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NUCLEAR ENERGY AGENCY
RADIOACTIVE WASTE MANAGEMENT COMMITTEE

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RWMC Regulators' Forum (RWMC-RF)

THE REGULATORY CONTROL OF RADIOACTIVE WASTE MANAGEMENT IN NEA MEMBER COUNTRIES

The present up to date report represents the status in the member countries up to June 2002. The report will be published by the NEA. At the same time, the national contributions will be posted on the open NEA web site. The intention is to update these contributions and the present compilation at least yearly.

English - Or. English

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FOREWORD

Stakeholders in the matter of radioactive waste management include waste producers, waste management agencies, regulatory authorities, local communities, elected representatives, the technical intermediaries between the public and decision-makers, as well as national governments, civil society organisations and, in the wider waste management context, international bodies such as the ICRP and OSPAR. The involvement of both technical and non-technical stakeholders will become increasingly important as more countries move towards the siting and implementing of geologic repositories. This last observation is already true in respect of other aspects of radioactive waste management such as transport, interim storage and the authorised discharge of liquid and gaseous effluents into the environment. A feature of this involvement is the increasing extent to which reference is made to procedures and standards applied internationally as well as nationally, and to comparisons between them. It is not apparent that such comparisons are always well informed.

As major stakeholders, the radioactive waste management regulators in the Radioactive Waste Management Committee (RWMC) of the NEA have already recognised the value of exchange and comparison of information about national practices and of having an informal, international network for discussion of issues of common concern. The opportunity for such activity is provided by the Regulators' Forum of the RWMC (RWMC-RF) whose first major action was to compile information about the regulatory control of radioactive waste management in NEA Member Countries, with emphasis on waste disposal. This document presents the initial results of that work. Information is given for each of 14 NEA Member Countries against a standard template designed by the RWMC-RF to facilitate easy accessibility to specific aspects and comparison between different countries. It includes factual information about national policies for radioactive waste management, institutional frameworks, legislative and regulatory frameworks, available guidance, classification and sources of waste, the status of waste management, current issues and related R&D programmes. It should, thus, provide an important source of reference for all stakeholders intent on learning about international practices.

As regards RWMC-RF intentions, specifically, the national contribution and this compilation are intended to be updated yearly and made widely available. The compilation forms the basis of a set of discussions and documents that are designed to identify elements of good practice in the regulation of radioactive waste management and to facilitate the sharing of experience amongst regulatory authorities. The aim is to help these authorities learn from each other in their continuing task of improving, refining and making more transparent all aspects of the regulatory process.

It is intended, in due course, to extend this compilation of information to cover other NEA Member Countries and, where appropriate other key elements of radioactive waste management regulation.

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BELGIUM

1. NATIONAL AND REGULATORY FRAMEWORK

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1.1.1. National policy

The construction and the operation of nuclear installations are regulated by the Federal Government. These regulations are laid down by the Royal Decree of August 20, 2001. They implement the law of April 15, 1994 on the protection of the population and the environment against the hazards of ionising radiation and the establishment of the Federal Agency for Nuclear Control (FANC), and also to implement a number of European directives, the European Basic Safety standards (Council Directive 96/29/Euratom) being the most important one.

Belgium has ratified the London Convention on sea dumping of waste and has subscribed to the prohibition of the dumping of low-level radioactive waste into the ocean.

The transport of radioactive waste must be carried out in accordance with the relevant international modal regulations (ADR for road transport, RID for rail transport, IMO dangerous goods code for sea transport and the ICAO Technical Instructions for air transport). Furthermore, the follow-up of the transboundary movements of radioactive waste must comply with the relevant European regulations.

1.1.2. Institutional framework

The regulatory function for radiological protection and nuclear safety, including waste safety, is assumed by the Federal Agency for Nuclear Control, established by the law of April 15, 1994. It is a government agency with its own board of directors. The daily management is entrusted to the general manager.

The role of the Agency can be summarised as follows:

- to prepare laws and regulations related to radiation protection and nuclear safety;
- to follow-up the scientific and technical evolution and to propose new regulations or amendments to existing regulations to the Minister who is politically responsible for radiation protection and nuclear safety, in order to keep those regulations up to date;
- to implement and enforce those regulations;
- to ensure compliance with those regulations.

The Agency is also the scientific and technical support of the Ministry of Foreign Affairs in matters related to radiation protection and nuclear safety, and to the Ministry of the Interior for matters related to emergency preparedness. Furthermore, the Agency has been given the duty of informing the general public on radiation protection and nuclear safety.

1.2. Regulatory framework

1.2.1. Regulatory function

With respect to the implementation and enforcement of the regulations, the main functions of the Federal Agency for Regulatory Control are to handle the applications for different types of licenses (operation of nuclear facilities, decommissioning of nuclear facilities, transport and import of radioactive material, distribution of radio-pharmaceuticals, medical and industrial applications of ionising radiation, etc.), for recognition of qualified experts in radiological protection and medical radiation physics, as well as for recognition of medical doctors in charge of medical surveillance of workers.

Depending on the type of installation and the nature and level of the hazards involved, the license is issued as a royal decree, signed also by the Minister who is politically responsible for nuclear safety and radiation protection, or as a license signed by the general manager of the Agency or somebody who has been duly given mandate to sign.

After granting the licenses, the Agency is also in charge of ensuring compliance with the particular provisions of the licenses.

1.2.2. Organisation and resources

According to the law of April 15, 1994, which stipulates that regulatory and control functions of the Agency must be clearly separated, three departments have been set up: the licensing department, the control department and the financial and administrative department.

The licensing department is in charge of handling the license applications and to make proposals for decisions and additional particular conditions attached to the license. For so-called nuclear facilities of class I (nuclear power plants and other nuclear fuel cycle facilities, facilities for storage and disposal of radioactive waste), the department has to seek the advice of the local authorities and a scientific council. It also has to seek the advice of the European Commission, in case article 37 of the Euratom treaty applies.

The control department is in charge of ensuring compliance with the general provisions of the regulations and the particular provisions of the licenses. It has the assistance of recognised inspection bodies. It also acts as operator of the national monitoring network (Telerad) and is called upon in case of a nuclear/radiological emergency.

The financial and administrative department is, in particular, in charge of the collection of the annual charges from the licensees and the fees from the license applicants. Those charges have been fixed by Royal Decree, dated August 24, 2001.

2. LEGISLATION AND REGULATION

2.1 Legislation

Two laws form the basis for regulating the management of radioactive waste. The aforementioned law of April 15, 1994 (as amended), sets the framework for the safety and radiation protection regulations.

The legal framework for the management of radioactive waste is set by the law of August 8, 1980 (as amended). By this law, a national agency for the management of radioactive waste (NIRAS/ONDRAF) was established. The responsibilities of that Agency are further detailed in a royal decree of March 30, 1981 (as amended).

2.2 General regulation

General regulations for the protection of the general public, workers and the environment against the hazards of ionising radiation are laid down by royal decree. These regulations specify, amongst others, the general principles for radiation protection, the different licensing procedures and the organisation of the health physics control.

Installations for the management and disposal of radioactive waste are so-called class I installations. The license application is sent to the FANC, which seeks the advice of the local authorities and the scientific council. The local authorities inform the population and take the comments of the population into account in establishing their advice. The FANC also seeks the advice of the European Commission in cases where article 37 of the Euratom Treaty applies, and consults individual countries potentially affected on their territory by the planned operations in the framework of the examination of the environmental impact assessment report. After the examination of the safety analysis report and the environmental impact assessment report, as well as the comments received as a result of the consultation procedures by the FANC and its scientific committee, the final decision is taken under the form of a royal decree. When the decision is favourable this royal decree constitutes the license, which becomes the reference document for compliance assurance activities for the acceptance inspections before operations and during the operational lifetime of the facility.

2.3 Specific regulations

The license generally refers to the safety and environmental assessments, and comprises specific conditions.

In application of the royal decree of March 30, 1981, NIRAS/ONDRAF has prepared general rules for the establishment of acceptance criteria for conditioned and for unconditioned radioactive waste. They were approved by the competent authority and are now the legal basis for the establishment of specific acceptance criteria by NIRAS/ONDRAF for each class of waste.

2.4 Guidance

So far, only facilities for pre-disposal management of radioactive waste have been licensed. It is normal practice that relevant guidance from international organisations (European Commission, International Atomic Energy Agency, International Standards Organisation, …) and organisations in other countries are taken into account. That will not be different for disposal facilities.

2.5 Others

3. CURRENT STATUS

3.1. National status and issues

3.1.1. Waste classification and sources

The waste classification is based on the IAEA guidance in this respect.

Three categories have to be distinguished:

- type A: short-lived low- or intermediate-level waste; waste containing radionuclides with a half-life less of 30 years or less; it may contain traces of long-lived radionuclides;
- type B: long-lived low- or intermediate-level waste;
- type C: high-level and very high-level waste; waste containing large amounts of short-lived and long-lived radionuclides that emit alpha, beta and gamma radiation

3.1.2. Waste management strategy

The waste management programme is defined by NIRAS/ONDRAF. It can be summarised as follows:

- processing and conditioning are performed in the facilities operated by Belgoprocess, a subsidiary of NIRAS/ONDRAF, and located in Mol-Dessel;
- intermediate storage, including the storage of waste resulting from reprocessing of nuclear fuel, takes place in the storage facilities operated by Belgoprocess in Dessel; the intermediate storage of spent fuel takes place on the sites of the nuclear power plants;
- the investigation programme for disposal of low-level and short-lived waste aims at conducting preliminary site characterisations during 1999-2002 and at obtaining a governmental decision on the technical disposal solution (near-surface or geological disposal) in 2004; the local authorities and population are involved in the current investigation programme;

- research and development work is continuing for the geological disposal of high-level and long-lived waste, in particular in the underground laboratory in Mol.

3.2. Regulatory issues

3.2.1. Current issues/problems

The difficulties related to the development of internationally accepted clearance levels is a major problem. In addition to this, the application of the exemption and clearance principles to materials containing naturally occurring radionuclides (NORM) is not easy. It may be worthwhile to consider the introduction of a new category of waste, in order to deal with the large amounts of waste containing NORM.

3.2.2. Policy and regulation developments

Belgium has signed the joint convention on the safety of spent fuel management and on the safety of radioactive waste management (8^{th} December 1997). Work is underway to ratify this convention, such that Belgium becomes party to it.

3.3. R&D programme

3.3.1. Functions

R&D in the field of radioactive waste management, and disposal in particular, is performed mainly under the responsibility of NIRAS/ONDRAF. The research activities are performed by the nuclear research centre in Mol (CEN•SCK), universities and other research institutes, as well as engineering companies.

3.3.2. Contents of R&D plans

Most of the R&D work is related to the disposal of radioactive waste:

- development of technical solutions for the long-term management of low-level and short-lived waste;

- geological disposal of long-lived and high-level waste in clay; in this respect, an underground laboratory in Mol, known as HADES (High Activity Disposal Experimental Site), has been constructed. Worth mentioning is the ongoing research programme, known as PRACLAY (Preliminary demonstration test for clay disposal), which investigates the response of a clay formation to heating, using a full-scale simulation, and also aims at demonstrating the techniques involved in excavation of the galleries and back-filling.

CANADA

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National Framework

Canada is a federal state in which legislative authority is split between Federal (National) and Provincial Governments. For the nuclear industry, overall authority for regulation is solely vested in the Federal government. For other policy and environmental issues, the jurisdiction is mixed and thus more complex. The relevant distribution of powers is given in subsequent sections.

1.1.1 National policy

The Canadian radioactive waste policy framework consists of a set of principles governing the institutional and financial arrangements for disposal of radioactive waste by waste producers and owners.

- The federal government will ensure that radioactive waste disposal is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.
- The federal government has the responsibility to develop policy, to regulate, and to oversee producers and owners to ensure that they comply with legal requirements and meet their funding and operational responsibilities in accordance with approved waste disposal plans.
- The waste producers and owners are responsible, in accordance with the principle of “polluter pays”, for the funding, organisation, management and operation of disposal and other facilities required for their wastes. This recognises that arrangements may be different for nuclear fuel waste, low-level radioactive waste and uranium mine and mill tailings.

1.1.2 Institutional framework

Federal Government

Canadian Nuclear Safety Commission (CNSC) National Regulator	Natural Resources Canada (NRCan) National Policy Oversight	Environment Canada Protection of the Environment	Canadian Environmental Assessment Agency (CEAA) Environmental Assessments

Provincial Governments
(structures vary)

Provincial Governments are responsible for:

- Choice of energy options (hydro, fossil, nuclear)
- Exploitation of natural resources (uranium mining, etc.)
- Protection of environment (joint responsibility)

1.2 Regulatory Framework

1.2.1 Regulatory function

The mission of the Canadian Nuclear Safety Commission (CNSC) is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. The CNSC is an independent agency of the Government of Canada. It reports to Parliament through the Minister of Natural Resources Canada.

Under the *Nuclear Safety and Control Act*, the CNSC's mandate involves four major areas:

- Regulation of the development, production and use of nuclear energy in Canada;
- Regulation of the production, possession and use of nuclear substances, prescribed equipment and prescribed information;
- Implementation of measures respecting international control of the use of nuclear energy and substances, including measures respecting the non-proliferation of nuclear weapons; and,
- Dissemination of scientific, technical and regulatory information concerning the activities of the CNSC.

The *Nuclear Safety and Control Act* is supported by several regulations as listed under Section 2.2 below. The CNSC regulatory framework includes regulatory documents such as policies, standards, guides, notices and procedures.

Regulatory control is achieved by setting regulatory requirements and issuing licences containing conditions that must meet. Requirements for licensing vary with the type of facility or regulated activity. When applying for a licence, applicants are required to identify potential risks and consequences under both normal use and accidental conditions, and to establish specific engineering measures and operating practices to mitigate those consequences. Once licences are issued, CNSC inspectors are active in monitoring operations to verify that they comply with regulatory requirements.

The CNSC regulatory control for the non-proliferation of nuclear weapons is carried out through licence conditions requiring careful control and accounting of prescribed substances, by controlling imports and exports of prescribed substances, information and equipment and by ensuring that specific obligations of Canada under the *Treaty on the Non-Proliferation of Nuclear Weapons* are fulfilled.

1.2.2 Organisation and resources

The task of the CNSC is to regulate the use of nuclear energy and materials and to respect Canada's international commitments on the peaceful use of nuclear energy. This is accomplished by the work of a Commission of up to seven members and a staff of approximately 450 employees.

The Commission functions as a tribunal, making independent decisions on the licensing of nuclear-related activities in Canada; establishes legally-binding regulations; and sets regulatory policy direction on matters relating to health, safety, security and environmental issues affecting the Canadian nuclear industry. The Commission takes into account the views, concerns and opinions of interested parties and intervenors when establishing regulatory policy, making licensing decisions and implementing programs.

Staff prepares recommendations on licensing decisions, presents them to the Commission for consideration during public hearings and subsequently administers these decisions once they are made by the Commission.

The Commission

The *Nuclear Safety and Control Act* provides for the appointment of up to seven **Commission Members** by Order in Council. One member is designated the **President and Chief Executive Officer** of the CNSC.

The **Secretariat** plans the business of the Commission and gives technical and administrative support to the President and to the other Commission members. This involves related communications with the Minister's Office and all other stakeholders, including government departments, intervenors, licensees, media and the public. The Secretariat is also the official registrar in relation to Commission documentation and manages the hearing process.

CNSC Staff

CNSC staff work within the following organisational structure:

The **Operations Branch** is responsible for regulation of the development, production and use of nuclear energy, the production, possession, transport and use of nuclear substances and radiation devices in Canada. The organisation of this branch provides focus on the regulation of different sectors of the nuclear industry and support implementation of consistent regulatory and business processes. The Operations Branch comprises the following five directorates:

Directorate of Power Reactor Regulation
Directorate of Nuclear Cycle and Facilities Regulation
Directorate of Nuclear Substance Regulation
Directorate of Assessment and Analysis
Directorate of Operational Strategies

Corporate Services is responsible for the CNSC's programs and policies for the management of its financial and human resources and for its information, physical and information technology assets. In addition, Corporate Services is responsible for the organisation's communications, external relations, strategic planning and emergency preparedness programs.

The **Office of Regulatory Affairs** is responsible for organisation-wide programs, initiatives and actions that enhance the CNSC's regulatory effectiveness, efficiency and overall operation.

The **Office of International Affairs** (OIA) licenses the export and import of controlled nuclear items. It implements Canada's bilateral nuclear co-operation agreements, international safeguards agreements, domestic nuclear security and international physical protection requirements. The OIA manages a safeguards research and development program, advises on multilateral nuclear non-proliferation issues and co-ordinates the CNSC's participation in other international activities.

The **Legal Services Unit**, which is staffed by Department of Justice lawyers, provides legal advice to the Commission and staff.

The **Audit and Evaluation Group** is responsible for examining corporate management accountability and program performance. The group carries out internal audits and evaluations, and makes recommendations for continuous improvement.

2. LEGISLATION AND REGULATION

2.1 Legislation

On March 20, 1997, Parliament passed the *Nuclear Safety and Control Act* (NSC Act) to replace the *Atomic Energy Control Act* of 1946. This Act came into force on May 31, 2000.

2.2 General Regulations

The NSC Act is supported by the following new regulations, which also came into effect on May 31, 2000:

- General Nuclear Safety and Control Regulations.
- Rules of Procedure
- Radiation Protection Regulations.
- Class I Nuclear Facilities Regulations.
- Class II Nuclear Facilities and Prescribed Equipment Regulations.
- Uranium Mines and Mills Regulations.
- Nuclear Substances and Radiation Devices Regulations.
- Packaging and Transport of Nuclear Substances Regulations.
- Nuclear Security Regulations.
- Nuclear Non-Proliferation Import and Export Control Regulations.

The *Radiation Protection Regulations* prescribe dose limits for the general public and workers who may be exposed to ionising radiation from the use and possession of radioactive materials and from the operation of nuclear facilities. The *Radiation Protection Regulations* are based on the recommendations made by the International Commission on Radiological Protection (ICRP) in 1990. The CNSC monitors the annual doses received by workers at licensed facilities. All dose data are recorded in a national registry kept by Health Canada.

2.3 Specific Regulations

The Canadian regulatory regime uses general regulations supported by regulatory documents, as discussed in the next section. All facilities licensed to manage waste are subject to either the *Class I Nuclear Facilities Regulations* or the *Nuclear Substances and Radiation Devices Regulations*. There are no specific regulations for waste management.

2.4 Regulatory Documents

In addition to the various regulations issued pursuant to the *Nuclear Safety and Control Act,* the CNSC issues regulatory documents in the form of regulatory policies, standards, guides, notices and procedures. In keeping with the mandate of the CNSC, its regulatory documents encompass a broad range of subject matter and uses. Some regulatory documents, when appropriately incorporated into a licence, establish regulatory requirements. Others provide guidance, advice, information or notices to licensees or the public, or document the regulatory philosophies, positions or expectations of the CNSC on regulatory matters.

3. CURRENT STATUS

3.1 National Status

3.1.1 Waste classification, sources and facilities

Nuclear facilities and users of prescribed substances produce radioactive waste. The CNSC regulates the management of radioactive waste to protect the health and safety of persons and the environment.

Canada has no formal system of waste classification based on specific activity or half-life. A more flexible descriptive approach is used.

The radioactive content of the waste varies with the source. Management techniques, therefore, depend on the characteristics of the waste. As of October 31, 2001, there were 18 licensed waste management facilities and activities in operation: 12 in Ontario, two in Quebec, one each in Saskatchewan, Alberta and New Brunswick, and one covering the Low-level Radioactive Waste Management Office’s decontamination activities at various locations in Canada. In addition, there were waste management facilities and activities associated with other CNSC-licensed facilities, namely Atomic Energy of Canada Limited’s (AECL) Chalk River Laboratories in Ontario and Whiteshell Laboratories in Manitoba, and active and decommissioned uranium mining/milling operations in the Northwest Territories, Saskatchewan and Ontario.

Appendix I lists licensed radioactive waste management facilities and activities, and Appendix II lists licensed uranium mine/mill facilities, as many have mine tailings associated with them.

Because of the construction and location of waste management facilities, members of the public do not receive any significant dose of radiation from the waste. Further, doses to workers at waste management facilities are being maintained well within regulatory limits.

Reactor Waste

Irradiated fuel from a power reactor is highly radioactive and remains so for a long time. It is stored initially under water in large pools at the reactor site. After a minimum number of years in pools, some of the spent fuel is stored in dry concrete containers.

The fuel from the Douglas Point, Gentilly-1, NPD and WR-1 reactors, all now permanently shut down, is stored dry, in welded steel containers inside concrete “silos”. In each case, the reactor and associated facilities have been partially decommissioned and are in a “storage-with-surveillance” mode. Typically, the wastes from decommissioning are stored within the reactor facility in a variety of ways appropriate to the hazards of the wastes.

Irradiated fuel is stored on-site in above-ground dry concrete container facilities at the following nuclear power plants: Pickering Nuclear Generating Station, Point Lepreau Nuclear Generating Station and Gentilly-2 Nuclear Generating Station. An above-ground dry concrete container facility is under construction at the Bruce Nuclear Generating Station, and this facility is expected to commence operation in 2002.

Other less intensely radioactive wastes resulting from reactor operations are stored in a variety of structures in waste management facilities located at reactor sites. Prior to storage, the volume of the wastes may be reduced by incineration, compaction or baling. As well, there are facilities for the decontamination of parts and tools, laundering of protective clothing, and the refurbishment and rehabilitation of equipment.

Refinery Waste

In the past, wastes from refineries and conversion facilities were managed by means of direct in-ground burial. This practice was discontinued in 1988. The volume of waste produced has been greatly reduced by recycling and reuse of the material. The waste now being produced is drummed and stored in warehouses pending the establishment of an appropriate disposal facility.

The seepage and runoff water from the waste management facilities where direct in-ground burial was practised continues to be collected and treated prior to discharge.

Radioisotope Waste

A number of waste management facilities process and manage the wastes that result from the use of radioisotopes for research and medicine. In general, these facilities collect and package waste for shipment to licensed storage sites. In some cases, the waste is incinerated or allowed to decay to insignificant radioactivity levels, and then discharged into the municipal sewer system or municipal garbage system.

Historic Waste

The federal government has commissioned the Low-level Radioactive Waste Management Office to undertake certain initiatives with respect to accumulations of so-called “historic” wastes (low-level radioactive wastes that accumulated prior to regulation) across Canada, in anticipation of its ultimate transfer to appropriate long-term waste management facilities. The activities of the Office are being monitored by the CNSC and, where appropriate, licences have been issued for particular waste accumulations. In the Town of Port Hope, Ontario, the Office has consolidated some historic waste accumulations and established temporary holding facilities for wastes uncovered during routine excavation within the town.

To address radioactive waste issues in the Port Hope area, the Federal Government signed a legal agreement in March 2001 with the Town of Port Hope and the neighbouring Hope Township and Municipality of Clarington to establish long-term radioactive waste management facilities at these locations. Signature of the agreement marks the beginning of a 10-year multi-phase project, involving detailed design, environmental assessment and regulatory review of the proposed facilities, to improve the management of the area's historic wastes and particularly, the unlicensed wastes in the Port Hope area.

Decommissioning

The *Nuclear Safety and Control Act* and its supporting Regulations explicitly address the decommissioning of facilities, and include provisions for the Commission to require that applicants provide a financial guarantee to fund the decommissioning of their facilities. The shutdown and decommissioning of facilities licensed by the CNSC must be carried out according to plans approved by the Commission.

Major decommissioning projects are continuing at Atomic Energy of Canada Limited's research facilities at Whiteshell and Chalk River, and at AECL's demonstration/prototype power reactor sites (Douglas Point, NPD, and Gentilly-1). These reactors, and the WR-1 reactor at Whiteshell, are now partially decommissioned and are in a state of "storage-with-surveillance". This surveillance period is to allow for the decay of radioactivity in the reactor, thus reducing radiation dose to workers involved in the final dismantlement. AECL is continuing to submit conceptual and final decommissioning plans for components of its research facilities.

Decommissioning of the Stanrock and Denison (Denison Mines Limited) and the Quirke, Panel and Stanleigh (Rio Algom Limited) uranium mining facilities in the Elliot Lake area (Ontario) is continuing. Rio Algom Limited is also completing the process of submitting the documentation required by the CNSC for licensing decommissioning activities at the other idle mines in the Elliot Lake area. These mine sites have not been operational for almost 40 years, and were not previously licensed. Indian and Northern Affairs Canada is conducting decommissioning work under CNSC licence at the Rayrock idle mine site in the Northwest Territories.

The University of Toronto has completed the decommissioning of its sub critical assembly and its Slowpoke research reactor.

3.1.2 Waste management strategy

Waste owners and the operators of waste management facilities are responsible for the safe management of waste. As noted above, the new Act allows the regulator to require financial guarantees to fund the decommissioning of facilities. Canada does not have a central national waste disposal facility for the wastes it creates. Currently all waste is in safe storage (usually at the site of its production), or is disposed on site (uranium mine tailings).

3.1.3 Current initiatives

In April 2001, the Government of Canada introduced in Parliament the draft Nuclear Fuel Waste Act (Bill C-27). This bill will require nuclear utilities to form a waste management organisation (WMO) as a separate legal entity. It will also require the utilities to establish a segregated trust fund to finance long-term nuclear fuel waste management activities.

Bill C-27 will require that, within three years of the coming into force of the Act, the WMO submit to the Government a study setting out its proposed approaches for the long-term management of nuclear fuel waste, and its recommendation on which approach should be adopted. The bill will require the WMO to include in the study approaches based on both storage and disposal. The bill also requires that the WMO carry out public consultations.

The Government of Canada will select one of the approaches for the management of nuclear fuel waste from among those set out in the study, and the WMO will be required to implement the selected approach. The bill could come into force as early as 2002.

3.2 National and Regulatory Issues

The lack of a national waste disposal facility in Canada limits the options available for radioactive waste management, remedial actions and the decommissioning of facilities. As in other countries, a key issue is the resistance of many stakeholders to the siting of waste management facilities. Thus there is a need to address the differing levels of confidence in waste management technology as seen by technical and non-technical stakeholders.

3.3 Research and Development

3.3.1 Functions

The CNSC conducts limited research aimed at helping to develop appropriate criteria to protect people and the environment as well as to develop appropriate regulatory guidance. Research is also conducted to help CNSC staff understand the nature of the safety issues related to waste management and to gain experience with the use of a variety of assessment tools and techniques.

3.3.2 R&D program

Appendix III lists the current projects which are underway and the new ones to be started within the next 12 months, and Appendix IV provides a list of related reports published by the CNSC and its predecessor, the Atomic Energy Control Board (AECB).

APPENDIX I, OCTOBER 31, 2001

LICENSED WASTE MANAGEMENT FACILITIES AND ACTIVITIES

Facility and Location (Licensee)	Type of Waste
Radioactive Waste Operations Site 1, Bruce Nuclear Power Development Tiverton, Ontario (Ontario Power Generation)	Storage of old solid wastes from Ontario Power Generation nuclear generating stations (no new waste)
Western Radioactive Waste Management Facilities, Bruce Nuclear Power Development Tiverton, Ontario (Ontario Power Generation)	Incineration, compaction and storage of wastes from Ontario Power Generation nuclear generating stations
Douglas Point Radioactive Waste Management Facility Douglas Point, Ontario (Atomic Energy of Canada Limited)	Storage of old solid wastes from Douglas Point Generating Station (no new waste)
Gentilly-2 Radioactive Waste Management Facility Gentilly, Quebec (Hydro-Québec)	Storage of solid wastes from Gentilly-2 Nuclear Power Station and old solid wastes from Gentilly-1 Nuclear Power Station
Gentilly-1 Radioactive Waste Management Facility Gentilly, Quebec (Atomic Energy of Canada Limited)	Storage of old solid wastes from Gentilly-1 Nuclear Power Station (no new waste)
Point Lepreau Solid Radioactive Waste Management Facility Point Lepreau, New Brunswick (New Brunswick Power Corporation)	Storage of solid wastes from Point Lepreau Generating Station
Pickering Used Fuel Dry Storage Facility Pickering, Ontario (Ontario Power Generation)	Storage of spent fuel from Pickering Nuclear Power Station
University of Alberta Waste Management Facility Edmonton, Alberta	Incineration of low-level combustible liquid wastes and storage of aqueous and solid wastes from the University and Edmonton area
Port Granby Waste Management Facility Newcastle, Ontario (Cameco Corporation)	Storage of wastes from Cameco refinery and chemical treatment of drainage and run-off water

APPENDIX I, cont'd

LICENSED WASTE MANAGEMENT FACILITIES AND ACTIVITIES

Facility and Location (Licensee)	Type of Waste
University of Toronto Waste Management Facility Toronto, Ontario	Storage and handling of wastes from the University and Toronto area
Welcome Waste Management Facility Welcome, Ontario (Cameco Corporation)	Storage of old wastes from previous Cameco Port Hope operations and chemical treatment of drainage and run-off water
Bruce Power Central Maintenance & Laundry Facility Tiverton, Ontario (Bruce Power)	Handling of wastes from decontamination of equipment and tools, laundry of contaminated clothing and general maintenance activities at BNPD
Monserco Waste Services Inc. Mississauga, Ontario (Monserco)	Storage, processing and handling of wastes from the Toronto area
University of Saskatchewan Waste Management Facility Saskatoon, Saskatchewan	Storage and handling of wastes from the University and Saskatoon area
NPD Waste Management Facility Rolphton, Ontario (Atomic Energy of Canada Limited)	Storage of solid wastes from the partial decommissioning program
Port Hope Waste Management Facility Port Hope, Ontario (Atomic Energy of Canada Limited)	Storage of wastes from the remedial program
Pine St. Extension Port Hope, Ontario (Atomic Energy of Canada Limited)	Contaminated soil storage
Various locations for small decontamination projects (Atomic Energy of Canada Limited)	Decontamination of historic waste sites

APPENDIX II, OCTOBER 31, 2001

LICENSED URANIUM MINE/MILL FACILITIES

Facility and Location (Licensee)	Licensed Capacity or Activity
Rabbit Lake, Saskatchewan (Cameco Corporation)	6.5 million kg U
Key Lake, Saskatchewan (Cameco Corporation)	7.2 million kg U
McArthur River Project, Saskatchewan (Cameco Corporation)	7.2 million kg U
Cigar Lake Project, Saskatchewan (Cigar Lake Mining Corporation)	Care and Maintenance
Cluff Lake, Saskatchewan (Cogema Resources Inc.)	2.02 million kg U
Midwest Project, Saskatchewan (Cogema Resources Inc.)	Care and Maintenance
McClean Lake Project, Saskatchewan (Cogema Resources Inc.)	3.6 million kg U_3O_8
Kiggavik-Sissons Project, Northwest Territories (Cogema Resources Inc.)	Care and Maintenance
Shea Creek Project, Saskatchewan (Cogema Resources Inc.)	Care and Maintenance

APPENDIX II (cont'd)

LICENSED URANIUM MINE/MILL FACILITIES

Facility and Location (Licensee)	Licensed Activity
Rayrock, Northwest Territories (Indian and Northern Affairs Canada)	Decommissioning
Stanrock Mine, Elliot Lake, Ontario (Denison Mines Limited)	Decommissioning
Stanleigh Mine, Elliot Lake, Ontario (Rio Algom Limited)	Decommissioning
Beaverlodge Mining Operations, Beaverlodge, Saskatchewan (Cameco Corporation)	Decommissioning
Dawn Lake Project, Saskatchewan (Cameco Corporation)	Decommissioning
Denison Mine, Elliot Lake, Ontario (Denison Mines Limited)	Decommissioning
Dubyna Mine, Uranium City, Saskatchewan (Cameco Corporation)	Decommissioning
Panel Mine, Elliot Lake, Ontario (Rio Algom Limited)	Decommissioning
Quirke Mine, Elliot Lake, Ontario (Rio Algom Limited)	Decommissioning
Madawaska Mine, Bancroft, Ontario (Madawaska Mines Limited)	Decommissioning

APPENDIX III

CURRENT WASTE MANAGEMENT RESEARCH PROJECTS AT THE CNSC

(concerning geoscience, geotechnical and regulatory aspects
of waste management and decommissioning)

Transport of Iodine-129

Post-closure performance assessments of a spent fuel repository indicate that long term radiological doses to humans will be dominated by ^{129}I. However, these assessments have relied on certain assumptions and probabilistic estimates of iodine transport parameters. This study will provide empirical information on the geochemical controls on iodine - 129 mobility in groundwater flow systems and its interaction with the biosphere as it is discharged to surface, to enable independent and reliable assessment of the validity of iodine - 129 pathways analyses. Phase 1 (Partitioning of Iodine - 129 in the Environment) investigated the movement and uptake of iodine - 129 in a unique watershed at Chalk River Laboratories (CRL) which has received anthropogenic loadings of this isotope. Phase 2 (Iodine-129 Transport in Typical Precambrian Shield Groundwaters) will perform a comparative study in an area unaffected by radioactive waste ^{129}I, to confirm that the ^{129}I partitioning observed during Phase 1 is representative of typical Precambrian Shield watersheds affected only by bomb fallout ^{129}I. This four-year study will have cost about $167,000 by the time it is completed in 2001.

Participation in DECOVALEX

DECOVALEX (DEvelopment of COupled models and their VALidation against EXperiments) is an international co-operative project, initiated by the Swedish Nuclear Power Inspectorate, to support the development of mathematical models of coupled Thermal, Hydrological and Mechanical processes in rock formations. These models are needed to predict the perturbing effects of excavation, operation and long-term evolution of nuclear fuel waste repositories. AECB participated as an observer in DECOVALEX I (1992-1995) and as a funding organisation for DECOVALEX II (1995-1999), and is participating as a funding organisation in DECOVALEX III (1999-2002). The eight years of full participation will have cost $288,000. In addition to a CNSC modelling team, McGill University participates in the simulation of the FEBEX experiment (a DECOVALEX III test case) through a $26,000 CNSC research contract ending in 2002.

Performance of the In-Pit Disposal of Uranium Mill Tailings

Although disposal of uranium tailings in mined-out open pits is practised at a number of mines in Canada, no such facilities have been closed and decommissioned to fully demonstrate the technology. This study uses a laboratory-scale physical model of a generic in-pit disposal facility (constructed under an earlier AECB research contract) to perform and analyse experiments that will provide empirical evidence of the factors that affect the geotechnical and environmental performance of in-pit disposal systems. This will allow CNSC staff to identify any safety issues related to both the operation and the decommissioning of existing and future facilities, and assist CNSC staff to address public concerns raised during Environmental Panel hearings. This is Phase II of the project, will take about three years to complete, at a cost of $25,000 per year.

Paleothermometry of Canadian Shield Groundwaters

The purpose of this project is to determine the paleoclimatic conditions under which deep shield groundwaters were recharged by measuring the noble gas concentrations in samples collected from selected mine sites on the shield. Because the solubility concentrations of these gases (i.e.; Ne, Ar, Kr and Xe) are temperature dependent, measurements of these gases provide information on the ambient temperature conditions at the time of recharge which can be used to determine the age and origin of these deep groundwaters. The age and origin of deep shield groundwaters is controversial and remains largely unresolved. Isotopic dating of these waters has been stymied by subsurface production within the host rocks of many of the radionuclides (i.e.; ^{36}Cl, ^{129}I) that have the potential for dating old groundwaters. Noble gas paleothermometry offers an alternative method for inferring the age of the water by comparing the temperature of the recharge water, as determined by the temperature-dependent solubility concentration, to the paleoclimatological record for the area of concern. The residence time of groundwater in contact with buried radioactive waste is an important factor in determining the transport time of radionuclides from a disposal facility to the biosphere and the potential long term doses to humans. The results from this study will enable the CNSC to better understand the origin of deep groundwaters on the shield and the safety implications for potential deep geologic disposal. This two-year study will have cost about $75,000 by the time it is completed in 2002.

Geographic Information Systems

Geographic Information System (GIS) software has the potential to help the CNSC make better use of its scientific and licensing system data. GIS is rapidly emerging into an integral component of nearly every type of business and government service and can facilitate the creation of maps with specific databases owned and managed by the CNSC. GIS can provide a solid, reliable system for integrating data, performing expert analysis on key issues, and visualizing results on presentation-quality maps and data displays. Multimedia or Internet data can be added to maps, providing an additional visual context to the data. Results of data analysis can be better understood, and can be easily integrated into many types of analyses, empowering better decision making throughout the CNSC. This study, at a cost of $17,000 in 2001, is to help document the basis for a larger initiative to integrate GIS technology into the CNSC data management system. Another part of this initiative has included a demonstration of interfacing a GIS to a database to map and display compliance monitoring data from two licensed uranium tailings sites (a three month contract for $10,900).

APPENDIX IV

CONTRACT RESEARCH REPORTS PUBLISHED BY THE CNSC AND AECB

(concerning geoscience, geotechnical and regulatory aspects
of waste management and decommissioning)

Physical and Numerical Modelling of an In-Pit Tailings Management Facility
Duke Engineering & Services (Canada) Inc.
Canadian Nuclear Safety Commission Research Report RSP-0141
2001-09-21

Demonstration of M3 Modelling for Cigar Lake Hydrogeochemical Data
I. Gurban, M. Laaksoharju, M. Gascoyne, C. Andersson and K. Raven, Duke Engineering & Services
Canadian Nuclear Safety Commission Research Report RSP-0133
2001-01-04

Thermal Consolidation Effects around a High Level Repository Phase III: Permeability Characteristics of Fractures Subjected to Combined Axial Loads, Shear Loads and Thermal Gradients
A.P.S. Selvadurai, Department of Civil Engineering and Applied Mechanics, McGill University
Canadian Nuclear Safety Commission Research Report RSP-0085
1999-03-15

Partitioning of I-129 in the Environment: The Fate of Radioiodine in a Shallow Sand Aquifer System at Chalk River Laboratories, Ontario, Canada
Gwen M. Milton and Tom G. Kotzer, Atomic Energy of Canada Limited
Canadian Nuclear Safety Commission Research Report RSP-0089
1999-01-01

Hydrogeological and Hydrochemical Study of the Miramar Con Mine- Yellowknife, NWT
K.G. Raven, Raven Beck Environmental Ltd. and I.D. Clark, University of Ottawa
Atomic Energy Control Board Research Report RSP-0048
1998-01-01

Comprehensive Review of the Literature on Institutional Controls to Limit Land Use
Environmental - Social Advisory Services (ESAS) Inc.
Atomic Energy Control Board Research Report INFO-0680
1997-08-01

Sinusoidal Testing of Fractures to Measure Hydraulic Heterogeneity
A.P.S. Selvadurai, Department of Civil Engineering and Applied Mechanics, McGill University
Atomic Energy Control Board Research Report RSP-0038
1997-06-01

Thermal Consolidation Effects Around a High Level Repository - Phase II
A.P.S. Selvadurai, Department of Civil Engineering and Applied Mechanics, McGill University
Atomic Energy Control Board Research Report RSP-0029
1997-03-01

Environmental Monitoring of Uranium Mining Wastes Using Geophysical Techniques – Phase I
Rodney R. Koch, Cogema Resources Inc.
Atomic Energy Control Board Research Report INFO-0658
1996-08-01

The Feasibility of Directly Dating Quartz
A. Leroy Odom, National High Magnetic Field Laboratory, Florida State University
Atomic Energy Control Board Research Report INFO-0657
1996-07-01

Experimental Modelling of Thermal Consolidation Effects Around a High Level Waste Repository
A.P.S. Selvadurai, Department of Civil Engineering, Carleton University
Atomic Energy Control Board Research Report INFO-0610
1995-12-01

Review of Selected Hydrogeological and Geophysical Characterization Methods for Intact Crystalline Rocks
K.G. Raven and A.C.F. West, Raven Beck Environmental Ltd.
Atomic Energy Control Board Research Report INFO-0506
1995-02-01

Survey of Geoscientific Data on Deep Underground Mines in the Canadian Shield
K.G. Raven, Raven Beck Environmental Ltd. and I.D. Clark, University of Ottawa
Atomic Energy Control Board Research Report INFO-0503
1994-12-01

Aqueous Uranium Concentrations in the Natural Environment
M.T. Anderson, Environmental and Technological Research Associates Ltd. (ETRA)
Atomic Energy Control Board Research Report INFO-0411
1992-04-01

Propagation of Measurement Uncertainty in Hydrogeologic Data
Intera Technologies Ltd.
Atomic Energy Control Board Research Report INFO-0410
1992-04-01

Liquifaction of Uranium Tailings
Acres International Ltd.
Atomic Energy Control Board Research Report INFO-0409
1992-02-01

An Evaluation of Contaminant Retardation Mechanisms
Intera Technologies Ltd.
Atomic Energy Control Board Research Report INFO-0406
1992-02-01

Remote Sensing to Monitor Uranium Tailings Sites – A Review
Intera Kenting
Atomic Energy Control Board Research Report INFO-0403
1992-01-01

Link Between Ore Bodies and Biosphere Concentrations of Uranium
S. Gordon
Atomic Energy Control Board Research Report INFO-0349
1992-01-01

An Evaluation of the Dissolution Process of Natural Uranium Ore as an Analogue of Nuclear Fuel
V. Stern
Atomic Energy Control Board Research Report INFO-0386
1991-05-01

Frost Evolution in Tailings
EBA Engineering Consultants Ltd.
Atomic Energy Control Board Research Report INFO-0383
1991-04-01

Assessment of Computer Programs for Coupled Flow-Thermal-Mechanical Processes in the Assessment of Deep Disposal of Radioactive Waste
Acres International Ltd.
Atomic Energy Control Board Research Report INFO-0380
1991-04-01

FINLAND

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

The Nuclear Energy Act states that nuclear waste generated in Finland shall be handled, stored and permanently disposed of in Finland. Respectively, nuclear waste generated elsewhere than in Finland, shall not be handled, stored or permanently disposed of in Finland. There are only minor exemptions to these principles. Nuclear waste is defined as radioactive waste in form of spent fuel or in some other form, generated in connection with or as a result of the use of nuclear energy.

