeping

In accordance with the requirements of the Atomic Act, RAWRA is required to maintain records on wastes for an unlimited period. These records must be stored both at the waste management facility and at the head office in the form of paper and as digital records on CD-ROM. This record management system was developed for waste accepted and stored by RAWRA. It is not accessible by the public, but RAWRA provides summary information on generators, quantities and types of wastes to the public.

However, the record management system for geological disposal has not been established yet.

A-5. FINLAND

A-5.1. Organization and legislation

A-5.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.
- Ratifies the government's decision in principle on the project plan and the site.

Government

Ministry of Trade and Industry

- Establishes policies.
- Makes decision in principle on the project plan and the site on the basis of the implementing organization's application.
- Grants licenses.
- Issues general safety regulations.

REGULATION

Regulatory Authority

Radiation and Nuclear Safety Authority (STUK)

- Proposes regulatory guidelines.
- Is responsible for technical and safety reviews of license applications.
- Monitors the scientific and technical validity of Posiva Oy activities.

IMPLEMENTATION

Implementing Organization

Posiva Oy

- Is responsible for implementation of spent nuclear fuel disposal.

Financial Resources Management Body

Ministry of Trade and Industry

- Is responsible for management of the State Fund.
- Is responsible for confirming the assessed liability and the Fund target.

The interactions between the government and different organizations involved in the SNF long term management in Finland are shown in Fig. A-5.1.

A-5.1.2. Implementing organization

Posiva Oy was established in 1995 as a private company by the two nuclear utilities, Fortum Power and Heat Oy and TVO (Teollisuuden Voima Oy) to implement the disposal of spent nuclear fuel. The two nuclear utilities take care of storing the SNF until disposal.

Radiation and Nuclear Safety Authority (STUK) oversees the scientific and technical validity of Posiva's activities and reports the results to the Ministry of Trade and Industry.

A-5.1.3. Laws and regulations

The fundamental framework for radioactive waste management in Finland comprises:

- Nuclear Energy Act and Decree of (1988)
- Nuclear Liability Act (1989) and Decree
- Decree on the State Nuclear Waste Management Fund (1988)
- Environmental Impact Assessment Act (1994)

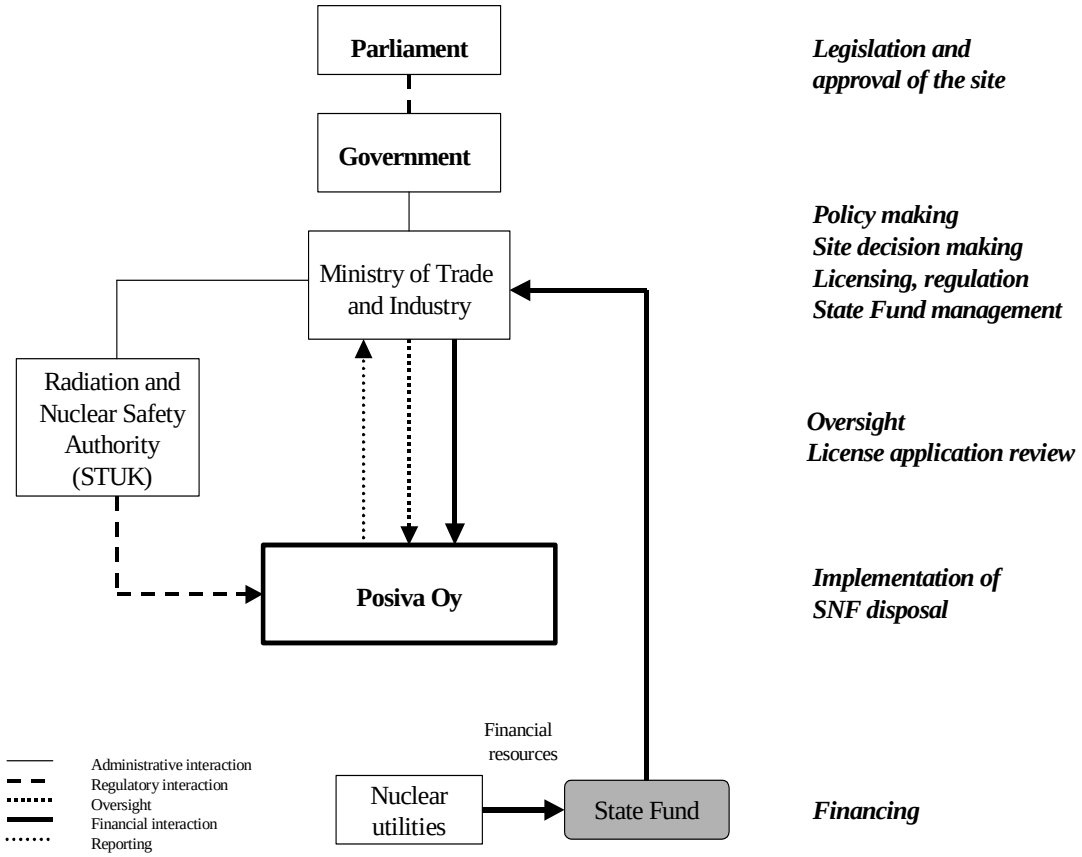


Fig. A-5.1. Organizational structure.

The following general safety regulations, issued by the government, are related to the spent nuclear fuel management:

- General regulations for the safety of nuclear power plants (1991) (also storage of spent nuclear fuel)
- General regulations for the safety of spent fuel disposal (1999)

In addition to the above documents, several safety guidelines were issued by STUK.

A-5.2. Waste streams and proposed repositories

A-5.2.1. Waste stream assumptions

Finland has two nuclear power plants: Loviisa NPP with two WWER type reactors in operation, and Olkiluoto NPP with two BWR type reactors in operation, with a total capacity of about 2.7 GW(e).
Finland is pursuing an open nuclear fuel cycle. About 1134 t HM of SNF have been stored in the country by the end of 2000. Assuming that the lifetime of Finland's nuclear power reactors ranges from 40 to 60 years, the amount of SNF generated by the end of their lifetime would be 2600 to 4000 t HM.

A-5.2.2. Proposed repository

The major characteristics of the proposed Finnish repository are included in an application for "Decision in Principle" from Posiva Oy, which was approved by the Parliament in May 2001. These characteristics are summarized as follows:

Candidate site	Olkiluoto
Capacity	2600–4000 t HM of SNF
Depth	400–700 m
Surface area	0.5–1 km²
Host rock	Granite
Engineered barriers	UO_2 matrix, iron-copper canister, bentonite buffer, backfilling and sealing

No other types of radioactive wastes are expected to be disposed of together with SNF.

A-5.2.3. Management time schedule

The schedule for development of an SNF disposal system in Finland is summarized below. The milestones after 2010 were taken from the government's national policy (issued in 1983).

May 2001	Ratification of the "Decision in Principle" by the Parliament (the Parliament approved the Olkiluoto area in the Eurajoki municipality as the site for a spent nuclear fuel repository.)
2004	Start of construction of an underground rock characterization facility
Early 2010s	Start of construction of a disposal facility
Early 2020s	Start of operation of the SNF disposal facility
2050s	Start of closure of the repository (at the earliest)

A-5.3. Siting of geological repositories

A-5.3.1.Siting process

According to the nuclear energy legislation, Finland's SNF shall be permanently disposed of within the country. The disposal programme was originally established by the government in 1983. The programme was carried out until 1995 by nuclear utilities, and since then by Posiva Oy.

The milestones of the siting process in the past were as follows:

- Site screening completed in 1985 on the basis of geological and scientific information, resulting in selection of about 100 potential areas for site investigations.
- Preliminary site investigations were conducted at five sites in 1987-1992.
- Detailed site investigations were conducted at four sites (three original sites and one additional site) between 1993 and 1999, and the environmental impact assessment was carried out from 1997 to 1999.
- Selection of the Olkiluoto site and its approval in the "Decision in Principle" process occurred between 1999 and 2001. (The Olkiluoto site was proposed in 1999 by Posiva Oy in the application for the "Decision in Principle". This application was approved by the host municipality in January 2000 and by the government in December 2000. The decision of the government was ratified by the Parliament in May 2001.)

Approval of the "Decision in Principle" of the government and its ratification by the Parliament is the first licensing step in the disposal project. Completion of this step confirms the political acceptance of the repository project by the government and Parliament. Subsequently, the construction license will be requested before construction of the facility begins.

A-5.3.2. Development of siting criteria

Different approaches were taken for the development of siting criteria for different stages of the siting process. The implementing organization developed the criteria for the screening process and preliminary investigations. STUK reviewed the results.

Prior to the "Decision in Principle", the general regulations for the safety of spent fuel disposal were proposed by STUK and issued by the government in 1999. The regulations include site suitability criteria, details of which were specified in STUK guidelines. These regulations were reviewed extensively by the expert organizations.

A-5.3.3. General procedures for decision making in each phase or stage

In the siting process before the "Decision in Principle", there were two main milestones (one in 1985 and another in 1992). The screening of potentially suitable sites and the results of the preliminary investigations were reported in 1985 and 1992, respectively. STUK reviewed these results and submitted statements to the Ministry of Trade and Industry that decided to continue the siting project.

The decision on site selection was made by the "Decision in Principle". In the "Decision in Principle" process, the government approved the application of Posiva Oy, based on positive recommendations from STUK and the acceptance the host municipality. Finally, the Parliament ratified the government's decision.

A-5.3.4. Role of local governments

In accordance with the Nuclear Energy Act, acceptance by the host municipality is a prerequisite for the "Decision in Principle".

In 1987, when the first field investigation began, the implementing organization and the candidate municipalities established co-operation groups to exchange information. In the past few years, key issues such as the results of the environmental impact assessment have been raised and discussed extensively by the groups. The initial co-operation group continued its activities since 1987, and new groups were established in 1997.

A-5.3.5. Financial assistance

Although there is no legal obligation for any assistance, the financial assistance can be provided to the local municipality near the site through arrangements negotiated between the municipality and Posiva Oy.

A-5.4. Management costs

A-5.4.1. Total estimate cost and its breakdown

Assuming a lifetime of 40-years for Finland's nuclear power reactors, their operation would generate 2600 t HM of SNF. The total future cost for the management, including disposal of this SNF, and its breakdown, are shown in the following table:

Cost element	Estimated cost (million EURO 2000)
Interim storage of SNF	173
Transportation of SNF	28
Construction of the disposal facility	222
Operation of the disposal facility	521
Decommissioning and sealing of the disposal facility	48
R&D including siting and administration	202
Regulatory/institutional control	44
Real estate taxes	49
Total	**1287**

The personnel costs of the Regulatory Authority are included in the amount specified under "Regulatory/institutional control".

A-5.4.2. Organization responsible for cost estimation

Waste generators (i.e. operators of the nuclear power plants) are responsible for estimating the cost of management of SNF. They have delegated this task to Posiva Oy. The cost estimate is reviewed and approved by the Ministry of Trade and Industry, with assistance from STUK and the Technical Research Centre of Finland.

A-5.5. Financing system

A-5.5.1. Overview of the financing system

The State Nuclear Waste Management Fund was established in 1988 by the Nuclear Energy Act to secure financial resources for management and disposal of SNF (e.g. storage, transportation and disposal of SNF, decommissioning of the facilities, R&D). The fund was established external to the electric utilities' financial management systems.

The overall structure of the financial management system is summarized in Fig. A-5.2.

The future cost of management of existing wastes (i.e. assessed liability) is calculated annually by the nuclear power companies and Posiva Oy, and the calculations are proposed to the Ministry of Trade and Industry. Then, the Ministry confirms the assessed liability and the amount of money that each individual waste generator must have in the Fund to cover the share of the liability. The Fund then confirms the fee of each license-holder. The amount determined (the fee) must be paid to the Fund by the end of the following March.

The waste generators pay the difference between the Fund target and the amount existing in the Fund, as radioactive waste management contributions (the fee, see above). If an outstanding liability exists (i.e. the liability due to future costs not covered by the contributions paid into the Fund), the licensee must furnish securities as a precaution against insolvency. If the payments made by waste generators to the Fund are in excess of the target, the excess is to be returned to the waste generators.

The Fund is managed by the Ministry of Trade and Industry. The waste generators can borrow 75% of their respective Fund share against full securities. The State has priority in borrowing the remaining 25%. The interest rate for these loans at present is Euribor 360–0.15% points. If the waste generators or the State do not borrow their share, or leave a part of it, then the remaining financial resources are invested in a secure manner.

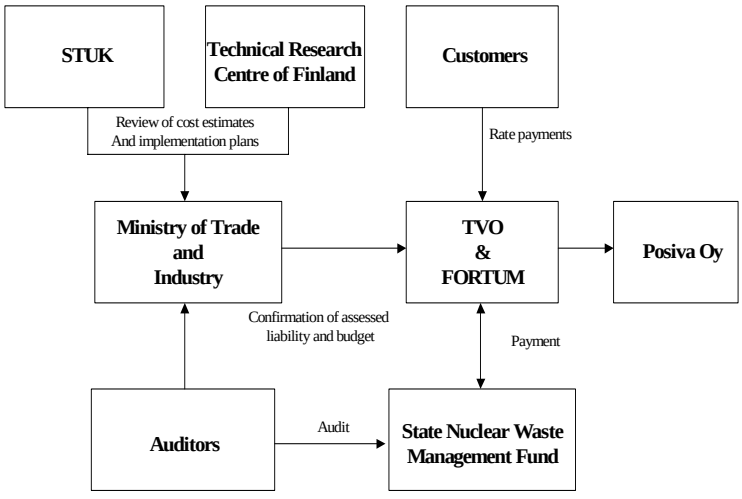


Fig. A-5.2. Financing system.

A-5.5.2. Waste management fee

The annual contributions to the Fund are not based on a fee per kW•h. However, roughly the cost for radioactive waste management, including decommissioning, is calculated to be about 0.014 FIM/kW•h (0.0023 EURO/kW•h), which would be equivalent to approximately 10% of the total power production cost.

A-5.5.3. Withdrawal

Financial resources in the Fund are not directly withdrawn by the implementing organization. When certain waste management activities are carried out, the assessed liability decreases correspondingly and the excess funds are refunded to the waste generators.

A-5.5.4. Auditing the Financing System

The cost estimate and a management plan are reviewed and approved by the Ministry of Trade and Industry. The Ministry requests STUK to review safety aspects of the plan, and requests the Technical Research Centre of Finland to review the appropriateness of the cost estimate.

The Fund is audited annually by independent accountants appointed by the Ministry.

A-5.5.5. Revenue and Expenditure of Financial Resources

The estimated cost of future management of the waste existing at the end of 2001 is about 1.2 billion EURO.

A-5.6. Public involvement and transparency

Local municipalities and landowners played an important role in selection of the areas for preliminary site investigation, as well as in reviewing the results of geological investigations. The public in the concerned municipalities were openly informed of the results of the investigations. The co-operation groups, composed of the municipalities and the implementing organization, considered it important to let as many as municipal residents as possible participate in and be involved in the discussions of issues concerning investigation activities. To encourage participation of the residents, the public was extensively informed of the opportunities for debates. Also information was provided regarding the ongoing dialogues and discussions in each municipality where a candidate site would be located.

Public involvement was also facilitated through public review of the Environmental Impact Assessments (EIA) carried out between 1997 and 1999 for the four municipalities, along with the detailed site investigations.

As required by the legislation, the Ministry of Trade and Industry organized public hearings in the process of developing both the EIA and the “Decision in Principle”. Any member of the public was admitted to express his or her opinions in both oral and written forms.

In the past, the following methods have also been used by Posiva Oy to interact with the public:

- Newsletters on environmental impact assessment (EIA) were distributed to each household in the candidate municipalities. Explanatory material was made available at Posiva’s local offices.
- Public events and small group meetings were organized.
- Exhibitions were organized to describe the site investigations and present the results of the environmental impact assessment, including opportunities for the public to provide comments and make their opinions known.
- Interviews with citizens and discussions in newspapers were organized.

STUK has also conducted long term interactions with inhabitants and representatives of the municipalities by visiting them, organizing seminars and meetings, and disseminating materials.

As a result, the municipal council of Eurajoki, where the Olkiluoto site is located, approved the siting proposal with clear majority.

A-5.7. Other considerations

A-5.7.1. Nuclear liability

The Nuclear Liability Act stipulates that an implementing organization has the primary responsibility, with a maximum indemnification amount of 252 million EURO. Finland has supported the plan to change the international agreement system that would increase the amount of indemnification to 700 million EURO.

Liability terminates only when radioactive waste has been disposed of in an acceptable manner. Then, it is planned that the State will take over the implementing body's responsibility.

A-5.7.2. Retrievability and institutional controls

The general safety regulations state that disposal of SNF shall be planned so that no monitoring of the site is required to ensure long term safety, and that retrievability of the waste canisters must be maintained so that technology developed in the future can be applied to disposal of the wastes. The Nuclear Energy Act also requires that the disposal site shall be registered as a "No admission" area in the land registration system.

The necessity of other institutional controls in the post-closure phase has not been concluded yet.

A-5.7.3. Records keeping

The Record Management System will be discussed in the future in reference to the existing system for the LILW repositories, in which the implementing organization and the regulator are responsible for keeping records for a repository and disposed wastes. Electronic means and paper documents are, at present, used as the media for records. No time limit has been defined for retention of the records. The records are available to the public upon request.

A-6. FRANCE

A-6.1. Organization and legislation

A-6.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.
- Will debate the HLLLW[7] policy in 2006.

Government

Ministry of Industry
Ministry of the Environment
Ministry of Research
Ministry of Health

- Establish policies.
- Grant licenses.

REGULATION/OVERSIGHT

Regulatory Authority

General Directorate for Radiation Protection and Nuclear Safety

- Is responsible for nuclear safety and radiation protection regulation.

Oversight/Advisory Body

National Evaluation Commission (CNE)

- Reviews HLLLW R&D programme and provides advice to the Parliament and the government.

IMPLEMENTATION

Implementing Organization

National Radioactive Waste Management Agency (ANDRA)

- Is in charge of long term management of all radioactive waste in France.

Financial Resources Management

- Financial resources are maintained in reserve by waste generators.
- Resources are provided to ANDRA according to a 5-year plan.

The interactions between the governmental and other organizations involved in the HLW and/or SNF long term management in France are shown in Fig. A-6.1.

A-6.1.2. Implementing organization

ANDRA was initially established in 1979 and was reorganized by the Law of 30 December 1991 as an industrial and commercial public establishment responsible for long term management of radioactive waste in France. ANDRA conducts the following activities:

- Assists, especially in co-operation with the Atomic Energy Commission (CEA), in defining and conducting the research and development programme on long term radioactive waste management;

[7] HLLLW: High level long lived radioactive waste.

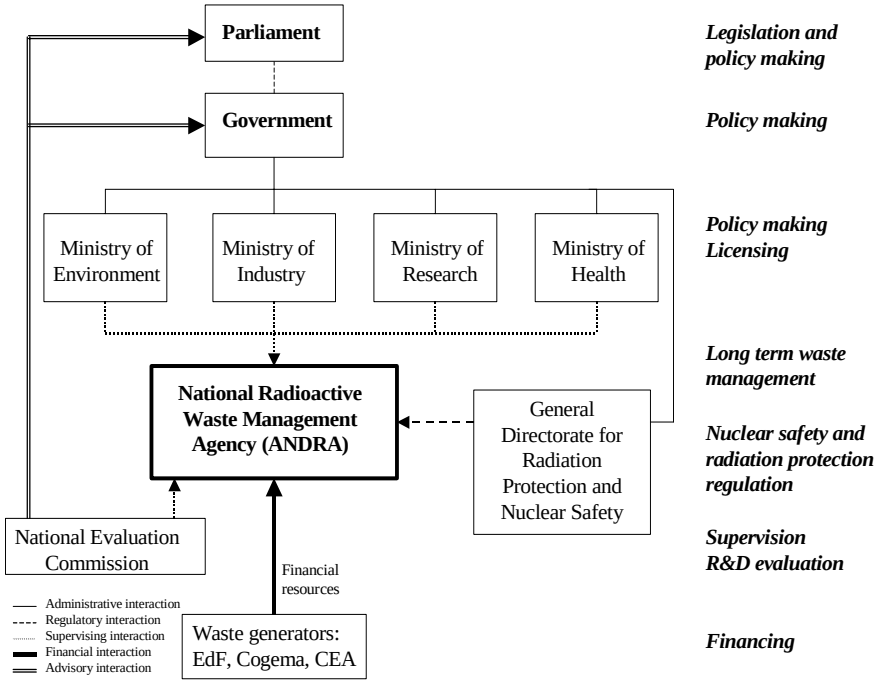


Fig. A-6.1. Organizational structure.

- Manages disposal facilities, either directly or through a third party acting on its behalf;
- Designs, sites and constructs new disposal facilities, taking into consideration the long term radioactive waste generation forecast and management plans. Carries out studies necessary to accomplish this function, in particular construction and operation of underground research laboratories to study deep geological formations;
- Prepares specifications regarding radioactive waste conditioning, storage and disposal, in compliance with safety regulations;
- Maintains an inventory of all radioactive waste in France.

The National Evaluation Commission (CNE), created by the Law of 30 December 1991, is composed of 12 scientists appointed by the Parliament and the government. CNE reviews the results of the HLLLW R&D programmes annually and reports the results to the Parliament and the government.

A-6.1.3. Laws and regulations

Law No.91-1381 of 30 December of 1991 (the "Waste Act") establishes the legal framework for management of radioactive waste, including a framework specifically for management of HLLLW. The "Waste Act" calls for studies to be conducted over a period of fifteen years in the three following research areas:

- *Partitioning and transmutation of long lived radionuclides in the waste*. This research area focuses on reducing the toxicity and/or half-life of certain radionuclides contained in the waste through fission or capture by exposing them to a particle flux, in either a breeder reactor or an accelerator, or some other hybrid system. The so-called transmutation can only be applied to some radionuclides, and not to the waste. As a result, a preliminary chemical or physical step of partitioning is also needed. CEA is responsible for exploration of this option;
- *Evaluation of options for retrievable or non-retrievable disposal in deep geological formations*, particularly through the creation of underground laboratories. This research area, managed by ANDRA, involves studies in a deep geological laboratory, including testing performed according to the requirements of the Waste Act, as described in the next section;

4 *Study of conditioning processes and long term surface storage techniques for the waste*. This consists of studying waste packaging and waste storage options. Included in the packaging are processes to be developed to stabilize or immobilize the radionuclides, often with the new inorganic matrix. This option is being studied by the CEA.

The three research areas complement one another and are scheduled to be completed in time to support the 15-year rendezvous specified by the "Waste Act". During the period over which these studies will be underway, the National Evaluation Commission, also set up by the "Waste Act" and composed of 12 eminent scientists designated by the Parliament, Senate and the government (including at least 2 international experts), will prepare an annual status report, based on technical reports from the various entities involved in the research and the results of public hearings.

Based on Law No. 91-1381, several decrees have been issued, as listed below:

4 Decree No. 92-1366 of 29 December 1992, which specifies requirements applicable to public interest groups to which assistance is provided,
4 Decree No. 92-1391 of 30 December 1992 on ANDRA,
4 Decree No. 93-940 of 16 July 1993, which deals with construction and operation of underground research laboratories,
4 Decree No. 99-686 of 3 August 1999, which establishes a local information and monitoring committee at the site of any URL,
4 Decree No. 99-687 of 3 August 1999, which establishes a commission on selection of the site for a URL in a granite formation.

A-6.2. Waste streams and proposed repositories

A-6.2.1. Waste streams and SNF assumptions

France has 58 PWR type nuclear power reactors and one FBR in operation, with a total capacity of about 63.1 GW(e). France also has 11 shutdown NPPs. The amount of waste and SNF generated and to be generated by the present nuclear power plants and other nuclear fuel cycle installations is:

4 Between 1 and 2 million m^3 of very low level waste (dismantling waste),
4 1 300 000 m^3 of low and intermediate level short lived waste (including 625 000 m^3 already disposed of),
4 14 000 m^3 of intermediate level long lived graphite waste,
4 56 000 m^3 of intermediate level long lived waste,
4 3500 m^3 of high level long lived waste (glass),
4 15 000 t HM of spent nuclear fuel.

SNF is not considered waste in France and it will be reprocessed.

A-6.2.2. Proposed concepts

Based on the results of studies to be completed by 2006, the Parliament will discuss and decide on the national policy for management of high level long lived radioactive waste. This decision could include the deep geological disposal option.

A-6.2.3. Management time schedule

The law of December 1991 established a 15 year R&D programme concerning three primary options for management of France's HLLLW. Based on the results of these studies, due to be provided in 2006, the Parliament will discuss and decide on the national policy for management of HLLLW. This decision could include specification of the time schedule for HLLLW disposal, if the disposal option is considered.

A-6.3. Siting of geological repositories

A-6.3.1. Siting process

In 1987, ANDRA initiated activities to site a geologic repository and developed plans for four sites (granite, clay, salt, and shale sites). However, there was a substantial protest in 1990 from the public, including certain organizations and politicians. The situation was so serious that the Prime Minister announced a moratorium. A commission of the Parliament concluded in 1990 that another solution should be sought. The necessity for a new approach was stressed and two new directions were indicated, as follows:

- Research activities on options for disposal of radioactive waste should be initiated, including geological disposal and other alternatives, and
- A decision making process should be developed, to involve both the public and elected officials.

The Law of 30 December 1991 called for studies to be conducted over a 15-year period in the following three research areas:

- Partitioning and transmutation of long lived radionuclides in the waste,
- Evaluation (particularly through URLs) of disposal options in deep geological formations, with and without retrievability,
- Conditioning processes and long term surface storage technologies for radioactive waste.

Based on the results of the studies and research in URLs to be provided in 2006 (as mentioned above), the Parliament will discuss and decide on the national policy for management of high-level long lived radioactive waste, possibly including establishment of a siting process.

A mediator was designated by the government in 1992 to identify communities wishing to volunteer to host a URL. The mediator's consultation resulted in identification of 10 suitable candidate sites. In 1993, the mediator suggested four departments as potential locations for one or more URLs: Gard in southern France (clay), Meuse and Haute-Marne in Eastern France (both also clay) and Vienne in western France (granite).

After drilling tests in 1994, ANDRA concluded in 1995 that the Haute-Marne and Meuse departments should be considered as one site due to geological similarity. In 1996, ANDRA confirmed the geological characteristics of the sites under consideration and then applied to the government for authorization to construct and operate URLs in three areas: Gard, Meuse/Haute-Marne and Vienne.

In 1998, the government approved construction of one URL in a clay formation in Eastern France. The research programmes at Vienne and Gard were cancelled. In 2000, ANDRA was granted a license to construct and operate a URL in the clay formations at Bure. The government established at the same time a mission to screen possible granite sites for construction of the second URL. These missions failed and, up to now, the site selection process for the second URL has been terminated.

The main stages of the R&D programme at Bure URL will be as follows:

2000–2001	Modelling of the repository and preparation of the first safety assessment "Dossier argile 2001".
2002–	International peer review by the end of 2002.
2002–2004	Model fitting and preparation of the second safety assessment.
2005	Safety assessment, based on use of all data collected.

Concerning R&D in a URL in a granite formation, the major scientific questions planned to be addressed over the next few years (e.g. fracturing, hydrogeology and thermo mechanical behaviour) pertain to definition of the most appropriate repository design and waste form(s) to be used.

Evaluation of these issues will be conducted in foreign laboratories established for developing a methodology. The results will be incorporated into a first assessment report in 2003.

A-6.3.2. Development of siting criteria

The regulatory authority issued a basic safety rule "Determination of goals to be sought in the design and construction phases of radioactive waste repositories in deep geological formations for ensuring technical safety after operation of a repository", in June 1991. This document will be used in the future as the basis for establishment of repository siting criteria.

A-6.3.3. General procedures for decision making in each phase or stage

As discussed in Section A-6.3.1, an overall report on three areas of research will be prepared in 2006. This report may include a proposed location for a repository, based on the results of the research. On this basis, the Parliament will discuss and establish a national policy on management of HLLLW.

The public is involved in the decision making process as discussed in Section A-6.6.

A-6.3.4. Role of local governments

During examination of the application for construction and operation of a URL, Heads (Préfets) of the departments concerned were requested to organize public enquiries in order to allow members of the general public to be informed and to make comments.

Communities near the proposed URL were also involved. They expressed their opinions by voting: 85% of the citizens of communities within 10 km of the URL voted in favour of continuing the research activities, and 84% of the citizens of communities who would be directly affected by the URLs voted in favour.

A-6.3.5. Financial assistance

Every potential site or region for studies from the surface receives 760 000 EURO during the preliminary phase. In addition, the region and the department in which a URL has been sited will receive 9 million EURO every year, up to 2006. The purpose of this financial assistance is to provide support for regional development projects.

A-6.4. Management cost

Since the policy on management of the back-end of the nuclear fuel cycle has not been established, an official cost estimation is not available.

A-6.5. Financing system

A-6.5.1. Overview of the financing system

The waste generators are responsible for financing the expenses of the ANDRA's nuclear waste management programme. EdF (the French electricity company), Cogema (the French fuel cycle company) and CEA (the French Atomic Energy Commission) are required to build up reserves to pay the present and future costs of waste management.

A-6.5.3. Withdrawal

There are various kinds of contracts between ANDRA and waste generators, including pre-financing contracts enabling ANDRA to conduct R&D and to cover future expenses relating to establishment and operation of URLs and disposal. Withdrawal is made in accordance with the provisions of these contracts.

A-6.5.4. Auditing the financing system

ANDRA is subject to economic and financial control by the Government. A government auditor performs periodic audits.

A-6.6. Public involvement and transparency

During the deliberations conducted by Parliament in 1990 (see Section A-6.3.1), a new platform was issued: *responsibility, transparency, and democracy*. The Law of 30 December 1991 states that elected representatives and members of the public must be kept informed of the activities involved in establishing and conducting research in URLs. The decrees of 3 August 1999:

- Require establishment of an information and monitoring committee, consisting of elected representatives; representatives of the government, environmental groups and unions; representatives of other associations and an administrator of the URL (responsible for providing information to the public near the URL). The committees can organize public hearings;
- Authorize construction and operation of the URL in clay, and
- Appoint a consultation commission for the selection of potential areas for implementation of a second URL (in granite).

During examination of applications for construction and operation of URLs, public consultation through a public inquiry was organized in 1997 in accordance with the Laws of 30 December 1991 and of 12 July 1983.

A-6.7. Other considerations

A-6.7.1. Nuclear liability

Third party liability is subject to the 1960 Paris Convention, as well as the 1963 Brussels Supplementary Convention. Third party liability applies to the operator of a nuclear installation. The liability of the land-based operator is limited to a maximum of 91 million EURO. Any compensation above this limit would be paid by the state from public funds, within the limits specified by the Brussels Convention.

A-6.7.2. Retrievability and institutional controls

Retrievability is a key factor and was one of the most substantial issues raised during the preparation and vote on the 1991 law. More detailed specifications for long term activities are being studied, based on the Law of 30 December 1991.

A-6.7.3. Records keeping

ANDRA is currently required to maintain an inventory of all radioactive wastes in the country. A records keeping system for use after operation of a geological repository will be studied and decided on in the future. Such a system is already in operation for management of data concerning low and intermediate level and short lived radioactive waste disposed of at the Manche and Aube centres.

A-7. GERMANY

A-7.1. Organization and legislation

A-7.1.1. Organizational structure

POLICY/LEGISLATION

Parliament (Bundestag)

- Enacts laws.

Government

Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU)

- Establishes policies.
- Requests budget to implement the programme.

REGULATION/OVERSIGHT

Regulatory Authorities

Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU)

- Establishes safety requirements.

Federal States *(delegated)*

- Are responsible for granting a construction license.

Oversight Body

Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) *(Independent Unit)*

- Oversees all licensing and implementation activities.

IMPLEMENTATION

Implementing Organizations

Federal Office of Radiation Protection (BfS) of BMU

- Is responsible for implementation of HLW and SNF disposal.

German Company for Construction and Operation of Waste Repositories (DBE) *(delegated)*

- Implements HLW and SNF disposal.

Financial Resources Management

- Nuclear facilities operators are responsible for maintaining financial resources.

The interactions between the government and different organizations involved in the HLW and/or SNF long term management in Germany are shown in Fig. A-7.1.

A-7.1.2. Implementing organization

According to the Atomic Energy Act, the Federal Government is responsible for establishing a repository for radioactive waste. The responsibility for construction and operation of the repository was delegated by law to the Federal Office of Radiation Protection (BfS), a subordinated body within the Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU). As a result, BfS is the licensee for the repository. The license must be obtained from the Federal state in which the repository is located. BfS is assisted by a private company (the German Company for the Construction and Operation of Waste Repositories [DBE]), which will construct and operate the repository on behalf of BfS.

An independent unit within BfS oversees the activities of the BfS implementing unit.

