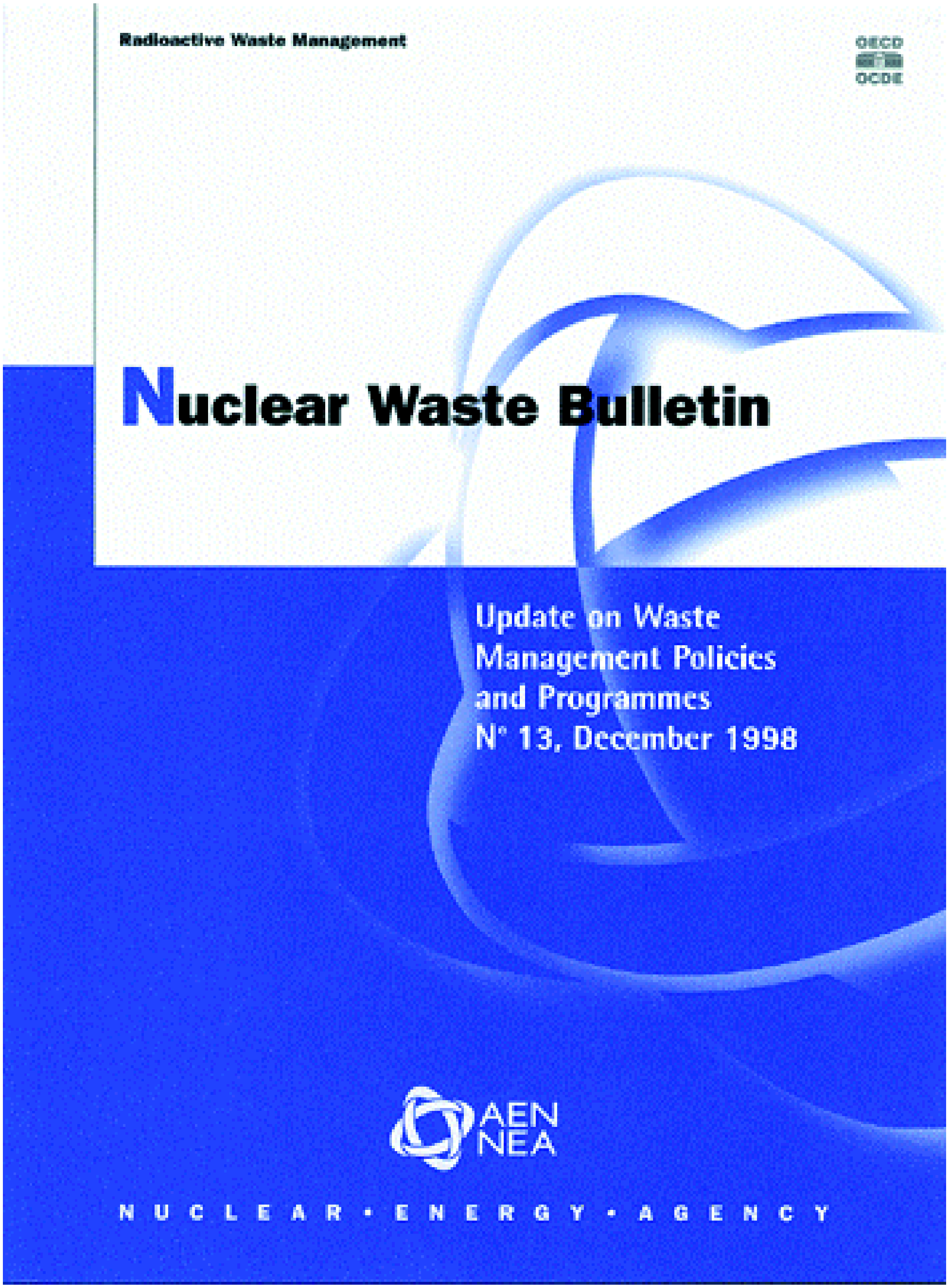
Radioactive Waste Management

OECD
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Nuclear Waste Bulletin

Update on Waste Management Policies and Programmes

N° 13, December 1998

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EDITOR'S NOTE

The NEA Nuclear Waste Bulletin has been prepared by the Radiation Protection and Waste Management Division of the OECD Nuclear Energy Agency to provide a means of communication amongst the various technical and policy groups within the radioactive waste management community. In particular, it is intended to provide concise information on current activities, policies and programmes in Members countries and within other international organisations. It is also intended that the Bulletin assists in the communication of recent progress in the development of technologies for the management and disposal of radioactive waste.

The Bulletin does not include an exhaustive description of national programmes, rather it provides yearly updates. The reader is therefore invited to go back to the information given in previous bulletins and, if necessary, to contact national correspondents in order to obtain more complete information. *The information presented herein is up-to-date to the first few months of calendar year 1998.*

With respect to the last year issue, the bulletin contains two new sections:

- "Highlights of recent developments",
- "Focus country".

The "Highlights" section provides a brief overview of major developments and allows the reader to better orient himself to the material in the section on "National programmes and policies".

The "Focus country" section is intended to give, each year, a fuller report of the status of radioactive waste management in some specific countries. This year's focus countries are Finland and Hungary.

ACKNOWLEDGMENTS

The NEA gratefully acknowledges the help of Mr. M. Kucerka and his team in the Czech Republic, in the preparation of the present version of the Nuclear Waste Bulletin.

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COUNTRY HIGHLIGHTS

AUSTRALIA

- The Billa Kalina region in South Australia had been identified as the most suitable region in which to locate a national near surface repository.
- The Commonwealth State Consultative Committee on the Management of Radioactive Waste agreed to pursuing co-location of a storage facility for long-lived intermediate level waste (Category S) with a near-surface waste repository.
- The Government announced its decision to establish a replacement research reactor at Lucas Heights, to be commissioned in 2005.
- The government had decided against establishing a domestic spent fuel reprocessing facility.
- The development of ceramic waste forms for the immobilisation of high-level and long-lived radioactive waste is continuing.

BELGIUM

- The federal council of ministers opted for a near surface disposal of low-level and short-lived radioactive waste
- The interim storage of vitrified high-level waste resulting from Belgian spent fuel reprocessing in La Hague (France) was made ready to receive the HLW containers
- Research related to geological disposal continues according to plan.
- The law of 12 December 1997 specifies the mission of NIRAS/ONDRAF with regard to the national inventory of nuclear facilities and installations, as well as of sites containing radioactive waste.
- NIRAS/ONDRAF was put in charge of the co-ordination of the project “Multimedia compact disk explaining how radioactive waste management is carried out in the European Union”.

CANADA

- The federal Atomic Energy Control Board (AECB) approved a construction licence for the McArthur River project.

- The Ontario Hydro Board of Directors announced its Nuclear Asset Recovery Plan (NAOP) which entailed the lay-up of seven of its 19 operating CANDU reactors in order to dedicate resources to bringing the other 12 units back to their previous standard of excellence.
- Environmental groups criticised the plan to remove 4 000 MWe of nuclear generating capacity from the grid, claiming that the increased burning of coal and oil might produce as much pollution as seven million more cars, and that there will be ".... more smog, more deaths, and more acid rain."
- The Nuclear Safety and Control Act (NSCA), replacing the existing Atomic Energy Control Act of 1946 received Royal Assent in March 1997.
- The Minister of Energy, Mines and Resources referred the Disposal Concept for Nuclear Waste to the Environment Minister for a review by a Panel under the Federal Environmental Assessment and Review Guidelines Order.
- Ontario Hydro is conducting conceptual engineering studies for a low-level radioactive waste disposal facility.
- AECL is in discussions with the federal regulatory agency, the AECB, to license a prototype below-ground concrete vault known as IRUS.
- The federal government is seeking a site for the long-term management of the historic wastes.

CZECH REPUBLIC

- The Act No. 18/1997 Coll., on "Peaceful Utilisation of Nuclear Energy and Ionising Radiation (the Atomic Act)" came into force on 1st of July 1997.
- The Radioactive Waste Repository Authority (RAWRA) was established in June 1997.
- A conceptual design of the deep geological repository in a reference non specified site, would be completed in the 1998.

FINLAND

- The Programme for the Environmental Impact Evaluation Procedure for Spent Fuel Repository Siting has been delivered for review and comments in February 1998.
- Detailed site investigations for the spent fuel repository were started in March 1997.
- The regulatory process concerning the operating licence application submitted by Imatran Voima Oy (IVO) for the rock cavern LLILW repository from the Loviisa nuclear power plant has continued.
- The radiological and other effects brought about by the transportation of spent fuel from the NPP sites to four candidate locations of the encapsulation and disposal facility are analysed during 1998.

FRANCE

- The Manche disposal facility is now entering on the institutional control period.

- CENTRACO, a new facility for the treatment and the conditioning of LLW has not yet received the authorisation for operation and the relevant advisory committee will examine the application for operation permit in 1998.
- Studies conducted for long-lived waste management are in progress
- The National Evaluation Commission presented its scientific assessment on the advisability of continuing on geological radwaste disposal by the construction of the underground laboratories planned by ANDRA.

GERMANY

- The BMBF independent R&D programme, on further development of repository concepts and on improvement of analytical tools for long-term safety assessments, satisfactorily continues.

HUNGARY

- Characterisation of the selected site for an underground repository for L/ILW is in progress.
- The Hungarian Atomic Energy Commission issued a licence for commissioning of the spent fuel modular vault dry storage (MVDS) facility.
- Site characterisation studies for HLW disposal started at the geological formation named Boda Claystone Formation (BCF).
- A Central Nuclear Financial Fund was set up in 1998 for financing radioactive waste management as well as decommissioning of nuclear facilities, and a Public Agency for Radioactive Waste Management (PURAM) was established to carry out these activities.

ITALY

- A vitrification unit applying a French technology is under detailed design (CORA project).
- The solidification of all liquid wastes stored at the Trisai Research Centre site has been completed in 1997.
- ENEA leads actions directed to select and qualify a site for the final repository for LLW.
- The cementation plant of the LLW at the Garigliano NPP began operation.
- The incineration campaign at Mol (B) of resins from Caorso NPP has been completed.
- A formal application for decommissioning the Caorso (BWR), Garigliano (BWR) and Latina (Magnox) nuclear power plants has been presented to the Ministry of Industry.

JAPAN

- About 100,000 drums were already buried at the end of 1997 at the low level radioactive waste burial center of Rokkasho-mura.
- The Tokai Power Station, the oldest commercial nuclear power plant in Japan, will be shutdown for decommissioning approach in March 1998.
- The AEC's Advisory Committee on Nuclear Fuel Cycle Backend Policy issued "Guidelines on Research and Development Relating to Geological Disposal of High-level Radioactive Waste in Japan".
- The above guidelines concerns, in particular, the "H12" report that PNC is required to submit to the government by the year 2000.
- A "Research Co-ordination Committee" is promoting co-operation among organisations involved in R&D on HLW disposal.
- Construction of the QUALITY facility (Quantitative Assessment Radionuclide Migration Experimental Facility) has started at PNC Tokai Works.
- A Draft Report on How to Implement HLW Disposal has been released by a Special Committee of the AEC. The report, dealing with public acceptance issues, has been opened to the public for comments.
- Under the contracts between COGEMA and the Japanese electric power companies, 68 canisters of vitrified waste have been returned from France last year.
- An R&D programme on TRU waste has been initiated between PNC, CRIEPI, RWMC, and the utility companies.
- The JAERI Reprocessing Test Facility decommissioning programme will continue until 2004. JRR-2 will be decommissioned by 2007.

KOREA

- KEPCO (Korea Electric Power Co.) has been empowered by the amendments of "Atomic Energy Law" and "Electricity Enterprise Law", to carry out an overall project management for LILW.
- AEC accepted the technology development programme for HLW disposal.
- The decontamination and decommissioning project of the TRIGA Mark-II and III research reactors was started in January 1997.

THE NETHERLANDS

- As a result of a decision made by the Dutch Electricity Generating Board SEP the nuclear power station of Dodewaard stopped producing electricity.
- The State Council revoked the construction licence for new storage facilities on formal grounds, and the licensing procedure had to be restarted.

- A change of present policy based on reprocessing of spent fuel is under discussion.

NORWAY

- The Directorate of Public Construction and Property (Statsbygg) has concluded the construction of a radioactive waste facility at Himdalen.
- Institute for Energy Technology (IFE) has been granted licence by the Government to operate the Himdalen facility.
- The Joint Norwegian – Russian Expert Group for Investigation of Radioactive Contamination in the Northern Areas has issued a report "Sources contributing to radioactive contamination of the Techa River and areas surrounding the "Mayak" Production Association, Urals, Russia".

SPAIN

- The operation of El Cabril disposal facility is progressing very satisfactorily.
- ENRESA was granted with the municipal licence to initiate the operations for dismantling Vandellós I NPP.
- R&D programme continues according the 3rd R&D Plan (1995-1999).

SWEDEN

- The Swedish Government decided to recall the operating permit for the 1st unit in the Nuclear Power Plant at Barsebäck.
- The sea transportation system of radioactive waste has operated without disturbances.
- A new revision of R&D programme is due in September 1998.
- A process of completion and review of feasibility studies of siting of a deep repository is in progress.
- SKI and SSI are developing regulations in different areas of nuclear safety.
- SKB must present an analysis of the whole system of facilities and activities related to the final disposal of spent fuel.
- SKB has sent an application to SKI to extend the storage capacity of the central interim storage facility for spent nuclear fuel (CLAB stage 2).
- SKI asked OECD/NEA to review SKI's project on safety assessment of final disposal of spent fuel, SITE-94.

SWITZERLAND

- ZWILAG submitted the application for the operation licence of the conditioning facilities (including a plasma oven).

- A working group has been implemented to discuss technical issues and to provide input to decide on further procedures of the Wellenberg project.
- Within the HLW/ILW repository programme, two host rock options are under consideration.
- A variety of experiments are underway or will be started shortly both at the Grimsel and Mt. Terri laboratory.

UNITED KINGDOM

- The Secretary of State dismissed Nirex's appeal against refusal of the planning permission to construct an underground laboratory, or rock characterisation facility (RCF).
- Nirex's staff has been reduced from over 200 to 88.
- The NRPB independent assessment concluded that all the identified historic dumpings would give rise to doses well within internationally agreed limits and would pose an insignificant risk to public health or the marine environment.

UNITED STATES OF AMERICA

- The Environmental Protection Agency (EPA) is developing a new radiation protection standard.
- OCRWM Program Plan (1996) strategy is to address by 1998 the major unresolved technical questions so that a viability assessment of licensing and constructing a geologic repository at the Yucca Mountain site can be performed.
- OCRWM continued to perform activities associated with the construction of the underground Exploratory Studies Facility (ESF).
- OCRWM plans to complete the generic, non-site-specific interim storage facility work in 1998.
- The court ruled that DOE remains obligated to accept SNF from electric utilities, but since a facility will not be available, utilities should pursue the remedies for delay.
- As of the beginning of FY 1998, responsibility for the 21 remaining geographic sites under the Formerly Utilised Sites Remedial Action Programme was transferred to the U.S. Army Corps of Engineers by congressional action.
- Carlsbad Area Office expects to receive an approval in April 1998 to begin operations at WIPP.
- In FY 1997, nearly 500 release sites were remediated and more than 175 facilities were decommissioned, bringing the total number of completions to approximately 4 300.
- In 1997, engineers at the WIPP built two full-scale prototypes of a new container for shipping DOE's contact-handled transuranic waste.
- Throughout 1997, Nuclear Material and Facility Stabilisation undertook to reduce risks by stabilising nuclear and other materials and spent fuels, as recommended by the Defense Nuclear Facilities Safety Board.
- The United States will accept, over a 13-year period, up to approximately 20 metric tons of research reactor spent nuclear fuel from 41 countries.

COUNTRY FOCUS

FINLAND

1. Recent developments

1.1 Preparation of Safety Criteria for Spent Fuel Disposal Progressing

The Finnish Nuclear Energy legislation states that general safety regulations are issued by the Government based on the proposals made by the Radiation and Nuclear Safety Authority (STUK), which also issues detailed safety requirements, so called YVL-guides. As the first licensing step for spent fuel disposal, the Decision in Principle Process, may be started in 1999, STUK has made a proposal for general safety requirements. The aim is to get the regulations finalised and accepted by the Government by early 1999. The regulation will cover the operational phase of the encapsulation and disposal facility as well as the post-closure safety of the spent fuel repository.

1.2 Environmental Impact Assessment Process and the First Licensing Step for Spent Fuel Disposal

According to the Nuclear Energy Act, the first licensing step towards a final repository of nuclear waste is the so-called Decision in Principle. At this step the Finnish Government shall consider whether "the construction project is in line with the overall good of society". In particular, the Government shall pay attention to the need of the facility with respect to country's energy supply and to the suitability of the proposed site of the nuclear facility and its effects on the environment. For the decision, STUK has to make a preliminary statement on the safety of the facility and the host municipality (or municipalities if there are several candidates) must state their acceptance of siting the facility. A positive decision can only be made by the Government if both STUK's and the municipalities' statements are positive and it has still to be endorsed by the Parliament.

The application for the Decision in Principle must include an Environmental Impact Assessment (EIA) report for the planned facility. For this purpose Posiva started the formulation of a programme for the EIA process at all four candidate sites for a spent fuel disposal facility in the early 1997s. At this stage, a comprehensive public interaction programme was launched consisting of a large number of public meetings and brainstorming sessions, distributing various printed material and videotapes and different presentations at local fairs and other public gatherings. The EIA programme was officially submitted to the Ministry of Trade and Ministry (the contact authority) early in 1998 and, on the basis of comments from a number of parties concerned and expert bodies, the Ministry gave its statement on the programme in June 1998. The statement emphasises the importance of a complete review of all environmental and social aspects of the project in the EIA report, including a fairly extensive summary of radiation safety analyses for the operational and post-closure phases. The Ministry also calls for enhanced discussion and assessment of alternatives to Posiva's reference concept.

In accordance with the Espoo Convention the EIA programme was also submitted to review by Sweden, Russia and Estonia. Sweden and Russia have expressed their interest in participation in the process.

Posiva aims at submitting the EIA report to the Ministry in early 1999. After that the Ministry will ask for statements from the local and central authorities and opinions from the public on the EIA report. After the hearings, the Ministry gives its statement, which completes the EIA process. Posiva's present plan is to submit the application for the Decision in Principle soon after the EIA report has been submitted. Unless new negative evidence is obtained from the site assessments, all four investigation sites will be included as possible candidate sites for the disposal facility and the final decision on the site will be made at the end of 2000.

As described above, STUK will make a safety related review of the documents that will be submitted to support the Decision in Principle-application. These documents will include an updated safety assessment, summaries of site investigations and renewed technical plans for the encapsulation and disposal facility. In the review, STUK makes a judgement whether the concept and the proposed site is (or sites are) likely to provide safe disposal of spent fuel; thus no definite position on the safety is required in this licensing stage.

1.3 Status of the Second Repository for Low and Intermediate Level Waste

Imatran Voima Oy (IVO) started the construction of a rock cavern repository for low and medium level waste from the Loviisa nuclear power plant in 1993 and completed the construction works in 1996. The repository has been excavated at the depth of approx. 110 meters in the bedrock at the island of Hästholmen where the Loviisa power plant is located. The present repository consists of two finalized rock caverns for LLW and an excavated cavern for solidified ILW. The construction and installation work of engineered barriers of the ILW cavern, consisting mainly of concrete structures, will be completed later.

In early 1998, STUK completed a review of the Final Safety Analysis Report (FSAR) and other relevant documents and submitted its statement on IVO's application for the operation license to the Ministry of Trade and Industry. In April 1998, the Government granted the license for the repository.

At TVO's power plant at Olkiluoto, a repository for LILW has been in operation since 1992.

2. General strategy

2.1 Overall Waste Management Strategies and Systems

In 1997, about 30.4% of all electricity produced in Finland was generated by nuclear power. Four reactors, with a total capacity of 2 656 MWe(net), are currently in operation. At Loviisa, there are two 488 MWe PWR units and at Olkiluoto two 840 MWe BWR units. Modernisation programmes including power upgrades have recently been completed by both utilities.

The owner of the two VVER-440 reactors at Loviisa, Imatran Voima Oy (IVO), made initially contractual arrangements for the entire fuel cycle service from the former USSR, including return of spent fuel. However, in 1994 the Parliament approved an Amendment of the Nuclear Energy Act requiring domestic final disposal of all nuclear wastes produced in Finland, including spent fuel from NPPs.

The owner of the Olkiluoto NPP, Teollisuuden Voima Oy (TVO), has initially opted for storing and, later on, disposing of its spent fuel in a deep geological repository in Finland. Due to the Amendment of the Nuclear Energy Act, also Imatran Voima Oy has nowadays adopted this strategy. However, the planned long interim storage of spent fuel keeps also other options open.

Conditioning, storage and final disposal of low- and intermediate-level wastes from reactor operation, as well as waste from their decommissioning, will take place at the NPP sites.

2.2 National Legislation

According to the Nuclear Energy Act of 1987, licences for nuclear facilities are granted by the Government. However, in the first licensing stage (Decision in Principle), the Parliament has the right to overrule the decisions by the Government on building major nuclear installations, such as a nuclear power plant or a waste disposal facility. The consent of the proposed host municipality for the nuclear installation is a necessary prerequirement for the Decision in Principle. Furthermore, a positive statement by the Radiation and Nuclear Safety Authority (STUK) on the safety of the facility is a necessary prerequisite for the Government’s decision.

The principles of the waste management policy were originally set in the Finnish Government's policy decision of November 1983 and later in the decisions by the Ministry of Trade and Industry (MTI). These decisions set also a target schedule for the preparatory works of waste management.

The general safety regulations are issued by the Government while STUK gives the detailed ones.

2.3 Organisational Structure

The utilities have the financial and operational responsibility for nuclear waste management in Finland. They founded in 1995 a joint company, Posiva Oy, for the research, development, planning and later implementation related to spent fuel disposal. MTI oversees that implementation of waste management and related R&D complies with the national policy and that financial provisions for future waste management costs are adequate. STUK is responsible for the control of nuclear safety and for the technical and safety related review of licence applications and other important documents.

The Advisory Committee on Nuclear Energy gives support to MTI and the Advisory Committee on Nuclear Safety to STUK in their major duties concerning nuclear energy and safety. To guarantee the financing of future waste management operations, money is collected from the utilities to the State Nuclear Waste Management Fund according to the annual decisions of the Ministry of Trade and Industry.

2.4 Overall Schedule

Spent fuel management

In consistence with the Government's policy decision of 1983, TVO launched a programme with the following milestones, aiming at the disposal of spent fuel in a deep geologic repository in Finland. From the beginning of 1996, Posiva Oy has taken charge of implementing this programme.

- In 1985, about 100 candidates sites were selected for investigations on the basis of geological and other relevant scientific information. By the same date, the technical plans and safety assessments related to the disposal of spent fuel were updated.
- A separate spent fuel interim store (KPA-store) at Olkiluoto was commissioned in 1987.
- In 1987, five sites were nominated for preliminary site investigations and the investigations were started.
- In 1992, the preliminary site investigations and evaluations were completed and three most appropriate sites were proposed for the detailed investigations. Updated technical plans and safety assessments for spent fuel disposal were also reported to the authorities.
- By 2000, detailed site investigations will be completed and the disposal site be selected. A technical disposal plan that meets the safety and environmental protection requirements will be drawn up.
- By 2010, technical designs and other documents needed for the construction licence application will be submitted to the regulatory authorities.
- The construction of the repository and the encapsulation plant will be completed by the year 2020.

IVO has recently started the extension of the spent fuel storage capacity at the Loviisa NPP. The last shipment of spent fuel to Russia took place in autumn 1996.

Reactor waste management

Low and intermediate level wastes from reactor operations will be disposed of in underground repositories in the bedrock of the power plant sites. The construction of the repository at the Olkiluoto plant began in 1988 and the operation of the repository commenced in May 1992. The construction of the repository at the Loviisa plant was started in 1993 and the Government granted the operation licence in April 1998.

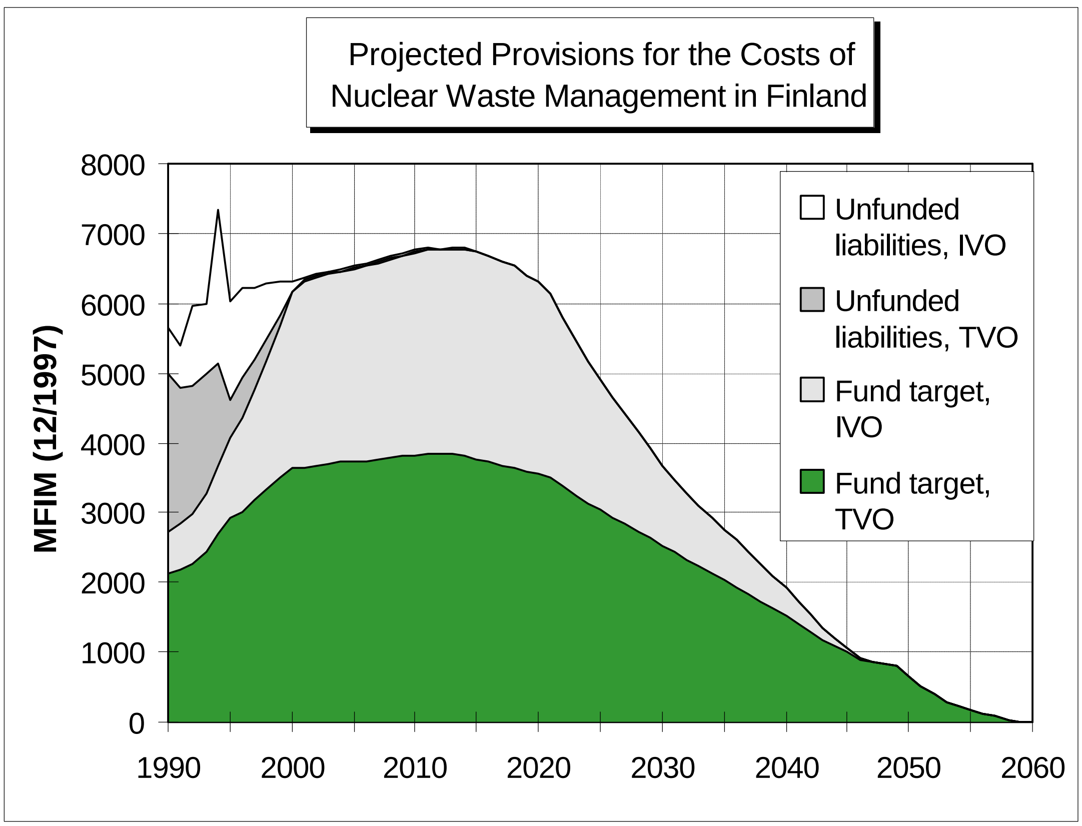
Decommissioning of nuclear power plants

The wastes from the decommissioning of the reactors are planned to be disposed of in underground repositories co-located with the repositories for operational reactor wastes at the power plant sites. The utilities shall maintain decommissioning plans for the nuclear power plants. Updated plans must be submitted to the authorities for review at regular intervals of five years; the next reporting will take place at the end of 1998. The utilities have prepared fairly detailed decommissioning plans, including technical plans and safety assessment for the disposal of decommissioning wastes.

2.5 Costs and Funding

To ensure that the financial liability is covered, the utilities must each year present cost estimates for the future management of nuclear wastes, including decommissioning of NPPs. The latest cost estimates, based on waste quantities at the end of 1997 and decommissioning of NPPs, arise to about FIM 6 230 million (USD 1 120 million) for TVO and IVO together, with no discounting.

The utilities are obliged to set aside a certain amount of money each year to the State Nuclear Waste Management Fund. For the outstanding liability, i.e. due to future costs not yet covered by the contributions paid into the fund, the licensee must furnish securities as a precaution against insolvency. The administrative procedures are described in detail in the nuclear energy legislation. The past and expected future development of the total fund holdings and unfunded liabilities are depicted in the figure below.



2.6 International Co-operation

For small countries like Finland, international co-operation in the waste management field is of great importance. 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. There is also co-operative nuclear waste research between the Nordic countries. Posiva Oy has formal bilateral co-operation agreements with the SKB (Sweden), NAGRA (Switzerland), and AECL and Ontario Hydro (Canada).

Finland is presently actively participating in the nuclear waste management related research projects of the Nuclear Fission Safety (NFS-2) programme of the European Commission. Active research co-operation contacts with the Äspö Hard Rock Laboratory (HRL) Project are continuing as well.

3. Storage systems

3.1 National Policy

The national policy is based on storing spent fuel and nuclear wastes at the power plant sites until they are disposed of in Finland.

3.2 Requirements

The total amount of spent fuel from the Loviisa plant during its planned lifetime of 40 years will be about 1070 tU. Of this amount, about 330 tU has been transported to the Russia. Thus, a storage capacity of approximately 740 tU is needed.

The total spent fuel arising at the Olkiluoto plant is estimated to be 1 870 tU, based on 40 years operation. The operating lifetime of the interim storage would be about 60 years.

3.3 Description

The wet storage concept for spent fuel has been chosen mainly because of the extensive experience obtained from that technique.

At the Loviisa plant, there is storage capacity in water pools for about 300 tU. Besides the refuelling pools, there is an original store, where fuel is stored in baskets, and a newer fuel rack store. These pools are partly below ground level. As a consequence of the policy change IVO has started the extension of the spent fuel storage capacity at the Loviisa NPP with four additional pools. Thereafter, the storage capacity will be 610 tU.

At the Olkiluoto plant spent fuel is initially cooled for a few years in the water pools in the reactor buildings with capacity of about 370 tU. Subsequently, spent fuel is transferred to an on-site facility (KPA-store) for longer-term storage. Its modular design enables the gradual expansion of the capacity to meet the requirements of storage capacity. Presently the storage section contains three storage pools, 400 tU/pool with high-capacity fuel racks. The pools are 13.5 m deep and have stainless-steel-clad walls of thick reinforced concrete. The pool bottoms stand on bedrock and are 7 m below ground level.

At Loviisa, wet waste are stored in tanks and solid waste in storage rooms at the plant. At Olkiluoto, solid waste and bitumenized wet waste are stored inside the plant before transfer to the disposal facility.

3.4 Schedule

The KPA-store at Olkiluoto was commissioned in 1987. The newest water pool facility at the Loviisa NPP was commissioned in 1984; additional capacity will be available by 2002.

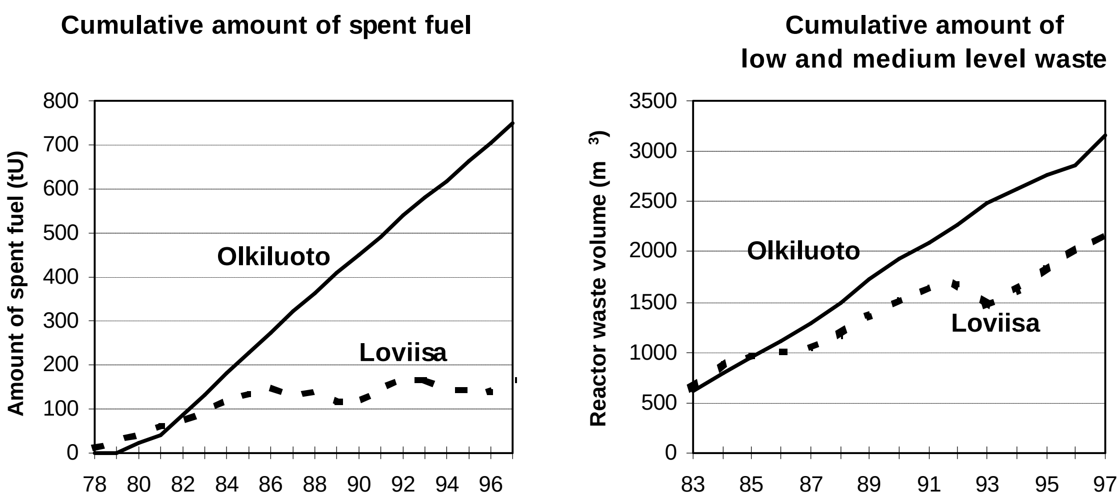
3.5 Costs and Funding

The investment cost of the KPA-store Olkiluoto was about 200 FIM/kgU (about 50 USD/kgU).

3.6 Experience/Status

At the end of 1997 the total amounts of spent fuel in the storage pools of the Loviisa and Olkiluoto plants were about 164 tU and 760 tU, respectively.

By the end of 1997, the accumulated reactor waste amount to about 2 160 m^3 at the Loviisa NPP. At the Olkiluoto NPP, the respective amount is about 3 160 m^3, of which about 2 700 m^3 has already been disposed of.



3.7 Safety Considerations

The decision on general safety requirements for nuclear power plants, issued by the Government in 1991, addresses also interim storage of spent fuel and reactor waste. The more detailed safety requirements are given in the decisions and guides of STUK. The safety evaluations for the storage of spent fuel and reactor waste have been included in the FSARs for the nuclear power plants.

So far, no major safety-related incidents associated with interim storage of spent fuel or reactor waste have occurred.

4. *Transportation systems*

Between 1981 and 1996, fifteen shipments of spent fuel were sent from Loviisa to the Russia and in total about 330 tU of spent fuel was shipped. Casks of TK-6 type and a special train were leased from the Russia for the transportation. Due to the Amendment of the Nuclear Energy Act, the shipments were finished at the end of 1996.

At Olkiluoto spent fuel is transferred from the storage pools inside the reactor units to the interim store at the NPP site. The transfer cask is of CASTOR-type designed according to the specifications of TVO spent fuel.

As the reactor and decommissioning wastes are stored and will most likely also be disposed of on-site, there is no need for very specialised transportation systems for these wastes.

As a part of the ongoing environmental impact assessment for spent fuel disposal, the radiological and other effects brought about by the transportation of spent fuel from the NPP sites to four candidate locations of the encapsulation and disposal facility will be analysed considering different transportation routes and modes (by truck, rail and sea).

5. *Disposal systems*

5.1 National Policy

Spent fuel

Nowadays both utilities aim at disposal of spent fuel into the Finnish bedrock. Spent fuel will be stored in water pools for some decades. Thereafter, spent fuel will be encapsulated and transferred to an underground repository at a depth of about 500 m in crystalline bedrock.

Low and intermediate level wastes

The national policy is to dispose of all low and intermediate level wastes in rock cavities at the NPP sites. The disposal facility at the Olkiluoto NPP site was taken into operation in 1992 and the one at the Loviisa NPP site in 1998.