Producers of nuclear waste are responsible for all nuclear waste management measures and their appropriate preparation, and are also responsible for their costs. The Ministry of Trade and Industry (MTI) has issued a long-term schedule for the implementation of nuclear waste management.

There is no specific policy for dealing with other radioactive waste than nuclear waste. Each user of radioactive substances is required to take all the measures needed to render harmless the radioactive waste arising from its operations.

The state has the secondary responsibility in case that a producer of nuclear or other radioactive waste is incapable in fulfilling its management obligation.

1.1.2 Institutional framework

Key organisations for radioactive waste management are as follows:

- The NPP utilities FPH (Fortum Power and Heat Ltd) and TVO (Teollisuuden Voima Ltd) take care of interim storage of spent fuel, conditioning and disposal of operating LILW and planning for the decommissioning of NPPs.
- A joint company by FPH and TVO, Posiva Ltd, is responsible for the preparations for and later implementation of spent fuel disposal.
- Radiation and Nuclear Safety Authority (STUK) operates a central interim storage for small user radioactive waste.

1.2 Regulatory framework

1.2.1 Regulatory function

The key organisations for regulatory functions are as follows:

- The Government grants licenses for nuclear facilities and issues general safety regulations.
- MTI oversees that implementation of waste management and related R&D complies with the national policy and, together with the State Nuclear Waste Management Fund, that provisions for future waste management are adequate.
- STUK is responsible for the control of radiation and nuclear safety, for issuing detailed safety regulations and for the technical and safety related review of licence applications and other important documents.

Both MTI and STUK have Advisory Committees. The regulatory framework is illustrated in Figure 1.

Figure 1. Main bodies involved with radioactive waste management

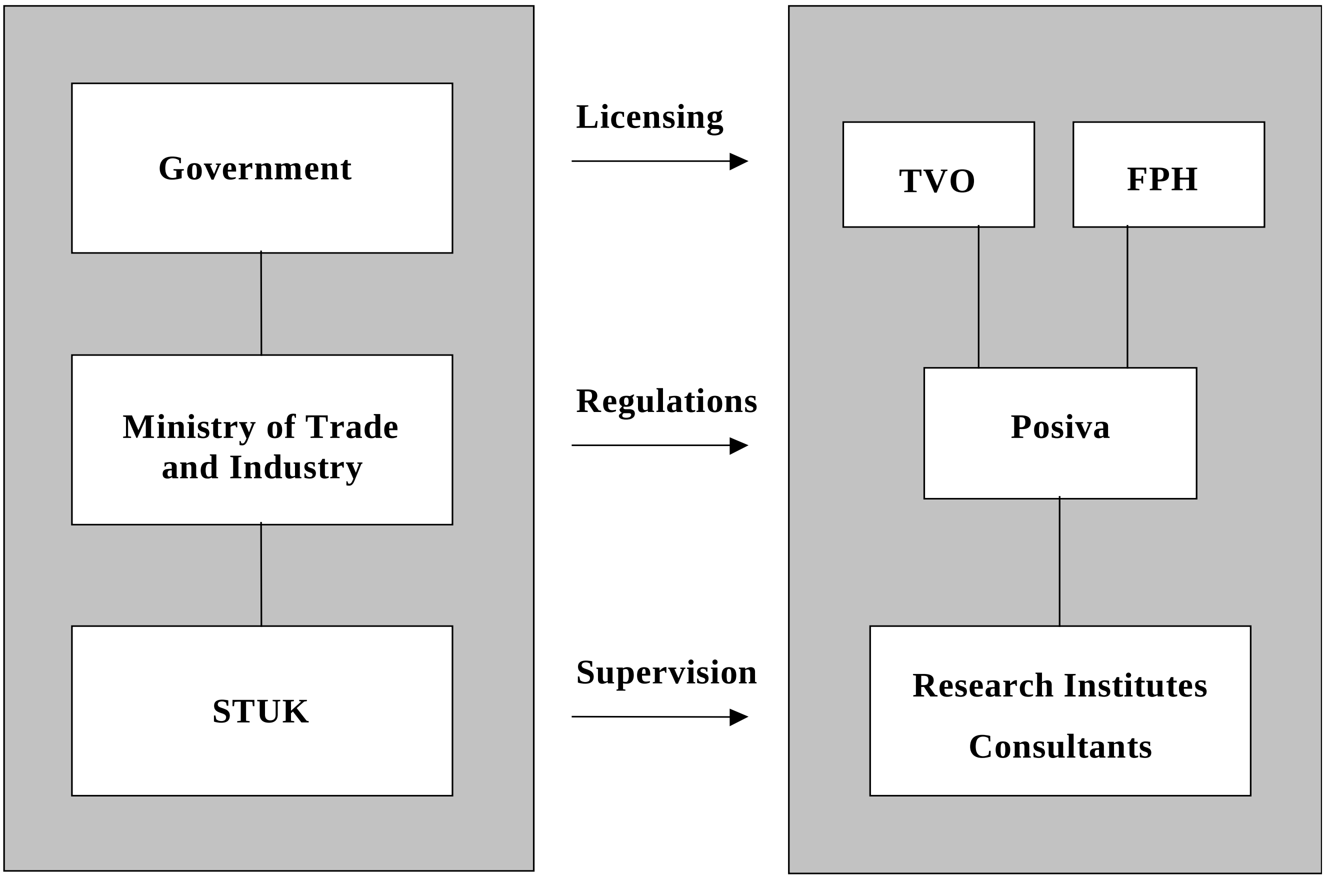
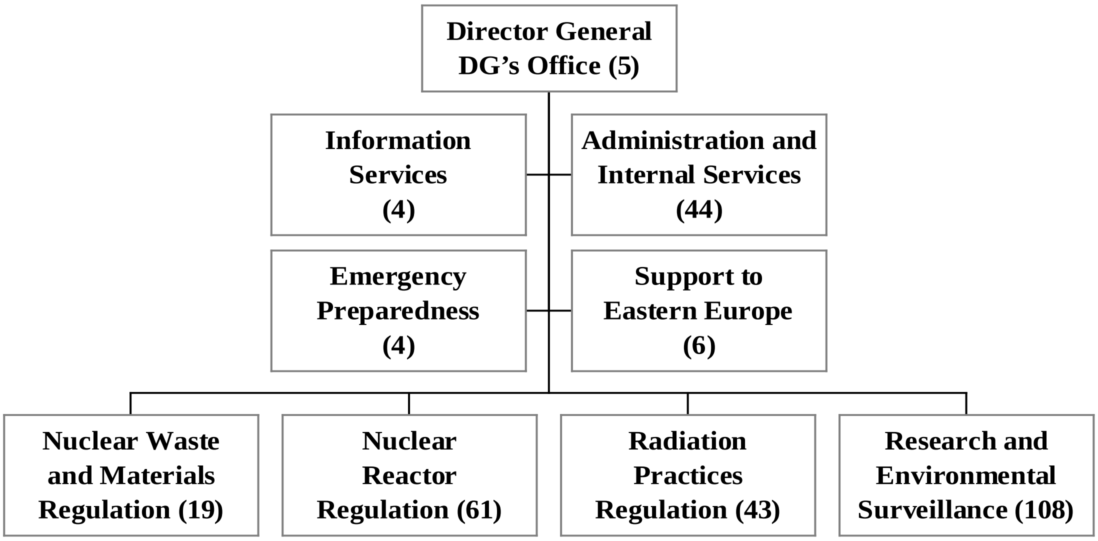


Figure 2. The organisation of STUK



1.2.2 Organisations and resources

The number of full-time waste management professionals is one at the MTI and seven at STUK. STUK's organisational chart is given in Figure 2. Whenever required, the expertise of STUK's other units can be employed for the review of important waste management documents.

2. LEGISLATION AND REGULATION

2.1 Legislation and related regulations

The main legislation regulating waste management activities includes the following laws and ordinances:

- Nuclear Energy Act and Decree (1988) define the responsibilities, licensing and enforcement procedures and financial liabilities for future nuclear waste management.
- Decree on the State Nuclear Waste Management Fund (1988) specifies the system for financing future nuclear waste management.
- Radiation Act and Decree (1991) include e.g. general radiation protection principles, provisions for radiation work and provisions for management of non-nuclear radioactive waste.
- Environmental Impact Assessment Act (1994) defines the EIA process to be implemented prior to the first licensing step pursuant to nuclear energy legislation.
- Act and Decree on Radiation and Nuclear safety Authority (1991)

2.2 General safety regulations

The following general safety regulations, issued by the Government, relate to nuclear waste management:

- General regulations for the safety of nuclear power plants (1991) address also interim storage of spent fuel and treatment and conditioning of operating LILW at NPPs.
- General regulations for the safety of a disposal facility for reactor waste (1991) address disposal of operating LILW from NPPs.
- General regulations for the safety of spent fuel disposal (1999) address disposal of spent fuel into bedrock.

2.3 Guidance and specific regulations

The detailed safety regulations are given as STUK-guides. The licensee shall comply with these guides unless he puts forward some other acceptable procedure or solution, by which a comparable safety level is achieved. There are five such guides related to waste management:

- Guide YVL 8.1, Disposal of reactor waste (1991).
- Guide YVL 8.2, Clearance from regulatory control of nuclear waste (2002).
- Guide YVL 8.3, Treatment and storage of radioactive waste at nuclear power plant (1996).
- Guide YVL 8.4, Long-term safety of disposal of spent nuclear fuel (2001).
- Guide YVL 8.5, Operational safety of a disposal facility for spent nuclear fuel (to be issued in 2002)
- Guide ST 6.2, Radioactive wastes and discharges (1992).

In the preparation of the technical rules, international conventions, standards and recommendations are utilised, whenever applicable. Finland has ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The licences for nuclear facilities, such as for LILW repositories, contain only a few safety related conditions. For instance, limit for the gross activities in various disposal rooms are given. Prior to issuance of licences, STUK has to review and approve certain important safety related documents, such as the preliminary/final safety analysis reports, and these must be updated during construction/operation of the facility.

2.4 Licensing procedures

For major nuclear facilities, the nuclear legislation defines a three-step licensing procedure:

- Decision-in-principle; the Government makes the licensing decision, but approvals by the host municipality and the Parliament are required.

- Construction license, issued by the Government.
- Operating license, issued by the Government.

STUK conducts the safety related review in each of these licensing processes and the MTI prepares the licensing decisions.

Minor licenses for waste management operations are granted by STUK.

3. CURRENT STATUS

3.1 National status

3.1.1 Waste classification and sources

The sources of nuclear wastes are the two nuclear power plants with four reactors together and a small research reactor. Only a small uranium mining and milling facility has existed and nowadays the site has been restored. Other radioactive waste arise from a number of facilities using radioisotopes in medical, research and industrial applications.

The amounts of stored radioactive wastes at the end of 2001 were as follows:

- Spent nuclear fuel: about 1 200 tU
- LILW from NPPs: about 7 200 m^3, most of which was disposed of
- Small user radioactive waste in central storage: about 40 m^3

No major decommissioning projects are foreseen within a couple of decades.

Waste classification according to their disposal route is illustrated in Figure 3. There is also a classification system, based on activity concentrations, for the purpose of clearance or treatment and storage of LILW at NPPs. (see Guides YVL 8.2 and 8.3) For small user waste, constraints for disposal in landfill or sewage system have been defined.

3.1.2 Waste management strategy

According to the nuclear energy legislation, spent nuclear fuel shall be permanently disposed of in Finland. A spent fuel disposal programme is being implemented by Posiva with the following main objectives:

- Disposal site selection in 2000 (the Olkiluoto site was proposed by Posiva in the Decision in Principle application of 1999; this application was approved by the host municipality in Jan 2000 and by the Government in Dec 2000 and the decision was ratified by the Parliament in May 2001)
- Start of construction of an underground rock characterisation facility at Olkiluoto in 2004
- Start of construction of the disposal facility in early 2010
- Start of operation of the disposal facility in early 2020.

FPH and TVO have on-site pool-type interim storages for spent fuel. Their capacities will be adequate until early 2010's.

FPH and TVO have also rock cavern-type repositories for operating LILW. FPH's repository became operational in 1998 and TVO's in 1992. Both utilities plan to dispose of decommissioning wastes as well into similar repositories.

The preferred policy is to return sealed radioisotope sources to their manufacturer. Such small user waste that cannot be cleared from regulatory control, is transferred to STUK, conditioned and stored in a rock cavern, located at the premises of TVO's LILW repository.

3.1.3 Current issues

The first licensing step for spent fuel disposal, the Decision-in-Principle process, has come to the end. It involved a crucial enquiry concerning the political and local acceptance of the plans and a preliminary judgement of their safety. STUK's preliminary safety appraisal was made public and the host municipality's position on the siting application was taken in early 2000. Both were positive with respect to the continuation of the disposal project. The Government made the Decision-in-Principle in December 2000 and it was ratified by the Parliament in May 2001. The Decision-of-Principle will be succeeded by a new R&D phase, including confirmation of the suitability of the selected disposal site through an exploratory shaft and other investigations needed for a convincing safety case. A program report for this phase has been published by Posiva and reviewed by STUK,

3.2 Regulatory issues

The greatest regulatory challenges are related to R&D period succeeding the Decision-in-Principle. The regulatory judgement is currently based on a safety case that still involves major uncertainties: the performance analysis methodology is deficient, the geological data are not yet particularly site specific and the long-term performance of engineered barriers has not been adequately demonstrated. During the 10-year period preceding the construction license process, an extensive R&D program with related regulatory involvement is needed to resolve the open issues.

Another issue is the NORM waste, i.e. waste containing enhanced concentrations of naturally occurring radioactive materials. Nowadays, they are generally not classified as radioactive wastes and consequently their disposal methods do not meet the criteria for radioactive wastes. Due to the large volumes of NORM waste, the same disposal methods as e.g. for LILW from NPPs are seldom applicable. A national plan for dealing with NORM waste is needed.

3.3 R&D programme

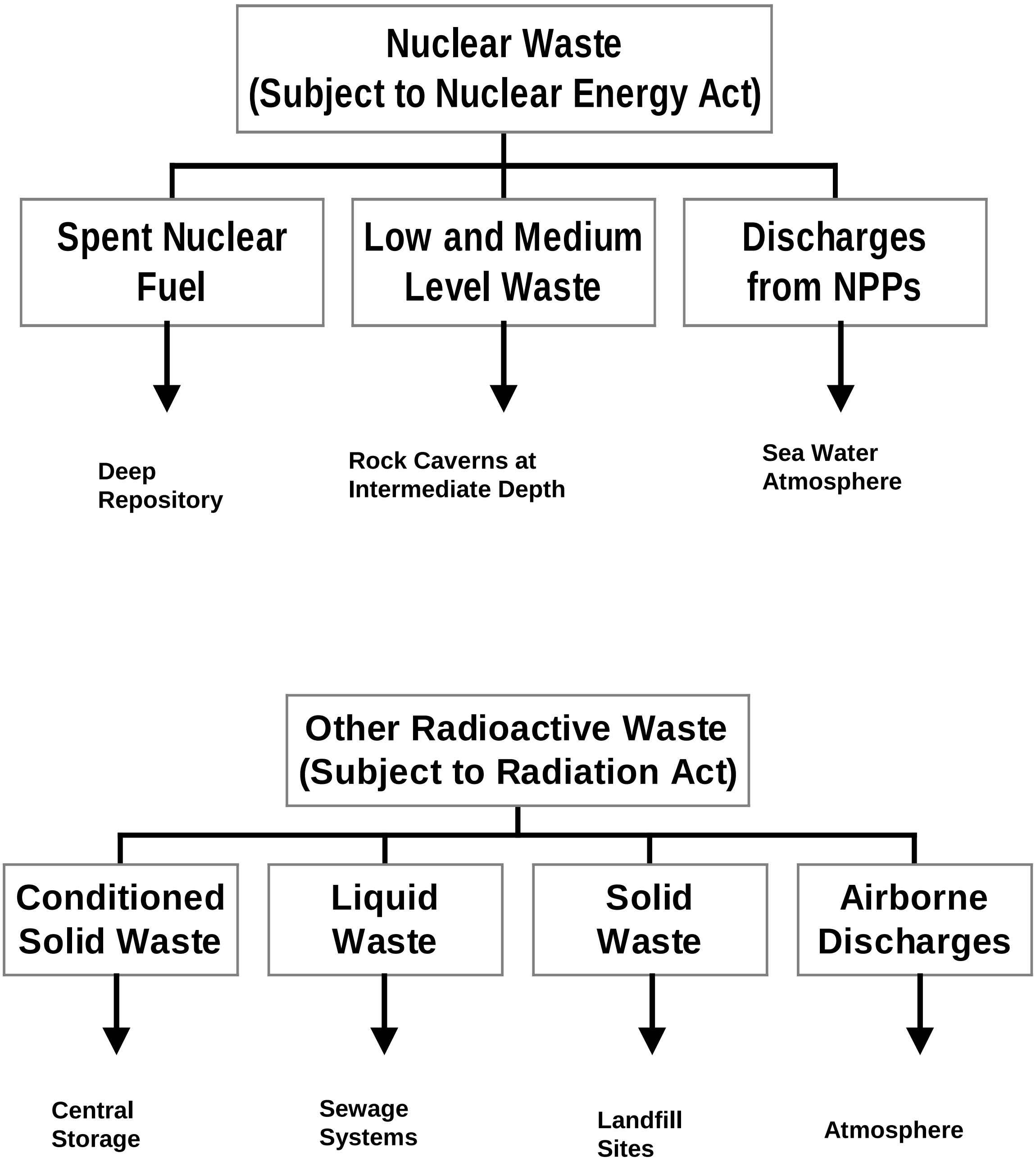
Producers of nuclear waste carry out R&D for the safe management of their wastes. The budget amounts to about 10 million euros annually. The program is focused on spent fuel disposal. Extensive geological investigations as well as development of disposal concept and performance assessment have been carried out for about 15 years. Most of the practical work has been contracted to Governmental research institutes and private consulting and geotechnical companies.

The waste producers' R&D program is reviewed annually by the authorities.

There is also a publicly co-ordinated nuclear waste research program, aimed at supporting the regulatory activities and maintaining expetise in the field. Its funding is about 10 % of that of the utilities' program.

The representatives of the Finnish research institutes, authorities and utilities participate in the waste management related co-operation within the European Union, OECD/NEA and IAEA. Finland participates in the nuclear waste management related research projects of the Nuclear Energy Research Programme of the European Commission. Posiva Oy has formal bilateral co-operation agreements with NAGRA (Switzerland), NUMO and RWMC (Japan), Ontario Power Generation (Canada), RAWRA (Czech Republic) and SKB (Sweden).

Figure 3 Classification of radioactive waste for disposal purposes



FRANCE

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 . National framework

1.1.1. National policy

The French nuclear activities produce solid, liquid or gaseous waste, some of which is radioactive. The national policy on radioactive waste is that reliable, transparent and stringent management of this waste must ensure the protection of individuals, preservation of the environment and limitation of undue burdens imposed on future generations.

Concerning the control of the safety of nuclear activities, including waste management, an extensive regulatory system has been set up consisting of laws, decrees and guidance rules. Its objective is to ensure the safety of nuclear facilities and the protection of man and environment. The regulation concerning radioactive waste management deals with, waste management strategies, design basis related to safety, quality, release of effluents, impact on the environment, radiation protection, performance assessment, licensing procedures, incidents, the organization of the control of safety, involvement of the public, …

A strong principle in France is that it is the responsibility of the nuclear operators as waste producers to dispose of their waste or have it disposed of in a suitable manner. The competent authorities regulate and control the radioactive waste management activities.

A specific public agency, ANDRA, has the responsibility for the long-term management of radioactive waste. This agency operates waste repositories, defines the acceptance criteria for waste packages in these repositories and controls the quality of their production. It also keeps a national inventory of radioactive waste in France.

In order to share the experience of other countries, France signed the "Joint convention on the safety of spent fuel management and on the safety of radioactive waste management" on September 5, 1997. The joint convention was ratified on February 22nd, 2000.

1.1.2. Institutional framework

The French Nuclear Safety Authority (ASN) is entrusted with the definition and application of the regulations of the main nuclear facilities, known as «basic nuclear installations» (BNIs) such as nuclear reactors, fuel cycle plants, shut-down nuclear facilities, waste treatment plants, radioactive waste interim storage facilities and final repositories.

The French Nuclear Safety Authority combines the resources of the "Direction Générale de la Sûreté Nucléaire et de la Radioprotection" (DGSNR), and the Nuclear Installation Departments (DIN) set up within the Regional Directorates for Industry, Research and the Environment (DRIRE).

The DGSNR was created by decree on February 22nd, 2002. This directorate combines the former "Direction de la Sûreté des Installations Nucléaires" (DSIN), part of the former radiation protection departments (within the Ministry of Health and the Office for Radiation Protection (OPRI)), and part of the former commission of artificial radionuclides (CIREA), which was the authority responsible for radioactive sources.

DGSNR reports to the ministries for industry and environment, for nuclear safety related issues, and to the ministry for health, for radiation protection issues. It is the nuclear safety and radiation protection authority for all civil nuclear activities, including transportation, and all installations using sources of ionizing radiations.

Nuclear facilities which are not considered as Basic Nuclear Installations because they deal with a quantity of radioactive material at an activity level below the threshold of BNIs are required to comply with the environmental protection provisions specified in the law 76-663 of July 19, 1976, insofar as they belong to the category of facilities classified on environmental protection grounds (ICPE). They are controlled at the local level by the DRIRE under the supervision of the Ministry of Environment.

Uranium mines are under the supervision of the Ministry of Industry. Nuclear installations connected to military activity are under the control of the "Délégué à la sûreté nucléaire et à la radioprotection pour les activités et installations concernant la défense" (DSND).

As for the research relative to the management of high level and long-lived waste the law of 30 December 1991 prescribes that a National Review Board be created, audit the different actors of this research and publish a report to the government each year.

1.2. Regulatory framework

1.2.1. Regulatory function

The French Nuclear Safety Authority's sphere of activities comprises :

- assessment of BNIs safety ;
- radioactive waste management safety ;
- radioactive effluent monitoring and environmental protection ;
- safety of the transportation of radioactive and fissile material for civil use ;
- radiation protection.

The main assignments of the French Nuclear Safety Authority are:

- drafting and monitoring the application of the general nuclear safety and radiation protection regulation ;
- implementing licensing procedures for BNIs, management of radioactive sources and transportation of radioactive materials ;
- organizing and implementing surveillance of BNIs, radioactive sources, radiological installations as well as radioactive transports ;
- preparing setting up of emergency response plans ;
- providing information to media and general public on nuclear safety and radiation protection problems ;

- contributing to the activities of international organizations and promoting bilateral relations.

In the framework of its regulatory functions concerning the safety of BNIs, DGSNR issues basic safety rules (RFS) which constitute guidelines defining the safety objectives to be achieved and describing accepted practices deemed compatible with these objectives.

The licensing of BNIs is performed within the framework of the decree of December 11th, 1963 which provides for an authorization decree procedure followed by a series of licenses issued at key points in plant lifetime: provisional license for start-up of normal operation, final license after several years of operation, decommissioning licenses.

Before the authorization decree is signed, the facility has to provide a preliminary safety analysis report and an environmental impact study. The reports are subjected to public debate in the framework of a public inquiry (law 83-630 of July 12th, 1983 and decree 96-388 of May 10th, 1996). A technical instruction procedure is followed implying a peer review by an Advisory Committee. Consultations of the different ministries concerned is set up.

1.2.2. Organization and resources

Organisation of the French Nuclear Safety Authority

The total staff of the French Nuclear Safety Authority, in 2002, is near 300 persons and in the framework of the new organization should double in the coming years. Before 2000, ASN had financial resources based on fees paid by BNI operators in return from regulatory procedures. Since 2000, BNIs pay an annual tax to the State and ASN has financial resources from the national budget (79 M in 2001). DGSNR comprises 10 departments, 3 of which are actually in charge of the different kinds of BNIs, 4 are in charge of radiation protection, one is in charge of organization of control and organization in case of emergency situations, one is in charge of pressure vessel control and one is in charge of international affairs.

The control of waste package conditioning, interim storage and disposal facilities is under the responsibility of the Research, Waste and Decommissioning Department of DGSNR (13 persons).

Technical support of the French Nuclear Safety Authority

The main technical support organization of the French Nuclear Safety Authority is the “Institut de Radioprotection et de Sûreté Nucléaire” (IRSN) created in February 2002. IRSN is constituted by the former Institute for Nuclear Safety and Protection (IPSN), and by part of the former Office for Radiation Protection (OPRI). It employs 1500 persons. It is an independent public agency, separated from the CEA (French Atomic Energy Commission). Its household takes its source mainly from the ministry for environment but the ministries for industry, research, defense and health are also members of the administration council.

A large part of IRSN activity is devoted to R&D dedicated to safety and radiation protection. The detailed analyses of the operator’s safety files are performed by the Safety Evaluation Department (DES, staff around 350) which is part of IRSN. The technical support work for the French Nuclear Safety Authority is performed in the framework of a convention. For waste management, the staff of

DES is 40 professionals, 40 other professionals of IRSN are focusing on R&D concerning waste management.

Advisory Committees

Advisory Committees comprising technical experts and representatives from the administration are consulted by the DGSNR within their sphere of competence. They are nominated by the government for a period of three years.

An Advisory Committee on disposal of radioactive waste has been created in 1985. Another Advisory Committee deals with the safety of waste treatment plants and interim storage facilities.

2. LEGISLATION AND REGULATION

2.1. General regulation

Regulation on Basic Nuclear Installations and the organisation of their control

- Law 61-842 of August 2, 1961 on atmospheric pollution and its application decree 63-1228 of December 11th, 1963. They concern the definition, the licensing and control of basic nuclear installations including nuclear waste processing plants, interim storage facilities and nuclear waste disposal facilities such as surface disposal facilities of short lived low and intermediate level wastes ;
- Decree n° 73-278 (13 March 1973) : Creation of the French Nuclear Safety Authority ;
- Decree n° 2002-255 (22 February 2002) : Creation of the “Direction générale de la sûreté nucléaire et de la radioprotection”.

Regulation on waste management

- Law 75-633 of July 15th, 1975, modified in 1993, relative to treatment, disposal and elimination of waste and the information of the public on environmental impact. Its main implications are on very low level waste management ;
- Law 91-1381 of December 30th, 1991 on the research related to high level waste and long lived waste management ;
- Ministerial order of December 31st, 1999 concerning waste management in BNIs (emphasis on very low level waste management).

Regulation on environmental impact assessments

- Law 76-629 of July 10th, 1976 ;
- Decree 77.1141 of October 12th,1977.

Regulation on installations classified on environmental protection grounds

- Law 76-663 of July 19th, 1976 relative to installations classified on environmental protection grounds ;
- Decree 77-1133 of September 21st, 1977.

Regulation on implication of the public

- Law 83-630 of July 12th, 1983 on democratization of public inquiries ;
- Decree 96-388 of May 10th, 1996 on public consultation prior to siting of facilities.

Regulation on quality of conception, construction and operation of BNIs

- Ministerial order of August 10th, 1984.

2.2 *Specific regulation related to radioactive waste management*

Creation of ANDRA

- Decree n° 92-1391 of December 30th, 1992. Creation of ANDRA as an independent public agency separated from the CEA.

Licensing of underground research laboratories

- Decree n° 93-940 of July 16th, 1993. Application of the law of December 1991 - Procedure for authorizing the creation and operation of underground research laboratories ;
- Decree of August 3rd, 1999 authorizing ANDRA to create and operate, at Bure (Meuse), an underground laboratory in order to study deep geological formations for disposal of high level waste and long lived radioactive waste.

Licensing of Centre de la Manche (surface repository)

- Authorization decree (June 19th, 1969) ;
- Letter SIN 693 A 85 (February 6th, 1985) : Technical prescriptions ;
- Decree for changing of operator (March 24th, 1995). Changing from CEA to ANDRA.

Licensing of Centre de l'Aube (surface repository)

- Authorization decree (September 4th, 1989) ;
- Ministerial letter CAB N° 12 86 MZ (December 24th, 1991). Operating license and technical prescriptions ;
- Decree for changing of operator (March 24th, 1995) : Changing from CEA to ANDRA ;
- Definitive operating license (September 2nd, 1999).

2.3. *Basic Safety Rules related to radioactive waste management*

- **RFS I.2** (June 19th, 1984) : Safety objectives and design basis for surface disposal of short lived, low and intermediate level radioactive waste.

- **RFS III.2.a** (September 24th, 1982) : General safety measures for production, control, treatment, conditioning and interim storage of reprocessing waste.

- **RFS III.2.b** (November 12th, 1982) : Particular safety measures for production, control, treatment, conditioning and interim storage of high level waste from reprocessing to be conditioned in glass matrix.

- **RFS III.2.c** (April 5th, 1984) : Particular safety measures for production, control, treatment, conditioning and interim storage of low or intermediate level waste from reprocessing to be conditioned in bitumen matrix.

- **RFS III.2.d** (February 1st, 1985) : Particular safety measures for production, control, treatment, conditioning and interim storage of waste from reprocessing to be conditioned in concrete matrix.

- **RFS III.2.e** (October 31st, 1986 revised May 29th, 1995) : Conditions prior to acceptance of solid waste in surface disposals.

- **RFS III.2.f** (June 10th, 1991) : Definitions of safety objectives for disposal of radioactive waste in deep geological formations in the post-closure phase.

3. CURRENT STATUS

3.1 National status and issues

3.1.1. Waste classification and sources

Radioactive wastes produced in France vary considerably by their activity level, their half-lives, their volume or even their nature (scrap metal, rubble, oils, etc.). The treatment and final disposal solution must be adapted to the type of waste considered in order to manage them safely.

The radiological risk can be assessed on the basis of two main parameters : the activity level, indicating the toxicity of the waste, and the half-life, which depends on the radioactive decay periods of the radioelements it contains.

The classification makes the distinction between short-lived waste and long-lived waste, and on the other hand on the distinction between very low, low, medium or high level waste. It is based on the existing or expected management pathways (see 3.1.2).

Table 1 : Existing or future disposal channels for the main solid wastes and residues resulting from radioactive effluent treatment

<table>
<tr><th>ACTIVITY/PERIOD</th><th>Short-lived</th><th>Long-lived</th></tr>
<tr><td>Very low level</td><td>Dedicated disposal facilities (under investigation)
Recycling channels (under investigation)</td><td></td></tr>
<tr><td>Low level</td><td rowspan="2">Surface disposal at the Aube repository
Recycling of certain metals (under investigation)
Dedicated disposal facilities for tritiated waste (under investigation)</td><td>Dedicated disposal facilities planned for waste containing radium and graphite (under investigation)</td></tr>
<tr><td>Medium level</td><td>Waste management channels being devised in the framework of law 91-1381 of December 30, 1991</td></tr>
<tr><td>High level</td><td colspan="2">Waste management channels being devised in the framework of law 91-1381 of December 30, 1991</td></tr>
</table>

Very low level waste

Very large quantities of very low level waste were produced in the past during operation of the French uranium mines. This waste contains a very small quantity of long-lived radioelements, notably radium. Since moving the millions of tons concerned is obviously out of the question, it is planned to restructure the mining sites where they are currently stored, taking maximum advantage of the characteristics of these residues (low solubility and permeability), aiming at a long term stable solution, requiring neither frequent maintenance nor constant surveillance.

Today's very low level waste comes mainly from the dismantling of nuclear facilities or conventional industrial sites using slightly radioactive substances. The quantity involved will increase considerably when the time comes for the large scale complete dismantling of power reactors currently in operation. Radioactivity in these cases amounts to a few becquerels per gram.

Long-lived low level waste

The long-lived low level wastes include the particular category of waste containing a significant quantity of radium and producing radon. These wastes were notably produced in the past by the rare earth industry.

Short-lived low and intermediate level waste

The activity of short-lived medium and low level waste, designated "A waste" by the nuclear operators, is mainly due to beta or gamma radiation emitting radionuclides, with a half-life of less than 30 years. Alpha particle emitters are strictly limited. This type of waste comes from nuclear reactors, fuel cycle facilities, research centers as well as university and hospital laboratories. They consist mainly of manufacturing waste, worn equipment, materials cleaning rags and protective clothing. This category also includes products from gaseous and liquid waste treatment at nuclear installations.

High level waste and long-lived medium level waste

These wastes contain long half-life radionuclides, notably the alpha emitters. They comprise both medium level and high level wastes. The former, known as "B wastes" by the nuclear operators, mainly come from various reprocessing lines (hulls and end-pieces) and associated maintenance operations. Within these wastes, the alpha emitters can be found in significant quantities. The second category, known as "C wastes", generally originate from fission and activation products deriving from spent fuel processing. Their activity is such that the heat release for each 150 litre container can reach 4 kW. These high activity wastes also include CEA fuel, irradiated in research reactors and currently unused, together with EDF spent fuel which is not intended for reprocessing.

The table below presents, for each category of radioactive waste currently produced, an estimation of the annual throughput and the total activity and volume foreseen by 2020. These data constitute simply an indication and can vary depending on the treatment options selected and the spent fuel management strategy adopted. However, they clearly show that the largest volumes concern very low level or short-lived low and medium level waste, representing only a minute fraction of the total activity. The high level waste, representing a very small volume, comprises more than 98% of the total activity.

These data exclude the very large quantities (several million cubic meters) of very low level waste expected after 2020 during the complete dismantling of nuclear installations currently operating or shut down.

Further information on the state and localization of radioactive waste on French territory, including military installations, can be obtained from the national inventory of radioactive waste, edited annually by the ANDRA. The latest edition of this annual report was published in September 2001.

Table 2 : Annual quantities of waste produced and total quantity expected by 2020 (sources: ANDRA, IPSN). ***Postulates*****: 58 PWR power reactors operating, 28 of which use MOX fuel; 800 tons of irradiated fuel reprocessed per year.**

NB.: This excludes waste from the reprocessing of foreign irradiated fuel which, in compliance with law 91-1381 of December 30, 1991, is returned to the owners after an interim storage period.

Type of waste	Estimated annual throughput (m^3)	Volumes foreseen for 2020 (m^3)	Corresponding total activity in 2020 (TBq)	
Very low level	10,000 to 50,000	250,000	3	
Short-lived medium and low level	20,000	500,000	250	30,000
Long-lived medium level	1,600	50,000	500,000	20,000,000
High level (vitrified)	100	5,000	5,000,000	1,000,000,000

3.1.2. Waste management strategy

For the French Nuclear Safety Authority, the management strategy adopted must cover all categories of waste. This would involve setting up specific waste management channels, taking into account not only radiological risks, but also chemical and sometimes biological hazards incurred by these wastes.

The waste management begins with the nuclear plant design, proceeds during the operating life of the installation through concern for limitation of the volume of waste produced, of its noxiousness and of the quantity of residual radioactive materials contained. It ends with waste elimination (recycling or final disposal) via the intervening stages of identification, sorting, treatment, packaging, transport and interim storage. All operations associated with management of a category of waste, from production to disposal, constitute a waste management channel, each of which must be adapted to the type of waste concerned.

The operations within each channel are interlinked and all the channels are interdependent. These operations and channels form a system which has to be optimized in the context of an overall approach to radioactive waste management encompassing safety, traceability and volume reduction issues.

The objective of the French Nuclear Safety Authority is to ensure that all categories of radioactive waste are managed safely and find an exutory.

Table 1 shows the stage reached in implementation of the different waste management channels, notably the final disposal channel adopted. The absence to date of definitive disposal solutions for certain categories of waste will be noted.

Very low level waste

The very low-level waste is currently temporarily stored on production sites. Efforts are being made to rationalize its management. The corresponding regulatory framework has been set up through a ministerial order signed on December 31, 1999. Operators of nuclear facilities should produce “waste studies” which describe the management of the different categories of waste in the facility and the disposal channels.

Exutories under investigation are : a dedicated repository that is planned to be in operation in 2003 and recycling of certain types of materials .

Short-lived low and intermediate level waste

The technical solution adopted for the long-term management of this type of waste is disposal in a surface repository, where adequate waste packages are placed in concrete structures. This provides for containment of the radionuclides during a sufficient length of time for their activity level to decay.

In the past, this type of waste was disposed of at the Manche Disposal Centre operated by ANDRA. Waste reception has stopped in 1994 and this disposal is now entering a surveillance phase. This type of waste is disposed of, since 1992, at the Aube Disposal Centre also operated by ANDRA.

In May 1995, DSIN defined, in the basic safety rule RFS III.2.e, revised requirements for radioactive waste package acceptance for disposal in a surface repository. The respective responsibilities of ANDRA and the waste producers are detailed in this rule. The French Nuclear Safety Authority carries out inspections to check that the acceptance procedures comply with the requirements of RFS III.2.e and are correctly implemented.

High level waste and long-lived medium level waste

Disposal options for this type of waste, currently stored on the production sites, are being sought along the lines specified by law 91-1381 concerning radioactive waste management passed on December 30, 1991. This law requires the implementation of a fifteen years research program along three different research directions :

- research of solutions to separate and transmute long life radionuclides in the waste ;
- studies of retrievable and non retrievable disposal in deep geological layers supported by investigations in underground laboratories ;

- studies of processes for conditioning and long term surface storage of these waste.

The discussion and information process conducted by the mediator Christian Bataille, member of the French Parliament, and the favorable geological characteristics, led to the choice in January 1994, by the government, of four geological areas in the departments of GARD (clay), VIENNE (granite), HAUTE-MARNE (clay) and MEUSE (clay).

Preliminary surface investigations carried out by ANDRA allowed this agency to select three potential sites for the location of a deep geological laboratory. One is located at the border between the two departments of Meuse and Haute-Marne and is now called East site. The two others are located in Gard and in Vienne.

In June 1996, the government allowed ANDRA to apply for the creation of laboratories on these three sites. ANDRA applied for the East, Vienne and Gard sites mid 1996. DSIN sent the application to the Prefets of the Departments who organized local public inquiries and asked for advice of the local administrations, as well as elected representatives. At the same time, the applications provided by ANDRA were submitted to a review by IPSN and the standing group of experts on waste management in March and April 1997, on the basis of the basic safety rule, RFS III.2.f which defines the general safety objectives for geological disposal of high level waste and long lived waste. On the basis of the reports from the Prefets and the conclusions of the review, DSIN considered in its report of December 1, 1997 that two sites were suitable, the East site and the Gard site.

On December 9, 1998 the French Government decided that the research on geological disposal should be performed at two sites : a clay site at Bure (Eastern France) and a granitic site to be selected.

As set out by the law of December 1991, a National Review Board is in charge of evaluating the progress made in the three ways of research. Seven annual reports were provided to the Government and the Parliament from July 1995 to June 2001.

In 2006, on the basis of the results of the research program one of the selected sites may be proposed to the French Parliament as the location for a high level waste and long-lived medium level waste repository.

3.1.3. Current issues / problems

Very low level waste

ANDRA and France-Déchets announced, in 1999, the setting up of a partnership to create a dedicated VLLW repository next to the Aube Disposal Centre. A site has been selected and is being characterized. The statement of public interest was delivered in October 2001.

Long-lived low level waste

A special method of disposal for radiferous waste is currently being studied by ANDRA for this type of waste. This is closely followed by the French Nuclear Safety Authority.

Short-lived low and intermediate level waste

For surface disposals, an important issue is the definition of the conditions for entering the surveillance phase. With regard to the Manche Disposal Centre (surface repository), whose operation ended in 1994 and which is now set to enter the surveillance phase, the French Nuclear Safety Authority makes sure that the recommendations laid down by the committee, set up on the subject, in 1996, by the ministers for industry and for environment, will be applied. The ASN has formally approved the safety report produced by ANDRA in January 1999. A public inquiry was held from February 2nd to April 17th 2000 as part of the licensing procedure for entering the surveillance phase. This public inquiry concerned as well the revision of the ministerial order for authorization of effluent release relative to this facility. It led to a favorable advice on June 2000. Since then, the decree creating the new facility, in the surveillance phase, is awaiting the signature of the Government.

The Aube Disposal Centre was authorized by a decree of September 4th, 1989. Its lifetime is planned for 30 years and could be extended to 60 years as the quantity of waste yearly received has drastically decreased. Following the provisions of the creation license, issued in 1989, ANDRA produced a new safety report for the repository in December 1996, integrating operating feedback from the first years of operation. On this basis, the final operating license was granted on September 2nd,1999. In parallel, the authorization for effluent releases is in the process of being revised. In 2000, 13,240 m3 of LILW have been delivered to the Aube Center and three structures have been shut down. Since the beginning of its operation the Aube Center had received, at the end of 2000, 111,651 m3 of LILW.

Taking into account the experience feedback and the final safety report of the Aube Disposal Centre, the RFS III.2.e on requirements concerning radioactive waste packages for disposal in a surface repository is currently in the process of being revised.

