DRIVING FORCES AND PRIORITIES IN THE HUNGARIAN RADIOACTIVE WASTE MANAGEMENT

F. Takáts
TS Enercon llc,
1025 Budapest, Csalogany u. 23 – 33, Hungary

P. Ormai
Public Agency for Radioactive Waste Management (PURAM)
2040 Budaors, Puskas Tivadar u. 11, Hungary

ABSTRACT

Hungary, being a candidate state to the European Union, pays particular attention to the measures that are typically considered as good practice within the EU when developing and implementing its national programme for the safe management of spent fuel and radioactive waste. The Public Agency for Radioactive Waste Management (PURAM) has been designated to carry out the multilevel tasks in the field of radioactive waste management. In accordance with changes in infrastructure, Hungary is about to make significant strategic and technical decisions. There are several technical priorities for the coming years, such as improving the existing L/ILW repository, construction of a new repository for L/ILW, extension of the interim storage facility for spent fuel and setting up a revised back-end policy. Preparations for decommissioning of the nuclear facilities have to be developed as well. The paper outlines the main problem areas as well as the approach to managing radioactive wastes. It will be concluded that priorities can be set, but key dates and deadlines will always contain an element of uncertainty due to public and political acceptance problems.

INTRODUCTION

Nuclear power plants produce radioactive waste as unavoidable by-products of electricity generation. Hungary has neither significant fossil-fuel deposits nor renewable energy supplies, and the contribution of nuclear power is crucial to the national economy. Currently, almost half of the electricity generated in Hungary is produced at the four units of the Paks Nuclear Power Plant (NPP). The electricity is being generated in the national interest. Unfortunately, one cannot expect to enjoy the benefits of nuclear power without also having to cope with some of its problems. Perhaps the most significant of them is the disposal of radioactive waste.

Hungary, being a candidate state to the European Union, pays particular attention to the measures that are typically considered as good practice within the EU when developing and implementing its national programmes for the safe management of spent fuel and radioactive waste. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management provides the appropriate guidance on internationally recognised principles and practices with regard to the safe management of spent fuel and radioactive waste.

The Hungarian Atomic Energy Act of 1996 specifies as one of the basic principles that in the application of atomic energy, radioactive waste and spent fuel shall be stored and disposed of in accordance with the most recent, certified results of science, international expectations and

experience, in such a way that human health is not threatened and that no unacceptable burden is passed on to future generations.

The Public Agency for Radioactive Waste Management (PURAM) has been designated to carry out the multilevel tasks in the field of radioactive waste management. In accordance with changes in infrastructure, Hungary is about to make significant strategic and technical decisions. There are several technical priorities for the coming years, such as improving the existing L/ILW repository, construction of a new repository for L/ILW, extension of the interim storage for spent fuel and setting up a revised back-end policy. Preparations for decommissioning of the nuclear facilities have to be developed as well.

SPENT FUEL MANAGEMENT

In order to assure the continuous and reliable operation of the nuclear power plant, it became necessary to provide for interim storage of the spent nuclear fuel in Hungary. It was for these reasons that the Hungarian Atomic Energy Commission classified construction, licensing and operation of an Interim Storage Facility for Spent Fuel (ISFSF) as a top priority in 1993. The facility has been commissioned in 1997. The system is a modular, vault dry storage type. Due to the modularity of the storage, there is a possibility for a step by step expansion, according to the operational needs of the power plant. At present, there are seven vaults in operation, each with a capacity to store 450 assemblies. The quantity of the spent fuel assemblies stored in the ISFSF as of January 1, 2002 was 2400 i.e. 5.5 vaults are filled. The expansion of the storage facility is now in progress and it is anticipated that by the end of 2002, the 11^{th} chamber will be completed, bringing the total capacity to 4950 assemblies. The facility allows for the storage of spent fuel assemblies for a period of 50 years. Hence, it is not necessary to take immediate action in respect of the final disposal of the spent fuel and decision on this may be delayed without compromising safety.

Taking into account the amount of spent fuel assemblies that will be generated by the end of the anticipated lifetime of the power plant, there will be a need for the interim storage of at least 11 000 spent fuel assemblies. In order to be sure that the adopted storage technology is both safe and economic, PURAM launched an international tender to look for alternative storage solutions for this spent fuel amount. Concrete based dry storage technologies were shortlisted, and the final selection is expected to take place in 2002.