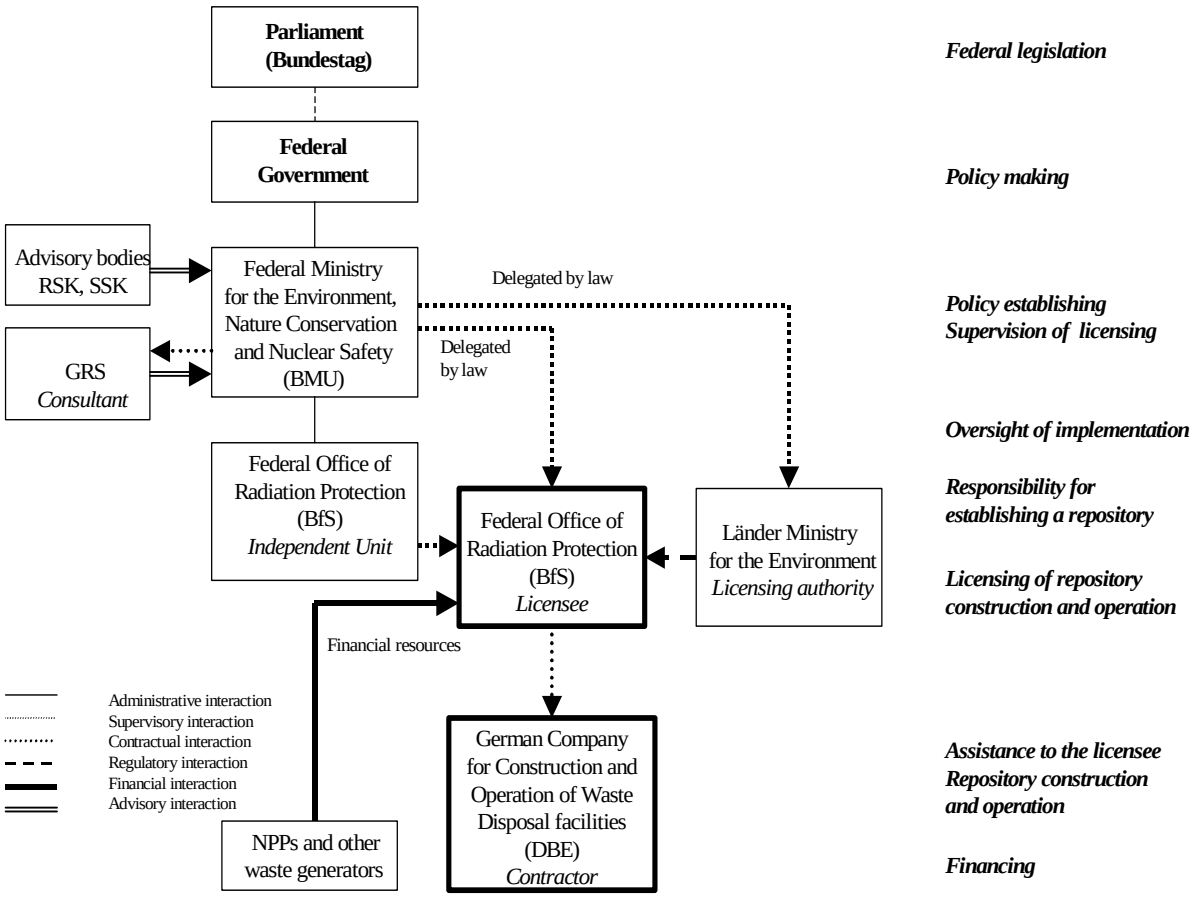


Fig. A-7.1. Organizational structure.

A-7.1.3. Laws and regulations

Since the early sixties, i.e. from the very beginning of use of nuclear energy, the German radioactive waste disposal policy has been based on the decision that all types of radioactive waste are to be disposed of in deep geological formations. Near surface disposal was not practiced in Germany because of the high population density and climatic conditions.

The disposal of radioactive waste in a final repository is governed by the following laws and regulations:

- Atomic Energy Act (1959), last amended by the act of 5 March 2001;
- Precautionary Radiation Protection Act (1986), last amended by the act of 24 June 1994;
- Radiation Protection Ordinance as promulgated on June 30, 1989, last amendment of 18 August 1997;
- Federal Mining Act;
- Safety Criteria for the Disposal of Radioactive Waste in a Mine;
- Act of the Assessment of Environmental Impacts (1990), last amended by the act of 18 August 1997.

The protection objective of disposal of radioactive waste in a repository is laid down in the Atomic Energy Act and the Radiation Protection Ordinance. The Federal Mining Act regulated all aspects concerning the operation of a disposal mine. The Safety Criteria specify the measures to be taken in order to achieve that this objective has been reached. In addition, environmental legislation must be taken into account; in particular an environmental impact assessment has to be performed. The requirements in the Atomic Energy Act applicable to payment for waste disposal of the wastes are

supplemented by the “Ordinance on Advance Payments for Final Disposal (1982)” last amended by the act of 25 September 1990.

As a result of the Federal Government’s decision in 2000 to abandon nuclear energy, and related modification of the waste management policy, necessary amendments of the legislative basis are expected.

A-7.2. Waste streams and proposed repositories

A-7.2.1. Waste stream assumptions

Germany has 19 light water nuclear power reactors in operation with a capacity of about 21 GW(e) and 18 shutdown nuclear power reactors.

According to the "Agreement between the Federal Government and the Utilities dated 14 June 2000", which was signed by the Federal Government and four main utilities, the remaining amount of electricity to be produced by the 19 operating nuclear reactors is limited to a total of 2623.3 TW•h. This means that the remaining lifetime of the nuclear reactors is about thirty two years from 1 January 2000, on average. This agreement also specifies that spent nuclear fuel generated after 1 July 2005 will be directly disposed of.

The latest estimate of the amount of radioactive waste that will have been generated in Germany through 2080 includes the following two separate inventories:

- 22 000 m³ of HLW (this volume includes the overpacks), and
- 9000 t HM of SNF (this SNF will all have been generated by 2020).

At the present time, Germany has not decided which parts of the above inventories will be kept in storage and which will be disposed of.

A-7.2.2. Proposed repositories

Work had been underway in Germany to investigate the salt dome at Gorleben as the site for a geological repository. However, in 2000, the Federal Government made an agreement with the nuclear utilities under which exploration of the salt dome at Gorleben would be interrupted for at least three to at most ten years, to clarify the concept of its proposed use as a repository and related safety questions. Also the Federal Government initiated an activity to amend the Atomic Energy Act and to develop a new plan for radioactive waste management so that a single repository will be commissioned around 2030 for all types of radioactive wastes. It is likely to take a few years before these changes are completed.

A-7.2.3. Management time schedule

The Federal Government has a policy to begin operation of a geological repository around 2030. A detailed time schedule is being discussed by the “Committee on Siting Procedure for a Repository” (Akend). The Federal Ministry of Environment has the legal responsibility for developing the time schedule.

A-7.3. Siting of geological repositories

A-7.3.1. Siting process

In 1999, the Federal Government issued a new initiative for radioactive waste management, and the Federal Minister of Environment organized “The Committee on the Siting Procedures for a Repository” (Committee). The Committee released a draft conclusion in September 2000, in which the time schedule for site selection was presented as follows:

- First phase (until 2002) – A siting process and site selection criteria will be developed by the Committee. External experts and public will be involved in the discussion;
- Second phase (until 2004) – Legal and political approval of the siting process will be completed;
- Third phase (after 2004) – Site selection activities will begin.

The draft also proposes a stepwise siting process composed of 7 steps as specified below:

- Step 1: Eliminate areas with potentially negative geological conditions,
- Step 2: Identify areas with potentially positive geological conditions,
- Step 3: Eliminate areas with unfavourable societal conditions,
- Step 4: Narrow down to regions where favourable geological conditions can be anticipated,
- Step 5: Narrow down to sites where public acceptance can be achieved for further investigation,
- Step 6: Conduct site investigations without mining activities,
- Step 7: Evaluate candidate sites.

Information on the siting process is to be made available to the public from the very beginning of the process. Public involvement in step 5 is being considered.

The role of underground research laboratories will be considered based on the results gained during the siting process. The Committee recommended that relevant research should be intensified in the international underground research laboratories to improve knowledge about various host formations and characterization.

A-7.3.2. Development of siting criteria

The Committee proposes the following basic requirements in the draft conclusion, which will be developed as practical within the time schedule presented by the Committee:

- No or minimum groundwater movement,
- Favourable hydro-chemical conditions,
- Minimum probability of the formation of a water path through the repository,
- Favourable conditions regarding gas production,
- Favourable rock formation,
- Good long term rock stability,
- Good resistance of rock to stress induced by temperature changes,
- Minimum probability of mining activities.

Based on these preparatory activities, the siting criteria will be finalized and issued by the Federal Ministry of Environment.

A-7.3.3. General procedures for decision making in each phase or stage

General procedures for decision making will be developed within the time schedule presented by the Committee.

A-7.3.4. Role of local governments

Local government and the public will be deeply involved in decision making. Details regarding how to conduct these activities are under consideration.

A-7.3.5. Financial assistance

There is currently no legal requirement for financial assistance to be provided to local communities. However, the establishment of such a requirement may be discussed by the Committee in the future.

A-7.4. Management costs

A-7.4.1 Total estimated cost and its breakdown

As a result of the Federal Government's decision in 2000 to abandon nuclear energy, and modification of the waste management policy (i.e. pursuing the concept of a single repository for all kinds of radioactive waste), the cost estimate carried out in 1997 based on the Gorleben project (in which a geological repository was pursued for high level waste and spent nuclear fuel and the total cost was estimated 4650 million EURO at the end of 1997) is no longer valid. Therefore there is no valid cost estimate available at this time for radioactive waste disposal in Germany.

A-7.4.2. Organization responsible for cost estimation

A new basis for a new cost estimate is currently being prepared by the Federal Office of Radiation Protection, which is legally responsible for the cost estimation of waste disposal.

A-7.5. Financing system

A-7.5.1. Overview of the financing system

The Atomic Energy Act rules out that the generators of radioactive waste are responsible for waste management, including providing the funds to pay for waste disposal ("polluter pays"). The generators must also bear the cost of exploration for repositories, according to the "Ordinance on Advance Payments for Final Repository (1982)".

The ***nuclear utilities*** have built up reserves to pay the future costs of waste disposal and decommissioning. The reserves held by the nuclear utilities are audited by each utility.

On the other hand, there are special arrangements for ***small generators*** of radioactive wastes. They are required to transport their wastes to storage depots operated by the Federal States and must pay a fee dependent on the amounts of the delivered waste. This fee has been established to cover all of the waste management costs (e.g. storage, final disposal). After payment of the fee, small generators bear no further financial responsibility, any further costs will be overreached by the Federation.

Responsibility for paying the costs of radioactive waste disposal will be shared among the various waste generators as follows:

93% – Operators of NPPs [formerly, 75.5% – operator of a spent fuel reprocessing plant[8] and 17.5% – operators of nuclear power plants producing more than 200 MW(e)],
4% – Operator of the Karlsruhe pilot reprocessing plant,
3% – Small generators.

The Federal Government has accepted responsibility for the future costs of closure and decommissioning of the Morsleben repository located in the East Germany.

A-7.5.2. Waste management fee

As a result of the Federal Government's decision in 2000 to abandon nuclear energy, and modification of the waste management policy (i.e. pursuing the concept of a single repository for all kinds of radioactive waste), the cost estimates carried out in 1997 based on the Gorleben and Konrad projects are no longer valid. A new cost estimate will be prepared in the future based on a new policy. Consequently, there is no basis for calculation of the fee at the present time.

[8] Since construction of a reprocessing plant in the country has been abandoned, the costs that had previously been allocated to an operator of the reprocessing plant are now allocated to the operators of nuclear power plants. Consequently the NPP operators now pay 93% of the advance payments. This apportionment is currently a matter of dispute in the Court.

A-7.5.3. Withdrawal

The annual expenditures for exploration for disposal sites are budgeted and financed by the Federal Government. The amount budgeted is then charged to the waste producers in the following year.

A-7.5.4. Auditing the financing system

The Federal Audit Office audits all of the federal activities financed by national budget (i.e. exploration activities at Konrad and Gorleben). The reserves held by the nuclear utilities are audited regularly by each utility.

A-7.5.5. Revenue and expenditure of financial resources

The reserves held by the nuclear utilities amount to around 25–30 billion EURO at present. The expenditures for the repository projects at Konrad and Goreleben have amounted to about 2 billion EURO, 95% of which has been financed by the waste producers.

A-7.6. Public involvement and transparency

The Committee on the Siting Procedures for a Repository concluded that the following elements should be fully taken into account: transparency, accountability, credibility, competence, fairness, practicability, and efficiency.

The site selection process will be conducted in three phases (as mentioned in Section A-7.3.1 above). The public involvement process will be different for each of these phases, as discussed below:

- In the first phase, the siting process and site selection criteria will be developed by the Committee, including consideration of recommendations made by external specialists and experts. The records of these discussions will be provided to the public.
- In the second phase, activities such as dialogues with stakeholders will be conducted with the intent of gaining public acceptance of the siting process (as proposed by the Committee during the first phase), thus allowing the siting process to be formally established through legislation.
- In the third phase, representatives of communities will be involved in the actual site selection process.

The Federal Government may provide financial assistance to local communities to support their participation in these activities. A cost benefit analysis has not yet been carried out.

A-7.7. Other considerations

A-7.7.1. Nuclear liability

The Atomic Energy Act specifies that the Federal Government is liable for any damage arising from radioactive waste disposal activities.

A-7.7.2. Retrievability and institutional controls

The requirements for final disposal of radioactive waste specify that such disposal shall be maintenance-free, safe and that it will result in definitive elimination of the radioactive waste with no intention that it be retrievable. As a result, there are no regulations concerning retrievability of radioactive waste from a repository in Germany.

However, in line with recent international developments, retrievability of radioactive waste that has been disposed of in a deep geological formation is now under review by the Federal Government.

A monitoring system will be installed to ensure that the requirements are met for radiation protection and safeguards, and the safety of all activities during the repository's operational phase. Monitoring after closure of the repository is under discussion.

A-7.7.3. Records keeping

Germany plans to establish a comprehensive and continuous documentation system during construction, operation and closure of the repository. A set of data on the repository, including waste quantity and types, and relevant technical information is to be included. All files will be stored in safe places by the licensee and the supervisory authority, as well as by the Board of Mines. An announcement on the records will be made every year during the closure phase. The contents and location of the records are to be regulated and described in the final operation plan.

A-8. HUNGARY

A-8.1. Organization and legislation

A-8.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.
- Issues preliminary approval of nuclear projects.
- Approves fees.

Government

- Establishes policies and strategies for radioactive waste management.

REGULATION/OVERSIGHT

Regulatory Authorities

Hungarian Atomic Energy Authority (HAEA)/Nuclear Safety Directorate (NSD)

- Is responsible for regulation and licensing of SNF storage and disposal

Public Health and Medical Officers Service *(on behalf of the Minister of Health, Social and Family Affairs)*

- Is responsible for regulation and licensing of HLW SNF disposal.

Oversight Bodies

Minister supervising HAEA *(at present the Minister of Economy and Transport)*

- Supervises HAEA activities.

Hungarian Geological Survey

- Approves the PURAM's geological research plan and final reports.

Advisory Bodies

Scientific Advisory Board

- Provides scientific oversight of PURAM activities.

Special Committee of the Hungarian Atomic Energy Commission

- Comments on and recommends policies and strategies for waste management and fund management.

IMPLEMENTATION

Implementing Organization

Public Agency for Radioactive Waste Management (PURAM)

- Is responsible for implementation of SNF storage and disposal.
- Is responsible for preparation of HLW disposal.
- Is responsible for preparation of waste management cost estimates.

Financial Resources Management Body

Minister supervising HAEA *(at present the Minister of Economy and Transport)*

- Is responsible for supervision of HAEA in respect of the fund management.

The interactions between the government and different organizations involved in the long term management of SNF and/or HLW in Hungary are shown in Fig. A-8.1.

A-8.1.2. Implementing organization

The Act on Atomic Energy of 1996 states that radioactive waste management and decommissioning of nuclear facilities shall be performed by an organization designated by the government. Accordingly, the Public Agency for Radioactive Waste Management (PURAM) was established in 1998 as a state-owned, non-profit organization for the above purpose.

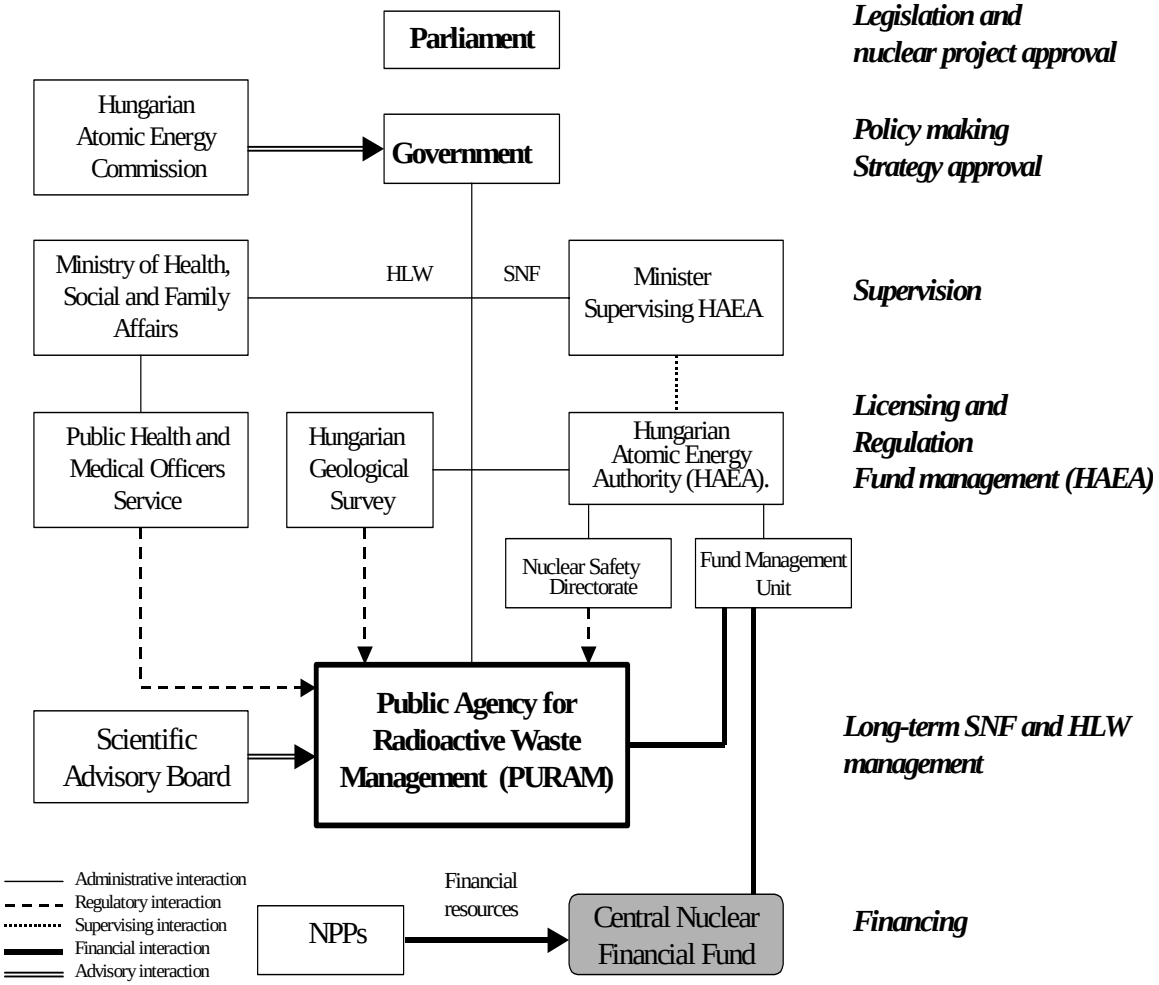


Fig. A-8.1. Organizational structure.

PURAM conducts the following activities:

- Planning and reporting:
  - 4 Developing and promoting research and investment plans,
  - 4 Calculating waste management costs used to determine fees to be paid to the Fund,
  - 4 Preparing technical and financial reports,
  - 4 Developing decommissioning strategies and plans.
- Research, development and implementation:
  - 4 Siting, construction, and licensing of a low and intermediate level waste (L/ILW) repository,
  - 4 Extension of the storage facility for SNF,
  - 4 Preparation for HLW disposal,
  - 4 Operation of L/ILW repositories, the storage facility for SNF, and a HLW repository.
- Others:
  - 4 Collection and transportation of radioactive waste,
  - 4 Communication and internal co-operation.

A Scientific Advisory Board was established by PURAM to oversee scientific aspects of their activities.

The regulatory authority for nuclear facilities is Hungarian Atomic Energy Authority (HAEA). Within HAEA the Nuclear Safety Directorate is the competent organ, while another part of HAEA is dealing with the management of the Central Nuclear Financial Fund. Interim storage and direct disposal of

SNF is licensed by HAEA. However, if no significant amount of fissile material is present, according to the Hungarian legislation this facility is not a "nuclear" facility. Therefore, the disposal of HLW from reprocessing is regulated and licensed by the Public Health and Medical Officers Service (on behalf of the Minister of Health, Social and Family Affairs.

The Hungarian Geological Survey approves the PURAM's geologic research plan and final reports. Other special authorities have also licensing responsibilities in the field of environmental protection, public order, emergency preparedness, transport, etc.

A-8.1.3. Laws and regulations

The legal framework for radioactive waste management was provided in the Atomic Energy Act of 1996, along with requirements for other nuclear activities.

The following decree and orders have been issued to establish an implementing organization and financing system:

- Government Decree No. 240/1997 (XII.18.) Korm. (Establishment of the implementing organization),
- The Order of the Minister of Industry, Trade and Tourism No. 67/1997 (XII.18.) (Establishment of the financing system),
- The Order of the Minister of Industry, Trade and Tourism No. 62/1997 (XI.26.) (Setting up the siting requirements).

A-8.2. Waste streams and proposed repositories

A-8.2.1. Waste stream assumptions

There are four WWER type nuclear power reactors in operation in Hungary with a capacity of approximately 1.8 GW(e). These reactors generate about 400 SNF assemblies annually, weighing approximately 46.5 t HM on average. The nuclear reactors are continuously increasing the fuel burn up that leads to decreasing the quantities of SNF generated each year in the future.

Between 1989 and 1998, 2331 SNF assemblies were shipped back to Russia. Shipments to Russia have become more and more difficult and expensive since the beginning of the 90s. As a result, a modular-type storage facility had been constructed and was commissioned in Hungary in 1997. The facility will have a capacity to store 11 100 assemblies, approximately 1320 t HM. This is enough to store the current inventory of SNF assemblies, as well as those to be generated at the four nuclear power reactors from now to the end of their 30-year operating lifetime.

A-8.2.2. Proposed repositories

Based on the present SNF generation estimates, a repository has been proposed for disposal of approximately 11 000 SNF assemblies and other long lived wastes.

Although one of the potential host rocks, clay-stone, has been thoroughly investigated, no specific features of a repository have been defined yet.

A-8.2.3. Management time schedule

In 1999, the government rejected the PURAM's plan, under which investigations were proposed to be continued in a claystone formation, accessible from the ex-uranium mine. PURAM is now elaborating a new policy and strategies, which will be discussed widely and finally approved by the government.

Development and approval of a new plan is expected to take 5 to 7 years from now. If geological disposal is selected as a preferable option, then 20 to 25 years will be required for completion of

research and siting activities. An additional 10 to 15 years will be required for licensing and construction activities.

In 2000, PURAM prepared the mid and long term plans for activities to be financed from the Central Nuclear Financial Fund. In the plan, direct disposal of SNF in a deep geologic repository was considered as a reference option for long term management. The schedule for establishment of the proposed repository is as follows:

2003–2007	Selection of realistic scenarios. Preparation of work plans and carrying out investigations needed for establishing an underground research laboratory.
2007–2012	Construction of the underground research laboratory.
2033–2046	Construction of a geological repository.
2047	Operation of the repository.

A-8.3. Siting of geological repositories

A-8.3.1. Siting process

Investigations of sites suitable for use as a geological repository have been underway since 1993. However, after the government rejected the PURAM's investigation plan, PURAM decided to develop a new policy on disposal of SNF and HLW. The new policy will include strategies for closure of the nuclear fuel cycle and disposal of HLW resulting from spent fuel reprocessing. The policy will be made available for open discussions to gain a wider range of consensus by radioactive waste management professionals and the public at large. PURAM expects that the efforts to fully develop and approve the new policy will require 5 to 7 years from the present date.

A-8.3.2. Development of siting criteria

The Minister of Industry, Trade and Tourism specified the fundamental geological and mining requirements for siting and planning of waste disposal facilities in its Decree No. 62/1997, (XI.26). These fundamental requirements are summarized below:

(a) Investigation of geologic suitability
- The method to investigate the geological environment shall be subject to geological research, in which the following points shall be enforced:
  - Investigation shall proceed step by step, comprehensively and to the extent that is required;
  - Each research phase shall be defined,
  - The best methods and technologies that are technically and economically attainable shall be employed,
  - Data shall be stored and retrieved,
  - Quality control shall be considered.
- Geological data required for the safety assessment shall be determined in the course of the geological research.
- The geological suitability of the potential sites shall be investigated and certified in the final geological research report.
- Engineered barriers shall be planned and constructed so that their interaction with the geological environment does not endanger the geological barrier.

(b) Selection of sites for radioactive waste disposal facilities and the investigation of geological suitability shall be divided into phases, which shall be specified in the geological research plan.

(c) Contents of the geological research plan shall be determined on the basis of the geological requirements to be specified.

With regard to radiation criteria, the Health Minister established public radiation dose limits in its Decree No.16/2000, (VI.8.), summarized as follows:

– The sum of external and internal exposures from artificial sources shall not be greater than 1 mSv/year.

In addition, the Minister of Public Welfare established the radiation requirement for final disposal of radioactive waste in Annex 12 of its Decree No.7/1998, summarized as follows:

– The effective dose equivalent for the public living near the facility shall not be greater than 250 μSv/year.

However, a proposal has been made to reduce the effective dose equivalent from 250 to 100 μSv/year and to adopt a risk constraint for individual events of 10^{-5}/year.

At present, a period of between 1000 and 10 000 years is considered as the time frame to be addressed in the safety assessment.

A-8.3.3. General procedures for decision making in each phase or stage

After approval of the new policy and strategies, PURAM will prepare the research plan and final research reports to be approved by the Hungarian Geological Survey. Under the Act on Atomic Energy Parliament must provide a preliminary approval prior to initiation of the establishment of any disposal facility.

A-8.3.4. Role of local governments

Regarding the involvement of local governments in the site selection process see Section A-8.6.

A-8.3.5. Financial assistance

The Act on Atomic Energy requires the licensees of nuclear power plants (NPPs) and radioactive waste disposal facilities to promote public understanding. The Act allows the licensees to provide financial assistance to supportive groups from affected municipalities to allow them to engage in various disposal activities.

A-8.4. Management costs

A-8.4.1. Total estimated cost and its breakdown

The total cost and its breakdown are estimated as given below:

Cost element	Cost (billion HUF 2000)
R&D	5.5
Interim Storage	58.3
Siting	20.5
Land Acquisition	1.0
Design	13.0
Licensing (regulatory)	2.0
Construction	127.8
Waste Transportation	33.6
Repository Operation	71.1
Closure and Institutional Control	26.5
Total	**359.3**

A-8.4.2. Organization responsible for cost estimation

As specified in the government decree of 1997, PURAM is responsible for the cost estimation. The cost estimates are subject to review by and consultation with the Hungarian Atomic Energy Authority and the Hungarian Energy Office.

A-8.5. Financing system

A-8.5.1. Overview of the financing system

According to the Act on Atomic Energy and the related government Decree, the financing system is based on a Central Nuclear Financial Fund established in January 1998 to finance radioactive waste management (including storage and disposal of SNF), as well as decommissioning of nuclear facilities.

Establishment of the Fund reflects compliance with the principle that radioactive waste disposal must be carried out by the organizations that enjoy the benefits of the activities generating the waste.

The fee is determined in the course of approval of the national budget by the Parliament, based on calculations made by PURAM using a discount rate of 3%. A schematic diagram of the procedure for determining the fee and PURAM' estimation is shown in Fig. A-8.2.

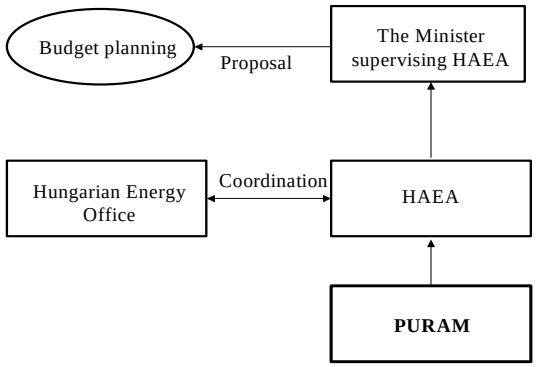


Fig. A-8.2. Procedure for determining the fee.

Any nuclear utility that operates a NPP is required to pay fees to the Fund during its life cycle. The yearly amount takes into account the total cost and the expected operational life time of the plant. Other waste producers, on the other hand, are required to pay a certain amount of tariff determined on a case-by-case basis, depending on the kinds and quantities of wastes they produce. The funds collected from these tariffs are negligible in comparison to the funds obtained from the nuclear utilities for NPP operations.

To ensure that the Fund reserves its value despite the inflation, the government is authorized to allocate an additional sum that is calculated on the average assets of the Fund in the previous year using the average base interest rate of the central bank in the previous year, to be debited to the central budget in the course of planning the budget bill. Thereafter the amount is paid to the Fund from the State budget. The assets of the fund are kept separated in the unified treasury account.

The Minister supervising the Hungarian Atomic Energy Authority is dispensing the Fund, and the Hungarian Atomic Energy Authority is responsible for management of the Fund. The Special Committee established under the Hungarian Atomic Energy Commission may also make comments and recommendation on management of the Fund.

A-8.5.2. Waste management fee

The fee charged to nuclear utilities was 1.18 HUF/kW•h in 2001. The details of the fee are provided in the following table:

Fee sub-elements	HUF/kW•h
L/ILW disposal	0.13
L/ILW transport	0.004
Construction, operation and decommissioning of a SNF storage facility	0.25
NPP decommissioning	0.33
HLW transportation	0.025
HLW disposal	0.38
PURAM	0.06
Total	**1.18**

The fee is reviewed every year when the Parliament approves the national budget.

A-8.5.3. Withdrawal

Waste management activities are paid for from the Fund according to the government budget approved each year by the Parliament.

A-8.5.4. Auditing the financing system

The financial system is subject to auditing by a chartered accountant and the State Accounting Office of the government.

A-8.5.5. Revenue and expenditure of financial resources

A summary of the annual status of the Fund for the years from 1998 to 2002 is provided in the following table:

Fund categories	Funds (million HUF)				
Years	**1998**	**1999**	**2000**	**2001**	**2002**[9]
Payments by NPP operators	7428.7	9164.9	9311.3	14 877.1	17 199.3
Payments by others	3.6	6.2	5.6	9.8	6.5
Contributions from the central budget	0	227.9	1132.1	0	0
Expenditures from the Fund	3941.1	3630.9	2094.1	6084.0	11 368.8
Accumulation in the Fund	3832.7[10]	5768.1	8354.9	8802.9	5837.0

A-8.6. Public involvement and transparency

During the siting process, an Environmental Impact Assessment (EIA) will be carried out as specified in the Act on Environmental Protection. Public hearings will be held for citizens in local and neighbouring municipalities and other interested groups as part of the EIA process.

In addition to the steps required by the legal requirements, various measures will be taken to promote public involvement in the siting process. These activities are anticipated to be similar to the activities carried out for other Hungarian nuclear facilities, as summarized below:

4 First, a letter is sent to the municipality notifying them of the proposed Project. The letter also described that no decision has been made and the facilities would be built in areas where most of the residents would agree to the Project. Those who expressed interest or opinions are invited to information sessions that are organized to provide them with relevant information and to provide an

[9] The amounts for 2002 are planned values.
[10] There was additional income in this year due to the tax refund.

opportunity for a consultation with them. These sessions are considered as one of consultative processes through which people express their views and opinions. The sessions focus first on describing the proposed Project and the siting process, thereafter on technical issues such as management of radioactive materials and potential risks, and the role of the communities in the process.

4 Next, technical visit to the nuclear facilities are organized. These visits provide occasions for members of the public to see the facilities and have contacts with people working in them, thus contributing to understanding of not only the facilities but also of the personnel.
4 Cultural and social events are organized to develop the mutual contacts between members of the communities and project personnel. Some of these events have nothing to do directly with the facilities.
4 Finally, a "Social Control and Association" organization is established with participation of members of the public from villages near the possible facilities. This organization monitors the status of the investigation activities and provides the public with information on their status.

A-8.7. Other considerations

A-8.7.1. Nuclear liability

The Act on Atomic Energy regulates nuclear liability in accordance with the revised and updated Vienna Convention on third party liability. Radioactive waste management facilities and repositories, except those without significant quantities of nuclear materials, are regulated by these rules. The Act specifies that the liability of the operator of a nuclear installation for damage from nuclear accidents shall be absolute and limited.

A-8.7.2. Institutional controls

The long term radiation protection requirements applicable to the final disposal of radioactive waste are specified as follows in Annex 12 of the Decree, No. 7/1998, issued by the Minister of Public Welfare:

4 After closure of the repository (termination of waste emplacement), institutional control shall be maintained for at least 50 years.
4 Thereafter, an additional control period may be specified by the competent authority.