A new facility, CENTRACO, has been licensed to operate at the beginning of 1999. It receives short-lived low-level or intermediate-level waste either for incineration or, in case of metal scrap, for melting. It contributes to minimization of the volume of the waste before its disposal in a surface repository. CENTRACO has reached, in 2000, its nominal operation.

The short-lived medium and low level wastes include certain categories which have characteristics making them unsuitable for acceptance at the Aube repository. These are wastes containing tritium, which is difficult to confine, and also graphite waste, which contains a non-negligible proportion of long-lived radionuclides. A working party comprising regulator, waste producers and implementers, is entrusted with devising the most suitable management channels for these types of waste. ANDRA is studying dedicated repository designs for these particular types of waste.

Interim storage of "old" radioactive waste

For all waste for which a final solution has not been found, it is essential that satisfactory temporary solutions are implemented. The French Nuclear Safety Authority makes sure that these temporary solutions are not only safe, but also that they do not become definitive as a result of lack of action. In this respect, the CEA and COGEMA have started a clean-up of their installations where "old" waste is temporarily stored.

High level waste and long-lived medium level waste

Following the decision of December 9th, 1998, the government signed, on August 3rd, 1999, three decrees :

- the decree authorizing ANDRA to implement and operate at the Bure site, in Eastern France, an underground laboratory in order to study deep geological formations where radioactive waste could be disposed of ;

- the decree giving general guidelines to set up local committees in charge of following the activities implemented in underground laboratories ;

- the decree deciding the creation of a commission composed of three members in charge of the dialogue prior to selecting one or several granitic sites for a second underground laboratory.

Concerning the first decree, the French Government granted, on August 7th, 2000, the authorization to ANDRA to sink the shafts of the underground laboratory. The sinking of the shafts is underway since September 2000 and will last for two years and a half. At the beginning of May 2002, the main access shaft is 220 m deep. Experiments and site investigations are being performed during shaft sinking. The main emphasis is given on minimization of rock mechanical disturbances and evaluation of the impact of shaft sinking on groundwaters in the sedimentary cover. Further ministerial authorizations will be required for excavating the drifts of the underground laboratory.

Characterization of the host rock from the drifts of the underground laboratory will be performed between 2003 and 2005. These investigations will be the basis for the global report that ANDRA should produce at the end of 2005 on the feasibility of creating a high level waste and long-lived medium level waste repository on this site.

Prior to the August 7th, 2000 authorization, ANDRA sent to the French Nuclear Safety Authority a series of documents concerning the geology of the Bure site, the initial design option for a repository, the safety approach and the experimental program during shaft sinking. ANDRA sent as well a global development plan concerning the research relative to the deep disposal project.

On the request of the French Nuclear Safety Authority, these documents were analyzed by the Nuclear Protection and Safety Institute (IPSN) and the Advisory Committee on radioactive waste repositories, in 2000.

This resulted in a series of recommendations that the French Nuclear Safety Authority addressed to ANDRA for the following steps it conducts for studying the feasibility of deep geological disposal on the Bure site.

In December 2001, ANDRA sent to the ASN a safety file comprising the following elements :

- detailed information on the geology of the Bure site, the waste package inventory, the materials to be used for artificial barriers and the biosphere ;
- a phenomenological analysis of the different states of the repository system ;
- a functional analysis of the repository system and a conceptual design ;
- a qualitative analysis assessing the robustness of the system ;
- a quantitative analysis based on the normal evolution scenario and the sealing defect scenario.

The different elements of this safety file will be reviewed in 2002 and 2003 by the DGSNR and its technical supports, including the Advisory Committee on radioactive waste repositories, in order to provide feedback to ANDRA before the publication of its feasibility study report due at the end of the year 2005.

Concerning the second decree, the local information follow-up committee was set up on November 15th, 1999. It meets on a regular basis.

Concerning the search of a granitic site, ANDRA set up an expert group composed of French and foreign experts and proposed in 1999 a first selection of 15 sites on the basis of a bibliographical study. This first selection was approved by the National Review Board. The Government nominated, on November 19th, 1999, the three members of the commission in charge of the dialogue on the selected sites. The commission began its work at the beginning of the year 2000 but had to stop because of a strong local opposition. A report to the Government was published on July 2000. The siting process is postponed after the presidential and legislative elections of 2002.

The other directions of research provided for by the law passed on December 30th, 1991 are under the responsibility of the "Commissariat à l'Energie Atomique" (CEA).

Concerning the research on separation and transmutation, the Phenix fast breeder reactor at Marcoule is to be used to conduct irradiation experiments and test new matrices for plutonium burning and minor actinide transmutation. A project of a sub-critical reactor coupled with a particle accelerator is also being studied.

Concerning processes for conditioning and long term near surface storage of the waste, the government approved, in 2000, the recommendations of a report by the CEA to initiate basic design studies. Both surface and sub-surface long term interim storage facilities are being envisaged.

3.2. Regulatory issues

3.2.1. Current issues/problems

The ASN has three priorities :

- safety at each stage in radioactive waste management : production, treatment, packaging, interim storage and disposal ;
- safety of the overall radioactive waste management strategy, ensuring overall consistency ;
- the setting up of channels well adapted to each categories of waste. Any delay in identifying waste disposal solutions increases the volume and size of the on site interim storage facilities.

The emphasis has been recently on regulation of radioactive waste produced in nuclear installations. The regulation on radioactive waste coming from conventional industry and hospitals should be developed as well.

Concerning the research associated to high level waste and long-lived intermediate level waste the main regulatory issue concerns the short period of time left before 2006 when a new law should be voted by the Parliament to implement a procedure for construction of a deep disposal facility and/or the continuation of research.

DGSNR follows closely the research programs set up by ANDRA. In this process, DGSNR is particularly concerned with :

- the priority that must be given to safety ;
- the necessity to avoid delays and to comply with the schedule of the law of December 1991;
- the need that the research developed in the laboratories be operational and not academic.

3.2.2. Policy and regulation developments

An anticipated regulatory issue will be the licensing procedures concerning the creation of disposals for specific types of wastes. A design concept has been proposed for very low level waste. ANDRA will propose concepts for disposal of radiferous, tritiated and graphite waste. Specific guidance rules should be issued on these matters.

For short-lived low and intermediate level waste the main concern is the regulation concerning the institutional control period for disposals and the definition of the different phases of this control period. The Basic Safety Rule, RFS III.2.e, is in the process of being revised.

DGSNR has initiated the elaboration of a new Basic Safety Rule concerning interim storage of long-lived radioactive waste. It is based on the experience feedback from existing interim storages.

Concerning the deep disposal of high level waste and long-lived intermediate level waste the review of the documents produced by ANDRA is presently performed along the lines of the Basic Safety Rule, RFS III.2.f, published by the Nuclear Safety Authority in June 1991. It sets out the radiation protection objectives to be met for the disposal, basic principles for repository design linked to safety, site selection criteria and guidance for elaborating the safety case. The revision of this Basic Safety Rule is under progress taking into account the new ICRP 81, experience feedback at the national and international level and the possible incorporation of a retrievability period. Bilateral cooperation on guidance rules for deep disposal has been established with German counterparts of French organizations, from 1997 to 1999, and with Belgian counterparts, since 2000.

The main lines of this revision will concern the radiation protection objectives and compliance criteria depending on time frames and type of scenarios and respective responsibilities of the implementer and the regulator. It will also concern the safety guidelines for the design of the repository, taking into consideration the role of the different safety functions in the definition of the multi-barrier system and including safety requirements for the operational period and retrievability period. Guidelines for the elaboration of the safety case including multiple lines of reasoning and confidence statements will be provided.

Waste packages for deep disposal are currently being produced by main high level waste and long-lived medium level waste producers : EDF, COGEMA and CEA. Following requests from the French Nuclear Safety Authority, ANDRA has established first level specifications and an acceptance process for these waste packages in order to include them in the deep disposal project. This acceptance is based mainly on the radiological and physico-chemical characterization of the waste packages which are being produced and the quality management for their fabrication. ANDRA is performing controls on sites to assess the quality of this fabrication.

DGSNR is establishing a safety guide in order to precise the role of the waste producers, the implementer and the regulator for waste package specification and waste acceptance. The main concern is that waste packages being produced now have a large chance to meet the requirements of a future deep disposal without major reconditioning. Emphasis will be given on consistency between specifications for deep disposal under the responsibility of ANDRA and interim storage specifications under the responsibility of CEA.

3.3. R&D programs

3.3.1. Functions

The main objectives of R&D programs relative to the safety analysis of nuclear waste disposals, developed by IRSN, concern the safety approach (safety strategy, site characterization, repository concepts, performance assessment) and the scientific and technical bases for safety assessment, construction and operation of the repository.

3.3.2 Contents of R&D programs

Safety approach

This work developed by IRSN consists in developing independent modeling capabilities for safety assessment (MELODIE code) and testing different general safety assessment methodologies by participating to international exercises such as EVEREST and SPA and mechanical behavior modelling (DECOVALEX).

Site investigation analysis

The expertise in judging the applicant approach is developed by performing experimental work in independent geological formations such as a clay layer in the Tournemire tunnel in central France. The research program, carried out from a tunnel inside the geological formation itself, consists of detailed studies on fluid transfers characterisation through argillaceous formation, impact of excavations on clay-rock behaviour and test of high resolution geophysics with 3D seismic reflection to assess the sensitivity of the method for investigating secondary fracturing in clay.

GERMANY

1 NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

The safety policy of the German Federal Government with respect to nuclear technology and radioactive waste management (RWM) gives utmost priority to the protection of man and the environment.

After the federal election of September 27, 1998, the new majority of the Social Democratic and the Green party elaborated a coalition treaty which was published on October 20. 1998. The coalition treaty as a basis for governmental policy marks drastic changes in the field of nuclear energy and radioactive waste management. It is intended to irreversibly abandon out nuclear energy generation in Germany. The main objectives of the treaty in the field of RWM are as follows:

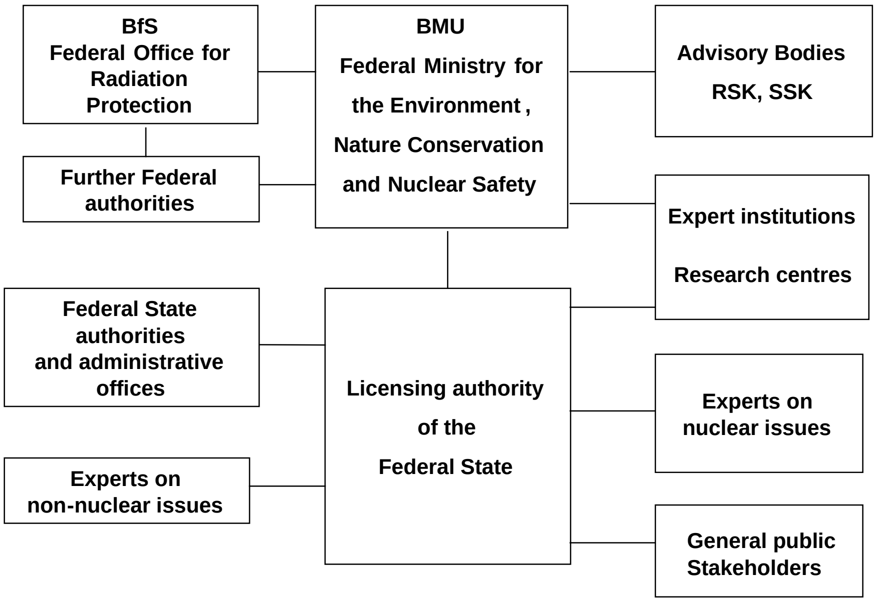
- Development of a new national RWM plan for the “legacy” of radioactive waste.
- Restriction of spent fuel management to direct disposal; termination of reprocessing of spent fuel as soon as possible.
- Extension of interim storage capacities at reactor sites for both radioactive waste and spent fuel; transport of spent fuel will be only granted when storage capacity at reactor site is exhausted and responsibility for this exhaustion is not with the utility’s owner.
- Raising the level of insurance cover for nuclear accident liability.
- Cancellation of the amendment of the Atomic Energy Act (except EU directives) from 1998; as one consequence, disposal of radioactive waste must remain a public task and must not be privatised.
- Suitability of Gorleben as disposal site is doubted. Therefore, its exploration shall be interrupted. Suitability of further sites in different host formations shall be explored. Based on site selection criteria potential sites shall be identified.
- The disposal of radioactive waste into Morsleben will not be resumed. The licensing procedure remains restricted to decommissioning.

Implementation of these objectives into practical policy is currently elaborated. The new policy will be enforced by changes of the legislative basis; necessary amendments are in preparation.

1.1.2 Institutional framework

An overview over the authorities involved in licensing and supervision of nuclear facilities as well as advisory commissions and consulting expert organisations is given in Figure 1.

Figure 1: Authorities, advisory committees and experts concerned with nuclear safety and radiation protection



Federal Authorities

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)

The Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) is responsible for nuclear safety and radiation protection. In this field it has the competence to issue directions and to supervise the legality and expediency of the acts of authorities responsible for enforcing the Atomic Energy Act and the Radiation Protection Ordinance. Under the Act on the Precautionary Protection of the Population against Radiation Exposure the BMU has the power to fix dose levels, which may be implemented by ordinances jointly issued with other interested Federal Ministries. The BMU has also exclusive power to issue recommendations to the public as to the conduct they should adopt following a nuclear incident, but must do so in close contact with other competent authorities of the Bund or Länder (Federal States).

Further Federal Authorities

Apart from the BMU, the following federal ministries take part in RWM according to their specific responsibilities:

- Bundesministerium für Bildung und Forschung (BMBF: Federal Ministry of Education and Research)
- Bundesministerium für Wirtschaft und Technologie (BMWi: Federal Ministry of Economics and Technology)
- Bundesministerium der Finanzen (BMF: Federal Ministry of Finance)
- Bundesministerium für Verkehr, Bau und Wohnungswesen (BMVBW: Federal Ministry of Transport, Building and Housing)

Federal Offices

Bundesamt für Strahlenschutz (BfS)

The Federal Office for Radiation Protection (BfS; Bundesamt für Strahlenschutz) is a federal authority in the portfolio of the BMU. BfS implements federal administrative tasks in the field of radiation protection including radiation protection precaution as well as nuclear safety, the carriage of radioactive substances and the management of radioactive waste including the erection and operation of federal installations for the safekeeping and final disposal. It supports BMU on a technical and scientific level in these fields.

BfS also performs scientific research in the fields of radiation protection, nuclear safety, transport of radioactive substances and radioactive waste management.

Bundesausfuhramt

This body being an authority within the portfolio of the Federal Ministry of Economics and Technology is responsible for the issue of import and export licences of nuclear material. In carrying out this function, it is bound by the technical instructions issued by the BMU.

Länder (Federal States)

On behalf of the Federal Government the Länder (Federal States) execute administrative duties (licensing and supervision) under nuclear and radiation protection law not performed by the federal authorities. Thus, the Federal States are the competent licensing authorities for all nuclear installations concerning their territory, except interim storage facilities for spent nuclear fuel. They supervise all nuclear facilities, repositories excluded. To ensure the uniform implementation of the Atomic Energy Act, the Federal States are subject to federal supervision by the BMU. The BMU has the right to issue directives to the competent nuclear authority of the respective Federal State, particularly in order to get consistent and suitable regulatory decisions. Federal supervision covers both legality and expediency of the Federal States' way of proceeding.

The Länder (Federal States) have to operate Landessammelstellen (regional collecting depots), i.e. interim storage facilities for radioactive waste originating in particular from isotope application in industry, research and development as well as medicine.

Advisory Bodies

Federal supervision is supported by advisory bodies set up by BMU.

The **Reactor Safety Commission** (Reaktor-Sicherheitskommission – RSK) is responsible for advising BMU on all major issues concerning the safety of nuclear reactors and the nuclear fuel cycle.

The **Radiation Protection Commission** (Strahlenschutzkommission – SSK) is responsible for advising BMU on all major issues concerning radiation protection and radiation protection precaution.

The Office of the **Nuclear Safety Standards Commission** (Kerntechnischer Ausschuß – KTA) was set up by BMU. The commission consists of members of the licensing and supervisory authorities, expert organisations for safety assessment and the industry and utilities involved in design and operation of nuclear facilities. The Nuclear Safety Standards Commission is responsible for the establishment of safety standards and promotes their application in all those fields of nuclear technology, where a common opinion of experts can be achieved.

Expert institutions and research centres

The regulatory authorities are assisted by technical safety organisations like the Company for Industry and Reactor Safety (Gesellschaft für Anlagen und Reaktorsicherheit mbH – GRS), the Öko-Institut, research centres (e.g. Jülich Research Centre, GSF Research Centre Munich, GKSS Research Centre Geesthacht, Karlsruhe Research Centre) and a variety of other independent institutions and experts.

1.2 Regulatory framework

The regulatory framework for RWM is based on a hierarchy of acts, ordinances, safety rules and guidances. It provides the basis that radioactive wastes are managed and eventually disposed of in such a way that human health and the environment are protected now and in the future without imposing undue burdens on future generations. The national framework is in compliance with internationally accepted safety principles as specified in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and, for example, in the RADWASS "Safety Fundamentals" of the IAEA as well as in the radiation protection principles recommended by ICRP.

1.2.1 Regulatory functions

Pursuant to section 23 of the Atomic Energy Act, the BfS is the competent authority for the licensing of the carriage of nuclear fuel and large radiation sources as well as for the licensing of the storage of nuclear fuel outside Government custody and the withdrawal or revocation of such licences. All other licensing activities regarding radioactive waste management are executed by the Federal States on behalf and under supervision of the Federal Government. These licenses include transportation, conditioning, interim storage and disposal of radioactive waste. In compliance with national legal regulations, the competent licensing authority for the transport of radioactive waste by rail is the Eisenbahnbundesamt – EBA (Federal Office for Railways) whereas the transport of radioactive waste by road is authorized by the competent authorities of the Federal States.

The disposal of radioactive waste in a repository is in particular governed by the following specific acts and regulations: Atomgesetz (Atomic Energy Act), Strahlenschutzverordnung (Radiation Protection Ordinance), and Bundesberggesetz (Federal Mining Act). The protection objectives of radioactive waste disposal in a repository are prescribed by the Atomic Energy Act and the Radiation Protection Ordinance. The Federal Mining Act regulates all aspects concerning the operation of a disposal mine.

According to section 9a of the Atomic Energy Act, the Federal Government has to establish installations for the disposal of radioactive waste, i.e. disposal of radioactive waste is assigned to the Federal Government as a sovereign task. On November 1, 1989, this competency was assigned to the Bundesamt für Strahlenschutz (BfS, Federal Agency for Radiation Protection). Accordingly, the BfS is responsible for the establishment and operation of those federal installations, acting on behalf of the Federal Government.

For the establishment of a repository, pursuant to section 9b of the Atomic Energy Act, a plan-approval procedure, i.e. a special kind of a licensing procedure, has to be initiated with the responsible licensing authority of the respective Federal State. BfS is the authorized applicant. It is the objective of the plan-approval procedure to examine a project which is important for the region concerned, weighing and balancing the interests of the body responsible for the project and public and private interests affected by the planning in one procedure and to reach a decision which is legally binding in relation to third parties. The plan-approval procedure includes, among other things, the participation of all authorities concerned.

An important factor in the licensing procedure is public participation: the project is made available to the members of the public, who can express their objections to it, and these are then discussed at a non-public hearing, which involves the applicant, the licensing authority and the objectors.

The procedure is terminated by the plan-approval decision, i.e. the license. This decision embraces the so-called concentration effect, whereby it replaces all other approvals except that required by the Federal Mining Act. Thus, the legal competencies for the licensing of the construction and operation of a repository are regulated in such a way that only two procedures must be performed: the procedure under atomic law on the one hand and the procedure under mining law on the other.

Oversight over compliance to the issued licenses regarding RWM activities is generally executed by the Federal State where the activity takes place. Again, the Federal States thereby act on behalf and under supervision of BMU. There are two exceptions to this general State’s responsibility for nuclear oversight: transport of radioactive substances on public railroads and facilities for the final disposal of radioactive waste. Oversight over the former is executed by the central railways office (Eisenbahn-Bundesamt – EBA) and over the latter by BfS.

The BMU as part of the Federal Government is responsible for the preparation and further development of the legal framework as to the peaceful use of atomic energy. The proposals are eventually discussed and ratified by the parliament.

1.2.2 Organisation and resources

The total staff of BMU are about 800 people. About 1 to 2% of this staff are concerned with regulatory tasks of radioactive waste management. About 5% of BfS staff (in total about 660 people) are concerned with regulating tasks relevant to radioactive waste management. The staff of the Federal State authorities concerned with regulating RWM differs from Land to Land. Generally, it can be stated that the respective staff only comprises a few people. RSK and SSK commissions comprise 14 members each. Pursuant to actual activities and demands, BMU and the Federal States receive in particular technical support from the expert organisations like GRS or Technical Inspection Agencies (TÜV). Total staff of GRS are about 650 people. About 20% of this staff are concerned with RWM.

2 LEGISLATION AND REGULATION

2.1 Legislation

German legislation *most* relevant to RWM includes the acts enlisted in Table 1. Due to the concentration effect of the plan approval procedure (see section 1.2.1) for disposal many other acts and ordinances must be considered, too, e.g. the Act on Nature Conservation and Landscape Cultivation (NatSchG) or the Act on Water Resources Management Act (WHG). These non-nuclear acts will not be treated in this paper.

Table 1:Acts relevant to RWM

German Abbreviation	Act	Item
AtG	Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards – Atomic Energy Act	• waste disposal and handling of radioactive material • waste repository construction and operation
UVPG	Act on the Assessment of Environmental Impact – Environmental Impact Assessment Act	• environmental impact assessment for RWM facilities
BBergG	Federal Mining Act	• construction and operation of waste repositories
StrVG	Act on the Precautionary Protection of the Population against Radiation Exposure – Precautionary Radiation Protection Act	• supervision of radiation
GGBefG	Act on the Transport of Dangerous Goods – Dangerous Goods Transport Act	• transport

Most relevant ordinances with respect to RWM are given in Table 2.

Table 2:Ordinances relevant to RWM

German Abbreviation	Ordinance	Item
AtVfV	Ordinance on the Procedure for Licensing Facilities under Section 7 of the Atomic Energy Act – Nuclear Licensing Procedure Ordinance	– licensing procedure for nuclear facilities
StrlSchV	Ordinance on the Protection against Damage and Injuries caused by Ionising Radiation – Radiological Protection Ordinance	– radiation protection
AtDeckV	Ordinance Concerning the Financial Security Pursuant to the Atomic Energy Act – Nuclear Financial Security Ordinance	– financial security
AtKostV	Cost Ordinance under the Atomic Energy Act – Atomic Energy Act Cost Ordinance	– costs of radioactive licensing
EndlagerVlV	Ordinance on Advance Payments for the Establishment of Federal Facilities for Safe Custody and Final Storage of Radioactive Wastes – Final Storage Advance Payments Ordinance	– costs of radioactive waste disposal
-	Ordinance on the Protection of Groundwater against Pollution Caused by certain Dangerous Substances - Groundwater Ordinance	– groundwater protection
UVP-V Bergbau	Ordinance on Assessment of Environmental Impact for Mining Projects	– environmental impact assessment for Federal waste repositories
GGVE	Ordinance on the Internal and the Cross-border Transport of Dangerous Goods by Rail – Dangerous Goods Ordinance Rail	– transport
GGVS	Ordinance on the Internal and the Cross-border Transport of Dangerous Goods by Road – Dangerous Goods Ordinance Road	transport

2.2 General regulations

Nuclear energy law in Germany is influenced by and in part directly subject to international treaties, particularly within the framework of EURATOM, OECD and the IAEA and ICRP. For instance, as far as the traffic law regulations are concerned, the national regulations correspond to the recommendations of the International Atomic Energy Agency (Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6) as well as to RID, ADR, IMO, ICAO and ADNR. For construction and operation of RWM facilities European and German industrial standards, e.g. DIN/ISO requirements have to be applied. Safety criteria for the final disposal of radioactive waste in a mine have been published in 1983. They are presently under revision.

2.3 Specific regulations

Site specific regulations do not exist in Germany.

2.4 Guidance

In 1989, a guideline for the control of radioactive wastes with negligible heat generation has been published (Richtlinie für die Kontrolle radioaktiver Abfälle mit vernachlässigbarer Wärme-entwicklung, die nicht an eine Landessammelstelle abgeliefert werden). Its purpose is to guarantee more clarity in waste management and to ensure better supervision of the various waste management steps by the responsible authorities. The guideline gives guidance to the control of waste and facilitates supervision.

3 CURRENT STATUS

3.1 National status and issues

3.1.1 Waste classification and sources

Radioactive materials subject to regulatory control may be released from the radiological protection system if their use presents only a minor radiological risk. This procedure is called clearance and the corresponding levels of radioactivity concentration are called clearance levels. The clearance may be restricted to certain conditions or specific uses or management routes (conditional clearance) or may be without restrictions (unconditional clearance). The different options for the management of residues and wastes from a licensed practice are summarised in Table 3.

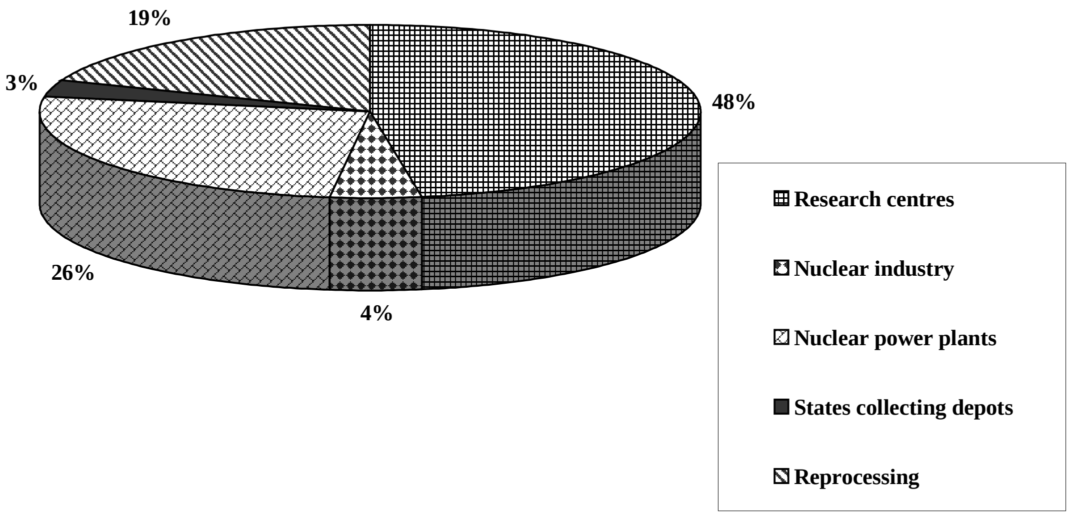
Table 3: Management of residues and wastes from a licensed practice

Under regulatory control			**Conditional Clearance**			**Unconditional Clearance**
Disposal	***Recycling***	***Reuse***	***Disposal***	***Recycling***	***Reuse***	
deep geological disposal of radioactive waste	production of waste containers and shielding plates used in the nuclear field	of equip-ment, tools and compo-nents in nuclear facilities	as conventional waste (incineration or municipal landfill disposal)	as secondary raw material (e.g. use of scrap for general melting or special products; recycling of building rubble)	of equip-ment, tools and compo-nents	No conditions on treatment or use after clearance (incl. Reuse, recycling, disposal)

In the Federal Republic of Germany it is intended to dispose of all types of radioactive waste in deep geological formations. This approach comprises spent fuel elements, vitrified fission product solution, nuclear power plant operational and decommissioning wastes as well as spent sealed radiation sources and miscellaneous waste originating from small waste generators. According to this approach, essential disposal-related waste package characteristics must be considered when developing a waste classification system. As the decay heat per waste package and, thus, the thermal influence upon the host rock are of great importance, in particular with regard to waste disposal in deep geological formations, it was decided to introduce a basic classification making a distinction between heat-generating radioactive waste and radioactive waste with negligible heat generation. Wastes with negligible heat generation consist of operational wastes from nuclear power plants (e.g. filters, ion exchange resins, clothes or cleaning rags), decommissioning wastes as well as radioactive wastes from research, medicine and industry. Heat-generating wastes are especially the vitrified fission product solution originating from reprocessing of spent fuel elements and spent fuel elements from power reactors envisaged for direct disposal.

As to the waste arisings, the BfS carries out an annual inquiry into the amounts of unconditioned and conditioned radioactive waste in Germany. According to the latest inquiry, about 28 450 m^3 of radioactive residues and unconditioned waste (including 460 m^3 of heat-generating waste) and about 61,190 m^3 of conditioned waste (including 1 420 m^3 heat-generating waste) had been accumulated in Germany by the end of 1997. Main contributors are: nuclear power plants, research centres and reprocessing facilities as given in Figure 2 (including radioactive waste originating from decommissioning and dismantling, but excluding spent nuclear fuel elements).

Figure 2 Main contributors of radioactive waste with negligible heat generation (as of December 1997)



3.1.2 Waste management strategy

Radioactive waste disposal policy in Germany is based on the decision that all types of radioactive waste are to be disposed of in deep geological formations. The Atomic Energy Act gives the responsibility for the disposal of radioactive waste to the Federal Government with BfS as the responsible authority. All other waste management procedures, i.e. spent fuel storage, reprocessing, conditioning, transportation and interim storage is within the responsibility of the waste generators. The Federal States must construct and operate regional collecting depots for the interim storage of radioactive waste originating in particular from radioisotope application in industry, universities and medicine.

As far as disposal of radioactive waste is concerned, up to now, two repository projects have been considered and one repository was operated:

- The abandoned Konrad iron ore mine in the Federal State of Lower Saxony has been investigated for the disposal of radioactive waste with negligible heat generation, i.e. waste packages which do not increase the host rock temperature by more than 3 K on an average. The licensing procedure has been started on August 31, 1982. A draft licensing decision has been worked out by the licensing authority in 1998. When the license is granted a construction phase of about four years is needed before operation can start.
- The Gorleben salt dome in the north-east of Lower Saxony is being investigated for its suitability to host a repository for all types of radioactive waste, mainly for heat-generating radioactive waste originating from reprocessing and spent fuel elements. There are doubts about its suitability.
- Since German unity which took place on October 03, 1990, the Morsleben facility has the status of a federal repository in the sense of section 9 a (3) of the Atomic Energy Act. From January 13, 1994, until September 28, 1998 short-lived low and intermediate level radioactive waste with alpha emitter concentrations of up to 4.0×10^8 Bq/cm^3 were disposed of.

The present status is as follows:

Konrad repository project	• The licensing procedure will be continued until a decision can be taken. • At present, possible effects due to waste package contamination are evaluated. • The need for the Konrad repository will be reviewed, especially with respect to economic aspects.
Gorleben repository project	• Underground investigations shall be possibly stopped prior to clarifying the avoidance of compensations. • Evaluation of issues, e.g. retrievability, gas production, role of nature and technical barriers and human intrusion. • Review of assessment basis.
Morsleben repository	• Licensing procedure for decommissioning in progress.

3.1.3 Current issues/problems

Today in Germany there is no final disposal facility for any type of radioactive waste in operation.

Due to this fact, there are no legally binding waste acceptance requirements, permitting final processing and packaging of radioactive wastes. Waste conditioning requirements for long-term storage do not exist. Thus, due to unknown future disposal requirements especially the waste documentation must be rather comprehensive and be preserved safely.

In future reprocessing of spent nuclear fuel shall be stopped and the amount of transports of spent fuel elements shall be considerably reduced. Due to this policy more interim storage facilities for spent nuclear fuel will be needed.

3.2 Regulatory issues

3.2.1 Current issues/problems

An amendment of the Atomic Energy Act and the Final Disposal Advance Payments Ordinance with regard to the financing of repositories was made necessary by a court decision in a test case (Musterprozeß Isar-Amperwerke).

3.2.2 Policy and regulation developments

The government plans to amend the Atomic Energy Act according to the coalition agreement dated October 20. 1998. Improvement of the German safety criteria for disposal of radioactive waste is in revision. Due to the doubts regarding suitability of the Gorleben site, further sites in different host formations shall be investigated. As a first step in this direction, BMU has established an interdisciplinary advisory committee for site selection comprising some 15 members of widely different views. The task of this committee is to recommend a transparent procedure and scientifically sound criteria for site selection. These will be subsequently discussed with environmental groups, stakeholders, other interested initiatives, and the general public, before they are applied. During this development phase, which will probably last for some years, new sites are neither selected nor investigated.

3.3 R&D programmes

3.3.1 Functions

There are several institutions and organisations which promote R&D programmes in the frame of RWM. The main institutions are listed below:

- BMBF
- BfS
- BMU
- Industry

Regarding waste disposal two kinds of research are to be distinguished:

- research necessary for the construction of German repositories, and
- research which is independent of preparatory work on repositories, and falls under the general objective of continually improving the protection of man and the environment, independent of licensing and/or monitoring requirements.

Research and development (R&D) work for the construction of repository projects is initiated by BfS, the cost being reimbursed by the waste producers (mainly the utilities). Independent research is the responsibility of BMBF. For both kinds of research, i.e. site-specific R&D and independent research, the projects are mainly carried out by the major research centres at Karlsruhe and Jülich, the GRS, the Federal Institute for Geosciences and Natural Resources (BGR), the German

Company for the Construction and Operation of Repositories for Waste (DBE), universities and other bodies.

Several bilateral, multilateral and international co-operations on different aspects of repository development are in progress.

3.3.2 Contents of R & D plans

The R&D programmes cover, among other things, the development of concepts for disposal, safety aspects, improvement of instruments for safety assessments of repositories, and development of fission material monitoring.

HUNGARY

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

On the 1 of June 1997 the Atomic Energy Act No. CXVI. of 1996 entered into force in Hungary, expressing the national policy in the application of atomic energy. It regulates among others the basic aspects of the radioactive waste management and authorises the Government and the competent Ministers to issue executive orders specifying the most important requirements in this field.

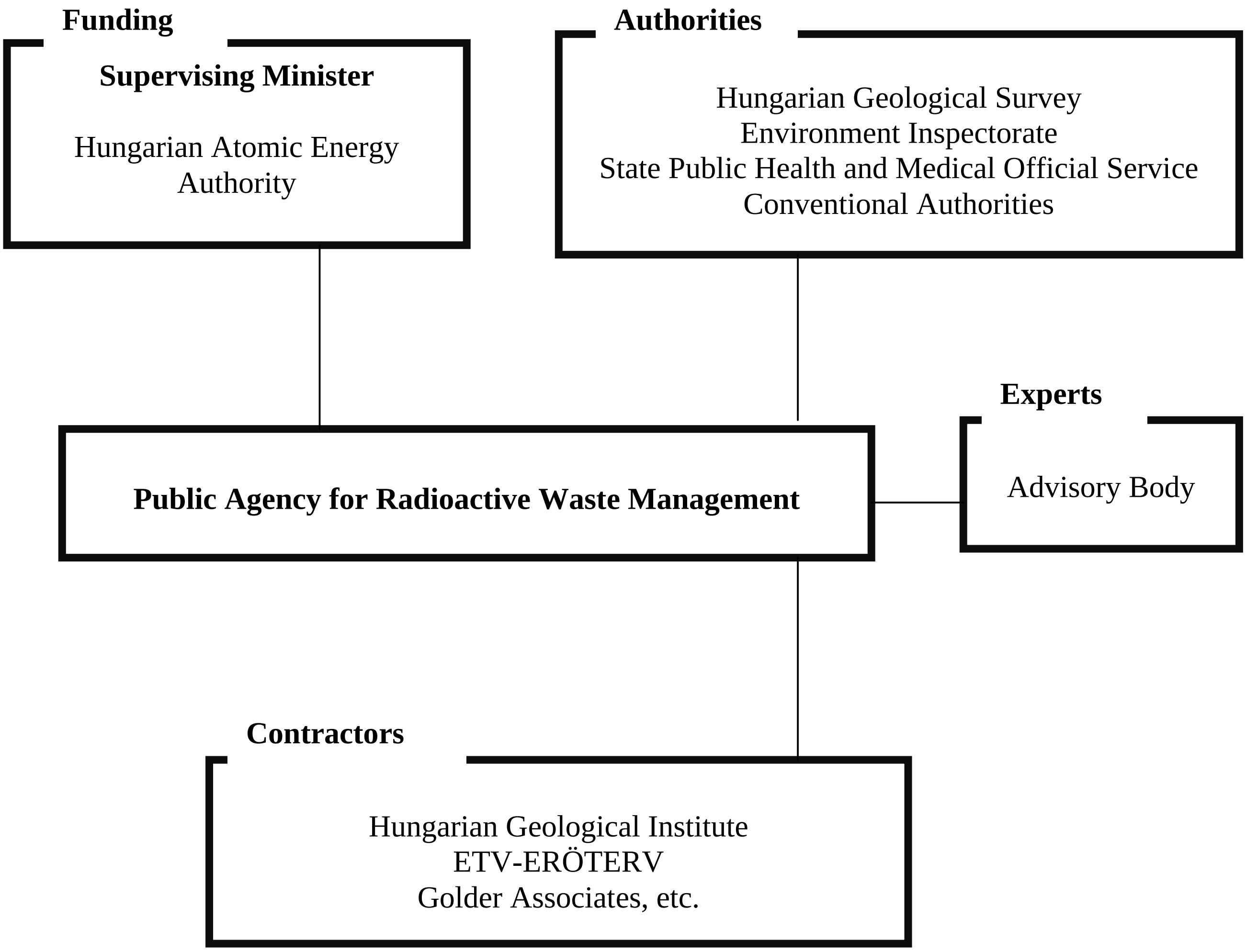
The Act requires that a licence for the application of atomic energy shall be granted only if the safe storage, i.e., interim storage or final disposal, of the radioactive waste and spent fuel generated by the licensed activity can be assured in accordance with the most recent proven results of science, internationally accepted norms, as well as experience.

1.1.2 Institutional framework

According to the Atomic Energy Act and Governmental Decree No. 240/1997 (XII.18.) Korm.*[*] the Central Nuclear Financial Fund has been set up on 1 January 1998 to finance radioactive waste disposal, interim storage and disposal of spent fuel as well as decommissioning of nuclear facilities. As required by the Act, the Government authorised the Director General of the Hungarian Atomic Energy Authority (HAEA) to establish the Public Agency for the Radioactive Waste Management (PURAM), now in operation since 2 June 1998. The Minister supervising the HAEA has jurisdiction over the Fund, while HAEA is responsible for its administration.

PURAM performs the tasks related to the final disposal of radioactive waste, as well as to the interim storage and final disposal of spent fuel, and to the decommissioning of nuclear facilities. The scheme below illustrates the organisational chart of radioactive waste disposal in Hungary.

* Korm. is the abbreviation of Kormány, that is Government in English



1.2 Regulatory framework

1.2.1 Regulatory function

Key organisations with regulatory functions are the following:

The Minister of Health, through the State Public Health and Medical Officer Services (SPHMOS) performs the regulatory tasks with respect to radiation safety. SPHMOS is the responsible regulatory body for licensing and controlling the siting, construction, commissioning, operation, modification and closure of a radioactive waste disposal facility.

HAEA is the nuclear safety regulatory body. Facilities for the interim storage or final direct disposal of spent fuel are - as defined by the Act on Atomic Energy - nuclear facilities, falling under the regulatory competence of the HAEA. The HAEA has also regulatory tasks in connection with radioactive waste collection, handling and treatment on the site of nuclear facilities as well as in safeguards, international transportation, packaging and recording of radioactive materials.

The Act on Atomic Energy authorises also the relevant Ministers to regulate various aspects of the application of atomic energy, falling into their scope of competence. In that undertaking they are supported by their appropriate organisations (see 1.2.2).

1.2.2 Organisations and resources

In radioactive waste management the licensing authority is the State Public Health and Medical Officer Service (on behalf of the Minister of Health). It is responsible also for the inspection and enforcement, based on a countrywide network. It is supported by the Frederic Joliot-Curie National Research Institute for Radiobiology and Radiation Hygiene.

In the licensing procedure all other public administration organisations participate as so-called special authorities, in their scopes of authority and responsibility identified by separate legal regulations. In accordance with the Atomic Energy Act the responsible Ministers are enforcing - through their organisations - the following aspects in the licensing procedures:

- the Minister of the Interior, through the National Headquarters of the Police, the Fire Protection and Civil Defence: the public security and domestic order, fire protection, physical protection and emergency preparedness;
- the Minister of Agriculture and Regional Development, through the Veterinary and Food Control Services: food, plant and animal hygiene, as well as soil protection;
- the Minister of Economic Affairs, through the Hungarian Geological Survey: geology;
- the Minister of Environment Protection, through the National Authority for Environment: environment protection, nature conservation and water quality protection;
- the Minister of Transport and Water Management, through the National Authority for Transport and the Water Management Directorates: transport, water utilisation and protection of water bases;
- the building authority competent for the area: regional planning and building; and
- the President of the Mining Bureau of Hungary, through its organisation: mining technology and mining safety.