CLOSING OF THE FUEL CYCLE

As a consequence of operation of the nuclear power plant, some 100 m^3 of high level radioactive waste will be generated by the end of the life-time, while the decommissioning will add to this volume some 3700 m^3 of waste additionally. Based on this it will be undoubtedly necessary to construct a high level radioactive waste repository in Hungary. If direct disposal of spent fuel assemblies is chosen, then the disposal inventory will be the 11 100 spent fuel assemblies together with the 3800 m^3 of high level radioactive waste.

Among the small countries with similar possibilities Hungary was in outstanding position due to its ambitious project launched in 1993 for disposal of the HLW. Through a „desk-top" review of the country it became clear that the most promising location for the disposal of the HLW is the aleurolit formation in the vicinity of Boda, with which the geological community became familiar in detail during the operation of the Mecsek uranium mine. The exploration drift from the uranium mine reached the clay-stone formation in 1994 when underground data

collection began. There was a short term programme launched in the period between 1995 and 1998 with the participation of AECL, Canada in order to explore how this rock body could be characterised from the point of view of a high level waste repository. The research was limited in time by the fact that the closure of the Mecsek uranium mine was scheduled for 1998. On the basis of the measurement results the formation turned out to be suitable for further investigations, and there was no single result that could question the usability of the rock body for the purposes of a HLW repository. On the basis of these results a proposal was made in 1998 for further development and operation of the research laboratory. However, a high level decision in summer 1989, meant the closure of the mine was to be in accordance with the original schedule and it was therefore not possible to further operate the research laboratory.

FUTURE PLANS AND OUTLOOK

With the rejection by the government in 1999 of the PURAM plan for an underground research laboratory at the previously investigated area, as a step towards the development of a deep repository, Hungary was left with no practical plan for the disposal of high level and other long-lived waste.

In this new situation, learning from the lessons of the former procedure, the new HLW project was launched aimed at developing a new policy.

The different possibilities to be considered for the evaluation of alternatives for managing HLW/SF in Hungary are: extended supervised storage, separation and transmutation, and direct deep geological disposal. All are potential components in an overall waste management strategy leading to disposal.

The safe disposal of radioactive wastes requires consideration of a broad range of scientific and technical factors relating to potential impacts on the biosphere, as well as basic ethical principles that reflect the expectations of society. Therefore, choosing a spent fuel and HLW management strategy is not just a technical question or an economical one. It is also a question of ethical judgements, political and social acceptance and decisions as to what should be done now and what can be postponed until the future.

When evaluating waste management alternatives different criteria or issues can be selected depending upon the decision-makers or the stakeholders involved. The issues selected in the preparatory report pretend to be at least the minimum ground from which a proper analysis can be oriented and worked out for the detailed evaluation of possible scenarios for the Hungarian program.

Once the possible scenarios have been identified, an organisational scheme for carrying out the evaluation work of the possible scenarios for managing the HLW/SF in Hungary in the next future is proposed.

Concerning the identification of possible scenarios for Hungary, in the front end of the selection two fundamental questions will guide the whole process. On the one hand there is a question on whether spent fuel should be reprocessed or not and, on the other hand there is a question on whether the long term solution should be to wait and see or to dispose in geological formations. The answer to these questions is not straightforward from a radioactive waste management standpoint, as they are linked in some respects to the question of the future

national energy supply. An investment in reprocessing and recycling is not realistic without the prospect of continued use of nuclear power in the future. This is also true for transmutation, which in itself requires reprocessing but also a large investment in new nuclear power technology.

Another important question is whether today's generation should solve the waste problem or whether responsibility should be shifted in all or in part to future generations. This question is linked to the pace of technical development, as well as to the flexibility needed in the strategy to accommodate possible improvements or future developments.

Reprocessing affects the form of and, to some extent, the contents of the waste, but this does not have a crucial importance for the long-term solution for radioactive waste.

If the choice is made to wait for a long-term solution, there is a really only one option: supervised storage for a period of time, whether the spent fuel is reprocessed or not. Whilst, if geological disposal is selected, a number of choices of a more technical nature remain, like for instance, the degree of retrievability of the waste after disposal.

