

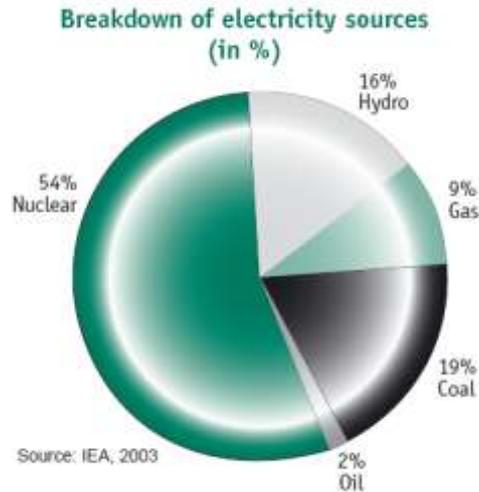
# **RADIOACTIVE WASTE MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES**

## **SLOVAK REPUBLIC [2005]**

### **NATIONAL NUCLEAR ENERGY CONTEXT**

Commercial utilisation of nuclear power in the Slovak Republic started in 1972 and by 2002 there were 6 nuclear power units connected to the electricity grid. In 2002 they generated 16.5 TWh of electricity, 53.9% of the total electricity generated in that year.

Also in 2002, the spent fuel storage capacity was 1 690 tonnes heavy metal (HM) which was utilised up to 60%. The three operational nuclear power plants in the Slovak Republic are Bohunice V-1, Bohunice V-2 and Mochovce. Bohunice V-1 NPP comprises two first-generation, Russian-designed pressurised water reactors (PWR), units 1 and 2. Bohunice V-2 NPP comprises two second-generation Russian-designed PWRs, units 3 and 4. Mochovce NPP also comprises two second-generation Russian-designed PWRs, units 1 and 2. Construction of another two PWR units at Mochovce was started but was subsequently ceased, after about 50% completion. The first nuclear power plant built in what is now the Slovak Republic was a gas-cooled, heavy water moderated reactor (GCHWR) of 150 MWe capacity, and it was located at Bohunice. It is known as A-1 and was shutdown in 1977 following an operational incident.



## SOURCES, TYPES AND QUANTITIES OF WASTE

In the Slovak Republic, radioactive wastes are generated by way of nuclear power production and by the use of radioactive materials in medical, research and industrial institutions. These wastes are described, by reference to their source, as “radioactive waste from NPPs” and “institutional radioactive waste”. All producers of radioactive waste are required to keep the amounts of waste that they create as low as reasonably achievable, by both technical and administrative means and, at each NPP, the programmes for radioactive waste minimisation are evaluated annually.

### **Liquid radioactive waste**

Liquid radioactive waste includes concentrates, sludges, sorbents and oils, of which the most significant are the concentrates. The commissioning of Mochovce NPP in 1999, and the higher generation of concentrates during start-up, has increased the generation of such waste since then.

### **Solid radioactive waste**

Apart from spent nuclear fuel, which is a specific form of waste, solid radioactive waste consists of filters, metal waste, concrete, and combustible and compressible materials. At Bohunice V-1 and V-2 NPPs and at Mochovce NPP such waste is first sorted, where it arises, according to activity level and to plans for its further treatment.

Precise information is not available for the quantities of solid waste generated and stored because some combustible wastes are incinerated continuously and are not included in records. Also, the operators record some types of radioactive waste by individual item or by weight, depending upon the method of storage. However, a significant increase in solid waste generation took place between 1998 and 2000 as a result of Bohunice V-1 NPP reconstruction.

## **Total quantities of radioactive waste**

The total amount of solid waste stored at the NPPs was approx. 3 280 m<sup>3</sup> at the end of 2001. The table 7 630 m<sup>3</sup> of liquid concentrates were in store at the below summarises the quantities of stored wastes, Bohunice site at the end of 2002. This represents including the institutional waste and the waste arising 64% of its storage capacity for this type of waste from decommissioning of the A-1 NPP.