2. LEGISLATION AND REGULATION

2.1 Legislation

The most important laws, governmental decrees and ministerial orders are the following:

- Act No. CXVI. of 1996 on Atomic Energy
- Governmental Decree No. 87/1997. (V. 28) Korm. on Duties and Scope of Authority of the HAEC and on the Scope of Duty of Authority, and Jurisdiction for Imposing Penalties, of the HAEA.
- Governmental Decree No. 240/1997. (XII. 18.) Korm., on establishment of the organisation designated for implementing radioactive waste disposal and spent fuel, as well as decommissioning of nuclear installations, and on the financial source performing tasks.

- Governmental Decree No. 124/1997. (VII. 18.) Korm., on radioactive materials as well as equipment generating ionising radiation, exempted from the scope of the Atomic Energy Act No. CXVI of 1996.
- Order of the Minister of Public Welfare No. 23/1997. (VII. 18.) NM defining the exemption levels (activity concentrations and activities) of radionuclides.
- Order of the Minister of Health No. 16/2000. (VI. 8.) EüM on the execution of certain provisions of the Act No. CXVI. of 1996 on Atomic Energy.
- Order of the Minister of Health and Social Affairs No. 7/1988 (VII. 20) SZEM regarding the enforcement of the Enacting Clause of the Council of Ministers No. 12/1980 (IV.5)MT to Act No. I. of 1980 on Atomic Energy (its regulations on radioactive waste are still in force until the new order in preparation on radioactive waste management enters into force).
- Order of the Minister of Industry, Trade and Tourism No. 62/1997(XI.26.) IKIM on the Geological and Mining Requirements for the Siting and Planning of Nuclear Facilities and Radioactive Waste Disposal Facilities.
- Order of the Minister of Industry, Trade and Tourism No. 67/1997(XII.18.) IKIM on the operation and administration of the Central Nuclear Financial Fund.

2.2 General regulation

At present general regulation does not exist yet in the field of radioactive waste management, but in the field of radiation protection there is a comprehensive regulation in force. Detailed codes regulate the safety of nuclear facilities, and they apply to the management of spent fuel and the management of radioactive waste in the nuclear facilities.

2.3 Specific regulations and guidance

No specific regulations and guidance were issued yet, but the above mentioned orders have special attachments containing the basic requirements for the licensing of a radioactive waste repository (7/1988 (VII. 20)SZEM) and the general research aspects for geological site suitability of nuclear facilities and radioactive waste disposal facilities (62/1997(XI.26)IKIM). Technical guidance is also given to the radioactive waste generators, outlining the main requirements of waste acceptance.

In the current radioactive waste management activities as well as in preparing the specific regulations Hungary is taking into account the RADWASS documents of the International Atomic Energy Agency, the regulations of the European Union and - in bilateral co-operation - the national regulation of more advanced countries, e.g. Finland, Canada.

2.4 Licensing procedures

The Parliament's prior approval (decision-in-principle) is required to initiate the establishment of a radioactive waste disposal facility.

The licensing authority for a radioactive waste repository is the State Public Health and Medical Officer Service (SPHMOS), the licenses are issued by the Office of the State Medical Officer (head of SPHMOS) and special authorities referred to in 1.2.2 are participating in the procedure.

The interim storage and final (direct) disposal of spent fuel is licensed by HAEA.

3. CURRENT STATUS

3.1 National status

3.1.1 Waste classification and sources

According to the Hungarian Standard MSZ 14344 (supported by a ministerial order), the waste classification on the basis of activity concentration is the following:

Low level	less than 5. 10^5 kBq/kg
Medium level	5. 10^5 - 5. 10^8 kBq/kg
High level	greater than 5. 10^8 kBq/kg

If the determination of the radioactive concentration of solid waste is not feasible in reactor and accelerator facilities and alpha bearing waste are excluded, then the surface dose rate measurement is accepted for the basis of classification:

Low level	less than 300 μGy/h
Medium level	300 μGy/h - 10 mGy/h
High level	greater than 10 mGy/h

Quantities of radioactive waste and spent fuel:

I. Yearly arising quantities

a) LILW from the NPP (4 units)	
solid waste	100-120 m^3
liquid waste	200-220 m^3
b) spent fuel from the NPP (4 units)	440 assemblies (52,8 THM)
c) other applications	10-20 m^3

II. Total amount

a) LILW from the NPP (operation and decommissioning)	24 000-40 000 m^3
b) spent fuel from the NPP	11 000-12 000 ass. (1320-1440 THM)

The total quantities of the wastes from the Paks NPP have been estimated on the basis of a 30-year operating lifetime and waste production rates recorded to date during operation, pending on the waste treatment technology to be applied.

It has been assumed that the total decommissioning waste as conditioned for disposal will comprise about 20 000 m^3.

3.1.2 Waste management strategy

LILW

In 1976, a radioactive waste treatment and disposal facility at Püspökszilágy was commissioned to condition and dispose of institutional LILW waste. It is a near-surface type repository with concrete trenches and disposal wells.

It was not intended to dispose there of radioactive wastes from the NPP. The concept laid down in the late 1960s for the management of radioactive waste of VVER type NPPs was to store the waste on site and postpone the decision on conditioning and disposal until the decommissioning stage. This concept was revised by the competent Hungarian organs and a site selection started as early as 1983 with the aim to construct a LILW repository. This procedure was interrupted in 1990 due mainly to lack of public acceptance. In 1993 a new project was launched and its realisation is in progress.

Spent fuel

Paks NPP, just as other East European VVERs, was supplied by the Soviet Union. As part of the relevant agreement, the Soviet Union undertook to take back all spent fuel.

In 1992, however, Russia passed legislation prohibiting the import of foreign spent fuel without sending back the high level waste and other products originating from the reprocessing as it was the case for Hungary. Since that time the reshipment requires lengthy, case by case negotiation. At the same time Ukraine became a transit state and a trilateral governmental agreement was concluded between Russia, Ukraine and Hungary to provide an appropriate legal framework for the shipments. With storage space in its spent fuel pools running low, and future acceptance of spent fuel by Russia uncertain, the Paks NPP awarded a contract to GEC Alsthom Engineering Systems in 1992 for the construction of a modular vault dry storage (MVDS) system. In September 1997 the first fuel assemblies were received by the facility having now 7 vaults (each for 450 assemblies), with another 4 vaults in construction.

The interim storage of the spent fuel offers the possibility for Hungary to follow the “wait and see” strategy in closing the nuclear fuel cycle.

HLW

Due to the interim storage of the spent fuel and the „wait and see” strategy in the back end of the fuel cycle there is no immediate need to establish a HLW repository before the middle of the century. However, as the HLW site selection process requires a very long period of time and there was a unique opportunity (see also 3.1.3), exploratory work has been done in a claystone formation and - based on existing data - a country wide screening took place looking for potential sites. The long-term policy of HLW management is now in preparation.

3.1.3 Current issues

LILW

The site selection process identified a potentially suitable site at Üveghuta, in a granitic host rock for a repository in mined cavities, 200-250 m below surface. The Geological Institute of Hungary- based on its exploration - recommended to start here the detailed investigations, necessary for the licensing. There are also other candidate sites to fall back upon if Üveghuta fails. The public at and near these sites is mostly supporting the establishment of the repository. However in 1999 some experts were questioning whether the results provide enough basis for a decision in favour of Üveghuta, and there were some local groups opposing the site.

In order to achieve consensus on the political as well as scientific debate on the report the Hungarian Atomic Energy Authority asked the International Atomic Energy Agency (IAEA) for a WATRP (Waste Management Assessment and Technical Review Programme) mission to carry out a peer review for the validation of the activities and results of the site selection and to give recommendations based on international good practice. The mission took place in November 1999. The team found the process to select Üveghuta site reasonable and confirmed that the Üveghuta site was potentially suitable to develop a safe repository. The continuation of the site characterisation and repository design were recommended.

The team emphasised that licensing criteria should take into account that overall safety is to be achieved through a combination of engineered and natural barriers. The immediate step to be taken was – as recommended by the mission – the preparation of an integrated safety assessment based on the available geological data to define the further needs for the geological investigations. This has also been supported by a PHARE project aimed at a hydro-geological research program and assistance in the safety evaluation of the site. In 2001 a long-term research project was elaborated on this basis that would end in 2004 with the first steps of the licensing procedure.

HLW

In connection with the uranium mining activities a claystone formation (the Permian Boda Claystone Formation)- accessible in a depth of 1 100 m from the mine - was found that appears to be a suitable host rock for a HLW repository. The uranium mine was to be closed because it was depleted, so the Government took the decision that the claystone should be explored as far as possible before the closure of the mine. A research programme was carried out and it confirmed the preliminary suitability of the formation. Decision on possible alternatives or the establishment of an underground laboratory will be taken later, pending on the long-term strategy of the management of HLW.

3.2 Regulatory issues

The repository for institutional wastes in Püspökszilágy has a limited operational licence, till the end of 2002. The authorities require that a safety assessment should be prepared based on up-to-date methods and considering the present international requirements. Hungary is assisted in this undertaking by a PHARE project.

The regulatory evaluation of the safety assessment of the Püspökszilágy repository and the licensing process of the new LILW repository will be a great challenge to the licensing authorities.

3.3 R&D programme

LILW treatment

Boric acid recovering and cleaning from the NPP’s liquid waste /evaporation concentrate/ as well as Cs concentration on cartridges is being developed on contractual basis with the IVO International Ltd. The possibility of application of other volume reducing technologies /incineration, supercompacting/ has also been studied.

LILW disposal

Most R&D being performed in Hungary on LILW disposal is directed at identification of a suitable site for either a near surface or a mined cavity type repository, including site investigations, laboratory analysis of borehole samples, determination of soil characteristics /sorption, water permeability, isotope migration rates etc./ and performance assessment.

Other important fields of R&D include waste characterisation, waste acceptance criteria, QA/QC program and facility design.

HLW

Based on preliminary assessments the use of Permian Boda Claystone Formation in the Mecsek Mountain area is considered suitable for high level waste disposal. To evaluate the suitability of this formation as a location for a waste repository, systematic investigations were carried out with the assistance of the Canadian AECL (see 3.1.3).

Back end of the fuel cycle

Hungary will launch a long term research project comprising the major aspects of the back end of the fuel cycle in order to be prepared for a decision on the closure of the fuel cycle, by reprocessing (eventually supported by transmutation or other methods) or by direct disposal.

ITALY

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

In Italy the use of nuclear fission for energy supply started in the early sixties.

Three nuclear power plants, 160 MWe GCR at Latina, 270 MWe PWR at TRINO and 160 MWe BWR at Garigliano, were in operation since the year 1964. In the year 1981, a fourth unit, 882 Mwe BWR at Caorso started its commercial operation.

In the same period, fuel cycle activities were developed by CNEN (the Nuclear Energy Research Agency), now ENEA (the National Agency for the New Technology, the Energy and the Environment), in industrial and/or experimental-pilot scale, such as uranium fuel fabrication; plutonium fuel fabrication and fuel reprocessing.

After the Chernobyl accident, a general public debate took place in Italy on the implications of the use of nuclear energy.

As a consequence of a referendum in November 1987, the new National Energy Plan called for the abandonment of nuclear power, and the decision was made to close the Latina, Trino and Caorso power plants (Garigliano was already shut down since 1978 and in decommissioning since 1985).

At the same time, according to a reduction of the interministerial Committee for the Economical Planning (CIPE), the National Electricity Company ENEL, that is the National Utility, was charged with starting the actions for the decommissioning of all its own nuclear power stations.

In 1999, all the ENEL’s liabilities and assets connected to nuclear power have been assigned to a newly established company, named SOGIN (Società Gestione Impianti Nucleari). The mission of SOGIN cover:

- The decommissioning of the NPPs in Italy;
- The management of the back end of the fuel cycle;
- The valorization of the assets such as sites, components and resources;
- Providing engineering and consultancy services in the nuclear field within the domestic and the international market.

Strategic guidelines for the management of the past national nuclear activities and in particular for the radioactive waste management and decommissioning of the nuclear installations, are provided in a recent (1999) document issued by the Ministry of Industry, now Ministry for Productive Activities.

Italy signed the Joint Convention on the Safety of the spent fuel management and on the safety of the radioactive waste management" on 1997 and ratification is in progress.

1.1.2 Institutional framework

In the framework of the Radioactive Waste management in Italy, the competent national bodies are the following:

Ministry for Productive Activities

The Ministry for Productive Activities (formerly of Industry) is the authority that issues the operating licence for all nuclear and radioactive installations, after the positive technical advice of ANPA. For installations related to radioactive waste storage and disposal, the concerted agreement of the Ministries of Environment, Internal Affairs, Welfare, and Health is also required.

ANPA (National Agency for Environmental Protection)

ANPA is responsible for the regulation and supervision (by inspection) of nuclear installations in matters of nuclear safety and radiation protection. Any licence granted by the Ministry for Productive Activities incorporate the corresponding preceptive and legally binding report of ANPA. It is a body governed by public law with administrative and financial autonomy, under the supervision of the Ministry of the Environment.

Technical Commission for Nuclear Safety and Health Protection from Ionizing Radiations

This Commission is composed of experts from ENEA, ANPA, and from various Ministries, and gives technical advice concerning the granting of licences for nuclear installations.

1.2 Regulatory framework

1.2.1 Regulatory function

Authorization is formally granted by the Ministry for Productive Activities based on ANPA technical judgements and prescriptions. Figure 1 shows the licensing process for all nuclear and radioactive waste management activities, including decommissioning.

The main tasks of ANPA to fulfil the obligations of the Legislative Decree no. 241/2000 are:

- controls and inspections on existing nuclear installations,
- licensing on new nuclear installations,
- controls and inspections on possession, commerce, transportation, utilisation, dismission of radioactive material,
- controls and inspections on radioactive waste management,
- radioprotection of workers, public, environment,
- nuclear emergency preparedness,

- fulfilment of International Agreements on control and surveillance of nuclear materials (e.g.: Safeguards regime, Additional Protocol),
- promotion of international co-operation in the field of nuclear safety and radiation protection,
- promotion of actions aimed at maintaining and improving the national know-how and the national safety culture in the field of nuclear safety and radiation protection.

In addition to these duties, ANPA has also to:

- support the State Administrations to issue specific decrees for the implementation of the fundamental nuclear laws, specific technical guides,
- realize a National Database on all nuclear applications.

ANPA responsibilities for the licensing process of nuclear installations include:

- assessment of the safety analysis carried out by the operating organisation
- inspection of equipment and materials during the design, construction and operational phases for the systematic verification of facility operation safety
- enforcement action to remedy any failure to meet both the licensing conditions and any safety operation criteria

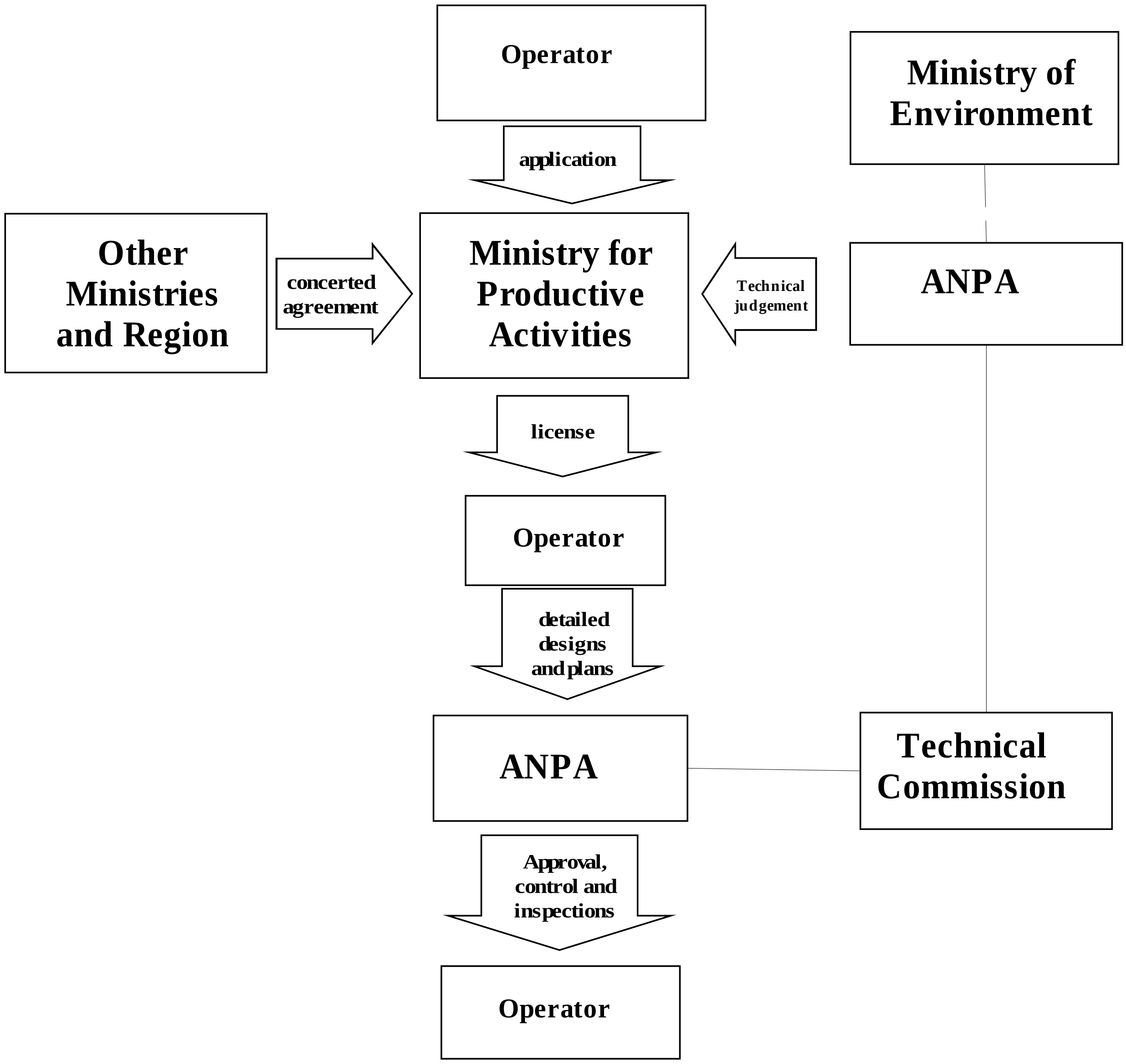


Figure 1 - Licensing process for radioactive waste management activities, including decommissioning

1.2.2 Organisation and resources

Within ANPA, while the overall responsibility rests to the Chairman and to the General Director, the duties of Regulatory Body are carried out by the Department of Nuclear and Radiological Risk.

At present, about 70 specialists (of which 26 acting also as inspectors) belong to the Department, which is subdivided in the following Sectors:

- co-ordination of inspection and regulations
- co-ordination of nuclear emergency
- integrated analysis

- nuclear technologies
- decommissioning and radioactive waste
- nuclear assistance in the Phare-Tacis area
- radiation protection and ionising radiation sources
- radioactive transportation and fissile materials.

2. LEGISLATION AND REGULATION

2.1 General legislation and regulation

The main corpus making up, inter alia, the Italian system are itemised below, as regards Statutes and Legislative acts:

Law no. 1860 of 31 December 1962 published in the Italian Republic’s Official Journal no. 27 of 30 January 1963, as amended by the President's Decree no. 1704 of 30 December 1965 (Italian Republic’s Official Journal no. 112 of 9 May 1966) and by the President's Decree no. 519 of 10 May 1975 (Italian Republic’s Official Journal no. 294 of 6 November 1975).

Legislative Decree no. 230 of 17 March 1995 published in the Supplement to Italian Republic’s Official Journal no. 136 of 13 June 1995, implementing six EURATOM Directives on radiation protection (EURATOM 80/836, 84/467, 84/466, 89/618, 90/641 and 92/3). The Decree replaced the previous DPR n°185 issued in 1964 and establishes radiation protection requirements for workers, public and environment.

Legislative Decree no. 241 of 26th May 2000 has transposed EU (European Union) directive 96/29/Euratom laying down basic safety standards for the radiation protection of workers and the public; the standards laid down in the directive incorporate the 1990 Recommendations of the International Commission on Radiation Protection (ICRP) into EU radiation protection legislation. Decree no. 241 has modified and integrated Legislative Decree no. 230 of 1995.

Besides, Legislative Decree no. 257 of 9th May 2001 was promulgated in order to modify certain details in Legislative Decree no. 241 of 2000 concerning requirements for notification and authorisation of non nuclear installations where ionising radiation is used for industrial, research and medical purposes.

Legislative Decree no. 230 of 1995, as modified by Legislative Decrees no. 241 of 2000 and no. 257 of 2001, now contains thirteen Technical Annexes which make almost all of the provisions applicable as of 1st January 2001, although some ministerial decrees enacting some of the provisions of the Legislative Decree have still to be published.

2.2 Guidance

The reference document concerning the Italian radioactive waste management is the Technical Guide n° 26, issued by ANPA, which provides waste classification as well as the technical requirements for the waste forms and the waste packages.

Other relevant guidelines are provided with the Technical Guide n. °8 "Quality Assurance Criteria", and with the "Qualification and Control Programme for the Conditioning of the IInd Category waste" (Technical Position n.1/26), where it is stated that the operator must submit to the regulatory authority a complete documentation concerning:

- Quality Assurance Programme
- Adopted criteria for the waste conditioning facility design, operation and control
- Results of product characterization.

3. CURRENT STATUS

3.1 National Status and Issues

3.1.1 Waste classification and sources

As established by the Technical Guide n° 26, according to the radioisotopes characteristics and concentrations and having as principal reference possible options for final disposal, radioactive waste are classified into three Categories:

Category I: Waste which decay in a few months to radioactivity level below safety concerns (mainly hospital and research waste with T1/2<1 year). *(disposal performed according to general waste regulations)*

Category II: Waste which decay to radioactivity level of few hundreds of Bq/g within few centuries. Activity of several radionuclides shall not exceed given values. *(near surface disposal)*

Category III: Long lived waste not included in category I and II; high level waste from reprocessing of spent fuel and alpha bearing waste from the fuel cycle and R&D activities. *(deep geological disposal)*

For the IInd Category waste, the document lists conditioning requirements and specific acceptance criteria for shallow land disposal.

Within Category II, two subcategories are defined:

- solid waste whose activities concentration is below established limits, as listed in Tab.1, which can be disposed of without further conditioning process;
- waste with activity concentration above the established limits which need to be conditioned and must fulfil further requirements, as listed in Tabs.2 and 3, to be accepted for final disposal.

Tab. 1 - Limits under which a low-level waste can be disposed of without a conditioning process.

Radionuclides with $T_{1/2}$ > 5y	370 Bq/g	(10 nCi/g)
$^{137}Cs + ^{90}Sr$ 740 Bq/g	(20 nCi/g)	
Radionuclides with $T_{1/2} \leq$ 5y	18,5 kBq/g	(500 nCi/g)
^{60}Co 18,5 kBq/g	(500 nCi/g)	

Tab.2 - Technical requirements for the IInd Cat. conditioned waste.

Compressive strength	at least 5 MPa (UNI - Destructive tests for concrete)
Thermal cycling	after 30 thermal cycles (-40°C / + 40°C) compressive strength must be at least 5 MPa
Radiation resistance	after an absorbed dose of 108 rads compressive strength must be at least 5 MPa
Fire resistance	incombustible or self-extinguishing according to the ASTM D 635-81 test method
Leaching rate	measurement according to long term leaching test
Free liquids	measurement according to ANSI/ANS 55-1
Biodegradation resistance	compressive strength >5 MPa after biodegradation test ASTM G21 and G22
Immersion resistance	compressive strength >5 MPa after 90 days of water immersion
Radionuclide concentrations	not exceeding values of the Tab.3

Tab.3 - Radionuclide concentrations limits for the IInd Cat. Conditioned.waste.

Alpha emitters $T_{1/2} > 5y$	370 Bq/g
Beta/gamma emitters $T_{1/2} > 100$ y	370 Bq/g
Beta/gamma emitters $T_{1/2} > 100$ y in activated metals	3,7 kBq/g
Beta/gamma emitters $5 < T_{1/2} < 100$ y	37 kBq/g
$^{137}Cs + ^{90}Sr$	3,7 MBq/g
^{60}Co	37 MBq/g
^{3}H	1,85 MBq/g
^{241}Pu	13 kBq/g
^{242}Cm	74 kBq/g
Radionuclides $T_{1/2} < 5$ y	37 MBq/g

A general criterion is in force in Italy for unrestricted release from any installation subject to either notification or authorization requirements. Radioactive materials from such practices can be unconditionally released from regulatory control if the radionuclides concerned comply with conditions regarding both activity concentration and radioactive half-life:

- activity concentration ≤ 1 Bq/g, and
- half-life < 75 days.

Waste Inventory

The overall national inventory of the radioactive waste, spent sources and spent fuel presently stored in the 25 nuclear installations in Italy has been prepared by ANPA. The Data Base is able to present the data in terms of volumes, mass, activity and physical status.

A volume inventory of the Italian radioactive waste is: some 8.000 m^3 of VLLW, some 17.000 m^3 of LLW-SL, and 1000 m^3 of LLW-LL and HLW.

To this amount it should be added some 50.000 m^3 of LLW from decommissioning activities and some 6.000 m^3 of waste coming from Spent Fuel reprocessing at Sellafield (5.000 m^3 of M-LLW, 900 m^3 of ILW and 16 m^3 of HLW).

3.1.2 Waste Management Strategy

In Italy, there is not yet a LLW disposal facility and the radioactive waste from NPPs and from experimental fuel cycle facilities is still stored at their points of origin. Radioactive waste from medical, industry and research activities is collected for temporary storage by private operators. Most of this waste is stored as produced, waiting for treatment and/or conditioning.

3.1.3 Current Issues and Problems

On August 2000 a Ministerial Decree 4/8/2000 from Ministry of Industry, on the basis of ANPA technical judgement, authorized SOGIN, the Organization owner and responsible for the decommissioning of the 4 NPPs formerly owned by ENEL (the electric company of Italy), to carry out the following activities in the framework of the decommissioning plan for the Caorso NPP:

- Transfer of the spent fuel into dual purpose metal casks
- Conditioning of all the operational radioactive waste
- Dismantling activities on turbine building, RHR tower and off-gas system
- Decontamination of the primary circuit.

Furthermore, the Decree provided the clearance levels for the release from regulatory control of the material produced during the activities above.

Since 1996 ENEA is undertaking a Task Force for the investigation of the appropriate strategies and technologies to be adopted for the radioactive waste disposal. An Engineered Near Surface LLW Disposal Facility is considered by ENEA and they are currently involved in site selection criteria definition in order to start with a screening in the Italian territory.

The general safety objectives and criteria of a pre-conceptual design of the LLW repository, prepared by the ENEA Task Force, is currently under evaluation by ANPA.

On the institutional side, an Expert Group was set up on January 2000 by the relevant Ministries and Regional Authorities with the main objective to identify and propose a procedure for the site selection with the required level of consensus from the public and local authorities. The Group presented preliminary conclusions on September 2001 and a decision by the Government on how to proceed is now expected.

Among the current activities carried out by ENEA it is worth mentioning:

- detailed design activity for the vitrification plant to be built at the EUREX pilot reprocessing plant;

- design for a dry storage facility (metal cask) for the Elk River spent fuel stored at ITREC pilot reprocessing plant;
- activities directed to develop a conceptual design for a Centralized site where to allocate a near surface disposal for LLW and a long term storage facility for HLW and Spent Fuel.

3.2 Regulatory Issues

3.2.1 Current Issues and Problems

Among the issues currently under discussion or in the licensing phase in ANPA it is worthwhile mentioning:

1. Evaluation of the comprehensive decommissioning plan for the Garigliano, Caorso and Trino NPPs.
2. The project of a storage facility for spent fuel dry storage in dual purpose casks at Caorso NPP.
3. The procedure for the release of solid material produced in dismantling the Caorso NPP.
4. General safety criteria for a LLW vitrification facility proposed for Caorso NPP.
5. A vitrification facility (CORA) of the liquid waste (112 m^3 of HLW and 109 m^3 of LLW) stored at EUREX, the ENEA pilot reprocessing plant at Saluggia.

3.2.2 Policy and Regulation Development

By the end of 1999, the Ministry of Industry, Commerce and Crafts, now named Ministry for Productive Activities, issued a document providing strategic guidelines for the management of liabilities resulting from past national nuclear activities.

Highlights of this new policy were:

- Treatment and conditioning of all radioactive waste stored on the sites.
- The start up of a concerted procedure, by means of a specific agreement between the Government and the Regions, for the selection of a superficial national site for the final disposal of low and intermediate level waste and for the interim storage of the spent fuel and the high level waste.
- The adoption of the strategy for a prompt decommissioning (“DECON”) of all national shut-down nuclear installations, thus abandoning the previous “SAFE STORAGE” option.
- The establishing of a new national company, SOGIN, assignee of all shutdown nuclear power plants, with a mandate to perform their prompt decommissioning.
- The creation of a National Agency for the Management and Disposal of Radioactive Waste, whose main mandate would be to realize and operate the national radwaste disposal site.
- The allocation of special funds for all these activities by means of a specific drawing from the electric energy bills.

According to these directives all the nuclear installations should be completely decommissioned by the year 2020.

The new policy was followed by a Ministerial Decree of January 26, 2001. The Decree establishes plans and procedures for funding the decommissioning of the nuclear facilities, NPPs and fuel cycle facilities, from dismantling to waste conditioning and disposal.

The strategy identified in the Decree of January 26, 2001, was further detailed by a Ministerial Decree of May 7, 2001, which provided operative directives to SOGIN for implementing a prompt decommissioning of the four national power stations up to an unconditional release of the respective sites within twenty years. Such a Decree provided also directives to SOGIN for the safe management of radioactive waste and spent fuel associated to the power stations together with funding provision with an additional fee on the consumed KWh.

On this basis, SOGIN has modified its decision on the decommissioning strategy to be implemented, moving from SAFE STORE to accelerated dismantling (DECON). This change implied that the applications for the decommissioning licenses had to be reviewed, and in particular that a large part of the submitted documents were no longer applicable. During the time needed to update the documents, the licensee asked for being authorised to perform at least some minor decommissioning activities, consistent with both the strategies. It must be underlined that the most important obstacle to the choice of the strategy came from the lack of a Low Level Waste repository solution: the viability of the new strategy was ensured by the commitment of the Government to take all the actions needed for speeding up the process of site selection. The envisaged date for repository availability is 2010.

In this new context a comprehensive plan for a prompt decommissioning was already presented (August 2001) by SOGIN to the former Ministry of Industry, now Ministry for Productive Activities for Garigliano and Caorso NPPs, and is currently under review by ANPA. As far as Trino station, SOGIN presented the plan at the end of 2001. For Latina, a gas cooled reactor, the preparation of a DECON plan was more difficult and the plan has been submitted in spring 2002.

Furthermore, the Ministerial Decrees of 2001 established that the decommissioning of the ENEA fuel cycle facilities can be funded by an additional fee on the consumed KWh if the activities are carried out by ENEA in Consortium with SOGIN.

This provision brought to the creation of a Consortium, called SICN, among ENEA and SOGIN.

A first action of the Consortium has been the review of the ENEA fuel cycle facilities decommissioning programmes.

3.3 R&D Programme

3.3.1 Functions

R&D activity in the field of the safety of the radioactive waste management it is carried out by ENEA and SOGIN. To monitor and, in some case, to take part in the development of safety oriented R&D, ANPA actively participates during periodical presentations of the results.

3.3.2 Content of R&D plans

Main areas are:

- Radioactive waste characterization

Development of measurement techniques and procedures for the radiological characterization of the radioactive waste packages as well as procedures for the preliminary radiological characterization of the nuclear installation before the dismantling activities.

- Disposal of low level waste

A special Task Force was appointed in 1996 to perform research activity for the development of a conceptual design of an engineered near surface LLW disposal facility, with a particular focus on the development of a methodology for the safety assessment.

- Partitioning and Transmutation

ENEA is involved in several international project such as: PARTNEW (partitioning of long lived radionuclides from HLW) and ADS (Accelerator Driven System). In particular, ANPA has actively co-operated with ENEA staff in evaluating the transmutation effectiveness.

With the reference to the research activity on transmutation, ENEA recently applied to ANPA for a preliminary authorization to carry out experimental activities on a TRIGA reactor.

JAPAN

1. NATIONAL AND REGULATION FRAMEWORK

1.1 National Framework

1.1.1 National Policy

In Japan, disposal of low-level radioactive waste originated from nuclear reactor operation has been implemented since 1992. Specified Radioactive Waste Final Disposal Act which defines procedure of site selection, executive body and fund accumulation of disposal of high-level radioactive originated from reprocessing of spent fuel (vitrified waste) passed through National Diet on 31 May, 2000. As for disposal of the other types of radioactive waste such as transuranic (TRU) waste and waste originated from uranium fabrication facilities (uranium waste) and so on, basic principles of safety regulation are not yet established.

The responsibility for treatment and disposal of radioactive waste originated from operations basically lies the operators themselves.

1.1.2 Institutional Framework

Japan Nuclear Fuel Ltd. (JNFL) disposes of low-level radioactive waste and stores high level radioactive waste. Nuclear Waste Management Organization of Japan (NUMO) was established and chartered under Specified Radioactive Waste Final Disposal Act on 1 October, 2000, to be an executive body for disposal of high-level radioactive waste.

1.2 Regulatory Framework

1.2.1 Regulatory Function

The key organizations for nuclear safety regulation are as follows (see Figure 1):

- Nuclear Safety Commission
  - Deciding basic principles related to nuclear safety regulation
  - Establishment of safety standards
  - Review of the safety examination result by regulatory body(so-called “double check”)
- Ministry of Economy, Trade and Industry(METI)
  - Regulation on use of nuclear materials for energy utilization
- Ministry of Education, Culture, Sports, Science and Technology(MEXT)
  - Regulation on scientific use of nuclear materials, use of radio-isotopes, radiation generating apparatus

- Ministry of Land, Infrastructure and Transport(MLIT)
  - Regulation on the maritime transportation of nuclear materials

The key organizations for radioactive waste regulation are as follows (see Fig.2):

- Nuclear Safety Commission
  - Investigation and examination concerning basic principle on regulation of radioactive waste management (Special Committee on Comprehensive Nuclear Safety)
  - Establishment of safety standards of radioactive waste management (Special Committee on Nuclear Safety Standards)
  - Review of the safety examination on radioactive waste management facilities by regulatory body
- The Subcommittee for Radioactive Waste Safety, Nuclear and Industrial Safety Subcommittee, Advisory Committee for Natural Resources and Energy, METI
  - Investigation on safety policy concerning radioactive waste disposal and storage
- Radioactive Waste Regulation Division, Nuclear and Industrial Safety Agency, METI
  - Establishment of regulative laws and provisions
  - Regulation on radioactive waste disposal facility and storage facility
  - Regulation on off site radioactive waste management
  - Regulation on decommissioning of nuclear facilities
- Nuclear Safety Division, Science and Technology Policy Bureau, MEXT
  - Regulation on management of radioactive waste originated from scientific use of nuclear materials and radio-isotopes
- Technology and Safety Division, Policy Bureau, MLIT
  - Regulation on the maritime transportation of radioactive waste

Figure 1. Government Organizations Related to Nuclear Safety Regulation

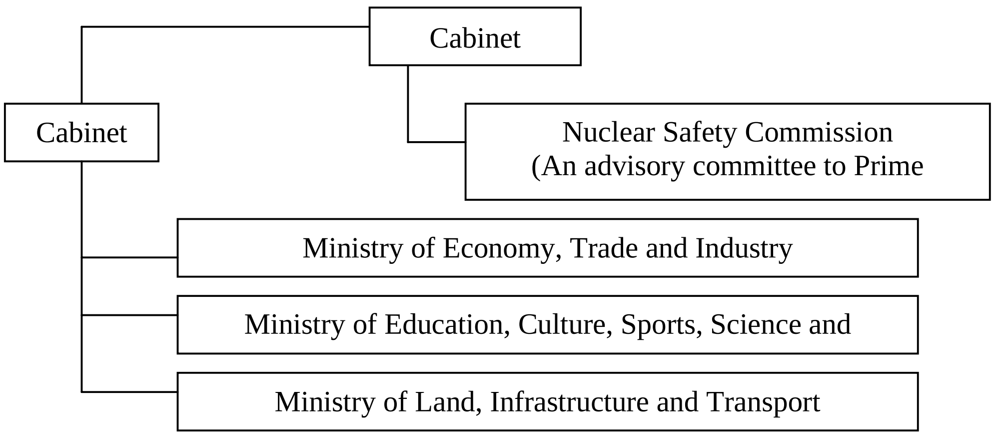
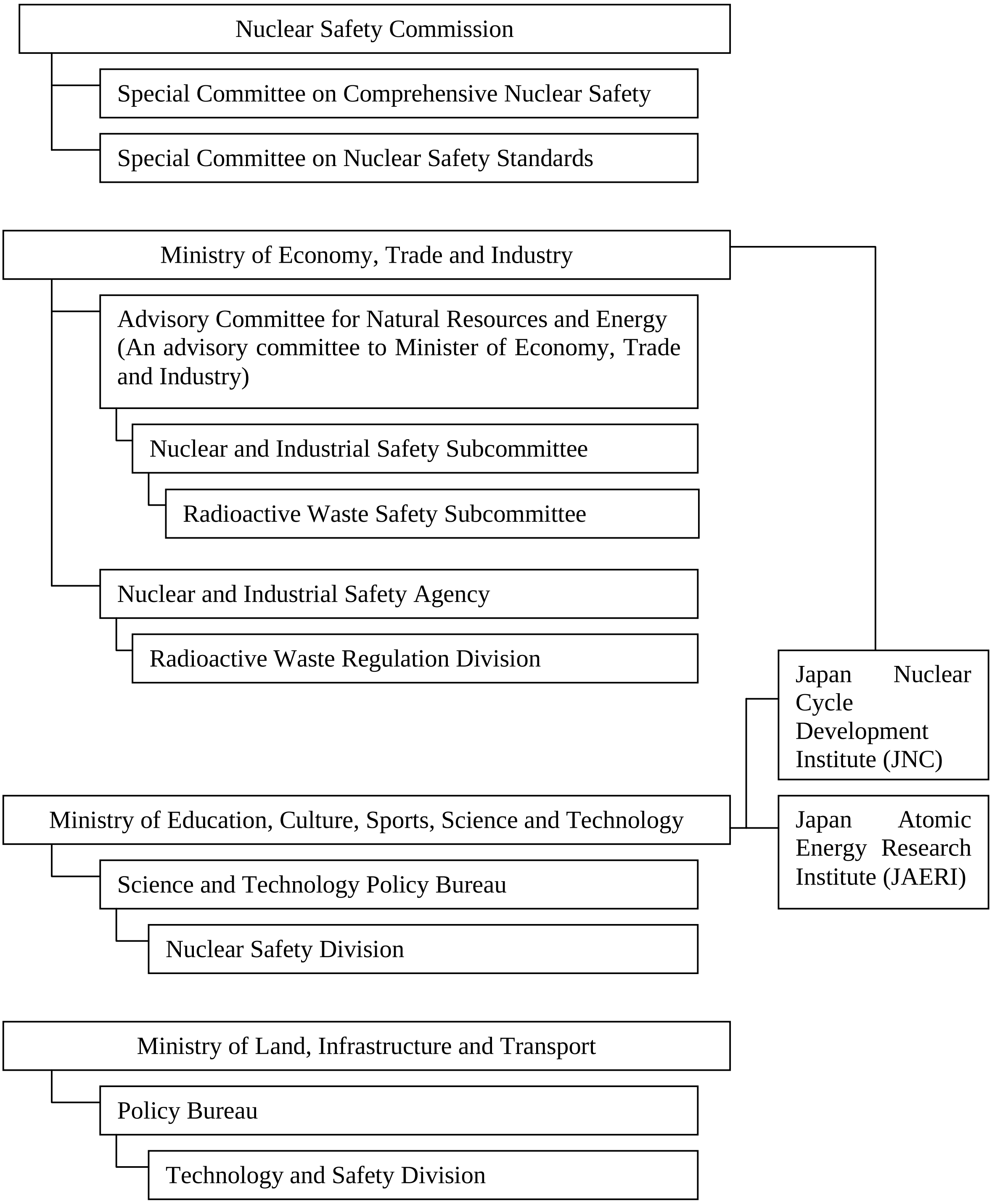


Figure 2. Government Organisations Related to Radioactive Waste Regulation



2. LEGISLATION AND REGULATION

The Framework for the regulation on nuclear activities is as follows:

- The Atomic Energy Basic Law (The Basic Law):

  Basic Policy (peaceful uses, safety assurance, democratic management, autonomous activities, publication of results)

- The Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (Regulation Law):

  Ensure the peaceful and safety uses for nuclear source materials, nuclear fuels and nuclear reactors

- The Law Concerning Prevention from Radiation Hazards due to Radio-isotopes, etc. (Prevention Law):

  Regulation on radio-isotopes and radiation generating apparatus

3. CURRENT STATUS

3.1 National Status and Issues

3.1.1 Waste Classification and Amount

The amounts of stored radioactive wastes are as follows:

Category of Wastes		Cumulative Amount of Wastes • as of Mar '01 •
High Level Radioactive Waste(vitrified waste)		•561 canisters (vitrified waste) • 432 m^3
Waste generated from nuclear reactors	Low Level Radioactive Waste Containing Comparatively high Radioactivity•core internal structure etc.•	• • control rod • 7 373 • • channel box etc. • 53 347
	Low Level Radioactive Waste	519 847 drums (200L) at nuclear power plants (130 851 drums (200L) were disposed at Rokkasho Disposal Facility)
	Very Low Level Radioactive Waste	1 670 t was disposed at JAERI's Tokai site
TRU Waste		• 78 724 drums(200L) • 2 614 m^3 } at JNC
Waste originated from Uranium fabrication facilities		35 336 drums(200L)
Waste originated from medical, industrial and research facilities		396 000drums(200L) *

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• * This number includes "TRU Waste" and JNC's "Waste originated from Uranium fabrication facilities".