A-8.7.3. Records keeping

The legislation requires that all nuclear licensees, including those responsible for storage and disposal of radioactive waste, must develop and maintain records at the place of their activities based on the requirements. The records keeping system must be approved by the licensing authority.

A-9. JAPAN

A-9.1. Organization and legislation

A-9.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.

Government

Ministry of Economy, Trade and Industry

- Establishes the Basic Policy.
- Establishes the Final Disposal Plan.
- Calculates fees.

REGULATION/OVERSIGHT

Regulatory Authority

Ministry of Economy, Trade and Industry (Nuclear and Industrial Safety Agency)

- Establishes requirements.
- Grants licences.

Oversight Bodies

Atomic Energy Commission

- Provides oversight on the Basic Policy and the Final Disposal Plan.

Nuclear Safety Commission

- Provides oversight on technical matters of the Basic Policy and the Final Disposal Plan.
- Provides oversight on regulation of nuclear safety.

Advisory Committee for Energy

- Provides scientific and technical oversight on the activities of implementing organizations.
- Suggests policies and strategies on transparency.

IMPLEMENTATION

Implementing Organization

Nuclear Waste Management Organization of Japan (NUMO)

- Is responsible for implementing final geological disposal of HLW.
- Is responsible for collecting fees.

Financial Resource Management Body

Radioactive Waste Management Funding and Research Centre (RWMC)

- Is responsible for management of the fund.

The interactions of the government and different organizations involved in the HLW long term management in Japan are presented in Fig. A-9.1.

A-9.1.2. Implementing organization

In accordance with the Specified Radioactive Waste Final Disposal Act, the Nuclear Waste Management Organization of Japan (NUMO) was established in 2000 to be the HLW disposal implementing organization in Japan. NUMO was established by the private sector and was approved by the Minister of Economy, Trade and Industry.

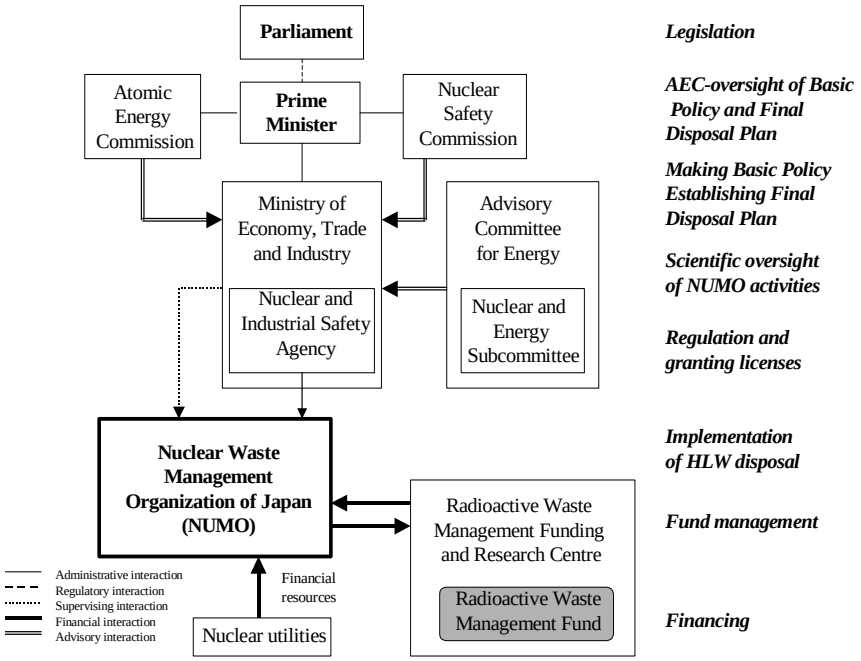


Fig. A-9.1. Organizational structure.

NUMO is responsible for conducting the following activities:

- Implementation of final geological disposal of HLW,
- Collection of fees to provide funds to pay for the NUMO's disposal activities.

The Act further specifies that the Ministry of Economy, Trade and Industry shall evaluate whether the implementing organization has an adequate work plan for recruitment of personnel, facilities and implementation, and technical and financial resources sufficient to carry out its responsibilities.

The scientific appropriateness of the siting process is to be investigated not only by the Ministry of Economy, Trade and Industry (the Ministry) but also by the technical consultants group on HLW disposal, organized under the Advisory Committee for Energy that was established to advise the Minister on energy policies.

A-9.1.3. Laws and regulations

The following laws and regulations govern the disposal of HLW in Japan:

- The Specified Radioactive Waste Final Disposal Act (the Act) (2000, Law No. 177) (siting process, implementing body, financing system, basic siting criteria).
- The ordinance on implementing organizations (2000, Ministry's ordinance No. 152).
- The ordinance on financing of and accounting for implementing organizations (2000, Ministry's ordinance No. 153).
- The ordinance on the cost necessary for final disposal (2000, Ministry's ordinance No. 398)
- The notification on the conversion factors for the amount of vitrified waste per amount of thermal generation from spent fuel (2000, Ministry's notification No. 768).
- The notification on the organization responsible for management of the funds (2000, Ministry's notification No. 661).
- The notification on the specified securities and financial entities for maintaining the funds (2001, Ministry's notification No. 52).

The Act states that safety regulation for final disposal shall be prescribed by other Acts in the future.

A-9.2. Waste streams and proposed repositories

A-9.2.1. Waste stream assumptions

As of the end of June 2001, 51 light water nuclear power reactors were in operation in Japan with a total capacity of about 45 GW(e). Four units with a total capacity of 4.7 GW(e) are under construction, and another six units with a total capacity of 7.2 GW(e) are being planned. In addition, a prototype ATR is in service and an FBR is under construction.

Japan is pursuing the nuclear fuel reprocessing policy. The amount of vitrified HLW expected to be generated from reprocessing of the spent nuclear fuel generated at power reactors is estimated in the Final Disposal Plan, as follows:

At the end of 2000	about 14 400 canisters (in accumulation)
2001–2004	1100 canisters per year
2005 &2006	1200 canisters per year
2007 &2008	1300 canisters per year
2009	1400 canisters per year

Assuming that the annual HLW generation rate is equivalent to that in 2009, the total amount of HLW that is expected to be generated after 2010 is estimated as below[11]:

By 2013	about 30 000 canisters
By 2020	about 40 000 canisters

A-9.2.2. Proposed repositories

The Basic Policy established by the Ministry specifies that the final repository should have sufficient capacity for more than 40 000 canisters of HLW, which corresponds to the amount of spent nuclear fuel generated by 2020. The Act specifies that the repository shall be located deeper than 300 m underground. The host rock in which to locate the repository has not been selected yet.

The following engineered barrier systems are being considered:

Vitrified waste	High level waste vitrified and sealed in stainless steel canisters.
Overpack	The vitrified waste is placed in a waste container. Container materials under consideration include bare carbon steel, carbon steel coated with titanium, and copper.
Buffer materials	The space between the overpack and the repository rock is to be filled with buffer materials, such as bentonite clay.

Japan has not decided yet whether types of radioactive waste, other than HLW, will be disposed of in the repository. However, the Act would allow disposal of radioactive waste generated after reprocessing of spent nuclear fuel used for purposes other than power generation.

A-9.2.3. Management time schedule

The time schedule for future SNF and HLW disposal activities is specified in the Final Disposal Plan, which will be reviewed every 5 years and updated as necessary. The latest time schedule stated in the Plan is summarized as follows:

[11] The amount of HLW per a SNF assembly varies with the burnup of nuclear fuel, the canister capacity, etc. However, for purposes of performing an approximate conversion between the number of SNF elements and HLW canisters, please note that the Japanese government has stated that about 12 600 canisters of HLW will arise from reprocessing of the 17 000 t HM of SNF generated in the past. In the future, reprocessing of SNF from NPPs will result in generation of approximately 30 canisters of HLW per year for each 1 GW(e) of nuclear electrical generating capacity.

June 2000	Enactment of the Act
October 2000	Establishment of the implementing organization (NUMO)
November 2000	Designation of the fund management organization (RWMC)

(present)

♦

(Literature Survey)

♦

Following years — Selection of preliminary investigation areas

♦

(Borehole programmes, etc.)

♦

About 2010 — Selection of areas for detailed investigation

♦

(Test programmes in underground exploration facilities)

♦

About 2020 — Selection of the site for repository construction

♦

(Safety examination, construction of a repository)

♦

About 2030 — Start of repository operations

A-9.3. Siting of geological repositories

A-9.3.1. Siting process

According to the Act and relevant ordinances, the siting process will consist of 3 phases, as follows:

(1) ***Selection of preliminary investigation areas*** – Areas to be the subject of preliminary investigations will be selected by conducting literature surveys (i.e. review of various records and documents).

(2) ***Selection of detailed investigation areas –*** Areas to be the subject of detailed investigations will be selected based on a review of the results of the preliminary investigations (i.e. comprehensive investigations using techniques such as boreholes, surface explorations, physical investigation and trench digging).

(3) ***Selection of a site for repository construction –*** The site(s) to be developed into a geological repository will be selected based on a review of the results of the detailed investigations (detailed physical and chemical investigations in one or more underground facilities, including consideration of the flow of underground water).

The detailed process of each selection is shown in Fig. A-9.2.

NUMO plans to make an open solicitation in which they will ask communities to volunteer as sites to be the subjects of preliminary siting investigations. Literature surveys will be performed for the areas for which applications are filed (and surrounding locales), and preliminary investigation areas will be selected from among the areas that volunteer.

The Japan Nuclear Cycle Development Institute is developing two underground research laboratories, one in Tono and another in Horonobe, which will be used only for research purposes. To support site selection, the implementing organization will conduct characterization of the candidate sites in underground facilities during the detailed investigation stage.

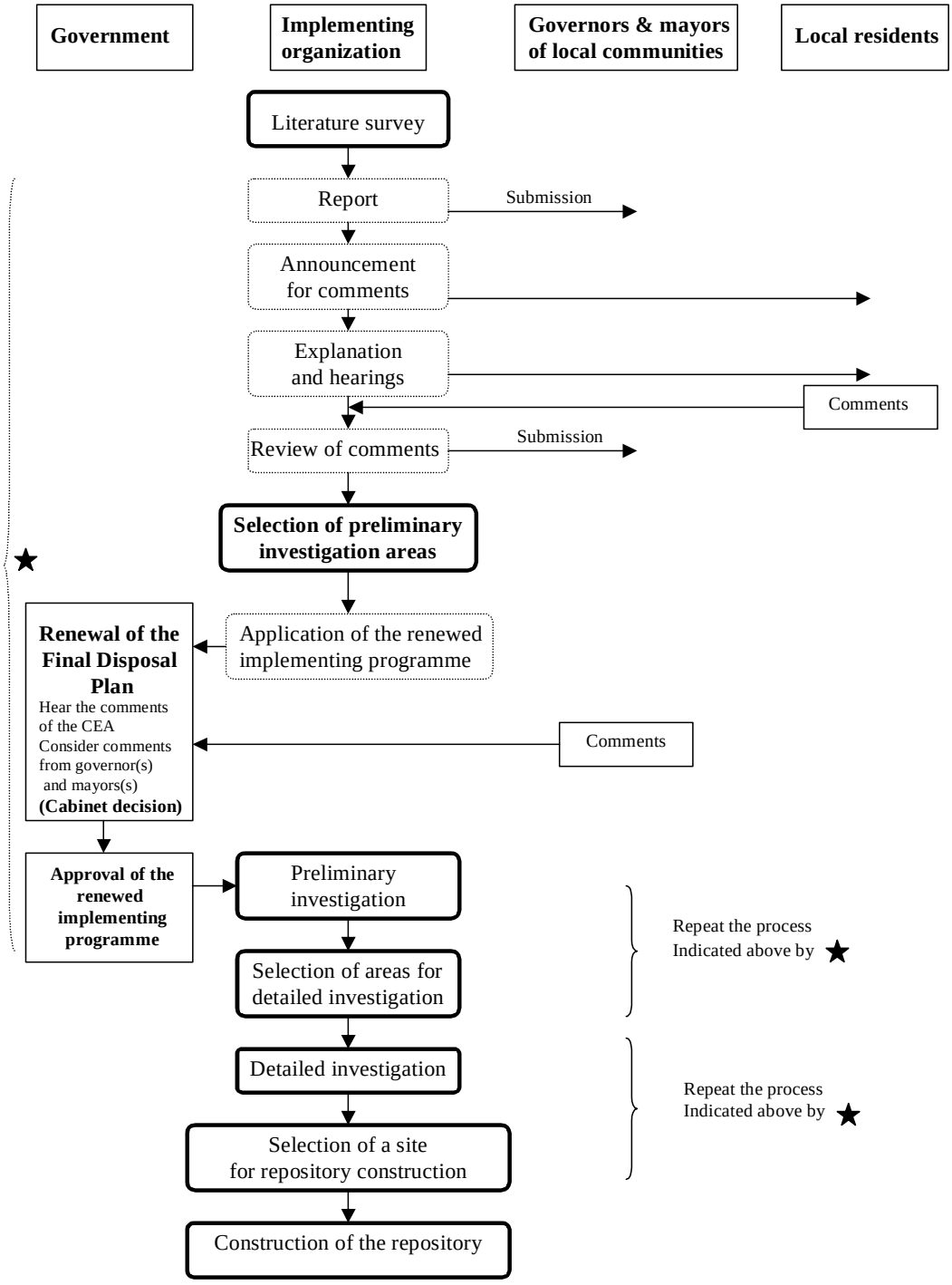


Fig. A-9.2. Siting process.

A-9.3.2. Development of siting criteria

The Act and relevant ordinances specify the fundamental criteria applicable to the three phases in the siting process. The criteria described in the Act are mainly related to the movement of strata, the nature of faults, the impact of underground water and the potential for valuable mineral resources. More detailed criteria are to be developed by the Ministry in an ordinance.

A-9.3.3. General procedures for decision making in each phase or stage

The Ministry is responsible for deciding whether to go further after completion of each phase of the site selection process. According to the Act, the implementing organization is required to update the Implementing Programme and submit it to the Ministry for approval after completion of each phase of the site selection process. Upon receipt of the updated Implementing Programme, the Ministry will update the Final Disposal Plan and send it to the Cabinet for consent. After the Cabinet consents with the updated Final Disposal Plan, the Ministry will approve the updated Implementing Programme.

A-9.3.4. Role of local governments

The Act and relevant regulations contain the following requirements pertaining to the role of local governments:

- The implementing organization is required to submit the report on each phase of the site survey to the governor(s) and mayor(s) concerned for their review and comment upon completion of the report.
- The implementing organization is required to consider any comments received and submit the revised documents to the governor(s) and the mayor(s), including the public comments and the implementing body's responding views.
- The Ministry is required to fully respect the comments made by governor(s) and mayor(s) when it approves selections of the preliminary investigation areas.

A-9.3.5. Financial assistance

Financial assistance to local communities is expected, but the amounts and process for distribution have not been decided in detail yet.

A-9.4. Management costs

A-9.4.1. Total estimated cost and its breakdown

The total cost of geological disposal in Japan have been estimated as follows:

	Element costs (billion yen 2001)		
Project elements	**Sedimentary rock**	**Granite**	**Average**
R & D	108.8	108.8	108.8
Siting & land acquisition	216.8	241.8	229.3
Design & construction	1037.3	863.7	950.5
- Surface facilities	32.9	25.7	29.3
- Underground facilities	671.9	243.7	457.8
- Surface equipment	202.7	265.8	234.2
- Underground equipment	99.7	298.3	199.0
- Others	30.1	30.2	30.2
Repository operation	666.2	764.3	715.2
Decommissioning & closure	77.3	86.1	81.7
Monitoring	122.6	122.6	122.6
Project management	610.7	539.2	575.0
Tax	108.9	107.3	108.1
Total	**2948.6**	**2833.8**	**2891.2**

The cost estimate is based on the assumption that a repository will have a capacity for 40 000 canisters of HLW.

The estimated costs include expenses incurred by the implementing body, but not any cost other than disposal. The costs of HLW storage and transportation from the storage facilities to the disposal site will be born by other organizations (e.g. utilities). Also the cost estimates include compensation for the implementing body, but not for regulatory and oversight organizations.

A-9.4.2. Organization responsible for cost estimation

The Ministry is designated by the Act as the organization responsible for the cost estimation. The Ministry consults with the Nuclear Power Subcommittee of the Advisory Committee for Energy to obtain comments on the adequacy of the cost estimates.

A-9.5. Financing system

A-9.5.1. Overview of the financing system

In 2000, the Act established the Radioactive Waste Management Fund (the "Fund") into which financial resources for geological disposal of HLW were to be deposited. The Fund is managed by the non-profit Radioactive Waste Management Funding and Research Centre and is maintained externally from the utilities to avoid having the fund be left unsecured by a potential excessive debt or bankruptcy of the utilities during the long period over which the HLW must be managed.

The Act requires that an annual fee shall be collected from the nuclear utilities. This fee is calculated each year for the nuclear power reactors operated by a utility through use of the following formula:

Annual fee = A × B

where:
A is the final disposal cost per HLW canister,
and B is the number of HLW canisters equivalent to the amount of SNF generated during the year by operation of the utility's reactor(s).

The Ministry has issued an order that specifies that A shall be determined as follows:

$$A = \frac{\text{Total expense required for final disposal after a certain point of calculation*} - \text{Balance of the fund at a certain point of calculation (including the profit incurred up to then)}}{\text{Total number of HLW canisters to be disposed of *} - \text{The number of HLW canisters for which disposal expenses have been paid *}}$$

* Converted into a value at a certain point of calculation.

The time value of money is considered in making the calculations (i.e. a discount method is used). Taking into account the average interest of 10-year government bonds over the last 5 years, and the consumer price index during the last 5 years, the discount rate was assumed to be constant at 2%. The discount rate will be reviewed every 5 years and revised if necessary.

The utilities are required to pay the fees for disposal of spent nuclear fuel generated prior to establishment of the financing system on an instalment basis. Some of the nuclear utilities charge the HLW disposal costs as an explicit portion of the electricity rates. However, other utilities do not identify the HLW costs separately. The fees are collected by NUMO and transferred to the Fund. Then, in accordance with the requirements of the Act, the fees are deposited and/or invested as follows:

- Investments in government bonds and other securities, as specified by the Ministry,
- Deposition in banks or other financial institutions, as specified by the Ministry, or in the Central Postal Office,
- Investments in trust funds operated by trust companies and trust banks.

The securities specified by the Minister are as follows:

- Bonds issued by local governments and organizations established by other legislation,
- Particular corporate bonds and sovereignty bonds issued in Yen currency.

A-9.5.2. Waste management fee

The amount of fee charged to any particular nuclear power plant depends on the thermal-efficiency of the nuclear power plant. The fee per kW•h in 2001 is approximately 0.13 Yen on average for electricity generated at NPPs. An additional 0.07 Yen per kW•h is charged as a fee for operations prior to establishment of the fund. The Ministry determines the annual fee.

A-9.5.3. Withdrawal

The Act specifies that the implementing organization shall make plans for their budget, implementation and financing in advance for each fiscal year. The Ministry then approves the plans before the fiscal year begins. The implementing organization is allowed to make withdrawals from the Fund to cover their expenses, after the Ministry's approval.

A-9.5.4. Auditing the financing system

The Act stipulates that the Ministry is responsible for auditing the financing system. Although auditing by a third party is not mentioned in the legislation, the Advisory Committee has recommended that an independent accountant should audit the financing system every fiscal year.

A-9.5.5. Revenue and expenditure of financial resources

Fiscal year	Revenue (billion yen)	Expenditure (billion yen)
2000	103	0.85
2001	70	2.88

A-9.6. Public involvement and transparency

The Act and other relevant regulations require that the following steps be taken to provide for public involvement and transparency during repository site selection:

- The implementing organization must make the report for each phase of site selection available for public inspection and comment in the province(s) involved for one month when the report is completed in each phase.
- The implementing organization is required to organize a meeting with the public in the province(s) involved during the public comment period. During the meeting, the implementing organization disseminates and explains the results of the report to the public.
- Members of the public are allowed to submit their opinions within 2 weeks after termination of the public inspection and comment period.
- The implementing organization must take public opinions into consideration during the site selection process, such as in the selection of a possible area(s) for preliminary investigation.

The government committed, in the Basic Policy, that education on energy, nuclear and waste management matters would be strengthened by dispatching experts to schools, and inviting teachers and students to relevant laboratories, as well as by disseminating relevant information and supplying educational materials.

The Nuclear Power Subcommittee of the Advisory Committee reviews the activities of the implementing body, and gives recommendations on steps to ensure transparency.

A-9.7. Other considerations

A-9.7.1. Nuclear liability

The nuclear accident liability system for geological disposal has not been developed yet.

A-9.7.2. Retrievability and institutional controls

The Act stipulates that the implementing organization shall close repositories after approval by the Ministry. The criteria for repository closure will be developed in the future.

The Nuclear Safety Commission has specified that it would be important to maintain retrievability until a safety analysis has been performed to confirm that closure is appropriate, considering data collected during construction and operation of the repository.

A-9.7.3. Records keeping

The Act specifies that the Ministry must keep records of HLW disposal activities permanently. Details on how to comply with this requirement will be developed in the future.

A-10. REPUBLIC OF KOREA

A-10.1. Organization and legislation

A-10.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.

Government

Government/Atomic Energy Commission (AEC)

- Establishes waste management and disposal policies.

REGULATION/OVERSIGHT

Regulatory Authority

Ministry of Science and Technology (MOST)/Korea Institute of Nuclear Safety (KINS)

- Develops regulations.
- Grants licenses.

Oversight Body

Atomic Energy Safety Commission (AESC)

- Provides advice concerning important nuclear safety matters.
- Provides scientific oversight of the activities of the implementing organization.

IMPLEMENTATION

- An Implementing Organization has not been established yet.

A-10.1.2. Implementing organization

The Republic of Korea currently does not have concrete programmes for disposal of SNF. As a consequence, an implementing organization responsible for disposal of SNF has not been established yet.

A-10.1.3. Laws and regulations

The Atomic Energy Act (2001.1), passed by the Parliament, specifies the guidelines for radioactive waste management in Republic of Korea. The Enforcement Decree of the Atomic Energy Act (2001.7), issued by the Government, establishes the requirements for implementation of the Atomic Energy Act. More detailed regulations and criteria for disposal of SNF have not been developed yet.

A-10.2. Waste streams and proposed repositories

A-10.2.1. Waste stream assumptions

At present, 12 PWR type nuclear power reactors with a total capacity of about 10.9 GW(e) and 4 CANDU type power reactors with a total capacity of about 2.8 GW(e) are in operation in Republic of Korea. An additional 4 PWR type reactors with a total capacity of about 4 GW(e) are under construction.

In accordance with the fourth long term electricity development plan (issued by the government in 2000), Republic of Korea plans to construct and operate 8 new nuclear power units by 2015, resulting in a total energy capacity of about 26 GW(e).

The total amount of SNF generated by the end of 2001 was approximately 5380 t HM. Republic of Korea plans to have 26 reactors in operation in 2015, and two other reactors being decommissioning. If the operational lifetime of these reactors is 40 years, the total amount of SNF projected to be unloaded from the reactors over time will be as follows:

Year	Cumulative amount of SNF (t HM)
2010	11 000
2040	34 000

A-10.2.2. Proposed repositories

An R&D programme was launched in 1997 to establish a reference repository system for disposal of SNF generated in the country. The basic assumptions used in this programme are summarized as follows:

Capacity: 36 000 t HM:
- 20 000 t HM (about 45 500 assemblies) of SNF from PWRs
- 16 000 t HM (about 842 100 bundles) of SNF from CANDUs

Depth: 500 m

A-10.2.3. Management time schedule

According to the radioactive waste management policy established by the Ministry of Science and Technology at the 249th AEC meeting in 1998, Republic of Korea anticipates that a facility for storage of the SNF will be commissioned by 2016[12]. However the time schedule for construction and operation of a repository has not been proposed yet.

A-10.3. Siting of geological repositories

A-10.3.1. Siting process

The disposal project for SNF in Republic of Korea is at a very early stage. A long term research programme is being conducted from 1997 through 2006 by the Korea Atomic Energy Research Institute (KAERI) to establish a reference repository system and to assess the feasibility of a deep geological repository, considering aspects such as geological conditions and long term stability. During the research, the following fundamental information will be collected:

4 Delineation of unstable regions for a repository, in terms of neo-tectonic aspects, throughout the peninsula,
4 Basic hydraulic and hydro-chemical characteristics of the groundwater systems in various topographic regions,
4 Basic mechanical and thermo-chemical properties in deep geological formations.

The repository siting process will be considered and developed based on the results of the research mentioned above.

Development of an underground research laboratory (URL) will be considered and planned after completion of the above research. A site-specific laboratory is considered to be desirable in many countries, including Republic of Korea. However, as an interim step, Republic of Korea is considering whether it may be desirable to first build technical capabilities through international co-operation projects, before establishing a development plan for a site-specific URL.

[12] Ref: Jang-Soo Nam, Korean Radioactive Waste Repository Project and Public Acceptance, Proceedings of the 23rd KAIF-JAIF Seminar on Nuclear Industry, Seoul, Korea, 24-25 September 2001, p. 154.

A-10.3.2. Development of siting criteria

The basic criteria for siting will be developed in the future, with reference to the generic criteria developed by the IAEA and other countries that have had experience in the repository site selection process. The criteria will cover socio-economic aspects, as appropriate, as well as radiological and environmental issues. The technical basis for the repository siting criteria will be proposed by KAERI in 2006 at the completion of their long term HLW SNF disposal research. Based on the KAERI work, KINS will develop the technical criteria, and submit the criteria to MOST for approval.

A-10.3.3. General procedures for decision making in each stage or phase

The detailed decision making process will be considered and decided upon in the future, taking into consideration the roles of MOST (responsible for SNF disposal) and the AEC (responsible for deliberating and deciding important matters concerning nuclear energy).

A-10.3.4. Role of local governments

Republic of Korea expects that local governments will inevitably be involved in the siting process. Details on how this involvement will be carried out will be considered in the future.

A-10.3.5. Financial assistance

A detailed programme for financial assistance has not been established yet. This subject will be addressed in the future, giving consideration to the programme applied to low and intermediate level radioactive waste disposal.

A-10.4. Management costs

Republic of Korea is at an early stage of fundamental R&D, and no cost analysis has yet been performed. The organization to be responsible for cost estimation has not been determined yet.

A-10.5. Financing system

A financing system has not been established yet. The financing system is to be studied in the long term SNF disposal research project, including consideration of options for an authority to be responsible for managing the system.

A-10.6. Public involvement and transparency

The Republic of Korea government recognizes that public involvement and transparency are necessary to successful implementation of nuclear projects, including disposal of SNF. A high priority will be given to these topics as the programme is developed in more detail.

There have already been many activities conducted to boost public awareness for LLW disposal programmes (e.g. public hearings, tours of overseas LLW repositories, off-site campaigns, and coordination of local community involvement by prominent professors). The policies and strategies for public involvement in the SNF disposal project will be developed with consideration of the experience that has been gained from LLW repository siting in Republic of Korea, and similar repository siting activities in other countries.

A-10.7. Other considerations

Republic of Korea is currently in an early stage of research activities. Such issues as nuclear liability, waste retrievability, institutional control and a records keeping system will be discussed and developed in the future.

A-11. LITHUANIA

A-11.1. Organization and legislation

A-11.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.

Government

- Approves the strategy for waste management.
- Changes fees.
- Approves projects to establish SNF and radioactive waste management installations.

REGULATION

Regulatory Authority

State Nuclear Power Safety Inspectorate (VATESI)

- Develops siting criteria.
- Responsible for nuclear safety regulation.
- Grants licenses for SNF and radioactive waste management installations.

IMPLEMENTATION

Implementing Organization

Radioactive Waste Management Agency (RATA)

- Implements SNF disposal.
- Prepares the strategy for waste management.

Financial Resources Management Body

Ministry of Finance

- Manages the Decommissioning Fund (which includes the funds for SNF disposal).

The interactions of the government and different organizations involved in the SNF long term management in Lithuania are presented in Fig. A-11.1.

A-11.1.2. Implementing organization

As required by the Law on Radioactive Waste Management, the State Enterprise Radioactive Waste Management Agency (RATA) was established in 2001, as a state owned implementing organization for SNF and radioactive waste disposal. An oversight body has not been established yet. At the present time, the operator of the Ignalina Nuclear Power Plant manages operational waste and SNF.

A-11.1.3. Laws

The following laws specify the requirements for disposal of SNF in Lithuania:

- The Law on Radioactive Waste Management (1999) – (general requirements for siting, design, etc.).
- The Law on the Fund of State Enterprise Ignalina Nuclear Power Plant Decommissioning (2001) - (financing system).

The fundamental institutional framework for waste management (such as the licensing system) is stipulated in the Law on Nuclear Energy (1996), along with requirements applicable to other nuclear activities.

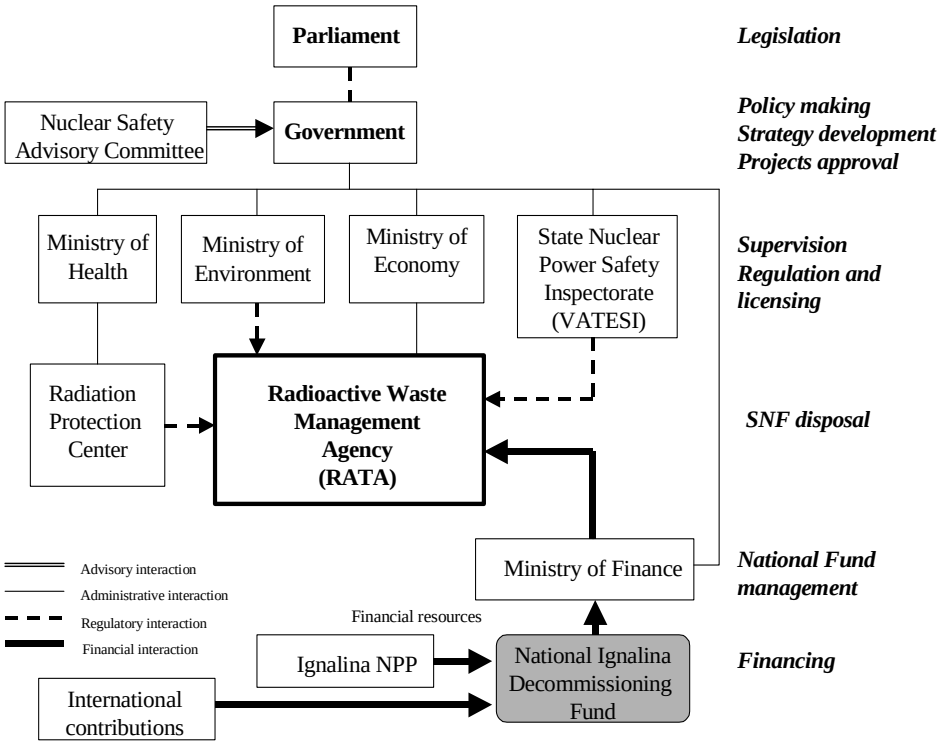


Fig. A-11.1. Organizational structure.

A-11.2. Waste streams and proposed repositories

A-11.2.1. Waste stream assumptions

There are two RBMK-1500 type nuclear power reactors in operation at the Ignalina Nuclear Power Plant site in Lithuania, each with a restricted capacity of about 1.3 GW(e).

Assuming that Ignalina-1, which started operation in 1983, is to be shut down before 2005 and that Ignalina-2, which started operation in 1987, will operate until 2009, the total amount of SNF expected to be generated in Lithuania is about 2500 t HM.

A-11.2.2. Proposed concepts

The Lithuania's "National Strategy for Radioactive Waste Management" had been prepared by RATA and was approved by the government on 6 February 2002. This document specifies that disposal in a geological repository is one of the options for the SNF long term management in Lithuania (along with long term storage and shipment of SNF to other countries and participation in regional repository projects). The National Strategy does not provide any specific parameters for a proposed repository.

A-11.2.3. Management time schedule

As specified in the "National Strategy for Radioactive Waste Management", investigations of the feasibility of SNF disposal in a geological repository will be carried out until 2040.

A-11.3. Siting of geological repositories

A-11.3.1. Siting process

The Geological Survey of Lithuania, in co-operation with the Lithuanian Energy Institute and the Lithuanian Geology Institute initiated a preliminary investigation entitled "Evaluation of the territory of Lithuania according to suitability for a deep radioactive waste repository" in 2000. The purpose of

this investigation is to identify the most suitable geological formation in Lithuania (granite, clay, etc.) for SNF disposal. Lithuania is also conducting a project with the Swedish Nuclear Fuel and Waste Management Co., SKB, to transfer know-how needed by Lithuania to assess the feasibility of SNF disposal. The National Strategy specifies that Lithuania will undertake a long term scientific inquiry (lasting until the year 2040) on the potential for construction of a deep geological repository.

A-11.3.2. Development of siting criteria

The State Nuclear Power Safety Inspectorate (VATESI) is responsible for development of safety criteria, which will be used for identification of suitable geological formations for repositories. In developing the criteria, VATESI will consult with the Radiation Protection Centre and the Ministry of Environment, as well as external technical support organizations. The criteria are expected to address three major topics: geological aspects, radiological safety, and environmental aspects.

A-11.3.3. General procedures for decision making in each phase or stage

The procedure for decision making in each phase or stage of the geological repository project will be considered in the future.