## **RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES**

### **Waste management policies**

The strategy for radioactive waste management in the Slovak Republic was established by a Government decision in 1994, and is in accordance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which it ratified in 1998. This strategy includes the following steps:

- Conditioning of radioactive waste into a form suitable for disposal or long-term storage.
- Disposal of radioactive waste in a near-surface repository.
- Storage of radioactive waste that is not suitable for disposal in the near-surface repository.
- Research and development of a deep geological repository.

In 1996, an independent NPP Decommissioning and Radioactive Waste Management Company, SE-VYZ, was set up within Slovak Electric Plc, the Slovak electricity company. SE-VYZ is responsible for both predisposal and disposal phases of radioactive waste management and for decommissioning of nuclear facilities. It now operates all waste management facilities, excluding those facilities owned and operated by the Nuclear Power Plant Research Institute, VÚJE.

It has been decided by Government to shut down units 1 and 2 of the Bohunice V-1 NPP in 2006 and 2008 respectively. Spent nuclear fuel arising from these reactors at Bohunice will amount to between 4 028 and 4 768 assemblies by the end of their life time, depending on the level of uranium enrichment of the fuel. In addition, approx. 1 860 m<sup>3</sup> of wastes that will not meet the criteria for near-surface disposal are expected to arise from decommissioning of these reactors.

The two power units at Mochovce, which have been in operation since 1999 and 2000 respectively, are expected to generate 2 959 spent fuel assemblies during their lifetime. Approximately 760 m<sup>3</sup> of wastes that will not meet the criteria for near-surface disposal are also expected to result from decommissioning of these reactors.

In total, 2 500 tonnes HM of spent nuclear fuel is expected to be generated from operation of these NPPs over their lifetime.

As regards the A-1 NPP at Bohunice, its spent nuclear fuel has been transported to the Russian Federation. However, approximately 1 500 m<sup>3</sup> of the A-1 NPP decommissioning waste will not meet the criteria for near-surface disposal.

## **Programmes and projects**

### ***Pre-treatment of radioactive waste***

The first step after radioactive waste is generated is termed “pre-treatment”, and generally consists of collection, segregation and a period of interim storage. This initial step is important because it provides an opportunity to separate waste streams according to the requirements for their effective treatment, conditioning and disposal as set out in the Government decision of 1994. This represents a substantial change from the earlier policy of interim on-site storage of all wastes until eventual decommissioning of the nuclear plant.

The typical annual production of waste from the four reactor units at the Bohunice site is 400-500 m<sup>3</sup> of concentrates, 100-200 m<sup>3</sup> of solid waste and about 25 m<sup>3</sup> of spent sorbents.

### ***Treatment and conditioning of radioactive waste***

Treatment is intended to improve the safety or economy of radioactive waste management by subjecting the waste to operations such as volume reduction, radionuclide removal and change of chemical composition. This may be carried out by processes such as incineration, compaction, evaporation, ion exchange, precipitation, etc.

Conditioning of radioactive waste involves those operations that transform radioactive waste into a form suitable for transportation, storage and disposal. The operations may include immobilising the waste, placing it into containers and providing additional packaging. Common immobilisation methods include solidification in cement or bitumen and vitrification in a glass matrix.

The main effort is currently concentrated on providing the NPPs with these treatment and conditioning technologies.

The low-level waste incinerator at the Bohunice site is owned by VÚJE and has operated since 1992. An associated plant for cementation of incinerator ash has operated since 1995. Only Bohunice V-1 NPP and Bohunice V-2 NPP radioactive waste is treated in this facility.

Two bituminisation facilities have been commissioned. The first is owned by VÚJE and has been used since 1984, first for experimental purposes and later for bituminisation of concentrates and organic spent fuel coolant, but it was out of operation during 2002. The second is owned by SE-VYZ and was commissioned in 1994 for bituminisation of PWR concentrates. Another SE-VYZ facility for bituminisation of concentrates (PS-100) is undergoing active tests after issue of an operating licence in 2002. The capacity of each facility is 120 litre/hour of concentrate, and the total amount treated by bituminisation by the end of 2002 was approximately 1 290 m<sup>3</sup>.