5.2 Requirements

Spent fuel

The estimated amount of the spent fuel to be disposed of in Finland, arising from 40 years operation of NPPs, is approximately 2 600 tU. However, increase of the nuclear capacity and extension of the lifetime of the existing NPPs is under discussion.

Low and intermediate level waste

The estimated total amounts (as packed) of different waste types, employed in the safety analyses of the repositories, are the following:

Utility	Dry maintenance waste	Solidified wet waste	Decommissioning waste activated	contaminated
TVO; Olkiluoto	5 600 m^3	3 100 m^3	5 500 m^3	23 700 m^3
IVO; Loviisa	2 400 m^3	5 400 m^3	4 500 m^3	8 800 m^3

5.3 Regulations

Reactor waste

The Government decided on the general requirements on the safety of reactor waste disposal in 1991. More detailed requirements are given by the Radiation and Nuclear Safety Authority (STUK) in its decisions and guides.

Spent fuel

In the development of radiological and safety criteria for disposal systems of high-level wastes, the international efforts within the IAEA, ICRP and OECD/NEA are closely followed. Preparation of the Decision of the Government on the general safety requirements for spent fuel disposal is underway.

5.4 Site Selection

Reactor waste

At the end of 1970's, the nuclear power plant sites at Olkiluoto and Loviisa were chosen as candidate locations for repositories of low and intermediate level reactor wastes. To confirm that the bedrock at these sites possesses the sufficient characteristics to safely host a repository, a comprehensive investigation programme was carried out at both sites.

Spent fuel

The selection process for a spent fuel disposal site has included the following stages:

- In 1985, based on identification regional bedrock blocks, selection of 102 potentially suitable areas. Of these, the Ministry of Environment later discarded 17 areas.
- In 1987, choice of five areas for preliminary site investigations. Before this, STUK made a general review on the site screening process and gave some recommendations for further site selection.

- Since 1987, deep drillings and related geological investigations were carried out at the selected sites (Romuvaara in Kuhmo, Veitsivaara in Hyrynsalmi, Syyry in Sievi, Kivetty in Konginkangas and Olkiluoto NPP area in Eurajoki).
- At the end of 1992, the preliminary investigations were completed and three most appropriate sites (Romuvaara, Kivetty and Olkiluoto) were included in the shortlist of sites for detailed investigations.
- At the end of 1996 R&D studies on technical concepts, site investigations and safety analyses were updated and delivered to authorities for review.
- In the beginning of 1997, site investigations at the Loviisa NPP site (Hästholmen) were started.
- Environmental impact assessment (EIA) procedure was launched in 1997 in four municipalities. According to Posiva's plans, the EIA report will be finalised in early 1999.

Agreements with the landowners (power utilities and government) have been sufficient for starting the site investigations. The construction of the final repository will require approval from the local municipal council.

5.5 Underground Research

There is no large-scale underground research laboratory in Finland, but some experiments, such as full-scale demonstration of boring of disposal holes for spent fuel canisters, are done in a research tunnel co-located with the LILW repository at Olkiluoto. Posiva Oy has renewed in 1998 the co-operation agreement with the Swedish SKB company as regards the continuation of the research in the Äspö Hard Rock Laboratory (HRL).

The preliminary investigations at the five candidate sites for spent fuel disposal were completed in 1992 and more detailed investigations at four sites have been performed from 1993 onwards. A number of deep drillings has been done at each site. If the Decision in Principle and disposal site selection will be made as planned, construction of the exploratory shaft will be started in 2003.

5.6 Repository Concepts

Reactor waste

The repositories for low- and intermediate level reactor waste are located in the bedrock of the two NPP sites The designs of the Olkiluoto and Loviisa repositories are somewhat different mainly because of the local geological conditions. At Olkiluoto the host rock massif favours vertical silo-type caverns, whereas at Loviisa horizontal tunnels are more suitable.

At the Olkiluoto site the host rock consists of an intact tonalite massif surrounded by micagneiss. Groundwater of the site is of fresh or brackish type with no great variations in salinity. The repository consists of two silos at the depth of 60-100 m, one for bitumenized intermediate level wastes, and the other for dry maintenance waste. The diameter of the silos is 24 m and the height 34 m. The silo for maintenance waste is a shotcreted rock silo. The silo for bitumenized waste consists of a thick-walled concrete silo inside the rock silo. No backfilling will be used inside the concrete silo. The empty space between the concrete silo and the rock will be filled with crushed rock. All wastes will be emplaced in concrete boxes that take e.g. 16 drums.

The bedrock of the Loviisa site on the island of Hästholmen consists of rapakivi granite. The groundwater on the island contains two zones of different salinity. The repository is located at the depth of 110 m, below a gently dipping fracture zone that constitutes a boundary between overlying zone of fresh groundwater and a lower zone of very saline groundwater. Accordingly, the repository will be situated in a zone of almost stagnant groundwater.

The repository in Loviisa will consist of two tunnels for dry maintenance waste and a cavern for immobilised wet waste. This cavern has been excavated but the construction and installation works will be completed later. Evaporator concentrates will be treated by separating caesium with selective ion exchangers. For remaining wet waste, design of a plant based on a cementation process is underway.

The safety analyses for reactor waste disposal were performed by utilising the scenario technique. Scenarios were employed to cover potential unfavourable changes in the local groundwater and biosphere conditions as well as the uncertainties in the performance of the barriers.

The authorities accepted the preliminary safety analysis reports for both Loviisa and Olkiluoto repositories in 1988. STUK accepted the final safety analysis report for the Olkiluoto repository in 1991 and that for the Loviisa repository in 1998.

Spent fuel

The encapsulation plant is planned to be located at the disposal site. Spent fuel would be encapsulated in copper-iron canisters each containing 12 BWR or PWR fuel assemblies. The canister design (Advanced Cold Process – canister) consists of an inner cast iron insert as a load-bearing element and an outer container of oxygen-free copper to provide a shield against corrosion. The canisters are emplaced in boreholes drilled in the floors of tunnels which are constructed at a depth of about 500 m in crystalline rock of good quality. The annulus between the canister and the rock walls of the boreholes will be filled with compacted bentonite. During closure the tunnels will be backfilled with a mixture of sand and bentonite.

A series of safety assessments for spent fuel disposal has been prepared by the implementor: TVO-85, TVO-92, TILA-96 and the next one, TILA-99, will be published at the end of 1998. Their outcome is that the planned system for spent fuel disposal fulfills the proposed safety criteria. Provided that no major disruptive event hits the repository, initially intact copper canisters preserve their integrity for millions of years and no significant amount of radioactive substances will ever escape from the repository. Impacts of potential canister failures have also been analysed employing conservative assumptions, models and data.

The review by STUK of the TILA-96 analysis concluded that the study strengthens confidence in the safety of the disposal concept. STUK gave also several recommendations concerning future R&D efforts.

The new integrated performance assessment, TILA-99, will be based, as far as practicable, on data obtained from investigations at the four candidate sites. It will support the Environmental Impact Assessment report to be submitted for comments in early 1999 and the Decision in Principle application to be submitted later for approval.

Decommissioning waste

The latest updating of the decommissioning plans was presented in 1993. The disposal plans for wastes from decommissioning of the NPPs are based on the extension of the on-site repositories for reactor wastes. Besides the dismantling wastes, also activated metal components accumulated during the operation of the reactors will be disposed of in those repositories. The engineered barriers in different parts of the repositories are selected taking account of the radiological and other safety related characteristics of each waste type. A special feature of the Loviisa decommissioning plan is the emplacement of large components, such as pressure vessels and steam generators, in the disposal rooms as such, without cutting them in pieces.

The results of the safety analysis show that the planned disposal concepts provides good isolation for the waste and efficiently hinders releases into the biosphere. The regulatory review concluded that further planning of the disposal of decommissioning wastes could be focused on the concept of 1993.

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HUNGARY

1. General strategy

1.1 Overall waste management strategy

The aim of the radioactive waste storage and disposal is to isolate the radioactive waste from the environment to such extent that they could not cause – neither now nor in the future – any unacceptable risk for the man and for the natural environment.

Although radioactive isotopes are used in many areas (in medicine, industry, agriculture, and research) most of the radioactive waste generated in Hungary arise from the operation of Paks Nuclear Power Plant (hereinafter Paks NPP). See Fig 1. Paks NPP consists of four practically identical Russian designed VVER-440 Model V213 reactors that were commissioned in 1983, 1984, 1986 and 1987, respectively. The plant's four units generate about 42% of the country's domestic electricity production.

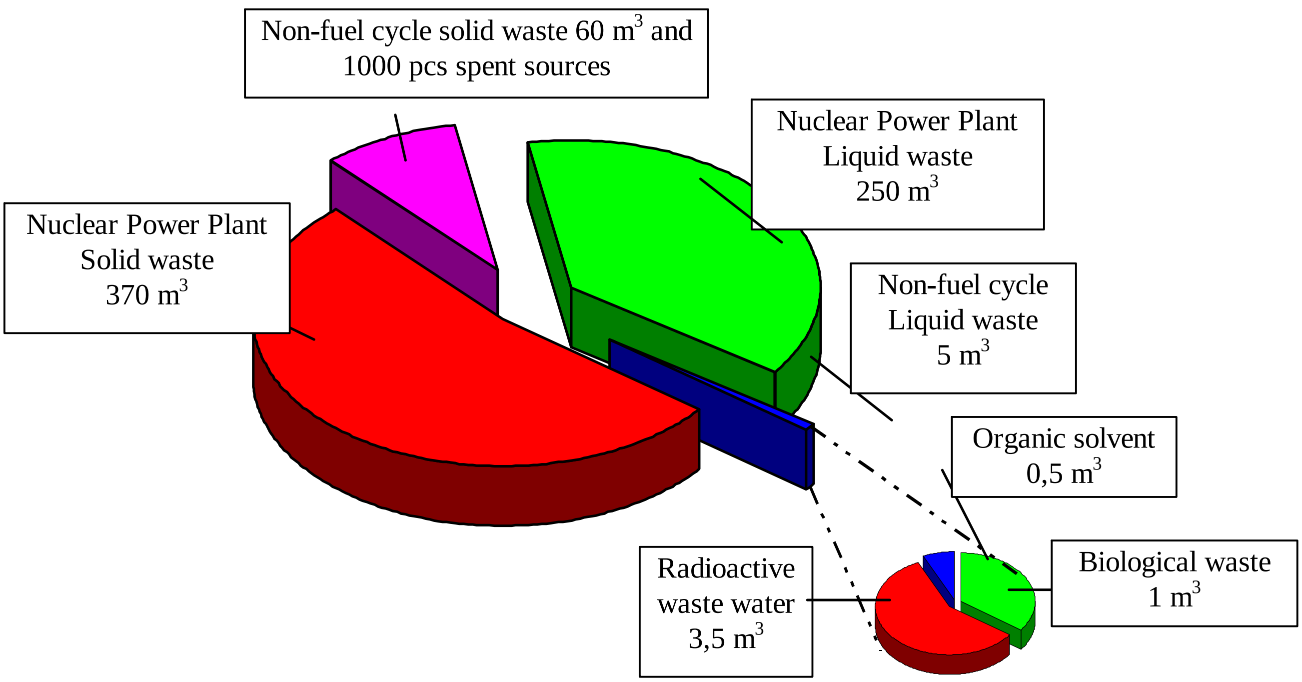

Fig 1. Sources, types and yearly average quantities of LLW/ILW waste in Hungary

The strategy which has been chosen for the back-end of the nuclear fuel cycle keeps open both reprocessing and direct disposal routes ("wait and see").

It was highly desirable to proceed by planing for possible disposal of spent fuel some 50 years or more in the future as insurance against the waste remaining in Hungary or being returned after reprocessing.

In 1976, a permanent on-surface repository at Püspökszilágy was commissioned to dispose of L/ILW institutional waste. The repository was originally operated by the Hungarian Atomic Energy Commission, and later by the Ministry of Public Welfare.

Because there has not been final disposal site for radwaste of Paks NPP origin, the central disposal site has temporarily (between 1988-1996) solid low level waste.

In 1992, a National Project aimed at solving the problems in the treatment and disposal of the NPP waste was launched. This project contemplates the creation of an overall waste management scheme, including all related issues of conditioning, disposal, development of legislation and assignment of responsibilities.

Normally, the siting of any HLW repository should be started by a screening of the entire country for suitable locations. But Hungary is having a geological formation which is considered at least on the base of the first investigations as a national "treasure". This is a claystone formation (called Boda Claystone Formation and abbreviated as CFB) in the Mecsek mountains. In 1993, a specific study program started for further examination of this potential host rock.

1.2 National policy – implementing law

1.2.1 Regulatory framework

The first comprehensive regulation of peaceful uses of atomic energy in Hungary was accomplished by Act No. I of 1980 on Atomic Energy [1]. This Act represented an up-to-date system of norms at the time of its adoption by Parliament, the supreme legislative body of the country. Many of the fundamental principles and practical guidelines contained in the Act are still valid and acceptable. However, the significant changes that took place in the economic and social conditions of the country parallel to the changes in the political regime and in the structure of state administration during the past few years necessitated a thorough revision of the Act and its associated governmental and ministerial orders [2] [3].

On 10 December 1996, the Hungarian Parliament, following careful preparatory work of a few years duration, under the coordination of HAEC, discussions with competent national bodies to establish an agreement, and consultations with representatives of international organizations, adopted the new Atomic Energy Act [4], which replaced 1980 Act. The Atomic Energy Act of 1996 (hereinafter referred to as "the Act") while preserving the essentials of the 1980 Act, aims to conform to recent international rules and recommendations as promulgated by the IAEA and the OECD/NEA. It entered into forces six months after its promulgation i.e. on 1 June 1997, with the exception of articles 62-64 (concerning the Central Nuclear Financial Fund), whose date of entry into force was specified to be 1 January 1998.

As with the 1980 Act, the different Ministries are responsible for implementing the Act in their respective fields of jurisdiction by means of separate regulations. Until new regulations are brought into effect the existing regulations continue to apply, with some exceptions where new regulations came into force on the same day as the Act itself.

The powers to implement the Government's responsibility under the Act for the control and supervision of the safe utilisation of nuclear energy are vested in the Hungarian Atomic Energy Commission (HAEC) and the Hungarian Atomic Energy Authority (HAEA), as well as the Ministers concerned. The HAEC is, generally speaking, concerned with the development of policy, as well as the overall co-ordination and monitoring of activities, in the nuclear field. Its members are comprised of senior officials of the Ministries and public organisations performing regulatory tasks under the Act. The HAEA, on the other hand, is an authority and, as such, coordinates or performs the particular regulatory tasks necessary to ensure the safe application of atomic energy. The responsibilities of the HAEA and HAEC have been specified in Government Decree No. 87/1997. (V.28) Korm. The Decree came into effect on 1 June 1997 and defines in detail the statutes of the HAEC and HAEA.

As regards the general regime under the Act, the HAEA has a central coordinating role in regulating nuclear activities. It has general responsibility for activities such as keeping central records of radioactive materials, accountancy and control of nuclear materials, licensing the transport of radioactive materials, as well as approval and inspection of the packaging of radioactive materials as required in the transport regulations of dangerous goods and in international agreements, co-ordination of research and development related to the safe use of atomic energy and co-ordination of international co-operation related to the application of atomic energy.

Additionally, HAEA shall function as the authority in regulatory licensing of structures connected to nuclear facilities with regard to nuclear equipment and fuel, nuclear safety and technical radiation protection licensing and inspection of activities related to the design, manufacture, construction, commissioning, operation, modification, importation, shutting down and decommissioning as well as monitoring the existence of a quality assurance system.

Under the general regime of licensing, the HAEA is the regulatory body responsible for licensing the siting, construction, enlargement, commissioning, operation, modification, putting out of operation and decommissioning of a nuclear facility.

In the definition section of the Act, a nuclear facility is defined as including a nuclear power plant, a nuclear district heating plant and a nuclear reactor for research and training. Radioactive waste repository is not considered as nuclear facility.

1.2.2 Licensing

Under the Act the Minister for Public Welfare, through State Public Health and Medical Officer Service /SPHAMOS/ and as part of the radiation safety procedures, carries out:

(a) licensing and monitoring of all activities with radioactive materials; and

(b) licensing and inspection of non-nuclear facilities which serve activities with ionising radiation or radioactive material (including radioactive waste repositories).

Under the Act the Parliament's preliminary approval in principle is required to initiate activities in preparation for the establishment of a new radioactive waste disposal facility.

The Minister for Public Welfare, through SPHAMOS, is responsible for licensing and monitoring the siting, construction, commissioning, operation, modification and closing down of radioactive waste disposal facilities. Under Section 21 of the Act the following Ministers and public administration bodies are responsible for enforcing specified aspects associated with the licensing of the waste disposal facility:

- The Minister for the Interior, through the offices of the National Police Force and the Fire Protection and Civil Defence Service, enforces aspects relating to public and domestic order, fire protection, security and civil defence.
- The Minister for Agriculture, through the offices of the Animal Health and Food Control Stations, enforces aspects relating to food, plant and animal hygiene, as well as soil protection.
- The Minister for Industry, Trade and Tourism, through the Hungarian Geological Survey, enforces aspects of licenses relating to geology.
- The Minister for Environment Protection and Regional Development enforces aspects relating to environment protection, nature conservation and water quality protection.
- The Minister for Transport, Communication and Water Management enforces aspects relating to traffic, transport, water utilisation and protection of water bases.
- The building authority competent for the area enforces aspects relating to regional planning and building.
- The President of the Hungarian Mining Authority enforces aspects relating to mining technology and mining safety.

Facilities for the interim storage or final direct disposal of spent fuel are nuclear facilities, falling under the regulatory competence of the HAEA Nuclear Safety Directorate.

In addition, the police, as a special authority, are responsible for issuing an approval, pursuant to separate legal regulations, for the final disposal facilities of radioactive waste. The police also issue a licence, pursuant to separate legal regulations, for transporting spent nuclear fuel in Hungary and across borders.

A licence for the application of atomic energy will only be granted if the safe interim storage or final disposal of the radioactive waste generated can be assured in accordance with the most recent scientific knowledge.

The interim storage of radioactive waste and spent fuel is licensed only for a defined period of time.

A facility for final disposal of radioactive wastes – like any other facilities – is subject also to the conventional licensing procedure. The relevant authorities and organs are among others the following: Municipal administration (utilisation of land and construction of buildings), Hungarian Mining Authorithy, National Agency for Nature Conversation, National Water Management Directorate, National Agency for Historic Monuments, etc.

1.3 Organisational structure

1.3.1 The waste operator

According to Hungarian law, the producers of radioactive waste are responsible for all waste management up to disposal, taking into account the legal and regulatory requirements.

Before 1998, the removal of the waste from small licensees, and the transport to the Radwaste Treatment and Disposal Facility was carried out on a cost-free basis by the Facility upon the request of waste producers. The repository, situated some 40 km north of Budapest, was opened by the HAEC in 1976 and was operated by Capital Institute of State Public Health and Medical Officers Services of Ministry of Public Welfare.

The biggest waste generator i.e. Paks NPP process their own waste. Both treated solid and unconditioned liquid waste is kept in interim storage on the site pending final disposal.

1.3.2 The Regulatory body

Existing regulation is based on Act No. 1 of 1980 an Atomic Energy and its executive orders.

The detailed regulations for radioactive waste management are contained in Ordinance No. 7 of 20 July 1998 of the Minister for Public Welfare. A revision of this Ordinance – taking into account the new act on atomic energy – at the time of writing (Febr. 1998) was under preparation.

The ministerial order specified also those other authorities, who are involved in the licensing process. In Hungary it is the general rule of administration that a licensing authority invites in its licensing procedure all those other regulatory organisations who are authorised to make decisions related to the subject of the procedure from some special point of view. The licence can be granted only if all the involved authorities gave their consent to it. In the case of a radioactive waste repository the following authorities have responsibilities:

Licensing authority: State Public Health and Medical Officer Service (on behalf of the Minister of Public Welfare)

Other authorities participating in the licensing procedure of the licensing authority: Inspectorates of Environment Protection, Veterinary and Food Control Service, Hungarian Geological Survey, General Inspectorate of Transport, National Headquarters of Fire Protection, National Headquarters Civil Defence, National Police Headquarters.

Some other authorities have also regulatory tasks in connection with the radioactive waste management, such as the Hungarian Atomic Energy Authority in waste collection, handling and treatment on the site of nuclear facilities and in international transportation, packaging and recording of radioactive materials.

1.3.3 Waste management organization

Under the new Act on Atomic Energy, the performance of 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 a nuclear facility are the responsibility of an organisation designated by the Government, since their efficient accomplishment is in the national interest.

The governmental decree establishing this organization entered into force on 1 January 1998 [6].

1.4 Policy on spent fuel management

Fuel for Paks NPP, just as for all other East European VVERs, has been supplied in the past by the Soviet Union. As part of fuel agreement, the Soviet Union undertook to take back and dispose of all spent fuel. Using another supplier would have left Hungary with the problem of high level waste disposal.

In 1992, however, Russia passed legislation prohibiting the import of foreign radioactive waste, and 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. The HAEC issued a licence in February 1995 for the construction of the facility, and a licence for the commissioning of the facility in February 1997. The first fuel assemblies were received by the facility in September 1997. Further licensing steps will be provided by the HAEA.

1.5 Overall schedule

1.5.1 Low and intermediate level waste

According to the approved plan, the National Project was to be carried out in two phases. The first phase (1993-1996) was to provide the basis for decision on the siting of the repository. In the second phase the actual realization of the facility was foreseen.

1.5.2 Very low level waste

No such a waste category is currently defined in Hungary, hence creation of waste disposal facility specially dedicated to very low level waste is not studied.

1.5.3 Long-lived and high level waste

When discussing the proposal on the National Project, the Hungarian Atomic Energy Commission considered it very important that a comprehensive strategy be elaborated that would cover all the issues related to the management and final disposal of the low and intermediate level radioactive wastes arising during the operation of the plant, the wastes resulting from the closing of the nuclear fuel cycle and finally the wastes coming from the decommissioning of the plant. This strategical plan stipulates the milestones as follows.

By 2040 in Hungary the final disposal facility – serving either for direct disposal of the spent fuel assemblies or of the high activity waste produced by reprocessing and packed into containers – has to be commissioned. The 50 years available till this time – according to the foreign experience – will be both enough and required for thorough preparation of the construction.

The time required both to construct the disposal facility and for pre-construction detailed surveys and design work - that are to be accomplished only for the selected area – are assumed generally for 10-20 years. The geological “screening” covering more potential locations that precede the final selection takes approx. 20 years. To get accomplished the activities above the same time will be needed in Hungary, so the preparations are to be made in the nineties.

By taking into account the facts above, a programme aiming at the following milestones could be proposed:

- Up to 1998 the conceptions of final disposal has to be worked out – conceptions of the high activity reprocessing waste disposal or that of the contained assemblies. The conceptions have to include the disposal specifications and the programme of a nation-wide screening for site surveying options.
- By in-situ surveys, characteristics of the Boda Claystone Formation shall be evaluated, and preliminary decision shall be made upon its suitability, whether it is capable to be host rock for HLW repository. (The advantage of the accessibility of the deep level claystone from the existing uranium mine with low cost shall be utilized).
- Up to 2000, based on the specifications and requirements, the potential sites are to be investigated and explored and the potential solutions are to be worked out.
- Up to 2010, one site has to be selected from the options, and final decision has to be made on the reprocessing or on direct disposal.
- For in-situ exploration of the selected geological formation, it is practical to construct an underground laboratory. Long-term and detailed site characterization programmeme shall be established.
- Up to 2025, the selected site has to be explored in details, and the facility has to be designed.
- Up to 2040, the disposal facility has to be constructed.

1.6 Total system cost and funding

The new Act is requiring that the licensee, or in the case of budgetary organisations, the central budget shall be liable to cover the costs of the final disposal of radioactive waste, as well as the interim storage and final disposal of spent fuel, and of the decommissioning of a nuclear facility. For this purpose the Central Nuclear Financial Fund (herein after Fund) has been set up as of 1 January 1998. The Fund is a separate state fund pursuant to Act XXXVIII of 1992 on Public Finance exclusively earmarked for financing the construction and operation of facilities for the final disposal of radioactive waste, as well as for the interim storage and final disposal of spent fuel, and the decommissioning of nuclear facilities.

The Hungarian Atomic Energy Authority – under the control of the Government – continues to play an important role the field of the radioactive waste management. The member of the Government exercising supervision over HAEA shall dispose of the Fund and the manager of it will be the HAEA.

The licensees are obliged to cover the costs of the final disposal of radioactive waste, as well as of the interim storage and final disposal of spent fuel, and of the decommissioning (demolishing) of nuclear facilities by contributing to the Fund. In the case of nuclear facilities, the amount of payment shall be determined in a way that it fully covers all the costs arising as a result of the final disposal of radioactive waste and of the interim storage and final disposal of spent fuel generated during the total operating and institutional control period of the facilities and at the time of decommissioning, as well as all the costs related to the decommissioning of the nuclear facilities.

The amount of payments will be determined by the law on the annual budget on the basis of the cost estimate prepared by the organisation responsible for the radioactive waste management. The payments made by the licensees may be accounted for within the category of other costs. In the case of a nuclear power plant, these should be taken into account when determining the price of electric energy.

1.7 Quality assurance considerations

All waste management organizations (i.e. Paks, NPP, research institute etc.) have quality assurance programmes. Quality assurance systems are generally based on the ISO 9000 guidelines.

As part of the European Commission′s PHARE programme Quality Assurance and Quality Control procedures for safe management and disposal of L/ILW are to be elaborated. The objective of this project is, on the one hand to develop a generic approach containing the QA/QC procedures and methodologies need for the safe management of L/ILW, on the other hand, to apply this method as an example to the specific case for Hungary. The safety case of the waste disposal facility will be based, among others, on the well documented characteristics of the waste (including containers and packages) as well as on a reliable inventory.

The overall and coherent radioactive waste management strategy will consider a set of procedures and methodologies aiming at providing reliable basis for the safety analysis and confidence in the system.

1.8 International cooperation

Hungary is a member of the International Atomic Energy Agency since 1957. In the framework of technical cooperation and regional programmes many areas of the radioactive waste management have been dealt with. Moreover, technical assistance was provided by ENRESA (Spain) and ANDRA (France) on radioactive waste characterization programme.

France – through the CEA – and the Hungarian Atomic Energy Commission signed an umbrella agreement for cooperation – among others – in the field of nuclear waste management R&D.

Hungarian institutions joined a CEC project on “Management and storage of radioactive waste” (Task 3: Characterization and qualification of waste forms, packages and their environment).

The European Commission, as part of its PHARE programme regularly provides technical support to the Hungarian authorities in the decision-making process for the selection of a disposal option and candidate disposal site for a L/ILW disposal facility.

Intensive contacts are maintained with NEA/OECD.

Canadian AECL have actively participated in the HLW site investigation programme.

2. Storage system

2.1 National policy

2.1.1 HLW

See 1.4.

2.1.2 L/ILW

The concept laid down in the late 1960s for the management of radioactive waste of VVERs was to store the waste on site and postpone the decision on conditioning and disposal until the decommissioning stage.

As this concept was not acceptable by the competent Hungarian authority, site selection started as early as 1983 with the aim of finding final solution. Unfortunately all the attempts for siting a repository have failed so far.

Interim storage represents only one step in the chain of waste management activities and is understood to mean the supervised storage of radioactive wastes which are destined for final disposal. Such a temporary storage is necessary because despite the fact that technical feasibility of constructing a repository for low and intermediate level wastes has already been demonstrated, such a facility will not start operations before the year 2002 in Hungary.

2.2 Requirements

The spent fuels of Paks NPP first are being stored in storage pools on the site. The interim spent fuel store (MVDS) then provides storage for spent fuel assemblies discharged from reactors for a licensed period of 50-year.

Institutional L/ILW is subject to immediate disposal. L/ILW of Paks NPP origin should be stored at plant site pending final disposal.

2.3 Description of facilities

2.3.1 Low and intermediate level waste

Paks Nuclear Power Plant has limited on-site storage capability in the auxiliary buildings where solid waste drums can be kept until disposal.

By reconstruction this internal facility will be extended to provide sufficient capacity until such time the repository become operational.

Prior to treatment, liquid wastes are being stored also in the auxiliary building in stainless steel tanks.

Paks NPP has a capacity for storing 4 300 m^3 of evaporator concentrates. By the end of 1997 more than half of the storage capacity has been used.

There is sufficient capacity for spent resin. Of the 2100 m^3 overall capacity only 30 m^3 used ion exchange resin has been taken up till now.

The liquid radioactive wastes (evaporator concentrate, spent ion-exchange resin) are transported by pipeline to the liquid waste storage tanks. Conditioning of the liquid wastes has not started yet.

Solid L/ILW with or without compaction is placed in 200-litre steel drums, which are being stored on site pending disposal.

Activated metal components (interior parts of the reactor, control rod mechanism, etc.) are placed in storage holes in the reactor halls. Activated metal wastes will be treated together with decommissioning waste.

2.3.2 Spent fuel

The spent fuel assemblies discharged from the reactors are located one by one into vertically arranged carbon steel tubes in the store constructed on the site of the Paks NPP. The store itself can functionally be divided into three major structural units.

The first one is the vault module where the spent fuel assemblies are stored. This vault module is a structure enclosed by thick reinforced concrete walls and shell structures filled with concrete, the basic function of which is to provide radiation shielding. Each vault is capable of accommodating 450 spent fuel assemblies. The cooling required to remove the remnant heat generated by the fuel assemblies is provided by a natural draught driven air flow developing across the vaults and the connecting ventilation stack.

The second component is known as reception building in which the reception, preparation, and unloading of the spent fuel transfer cask takes place. This building is made up of a reinforced concrete sub-structure with basement and a structural steel superstructure forming a hall. The fuel handling systems and the various auxiliary systems are installed in this building.

The third component is the charge hall where the fuel handling machine travels during fuel transfer operations. The hall is bordered by the reinforced concrete wall of the ventilation stack on one side and by a steel structure with steel plate sheeting on the other side. The basic function of the sheeting is to protect the fuel handling machine against climatic stresses.

Loading of the store with spent fuel assemblies takes place as follows:

The water filled C-30 type transfer cask containing 30 spent fuel assemblies is lifted from the railway wagon, used to transport the cask from the power plant to the MVDS, and transferred onto the cask transfer trolley at the cask reception area. Following the completion of various preparation activities on the cask the trolley moves to the cask loading/unloading port.

This loading/unloading port is an opening in the floor of the reception building and it interconnects this building with the charge hall. At this stage the fuel handling machine lowers the fuel grab through this port in which fuel drying tube is installed.

When the fuel grab lowered into the cask it engages a fuel assembly and raises it into the drying tube. After completion of the drying process the fuel handling machine lifts the fuel assembly into its turret structure and moves to the designated fuel storage tube. Following the exact positioning of the machine at the tube entry the spent fuel assembly is lowered into the fuel storage tube.

Once the fuel handling machine has moved away from the fuel storage tube the air is evacuated from the tube and replaced with nitrogen; the tube remains connected to the built-in nitrogen service system.

In the meantime, the cask transfer trolley referred to earlier locates another fuel assembly underneath the cask loading/unloading port by rotational and longitudinal movements, and this next fuel assembly is loaded into the next designated storage tube by repeating the fuel handling operations above.

The MVDS is modular and can be extended when required. The present configuration consists of a reception building and one vault module with three vaults.

3. Transport system

In transportation of spent fuel the competency of the HAEA Nuclear Safety Directorate (formerly Nuclear Safety Inspectorate) ends at the border of Paks NPP and, outside the plant area the safety and security of transportation is taken care by other national authorities.

Spent fuel has been transported by rail to the former USSR in Soviet-designed TK-6 rail transport cars using C-30 casks. After at least 3 (later 5) years at-reactor wet storage of the spent fuel, consignments have been shipped. Spent-fuel transportation by TK-6 railroad car was performed under regulations consistent with those of the IAEA. The VVER-440 fuel was transported vertically. Spent fuel was shipped dry, using a nitrogen-gas coolant. If the fuel burn up was greater than 24 000 MWd/MT, neutron shielding was used. The TK-6 rail car weighs 90 MT and its capacity is 30 assemblies or 3.8 MT. Cask decontamination methods that have been developed include chemical and electrochemical techniques (for the metal-wall C-30 casks) and strippable polymeric coatings (for the TK-6 epoxy resin-coated container). See Table 1.

Table 1. Spent fuel returned to Russia

Period	Number of spent fuel assemblies	
	Produced	**Re-shipped to Russia**
1984	116	0
1985	236	0
1986	235	0
1987	352	0
1988	465	0
1989	470	116**
1990	477	235
1991	468	210
1992	464	240
1993	470	180
1994	464	0
1995	434	480
1996	461 + 126*	240
01.03.97.		450
Total	**5100 + 126**	**2151**

* Fuel assemblies from the Greifswald NPP.

** As part of the inventory, 180 assemblies were stored in containers due to postponement of transport.

Movement of the spent fuel assemblies, from the reactor building to the newly built MVDS, takes place by use of a special transport device specially designed for this purpose. This transport facility is made up of a transport cask, accommodating 30 fuel assemblies, and a railway bogie carrying the transport cask itself. The fuel assemblies are vertically inserted into the water filled transfer cask within the reactor pool.

Hungarian legislation for radioactive waste transport complies with international regulations (e.g. ADR, RID, ADN).

A transport container for low level and intermediate level waste has been designed in accordance with IAEA requirements. It can hold up to 14, 200-litre drums, or various different size containers (boxes, cut pipes, etc.) Based on this design, a full-scale waste container has been built and tested according to IAEA test conditions. The container was designed for transport of all forms of low- and /intermediate-level waste.

4. Disposal system – short lived LILW

4.1 National Policy

In 1976, the radioactive waste treatment and disposal facility at Püspökszilágy was commissioned to condition and dispose of institutional L/ILW waste. The type of disposal is near-surface in concrete trenches. Since there has not been any final disposal site for radwaste of the Paks NPP, with the permission of regulatory body, the central disposal site temporarily disposed of solid radioactive waste originating from the nuclear power plant, under restricted conditions (waste type, activity contents and package).

Due to the strong public opposition the disposal of waste from the nuclear power plant was stopped in 1989. Three years later, after having reached an agreement with the local communities, the Paks NPP was again authorised to ship solid, low level radioactive waste to the facility. This practice continued till the end of 1996.

The disposal capacity currently available ensures disposal of institutional waste for many decades, but for low and intermediate level waste coming from the nuclear power plant a new facility should be built.

In the framework of the National Project two repository designs in different geologic settings were studied.

The quantities of the wastes have been estimated on the basis of a 30-year operating life and waste production rates recorded to date during operation.