3.2 Regulatory Issues

3.2.1 Current Issues/Problems

To establish the national safety standards, laws and provisions for disposal of radioactive waste as shown below:

- High Level Radioactive Waste.
- TRU waste.
- Radioactive waste from operation and decommissioning.
  Comparatively high radioactive concentration waste.
  (Ex. Reactor core internal structure etc.).
- Waste originated from medical, and research facilities.
- Clearance level.

3.2.2 Policy and Regulation Developments

Waste Categories		Atomic Energy Commission	Nuclear Safety Commission			Situation of establishment of regulatory law and provision
		Disposal Scheme	Basic concept of safety regulation	Restriction at repository etc.	Method of safety examination	
High Level Radioactive Waste(vitrified waste)		Studied (May '98)	Under study *1	To be studied		To be established
Waste originated from Nuclear Reactors	LLW Containing Comparatively high Radioactivity (core internal structure etc.)	Studied (Oct '98)	Studied (Sep '00)	Studied (Sep '00)	To be studied	Almost established (Dec '00)
	Low Level Waste (disposed in concrete pit)	Studied (Aug '84)	Studied (Oct '85)	Studied (Feb '87-Jun '92)	Studied (Mar '88-Jan '93)	Almost established (Mar '87-Feb '93)
	Very Low Level Waste (disposed in trench)			Studied (Jun '92-Sep '00)	Studied (Jan '93)	Almost established (Sep '92-Dec '00)
TRU waste		Studied (Apr '00)	Under study	To be studied		To be established
Waste generated from Uranium fabrication facilities		Studied (Dec '00)	To be studied			To be established
Waste generated from medical and research facilities		Studied (Jun '98)	Under study	To be studied		To be established
Clearance Level		Studied (Aug '84)	Studied (Mar '99-Jul '01) *2			To be established

*1 The first report was issued on 6 November 2000, to point out the basic concept of safety regulation of disposal of high-level radioactive waste.

The major points of the report are as follows:

a) Safety securing principles: As high-level nuclear waste contains long-lived radionuclides, safety system (i.e. site selection, engineering system) should be established from long-term viewpoint. Safety should be confirmed by safety assessment at the stage of license application, which is first stage in safety regulation.
b) Safety securing in disposal of high-level waste: Safety securing system should be applied in all stages of disposal project from license application, construction, operation, repository closure to project termination. Nuclear Safety Commission will participate in securing safety in all stages.
c) Geological Environment: Disposal site should be suitable for isolating the radioactive nuclides, maintaining the distance from human environment, and geologically stable from any activity of surface geology. Uplift, erosion, fault, volcano, and volcanic activities should be especially taken into account. Deposit of mineral resources should be avoided from economical viewpoint.
d) Safety regulation of disposal of high-level waste: At license application, an implement entity should deign repository with appropriate engineering system and the government should confirm the repository reliability by safety assessment. At the construction and operation stage as well as repository closure, safety should be confirmed to secure the result of safety assessment. The Commission will establish guidelines and technological standards for safety examination and safety confirmation in every stage.
e) Consideration in future: Guideline and standard should be established in the concrete with consideration of site selection progress. Safety policy should be revised with progress of science and technology in safety study. Information disclosure is important to acquire public acceptance.

*2 Clearance levels for materials arising from reactors and basic concept of certification procedure for clearance at reactors were proposed.

NORWAY

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

It is necessary to obtain licence from the Government to build, own and operate a nuclear facility, including facilities for treatment and disposal of radioactive waste. The Norwegian Radiation Protection Authority (NRPA) gives advise to the Government regarding applications for licence. A combined storage and repository facility for ILW and LLW is in operation and all LILW from research reactors and from research, industry and medical applications will be deposited at this site.

No decision has yet been taken regarding the spent fuel from the research reactors, but an expert committee has recommended that it be stored for at least 50 years at an intermediate storage facility before final deposition.

Norway has signed and ratified the Joint convention on the safety of spent fuel management and on safety of radioactive waste.

1.1.2 Institutional framework

The Institute for Energy Technology (IFE) is responsible for handling, treating and storing of all Norwegian radioactive waste. They have a conditioning plant at the Kjeller facility. They are also responsible for the operation of the combined disposal and storage facility for LILW in Himdalen, Aurskog - Høland. This facility started operation in March-99.

The Directorate of public Construction and property (Statsbygg) is the builder and owner of the Himdalen facility.

The Norwegian radiation Protection Authority, NRPA, is the national authority for radiation protection and nuclear safety and reports to the Ministry of Health.

The general public and other stakeholders participate during the licensing process and in the environmental impact statements through formal hearing procedures.

1.2 Regulatory framework

1.2.1 Regulatory function

The Norwegian Radiation Protection Authority (NRPA) is the regulatory body in Norway for both radiation protection and nuclear safety. NRPA is reporting to the Minister of Health (MH). MH is the licensing organisation for operation of nuclear facilities in Norway (the waste repository at Himdalen, research reactors at IFE etc.). NRPA handles any licensing applications and gives recommendations to the MH.

1.2.2 Organisation and resources

NRPA has 95 employees. NRPA is funded by the national budget mainly from MH, but also from other ministries.

2. LEGISLATION AND REGULATION

2.1 Legislation

- The Atomic Energy Act of 1972 regulates basic principles and objectives for safety of nuclear installation, including licensing procedures for construction and operation of nuclear facilities.
- The Act No 36 of 12. May 2000 on Radiation Protection and Utilisation of Radiation regulates the safety of radiation sources and their use, the protection of workers, the environment and the general population.
- Act No 77 of 14. June 1985 on planning and building regulates the environmental impact statements including public participation.

2.2 General regulation

- The Atomic Energy Act and the Act on Radiation Protection and Utilisation of Radiation are the two relevant laws.
- The licensing procedure is regulated in the Atomic Energy Act, and the EIS is regulated through the Planning and building act.

2.3 Specific regulations

- The repository for LILW at Himdalen: Construction license was granted to Statsbygg by Royal Decree.
- License was granted by Royal decree for the period 2000 to 2010 to IFE for operation of their nuclear facilities including the waste conditioning plant and waste storage at the IFE site.
- Safety reports are required for each nuclear facility.

2.4 Guidance

- NRPA has established specific guidelines and requirement for the facilities. An IAEA WATRP-review was used during the licensing process. International guidelines are used as references.
- The operator is obliged to have internal guidelines for operation, radiation protection, QA etc.

3. CURRENT STATUS

3.1 National status and issues

3.1.1 Waste classification and sources

Waste sources: The research reactors at IFE, industry, medicine, isotope production, smoke detectors and other consumer's products.

Classification of waste: a) ILLW (waste from reactor operation, from industry research and medicine) b) Spent nuclear fuel from research reactors.

3.1.2 Waste management strategy

All Norwegian LILW is handled, treated, conditioned and stored at the IFE, Kjeller site.

The waste packages (mainly 210 l drums) will be disposed of in the Himdalen facility (in operation since March-99 until 2030). The capacity at Himdalen is an equivalent of 10 000 drums. Approx. 100 -120 drums are generated each year. Some LILW waste (mainly historical waste) will be stored in the storage section of the Himdalen facility, waiting for a final decision, either to relocate it or to encasing it in concrete for final disposal. The decision will be taken at closure of the facility, year 2030.

No decision has yet been taken regarding the spent fuel from the research reactors, but an expert committee has recommended that it be stored for at least 50 years at an intermediate storage facility before final deposition.

3.2 Regulatory issues

3.2.1 Current issues/problems

- The final strategy for handling of the spent fuel from the research reactors is under discussion

SPAIN

1. NATIONAL AND REGULATORY FRAMEWORK

1.2 National framework

Spanish electricity output from nuclear energy is around 7 600 Mwe, accounting for about 30% of total electricity production. Spain has an almost complete nuclear fuel cycle including uranium mining, production of uranium concentrates, fabrication of nuclear fuel assemblies, generation of nuclear power and radioactive waste management. Fuel enrichment is performed overseas. There is no nuclear production for military purposes in Spain.

Spain has no reprocessing facilities. The fuel is presently stored at the nuclear power stations. However, in the early days of its nuclear power programme, Spain reprocessed its fuel in France and the UK. Low and Intermediate Level Waste (LILW) generated in nuclear and radioactive facilities, including waste arising from decommissioning, are disposed of in a near surface repository.

1.1.1 National policy

National policy for radioactive waste management is established in the General Radioactive General Plan (GRWP), drawn up by the Radioactive Waste Company (ENRESA) on a yearly basis which is submitted by the Ministry of Economy to the Government for approval, where appropriated, and subsequently presented to the Parliament. According to the legal provisions regarding the GRWP, the document shall include the necessary actions and technical solutions to be developed throughout the period of validity of the Plan and the economic and financial aspects, aimed to the proper management of radioactive wastes. The 5th edition of the GRWP approved in 1999 is presently in force.

The licensing and control of the safety of radioactive waste management (RWM) activities are carried out in Spain within the same regulatory framework as the rest of the nuclear and radioactive activities. No specific safety regulations exist for RWM, except those defining responsibilities for the implementation and regulation of the financial aspects of the RWM activities.

Spain is a member of the European Union since 1986, and as a consequence, European regulations are in force in Spain and the Council Directives must be transposed to the national regulations. On the other hand, Spain has ratified the Convention on the Environmental Impact Assessment in a Transboundary Context and the Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Nuclear Safety Convention, and other relevant Conventions.

1.1.2 Institutional framework

The following institutions have responsibilities for RWM in Spain:

- *The Government* which, as the executive political power, is empowered to direct and approve RWM policy and establish the objectives and goals of the Administration, issuing mandatory regulations

- *The Ministry of Economy* (MINECO) assumed in 2000 the responsibilities formerly attributed to the *Ministry of Industry and Energy* (MINER) in the area of nuclear activities, being responsible, via the Directorate General for Energy and Mines, for rule making, for granting the licenses, and enforcing actions. Concerning the RWM, the MINECO is also responsible for controlling the technical and economic actions and plans.

- *The Ministry of Environment* is responsible for issuing the Environmental Impact Declaration of certain public and private industrial projects and activities specified in the Environmental regulations, including spent fuel and radioactive waste storage facilities outside the nuclear power plants and radioactive waste disposal facilities.

- *The Nuclear Safety Council* (Consejo de Seguridad Nuclear, CSN), created in 1980, is the regulatory body in charge of nuclear safety and radiation protection control. The CSN is required to issue mandatory and binding reports prior to any authorisation of nuclear and radioactive facilities by the MINECO, including those related to the licensing of radioactive waste installations.

- ENRESA, the *Spanish National Company for Radioactive Waste*, a state-owned company constituted in 1984 by Royal Decree, is in charge of radioactive waste management and decommissioning of nuclear facilities.

1.2 Regulatory framework

Nuclear and fuel cycle facilities need authorisation for siting, construction, start-up, operation, modification and decommissioning. Small radioactive facilities only require starting up, modification and decommissioning authorisations. Radioactive waste repositories and temporary storage are considered as nuclear facilities.

Site and dismantling authorisations of nuclear facilities also require a formal Environmental Impact Declaration. A public inquiry must be carried out prior to granting a siting authorisation.

1.2.1 Regulatory function

The CSN, created by Law 15/1980, as the sole institution responsible for nuclear safety and radiological protection, is an independent public institution that reports on its activities directly to the Parliament yearly, via the Parliamentary Commission for Industry, Energy and Tourism.

The CSN main functions are:

- To propose regulations and advise the Government on subjects of its competence, including the criteria for siting nuclear facilities once the autonomous regions have been informed.

- To carry out assessment and issue mandatory and binding report prior the authorisations for siting, construction, start-up, operation, modification and closure of nuclear installations and for the transportation of radioactive material.

- To inspect and control the different stages of the lifetime of the nuclear and radioactive installations.
- To control and monitor environmental radiation levels in and around the facilities.
- To approve Radiological Protection services and Personal Dosimetry services, assess Medical Services and control radiation doses to professional workers.
- To issue and review the personal licenses for operators of nuclear and radioactive facilities.
- To report to both Houses of Parliament, give advice to other public institutions, like municipalities, regional governments and Courts of Justice, and inform the public and the media.
- To establish and promote research and development plans on safety and radiological protection.
- To collaborate in the drawing up of emergency plans and to provide technical support.
- To carry out official relations with similar institutions and International Organisations.

In 1999, a specific mission was assigned to the CSN by Law 14/1999, *"to perform studies, reviews and inspections relative to the plans, programmes and projects developed during all the phases of radioactive waste management"*. This new responsibility defines more clearly the role of the CSN during the pre-licensing phases of interim spent fuel storage and disposal of radioactive waste.

The owner, ENRESA in case of a RWM facility, is responsible for its own facility safety and it is obliged to submit an application to the Ministry of Economy (MINECO) for each authorisation required in the legislation. The application must be supported by a number of licensing documents, including a Safety Assessment Report. Before answering the applicant, the MINECO needs the opinion of the CSN.

The CSN reviews the Safety Assessment Report and other licensing documents, and issues its report about the nuclear safety and radiation protection aspects. The CSN opinion is binding when it is negative or when it establishes safety limits and conditions, in case of positive judgement.

Finally, the MINECO grants the authorisation under the limits and conditions imposed by the CSN. Once the license has been granted, the CSN controls the compliance of the limits and conditions by performing audits, inspections, periodic reports, and independent assessments.

Prior to the site authorisation, the owner of a nuclear facility is obliged to perform an environment impact assessment and submit it to the Ministry of Environment. The Ministry of Environment and the MINECO conduct a public enquiry, according to the procedure set up in the environmental and the nuclear regulations. Then, the Ministry of Environment, taking into account the results of the public enquiry, elaborates jointly with the CSN the Environmental Impact Declaration, which is enclosed to the authorisation

1.2.2 Organisation and resources

The CSN has its own technical staff and its own equity and budget, independent from those of the Government and the rest of the Administration. Until the beginning of 2000 financial year, the organisation was entirely self-financed through the revenues coming from the fees applied by services rendered. New functions attributed by law in 1999 for the radiological surveillance of the environment in the whole territory does not attract any fee, being financed by funds charged to the General State Budget. The staff of CSN consists of about 400 employees (200 technical expert plus 200-administration personnel).

The CSN´s basic structure, as modified on 7th April 2000, establishes a Technical Direction on Nuclear Safety (TDNS) and a Technical Direction of Radiation Protection (TDRP). According to this new structure, the CSN´s spent fuel and radioactive waste management activities are divided between these two technical directions. The Deputy Direction of Nuclear Technology, under the TDNS, includes a High Level Waste Department, which is in charge of the activities related to the storage and disposal of spent fuel and high level waste. The Deputy Direction of Environmental Radiation Protection, under the TDRP, co-ordinates a Dismantling Department and a Low Level Waste Department.

ENRESA is a public company, responsible for waste management, nuclear facilities decommissioning and related research. Management of waste arising from nuclear power plants (NPPs) is financed by a fee of the total electricity consumption, and management of waste coming from small radioactive facilities is financed by a tariff approved by the MINECO.

2. LEGISLATION AND REGULATION

2.1 Legislation

Spanish basic nuclear legislation is composed of a number of national acts and international conventions ratified by the Parliament. The following acts are directly applicable to the RWM:

- *Nuclear Energy Law (L 25/1964)*

  The basic Law L 25/1964, regulating the use of the nuclear energy and radioactive substances, established the responsibilities and the regulatory framework for the licensing of nuclear and radioactive installations, defined measures for the safety and protection against ionising radiation, and contained provisions for civil liability derived from nuclear damage and penalties and administrative sanctions. This Law stipulated that nuclear and radioactive installations should have special facilities for handle, storage and transport of radioactive waste. The Nuclear Energy Act has been modified and developed by other Laws, Royal Decrees, and Ministerial Orders.

- *Creation of CSN Law (L 15/1980 of 22nd April)*

  This Law created the CSN as the sole competent Authority for nuclear safety and radiation protection, independent from the Government and from the rest of the Administration, and established its collegiate composition, defining its functions, actuation and financing procedures, and creating the Technical Body for Nuclear Safety and Radiological Protection.

- *National Electric System Law (L 54/1997)*

  This Law regulates the operation of the electricity, and applies also to certain areas of the nuclear industry, since its additional provisions modify the Nuclear Energy Act and the

Law creating the CSN. It updates the enforcement framework, introducing a new definition of radioactive waste and an additional provision regarding the financing system of the radioactive waste management.

- *Law on Public Fees and Prices for services rendered by the CSN (L 14/1999)*

  The objective of this Law is to update the financial regime of the CSN, initially established by Law 15/1980, adapting it to the reality in order to cover a series of new functions undertaken by the CSN that were not previously specified. Through this Law, the dismantling of nuclear and radioactive installations are detailed for tax purposes, and the performance of studies and drawing up of reports relating to the management of spent fuel and high level radioactive waste are also contemplated. According to this law, the CSN may issue instructions itself.

- *Environment Impact Assessment Royal Legislative Decrees (RDL 1306/1986 of 26th June 1986 and RDL 9/2000 of 7th October 2000))*

  These RLD´s, with character of national basic legislation, incorporate the EU Directives 85/337/CEE and 97/11/CE respectively, setting up that any industrial project, which may have impact on the environment, need an Environment Impact Declaration. Projects specified in the Annexes include those related to NPPs, spent fuel treatment and storage facilities outside the NPP´s sites and radioactive waste disposal.

Other aspects of the RWM activities and facilities like civil liabilities, industrial risk prevention, non-radiological hazards, and mining safety, are regulated by specific regulations, outside of nuclear regulatory system.

2.2 General regulations

Most important national regulations applicable to the RWM are:

- *Regulation of nuclear and radioactive facilities (Royal Decree 1936/1999)*

  RD 1936/1999 replaces the previous Regulation approved by Royal decree 2869/1972, introducing important modifications of the licensing procedure for all stages of the different nuclear and radioactive facilities. The Decree contemplates the following authorisations for nuclear installations: preliminary or site authorisation, construction permit, operating permit, authorisation for modifications to the installation, authorisation for decommissioning and dismantling, authorisation for the change of ownership. These regulations have been revised in December 1999 to update a former version (D *2869/1972*) to make it compatible with the EU Directive 96/29/EURATOM.

- *Regulation on protection against radiation protection (Royal Decree 738/2001)*

  This regulation, which replaces the one issued in 1992, establishes the radiation protection system based on the ICRP recommendations and constitutes the transposition of the EU Directive 96/29/ EURATOM. It introduces the concept of practice, maintains the principles of justification, optimisation and dose limitation for such practices, and goes on to establish the fundamental principles governing the operational protection of exposed workers, and recognises clearance and exclusion concepts.

- *Regulation on Environmental Impact Assessment (Royal Decree 1131/1988)*

  RD 1131/1988 defines the content and procedure to perform the Environmental Impact Assessment of relevant industrial projects, including radioactive waste management facilities.

- *Transport regulations*

  Safety aspects of transport of radioactive waste are covered by various Royal Decrees and regulations (road, railways, maritime, and aerial) developing the Nuclear Energy Act, and implementing the IAEA and the EU radioactive material transport regulations.

2.3 Specific regulations

Specific regulations are mainly focused on setting up a national system to manage the radioactive waste or to solve specific issues related to authorisation of particular facilities or activities.

- *Royal Decree of ENRESA's constitution (RD 1522/1984), as amended*

  ENRESA was established by this Royal Decree which defines its objectives and responsibilities. Royal Decree 404/1999, enacting the Law 40/1999 governing the National Electricity System, reaffirms the responsibility of the Government for approving the PGRR, updates the financing system for the RWM and dismantling of nuclear installations and assigns its control to the MINER, currently assumed by the MINECO.

- *Royal Decree on the restructuring the fuel cycle activities (RD 1899/1984)*

  RD 1899/1984 provides a frame for the development of ENRESA's work programme and financing provisions for RWM.

2.4 Guidance

CSN has published a series of about 40 Safety Guides giving recommendations on how facility owners can meet legal obligations and demonstrate compliance with the Spanish legislation. Safety Guidelines are not legal requirements, and cover such topics as:

- *Operation of Nuclear Power Plants*
- *Radiological Environmental Monitoring*
- *Radiological Protection Standards*
- *Radioactive Waste Management*
- *Transport of Radioactive Materials*
- *Control and Monitoring of Liquid and Gaseous Effluents Emitted from Nuclear Centres*

This activity is complemented with the participation in the IAEA RADWASS programme. In some cases, after a careful study, certain RADWASS documents could be endorsed as a Spanish Safety Guide.

2.5 Others

Other specific regulations have been issued regarding particular activities in Spain. Most important of them are the following:

- Royal Decree prohibiting the use of radioactive lightning rods and regulating its transference to ENRESA for its management.

- CSN´s Resolution setting up the general safety criteria for geological disposal radioactive waste in Spain.

- L&ILW facility "El Cabril" Construction Permit. MINER Order (1989).

- L&ILW facility "El Cabril" Operation Permit. MINER Orders (1992 and 1996).

- Andujar Uranium Fabrication Plant dismantling and site restoration authorisation. MINER Order (1991).

- La Haba Uranium Fabrication Plant in situ dismantling and site restoration authorisation. MINER Order (1995).

- Vandellos I NPP Dismantling and License ownership transfer permit. MINER Order (1998).

These Ministerial Orders impose the safety and radiological protection limits and conditions for the corresponding authorisation, complementing the existing nuclear regulation with provisions on RWM specific aspects (such as those regarding to the waste acceptance criteria in the case of the El Cabril LLW disposal facility)

3. CURRENT STATUS

3.1 National status and issues

3.1.1 Waste classification and sources

No waste classification system has been formally adopted in Spain. However, RWM implementation is being carried out according to factual classification, based on the following waste groups:

A. Residual material containing very low concentration of short lived radionuclides.

B. Tailing from uranium production facilities containing very low concentration of long lived radionuclides.

C. Radioactive waste containing low or moderate concentration of short lived radionuclides and negligible concentration of alpha emitters (L&ILW), to be disposed of in the El Cabril disposal facility.

D. Radioactive waste containing generally high concentration of all kind of radionuclides. There are two groups in this category: HLW vitrified waste arising from reprocessing in France of Vandellos I NPP spent fuel, and LWR spent fuel accounting a total expected of about 7 000 tU. In addition, other waste not acceptable in the El Cabril facility would be included in this category.

3.1.2 Waste management strategy

The 5th GRWP sets out a management system for radioactive wastes that includes the following main technical activities and phases:

The mainlines of the RWM in Spain are:

- Residual material may be cleared after demonstration that the radiological risk is trivial.

- Tailings from uranium production are disposed of in land burial shapes in situ.

- L&ILW are disposed of in El Cabril facility. Predisposal activities are carried out in nuclear facilities or in El Cabril, in case of small producers.

- The strategy for storage of spent fuel considers an at reactor phase, using both wet and dry methods. At present, re-racking has been competed in the pools of all NPP´s and a temporary dry storage facility for the Trillo NPP spent fuel has been built due to lack of capacity in its pool. A centralised away-from-reactor solution is foreseen to be implement before 2010 for the medium and long term. This solution might be complemented with the construction of individual temporary storage facilities at certain NPPs, or with another centralised facility serving various plants.

- The strategy adopted to date for the definitive management of spent fuel and HLW has been based exclusively on ensuring the availability of the scientific and technological know-how and capacity required for definitive disposal in deep geological formations. The present GRWP establishes the following highlights:

– No decision for a final solution will be taken before 2010. The geological studies for the siting process will be limited to maintain the existing information and to ensure its value, so that it can be of use in a further selection process when a decision is finally taken and for the safety assessments to be prepared.

– Additional work for the existing preliminary repository designs will be oriented to incorporate the criteria of retrievability.

– The Safety Assessment capabilities developed should be maintained in the future through exercises incorporating the experimental data and models of the research groups susceptible to standardisation at international level.

– In the meantime it will be necessary to carry out the widest possible campaigns, in order to facilitate better knowledge and understanding both of the problem to be solved and the technology to be used to achieve such solution.

– The feasibility and implications of new technologies, specifically partitioning and transmutation, should be also evaluated during this period of time.

3.1.3 Current issues/problems

No specific safety issues are identified in the management of L&ILW. However, the existing capacity of El Cabril facility is quite limited and important efforts are being taken to optimise it. This requires both technological and regulatory action to implement it.

In this way, several actions have been launched:

- To carry out a volume reduction programme performed jointly by ENRESA and producers.

- To implement a plan of action for managing residual material.

- To perform a new assessment of the El Cabril Facility safety based in a better knowledge of the plant and surroundings, using a more realistic methodology.

- To update the waste acceptance criteria in order to diversify the kind of containers accepted in El Cabril Facility.

Specific considerations are being taken for the characterisation of historic waste and waste arising from old facilities dismantling.

General problems for siting new storage or disposal facilities are being faced, mainly due to public opposition. According to the 5th GRWP, the activities related to the selection of specific sites for a deep geological repository are suspended until the definitive management methods and the corresponding regulatory process are established, and a better social acceptance can be reached.

The major objectives of the ENRESA´s Action Plan (2002-2010) for the definitive management of spent fuel and high level waste are the following:

- To make available by the end of the period the necessary documents reflecting the level of knowledge acquired, aiming at presenting recommendations to the Government for the decision making process.

- To integrate both, the acquired knowledge and capacities, aiming at orienting the strategic needs and definition of priorities for the activities to be developed in the future.

- To promote the dialogue with the different stakeholders to facilitate the proposed solutions.

3.2 Regulatory issues

During the last few years, the national regulatory system of RWM has been reconsidered. The necessity to develop a specific regulatory frame for RWM arises as a major conclusion of this analysis. In this sense two lines are being launched:

A first line will be oriented:

- To establish a clear frame for managing very low level waste, clarifying the definition of radioactive waste

- To adequate the general requirements of nuclear safety and radiation protection to the management of L&ILW

- To define a specific frame for the decommissioning of nuclear power plant.

A second line will be oriented to the development of regulatory framework for the management of spent fuel and HLW. In doing so, two previous considerations have been taken into account:

- An important effort must be paid to increase the CSN technical and scientific capabilities.

- Significant effort should be dedicated to the licensing of spent fuel and HLW temporary storage solutions.

- No regulatory decision will be needed in the next years in order to authorise facilities to dispose of HLW. Consequently, a close dialogue and collaboration between CSN and ENRESA should be very useful and do not compromise future actions.

Under these consideration a number of initiatives, initiated at the end of the 1990s according to the successive CNS´s Strategic Plans, are being carried out:

- The CSN is prospecting the international developments and assessing their potential application to the Spanish programme, and fostering participation in the development of the pertinent safety assessment methodologies for these facilities. Performing these activities must be coherent in time with the schedule and objectives laid down in the GRWP.

- A general co-operation agreement between CSN and ENRESA was signed (June, 2nd, 1998) in order to: encourage the exchange of information and experiences, facilitate the analysis and discussion of safety related issues, and promote R&D plans and projects of mutual interest. The possibilities for the implementation of common initiatives under such agreement are presently under study in both organisations.

- The CSN work program includes a number of specific projects oriented to obtain a wide view of the regulatory state of the art in order to the further review the safety assessment exercises of repository concepts that ENRESA is preparing in compliance with the 5th GRWP. Examples of these projects are the study of modelling techniques, intercomparison of safety analysis performed by regulators and implementers, study of techniques for aiding in the decision making process and study of safety indicators.

3.2.1 Current issues/problems

The main issue in the Spanish regulatory frame of RWM is the lack of a specific regulation. This lack is presently solved by a decision system based in a case by case solution spending a lot of efforts and resources. In particular, the following topics are very frequently on the table and represent and important workload for the regulatory authority:

- Clearance implementation.

- Modification of L&ILW management practices.

- Management of residues containing NORM.

Issues regarding the safety of extended periods of storage of spent fuel are beginning to be studied at the CSN in order to characterise the spent fuel and analyse the behaviour of the spent fuel and associated facility components during long-term storage, taking into account the management interdependencies.

Issues regarding the safety of geological disposal include:

- The adoption of a step-wise regulatory review process that does not compromise the independence of the CSN.

- The definition by the CSN of the degree of review of the performance assessments (PA) made by the proponents

- The need for an early development of guidance and criteria for the regulatory process.

- More specific technical issues are: treatment of uncertainties; confidence building, mainly relative to the modelling strategy; the question of completeness of scenarios; the handling of future biosphere and human intrusion; the impact of retrievability; and the use of complementary safety indicators. Some examples of the ongoing studies are the following:

– *Intercomparative analysis of the more significant integrated PA studies.* Initiated in 1997 in order to: a) obtain vision of the state-of-art; b) analyse the differences and similarities in the treatment of key issues of the different PAs; c) identify issues requiring further examination; d) identify future lines of work in this area. In the first phase of the study already finalised, fourteen PAs in crystalline rock have been examined. PAs in clay rock and other host rocks are being studied at present, in the second phase of the project.

– *Application of the concept of retrievability to geological disposal* in order to determine its implications on the regulatory and the safety evaluation aspects.

3.2.2 Policy and regulation developments

In the near future, a significant effort will be paid for developing new Safety Guides or endorsing IAEA Safety Guides from RADWASS Programme.

Related to spent fuel and HLW management, the effort will be paid to develop a national regulatory framework.

3.3 R&D programme

3.3.1 Functions

According to the L 15/1980, as amended by L 14/1999, the CSN must promote, supervise and finance research and development plans in areas related to nuclear safety and radiation protection. According to RD 1522/984, ENRESA is responsible for research and development in nuclear waste safety.

CSN and ENRESA issue periodically their own R&D plans. These plans include a number of projects which are undertaken in collaboration with different national and international organisations, among which special mention might be made of the Spanish universities, public centres and companies. Part of these R&D activities are implemented under the general co-operation agreement between CSN and ENRESA.

3.3.2 Contents of R&D plans

The current CSN’s Five Years Research Plan includes the following lines of work in the field of radioactive waste safety:

R&D activities for improving safety aspects of LILW are oriented to select a most specific methodology for assessing safety of near surface repositories and implement it to the El Cabril safety case, to study new immobilisation matrix, and to develop instrumentation applicable to de measurement of very low concentration of radionuclides.

R&D programme related to the safe management of HLW is focused on developing safety assessment and site evaluation methodologies and tools

- Research activities in the *area of site evaluation* aim at: 1) the development of methodologies for a better knowledge of siting impact on the safety of the facilities, mainly in the fields of hydrogeology and sismotectonics; 2) the improvement of siting characterisation techniques; and 3) the detailed mapping of background radiation in Spain. Examples of ongoing project include:

– *Hydrology of low permeability rocks*: the methodology for the characterisation of flow and transport process in fracture media designed and tested in a previous phase will be applied to the site of the El Berrocal uranium mine.

– *Reactive transport*: the main objective of this project is the development, adaptation and verification of numerical models for the study of reactive transport of radionuclides in he geosphere at different scales.

- Research activities in the *area of safety assessment* aim at: 1) assimilating the lessons learnt from previous national and international R&D programmes and projects, 2) increasing the CSN technical capability and 3) drawing some practical conclusions that may be suitable for the development of the Spanish regulatory framework in this field. Special mention should be made of the projects:

– *Modelling:* "An intercomparative analysis of the modelling approaches used in the safety assessment (SA) of deep geological repositories for HLW". Initiated in 1999 the project is aimed at: 1) providing the CSN with updated information on the status and practical capabilities of modelling strategies applied in SA and the approaches used for validation and confidence building.

– *Natural analogues*: "A study of the role of natural analogues (NAA) in the safety assessment (SA) of deep geological repositories for HLW and the communication to non-technical audiences". Launched in 1999, the first phase of the study, recently finished, includes the compilation of information for the most significant and best characterised NAA in a database with over 1,300 references, as well as a preliminary classification of the results obtained from each NAA regarding their potential applications to the SA of repository concepts contemplated in the Spanish programme.

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SWEDEN

In Sweden, radioactive waste management is regulated by two governmental authorities, the Swedish Nuclear Power Inspectorate (SKI) and the Swedish Radiation Protection Institute (SSI). Both authorities work under the Ministry of the Environment. The Swedish Nuclear Fuel and Waste Management Co (SKB), set up jointly by the utilities, constitutes the industrial counterpart.

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

The main principle in the legislation is that the responsibility for the safe handling and disposal of radioactive waste as well as for radiation protection rests with the reactor owners, whereas SSI and SKI are responsible for the supervision of radiation protection and safety, respectively.

There is wide spread consensus that Sweden as a nation should take care of own its own waste, and that Sweden should not host waste from other nations, especially not for final disposal. The fact that small quantities of MOX fuel is stored for final disposal in Sweden is a result of exchange settlements in connection with the termination of reprocessing contracts, and should not be seen as an exemption from this main principle.

Another main principle is that the present generation, which have used electricity from nuclear power, should take responsibility for the waste. To wait for possible but uncertain technical and economical break-through in new areas (such as transmutation) and not take appropriate action for a safe final solution is not seen as a responsible policy.

On the international arena, Sweden is committed e.g. to the Nuclear Safety Convention and the Joint Convention on the Safety of Radioactive Waste Management and the Safety of Spent Fuel Management. In its nuclear waste program, Sweden is also committed to a number of international conventions for environmental protection such as the London Convention against sea dumping, the Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR) and the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki convention). As a member of the European Union, Sweden is also committed to the articles in the EURATOM treaty.

1.1.2 Institutional framework

The nuclear power utilities have assigned their legal obligation to develop and implement final disposal measures to the jointly owned company, the Swedish Nuclear Fuel and Waste

Management Co (SKB). Consequently, in accordance with the principles specified above, SKB must pursue the research and development activities so that a solution to the waste management problem is not unnecessarily delayed. This is also a condition for continued operation of the Swedish nuclear power reactors.

For many years, the reactor owners have paid fees into a government-administered fund, the Nuclear Waste Fund, in order to cover the future expenses for the final disposal system. At year-end 1999, the Fund had a balance of about 23 Billion SEK.

SKI is the regulatory body for the safety of nuclear installations and is also responsible for the review of the R&D programme of SKB. SSI is responsible for regulations in the area of ionising radiation. The functions of SKI and SSI are further specified below. The Swedish National Council for Nuclear Waste (KASAM), an advisory committee to the government, performs independent review of the R&D program. KASAM also presents an assessment of current knowledge regarding nuclear waste to the government every third year.

1.2 Regulatory framework

1.2.1 Regulatory function

SKI is the competent governmental body as regards safety aspects on nuclear activities (including both technical and organisational aspects) under the Act on Nuclear Activities (1984:3) and in accordance with the Ordinance on Nuclear Activities (1984:14) and the governments Instruction to SKI. A license application according to the Act on Nuclear Activities will be reviewed by SKI. As part of this review SKI will ask SSI and other concerned organisations for comments. The SKI review results in recommendations to the following government decision.

The Act on Nuclear Activities also requires the nuclear power plant owners to perform the R&D work necessary for the waste generator to safely handle, store and dispose of spent fuel and nuclear waste. SKI is responsible for the review of the R&D programme. SKI shall present the views and recommendations to the government. The government decides if the R&D programme fulfils the requirements in law and may issue conditions on future work.

SKI is also responsible for the review of the cost calculations and development of funds for the establishment of future nuclear waste facilities. SKI shall provide the government with proposals for a fee on electric energy production to cover the future costs for handling and disposing of the spent fuel and the decommissioning of the nuclear power reactors as well as other nuclear waste facilities. SKI shall also review the securities proposed to cover unforeseen costs not covered by the fees. SKI shall also supervise the use of the funds.

SSI is the competent governmental authority in all areas of radiation protection, under the Radiation Protection Act (1988:220) and in accordance with the Radiation Protection Ordinance (1988:293) and Instruction (1988:295). This includes protection of man (workers as well as the general public) and the environment from adverse effects of both ionising and non-ionising radiation. The Ordinance on Nuclear Activities (1984:14) authorises SSI to licence near-surface repositories for low-level waste up to a total activity of 10 TBq, out of which 10 GBq alpha activity. For other repositories, SSI is authorised to issue special licensing conditions with regard to radiation protection.

Both SKI and SSI have international development co-operation undertaken by a special project management organisations, SIP and SIUS. The projects are mainly directed towards Eastern and Central Europe, on issues related to reactor safety and radioactive waste management.

1.2.2 Organisation and resources

SKI is organised in three main offices; Reactor Safety, Nuclear Materials (Safeguard) and Nuclear Waste Safety. SKI has about 115 employees. The Office of Nuclear Waste handles most of the issues related to spent fuel and nuclear waste. This includes inspections of waste management facilities, review of documentation on waste management, development of regulations, etc. The Office of Nuclear Waste is also engaged in developing competence in technical areas related to the nuclear waste programme and in building capability in safety assessment methodology.

In all, SSI has about 120 employees, all in the SSI headquarters in Stockholm. Out of these, about 35 are currently involved in matters connected to the nuclear fuel chain. The Department of Waste Management and Environmental Protection handles most of the radiation protection issues that are related to radioactive waste, either the waste is dischargeable or disposable, as well as radiation protection in connection to management of spent fuel. The Department has about 20 employees, and is divided into two programme areas, Environmental Assessment and Risk Reduction, respectively. Activities include issuing of regulations, licensing, inspection of the management of waste and discharges at the utilities, environmental monitoring, and international co-operation. The Department also performs, in its laboratories or during inspections, control measurements of waste packages intended for disposal in the repository for low- and intermediate level operational waste (SFR) or in near-surface disposal facilities. Similarly, control measurements are being performed on waste water, filters from the gaseous discharge monitoring systems in the stacks, goods and buildings intended for clearance, and environmental samples.

2. LEGISLATION AND REGULATION

2.1. Legislation

The general scope of four of the acts relevant to radiation protection and nuclear safety is indicated below. Amendments to the legislation, including the ordinances and instructions, are presently being pursued by the government. These amendments cover, *inter alia*, definitions and authorisations, partly as a consequence of implementation of the EU Basic Safety Standards.

The Act (1984:3; 1992:1536) on Nuclear Activities

The Act defines nuclear materials, nuclear waste, nuclear installations and nuclear activities, requiring licensing. This act assigns the full responsibility to the licensee for the safety of nuclear activities, including safe handling and final disposal of spent fuel and nuclear waste. Pursuing a timely and comprehensive research development and implementation program to achieve the final disposal goals is stated as a legal requirement for continued operation of the reactors. The act also establishes the legal authority of SKI as the regulatory body.

With respect to final disposal of spent nuclear fuel, the act requires periodic regulatory reviews to be performed every three years to ensure that the Swedish nuclear utilities, through their jointly owned implementer, the SKB company, pursue the required comprehensive research, development and implementation program in a timely and technically satisfactory manner to achieve the final disposal goals.

As regards the licensing process for nuclear facilities the following applies: The licensee applies for a license to the government. The application is sent to the SKI for review. SKI will in turn send the application to SSI, the local authorities and also to other organisations. If a license is given according to the Act on Nuclear Activities no license according to the Act on Radiation Protection has to be given, although SSI may define certain conditions for operation.

A stepwise licensing process has been outlined for the siting and construction of a repository for spent nuclear fuel. The licensing of a repository for spent fuel will be co-ordinated with the license application for an encapsulation facility. It is also important to note that all environmental aspects on the facilities also will be regulated according to new environmental legislation entering into force 1999 (Environmental Code, see below).

The Radiation Protection Act (1988:220, with amendments)

This act specifies general radiation protection requirements with regard to protection of workers, the public and the environment. All types of potentially harmful radiation are covered, ionising as well as non-ionising. The Act assigns the responsibility to the licensee to carry out its operations while maintaining adequate levels of radiation protection. *The Radiation Protection Ordinance (1988:293, with amendments)* and *Instruction (1988:295, with amendments)* establishes the legal authority of SSI as the regulatory body in radiation protection issues, as well as assigns to SSI the responsibility to maintain a national research competence in radiation protection, through financing research programmes carried out by universities and comparable institutions. Furthermore, SSI has in recent amendments being authorised to formulate guidelines for EIA in areas related to radiation protection.

The Act (1981:669) on Financing of Future Costs for Spent Fuel and Nuclear Waste

The Act requires the nuclear power plant owners to submit, each year, estimates of all future costs for management and final disposal of spent fuel and nuclear waste, including decommissioning, and their time distribution. This act furthermore requires the cost estimates to be reviewed by SKI as a basis for a government decision on a fee per produced nuclear kWh to be paid into interest-bearing funds managed by the government. Finally, the act establishes the procedures for reimbursing the utilities for costs incurred for waste management and disposal.

The Environmental Code (1998:808)

The Environmental Code co-ordinates a number of environmental laws, and certain provisions in the Code will also influence radiation protection and nuclear safety, e.g. as regards EIA, environmental quality norms, and general principles (e.g. sustainable development). Of particular importance are the requirements on EIA and consultations with affected parts of the public, especially those living close to a potential repository. According to the Code a municipality has veto right against e.g. a planned repository within its boarders (although a veto may in principle be overruled by the government under certain conditions).