A pilot vitrification facility, with a capacity of 50 litre/ day, has been used since 1996 for conditioning inorganic spent fuel coolant from the A-1 NPP. Because of corrosion damage to the fuel cladding during operation and spent fuel storage at the A-1 NPP, the total activity in this spent fuel coolant represents nearly 10% of the radioactive inventory of the damaged spent fuel, and hence the vitrified product is not acceptable for near-surface disposal. Modification of this facility for conditioning of spent fuel coolant with higher levels of <sup>137</sup>Cs is currently under development.

The Bohunice Radioactive Waste Conditioning Centre (BSC) was designed by NUKEM of Germany, and is now the main facility for radioactive waste treatment and conditioning. The processes available include cementation, incineration, high-pressure compaction and evaporation. Because of its complexity, commissioning of the BSC was carried out in two phases during 2000, and a licence for its operation was granted in 2001 by the Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR).

Operation of the BSC during 2002 has achieved the incineration of 74.8 tonnes of solid waste and 5m<sup>3</sup> of liquid waste, the compaction of 107.5 tonnes of solid waste, the cementation of 322.5 m<sup>3</sup> of concentrates and the filling of 203 fibre-reinforced concrete (FRC) containers.

Construction of a facility for treatment and conditioning of liquid radioactive waste from Mochovce NPP is expected to start in 2004.

### *Near surface disposal*

For those wastes that contain only low or medium levels of activity consisting mainly of short-lived radionuclides, commonly described as low- and intermediate-level radioactive wastes (LILW), the final step of the national radioactive waste management system is disposal in a near-surface disposal facility in Mochovce.

Its safety is ensured by a combination of engineered and natural barriers that keep the disposal vaults dry and prevent radioactive releases into the environment. The repository was built in a geological formation with low permeability and high sorption capacity, and the disposal vaults were surrounded by an additional, artificially constructed clay layer. The temporary and final covers are designed to avoid water penetration into the disposal vaults. The repository is designed for disposal of solid and solidified LILW in special fibre-reinforced concrete containers that represent an additional engineering barrier. (The licence for these containers belongs to a French company, *Sogefibre*, and they are approved by ANDRA in France.)

Selection of the repository site was carried out between 1975 and 1978. Out of 34 sites selected on a preliminary basis, 12 were chosen for further investigation and, based on agreed selection criteria, the site of Mochovce was chosen as the most suitable for repository construction. Permission for the Mochovce repository commissioning was granted by the ÚJD SR in October 1999 and, after assessment of the repository commissioning report, permission for full operation was granted in September 2001. By the end of March 2003 a total of 392 containers were disposed of. The capacity of this near-surface disposal facility for LILW is sufficient for all operational waste, but not for all decommissioning waste, and it is

expected that the capacity of the Mochovce repository will be increased in due course to accept also decommissioning waste.

For the time being, conditioned radioactive waste that is not acceptable for disposal in the near-surface repository will be stored at the NPP site where it arises. Further arrangements for its storage are under discussion, as are arrangements for buffer storage of short-lived waste whose activity will eventually decay to levels that are acceptable for near-surface disposal, or for release from radiological control.

### ***Deep geological disposal***

It is estimated that, during their design lifetime, the nuclear power plants will produce 2 500 tonnes HM of spent nuclear fuel and 3 700 tonnes of radioactive waste that is unacceptable for the near-surface repository at Mochovce and will require deep geological disposal. Research and development for deep geological disposal of high level waste and spent fuel in the Slovak Republic started in 1996. Current work involves preliminary geological investigations, source term studies, safety analyses and public involvement designed to provide a basis for pre-selection of repository sites. As regards selection of a host-rock environment, both crystalline and sedimentary rocks are under consideration. International experience has been used in defining the first set of criteria for site selection.