The volume of evaporator concentrates for disposal is expected to be 7 500 m^3, and of used ion exchange resins 320 m^3.

Most dry waste is compacted at the reactor site and the total volume of compacted and uncompacted waste for disposal will be approximately 3 500 m^3.

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

4.2 Requirements

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 can be assured in accordance with the most recent proven results of science, internationally accepted norms, as well as experience. Under the Act the interim storage and final disposal of radioactive waste and spent fuel shall be considered safe if:

a) the protection of human health and the environment is ensured during the whole period of these activities;

b) the effect exercised on human health and the environment is not higher beyond the country borders than that accepted within the country.

4.3 Regulations

The detailed regulation of radioactive waste management as well as other executive orders of the new Act on Atomic Energy are now drafted and will provide a new, up-to-date legal framework for the peaceful application of atomic energy in Hungary.

To date, the Hungarian nuclear waste disposal regulations have not adopted risk-based standards.

At present regulations envisage 1 000-10 000 year time frame (cut-off time) for assessing the adequacy of a proposed L/ILW repository. However in making preliminary judgement on suitability of sites under consideration – with different repository design and in different geologic settings – by using probabilistic performance assessment the 1 x 10^{-6} annual health risk increment for potentially exposed people as used in other radioactive waste programme worldwide was applied.

The radiation protection requirements of the final disposal of radwaste is set down in the Annex 12 of Decree No. 7/1998 issued by the Minister of Public Welfare. It stipulates:

- The disposal can be accepted as a final one only if it lasts at least twenty times the half-life of the longest lived dominant radionuclide.
- Final disposal of radwaste can be licensed only in a manner and on site that does not cause unacceptable risk to the society and does not harm human life, the health of present and future generations, the human environment and goods.
- Members of the public living in the neighbourhood of the facility should not be exposed to a yearly effective dose equivalent above 0.25 mSv.
- A shallow ground disposal facility can be sited only in a geological environment acceptable from the point of view of tectonics, seismology, etc. and at least on 1 km distance from densily populated areas, recreational districts, surface waters (river, lake), dams, mines and factories producing dangerous and explosive goods.
- If the natural parameters of the site are not quite adequate, the selected site should be improved by engineered structures.
- The facility of the final disposal of radwaste – taken into account the natural characteristics of the site, the packaging and conditioning of the waste – shall be designed in such a way that the radiation protection of the surrounding public should be assured even in extraordinary and accidental situation. The fulfillment of these requirements must be proved in the preliminary and final safety analysis report.
- The site shall be surrounded with an appropriate fence. In addition to that a safety zone must be established around the site of 0.5 km width, marked by appropriate sings.
- The capacity of the facility for the final disposal of radwaste shall be sufficient for the quantity of waste arising in ten years with the possibility to increase further the capacity.
- On the site of the facility the disposal area serving for the waste should be separated from the area where the workers of the facility are staying.

- The operator has to make an inventory and a recording of the quantity, properties of the radwaste, time, place and method of disposal.
- The radwaste disposed in the facility must be prepared according to the relevant safety and technological requirements.
- The monitoring of radiation on the site and in the environment is the task of the operator. The authority supervises the fulfillment of this task.
- In the post-sealing period the operator has to provide for the supervision of the facility for the monitoring of radiation in the environment and the prevention of the intrusion of persons and animals for at least 50 years and after that date as long as the authority requires it.

4.4 Site selection

The site selection has been performed in two phases as described below.

4.4.1 First phase of the Project

In the early stage of the project the strategy was approved to study alternatives both for disposal method and for location of facility. It was agreed that on-site investigations would only start in case of voluntary acceptance by the communities concerned. For site exploration the objective was the whole of Hungary up to the depth of 300 m.

The method used in site exploration was one of gradual approximation, whereby the exploration was performed in stages, thereby limiting more expensive investigations to progressively smaller areas. The geological exploration has been carried out by the Geological Institute of Hungary in four stages:

- countrywide screening, 1:500.000;
- regional screening, 1:100.000;
- reconnaissance by field research, 1:25.000;
- preliminary evaluation by drilling.

1st exploration stage

In the first step of the exploration (negative screening) on a scale of 1:500.000 all areas were ruled out that have to be protected from geological, political, economical etc. consideration, or where the disposal site has to be protected from industrial or natural influences. Site could not be chosen in a 30 km zone along the border, in areas of flood or overflows, within earthquake populations and zones of potential movements upon young faults.

Out of the 93 000 km^3 area of Hungary about 6 000 km^2 was worth doing more research for near-surface, 23 000 km^2 for subsurface disposal.

That step was followed by positive screening or area selection. Most important requirements were uniformity of rock masses, their great thickness and low hydraulic conductivity. Suitable objects were expected in areas where the number and density of potential geologic objects proves to be high. The area with the most potential is situated within an approximately 5 000 km^2 region. See Figure 2.

2nd exploration stage

Both the negative and positive screening were repeated for the region designated with the help of much more detailed information on a scale of 1:100.000. Positive screening with criteria similar to those in the previous stage resulted in numerous prospective objects. 128 of these were near-surface and 193 for subsurface disposal including one granite object. Sedimentary objects of both types were listed and ranked separately.

The fundamental aims of all actions, events and programmes have been to establish a long-term relationship between the local community and to keep the local residents continually interested and confident in the development. After the screening letters inviting indications of interest were sent to all interested municipalities. The objective was to invite communities to volunteer their locality as a potential site.

After the checking public acceptability of sites only 12 near-surface and 18 subsurface objects (including the granite) remained.

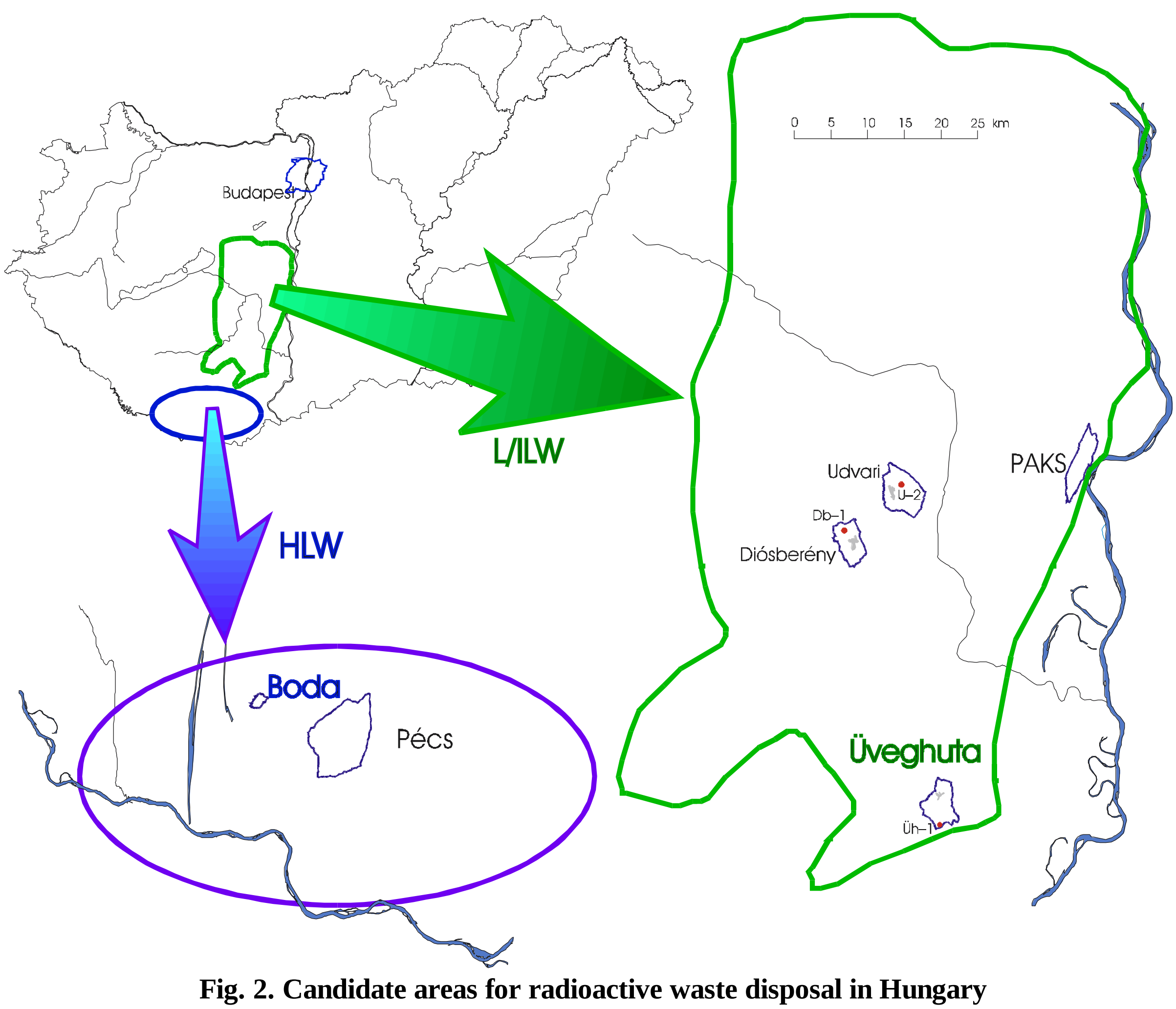

Fig. 2. Candidate areas for radioactive waste disposal in Hungary

3rd exploration stage

Stage 3 investigations were based on the idea that all exclusion criteria were valid and should be continually checked and rechecked. This process becomes easier with the reduction of suitable areas. However, the increasing volume of data from different sites become less suited to standard treatment, and local factors had to be increasingly taken into account in the evaluation.

In the chosen areas field studies were started to determine the site suitability. The emphasis was put on checking the fulfillment of geological and hydrogeological requirements such as:

- uniformity and permeability of the rocks;
- lack of upwelling ground water;
- long return period (pollution travel time to the surface).

Hydrogeological cross-sections – with hydraulic conductivity data for different formations related to the recharge – served as a basis for numeric flow modeling to estimate return periods.

4th exploration stage

On the basis of the scientific investigations, preliminary safety analysis and economical studies the Task Force selected three candidate villages where on-site investigations were started, additional three were kept reserve.

Field reconnaissance for disposal was started in two sites for near-surface disposal in loess, and in one for subsurface disposal in granite. Data on the subsurface sedimentary objects were analyzed more widely and more intensively than previously, and it was concluded that further studies even on objects with public acceptance should not be undertaken.

In next step, boreholes were drilled in three potential objects, and the data from them were widely studied. The drilling was performed under quality assurance and round-the-clock technical control so that the results can pass any international tests. In all boreholes geophysical well logging by a wide spectrum of methods was performed.

Granites have been studied and are regarded as a potential host rock in a number of countries which have abundant and diverse methodological experience. On the contrary, loess is generally regarded unsuitable for the disposal. Disposal in loess has been opposed by a number of Hungarian professionals as well.

The investigations carried out in 1995-1996 bore much higher return periods for granites than for loess. Simultaneously, granite features symmetrical and stable migration pattern. All these arguments served to promote the granite at Üveghuta site (see Figure 1).

However, the symmetrical migration pattern and high return period received for granite can be due to the fact that there was a lack of data and therefore it was necessary to suggest a homogenous rock body for calculating purposes. It was also clear that the granites bear fractures and are not everywhere impermeable like in the borehole.

The investigations above closed the first phase of the National Project, and their results formed the basis for designing studies for the second phase.

4.4.2 Second phase of the Project

The second phase of the National Project consists of three stages:

- selection of a site within the granite terrain at Üveghuta (southwestern Hungary);
- assessment of the geological suitability of the selected site;
- characterization of the selected site.

These stages are described below.

1st exploration stage

The first stage consisted of geological evaluation of five areas in the neighborhood of the Üveghuta borehole. This first stage comprised detailed hydrogeological reconnaissance, geophysical survey and drilling (15-80 m). It was completed by July 1997, and the site designated as No. 4 at a groundwater watershed was selected for studying in Stage 2.

2nd exploration stage

The second stage comprised drilling of four boreholes to 300 m depth. The boreholes are drilled by use of insert diamond bits, their spacing is 200 m. The boreholes are fully cored and logged by wireline geophysical methods. Borehole televiewer has been added to the standard suite of geophysical tools used in 1996, and this permits three-dimensional definition of fracture orientations. Core scanning by a newly constructed, portable Hungarian equipment gives detailed information on the texture and tectonics of the rock mass, and in combination with televiewer data offers a way to orient this information in space. Single-hole hydro dynamic testing is performed by Golder Associates in each borehole to determine fresh-water heads and formation properties. The completed wells will be instrumented for long-term monitoring (water-sampling and pressure-measurement) system.

Reflection and refraction seismic survey, horizontal tomography from the surface and shallow boreholes, velocity and absorption crosshole tomography as well as downhole seismic profiling are in progress to better determine the rock massif structure.

The Stage 2 fieldwork is to be completed in February 1998, and reporting on the studies as well as developing safety assessments will be completed in September 1998.

3rd exploration stage

On completion of the 1997-98 investigations and interpretation of their results a further safety assessment will be performed, and this will form the basis for the decision to be made concerning the suitability of the selected site for a subsurface repository for L/ILW and whether it merits further, more detailed, site characterization (Stage 3). The latter will be carried out with the PHARE Project No. 4.09/94 support in 1998-99, its contents being under discussion.

4.4.3 Further activities

Detailed site characterization will be followed by final safety assessment, environmental studies, designing and licensing process. The repository is planned to start operation in 2002.

4.4.4 Public relation aspects

The public relations campaign was planned to be carried out on three levels: general public, special groups (government, media, environmentalists, anti-nuclear activists) and the population of the areas found suitable for the construction of the disposal facility.

Concerning the general public, the primary goal of the PR campaign was to neutralise the present unfavourable public opinion on nuclear energy. Since the refusal towards the proposed solution of the radioactive waste disposal has been mainly grounded on ignorance, the national media was to be utilised at the earliest possible stage to inform the public about the Project. A national information programme was to be carried out to clear up the misconceptions about nuclear energy in general and the disposal of radioactive waste in particular.

Regarding the local public relations activities, the fundamental aim of all actions, events and programmes was to establish a long-term relationship between the local communities and the nuclear power plant and to continuously keep the local residents interested and confident in the development.

According to the PR strategy the repository was presented as a mutually advantageous solution based on voluntary co-operation of sovereign partners that serves the interest of the whole nation without forcing anything on anybody. The basis of the partnership is the trust of the local residents.

In order to increase the credibility and the reliability of the Project, outsider supporters were regularly drawn into the PR activities (Hungarian and foreign scientists, residents and principals of communities hosting radioactive waste).

It was made clear from the very beginning that exactly what types of radioactive waste would be disposed of in the proposed repository and what are the characteristics of these wastes.

After the first stage of the screening letters inviting indications of interest were sent to all interested municipalities.

This first letter was only introductory and informing the mayor about the Project, nothing had to be decided on. Great emphasis was put on explaining to them that the disposal unit will only be built in a village where most of the residents agree to it. Burson-Marsteller's telephone number was given in the letter as a “hot line”. They could call the members of the Paks Team and get more information.

As was expected, some municipalities requested further information, while others not or even refused the invitation. Those formally expressing interest were involved in the next phase of the Project.

Information sessions were held for those municipalities that expressed interest in learning more about the LILW disposal Project and the siting process.

Through a consultative process, attempts were made to ensure that all interested and potentially affected people obtain full information, and were given the opportunity to express their views and have their concerns addressed in addition, the experts informed the people of the technology options available and the possible benefits.

In April 1995 the second round of the scientific screening had been finished. This time it was a screening on 1:100000 scale, where the 5 000 square kilometre area was narrowed down. The new situation demanded to write a second letter to both the villages who were new and the ones who stayed in from the first round.

This stage resulted in one of the two outcomes. Either there were no suitable areas found in the community, in which case the community received no further consideration, or field investigations confirmed the availability of potential area (sites) and the technology to use at those sites.

Once the community was satisfied that on adequate amount of information was assembled and that the pertinent issues and concerns were adequately discussed and dealt with, then the views was tested through public opinion poll commissioned by the local council.

The second letter explained the situation and asked the municipalities to form opinion on the further involvement in the Project. The letter contained a summary of the benefits to the village and a questionnaire on which answering was made easier. Based on experiences in previous village meeting, some typical questions were answered in the letter.

The second letter differed from the first letter in that the PR company team actually asked the villages to commit themselves to some kind of an answer, either rejecting, or accepting the first research excavation taking place in their village. On the basis of the scientific investigations, preliminary safety analysis and economical studies the Task Force selected three candidate villages where on-site excavations were to be started and additional three were kept in reserve.

In the course of the on-site investigations the public information programme was continued. Besides the local municipalities involved, the neighbouring villages were also kept informed. The press and the scientific community were provided information in an organised manner (press conference, scientific day etc.).

As a result of the intensive PR campaign six municipalities expressed high degree of intention to collaborate.

Having designated the site for further investigations, the affected municipality Üveghuta called for the neighbouring villages to form an association with an aim of exercise control over the site investigation activities as well as of disseminating information within the region.

In April, 1997 six municipalities locating within 5 km radius of the potential site established the Social Association for Control and Information (Hungarian abbreviation is TETT).

The new Act on Atomic Energy foresees that the licensee of a radioactive waste disposal facility, in order to provide information regularly to the population of the communities in the vicinity of the facilities, will promote the establishment of a public control and information association and can grant assistance to its activities. In line with that provision it was arranged that the relevant bodies receive appropriate assistance and be provided with the infrastructure to co-operate with the public.

4.5 Disposal concept

The technical concept is based on the installation of a multi-barrier system between the radioactive waste and the biosphere. Disposal of operational and decommissioning LLW and short-lived ILW is planned at the same site and in the same depth. Long-lived ILW is anticipated to be disposed of together with the HLW.

In the framework of the National Project two main types of waste disposal options were defined and were to be evaluated, i.e. near surface disposal in concrete trenches and subsurface disposal either in silos or drifts (tunnels) constructed by mining methods. Currently the preferred option is a tunnel-type repository in granite site.

According to the conceptual design for the mined repository it would consist of 3 000 m of storage tunnels in granite, 6 m high by 8 3 m wide, and access tunnels, 4 m high by 7.2 m wide. The tunnels will be unlined but will have a reinforced concrete floor with an epoxy surfacing. It is currently planned that there will be two entrances to the repository. The repository is planned to be at an elevation of ca. 20-80 m above sea level. This is equivalent to a depth below ground surface of about 150-250 m. The entrances to the repository for both construction and for operation would be by declines. It is thought that the excavated material (ca. 250 000 m^3) can be sold as construction material, and it will be stored in quarries until it is required.

The waste packages will be placed in a concrete overpack with 5-6 cm wall thickness. Options available include the use of special cements, of additives and of substitute constituents within the concrete mix. These can decrease the permeability of the concrete and/or decrease its susceptibility to certain kinds of chemical deterioration. Options also exist with respect to the use of linings and to the type of reinforcement used. Choice of steel type or use of coatings may delay or prevent the onset of corrosion and of cracking of the concrete. Within the overpack porous concrete is assumed to be placed between the drums. Within the space between and around the overpacks a mixture of crushed granite with 10% bentonite is to be placed.

The planned final closure of the repository will involve backfilling the tunnels with the crushed granite and bentonite mixture, and then constructing concrete plugs near the surface. It is anticipated that the area containing the wastes from the operational period, and that for the materials from the first stage of decommissioning, will continue to be drained until the repository is full. It is also assumed that collection systems installed at the tunnel surface to intercept local inflows will remain effective during this period.

4.6 Research

L/ILW 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, supercompaction/ has also been studied.

L/ILW disposal

Most R&D being performed in Hungary on L/ILW 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 characterization, waste acceptance criteria, QA/QC programme and facility design.

5. Disposal system – high level waste

5.1 National Policy

See. 1.1.

5.2 Requirements

Assuming 30-year of plant operation, the estimated amount of spent fuel will total some 13 000 assemblies, i.e. about 1 800 tons of heavy metal. This amount may decrease if modified fuel utilization methods will be applied in the remaining operating time. The envisaged steps and milestones for realization is given in Paragraph 1.5.

5.3 Regulations

The objectives to be followed in the research and later in the engineering phases, in order to guarantee safety for final disposal of HLW in deep geological repository have not been formulated by law.

Guidelines have been drafted when discussing the site selection programme.

5.4 Site selection

The investigation has started by studying of the geological formation named Boda Claystone Formation (BCF), located on SW-Hungary, west of the city of Pécs. The reasons for the site selection without any preliminary, countrywide screening were as follows:

- BFC dips under a uranium-ore-bearing sandstone formation mined for 42 years. Utilizing the facilities and infrastructure of uranium ore mine it was possible to explore the formation relatively quickly at the depth of 1 050 m below ground surface.
- As a result of geological exploration connected to the uranium ore mining the BCF is located in the most studied area of the country. The amount of information regarding the potential host rock and its geological environment already exceeded the knowledge level of any other potential formations.

The works aimed at the qualification of BCF proceed in good investigation situation because of favorable geometry. The BCF is a sedimentary rock formation of Late Permian age, which is known from more than 150 km^2 area. Inside the 50 km^2 affected by detailed investigation, its thickness is between 700 and 900 m, as verified by boreholes. The entire depth range can be studied simultaneously, and with its relations, between the surface exposed area of 14 km^2 and the exploration tunnel system developed in the average depth of 1 050 m from the surface, the most abundant information can be obtained. Using surface and drilling research methods, the investigation can be extended to the formation underlying BCF as well.

On the basis of large-scale geological, sedimentological and tectonic habit of the area, the main features of major rock units, potentially selected for HLW disposal and of those studied in the exploratory tunnel, are identical. On the basis of recent investigations the upper 500-600 m thick part of BCF can be primarily suggested for further investigations. The exploratory tunnels and boreholes drilled from them affected the 400 m thick part of Boda Formation adjacent to the overlying beds.

The exploratory tunnel and the boreholes made it possible in a relatively small region to study *in situ* almost every rock varieties located on the contamination pathway and having different geological, hydrogeological and geotechnical features. Owing to the orientation of tunnel system, detailed anisotropy studies can be carried out.

Based on preliminary assessments the use of Permian Boda Claystone Formation (BCF) in the Mecsek Mountain area is being considered for high level waste disposal. To evaluate the suitability of this formation as a location for a waste repository, systematic investigations have started in the framework of the National Project.

Information about the lithology and structure of the overlying standstone formation has been collected during uranium mining over the past 40 years. Two of the 50 boreholes drilled from surface have penetrated BCF to considerable depth (a few hundred meters).

The investigations made so far from an exploratory tunnel and the two previous deep boreholes indicate that the formation is a highly compact rock unit of very low permeability.

The region that has been identified as a potential siting area will require a comprehensive characterizaion programme to select a preferred disposal site.

The objective of the currently performed short-term characterization programme (1996-1998) is to consolidate the information before starting the long-term programme that could take 10-15 years to complete before a final disposal site is approved. At present, the existence of the access tunnel from the uranium mine into BCF at 1 100 m depth provides an unique opportunity to conduct in-situ investigations.

About 50 boreholes were drilled from surface to investigate the uranium deposits in the sandstone. Four boreholes have penetrated the underlying Boda Claystone Formation to considerable depths (a few hundred metres). Two of these boreholes were drilled to 1 200 m depth to obtain information about the vertical characteristics of the claystone for most of its thickness. In 1993 a specific programme was started for further examination the Boda Claystone Formation.

The investigations so far from an exploratory tunnel and the two previous deep surface boreholes, indicate that the Formation is a highly compact rock unit of very low overall permeability ($< 10^{-10}$ m/sec).

Based on the investigation of faults, fractures and their relative movements by studying the overlying uranium bearing sandstone, it is believed that most of the faults in the claystone are sealed and filled by calcite, barite, gypsum and clay minerals. So far, the data suggests there are only a few broad fault zones crossing the Formation. Methods to determine the location, orientation, extent and hydrogeologic characteristics of these fault zones are currently being assessed.

The region of the BCF that has been identified as a potential siting area will require a comprehensive characterization programme to select a preferred disposal site. The existence of the access tunnel from the Mecsekurán Ltd. uranium mine into the Boda Claystone formation at 1100m depth, provides an opportunity to characterize some potentially important vertical tectonic structures that could act as groundwater pathways through the claystone. Thus the characterization programme for this area of the Boda Claystone differs from a characterization programme that would be developed for a site or formation where there is no existing underground access.

The characterization activities are part of a long-term characterization programme that could take 7 to 15 years to complete, before a final disposal site in the Boda Claystone is approved. However, there is a need to determine whether or not a long-term programme should be initiated in the Boda Claystone.

The data obtained by the recent investigations and those collected by Mecsekurán Ltd., Mecsek Ore Mining Company, and other Hungarian institutions can be used to select a preferred site for a high-level waste repository within the potential siting area. There are two possible alternatives that would affect the characterization programme. They are:

- the preferred site is close enough to the uranium mine so that it can be accessed from it; or
- the preferred site is located such that new access from the surface would be necessary or preferred.

If the preferred repository site is located away from the existing Mecsekurán Ltd. uranium mine where new access from surface is required or preferred, the characterization will initially be mainly from the surface at the undisturbed portion of the Boda Claystone Formation and will progress logically to underground characterization as new underground access is constructed.

There are certain time constraints to the short-term programmeme, due the governmental decision on closure of the uranium mine by 1997. All field activities, both surface and underground, must be completed in a two-year period, starting in May 1995. Analyses and interpretation of the field data must be completed within a reasonable time after March 1998.

References

1. Act No. I. of 1980 on Atomic Energy.

2. Enacting Clause of the Council of Ministers No. 12/1980 (IV.5) to Act No. I. of 1980 on Atomic Energy.

3. Order of the Minister of Health and Social Affairs No. 7/1988 (VII. 20) regarding the enforcement of the Enacting Clause of the Council of Ministers No. 12/1980 (IV.5) to Act No. I. of 1980 on Atomic Energy.

4. Act No. CXVI. of 1996 on Atomic Energy.

5. 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.

6. Governmental Decree No. 240/1997. (XII. 18.) Korm., on establishment of the organization designated for implementing radioactive waste disposal and spent fuel, as well as decommissioning of nuclear installations, and on the financial source performing tasks.

Further information can be obtained from: *Ms. Ildikó Czoch, Director, Safeguards, Hungarian Atomic Energy Authority (HAEA), PO Box 676, H-1539 Budapest 114, [Tel. +36 (1) 355 9764, Fax: +36 (1) 375 7402].*

NATIONAL PROGRAMMES AND POLICIES

AUSTRALIA

In March 1995 the Senate Select Committee on the Dangers of Radioactive Waste was established to report on radioactive waste management issues in Australia. The Committee's Report, tabled in the Senate in April 1996, included a recommendation for a national above ground store for all levels of radioactive waste. The Government's response to the report of the Senate Select Committee was tabled on 21 November 1996.

1. National near surface repository

For low level and short-lived intermediate level radioactive waste, international standards and practice indicate that near-surface disposal is appropriate. The Government therefore indicated its intention to proceed with the study to identify a site for a near surface repository for the disposal of Australia's inventory of low level and short-lived intermediate level radioactive waste. The study had been suspended in 1995 pending consideration of the report of the Senate Select Committee's report.

The site selection study was begun in 1992 following refusal of State/Territory governments to volunteer a site. Site selection criteria emphasise factors such as suitable geology, remoteness from population centres and arid climate.

Less than 3,500 cubic metres of low and short-lived intermediate level waste, arising from medical, industrial and research use of radionuclides, is stored at some 50 sites around Australia. The Commonwealth is responsible for over 90% of the waste inventory and arisings. Wastes include lightly contaminated soil, plastic, paper, protective clothing, gauges and electron tubes. Interim storage arrangements are unlikely to pose a health hazard but have caused public apprehension in some areas and Government agencies have had difficulties making alternative arrangements.

On 18 February 1998 the Government announced that the Billa Kalina region in South Australia had been identified as the most suitable region in which to locate a national near surface repository. A discussion paper "A radioactive Waste repository for Australia; Site selection study – Phase 3 Regional Assessment" has been released along with an information kit containing comprehensive information about the project.

Billa Kalina was identified as the preferred region of eight regions previously identified in Phase 2 of the siting study. The Billa Kalina region contains the largest area of suitable land in which to conduct further investigations.

A community consultation programme has been developed to allow for stakeholders to obtain information about the project and comment on the proposal. State and Regional Consultative

Committees will allow for ongoing discussions with the community. A regional information office and toll free telephone number have been established to allow for interested members of the public to obtain copies of the report and information kit. Public comment on the proposal has also been invited, with submissions to be made prior to 30 April 1998.

The selection of the final site will follow extensive field investigations and community consultation, which may take up to a year. The repository will be operated in accordance with the *Code of Practice for the Near-Surface Disposal of Radioactive Waste in Australia (1992)* which is based on international guidelines.

2. Category S wastes

The Government's response to the report of the Senate Select Committee accepted, in principle, a recommendation for the establishment of a storage facility for long-lived intermediate level waste (Category S) such as would result from reprocessing of spent fuel rods from Lucas Heights. The Commonwealth State Consultative Committee on the Management of Radioactive Waste agreed in November 1997 to pursuing co-location of such a facility with a near-surface waste repository. The Government will therefore consider co-locating a store at the site chosen for a near surface repository. In view of the small volume of long-lived intermediate level waste in Australia (approximately 300 cubic metres), and the expected small volume of future arisings, a geological disposal facility is not currently planned.

3. HIFAR–spent fuel

On 3 September 1997 the Government announced its decision to establish a replacement research reactor at Lucas Heights, to be commissioned in 2005. The government also announced that it had decided against establishing a domestic spent fuel reprocessing facility.

Six hundred eighty nine US origin spent fuel rods will be repatriated to the US with no waste to be returned to Australia. The balance of 1 300 rods is of UK origin, and will be shipped to Dounreay in Scotland for reprocessing. Reprocessing is expected to yield 200 cubic metres of cemented long-lived intermediate level waste, which will be returned to Australia in 10-20 years. This material will be handled along with other Category S wastes. Australia already holds waste of this type in secure storage, including obsolete industrial and medical radiation sources and radium gauges. Storage arrangements for intermediate level wastes will be finalised before return of cemented wastes of this level from the UK. A strategy for management of radioactive wastes from a replacement reactor will be developed following a decision on the type of research reactor to be constructed and its spent fuel arisings.

4. Research and development of titanate ceramic waste forms

The development of ceramic wasteforms for the immobilisation of high-level and long-lived radioactive waste is continuing. In particular, ANSTO is continuing to collaborate with Lawrence Livermore National Laboratory on the development of a ceramic wasteform for the immobilisation of surplus weapons plutonium. A ceramic wasteform is also being assessed for the immobilisation of the wastes arising from the production of molybdenum-99 at the ANSTO site.

Further information can be obtained from: *Dr. Ron Hutchings, Counsellor (Nuclear), Australian High Commission Strand, London WC2B 4LA, United Kingdom, [Tel. +44 (171) 887 5759, Fax: +44 (171) 873 9026),E-mail: ron.hutchings@dfat.gov.au].*

BELGIUM

1. Radwaste processing and conditioning

The CILVA low-level radwaste processing installation on the site of NIRAS's subsidiary company Belgoprocess in Dessel reached the following performances: 102 m^3 solid waste was pre-compacted, 578 m^3 supercompacted, 133 tons solid and 87 m^3 liquid waste incinerated, 327 m^3 cemented. Besides, 26 308 m^3 purified effluents were discharged, 28 tons sludges from the "Cuve 2000" were conditioned, and 22 142 m^3 condensates and cold effluents as well as 3 640 m^3 slightly and warm effluents were treated.

Important progress was made in the preparation of the clearance of the so-called HRA/SOLARIUM waste and areas, and in the processing of the alpha waste: the related industrial processing projects were prepared.

2. Interim storage of conditioned radwaste

By the end of 1997 the following quantities of conditioned radwaste were stored on the Belgoprocess site:

Type of waste	m^3	Packages	
Low-level waste	9 930	Drums	23 626
Medium-level waste	3 538	Drums	14 668
Vitrified high-level waste	215	Stainless steel containers	2 335

The building intended for the interim storage of vitrified high-level waste resulting from Belgian spent fuel reprocessing in La Hague (France) was made ready to receive the HLW containers that will be repatriated to Belgium. It is expected that the first containers will be repatriated by the end of the first semester of 1998.

3. Disposal of conditioned radwaste

3.1 Near surface disposal of low-level and short-lived radioactive waste

In April 1997, the study of the comparison of the various options for the long-term management of low-level and short-lived radioactive waste was presented to the competent authorities. In this study, the options of prolonged storage, surface disposal and geological disposal are compared from the point of view of safety and costs. On 16 January 1998, the federal council of ministers opted for a final solution, i.e. disposal, and ordered NIRAS/ONDRAF to concentrate its research, including exploration and reconnaissance, on the existing nuclear zones and zones situated on the territory of municipalities who have shown their interest.

3.2 Geological disposal of high-level vitrified waste in clay

Research related to geological disposal progressed according to plan. The PRACLAY programme saw the start of the construction of a second access shaft from which a connecting gallery to the existing CEN-HADES underground laboratory, and the planned actual Praclay gallery will be constructed. According to the recommendations of the SAFIR commission, who evaluated the first safety and feasibility interim report with regard to geological disposal in the so-called Boom clay, ONDRAF/NIRAS started to investigate the so-called Ypres clay that is found in the Doel nuclear power plant region, with a reconnaissance drilling campaign in November 1997 (it is expected that this campaign will last till March 1998). The samples will be analysed by specialised laboratories of the universities of Gent and Louvain-la-Neuve.

4. Nuclear inventory

The missions of NIRAS/ONDRAF with regard to the national inventory of nuclear facilities and installations, as well as of sites containing radioactive waste were specified by the law of 12 December 1997. This law also provides for the financing of the activities that will be developed in view of this inventory. A first version of the inventory is planned before the end of 1999.

5. Cassiopee

According to the rotation agreed upon by the interest grouping, NIRAS/ONDRAF acts, since 1 January 1997, as general manager and is also in charge of the accountancy of Cassiopee.

6. Information policy

In order to make the Praclay experiment more accessible for visitors, an exhibition has been set up on the site where the experiment is being performed.

The European Commission accepted to finance the project “Multimedia compact disk explaining how radioactive waste management is carried out in the European Union”. NIRAS/ONDRAF was put in charge of the co-ordination of this project.