In the assumption that a decision on whether to reprocess or not is more closely linked to an energy policy rather than to a radioactive waste management programme, the following possible SF/HLW management strategies appear to be more suitable to be analysed for the Hungarian programme:

- Deep Geological Disposal
  Nearly all countries with nuclear power programmes are oriented to this solution, although with different paces and timeframes. It is generally accepted as a final solution for HLW, SF and other long-lived waste, taking ethical and environmental considerations also into account.

  At the same time it can be conceived and designed with sufficient flexibility as to follow technology evolution in a reasonable timeframe.

- Supervised Extended Storage
  Extended or long-term storage is increasingly being considered as an option for HLW/SF management. In general, long-term storage is intended to provide additional time to allow for the development of improved options, delays in design and construction programmes for planned disposal facilities or to gain increased public acceptance of proposed options.

  In the case of Hungary it could provide flexibility for the future consideration of other options, in particular the possibility of regional or international repositories.

These two strategies are proposed to be further analysed for the detailed evaluation of the scenarios from a technical, economic and social point of view.

The development and approval of this new strategy will require 5–7 years. If geologic disposal were selected as a preferred option, then international experience indicates the execution of the research preparatory activities will require some 20–25 years of work. An additional 10–15 years for licensing and construction of the disposal facility can be envisaged.

Geological disposal at the Boda site remains one of the preferred options. In parallel with the development of a new policy, we plan to conduct country-wide screening to identify potential new host rock areas for a HLW repository, to continue the surface investigations of the Boda area, and to continue the mathematical processing of the accumulated geological parameters.

The policy will be put for debate with an aim to gain wide scale professional and public consensus.

Improving the existing disposal site

Safety re-evaluation

The only radioactive waste repository in Hungary, at Püspökszilágy, has been in use since 1976. It has received waste from various small-scale producers and, in particular, has been the site for the disposal of a number of spent radiation sources. The available capacity provides a solution until 2006. Future development of the Püspökszilágy facility is under discussion. (1)

The safety of the facility has not been the subject of any comprehensive assessment. As the temporary licence of the extended part of the Radioactive Waste Treatment and Disposal Facility (RWTD) expired on 31 December 2000, the regulatory body required a comprehensive safety assessment as a condition for issuing a permanent licence. Two safety analyses were completed: one was performed by the Hungarian ETV – ERŐTERV, while the other one was made by the AEA Technology of the UK in a project funded under the European Commission PHARE programme. Safety assessments attempted to answer the question whether the site would remain safe in the future, or if corrective measures were needed, through which the required level of safety could be guaranteed. The work was carried out in the period between September 1999 and March 2001 and was based on data and research commissioned by PURAM.

As part of the supporting studies for the safety assessment, in March 2000, an uncemented compartment and a cemented compartment in a vault were opened to check on the condition of the disposed wastes. The basic objective of the investigations was to check and evaluate the condition of the waste as well as the conditions of the more than 20 year old concrete and metal structures. Having finished the investigations, the compartments were closed and sealed again. The vaults were found to be dry and the vaults, cap and wastes were found to be in good condition with little apparent degradation of either concrete or waste packaging.

Results of the safety assessments demonstrate that the safe operation of the repository as well as the safety of the environment is guaranteed till the end the passive institutional control period.

Based on the results of the safety assessments consideration is given to possible developments at the site which could include the retrieval of certain waste types from the site and putting into on-site interim store pending final disposal in geological repository, remedial measures to improve safety related to wastes that are currently disposed, the disposal of further wastes by providing free capacity within the existing facility.

Having identified the key issues and uncertainties in the assessment, further work will be undertaken to resolve these issues and uncertainties, leading eventually to a position in which full assurance of the post-closure safety of the repository can be provided. This further work

is likely to involve changes in the characteristics of the RWTD, updating of plans for its closure and enhancements of the methods used to evaluate its post-closure radiological impact.

A middle-term programme has recently been set up by PURAM, which designates in detail the tasks to be performed. The results of the safety assessment may be used to focus the subsequent research programme and to identify issues that require further consideration.

According to PURAM's plan, the RWTD will be operational for an additional 40-50 years, by receiving the radioactive waste from the small-scale producers of the country. By the end of this period, a deep geologic repository should be available to receive those long-lived wastes temporarily stored in the Püspökszilágy facility, which are not amenable for near surface disposal. Bearing this approach in mind, initial measures are to be taken to provide additional disposal capacity within the site.