This work, and a critical review of existing geological data, led to identification of 15 prospective sites that are potentially suitable for a deep geological repository. Further investigation, taking account of geological, structural, tectonic, hydrological, rock-engineering and geochemical properties, together with consideration of natural resources and possible conflicts of interest, has led to selection of four areas proposed for further exploration in more detail.

## **RESEARCH AND DEVELOPMENT**

Management of the radioactive waste from the early development work at the A-1 NPP at Bohunice presents a special problem because of insufficient segregation and record-keeping during its operation. A large part of the liquid operational waste was treated and conditioned for disposal or was treated in order to reduce its level of activity. At the end of 2002 the inventory of liquid radwaste was 860 m<sup>3</sup>. About 10 m<sup>3</sup> of fresh liquid concentrates are produced annually from decommissioning of the NPP and these are bituminised.

## **DECOMMISSIONING AND DISMANTLING POLICIES AND PROJECTS**

Decommissioning started in the 1980s on a step-by-step basis and, after 1994, continued according to an overall decommissioning plan. The first phase of this plan, up to 2007, is focused on completion of the waste management infrastructure and on treatment, conditioning and disposal of all operational wastes. Significant dismantling will start only during the second phase, after discussions of options that include

early dismantling, and deferred dismantling of the reactor and primary cooling circuit with safe enclosure. Decommissioning options for the Bohunice V-1 NPP are currently under expert evaluation and discussion.

## TRANSPORT

The licensing procedure for transport of radioactive waste in the Slovak Republic firstly requires approval for the transport containers and equipment, and then permission for the actual shipment of waste using the approved containers and equipment. A new type of container for transport of liquid radioactive waste was approved in 2002. The validity of previous permits has been extended for seven types of transport containers that have already been approved. During 2002 about 582.6 tonnes of solid radioactive waste and 682.6 m<sup>3</sup> of liquid radioactive waste were shipped to the waste treatment plant, and 214 filled FRC containers, equivalent to 663.4 m<sup>3</sup> of solid and solidified waste, were shipped to the disposal repository.

## COMPETENT AUTHORITIES

The **Nuclear Regulatory Authority of Slovakia (UJD SR)** is responsible for supervision of nuclear safety, including all aspects of radioactive waste management (except preconditioning management of institutional waste).

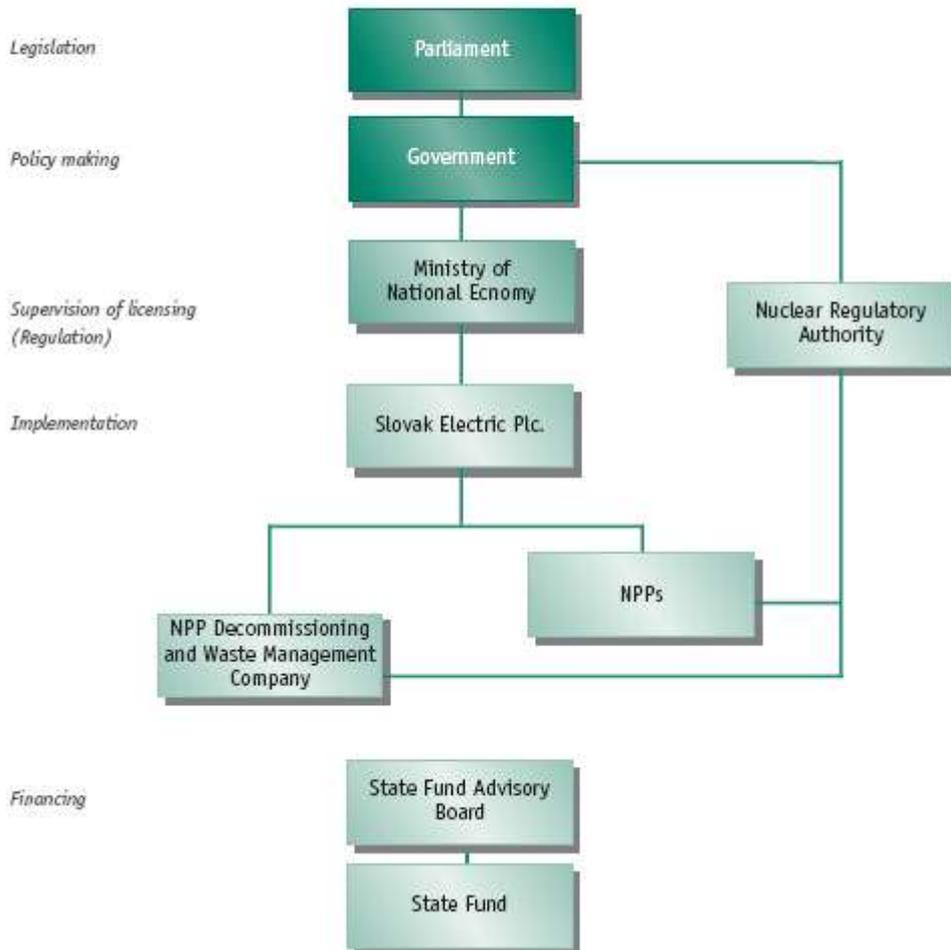
The **Ministry of Health** is responsible for radiation protection regulations.