Further information can be obtained from: *Dr. Fred Decamps, Directeur général, Organisme National des Déchets Radioactifs et des Matières Fissiles, ONDRAF, Place Madou 1, Boîtes 24/25, 1210 Brussels, [Tel. +32 (2) 212 1012, Fax:+32 (2) 212 1055, E-mail:f.decamps@nirond.be].*

CANADA

1. Uranium industry

1.1 Overview

The outlook for Canada's uranium industry improved in 1997, as uranium production capability continues to expand. In May, the McArthur River project in northern Saskatchewan cleared the environmental review process when governments granted approvals to proceed. In August, the federal Atomic Energy Control Board (AECB) approved a construction licence for the project. Ore from McArthur River will greatly extend the useful life of the Key Lake mill, and allow an annual increase in output to 6 900 tU.

As of January 1, 1997, Canada's total "known" recoverable uranium resources were 430 000 tU, compared with 490 000 tU as of January 1, 1996. The 14% decrease relates mainly to the closure of Rio Algom Limited's Stanleigh operation at Elliot Lake, Ontario, in mid-1996, and to increased Canadian uranium production in 1996. Primary output from Canada's three uranium-producing operations in Saskatchewan exceeded 12 025 tU in 1997, up almost 3% from 1996 production of 11 706 tU.

1.2 Environmental Assessment Reviews

In May 1997, the federal government released its response to the report of the Joint Federal-provincial Panel on Uranium Mining Developments in Northern Saskatchewan on the McArthur River uranium mining proposal. Through its licensing process, the AECB will address the Panel's recommendations on the technical issues related to the health and environmental effects of the project to ensure that the venture poses no undue risk. The AECB will also conduct a thorough and detailed analysis of decommissioning options throughout the various phases of the licensing process.

In August 1997, public hearings were concluded for the Cigar Lake and Midwest projects, also located in northern Saskatchewan. The Joint Federal-Provincial Environmental Review Panel report concerning the Cigar Lake and Midwest uranium mining projects was presented to the governments of Saskatchewan and Canada on November 13, 1997. Since that time, federal departments have been working to prepare a response. Should the Midwest and Cigar Lake projects be given approval to proceed, as the Joint Panel recommended, these projects would then advance to the regulatory licensing approval process. Federal and provincial regulatory authorities would then be required to determine if these projects should be licensed for production. A federal and provincial response is expected by the end of March 1998.

1.3 Other Developments

In June 1997, Cameco acquired from Cogema Resources Inc. (CRI) the remaining 25% interest in the Highland in-situ leach uranium project in Wyoming that was not previously owned through Power Resources Inc, which Cameco acquired in January 1997. In return, Cameco transferred to CRI its participating 20% interest in the Kiggavik uranium property, located in the Northwest Territories, and entered into a contract to supply CRI some 300 tU over the 1997 to 1998 period.

Also in mid-1997, the Tokyo Electric Power Co., Inc. (TEPCO), Japan’s largest nuclear power utility, acquired a 5% interest in the Cigar Lake project from Idemitsu Kosan. The transaction reduces Idemitsu’s holding in Cigar Lake to 7.875%.

On August 25, 1997, it was reported that CRI had signed a 10-year contract with TEPCO to supply some 4 580 tU beginning in 1999. The uranium, to come from the McClean Lake and Midwest projects in northern Saskatchewan, will be supplied by McClean Uranium Limited, owned by CRI. (70%) and Denison Mines Limited (30%).

2. Nuclear power programme

Nuclear Power Data*

	Canada	Ontario	New Brunswick	Québec
Electricity Demand Growth (% p.a.)	1.1	-1.0	1.0	1.0
Nuclear Share (%) of Electric Utility Generation	16.0%	54.1%	29.9%	3.1%
Reactors in Service	21**	19	1	1
Capacity In Service (Net MWe)	14668	13395	635	638

* As of December 31, 1996.
** Bruce A, Unit 2 was taken out of service on October 8, 1995.

2.1 CANDU Performance

In 1996, Canada’s nuclear plants generated about 16% of Canada’s electricity. Most of the nuclear electricity generated was in the province of Ontario. Construction on the CANDU 6 units in South Korea at the Wolsong site is well on track. Wolsong 2 is now in-service. In-service dates for Wolsong 3 and 4 are June of 1998 and 1999, respectively. The first unit at Cernavoda is fully operational and is generating about 10% of the country’s electricity.

The overall performance of some of Ontario Hydro’s nuclear units has declined in the last couple of years because of operational and management problems at the units. These problems are not safety-related nor are they related to the CANDU design. However, they have impacted on Ontario Hydro’s business performance. The Ontario Hydro Board of Directors to deal with the problem has adopted tough measures.

Four CANDUs are in the list of the top 25 reactors worldwide on the basis of lifetime performance to the end of December 1996. The CANDU reactors on the list include Pickering 7, Point Lepreau, Darlington 3 and Wolsong 1 in South Korea. The CANDU 6 units have gross annual (1996) capacity factors and gross lifetime capacity factors of over 80%.

2.2 Status of the Canadian Nuclear Programme

On August 13, 1997 the Ontario Hydro Board of Directors announced its Nuclear Asset Recovery Plan (NAOP) which entailed the lay-up of seven of its 19 operating CANDU reactors in order to dedicate resources to bringing the other 12 units back to their previous standard of excellence. Once that target is achieved, Ontario Hydro will evaluate the restart of the seven laid-up units by preparing the necessary business cases including a review of other generation options that will be available to the utility at that time. Ontario Hydro is continuing to review its NAOP with a view to confirming further decisions in its business planning cycle. The 4 units at Pickering have been laid up. The three operational units at Bruce A are to be laid up in the spring of 1998 (Unit 2 was mothballed in 1995). Decisions relating to Bruce A will depend on the overall success of the 12 unit recovery plan, on system needs and on the business case analysis.

Environmental groups criticised the plan to remove 4 000 MWe of nuclear generating capacity from the grid, claiming that the increased burning of coal and oil might produce as much pollution as seven million more cars, and that there will be ".... more smog, more deaths, and more acid rain."

An all-party "Select" Committee was established by the Ontario government to review the Ontario Hydro NAOP. The Report of the Select Committee was tabled in the Ontario Legislature in December 1997. In its report, the Committee:

- "affirmed" the recovery plan, noting that "the safe and efficient operation of Ontario Hydro's nuclear generating stations is vitally important to the people of Ontario";
- recommended that Ontario Hydro return its nuclear plants to world class standards in terms of performance and safety in a fiscally and environmentally responsible manner;
- calls on the AECB to enhance its monitoring and its reporting on Ontario Hydro safety performance and to develop more stringent standards to ensure compliance.

In a further move, the Ontario government released a White Paper outlining legislative proposals for restructuring of Ontario Hydro to clear the way for a competitive market for electricity by 2000. It is proposed that Ontario Hydro should be split into three Crown corporations: a generating company, a transmission and retail company and a non-profit company to operate an electricity exchange and settle accounts between buyers and sellers of electricity.

3. Regulation

Options for the future of the Whiteshell Laboratories *(AECL)* are under review.

The Nuclear Safety and Control Act (*NSCA*), replacing the existing *Atomic Energy Control Act* of 1946 received Royal Assent in March 1997 and it is expected that it will be proclaimed in late 1998 after the new regulations pursuant to the Act have been approved.

The *Nuclear Liability Act (NLA)* establishes the legal regime that would apply in the event of a Canadian nuclear accident affecting third parties. The NLA is modelled closely after the Vienna and Paris conventions. Following a 1994 court decision upholding the constitutionality of the Canadian NLA, Natural Resources Canada began a comprehensive review of the legislation. The review is ongoing and is being influenced by proposed revisions to the Vienna Convention. A discussion paper has been issued and circulated to major operators covered by the NLA for consultation. Comments will now be factored into the ongoing government review.

4. Radioactive waste management

4.1 Policy framework for radioactive waste

In July 1996, the Minister of Natural Resources Canada announced a policy framework for radioactive waste that will guide Canada's approach to the disposal of nuclear fuel waste, low-level radioactive waste, and uranium mine and mill tailings in Canada. The framework lays out the ground rules and sets the stage for the further development of institutional and financial arrangements to implement disposal 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 radioactive waste producers and owners in order that they meet their operational and funding responsibilities in accordance with approved disposal plans. The Framework recognises that there will be variations in approach in arrangements for the different waste types.

With respect to nuclear fuel waste, no decisions will be made regarding the next steps for the long-term management of nuclear fuel waste in Canada until the federal government has studied the recommendations of the Canadian Environmental Assessment Agency (CEAA) Panel that completed a public review of the disposal concept for nuclear fuel waste. Any response by government will only be made after a careful and thorough consideration of the Panel recommendations.

For low-level radioactive waste and uranium mine and mill tailings, the federal government wants to be sure that waste owners and producers have in place the institutional and funding arrangements to ensure that the disposal of these wastes can take place when required.

4.2 Nuclear fuel waste (high-level waste)

Following public scoping sessions, the issuance of guidelines to AECL for the preparation of the Environmental Impact Statement (EIS) and the submission of the EIS to the Environmental Assessment Panel, public hearings took place from March 1996 to March 1997. The Panel is expected to release its recommendations on the safety and acceptability of the disposal concept and the next steps for the long-term management of nuclear fuel waste in Canada to the government in March 1998.

The Panel recommendations and the government response to the recommendations will set the stage for the next steps regarding the long-term management of the fuel waste in Canada.

4.3 Low-level waste

In Canada, low-level radioactive waste is either waste produced on an ongoing basis or is classified as historic waste. Ontario Hydro and AECL are the two largest producers of ongoing low-level waste. Historic waste is waste for which no private producer can be held responsible or for which the federal government has assumed the responsibility.

4.3.1 Ongoing Wastes

Ontario Hydro produces about 80% of the annual volume of low-level radioactive waste in Canada. To date there has been no pressing need in Ontario Hydro for early disposal; volumes are small and the waste is being safely stored on an interim basis. However, in its 1992 plan for these wastes, the utility fully recognised that, in the longer term, disposal is a necessary step in responsible waste management, so that future generations are not burdened with managing this waste. Ontario Hydro is conducting conceptual engineering studies for a low-level radioactive waste disposal facility. However, siting will not start until the year 2000. Discussions with other waste owners with respect to a multi-user facility are at an early stage. The year 2015 is used by Ontario Hydro as a planning reference date for bringing a disposal facility into service.

The other major producer, AECL, is in discussions with the federal regulatory agency, the AECB, to license a prototype below-ground concrete vault known as IRUS (Intrusion-Resistant Underground Structure) for relatively short-lived waste. As part of the AECB regulatory review of the license application for IRUS, the regulatory agency has asked AECL to update and complete its public consultation programme.

4.3.2 Historic Wastes and the Low-Level Radioactive Waste Management Office

A large proportion of the existing inventory of low-level radioactive wastes in Canada consists of "historic wastes". In the past year, the Low-Level Radioactive Waste Management Office (Office) continued its clean up and monitoring initiatives at the major historic waste areas. These include Port Hope in Ontario, Northern Alberta, the Northwest Territories and Surrey in British Columbia.

Port Hope Area Wastes

The bulk of Canada's historic wastes are located in and around the southern Ontario community of Port Hope. These wastes relate to the long-time operations of a radium and uranium refinery in the community. The federal government is seeking a site for the long-term management of the wastes. In 1995, a siting task force recommended that the community of Deep River host a disposal facility for these wastes. In October 1997, Deep River withdrew from negotiations with the federal government on the matter as a legal agreement on conditions for the development of the facility had not been reached and a municipal election was imminent.

The federal government is now reviewing its options for dealing with the situation. Among those options is the prospect that the communities where the waste is now located may agree to the development of a local facility for the wastes. All three communities where the wastes are now located have passed resolutions supportive of a local solution to the problem.

Radioactive Contamination in Northern Alberta and Northwest Territories (NWT)

Uranium ore, mined in the 1930s, 40s and 50s in Port Radium on Great Bear Lake in the Northwest Territories, was transported by barges to Fort McMurray in northern Alberta where the cargo was put on rail and transported to southern Ontario for processing. Cargo spills occurred at barge transfer points. The sites where the cargo spills occurred were discovered in 1991.

Although the radiological impact of the resulting contaminated sites is minimal, the federal government nevertheless decided to conduct a phased project involving clean-up activities based on sound waste disposal principles. This project is on going.

Surrey Wastes

In 1996, the Surrey Siting Task Force recommended that a small amount of contaminated soil and niobium slag at two industrial sites in Surrey, British Columbia should be removed and managed at out-of-province facilities in Alberta and Ontario. The bulk of the material was recommended to go to a commercial disposal facility in Alberta. An environmental screening of the recommendations concluded that the impacts are insignificant with mitigation. Further public consultation and discussions with Alberta provincial regulatory authorities must take place, however, before a decision is taken on implementation.

5. Uranium mine and mill tailings

In Canada, about 200 million tonnes of uranium mine and mill tailings have been generated since the mid-1950s. These comprise about two percent of all mine and mill tailings in the country. Most of the existing uranium tailings are located in the provinces of Ontario and Saskatchewan. There are twenty-two tailing sites, nineteen of which are no longer receiving waste material. Only the operations in Saskatchewan are now active.

With regard to financial responsibility for decommissioning and long-term maintenance of the tailings, the general policy in Canada is that the producer pays. The AECB requires that operators provide financial assurances that decommissioning of uranium facilities will take place in a responsible and orderly manner in the short- and long-term. Where a producer or owner is unable to pay, responsibility for decommissioning would rest with the Canadian federal and provincial governments.

Federal Environmental Assessment Reviews

Proposed decommissioning plans are submitted to the federal Minister of Environment under the *Canadian Environmental Assessment Act*. In 1993, for the first time in Canada, an Environmental Assessment Panel began an environmental review of proposed decommissioning plans for uranium mine sites located in the Elliot Lake region of northern Ontario. Public hearings began in 1995 and the Panel submitted its recommendations in mid-1996. The federal government responded to the Panel in March 1997 and announced, in April 1997, that the decommissioning licensing process could proceed. The AECB takes into account the Panel recommendations while proceeding with its normal licensing process.

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THE CZECH REPUBLIC

The year 1997 was extremely important from the point of view of RWM. In that year a complete reorganisation of the RWM system in the Czech Republic began. According to the new regulations the system should be fully reorganised and should be able to operate in compliance with all requirements laid down by the Atomic Act and all complementary regulations no later than in June 2000.

1. Regulations

1.1 The Atomic act

In January 1997 Parliament approved Act No. 18/1997 Coll., on "Peaceful Utilisation of Nuclear Energy and Ionising Radiation (the Atomic Act)". The Act came into force on 1st of July 1997. The Act defines new principles in the RWM, among others:

- The State guarantees the safe final disposal of all radioactive waste and spent fuel conditioning before its disposal.
- The owner of radioactive waste (waste generator) is responsible for safe radioactive waste management including its conditioning into a form acceptable for its final disposal, except for the conditioning of spent fuel.
- Waste generators shall cover all expenses connected with management of waste generated and/or waste expected to be generated during their future activities, including its final disposal and the post-closure monitoring of the repositories.
- The State may contribute to cover expenses of management of radioactive waste resulting from past practices.
- The Radioactive Waste Repository Authority (RAWRA) and a fund for the collection of resources from waste generators for radioactive waste disposal (so called Nuclear Account) shall be established.
- All existing radioactive waste repositories in the Czech Republic shall be, within 3 years, ceded into the property of the State.
- Radioactive waste shall become the property of the State in the moment of its acceptance by RAWRA for its disposal or conditioning.
- The licensee is responsible for its nuclear installations decommissioning including the processing of generated radioactive waste.
- A licensee shall create a special reserve to cover the expenses of future decommissioning of its installation(s).

1.2 Implementing regulations of the Atomic Act

A) Decree of the State Office for Nuclear Safety No. 184/1997 Coll., on "Requirements for Assurance of Radiation Protection". Chapter II of the Decree deals with requirements for RWM and includes:

- general requirements for RWM (§ 20);
- requirements for equipment for RWM (§21);
- collection and classification of RW (§22);
- treatment of RW (§ 23);
- conditioning of RW (§24);

- storage of RW (§25);
- disposal of RW (§26);
- limits and conditions for safe RWM (§27);
- recordkeeping on RW and passport of RW (§§28, 29).

B) Decree of the State Office for Nuclear Safety No. 215/1997 Coll., on "Criteria for Siting of Nuclear Facilities and Very Important Radiation Sources". The Decree lays down general criteria for siting that are obligatory also for siting of radioactive repositories. However, for siting of a deep geological disposal facility it would be useful to develop more detailed criteria.

The State Office for Nuclear Safety has also issued other regulations concerning the utilisation of nuclear energy and a majority of them are more or less also related to RWM (e.g. requirements on QA/QC, transportation of radioactive substances, etc.).

C) The Government has approved the Statute of RAWRA and has issued the ordinance No. 224/1997 Coll., on "Amount and Method of Payment of Levies to the Nuclear Account". Besides the levies, the ordinance 224/1997 also regulates a system of recordkeeping of waste generators and generated waste.

2. Waste management

The Radioactive Waste Repository Authority (RAWRA) was established in June 1997 and is now in the first phase of its operation. According to the Atomic Act RAWRA is responsible for radioactive waste disposal and related activities.

The scope of its activity includes:

- siting, development, construction, operation, closure of RW repositories;
- radioactive waste management;
- conditioning of spent fuel before its final disposal;
- evidence of waste generators and disposed waste;
- co-ordination of R&D Programme in the field of RWM;
- management of levies;
- control of reserves of licensees for decommissioning of their installations;
- provision of services for waste generators.

In the year 1997 RAWRA developed its basic internal regulations, established database of waste generators and started managing the levies to the Nuclear Account. The Government has approved its plan of activities and budget for 1998.

The existing LLW repositories (Dukovany, Richard and Bratrstvi) are operated by their respective operators (CEZ plc., ARAO plc.). In 1998 there will start the first phase of their transition to State ownership. It includes the accomplishment of an audit of the RW inventory and of all technical, operational and safety documentation, defining a legal framework of the transition and preparation of necessary agreements.

The institutional waste repository Hostim, in a former limestone mine (shut down in 1964), was permanently closed and sealed by concrete, but still remains under institutional control.

3. R&D Programme

The Programme of High-Level Waste Geological Repository Development, up to the end of 1997 financed and coordinated by the Ministry of Industry and Trade, will be from 1998 financed from the Nuclear Account and coordinated by RAWRA.

Based on the general studies of the deep geological disposal system carried on in the period 1993-1997, a conceptual design of the deep geological repository in a reference non specified site, would be completed in the 1998 including EIA and a time schedule and budget for its realisation.

An evaluation of the site of Ruprechtov (provided by NRI Rez in co-operation with GRS) for purposes of geological analogue studies is in progress. It is expected to complete the evaluation in 1998.

A conceptual study of an underground laboratory has been completed and is under discussion.

4. Decommissioning

CEZ has completed a conceptual study of decommissioning of the NPP Dukovany and submitted it for approval to the State Office for Nuclear Safety. RAWRA is responsible for auditing of appropriateness of proposed decommissioning costs, in relation to the design, for purpose of creation of a decommissioning reserve fund by CEZ.

5. International relations

The Czech Republic has adopted and signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The first year of a PHARE project "Technical Support to the Czech Republic in Establishing of the National Radioactive Waste Management Agency" has been completed. During performance of the project a close co-operation of the RAWRA with CASSIOPEE organisations (ENRESA, ANDRA, ONDRAF, DBE, NIREX, and COVRA) has been established.

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FRANCE

1. Near surface disposal facilities

1.1 The Manche Disposal Facility

The Manche disposal facility is now entering on the institutional control period. The installation of the cover represented the last step and it was completed by June 1997. Before receiving from the government the authorisation to cover the disposal facility, a public inquiry has been organised and a Commission appointed by the Government has assessed the situation at the Manche Disposal Facility and its impact on the environment.

Three essential elements stand out:

- The inventory made by ANDRA at the Commission's request gives a satisfactory assessment of the quantities and characteristics of the civilian and military waste disposed of at the facility.
- Moreover, the Commission considered that the Manche Disposal Facility did not pose any significant health risk for the local population if ad-hoc measures were taken and that the cover brought an essential safety element to the facility.
- The Commission recommends that the facility be submitted to an initial 5-year monitoring period in accordance with the ANDRA programme. Beyond that, the Commission advocates the implementation of a very long-term isolation solution capable of protecting the environment and people if the monitoring were to be interrupted.

From now on, a specific monitoring commission for the Manche disposal facility will be asked to provide its view on all aspects concerning the future of the site.

1.2 The Aube disposal Facility

During the disposal design phase, predicted annual deliveries were about 35 000 m^3. Therefore, the capacity of 1 000 000 m^3 would have been filled up after 30 years of operation. Nowadays, deliveries are far away from that prediction, and according to the latest evolution, a 60-year operating period becomes foreseeable.

Since the opening and by the end of 1997, 175 500 waste packages were delivered to the disposal facility, corresponding to a total volume of 82 000 m^3 (17 150 m^3 in 1997, 44% EDF, 32% COGEMA, 17% CEA).

Waste packages treated in conditioning facilities (compaction or grouting) represent about 30% of total if volume is considered but 60 % regarding the number of packages. Percentage of drums for compaction has gradually decreased these last years, but it must be outlined that commissioning of a new low-level incineration and melting facility could tremendously reduce figures. Forecast volume of delivered waste packages is approximately 13 700 m^3 for the year 2000.

2. Centraco

CENTRACO is a new facility for the treatment and the conditioning of low-level or very low-level waste, either by fusion of metallic waste, or by incineration. With this plant, metallic waste could be recycled as wrappings, to be used for conditioning other more radioactive waste. It is located near Marcoule, in the Southern part of France, and operated by SOCODEI. This facility has not yet received the authorisation for operation and the relevant advisory committee will examine the application for operation permit in 1998.

3. Research on long-lived waste management

The law on radioactive waste management research established a clear-cut legislative framework with defined objectives for the research to be performed. According to the "Waste Act" (December 30, 1991), studies in the three following research areas must be conducted for long-lived waste management:

- Partitioning and transmutation of long lived radioactive elements in the waste. The CEA (French Atomic Commission) is in charge of this option.
- Evaluation of options for retrievable or non-retrievable disposal in deep geological formations, particularly through the creation of underground laboratories. This research area is managed by ANDRA.
- Study of conditioning processes and long-term surface storage techniques for the waste. This option is studied by the CEA.

These three research areas complement each other.

The scientific results obtained from 1994 to 1996 during the preliminary surveys conducted from the surface helped to consolidate and supplement the knowledge about the three candidate sites (Eastern France in clay, Southern France in clay and West/central France in granite) for the construction of underground laboratories. None of the three sites revealed any features making it totally unfit for the construction of underground laboratories and, subsequently, possibly the construction of a repository. According to the initial schedule, the three applications for an installation and operation permit (Demande d'Autorisation d'Installation et d'Exploitation, DAIE) for underground research laboratories, and the associated statutory files (building permit, declaration of public utility) were filed by ANDRA with the supervisory Ministries in the third quarter of 1996. The Nuclear Installation Safety Directorate, DSIN, after having acknowledged the admissibility of these files, has requested the Préfets of the "Départements" concerned to expedite their examination. This is expected to last about a year. In fact, the applications must be analysed by the administration services, both central and departmental, as well as the territorial authorities (municipal, general, regional councils). Besides, pursuant to the law of 30 December 1991 and subject to the law of 12 July 1983, the applications must be open to public consultation through a public inquiry on each of the candidate sites. These inquiries took place respectively from February to April 1997.

So far, the different territorial authorities have expressed themselves by vote. Nearly all the territorial authorities directly concerned voted broadly in favour of the laboratory project, thus confirming the initial declaration of candidacy. Among the second-ranking authorities concerned, two voted against (General Council of Vaucluse and Regional Council of Provence/Alpes/Côte d Azur), and one voted for (General Council of Charente).

The three Inquiry Commissions have filed their report. These reports are all favourable to the installation of a laboratory on the site considered. The site investigating Commissioner for the Est site accompanied his approval with three reservations which in no way question the project concerned (clarification of the concept of reversibility, simultaneous effort in the three research directions prescribed by the law of 30 December 1991, study of the preservation of the memory of the site, in the case of a subsequent repository. The Commissioner for the Vienne site (actually the same) added similar recommendations. The Commissioner for the Gard site expressed no reservations.

The National Evaluation Commission, on the occasion of the publication of its third annual report in September 1997, presented its scientific assessment on the advisability of continuing on geological radwaste disposal by the construction of the underground laboratories planned by ANDRA. It expressed a highly favourable opinion on the Est site, confirming its judgement expressed in its report for the previous year. It was favourable to the Gard site, considering the further efforts made by ANDRA in 1996 and 1997 on the continuity of the target silty formation, the seismo-tectonic context of the area and its hydrogeological environment, and on the consequences of the potential closure of the Mediterranean Sea and the concomitant drop in the level of its waters, causing a resumption of the erosion of the Rhône Valley. On the other hand, the Commission considered that the Vienne site, due to its intrinsic complexity, its hectometric fracturing (in view of a potential repository with a kilometric base hence demanding a very specific architecture remaining to be determined) and the risk of hydraulic connections between the granodiorite formation and the overlying aquifers, displayed negative aspects which appeared insurmountable today.

ANDRA now is awaiting a governmental decision to continue its research in one, two or three underground laboratories, pursuant to the Decree of the Council of State to be published in the forthcoming weeks.

Further information can be obtained from: *Mr. Jacques Tamborini, International Relations, ANDRA, Parc de la Croix Blanche, 1-7, rue Jean Monnet, 922 98 Chatenay-Malabry Cedex, [Tel. +33 1 46 11 8196, Fax: +33 1 46 11 8268, E-mail: jacques.tamborini@andra.fr].*

GERMANY

1. Regulation

On 16 July 1997 the Federal Cabinet approved a bill to amend the Nuclear Energy Act. At its session on 19 December 1997 the German Bundesrat (upper house) held that the Act required the consent of the Bundesrat in accordance with Art. 85 para. 1 of the Basic Law and voted to refer it to the Mediation Committee. The amendment is aimed at:

- facilitating safety-oriented retrofitting of existing nuclear power stations;

- making it possible for the task of final disposal of radioactive waste to be performed by a state-commissioned and state-supervised “beliehener Unternehmer” (independent private undertaking charged with specific functions in the national interest);
- extending the transitional periods laid down in the Unification Treaty for nuclear installations in the new Länder by five years.

2. Return of waste from reprocessing and interim storage of SNF

Between 1973 and 1997 a total of some 1 800 items (approx. 1 650 shipments) involving about 5 700 tonnes of spent nuclear fuels were shipped for reprocessing.

The return of waste from reprocessing began in 1996 with the interim storage of the first container with vitrified residues, followed in 1997 by two further containers. According to current plans, some 3 500 drums of low-heat waste, packed in about 700 thick-walled large containers, will be returned to Germany by the end of 2003, and some 6 000 vitrified residues, packed in about 215 transport and storage containers, by 2012.

Assuming that all contractually agreed quantities are reprocessed in France and the UK as planned, the reprocessing of German fuel elements will give rise to some 55 tonnes of plutonium. Some 8.5 tonnes of plutonium was processed to mixed oxide fuel elements at the Hanau facility up to 1995.

On 7 November 1997 the Federal Office for Radiation Protection (BfS) authorised the storage of spent fuel elements in the existing transport container store at Ahaus (TBL-A). This allows the applicants to use the 420 LWR bays of the TBL-A to store a maximum of 3960 t of heavy metals.

3. Disposal programmes and facilities

Morsleben Repository

On 9 May 1997 the BfS informed the ministry for environment of the Land of Saxony-Anhalt that it intended to close down the Morsleben repository for radioactive waste.

Owing to the reduced quantity and the nature of the radioactive waste occurring in the foreseeable future, there is no sense in long-term continuation of operations at the Morsleben repository, as adequate capacity is planned in the Konrad and Gorleben projects. BfS was thus abandoning plans to develop Morsleben as a third repository alongside the Konrad and Gorleben projects. Current emplacement operations are not affected by this move.

In November 1997 a study concept for the environmental impact assessment for closure of the Gorsleben repository was submitted to the Land of Saxony-Anhalt as the plan approval authority. The documents set out the expected environmentally relevant impacts of the project and the content requirements for the final environmental impact study. Because the work on preparing documentation for the plan approval procedure for continued operation also embraces closure, no additional studies will be needed.

By the beginning of 1991, some 14 500 m^3 with a total activity of approximately 1.7×10^{14} Bq from the former GDR (the new Federal Länder) had been emplaced at the Morsleben repository. From 13 January 1994 - the date when operations were resumed following interim studies – to 31 January 1998, about 17 593 m^3 was emplaced, approx. 1 663 m^3 of it in the emplacement chamber "Abbau 2" of Eastern Field which has been in use since 22 October 1997.

This waste has a total alpha emitter activity of 6.0×10^{10} Bq and a total beta/gamma emitter activity of 5.9×10^{13} Bq.

Gorleben Repository

The geoscientific investigation programme was conceived in two consecutive phases. The first phase during which the geological conditions were explored from the surface is completed.

In the second phase, the salt dome is to be investigated underground from two shafts, galleries and drillings. Shaft 1, with a diameter of 7.5 m, reached its final depth of 933 m on November 10, 1997. In the region of shaft 2, which has a depth of 843 2 m, a link was created by means of a connecting passage. Further cutting of the infrastructure areas required for the further underground investigation (storage and working rooms) as well as rooms for mining activities (workshops) was undertaken between the two shafts.

The exploration level is at a depth of about 840 m below surface, while the repository level will be at 880 m below surface.

From the infrastructure area, the southern main drift has been driven and two cross-cuts are started. The drifts now have a total length of more than 3 500 m. Parallel to the drifts and cross-cuts, the geoscientific exploratory drilling has continued with a total drilling meterage of more than 8 500 m now.

Completion of exploration area 1 including all infrastructure chambers is expected until end of May 2000. Further schedules are:

- exploration of north-eastern part of salt dome completed: second half of 2004;
- evaluation of north-eastern part of salt dome: end of 2004;
- suitability statement after completion of long-term safety analysis: end of 2005.

The further timetable depends on the decisions taken by then on the necessary capacity of the repository.

The total costs for the period until the Gorleben repository goes into service are estimated at DM 4.62 billion (as of 31.12.1997). Some DM 1.9 billion of this had been spent by the end of 1997. In the Federal budget for 1998, a figure of DM 225-235 million is allocated to the Gorleben repository project. On the basis of the Repositories (Advance Payments) Ordinance, advance payments towards the necessary expenditure are levied from waste producers by the Federal Office for Radiation Protection in respect of the contributions pursuant to the Nuclear Energy Act.

Konrad Repository

The former iron-ore mine Konrad in Salzgitter is planned as a repository for radioactive wastes with negligible heat production. This waste category accounts for more than 95% of the entire volume of waste existing in Germany or planned for the years ahead. With up to 650 000 m^3 of emplacement cavities, the planned Konrad final repository will offer sufficient space to accommodate all low-heat radioactive waste for many decades.

The plan approval application was submitted on 31 August 1982 after the basic suitability of the site had been established by the results of investigations over a six-year period. The applicant submitted a comprehensive project plan with some 500 documents. The public participation procedure took place between 1991 and 1993. Completion of the plan approval procedure by the plan approval authority is expected shortly.

Conversion of the mine into a repository will take about four years, at the end of which the repository can go into service. The total cost of the Konrad repository project amounts to about DM 2.7 billion, of which about DM 1.36 billion has already been spent.

4. R&D programmes

R&D independent of the direct needs for planning, construction, licensing and closure of the German repositories is financed by BMBF. It comprises work on underground disposal of chemotoxic waste, too.

In addition to the existing co-operation in bilateral and multilateral frames BMBF and USDOE in February 1998 signed an agreement on co-operation in the field of energy research which also comprises R&D on waste management and disposal.

The scientific and technical status of the BMBF research to date is described in the few following highlights.

Drift sealing: A project aiming at a concept for a long-term drift sealing system is under development. Besides laboratory and mock-up tests, the project also includes a 1:1 in-situ experiment under representative conditions in a salt mine. This test dam will finally be tested under more severe conditions up to its failure in order to quantify the safety margins under real conditions.

Shaft sealing: In 1996 the R&D project "Shaft Seals for Underground Disposal Facilities in Salt Mines" was initiated which aims at planning, constructing and testing of long-term stable shaft sealing components in 1:1-scale. It includes laboratory experiments on swelling clays (Ca-carbonites), small scale experiments on the behaviour of these clays and basaltic gravel serving as abutment for the bentonite sealing element, and, finally, the large scale seal test in an abandoned salt mine of the Kali + Salz AG. As regards the loading of the seal, the tests will be performed until failure.

Crystalline formations: In amendment of the research carried out for final disposal in salt formations, additional R&D activities aim at crystalline formations. The experimental investigations are, without exception, carried out in international co-operation. Corresponding agreements exist with the Swiss NAGRA (since 1982) regarding the GTS and with the Swedish SKB (since July 1995) regarding their HRL-Ä on the isle of Äspö close to Oskarshamn.

R&D work conducted at the GTS focused on investigating two-phase flow phenomena and on characterising the excavation-disturbed zone. The field investigations were completed in 1997. Subsequently, the project "Conclusion of the Tunnel Near Field" (CTN) was initiated in which the research carried out so far is being evaluated together with NAGRA. This study will be finished by October 1998.

One of the major activities in the Äspö Hard Rock Laboratory is a field experiment to study two-phase flow conditions in a saturated crystalline rock. The objective is to develop a numerical model suitable to simulate two-phase flow and transport. In addition, in-situ and laboratory experiments are being performed on radionuclide and colloid transport in the host rock around a repository.

Geochemical approach to safety evaluation: Sufficient confidence in validity and limitations of geochemical information can only be provided by considering the thermodynamic and kinetic interdependence of the major geochemical reactions concerned. In assessing source terms for the performance analyses of HAW glass and spent fuel as well as to radionuclide migration in the far field the Institute for Technology of Nuclear Waste Management and Disposal of the Karlsruhe Research Centre (FZK-INE) works on colloid formation to quantify their role as a key uncertainty of this approach.

The quality and validity of geochemical calculation results depends strongly on the quality of the thermodynamic data of the various radionuclides. Currently, work is underway to develop – also in co-operation with the OECD/NEA – a consistent thermodynamic data base for aqueous species and pure solid phases of actinide elements and long-lived fission products, applicable both to low and high ionic strength solutions.

Ground water movement: To better simulate saline ground water behavior and its movement around a salt dome a fast 3-D computer code is developped and being verified by comparison with other codes. In the course of this verification two INTRAVAL test cases were recalculated among others. The results showed satisfactory agreement. It became also obvious that due to the speed of the code it will be possible to model large and complex regions like the Gorlebener Rinne as a realistic 3D system.