The Code supports other environmental policy instruments, such as sectorial responsibility and verifiable environmental objectives.

2.2 General regulation

SKI Regulations

Earlier, separate licensing conditions were given for each nuclear facility. The view was that such regulatory approach was sufficient to regulate safety (together with the general requirements given in laws and ordinances) given the limited number of nuclear facilities in Sweden. A few years ago this view changed and it was decided to develop regulations that would allow more uniform licensing conditions to be given. SKI is therefore now in a phase when a number of regulations are being developed.

As an overall regulatory basis, SKI has general regulations for the entire filed of nuclear activities: The *SKI* Regulations *on safety requirements in certain nuclear facilities (SKIFS 1998:1)*. This regulation covers facilities of different types; reactors as well as waste management facilities. It does not, however, cover the long-term safety of a repository. The regulation includes a wide range of requirements e.g. documentation, procedures for safety review and reporting.

Main features of regulations for disposal

The *SKI Draft Regulations on the long-term safety of nuclear waste repositories* states that, in principle, the risk generated by a repository for spent fuel should be evaluated up to the time the repository activity content becomes comparable to a natural uranium ore, i.e. up to some hundred thousand years.

The risk evaluation should be done using state-of-the art performance assessment methods, recognising and discussing the increasing uncertainties with increasing time perspectives in the assessments. For the first thousand years dose calculations will be essential for assessing the repository performance. For long-term exposures (>10 000 y) comparison with the natural turnover of naturally occurring radionuclides can be a complementary criterion. Although such long-term calculations should be performed, it is understood that with increasing time perspectives, quantitative results, with associated uncertainties, should be regarded as safety indicators. Using such indicators, it is recognised that the final risk assessment will involve a substantial amount of qualitative judgements.

No subsystem criteria are given in regulations. However, when an application to construct a repository is presented to SKI, it must include specifications on sub-systems shown to be consistent with system behaviour assumed in the performance assessment.

Compliance requirements

Although little formal regulatory guidance on compliance requirements have been issued so far, it appears obvious that a strict comparison of calculation results with criteria is not meaningful. Calculation results, e.g. doses, with associated uncertainty estimates should be regarded as indicators of the level of safety and radiation protection achieved rather than dose predictions. Thus it appears that “reasonable assurance “ is the only justifiable approach.

Final disposal shall be implemented in such a way that the risk caused by the releases of radioactive substances from a repository will not be greater than the risk defined by SSI in SSI FS 1998:1.

To demonstrate compliance with SKI regulations the assessment of long term safety shall be based on a systematic approach to identify features, events and processes that could deteriorate the barrier functions of the repository. A scenario in the safety assessment report includes the description on how a given combination of different conditions (external and internal) influence the repository function. The scenarios shall be structured into a main scenario, less probable scenarios and residual scenarios.

Different types of uncertainty (scenario, system, model, parameter etc) shall be discussed and taken into consideration in the safety assessment report. The time period covered by the safety assessment shall correspond to the time period for which the repository represents a risk compared to naturally occurring radionuclides in the geological environment.

There are a number of other regulations relevant for nuclear waste management. For example, *SKI Regulations on mechanical constructions in nuclear facilities* (*SKIFS 1994:1)* regulates the requirements on mechanical constructions such as handling equipment e.g. traverses and pressure vessels. In addition, a number of regulations covering different issues will be developed in the future, including regulations relevant to nuclear waste and the EIA process.

SSI Regulations

SSIs Code of Statutes contains over 40 regulations. Here we refer to four of them that are directly relevant to waste management.

SSI FS 1991:5 Regulations on limitation of releases of radioactive substances from nuclear power stations.

These regulations contain provisions on releases and environmental monitoring, including dose constraints. The most important requirements are:

- The releases should be kept ALARA
- The dose constraint for the critical group is 0.1 mSv per year.
- The global collective dose should be limited to 5 manSv per year per GW installed electric effect, to ensure protection of individuals in the far future.
- Releases should be measured and reported to the SSI.
- An environmental monitoring programme should be established.

SSI FS 1998:1 *Regulations* concerning the final management of spent nuclear fuel and nuclear waste.

These regulations are focused on *the* final disposal of spent nuclear fuel, but also apply to some pre-disposal activities. The regulations were, before being approved by the SSI Board, reviewed extensively nationally and internationally, and the draft regulations as formulated and commented in SSI Report 97-02 “Health, *Environment and High-Level Waste”* was sent to NEA for scrutiny. The regulations contain fundamental radiation protection objectives, e.g.:

- Optimisation should be applied to the entire disposal system, and not only to individual activities and/or facilities. Proper attention should be paid to best available technique, BAT.
- The collective dose should be used for comparing different management options.
- The annual risk for an individual in the most exposed group should not exceed 10^{-6}.
- Biodiversity and sustainable use of biological resources should be protected.
- The consequences of human intrusion should be assessed.
- The protective capability of a final repository should be assessed for two time-periods: in the order of a thousand years and the time beyond a thousand years.

*Regulations concerning the handling etc. of radioactive waste at nuclear installations (*In preparation):

These *regulations* apply to the handling, treatment, conditioning, storage etc. of radioactive waste at nuclear installations. The proposed requirements include:

- Plans should be established for the management of all wastes.
- Waste categories for final disposal must be approved by the authorities.
- All areas where waste is handled, treated, conditioned, stored etc. should be documented.
- The waste management should be documented and necessary instructions should be established (e.g. measurements of nuclide composition).
- A point of contact for the waste management should be appointed at each installation.

SSI FS 1997:1 Regulations concerning archives at nuclear installations.
These regulations specify documentation that should kept in archives and for long time. For example, samples collected as a part of the environmental monitoring programme should be kept for 10 years while documents concerning waste disposal should be kept beyond 100 years.

2.3 Specific regulations

In addition to the general regulations issued by SKI and SSI there are conditions for nuclear installations in operation or under construction. CLAB and SFR are the two major nuclear waste installations in operation. The SFR repository was licensed by government decision in 1983 and taken into operation 1988. Following normal procedures SKI sets conditions on the operation from safety point of view and SSI for radiation protection. Especially, there is a system, handled by SKI and SSI in co-operation, for approval of waste categories to be disposed of in SFR.

Sweden has a system for recurrent safety evaluation of nuclear power plants. Normally the safety of a reactor is re-evaluated *with* a ten-year interval. This system, which is based on government decision, is used also for CLAB. In 1998 the government approved an application from SKB to enlarge CLAB to a storage capacity of 8 000 ton spent nuclear fuel. In this decision the government gave a number of conditions for the entire CLAB facility, which include quality assurance, periodic safety reviews, reporting of incidents. The conditions also include certain conditions for the enlargement construction that had been proposed by SKI concerning e.g. a control program, a new safety report before operation etc.

2.4 Guidance

In general, the laws and regulations mentioned in sections 2.1 and 2.2 provide the regulatory framework for the nuclear waste program. The system, required by law, that SKB puts forward an R&D program for review every third year gives opportunity for regulatory guidance of the SKB program. The regulatory review reports of the SKB R&D program, and the subsequent government decisions have provided extensive general regulatory guidance on the step-wise process of assessing technical options and finding a suitable site for final disposal of spent fuel, as well as on performance assessments supporting this process.

On the international level the work of both IAEA and OECD/NEA gives valuable guidance for the Swedish program. In particular, the IAEA Safety Series is often referred to and the NEA work, especially the parts that are related to performance assessment, is productive and useful in the practical safety work.

3. CURRENT STATUS

3.1 National status and issues

3.1.1 Waste classification and sources

Most of Sweden's nuclear waste is generated in the production of electricity at nuclear power plants. But a small amount *is* produced in hospitals, by other industries or in research institutions. The waste is classified as low-, intermediate-, or high-level, depending on the type and quantity of radioactive materials it contains.

Radioactive Waste in Sweden

	Long-lived radiation shielded for 100 000 years	**Short-lived** radiation shielded for up to 500 years
Low-level		Operational waste
Intermediate-level radiation shielded	Certain reactor parts	Operational waste + decommissioning waste
High-level radiation shielded and cooled	Spent nuclear fuel (certain reactor parts)	

So far, the Swedish nuclear program has generated 2 500 tonnes of high-level nuclear waste in the form of spent nuclear fuel which is currently in interim storage in pools at the Central Interim Storage Facility for Spent Nuclear Fuel (CLAB) at Oskarshamn.

Short-lived low- and intermediate level operational waste from the nuclear power plants, industry research and medical applications is already today being transported to the existing SFR repository at Forsmark. In addition to this, different types of operational and decommissioning waste will be generated from the decommissioning and dismantling of the nuclear power plants and other nuclear installations.

3.1.2 Waste management strategy

The SFR and CLAB *represent* early cornerstones in the Swedish nuclear waste management strategy and they provide a good prerequisite for the further development of the nuclear waste management system.

After recurrent evaluations by SKI and other experts, including SSI and the National Council for Nuclear Waste (KASAM), the government has accepted that the main line of SKBs research and development work for the final disposal of spent nuclear fuel is the KBS-3 method. The method involves the final *disposal* of the spent nuclear fuel in copper/steel canisters, surrounded by a layer of protective bentonite clay, at a depth of about 500 m in stable Swedish crystalline bedrock. An important safety principle is that the spent nuclear fuel should be protected by several barrier functions/surrounding layers.

In SKIs and SSIs view, with the present state of knowledge, the KBS-3 method provides, from the Swedish perspective, *adequate* balance between requirements concerning long-term safety, protection from intrusion and reasonably good possibilities for retrieval if, for some reason, this should be necessary or desirable in the future. However, there is yet no final approval of KBS-3. In the safety analysis report SR 97 published in 1999, SKB claims that the prospects of building a safe deep repository for spent nuclear fuel in the Swedish bedrock are "very good". SR-97 is subject for in-depth review by SKI and SSI, including an international review by NEA.

In its decision on January 24, 2000, the government stipulates certain conditions that must be fulfilled before SKB starts site investigations (the next step in the site selection process that will include deep bore holes) on at least two sites. The government requests that SKB should submit:

- A complementary systems analysis comparing different alternatives for waste management.
- A comprehensive evaluation of all feasibility studies that SKB has accomplished in the municipalities.
- A program for site investigations.

The government also states that SKB must do this work in consultation with the municipalities, county administrations and authorities.

Since the seventies, alternative methods for the management of spent nuclear fuel and nuclear waste have been evaluated in parallel with the development of the KBS-3 method. These include alternative geological deep repository methods, e.g. depositing the fuel and waste in long tunnels and deep bore holes. In its decision the government said that SKB must show which efforts would be needed to develop the concept of very deep bore holes as an alternative to the same level as KBS-3.

The systems analysis must also describe what will happen if the development of a final disposal method is postponed and if it is decided, instead, to prolong the interim storage of the spent nuclear fuel in CLAB, or in another underground storage facility. It could be possible to justify this alternative by stating that better methods for disposing of nuclear waste could emerge in the future.

Prolonged interim storage means passing on responsibility to future generations for storage which will require constant monitoring to ensure that safety is not jeopardised. A long-term stable society with technical and financial resources to maintain and monitor the repository is required for this.

3.1.3 Current issues

The result of the review of the R&D programme of 1998, and later clarification by SKB and SKI is that SKB will select two sites for site investigations before the end of 2000 and that the SKI review of the SKB basis for site selection will be concluded before July 2001. After the SKI review, and a possible government decision, the (at least) two municipalities will take their decisions whether they accept site investigations or not. The goal of SKB is to start site investigations before the end of 2001.

This is a very demanding time schedule. In practice SKB has to balance between two factors of importance for the involved municipalities, On one hand all of them must be given enough time to involve the citizens and to build knowledge that enables them to take decision on good grounds. On the other hand, for the municipalities that came in early in process a too long time frame would endanger their commitment in the process.

It is not just a matter of meeting a certain time schedule. In order to be acceptable to the municipalities as a basis for decisions, SKB will have to present an understandable, transparent and logical framework for the site selection. SKB is now working hard to meet these goals.

The review process also has to meet high demands for transparency in the complex issue of site selection that involves many geological safety related factors but also many socio-economic factors. SKI/SSI is now preparing them for this and special hearings are planned to be held in the selected municipalities.

3.1 Regulatory issues

3.2.1 Current issues

Here we first address some issues related to transparency and public involvement – then practical issues related to standards and criteria.

Need for transparency

For both SKI and SSI, the continued effort of the SKB for siting and technically developing the system for final management of spent nuclear fuel will provide substantial future challenges. Even if the procedures for licensing and EIA processes now are well defined there is still unresolved issues related to the decision process. Especially the above-mentioned need for transparency in the decision process and, in particular, risk assessment is subject for on-going research and development. The RISCOM Pilot study and the VALDOR Conference in 1999 have made significant contributions, but work continues.

Regulator involvement

For a regulatory body, one particular issue is the need for involvement in the community EIA processes while maintaining independence for licensing. This subject was addressed in the RISCOM Pilot study, and it was concluded that regulator involvement is needed and possible without endangering the independence and integrity as regulator. The municipalities ask for an active role of the regulators – they are seen as “the peoples experts” in safety issues. An active role is also needed to gain the necessary trust in the communities. So far the experiences are good in this respect.

Retrievability

On the international arena, the concept of retreivability has been given increasing attention recent years, and sometimes retrievability is considered important for public acceptance of a repository. However, there are also concerns what retrievability may lead to. The public wants a safe solution for the spent fuel and the experiences in the communities do not support the idea that the public sees retrievability as a safeguard against possible shortcomings in the disposal method. The regulators must first of all guard that possible measures for retrievability do not endanger the long-term safety of a repository.

Safety indicators

SSI and SKI have recently decided to jointly explore the use of other safety indicators than dose and risk. The collaboration includes the development of a hierarchically structured set of safety indicators. An example of a possible indicator, which is often discussed, is the flux of (radio)nuclides from the geosphere to the biosphere. Research will be needed for “base-line” studies, i.e. the establishing of suitable reference levels etc. SSI and SKI both participate in the CRP within the IAEA on this subject.

3.2.2 Policy and regulation developments

In recent years both SKI and SSI have published a number of new regulations in the areas of repository safety and radiation protection. This development towards a more comprehensive system of regulations will continue. This will be done in close co-operation between the two authorities in order to ensure consistency.

Yet there has been no licensing of nuclear installations since the new Environmental Code came into force. Even if licensing of a repository is still a number of years ahead, the requirements in the Code on consultations with municipalities and others affected will be applied in a relatively early stage of the site selection process. The precise procedures for this are now subject for discussion and clarification.

3.1 R&D programme

3.3.1 Functions

The regulatory authorities, SKI and SSI, must supervise and provide impetus for SKBs work. To do this, the authorities must be a competent counterpart to SKB. Consequently, the authorities are conducting an extensive research programme.

SKI has a rather comprehensive R&D programme with a budget of about 2 MUSD. It provides the basis for planning SKIs regulatory role in nuclear waste management, review and supervision of safety in nuclear facilities, review and supervision of SKBs R&D programme and review and supervision of the funding system for future costs for management and disposal of spent fuel and radioactive waste and the decommissioning of nuclear facilities. The SKI strategy is to develop and maintain an independent performance assessment capability for the expected reviews of licence applications for the deep repository and the encapsulation facility. The SSI research is more focused on effects of ionising radiation and biosphere transport of radionuclides. Risk communication is an area of great common interest of both authorities with focus on building appropriate procedures for transparent decisions.

3.3.2 Contents of R&D plans

Essentially all areas of importance for the evaluation of safety and radiation protection of nuclear waste installations are covered in the research programs of SKI and SSI. Continued activities by the authorities involve research in the general area of criteria, indicators and compliance. Also technical issues (e.g. copper corrosion, bentonite etc) and performance assessment methodology are included in the SKI R&D programme.

Safety assessment methodology

SKI has concluded its project SITE-94, a major effort in development of competence in safety assessment methodology. SKI continues its efforts to develop competence in this area e.g. to continue the development of scenario methodology, modeling of radio-nuclide transport, modelling time dependent factors, treatment of uncertainties and use of site specific data.

The repository for low and intermediate long lived radioactive waste will also require development of performance assessment methodology.

Technical issues

SKI has a R&D programme that includes several issues; treatment technology and storage, repository technology, geochemistry, geology, hydrology and steel/copper canister. Topics that are judged to be critical for the long-term safety are e.g. welding and testing of the copper canister, canister corrosion, the influence on repository performance by concrete and redox buffering. The progress in the Äspö underground research laboratory and the copper canister laboratory in Oskarshamn is continuously followed by SKI.

Risk communication

The recent development in the Swedish nuclear waste disposal programme has put new demands on the regulators. It has become evident that transparent decision making procedures must be developed, that allow insight from people outside the group(s) of expert(s) and political decision makers. SKI and SSI have therefore jointly financed a project concerning transparency in risk assessment, the RISCOM Pilot study that was concluded in the beginning of 1998. Contract negotiations are now on-going between SKI (as co-ordinator) and EC concerning a broader study on transparency and public participation in nuclear waste management. In this study some of the recommendations put forward in the RISCOM Pilot study will be implemented and tested

SSI and SKI have, together with EU DGXI, sponsored the first an international symposium on issues related to risk communication (VALDOR) which took place in Stockholm in June 1999. A second VALDOR is planned for June 2001.

Health and environmental standards and criteria

SSI, jointly with the US Environmental Protection Agency and the Stockholm Environment Institute, organised an international symposium on health and environmental criteria, in Stockholm 31 August – 4 September 1998. Research projects are being initiated on environmental protection criteria, and the first reports on the outcome of these studies were presented at the International Symposium on Environmental Protection Approaches for Nuclear Facilities (Ottawa, May 1999), organised jointly by SSI, the Atomic Energy Control Board (Canada) and Environment Australia. Contract negotiations are on-going between SSI (as co-ordinator) and EC concerning environmental assessments.

SWITZERLAND

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National Framework

1.1.1 National Policy

The back-end of the nuclear fuel cycle is not prescribed by the present legislation. The strategy which has been chosen by the nuclear power plant operators includes both reprocessing and storage of spent fuel in view of later reprocessing or direct disposal. The reprocessing occurs abroad, but the radioactive waste arising from that will return to Switzerland.

All radioactive wastes are to undergo final disposal in repositories situated in suitable geological formations; no near-surface disposal is planned. Two repositories are foreseen, one for mostly short-lived low and intermediate level waste and the other for high level waste (and spent fuel, if not reprocessed) and long-lived intermediate level reprocessing waste. The realisation of the repository for low and intermediate level waste is actually planned. Because of the necessary cooling time prior to disposal, the repository for high level waste is not needed before several decades from now. However the demonstration of the feasibility in Switzerland of safe and permanent disposal of such waste is requested by the legislation. The option for the disposal of the limited quantities of high level waste within the framework of a bilateral or multilateral project is kept open.

Since there is no repository available, all radioactive waste are stored in adequate storage facilities. Each nuclear power plant has the interim storage capacity for its own operational waste. The radioactive waste from medicine, industry and research is stored at a federal interim storage facility. A central storage facility for all kinds of radioactive waste, especially for vitrified high level reprocessing waste and spent fuel, is under construction.

Switzerland has ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management prepared by the IAEA.

1.1.2 Institutional Framework

The Federal State takes over the responsibility for the management of the radioactive waste generated by the use of radioisotopes in medicine, industry and research. The producers of radioactive waste, i.e. the operators of nuclear power plants and the Federal State (for the waste from medicine, industry and research) formed the National Co-operative for the Disposal of Radioactive Waste (Nagra) which is responsible for the planning for the disposal of all kinds of radioactive waste. Dedicated companies domiciled at the site are responsible for the construction and operation of waste management facilities. The company ZWILAG (Zwischenlager Würenlingen AG) is responsible for the central storage facility in Würenlingen. The company GNW (Genossenschaft für Nukleare

Entsorgung Wellenberg) is responsible for the proposed repository for low and intermediate waste at the Wellenberg site. The responsibility for spent fuel reprocessing abroad and for conditioning and interim storage at the nuclear power plants remains with the operators.

The licensing authority is the Federal Council (Federal Government). It is supported in its decisions by the Federal Office of Energy which organises the licensing procedures. The Swiss Federal Nuclear Safety Inspectorate (HSK) is part of the Federal Office of Energy and has the three main tasks to elaborate safety requirements, review license applications and supervise the construction and operation of the facilities. This regulatory organisation is complemented by several advisory bodies, for instance the Nuclear Safety Commission.

1.2 Regulatory Framework

1.2.1 Regulatory Function

The Swiss Federal Nuclear Safety Inspectorate (HSK) is the government's supervisory authority (regulatory body) for safety and radiation protection in the field of nuclear energy, including radioactive waste management. According to the institutional framework described in 1.1.2 above, HSK is not the licensing authority, but has the mission to supervise and judge the Swiss nuclear installations right through from the planning stage, to construction, operation, decommissioning and dismantling. To this end, HSK is assigned five functions.

Formulation of safety requirements

HSK takes part in drawing up legislation concerning nuclear safety and radiological protection. It defines the safety requirements to be met by nuclear installations, specifies the body of regulations (standards and rules) to be applied and issues its own guidelines. In the field of radioactive waste management, two specific guidelines are in force, R-14 concerning conditioning and interim storage, and R-21 concerning the post-closure phase of a repository. A further guideline on the active phase of a repository (construction, operation and closure) is under preparation.

Assessment of projects

HSK prepares the safety evaluation reports at each stage of the licensing process for nuclear installations and for geological investigations in view of radioactive waste disposal. The licensing stages for nuclear installations include general licence, construction licence, operating licence and modifications that require a licence, including decommissioning and dismantling, or closure. The safety evaluation reports make recommendations concerning the granting of licences and propose licence conditions.

Supervision of nuclear installations

In its role as supervisor, HSK verifies compliance with legal requirements as well as with the conditions laid down by the licensing authority and issues permits for operations within the framework of the licence. For instance, each type of waste package needs a permit from HSK prior to routine production. Such a permit is delivered on the basis of a detailed specification characterising the waste package and after Nagra has certified the suitability of this type of waste package to be disposed of in one of the planned repositories.

Keeping up to date with developments in science and technology

HSK monitors experience gained world-wide and developments in science and technology as far as they affect nuclear safety and radiological protection. HSK also fosters contacts with other safety authorities and international organisations. A particular importance is attached to the exchange of experience and in the elaboration of international safety guidelines.

Information

HSK answers the questions posed by Parliament, political authorities and the general public relating to the safety of the nuclear installations and to possible radiological implications for human health and the environment. It has made a duty to respond to events of public concern by providing quick, complete and understandable information.

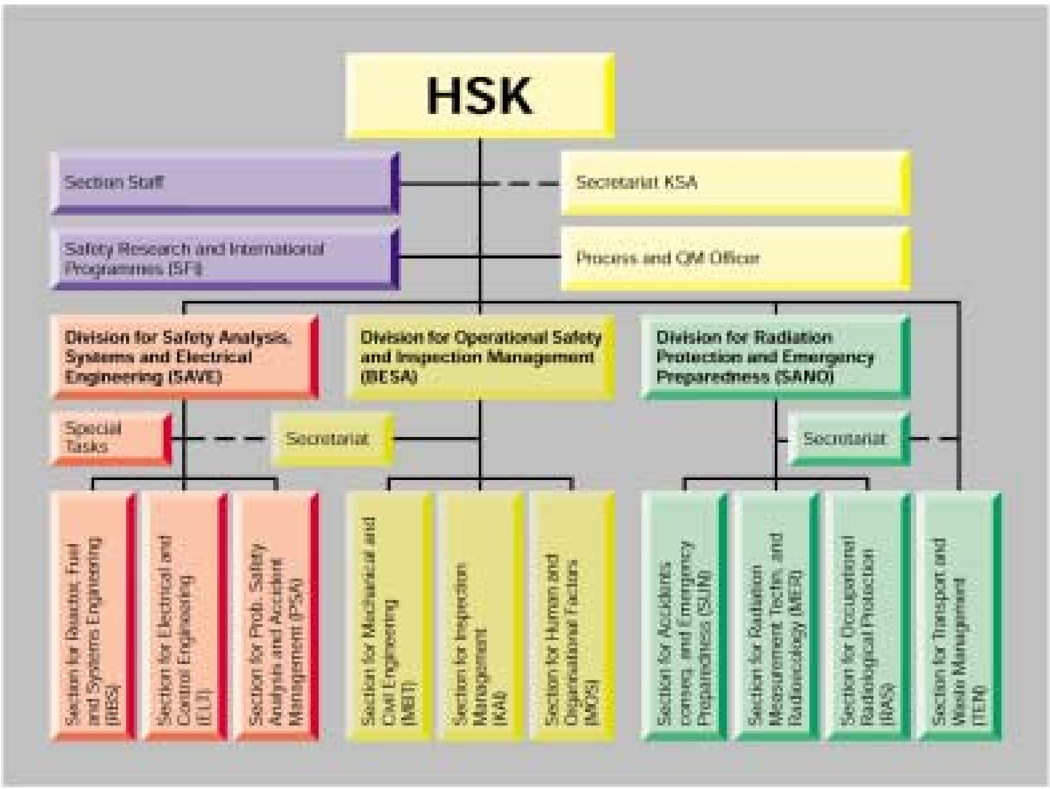
1.2.2 Organisation and Resources

HSK employs about 90 persons: physicists, mechanical, electrical and civil engineers, geologists, chemists and biologists, in addition to technical and administrative personnel. HSK is divided into three divisions, one additional technical-scientific section and a supporting staff, all of these units reporting directly to the Director (see organisational chart below). For particular tasks, HSK enlist the aid of experts from external organisations.

In recent years the annual budget has been of the order of 25 million Swiss francs. Expenditure is met by funds from the federal government. Applicants for nuclear licences are subject to fees and the operators of nuclear installations are invoiced for the HSK services.

The HSK Section for Transport and Waste Management comprises ten persons. It deals with matters concerning transport of radioactive materials, conditioning, storage and disposal of radioactive waste, and decommissioning of nuclear installations. It evaluates the proposed methods for conditioning radioactive waste, issues the necessary execution permits and supervises the operation of the corresponding facilities. It performs a leading function in the safety evaluations by HSK of facilities for storage and disposal of radioactive waste. It follows and appraises the geological investigations towards radioactive waste disposal. As the Swiss Competent Authority, it also issues the package and shipment approval certificates for the transport of radioactive materials in Switzerland.

Organisational chart of HSK



2. LEGISLATION AND REGULATION

2.1 Legislation

The Swiss federal legislation concerning the radioactive waste management consists of the following laws and ordinances:

- Atomic Energy Law, 23 December 1959
- Federal Act on the Atomic Energy Law, 6 October 1978
- Nuclear Liability Law, 18 March 1983
- Radiological Protection Law, 22 March 1991
- Ordinance on Decommissioning Fund, 5 December 1983
- Atomic Energy Ordinance, 18 January 1984
- Ordinance on Preparatory Measures, 27 November 1989
- Radiological Protection Ordinance, 22 June 1994
- Ordinance on the Collection of Radioactive Waste, 8 July 1996

This legislation is partly outdated and does not contain detailed provisions on radioactive waste management. A totally new Nuclear Energy Law which addresses more specifically radioactive waste management has been submitted to the Parliament in March 2001.

The main features of the current legislation concerning radioactive waste management are as follows:

- For radioactive waste management facilities, as for other nuclear facilities, licenses to be granted by the Federal Council (Federal Government) are required.
- A general license which has to be approved by the Parliament is required prior to the licenses for construction and operation of a facility.
- The producers of radioactive waste are responsible for its safe management, including permanent disposal.
- The Federal State takes over the responsibility for the collection, conditioning, storage and disposal of radioactive waste generated by the use of radioisotopes in medicine, industry and research.
- Imports and exports of radioactive waste for the purpose of disposal are, as a general rule, not allowed.
- Geological investigations of a potential disposal site by deep drillings and exploratory shafts or galleries (so-called preparatory measures) require a license.

A waste management facility requires further authorisations (for instance, a mining concession for a repository) according to cantonal and communal legislation.

The draft new Nuclear Energy Law contains further provisions regarding radioactive waste management:

- Decommissioning of no more used nuclear installations is required.
- Spent fuel has to be disposed of as radioactive waste; reprocessing is no longer allowed.
- Radioactive waste shall be disposed of in a geologic repository; the eventual closure of the repository is preceded by an observation phase; retrievability must be guaranteed until closure of the repository; the site Canton has to approve the closure of the repository.

Licensing Procedure

Licences are needed for the construction, for the operation and for important modifications including decommissioning, dismantling or closure of nuclear installations. The licences are granted by the Federal Council (federal government). As a prerequisite for the construction and the operation licence, a so called general licence is needed, which has to be approved by the Parliament. The general licence fixes the site and the general layout of the installation and, for a storage or disposal facility, the nature and approximate amount of the radioactive waste to be put into the facility. In addition to that, a licence for preparatory measures is needed for exploratory drillings, shafts or galleries, if these site investigations are made in view of a disposal facility for radioactive waste.

The licensing procedure is conducted by the Federal Office of Energy and consists of the following main steps:

- Submission of the application with a description of the project and a safety analysis report.
- Deposition of the licence application documentation for public consultation; individuals, communities and organisations can formulate objections against the project.
- Consultation of cantonal governments and federal offices.
- Review of the project by HSK and possibly other concerned authorities.
- Statements of the applicant concerning the objections resulting from the consultations.
- Second deposition for public consultation of possibly modified project documentation, review reports of the safety authorities and statements on the objections from the first round of consultations.
- Compilation of all the material collected and proposal for a decision.
- Decision by the Federal Council, generally with a series of conditions.

The decision taken by the Federal Council cannot de contested, except for the general licence, which has to be approved by the Parliament. This is not fully in line with the directives of the European Union. The draft new Nuclear Energy Law introduces modifications of the licensing procedure in order to make it compatible with the European Legislation.

2.2 General Regulation

Since the legislation does not contain detailed provisions, especially concerning radioactive waste management, more precise requirements are set in the guidelines issued by HSK. Such guidelines state in detail how the Swiss nuclear safety authorities intend to carry out their legal tasks. The intent is to give advice to designers, constructors and operators of nuclear installations regarding the criteria by which the responsible authorities assess formal licence applications and supervise the facilities. The guidelines are not legally binding, but the fulfilment of the requirements set in the guidelines is a prerequisite for a positive assessment of a project by HSK.

Two guidelines issued by HSK concern specifically radioactive waste management: R-14 on conditioning and interim storage, and R-21 on the post-closure phase of a repository. A further guideline on the active phase of a repository (construction, operation and closure) is under preparation. Further guidelines related to nuclear installations apply to the design, construction and operation of radioactive waste management facilities. The guidelines will be amended where necessary according to the new Nuclear Energy Law.

Guideline HSK-R-14: Conditioning and Interim Storage of Radioactive Waste

Conditioning

Conditioning and interim storage represent steps on the way to disposal of radioactive waste, thus conditioned waste packages which are authorised for interim storage must also be suitable for disposal.

Radioactive waste should be conditioned in such a way that the resulting waste package can be subjected as a unit to the waste management stages of transport, interim storage and disposal. Subsequent packaging procedures (e.g. over-packing for transport or disposal) are admissible. To achieve this objective, requirements concerning the waste form, the packaging, the waste package, the data acquisition and the quality assurance are set. The procedure for obtaining the permit for the production of waste packages is fixed. A prerequisite for granting the permit is that Nagra certifies the suitability of the type of waste package to be disposed of in one of the planned repositories.

Interim storage

The interim storage system comprising the store and the waste packages must equally fulfil two goals: the protection of human health and the environment against emissions from the waste packages and the protection of the waste packages against harmful effects. For this purpose, the following protection objectives must be met during the expected operational life of the interim storage system:

- The individual dose to the most exposed population group from normal operation, including internal events which may be expected to occur once or more times during the operating life, shall not exceed 0.1 mSv per year.
- The dose in case of events which are not anticipated to occur, but which cannot be ruled out, shall not exceed 1 mSv.
- The radiological consequences of the crash of a Swiss military aircraft with full fuel tanks involving a fuel fire shall be realistically evaluated as a bounding assessment of the consequences of an unlikely severe accident. The resulting dose shall not exceed 100 mSv.
- The integrity of the stored waste packages must be maintained completely during normal operation and to the highest possible degree in the event of incidents.

A series of technical measures are indicated, which are regarded as acceptable means for fulfilling the protection objectives.

Guideline HSK-R-21: Protection Objectives for the Disposal of Radioactive Waste

The guideline R-21 relates to the long-term safety in the post-closure phase of a repository. It applies to all methods of geological disposal and to all categories of radioactive waste. Another guideline relating to the operational phase of a repository is in preparation.

The overall objective of radioactive waste disposal and the principles to be observed which are stated in the guideline R-21 are derived from the internationally agreed IAEA Safety Fundamentals for radioactive waste management (SS 111-F, 1995). As a concretisation of the overall objective and the associated principles, the safety requirements are expressed in the form of three protection objectives:

PO 1 The release of radionuclides from a sealed repository subsequent upon processes and events reasonably expectable to happen, shall at no time give rise to individual doses which exceed 0,1 mSv per year.

PO 2 The individual radiological risk of fatality from a sealed repository subsequent upon unlikely processes and events not taken into consideration in PO 1 shall, at no time, exceed one in a million per year.

PO 3 After a repository has been sealed, no further measures shall be necessary to ensure safety. The repository must be designed in such a way that it can be sealed within a few years.

One recognises the following main features:

- A basic deterministic approach is required for the safety assessment.
- Where useful or necessary, the deterministic calculations should be complemented by probabilistic analyses.
- The requirements apply to the disposal system as a whole.
- Calculations should be carried out at least as far in time as the maximum potential consequences (no axiomatic cut-off time).

The guideline R-21 gives a number of indications concerning the safety assessment:

- A safety assessment is needed at each stage of the licensing process. The corresponding calculations must be based on information collected throughout the characterisation, construction and operation phases.
- The results of calculations concerning the far future are not to be interpreted as effective predictions of radiation exposure of a defined population group. They are indicators for evaluating the impact of a potential release of radionuclides into the biosphere and are compared with the limits specified in the protection objectives.
- For such calculations, reference biospheres and an affected population with, from a current point of view, realistic living habits should be assumed. The population group most likely to be affected is meant to be a limited number of people. The calculation should pertain to the potential exposure of an average individual of that group.
- Processes and events with extremely low probability of occurrence or with considerably more serious non-radiological consequences, as well as intentional human intrusion into the repository system, are not required to be considered in the safety assessment.
- Each computer code used in the safety assessment has to be verified. Further, there has to be confidence that the models used are applicable for the specific purpose. The applicant has to give the possible ranges of variation in the data used in the models and of the results of the calculations. Where uncertainties remain, conservative assumptions must be made.

2.3 Specific Regulations

Specific regulations are implemented in the licences granted by the Federal Council. In the field of radioactive waste management, licences have up to now been granted for various geological investigations and for the construction and operation of storage facilities. The licences generally contain a series of obligations which also define the steps or activities which are subject to a permit by HSK.

All the licences for geological investigations require the formation of a supervisory commission constituted by representatives of the federal, cantonal and local authorities involved at the particular site, generally including also persons from groups opposing the project.

The operation licences for storage facilities specify in detail the limits for effluent discharges from the facility. They also set the criteria for the acceptance of waste packages. The licence for the central storage facility specifies the reference requirements which shall be met by the transport and storage casks to be used for spent fuel and vitrified high-level waste.

2.4 Guidance

Guidance is given in the guidelines mentioned under section 2.2. In addition to that, the operators and the regulators have to consider the guidance provided by the international organisations like OECD-NEA and IAEA.

3. CURRENT STATUS

3.1 National Status and Issues

3.1.1 Waste Classification and Sources

Materials or waste are considered to be radioactive if they fall within the scope of application of the legislation on radiological protection as it is set in the Radiological Protection Ordinance. The main sources of radioactive waste in Switzerland are the nuclear power plants. There are 5 reactors in operation (3 PWR, 2 BWR) totalling around 3 000 MWe. This gives or eventually will give rise to following waste streams:

- waste from the reprocessing of the spent fuel,
- operational waste,
- decommissioning waste.

Further radioactive waste arise from the use of radionuclides in medicine, industry and research. Switzerland has no uranium mines and no enrichment, fuel fabrication or reprocessing plants.

The classification of the radioactive waste is as follows:

- High-level waste: Vitrified high-level waste from reprocessing, or spent fuel, if not reprocessed and declared as waste.
- Long-lived intermediate-level waste: Alpha-bearing intermediate-level waste from reprocessing.
- Low- and intermediate-level waste: All other radioactive wastes, mostly short-lived.

3.1.2 Waste Management Strategy

The overall radioactive waste management policy is briefly described in section 1.1.1 above.

The radioactive waste arising all over the country from the use of radioisotopes in medicine, non-nuclear industry and research is collected by the Paul Scherrer Institute (PSI, research establishment) on behalf of the Federal Office of Public Health. It is then conditioned and stored until disposal at the Federal Interim Storage Facility at PSI.

The radioactive waste arising from the operation of the nuclear power plants is conditioned (mostly on-site, partly at PSI, e.g. for incineration) and stored until disposal in the respective storage facilities of the plants. Up to now, most of the spent fuel has been sent for reprocessing to France (COGEMA) and the United Kingdom (BNFL). The waste arising from reprocessing will be returned to Switzerland and stored at the Central Storage Facility operated by ZWILAG near PSI which will start operation in 2001. The Central Storage Facility also includes a conditioning facility and a modern plasma oven for incineration and melting of radioactive waste. In the future, the spent fuel will be stored for several decades in transport and storage casks at the Central Storage Facility. The decision, whether this spent fuel should be reprocessed at a later time or disposed as waste, is presently kept open. The draft new Nuclear Energy Law prohibits the reprocessing of spent fuel.

Two repositories are foreseen for the disposal of all Swiss radioactive waste. A repository for the expected large amount of low- and intermediate-level waste (about 80’000 m^3) is planned at the Wellenberg site in the Canton Nidwalden in Central Switzerland. This repository will consist of a mined system of horizontally accessible caverns in a mountain side. An application for the general licence was made in 1994. The federal licensing procedure has however been adjourned, after the mining concession requested by the cantonal legislation was refused by the citizens of the Canton in 1995. The project has been politically de-blocked in spring 2000. As a first step a mining concession only for an exploratory gallery was applied for in January 2001. The cantonal referendum on this mining concession is scheduled in December 2001.

The repository for the high-level and the long-lived intermediate-level waste is foreseen to be located in a deep geological formation and would consist of a drift system with access by a shaft or a ramp. Two potential host rock formations both in Northern Switzerland are being investigated for that purpose, the crystalline basement and Opalinus Clay sediments. There is no urgent need for this repository yet; the option of the disposal of the Swiss high-level and long-lived intermediate-level waste within the framework of an international project is kept open.

3.1.3 Current Issues and Problems

A important issue relates to the fundamental question, whether final disposal is the right way to get rid of radioactive waste. Several non-governmental organisations and politicians claim that disposal cannot ensure the necessary long-term safety; one has therefore to keep the waste indefinitely under control in an storage facility. This should not only apply to high-level, but to all radioactive waste. A dialogue between representatives of nuclear energy proponents and opponents and authorities was launched by the energy minister in 1998, but no consensus could be reached. The energy minister then set up in June 1999 an Expert Group on Disposal Concepts for Radioactive Waste (EKRA) which was mandated to compare different waste management concepts. The Group developed and recommended the concept of monitored long-term geologic storage, which combines final disposal with the possibility of control and reversibility. The report of the Group was presented in February 2000 and was very well received by the media. It contributed to de-block the Wellenberg project (see 3.1.2). EKRA's recommendations have been taken into account in the draft new Nuclear Energy Law.

Also the reprocessing of the spent fuel is strongly criticised by some persons because of an alleged environmental pollution attributed to the reprocessing plants in France and United Kingdom. The draft new Nuclear Energy Law contains an article prohibiting spent fuel reprocessing. The existing contract may be honoured.

3.2 Regulatory Issues

3.2.1 Current Issues and Problems

A difficulty, which might be of a general nature, for the regulatory body in the context described under section 3.1.3, is to defend the revised concept of disposal with the possibility of reversibility, which is considered to be sound in the radioactive waste management community, without appearing to the political authorities and to the general public as being promoters of specific disposal projects for which the same regulatory body should be the neutral and independent supervisory authority. We have to convince the general public that it is possible to advocate the general concept, but to preserve the independence of view when judging specific projects.

Further current issues are specific to Switzerland. An International Regulatory Review Team (IRRT) convened by IAEA visited HSK in December 1998. The Team made several recommendations and suggestions concerning improvements which are necessary or desirable to strengthen the regulatory body. HSK has set up an action plan to implement the improvements recommended by the IRRT. In addition to that HSK is involved in the creation of a new national agency which would group together the different federal safety authorities.

3.2.2 Policy and Regulation Development

A totally new Nuclear Energy Law has been submitted to the Parliament which addresses more specifically radioactive waste management. Also a guideline relating to the active phase of a repository is under preparation.

3.3 R&D Programme

3.3.1 Functions

R&D on radioactive waste management is mostly performed at the Paul Scherrer Institute (PSI). A substantial part of this R&D is funded by Nagra, the organisation responsible for the preparation of the disposal of radioactive waste. HSK, the regulatory body for nuclear energy, is funding and steering regulatory R&D, but not in the field of radioactive waste management. However, HSK follows and comments the work done at PSI.