Lithuania expects that the main decision milestones and participating parties for the geological repository site selection process would be as specified for general government projects in existing legislation. In general, an environmental impact assessment would have to be completed at the end of the site selection process, along with a nuclear safety examination. During both these processes, comments would be collected from the relevant governmental organizations and local governments, and from members of the public during public hearings. After completion of these procedures, the competent authorities (the Ministry of Environment and the Regional Environmental Department) would make a decision on the acceptability of the proposed repository site.

However, since Lithuania has not made a decision to pursue development of a geological repository at this time, no comprehensive methodology or procedure for development of a repository has been developed.

A-11.3.4. Role of local governments

On the assumption that the processes specified in the current legislation would be followed, local governments will be involved in the environmental impact assessment to ensure that their comments and concerns are addressed.

A-11.3.5. Financial assistance

Financial assistance to the communities around a geological repository will be considered in the future. Such financial assistance would probably be based on the existing financial assistance provided to local communities near Ignalina NPP, including the following:

- Contributions to the fund for regional development,
- Discounts on electricity rates.

A-11.4. Management costs

A-11.4.1. Total estimated cost and its breakdown

According to the preliminary estimates made by RATA in 2001, the total waste management costs would be as follows:

- Interim storage: 100 million EURO
- Final disposal: 1500–2000 million EURO

No cost breakdown is available.

A-11.4.2. Organization responsible for cost estimation

The Law on Radioactive Waste Management specifies that the RATA is responsible for cost estimation for the management of SNF and HLW.

A-11.5. Financing system

A-11.5.1. Overview of the financing system

The National Ignalina Decommissioning Fund was established in 1992 to cover the waste management costs, including costs for management of SNF and decommissioning of nuclear facilities. The Fund receives its income from fees collected through a levy on the wholesale cost of electricity.

The Ministry of Finance manages the Fund. Financial resources are deposited in a special account of the State Treasury in the form of national and foreign currency and securities.

A-11.5.2. Waste management fee

Since 1998, 6% of the wholesale electricity rate (about 4.9 Litas/MW·h in 2002[13]) have been collected from the operator of Lithuania's nuclear power plant and deposited into the Fund. The government can change the fee, if necessary.

A-11.5.3. Withdrawal

According to the Rules of the Decommissioning Fund, the Council of the National Ignalina Decommissioning Fund must approve all withdrawals from the Fund.

A-11.5.4. Auditing the financing system

The Fund is audited by the State Control Department of the government.

A-11.5.5. Revenue and expenditure of financial resources

As of the beginning of 2001, 40 million Litas have been collected and accumulated in the Fund. There has been no expenditure since the establishment of the Fund. However, 5 million Litas have been budgeted to pay for a newly established Decommissioning Project Management Unit at Ignalina NPP in 2002. Another 2 million Litas have been budgeted to finance a local government restructuring programme, also in 2002.

A-11.6. Public involvement and transparency

Members of the public are involved in the Environmental Impact Assessment (EIA) process, which will include public hearings. Members of the public are given an opportunity to provide comments and proposals on the draft EIA report to be completed by the implementing organization in a manner prescribed by the Ministry of Environment.

The implementing organization will be required to complete the report taking into account the public comments and proposals. During the completion of the EIA, scientists and foreign experts may be involved as consultants.

[13] 1 Litas ° US $0.29.

A-11.7. Other considerations

A-11.7.1. Nuclear liability

Third party liability is subject to the Vienna convention on nuclear liability, whereby the liability of the operator of a nuclear installation for damage resulting from a nuclear accident shall be absolute and limited.

A-11.7.2. Institutional controls

The Law on Radioactive Waste Management requires that the repository shall be closed by the government's decision. Post-closure surveillance of a repository would be carried out by RATA, which would prepare a programme for post-closure surveillance of the repository, co-ordinate it with the Ministry of Environment and submit it to the State Nuclear Power Safety Inspectorate for approval. Repository post-closure surveillance may be terminated with permission from the licenser and upon the concurrence of the government.

A-11.7.3. Records keeping

The operator must ensure that records pertaining to disposal of radioactive waste, which are prescribed by the license, as well as technical documentation regarding the site of the repository and its structures, must be kept indefinitely until closure of a repository in the manner set forth by law.

A-12. NETHERLANDS

A-12.1. Organization and legislation

A-12.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws

Government

- Establishes policies.

REGULATION

Regulatory Authorities

Ministry of Housing, Spatial Planning and Environment*

Ministry of Social Affairs and Employment

Ministry of Economic Affairs

- Establish criteria.
- Jointly grant a license.

* Primary responsibility was assigned to the Ministry of Housing.

IMPLEMENTATION

Implementing Organization

Central Organization for Radioactive Waste (COVRA)

- Is responsible for implementation of radioactive waste management, including storage of HLW.

Financial Resources Management

- Utilities and other waste generators are responsible for maintaining financial resources.

The interactions of the government and different organizations involved in the HLW and/or SNF long term management in Netherlands are presented in Fig. A-12.1.

A-12.1.2. Implementing organization

The Central Organization for Radioactive Waste (COVRA) was established in 1982 and designated in 1987 by a governmental decree as the implementing organization responsible for radioactive waste management in Netherlands. It was set up as a private company, owned by two nuclear utilities (Dodewaard (30%) and Borsele (30%)), the Energy Research Foundation (30%) and the government (10%).

When the government announced its intention to phase out use of nuclear power by 2004[14], and liberalize the electricity market in 2001, the ownership of COVRA became an issue. As a result, the decision was made to transfer the ownership of COVRA to the government. The agreement to transfer the ownership of COVRA was scheduled to be finalized in the first half of 2002[15].

There are no concrete plans for disposal of SNF and HLW at the present time. As a result, the activities of COVRA are limited so far to treatment, conditioning and storage of radioactive waste and spent fuel.

[14] The new government has decided not to shut down the Borssele NPP in 2004, with a view to the obligations of the Kyoto protocol on greenhouse gas emissions.

[15] As of 15 April 2002 the State is 100% owner of COVRA.

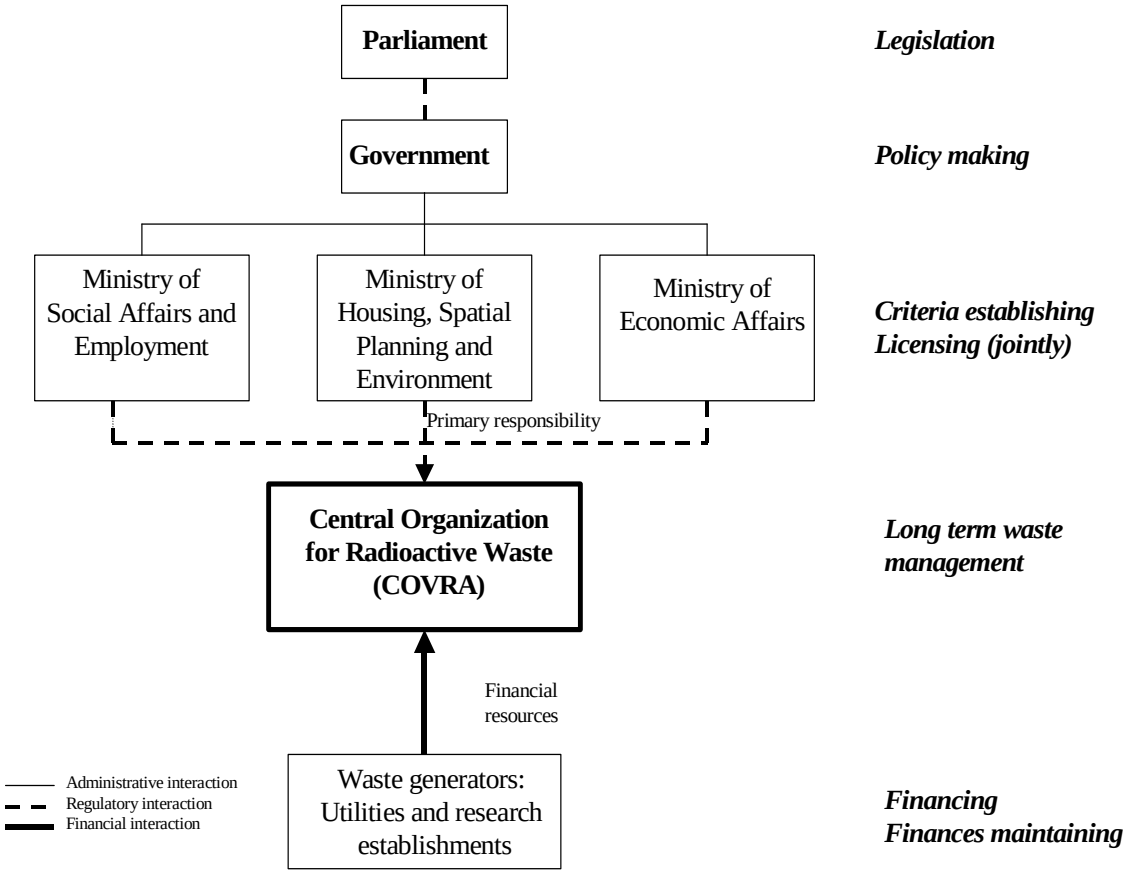


Fig. A-12.1. Organizational structure.

A-12.1.3. Laws and regulations

Radioactive waste management is regulated as one of the nuclear activities under the Nuclear Energy Act (1963, last revised in 2000). There are no separate laws for disposal of SNF and HLW, except for the law having established the implementing organization "Decree on the establishment of the Central of Radioactive Waste (COVRA) as a recognized waste management organization (1987)".

A-12.2. Waste streams and proposed repositories

A-12.2.1. Waste stream assumptions

There is one PWR type nuclear power reactor (Borssele NPP) with a capacity of 449 MW(e) in operation in the Netherlands. There is another power reactor in the country, a BWR with a capacity of 56 MW(e) (Dodewaard NPP) that has been shut down.

Both nuclear power plants have entered into contracts for reprocessing of their spent fuel, the operating Borssele NPP has contracted with La Hague (France) and the shutdown Dodewaard reactor has contracted with Sellafield (UK). In accordance with these contracts, the HLW resulting from reprocessing will be returned to the Netherlands. Since the Netherlands does not expect to have a capability to dispose of this HLW for the next few decades, an engineered HLW storage facility (named HABOG) is being established at the COVRA site. Construction of HABOG is well under way. The first shipment of reprocessing waste, including vitrified HLW, is scheduled to arrive from France in 2004.

Spent fuel from the research reactors in Petten and Delft is also planned to be stored in HABOG. No further use of these materials is envisaged.

The total amounts of HLW, spent nuclear fuel, etc. to be stored in HABOG at the COVRA site are estimated and shown in the table below (based on estimates of the total amounts of SNF and HLW to be generated over the next 100 years):

Waste category	Volume (m^3)
Heat-generating waste	
– Fuel elements and fissile residues	40
– Vitrified HLW	70
Non heat-generating waste	
– Decommissioning waste	2000
– Reprocessing waste	810
– Other high activity waste	120

A-12.2.2. Proposed concepts

The government of the Netherlands concluded in 1993 that decisions regarding geological disposal of the radioactive waste should be deferred until it can be reasonably recognized that the public has sufficient confidence in the safety of an underground repository. The plan in the Netherlands is to implement long term storage of the waste to give the country adequate time to conduct investigations on the options for disposal and consider their conclusions. Accordingly, investigation of disposal options is under way, but no concrete concept for establishment of a repository has been officially proposed.

A-12.2.3. Time schedule for waste disposal

In 1993, the government decided that all radioactive waste should be placed for long term storage into an engineered facility at the COVRA site. This storage is envisaged to last for 50 to 100 years. No concrete plan for disposal exists at this time.

A-12.3. Siting of geological repositories

A-12.3.1. Siting process

Since there is no concrete plan for waste disposal, no formal siting process has been defined.

However, in the past, more than 25 years ago, research was carried out at a number of candidate sites in the northern part of the country to identify suitable salt formations. These studies determined that about 20 sites met the safety criteria for candidate repositories. However, further site characterization did not take place due to the strong opposition of local citizens and environmental groups. The latest national study, completed in February 2001, recommends that new efforts to identify a repository site should proceed in a stepwise process and that other types of host rock, clay in particular, should be taken into consideration.

A-12.3.2. Development of siting criteria

No siting criteria that may be needed in the future have been established yet. Nevertheless, studies completed in the past by the Interdepartmental Commission on Nuclear Energy, with representation of all concerned ministries, resulted in suggestion of the following criteria for selection of a site for disposal of radioactive waste:

- Site selection criteria:
  - 4 Availability of a suitable host rock formation:
    - ü At least 400 m deep
    - ü Adequate layer or dome thickness
    - ü No aquifers connecting to the biosphere
    - ü Not in use for other purpose (e.g. oil drilling, mining, salt production)
  - 4 Absence of seismicity

- 4 Adequate infrastructure
- 4 No densely populated areas nearby
- 4 Close to other nuclear fuel cycle activities, if possible

• Overriding criterion:
  - 4 Co-operation by local authorities.

A-12.3.3. General procedures for decision making in each phase or stage

No general site selection procedures have been established. It is envisaged that a decision by the government and approval by the Parliament would be needed as a first step to initiate a disposal programme.

A-12.3.4. Role of local governments

The Nuclear Energy Act (which regulates all nuclear activities) does not include provisions for the involvement of local administrations or members of the public. Since the Mining Act would apply to construction of the underground portions of a repository, the Ministry of Economic Affairs has sole authority for its implementation. On the other hand, the Environmental Protection Act will also apply to the siting process. This Act states that local governments are involved in the Environmental Impact Assessment as "involved administrative bodies". Local and provincial governments are also considered to be "competent bodies" for legislation and regulations regarding land use planning for any proposed repository site.

A-12.3.5. Financial assistance

There are no formal arrangements to provide financial assistance to communities affected by a repository.

A-12.4. Management costs

A-12.4.1. Total estimated cost and its breakdown

The Ministry of Economic Affairs asked certain independent organizations having extensive experience in financial planning of major engineering projects to study the costs of waste management activities. The conclusions are shown in the following table:

Cost element	Estimated cost (million EURO 1999)
Construction of HABOG	115
Operation and maintenance during emplacement of waste (10 years)	27
Operation and maintenance during storage (100 years)	227
Total storage cost	**369**
Repository design and construction	230–860
50 years retrievability	90
Total disposal cost	**320–950**

Notes:

(1) These costs depend strongly on: the design requirements of a repository, the type of host rock, the time period during which the waste is kept accessible for retrieval and any post-closure institutional controls that are deemed necessary.

(2) Because no concrete plans for a repository exist at this time, the values specified for geological repository related activities should be interpreted only as indicative.

(3) Acquisition of land for a repository has not been taken into account.

(4) It is assumed that HLW/SNF would be emplaced first in a repository for a demonstration period of 10 years, during which the repository would be kept fully staffed.

(5) The costs associated with the storage of HLW/SNF in HABOG have been estimated with more accuracy. However, the decommissioning costs of the storage facility have not been taken into account. The costs do not cover expenses for regulatory activities.

(6) There is no legal obligation to compensate local communities as the "burden" of having a repository in the region.

A-12.4.2. Organization responsible for cost estimation

Utilization of nuclear power was promoted by the government after the oil crisis in 1973 to diversify energy supply sources. As a result, disposal costs were initially estimated by the Ministry of Economic Affairs. However, in July 2001, responsibility for making policy on radioactive waste management, including cost estimation, was transferred to the Ministry of Housing, Spatial Planning and the Environment.

A-12.5. Financing system

A-12.5.1. Overview of the financing system

The generators of HLW and/or SNF are required to provide the financial resources required to manage the waste, including final disposal. The waste generators mainly consist of the three former shareholders of COVRA (the operators of Borssele NPP (EPZ) and Dodewaard NPP (GKN), the Energy Research Foundation (ECN)), and the operators of the HFR research reactor (European Commission) and the IRI research reactor (Technical University Delft). They have committed to finance construction and operation of a storage facility for HLW and SNF (i.e. HABOG), and to maintain financial reserves for waste disposal in the future. The amount of the reserve is calculated using a discounting method based on the assumption of a long term storage period of 140 years and an interest rate of 3.5%.

The procedures for collecting, maintaining and disbursing the financial resources are summarized in Fig. A-12.2.

Until the transfer of ownership of COVRA to the State, the financial resources were maintained and managed by the waste generators themselves. It was envisaged that ultimately in 2015, the accrued financial reserves for operation of HABOG and the future disposal of the wastes would be transferred to COVRA. The conditions for this transfer would be specified in an agreement between the government and the non-government shareholders in COVRA.

Now the non-government shareholders in COVRA have resigned as shareholders on 15 April 2002, and the situation has changed. The utilities have bought off all current obligations and future liabilities in the same transaction as the transfer of shares. The net balance of this transaction was added to a fund, managed by COVRA, earmarked as a financial resource for long term storage and disposal of radioactive waste. The Ministry of Finance has been designated to approve the annual budget of COVRA on behalf of the government. This Ministry has also assumed responsibility for supervision of the fund. The Ministry of VROM continues to exercise its responsibility for the development of waste management policies and strategies.

A-12.5.2. Waste management fee

The nuclear utilities and other waste generators are committed to co-operate for financing the construction and the operation of the high level waste storage facility and make payments on request. There is no surcharge on electricity rates.

By the down payment of a sum of money consisting of the discounted total costs for finishing construction and operation of the HABOG as well as the foreseeable risks as part of the transfer of ownership of COVRA to the State, the utilities are now exempted from any future liabilities in connection with the management of radioactive waste.

A-12.5.3. Withdrawal

After the transfer of shares to the government in 2015, the Ministry of Housing, Spatial Planning and Environment and the Ministry of Finance will be jointly responsible for approval of the waste management programme and the budget of COVRA. COVRA bears the responsibility for the management of the financial resources for long term storage and disposal.

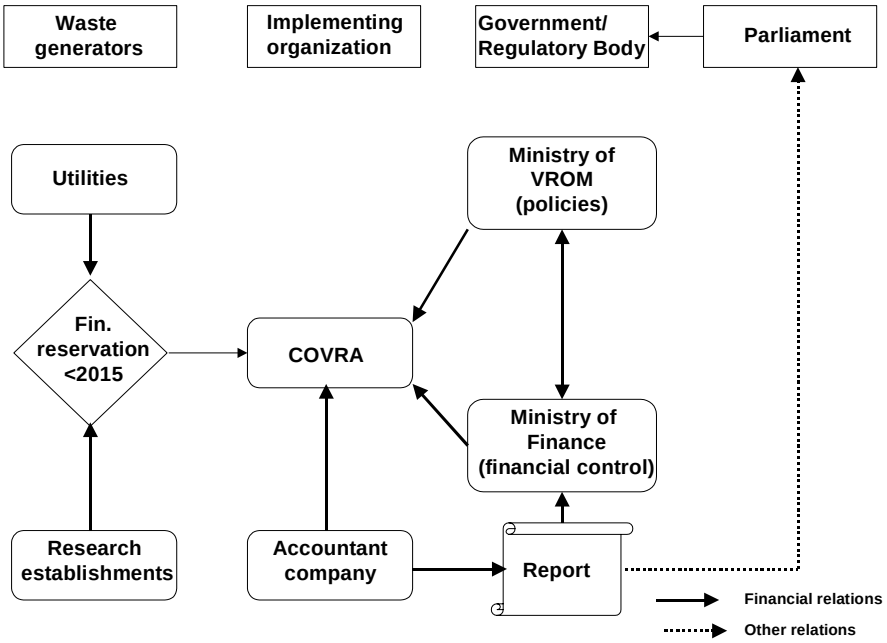


Fig. A-12.2. Financing system.

A-12.5.4. Auditing the financing system

The utilities were audited every year by private accountants. The Ministry of Finance and COVRA are in the process of setting up an auditing system to be used after transfer of the shares to the government.

A-12.6. Public involvement and transparency

The Environment Protection Act, which will apply to the repository siting process, specifies formal procedures for involvement of the public in industrial activities that have the potential to cause a notable impact on the environment. The general idea behind this regulation is to ensure that these activities take place in an entirely open manner with maximum transparency. These procedures aim to ensure that every citizen is allowed to comment on the plans for a proposed project, and raise objections if they wish. The procedures include notification of the public regarding proposed activities through notices published in local and national newspapers. The public is allowed to comment on the scope of Environmental Impact Statements (EIS) prior to preparation of the EIS, and to review and comment on the EIS and participate in public hearings concerning the EIS. Public comments and objections must be considered by the government in the process of making decisions on whether or not to proceed with the proposed projects.

A-12.7. Other considerations

A-12.7.1. Nuclear liability

The Netherlands has implemented through national legislation the Conventions of Paris and Vienna, as well as the Joint Protocol on third party liability for a damage caused by accidents in nuclear installations. The third party liability applies to an implementing organization responsible for radioactive waste management. The liability of the operator is limited to a maximum of 340 million EURO.

There are no other organizations bearing a liability for damages resulting from radioactive waste management, since COVRA is the only organization charged with this responsibility.

A-12.7.2. Retrievability and institutional controls

There are no concrete plans yet for geological disposal. Accordingly, no plans for institutional controls after closure of a repository have been established at this time.

On the other hand, in 1994, government adopted a position paper that specified that any underground disposal facility to be constructed should be designed in such a way that every step in the process could be reversed. In this context, in 2001, the COVRA Commission published the final report of a new national study on the feasibility of radioactive waste retrieval from a geological repository, the conclusions of which are as follows:

- Retrieval of radioactive waste from salt and clay repositories is technically feasible.
- Safety criteria can be met, even if the maximum permissible individual radiation dose remains 10μSv/a.
- Structural adjustments to the repository design would be required to ensure accessibility for retrieval operations.
- Costs for a retrievable repository would be higher than those for a non-retrievable repository.

A-12.7.3. Records keeping

A record management system is in place with the implementing body, i.e. COVRA. The types and quantities of radionuclides in the wastes collected from the users are recorded by COVRA. The records are maintained on a computer (PC) system. Back-up disks and tapes are stored in a safe place on the COVRA site. The records are required to be maintained as long as COVRA exists. The system itself is not accessible by the public, but the COVRA annual report, which includes a current inventory of conditioned waste in storage, is made available to the public.

A-13. RUSSIAN FEDERATION

A-13.1. Organization and legislation

A-13.1.1. Organizational structure

POLICY/LEGISLATION

Parliament (Duma)

- Enacts laws.

Government

Ministry for Atomic Energy (Minatom)

- Develops policies and strategies for waste management.
- Develops and manages the federal waste management programmes.
- Co-ordinates research activities.
- Prepares the budget for waste management.

REGULATION/OVERSIGHT

Regulatory/Oversight Authority

Gosatomnadzor of Russia

- Is responsible for nuclear safety regulation and nuclear activities oversight.

Regulatory Authority

Ministry of Natural Resources

- Is responsible for environment protection regulation.

IMPLEMENTATION

Implementing Organization

Minatom, supported by:

Research and Siting Organization*

- Is responsible for research and siting.

Design Organization*

- Is responsible for organizing disposal projects, including design of facilities.

Construction and Maintenance Organization*

- Is responsible for construction and operation of the repository.
-

* These organizations are state institutions supervised by Minatom.

Financial Resource Management Body

Minatom

The interactions of the government and different organizations involved in the HLW and/or SNF long term management in Russia are presented in Fig. A-13.1.

A-13.1.2. Implementing organization

The functions necessary to implement disposal of solid and solidified radioactive waste in geological formations are divided into three elements, i.e. research, design, and repository construction and operation. Different organizations have been designated to carry out these three functions. All of these organizations are state organizations supervised by Minatom.

The oversight and regulation function is performed by Gosatomnadzor of the Russian Federation and the Ministry of Natural Resources, making the establishment of separate oversight bodies unnecessary.

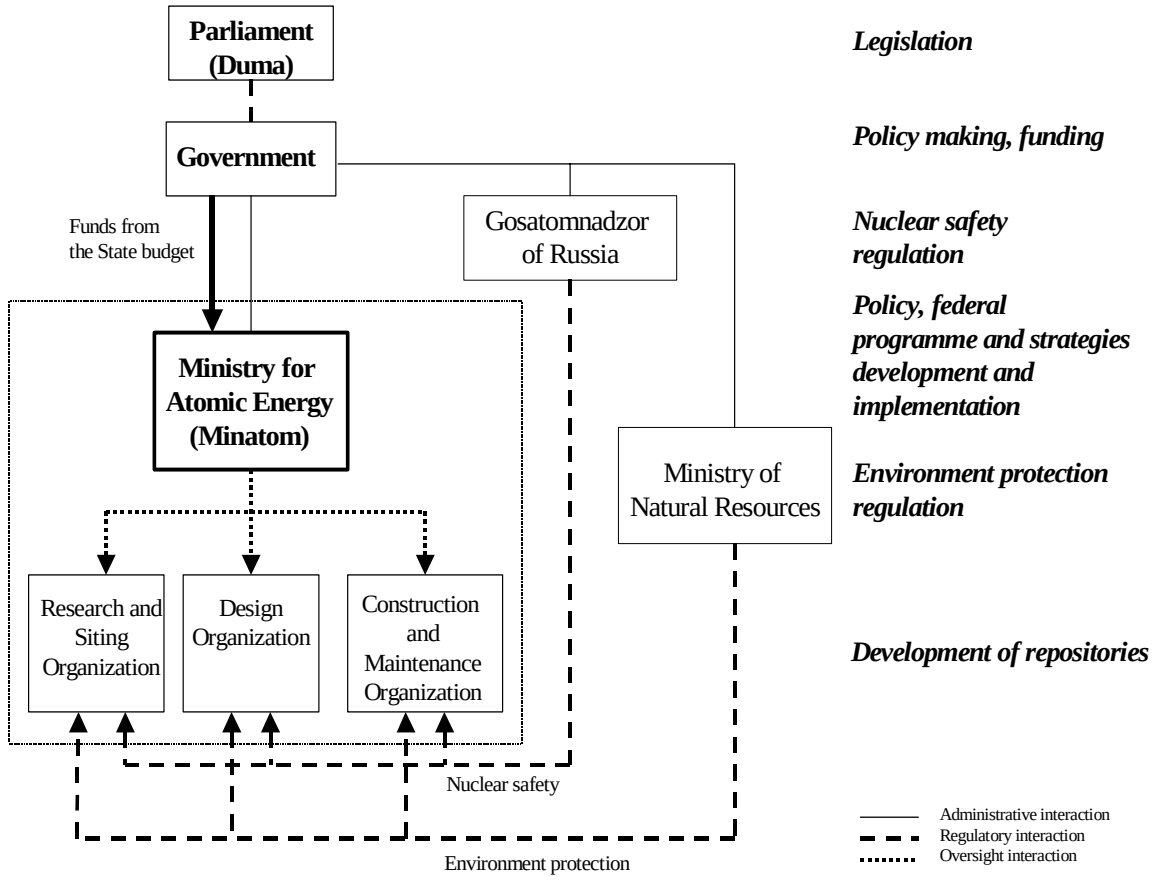


Fig. A-13.1. Organizational structure.

A-13.1.3. Laws and regulations

The fundamental institutional framework (responsibilities and requirements) for radioactive waste management is stipulated in the "Law on Utilization of Atomic Energy", "Law on Radiation Safety of the Public", "Law on Environmental Assessment", and "Law on Sanitary-Epidemiological Health of the Public". The major regulations establishing nuclear safety requirements in detail for management of solid and solidified radioactive waste are as follows:

4 The Concept of Reliable Isolation of Radioactive Waste in Geological Forms (1993),
4 Federal Standard on Solidified High Level Waste (P50926-96),
4 Federal Standard on Radiation Control at Radioactive Waste Disposal Sites (12.1.048-85).

A-13.2. Waste streams and proposed repositories

A-13.2.1. Waste stream assumptions

At the end of 2001, the Russian Federation had a total of 30 nuclear power reactors in operation, with a total capacity of 22.6 GW(e) [excluding very small reactors having an electrical output capacity of about 10 MW(e)]. Of these reactors, 15 are light water reactors (such as WWER), 14 are RBMKs, and one is an FBR. There are 4 additional power reactors under construction [3 WWER and 1 RBMK with a total capacity of 4 GW(e)].

Data is not available to specify the quantity of SNF and HLW currently in storage in the Russian Federation.

A-13.2.2. Proposed repositories

Four facilities in geological formations are planned for storage and disposal of solid and solidified radioactive waste, as follows:

Site	Beginning of investigation	Type of geological formation	Depth (m)	Status	Commissioning date
"Mayak" Enterprise (Chelyabinskaya obl.)	1975	Hard rock, porphirites	100–500	Geological exploration. Underground laboratory being designed	2025
Mining and Chemical Combine (Krasnojarsk region)	1990	Hard rock, granites	100–1000	Detailed geological exploration	2030
Priargunski Mine (Chita province)	2000	Hard rock, diabase	100–800	Preliminary discussion	2030
Novaya Zemlya Archipelago	1985	Hard rock, permafrost	30–100	Being designed	2005-2010

The facilities under consideration at the "Mayak" Enterprise and the "Mining and Chemical Combine" (Krasnojarsk region) are proposed for storage of solidified HLW. At the "Priargunski-Mining Combine" (Krasnokamensk, Chitinskaya obl.), proposals are being studied for construction of a deep geological repository for disposal of solidified radioactive waste, including waste in a glass form. In the Novaya Zemlya archipelago region, a near surface storage facility is being developed for SNF that is not subject to reprocessing.

A-13.2.3. Management time schedule

According to the current plans, geological disposal will not begin until 2025 – 2030, except for the repository in the Novaya Zemlya archipelago, where repository operation is to begin no later than 2010.

A-13.3. Siting of geological repositories

A-13.3.1. Siting process

The siting process has been, or is being, conducted differently for each of the sites under consideration.

At Mayak, five possible areas are being examined. Construction of an underground research laboratory is being considered as the first step in developing a geological repository. The site proposed for the URL is in an area very close to the surface facility used for storage of vitrified waste.

At the Mining and Chemical Combine, 5 areas have been selected for more detailed investigation. The main factor defining the possibility of repository construction is the degree of tectonic disturbance of the granites and the surrounding metamorphic rocks. Tectonic fracturing should be minimal to reduce the possibility of unacceptably high radionuclide transport rates.

At the Priargunsky Mining Combine, the design of underground facilities for radioactive waste disposal will be developed after completion of ore extraction mining activities in 2020. Plans are to use the existing infrastructure to the maximum extent possible.

In the Novaya Zemlya archipelago, preliminary site selection was carried out by identifying areas within the Northern cryolite zone (in the Arctic geocryological area) where appropriate geocryological formations are continuous with respect to both horizontal area and depth. Further narrowing of the

regions under consideration was based on analysis of the potential for raionuclide transport through the geological medium after disposal. Areas currently having low population density and less potential for economic development in the future were given preference. During the second stage of site selection, sites were selected which were located outside of the areas in which intensive development of permafrost-geological processes have occurred, and away from areas with modern biogenic formations. Sites with raised relief were given preference. In addition, the ease with which infrastructure could be developed was considered. At the third stage, characterization of the host rock expected to be used for radioactive waste disposal was performed. Finally, a site was chosen in the southern part of the southern island.

A-13.3.2. Development of siting criteria

The fundamental safety requirements for disposal of all kinds of radioactive waste in geological formations are stipulated in the Law on Utilization of Atomic Energy. Detailed criteria are established in the Radiation Safety Standard and Fundamental Sanitary Rules for Radiation Safety developed by Gosatomnadzor of Russia.

A-13.3.3. General procedures for decision making in each phase or stage

Minatom will select the sites for geological repositories on the basis of the results of research activities.

A-13.3.4. Role of local governments

Local authorities become involved in the repository siting process shortly before the construction application is to be submitted to the federal authorities. Local authorities organize public hearings during which the repository design is addressed. The construction application must include the results of the public discussion.

A-13.3.5. Financial assistance

Since geological repositories will generally be developed in unpopulated areas in the Russian Federation, expectations are that there will be no need to consider provision of financial assistance to local governments within whose jurisdictions the repositories will be sited.

A-13.4. Management costs

A-13.4.1. Total estimated cost and its breakdown

The project in the Novaya Zemlya archipelago region (for disposal of LLW and ILW, and long term storage or disposal of SNF that is not subject to reprocessing) is the most advanced of the four projects summarized in the table in Section A-13.2.1 above. The costs for this project are estimated as follows:

- Total amount invested — US $70 million including:
  - Capital investment — US $55 million
  - Annual operational expenses:
    - Starting period (5 years) — US $6 million
    - Succeeding years — US $8 million
- Cost of disposal of ILW and LLW per m^3 of waste:
    - Starting period (5 years) — US $2500
    - Succeeding years — US $2000
- Cost of long term storage per assembly of spent nuclear fuel:
    - Starting period (5 years) — US $25 000
    - Succeeding years — US $15 000

Since the other projects are still under investigation, no cost estimates have been conducted for them at this time.

A-13.4.2. Organization responsible for cost estimation

The cost estimation is carried out by the organization responsible for design of the repository. These cost estimates are then reviewed by experts designated by Minatom.

A-13.5. Financing system

A-13.5.1. Overview of the financing system

The Federal Government finances the cost of all radioactive waste management from the federal budget.

A-13.5.2. Waste management fee

Due to the financing system used in the Russian Federation, there is no disposal fee.

A-13.5.3. Withdrawal

Since funds are obtained from the federal budget, the "withdrawal" concept is not applicable in the Russian Federation.