Natural analogues: Several German research institutions work on NA-projects and cooperate with international partners from the US, the UK, France, Sweden, Australia, Japan, and the Czech Republic. These investigations concentrate on U and Th mobilisation, U and Th isotope distribution, old backfill in salt mines, fluid inclusions in rock salt, and natural basaltic glasses intruded in salt formations.

Further information can be obtained from: *Dr. Herwarth Sameith, Acting Head of the Division for Reactor Safety, Waste Management and Disposal, Federal Ministry for Education, Science, Research and Technology, Godesberger Allee 185-189, Postfach 200240, 53175 Bonn, [Tel. +49 (228) 57 37 42, Fax: +49 (228) 57 36 05, E-mail:herwarth.sameith@bmbf.bund400.de] and Dr. Manfred Bloser, Head of Division, Disposal of Radioactive waste Supervision of Planning, Construction, Operation and Decommissioning of Repositories, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), RS III 6(B), Postfach 12 06 29, 53117 Bonn, [Tel. +49 (228) 305 2951, Fax: +49 (228) 305 2899/2296, E-mail: manfred.bloser@grs.de].*

ITALY

1. General

In Italy the problem of the waste management has been stressed during 1997 at institutional level. In order to verify the actual developments in the Radioactive Waste Management and to highlight requirements and priorities, in November 1997 **ANPA** held a Conference on the "Nuclear Decommissioning and Safe Disposal of Radioactive Waste". In that occasion, a national debate was held, involving Ministries of Industry and of the Environment, representatives of the Parliament, as well as representatives of operators interested in waste management.

At the Conference the following issues were identified, particularly with references to the priorities established in Italy for a safe disposal of the radioactive wastes currently stored in the country following the phasing out of the nuclear activities:

- to issue a national policy for the radioactive waste management and to create a dedicated agency;
- to provide the country with a national Repository for the LLW disposal;
- to realize a centralized facility for the long term storage of Spent Fuel and HLW;
- to complete the conditioning of the existing stored waste.

2. Operations under way

At ENEA the conditioning of the radioactive wastes produced in the past nuclear activity is now actively pursued. Following the government direction, ENEA has undertaken actions directed to select and qualify a site for the final repository for LLW. A special Task Force, purposely appointed in 1996 to implement the required actions, is now pursuing the activities for the selection of a number of suitable sites or areas. Two sites have been so far preliminary evaluated and pre-characterised. A repository design option has been selected for either site and a preliminary performance assessment has been carried out. Six other areas covering several Italian regions are being selected. In order to achieve the consensus, the government strategy is based on a procedure of consultation with all the Italian regions with suitable characteristics, as a first phase of a voluntary siting process. An extensive campaign of information on the waste disposal is being prepared. Other recent developments are:

- For the conditioning of some 200 m3 of HLW and LLW stored at EUREX plant (Saluggia, northern Italy), a vitrification unit applying a French technology is under detailed design (CORA project). The contract for the realisation of the unit has been signed with an industrial joint venture including the French SGN. The vitrification station is expected to be in operation in 2001. The CORA project will be a major undertaking in Italy in the waste management in the coming years.
- At the Trisaia Research Center (southern Italy) the cementation plant SIRTE, the first solidification plant for liquid LLW operated in Italy, in operation since May 1995, has completed in 1997 the solidification of all the liquid wastes stored in the site.
- The facility is presently being upgraded to allow the cementation of the some 3 m3 of high active liquid produced during the reprocessing campaign of the ITREC pilot plant.

The solidification of the liquid wastes at the site is expected to be completed by the year 2000.

- At the Trisaia Research Center, a site remediation activity has been also completed during 1997, allowing the safe disposal of some 1 000 m3 of contaminated soil collected during the recovery of buried drums containing solid LLW.

The conditioning of the radioactive waste at the ENEL shutdown nuclear power plants continued. The main achievements during 1997 are:

- the cementation plant of the LLW at the Garigliano NPP began operations;
- the incineration campaign at Mol (B) of resins from Caorso has been completed.

As for the spent fuel, ENEL has decided to pursue the completion of the Service Agreement with the BNFL by sending the remaining 53 t of spent fuel from the Avogadro storage pool to Sellafield. For the remaining spent fuel (285 t) ENEL plans to store them in a dry storage system, being presently selected among the most qualified vendors.

As for decommissioning activity, formal application has been presented during 1997 to the Ministry of Industry for the NPPs Caorso (BWR), Latina (Magnox) and Garigliano (BWR).

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JAPAN

1. LLW disposal programme

Low level radioactive waste burial center for solidified homogeneous waste generated at nuclear power stations has been in operation at Rokkasho-mura in Aomori Prefecture since 1992. This facility is permitted to bury 200 000 drums and about 100 000 drums were already buried at the end of 1997. License application for second stage of disposal facility has been started in January 1997. Solidified dry low level radioactive wastes such as metal, thermal insulator and plastic are planned to be disposed of at the facility.

The Atomic Energy Commission of Japan (AEC) is discussing the disposal policy for such waste, whose radioactivity concentrations are greater than the upper bound concentrations for near surface disposal. These wastes, which are spent control rod, burnable poison, reactor internals, are generated by operation and decommissioning of nuclear power plants. The Tokai Power Station of the Japan Atomic Power Company (JAPCO), which is the oldest commercial nuclear power plant in Japan, will be shutdown for decommission approach in March, 1998.

Having introduced the concept of “clearance” into the regulatory policy of radioactive waste in mid-1980s, the Nuclear Safety Commission of Japan (NSC) started approaches toward establishing of clearance levels in May 1997. The Commission started with the development of the unconditioning clearance levels for concrete and metal wastes arising from operation and decommissioning of nuclear reactors, and identified possible exposure pathways in burial and recycle/reuse of these wastes.

The AEC also published the draft report about the policy to dispose of low level waste arising from nuclear research facilities and radioisotope users, and is inquiring of public comment about the report.

2. HLW disposal programme

In accordance with the national programme defined by the AEC, Power Reactor and Nuclear Fuel Development Corporation (PNC) is required to submit the second progress report (tentatively called "H12"), including an integrated performance assessment, to the government by the year 2000. Since its establishment in September 1995, the AEC's Advisory Committee on Nuclear Fuel Cycle Backend Policy (hereinafter "the Advisory Committee") has been discussing ways in which future R&D programmes relating to HLW geological disposal should be conducted. These discussions are based on the recognition that, this is an urgent problem, and, it is essential to formulate concrete technical measures for geological disposal. In addition, it is important to provide clear and transparent information on these activities in order to obtain understanding and public acceptance of disposal projects.

2.1 Guidelines for the 2nd Progress Report of R&D on HLW Disposal

The PNC first progress report (H3) issued in 1992 provides a comprehensive evaluation of the technical relevance of geological disposal and demonstrates the feasibility of ensuring safe geological disposal in Japan. The H12 report, which will be founded on the basis of the achievements identified in H3, will further demonstrate the technical feasibility and reliability of the geological disposal concept and will provide key input for site selection and development of regulations. In this context, the Advisory Committee has been considering issues such as the approach to R&D to be performed by PNC in cooperation with relevant agencies and organizations, the way to identify technically important issues and how to evaluate research results objectively and transparently in the H12 report, and issued the guidelines in 15 April 1997, entitled "Guidelines on Research and Development Relating to Geological Disposal of High-level Radioactive Waste in Japan". The guidelines have been written after the following step. In the first step, the draft guidelines have been prepared by the Advisory Committee. The next step, they have been opened to the public for comments. The final step, after due consideration for their comments, the final guidelines have been written by the Advisory Committee. In the guidelines, the H12 report is required not only to demonstrate more clearly the feasibility of the specified disposal concept in Japan, but also to provide a scientific and technical basis for both the siting procedure to be adopted by the implementing organization and for development of an appropriate regulatory infrastructure. The generic assessment being carried out for the H12 report thus will play an important role in the overall HLW disposal programme.

The guidelines consist of two parts. Part 1 discusses the basic technical issues relevant to geological disposal of HLW in Japan and matters to be discussed in the H12 report. Part 2 highlights technically important issues which have to be covered by way of preparation for the H12 report. In preparing the guidelines, efforts have been made to keep it as understandable as possible; a number of references and a glossary of technical terms are attached for this purpose.

In parallel with the R&D programme, there is also a plan in the national programme that the implementing organization for HLW disposal will be established around the year 2000 to initiate the siting phase. The programme will then move from the generic into the site-specific phase. Development of site characterization methodologies will become a more important issue as the national programme progresses.

2.2 Research Coordination Committee for Further R&D on HLW Disposal

Obtaining public understanding and confidence is an essential component of performing R&D relating to geological waste disposal. A considerable investment of manpower and economic resources over an extended period is also necessary for such an activity. Close cooperation among the research organizations involved in R&D activities is required for real progress to be made. To this end, PNC, which acts as the core organization for R&D, the Japan Atomic Energy Research Institute (JAERI), the Geological Survey of Japan (GSJ), the National Research Institute for Earth Science and Disaster Prevention, the Central Research Institute of the Electric Power Industry (CRIEPI), universities and private sector agencies are in close cooperation to conduct R&D programmes, with support from power companies, to make maximum use of available expertise. It is important that a technical foundation for geological waste disposal in Japan be established through these joint efforts. PNC and other organizations involved have been working in close cooperation to conduct R&D work in an effective and efficient manner. Within the guidelines, it is suggested that a "Research Coordination Committee" be organized with the aim of promoting the sharing of results among different organizations and strengthening mutual cooperation as part of preparation of the H12 report. The first meeting of the Research Coordination Committee was held on 24 September 1997.

2.3 QUALITY Project

Construction of Radiogenic facility for acquisition of fundamental data on nuclide migration has been started at PNC Tokai Works as QUALITY (Quantitative Assessment Radionuclide Migration Experimental Facility) Project since 22 January 1998. The major purpose of QUALITY Project is to acquire data on glass dissolution, nuclide solubility and radionuclide migration behaviors under simulated geological conditions by controlling atmosphere in the glove boxes. Operation of the QUALITY Project will be started in August 1999.

2.4 The Draft Report on How to Implement HLW Disposal

The Special Committee on High-Level Radioactive Waste Disposal (hereinafter "the Special Committee") was also established in September 1995 by the AEC. The Special Committee has been considering various aspects of HLW disposal, including social and economic aspects, with a view to ensuring that such disposal will be accepted by the Japanese public in the coming century. Based on its discussions, the Special Committee released a draft report on how to implement HLW disposal on 18 July 1997. The draft consists of two parts. Part 1 discusses general considerations relating to implementing of HLW disposal. Part 2 highlights four specific issues essential to further implement disposal of HLW: 1) how to promote public understanding of HLW disposal, 2) how to build public confidence in disposal technology and construct a financial and social supporting system for implementation, 3) how to coexist with local communities at the disposal site and 4) how to proceed with site selection.

The draft report has been opened to the public for comments. In parallel with calling for comments, a series of meetings for open discussion with the general public are being held in several major places; in Osaka on 19 September 1997, in Sapporo on 30 October, in Sendai on 12 November 1997, in Nagoya on 11 December 1997 and in Fukuoka on 14 January 1998. After the review of comments made by the general public, the final version will be published around Spring 1998.

2.5 *Returned Vitrified Waste from Overseas Reprocessing*

Japanese electric power companies are procuring reprocessing services for their spent fuel from COGEMA of France and BNFL of the United Kingdom. Under the contracts between these European reprocessors and the Japanese electric power companies, COGEMA and BNFL are entitled to return the vitrified residues to the Japanese electric power companies, and both COGEMA and BNFL have decided to return it.

The total quantity of vitrified waste to be returned from both reprocessors is estimated approximately three thousand and several hundred canisters at this stage. Vitrified wastes are securely placed inside specially designed transport flasks, and the transport is made by sea using a specially designed vessel. The flask and the vessel are designed and manufactured in accordance with all the relevant safety standards of the International Atomic Energy Agency (IAEA) and the International Maritime Organization (IMO). The transport of vitrified wastes from France and the U.K. to Japan is expected to last about 10 years once or twice a year. The first returned vitrified waste from France was unloaded at Mutsu-Ogawara port of Rokkasho-mura in Aomori Prefecture on 26 April 1995. They are then to be stored and managed in the Waste Management Center of JNFL at Rokkasho-mura. Each of vitrified waste are checked for appearance and surface contamination, measured and weighed, and inspected for containment, radioactivity and calorific value prior to the storage. After checking of the inspection data, and upon confirmation and approval from the Science and Technology Agency (STA), the vitrified wastes are placed in the storage pit. All the returned vitrified waste will be stored there for some 30 to 50 years.

Transports have finished two times by last year, 68 canisters have been returned from France.

3. *TRU waste disposal programme*

Waste containing TRU elements have been generated at the PNC Tokai Reprocessing Plant and MOX fuel fabrication facilities. In the near future, overseas reprocessing and the JNFL commercial reprocessing plant under construction at Rokkasho-mura, northern part of Japan, will become additional waste sources.

In accordance with the national programme of the AEC, PNC has been conducting R&D on TRU waste disposal in cooperation with JAERI. Utility companies are required to support these R&D efforts as waste generators. In the programme, it is started that the first progress report on a TRU waste disposal concept should be summarized by the end of the 1990s. In order to effectively carry out R&D for this purpose, PNC and the utility companies agreed to establish a cooperative project team on 24 June 1997. The project team consists of representatives from PNC, the utility companies, CRIEPI and the Radioactive Waste Management Center (RWMC). Activities were initiated on 1 July 1997.

4. *Decommissioning*

As the Japan’s basic philosophy on decommissioning, commercial power reactors are considered to be dismantled and removed as soon as possible after its operation is terminated, taking into account safety, social issues and reutilization of its site. Based on this philosophy, the Japan Power Demonstration Reactor (JPDR) decommissioning programme was conducted by JAERI since 1981 to 1996. After the development of decommissioning technologies during 1981 to 1986, actual dismantling of the JPDR was conducted to verify the usefulness of the technologies for future use in dismantling commercial power reactors. The programme was successfully completed by the end of March, 1996. The extremely low level radioactive waste arising from demolishing the JPDR biological shield was disposed into the near surface burial place as a safety demonstration test. R&D of advanced decommissioning technologies has been conducted under consideration of lessons learned in the JPDR decommissioning programme. In addition, the JAERI Reprocessing Test Facility (JRTF) decommissioning programme started in December, 1996 to demonstrate the dismantling of fuel cycle facilities. This programme will continue until 2004. The Japan Research Reactor No.2 (JRR-2) was finally shutdown in December, 1996. The facility will be decommissioned by 2007.

The Tokai Power Station, which is the oldest commercial nuclear power plant of the Japan Atomic Power Company (JAPCO) will be shutdown by March 1998. Its decommissioning will be carried out by utility companies at the first time in Japan.

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KOREA

1. Programme for LILW disposal

From 1997, the role of overall project management for LILW has been implemented by KEPCO (Korea Electric Power Co.) by the amendment of "Atomic energy Law" and "Electricity Enterprise Law". Then NETEC (Nuclear Environment Technology Institute) as a special organisation of KEPCO performs the following activities:

- siting for LILW disposal;
- construction and operation of LILW disposal facility; and
- collection and treatment of the wastes from RI applications.

At present the KEPCO is reviewing comprehensively the design concepts of both vault and rock cavern for the final disposal of LILW, of which a disposal method will be determined in consideration of site conditions. It is anticipated that the disposal facility will be in operation in about 10 years from now, considering the presumed time of site acquisition and the construction period of the disposal facility.

2. R&D programme for HLW disposal

Under the 10 years plan, accepted at the 247th AEC meeting held on June 13 in 1997, the technology development programme for HLW disposal has been set up as the following fields to reach to the target for the development of a reference deep geological repository concept pertinent to the Korean geological and industrial circumstances up to the year 2006:

- repository system development and performance assessment;
- geoenvironmental science research;
- engineered barrier development;

- underground radionuclide migration study;
- geotechnical engineering research.

Based on the above fields, KAERI has been being actively carried out the followings:

- drafting a disposal concept and total system performance assessment methodology;
- survey of uranium mine area for natural analogue study and possible host rocks;
- characterisation of domestic bentonite as a buffer material; and
- sorption study on filling minerals and migration experiment through geologic medium.

Under these activities, our portion of the ASARR project co-ordinated by OECD/NEA has been successfully carried out and the 4^{th} joint technical committee meeting was held in February of 1998 at KAERI.

3. D&D project of the TRIGA Mark-II and III

The decontamination and decommissioning project of the TRIGA Mark-II and III research reactors was started in January 1997. Some fundamental activities such as planning of the project, collection and verification of the history of the reactors, environmental assessment, inspection of the spent fuel for transportation, and selection of a domestic vendor for the D&D design work were done. In 1998, the design work and licensing of the project will be done. The field works will start around the middle of the next year, and will probably last 2-3 more years.

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THE NETHERLANDS

1. Decommissioning

As a result of a decision made by the Dutch Electricity Generating Board SEP the nuclear power station of Dodewaard stopped producing electricity on 26 March, 1997. This nuclear power station is a BWR with a capacity of 58 MWe. It became critical in 1968 and was originally intended to operate until 2004.

At the request of the Ministry of Housing, Spatial Planning and the Environment (VROM), a general study was performed by the Netherlands Energy Research Foundation ECN with respect to three decommissioning strategies: rapid decommissioning within ten years, postponed decommissioning within 50 years and "in situ" decommissioning.

A wide variety of possible consequences of implementing these decommissioning strategies was considered and compared. In conclusion, rapid decommissioning would be preferable.

It was felt, however, that an in depth study focusing on the Dodewaard casus including its typical financial aspects was needed in order to be able to get to final conclusions. Therefore, the Technical University of Delft in co-operation with the Netherlands Economical Institute was requested to carry out such a study. Recently the results were presented. Summarizing the conclusions none of the aspects studied are discriminating except the financial ones which indicate that postponed decommissioning may be preferable.

As it stands now, there is no governmental point of view on this issue.

2. Radioactive waste storage

For the handling and storage of high level waste the construction of a naturally cooled storage vault is needed. In this storage vault different types of waste would be stored such as high level waste arising from reprocessing of the fuel from the nuclear power stations at Borsele and Dodewaard, spent fuel from the research reactors at Petten (including the HFR owned by JRC) and Delft and other high level waste originating from research activities. The licence for this vault according to the Nuclear Energy Act was granted 19 December, 1996. In the same licensing procedure the realisation of storage facilities for depleted uranium and for low level radioactive waste originating from ore processing industries such as phosphoric acid plants was included.

The State Council however, in its decision on 18 September, 1997 annulled the licence on formal grounds: it was not signed by the Minister of Transport and Public Works neither was she involved in the licensing process itself. As a consequence the licensing procedure had to be restarted; it is expected that this process will be completed somewhere in spring 1998. Due to this delay, construction of a naturally cooled storage vault will not be completed in time.

3. Reprocessing

A discussion was initiated in Dutch Parliament about possibly terminating the reprocessing of spent fuel from Dodewaard and Borsele nuclear power stations. At the request of the Ministry of Economic Affairs ECN carried out a study mainly with respect to environmental, proliferation and financial aspects of reprocessing as compared with its alternative, direct storage. In conclusion, there is only a single substantially discriminating factor: financial aspects. In the present circumstances, continuation of the reprocessing strategy is by far much cheaper than any of its alternatives studied.

The ECN study, together with a governmental paper focussing among others on historical, legislative, contractual and proliferation aspects was sent to Parliament in June, 1997. As a political standpoint Government concluded there are no urgent reasons to change the actual strategy based on reprocessing of spent fuel.

A discussion in Parliament with the Minister of Economic Affairs was scheduled in September 1997. However, Parliament decided to postpone such a discussion and at first have a hearing involving relevant parties. This hearing took place on 24 October 1997. Quite a few parties were invited, among which are representatives of GKN (Dodewaard), EPZ (Borsele), ECN, Greenpeace, IAEA, NCI, Cogéma and BNFL.

On 22 January this year there was a discussion between the Minister and a Permanent Commission of Parliament on this issue. The Government took the position that there are no weighty and urgent reasons to change present-day policy based on reprocessing of spent fuel. One of the opposition parties agreed with this position. However two of the governmental parties expressed their doubts on this issue.

On 11 March, there was a plenary discussion on this subject in Parliament. The coalition introduced a motion asking for more investigations with respect to possibilities and consequences of changing the reprocessing strategy including financial aspects. This motion was acceptable to Government. Parliament will take a vote on this motion next week.

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NORWAY

1. Combined repository and storage facility for LLW and ILW

The governmental organisation Directorate of Public Construction and Property (Statsbygg) has now concluded the construction of a radioactive waste facility at Himdalen, about 40 km east of Oslo, and the formal inauguration will take place 24 September 1998. The facility is constructed in a hard rock formation with its entrance in a hillside. The four waste caverns are accessible through a tunnel that declines slightly towards the entrance and have about 50 m rock coverage. The waste will be emplaced in concrete structures with waterproof cover, and a self-drainage system has been constructed in order to keep the waste and the caverns in a dry state (i.e., not immersed in water). With a total capacity of 10 000 drums, the facility is planned to receive all LL- and ILW-generated in Norway until year 2030.

Institute for Energy Technology (IFE) has been granted licence by the Government to operate the Himdalen facility. IFE is presently operating at Kjeller the only radioactive waste treatment plant in Norway, where waste from the institute’s two research reactors and from industrial, medical and other applications is treated and stored.

The transport and disposal of the about 2 300 waste containers (mainly drums) now being stored at IFE will, according to the present plans, start in September 1998 and go on until the spring 2000. The 1000 drums which are buried in a shallow ground repository at IFE’s premises at Kjeller will then be retrieved, treated and transported to the Himdalen facility. This operation will start in late spring 2000 and be finalised during second half of 2001.

2. Norwegian – Russian investigations on radioactive contamination in Russia

The Joint Norwegian – Russian Expert Group for Investigation of Radioactive Contamination in the Northern Areas has in October 1997 issued a report with the following title: "Sources contributing to Radioactive contamination of the Techa River and areas surrounding the "Mayak" Production Association, Urals, Russia." The report gives a comprehensive description of the radioactive waste treatment activities at the Mayak plant (including quantities), the "Kyshtym" and "Karachay" accidents in 1957 and 1967, respectively, and the substantial contamination of the environment. It also gives the results of a joint Russian – Norwegian field work within the health protection zone around the plan and downstream of the Techa River. The report may be obtained from the Library of the Norwegian Radiation Protection Agency, Osteras, Norway.

Further information can be obtained from*: Mr. Gordon Christensen, Head, Health and Safety Department, Institute for Energy Technology (IFE), PO Box 40, 2007 Kjeller, [Tel. +47 (63) 80 60 00, Fax: +47 (63) 81 2 561, E-mail: gordon.christensen@ife.no].*

SPAIN

1. General

At the end of 1996 an Inquiry Committee was set up within the Commission for Industry of the Spanish Senate in order to study the problematic related to radioactive waste management in Spain. Representatives of different groups and institutions, as well as experts from national and foreign organisations have reported to this Committee during all this time. Besides, the Committee has visited other countries, like for instance France, Japan, Sweden or the United States aiming at obtaining a closer view of other programmes. The Committee is now in the final stage for the preparation of a report, which could be released, in the next months. It is expected that this report will contain an overview of the situation in Spain as well as some considerations, which could form the basis for the subsequent legal developments.

2. Low and intermediate level waste

The operation of El Cabril disposal facility is progressing very satisfactorily. As of December 1997 some 14 000 m^3 of conditioned waste had been disposed of. The Safety Authorities granted renewal of the operating license at the end of 1996. Efforts are now mainly oriented to optimise the whole system with a view to obtain the best value of the available disposal capacity. Both the Nuclear Safety Council (CSN) and ENRESA are working in this direction. On the one hand the CSN in collaboration with CIEMAT is developing a methodology for undertaking a new safety assessment of the installation. On the other hand ENRESA, in compliance with the requirements of the new license, is trying to optimise the waste acceptance criteria, taking into account the role of the different barriers, the experience gained during the waste characterisation process and the safety analysis itself.

3. *Decommissioning and dismantling of nuclear installations*

At the end of February ENRESA was granted with the municipal licence to initiate the operations for dismantling Vandellós I NPP. Previously the Ministry of Industry and Energy had approved the Decommissioning Plan on the basis of the favourable report of the Nuclear Safety Council and Environmental Impact Statement issued by the Ministry for the Environment. ENRESA will act as the responsible operator during the dismantling period, after which HIFRENSA, the owner utility, will recover the released part of the site.

The plant will be dismantled to a level 2 in a period of five years, during which all buildings, structures and systems will be removed, except the reactor box. After a dormancy period of some 30 years the dismantling will be completed to a level 3, thus releasing the whole site.

4. *High level wastes*

4.1 Interim Storage of Spent Fuel

The storage capacity of the pools at the nuclear power plants is being increased by means of re-racking. This operation is now being completed in the last two units. This solution will be complemented by means of metal casks depending on the specific needs of the nuclear power plants. Trillo NPP will need this complementary solution by 2002. In this respect a dual – purpose metal cask has been approved and is now being manufactured in Spain. Studies of different alternatives for a centralised interim storage facility are now under way.

4.2 Final Disposal

The general strategy is under review, taking into account the difficulties encountered in the site selection process, the socio-political and public acceptance aspects and the experience of other national programmes. The outcome of the Senate Inquiry Committee should play an important role in defining the future course of activities.

4.3 R & D Programme

Work on the 3rd R & D Plan (1995-1999) continues with the following activities:

- Verification of the instrumental and numerical methodologies for the characterisation of sites and geological barriers.
- Verification of the feasibility and performance of the engineered barriers at full scale and under realistic conditions of temperature and depth.
- Acquisition of basic data of the most relevant processes of the different repository subsystems.

Major on-going R&D projects on engineered barriers focus on the following areas: Spent fuel leaching, canister corrosion, thermohydromechanical and thermohydrogeochemical performance of clay barriers backfilling and sealing of galleries and shafts, radiation effects on bentonite, gas migration through bentonite, filling materials for the canister, gas generation and corrosion products, effects of cement on clay barrier performance.

Major R&D projects on geological barriers focus on the following areas: paleohydrogeology and paleoclimatology, hydrochemical and hydrogeological studies, numerical modelling, migration studies, natural analogues, thermomechanical and hydrogeochemical characterisation.

An important part of the R&D programme is the participation in committees and fora hosted by OECD/NEA, IAEA and CEC to facilitate accelerated information exchange between nations. This international effort in the area of radioactive waste management offers to ENRESA a convenient and cost effective access to underground research facilities, where we are performing investigations such as:

- a full scale engineered barrier experiment in crystalline host rock (FEBEX) in Grimsel (Switzerland);
- a large-scale in-situ demonstration test for repository sealing in argillaceous host rock (RESEAL) in Mol (Belgium);
- a Backfill and Plug Test and Tracer Retention Understanding Experiment in Äspo (Sweden);
- a series of experiments on the evolution of the excavated damaged zone, heating and diffusion in argillaceous rocks in Mt. Terri (Switzerland);
- backfill behaviour experiment in emplacement drifts and boreholes in salt in Asse (Germany).

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SWEDEN

1. Report by the Implementer, SKB

1.1 General

As consequence of a three party agreement Swedish Government decided in 5 February, 1998 to recall the operating permit for the 1st unit in the Nuclear Power Plant at Barsebäck. A legal complaint has been filed by the owner, Sydkraft, with the European Union Commission on the grounds that the decision is in violation of EU rules on fair competition.

In 1 October 1997 Mr. Peter Nygårds took over as president for SKB, the Swedish implementing organisation for management of radioactive waste. The former president, Dr. Sten Bjurström, will continue to work within the area, with the aim to strengthen the international co-operation among implementing organisations.

1.2 Waste management

The Swedish system for management of radioactive waste consists of a ship based transportation system, a final repository for low and medium level waste (SFR) at the Forsmark nuclear plant, and a central interim storage facility for spent nuclear fuel (CLAB) at the Oskarshamn nuclear plant.

The sea transportation system has operated without disturbances. During 1997 a total of 49 transport casks with spent fuel and 5 with core components have been transported from the nuclear power plants to CLAB, where a total of about 2 650 tonnes of spent fuel was stored at the end of 1997. To meet future needs SKB has applied for a permit to expand the Swedish (CLAB) from the present 5 000 tonnes to 8 000 tonnes.

About 80 containers of low and medium level waste have been transported to SFR. At the end of 1997 a total of 23 000 m^3 had been disposed of in the facility.

1.3 R&D-programme

According to the law every third year SKB is required to give an overview of the status of the ongoing programme and present a revised programme on the R&D and other activities required for safe management of radioactive waste in Sweden. The latest was presented in 1995 and forms, together with the Governmental decision from 1996 based on comments and recommendations of the Swedish authorities, the basis for the present SKB programme.

Major activities today focus on a systems analysis describing the whole system planned for the waste management and how it interacts, including a discussion of alternatives, and an assessment of the long-term safety of the total repository system. A new programme is due in September 1998.

1.4 Siting

The Swedish siting process foresees 5-10 studies to be made of the feasibility to site a deep repository in various communities in Sweden before two sites are selected for surface based site investigations to form the basis for an application for a permit for detailed investigations from tunnels or shafts on one site. Feasibility studies involve studies in a number of areas to evaluate what a siting of a deep repository would mean locally, e.g. regarding geology, technique and environment, as well as economy, employment, infrastructure and tourism. A site investigation involves site characterisation with core drilling and geophysical methods.

Two feasibility studies have been completed and reviewed locally. In both cases local referenda have been held, resulting in a vote against a continuation of the investigations; in Storuman with 70% against and 30% for, in Malå with 55% against and 45% for. Both communities are located in northern Sweden.

In two more communities (Östhammar and Nyköping where the Forsmark nuclear plant and the Studsvik Nuclear Laboratories are situated) the feasibility studies have been completed and the results are presently reviewed locally. In a third community (Oskarshamn, where the Oskarshamn nuclear plant is situated) the feasibility study is ongoing. SKB plans to make further feasibility studies of communities or regions to establish an acceptably broad basis for the next step in the siting process – the selection of sites for site investigations.

1.5 The Äspö HRL

The reporting of the 10 year long R&D-activity to investigate and test methods available for site investigations has been completed, and 5 summarising reports have been published in the SKB series of Technical Reports. The reports will be discussed together with similar efforts in other countries in the Third Äspö International Seminar at the Äspö Hard Rock Laboratory June-10-12 1998.

Ongoing activities at Äspö HRL focus on:

- conclusion of the investigations and testing of the methodology for detailed geoscientific investigations;
- testing of models describing the barrier function of the host rock;
- demonstration of disposal technology and the performance of safety barriers.

2. Report by the Regulators, SKI and SSI

2.1 General

In general SKI is changing its policy and methods for review and supervision of nuclear safety. In the future the focus of SKI activities will be more directed on supervision and review of the operators procedures and practices, including organisation and competence, instead of detailed technical reviews of individual cases. As a base for supervision and review SKI is developing new regulations. This new policy will also influence SKI's internal work procedures and SKI procedures for supervision and review are now being developed.

The new organisation of the SSI has been in operation for nearly a year and a half. All activities related to radioactive waste management, including routine discharges and environmental monitoring, as well as research, are being pursued within the Department of Waste Management and Environmental Protection. Governmental funding has increased due to the decision to close one of the units of the Barsebäck nuclear power plant. In general, the institute is strengthening its supervision of nuclear power and other practices, but will gradually decrease its direct involvement in fundamental research on radiation biology.

2.2 Regulations

SKI is developing regulations in different areas of nuclear safety:

- Regulation on general safety requirements for nuclear facilities in operation also covers waste management facilities including the operational phase of repositories.
- Regulation on long term safety of final disposal of long-lived nuclear waste. This regulation will include aspects on safety assessment methodology, including time frames. The regulation has been sent for comments internationally. A compilation of national and international comments is available in English.
- Other regulations are under development (including regulations on decommissioning of nuclear facilities).

The importance of co-ordination and harmonisation of SKI and SSI regulations is recognised.

SSI draft regulations on final management of spent nuclear fuel or nuclear waste have been reviewed by approximately 35 national and 10 international organisations. The regulations are presently being revised by the institute with the view of their approval by the Board of the SSI early autumn 1998 and entering into force during 1999. The essential elements of the regulations are:

- the final management shall be optimised and take due account of best available technique;
- collective doses shall be calculated for comparative purposes;
- a risk target of 10^{-6} per year for individuals representative of the most exposed regional population;
- protection of biological diversity and biological resources;
- two time-frames; the first 1000 years and the period from 1000 years and beyond;
- consequences of human intrusion shall be assessed.

The responses have in general been favourable; thus, the revision mainly concerns the commentary to the regulations, not so much the regulations themselves.

A draft regulation on the handling of radioactive waste at nuclear power plants will be submitted for national review during the year. The SSI will also revise its regulations on limitations of discharges from nuclear power plants.

2.3 System analysis

According to the governments decision on SKB's R&D programme-95 SKB must present an analysis of the whole system of facilities and activities related to the final disposal of spent fuel. This includes an encapsulation facility, a transportation system and the final repository. Alternatives including the "zero alternative", i.e. storage in CLAB for an extended time period, must also be discussed. SKI and SSI have together formulated requirements on the structure and content of SKB's reporting.

2.4 CLAB-2

SKB has sent an application to SKI to extend the storage capacity of the central interim storage facility for spent nuclear fuel (CLAB stage 2) from 5 000 to 8 000 tonnes. SKI is presently reviewing the application and will submit its findings and recommendations to the government within a few weeks. SKB is proposing to build another rock cavern parallel to the existing cavern. Much interest is put on the safety of the existing part of CLAB, where spent fuel is being stored, under the excavation phase. The distance between the two caverns will be about 40 m. SSI has reviewed SKB´s application. SSI concluded, and reported to SKI, that radiation protection issues were sufficiently covered in the material accompanying SKB´s application, and that the institute was in the position to approve the application from the point of view of radiation protection.

Beyond what is required in Swedish legislation SKI has taken the opportunity to invite (together with SSI) to a local hearing about the proposed expansion at an early stage and also to arrange together with the authority responsible for general environmental aspects, a joint official meeting on nuclear safety, radiation protection and general environmental issues. Normally non-radiological environmental aspects are discussed in a separate meeting.

2.5 Decommissioning

SSI is strengthening its competence in issues related to decommissioning, partly due to the governmental decision to withdraw the operating permit for Barsebäck unit 1, and is also recruiting new staff to handle the particular radiation protection and waste management issues associated with decommissioning.