3.3.2 Contents of R&D plans

The aims of the waste management R&D activities at PSI are to develop and test models, and to acquire selected data in support of the performance assessments for repositories. The work is split into the following six areas:

- Thermodynamic modelling (data evaluation, trace element behaviour, project specific solubility databases and speciation, etc).
- Transport mechanisms (coupled transport phenomena in clay, modelling migration experiments, etc).
- Diffusion processes (in conditioned clay, natural rocks and cements, field and laboratory experiments) and organic ligands (complexation).
- Clay systems (sorption measurements and databases, mechanic sorption models, etc).
- Cement systems (sorption studies, coprecipitation, etc).
- Colloid chemistry (colloid sampling in clay and marl groundwaters, global colloid properties).

UNITED KINGDOM

The following text is focused mainly on the disposal of radioactive wastes. Other aspects of radioactive waste management on nuclear sites are outlined more briefly.

1. NATIONAL FRAMEWORK

1.1 National Policy

Government policy on radioactive waste management is set out in a White Paper of July 1995 "Review of radioactive waste management policy - final conclusions" [1]. The policy is based on the same basic principles as apply more generally to environment policy, and in particular on that of sustainable development. The White Paper gives a widely quoted definition of this concept as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

A 1994 White Paper [2] on sustainable development sets out the following supporting principles:

- decisions should be based on the best possible scientific information and analysis of risks;
- where there is uncertainty and potentially serious risks exist, precautionary action may be necessary;
- ecological impacts must be considered, particularly where resources are non-renewable or effects may be irreversible; and
- cost implications should be brought home directly to the people responsible - the polluter pays principle.

More specifically, and consistent with the above, Government policy is that radioactive wastes should be managed and disposed of in ways which protect the public, workforce and the environment. The radiation protection principles and criteria adopted in the UK and applied by the regulatory bodies are designed to ensure that there is no unacceptable risk associated with radioactive waste management. In defining these principles and criteria and in their application by the regulators, it is recognised that a point is reached where additional costs of further reductions in risk exceed the benefits arising from the improvements in safety achieved, and that the level of safety and the resources required to achieve it should not be inconsistent with those accepted in other spheres of human activity.

In 1999 the Government published a strategy for sustainable development (3) restating the Government's commitment to sustainable development. This is of broad relevance to various policy fields, including that of radioactive waste management.

The Joint Convention on the Safety of Radioactive Waste and Spent Fuel Management come into force in June 2001. The UK has ratified the Joint Convention.

The UK's radioactive waste management policy is currently the subject of a major review, as indicated below in section 3.1.3.

1.2 Institutional Framework

The relevant institutions involved in radioactive waste management and their relationships are shown in Figure 1 together with a brief indication of their roles.

2. LEGISLATION AND REGULATION

2. 1 Legislation and Regulatory Framework

Radioactive Substances Act 1993 (RSA 93)

Under RSA 93, no person may dispose of radioactive waste except in accordance with an authorisation under the Act, or except where the waste is excluded by the Act or by an Exemption Order. The developer of a disposal facility for radioactive wastes will be required to apply to the relevant Agency for authorisation of disposals on or from the site of the facility.

Control under the Act is exercised in England and Wales by the Environment Agency and in Scotland by the Scottish Environment Protection Agency. Where an application is made for disposal of radioactive waste on or from a site licensed under the Nuclear Installations Act 1965, the Agency is required to consult the Food Standards Agency and the Health and Safety Executive before deciding whether to grant an authorisation and, if so, subject to what terms and conditions.

In England, powers are available to the Secretary of State for **Environment, Food and Rural Affairs**, together with the Secretary of State for Health, to call in any application for radioactive waste disposal from a nuclear licensed site and to determine it themselves or to issue directions to the Environment Agency. Analogous arrangements are available to the Devolved Administrations in Wales and Scotland.

Health and Safety at Work etc Act 1974 and Nuclear Installations Act 1965

The safety of operational nuclear facilities in the UK, including those for waste treatment and storage, is regulated by the Health and Safety Executive (HSE) using the 1965 Nuclear Installations Act - as amended (NI Act) under the general requirements of the Health and Safety at Work, etc Act. The NI Act requires organisations to obtain a nuclear site licence from the HSE before using a site for licensable activities. It also enables HSE to attach conditions in the interests of safety and for handling nuclear matter to any licence granted. Such conditions include the requirement for licensees to justify the safety of operations, i.e. provide a safety case and make arrangements for the safe management of radioactive waste.

It is intended that the safety of long-lived waste repositories during their operational phase will be regulated under the NI Act. The licensee(s) of such facilities would thus need to provide a safety case for the operational phase. HSE's Nuclear Installations Inspectorate would independently assess such cases and regulate the associated operations.

In accordance with their joint interests, HSE and the environment agencies have a very close and constructive working relationship, which is formalised through "memoranda of understanding". The goals of the regulators are, together: to deliver effective and efficient regulation of the nuclear industry; to maintain and improve standards of protection of people and the environment from the potential hazards from ionising radiations; and to ensure that radioactive wastes are appropriately managed in both the short and long term, in accordance with legislation, UK Government policy, and international obligations.

Radiological protection standards

The National Radiological Protection Board, (NRPB), has a statutory responsibility to advise government departments and statutory bodies on the acceptability and applicability for the UK of the recommendations of ICRP. In 1993, NRPB issued a statement on the 1990 recommendations of ICRP [4]. A statement on radiological protection objectives for the land-based disposal of solid radioactive wastes [5] was issued in 1992. The advice contained in the NRPB statements has been taken into account by the environment agencies in preparation of Guidance on Requirements for Authorisation of Disposal Facilities on Land for Low and Intermediate level Radioactive Wastes [6].

EURATOM requirements

A Directive issued under the Euratom Treaty lays down basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation [7].

Article 37 of the Euratom Treaty of the European Community requires that "each Member State shall provide the Commission with such general data relating to any plan for the disposal of radioactive waste in whatever form as will make it possible to determine whether the implementation of such a plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State". Not more than six months after receiving the data, the Commission will publish its Opinion in the Official Journal after consulting a Group of Experts. The relevant consents to bring the facility into operation cannot be issued until the Opinion of the Commission has been published.

Town and Country Planning Act, 1990

Any proposed specialised land disposal facility is likely to be a development under the Town and Country Planning Act 1990 and as such to require planning permission in addition to being subject to other regulatory requirements. Planning applications are made to the local planning authority, but the relevant Secretary of State may call in planning applications which he considers might raise issues of national or regional importance. Before determining any called-in planning application, the Secretary of State will normally hold a public inquiry.

Any such disposal facility will also be subject to EC Directive No 85/337 as amended by EC Directive No 97/11, on the assessment of the effects of certain public and private projects on the environment. This was implemented for projects that require planning permission in England and Wales by the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 and, in Scotland, by the Environmental Assessment (Scotland) Regulations 1999. "Installations designed solely for the final disposal of radioactive waste" and "installations designed solely for the storage (planned for more than 10 years) of radioactive waste in a different site from the production site" require environmental assessment in every case. Where environmental assessment is required, the developer must prepare an environmental statement that includes a description of the likely significant effects on the environment and the measures envisaged to avoid, reduce or remedy any significant adverse effects.

Involvement of environment agencies under Town and County Planning Act

In determining a planning application, the planning authority or the inspector at any planning inquiry may consult the relevant Agency on possible environmental impacts of the development. Where requested to do so, the Agency will also comment, in the light of the information available at the time, on whether or not there appears to be any impediment to issue of an authorisation for disposal of waste of the categories and quantities intended. Similarly, HSE/NII would be consulted on whether there appears to be any impediment to granting a site licence.

Notwithstanding any provisional views given by the Agency at the planning stage, the authorisations under RSA 93 and licensing by HSE/NII under the NI Act 1965 will remain legally separate from decisions under the town and country planning legislation.

In commenting on the development proposal to the planning authority or the inspector at any planning inquiry, the Agency will consider whether:

- the proposal is consistent with government policy for radioactive waste management as set out in the 1995 White Paper [1];
- the disposal system chosen is appropriate for the relevant wastes;
- the site, including the geological and Hydrogeological environment, is suitable for the purpose;
- the facility design, proposals for development and the engineered structure appear suitable for the categories and quantities of waste proposed; and
- the proposals appear likely to secure protection of human beings and the environment on a continuing basis both in relation to the normal evolution of the system and to disruptive events.

Nuclear reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999.

EC Directive No 85/337, as amended by EC Directive No 97/11 also requires environmental assessments to be carried out before reactor decommissioning projects can commence. The requirements of the Directive have been introduced into UK law through the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (the EIDAR 99 Regulations). The EIADR 99 Regulations require an Environmental Impact Assessment (EIA) to be carried out by the licensee before HSE considers granting consent for a dismantling or decommissioning project for a nuclear reactor or nuclear power station to commence. HSE consults relevant bodies (including the Agency), and the public on an Environmental Statement (ES) provided by the licensee. It takes the results of such consultation into account when considering consent. HSE may attach any conditions to a consent to start a decommissioning project as appear desirable in the interests of limiting the impact of the project on the environment.

2.2 Guidance

For the purpose of implementing Government policy on radioactive waste management, and after extensive consultation, the environment agencies have prepared Guidance on Requirements for Authorisation of Disposal Facilities on Land for Low and Intermediate level Radioactive Wastes [6].

Amongst other things this Guidance sets out principles and requirements for disposal of low and intermediate level wastes in the first instance but it has regard to the presence of long-lived radionuclides in the wastes and so, in due course, will be broadly applicable also to the disposal of high level wastes.

The essential principles are as follows:

Principle No. 1 – Independence of safety from controls

Following the disposal of radioactive waste, the closure of the disposal facility and the withdrawal of controls, the continued isolation of the waste from the accessible environment shall not depend on actions by future generations to maintain the integrity of the disposal system.

Principle No. 2 – Effects in the future

Radioactive wastes shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today.

Principle No. 3 – Optimisation (as low as reasonably achievable)

The radiological detriment to members of the public that may result from the disposal of radioactive waste shall be as low as reasonably achievable, economic and social factors being taken into account.

Principle No. 4 – Radiological protection standards

The assessed radiological impact of the disposal facility before withdrawal of control over the facility shall be consistent with the source-related and site-related dose constraints and, after withdrawal of control, with the risk target.

The associated radiological requirements are,

Requirement R1 – Period before control is withdrawn (dose constraint)

In the period before control is withdrawn, the effective dose to a representative member of the critical group from a facility shall not exceed a source-related dose constraint. Also during this period, the effective dose to a representative member of the critical group resulting from current discharges from the facility aggregated with the effective dose resulting from current discharges from any other sources at the same location with contiguous boundaries shall not exceed an overall site-related dose constraint of 0.5 mSv/y.

Requirement R2 – Period after control is withdrawn (risk target)

After control is withdrawn, the assessed radiological risk from the facility to a representative member of the potentially exposed group at greatest risk should be consistent with a risk target of 10^{-6} per year (i.e. 1 in a million per year).

Requirement R3 – Use of best practicable means

The best practicable means shall be employed to ensure that any radioactivity coming from a facility will be such that doses to members of the public and risks to future populations are as low as reasonably achievable.

Requirement R4 – Environmental radioactivity

It shall be shown to be unlikely that radionuclides released from the disposal facility would lead at any time to significant increases in the levels of radioactivity in the accessible environment.

And the related technical requirements are:

Requirement R5 – Multiple-factor safety case

The overall safety case for a specialised land disposal facility shall not depend unduly on any single component of the case.

Requirement R6 – Site investigations

The developer shall carry out a programme of investigations to provide information necessary for the safety case and to demonstrate the suitability of the site.

Requirement R7 – Facility design and construction

The facility shall be designed, constructed, operated and be capable of closure so as to avoid adverse effects on the performance of the containment system.

Requirement R8 – Waste form and characterisation

The developer shall derive waste acceptance criteria consistent with assumptions made in assessments of the performance of the system and with the requirements for handling and transport.

Requirement R9 – Monitoring

In support of the safety case, the developer shall carry out a programme to monitor for changes caused by construction of the facility and emplacement of the waste.

Requirement R10 – System of records

The developer shall set up and maintain a comprehensive system of records for the recording of detailed information on all aspects of the project affecting the safety case.

Requirement R11 – Quality Assurance

The developer shall establish a comprehensive quality assurance programme for all activities affecting the safety case. This shall include supporting activities such as research and assessment.

In addition to these principles and requirements, of course, due consideration will be given to the basic principles for radioactive waste management set out in the IAEA Safety Fundamentals [8], published under the RADWASS programme, and to the Standards and Guides which flow from them.

In relation to the safe management of radioactive wastes on nuclear licensed sites, guidance has been issued by HSE [9] containing the following fundamental expectations:

- Production of radioactive waste should be avoided. When radioactive waste is unavoidable, its production should be minimised.
- Radioactive material and radioactive waste should be managed safely throughout its life cycle in a manner that is consistent with modern standards.
- Full use should be made of existing routes for the disposal of radioactive waste.

- Remaining radioactive material and radioactive waste should be put into a passively safe state for interim storage pending future disposal or other long-term solution.

3. CURRENT STATUS

3.1 National Status and Issues

3.1.1 Waste Classification and Sources

In the UK, radioactive waste is classified under the following broad categories, according to its heat-generating capacity and activity content:

1. **high-level, or heat-generating, wastes (HLW),** in which the temperature may rise significantly as a result of their radioactivity, so that this factor has to be taken into account in designing storage or disposal facilities;
2. **intermediate-level wastes (ILW)** with radioactivity levels exceeding the upper boundaries for low-level wastes, but which do not require heating to be taken into account in the design of storage or disposal facilities;
3. **low-level wastes (LLW),** containing radioactive materials other than those acceptable for disposal with ordinary refuse, but not exceeding 4 gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity (eg wastes which, under existing authorisations, can be accepted by BNFL's disposal facility at Drigg in Cumbria, or UKAEA at Dounreay in Caithness);
3. **very low-level wastes (VLLW),** which can be safely disposed of with ordinary refuse ("dustbin disposal"), each $0.1m^3$ of material containing less than 400 kilobecquerels (kBq) of beta/gamma activity or single items containing less than 40kBq of beta/ gamma activity.

Most of the radioactive waste that arises in the UK originates from the nuclear power industry. This includes waste from the manufacture of fuel, reactor operations, decommissioning, spent fuel reprocessing and related research and development activities. Wastes also arise from the defence programme, of which the major components are nuclear weapons production and the nuclear submarine propulsion programme. In addition, many medical, industrial, educational and research establishments produce small quantities of radioactive wastes.

3.1.2 Waste Management Strategy

Low level wastes are currently disposed of to the BNFL owned shallow burial facility at Drigg. (Very low-level wastes may be disposed of with ordinary refuse and solid low level waste may also be buried with special arrangements in municipal landfills). Intermediate level and high level wastes are stored, generally where they arise, pending availability of disposal routes. Given the now likely requirement for extended storage of such wastes, it may be noted that the Government made specific reference to the associated requirements in its 1995 White Paper [1]. This states that,

> "The Government believes that where the demands of safety are overriding, waste must be treated as necessary to improve storage conditions. In addition, where early treatment of waste will secure worthwhile safety benefits, or worthwhile economic

benefits without prejudicing safety, the general presumption against action which might foreclose future waste management options may be relaxed. The relevant costs and commercial risks must be borne by the owner of the waste. Decisions by operators and regulators will need to have regard to all relevant factors, including the following:

a. the need for continuing safe storage of the waste, treated and/or contained as necessary;

b. the benefits of placing the waste in a chemically and physically stable form, so that safety may be achieved by passive means the risk that treated waste will be incompatible with future disposal requirements and the practicability of re-working treated waste in the future, for disposal or for a period of further storage, should this be necessary;

d. the state of storage facilities, including the benefits which would be derived from refurbishment or upgrading;

e. the need to minimise waste degeneration, secondary waste arisings and releases to the environment;

f. the need to minimise dependence on active safety systems maintenance, monitoring and human intervention;

g. the retrievability of the waste for disposal."

3.1.3 Current Issues

Following the refusal, in March 1997, of planning permission for construction of a Rock Characterisation Facility by Nirex for investigation of a potential disposal site near Sellafield, a Parliamentary Committee studied the issues associated with radioactive waste management and issued a report on its findings [10]. More recently, in September 2001, the UK Government and the Devolved Administrations for Scotland , Wales and Northern Ireland issued a consultation paper "Managing Radioactive Waste Safely" [11]. The paper is intended to launch a national debate which will lead up to a decision on how to manage the UK radioactive waste in the long term. An aim is to develop and implement a UK nuclear waste management programme which inspires public support and confidence. The paper asks a number of questions, including whether certain radioactive materials, such as plutonium, or spent nuclear fuel, should be classified as waste. Consultation closes on 12 March 2002.

The Government is also developing Statutory Guidance to the Environment Agency on the regulation of radioactive discharges into the environment from nuclear licensed sites. Amongst other things, this has regard to the UK strategy for sustainable development [2] and to international obligations, in particular those under the Oslo and Paris (OSPAR) Convention.

Major issues for radioactive waste management at nuclear licensed sites in the UK include the retrieval of legacy wastes, and methods of treatment for waste with no identified disposal route.

Practical regulatory issues for discussion regarding disposal of wastes

So far as the regulatory methodology is concerned some practical issues remain to be resolved. In the UK there is already a substantial body of experience in dealing with disposal of low level waste by shallow burial but, as in most other countries, little direct experience in dealing with geological disposal of long-lived intermediate and high level wastes. The issues fall into two categories; those of a technical nature and associated with the long timescales involved and those of an administrative or legal nature.

Technical issues

Most of these issues are well recognised and have been the subject of discussion for some time. The difference now is that decisions are imminent and will have to be made on a basis that is transparent, capable of clear explanation to all interested parties and that secures the confidence of society at large.

They include,

Model validation*:* Do we understand the relevant physical and chemical processes well enough? Are our models good enough representations of the natural processes? Will they be good enough for the relevant timescales? What is enough? What to do if regulators or, more importantly, society at large cannot be convinced on these points?

Handling of uncertainties*:* How to identify and handle those uncertainties in elements which may have an important and perhaps irreversible influence on long-term outcomes?

Critical groups or potentially exposed groups: How to define for the purpose of assessing consequences against a target for risk or potential exposure given the two-dimensional nature of this parameter (i.e. probability and consequence)?

Retrievability: What does this mean if applied to the post-closure phase? How to assess the effect of such provision on the long-term integrity of a repository

Spatial equity*:* How to ensure that legitimate interests of those who have derived no benefit from the source of waste are adequately protected? The history of sea-dumping may be informative here. (This is distinct from temporal equity which is fully recognised by reference to protection of future generations)

Protection of the environment, as such: How to identify those sectors of the environment (flora and fauna) which may be affected? How to measure the effects? What standards of protection to apply? How to enforce?

Decision logic*:* To what extent should decisions be based on pass/fail by reference to some fixed standard or upon a multi-attribute analysis which allows, in some transparent fashion, for discretion and qualitative judgement? If the latter, how is transparency and public confidence achieved.

Step-wise approach to regulation*:* How and when should regulator/developer interface be established, how should it be structured and how should public be involved.

Administrative/Legal issues

In order to be able to comment, effectively, on any proposal for deep disposal of long-lived waste consideration is also being given to the terms and conditions of an authorisation and to what would be required to satisfy them. This raises issues which may merit discussion. They include the following,

Definition of "Disposal": When is waste emplaced in a repository actually disposed of, for legal purposes? This would need to consider potential issues such as retrievability and delayed backfilling.

Boundaries of Applicability: Should the same authorisation apply to the operational phase and to the closure and post-closure requirements?

Types of Radioactivity limit: Should activity limits relate to volume, mass, emplacement rate, total for repository (or structural element of it) or to a combination of these.

Discharges during operational phase: Is there likely to be any unusual requirement in respect of any liquid and gaseous discharges during this phase.

Restrictions: How best to express limits for heat generation, for criticality or for incompatible materials. (e.g. cellulosics in the presence of actinides).

Non-standard Waste forms: How to deal with out-of-specification waste or waste not covered by safety case.

Waste Retrieval: How to address provision for this if necessary?

Quality Assurance/Checking: How, and when, best to address the need for checking of packaged waste before emplacement?

Records: What provision needs to be made for marking of packages and for keeping of records, and for how long?

Closure and Post-Closure Requirements: What needs to be included in the authorisation, as such? (As opposed to being defined in the safety case)

3.3 R&D Programme

3.3.1 Functions - Responsibilities

The Environment Agency's radioactive waste research and development programme focuses on requirements for the regulatory aspects of radioactive waste disposal within the Agency's broad remit for environmental protection.

A significant part of the research programme has been undertaken to maintain and extend the Environment Agency's expertise to assess safety cases, submitted under the Radioactive Substances Act 1993 (RSA93), for existing and proposed radioactive waste disposal facilities. This expertise is being applied in the assessment of British Nuclear Fuel's developing safety case for its Drigg near-surface disposal facility to be submitted to the Agency in September 2002. Since 1997, the programme has been broadened to include more research directly supporting regulatory activities and also environmental impact research. Overall the programme reflects the need for the Agency to maintain and develop its capabilities as the sole regulator of radioactive waste disposal under RSA 93 in England and Wales, and the broader duties of the Agency under the Environment Act 1995.

Regulatory involvement in R&D Planning

In addition to undertaking its own research, the Agency undertakes research to support its regulatory duties, and its broad strategic remit for environmental protection. It liases on research matters with other regulators, Government departments and industry in the UK, together with international organisations.

3.3.2 Contents of R&D Plans

The Agency's R&D programme has changed significantly following the Government decision in March 1997 not to give planning consent for UK Nirex's proposed Rock Characterisation Facility. This effectively halted the UK programme for a deep underground repository near Sellafield. Consequently, the Agency's R&D moved away from the technical issues surrounding geological disposal to more strategic studies aimed at supporting current and future regulatory needs.

In the area of radionuclide migration and transport, the Agency contributed to the NEA/EU study on gas migration and two-phase flow through engineered and geological barriers for a deep repository for radioactive waste [12]. The Agency also contributed to a collaborative programme to update a book on natural analogue studies first published in 1994 [13]. The book takes into account of developments in thinking in the area of natural analogue studies, particularly in relation to their use in providing qualitative illustrations of safety. The book provides an updated review of natural analogue studies that maintains its value as a technical reference but is also accessible to wider audiences.

The Agency has completed a study that aimed to identify a suitable approach for making judgements of acceptability in relation to a risk target [14]. The project examined the basis for using the expectation value of risk and investigated what approach the Agency might adopt in judging the acceptability of a dose versus probability profile for a given facility. A jointly funded study with UK Nirex has been completed on potential natural safety indicators such as geochemical fluxes and their application to radioactive waste disposal in the UK [15].

Environmental impact and biosphere studies include participation in two projects under the EU's Fifth Framework Programme (FP5):

- FASSET – aimed at developing a framework for environmental assessments of the radiological impact on biota and ecosystems. Work has already been completed by the Agency and English Nature on impact assessment of ionising radiation in wildlife [16]. The project report describes the behaviour and transfer of radionuclides in a number of different ecosystems relevant to authorisations for discharges of radioactivity in the UK.
- BIOCLIM – aimed at developing a climate-driven approach to biosphere evolution in order to aid long-term safety assessment of radioactive waste disposal.

The Agency has widened its R&D programme to consider issues of risk communication, transparency and public dialogue in relation to long-term radioactive waste management. An important project is the RISCOM II Project under FP5, which has the overall aim of supporting the participant organisations in developing transparency in their nuclear waste programmes and the means for a greater degree of public participation. The UK contribution to the RISCOM II project includes implementation and analysis of a series of novel dialogue processes and implementation of a schools web-site as a possible means of engaging younger people in the debate on radioactive waste management issues. Also under FP5, the Agency is participating in the BORIS project, which aims to enhance understanding of the geochemical processes that influence the long-term safety of radioactive waste disposal and, of particular interest to the Agency, to communicate the knowledge to a wide range of stakeholders. The project is based on studies at two sites (Tomsk-7 and Krasnoyarsk-26) in Russia at which liquid radioactive wastes have been disposed by deep borehole injection.

Forward Programme

The Agency is planning to undertake further studies on assessment of the impact of ionising radiation on wildlife as an extension of the work being carried out under the FASSET project. Generic work on underground disposal of radioactive waste will be very limited in scope pending the outcome of the current Government consultation on future radioactive management policy. The Agency will maintain a programme of R&D to support current regulatory work although this will be principally related to impacts of radioactive discharges.

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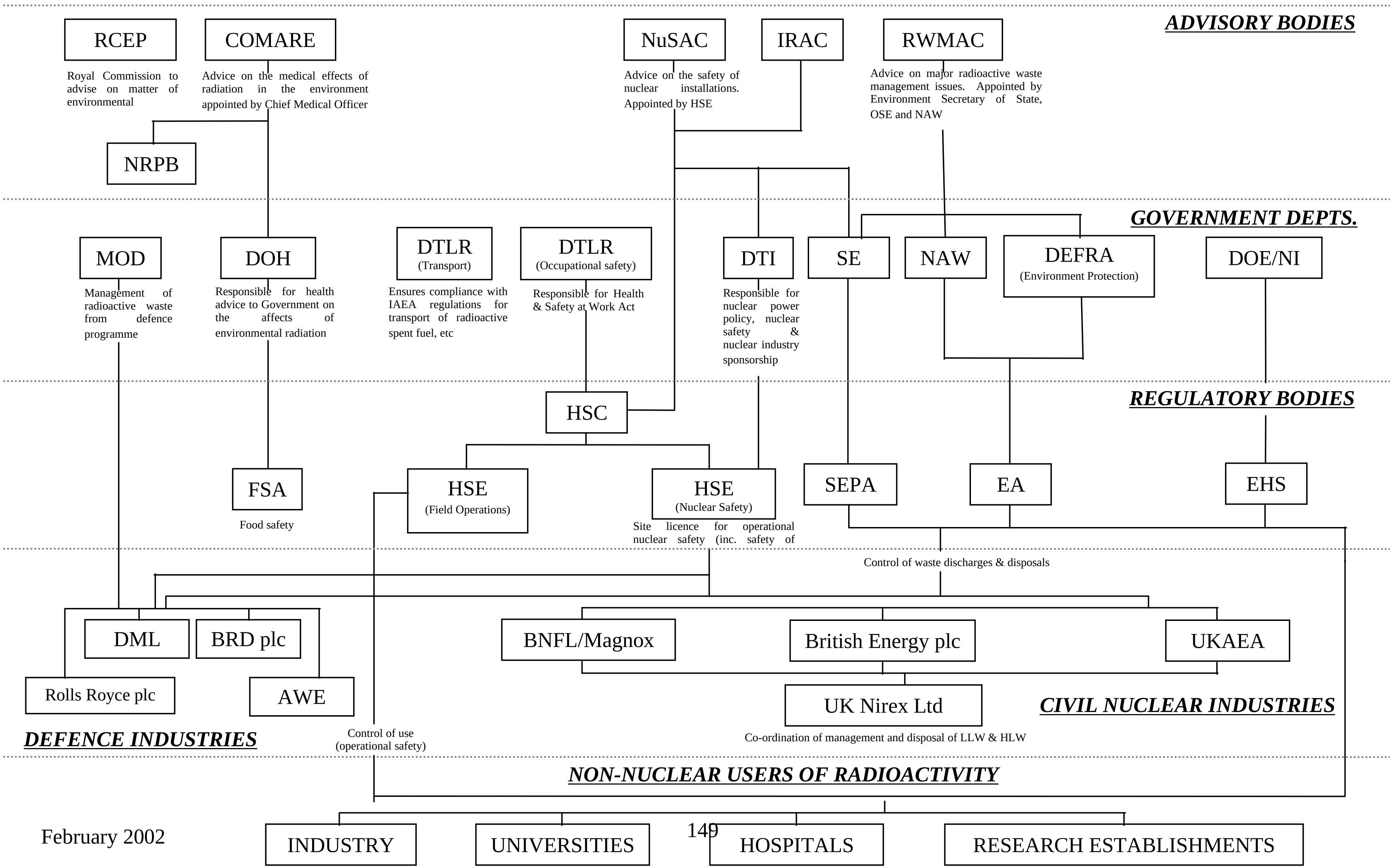
ANNEX I

GLOSSARY OF ACRONYMS (See also figure 1)

AWE	Atomic Weapons Establishment
BNFL	British Nuclear Fuels Plc
BRD	Babcock Rosyth Defence
COMARE	Committee on the Medical Aspects of Radiation in the Environment
DEFRA	Department for Environment, Food and Rural Affairs
DML	Devonport Management Limited
DOE/NI	Department of Environment/Northern Ireland
DOH	Department of Health
DTI	Department of Trade and Industry
DTLR	Department of Transport, Local Government and the Regions
EA	Environment Agency
EHS	Environment and Heritage Service
FSA	Food Standards Agency
HSC	Health and Safety Commission
HSE	Health and Safety Executive
IRAC	Ionising Radiation's Advisory Committee
MOD	Ministry of Defence
NAW	National Assembly for Wales
NRPB	National Radiological Protection Board
NuSAC	Nuclear Safety Advisory Committee
RCEP	Royal Commission on Environmental Pollution
RWMAC	Radioactive Waste Management Advisory Committee
SE	Scottish Executive
SEPA	Scottish Environmental Protection Agency
UKAEA	UK Atomic Energy Authority

Figure 1-Radioactive Waste: Policy, Advice, Regulation & Operation in the UK



USA

1. NATIONAL AND REGULATORY FRAMEWORK

1.1 National framework

1.1.1 National policy

The national policy on regulatory control of radioactive waste management in the United States of America has evolved through a series of laws that established the Federal governmental agencies responsible for the safety of radioactive materials. Beginning in 1954, Congress passed legislation that for the first time permitted the wide use of atomic energy for peaceful purposes. The 1954 Atomic Energy Act (AEA – see Appendix A for a narrative of the legislation) redefined the atomic energy program by ending the government monopoly on technical data and making the growth of a private commercial nuclear industry an urgent national goal. The Atomic Energy Act established the Atomic Energy Commission (AEC) with sole Federal responsibility to regulate the commercial use of source, byproduct and special nuclear material including the regulation of civilian nuclear reactors. The Atomic Energy Act directed the AEC "...to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes...." At the same time, it instructed the AEC to prepare regulations that would protect public health and safety from radiation hazards. Thus, the 1954 act assigned the AEC three major roles: to continue its weapons program, to promote the private use of atomic energy for peaceful applications, and to protect public health and safety from the hazards of commercial nuclear power.

In 1969, Congress passed the National Environmental Policy Act (NEPA) which established a national policy for the environment and provided for the establishment of the Council on Environmental Quality (CEQ). Subsequently, the U.S. Environmental Protection Agency (EPA) was created in 1970. At that time, EPA was given AEA authority for setting generally applicable standards for radioactivity in the environment. This authority has been used to establish standards for cleanup of uranium mill tailing sites, to establish environmental standards for the uranium fuel cycle, and to set environmental radiation protection standards for management and disposal of spent nuclear fuel (SNF), high level radioactive waste (HLW), and transuranic waste (TRU).[1] Standards developed by EPA, under the AEA, are implemented and enforced by others. A separate statute does give EPA authority to enforce its standards at DOE's Waste Isolation Pilot Plant[2] where TRU is now being disposed. In addition, under provisions of two major environmental statutes, the Clean Air Act (CAA) and the Safe Drinking Water Act (SDWA), EPA has the responsibility for regulating and enforcing the

1. As used in this document, HLW includes SNF and TRU, unless otherwise specifically stated.
2. For addition information on WIPP, the following DOE web site should be consulted: http://www.epa.gov/radiation/wipp.

levels of radioactivity in air emissions and in drinking water. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA can determine soil cleanup values and other residual radioactivity limits at contaminated sites that are covered by the Superfund Program. EPA also has authority to provide overall guidance to other Federal agencies on radiation protection matters that affect public health.

In 1974, Congress passed the Energy Reorganization Act which separated the AEC into the U.S. Nuclear Regulatory Commission (NRC) and Energy Research and Development Administration (ERDA) [the predecessor of the Department of Energy (DOE)]. Additional legislation further defined the roles of the NRC and the DOE, and introduced a role for the States through the Low-Level Radioactive Waste Policy Act of 1980 (LLWPA) and the Low-Level Radioactive Waste Policy Amendments Act of 1985 which assigned to the States, rather than the Federal Government, responsibility for providing disposal capacity for commercial LLW. With regard to HLW, the Nuclear Waste Policy Act of 1982 (NWPA), and the Nuclear Waste Policy Amendments Act of 1987 (NWPAA) specified a detailed approach for the disposal of HLW with DOE having operational responsibility for the HLW repository, and the NRC having regulatory responsibility for the transportation, storage, and geologic disposal of the waste.

Most recently in 1992, Congress passed the Energy Policy Act (EnPA) mandating a new and different process for developing the HLW disposal regulations for the proposed repository at Yucca Mountain, Nevada. Congress, through EnPA, directed the National Academy of Sciences (NAS) to evaluate the scientific basis for a Yucca Mountain standard, and directed EPA to promulgate new environmental standards based on and consistent with the findings and recommendations of the NAS.

Since the 1987 Nuclear Waste Policy Amendments Act limited characterization of candidate repository sites to Yucca Mountain, the requirements for the repository regulatory framework have evolved from the generic to the site-specific. To be consistent with the 1987 amendments, the Energy Policy Act of 1992 directed EPA to develop site-specific radiation protection standards for a repository at Yucca Mountain and directed NRC to revise its repository licensing criteria to be consistent with EPA’s standards. DOE accordingly decided to amend its general siting guidelines to reflect a site-specific evaluation. After the end of Fiscal Year 2001, the regulatory framework was finalized.

EPA finalized its radiation protection standards and issued the final rule, 40 CFR Part 197, on June 13, 2001. The standards are designed to protect the residents closest to a potential repository by establishing maximum levels that are within EPA’s acceptable risk range for environmental pollutants.

As directed by the Energy Policy Act, the NRC role is to implement the public health and safety standards established by EPA in any licensing process NRC may conduct for a repository at Yucca Mountain. NRC finalized its licensing criteria and published the final 10 CFR Part 63 on November 2, 2001, incorporating EPA's public health and environmental standards.

DOE issued its final repository siting guidelines, *General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Yucca Mountain Site Suitability Guidelines,* 10 CFR Part 963, on November 14, 2001. The publication of 10 CFR 963 completed the regulatory framework the Secretary used to determine whether the Yucca Mountain site is suitable for development as a repository

1.1.2. Institutional framework

U.S. legislation established a role for the following three Federal agencies regarding the geologic disposal of HLW from civilian nuclear power plants. DOE is responsible for developing general guidelines for the siting of a repository in a geologic formation, as well as for designing, building, and operating this geologic repository.[3] EPA is responsible for promulgating generally applicable standards necessary to protect the public from releases of radioactive material from the geologic repository. NRC is responsible the development of technical criteria and requirements for licensing any potential geologic repository – including repository construction, operations, and closure.

1.2. Regulatory framework

1.2.1. Regulatory function

NRC is an independent regulatory agency established by the Congress under the Energy Reorganization Act of 1974 to ensure adequate protection of the public health and safety, the common defense and security, and the environment in the civilian use of nuclear materials in the U.S. NRC's scope of responsibility includes regulation of: (i) commercial nuclear power; non-power research, test, and training reactors; (ii) fuel cycle facilities; medical, academic, and industrial uses of nuclear materials; and (iii) the transport, storage, and disposal of nuclear materials and waste.

To fulfill the agency's Congressionally-mandated mission, the NRC has established licensing procedures for regulating the use of byproduct, source, and special nuclear materials. Specifically, the NRC goals for radioactive waste management are to:

- Ensure treatment, storage, and disposal of waste produced by civilian use of nuclear materials in ways that do not adversely affect future generations; and to

- Protect the environment in connection with civilian use of source, byproduct, or special nuclear materials through the implementation of the AEA and NEPA.

1.2.2. Organization and resources

NRC has established an Office of Nuclear Material Safety and Safeguards (NMSS) to conduct public health and safety licensing, inspection, and environmental reviews for all domestic activities regulated by the NRC, except operating power and all non-power reactors. Specifically, NMSS directs all licensing and inspection activities of NRC associated with domestic nuclear fuel cycle facilities, uses of nuclear materials, transport of nuclear materials, management and disposal of LLW and HLW, and decontamination and decommissioning of facilities and sites. NRC also has an Office of Nuclear Regulatory Research (RES) which is responsible for establishing the technical basis for regulations, and provides information and technical basis for developing acceptance criteria for

3. The U.S. Nuclear Waste Technical Review Board (NWTRB) provides independent scientific and technical oversight of the DOE program. The NWTRB web site is located at http://www.nwtrb.gov.

licensing reviews. RES conducts research and performs analyses both in-house and through contractors to develop an independent basis for timely and realistic regulatory decisions, anticipates potential future safety problems and develops research programs to address these problems, and interprets research results to provide guidance for resolving licensing issues.

An important aspect of NRC's regulatory program is its inspection and enforcement activities. The NRC has four regional offices (Region I in King of Prussia, Pennsylvania; Region II in Atlanta, Georgia; Region III in Lisle, Illinois; and Region IV in Arlington, Texas) which conduct inspections of licensed facilities including nuclear waste facilities. NRC also has an Office of State Programs which establishes and maintains communication with State and local governments, and administers the Agreement States Program. An Agreement State is a State that has signed an agreement with the NRC allowing the State to regulate the use of radioactive material within that State, consistent with the Commission's regulations.

2. LEGISLATION AND REGULATION

2.1 Legislation

Relevant laws (see Appendix A for narratives on each Federal Act of Congress) authorizing NRC's regulatory programs include:

- Atomic Energy Act of 1954, as amended;
- National Environmental Policy Act of 1969, as amended;
- Energy Reorganization Act of 1974, as amended;
- Uranium Mill Tailings Radiation Control Act of 1978, as amended;
- Low-Level Radioactive Waste Policy Act of 1980 and the Low-Level Radioactive Waste Policy Amendments Act of 1985;
- Nuclear Waste Policy Act of 1982 and the Nuclear Waste Policy Amendments Act of 1987; and
- Energy Policy Act of 1992.

2.2 General regulations

The applicable general regulations for the each of the three Federal Agencies principally responsible for radioactive waste regulation are contained in Title 10 (for NRC and DOE) and Title 40 (for EPA) of the *U.S. Code of Federal Regulations* (CFR), which is published annually. Regulations are developed through an open process, including the opportunity for public comment, and are published daily, in proposed or final forms, in the *Federal Register*.

2.3 Specific regulations

A listing of specific regulations for each Agency is provided in Appendix B.

2.4 Guidance

NRC issues guidance on how to implement its regulations in the form of *Regulatory Guides* and *Staff Positions*. *Regulatory Guides* are drafted by the NRC staff to establish a standard approach to licensing. They are not intended to be regulatory requirements, but they do reflect methods, procedures, or actions which would be considered acceptable by the staff for implementing specific parts of the Commission's regulations. Current plans are to issue Regulatory Guides describing the standard format and content for license applications. *Staff Positions*[4] are divided into two general types: so-called "generic" positions, dealing with issues which relate to licensing activities for nuclear facilities independent of the technology or site selected; and site-specific positions, which give site guidance or advice applicable to a specific site. A listing of recently issued guidance by the NRC is provided in Appendix C. In addition to the above guidance mechanisms, the NRC staff uses Standard Review Plans, which provide guidance to the NRC staff in reviewing licensee submittals. These plans are made public, so that licensees and applicants understand what is needed to comply with regulations. In this respect, the licensees and applicants have this third type of guidance to assist them in preparing their demonstration of compliance with the applicable regulations and standards.

2.5 Others

The NRC staff and contractors have actively participated in Nuclear Energy Agency (NEA/OECD) and International Atomic Energy Agency (IAEA) activities dealing with disposal criteria, development of approaches for site characterization, and development of performance assessment methodologies. Important guidance for radiation protection programs is provided in International Commission on Radiation protection (ICRP) technical guidelines. The ICRP standards are cited in NRC staff documents which focus on dose assessments.

3. CURRENT STATUS

3.1 Background

Nuclear waste is a byproduct of the use of radioactive materials. HLW results primarily from SNF used by power reactors to produce electricity. LLW results from reactor operations, and from medical, academic, industrial, and other commercial uses, and generally contains relatively limited concentrations of radioactivity. Decommissioning waste results from the decontamination and removal of radioactive materials encountered at NRC-licensed facilities during site closure and restoration activities. Uranium mill tailing waste results from commercial uranium ore processing activities following mining and uranium extraction research and development projects, and uranium recovery waste results from *in situ* leach solution mining activities involving injection and recovery wells.

HLW: Currently 104 operating nuclear power reactors provide 20% of the electricity provided in the U.S. About 91,000 spent fuel assemblies are currently stored in the U.S. Of these, about 87,500 assemblies are stored at nuclear power plants, and approximately 3,500 assemblies are stored at away-from-reactor storage facilities, such as the General Electric plant at Morris, Illinois. The vast majority of the assemblies stored in the U.S. are stored in water pools, and less than 2 percent are stored in dry casks. These reactors contribute between 1800 and 2200 metric tons of heavy metal (MTHM) annually to the accumulating amount of spent nuclear fuel (SNF), estimated to be approximately 46,600 MTHM at the end of 2002. Projected SNF discharges taking into account plant life extensions could bring the total to 105,000 MTHM by the year 2046. In addition to SNF, there is

4. Also include Staff Technical Positions and Branch Technical Positions.

a need to manage high-level radioactive waste (HLW), SNF, and excess plutonium generated from defense programs. The Nuclear Waste Policy Act (NWPA) limits the emplacement of waste at the Yucca Mountain repository to 70,000 MTHM until a second licensed repository is in operation. Emplacement of more than this at Yucca Mountain would require either legislation or opening a second repository.