A-13.5.4. Auditing the financing system

The Federal Accounting Chamber is responsible for auditing expenditures from the federal budget, in accordance with the general rules applicable to the federal budget.

A-13.6. Public involvement and transparency

The expectations for and mechanisms used in conducting public involvement activities in the Russian Federation are evolving. Rules currently in place call for public discussions to be organized by local authorities shortly before a construction application is submitted to the federal authorities. Anyone who wishes to participate is allowed to take part in the discussion. The participants usually include individuals from the following categories:

- Representatives of scientific and technical groups responsible for designing the repository,
- Officials of local authorities responsible for environmental and sanitary-hygienic issues,
- Local experts on ecological issues,
- Journalists,
- Individual citizens who have an interest in the issue under discussion.

The results of public hearings are required to be considered during all stages of acceptance of proposed projects.

As an example, in the Northwest region of the country, construction of a large radioactive waste storage facility has gained a wide public support because the public understands that improvements in the ecological conditions in the region depend on development of the facility. During the last election of the governor of the Arkhangelsk province, all of the candidates declared their support for the project, under the expectation that such a position would gain additional votes for their parties. Public hearings were conducted on two occasions, during which many topics were discussed (e.g. safety of the facility, taxes, contracts from the operator, impacts on natural resources, utilization of the provincial industrial infrastructure).

A-13.7. Other considerations

A-13.7.1. Nuclear liability

According to the “Law on Sanitary-epidemiological Health of Population” and the “Law on Radiation Safety of the Public”, the Federal Government is liable for any damage caused by a nuclear accident. The limit of this liability has not been decided yet.

A-13.7.2. Retrievability and institutional controls

The applicable requirements specify that any geological repository must be monitored for several decades after closure, during which period appropriate measures must to be provided to ensure retrievability of HLW and/or SNF.

A-13.7.3. Records keeping

The record management system to be used after closure of a geological repository will be developed after construction of the first repository begins.

A-14. SLOVAKIA

A-14.1. Organization and legislation

A-14.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws

Government

Ministry of National Economy

- Develops policies and strategies for waste management.
- Is expected to make the final decision on site selection for a repository.

REGULATION

Regulatory Authority

Nuclear Regulatory Authority (UJDSR)

- Is responsible for nuclear safety regulation.

IMPLEMENTATION

Implementing Organization

Slovak Electric plc.

- Conducts radioactive waste management and disposal activities, including development of a deep geological repository.

Financial Resource Management Body

Ministry of National Economy

- Manages the decommissioning, SNF and radioactive waste management fund.

The interactions of the government and different organizations involved in HLW and/or SNF long term management in Slovakia are presented in Fig. A-14.1.

A-14.1.2. Implementing organization

In accordance with the State Decommissioning Fund Act, only the owner/operator of nuclear facilities can use the resources from the State Fund. Since the only owner/operator of nuclear facilities (including SNF and radioactive waste management facilities) in Slovakia is Slovak Electric plc. (at the present time, a 100% state owned joint stock company), Slovak Electric plc. is the only implementing organization today for radioactive waste management, including disposal. Within Slovak Electric plc., three subsidiary companies are involved: Jaslovske Bohunice NPP, Mochovce NPP, and SE-VYZ (NPP Decommissioning and Radioactive Waste Management Company).

The Nuclear Regulatory Authority of Slovakia (UJD SR) is responsible for supervision of nuclear safety (including all aspects of radioactive waste management), the Ministry of Health is responsible for radiation protection regulations, and the State Fund Board is responsible for providing advice to the Minister of National Economy regarding expenditures by the implementing body. The oversight function is performed at present by UJD SR and the Ministry of Health in Slovakia.

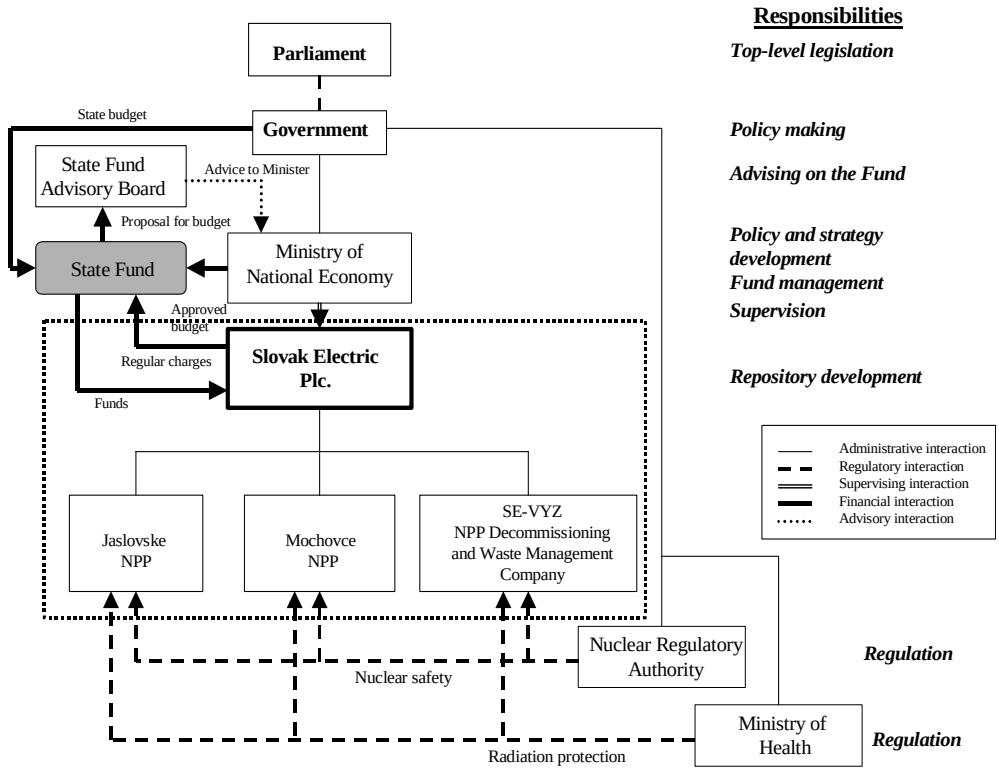


Fig. A-14.1. Organizational structure.

A-14.1.3. Laws and regulations

The following law and regulations specify the requirements for SNF/HLW management in Slovakia:

- Act No. 254/1994 on the State Fund for Decommissioning of Nuclear Power Plants and the Management of Spent Nuclear Fuel and Radioactive Waste, amended by Acts No. 78/2000 and No. 560/2001 (financing system).
- Regulation No. 190/2000, which regulates in detail the management of radioactive waste and spent nuclear fuel.

The basic requirements for safe management of radioactive waste and SNF and the general requirements applicable to radioactive waste generators and radioactive waste/SNF management facility operators are specified in Act No. 130/1998 on Peaceful Use of Atomic Energy (Atomic Act), along with requirements applicable to other nuclear activities.

A-14.2. Waste streams and proposed repositories

A-14.2.1. Waste stream assumptions

There are eight WWER type nuclear power reactors in Slovakia, six of which are in operation with a capacity of about 2.64 GW(e), and two for which construction has been suspended. There is one HWGCR (A-1 Bohunice NPP) that was shut down in 1979 and is currently being decommissioned.

All SNF generated at the A-1 Bohunice NPP has been transported to the Russian Federation. However, the study on decommissioning of the A-1 Bohunice NPP shows that approximately 1500 m^3 of decommissioning waste (approximately 500 of the packages/standard containers used in Slovakia) will not meet the criteria for near surface disposal.

The government has decided to shut down Bohunice-1and Bohunice-2 (also called NPP V-1) in 2006 and 2008. Bohunice-3 and 4 (also called NPP V-2) are expected to be shut down in 2015 and 2016, at the end of their thirty-five year operating lifetime. SNF arising from these reactors at Bohunice will amount to 4028–4768 assemblies by the end of their lifetimes, depending on the enrichment of the fuel. Another approximately 1860 m³ of wastes which will not meet the criteria for near surface disposal are expected to result from decommissioning of these reactors.

The two power units at Mochovce (which have been in operation since 1999 and 2000, respectively), are expected to generate 2959 fuel assemblies during their lifetime. Another approximately 760 m³ of wastes which will not meet the criteria for near surface disposal are expected to result from decommissioning of these reactors.

A total of 2500 tHM of SNF are expected to be generated due to operation of these NPPs.

A-14.2.2. Proposed repositories

The government of Slovakia has not yet established a policy on the final management of HLW and SNF. Nevertheless, it was decided to continue studying a repository for HLW and SNF. The need for a repository was mentioned briefly in the "State Plan of Geological Research and Investigation" (prepared by the Geological Section of the Ministry of Environment) and in the "State Energy Policy" (prepared by the Ministry of National Economy), both of which have been approved by the government.

After the division of the Czechoslovak Federation into separate Czech Republic and Slovakia, the former Czechoslovak federal deep geological repository development programme has continued in a revised form as a Slovakia programme. This programme has been financed from the State Fund for NPP decommissioning and spent fuel and radioactive waste management through Slovak Electric plc. (the only owner of nuclear facilities in the country and the exclusive user of the fund). Slovak Electric plc. has signed a contract with the DECOM Slovakia company under which DECOM Slovakia co-ordinates development of the repository. More than 50 documents/studies have been prepared within the framework of this deep geological repository development programme. The characteristics of the repository discussed in these documents are listed below. Such a repository would have sufficient capacity to dispose of all of the radioactive waste mentioned in Section A-14.2.1.

Capacity	Approximately 2500 t HM
Host rock	Crystalline rock formation (e.g. granite), or sedimentary rock formation (e.g. clay)
Depth	More than 500 m for crystalline rock, or 200-300 m for sedimentary rock
Engineered barrier system	Container, sealing material, etc.

Slovakia also plans to dispose of a small volume of institutional wastes, mainly spent sealed sources which cannot be disposed of in a near surface repository (e.g. radium sources from hospitals and large sources from industrial applications) along with the HLW and SNF.

A-14.2.3. Management time schedule

The government has not decided on the option for the long term management of SNF in Slovakia. The options being considered are as follows:

- Dispose of both HLW and SNF;
- Transport SNF abroad (to the Russian Federation) for reprocessing and dispose of returned HLW;
- Transport SNF abroad (to the Russian Federation) without HLW return.

The time-schedule for waste disposal (a national deep repository option) was described in a recent feasibility study carried out for the purpose of the planning the State Fund (see Section A-14.5.1) as follows:

Final governmental decision on the back-end of the nuclear fuel cycle and HLW management	2006–2010
Construction license	2030
Repository construction	2030–2050
Operating license	2037
Operation	2037–2095
Repository closure	2095–2102

A-14.3. Siting of geological repositories

A-14.3.1. Siting process

Siting activities have been carried out since 1997, based on the "Slovak Deep Geological Repository Programme". The main course of the Slovak repository development programme has been a preliminary site selection using archive data and maps, conducted by the Geological Survey of Slovakia. This effort resulted in selection of six sites, with the areas of tens of square kilometres each, as preliminary suitable areas. Then in situ geophysical investigations (e.g. boreholes) were initiated to identify areas suitable for further investigation. These investigations will continue for the next five years to narrow the number of suitable sites. There has not been any public involvement in the siting process up to now.

The strategic governmental decision concerning how to close the back end of the nuclear fuel cycle, including geological repository development, must be accomplished through use of an SEIA (Strategic Environmental Impact Assessment), as required by the Act of EIA. The final selection from among the last siting alternatives will be the subject of a standard environmental impact assessment process. The public and affected municipalities will be involved in the SEIA and EIA processes, as specified in the applicable legislation.

The necessity for an underground research laboratory will be studied in the course of the investigations discussed above.

A-14.3.2. Development of siting criteria

A set of criteria for the preliminary site selection has been developed by the research co-ordination organization (DECOM Slovakia Ltd.) with the assistance of the Geological Survey of Slovakia as one of the tasks in the "Slovak Deep Geological Repository programme". This programme was conducted under a contract with Slovak Electric plc. (as discussed above). There has been no involvement of regulatory authorities at this stage.

The criteria address all the topics included in IAEA Safety Series No. 111-G-4.1 (Siting of Geological Disposal Facilities) and IAEA-TECDOC-991 (Experience in Selection and Characterization of Sites for Geological Disposal of Radioactive Waste). In the course of review currently under way, socio-economic aspects and consistency with the siting criteria under consideration by the IAEA and European countries are also being considered.

A-14.3.3 General procedures for decision making in each phase or stage

As discussed in Section A-14.3.1, the government will decide on a strategy for management of HLW and SNF, including selection of a repository site, after the decision on the policy for closing the back end of the nuclear fuel cycle.

A-14.3.4. Role of local governments

According to Act No. 127/1944 and its amendment No. 391/2000 on Environmental Impact Assessment, the affected municipalities will be involved in the siting process so that they may make their opinions known and have them considered in the government's decision making process.

A-14.3.5. Financial assistance

The State Fund Act (No. 254/1994 amended by Acts No. 78/2000 and 560/2001) specifies that the owner/operator of a nuclear facility shall make payments to affected municipalities for protection of lives and the environment in the affected area as 1% of sale price of yearly produced electric power in nuclear power plants for every nuclear facility disaster area. Details of how this provision might be used in practice will be discussed in the future.

A-14.4. Management costs

A-14.4.1. Total estimated cost and its breakdown

For the purpose of planning the State Fund, an estimation of the total cost of managing the SNF and HLW is periodically prepared. A summary of this cost estimate and its breakdown are given in the following table:

Cost element	Cost (billion Sk 2000)
Long term storage of SNF for 50 years	15.600
Siting (from present to 2037)	
R&D	8.215
Public relations	0.200
Design	0.900
Construction (2030–2060)	20.210
Packaging of wastes (2037–2095)	10.500
Operation (2037–2095)	16.300
Closure of underground facilities (2057–2095)	2.660
Final closure (2095–2102)	0.600
Total	**~75.200**

A-14.4.2. Organization responsible for cost estimation

The current cost estimates were prepared partially under the Slovak Deep Geological Repository Programme, and partially at the request of Slovak Electric plc. for the purpose of planning the State Fund. The portions of the estimate done for Slovak Electric plc. were under the general management of the Ministry of National Economy. Supporting estimation studies were carried out by DECOM Slovakia and other repository programme participants at the request of Slovak Electric plc.

A-14.5. Financing system

A-14.5.1. Overview of the financing system

The State Fund to cover the costs for decommissioning of nuclear facilities, the back-end of the nuclear fuel cycle and conditioning and disposal of low level waste arising from decommissioning was established by the Act on the State Fund for Decommissioning of Nuclear Facilities and Spent Fuel and Radioactive Waste Management (Act No. 254/1994), amended by Acts No. 78/2000 and No. 560/2001.

The following assumptions were made to calculate the fee:

- The minimum difference between discount/interest and inflation rates shall be 2.92%
- The electricity rates shall increase to 1.9 Sk/kW•h at minimum in 2009.

According to the Act (as amended), the owner of the nuclear power plants (now Slovak Electric plc) shall pay to the Fund annually 6.8% of the sale price of the electricity sold by the plants and 350 000 Sk for each MW of installed electrical power. Based on the actual (year 2000) electricity rate, the fee has been calculated to be somewhat less than 0.13 Sk/kW•h. Details of the calculation of fund contributions are to be established by a binding legal enactment (regulation) to be issued by the Minister of National Economy.

The resources of the Fund may be used for the following purposes:

(b) Decommissioning of nuclear facilities,
(c) Management of spent nuclear fuel and radioactive waste after shut-down of nuclear facilities,
(d) Management of radioactive waste, the generator of which is unknown,
(e) Purchasing of lands for siting of radioactive waste and spent nuclear fuel repositories,
(f) Research and development on nuclear facility decommissioning and management of spent fuel and radioactive waste after shut-down of nuclear facilities,
(g) Siting, geological investigation, preparation, designing, construction, commissioning, operation and closure of spent nuclear fuel and radioactive waste repositories, including post-closure monitoring,
(h) Expenditures relating to management of the fund, up to 0.3% of the fund's annual income, and
(i) Contributions to the life and health protection of inhabitants and to the protection and development of the environment of municipalities inside the nuclear facility disaster areas.

The Ministry of National Economy is responsible for the management of the Fund. The financial resources are deposited in the State Fund account. These funds generate interest, the rates of which are established by the Slovakian National Bank.

A-14.5.2. Waste management fee

There is no separate fee for radioactive waste management in Slovakia. Instead, the financial resources required for these purposes are a part of the annual budget for expenditures from the State Fund, in accordance with the applicable legal requirements (see Section A-14.5.1) and decisions made by the Minister of National Economy (see Section A-14.5.3).

A-14.5.3. Withdrawal

Every year, the State Fund Advisory Board recommends to the Minister of National Economy the amount of funding to be withdrawn from the Fund. The Minister of National Economy has been assigned to approve the withdrawal.

A-14.5.4. Auditing the financing system

The financial system is audited by the Ministry of Finance and the Slovak National Bank.

A-14.6. Public involvement and transparency

In accordance with Act No. 127/1994 and its amendment No. 391/2000 on Environmental Impact Assessment, the public will be allowed to participate in the environmental assessment through public hearings. A progress report on the Slovak Deep Geological Repository Programme is prepared every year by the repository programme coordinating company (DECOM Slovakia) and sent to Slovak Electric plc. for the use in providing information to the public. Plans are under preparation within the repository development programme for additional future public involvement activities.

A-14.7. Other considerations

A-14.7.1. Nuclear liability

The Atomic Act addresses third party liability for damage caused by operational activities of nuclear facilities, including disposal facilities. Operators have the ultimate responsibility for any damages. Regulations concerning limits to the liability for waste disposal related activities are under preparation.

A-14.7.2. Institutional controls

Slovakia plans to investigate the requirements for institutional control in detail, after a government decision is made on a policy on the back-end of the fuel cycle. This investigation will be based on the provisions of regulation No. 190/2000 on radioactive waste management and spent fuel management.

A-14.7.3. Records keeping

In accordance with regulation No. 190/2000, a licensee is required to keep the records on radioactive waste management until a repository is closed. After closure, the records will be moved to an institution designated by the Government for performing institutional control. These records must include a history of the owners of the radioactive waste, treatment and processing, irradiation history, composition, emplacement, etc.

A-15. SOUTH AFRICA

A-15.1. Organization and legislation

A-15.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.

Government

Ministry of Minerals and Energy

- Develops policies and strategy for radioactive waste management.

REGULATION

Regulatory Authority

National Nuclear Regulator

- Grants licenses.
- Monitors regulatory compliance.

IMPLEMENTATION

Implementing Organizations

Ministry of Minerals and Energy (the function below may be delegated to an appropriate organisation(s))

- Is responsible for management of radioactive waste.

South African Nuclear Energy Corporation (NECSA) and ESKOM

- Are responsible for storage of SNF.

Financial Resource Management Bodies

South African Nuclear Energy Corporation (NECSA) and ESKOM

- Are responsible for maintaining financial resource

The interaction of the government and different organizations involved in the SNF long term management in South Africa is shown in Fig. A-15.1.

A-15.1.2. Implementing organization

The Ministry of Minerals and Energy is responsible for management of radioactive waste, including storage of spent nuclear fuel. The Minister may delegate this duty to one or more appropriate organizations. Spent nuclear fuel is currently stored at the reactor sites. No organization has been designated to be responsible for disposal of SNF at this time.

A-15.1.3. Laws and regulations

There is no national policy for disposal of SNF at this time. Accordingly, no specific laws and regulations have been developed for disposal of SNF. However, a draft radioactive waste management policy was issued in November 2000 and is currently under review.

A-15.2. Waste streams and proposed repositories

A-15.2.1. Waste stream assumptions

There are two sources of HLW and SNF in South Africa. They are the SAFARI I research reactor and two PWR type nuclear power reactors with a total capacity of about 1.8 GW(e).

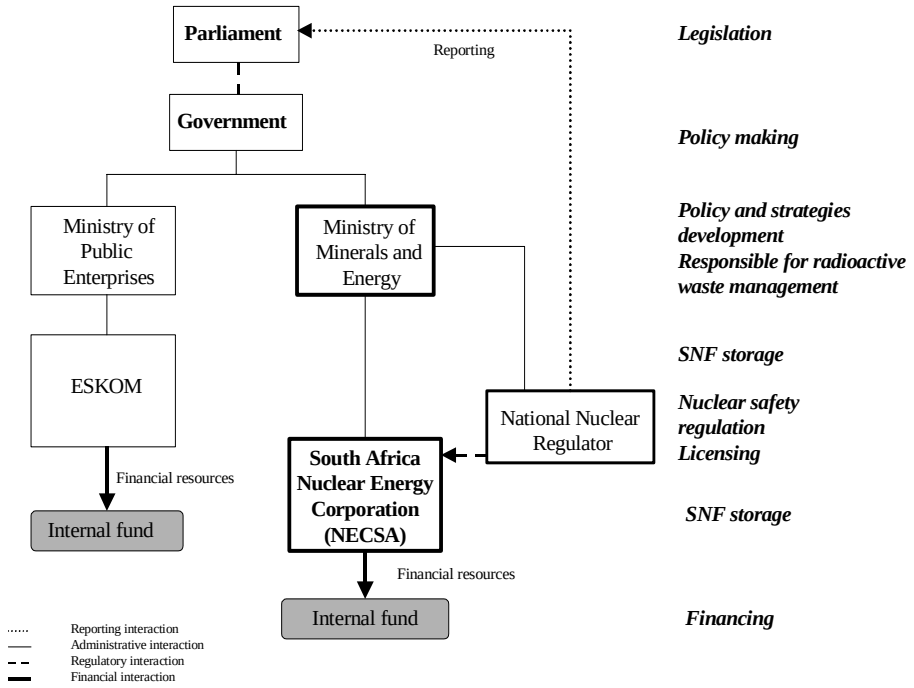


Fig. A-15.1. Organizational structure.

SAFARI I achieved criticality in 1965 and is planned to be shut down in 2020, although refurbishment is being considered. The total amount of SNF expected to be produced during the lifetime of SAFARI I will be 5 m³, containing 150 kg of uranium.

Efforts are currently under way to extend the lifetime of the two operating power reactors from 40 years at present to 50 years, with shut down in about 2035. This could result in generation of about 4000 SNF assemblies (equivalent to about 1900 t HM) during their lifetime.

A feasibility study for the so-called Pebble Bed Modular Reactor is being undertaken by ESKOM. If this reactor is built and operated, more SNF will be generated.

South Africa's tentative plans are to store their SNF for 50 years after shut down of their nuclear power reactors in about 2035. There are at present no plans to reprocess any of the SNF.

A-15.2.2. Proposed repositories

There is no formal national policy on the SNF disposal. As a result the specifications of a repository has not been defined.

However, a very preliminary investigation on the concept of repositories for HLW and SNF has been undertaken, based on consideration of deep geological disposal in granitic rock as a favoured option for further investigation. A summary of the features of the repository developed during this study is shown below:

Capacity for SNF	On the order of 2500 t HM
Host rock	Granitic mass
Depth	500 m
Area	130 ha
Excavation	15 000 m³ for SNF disposal 20 000 m³ for LLW disposal
Engineering barrier system	No specific barrier system has been considered, except bentonite backfill.

Facilities for disposal of low level waste were not included in this concept because a licensed low and intermediate level radioactive waste repository has been in operation in South Africa since 1986. This repository is expected to be completely adequate to meet South Africa's foreseeable needs.

A-15.2.3. Management time schedule

There is neither a national policy nor a strategy for disposal of HLW and SNF in South Africa. As a result, an official time schedule has not been developed at this time. However, the electricity generator envisages that disposal facilities will not be required until the last quarter of this century as a result of the extension of power reactor lifetime from 40 to 50 years and storage of the resulting SNF for 50 years at the reactor sites.

A-15.3. Siting of geological repositories

A-15.3.1. Siting process

When a national policy for management of SNF and/or HLW is formulated in the future, the Minister of Minerals and Energy will address in detail a siting methodology for a repository. Since South Africa has always adhered to international norms, expectations are that the country would take the following actions:

4 The initial stage will be a planning and conceptual design phase where concepts will be examined and evaluated.
4 A regional survey will be conducted to identify a number of potential sites. They will be subjected to detailed site characterization studies and preliminary safety assessments, leading to selection of a preferred site. It is expected that this phase will take five years to be completed.
4 Detailed investigations of the selected site will be conducted, including rigorous geo-technical evaluation and research in an underground research facility. Data obtained from these investigations will be used in final repository design, an environmental impact assessment and a site-specific safety assessment. Completion of this phase will lead to a major licensing process with the regulatory authorities.

A-15.3.2. Development of siting criteria

When a national policy for management of SNF and/or HLW is formulated in the future, a process to develop siting criteria will be conducted. It is expected that the country will adhere to international guidelines concerning its nuclear activities. In the possible siting process, guidelines and criteria are expected to be established in the initial stage.

A-15.3.3. General procedures for decision making in each phase or stage

When a national policy for management of SNF and/or HLW is formulated in the future, general procedures for decision making will be established.

A-15.3.4. Role of local governments

When a national policy management of SNF and/or HLW is formulated in the future, the role of local governments will be defined.

A-15.3.5. Financial assistance

When a national policy management of SNF and/or HLW is formulated in the future, financial assistance to local communities and people will be considered. In the interim, NECSA already actively contributes to the social and economic upliftment of local communities in the vicinity of its facilities.

A-15.4. Management costs

A-15.4.1. Total estimated cost and its breakdown

There is no official cost estimation. However, NECSA prepared a cost estimate so they could calculate and set aside the financial resources that will be necessary to pay for disposal of SNF in the future.

A-15.4.2. Organization responsible for cost estimation

The organization(s) responsible for preparing cost estimates for management of HLW/SNF will be designated by the Ministry of Minerals and Energy when a formal radioactive waste management policy and strategy have been established.

A-15.5. Financing system

A-15.5.1. Overview of the financing system

Financing systems have been established in which to accumulate the funds that will be required for long term storage and eventual disposal of the HLW and SNF from the SAFARI I research reactor and the two nuclear power reactors. Funds have been established internally by NECSA and ESKOM to cover the expenditures for all stages of the disposal projects from site selection to closure. Contributions are made to these funds on an annual basis.

A-15.5.2. Waste management fee

Due to the lack of a national disposal policy and a specific plan, it is difficult to estimate accurately the disposal costs in the future. However, the order of magnitude estimated costs of a repository as calculated by NECSA are used to determine the magnitude of these annual contributions.

A-15.5.3. Withdrawal

When a national policy for radioactive waste management is formulated in the future, the withdrawal system will be established.

A-15.5.4. Auditing the financing system

The funds held by NESCA and ESKOM are audited by internal and external auditors on an annual basis.

A-15.6. Public involvement and transparency

The government understands that stakeholder/public participation at every stage of the siting process is absolutely essential to allow acceptance of a repository by the public. Accordingly, the government has firmly committed to conduct this process in an open and transparent manner.

The nature and extent of this kind of the public/stakeholder involvement will be determined during the planning stage for the siting process.

A-15.7. Other considerations

A-15.7.1. Nuclear liability

Generators of radioactive waste, or operators of waste disposal facilities, as the case may be, shall be accountable for the technical, financial and administrative liabilities of such waste. Their responsibilities will be terminated at closure of the repository if the closure is confirmed to be in compliance with the conditions of the licence.

The responsibility of an operator of a repository will be terminated at closure of the repository, if the closure is confirmed to be in conformance with the conditions of the license.

A-15.7.2. Institutional controls

After closure of the repository, the government will be responsible for a period of institutional control, the time frame of which will be determined in the future.

A-15.7.3. Records keeping

The operator of any waste management or disposal facility is responsible for developing and keeping the record management system. After closure of the repository, the responsibility for maintaining the system will be passed to the government.

A-16. SPAIN

A-16. 1. Organization and legislation

A-16.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.
- Performs oversight of CSN activities.

Government

- Establishes policies.
- Approves the ENRESA's plan.

REGULATION

Regulatory Authorities

Ministry of Economy

- Grants licenses for construction, operation, etc.
- Maintains the national policy for management of radioactive waste through annual revision of the General Radioactive Waste Plan (such revisions must be approved by the Government).
- Controls the ENRESA's compliance of the policy defined in the approved Plan.
- Controls the management of the Fund

Ministry of Environment

- Reviews and approves EIA

Nuclear Safety Council (CSN)

- Develops safety guidelines.
- Issues binding reports used as the basis for granting licenses.

IMPLEMENTATION

Implementing Organization

ENRESA

- Is responsible for implementation of radioactive waste and SNF management.

Financial Resource Management Bodies

ENRESA

- Is responsible for Fund management.
- Calculates fees.

Oversight and Control Committee

- Develops criteria for management and maintenance of the Fund.

The interaction of the government and different organizations involved in the SNF and/or HLW long term management in Spain is shown in Fig. A-16.1.

A-16.1.2. Implementing organization

The National Waste Management Company ENRESA was established in 1984 by Royal Decree 1522/1984 to be the implementing organization. ENRESA is a state-owned company whose shareholders are the Centre for Energy-Related, Environmental, and Technological Research (CIEMAT), and the State Industrial Holding Company (SEPI), both of which are governmental institutions. The ENRESA role is to develop and implement radioactive waste and spent nuclear fuel management programmes, consistent with Spain's national policies and strategies.

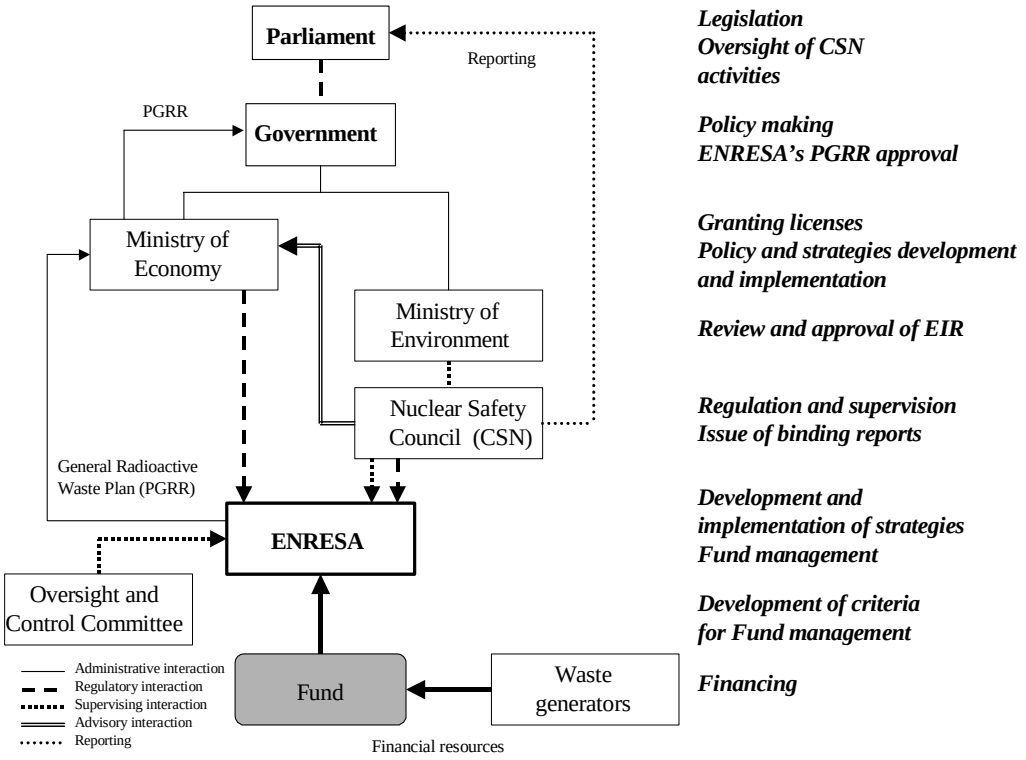


Fig. A-16.1. Organizational structure.

The Ministry of Economy is responsible for defining the radioactive waste policy, established in the General Radioactive Waste Plan (PGRR), a document which outlines the strategies and main lines of action to be proposed by the implementing organization- ENRESA on a yearly basis and to be approved by the government through the Cabinet, when appropriate. The Royal Decree authorizing the creation of ENRESA requires the company to draw up an Annual Report of Activities describing the actions taken during the previous financial year, and a revised version of the PGRR. The Plan generally contains the generation of radioactive wastes and spent fuel, existing and forecast, the technical approaches and the economic and financial aspects, and constitutes the reference framework for the strategies to be implemented by ENRESA.

The missions of ENRESA are as follows:

- Site selection, and design and construction and operation of facilities for storage and disposal of nuclear spent fuel and radioactive waste generated in Spain,
- Establishment of systems for collection, transfer and transport of the above-mentioned materials,
- Management of waste arising from decommissioning of nuclear and radioactive installations,
- Conditioning of tailings from uranium mining and milling, if required,
- Providing support to civil defence services in the event of nuclear emergencies.

ENRESA must obtain licenses for its operations from the Ministry of Economy. The Ministry of Economy grants such licenses only after a positive recommendation from the Nuclear Safety Council (CSN). CSN is the sole competent authority in the field of nuclear safety and radiological protection in Spain and, in general, is responsible for regulating and supervising nuclear installations. This, governed by a legal statute, is independent of the Administration and reports directly to the Parliament.

Ministry of Environment participates in the licensing process, in collaboration with CSN, for approval of the Environmental Impact Report.