The **State Fund Board** is responsible for providing advice to the Minister of National Economy regarding expenditures by the implementing body.

Currently, the UJD SR and the Ministry of Health are each responsible for inspection of the relevant nuclear facilities.

In accordance with the *State Decommissioning Fund Act*, only the owner/operator of nuclear facilities may use the resources of the State Fund. Since the only owner/operator of nuclear facilities is Slovak Electric Plc., a 100% state-owned joint stock company, it is currently the only implementing body for radioactive waste management, including disposal. Within Slovak Electric Plc., the three subsidiary companies are involved in these activities are: Jaslovske Bohunice NPP, Mochovce NPP, and SE-VYZ, the NPP Decommissioning and Radioactive Waste Management Company.

## Main bodies involved in radioactive waste management in the Slovak Republic



## FINANCING

The State Fund is designed to cover the costs of the back-end of the nuclear fuel cycle and of decommissioning nuclear facilities, including conditioning and disposal of waste arising from decommissioning. It was established by the *Act on the State Fund for Decommissioning of Nuclear Facilities and Spent Fuel and Radioactive Waste Management* (Act No. 254/1994), amended by Acts No. 78/2000 and No. 560/2001.

The following assumptions were made to calculate the associate fees:

- the minimum difference between discount/interest and inflation rates shall be 2.92%;
- the electricity rates shall increase to 1.9 Sk/kWh, minimum, in 2009.

According to the Act (as amended), the owner of the nuclear power plants (now Slovak Electric Plc.) shall pay to the Fund annually 6.8% of the sale price of the electricity sold by the plants and 350 000 Sk for each MW of installed electrical power. Based on the actual (year 2000) electricity rate, the fee has been calculated to be somewhat less than 0.13 Sk/Wh. Details of the calculation of fund contributions are to be established by a binding legal regulation to be issued by the Minister of National Economy.

The Ministry of National Economy is responsible for the management of the Fund. The financial resources are deposited in the State Fund account. These funds generate interest, the rates of which are established by the Slovakian National Bank.

There is no separate fee for radioactive waste management in Slovakia. Instead, the financial resources required for these purposes are a part of the annual budget for expenditures from the State Fund, in accordance with the applicable legal requirements and decisions made by the Minister of National Economy.

## **PUBLIC INFORMATION**

More information may be found by way of the websites listed below.

### **Government**

**Nuclear Regulatory Authority of the Slovak Republic (UJD)**  
Bratislava

Website: <http://www.ujd.gov.sk/main.html>

E-mail: [info@ujd.gov.sk](mailto:info@ujd.gov.sk)

### **Industry**

**Company Slovenské elektrárne, a.s.**  
Bratislava

Website: <http://www.seas.sk>