Centralised interim store

The other main objective of development at the RWTD site is to make preparations for conversion of the existing building of the Püspökszilágy repository into a centralised interim store for institutional radioactive waste, which are not suitable for near surface disposal. Two main categories include radium sources of medical applications, formerly stored at the National Institute of Oncology, and plutonium sources being stored in the Institute of Isotopes. The so-called "active building" was designed in the 1970s to treat and condition raw low and intermediate level radioactive waste (liquid and solid) from isotope applications but remained unused. The centralised interim store can also serve as a "buffer storage" especially in cases when an urgent need may arise to receive a larger amount of waste at the repository site.

SITING OF A NEW L/ILW REPOSITORY

From 1993 onwards, site exploration for a new L/ILW repository has been performed. Near surface and underground disposal methods were evaluated. The investigations were performed in four stages. Firstly the whole of Hungary, secondly a selected area were covered by desk-top studies. Public approval was given to just a few dozen out of several hundred potential geological objects. Four prospective areas, three for near surface and one for underground disposal, were covered by field reconnaissance. Boreholes were drilled at two near surface (loess) and one underground (granitic) sites. The granite at Üveghuta site seemed to be more suitable when compared with loess. The investigations summarised above closed the first phase of the National Project, and their results form the basis for designing studies in the second phase. The second phase of the National Project consists of three stages e.g. selection of a site in granite massif, assessment of the geological suitability of the selected site, characterisation of the selected site. (2)

The first stage of the second phase consisted of a geological evaluation of five areas in the neighbourhood of the original Üveghuta borehole. This evaluation was completed by July 1997 and a site at the major groundwater watershed was selected for study in stage 2.

The second stage comprised drilling of four deep boreholes. The stage 2 fieldwork was completed in February 1998, and reporting on the work and developing safety assessments were finalised by the end of 1998. On completion of the 1997/98 investigations and

interpretation a further safety assessment was performed. The decision concerning the suitability of the selected site for an underground repository for L/ILW and on whether it merits further more detailed site characterisation (stage 3) is yet to be decided.

The next stage of the repository development comprises detailed site characterisation. However, scientific dissension has made the situation quite uncertain and a political debate has emerged. To promote achieving consensus, the International Atomic Energy Agency was approached to organise a mission to carry out a peer review for the validation of the activities and results of the site selection and to give recommendations based on international good practice. The principal conclusions of the expert team's review were that the process that led to the selection of the preferred site appears reasonable and has appropriately considered both the Hungarian geology and public acceptance.

In June 2001, the Minister in charge approved the research plan for the next 4 years, hence the site characterisation and repository design is continuing on from 2002. (3)

The planned new repository in Üveghuta is designed for all radioactive waste of nuclear power plant origin other than the high level and long-lived intermediate-level waste. The facility is envisaged to be located in a granite formation in a hillside. The long-term safety of the repository relies primarily on the technical barriers in combination with slow water movement in the granitic host rock.

As for the appropriateness of the selected concept, the opinion laid down in the final report of the IAEA WATRP peer review on Üveghuta siting states as follows (4):

> "It is accepted in a number of countries that adequate protection of public health and safety against the hazards associated with short-lived low and intermediate level wastes can be achieved with engineered facilities on the surface. Placing such waste in a well engineered and well chosen underground repository provides additional protection from surface hazards, both man-made, e.g., security against aircraft accidents or sabotage, and natural, e.g., the avoidance of extreme weather conditions. In the case of Üveghuta, it will reduce infiltration by diversion of surface precipitation to the valley sides above the repository, which minimises groundwater contact with the waste and delays groundwater travel times from the repository to the biosphere. Underground structures are also inherently less vulnerable to seismic events. The team agrees with the Hungarian approach to locate the repository below ground because a well engineered underground repository can provide a greater measure of public protection and safety than a comparable surface facility."

Based on the existing information on the geological situation at the site the team recommends that, for a rock mass of the type to be expected at Üveghuta, a "design as you go" approach be followed, adapting the design of the repository to the geological situation, as revealed during excavation. The safety assessments that were based on limited early geologic investigations should be updated. There is a need for an integrated safety assessment using the currently available site and conceptual design information, and including a broader spectrum of scenarios. This integrated safety assessment should form the basis for continued site characterisation.