SKI is preparing for defining requirements on decommissioning activities at Barsebäck. SKI has asked the owner of the Barsebäck nuclear power plant to report to SKI about plans for the management of the spent fuel, long term plans for the decommissioning of the plant including waste management and also about the implications for the funding system for future costs for waste management and disposal.

2.6 Peer Review of SKI's SITE-94

Last year SKI concluded SITE-94, a project for development of SKI's competence in safety assessment of spent fuel disposal. In spring last year SKI asked OECD/NEA to review SKI's project on safety assessment of final disposal of spent fuel, SITE-94. NEA undertook to review SITE-94 and a special review team was set up. SKI regards the comments as positive in many respects, but also constructive criticism was given.

SKI will take the recommendations into account in future R&D planning. The review is available as a SKI Report.

2.7 Planned research projects related to radioactive waste management

General on R&D activities for 1998 (SKI)

SKI is planning for a rather comprehensive R&D programme (2-3 MUSD). The basis for planning is SKI's regulatory role; review and supervision of safety in nuclear facilities, review and supervision of SKB's R&D programme (required by law) 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.

SKI has established an R&D programme that will include several issues; treatment technology and storage, repository technology, geochemistry, geology, hydrology, steel/copper canister, safety assessment/risk communication and methodology for cost calculations. As much of SKI's R&D is related to Safety Assessment Methodology this is described in a separate paragraph.

Safety indicators (SSI and SKI)

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 intend to participate in the CRP proposed within the IAEA.

Risk communication (SKI and SSI)

The recent development in the Swedish nuclear waste disposal programme has put new demands on the regulators (SKI and SSI). It has become evident that transparent decision making procedures must be developed, that allows 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. A pilot study was concluded in the beginning of 1998. This study is planned to be followed by a project aiming at implementing, or at least testing, some of the recommendations put forward in the pilot study. Furthermore, SSI and SKI have together the consultant for the pilot study, approached the EU with a suggestion for a similar study on the European level, involving member states with active nuclear waste management programmes.

Safety Assessment Methodology (SKI)

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, modelling of radionuclide transport, time dependent factors in modelling, use of site specific data etc. SKI is also building competence in canister corrosion, influence on repository performance by concrete, redox buffering etc. SKI is also planning to develop new models and methodology as a follow up of SITE-94. Also the repository for low and intermediate long lived radioactive waste will require development of performance assessment methodology.

Loss of funds (SSI)

Most strategies for radioactive waste management and disposal to large extent rely on the establishment of funds, i.e. resources are set aside today to cover tomorrow's expenses. In a situation were disposal cannot be accomplished within reasonable time (say within 100 years) a situation may arise where the funds are lost, e.g. due to political, social or economical reasons. This could be the first link a chain leading to human intrusion or unacceptable degradation of facilities leading unacceptable risks for health and the environment. A research project is suggested to explore the stability over time of funds and other economical institutions (e.g. Nobel-foundations, various national academies etc.). A second project will address Expert judgements on likely benefits and threats from long-term funding.

The main purpose is to gain experience in the use of expert judgements. Including exploring procedures for the selection of experts, elicitation procedures and documentation of procedures and findings.

Critical group (SSI)

The ICRP concept of critical group is complicated to use over long time periods. A study is suggested to systematically identify "typical" human needs over the last one thousand years. Furthermore, besides the systematic collection of data the study should explore approaches to define the critical group, or rather to modify the traditional critical group. On example is the idea of introducing regional exposure groups, which is discussed within BIOMASS.

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SWITZERLAND

1. Nuclear power

Swiss nuclear electricity production again reached a record level in 1997. The nuclear component (23'971 GWh) as a fraction of total electricity production was 40 %. In addition, 3 nuclear plants supply thermal energy for industrial or district heating purposes.

2. Centralised interim storage of radioactive wastes

The utility-owned organisation ZWILAG is responsible for storage of spent fuel, HLW and other wastes, for conditioning of specific L/ILW waste streams and for incineration of wastes. The nuclear construction licence and the operation licence for the storage part were granted in August 1996 and the foundation stone of the facility was laid in January 1997. Construction is far advanced, the majority of the work still to be done is installation of the technical equipment. In December 1997, the application for the operation licence of the conditioning facilities (including a plasma oven) was submitted. Operation of ZWILAG should commence in a stepwise process from 1999. The successful realisation of this interim storage facility relieves time-pressure in Switzerland on establishing final disposal routes.

3. Programme for disposal of L/ILW

In 1994, the application for the federal general licence for a L/ILW repository at the Wellenberg site was submitted and a request for a mining-concession for the repository was made to the Canton of Nidwalden where the proposed Wellenberg L/ILW repository should be sited. At a public referendum in June 1995 the granting of the mining-concession was refused by a narrow margin (52 to 48 %). In Wolfenschiessen (the local community of the site), however, a large turn-out of voters (around

90 %) voted by 55 to 45 % in favour of the repository project. Subsequent to the political referendum, the on-going surface fieldwork was finalised and a synthesis of all geological investigations has been completed. Within the framework of the general licence application, the safety authorities review came to positive conclusions.

On request by the energy minister, a working group has been implemented to discuss technical issues and to provide input to decide on further procedures of the Wellenberg project. A steering committee set up two sub-groups covering technical and socio-economical aspects, respectively. At the technical level, Nagra is considering how its proposal for design and implementation of a L/ILW repository might be amended in order to satisfy various wishes expressed during the course of the referendum campaign by the local inhabitants in Nidwalden. This will lead to a modified project, which shall be implemented in a more step-wise fashion. In a first step, a new concession application will be restricted to an exploratory drift. The application for a concession for a modified repository project will only be submitted after results from the drift are available. The modification of the repository project will probably concern the emplacement concept and allow easy retrieval of the waste (caverns not backfilled) until a final decision to close the facility is taken in the future.

4. Programme for disposal of HLW and long-lived ILW

Within the HLW/ILW repository programme, two host rock options are under consideration: crystalline bedrock (for which a comprehensive regional field investigation programme has been performed to build up a project database) and Opalinus Clay. The goal of the HLW programme is to demonstrate around the end of this century that sites for a repository in Switzerland exist and can be identified with a high degree of probability. This is a high priority goal although actual implementation of a repository would take place well into the next century and is also dependent upon evaluation of international options.

For the Opalinus Clay option, a licence application for an approximately 1 050 m deep borehole in Benken (25 km north of Zurich) was submitted in 1995 and the necessary federal permit was granted in May 1996 followed by granting of the local permit by the community in February 1997. Legal objections have been rejected early this year. Drilling is planned to be started in the course of this summer. Furthermore, a 3D seismic survey over an area of about 50 km^2 around Benken has been successfully performed in spring 1997.

For the crystalline bedrock, a 2D seismic survey in an area of about 20-30 km^2 west of Leuggern has been carried out in winter 96/97 and the subsequent analysis will allow to select a potential drill site for additional deep boreholes.

5. Progress of R&D programmes

Within the scope of Phase V at the Grimsel rock laboratory, a variety of experiments are underway or will be started shortly in collaboration with partners from other countries (Germany, Japan, USA, Sweden, France, Spain, Taiwan and the European Community). Phase V is expected to last until 2002.

A further in-situ programme with international participation is underway at Mt. Terri where a new highway service tunnel gives access to an underground experimental site in Opalinus Clay. The present Mt. Terri programme consists of several experiments to obtain information on the hydrogeological, geochemical and geomechanical characteristics of the Opalinus Clay. For some new experiments, a new pilot tunnel (approx. 200 m long) is currently under construction. The following partners support the project: Swiss National Hydrological and Geological Survey (patronage), Nagra, ANDRA, ENRESA, SCK•CEN, PNC, Obayashi Corporation, BGR and IPSN.

Further R&D work is performed in the areas of modelling, laboratory experimentation and natural analogues. Most of this work is directly funded by Nagra but the Federal Authorities also award contracts in selected areas. At the federal research institute (PSI), 20 % of the resources are allocated to nuclear energy research (including contributions from Swiss utilities and from Nagra). The work includes an R&D programme jointly supported by Nagra and the Federal Government, the central theme being the study of long-term repository safety.

6. Other items

In connection with the discussion of Swiss energy policy for the future (Energy 2000) a so-called "Energy-Dialogue" involving both industry and environmental organisations has taken place in 1997. One of the open issues identified is "Radioactive Waste Management" which is the topic of a new "Dialogue-Group", which was implemented early this year.

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UNITED KINGDOM

1. UK radioactive waste policy

In August 1994, Nirex applied for planning permission to construct an underground laboratory, or rock characterisation facility (RCF), at Longlands Farm, near Sellafield in Cumbria. The purpose of the RCF would have been to investigate whether that site was suitable for an ILW repository. Following a public inquiry, Nirex's application for planning permission was refused, and Nirex appealed against this refusal to the Secretary of State for the Environment. The then Secretary of State dismissed Nirex's appeal in March 1997.

Following the change of Government in May 1997, the new Government began considering radioactive waste management in the light of the former Secretary of State's decision. The House of Lords Select Committee on Science and Technology decided to conduct an inquiry into nuclear waste management.

The Government welcomes the Select Committee's inquiry, and will want to see their report – which is expected in the summer – and to consult widely, before coming to a firm view on the way forward. One of the main reasons for Nirex's failure was the climate of mistrust and suspicion in which they were operating, and the Government therefore considers it essential that – whatever the way forward may be – it is undertaken on the basis of as wide a consensus as possible.

Since the RCF decision Nirex's staff has been reduced from over 200 to 88. However, the Government considers it vital that the scientific expertise and practical experience established by Nirex remains available to inform decisions on the way ahead.

2. Sellafield authorisations

The Environment Agency has received applications from British Nuclear Fuels plc (BNFL) for variations to its radioactive discharge authorisations for the Sellafield site. The applications are for increases in the limits for discharge to air of carbon-14, ruthenium-106 and iodine-129, and decreases for discharges to sea of tritium and technetium-99. The increases requested by BNFL are largely to accommodate a new effluent plant for treating stored waste. The Environment Agency launched a two-month public consultation on the applications, which commenced on 19 January 1998.

The Department has received a number of requests for the applications to be called in for the Secretary of State's own determination and these are being considered.

3. Sea disposal of radioactive waste

Following the discovery in 1997 of records relating to the dumping of radioactive waste in Beaufort's Dyke (a deep-water trench in the Irish Sea), Ministry of Agriculture, Fisheries and Food (MAFF) ministers commissioned a file search within MAFF and other relevant Government departments to identify any further past dumping of which knowledge had been lost.

A small number of other dumping sites was identified. The amounts of radioactivity involved were small, and it was not believed that they gave cause for concern in terms of either public health or the marine environment. Nevertheless, the Government asked the National Radiological Protection Board (NRPB) to carry out an independent assessment of the radiological impact of the various disposals and to advise on the need for any additional monitoring. The results of the assessment were announced to Parliament on 24 November 1997. It concluded that all the identified historic dumpings would give rise to doses well within internationally agreed limits and would pose an insignificant risk to public health or the marine environment.

4. Merger of Magnox Electric and BNFL

On 30 January 1998 Magnox Electric plc merged with BNFL. Both companies were wholly owned by the UK Government and the merger was accomplished by the Government transferring all the shares in Magnox Electric to BNFL. The UK Government remains the sole shareholder in BNFL. Full integration of the combined businesses of the two companies is expected to be completed early in 1999, subject to the companies meeting the requirements of the relevant UK regulators. At full integration, BNFL will be responsible for operating magnox nuclear power stations and will require authorisations for radioactive waste disposals from the Environment Agency and the Scottish Environment Protection Agency, and nuclear site licences from the Health and Safety Executive's Nuclear Installations Inspectorate. The principle aim of the merger is to improve the current arrangements for managing public sector nuclear liabilities and to reduce costs for the benefit of the UK taxpayer. The merger brings together financial and management responsibility for magnox generation and the associated fuel cycle.

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UNITED STATES OF AMERICA

1. Fuel cycle, waste production and management

1.1 U.S Department of Energy Office of Civilian Radioactive Waste Management

1.1.1 General

Currently 105 nuclear power facilities (reactors) provide more than 20% of the electricity produced in the United States. These reactors contribute between 1 800 and 2 200 metric tons of uranium (MTU) annually to the accumulating amount of spent nuclear fuel (SNF), currently estimated to be approximately 36 000 MTU. It is projected that by the year 2040 the inventory of SNF will have increased to 87 000 MTU. The Nuclear Waste Policy Act of 1982 (Public Law 97-425) established the Office of Civilian Radioactive Waste Management (OCRWM) within the Department of Energy (DOE) to develop and safely manage a Federal system for disposing of the Nation's SNF and high-level radioactive waste.

1.1.2 Funding

OCRWM continues to be funded through appropriations from the Nuclear Waste Fund, which is financed through a 1.0 mil per kilowatt-hour fee imposed on the utilities for electric power generated and sold by nuclear power facilities. Contributions are approximately $634 million per year. At the end of fiscal year (FY) 1997, the fund had received a total of approximately $11.1 billion, including investment earnings, and expended approximately $4.9 billion.

1.1.3 Storage

Since OCRWM could be authorised to conduct interim storage activities in the future, non-site specific issues related to the construction of a Centralised Interim Storage Facility, including potential use of a Dry Transfer System, are being identified and resolved. Non-site specific Topical Safety Analysis Reports have been developed for both a generic Centralised Interim Storage Facility and a Dry Transfer System. These topical reports have been submitted to the NRC for review. OCRWM plans to complete the generic, non-site-specific interim storage facility work and address long lead-time issues related to storage of waste including design, engineering, and safety analysis in 1998.

1.1.4 Transportation

In November 1997 the Office of Waste Acceptance, Storage, and Transportation issued a revised draft Request for Proposals for the acquisition of waste acceptance and transportation services. During 1998 OCRWM will continue to develop a market-driven approach to seek proposals from the private sector to carry out waste acceptance, storage, and transportation activities.

OCRWM is continuing development of a technical justification for the use of burn-up credit in the criticality analysis of the SNF transportation casks. Use of burn-up credit enables casks to be designed to accommodate an increased number of SNF assemblies. Increased cask capacity in turn results in fewer shipments and decreases transportation costs. A topical report describing the OCRWM methodology for the use of burn-up credit is under active review by the NRC.

1.1.5 Waste acceptance litigation

Subsequent to the electric utilities and state agencies 31 January, 1997 petition for a court review of the DOE announcement that it will not to begin commercial SNF disposal from utility sites on January 31, 1998, oral arguments were presented to the court on September 25, 1997. On November 14, 1997 the court ruled that DOE remains obligated to accept SNF, but since a facility will not be available, utilities should pursue the remedies for delay provided in the standard contract signed by the utilities and DOE. On December 29, 1997 the DOE filed a petition for Rehearing, asking the court to reconsider certain aspects of the ruling. Meanwhile DOE is exploring ways to proceed in a manner that results in fair and equitable solutions for all parties.

1.2 U.S. Department of Energy Office of Environmental Management

1.2.1 Overview

The Environmental Management programme is responsible for both the short- and long-term disposal and treatment of nuclear and chemical wastes generated during over 50 years of nuclear weapons production and nuclear research. The Environmental Management programme has historically included over 130 geographic sites in over 30 states and territories. Of these, cleanup activities were completed at 60 sites through FY 1997. As of the beginning of FY 1998, responsibility for the 21 remaining geographic sites under the Formerly Utilised Sites Remedial Action Programme was transferred to the U.S. Army Corps of Engineers by congressional action.

The number of sites and facilities under the programme's management has grown as projects have been transferred from other departmental programmes. The programme now manages several hundred of high-level radioactive waste tanks and thousands of contaminated buildings that must be deactivated and eventually decommissioned. EM also is responsible for safely storing 2 500 tons of DOE-owned spent nuclear fuel and stabilising and safeguarding 26 tons of plutonium scrap and residues. Since 1989, the programme has treated 4.2 billion gallons of ground and surface water; transported 1 000 000 tons of hazardous materials safely; and remediated over 5 000 public and private properties contaminated with uranium tailings. In 1996, the Environmental Management programme initiated an integrated planning process, built around a vision of accelerating its cleanup programme and a goal of completing the cleanup of as many sites as possible by 2006. At a small number of sites, treatment will continue for the remaining waste streams. The draft report "Accelerating Cleanup: Paths to Closure" was released for public comment in February 1998.

1.2.2 Waste management

The Waste Management programme is responsible for the storage and treatment of high-level waste, but not for its disposal; that responsibility belongs to the Office of Civilian Radioactive Waste Management.

The safe and efficient management of radioactive waste, much of which has been stored at DOE sites for up to 50 years, is a high priority. Currently, waste management facilities store and manage more than 660 million cubic meters of radioactive waste and a wide variety of hazardous chemical wastes at more than 40 sites nation-wide. About 83 per cent of the radioactive waste are also mixed with hazardous chemicals.

In May 1997, the Department issued the final draft of the Waste Management Programmatic Environmental Impact Statement, a broad environmental impact analysis of alternative strategies for waste management developed in conformance with the National Environmental Policy Act (NEPA). The document provides the basis for multiple Records of Decision that will define the Department's preferred strategy for managing major each type of radioactive waste.

In 1996, treatment of high-level radioactive waste began at waste vitrification facilities at the Savannah River Site in South Carolina and the West Valley Demonstration Project in New York. By the end of FY1997, a total of 291 canisters of high-level waste glass had been produced at these two sites. These canisters will be stored until a geologic repository becomes available.

EM has taken steps to transfer functions traditionally performed by the Department's management and operating contractors to private companies that will provide the service on a competitive, fixed-price basis. EM is working to privatise the Hanford Tank Waste Remediation System - the largest single project at the Department - to reduce the technical and cost-performance burden on the Department. The programme also is providing privatisation funding for projects to store spent fuel rods and treat low-activity waste at the Idaho National Engineering and Environmental Laboratory and the Savannah River Site; treat transuranic waste at Oak Ridge; and transport transuranic waste to Carlsbad.

1.2.3 Environmental restoration

Cleanup progress at Environmental Restoration geographic sites is measured by the completion of remediation at individual release sites (discrete areas of contamination) or facility decommissioning activities, which ultimately leads to the completion of an entire geographic site. Decommissioning operations range from small cleanup activities involving portions of buildings to complete structural dismantlement.

The Environmental Restoration programme includes more than 12 000 release sites and facilities. In FY 1997, nearly 500 release sites were remediated and more than 175 facilities were decommissioned, bringing the total number of completions to approximately 4 300.

1.2.4 Science and technology

DOE has centralised responsibility for co-ordinating technological development on mixed wastes at the Idaho site, on radioactive tank waste at the Hanford site, on contaminant plumes and landfill stabilisation at the Savannah River site, and on decontamination and decommissioning at the Federal Energy Technology Center at Morgantown, West Virginia.

Successful implementation depends on addressing concerns of stakeholders, involving industry early in the development process, and achieving commercial availability. Supporting assessments of innovative technologies can facilitate the implementation process by including site users, regulators, and stakeholders. The Office of Science and Technology provides EM a focal point for technology transfer activities with other countries and international organisations.

In 1997, engineers at the WIPP built two full-scale prototypes of a new container for shipping DOE's contact-handled transuranic waste. Called the Halfpack, the container was developed to carry heavier drums than the existing Transuranic package transporter (TRUPACT-II). DOE also conducted technology application demonstrations at the Portsmouth Gaseous Diffusion Plant on ground water and soil treatment technologies. Also at Portsmouth, DOE hosted an innovative technology demonstration conference in July 1997.

1.2.5 Nuclear material and facility stabilisation

The end of the Cold War has resulted in a dramatic increase in the number of surplus facilities and nuclear and non-nuclear materials requiring focused management. In their current condition and form, the facilities and various materials (e.g., plutonium and other special nuclear materials, uranium, spent nuclear fuel, and a myriad of chemicals) individually and in combination present a potential risk to site workers, the public, and the environment.

To address and control this risk, the Office of Nuclear Material and Facility Stabilisation has delineated a three-part objective: stabilise large quantities of nuclear materials, including spent fuel, to place them in a condition appropriate for continued storage; deactivate surplus facilities to reduce existing risks and thus the maintenance "mortgage" of these facilities; and prepare materials for ultimate disposition. To support and ensure success in these mission activities, the programme conducts facility surveillance and maintenance.

The Nuclear Material and Facility Stabilisation programme also is responsible for providing safeguard and security support to the entire Environmental Management programme. Milestones have been established for the stabilisation of some nuclear materials by the year 2002, including various forms of plutonium, uranium, special isotopes, and spent nuclear fuel. Based on the current inventory of materials and facilities in the programme, it is projected that the Nuclear Material and Facility Stabilisation mission will be complete by 2010.

Throughout 1997, Nuclear Material and Facility Stabilisation undertook to reduce risks by stabilising nuclear and other materials and spent fuels, as recommended by the Defense Nuclear Facilities Safety Board at the Hanford Site, the Savannah River Site, and other sites. These materials are located in spent-fuel storage pools, reactor basins, reprocessing canyons, and various facilities once used for processing and manufacturing nuclear weapons.

The Department currently owns and stores approximately 2 500 metric tons of heavy metal at a number of locations throughout the country. Most of this spent nuclear fuel is stored in facilities at the Hanford Site in Richland, Washington; the Idaho National Engineering and Environmental Laboratory in Idaho Falls; the Savannah River Site in Aiken, South Carolina; and the West Valley Demonstration

Project in West Valley, New York. A permanent disposal facility (YM) is not expected to be ready to accept Department-owned spent nuclear fuel before 2015.

Nuclear Materials and Facility Stabilisation is also responsible for implementing certain functions not directly related to shut down and clean up activities. In 1997, Nuclear Materials and Facility Stabilisation continued to play a key role in implementing U.S. nuclear weapons non-proliferation policy regarding foreign research reactor spent nuclear fuel. Under this policy, the United States will accept, over a 13-year period, up to approximately 20 metric tons of research reactor spent nuclear fuel from 41 countries. Only spent fuel, containing uranium enriched in the United States, falls under this policy.

2 Disposal programmes and facilities

2.1 Yucca Mountain (OCRWM)

2.1.1 Programme strategy

Funds appropriated by Congress continued to be used toward three near-term objectives that will maintain the momentum toward a national decision on the geologic disposal option:

1) update the regulatory framework, initiated in FY 1997, for evaluating the suitability of Yucca Mountain;
2) complete the Viability Assessment (VA) of the Yucca Mountain site in FY 1998; and
3) recommend the repository site to the President in 2001, if the site is suitable, and submit a license to the Nuclear Regulatory Commission (NRC) in 2002.

2.1.2 Viability assessment

A principal objective of the revised OCRWM Programme Plan (1996) strategy is to address by 1998 the major unresolved technical questions so that a viability assessment of licensing and constructing a geologic repository at the Yucca Mountain site can be performed. This objective requires completion of the following tasks to realise the VA:

1) develop the preliminary design concept for the critical elements of the repository and waste package;
2) perform a total systems performance assessment, based upon the design concept and the scientific data and analysis available by September 30, 1998, describing the probable behaviour of the repository in the Yucca Mountain geologic setting relative to the overall system performance standard;
3) prepare a plan and cost estimate for the remaining work required to complete a license application; and
4) prepare an estimate of the costs to construct and operate the repository in accordance with the design concept.

OCRWM has adopted several measures to ensure that the VA provides a complete and technically sound analysis of geologic disposal at Yucca Mountain. For example, seven abstraction workshops were provided to increase confidence that the performance assessment properly reflects the comprehensive process models for the natural and engineered barriers. In addition, to increase the transparency of these activities, the analyses were provided to outside experts for review.

2.1.3 Scientific investigations of Yucca Mountain

OCRWM continued to perform activities associated with the construction of the underground Exploratory Studies Facility (ESF). This work is being focused to address those key issues leading to the VA in September of this year (1998). On 25 April, 1997 the Tunnel Boring Machine penetrated the remaining rock at the South Portal of the ESF, thus completing an 8 kilometre long excavated tunnel through the Yucca Mountain. Part of this tunnel is located at the repository horizon adjacent to the area being considered for waste placement.

Construction continued on several alcoves of the ESF and technical work is underway in a number of locations. For example, three major in-situ thermal tests are being conducted to determine the effects of heat from emplaced radioactive waste on the surrounding rock. The power phase of the Single Heater Test, initiated in August 1996, in Alcove 5 [Thermal Test Facility (TTF)] was completed in May 1997. Some of the preliminary results indicate that heating effects are smaller than originally predicted. Data collection will continue throughout the cool-down phase, which is anticipated to be completed during the first quarter of 1998. In the Large Block Heater Test, conducted in Fran Ridge (an area adjacent to Yucca Mountain and in the same geologic formation as the potential repository), power was provided during the February 1997- January 1998 time frame. The purpose of this test, being performed with controlled thermal and moisture boundaries and with multiple fractures and inhomogenities, is to study the coupled thermal-mechanical-hydrologic-chemical processes initiated at Fran Ridge. The largest of the heater tests, the Drift Scale Test, was initiated in the TTF on December 3, 1997. The heaters were placed in a five-meter diameter drift to simulate waste packages. The test will provide information on temperature distribution and heat transfer modes. After two years of continuous heating, test results will be evaluated to decide whether to continue the heating.

In support of the movement to a dose based-standard (described above) which has heightened the importance of the saturated zone to the repository evaluation, OCRWM continued testing the saturated zone at the C-well complex. Tracer tests are being used to estimate flow and transport parameters, which in turn are used as input to numerical flow and transport models and will be used in transport calculations to support the total system performance assessment for the VA.

On December 9, 1997 work was initiated on excavation of a new “cross-drift” tunnel, which is basically an east-west (diagonal) extension of the 8 kilometre long ESF. This tunnel will cut through the entire stratigraphic section of the potential repository, thus permitting scientists and engineers to study the geologic nature of the area where nuclear waste would actually be placed. These studies will provide additional useful information that will help determine whether Yucca Mountain is a suitable site for a nuclear waste repository. (The importance of this direct exploration of the repository block is underscored by the findings indicating that more water is percolating through the site than originally anticipated).

From these activities will come the knowledge that is vital to the determination of Yucca Mountain viability and suitability to serve as the nations repository. Nothing has been found to date to indicate that the Yucca Mountain site would be unsuitable for a permanent geologic repository. The data that has been gathered from testing activities continue to confirm that the “natural barrier” of

Yucca Mountain is an important component of our strategy, along with the development of engineered barriers, to isolate the waste that could be disposed of in the proposed repository.

2.1.4 Total systems performance assessment

Recent efforts have focused on developing the foundation for the Total Systems Performance Assessment (TSPA) for the VA. In 1997 the description for the methodology and assumptions of the performance assessment was completed and is undergoing review. An external peer review was initiated that will continue through January 1999. The VA TSPA will provide a formal and reviewable analysis of the expected performance of a repository at the Yucca Mountain site based on the reference design. Although the reference design is not expected to be the final design (will evolve until license submittal expected in 2002), this analysis should provide all interested parties a reasonable estimate of the capabilities of a Yucca Mountain repository based on available data.

2.2 WIPP(EM)

The Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico, is an integral part of the Department's management and disposal initiatives for transuranic waste. Near-term activities for the facility include acquiring permits from Federal and State environmental regulations, completing other statutory requirements and initiating operations for deep-geologic disposal of transuranic waste. Under the WIPP Land Withdrawal Act (LWA) of 1992, the Environmental Protection Agency (EPA) is required to certify WIPP complies with radioactive waste disposal standards prior to operation. The 1992 LWA specifies that the total combined volumes of contact-handled (contact dose rate less than 2 milliSievert per hour (200 millirem /hr)) and remote handled (dose rate greater than 2 milliSievert per hour and less than or equal to 10 Sievert per hour (1 000 rem per hour)) transuranic wastes to be disposed of at WIPP will not to exceed 175 564 cubic meters (6.2 million cubic feet). Further, the 1992 LWA also specifies that the emplaced remote-handled transuranic waste will not exceed a total activity of 18.9×10^{16} Becquerel (5.1 million curies).

Three key events are needed for the opening of WIPP in May 1998. First the U.S. Department of Energy, Carlsbad Area Office (CAO) and the WIPP Management and Operating contractor will conduct Operational Readiness Reviews in March 1998. After the reviews are successfully completed, the CAO Manager will declare operational readiness. Second, the CAO expects to receive a final certification from the EPA in April 1998. Third, the CAO expects to receive an approval from the Secretary of the Department of Energy in April 1998 to begin operations at WIPP. Approval from the Secretary of the Department of Energy will "scribe in history" the transition from the WIPP licensing phase to the WIPP disposal phase; operations related to the disposal of transuranic waste in a deep-geologic repository. The first shipments of contact- handled transuranic waste could occur in June 1998. These shipments would mark the beginning of the disposal phase for WIPP.

As part of the WIPP disposal phase experimental programme, the CAO is developing specific research activities, related to programme objectives that will result in improving WIPP and National Transuranic Waste operations. Using these research activities as a guide, the CAO will establish co-operative research links with individual countries and groups of countries. Presently, co-operative experimental programmes with Canada (seals), Germany (seals and rock mechanics) and Switzerland (hydrology and chemistry) have been initiated as part of the CAO international research and development activities. Also, since WIPP is a unique, state-of-the-art facility, there are plans to utilise WIPP as an international test bed. Within permitting restraints, the WIPP will be offered as an underground research laboratory for other countries' research programmes. Finally, to foster research activities related to programme objectives, the CAO in conjunction with the Environment Agency of England and Wales will host a workshop on backfill in Carlsbad New Mexico, in May 1998.

3 Repository regulatory framework

3.1 Yucca Mountain repository programme activities

3.1.1 General

The *Energy Policy Act of 1992* directed the EPA to promulgate a site-specific dose- or risk-based radiation protection standard for Yucca Mountain to replace the release-based standard in 40CFR191 (*Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes*), and the NRC to conform their regulations to this new standard. Until the new regulatory guidance is available, DOE has established an interim performance measure and goal which requires that the expected dose rate to an average individual in a critical group living 20 kilometres from the repository should not exceed 25 mrem/year from all pathways and all radionuclides during the first 10 000 years after closure. The potential implications of this risk-based approach are provided in the recently released DOE document entitled *Repository Safety Strategy: U.S. Department of Energy's Strategy to Protect Public Health and Safety After Closure of a Yucca Mountain Repository, Revision 1*, dated January 1998 (YMP/96-01).

In FY 1998 the NRC continued its refocused high-level waste programme to resolve the Key Technical Issues (KTIs) most important to repository performance and give the U.S. Department of Energy (DOE) feedback prior to DOE's publication of its Viability Assessment for the Yucca Mountain site. An increase in the budget over that received in FY 1997 allowed the restoration of contractor support to the 3 of the 10 key technical issues eliminated due to budget reductions in FY 1997. During FY 1999, staff will review DOE's Viability Assessment, will continue the resolution of the key technical issues for licensing at the staff level and will begin to assemble a complete SRP for the 10 KTIs important to post-closure performance based upon the acceptance criteria developed for each issue.

The License Application (LA) for the Yucca Mountain Repository is scheduled for receipt in FY 2002. Section 114(d) of the NWPA as amended specifies that the Commission shall issue a final decision regarding issuance of a construction authorisation within 3 years of DOE's application with a provision for a 1-year extension. NRC's entire programme of relicensing consultation is focused on identifying issues early and providing DOE guidance needed to resolve them, prior to license application, so that DOE can submit a complete and high-quality application that NRC can review and make its decision within this statutory time frame.

3.1.2 Regulatory development activities

EPA contracted with the U.S. National Academy of Science (NAS) to conduct a study and provide recommendations to the EPA on the appropriate technical basis for each such standards. Although the NAS could consider a range of issues, its recommendations must address:

1) whether a standard based on doses to individuals is reasonable;

2) whether post-closure oversight and active institutional controls can effectively ensure that exposures of individuals will be maintained within acceptable limits; and
3) whether scientifically-supportable probability estimates of human intrusion into a repository over 10 000 years can be made.

The NAS report was issued on August 1, 1995. EPA is currently developing a rule, taking the NAS study into account, to set environmental standards for Yucca Mountain.

NRC has developed a strategy to revise NRC's HLW regulations, which was submitted to the Commission on December 24, 1997 (SECY-97-300).

3.1.3 Relicensing Issue Resolution Activities

In FY 1998 the NRC programme activities are focused on review of DOE's Viability Assessment (VA). DOE is currently scheduled to submit the Viability Assessment (VA) to Congress on September 30, 1998. NRC's review of DOE's VA is not an explicit statutory requirement. However, NRC expects to be asked to comment on DOE's VA because NRC's independent licensing view is an important consideration in any judgement about the viability of the repository programme. Moreover, early feedback provided to DOE through the staff's review of the VA is an extension of NRC's ongoing issue resolution activities during the relicensing phase of the repository programme.

In FY 1997, NRC staff has issued five Issue Resolution Status Reports (IRSRs) on KTIs for repository licensing. IRSRs are the primary mechanism for documenting issue resolution and include the acceptance criteria that are the basis for determining resolution. These acceptance criteria and their accompanying rationale will form the core elements of the SRP. In FY 1997 the staff completed acceptance criteria for issues and sub-issues in five IRSRs on Unsaturated and Saturated Flow under Isothermal Conditions, Thermal Effects on Flow, Evolution of the Near-Field Environment, Structural Deformation and Seismicity of the Yucca Mountain Site, and Repository Design and Thermo-mechanical Effects. Issue resolution reports, including acceptance criteria, will be completed for all KTIs by time of the Viability Assessment.

Examples of significant progress toward issue resolution include: the definition of areas of agreement on PA methodology, resolution on identification of faults that may significantly affect repository design or performance, agreement on the scope of DOE's thermal testing programme, and resolution regarding a bounding value for volcanic disruption of the repository. Finally, for the KTI on TSPA, major progress was achieved by updating the total system code used by the staff for its independent performance assessment.

3.2 WIPP activities

Environmental standards for the management and disposal of spent nuclear fuel, high-level and transuranic radioactive wastes (40 CFR Part 191) were established by EPA in 1985. In 1987, Federal court vacated and remanded the disposal portion of Part 191 to the Agency. The EPA was working to re-establish those standards when, in 1992, the Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act was enacted. It reinstated most of the standards but required repromulgation of the sections, which dealt with individual dose limits, and protection of ground water. This repromulgation was finished with publication of the amendments in December 1993. The WIPP Land Withdrawal Act also gave EPA the role of certifying compliance of the WIPP facility with Part 191 and many other environmental standards and regulations. In February 1996, EPA issued its final criteria for certifying WIPP compliance with disposal regulations. In October l997, the EPA proposed to certify that DOE's WIPP will comply with these regulations.