A-16.1.3. Laws and regulations

The major laws and regulations applicable to the management of HLW and SNF in Spain are as follows:

- Act 25/1964 on Nuclear Energy;
- Act 15/1980 on the establishment of CSN;
- Act 54/1997 on Electricity Industry;
- Royal Decree 1522/1984 on the establishment of ENRESA;
- Royal Decree 1899/1984 developing the functions of ENRESA;
- Royal Decree 1836/1999 regulations on nuclear and radioactive installations;
- Royal Decree 404/1996 developing Act 40/1994 and modifying R.D. 1522/84.

A-16.2. Waste streams and proposed repositoires

A-16.2.1. Waste stream assumptions

There are nine light water nuclear power reactors in Spain, with a total capacity of about 7.8 GW(e). According to the 5th General Radioactive Waste Plan approved by the government in July 1999, the existing reactors will operate for a 40-year lifetime. There is no plan to construct any new power reactors. In addition to the above reactors, there is a 460 MW(e) Vandellós I graphite-gas reactor, which is currently being dismantled by ENRESA.

In 1983, the government adopted an open fuel cycle policy. However, in the past, some SNF was reprocessed abroad. The following summarizes the amounts of radioactive waste that Spain must manage as a result of all the reactor operations:

Spent nuclear fuel	About 6750 t HM
Vitrified HLW resulting from reprocessing of SNF from the Vandellos reactor in France	About 80 m^3
Fission materials that were recovered before 1983 through reprocessing of spent fuel from the Santa María de Garoña plant in the United Kingdom	Minor quantities
Other wastes that cannot be disposed of in the El Cabril Low and Intermediate Level Radioactive Waste Disposal Facility due to their high activities and/or long half-lives	About 5000 m^3

A-16.2.2. Proposed repositories

Conceptual non-site specific repository designs have been developed by ENRESA for three candidate host rocks (clay, granite and salt) to provide a basis for R&D activities and for performance and safety assessment studies of a repository system. The primary characteristics of these repositories are summarized as follows:

Capacity	20 000 spent fuel assemblies containing about 7000 t HM
Depth	250 m for clay 500 m for granite 600 m for salt
Engineered barriers	Carbon steel canister 0.75 m thick buffer (bentonite for the clay and granite options, and salt briquettes for the salt option)

Use of these repositories for disposal of long lived intermediate low level waste is also being considered. The designs are being progressively modified, primarily to incorporate the retrievability concept.

A-16.2.3. Management time schedule

The 5th General Radioactive Waste Plan, which was prepared by ENRESA and approved by the Government, defines the time schedule relating to SNF and HLW disposal activities:

- No decision for the final management of SNF and HLW will be made before 2010, when the Parliament plans to evaluate technological progress and the results from research activities, and decides on the solution to be adopted. For planning purposes, the Spanish disposal facility could begin operations by 2035.
- No further siting activities will be performed until 2010.

ENRESA has modified its original strategy to meet this policy change. Major highlights of the new strategy are as follows:

- Identification of suitable sites: No further fieldwork will be performed for the moment.
- Design and performance assessment: Safety assessment will continue to play an important role in the programme, in particular, to integrate geological information, repository design and R&D data. The assessment will be used to guiding R&D activities and optimizing facility designs. Existing geological data will be used for the performance assessment of the deep repository.
- The research programme on partitioning and transmutation (PT) will proceed, in parallel with the continued efforts on geological disposal.
- International collaboration in foreign ***underground research laboratories*** will be continued and promoted.

A-16.3. Siting of geological repositories

A-16.3.1. Siting process

A siting process was initiated by ENRESA in 1986. It was defined as a stepwise, systematic screening process designed to gradually narrow down the area in four phases.

The process began by developing a National Inventory of Favourable Formation selected from granite, salt and clay geological media in Spain. This assessment was carried out during 1986-1987. The main objective was to identify and document potentially suitable geological formations that could be studied in further detail during subsequent stages. Then, a study of the favourable regions was carried out at the beginning of 1990, resulting in the identification of some 2500 square kilometres for the three geological media.

The second stage was aimed at narrowing down to favourable areas. At this stage, the technical specifications for each type of formation were developed, and fieldwork was executed. This project began in 1990 and was completed in 1995.

Work has continued since 1995 with more detailed geological studies and research. The initial plan called for the selection of sites suitable for use as a repository at the end of the 1990s. A legislative framework, including specification of the detailed steps for the siting process, public involvement and financial assistance to the affected communities was planned to be drawn up during 1995 to 1997 so that candidate sites would be selected by 2000.

This process was suspended in 1997. Although the activities carried out by ENRESA have been controlled by the government, no public involvement had been undertaken during the work. The government determined that no decision on disposal of SNF/HLW would be made before 2010. As a result, no specific plan on the siting process has been developed at this moment.
ENRESA is currently participating in studies using underground research laboratories in foreign countries.

A-16.3.2. Development of siting criteria

As mentioned in Section A-16.3.1, technical specifications for each type of formation were developed at the second stage. However, the siting activities were suspended in 1997 and no further siting activities, including development of criteria, are expected to be conducted before 2010. The organization that will be responsible for developing the siting criteria has not been designated at this time.

A-16.3.3. General procedures for decision making in each phase or stage

The general procedures for decision making during the siting process will be established after the option for disposal of the waste is decided on by the Parliament in about 2010.

A-16.3.4. Role of local governments

The role of local governments during the siting process will be defined when the option for waste disposal is decided on by the Parliament in about 2010.

A-16.3.5. Financial assistance

No rules have been established to define how financial assistance would be provided to local communities in the vicinity of the potential sites. On the other hand, the Order of 30 December 1988 and its later amendments authorize ENRESA to allocate funds to those town councils in which storage of radioactive waste or other relating activities are performed. Among these facilities are centralized temporary facilities specifically designed for the storage of SNF or long lived waste or HLW. The Order of 13 July 1998 specifies four categories of installations for which nearby communities may receive funding, as follows:

1st category:	Nuclear power plants storing their SNF on site,
2nd category:	Centralized temporary facilities specifically designed for the storage of SNF or long lived or HLW,
3rd category:	NPPs in the dismantling phase,
4th category:	Centralized facilities for storage of low and intermediate level radioactive waste.

A-16.4. Management costs

A-16.4.1. Total estimated cost and its breakdown

The General Radioactive Waste Plan contains the cost estimates radioactive waste management activities. The estimated total cost is about 10 000 million EURO. Figure A-16.2. shows the breakdown of the estimated total cost and the annual costs in the period 1985-2065.

The cost estimate includes investments, general expenses and the cost of social communications at the ENRESA head offices; the ENRESA Foundation and payments on stock capital; costs associated with reprocessing of spent fuel, disposal of spent fuel and high level wastes, and the costs of corresponding activities for other technologies (e.g. separation-transmutation); rehabilitation of uranium mines, decommissioning of AUM and La Haba (both of which are uranium mines); decommissioning of experimental reactors, and adoption and enhancement of various centres for energy-related, environmental, and technological research facilities; management of materials such as radioactive lightning rods, smoke detectors, special sources, contaminated scrap, etc.

In the 5th General Plan, about 5589 million EURO (about 57% of the total cost) is considered as costs related to SNF and HLW management.

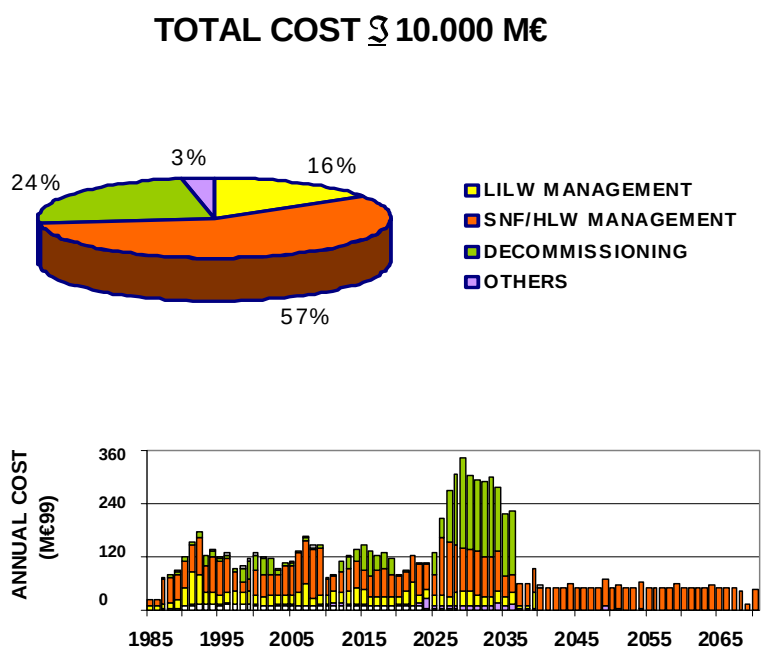


Fig. A-16.2. Estimated waste management cost.

A-16.4.2. Organization responsible for cost estimation

Royal Decree 1522/84, which established ENRESA, specifies that conduct of economic-financial studies is one of ENRESA's missions to establish an adequate economic policy.

The cost estimate for all radioactive waste management activities is included in the General Radioactive Waste Plan proposed by ENRESA, which is sent to the Ministry of Economy, which in turn submits it to the Cabinet for approval. Once approved by the Cabinet, the Plan is sent to the Parliament for information. The cost estimate is not subject to review, other than the review by the Ministry of Economy.

A-16.5. Financing system

A-16.5.1. Overview of the financing system

In accordance with the Spanish legislation, a Fund was established in 1983 to cover the costs of radioactive waste management and decommissioning of nuclear installations, for which ENRESA is responsible.

There are three types of waste generators: manufacturers of fuel assemblies, utilities, and generators of institutional wastes (such as hospitals, research institutes and industries). The fees for the second type of generators, which are the major contributors to the fund, are collected by means of a levy on the electricity rate. This levy is calculated based on the following assumptions:

- Spain's domestic nuclear power plants have a capacity of 7.6 GW(e) and a 40-year reactor lifetime,
- The average NPP operating period is 7000 hours per year,
- The following economic-financial factors:
  - Inflation rate: 2.0%
  - Discount rate: 2.5%
  - Average annual increase in electricity demand: 3.0%
  - Average annual increase of the electricity rates: 1.0% per year from 2000 to 2002.

The fees for the other two types of generators are collected by a tariff for the service rendered by ENRESA.

ENRESA is responsible for management of the Fund, based on criteria set by the Oversight and Control Committee formed by government representatives, e.g. Ministry of Economy, Ministry of Finance.

The financing system described above is shown in Fig. A-16.3.

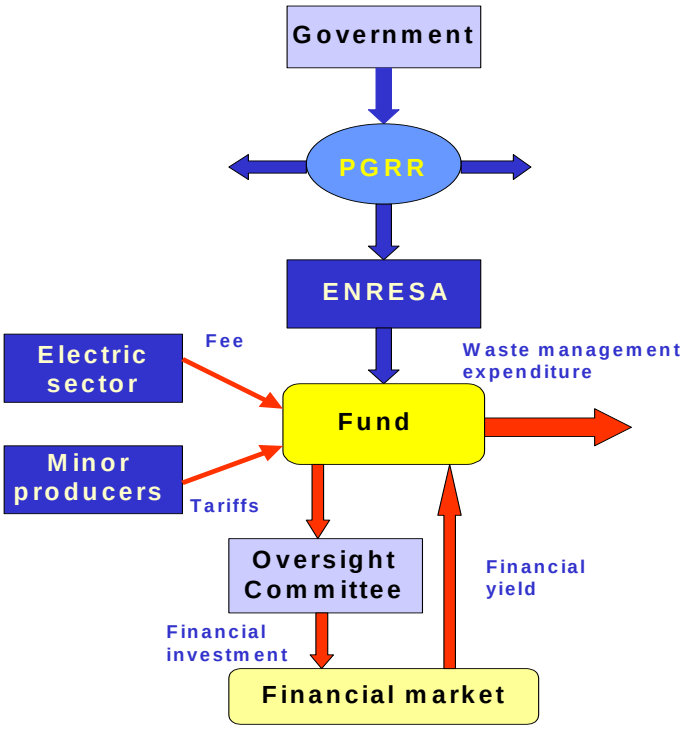


Fig. A-16.3. Financing system.

A-16.5.2. Waste management fee

In 2000, the levy on the electricity rate was set at 0.8% of electricity rate. ENRESA calculates the fee every year in the proposed Radioactive Waste Plan, which must be approved by the government.

A-16.5.3. Withdrawal

The costs for radioactive waste management activities in any given year are included in the annual plan prepared by ENRESA for that year. The plan must be approved by the government, see above. The ENRESA Board of Directors may then approve a budget for ENRESA, based on the approved plan to pay for the ENRESA activities conducted in that year.

A-16.5.4. Auditing the financing system

According to Royal Decree 404/1996, the Inter-Ministerial Committee for Follow-up and Control is responsible for supervision of the fund. In addition, ENRESA's accounts are subject to two auditing controls, as follows:

4 The governmental auditing body inspects ENRESA's operations and accounts.
4 An independent firm audits ENRESA's financial report every year before its submission to the Board of Directors and the Stockholder's Meeting.

A-16.5.5. Revenue and expenditure of financial resources

As shown in the table in Section A-16.4.1, expenses through the end of 1998 have been 1671.78 million EURO. In addition, 109.80 million EURO were expected to be reimbursed in 1999. The fund has a balance of 1566.02 million EURO as of 31 December 2000.

A-16.6. Public involvement and transparency

Public involvement in the siting process will be discussed when a new decision is made in 2010 on the policy for SNF/HLW disposal.

The 5th General Radioactive Waste Plan shows to what extent the ENRESA's activities are understood to the public. The plan states that the public is obviously sensitive to matters relating to radioactivity and that there is a lack of understanding of the potential for a technical solution. Accordingly, it will be necessary to carry out the widest possible information/educational campaigns in order to facilitate better knowledge and understanding of both the problem to be solved and the technology to be used.

ENRESA initiated work on a 3rd Communication Plan in 1998 by promoting visits by the public to ENRESA's facilities, organizing orientation sessions for professionals, distributing materials, etc. In addition, the four information centres in the country intensified their functions by providing more materials, organizing seminars for teachers and community leaders, etc.

A-16.7. Other considerations

A-16.7.1. Nuclear liability

As a Contracting Party of the Convention on Civil Liability in relation to Nuclear Energy, signed in Paris on 22nd July 1960, and the Complementary Convention signed in Brussels on 31st January 1963, the Spanish Law applies their principles. The operator of a nuclear facility is liable for damage caused by its installation. This liability is strict and absolute.

A-16.7.2. Institutional controls

Since no decision on disposal of SNF/HLW will be made before 2010, no specific plan has been developed at this moment.

A-16.7.3. Records keeping

Since no decision on disposal of SNF/HLW will be made before 2010, no specific records management plan has been developed at this time.

A-17. SWEDEN

A-17.1. Organization and legislation

A-17.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.

Government

Ministry of the Environment

- Makes the final decision on licensing of major nuclear installations and on the nuclear industry's R&D programmes for waste management. In both cases, the decisions are based on reviews by regulatory authorities.

REGULATION/OVERSIGHT

Regulatory Authorities

Swedish Nuclear Power Inspectorate (SKI)

- Is responsible for regulation and supervision of nuclear safety for all nuclear activities, including waste management.
- Reviews nuclear industry R&D programmes and cost calculations.

Swedish Radiation Protection Authority (SSI)

- Is responsible for regulation and supervision of radiation protection for any activity with radiation, incl. waste management.
- Reviews the nuclear industry's R&D programmes and submits findings to SKI.

Oversight/Advisory Body

Swedish National Council for Nuclear Waste (KASAM) *(Scientific committee under the Ministry of the Environment)*

- Provides advice to the Government and, on their request, to SKI and SSI.

IMPLEMENTATION

Implementing Organization

Swedish Nuclear Fuel and Waste Management Co., SKB *(Jointly owned by the nuclear power plants operators)*

- Is responsible for implementing any activity needed to develop, site, construct and operate facilities for disposal of nuclear waste, incl. SNF.
- Is responsible for developing the nuclear industry's R&D programmes and cost calculations.

Financial Resource Management Body

Board of the Nuclear Waste Fund

- Is responsible for fund management.

The interaction of the government and different organizations involved in the SNF long term management in Sweden is shown in Fig. A-17.1.

A-17.1.2. Implementing organization

In accordance with the Act on Nuclear Activities, the owners of nuclear power plants are responsible for taking any measures necessary to ensure safe management of the radioactive waste they generate, and for decommissioning their nuclear facilities. They are also responsible for jointly conducting relevant R&D programmes, which are submitted to SKI for review every third year. To carry out these responsibilities, they have established a jointly owned company, Swedish Nuclear Fuel and Waste

Management Co., SKB. Thus, SKB is responsible for siting, constructing and operating the facilities needed for disposal of radioactive waste, including storage and disposal of SNF, as well as any associated R&D activities.

In addition to SKI's review of the R&D programme, KASAM reviews the programme and submits their findings directly to the government. The government, then, decides whether the programme fulfils the requirements of the Nuclear Activities Act.

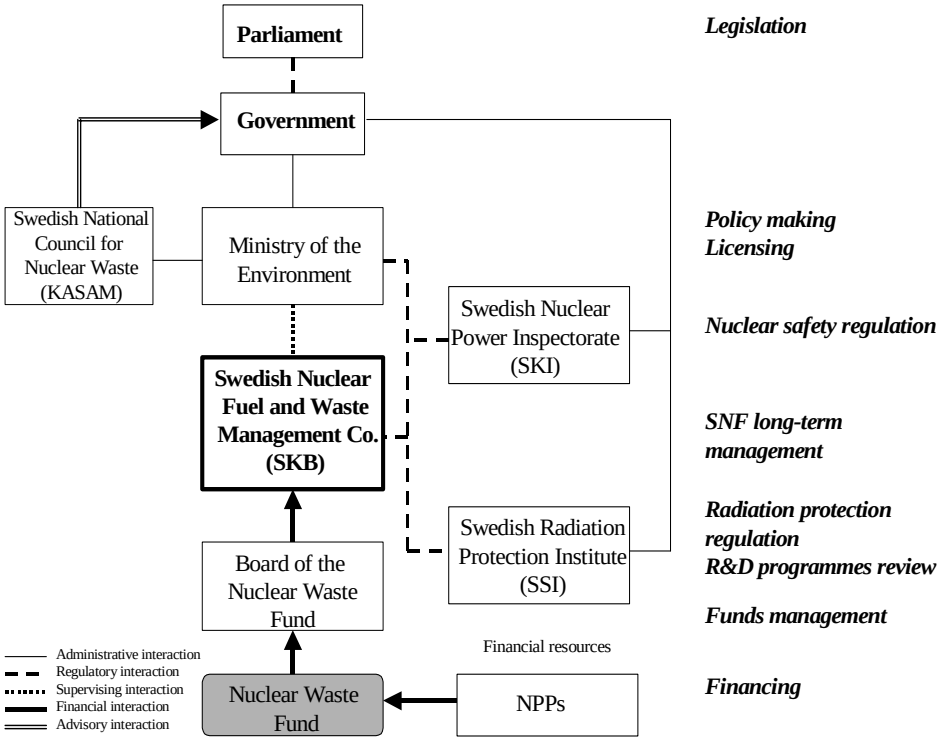


Fig. A-17.1. Organizational structure.

A-17.1.3. Laws and regulations

The following laws, ordinances and regulations specify the requirements for management of radioactive waste in Sweden:

4 The Nuclear Activities Act (1984:3), passed by the Parliament, specifies the requirements for radioactive waste management in Sweden, along with requirements for other nuclear activities.
4 The Nuclear Activities Ordinance (1984:14), issued by the government, establishes the more detailed requirements for implementation of the requirements of the Nuclear Activities Act, including identification of competent authorities.
4 Competent authorities issue regulations that provide further details regarding how to comply with the requirements of the applicable Acts and Ordinances. These regulations include the following:
  - The Regulations Concerning Safety in Certain Nuclear Facilities (SKI FS 1998:1), together with the Regulations concerning Safety in Connection with the Disposal of Nuclear Material and Nuclear Waste (SKI FS 2002:1), issued by SKI, establish the requirements for most nuclear facilities, i.e. nuclear power reactors, research or materials testing reactors, fuel fabrication plants, facilities for handling and storing SNF and for storage and disposal of radioactive waste.
  - The Regulations Concerning the Final Management of Spent Nuclear Fuel and Nuclear Waste (SSI FS 1998:1) primarily focus on requirements applicable to disposal of SNF, but also specify some requirements for pre-disposal activities.

- The Regulations Concerning Archives at Nuclear Installations (SSI FS 1997:1) specify the regulations for management of the records pertaining to nuclear activities.

4 The Act on the Financing of Future Expenses for Spent Nuclear Fuel, etc. (1992:1537), passed by the Parliament, specifies the requirements for the system to be used to finance the disposal of SNF.

4 The Ordinance on the Financing of Future Expenses for Spent Nuclear Fuel etc. (1981:671), issued by the government, established more detailed requirements for implementation of the requirements of the Act on Financing Future Expenditures on Spent Fuel.

A-17.2. Waste streams and proposed repositories

A-17.2.1. Waste stream assumptions

There are eleven light water reactors with a capacity of about 1.0 GW(e) in operation in Sweden, and one shutdown reactor. These reactors are located at four different sites in the country. Following a political decision in 1999, one reactor (Barsebäck 1) was shut down and a second reactor (Barsebäck 2) will be shut down, but probably not before 2003. There is also a research reactor in operation at the Studsvik site. Current Swedish legislation prohibits the construction of new nuclear power plants in Sweden.

Direct disposal is planned for all SNF generated in the country. SKB expects that a total of about 9000 t HM of SNF will have been generated by the Sweden's nuclear reactors by the end of their projected 40-year operating lifetime. At the end of 2000, about 3400 t HM of SNF were stored in the central storage facility CLAB. Approximately 300 t HM of SNF are generated every year.

No HLW is generated in Sweden. Nevertheless, the Swedish radioactive waste streams do include certain long lived wastes, which are planned to be disposed of in a deep geological formation. These wastes consist mainly of reactor internal parts and core components (approximately 9700 m^3).

A-17.2.2. Proposed repositories

Sweden plans to construct one deep geological repository for disposal of SNF. The primary design parameters of this repository are provided in the following table:

Capacity	9000 t HM of SNF (encapsulated in about 4500 canisters)
Depth of the repository	400–700 m underground
Host rock	Crystalline rock
Area	Surface facilities, 0.3 km^2
	Underground facilities, 1–2 km^2,
Engineered barrier	Copper canisters (for corrosion resistance) with cast iron inserts (for mechanical strength)
	Buffer material – bentonite clay in individual deposition holes

Certain long lived radioactive wastes are also planned to be disposed of in deep geological formations, e.g. primarily internal parts and core components from the reactors (the projected amount is 9700 m^3).

A-17.2.3. Management time schedule

The time schedule for disposal of Sweden's SNF has been developed and proposed by SKB. It is a part of the R&D programme that is subject to review by regulators and other concerned parties. Specifically, in December 2000, SKB proposed three candidates for site investigations, which involve extensive drilling and surface-based characterization. Consultations with the concerned municipalities (see Section A-17.3.3) resulted in one of them declining to be a candidate for site investigations (April 2002), while the remaining two have been accepted. The following sequence of events was proposed by SKB for development of the repository:

2002-2007	Site investigations
2007	Submission of the license application for siting and construction
2009-2015	Detailed characterization and construction
2013	Application for the initial operation
2015	Start of waste emplacement

In parallel, there will be a process for siting and constructing an encapsulation plant for SNF, as follows:

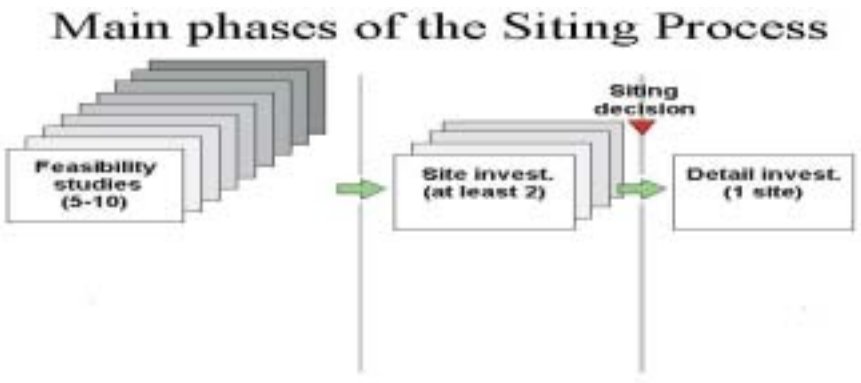
2005	Submission of the license application for siting and construction
2007–2012	Construction and commissioning, including inactive trial operation
2012	Submission of application for operation
2014	Active trial operation, followed by operation

The time schedules summarized above are not fixed neither by law nor by any other formal decisions, and may thus change with time.

A-17.3. Siting of geological repositories

A-17.3.1. Siting process

The siting process has been planned by SKB, and has been subject to review by regulators and other concerned parties, including municipalities engaged in the process. The process consists of three main phases, as illustrated in the figure below and described in the following text:



(1) Feasibility studies – Studies undertaken in this phase are based on existing data. No drilling is done. The studies consider a variety of aspects, which are grouped into the following four categories:

- *Long term safety*: Compilation and evaluation of existing data on the bed rock, groundwater flow and chemistry, etc.
- *Technology and safety in the operating phase*: Accessibility to infrastructure, feasibility for construction of facilities and transportation.
- *Land and environment*: Land use restrictions, potential for conflicting interests, consistency with municipal development plans, vulnerable nature, culture conservation interests, etc.
- *Society:* Availability of labour, public opinion, impacts on real estate and tourism, psycho-social effects, etc.

The initial plans envisioned carrying out feasibility studies in 5-10 municipalities. In reality, eight feasibility studies were completed and, in 2000, SKB proposed candidate areas in three municipalities for site investigations. Extensive information was included in the study, and consultation activities were carried out with the concerned municipalities and their citizens.

(2) Site investigations - The site investigation phase includes the following activities:

- Test drillings
- Safety assessment
- Facility design
- Environmental Impact Assessment
- Consultations with municipalities, the public, and local, regional and national authorities.

Although the most significant effort will be devoted to geological site characterization and evaluation, studies will also be performed on topics such as infrastructure, transportation, societal effects and local development.

The site investigations are expected to last for 4-8 years. During the site investigation phase, the siting and designing of the encapsulation plant for SNF will also be accomplished.

Current plans are to carry out site investigations in at least two municipalities. The site investigations will aim at creation of the information needed for preparation of the licence application during the third phase.

(3) Detailed characterization and construction – The third phase is subject to formal licensing according to both the Act on Nuclear Activities (regulatory review administered by SKI) and the Environmental Code (reviewed by a regional Environmental Court). The government grants the required licenses according to the conclusions of the reviews.

In this phase, very detailed investigation of the bedrock will be made in tunnels and shafts, and the first part of the repository will be constructed. Permits will be obtained from the appropriate regulatory authorities (SKI and SSI) to allow encapsulation of SNF in canisters and their deposition in the repository.

Generic programmes for the site investigations have been presented by SKB, and subjected to regulatory review. Detailed, site-specific programmes are under development and must be made available before the actual investigations may begin.

With regard to underground research laboratory, the Äspö hard rock laboratory was constructed by SKB between 1990 and 1995. R&D activities have been ongoing in Äspö since its construction. The aims of the R&D are as follows:

4 To develop and test methods for examining the bedrock,
4 To advance and demonstrate methodologies for adaptation of a deep repository to suit the local rock properties,
4 To enhance scientific understanding of the safety margins of deep repositories,
4 To develop and demonstrate the technology which will be used for disposal of SNF.

A-17.3.2. Development of siting criteria

SKB is responsible for developing siting criteria and is doing so as a part of their R&D programmes. The criteria are submitted to SKI for review every third year, and are also the subject of consultation with various stakeholders. Siting criteria have been developed and utilized, and will continue to be refined throughout the siting process. They will be different at different phases in the siting process since the knowledge and database increase with each phase.

The siting criteria focus on long term safety (e.g. geology, groundwater flow and chemistry), as well as other aspects (such as land use and the environment, societal aspects, infrastructure and transportation).

In the feasibility studies, the siting criteria were applied by SKB in 3 steps (in each municipality):

(1) Exclusion of areas with potentially negative geological conditions. For example, the following characteristics should be avoided:

- Rock types of potential interest for mineral extraction,
- Highly heterogeneous bedrock,
- Deformation zones and neo-tectonic faults,
- Pronounced groundwater discharge areas,
- Areas with indications of abnormal (for Sweden) groundwater chemistry.

(2) Identification of choice of areas for field checks and additional studies.

(3) Evaluation of siting alternatives. The following characteristics were considered advantageous by SKB:

- Well known rock type,
- Large area with few major fracture zones,
- High proportion of exposed rock and/or thin soil cover, simple and homogeneous bedrock, and a regular system of fractures,
- Access to infrastructure and good transportation options. Limited need to establish new transportation routes,
- Few conflicting land use and environmental interests,
- Positive opinion in the region.

For the site investigation phase, geological siting programmes have been presented and reviewed, including quantitative and qualitative criteria. The criteria are of two types, as follow:

- Requirements are absolute conditions that must be satisfied, and that remain constant throughout the siting process.
- Preferences are conditions that ought to be, but do not have to be, satisfied.

Both SKB and the authorities (SKI and SSI) emphasize that site suitability must be judged based on a comprehensive safety assessment, but cannot rely on a list of criteria only. Accordingly, the SKI regulations provide very general guidelines on siting. The main geological factors to be considered are of thermal, mechanical and chemical natures.

A-17.3.3. General procedures for decision making in each phase or stage

As described in Section A-17.3.1, the siting process can be separated in three main phases. For each phase of the process, the decision on whether to proceed is made by SKB. However, in practice, the concerned municipalities have a decisive influence on such decisions. The last phase requires formal permits by the government and the regulatory authorities to be started.

- Starting in 1993, and based on voluntary agreements with municipalities, SKB completed 8 *feasibility studies* during the period of 1993-2000. The municipalities monitored and commented on the studies, and their comments were included in the final report. Based on the results of these feasibility studies, SKB concluded in November 2000 that they would like to start site investigations during 2002 in three areas, situated within the borders of three of these municipalities. SKB asked the concerned municipalities for their approval of these plans. The municipalities had earlier let it be known that they demanded that a review of SKB's conclusions be performed by the regulatory authorities and by the government before the municipalities would be ready to give SKB an answer.

4 The results of the feasibility studies, including SKB's conclusions, were also commented on during the review of SKB's R&D programme that was co-ordinated by SKI. SKI presented the findings and recommendations to the government in June 2001. In November 2001, the Government announced that it had no objection to SKB starting investigations at the three proposed sites.

4 By March 2002, two of the municipalities (by almost unanimous decisions of the municipal council) had given their approval to SKB to start site investigations, although with clear conditions directed both to SKB, and to the Government and the regulatory authorities. The council of the third municipality turned out to be deeply divided on the issue. In April 2002, that council decided, with a narrow majority, to turn down SKB's proposal.

4 The activities during *site investigations* have been described in Section 3.1. They are expected to last for 4-8 years. Based on the results, SKB is expected to choose one site for detailed characterization and to apply for formal permits from the Government and the regulatory authorities to start these activities at this site.

4 The next phase of the siting process *(detailed investigation and construction)* is subject to formal licensing, in accordance with both the Act on Nuclear Activities (regulatory review administered by SKI) and the Environmental Code (reviewed by a regional Environmental Court). The license application will include a comprehensive safety assessment and an environmental impact statement (EIS), which must be based on extensive consultations involving parties such as local, regional and national authorities, the local municipality, potentially affected individuals, the public at large, and concerned s. The Government may only grant a license for detailed characterization if the host municipality agrees (i.e. the municipality has a veto). However, in principle, it is possible for the government to overrule a municipal veto.

As discussed above, there are a number of 'decision making points' during the site selection process. At an early stage, SKB selected municipalities for feasibility studies on the basis that these municipalities had both a geology that could be regarded as 'promising', and that they accepted the very idea of a feasibility study being done. SKB chose three candidates in three municipalities for siting investigations. The government endorsed SKB's conclusions in November 2001, after which two of the municipalities concerned accepted and one rejected SKB's proposal. When SKB, after 4–8 years of site investigations, is ready to select one site for detailed characterization, there will be a formal government decision and formal decisions by the regulatory authorities — based on a decision by the concerned municipality — on whether to start site characterization. Provided there are no unexpected difficulties, there will be later decisions by SKB to apply for licenses to construct and use a repository and decisions by the regulatory authorities — and perhaps the government as well — on whether to grant such licenses.

A-17.3.4. Role of local governments

Local governments are involved in each phase of the repository development process, as follows:

4 The consent of the concerned municipalities was a condition for SKB to conduct the feasibility study.
4 Site investigations may only be initiated after the municipality at the site decides to participate in the investigations.
4 Prior to proceeding with detailed investigations and construction, a license must be granted by the government. The government may only grant a license for detailed characterization if the municipality agrees with the project.

A-17.3.5. Financial assistance

The Act and the Ordinance on Financing of Future Expenses for Spent Nuclear Fuel etc. include provisions for financial assistance from the Nuclear Waste Fund for provision of information to and

confidence building among their citizens. Affected municipalities apply for financial support to SKI which might grant up to 4 million SEK annually to each municipality. The support is not general compensation but is used to cover the municipalities' actual cost for informing their inhabitants.