Based on the experience, most relevant conclusion is the need for gradual and systematic process of interaction between the regulators and implementers, in order to build a common

understanding of repository performance, interpret the regulatory criteria and achieved the necessary convergence at the early stages of licensing process. The development time for an underground repository takes several years, if not more than a decade to complete. Because of this long timeframe, there will be an increased emphasis on QA and documenting of decisions regarding the design of the repository and collection of data. Because many of the staff, who collect data and make decisions may not be available at the time of licensing, there is a need to maintain an adequate QA programme as well as the means to document important decisions.

Owing to the relatively early stage in the long-lasting site investigation and realisation process, many questions remain open. These questions shall progressively be answered in the course of the subsequent stages. In spite of these still open questions, positive conclusions were drawn concerning the site suitability. From the available knowledge it is expected with the requested reasonable assurance that a safe repository can be built at the Üveghuta site.

Most R&D being performed in the future on L/ILW disposal is directed at confirmation of the selected site, including site investigations, laboratory analysis of borehole samples, determination of soil characteristics (sorption, water permeability, isotope migration rates, etc.) performance assessment and environmental impact study.

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

DECOMMISSIONING

Although no nuclear facility in Hungary has reached the stage of decommissioning, the issue should be dealt with due care as it has significant impact on such important factors as e.g. the radioactive waste management and accumulation of money in the Central Financial Fund.

Currently there are no legislative and regulatory requirements, which would dictate the decommissioning strategy to be followed. The preferred option and scheduling for decommissioning of Paks NPP units has been laid down in the first medium- and long-term plan of PURAM based on the preliminary decommissioning study prepared in 1993 – and revised later in 1997 – with close collaboration of the Slovakian DECOM company (5).

Based on this study theoretically the following options seem to be open for Paks NPP:

- Complete dismantling of the plant
- Decommissioning of the twin units by safe enclosure including:
    a. common isolation of the twin unit together with its own facilities either with - or without decreasing the height of the building
    b. independent isolation of both units with their own facilities, either with decreasing the height of the building or leaving it
    c. isolated closing of the two reactor pits with the reactors in them
- Store with surveillance the twin units in their original state

As there is a big difference between the options to be chosen in time of realisation, in the volume of radioactive waste generated, and in technical tools and cost, to select the most acceptable solution needs a comparative evaluation taking into account all the conditions (technical, financial, safety).

Currently the reference scenario for calculating the fee to the Fund is the "safe store with surveillance for 70 years".

However not urgent, preparations for decommissioning of the other nuclear facilities (research- and training reactor) should also be done in due time. The responsibility rests with PURAM.

COST AND FINANCING

One of the prerequisites for any further activities is the allocation of the necessary funds. Unfortunately, this has recently become one of the weak points in the Hungarian waste management program. In the past, activities related to disposal of radioactive waste were conducted within the framework of the State budget for waste not originating from power generation, while the Paks NPP was responsible for financing the disposal of its waste. On 1 January 1998, the Atomic Energy Act established the Central Nuclear Financial Fund to be based on payments from parties using nuclear energy. The goal of this fund is to provide for the disposal of radioactive waste, interim storage, and final disposal of spent fuel, and the decommissioning (dismantling) of nuclear facilities. Thus, operators of a nuclear facility must accumulate, during the effective life-cycle of the power plant, the necessary funds to cover the costs of decommissioning the facility and disposing of the waste, as well as any costs arising over decades following such decommissioning. The funds are to be managed in such a manner that their value remains stable, and they may only be used for the aforementioned purposes.

The amount of payments by nuclear facilities (primarily the Paks NPP) to the fund is set forth in the annual Act on the State Budget, based on a cost projection provided by the Hungarian Atomic Energy Authority and the Hungarian Energy Office. In the interest of maintaining the value of the fund's resources, the Hungarian government should ensure the contribution of an appropriate amount to be paid from the State budget. Unfortunately, as a consequence of a "negative campaign" against the radioactive waste programme by some vocal politicians, the Parliament cut back the budget for the HLW programme for 2001 and 2002. Moreover, they annulled the government contribution, which seriously jeopardises the future of the fund. It is hoped that, after the Parliamentary elections in April 2002, the waste management projects will get a new impetus from sober decisions by the policy makers.

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