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INTERNATIONAL ORGANISATIONS ACTIVITIES

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

1. General

The Agency's activities in the area of radioactive waste management, has as its major focus, the establishment of a comprehensive set of internationally agreed safety standards. This is being achieved with the active involvement of Member States and is under the supervision of an international advisory committee. The other elements in the programmeme are mainly aimed at providing guidance and assistance to Member States in the implementation of these standards and on technical solutions to radioactive waste management. An important step towards reaching the goal of an international safety regime in the area of radioactive waste safety was the adoption, in 1997, of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) for which the Agency has the role of secretariat. When it is ratified, this convention and its ramifications are expected to strongly influence the future work of the Agency in the waste management, particularly safety area.

1.1 Contact Expert Group (CEG) for international radioactive waste management projects in the Russian Federation

The Contact Expert Group (CEG) for international co-operation in radioactive waste management with the Russian Federation, was established in September 1995 by a group of countries and international organisations with the secretariat's duties of the Group being performed by the Agency from April 1996. At present the CEG consists of twelve members (Belgium, France, Finland, Germany, Norway, Russian Federation, Sweden, UK, USA, European Union, International Institute for Applied Systems Analysis-IIASA and International Science and Technology Center-ISTC) and two observers (Japan and Nordic Environmental Finance Corporation-NEFCO).

The CEG held so far five meetings, the last two of them in June 1997 in St. Petersburg (Russia) and in November in Windermere (United Kingdom).

At its 4th meeting in June 1997 the CEG focused its consideration on the north-west region of the Russian Federation and after having reviewed reports by the Russian Federation ministries, institutes and organisations and the results of a number of specialised studies sponsored by CEG members, the Expert Group decided that it should immediately take initiatives to focus international co-operation with the Russian Federation on the situation in its north-west region. A document, called "CEG expert opinion", was prepared on this issue by the CEG.

1.2 Peer Reviews

At the request of the United States Department of Energy (DOE), the IAEA and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) carried out a peer review of the 1996 performance assessment of the Waste Isolation Pilot Plant (WIPP) near Carlsbad in south-eastern New Mexico. The facility has been sited and constructed to meet the safety criteria of the Environmental Protection Agency (EPA) and is intended to accommodate the long-lived actinide wastes from US defense related programmemes. The primary focus of the review by the team of international experts was on the technical soundness of the analyses and on the DOE's approach to post-closure performance assessment, examined from an international perspective. The review was conducted over a six-month period starting in October 1996, and included a detailed review of documentation provided by the DOE, a visit to the WIPP site, and discussion meetings between the team of experts and DOE staff and contractors. The review concluded that the performance assessment methodology is well founded and that the analyses are, in the main, technically sound. However, the team noted that the prescriptive nature of the EPA regulations had the effect of constraining the scope of the performance assessment in a way, which contrasts with general international practice. In the course of its examination of the information provided, the team of experts identified technical areas deserving further attention by the DOE.

2. Waste safety

2.1 Safety of Disposable Waste

Discussions on reaching international agreement on procedures for releasing previously regulated facilities and materials from control were held as part of a Specialists Meeting on Application of the Concepts of Exclusion, Exemption and Clearance: Implications for the Management of Radioactive Materials (organised jointly with the Radiation Safety programme). This continues to be an issue in many countries, and also between countries, as increasing numbers of nuclear facilities reach the end of their useful lives. Among the many issues debated were the regulatory control of exposures from low levels of naturally occurring radionuclides, the confusion over different types and values of clearance levels, the management of the disposal or reuse of materials containing very low levels of radionuclides, and the problems with the transboundary movement of such materials.

In 1997 progress was made towards the issue of several documents being developed within the Radioactive Waste Safety Standards (RADWASS) programme. Most important of these is the Safety Requirement on Near Surface Disposal of Radioactive Wastes and its accompanying Safety Guide on Safety Assessment. These documents were approved by the Waste Safety Standards Advisory Committee (WASSAC) after formal consultations with Member States had been completed. The next step in the approval process is review by the Agency's senior review body on safety documents, the Advisory Commission on Safety Standards (ACSS) before submission to the Board of Governors for approval. Other documents at an advanced stage in the approval process give safety guidance on the pre-disposal management of wastes, on the decommissioning of nuclear reactors and other facilities and on the control of discharges of radionuclides to the environment.

The RADWASS programme is supported by a number of 'ad hoc' working groups whose aim is to encourage consensus between experts in Member States on new and difficult topics. Discussion papers have been prepared on issues relevant to establishing the long term safety of underground waste repositories, on criteria for guiding the restoration of areas affected by residual wastes, on the management and disposal of materials containing very low levels of radionuclides and on the protection of the environment from ionising radiation. At a later stage it is expected that many of the concepts generated through this informal process will be incorporated into RADWASS documents.

2.2 Safety of released waste

In response to an increasing global concern for the health of the environment, consideration is being given for the first time to the development of an IAEA safety standard on the protection of the environment from ionising radiation. The current approach, of concentrating on humans and assuming that protecting humans to an acceptable degree will also provide adequate protection of the environment, has attracted criticism from several quarters. The main criticisms are that the current approach, although achieving protection of other species in most conceivable situations, could be seen as treating the environment in a secondary way and is different from the approach being adopted for most other pollutants. Separate criteria for environmental protection are being developed in some countries while others are reviewing the situation. A discussion paper has been prepared on the subject for consideration by the Radiation and Waste Safety Standards Advisory Committees (RASSAC and WASSAC) and a decision on whether to proceed to develop a safety standard will be taken during 1998.

As a further reflection of the increasing concern for the environment, work has started on the creation of a database of worldwide discharges of radioactive materials in liquid and gaseous forms. This may be seen as an addition to the existing database of disposal of solid wastes in the marine environment. The information is intended as an input to the UN Global Programme of Action for the Protection of the Marine Environment from Land-Based Sources in which the IAEA has a leading role in relation to radioactive substances.

2.3 Safety of residual waste

Reports of several assessments of the radiological situations resulting from past nuclear activities were completed in 1997. Assessments of the Radiological Conditions at Bikini Atoll, Marshall Islands (former nuclear weapon testing site), at the Semipalatinsk nuclear test site, Kazakhstan and in the Kara Sea in the Russian Arctic, where high level radioactive waste was dumped in shallow waters, were finalised and approved for publication in the new Radiological Assessment Report Series.

The study on the situation at Bikini Atoll was completed earlier, but on presentation of the draft report to the Government of the Marshall Islands in October 1996 the Agency was requested to carry out corroboratory measurements at Bikini Island. An expert team was duly sent to Bikini Island in May 1997 where it made direct measurements of external radiation dose rates at representative locations and took samples of soil and foodstuffs for subsequent analysis. The results of the measurements and analysis confirm the previously published data on which the assessment was based. An addendum to the original report has been prepared summarising the results of the corroboratory mission.

A study of the radiological situation at the Mururoa and Fangataufa Atolls commissioned by the French Government and initiated by the IAEA in 1996 is nearing completion. In 1997 the last series of measurements at the Atoll were made by an IAEA team of experts. However, the main work in 1997 has been in reviewing information, drawing conclusions and preparing reports. Early in 1998 the

International Advisory Committee for the study will meet for the last time to approve the main report and to make plans for the International Conference to be held on the subject in July 1998.

3. Waste technology

3.1 Handling, processing and storage of radioactive waste

In-situ immobilisation and isolation of radioactive waste

A technical document on “Technologies for in situ immobilisation and isolation of radioactive waste at disposal and contaminated sites” (IAEA-TECDOC-972) was published to provide information on in-situ technologies applied recently in some countries as an efficient and cost effective alternative to the “off-site” technologies for processing and conditioning of large volumes of low level radioactive waste arising from environmental restoration activities. In-situ immobilisation is used for converting contaminated soils, sludge and other contaminated material into durable leach-resistant products which meet current requirements for wastes to be disposed.

Liquid radioactive waste treatment using inorganic sorbents

A technical document on “Waste treatment and immobilisation technologies involving inorganic sorbents” (IAEA-TECDOC-947) was published documenting the application of this specific type of ion exchangers which demonstrate increased radiation stability and high affinity to particular radionuclides. A combination of different inorganic sorbents with other waste treatment methods further increase the ability and applicability of this method for processing of larger volumes of contaminated water, decontamination solutions, organic waste and others. Collected technical data and information will also be used in the new Co-ordinated Research Programme (CRP) on “Combined methods for radioactive waste treatment” initiated in 1997 aimed at elaborating and providing Member States with reliable and cost-effective integrated technologies for processing of liquid waste.

High level waste behaviour in repository conditions

A CRP, involving 14 leading laboratories from 13 Member States, fostering research in the field of high level waste form and package behaviour in simulated repository conditions was terminated in 1997. The CRP facilitated exchange of information on the optimisation of the composition of waste forms appropriate for specific waste origins and compared results of experiments on their behaviour in simulated repository conditions. Recent data was acquired and assessed on the effect of composition and other parameters of various waste forms (glasses, ceramics and spent UO_2 fuel) with regard to long-term leach behaviour in water and aqueous conditions representative for the main disposal environments presently considered. Collected data represents also a good basis for future work on modelling and prediction of long-term performance under repository conditions.

3.2 Disposal of radioactive waste

The site selection/characterisation phase for HLW disposal facilities continues to be the focus of many national disposal programmes. This fact is reflected in the IAEA activities as well. Thus three reports related to on site investigation and siting were completed during 1997. Two of the reports were related to hydrogeologic investigations. One report has been published just recently: "Experience in selection and characterisation of sites for geologic disposal of radioactive waste", IAEA-TECDOC-991.

In characterisation of a potential repository site, underground research facilities play an important role. Several IAEA Member States are running extended experimental programmes on underground research facilities. Significant progress has been made in an IAEA activity initiated a few years ago on the use of results obtained from underground research facility investigations. Since the European Commission and OECD/NEA have efforts in the same area, co-ordination on the subject is needed.

A recent discussion has emphasised that monitoring related to waste disposal is a multipurpose issue, which should be respectively considered and discussed both in technical and institutional terms. There are operational and post-operational monitoring needs related to radiological and non radiological monitoring aspects, discrimination of natural and radio activity in host rock conditions, as well as monitoring as a tool for validation and confidence building and as a contributor to public acceptance. This includes the monitoring after closure of the repository as well. The Agency undertakings related to monitoring both with reference to disposal of LILW and HLW made a good progress during 1997.

The assessment of long term behaviour of the disposal system is a central issue. These assessments require the coverage of long periods of time, large spatial scales and a multiplicity of concurring and successive conditions. The long time horizon is recognised also in two Co-ordinated Research Programmes. The first, fully initiated in 1996, is related to the isolation of long lived radioactive waste and proceeding according to plans and the other one on long term behaviour of LILW packages was subject of the first Research Co-ordination Meeting (RCM) held in November 1997.

3.3 Decommissioning technologies

A Technical Report on State-of-the-Art Technology for Decommissioning is under preparation. Most existing IAEA reports addressing decommissioning technologies were prepared in the early or mid-80s, basically reflecting decommissioning experience on relatively small research reactors or pilot facilities. At that time only feasibility studies or preliminary plans to decommission larger nuclear facilities were generally available. On account of the time elapsed after the publication of preliminary IAEA reports in the field of decommissioning technologies and the implementation of numerous large-scale decommissioning activities, it is felt that now is the right time to collect the experience gained by the decommissioners, to show the technological progress that has been achieved and the trends that are foreseen.

This report is not intended to be a decommissioning handbook (although it takes a significant amount of information from existing handbooks), but reflects upon the experience gained over the last 10-15 years in both field operations and in technology development and draws conclusions from this information. Technical details are given to a limited extent, while the reader is directed to detailed technical information provided in the quoted literature. A Technical Committee Meeting with participation of 15 Member States has been held 10-14 November 1997.

3.4 Planning and management of decommissioning

Another Technical Report on Planning and Management for the Decommissioning of Large Nuclear Facilities is under preliminary preparation. The emphasis will be on organisational aspects. This report is an ideal follow-up to an IAEA publication on Planning and Management of Decommissioning of Research Reactors and Other Small Installations (TRS No. 351, 1993). As said above, it is felt that enough experience is available now from the decommissioning of large reactors and large nuclear fuel cycle facilities to achieve a systematic evaluation of and provide guidance on organisational/administrative provisions, infrastructures and contractual services needed for decommissioning of large nuclear facilities. The first meeting related to the preparation of this report is a consultants' meeting and was held 24-28 November 1997.

A Technical Document (TECDOC) on Onsite Disposal as an Innovative Decommissioning Strategy is also foreseen for the 1997-98 programme of the IAEA. Onsite disposal i.e. permanent disposal of a nuclear facility or parts thereof within the site where the facility was erected and operated was proposed some years ago and implemented in sporadical cases. The purpose of this TECDOC (a preliminary publication where definitive guidance is not given) is to describe worldwide experience, prospects and national approaches to this strategy. As usual, the first meeting to implement this task is a consultants' meeting and was held 13-17 October 1997.

3.5 Quality management and quality assurance

One of the areas of increasing interest in the assistance to Member States is providing guidance on and insight in the role and practices of quality management and quality assurance in radioactive waste management.

Inspection and testing and records management in waste processing

Progress was made in the preparation of guidance on application of inspection and testing procedures in the process of radioactive waste conditioning and on maintaining records of waste and waste packages during waste processing and storage until final disposal. Two reports completed in 1997 define basic requirements and provide the guidance of the best practices applicable to inspection, testing and waste records management for waste generators, conditioners, transporters and disposal facilities operators (one document was published on "Inspection and testing in conditioning of radioactive waste", TECDOC-959).

Characterisation of radioactive waste forms and packages

A technical report on "Characterisation of radioactive waste forms and packages" (TRS No. 383) was issued in 1997 to assist Member States in the application of reliable policy and methods for waste forms and waste packages characterisation in accordance with applied acceptance criteria for interim storage, transportation and disposal. The report summarises the main important parameters of waste packages in view of acceptance and providing guidelines for sampling and determining their radiological, chemical and physical characteristics.

Inspection and verification of waste packages for near surface disposal

Closely associated with the previously mentioned work is the document prepared in 1997 providing a practical guideline on inspection and verification of waste packages for near surface disposal. From the larger perspective of a quality assurance programme a technical document covers the issue of waste package quality inspection/verification at the waste generator's site and inspection at the repository.

3.6 Technical co-operation

Technical procedures for the conditioning of spent radium sources have been improved and administrative procedures were established to make the programme more efficient. Organised by the IAEA, teams of specialists from Brazil and Austria carried out the conditioning of national radium inventories in Guatemala, Nicaragua and Croatia. In Chile a national team carried out the conditioning operation with IAEA assistance and supervision. The objective of the programme is to condition spent radium sources in developing countries and to eliminate their danger in Member States.

Among several workshops organised, it is significant to mention one implemented under the AFRA project in Zambia, which resulted in a draft guidance document on Management of Spent Sealed Sources as well as in development of conception and tables of content of two additional guidance documents which will be developed in 1998. These documents will be guidance on Management of Waste Generated from Application of Nuclear Techniques in Medicine and Research and on Management of Waste Resulting from the Use of Consumer Products.

A new interregional technical co-operation project (INT/4/131) on Sustainable Technologies for Managing Radioactive Wastes was fully specified and developed. The objective of the project is to transfer and establish sustainable technologies for the management of radioactive wastes in selected Member States, leading to improved radiological safety and helping to ensure safe and appropriate use of radioactive materials. Country specific project objectives have been established for more than 100 selected developing Member States, which are in need of radioactive waste technology upgrading. Based on priorities in need of assistance 35 Member States have been identified and proposed to be invited to join the project in 1998/1999 period.

A regional training course on the Management of Low and Intermediate Level Radioactive Waste was organised by the Agency in co-operation with the Malaysian Institute of Nuclear Technology Research (MINT). It was attended by 22 participants from fourteen Member States from East Asia and the Pacific region. The emphasis of this course was placed on the integrated systems approach to the management of low and intermediate level radioactive waste from all sources.

A Regional Training Course for Europe on Decommissioning of Research Reactors and Other Small Nuclear Facilities was held in Bucharest, 9-20 June 1997. It included 25 guarantees from developing countries, two observers, five external lecturers and two IAEA staff members (also delivering lectures). The decommissioning of research reactors is a critical issue in Central and Eastern Europe because of the large number of old reactors in the region. So far, little or no attention has been given to decommissioning planning and existing experience is inadequate.

4. *Ongoing co-ordinated research programmes*

• Combined methods of liquid radioactive waste treatment	1997-2001
• Chemical durability and performance assessment of spent fuel and HLW forms under simulated repository conditions	1998-2001
• Long term behaviour of low and intermediate level waste packages under repository conditions	1997-2001
• Extrapolation of short term observations to time periods for isolation of long lived radioactive waste	1996-2000
• New methods and techniques for optimisation of decontamination for maintenance or decommissioning	1994-1998
• Site characterisation techniques used in environmental restoration	1995-1999
• Decommissioning techniques for research reactors	1997-2001
• Safety assessment methodologies for near surface repositories (ISAM)	1997-2000
• Biosphere modelling and assessment (BIOMASS)	1996-2001

5. *Future agency sponsored international meetings*

- International Symposium on the Technologies for the Management of Radioactive Waste from Nuclear Power Plants (planned 1999)
- International Symposium on Research Reactor Utilisation, Safety and Management, (Lisbon Portugal, 1999).
- International Symposium on Radiological Assessment and Rehabilitation of Areas with Residual Activity, (planned 1999)

6. Recent publications

TECDOC-929	Treatment technologies for low and intermediate level waste from nuclear applications. Final report of a co-ordinated research programme 1991-1996.
TECDOC-939	Closeout of uranium mines and mills: A review of current practices.
TECDOC-947	Waste treatment and immobilisation technologies involving inorganic sorbents.
TECDOC-959	Inspection and testing in conditioning of radioactive waste.
TECDOC-972	Technologies for in situ immobilisation and isolation of radioactive wastes at disposal and contaminated sites.
TECDOC-975	Regulatory decision making in the presence of uncertainty in the context of the disposal of long lived radioactive wastes.
TECDOC-982	Planning for environmental restoration of uranium mining and milling sites in Central and Eastern Europe.
TECDOC-987	Application of radiation protection principles to the cleanup of contaminated areas.
TECDOC-991	Experience in selection and characterisation of sites for geologic disposal of radioactive waste.
TECDOC-1000	Clearance of materials resulting from the use of radionuclides in medicine, industry and research.
TRS No. 382	Design and construction of nuclear power plants to facilitate decommissioning.
TRS No. 383	Characterisation of radioactive waste forms and packages.
Proceedings Series	Planning and operation of low level waste disposal facilities.
Special RWM	Technology status and trends publication.

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EUROPEAN COMMISSION

1. EC research programmes

The European Commission is currently well advanced in the implementation of its R&D programme on "Nuclear Fission Safety" (1994-1998). This programme includes research on reactor safety, radioactive waste management and disposal and decommissioning as well as radiation protection. In the area of radioactive waste management, the Commission is involved in about 50 different projects with a financial contribution of about 40 million ECU (EC contribution for the duration of the programme). Hereafter some of the projects will be further commented upon.

The final results will be presented at the 5th European Community Conference on Radioactive Waste Management to be held in Luxembourg on 25-29 October 1999.

The R&D topics concerning radioactive waste management and decommissioning are:

- Safety Aspects of Waste Disposal
- Field Experiments in Underground Research Facilities
- Research on Basic Phenomena
- Partitioning and transmutation
- Decommissioning of Nuclear Installation

1.1 Safety Aspects of Waste disposal

The "Spent Fuel Performance Assessment" (SPA) project covers all elements needed to come to a total system analysis of the spent fuel in various host rock formations (clay, crystalline rock and salt formations). The project involves partners from Belgium, Finland, France, Germany, the Netherlands and Spain.

The different sources, types and amounts of spent fuel, which may be disposed of as waste, have been reviewed. Waste packages and repository design have been issued from the different national programmes. A review of the behaviour of the main components of the source term regarding the radionuclide release and related in the near-field modelling is specified.

A Cluster meeting on "Safety Evaluation of Spent Fuel Disposal" took place on 13-14 November 1997 in Brussels to discuss and exchange views on the two issues (i) source term characterisation and modelling near-field processes and (ii) sources of uncertainties and sensitivity analysis involving experts from other research projects (Spent Fuel Source Term, OKLO, GESAMAC) working on complementary aspects.

A Concerted Action on "The retrievability of long lived radioactive waste disposed in deep underground repositories" started in January 1998. The main objective of this study is to establish a clear interpretation and working definition of the concept of retrievability and a more useful common understanding of the meaning of retrievability. The project involves partners from Belgium, Finland, France, Germany, The Netherlands, Spain, Sweden, and the United Kingdom.

1.2 Field experiments in underground research facilities

The European Commission is currently supporting large field experiments in the HADES underground facility in Boom clay beneath Mol (B), in the Asse salt mine (D) and in the Grimsel Fels Labor (CH). The experiments are mainly aiming at testing and demonstration of the technical feasibility of waste disposal concepts and monitoring the long term behaviour of waste packages and repository components for delivering representative data to be used in repository performance assessment studies. These field experiments are accompanied by laboratory experiments and modelling exercises. Here it is worthwhile to mention the ongoing international (EC co-funded) benchmark exercises on the thermo-hydromechanical behaviour of unsaturated clays and crushed salt, used as backfill materials.

Within the framework of the EC-CLUSTER (CLub of Underground Storage, TEsting and Research facilities) a seminar was held in Alden Biesen (B) on 10-11 December 1997 where the current status of the ongoing EC co-funded projects was presented. Moreover papers were delivered on ongoing research at Äspö (S), Olkiluoto (FIN) and Tournemire (F) as well as present status concerning underground research laboratories in France and the United Kingdom. The proceedings will be published in the EUR series.

1.3 Research on Basic Phenomena

Under this topic the European Commission is supporting a number of international projects concerning waste minimisation, waste characterisation, quality control of waste packages and waste forms, gas generation and gas flow, radionuclide migration, natural analogue studies and paleohydrogeology.

1.3.1 Waste volume minimisation

Highly selective inorganic ion exchanger are being developed to decontaminate aqueous nuclear waste effluents from radionuclides. Another contract has the objective of extending the active demonstration of a mobile wet oxidation plant to a wider range of active organic waste.

1.3.2 Characterisation of waste forms and matrices

Research projects under this issue are aiming at the investigations and formulation of source terms for nuclear waste glass and spent fuel and involve:

- The compilation of data on the leaching behaviour of the R7T7 glass (the Versail database) under varying experimental conditions. Results of more than 100 leach tests from French, Belgian and German investigations are being introduced. Experimental investigations are continuing on glass dissolution kinetics, rare earth and actinide sorption phenomena and glass alteration in wet clay. To complement previous and on-going laboratory experiments and modelling of glass corrosion, an active in-situ test (CORALUS) has been designed and the details now finalised. This will take place at the Underground Research Facility HADES at SCK.CEN Mol (B).

- The long-term dissolution/alteration of spent fuel in granite, salt or clay formations. The range of experimental activities has been quite extensive, the interpretation of which has just started. Initial results from the corrosion of spent fuel powder in granite water in the presence of Fe show that the matrix corrosion rate is considerably reduced.
- Studies of long-term ageing of cement as a backfill barrier and a conditioning material, and of the interaction with and effect of additives from radioactive waste streams on the physical and chemical barrier properties of cement.

1.3.3 Quality control of nuclear waste packages and waste forms

Projects under this topic should contribute to the establishment of a coherent QA/QC system for radioactive waste packages foreseen for both interim storage and final disposal. The activities cover:

- a "round robin" test for non-destructive assays of 200 litre radioactive waste packages, involving 10 organisations. 14 drums containing non-fissile material and 4 drums containing fissile material are measured at the participating laboratories;
- the improvement of localisation and quantification of neutron emitters in waste packages by passive and active neutron assay techniques, and of the accuracy of conventional gamma scanning assay of intermediate and high-density radioactive waste packages;
- the development of fast, simple and standardised chemical analytical techniques for destructive radioactive waste control;
- the characterisation of accessible surface area of HLW glass monoliths by high energy accelerator tomography.

A "European Network of Testing Facilities for the Quality Checking of Radioactive Waste Packages" was created in 1992 on the initiative of the Commission.

1.3.4 Gas generation and gas flow

Under the umbrella of the EC PEGASUS project (Project on the Effects of GAS in Underground Storage facilities for radioactive waste), research is going on gas generation in LLW and ILW packages and gas migration through engineered and geological barriers. A progress meeting was held in Mol on 28-29 May 1998 and the proceedings published (EUR 18167).

A state-of-the-art report on the current understanding of "Gas migration and two-phase flow through engineered and geological barriers in a deep geological repository for radioactive waste" will be established in cooperation with OECD/NEA.

1.3.5 Radionuclide Migration

Under this topic theoretical studies, laboratory and field experiments, as well as modelling work, are continued to supply further information and data for performance assessment of geological disposal with respect to:

- colloids and organic complexation (CARESS, HUMICS, TRANCOM-CLAY projects);
- hydrogeological role of faults on the movement of fluid and radionuclides within a radioactive waste disposal system (Fault Zone Heterogeneity project);

- uncertainty and sensitivity of model assumption of radionuclide migration (GESAMAC project).

The three "colloids and organic complexation" projects will assess the impact of colloids and organic substances on the transport and retention of radionuclides in various sedimentary and crystalline rock formations to obtain migration parameters directly usable for performance assessment calculations.

A workshop on "Radionuclide Transport/Retardation Processes" will be held on 19-20 March 1998 in Brussels devoted to an overview of the ongoing progress in the various projects and to the Concerted Action on thermodynamic database and specific presentations of colloid transport modelling and data transferability into numerical models and sources of uncertainty.

The Concerted Action on "Joint European Thermodynamic Database for Environmental Modelling" (JETDEM) will review ongoing thermodynamic database activities (aqueous and pure substance database) in order to define a clear programme where future work is necessary to perform.

1.3.6 Natural Analogue Studies

- OKLO-Phase 2 project (coordinated by CEA-DCC, F) to come to a quantitative assessment of processes of RN migration, retention within the OKLO basin and Bagombe site to provide suitable data for repository PA models, whereby near-field (source term), far-field (geosphere) and overall PA aspects will be considered.
- A 1st EC-CEA workshop of the OKLO-Phase 2 Working Group took place at Sitges, E from 19-20 June 1997 and it is foreseen to publish the proceedings in the EUR report series.
- Palmottu project (coordinated by the Geol. Survey of Finland) aims to investigate the transport of RN in a natural flow system in a granite host rock in southern Finland. The study will contribute to develop, refine and test models and mathematical techniques that will be used to describe the expected behaviour of RN in assessing the performance of high level radioactive waste repository in fractured crystalline rocks.
- Natural Analogue project of T-H-M and T-H-C-M will investigate the changes undergone by a heated clay formation and to determine how applicable the field data are for studying PA issues of clay barrier. The work will focus the attention on Orciatico (I), Col de Perthus (F) and the Island of Skye (UK).

1.3.7 Palaeohydrogeology

Under this item, the Commission is supporting three projects, which should provide information on site evolution over geological times with the aim to develop and test approaches to palaeohydrogeology. The projects are :

- PAGEPA (Palaeohydrogeology and Geoforecasting for PA in Geosphere Repositories for Radioactive Waste Disposal) which focuses on developing a method to model the palaeohydrogeology of groundwater systems and to test their predictions geochemically at Äspö and Gorleben.
- EQUIP (Evidence from QUaternay Infills for Palaeohydrogeology), which is designed to develop geochemical approaches to the characterisation of past geohydrological events

and will emphasise on geochemical tools for palaeohydrogeology by sampling fracture minerals (principally calcite) at a number of sites (France, Finland, Sweden, UK).

PHYMOL (A first palaeohydrogeological study of the Mol site) will investigate palaeohydrogeological events at the Mol site, based on a wide range of site characteristics, in order to understand the long-term performance of the geological barrier at the site. A first "Palaeohydrogeology Cluster Workshop" has been organised by the EC and took place on 18-19 November 1997 in Brussels.

1.4 Partitioning and transmutation

The research on partitioning and transmutation involves strategy studies, partitioning development and transmutation experiments.

The strategy studies are assessing various aspects of the fuel cycles: aqueous and pyrometallurgical processes for partitioning, feasibility of transmutation in PWRs and fast reactors (FR), feasibility of advanced fuel or target fabrication and geological barrier efficiency for waste resulting from P&T scenarios. In addition the thorium cycles are evaluated. Also, the possibilities of accelerator-driven hybrid reactor systems are assessed. A consensus is emerging for further investigation of accelerator driven systems in the fast neutron spectrum with lead as coolant and target and solid fuel.

The transmutation of Americium-241 embedded in an inert matrix is being studied in an irradiation experiment in Petten which was completed in 1997 and that is now being analysed. The transmutation of Technetium 99 by adiabatic resonance crossing has been experimentally studied by CERN with neutrons produced by spallation in a lead target.

In the partitioning area further development of the DIAMEX process is under way for the coextraction of actinides and lanthanides followed by separation of actinides [III] from lanthanides [III] by using heterocyclic nitrogen donor atom extractants. Separation factors between americium and rare earth's elements have been achieved in nitric acid solutions. Another project deals with the synthesis of functionalised macrocycles for the selective extraction of radionuclides in view of decategorisation of medium-level waste by removal of strontium and actinides and by the removal of actinides from lanthanides in HLW.

1.5 Decommissioning

The program aims at testing innovative dismantling techniques in major decommissioning pilot projects, with a view to reducing radwaste, radiological impact and costs. Important tasks are the planning, selection of techniques and dismantling of the BR3 and KRB-A reactor pressure vessels.

Data collection from decommissioning projects is continued and is being made available via powerful databases (EC DB TOOL and EC DB COST). A group of European experts is currently identifying Strategic decommissioning Planning Tools (SPTs) in a concerted action.

A workshop on Melting and recycling of metallic waste material was organised jointly by Studsvik, NEA and the EC on June 11-13, 1997 in Nyköping, Sweden.

2. Fifth Framework programme

The European Commission has adopted in April 1997 the 5th Framework Programme (1998-2002), which programme is submitted to the Council and the European Parliament for decision. The Council achieved a political agreement on the programme at its session on 12 February 1998. The specific programme, including research on radioactive waste management, is under preparation and should be decided upon by the end of the year 1998.

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OECD NUCLEAR ENERGY AGENCY (NEA)

1997-1998 Activities of the Division of Radiation Protection and Radioactive Waste Management on behalf of the RWMC

1. Highlights of 1997-1998 Activities

Peer reviews – A major activity of the RWMC over the main part of 1997 has been the conduct of two peer reviews of national activities. A review of the performance assessment of the US Waste Isolation Pilot Plant (WIPP), was carried out jointly with the IAEA and completed in April 1997. A review of the Swedish SKI Project "SITE 94" was carried out between April and October 1997. It is felt that this activity helps national programmes move forwards in a tangible manner and the review reports provide good reference information on what is desired and what is feasible. Peer review requests will thus be accorded high priority. It is expected that this important activity will continue at an important pace in the coming years.

Regulator/Implementer Dialogue – At the basis of the RWMC working method is the dialogue between safety authorities and implementing agencies defining – and helping advance – the state-of-the-art in strategic and technical issues connected to the safe disposal of radioactive wastes. In this context, a topical session of the advisory group PAAG was organised in September 1997 to review the latest national and international regulatory developments in the field. Findings of the discussions will be reviewed by the RWMC. The dialogue is also extended, on an ad-hoc basis, to other NEA committees, as in the important workshop held, in January 1997, in Cordoba, Spain, co-organised with the CNRA and the CRPPH committees.

Confidence building – A major forthcoming task of the RWMC is to illustrate the role of safety assessments in connection with the incremental process of decision-making in repository development, and to describe the structure of a typical safety-assessment procedure. Confidence in the findings of safety assessments is seen as necessary in order to support these decisions. Despite differences in national approaches and practices, and despite the fact that assessment basis will vary both within and between repository projects, the Group on Validation/Confidence Building has identified a sufficiently general and common structure to serve as a framework for a document describing practical methods for obtaining and communication confidence.

Integration – As many national programmes are shifting from a research phase to a development and demonstration phase for potentially suitable sites for deep geologic repositories, the need has arisen to more closely co-ordinate site characterisation and safety-analysis specialists, to integrate design and construction issues, and to look at the interfaces between the various components of the repository system. These needs are reflected in the current programme of work of the two main technical advisory groups, PAAG and SEDE.

"Lessons Learnt from Ten Performance Assessment Studies, OECD/NEA, 1997", is a very important publication of the Working Group on Integrated Performance Assessments of Deep Repositories (IPAG). The group has systematically explored commonalities and differences in recently published Performance Assessments that address repository concepts in crystalline rocks, salt, and unsaturated tuff as well as most of the waste forms presently considered for deep geologic disposal.

PAAG and SEDE – Technical progress to be noted includes the completion of the International Data Base of Features, Events, and Processes (FEP) and three highly specialised workshops, on sorption modelling (Oxford, May 1997), on the modelling of the effects of spatial variability on radionuclide migration (Paris, June 1997) and on the use of hydrogeochemical information for testing flow models (Borgholm, September 1997). The finalisation of the FEPs data base and, in the future, its updates, will help the various national programmes address the issue of completeness of the scenarios examined in safety assessments studies. Initiatives have been undertaken in order to maintain and update the data base, and produce a document on the state-of-the-art in scenario development, following an ad-hoc workshop.

A second phase of the TDB project was prepared during 1997. The cost for the three-year project, estimated to almost 10 million FF, will be shared by 17 organisations from twelve different Member countries.

A technical and administrative framework has also been set up between the SEDE and the EC for the preparation of a joint Status Report on the state-of-the-art in the assessment of the potential impact of gas migration and of other two-phase processes on the performance of underground repositories.

The success of the second workshop of the Project on Radionuclide Migration in Geologic, Heterogeneous Media (GEOTRAP) confirmed the interest in this project. GEOTRAP constitutes a unique international forum on radionuclide transport issues that helps bridge the gap between geoscientific data acquired in the field and their uses for performance assessment purposes.

Decommissioning - For the past twelve years the NEA's Co-operative Programme on Decommissioning has served as a forum for the exchange of hands-on information and experience among decommissioning projects. Confidence in understanding the process of decommissioning was gained during this period, such that now, decommissioning is more of a "standard" industrial process than a series of enlarged pilot programmes. The experiences and information shared through the NEA's Co-operative Programme have significantly contributed to this progress. Ongoing activities include task groups studying decontamination techniques, detection and measurement techniques for clearance of materials, clearance levels and the structure of decommissioning costs. The costs project will result in the publication, in 1999, of a "standard" cost structure which can be used for comparisons between different projects in different countries.