Only municipalities directly engaged in the siting process are eligible to receive funds. Neighbouring municipalities are not eligible.

A-17.4. Management costs

A-17.4.1. Total estimated cost and its breakdown

The table below shows the estimated costs of the programmes that will be financed by the Nuclear Waste Fund. These costs estimates are based on plans for the time period from 2001 to 2065. All amounts are expressed in million Swedish crone (MSEK) at a price level of January 2001.

According to these figures, the costs for disposal of SNF can only be estimated at about 28 000 MSEK. For the compensation of the regulatory bodies, an additional amount of approx. 2000 MSEK shall be added to the total estimate. Other costs, such as financial assistance to local communities, are not of any significant level, but it may be worth mentioning that, during the last years, the contributions given to municipals for information measures have ranged from 8 to 15 MSEK per annum.

Cost element	Estimated cost (MSEK 2001)
Administration, R&D	4284
Transportation system, capital,operations & maintainance	1311
Decommissioning of NPPs	13 509
Central Interim Storage Facility for Spent Nuclear Fuel (CLAB)	3986
Encapsulation of SNF	6348
Disposal of SNF	13 398
Deep disposal of low and medium level waste	556
Disposal of decommissioning waste	1725
Total cost for the full programmes	**45 117**

A-17.4.2. Organization responsible for cost estimation

In accordance with the requirements of the Act on the Financing of Future Expenditures on Spent Nuclear Fuel, Etc., the reactor owners have calculated the costs of waste management every year since 1982. The reactor owners are required to co-operate with each other in this process. As a result, the calculation is carried out by SKB. The cost estimates are reviewed and monitored annually by SKI, and finally submitted to the government as a basis for a decision on the annual fee.

A-17.5. Financing system

A-17.5.1. Overview of the financing system

In 1981, the Nuclear Waste Fund was established by a legislation to cover the future expenses for the safe management of SNF, decommissioning and dismantling of nuclear power reactors, and SKB's R&D. The financing system has been regulated by the Act and the Ordinance on the financing of future expenses for spent nuclear fuel, etc.

SKI reviews the nuclear power plants' cost estimates every year, based on the cost estimates prepared by SKB, and makes a recommendation to the government on the size of the fee for the coming year. Then, every year, the government fixes the fee per kW•h of electricity generated at each nuclear power plant. The size of the fee is based on the assumption that each reactor generates electricity for 25 years.

A high proportion of the funds collected (88% as of 31 December 2001) are invested in accounts with real interest rates. Based on the actual real interest rate on these investments, the Board states that the average real return on the assets of the funds will be 4% until 2020. For succeeding years, a real rate of return of 2.5% is assumed.

The fees are collected from the reactor owners to the Fund. Up to the middle of 2002 the assets of the Fund were to be deposited in accounts at the National Debt Office, at conditions similar to those of government bonds. From 1 July 2002 all investments should be made on the market in the form of ordinary government bonds. An independent government authority, the Board of the Nuclear Waste Fund, is responsible for ensuring that administration of the assets satisfies the requirements for a long term adequate return and adequate liquidity.

In addition to the above financial system, operators of nuclear power plants are required to provide financial resources for the waste management of the research reactor at Studsvik and the closed reactor at Agesta.

A-17.5.2. Waste management fee

The Fund collects, on average, about 1 öre (0.01 SEK) per kW•h generated at each nuclear power plant. If the collections are allocated to the total electricity consumption, the fee will be approximately 0.5 öre per kW•h on average. The fee is determined each year in accordance with the procedure discussed above.

Furthermore, in accordance with the Studsvik Act, all reactor owners are required to pay a fee of 0.15 öre/kW•h for management of radioactive wastes from the research reactor at Studsvik and from the closed reactor at Agesta.

A-17.5.3. Withdrawal

The SKB's regular budget is currently approved by SKI every year. After approval of the budget, SKB submits, each quarter, a proposal for payment with a financial report over the performance during the last quarter as well as for the year to date. The reactor owners make a formal request to SKI for payments. SKI then makes a formal decision authorizing payments from the Fund, and the payment is made to the reactor owners by the Board of the Nuclear Waste Fund.

Applications for special expenditures may be submitted directly to the government.

A-17.5.4. Auditing the financing system

There are several different levels of audits, as discussed below:

- First, SKB's activities and the Fund are audited annually by independent and contracted accountants. SKI is also obliged to monitor and supervise the financing system. This is carried out by evaluating annual budgets and the plans and quarterly proposals for payments to SKB. SKI usually orders an extended audit to enhance the quality of the annual financial audit. At the extended audit, a large number of invoices may be presented on request and specific topics may be raised.
- SKI and the Board of the Fund reserve the right to execute extra audits and/or inquires on an ad hoc basis.

A-17.5.5. Revenue and expenditure of financial resources

The revenues and expenditures of the Fund as of 31 December 2000 are summarized as follows:

Fee-based income	23 234.6 MSEK
Financial income	14 417.3 MSEK
Expenses	13 062.5 MSEK
Capital per 31 December 2000	24 589.4 MSEK

A-17.6. Public involvement and transparency

The Environmental Code requires SKB to consult and inform both inhabitants living close to a planned repository and the public in a wider sense. In principal, there are no geographical limits and those individuals who are concerned are allowed to be involved. In addition, SKI and SSI are required to inform the public of any nuclear safety issues or risks.

The public can be engaged through various approaches, e.g. public hearings, information and discussion meetings, seminars, and discussions with the elected representatives. Lectures at school and work places, study visits to existing waste management facilities and exhibitions are organized to promote public understanding.

All municipalities involved have organized themselves to keep their inhabitants well informed and to allow them to be actively engaged in the siting process. For example, representatives from various interest groups and inhabitants in the areas near nuclear facilities were invited to participate in the municipalities' work relating to site investigation.

Local referendums may also be used, at the option of the municipalities.

A-17.7. Other considerations

A-17.7.1. Nuclear liability

Liability for damages from accidents and operations involving nuclear waste management is covered by the Act on Nuclear Liability. This Act provides that the operator of a nuclear installation, including an operator of a geological disposal facility, is liable to provide compensation to those who have suffered personal injury or damage to property. The operator's liability is strict and exclusive. The limit on the amount of the operator's liability was raised to 300 million Special Drawing Right (3300 MSEK) in 2001.

A-17.7.2. Retrievability and institutional controls

No plans for retrievability or institutional control have been established or formally decided. Nevertheless, R&D is being carried out on these subjects. The SKI regulations (SKI FS 1998:1) stipulate that a facility for final disposal of nuclear waste shall be designed so that the barriers provide the required safety with no intention of retrievability and without monitoring or maintenance after the repository is closed.

A-17.7.3. Records keeping

Generally, the implementing organizations are responsible for development and management of records, but no record management system has been developed.

SSI has issued regulations establishing requirements for records management, under which specified documents concerning waste disposal are required to be kept in archives for more than 100 years. Relevant records will be transferred to national and regional official archives when facilities are decommissioned or closed.

Records are available to the public when they are transferred to SKI or SSI. The authorities are required to make non-secret information available upon the request of the public.

A-18. SWITZERLAND

A-18.1. Organization and legislation

A-18.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

- Enacts laws.
- Ratifies general licenses.

Government

Federal Department of the Environment, Transport, Energy and Communication

- Establishes policies.
- Grants licenses.
- Sets fees.

REGULATION/OVERSIGHT

Regulatory Authorities

Swiss Federal Office of Energy (BFE)/Federal Nuclear Safety Inspectorate (HSK)

- Conducts the licensing process.
- Develops regulatory guidelines.
- Regulates radiological protection in nuclear facilities.
- Reviews projects.
- Supervises operation of nuclear facilities and transportation.

Swiss Federal Office of Public Health (BAG)

- Regulates radiological protection (except in nuclear facilities).
- Manages waste from medicine, industry and research.

Oversight Body

Swiss Federal Nuclear Safety Commission (KSA)

- Comments on license applications.
- Observes the operation of nuclear facilities and comments on fundamental safety issues.

Advisory Bodies

Interdepartmental Working Group on Radioactive Waste Management (AGNEB)

- Deals with important questions related to waste management.
- Prepares technical documents for government decision.

Geological Commission on Radioactive Waste Disposal (KNE)

- Provides advice on geological questions.

IMPLEMENTATION

Implementing Organizations

Nagra, National Cooperative for the Disposal of Radioactive Waste

- Is responsible for disposal facility preparatory work.

ZWILAG

- Is responsible for treatment and storage of radioactive waste and spent fuel.

Financial Resources Management Body

Management Committee for the Waste Management Fund

- Is responsible for the fund management.

The interactions of the government and different organizations involved in the HLW and SNF long term management in Switzerland are presented in Fig. A-18.1.

A-18.1.2. Implementing organizations

Nagra (the National Cooperative for the Disposal of Radioactive Waste) was established in 1972 by the nuclear power operators and the Federal Department of the Interior (which is responsible for radioactive waste arising in medical treatments, industries and research). Nagra is responsible for preparatory work for radioactive waste disposal facilities, including the inventory of radioactive waste. An implementing organization to be responsible for construction and operation of a geological repository will be designated once the decision to build a repository in Switzerland has been made. ZWILAG (a utility owned) is responsible for storage of SNF, HLW and other waste, for conditioning of specific L/ILW waste streams and for incineration of waste.

A-18.1.3. Laws and regulations

The requirements for the safety and financing systems for radioactive waste management are specified, along with requirements for other nuclear activities, in the following laws:

- The Atomic Energy Act (1959).
- Federal Decree on the Atomic Energy Act (1978).
- The Radiological Protection Act (1991).

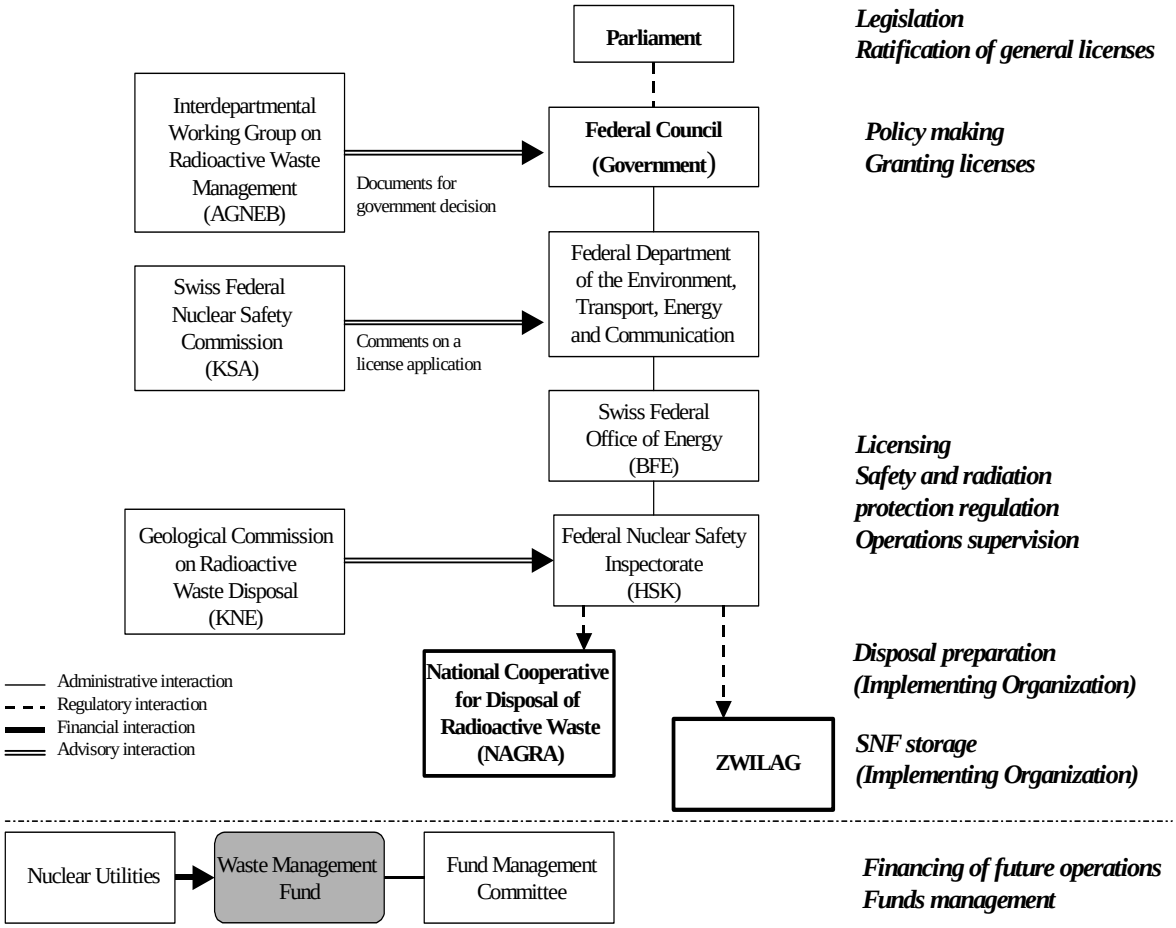


Fig. A-18.1. Organizational structure.

The requirements of these acts and the decrees are elaborated on in more detail in the following documents:

- Radiological Protection Ordinance (1994)
- Regulation on Preparatory Measures (1989)
- The Federal Ordinance on the Decommissioning Fund for Nuclear Facilities (1983)
- The Federal Ordinance on the Waste Management Fund for Nuclear Power Plants (2000)
- HSK Protection Objectives for the Disposal of Radioactive Waste (HSK-R-21/e, November 1993) (safety criteria and requirements).

The Atomic Energy Act is to be extensively revised (a new government draft was prepared in 2001 and is actually discussed in the Parliament).

A-18.2. Waste streams and proposed repositories

A-18.2.1. Waste stream assumptions

There are five light water reactors in operation in Switzerland, with a total capacity of about 3.2 GW(e). A total of about 3000 t HM of SNF is expected to be generated by the end of the lifetime of these power reactors (assuming a 40-year operational lifetime). However, the reactor lifetime may be extended, if such an extension is not precluded for safety reasons.

About 1200 t HM of SNF are to be reprocessed (this amount was increased from 1000 t HM a few years ago). Based on a 40-year reactor lifetime, existing contracts with the reprocessing companies, a closed fuel cycle for approximately 1000 t HM of SNF and an open fuel cycle for approximately 2000 t HM of SNF, the amounts of waste expected to be generated are estimated to be 1000 m³ of HLW and 5000 m³ of SNF (including the overpacks). The HLW volume without the overpacks is expected to be about 130 m³.

A-18.2.2. Proposed repositories

Switzerland is considering construction of a national repository for disposal of HLW/TRU[16]/SNF in a deep geological formation in Northern Switzerland. This repository would consist of a drift system for in-tunnel emplacement of HLW and SNF, separate tunnels for TRU, and access via vertical shafts or ramps. The following repository description is based on the Opalinus Clay project that forms the basis for demonstrating the feasibility of HLW/TRU/SNF disposal in Switzerland. This project is carried out by Nagra.

The HLW and SNF repository capacity is based on a 40-year reactor operating lifetime for the five existing nuclear reactors and the present reprocessing contracts.

Capacity	Approx. 660 canisters of HLW Approx. 1200 canisters (2000 t HM) of SNF	
Repository depth	650 m	
Host rock	Opalinus Clay	
Area	1000 m × 700 m underground	
Engineered barriers	For HLW: glass matrix steel flask steel canister bentonite backfill (host rock)	For SNF: fuel pellets fuel assemblies steel canister bentonite backfill (host rock)

[16] TRU: Transuranic radioactive waste.

A certain amount of TRU would be disposed of in the national repository, along with the HLW and SNF. The TRU waste stream would include the following components:

- Concentrates, slurries, (compacted) hulls and ends, and technological waste generated from reprocessing;
- Some waste containing long lived nuclides from industrial and research applications;
- Miscellaneous/Reserves.

The first two types of waste are expected to amount to approximately 800 m^3 (4000 m^3 if overpacked).

A-18.2.3. Management time schedule

Switzerland's next milestone in the HLW/SNF programme is to complete the project to demonstrate the existence of a sufficiently extensive rock body with the properties necessary for use as a geological repository. The report will be prepared by Nagra and submitted to the government by the end of 2002 for evaluation. Within the framework of that project, Nagra will propose a potential siting area for a national repository. Nevertheless, participation in a multinational repository project is also being kept as an option for the future.

In parallel with the Nagra project, a plan will be developed to define the subsequent steps to be taken to develop a national geological repository. This plan will be approved by the Federal Government. The key issues to be addressed in the plan will include the following:

- The time schedule for making a decision on whether a multinational solution can be pursued or whether the waste must be disposed of in Switzerland,
- Activities to be undertaken at the selected site (e.g. a rock laboratory),
- The time schedule for development of the repository.

The Swiss plans call for issuing the required licenses to allow the repository to commence operation around 2040/2050. With a 40-year operating lifetime for Swiss nuclear power reactors, and a minimum 40-year SNF and/or HLW cooling period prior to emplacement, the repository will be required to operate until 2065.

A-18.3. Siting of geological repositories

A-18.3.1. Siting process

Desk studies conducted in the late 1970s covered all areas of Switzerland, including a very wide range of potential host rocks. Due to the ongoing uplift of the alpine regions of the country, potential siting areas are restricted to the central plain and the Tabular Jura, extending to the border with Germany. The potential siting areas are less extensive than in most countries and the geology is relatively complex. Nevertheless, the wide range of geological formations offers several candidates for potential repository host rocks.

A three-phase geological repository siting strategy was conceived at the beginning of 1980s. The main elements of this strategy are summarized below:

Phase I Regional studies based on widespread borehole data, as well as extensive measurements from the surface (e.g. seismic surveys).

Phase II More intensive investigations (boreholes and detailed 2D or 3D seismic measurements) to examine the siting potential of smaller areas, selected from the best locations identified during Phase I.

Phase III Deep underground exploration and full characterization of a candidate site.

Since this strategy was developed, Phase I and II studies of crystalline basement and sedimentary formations have been conducted. Initially, the highest priority was placed on investigation of the crystalline basement, with more limited work proceeding on sedimentary rocks in parallel. The regional work on the crystalline basement was completed in 1989 and the corresponding synthesis reports were finalized in 1994. After completion of the work on crystalline rocks (including a 2D seismic survey in the area of Mettau [Canton Aargau] during the winter of 1996/1997 and identification of a potential drill site), a higher priority was placed on completion of the work on sedimentary formations. At the present time, the boreholes and seismic measurements for sedimentary formations have been completed. The results are scheduled to be submitted to the government by the end of 2002.

After consideration of the results of the Phase I and II studies, the government will determine whether the feasibility of geological disposal of HLW/SNF in Switzerland has been satisfactorily demonstrated (including confirmation of the existence of an adequately sized host rock body). If the decision is favourable, the Phase III studies, including exploration underground, will be conducted on the most promising site(s). The extensive Phase III subterranean characterization is expected to lead to proposals for the detailed layout of a repository.

There are two underground research laboratories in Switzerland, the Grimsel Test Site for crystalline rock and the international Mont Terri Rock Laboratory for Opalinus Clay, the latter being under the direction of the Federal Office of Water and Geology. They were established initially to develop and modify underground investigation technologies, and then, were utilized to collect data and develop and improve conceptual models. At present, work is being conducted in these laboratories, including significant international cooperation, to demonstrate the feasibility and safety of geological disposal.

A-18.3.2. Development of siting criteria

HSK is responsible for developing safety criteria for geological repositories to be used in Switzerland. The siting guidelines that have been developed are considered to be performance goals for a repository, rather than detailed criteria.

Separate criteria for site selection were developed by Nagra for the two kinds of candidate rocks, i.e. crystalline rock and sedimentary rock, as summarized below:

4 *Crystalline rock* – The selection of the crystalline basement as a potential host rock is based on the following criteria and assumptions:

- Low seismicity in the area
- Old, well-consolidated bedrock (good long term predictability)
- Favourable hydro-geological conditions
- Favourable hydro- and geo-chemical conditions
- Minimal possibility for use of natural resources (except for geothermal energy)
- The potential for use of data from foreign disposal projects based on a crystalline host rock (There is extensive information on this topic, as well as an extensive database that is partly applicable to the situation in Switzerland.)
- Granite and gneiss are attractive from both mechanical and engineering points.

4 *Sedimentary rock* – The selection criteria for sedimentary rocks are as follows:

- Sufficient depth and thickness
- Simple tectonics and geometry
- Low water flow

In addition to the criteria listed above, the following specific properties are considered for each formation:

- Lithostratigraphy,
- Thickness,
- Depth and extent (volume available),
- Special aspects such as neotectonics, natural resources, explorability, etc.,
- Rock mechanical parameters,
- Geological characteristics of flow systems, including permiability, porosity, etc.,
- Hydraulic properties, and
- Hydrochemical, geochemical and mineralogical conditions and sorption properties.

Finally, in addition to the criteria and properties listed above, which are primarily safety-oriented, a set of secondary criteria (e.g. for environment, land use, transportation) will also be considered in the site selection process.

A-18.3.3. General procedures for decision making in each phase or stage

After the report on the results of the investigations of sedimentary rock is submitted to the government by the end of 2002 (the report on crystalline rock was previously submitted in 1994), the government will evaluate whether construction of a geological repository is feasible. If the results of the evaluation are positive, the investigation will proceed. Several licenses will then be necessary.

All nuclear installations, including radioactive waste disposal facilities, must be licensed by the Federal Government, in accordance with the requirements of the Atomic Energy Act. During the repository siting phase, there are two licensing stages (i.e. a license for preparatory measures, and a general license following the siting decision). The Federal Government makes decisions on applications for such licenses through use of the following processes.

- *License for preparatory measures* – A license for preparatory measures is required in order to drill exploratory boreholes or to excavate shafts and galleries for site characterization.
- *General license* – This type of license specifies the site and general layout of the nuclear facility to which it applies and, for a repository, the nature and volumes of radioactive waste to be disposed of.
- *Licenses for construction and operation* – The criteria already considered for the general license are scrutinized more closely.

If the Federal Government decides to issue the general licence, this decision is published in the Federal Gazette, along with any conditions, provisions or an explanatory report (if necessary). The decision is then submitted to the Parliament for ratification.

A-18.3.4. Role of local governments

In the process of considering an application for a license for preparatory measures, involved federal agencies, the affected Cantons and local communities and the public at large will be consulted and allowed to lodge objections.

In the process of considering an application for a general license as well as for the licenses for construction and operation, once again, opinions are collected from involved federal agencies, the affected Cantons and local communities and the public at large.

After the Federal Government has granted a licence, separate licence application processes must be conducted within the involved communities and cantons, covering topics such as land use planning and mining concessions. Additional objections may be raised during consideration of this licence application.

A-18.3.5. Financial assistance

There have been no discussions on compensation or financial assistance to local communities around potential sites because no geological repository site has been selected as yet, and the repository will not come into operation for many years.

A-18.4. Management costs

A-18.4.1. Total estimated cost and its breakdown

The total cost estimate for HLW/SNF management in Switzerland has been prepared to cover all activities necessary for ensuring a final disposal of HLW/SNF and wastes arising from power reactors (excluding decommissioning wastes, for which a separate fund has been established). The key assumptions and boundary conditions used in preparing the cost estimates are summarized as follows, followed by a table summarizing the result of the cost estimate:

- An assumed 40-year lifetime for the five nuclear reactors, resulting in approximately 3000 t HM of SNF, of which around 1000 t HM will be reprocessed,
- A 15-year period for decommissioning and dismantling the reactors,
- A 40-year cooling period for SNF/HLW prior to disposal,
- Centralized waste handling up to 2040,
- Centralized storage of all waste categories up to 2064,
- L/ILW repository: Operation from 2015 to 2060,
- HLW/TRU repository: Operation from 2050 to 2064.

Cost element	Estimated costs (million CHF 1998)
Transport	262
Centralized waste handling	818
Interim storage	1056
Disposal containers	444
Fuel element management	4763
L/ILW disposal	1748
HLW/TRU disposal	3884
Total	**12 975**

The cost estimate summarized above includes all costs for construction and operation of waste management facilities, general expenses (expenses of safety authorities, etc.), transportation, containers, commissioning services from third parties and financial assistance to local communities.

A-18.4.2. Organization responsible for cost estimation

In accordance with the requirements of the Ordinance on the Waste Management Fund for Nuclear Power Plants, the Management Committee set up by the Federal Department of the Environment, Transport, Energy and Communication is responsible for the cost estimate for management of radioactive waste. The Management Committee requests the assistance of the waste producers (NPP operators) through their standing committee, the "Unterausschuss Kernenergie (UAK) der Ueberlandwerke". The Management Committee also relies on HSK to check the cost estimate from a technical point of view.

The UAK is currently putting the finishing touches on a new estimate, which will be ready for review by HSK in 2002.

A-18.5. Financing system

A-18.5.1. Overview of the financing system

In accordance with the requirements of the Ordinance on the Waste Management Fund for Nuclear Power Plants, a fund was established in 2001 in which to collect and maintain all of the financial resources that will be necessary to cover all waste management costs resulting from operation of the Swiss NPPs for the period after they cease operations.[17] The management committee mentioned in Section A-18.4.2 is also responsible for management of this fund and investment of its assets. These financial resources are composed of fees collected annually from the NPP operators and paid to the fund during the operating lifetime of the NPPs. The financial resources are being maintained externally from the NPP operators to ensure that the resources will be available to pay the waste management costs, even if the operators should become heavily indebted, be declared bankrupt or go into liquidation.

A-18.5.2. Waste management fee

The calculation of the annual fee is carried out, based on the assumed time schedule listed in Section A-18.4.1, in accordance with a financial-mathematical model, in which interest and inflation are carefully considered. The annual amount of the fee is determined for a period of five years for each nuclear power plant. The NPP operators pay the annual fee directly to the fund. Since the Fund only started operation in 2001, the NPP operators must also pay additional amounts into the fund as if the fund had existed since their NPPs began operation.

The fee is not calculated on a per kW•h basis. However, if the fee was a per kW•h charge, it would be almost 0.01 CHF per kW•h, averaged over all NPPs operating in Switzerland.

A-18.5.3. Withdrawal

Shortly before a nuclear reactor is to be shutdown, the Management Committee will prepare a financial plan and an annual budget for the cost of waste management. The costs to manage radioactive waste will then be paid from the Fund. Disbursements from the fund are limited to the costs listed in Section A-18.4.1.

A-18.5.4. Auditing the financing system

Before the new Ordinance was issued, NPP operators set aside financial resources in their own accounts, which were audited by private accountants. However, since the new Ordinance came into effect, the Fund is audited on an annual basis by an independent auditor. In addition, the financing system can be audited by external experts upon request by the Federal Department of the Environment, Transport, Energy and Communication.

A-18.5.5. Revenue and expenditure of financial resources

By the end of 2000, the operators of the NPPs had set aside 7.9 billion CHF, of which 3.4 billion CHF have already been spent to pay for the activities of Nagra, ZWILAG, etc. 1.44 billion CHF were paid into the Fund in 2001, including fees prior to the establishment of the fund. In 2002, further contributions to the fund are expected to be paid.

A-18.6. Public involvement and transparency

The various types of public involvement in siting process are discussed below:

[17] A separate Decommissioning Fund was established in 1984 to reserve the financial resources that will be required for eventual decommissioning of the Swiss NPPs.

- Formal public participation is ensured in the decision making process specified by the federal nuclear licensing procedure.
- In the process of licensing for preparatory measures, an application will be published in the Federal Gazette and made available for public inspection. People and communities likely to be affected by the license are allowed to lodge objections within a certain period of time. These comments and objections are considered by the government in determining whether to issue the license.
- In the process of issuing a general license, anyone has two opportunities to comment and lodge written objections. The license application will be made available to the public in the Federal Gazette for the purpose of inspection. Anyone can lodge written objections within the 90 days after publication of the application. The Federal Government will disclose their conclusions regarding the application for general inspection after they collect opinions from the Cantons, involved federal authorities and various expert bodies. Any member of the public can again lodge written objections regarding the government's conclusions. As for licensing of preparatory measures, these comments and objections are considered by the government in determining whether to issue the license.

When field surveys are conducted, a special committee is established to investigate whether all required conditions of the license are fulfilled. A representative of local opponent groups is usually included on this committee. If investigations are conducted close to the national border, cross border transparency and information exchange is enhanced (i.e. foreign regional authorities can delegate an observer to the committee).

Due to the formal public involvement process required by legislation, the government has organized constructive dialogues between stakeholders. Nagra, based on a policy of openness and transparency, has disclosed all of their investigation results in the form of Technical Reports. Nagra also periodically publishes various types of materials, depending on the expected audience, to provide the public information regarding Nagra's activities. Nagra promotes a two-way flow of information by maintaining direct contact and discussions with all levels of society in the country. Guided tours, open days and visits of groups to investigation sites or rock laboratories are being organized.

In 2000, Nagra's expenditure on public relations and documentation amounted to approx. 2.9 million CHF. Cost benefit analyses of expenditures on public communications are mainly conducted on an ad hoc basis after presentations and events, by polls or by direct feedback from the public on print products or web sites. Nagra's expenditures on public relations and documentation are published in the annual accounts as a total figure, including personnel costs and other expenditures.

In Switzerland, there is recognition that the right of people to be involved in the licensing procedure should be interpreted broadly. Approval has been given for participation by people living more than 20 km from the facility in question. People living abroad, but nearby, also have the right to participate in the licensing procedure.

A-18.7. Other considerations

A-18.7.1. Nuclear liability

The Swiss law on civil liability in the area of nuclear energy, dated 18 March 1983, states that the liability of the operator of a nuclear installation, including the operator of a final repository, is borne directly by the operator himself and is unlimited. The law requires operators to take standard risk insurance with a private insurance company for up to one billion CHF to cover nuclear-related damages, and up to one hundred million CHF to cover interest and court costs.

The state covers non-standard risks, which may be excluded by a private insurance company (e.g. damage caused by war, natural disasters, etc.), up to the same amounts.

Operators also pay insurance premiums to the state. These premiums are kept in a special nuclear damages fund, which amounts to 276 million CHF as of 31 December 2001.

Switzerland is currently discussing whether responsibility and liability should be transferred from the operator of a final disposal site to the state, once the repository has been sealed and certain conditions have been met.

A-18.7.2. Retrievability and institutional controls

The Federal Government established an Experts Group on Disposal Concepts for Radioactive Waste in 1999 to propose various concepts for radioactive waste disposal. The experts group issued their conclusions, a summary of which is shown below:

- Geological disposal is the only radioactive waste disposal method that can ensure long term safety (for up to more than 100 000 years).
- Social expectations are oriented towards reversibility.

As a result, the Experts Group developed the concept of “Monitored long term geological disposal”, which combines reversibility with final disposal. As a result of this conclusion, the requirements for monitoring, control and retrievability are being incorporated into a newly drafted nuclear energy law, currently under consideration.

A-18.7.3. Records keeping

In Switzerland, data regarding conditioned and most unconditioned radioactive waste is kept in a standardized, decentralized computer system called “ISRAM”. The data includes information on the structure and type of materials, of the waste packages, and on their radiological inventory. The generators of the wastes, and any organizations to which the wastes are transferred, are required to register the waste into ISRAM. A copy of the record is required to be maintained until the waste package is delivered to the organization responsible for final disposal. The information required to be kept is formalized according to regulation. ISRAM is not publicly accessible. It is maintained in a decentralized manner, i.e. each owner or person responsible for conditioned waste packages is required to enter data for their wastes into their local ISRAM database.

Upon delivery of wastes to an organization that is responsible for final disposal, a summary of data from ISRAM, as well as details of a final repository (layout, disposal concept, and safety concept) are required (in accordance with regulatory guideline HSK-R-21/e) to be maintained for use by future generations. However, since the Swiss geological repository project is still in an early stage of development, the details of necessary information and the methods of record keeping have not been established yet.

A-19. UNITED KINGDOM

A-19.1. Organization and legislation

A-19.1.1. Organizational structure

POLICY/LEGISLATION

Parliament

4 Enacts laws.

Government

Department for Environment, Food & Rural Affairs (DEFRA)

4 Establishes policies on radioactive waste management.

REGULATION/OVERSIGHT

Regulatory Authorities

Environmental Agency (England/Wales)
Scottish Environmental Protection Agency (SEPA) (Scotland)
Environment & Heritage Service (Northern Ireland)

4 Are responsible for nuclear safety regulation for waste disposal.

Advisory Body

Radioactive Waste Management Advisory Committee (RWMAC)

4 Advises on major radioactive waste management issues.

IMPLEMENTATION

Implementation Organization

4 An implementing organization has not been established yet.

Financial Resources Management

4 Owners of HLW/SNF (British Energy, BNFL, UKAEA) are responsible for maintaining financial resources to fund waste management.

A-19.1.2. Implementing organization

The United Kingdom currently has a policy which calls for above ground storage of vitrified HLW for at least 50 years. The United Kingdom does not have a policy on disposal of HLW. As a consequence, an implementing organization responsible for HLW disposal has also not been established.

A-19.1.3. Laws and regulations

The Nuclear Installations Inspectorate and the Environmental Agencies oversee storage of HLW. In the absence of a HLW disposal policy, there are no particular laws and regulations on disposal of HLW.