All of the operating nuclear power reactors are storing used fuel under NRC license in on-site spent fuel pools (SFPs), or in independent spent fuel storage installations. In 1977, the Carter Administration declared a moratorium on domestic reprocessing, which was later rescinded during the Regan Administration, in 1981. In response to the initial moratorium, the utilities expanded their SFPs by using high-density storage racks. In 1990, the NRC amended its regulations to authorize licensees to store spent fuel in dry storage casks, at reactor sites, approved by the NRC. Several cask designs have received certificates of compliance as a result of this regulation change.

LLW: The volume and radioactivity of waste vary from year to year based on the types and quantities of LLW shipped each year.[5] Generally, the volume of operational LLW being disposed has been decreasing over the years due to significant advances in volume reduction techniques. Large volumes of waste have been generated from facilities undergoing decommissioning, and sites being remediated, in recent years, however LLW activity in curies has also increased due to major components from decommissioning or replacement. Approximately 100 thousand cubic meters of LLW was disposed of in 2000 (constituting approximately 782 thousand curies of radioactivity).[6] In 2000, the sources of LLW by activity were: 93.8 percent nuclear power reactors, 6.1 percent industry with the remaining academic, medical, governmental and undefined (together less than 0.1 percent).

Commercial LLW disposal facilities must be licensed by either NRC, or an Agreement State, in accordance with NRC’s health and safety requirements. The facilities are to be designed, constructed, and operated to meet safety standards. The operator of the facility must also extensively characterize the site on which the facility is located and analyze how the facility will perform for thousands of years into the future. NRC's requirements place restrictions on the types of waste that can be disposed of. Current LLW disposal uses shallow land burial sites.

Uranium recovery: Specific staff activities under the Uranium Mill Tailings Radiation Control Act (UMTRCA) encompass the following: (i) oversight and programmatic direction for the uranium recovery program; (ii) implementation of policies and programs; and (iii) review of uranium recovery licensing and inspection programs for technical adequacy and consistency. The staff also provides technical assistance to Agreement States on uranium recovery issues and implements an active interface program including ongoing consultation with Federal, State, Indian tribe, and other entities to promote understanding of uranium programs and to resolve concerns in a timely manner.

Tailing wastes are generated during the milling of certain ores to extract uranium and thorium. These wastes have relatively low concentrations of radioactive materials with long half-lives. Tailings contain radium (which, through radioactive decay, becomes radon), thorium, and small

5. The NRC classification system for LLW is based on potential LLW hazards and has specified disposal and waste form requirements for each of the three general classes of waste, namely A, B and C. Class A waste contains lower concentrations of radioactive material than Class C waste.

6. Information on individual generators, handlers, shipments, and containers may be obtained from the Manifest Information Management System (MIMS). The Idaho National Engineering and Environmental Laboratory maintains and operates MIMS for the LLW community and the public. The MINS web site is located at http://mims.inel.gov. The most recent data are for calendar year 1998.

residual amounts of uranium that were not extracted during the milling process. The Office of Surface Mining, U.S. Department of Interior and individual states regulate mining. NRC regulates milling and the disposal of tailings in non-Agreement States, while State agencies regulate these activities in Agreement States when the agreement specifically includes tailings. Mill tailings consist of fine-grained, sand-like and silty materials, usually deposited in large piles next to the mill that processed the ore. Uranium mills are located principally in the western United States, where deposits of uranium ore are plentiful. NRC requires licensees to meet EPA standards for cleanup of uranium and thorium mill sites after the milling operations have permanently closed. This includes requirements for long-term stability of the mill tailings piles, radon emissions control, water quality protection and cleanup, and cleanup of lands and buildings.

Decommissioning: Over the last 40 years, operation at licensed nuclear facilities have caused radiological contamination at a number of sites. This contamination must be reduced or stabilized in a timely and efficient manner to ensure protection of the public and the environment before the sites can be released and the license terminated.

3.2 National status and Issues

HLW: During 2001 and early 2002, the U.S. Department of Energy completed the investigations needed to support a determination of site suitability, made that information available to the public, and invited public comment. On January 11, 2002, the Secretary of Energy, as required by the NWPA, notified Governor Guinn of Nevada of his intent to recommend the Yucca Mountain site for development of a geologic repository. Citing compelling national interests that warrant this decision, the Secretary stated that a repository was vital to ensure America's national security, support energy security, secure disposal of nuclear wastes, and provide for a cleaner environment. On February 14, 2002 the Secretary of Energy, after a comprehensive review of the science, testing, and analyses conducted over 20 years, recommended to the President that the Yucca Mountain site be developed as an underground repository for spent nuclear fuel and high-level waste. On February 15, 2002 the President approved the Secretary's recommendation and forwarded it to Congress for site designation.

In April 2002, Governor Guinn submitted a letter of disapproval to Congress. The site will be disapproved unless, during the first period of 90 calendar days of continuous session after the notice of disapproval, Congress passes a joint resolution of repository approval and the resolution becomes law.

Should the site designation become effective, DOE will submit a license application to the Nuclear Regulatory Commission (NRC) in 2004 for repository construction authorization. The license review by the NRC is expected to take about three years. The DOE will then spend approximately 2 years constructing the repository and subsequently apply to the NRC for a license amendment to allow receipt and possession of waste. Given adequate funding and successful completion of the licensing process, the first nuclear waste shipments could begin arriving at the repository by 2010.

LLW: LLWPA, amended in 1985, made States responsible for providing for the disposal of commercial LLW generated within their borders. The Act encouraged States to enter into compacts that would allow several States to dispose of waste at a regional disposal facility. Most of the States have entered into compacts At one time, a dozen new sites were being planned by the States, and a number of design and siting programs were implemented. However, to date, no new disposal facilities have been opened and no States have plans for a new facility at the present time.

Uranium recovery: NRC and DOE have a joint responsibility for implementing programs required by UMTRCA. UMTRCA established two programs to protect public health and the environment: Title I and Title II. The Title I program established a joint federal/state funded program for remedial action at abandoned mill tailings sites, with ultimate Federal ownership under license from NRC. Under Title I NRC must evaluate DOE’s designs and concur that DOE’s actions meet standards set by EPA. For Title I, only reviews for the groundwater remedial action program remain, as all surface remedial action was completed in fiscal year 1999. NRC and DOE have a memorandum of understanding (MOU) to minimize or eliminate unnecessary duplication of effort between the two agencies.

The NRC staff is responsible for planning and implementing the regulatory programs under UMTRCA. The Title I (of UMTRCA) program involves managing, coordinating, and conducting the safety and environmental reviews of pre-licensing and licensing activities, and the review and concurrence of documents related to the cleanup and licensing of abandoned uranium mill tailings sites. The Title II (of UMTRCA) program involves planning and directing the activities related to active, licensed uranium recovery facilities, including facility licensing and operation, as well as mill tailings management and decommissioning.

The Title II program deals with sites under license to the NRC or Agreement States. Under Title II NRC has the authority to control radiological and non-radiological hazards and ensure that NRC- and Agreement State- licensed sites meet all applicable standards and requirements during operations and before termination of the license. The staff reviews Title II licensee plans for operation, reclamation, decommissioning, and ground-water corrective action; license applications and renewals; license conditions changes; and annual surety up-dates. The staff also prepares environmental assessments for certain licensing actions. Long-term care of reclaimed tailings sites (by State or DOE) is licensed by the NRC under general licenses at 10 CFR Part 40.27 and 40.28.

Decommissioning: Under NRC regulations, decommissioning involves safely removing an NRC-licensed facility from service and reducing residual radioactivity to a level that permits the property to be released for unrestricted or restricted use. This action is taken by a licensee before termination of the license. In other cases, non-licensed facilities may also be required to decontaminate and decommission the site in order to meet NRC release limits. Appendix D lists the performance goals for measuring results toward meeting NRC’s nuclear waste safety and environmental protection goals. This activity comprises NRC's integrated regulation of the decontamination and decommissioning of facilities and sites associated with NRC-licensed activities, including associated research, rulemaking efforts, and the technical interface with EPA to resolve issues of mutual interest in accordance with the March 1992 MOU.

3.3 Waste management strategy

HLW: In its *Strategic Plan*, the NRC has committed itself in the HLW area to:

- Advise DOE and prepare to review a potential DOE license application for a HLW repository at a pace consistent with the national program;
- Participate in the development of a practical and implementable HLW radiation safety standards, which it has done. NRC will implement the HLW radiation standard through site-specific, performance (assessment)-based regulation.
- Focus on resolving the key technical issues (KTIs) that are considered most important to the potential performance of any Yucca Mountain repository to provide early feedback to DOE on potentially significant site, design, or assessment flaws as they are identified during the site characterization. Maintain the regulatory framework and the capability necessary to regulate transportation and storage of SNF.
- Increase Public Confidence

LLW: Similarly in the *Strategic Plan*, the NRC has committed itself in the LLW area to:

- Maintain a consistent national program
- Provide support to States, as requested, to resolve specific technical issues
- Review requests for onsite disposal
- Increase Public Confidence

At present there are only three active, licensed LLW disposal facilities: the Barnwell (South Carolina) site – access authorized for all LLW generators at the present time, but which will close to waste outside of the Atlantic Compact (South Carolina, Connecticut, and New Jersey) in 2008 ; the Hanford (Washington) site – restricted access to only the Northwest and Rocky Mountain Compacts; and the Clive (Utah) site – restricted to only Class A waste. LLW sites which are now closed are: Beatty, Nevada (closed 1993); Maxey Flats, Kentucky (closed 1977); Sheffield, Illinois (closed 1978), and West Valley, New York (closed 1975).

In 2000, the largest volume of LLW went to the Clive site (91.9 percent) with the remaining disposed at the Barnwell (3.4 percent) and Hanford (4.7 percent) sites. In contrast, the largest activity (curies) amount went to the Barnwell site (89.6 percent) with the remaining disposed at the Hanford (10.3 percent) and Clive (less than 0.2 percent) sites.

Decommissioning: NRC's License Termination Rule or LTR (10 CFR Part 20, Subpart E) authorizes two different sets of cleanup criteria – the *Site Decommissioning Management Plan* (SDMP) Action Plan criteria, and dose-based criteria. Under the provisions of 10 CFR 20.1401(b), any licensee that submitted its *Decommissioning Plan* (DP) before August 1998, and received NRC approval of that DP before August 20, 1999, could use the SDMP Action Plan criteria for site redemption. The Commission granted an extension of the DP approval deadline for 12 sites. In September 2000, the staff notified the Commission that all 12 DPI were approved by the deadline. All other sites must use the dose-based criteria of the LTR.

3.4 Current issues/problems

Major factors or assumptions affecting the NRC's nuclear waste safety strategy are as follows:

- Permanent disposal of HLW will continue to be a national goal; however, uncertainty exists about whether and how the U.S. Congress will allow the President's site recommendation take effect or, in the alternative, change the approach for reaching this goal achieving permanent disposal.
- There will continue to be opposition to the disposal of nuclear waste, delaying progress in developing both HLW and LLW disposal facilities.
- Sites that are developed by States in response to legislative requirements to develop new LLW disposal sites will most likely be licensed by the Agreement States rather than by the NRC.

HLW:

Accompanying the Secretary's recommendation of Yucca Mountain were NRC's preliminary comments regarding the sufficiency of DOE's at-depth site characterization and waste form proposal. NRC has made no findings with regard to whether the DOE has demonstrated compliance with applicable standards and regulations. Only after NRC has received, and accepted for review, a potential license application, would it seek to evaluate the adequacy of DOE's demonstration of compliance.

LLW: In the late 1980s and early 1990s, States were in various stages of forming compacts, and siting and trying to license LLW disposal facilities in an attempt to meet the milestones of LWPAA. To ensure that the NRC would be able to meet its statutory requirements of reviewing a license application within 15 months after an application was received, the Commission directed staff to develop a plan for developing and enhancing staff's ability to conduct a performance assessment of an LLW disposal facility. In response, staff proposed a plan that included developing guidance on conducting performance assessments of LLW disposal facilities.

In October 2000, the staff published a final report, "A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities: Recommendations of NRC 's Performance Assessment Working Group" (NUREG-1573). Prior to its finalization, the staff issued a preliminary draft of the report and distributed it to all Agreement States, the NRC Advisory Committee on Nuclear Waste (ACNW), DOE, EPA, and the U.S. Geological Survey (USGS). The staff held public workshops with the States, other Federal agencies, and the ACNW and made revisions to the report based on comments received at those workshops. The staff also conducted a performance assessment of a "mock" LLW disposal facility to test approaches, gain additional insights in resolving key issues, and enhance staff performance assessment capabilities.

Decommissioning: There are currently 22 SDMP sites and five additional complex decommissioning sites undergoing decommissioning; six formerly terminated sites warrant additional evaluation. Twenty-four other sites have been removed from the SDMP after successful remediation. In addition, 11 sites have been removed from the SDMP by transfer to an Agreement State or the EPA. The NRC is currently committed to removing one site from the SDMP in fiscal year 2001 (FY01) and FY02. Historically, the goal has been to remove three sites from the SDMP each year. However, since the remaining sites are rather complex decommissioning cases and dose modelling required under the LTR places more demands on licensees, in FY01 the goal was reduced to one site annually.

3.5 Regulatory Issues

HLW: EPA has the responsibility of developing environmental standards for disposal of HLW in geologic repositories. Since 1992, EPA had been working to develop new environmental standards for Yucca Mountain. However, before EPA could complete its work, Congress enacted the EnPA of 1992 (Public Law 102-486). Through EnPA, Congress mandated a new and different process for developing the HLW disposal regulations for the proposed repository at Yucca Mountain. EnPA directed the NAS to evaluate the scientific basis for a Yucca Mountain standard (see Appendix E for detailed issues to be addressed) and directed EPA to promulgate new environmental standards based on and consistent with the findings and recommendations of the NAS. The EnPA also directed the NRC to modify its technical requirements to conform to the new EPA standards, within 1 year. In August 1995, the NAS issued its findings and recommendations on an environmental standard for HLW specific to Yucca Mountain (National Research Council, 1995) (see Appendix E for detailed findings).

On June 13, 2001, EPA issued its final standards for Yucca Mountain.[7] As noted earlier, EnPA directs the Commission to modify its technical requirements and criteria to be consistent with

7. This activity is described in further detail at the following EPA web site: http://www.epa.gov/radiation/yucca.

these standards. The following is a summary of these final standards that are to be implemented by the NRC:

- *Radiation standards for storage:* EPA identifies a 0.15 mSv/year (15 mrem/year) dose limits to members of the public.
- *Radiation standards for disposal:* EPA identifies a 0.15 mSv/year dose limits to a reasonably maximally exposed individual (RMEI).[8]
- *Human intrusion standards:* EPA identifies a 0.15 mSv/year dose limits to a RMEI as well as the characteristics of the human intrusion scenario itself.
- *Ground-water protection standards:* EPA has a 0.04 mSv/year ground-water protection standard and associated requirements for determining compliance with the standard.[9]

Total effective dose equivalent: EPA uses the term "annual committed effective dose equivalent " to denote the total dose resulting from internal and external exposure to radiation resulting from a single year's exposure.

On November 2, 2001, NRC published conforming licensing regulations at 10 CFR Part 63 (66FR55732). The NRC regulations contain risk-informed, performance-based criteria for both pre-closure operations and post-closure performance of the proposed geologic repository for high-level waste at Yucca Mountain, Nevada. EPA's standards and NRC's regulations are generally consistent with recommendations of the National Academy of Sciences and with national and international recommendations for radiation protection standards. In preparing its final regulations, NRC considered more than 1000 discrete comments received in more than 100 individual letters and at numerous public meetings held in Nevada during the public comment period.

Decommissioning: The decommissioning process consists of a series of integrated activities, beginning with the facility in transition from "active" to "decommissioning" status and concluding with the termination of the license and release of the site. Depending on several factors, including the type of license, the use of radioactive material at the facility, or past management of radioactive material at the facility, the decommissioning may be relatively simple and straightforward or complex.

NRC developed a *Decommissioning Standard Review Plan* (NUREG-1727) to illustrate acceptable approaches to dose assessment and bases for determining compliance with NRC's performance-based requirements in this area. In addition, NRC sponsored development of the probabilistic *RESRAD* (Version 6.0) and *RESRAD-BUILD* (Version 3.0) computer codes[10] for site-specific dose impact analysis in support of the decommissioning license termination rule (10 CFR Part 20, Subpart E). Final versions of each of the computer codes were tested and issued by Argonne National Laboratory (the code developer) and the NRC. NRC also developed the *DandD* (Version 2.1) computer code,[16] a probabilistic Monte-Carlo screening code developed by the Sandia National Laboratories for the decommissioning of "simple" sites with limited site characterization data.

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8. EPA standards specify the characteristics of a RMEI for use in a the performance assessments used to demonstrate compliance with the standards for disposal. EPA also specify the criteria that pertain to the characteristics of the reference biosphere for use in the post-closure performance assessments.

9. EPA standards exclude unlikely features, events, and processes from performance assessment analyses for estimating compliance with the standards for human intrusion and ground-water protection.

10. Available from the NRC at http://www.nrc.gov/RES/rescodes.htm.

3.6 Current issues/problems

Uncertainties in assessing compliance with HLW regulatory requirements: A very challenging issue associated with NRC's determination of compliance of the proposed Yucca Mountain repository with the regulations will be the understanding and evaluation of DOE's treatment of uncertainty in its compliance demonstration. Two types of uncertainty have been identified by the NRC staff: regulatory and technical uncertainties. Regulatory uncertainties involve questions about what must be proven to demonstrate compliance with a regulatory requirement, rather than how the demonstration of compliance will be made. Technical uncertainties concern how compliance with a requirement will be demonstrated.

Technical uncertainties can be generally categorized as: (i) "data uncertainty," defined as uncertainty in the parameters and their values used in performance assessment models; (ii) "model uncertainty," which concerns uncertainty in the understanding of the physicochemical processes that affect repository performance; and (iii) "future states uncertainty," reflecting the imperfect ability to predict the future states of the environment in which the repository will exist. NRC may be able to address some technical uncertainties, before the receipt of a license application, through rulemakings or the development of additional regulatory guidance. However, DOE has the primary responsibility for dealing with technical uncertainties. DOE can be expected to rely on site characterization as well as its own total-system performance assessment efforts, to identify, characterize, and reduce technical uncertainties. The NRC staff will rely on its independent technical capability to evaluate the significance of this type of uncertainty.

Costs of decommissioning and LLW: The NRC has issued guidance in NUREG-1307 (Revision 9), "Report on Waste Disposal Charges: Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities." This report, which is revised periodically, explains the formula that is acceptable to the NRC for determining the minimum decommissioning fund requirements for nuclear power plants. The sources of information used in the formula are identified, and the values developed for the estimation of radioactive waste burial/disposition costs, by site and by year, are given. Licensees may use the formula, coefficients, and burial/disposition adjustment factors from this report in their cost analyses, or they may use adjustment factors at least equal to the approach presented herein.

On-site storage of spent fuel at nuclear power reactor sites: Originally, spent fuel was temporarily stored in spent fuel pools, but because there is no domestic reprocessing, storage space has became scarce. Therefore, the NRC issued regulations in 1990 to authorize licensees to store spent fuel in dry casks using NRC approved dry cask designs. To further alleviate the shortage of spent fuel storage space, there are now a number of independent spent fuel storage installations for the storage of commercial spent fuel in the US.

3.7 Policy and regulation developments

HLW: In response to EnPA and the 1995 NAS findings and recommendations, NRC developed proposed regulations specific to a Yucca Mountain repository. The NRC staff performed a preliminary review of its generic HLW regulations at Part 60, to identify areas of potential changes needed, to be consistent with a new dose-based standard and sensitive to the findings and recommendations of the NAS. The NRC staff decided to identify simpler, more transparent requirements than those in Part 60, for post-closure performance of a repository at Yucca Mountain, that are risk-informed and unambiguously performance-based. On June 13, 2001, the EPA issued final standards for Yucca Mountain at 40 CFR 197. On November 2, 2001, NRC published conforming licensing regulations at 10 CFR Part 63. In preparing its final regulations, NRC considered: (i) the insights acquired from international guidelines for regulation of HLW disposal; (ii) NRC and DOE performance assessments; (iii) the results of systematic analyses of the existing regulations; (iv) advances in the incorporation of uncertainty in risk-informed decision-making; and (v) a large amount of site-specific information, for Yucca Mountain, all of which have become available since Part 60 was developed. Furthermore, the NRC regulations contain risk-informed, performance-based criteria for both pre-closure operations and post-closure performance of the proposed geologic repository for high-level waste at Yucca Mountain, Nevada. EPA's standards and NRC's regulations are generally consistent with recommendations of the National Academy of Sciences and with national and international recommendations for radiation protection standards. NRC also took into account more than 1000 discrete comments received in more than 100 individual letters and at numerous public meetings held in Nevada during the public comment period.

Decommissioning: In July 1998, the Commission directed the staff to prepare various guidance documents in support of the "Final Rule on Radiological Criteria for License Termination." As a result, the staff has completed, and is developing several other, guidance documents that will help licensees prepare decommissioning documents, and provide the staff with uniform criteria for reviewing licensee submittals. The staff published NUREG-1727, "NMSS Decommissioning Standard Review Plan," in September 2000. The staff conducted several workshops with stakeholders to obtain input on the development of the Standard Review Plan. A list of the major decommissioning guidance documents, completed and under development, is presented in Appendix F.

Currently, the staff is consolidating its guidance to be more risk-informed and performance-based; this is being performed for over 80 decommissioning guidance documents. Upon completion in 2003, this will result in a 3-volume NUREG report that will provide the NRC staff and licensees with a single reference guidance document addressing the NRC's decommissioning approach for materials licensees.

3.8 Research and Development Programs

3.8.1 Functions

NRC's research program in nuclear waste safety focuses on improving the regulatory framework and reducing burden on the licensees in the area of assessing the performance of waste disposal, contaminated site cleanup, clearance, and decommissioning activities. At the NRC, the responsibility for generic waste-related research to support regulation resides in the Office of Nuclear Regulatory Research (RES). Confirmatory HLW research is managed by NMSS and carried out at the NRC's CNWRA.

Some current assessment techniques use overly simplistic or conservative assumptions to account for uncertainties and to ensure that dose estimates are over-estimated in order to adequately protect health and safety. Research is focused on improving supporting data, reducing uncertainties, and providing more realistic models of natural processes that control the movement of radionuclides in the environment. The results of this research will be applied most effectively at complex sites with large radionuclide inventories. This is because the simpler approaches dictate extraordinary actions to achieve compliance with regulatory standards.

Research studies, both in-house and those involving outside contractors, originate from(i) user needs developed from practical licensing reviews and experiences, (ii) anticipatory research issues identified from previous research accomplishments, (iii) NAS findings, (iv) inter-agency co-operation, iv) the scientific literature, and (vi) staff requirement directives from the Commission. The research involves both field studies to obtain real-world data, and analyses of relevant data which provide technical bases for resolving licensing issues.

3.8.2 Content of NRC's Research Program Plans

NRC's waste research program focuses on technical issues which have evolved from previous research findings and from licensing needs to achieve its mission of improving the regulatory framework and in reducing burden on licensees. The principal emphasis is on radionuclide transport through the environment, health effects, and dose assessments. The research involves both field studies to obtain real-world data, and analyses of relevant data to provide technical bases for resolving licensing issues. Some additional sources of important information that RES uses for formulating NRC waste research comes from the co-sponsoring of workshops and scientific meetings, participation of the NRC research staff in NAS symposia and technical meetings, and interactions with scientists from the international nuclear waste community such as IAEA and OECD/NEA sponsored working groups and conferences.

Examples of ongoing field studies include: (i) development of a methods to evaluate and test conceptual ground-water flow and transport models for a variety of geologic conditions; (ii) a co-operative project with the U.S. Department of Agriculture's Agricultural Research Service to evaluate "real-time" field instrumentation to estimate infiltration at decommissioning, LLW and HLW sites; (iii) the field sampling and laboratory analysis of radioactive soils and slags from decommissioning sites to determine radionuclide solubilities, release rates, presence of colloids and to develop a leaching model; (iv) source term characterization studies using decontamination waste and activated metals; (v) the assessing of chemical factors affecting radionuclide solubilities; and (vi) determining radionuclide chelating complexes that affect radionuclide transport..

NRC waste research also focuses on understanding and quantifying processes which affect radionuclide transport. For example, RES has the NRC lead in participating in a joint USGS-NRC systematic assessment of the processes controlling sorption. This study is designed to provide a technical basis for a more realistic treatment of sorption processes in performance assessment. For site clearance the National Agricultural Library is conducting a study for NRC on soil reuse parameters. The performance of concrete barriers under a variety of environmental settings is being studied co-operatively by NRC and the National Institute of Standards and Technology (NIST). Data on long-term concrete performance is being used to validate *4SIGHT*,[11] a computer code developed by NIST for predicting behaviour of concrete engineered facilities. This work is highly relevant to performance assessment of decommissioning, LLW, and HLW facilities where concrete is used.

A major new initiative in 2001 was the signing of an interagency agreement on research and development of multimedia environmental models for regulatory assessments by the following federal agencies: Department of Agriculture (Agricultural Research Service), Department of Defense (U.S. Army Corps of Engineers), Department of Energy (Office of Science and Technology), EPA (Office of Research and Development), Department of the Interior (USGS), and the NRC (RES). Multimedia environmental models for regulatory assessments promise to be an important tool for siting, and

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11. Synder, K.A., and J.R. Clifton, "4SIGHT MANUAL: A Computer Program for Modeling Degradation of Underground Low-Level Waste Concrete Vaults," National Institute of Standards and Technology, NISTIR 5612, June 1995.

regulatory decisions. This is to be a five year program in which the federal agencies are to work co-operatively and to share research information.

Appendix A

U.S. Policy Laws Governing Radioactive Waste Management

Atomic Energy Act of 1954, as amended, established the Atomic Energy Commission [the predecessor to the U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Energy (DOE)] with sole Federal responsibility to regulate the commercial use of nuclear materials, byproducts and sources including the regulation of civilian nuclear reactors.

National Environmental Policy Act (NEPA) of 1969, as amended, requires Federal agencies to consider environmental values and factors in agency planning and decision-making. Full compliance with the letter and spirit of the National Environmental Policy Act, the U.S.' national charter for protection of the environment, is an essential priority for U.S. Environmental Protection Agency (EPA), Council on Environmental Quality, DOE and NRC.

Energy Reorganization Act of 1974, as amended, established the NRC and Energy Research and Development Administration (ERDA) – the predecessor of DOE.

Uranium Mill Tailings and Radiation Control Act of 1978, as amended, vested the EPA with overall responsibility for establishing environmental standards for decommissioning of uranium production facilities, the NRC with responsibility for licensing and regulating uranium production and related activities, including decommissioning, and DOE with responsibility for long-term monitoring of the decommissioned sites. Uranium recovery and tailings disposal sites are divided into two categories: Title I dealing with DOE-remedial action programs of former mill tailings sites in which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1971 under a contract with any Federal agency; and Title II dealing with non-DOE mill tailings sites; and *in situ* leach uranium solution mining sites licensed by the NRC or an Agreement State according to NRC regulations.

Low-Level Radioactive Waste Policy Act of 1980 and the Low-Level Radioactive Waste Policy Amendments Act of 1985 authorized the States – rather than the Federal Government – responsibility to provide additional disposal capacity for commercial low-level radioactive waste (LLW) from Regional Compacts (of States) for the safe disposal of such LLW; and decide whether to exclude waste generated outside a Compact. The Act also provided a system of milestones, incentives, and penalties to encourage States and Compacts to be responsible for their own LLW.

Nuclear Waste Policy Act of 1982 (NWPA) and the Nuclear Waste Policy Amendments Act of 1987 (NWPAA) specify a detailed approach for the disposal of spent nuclear fuel and other high-level radioactive waste (HLW) with DOE having operational responsibility for the geologic repository for HLW, the U.S. Nuclear Waste Technical Review Board (NWTRB) having responsibility to evaluate the technical and scientific validity of activities undertaken by DOE at the Yucca Mountain site, and NRC having regulatory responsibility for the transportation, storage, and geologic disposal of the waste.

Specifically in **NWPA**, Congress made the following findings:

(1) Radioactive waste creates potential risks and requires safe and environmentally acceptable methods of disposal;

(2) A national problem has been created by the accumulation of (a) spent nuclear fuel from nuclear reactors; and (b) radioactive waste from (i) reprocessing of spent nuclear

fuel; (ii) activities related to medical research, diagnosis, and treatment; and (iii) other sources;

(3) Federal efforts during the past 30 years to devise a permanent solution to the problems of civilian radioactive waste disposal have not been adequate;

(4) While the Federal Government has the responsibility to provide for the permanent disposal of HLW as may be disposed of in order to protect the public health and safety and the environment, the costs of such disposal should be the responsibility of the generators and owners of such waste;

(5) The generators and owners of HLW have the primary responsibility to provide for, and the responsibility to pay the costs of, the interim storage of such waste until it is accepted for disposal by the Secretary of Energy in accordance with the provisions of this Act [42 U.S.C. 10101 et seq.];

(6) State and public participation in the planning and development of repositories is essential in order to promote public confidence in the safety of disposal of HLW; and

(7) HLW disposal has become major subjects of public concern, and appropriate precautions must be taken to ensure that such waste do not adversely affect the public health and safety and the environment for this or future generations.

NWPA defined the relationship between the Federal Government and the State governments with respect to the disposal of such waste; and established:

(1) A schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by HLW as may be disposed of in a repository;

(2) The disposal of such waste as a matter of Federal policy, and;

(3) The creation of a Nuclear Waste Fund, composed of payments made by the generators and owners of such waste, that will ensure that the costs of carrying out activities relating to the disposal of such waste will be borne by the persons responsible for generating such waste.

In 1987, Congress amended NWPA through **NWPAA**. The major elements of NWPAA were: (i) the creation of the NWTRB within the National Academy of Sciences (NAS); (ii) DOE was directed to study (characterize) only the Yucca Mountain site;[12] and (iii) report to Congress between 2007 and 2010 on the need for a second repository.

Energy Policy Act (EnPA) of 1992 mandated a new and different process for developing the HLW disposal regulations for the proposed repository at Yucca Mountain, Nevada. Congress, through EnPA, directed the NAS to evaluate the scientific basis for a Yucca Mountain standard, and directed EPA to promulgate new environmental standards based on and consistent with the findings and recommendations of the NAS. Moreover, once the final standards are promulgated, EnPA directs the NRC staff to modify its technical requirements to conform to the new EPA standards.

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12. At the time, DOE was characterizing other geologic sites in addition to the Yucca Mountain site. NWPAA stressed that if, at any time, the Yucca Mountain site were found unsuitable, scientific studies would be stopped immediately. If that happens, the Yucca Mountain site would be restored and DOE would seek new direction from Congress.

EnPA directed the NAS to provide EPA with recommendations on the following issues:

- Whether health-based standards based on doses to individual members of the public from releases to the accessible environment... will provide a reasonable standard for protection of the health and safety of the general public.
- Whether it is reasonable to assume that a system of post-closure oversight of the repository can be developed, based on active institutional controls, that will prevent an unreasonable risk of breaching the repository's engineered or geologic barriers or increasing the exposure of individual members of the public to radiation beyond allowable limits.
- Whether it is possible to make scientifically supportable predictions of the probability that the repository's engineered or geologic barriers will be breached as a result of human intrusion, over a period of 10,000 years.

Appendix B

Radioactive Waste Management Regulations

U.S. Nuclear Regulatory Commission

10 CFR Part 40, "Domestic Licensing of Source Material" [Covers uranium mill tailings and *in situ* leach uranium recovery licensing.]

10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories" [Covers generic criteria for siting, disposal and closure criteria for HLW disposal in a deep geologic repository.]

10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste" [Covers LLW disposal criteria.]

10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada" [Identifies proposed licensing criteria for disposal of SNF and HLW in the proposed geologic repository at Yucca Mountain.]

U.S. Department of Energy

10 CFR Part 960, "General Guidelines for the Recommendation for Sites for Nuclear Waste Repositories" [Specifies DOE's criteria for determining the suitability of siting a HLW repository in geologic media.]

10 CFR Part 963 (Proposed Rule published in the *Federal Register* on November 30, 1999) , "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories: Yucca Mountain Site Suitability Guidelines" [Consistent with 1987 amendments to NWPA, Part 963 deals with the criteria for determining the suitability of the potential site at Yucca Mountain, based on site characterization activities, as part of the material that will be considered by the Secretary in any site recommendation to the President.]

U.S. Environmental Protection Agency

40 CFR Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes"

40 CFR Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings"

40 CFR Part 194, "Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's (WIPP) Compliance with the 40 CFR Part 191 Disposal Regulations"

40 CFR Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada"

Appendix C

NRC Guidance

NRC issues guidance to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the NRC staff in its review of applications for permits and licenses. Guidance such as regulatory guides or staff technical positions, are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in guidance will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission. Some examples of guidance include:

HLW

- NUREG-1804, Revision 2, "Yucca Mountain Review Plan (Draft Report for Comment)." March 2002.
- NUREG-1494 "Staff Technical Position on Consideration of Fault Displacement Hazards in Geologic Repository Design," issued in March 1994.
- NUREG-1563, "Branch Technical Position on the Use of Expert Elicitation in the HLW Program," issued November 1996.

Uranium recovery

- NUREG-1724, "Standard Review Plan for the Review of DOE Plans for Achieving Regulatory Compliance at Sites with Contaminated Ground Water Under Title I of the Uranium Mill Tailings Radiation Control Act: Draft Report for Comment," issued June 2000.
- NUREG-1623, "Design of Erosion Protection for Long-Term Stabilization: Draft Report for Comment," issued February 1999; final to be published in 2002
- NUREG-1620, Rev. 1. "Draft Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act," issued January 2002June 2000.
- NUREG-1569, Rev. 1. "Draft Standard Review Plan for In Situ Leach Uranium Extraction License Applications," issued in January 2002.
- "Uranium Mill In-Situ Leach Uranium Recovery, and 11e.(2) Byproduct Material Disposal Site Decommission Inspection,"(Procedure 87654), issued March 2002.

Appendix D

NRC Safety and Environmental Protection Performance Goals

Protection of the environment from potential hazards associated with the civilian use of source, byproduct, and special nuclear materials involves actions to mitigate environmental impacts both during licensed activities and afterward. Prior to authorizing licensed activities, the NRC ensures that potential environmental impacts of such activities are assessed consistent with the requirements of the National Environmental Policy Act (NEPA) as implemented by applicable NRC regulations. In its Strategic Plan[13], the NRC has set the following as its goal in nuclear waste safety: "Ensure treatment, storage, and disposal of wastes produced by civilian use of nuclear material in ways that do not adversely affect this or future generations."

Performance goals for measuring results toward meeting NRC's nuclear waste safety goal:

- No significant accidental releases of radioactive material from storage and transportation of high-level waste (including spent fuel) or low-level waste.
- Establish the regulatory framework for high-level waste disposal, consistent with current national policy, as required by law after the legislatively required standard is issued.
- No offsite release of radioactivity beyond regulatory limits from low-level waste disposal sites.

Performance goals for measuring results toward meeting NRC's environmental protection goal:

- Zero offsite releases from operating facilities of radioactive material that may have the potential to cause adverse impact on the environment, and no increase in the number of offsite releases from operating facilities of radioactive material that exceed NRC's acceptance criteria (i.e., limits set forth in 10 CFR Part 20).
- Environmental impacts have been identified through the NEPA process before regulatory action is taken.
- No sites will be released until satisfactorily remedied in accordance with NRC release criteria.

13. The "Strategic Plan: Fiscal Year 1997- Fiscal Year 2002" was published in September 1997 as NUREG-1614, Volume 1.

Appendix E

NAS Findings and Recommendations in Response to the Energy Policy Act of 1992

Among the NAS findings and recommendations were the following key recommendations:

- The standard should set "...a limit on the risk to individuals of adverse health effects from releases from the repository...." The NAS explicitly recommended against a quantitative release limit. NAS declined to assign the appropriate level of risk, and stated that it views the determination of this level as a crucial policy judgement that should be addressed in a transparent rulemaking process. As a starting point in such a process, the NAS suggested that consideration be given to risk levels comparable to those recommended by the *International Commission on Radiological Protection* [100 mrem/year (1 mSv/year) maximum individual dose from all sources, with 10-30 mrem/yr (0.1-0.3 mSv/year) allocated for HLW disposal].
- That compliance assessment should be conducted over a time frame that includes the period where greatest risk occurs. The NAS found there to be no **scientific** [emphasis added] basis for limiting the time period of an individual-risk standard, such as was done by EPA in its generic standards for HLW and TRU disposal (Part 191).

Other NAS findings and recommendations included:

- Consider an alternative compliance assessment period of up to 1 million years;
- Re-consider the need for quantitative subsystem performance objectives;
- Treat human intrusion separately by a stylized calculation; and
- Assume that there would be no post-closure oversight beyond 100 years following permanent closure of the repository.

Appendix F

NRC Documents Supporting the Final Rule on Radiological Criteria for License Termination

Guidance Document	*Status*
Regulatory Guide DG-1067,"Decommissioning of Nuclear Power Reactors"	Issued August 2000
Regulatory Guide DG-1071, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report"	Issued August 2000
Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors"	Final guide issued January 1999
Regulatory Guide DG-1069, "Fire Protection Program for Permanently Shutdown and Decommissioning Nuclear Power Plants"	Draft guide issued July 1998; final guide scheduled for issuance in 2001
Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination"	Draft guide issued August 1998; DG-4006 superseded by NUREG-1727
Regulatory Guide, DG-1085, "Standard Format and Content for Decommissioning Cost Estimates for Nuclear Power Reactors"	Draft scheduled for issuance in 2001
NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans"	Issued April 2000
NUREG-1713, "Standard Review Plan for Decommissioning Cost Estimates for Nuclear Power Reactors"	Draft scheduled for issuance in 2001
NUREG-1727, "Decommissioning Standard Review Plan" (commonly known as SRP for Decommissioning)	Issued September 2000
Regulatory Issue Summary 2000-09, "Standard Review Plan for Licensee Requests to Extend the Time Periods Established for Initiation of Decommissioning Activities"	Issued June 2000
Division of Waste Management , "Guidance Document for Streamlining the Decommissioning Program for Fuel Cycle and Material Licensees"	Issued January 1999
"Environmental Standard Review Plan for the Office of Nuclear Material Safety and Safeguards"	Draft scheduled for issuance in 2001
NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual"	Published December 1997; Rev. 1 published August 2000
NUREG-1505, "Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys"	Published June 1998
NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions"	Published June 1998
NUREG-1549, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination"	Draft published July 1998

MANDATE OF THE RWMC REGULATORS' FORUM

The Radioactive Waste Management Committee (RWMC) of the NEA is a forum of senior representatives from waste management agencies, regulatory authorities, policy-making bodies, research and development institutions with responsibilities in waste management, and other government-nominated specialists. The wide range of expertise it musters amongst the NEA Members countries makes the RWMC a uniquely placed international forum to address issues in radioactive waste management. Regulatory aspects have been a customary item in the working programme of the RWMC and its advisory groups, but the need has arisen for increased attention on regulatory aspects at a strategic level. The recognition of this need led to the decision to more formally establish a forum of regulators within the RWMC with the aim (i) to enhance collaboration amongst regulators in the area of radioactive waste management (RWM), (ii) to enhance the visibility of regulatory and licensing issues in RWM, (iii) to enhance working contacts between regulators in the field of RWM with regulators in other areas and, ultimately, (iv) to enhance the effectiveness of the RWMC and the NEA in addressing issues at the interface of regulatory, technical, and policy aspects in RWM. The mandate of the RWMC regulators' forum is thus as follows.

The RWMC regulators' forum:

- facilitates multilateral communication and information exchange among RWMC regulators and promotes a frank interchange in open dialogue among peers
- defines and addresses future regulatory challenges and issues in the area of waste management and disposal; decommissioning and dismantling are also relevant issues
- promotes discussion and exchange with other groups involved with regulations both within the NEA, i.e., the CNRA and the CRPPH committees, and outside the NEA, such as the IAEA, the EC, and the ICRP; emphasis is on two-way exchange to benefit from related experience
- takes initiative within the RWMC in the area of regulation and licensing; this includes promoting discussions within the RWMC, proposing specific products to be developed, recommending relevant initiatives by other RWMC groups, and preparing concerted initiatives by the RWMC and other NEA committees

Participation in the RWMC regulators' forum:

- membership is reserved to RWMC members belonging to regulatory bodies.

The mode of operation is as follows:

- Communication takes place through:
  - i) a one-day meeting just prior to RWMC plenary sessions
  - ii) an electronic bulletin board reserved to the forum
- Members work in small groups to complete a programme of work that is determined in co-ordination with the RWMC Bureau
- The regulators' group organises regular discussions at the plenary meetings of the RWMC
- Reciprocal exchange of information regularly takes place with CNRA and other regulators' groups

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