2. Meetings

The following major meetings were organised since the latest session of the RWMC:

- 7th meeting of the SEDE Working Group on Measurement and Physical Understanding of Groundwater Flow Through Argillaceous Media ("Clay Club"), Millau, France, 21-23 May 1997.
- 8th Meeting of the NEA Co-ordinating Group on Site Evaluation and Design of Experiments for Radioactive Waste Disposal (SEDE), Borgholm, Sweden, 4-5 September 1997.

- 13th Meeting of the NEA Performance Assessment Advisory Group (PAAG), Paris, France, 24-26 September 1997.
- 16th Meeting of the Liaison Committee for Decommissioning Activities, Paris, 1-2 October 1997.
- Chemical Modelling of Sorption in the Field of Radioactive Waste Management, Sorption Modelling Project, Oxford, UK, 6-8 May 1997.
- Basis for Modelling the Effects of Spatial Variability on Radionuclide Migration, GEOTRAP Project, Workshop #2, Paris, France, 9-11 June 1997.
- Use of Hydrogeochemical Information in Testing the Models for Groundwater Flow, SEDE Workshop, Borgholm, Sweden, 1-3 September 1997.
- PAAG Topical Session on Regulatory Developments, Paris, France, 25 September 1997.

In addition, several meetings were held involving the RWMC Bureau, the Joint Core Groups of PAAG and SEDE, and the V/C Building group.

3. Publications

The following reports have been published since the latest session of the RWMC:

- The International Intraval Project, Phase 2, Working Group 1 Report, Flow and Tracer Experiments in Unsaturated Tuff & Soil, Las Cruces Trench & Apache Leap Tuff Studies, SKI and OECD/NEA, Paris 1997.
- The International Intraval Project, Phase 2, Working Group 2 Report, Finnsjön, Stripa and WIPP 2, SKI and OECD/NEA, Paris 1996.
- The International Intraval Project, Phase 2, Working Group 4 Report, The analyses of the Alligator Rivers Natural Analogue, SKI and OECD/NEA, Paris 1996.
- The International Intraval Project, Phase 2, Summary, SKI and OECD/NEA, Paris 1997.
- Field Tracer Experiments: Role in the Prediction of Radionuclide Migration, NEA/EC Workshop, NEA GEOTRAP Project (Radionuclide Migration in Geologic, Heterogeneous Media), Cologne, Germany, 28-30 August 1996, OECD/NEA, 1998
- Fluid Flow through Faults and Fractures in Argillaceous Media, NEA/EC Workshop, NEA Working Group on *Measurement and Physical Understanding of Groundwater Flow Through Argillaceous Media* ("Clay Club"), Berne, Switzerland, 10-12 June 1996, OECD/NEA, 1998.
- Lessons Learnt from Ten Performance Assessment Studies, Working Group on Integrated Performance Assessments of Deep Repositories, OECD/NEA, 1997.
- The Probabilistic System Assessment Group, History and Achievements, 1985-1994, OECD/NEA, 1997

- Analogue Studies in the Alligator Rivers Region, Six Monthly Report, 1 January to 30 June 1996, Available from the project manager or from the NEA Secretariat.
- Analogue Studies in the Alligator Rivers Region, Six Monthly Report, 1 July to 31 December 1996, Available from the project manager or from the NEA Secretariat.
- Nuclear Waste Bulletin, No. 12, OECD/NEA, 1998
- Regulating the Long-Term Safety of Radioactive Waste Disposal, Proceedings of an NEA Workshop, Cordoba, Spain, 20-23 January 1997.
- Modelling the Effects of Spatial Variability on Radionuclide Migration, Proceedings of the 2nd NEA/EC GEOTRAP Workshop, Paris, France, 9-11 June 1997.

Reports in preparation, to be published soon:

- Safety Assessments of Radioactive Waste Repositories: An International Database of Features, Events and Processes, Report of an NEA Working Group with database, in preparation.

Other NEA publications relevant to radioactive waste management:

- Modelling in Aquatic Chemistry, by I. Grenthe and I. Puigdomenech, et al., OECD/NEA, Paris, 1997.
- Management of Separated Plutonium: The Technical Options, OECD/NEA, Paris 1997.
- La Gestion du plutonium séparé : Les options techniques, OCDE/AEN, Paris 1997.
- Actinide Separation Chemistry in Nuclear Waste Streams and Materials, OECD/NEA, Paris, 1998.

DETAILED REPORT OF 1997-1998 ACTIVITIES

4. The RWMC

4.1 Introduction

The RWMC mandate stresses the role of the Committee as an international forum for the discussion of policies and basic questions, including technical matters, notably for disposal issues which are of primary concern to NEA Member countries.

The programme of work of the RWMC indicates that current priorities are in the areas of:

- Waste management strategies and policies with the objectives to exchange information and develop consensus statements, collective opinions and common philosophies of approach concerning the orientations and implementation of radioactive waste management programmes with emphasis on disposal. An important component of the

RWMC programme concerns the conduct of peer reviews of national activities made on request.

- Long-term safety and performance assessment of waste disposal systems, under the Performance Assessment Advisory Group (PAAG), covering assessment methodologies and confidence building issues.
- Evaluation of disposal sites, under the Co-ordinating Group on Site Evaluation and Design of Experiments for Radioactive Waste Disposal (SEDE), covering site investigation activities and the discussion of the modelling and role of the geosphere as a barrier in safety assessments.
- Decommissioning and dismantling of obsolete nuclear facilities through the Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installations Decommissioning Projects. This Programme, set up in 1985, is based on the participation of decommissioning projects of a certain importance. The number of participants and topics under discussion are gradually increasing.

4.2 Implementers/regulators dialogue

The aim of the RWMC is to promote the exchange and sharing of ideas, methods and experiences between the different Member countries. The members of the RWMC are senior representatives from the Agencies responsible for designing and building deep repositories (implementers) as well as from the Safety Authorities (regulators). It is felt that at the present stage of repository development, the dialogue between implementers and regulators is necessary for gaining and communicating confidence in the case for radioactive waste disposal.

In this context, a workshop on the Safety of Radioactive Waste Repositories was held jointly with the CNRA and the CRPPH in Cordoba in January 1997. As a direct follow-up, a Topical Session on Regulatory Developments was organised on 25 September 1997, on the occasion of the Thirteenth Meeting of the PAAG.

These two events have confirmed that dialogue between implementers and regulators is crucial for the long-term success of deep geological repositories. It became very clear that implementers and regulators were both in the same boat since both were faced with the same problem: in short, how to convince themselves and their scientific and policy-making counterparts, as well as the general public, that repositories would not prove in any way damaging to future generations. Regulators and implementers, both, have to lay the groundwork. They must do so by maintaining an on-going dialogue in a spirit of mutual understanding. It is clear, for instance, that:

- before issuing a regulation, regulators must ensure that methods exist by which the implementer can demonstrate compliance;
- national differences must be respected, but there should be no major inconsistencies between safety regulations from one country to another;
- the safety of repositories raises problems very different from that of nuclear power plants, since we are dealing with projections in the very distant future for installations that do not yet exist and whose characteristics will be highly site-dependent. Nevertheless, the considerable experience acquired with power plants could enable us to improve the safety approach for repositories.

Regulators and implementers are completely independent when it comes to issuing regulations, on one hand, and on the other hand, demonstrating compliance. However, only a previously commenced, long and constructive dialogue on an international basis will be able to pave the way for a final confrontation between safety Authorities and implementing Agencies on a realistic basis.

4.3 Peer reviews

A major discussion item of the 29th RWMC meeting, 13-14 March, 1997, was the frequency, priority level, and practical implications of the RWMC being involved in peer reviews of national programmes in the field of safety assessment of deep repositories. It was felt that this activity helps national programmes move forwards in a tangible manner and the review reports provide good reference information on what is desired and what is feasible. Peer review requests will thus be accorded high priority. This view was endorsed by the Steering Committee in October 1997. Two peer reviews of national activities have been conducted in 1997:

- The International Peer Review of the 1996 Performance Assessment of the US Waste Isolation Pilot Plant (WIPP), April 1997, as documented in "Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant" (CCA).
- The SKI SITE-94 Project: An International Peer Review Carried out by an OECD/NEA Team of Expert, September 1997.

4.4 Validation/confidence building working group (V/CB)

Confidence in the safety of deep geological disposal, and the way in which confidence can be communicated, are topics of great concern to the radioactive waste management community and are addressed in the new report "Confidence in the Evaluation of Safety of Deep Geological Repositories". The report is based on the work of a group discussing "Validation and Confidence Building" that was established in April 1996 under the RWMC. The group met four times and, in March 1997, presented an interim progress report to the RWMC. This initial material was further developed by the group during 1997, resulting in the more extensive, present version of the report.

The planning, construction, operation and closure of a deep geological repository typically proceeds in incremental stages. The safety case that is provided at a particular stage of repository development is a part of a broader decision basis that guides the repository-development process. Various aspects of confidence in the evaluation of safety, and their integration within a safety case, are discussed in detail in the report. The key messages arising from this discussion are highlighted below:

- A safety case should make explicit the approaches that are implemented in order to establish confidence in its assessment basis. The latter is a key element of any safety case.
- The implemented approaches to establish confidence should aim to ensure that the decisions taken within the incremental process of repository development are well founded.

- In order to achieve confidence in the assessment basis, confidence in each of its individual components has to be evaluated and stated as part of the safety case. If necessary, the assessment basis has to be modified, with the aim of enhancing confidence.
- Confidence evaluation and enhancement are performed iteratively in the preparation of a safety case.
- Qualitative and quantitative methods exist to evaluate confidence in the assessment basis in the presence of uncertainty. In particular, it can be determined whether safety is compromised by specific uncertainties by the analysis of the sensitivity of the results to these uncertainties.
- Means exist whereby confidence in an assessment basis can be enhanced. These aim to avoid or reduce specific uncertainties, or to limit their impact.
- Observations of natural geological system play an important role in the evaluation and enhancement of confidence, due to the long-time scales involved.
- A statement of confidence in the overall evaluated safety is part of the safety case and should include an evaluation of the arguments that were developed, in relation to the decision to be taken.

The basis for confidence and the methodology proposed account for recent progress in the assessment of deep geological disposal. When finalised, the report should be distributed to RWMC's sub-groups. It is expected that this will promote a systematic approach to confidence issues in the activities of these groups and ensure the production of examples showing the usefulness and efficiency of confidence evaluation and enhancement methods, in relation with the development of actual safety cases. When completed according to input from these groups, the report may contribute to an update of the Collective Opinion [NEA 1991] and/or to a self-standing document on confidence in the evaluation of safety of deep geological repositories.

5. ASARR

As part of its support activities to the Member Countries for the demonstration of the long-term safety of nuclear waste repositories, the NEA is sponsoring the ASARR project, a field study on the mobilisation and migration of uranium in the ground waters surrounding the Koongarra uranium ore body in the Alligators Rivers region of the Northern Territories of Australia. ASARR is an autonomous, self-funded project, but regular briefings of its programme have been given to PAAG and SEDE. Participants are the Australian Nuclear Science and Technology Organisation (ANSTO), the Japan Atomic Energy Research Institute (JAERI), the Korea Atomic Energy Research Institute (KAERI), and the United States Nuclear Regulatory Commission (USNRC). The Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), Germany, joined the project in 1997.

Some of the more specific focus areas of the project have been:

- Testing of recently developed models for the uptake of uranium species on the surface of the natural materials (sorption studies).
- The elucidation of previously identified mechanisms for the fixation of uranium within uranium-bearing minerals (mineralisation studies).
- The correlation between amounts of uranium in solution and the local mineralogy (solubility studies).

- The determination of the isotopic distribution of the uranium in the rock in order to test, amongst other things, the ability of fractured rocks to take up uranium and other actinides by matrix diffusion (U-disequilibrium studies).

An ASARR Review Meeting was held at JAERI/TOKAI, in October 1997. The fourth and final Joint Technical Committee meeting of the present phase of ASARR was scheduled for Taejon, Korea, 9 to 13 February 1998.

For three years ASARR has served as forum for the exchange of information and experience, for fostering technical progress, and for further development and training of younger scientists. The project has now come to an end. A renewal of the project under a new mandate will be proposed to the RWMC. It is felt that a new Analogue project under the auspices of the NEA should take place in such a way as to highlight and enhance progress in areas which are common to several analogue studies in the NEA Member countries. Thus, although the participating organisations will have hands-on experience of Analogue studies, the project should be issue-specific rather than site-specific.

6. PAAG

6.1 Introduction

The main task of the Performance Assessment Advisory Group (PAAG) is to promote a satisfactory understanding in the field of safety analysis of deep repositories and, in particular, to identify the open issues where progress is most urgently needed. Typically, it is the PAAG specialists who, in their respective countries, are responsible for preparing and reviewing the safety analyses of the waste repositories, while the SEDE specialists contribute the geoscience foundation to those studies. While purely technical issues are relatively straightforward to assess, a more difficult question is how to provide confidence that the information and the analyses are adequate for the prediction of very long term safety.

At its annual meeting, in September 1997, the PAAG reviewed, as usual, the state-of-the-art in performance assessment, was briefed on the progress in international non-NEA projects, and revised its own programme of work which, in the past few years, has been increasingly co-ordinated with that of SEDE. A topical session was also organised to review the latest national and international regulatory developments in the field.

6.2 PAAG programme of work

Besides providing an international forum for the exchange of information on issues relative to radioactive waste management, the PAAG is also covering, with side activities and working groups, several areas:

- The in-depth discussion of integrated, total system performance assessments applied to reference or site-specific repositories and already available (IPAG working group).
- Confidence building in the use of predictive models in PA (GEOTRAP project).
- Confidence building in the preparation of safety assessments (contributions to the RWMC Validation/Confidence Building working group).
- Scenario analysis (Scenario development workshop, User group of the FEPs data base).
- Data gathering and elucidation of data and model quality in geochemistry (TDB project, Sorption Modelling project).
- Interaction with other groups (BIOMASS).
- Awareness of importance of regulatory aspects (Topical Session 1997).

6.3 Integrated performance assessments working group (IPAG)

In a situation where PA studies are being used to defend present repository concepts and may soon be used in applications for the siting of deep repositories, it is of immediate interest to many NEA member organisations to increase the level of understanding of the existing performance assessment studies. The group is to discuss and compare recently published Performance Assessments as a means to systematically explore commonalties and differences in the present state-of-the-art in integrated PA-methodology. The commonalties define the state-of-the-art, and the differences may serve to highlight areas for further reflection and improvement.

As Phase-1 of the project, the Integrated Performance Assessments Working Group (IPAG) has completed a report on the lessons learnt from the analysis of 10 national IPA studies of deep repositories issued by safety authorities and implementing organisations over the past 7 years. These studies address repository concepts in crystalline rocks, salt, and unsaturated tuff as well as most of the waste forms presently considered for deep geologic disposal. The report has been published at the end of 1997. New initiatives include a Phase-2 of the IPAG focused on the regulatory experience of reviewing IPAs.

The work of the IPAG, the V/CB group, and the outcome of specialised topical sessions will foster the dialogue between implementers and regulators and, in part, will follow up on issues identified during the RWMC Cordoba workshop of January 1997.

6.4 Scenario analysis and FEPs data base

The overall aims of PAAG are to assist in the development of methods and tools of high quality for the assessment of the safety of radioactive waste disposal systems, and to promote a balanced and coherent use of these methodologies within national radioactive waste.

An important stage in development is the identification and documentation of all the features, events and processes (FEPs) that may be relevant to estimating the long-term safety or performance. This activity provides a basis for the broader activity of selecting FEPs that should be included, and developing scenarios that should be evaluated, in quantitative analyses.

Discussions within PAAG and RWMC confirmed that scenario development is an area of high priority and particularly suitable for international co-operation. It was suggested that the development of an international database of features, events and processes would be a valuable activity and, in 1993, PAAG set up a Working Group to oversee the development of such a database.

The International Data Base on Features, Events, and Processes (FEP) for safety assessments has just been completed. Seven countries contributed to this project. The finalisation of this data base and, in the future, its updates, will help the various national programmes address the issue of completeness of the scenarios examined in safety assessments studies. Initiatives have been undertaken in order to (a) maintain and update the database, and (b) produce a document on the state-of-the-art in scenario development following an ad-hoc workshop.

The database consists of two main parts, which are:

- The International FEP List – a comprehensive and structured list of factors relevant to the assessment of long-term safety of nuclear waste repositories.
- Project Databases – a collection of FEP lists and databases, with references, compiled during repository safety assessment studies.

The International FEP List consists of 150 factors and classification scheme by which to examine FEPs from the Project-specific Databases. Each project-specific FEP has been mapped to at least one FEP from the international FEP list.

Version 1.0 of the database includes over 1 200 project-specific FEP records from seven projects:

- AECL Scenario Analysis for EIS of Canadian Disposal Concept, 1994.
- HMIP Assessment of Nirex Proposals – System Concept Group, 1993.
- The Joint SKI/SKB Scenario Development Project, 1989.
- Nagra Scenario Development for Kristallin-I , 1994.
- NEA Systematic Approaches to Scenario Development, 1992.
- SKI SITE-94, Deep Repository Performance Assessment Project.
- US DOE Waste Isolation Pilot Plant, CCA 1996.

6.5 Thermochemical data base (TDB)

The Thermochemical Data Base (TDB) project aims to make available a comprehensive, internally consistent, internationally recognised and quality-assured chemical thermodynamic data base. The work is performed by the NEA Data Bank in close collaboration with the Radioactive Waste Management Committee (RWMC). High priority was assigned to a first series of five elements: Uranium, Americium, Technetium, Neptunium and Plutonium.

The Uranium and Americium volumes have been completed and were published by North-Holland Elsevier Science Publisher in 1992 and 1995, respectively. The draft of the Technetium book is ready for peer-review and should be published in the second half of 1998. A 700 pages draft report on Neptunium and Plutonium data is being updated and the subsequent peer-review will continue through 1998, with a publication scheduled for 1999.

The OECD has just published "Modelling in Aquatic Chemistry" also produced by the project. This publication contains general guidelines on how to use the TDB values and procedures to estimate values in cases where none can be selected based on published experimental work. The different subjects are introduced in an elementary way, including simple examples, thus avoiding the need for prior expert knowledge of the various subjects. The book contains chapters that are intended as guidelines for the chemical equilibrium modelling of aquatic systems, such as ionic strength and temperature corrections. There are also chapters which introduce non-equilibrium modelling, e.g., mass transfer between phases and transport of solutes in aquatic systems.

A second phase of the TDB project was prepared during 1997 by an ad-hoc group of experts. The TDB Phase II will officially start in March 1998 for an initial period of three years and is organised as a semi-autonomous project. The NEA Data Bank will continue to act as Project Co-ordinator and to be financed by the normal NEA budget at the same level as before. Support to reviewers will be provided through separate financial contributions from participating organisations in Member countries. The cost for the three-year project, estimated to almost 10 million FF, will be shared by 17 organisations from 12 different Member countries.

6.6 Sorption Modelling Project

A study was started in 1996 to investigate the potential of mechanistic sorption models for improving confidence in performance assessment predictions. The decision to launch this project arouse out of a growing awareness in the radioactive waste management performance assessment community that sorption distribution coefficients (K_d) should be supported by an understanding of the underlying processes.

Participants discussed the desirability of international co-operation to share the important experimental effort that is needed to practically apply chemical modelling to natural systems. The issue is complicated by the fact that national programmes are different and have consequently different needs, different levels of ambition, and are developing different approaches. Participants stressed the need for a cautious and pragmatic approach. They agreed that the objectives of phase I of the project should be:

- to organise an international meeting to gather new information and promote discussions within the scientific and waste management communities; and
- to produce, by the end of 1997, a status report intended to have a wide dissemination.

Following the above programme, the "Workshop on Chemical Modelling of Sorption in the field of Radioactive Waste Management" was organised on 6-8 May 1997, in Oxford, UK. The meeting was organised around four themes:

- Sorption in the context of performance assessment.

- The scientific framework of sorption chemical modelling.
- Practical approaches proposed to model natural systems.
- State-of-the-art of the use of mass action – mass balance models to describe sorption in natural systems.

The Sorption Modelling Project, and in particular the Oxford meeting, have attracted much interest. Participants were surprised by progress made recently in the field of chemical modelling of sorption in natural systems. Many successful attempts to model sorption of important nuclides onto a variety of natural solid phases have been presented and discussed. The potential of these models has now been clearly demonstrated.

More work than anticipated was necessary to digest and incorporate into a comprehensive report the vast amount of information collected at the Oxford meeting. An oral progress report was given to PAAG, in September 1997, by Cherry Tweed, Chairperson of the project but the availability of the first complete draft of the Status Report was delayed up to the beginning of 1998.

Participants should now review the draft Status Report, agree on the conclusions and prepare recommendations to PAAG for further work.

6.7 NEA information sheets on sorption investigations

Sorption experiments are usually extremely costly. It was felt beneficial for managers to be kept informed of such work carried out in other national agencies. This should help them to better manage their own resources, co-ordinating their effort with others, avoiding duplications, etc. For this purpose the NEA Secretariat collects information on on-going or planned sorption experiments in Member countries by means of a single sheet questionnaire. The information is than distributed to PAAG and SEDE members. Information sheets are in the process of being updated.

6.8 Stylised scenarios

PAAG, first through its Core Group, then with a small ad-hoc group, is providing an input to BIOMASS, a research project of the IAEA to establish a reference biosphere.
The PAAG suggested:

- using a simple model (i.e., drinking water) with site and time dependency as a reference case; and
- that variation be explored, and that the acceptability of this simple approach be judged by experts and regulators.

The PAAG suggestion decouples the biosphere from the overall system. The idea is to keep these uncertainties in the biosphere separate from the geologic/engineered system uncertainties.

7. SEDE Co-ordinating Group

7.1 Introduction

The Co-ordinating Group on Site Evaluation and Design of Experiments for Radioactive Waste Disposal (SEDE) is an international forum on methodologies and strategies for characterising and evaluating disposal sites. Since 1991, this Group has been fostering common, in-depth scientific and technical understanding with respect to important site characterisation and evaluation issues and has been contributing to building confidence in the appropriateness of geoscientific methodologies used at national level. It promotes a constant evaluation/understanding of the existing commonalities and differences between the programmes, and also facilitates the creation of a network of identified national experts among national waste management organisations, regulatory bodies and the scientific community.

The 8th meeting of the SEDE Group was held in Borgholm, Sweden, on 4-5 September 1997 at the invitation of the Swedish Nuclear Fuel and Waste Management Co, SKB, and comprised a technical visit to the Äspö Hard Rock Laboratory. Recent achievements that were discussed at this meeting and new initiatives that were proposed along the four SEDE Focus Areas are briefly described hereafter.

7.2 SEDE programme of work

As most national programmes are shifting from a research phase to a development and demonstration phase for potentially suitable sites, the need has arisen to (i) foster co-operation between site characterisation and safety-analysis specialists on the basis of site-specific geoscientific information, (ii) integrate design and construction issues, and (iii) consider the interfaces between the various components of the repository system. These needs are partly reflected in the current SEDE programme of work, which focuses on four areas whose objectives are:

- Underground Testing: build confidence in the *in situ* characterisation methodologies;
- Role of the Geosphere in Safety Assessment: confidence building in the geosphere as a barrier;
- Interface between the Geosphere and the Engineered Barrier System: assessment of the perturbation induced in the geosphere by the repository; and
- Argillaceous Media ("Clay Club"): build confidence in the characterisation of argillaceous media and in their barrier performances.

The on-going and further work of the SEDE addresses directly questions raised at the RWMC/CNRA/CRPPH workshop on "*Regulating the Long-Term Safety of Radioactive Waste disposal*" (Cordoba, 20-23 January 1997) and at the topical session on the "*Geosphere in Integrated Performance Assessments*" that was organised in the framework of the 1996 PAAG and SEDE meetings, e.g.:

- the role of regulatory authorities in the progress of site characterisation programmes and the rationale for a stepwise approach to site characterisation (*justification of going underground for testing*);

- confidence building in the geosphere stability and in the quantification of its behaviour with time (*long-term evolution of repository environments*);
- the use of characterisation to reduce uncertainty in site-specific data (*characterisation of the near-field geosphere*);
- the characterisation and treatment of geosphere heterogeneity for transport purposes (*GEOTRAP Project*).

Most of the SEDE work will require input from the performance assessment experts represented within the PAAG. In order to improve the interaction between the PAAG and SEDE, with a focus on the practical integration of site characterisation and performance assessment issues, small, multidisciplinary (PAAG and SEDE members, regulators and implementers), temporary project teams may be created. In addition, PAAG should provide SEDE with a series of open questions on key topics of interest and *vice versa*.

7.3 Focus area: underground testing

After more than 20 years of R&D work in underground research laboratories (URL), the SEDE considered timely to produce (by the end of 1999) a status document aimed at (i) synthesising the lessons learnt from URLs, especially *vis-à-vis* the performance assessment and repository development needs; (ii) assessing the transferability of data (e.g. from generic to site-specific facilities); (iii) building rationale for underground testing (e.g. confidence building in the extrapolation of surface-based data); and (iv) justifying a staged site-characterisation programme, notably from a regulatory point of view. For this initiative, co-operation with the PAAG, EC and IAEA will be explored.

7.4 Focus area: role of the geosphere barrier in safety assessments

Since 1996, the main activity under this Focus Area has been the GEOTRAP Project on *Radionuclide Migration in Geologic, Heterogeneous Media.* This project will be addressed specifically in the section that deals with Joint PAAG/SEDE Activities.

The SEDE also consider as a priority to contribute to the state-of-the-art in the matching of the results of the various methodologies used to characterise a site. As groundwater chemistry together with other information may provide a multidisciplinary method to test site-specific flow models, a workshop on the "Use of Hydrogeochemical Information in Testing the Models for Groundwater Flow" was organised just prior to the 8th SEDE meeting (Borgholm, 1-3 September 1997). This workshop allowed to acknowledge the significant progress that has been made in that field, and proved that this progress has not been communicated enough towards performance assessment end-users. It also helped define the inherent limitations to the integration of flow and chemistry. As the role of hydrogeochemistry in the site characterisation process, the main conclusion is that hydrogeochemistry could be used both in developing conceptual flow models and in testing the latter, but that a better formalism is required to help provide a consistent and transparent picture of the site and to help communicate the confidence gained to performance assessment specialists. The workshop proceedings, along with a synthesis, will be published by the NEA early 1998.

As the quantification of the geosphere behaviour with time and the long-term geosphere stability have been singled out on several occasions as key uncertainties in the development of a safety case for deep repositories, the SEDE (with PAAG) will elaborate further on these topics. This future initiative should help ensure that the earth-science knowledge of long-term stability of the geosphere be adequately integrated in scenarios for performance assessment.

7.5 Focus area: The interfaces between the geosphere and the engineered barrier system

Efforts to understand and assess the potential impact of gas migration, and of other two-phase processes, on the performance of underground repositories have been carried out for several years and have resulted in an important amount of documentation, most of it being rock-, concept-, and waste-specific. It was therefore considered that a critical review of the existing material is required in order to assess the state-of-the-art in this field from an international perspective and to provide national and international programmes a focus for the identification and prioritisation of research needed on unresolved issues. On this basis, the SEDE will help prepare, jointly with the EC, a Status Report on "*Gas Migration and Two-Phase Flow through Engineered and Geological Barriers for a Deep Repository for Radioactive Waste*". The report will take into account most of the engineered barriers and geologic media currently considered. The report will be drafted, within a 20-month period starting 1st January 1998, by a small group of experts in the framework of an EC Concerted Action, with co-funding from organisations represented within the SEDE.

Whereas it is very difficult to characterise the geosphere of a site on a regional scale to achieve a high level of confidence in the detection of all relevant features and processes, the "near-field geosphere" (i.e. the excavation disturbed zone and the undisturbed rock that immediately surrounds the excavation) is more amenable to detailed characterisation leading to its more reliable description in models and assessments. But, the near-field geosphere is also the most disturbed by excavation/investigation and by the presence of the repository. With the aim to reach better statements of confidence in characterisation capabilities, the SEDE will further consider topics related to the "*Characterisation of the Near-Field Geosphere in the Presence of the Excavation and in the Perspective of the Repository*".

7.6 Focus area: Argillaceous media

In accordance with the evolution of the national programmes and with the SEDE priorities, issues related to confidence building in the performance of natural argillaceous media as geologic barrier have been progressively added to issues related to the hydrogeological and hydrogeochemical characterisation of clays in the remit of the activities of the Working Group on "Measurement and Physical Understanding of Groundwater Flow Through Argillaceous Media" (informally named the "Clay Club"). This working group represents a unique technical and scientific forum that is recognised outside waste management organisations, and has helped Member countries:

- define strategy for and design of *in situ* testing;
- acknowledge the differences and commonalties among the whole range of argillaceous media considered as potential host rock;
- contribute to the understanding and coupling of the main driving processes for water, gas and solute movement through argillaceous media; and
- compare the state-of-the-art in the waste disposal field with that in other geoscientific disciplines.

The 7th meeting of the "Clay Club" was hosted by the French Nuclear Protection and Safety Institute, IPSN in Millau, France, on 21-23 May 1997. It included a technical visit of the Tournemire Underground Research Facility. Among the current priorities are:

- the drafting of a critical review report on "*Extraction of Water and Solutes from Argillaceous Rocks: Methods and Current Interpretations*" (1997-1998); indeed, the application of extraction techniques to clayey sediments is delicate and the representativeness of the water sample and the interpretation(s) to be given to the results of chemical and isotopic measurements could thus be questioned;
- the establishment of a Features Events and Processes Evaluation Catalogue for Argillaceous Media - FEPCAT Project (1998-1999): for each FEP, which might play a role in the behaviour of argillaceous media with respect to water, gas and solute movement, the proposed catalogue will provide an up-to-date overview of conclusions and key references related to its current understanding and relevance for geologic barrier performance (on the basis of materials provided by the national waste management organisations).

8. Joint PAAG/SEDE activities

8.1 GEOTRAP project

The joint PAAG/SEDE **GEOTRAP** Project on Radionuclide Migration in Geologic, Heterogeneous Media, is devoted to the exchange of information and in-depth discussions on present approaches to acquiring field data, and testing and modelling flow and transport of radionuclides in actual geologic formations for the purpose of site evaluation and safety assessment of deep repository systems. The project is articulated in a series of forum-like workshops whereby implementers, regulators and scientists could interact in a structured way. Two workshops have already been held, and the third one is currently being prepared.

The first workshop, devoted to "*Field Tracer Transport Experiments: Design, Modelling, Interpretation, and Role in the Prediction of Radionuclide Migration*", was organised jointly with the EC-DGXII, and hosted by the German Company for Reactor Safety (GRS) in Cologne (Germany) on 28-30 August 1996. This workshop facilitated discussion of the rationale and objectives of tracer tests, provided an overview of on-going *in situ* studies of radionuclide migration phenomena and of the characterisation of relevant properties of geologic media, and allowed assessment of the reliability and usefulness of these tests for the prediction of radionuclide transport. In addition to the papers presented at the workshop, the proceedings include a synthesis of the material presented, the discussions that took place and the conclusions and recommendations drawn, notably during the working group sessions.

The second workshop in the GEOTRAP Project was devoted to the "*Basis for Modelling the Effects of Spatial Variability on Radionuclide Migration*" and hosted by the French National Radioactive Waste Agency (ANDRA) in Paris (France) on 9-11 June 1997. Within the context of geosphere conceptualisation and performance assessment, the workshop discussed the importance of heterogeneity at different spatial scales and its impact on the quantification of radionuclide migration. In particular, the geological basis for the description of spatial variability, the various approaches in the conceptual representation of spatial variability and in its quantification were addressed as future areas for investigation and the feedback on further site characterisation and performance assessment activities. The proceedings, which will include a synthesis report, of this workshop are being prepared by the Secretariat.

The third GEOTRAP workshop will address issues related to "*Characterisation of Water Conducting Features and their Representation in Models of Radionuclide Migration*". It will deal with strategies and methodologies for characterising the properties of water conducting features in all types of host rocks and surrounding geospheres, and with the conceptualisation and abstraction of these properties from a modelling end-use perspective. The consistency and defensibility of the various approaches that have been followed by national programmes will be at the basis of the discussions.

On the basis of the two first workshops, the GEOTRAP project should meet its objectives and help bridge the gap between geoscientific data acquired in the field and their uses for performance assessment purposes.

8.2 The co-operative programme for the exchange of scientific and technical information concerning nuclear installations decommissioning projects

In response to the growing interest in the decommissioning of nuclear facilities, the Nuclear Energy Agency of the OECD launched in 1978 a programme of activities in this field. The work of the NEA was initially limited to the organisation of international meetings of experts and the preparation of surveys and state of the art reports. Subsequently, however, the Agency set up, in 1985, the International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects. This concept of working together among a number of decommissioning projects exchanging information, experience and possibly personnel, and carrying out other forms of co-operation as appropriate, obtained strong support from all OECD countries having one or more important decommissioning projects either underway or in the planning process.

The programme was formally initiated in September 1985 for a first five-year term, and was subsequently extended for a second five-year term in view of its successful performance. As this success has continued with now an even broader range of participating countries and projects, the agreement has been extended for a third five-year period.

The first five years of this programme represented a watershed in the evolution of decommissioning as a mature technical discipline. In its own right, each of the participating projects made a significant contribution not only towards developing various decommissioning technologies, but also in demonstrating them in the field. For the second five-year period the primary objective has been to contribute to the industrialisation of decommissioning by facilitating the exchange of information and of related experience between participating projects. This objective can be said to have been met, as evidenced by the continuing increase in participating organisations.

In order to assure the appropriate management and organisation of the Co-operative Programme, the Liaison Committee (LC), made up of project-management-level representatives of each project in the Programme, oversees the Programme's operations and administration, and sets Programme priorities, goals and objectives. The Technical Advisory Group (TAG), made up of technical representatives from the participating projects, reports to the LC and performs in-depth, technical studies assigned by the LC or proposed by the TAG and approved by the LC. Four such technical studies are currently underway.

Currently ongoing programmes within the Co-operative Programme include task groups studying decontamination techniques, detection and measurement techniques for clearance of materials, clearance levels, and the structure of decommissioning costs. The costs project will result in the publication, in 1999, of a "standard" cost structure which can be used for comparisons between different projects in different countries. The final document will be co-sponsored by the NEA, the EC and the IAEA. The work on clearance levels, that is, those radionuclide concentrations below which material is considered safe for unrestricted release, includes discussions with the EC and the IAEA concerning what numerical guidance should be chosen as the "international standard". This type of discussion represents the future for the Co-operative Programme, which will begin to shift its focus from technical feasibility type projects to more regulatory and policy type issues.

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