A-19.2. Waste stream proposed repositories

A-19.2.1. Waste stream assumptions

Most of the United Kingdom's HLW has come from the nuclear power industry. There are 20 Gas Cooled Reactors (GCR), 14 Advanced Gas-Cooled Reactors (AGR) and one PWR in operation in the United Kingdom, with a total capacity of about 13 GW(e) at the end of 1999. Six 6 GCRs, one AGR and 3 other reactors, with a total capacity of about 1.2 GW(e) have already been shut down.

On 1 April 1998, there was 1800 m³ of HLW in storage in the United Kingdom. Of this, 240 m³ were vitrified and 1560 m³ were awaiting vitrification.

Estimates of the amount of HLW to be generated in the future were made based on the following assumptions:

4 *Nuclear power stations:*
- GCRs will have an operational lifetime of 37 years on average, except for those at Calder Hall and Chapelcross (which will operate for 45 years),
- AGRs will have an operational lifetime of 30 years, except for those at Hunterston and Torness (which will operate for 35 years),
- PWRs will have 40 year operational lifetimes.

4 *Reprocessing:*
- Reprocessing of spent fuel from GCRs will continue until 2009,
- Reprocessing of oxide fuel will continue at THORP until 2013.

HLW will be generated at a rate of between 45 and 90 m³ a year until 2013. The total amount of vitrified HLW is predicted to reach 1890 m³ in 2013. The United Kingdom currently expects to manage arisings from PWRs as spent nuclear fuel.

A-19.2.2. Proposed repositories

Since the United Kingdom has not yet decided which option (e.g. storage or disposal of HLW and SNF) to adopt, it does not currently have any concrete concept for a proposed repository for HLW and SNF.

A-19.2.3. Management time schedule

Since the United Kingdom has not yet decided which option (e.g. storage or disposal of HLW and SNF) to adopt, it does not have a time schedule for disposal of HLW and SNF.

A-19.3. Siting of geological repositories

Since the United Kingdom has not yet decided which option (e.g. storage or disposal of HLW and SNF) to adopt, it does not have a policy for the siting process, siting criteria, decision making procedures, on the roles of local government in development of plans for a repository, or on financial assistance to the local communities around a potential site for disposal of HLW and SNF.

A-19.4. Waste management and disposal costs

A-19.4.1. Total estimated cost and its breakdown

Since the United Kingdom has not yet decided which option (e.g. storage or disposal of HLW and SNF) to adopt, it is not able to estimate the cost for disposal of HLW and SNF.

A-19.4.2. Organizations responsible for cost estimation

The costs of managing HLW and SNF are the responsibility of the owner of the material concerned. This situation is expected to continue for the foreseeable future. Of the current owners, BNFL and British Energy, are companies governed by the provisions of the United Kingdom’s Companies Acts, while the UKAEA is a non-departmental public organizationestablished under the Atomic Energy Act 1954. It will be the responsibility of these entities (and/or any future owners of this material) to make estimates of the cost of managing their HLW and SNF.

A-19.5. Financing system

A-19.5.1. Overview of the financing system

Funding the management of HLW and SNF is currently the responsibility of the owner of the HLW and/or SNF. Since it is not possible to prepare definitive estimates of the disposal costs, no subsidiary decisions or arrangements will be made until the long term management policy for HLW and SNF has been established.

A-19.5.2. Withdrawal

The owners of HLW and/or SNF are expected to make any expenditure associated with the management of the HLW and SNF in the same manner as they do for their other operating expenses.

A-19.5.3. Auditing the financing system

The accounts of the owners of HLW and/or SNF (i.e. British Energy, BNFL and the UKAEA) are all subject to independent audit. British Energy and BNFL, which are established under the Companies Act, appoint their own auditors. The accounts of the UKAEA, which was established under the Atomic Energy Act as a non-departmental body, are audited by the National Audit Office.

The auditors' comments are usually presented in published account documents.

A-19.6. Public involvement and transparency

DEFRA is responsible for establishing government policy for the long term management of HLW and SNF, including any associated consultation procedures. However, since the United Kingdom has not yet developed a long term policy for HLW and SNF, it has not established any concrete policy on public involvement and transparency for a repository for disposal of HLW and SNF. A policy review regarding the long term management of HLW, SNF, ILW and some plutonium and uranium is underway.

A-19.7. Other considerations

A-19.7.1. Nuclear liability

Liability for any damage caused by the operations of nuclear facilities is the sole responsibility of the relevant nuclear operator. The operator's liability is governed by the international liability regime, i.e. the Conventions on Civil Liability for Nuclear Damage and Joint Protocol.

A-19.7.2. Retrievability and institutional controls

Since the United Kingdom has not yet decided which option (e.g. storage or disposal of HLW and SNF) to adopt, it does not have a policy on long term considerations relevant to HLW and SNF disposal. A policy review is underway.

A-19.7.3. Records keeping

At the present time, the waste producers manage their own records and provide relevant information to those who need it, i.e. regulators. A portion of this information is made publicly available in "the UK Radioactive Waste Inventory", produced by DEFRA and Nirex[18].

[18] For data pertaining to high, intermediate and low level radioactive wastes.

A-20. UNITED STATES OF AMERICA

A-20.1. Organization and legislation

A-20.1.1. Organizational structure

POLICY/LEGISLATION

Congress

- Enacts laws.
- Provides direction through appropriation legislation.
- Affirms site selection.
- Appropriates funds for program implementation.

President

- Makes the site designation decision.
- Submits the site recommendation to Congress.
- Requests Congressional approval of the budget for the programme.

REGULATION/OVERSIGHT

Regulatory Authorities

Nuclear Regulatory Commission

- Establishes technical requirements for repository licensing, consistent with EPA standards.
- Responsible for granting the repository construction license, approving receipt and possession of nuclear material and approving closure of the repository.

Environmental Protection Agency

- Establishes standards on public health and safety.

Oversight Body

Nuclear Waste Technical Review Board (NWTRB)

- Provides independent technical and scientific oversight.
- Reports its findings to Congress and the Secretary of Energy.

IMPLEMENTATION

Implementing Organizations

Department of Energy (DOE)/Office of Civilian Radioactive Waste Management

- Is responsible for repository site selection, licensing, construction, operation and closure.

Utilities

- Are responsible for storage of spent nuclear fuel until it is accepted by DOE.

Financial Resources Management Body

Department of Energy/Office of Civilian Radioactive Waste Management

- Is responsible for collecting fees and managing the fund balance, for assessing adequacy of the fee and for recommending changes to the fee.

The interaction of the government and different organizations involved in the HLW and/or SNF management in the United States of America Spain is shown in Fig. A-20.1.

A-20.1.2. Implementing organizations

The Office of Civilian Radioactive Waste Management (OCRWM) was established within the Department of Energy by the Nuclear Waste Policy Act of 1982 to conduct the following activities:

- Final disposal of SNF and HLW,
- Collecting fees to fund the disposal of SNF and HLW, assessing the adequacy of the fee and recommending changes in the fee.

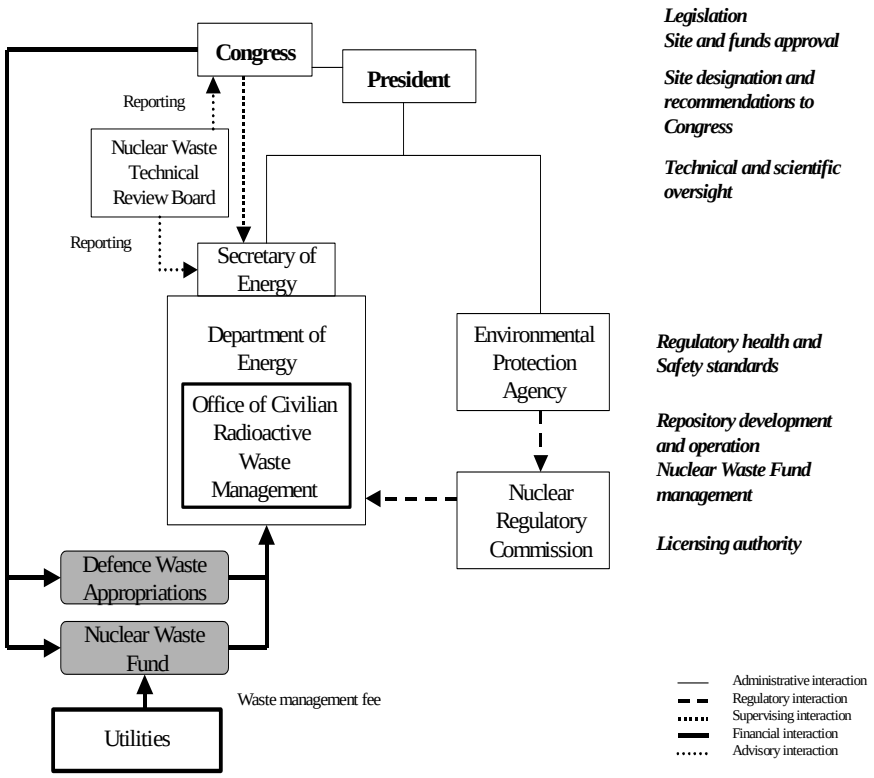


Fig. A-20.1. Organizational structure.

In the 1987 Amendment to the Nuclear Waste Policy Act, the Nuclear Waste Technical Review Board was created as an independent organization to evaluate the technical and scientific validity of activities undertaken by OCRWM. The Board reports its findings and recommendations to Congress and the Secretary of Energy.

The Amendment states that OCRWM should focus its investigations on a potential site at Yucca Mountain, Nevada, and that the State of Nevada and units of local government in the vicinity of Yucca Mountain are entitled to exercise oversight of site characterization activities, using federal funds. The State provides comments and recommendations to the Secretary of Energy.

A-20.1.3. Laws and regulations

The following laws and regulations establish the requirements for disposal of SNF and HLW in the USA:

- The Nuclear Waste Policy Act of 1982 (NWPA) - (established the implementing body, financing system, siting process and time schedule);
- The Nuclear Waste Policy Amendments Act of 1987 (Amended NWPA) - (designated Yucca Mountain for investigation, established an oversight body);
- The Energy Policy Act of 1992 - (directed EPA to issue public health and safety standards specific to Yucca Mountain, required post-closure oversight);
- 10 CFR Part 960 (original DOE siting guidelines);
- 10 CFR Part 963 (amended DOE siting guidelines specific to Yucca Mountain);
- 40 CFR Part 191 (original non-site specific EPA health and safety standards for geologic repositories);
- 40 CFR Part 197 (EPA public health and safety standards specific to Yucca Mountain);
- 10 CFR Part 60 (original non-site specific NRC licensing regulations for geologic repositories);
- 10 CFR Part 63 (NRC licensing regulations specific to Yucca Mountain).

A-20.2. Waste streams and proposed repositories

A-20.2.1. Waste stream assumptions

HLW and SNF are arising from various civilian and defence activities.

- *Commercial light water reactor SNF* – Through the end of 2001, about 44 600 t HM of SNF had been unloaded from 119 civilian light water reactors in the USA, of which 15 are permanently shut down and 103 are currently operating with a capacity of about 101 GW(e). One reactor is expected to restart operations. The current arisings include a few assemblies containing recycled plutonium, but otherwise all reactors are operating on an open fuel cycle. Projected future arisings include about 560 t HM of MOX SNF, consuming excess weapons plutonium on a once-through basis. With respect to projected future arisings, the 104 operating reactors are mostly licensed for 40 years of operation and are assumed to operate until termination of their licenses. Recently, the first 20-year operating license extensions were granted by the NRC, and a significant fraction of the owners of other reactors have expressed an intention to apply for 20-year extensions. There are no assumed new reactors included in the current projections. The total inventory of commercial spent nuclear fuel in the United States could exceed 100 000 t HM by the year 2035.
- *Commercial HLW* – The commercial HLW in the USA is predominately from operation of the West Valley, NY reprocessing plant. This plant has reprocessed 640 t HM of SNF and has now been substantially decommissioned.
- *Defence HLW* – Approximately 5000 waste disposal packages will be required for disposal of vitrified defence HLW.
- *Department of Energy and Navy SNF* – The principal inventory of DOE SNF is about 2100 t HM of production-reactor spent fuel. DOE also has small inventories of a considerable variety of test and research reactor spent fuel types and has taken title to some civilian spent fuel.

A-20.2.2. Proposed repositories

OCRWM is currently working on development of a deep geological repository at Yucca Mountain, Nevada, for disposal of SNF and HLW. The primary characteristics of this repository are listed in the table below. The total repository capacity shown in the following table (70 000 t HM) is the limit currently imposed by the NWPA prior to the start of work on a second repository. For commercial SNF, the amount is primarily based on the quantities arising under the present licensed condition. Additional quantities of SNF are expected to be generated by civilian power reactors as they receive 20-year operating license extensions from the Nuclear Regulatory Commission (NRC). The repository is being designed to have the flexibility to accommodate additional waste disposal capacity in the event that the statutory limits are changed and appropriate institutional and regulatory approvals are received.

Candidate site	Yucca Mountain, Nevada
Capacity	70 000 t HM (details of the waste types are shown below)
Repository depth	At least 200 m below the surface and at least 100 m above the water table
Host rock	Tuff volcanic rock
Engineered barriers	– Cylindrical waste package composed of a corrosion-resistant outer barrier (Alloy 22) and a corrosion-allowance inner barrier (stainless steel 316NG) - A drip shield (being considered). – Emplacement drift backfilling is currently being evaluated.

Estimated waste types and quantities for disposal

Waste type	Quantity (t HM or equivalent)
Commercial LWR SNF	63 000
Commercial HLW	640
Defence HLW	4027
Department of Energy and Navy SNF	2333
Total	**70 000**

In addition, several types of non-fuel-bearing wastes associated with SNF are expected to be accepted for disposal in the repository. These include control rod assemblies and blades, burnable poison rods, in-core instrumentation and compacted fuel assembly hardware from fuel assembly consolidation

A-20.2.3. Management time schedule

OCRWM is required by the NWPA to prepare the schedule for the US national programme for geological disposal of SNF and HLW. The key pre-start-up activity sequence is determined, to a significant extent, by the site evaluation and approval process that was legislated in the NWPA. The schedule for completion of the key activities, subject to a final determination that the Yucca Mountain site is suitable, is as follows:

2002	The US Congress and the President approved the Yucca Mountain site for repository development
2004	DOE submits a license application to the NRC
2007-2008	NRC issues a construction authorization
2010	Initial waste acceptance and disposal

According to the planned operating schedule and disposal rate, the first 70 000 t HM would be disposed of by mid-2033.

A-20.3. Siting of geological repositories

A-20.3.1. Siting process

Between 1954 and 1975, the USA conducted studies of potential repository sites in salt. Between 1976 and 1982, the search was expanded to include shale, basalt, and crystalline rocks. In the latter time period, the search for sites began on federal lands.

A formal siting process was developed under the DOE siting guidelines (10 CFR Part 960), as required by the NWPA. Under the guidelines, the site selection process was envisioned as follows:

(1) Survey the country for geologic provinces, narrowing to regions (search extended across several states),
(2) Survey regions, narrowing to areas (hundreds to thousands of square miles),
(3) Survey areas, narrowing to locations (tens to hundreds of square miles),
(4) Survey locations, narrowing to sites (areas large enough to contain a repository, a few to tens of square miles).

Screening the country's geologic provinces to regions, and the regions to areas was accomplished based on existing data and information. Screening of areas, locations, and sites required field investigations. Sites would then be screened, some would be nominated, and fewer would be recommended for site characterization. The site nomination to the President for characterization was to have been accompanied by an environmental assessment.

This process was applied to develop nine sites for consideration for the first repository. In 1986, the President approved three of these sites for characterization. After that, the Amended NWPA selected Yucca Mountain as the only site to be characterized.

A site characterization plan was developed for the Yucca Mountain site in 1988. The site characterization programme included surface-based testing, underground testing as required by the NRC, laboratory studies, and modelling activities for evaluation of performance.

On February 14, 2002, the Secretary of Energy, after a comprehensive review of the studies, testing, and analysis conducted over a 20-year period, recommended to the President that the Yucca Mountain site be developed as an underground repository for SNF and HLW. Citing compelling national

interests that warrant this decision, the Secretary stated that a repository is vital to ensure the national security, support energy security, secure disposal of nuclear wastes, and provide for a cleaner environment. Subsequently, on February 15, 2002, the President approved the Secretary's recommendation and forwarded it to Congress for site designation. In July 2002, the U.S. Congress voted to approve the recommendation of Yucca Mountain as the site for the nation's first geologic repository for spent nuclear fuel and high level radioactive waste. On July 23, 2002, after the Congressional vote of approval, President Bush signed the Yucca Mountain Resolution; the DOE will now work towards submitting a license application to the Nuclear Regulatory Commission to obtain authorisation to build a repository.

The license review by NRC is expected to take about three years. Given adequate funding and successful completion of the licensing process, the first nuclear waste shipments could begin arriving at the repository by 2010.

A-20.3.2. Development of siting criteria

When DOE was considering multiple sites, DOE promulgated siting guidelines in 10 CFR Part 960. These guidelines were developed by a DOE working group of technical experts that was assembled to develop the guidelines and respond to public comments during the public review process. The guidelines followed closely the Nuclear Regulatory Commission regulation (10 CFR Part 60) that had been promulgated for licensing of geological repositories. These guidelines envisioned selection of a site from several characterized sites, based on application of the siting guidelines to site specific information.

The siting guidelines (10 CFR Part 960) contained qualifying and disqualifying conditions that were to be used to screen and select sites in different rock types (salt, basalt, tuff, and crystalline rocks). Qualifying conditions included: system requirements, geo-hydrology, geochemistry, rock characteristics, climate change, erosion, dissolution, natural resources, site ownership and control, population density and distribution, meteorology, offsite installations and operations, surface characteristics, hydrology, and tectonics. Disqualifying conditions included geo-hydrology, erosion, natural resources, and population density and distribution.

As directed by Congress, the EPA issued its final rule on Yucca Mountain public health and safety standards (40 CFR Part 197) in June 2001. Also as directed by Congress, the NRC issued its final rule on licensing regulations for Yucca Mountain (10 CFR Part 63), consistent with EPA standards, in November 2001. Subsequently, DOE finalized its rule-making on siting guidelines for Yucca Mountain (10 CFR Part 963). Consistent with 10 CFR Part 63, the siting guidelines of 10 CFR Part 963 contains no disqualifying conditions. Instead, suitability criteria in hydrology, geophysics, and seismic activity related to processes pertinent to total system performance assessment were specified. There are nine suitability criteria as follows:

(1) site characteristics;
(2) unsaturated-zone flow characteristics;
(3) near-field environment characteristics;
(4) engineered barrier system degradation characteristics;
(5) waste form degradation characteristics;
(6) engineered barrier system degradation, flow, and transport characteristics;
(7) unsaturated-zone flow and transport characteristics;
(8) saturated-zone flow and transport characteristics; and
(9) biosphere characteristics.

In addition, disruptive processes and events are considered based on four suitability criteria as follows:

(1) volcanism;
(2) seismic events;
(3) nuclear criticality; and
(4) inadvertent human intrusion.

The criteria were examined in the performance assessment of the potential repository that was conducted to demonstrate compliance with the requirements of EPA (40 CFR Part 197) and NRC (10 CFR Part 63).

A-20.3.3. General procedures for decision-making in each phase or stage

The general procedures for decision-making are discussed above along with the discussion of the siting process (Section A-20.3.1) and the development of siting criteria (Section A-20.3.2).

A-20.3.4. Role of local governments

In general, during the process of promulgating new requirements, draft documents, including the DOE guidelines and NRC and EPA regulations, are provided to local government(s) for review and comments.

In particular, the State of Nevada and units of local government in the vicinity of the candidate site at Yucca Mountain were entitled to exercise oversight of site characterization activities and provide comments and recommendations resulting from their oversight activities to the Secretary of Energy.

A-20.3.5. Financial assistance

Financial assistance is available from DOE under the Amended NWPA through grants to the State of Nevada and any affected units of local government to allow them to participate in site related activities, including:

(1) review of activities for determining any potential economic, social, public health and safety impacts, and environmental impacts of an storage facility or a repository;
(2) development of a request for impact assistance;
(3) engaging in any monitoring, testing, or evaluation activities with respect to site characterization;
(4) improving the information available to Nevada residents concerning activities of the State, DOE, or the NRC regarding the site; and
(5) requesting information from DOE and making comments and recommendations to DOE concerning activities at the site.

A-20.4. Management costs

A-20.4.1. Total estimated cost and its breakdown

The summary of the total system life cycle cost estimation for SNF and HLW is shown in the following table:

Cost element	Cost (million US $ 2000)
Monitored Geologic Repository costs:	42 070
4 Development & evaluation (1983-License application)	6580
4 Surface facilities	7700
4 Subsurface facilities	8980
4 Waste package & drip shield fabrication	13 290
4 Performance confirmation	2270
4 Regulatory, infrastructure & management service	3250
Waste acceptance, storage & transportation	5960
Nevada transportation	840
Programme integration	4070
Institutional costs	4580
Total	**57 520**

A-20.4.2. Organization responsible for cost estimation

OCRWM is the organization responsible for developing the cost estimate for long term management of HLW and SNF in the USA. The cost estimate is subject to independent review by Burns and Roe of Oradell, NJ.

A-20.5. Financing system

A-20.5.1. Overview of the financing system

The Nuclear Waste Fund (NWF) was established in 1982 by the NWPA to fund DOE's programme for final disposal of HLW and SNF. Expenditures for the programme are financed by the NWF for commercial SNF, and by the Federal Government's general appropriation for Government managed wastes.

Evaluation of fee adequacy is based on the principle of full-cost recovery, as required by the NWPA. The full-cost recovery principle underlies the basic analytical methodology used by DOE. The methodology for projecting the adequacy of the fee uses a forecast of the revenue stream for fees paid into the NWF by the utilities, along with interest earned by the Fund, and compares it with disbursement forecasts to determine the sufficiency of funds.

Nuclear utilities are required to pay a fee to NWF through the US Treasury. For SNF generated prior to enactment of the NWPA, nuclear utilities were required to pay a one-time fee.

Annual surpluses are invested in Treasury securities. Annual shortfalls in revenue will be met by redeeming securities held by the NWF or by borrowing from the Treasury, if necessary.

The overview of the financing system is given in Fig. A-20.2.

A-20.5.2. Management fee

For commercial SNF, the charge for disposal cost is 1 mill (0.1 cent) per kW•h of electricity generated and sold. The fee has remained constant since establishment of the system. The NWPA allows Congress to change the fee by if it becomes inadequate to cover projected program costs.

A-20.5.3. Withdrawal

Withdrawal is made according to programme budgets, approved by Congress.

A-20.5.4. Auditing the financing system

KPMG Peat Marwick LLP conducts independent audits of the NWF. Audits are conducted annually.

A-20.5.5. Revenue and expenditure of financial resources

The revenues paid into the NWF, and expenses withdrawn from it are summarized in Table A-20.I.

A-20.6. Public and transparency

The NWPA includes specific provisions to ensure participation of members of the public and affected Native American tribes in the decision-making process. The public, including affected Native American tribes, are involved in at all phases of the programme such as review and comment on siting guidelines, environmental assessment, environmental impact statement, and site recommendation; participation at planning and review meetings; and county and university participation in site characterization. In 1998, DOE and the University and Community College System of Nevada entered into a co-operative scientific study agreement financed by DOE.

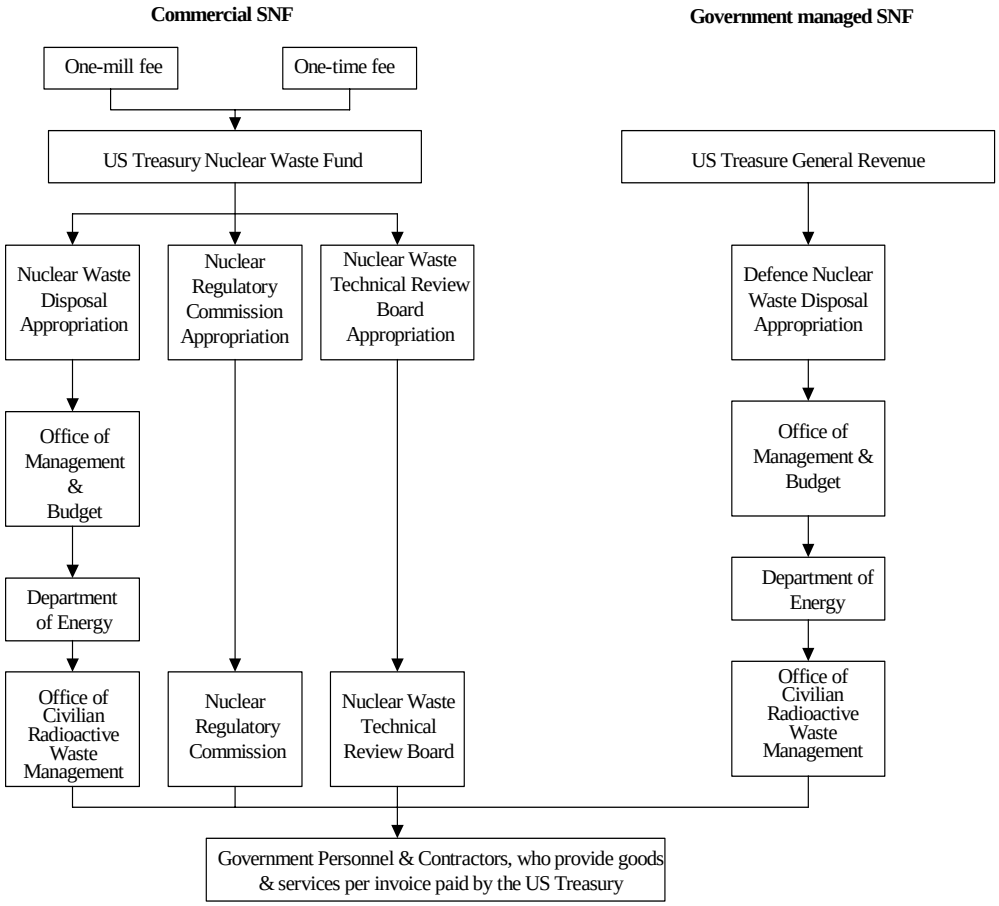


Fig. A-20.2. Financing system overview.

OCRWM promotes two-way communications with technical audiences and the general public through a multi-faceted outreach programme, including activities such as:

- Organized tours to Yucca Mountain and making briefings,
- Exhibition and presentation of Yucca Mountain activities at various conferences and events,
- Communicating via the Internet and a toll-free telephone line,
- Provision of documents.

Educational activities are provided to students, teachers and parents by workshops, environmental studies (including field trips), etc.

During site characterization, DOE reports semi-annually to the NRC and the Governor and legislature of the State of Nevada on the progress of site characterization activities and information collected.

The DOE has a communications staff that is responsible for developing, conducting and evaluating public communication initiatives. The cost of these activities amounts to approximately 1 percent of the cost of the overall site characterization effort.

A-20.7. Other considerations

A-20.7.1. Nuclear liability

In the USA, the Price-Anderson Act provides financial protection for individuals who may be injured by a nuclear incident, and for individuals who may be liable for damage resulting from a nuclear incident.

TABLE A-20.I. REVENUE AND EXPENDITURES

	Spent nuclear fuel fees			Defence fees	Treasury loan				
Fiscal year	**One-mil fees[2,4]**	**One-time fees[2]**	**Cumulative fees[2]**	**High-level waste fees[2]**	**Principal payment**	**Investment returns[3,5]**	**Total annual income**	**Annual disburse-ments[6]**	**NWF balance**
1983	74	0	74	0	254	0	327	169	158
1984	330	0	404	0	5	0	334	271	221
1985	367	1427	2198	0	–258	–74	1463	317	1367
1986	362	6	2566	0	0	73	441	385	1423
1987	435	6	3007	0	0	89	530	446	1507
1988	498	6	3511	0	0	165	669	412	1764
1989	513	6	4030	0	0	196	715	349	2130
1990	570	6	4606	0	0	161	737	372	2495
1991	594	6	5206	5	0	241	846	315	3026
1992	560	6	5772	8	0	268	842	354	3514
1993	466	11	6249	0	0	296	773	325	3962
1994	418	4	6671	0	0	210	632	364	4229
1995	615	0	7286	0	0	246	861	408	4682
1996	633	1	7920	0	0	212	847	218	5311
1997	596	0	8516	0	0	471	1067	178	6200
1998	600	0	9116	0	0	743	1343	186	7357
1999	662	0	9778	0	0	106	768	186	7939
2000	702	0	10 480	0	0	883	1585	290	9234
FY01 through 4/30/01	**483**	**0**	**10 963**	**0**	**0**	**364**	**847**	**115**	**9966**
Cum-to-date	9478	1485	10 963	13	0	4650	15 626	5660	9966
2001	620	0	11 100	0	0	624	1244	238	10 239
2002	640	0	11 740	0	0	688	1328	188	11 379
2003	625	0	12 365	0	0	742	1367	163	12 583
2004	612	0	12 977	0	0	791	1403	166	13 819

1. Current values as of April 30, 2001. Rows may not add due to independent rounding. Receipts and Disbursements do not include Defence Nuclear Waste Disposal appropriations because these funds do not flow through the Nuclear Waste Fund. For FYs 1993 through 2001, these appropriations were US $100M, US $120M, US $129.430M, US $163.4M, US $200M, US $190M, US $189M, US $111.6M, and US $199.7M, respectively.
2. Actual Fees from the "NWF Summary of Cash Balance" are issued monthly by the DOE Chief Financial Officer.
3. Actual Investment Returns for FY 2000 and prior years include coupon interest receipts; net premium and discounts paid and received on bills, notes, and bonds; and the annual change in market value of zero coupon bonds. Actual Investment Returns for "FY01 through 4/30/01" include accrued coupon interest and amortised premium and discounts of bills, notes, and bonds; and amortised interest income based on the effective yield at the time of bond purchase for zero-coupon bonds.
4. Forecast kW•h Fee Receipts are based on EIS projections as of 9/30/2000 with adjustments made for potential litigation settlements.
5. Forecast Investment Returns consist/include anticipated effect yield earnings on all securities from the date of purchase.
6. Forecast Disbursements are based on FY 2001 appropriations and the OCRWM FY2002 Congressional Budget Request, with appropriations adjusted to disbursements using Office of Management and Budgets simplified (50/50) formula plus US $27M for future appropriations to the NRC and NWTRB. Actual and Forecast disbursements include Programme Expenditure, NRC, Nuclear Waste Negotiator, and NWTRB appropriations, interest on Treasury loans (FY84 US $3M, FY85 US $5M) and interest refunded to utilities (FY88 US $7M, FY89 US $1M, FY92 US $7M, FY93 US $41M,FY94 US $48M, FY95 US $19M, FY96 US $1M).

For activities conducted for DOE, including operation of a waste repository, the Price-Anderson Act achieves its objectives by requiring DOE to include an indemnification in each contract that involves the risk of a nuclear incident. This DOE indemnification:

(1) provides omnibus coverage of a DOE contractor and all other persons who might be legally liable for injury or damage resulting from a nuclear incident;
(2) indemnifies fully all legal liability up to the statutory limit on such liability (approximately US $9.43 billion for a nuclear incident in the United States);
(3) covers any DOE contractual activity that might result in a nuclear incident in the USA;
(4) is not subject to the availability of appropriated funds; and
(5) is mandatory and exclusive.

The Department of Energy Acquisition Regulation (DEAR) specifies standard nuclear indemnification clauses that are incorporated into all DOE contracts and subcontracts involving source, special nuclear, or by-product material (nuclear material).

A-20.7.2. Institutional controls

The Department of Energy has not yet formalized long term institutional controls for the geologic repository. However, it is expected that active institutional control measures will be established for the

disposal of SNF and HLW, similar to those applicable to the DOE Waste Isolation Pilot Plant (WIPP[19]).

For WIPP, DOE will begin an active control period within sixty days of completion of final facility closure, decontamination and decommissioning. Active institutional controls to be used by DOE at WIPP include facility guarding, evaluation of land use in the area, post operational monitoring, land reclamation, and maintenance of fences and buildings or other structures.

In addition, passive institutional controls proposed by DOE to meet the applicable regulatory criteria include a system of permanent markers (including items such as surface monuments, small subsurface warning markers, buried rooms, and large earthen structures marking the area under which WIPP is located) and records archives.

A-20.7.3. Records keeping

DOE conducts an extensive records management programme, as required to comply with the regulatory requirements applicable to nuclear activities in the USA. However, the records management programme that will be put into place after repository closure has not yet been formalized. Nevertheless, DOE expects that the records management methodology to be established for disposal of SNF and HLW will be similar to that which has been specified for WIPP.

For WIPP, the DOE Carlsbad Area Office, located in New Mexico, has developed a Records Management System that complies with applicable rules and regulations. Records of WIPP related activities are required to be kept by the various organizations involved in operation of WIPP, unless they are approved for disposition. The record media consists entirely of paper. The storage methods, medium used, and disposition schedules must all be in accordance with requirements established in National Archive Records Administration orders and guidelines. Public access to selected documents is available on the Internet, by phone, or in established Reading Rooms.

[19] WIPP is a geological repository for disposal of transuranic wastes resulting from national defence activities. WIPP is located in a salt formation in the State of New Mexico and is currently in operation.

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