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What can a country with small nuclear program learn from other European countries?

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Abstract

In this paper the present status of the nuclear programme and radioactive waste management in Slovenia is briefly presented. The quantities of accumulated radioactive wastes are given and the storage capacities and plans and problems concerning the final disposal are described. Because of small nuclear programme and limited resources Slovenia cannot afford expensive research and development projects; therefore, in selecting the optimal long-term solution for its radioactive waste foreign experience and approaches are very important. Intercomparison of solutions in different areas of radioactive waste management in more developed countries can be of great help to such countries when the disposal programme is prepared, as is indicated in this paper. © 1997 Elsevier Science S.A.

1. Introduction

Slovenia is one of the smallest and youngest European countries. It declared its independence in 1991 after the collapse of the Yugoslav federation. In 1992 it was officially recognized by the European Union and became a permanent member of the United Nations.

Slovenia is located between the Adriatic Sea and the Alps. It is one of the Central European countries. Its area only slightly exceeds 20 000 km^2 and the population is about two million.

2. Nuclear facilities in Slovenia

What is maybe not well known is that Slovenia is a nuclear country. There are two nuclear facilities in operation: one nuclear power plant (NPP) and a research reactor.

The NPP is located in Krško near the border with Croatia. It is Westinghouse PWR, 632 MW (electrical) unit. The plant has been in commercial operation since the beginning of 1983. It provides more than one-third of the total electric power production in Slovenia. Since it has been constructed as a joint venture with the neighbouring country Croatia, the electricity generated by the plant is shared with Croatia in the proportion 50:50.

Near the capital Ljubljana a small TRIGA research reactor has been in operation since 1966. It is a General Atomics design, 250 kW, intended for research, training and isotope production.

A few years ago, in 1992, by Government decision the Žirovski vrh uranium mine in north-west Slovenia was closed before its operation fully started. The mine is being decommissioned now.

Slovenia has adopted a moratorium on building new nuclear power plants until 2000. However,

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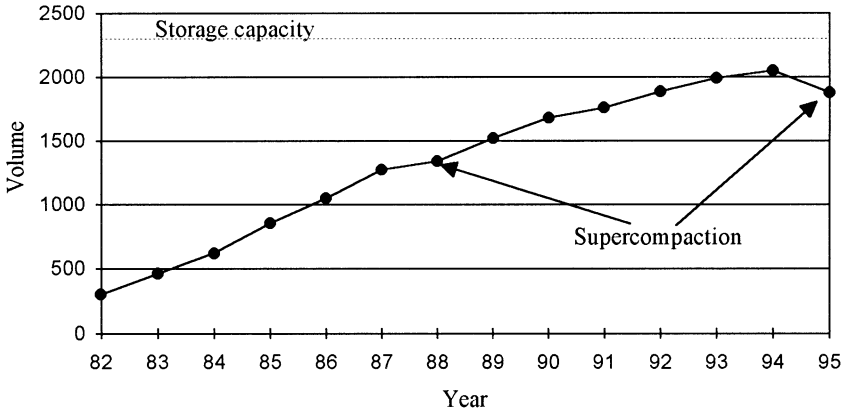

Fig. 1. The volume of low and intermediate level waste (LILW) (cubic metres) as a function of time in the NPP at Krško.

even the operation of the NPP at Krško is a subject of constant discussions. The question of a referendum on earlier closure of this NPP has been raised several times in the last few years, the last time just recently, although in the long-term strategy of effective use of energy, adopted by the Parliament this year, further use of nuclear power until the end of the lifetime of the NPP at Krško is included.

3. Radioactive waste

Radioactive waste in Slovenia arises from nuclear electricity generation, research, medicine, industry and mining (Mele and Loose, 1995).

The main producer of all categories of radioactive waste is the NPP at Krško. The average yearly production is less than 200 m^3 (Rožman, 1995). By optimization of working procedures and minimization of waste generation a considerable reduction in waste production in the NPP has been achieved over the last several years, which can be seen from Fig. 1. At present in normal operation the yearly production has become established at ≈ 100 m^3. Two supercompaction campaigns for volume reduction of existing waste quantities were also performed, as indicated in Fig. 1.

The amounts of all categories of radioactive waste in Slovenia at the end of 1995 are given in Table 1. It is seen that the contribution from other producers, such as research, industry and medicine, is small. It must also be mentioned that U tailings are covered by a separate law and are not treated like other low level wastes.

It has been estimated that to the end of its lifetime the NPP at Krško will produce about 7000 m^3 of operational waste and about 650 t U of spent fuel. Together with the decommissioning waste the total volume of LILW that will be generated by the NPP at Krško will still be smaller than the yearly production in some European countries (i.e. France or the UK). Also in this comparison it has not been taken into account that Slovenia is only one of the two owners and that waste will probably be shared between the two countries.

Table 1
Volumes of radioactive waste in Slovenia by types and different producers at the end of 1995

Waste	Volume
Low and intermediate level	
From NPP	1900 m^3
Research, industry and medicine	≈ 60 m^3
Spent fuel	
From NPP	181 t U
From TRIGA	130 fuel elements
Mining and milling	
U tailings	0.6×10^6 t

4. Storage

At present the radioactive waste is stored at the locations of nuclear facilities: the operational waste from the NPP on the Krško site and LILW from all other producers at the Research Reactor Centre near Ljubljana, where interim storage for small producers was built about 10 years ago.

The storage capacities are limited and will soon run out. This is specially true for the LILW storage in Krško. It has been estimated that at the same rate of waste production the storage will be fully occupied within 5 years. Further improvements in waste treatment and reduction in waste production are planned (mainly for liquid waste) in order to extend the operation of this storage.

Similarly to LILW, the spent fuel is stored at the locations of both reactors: spent fuel assemblies from the NPP are stored in the spent fuel pool of the NPP at Krško, while spent fuel elements from the research reactor are stored in a small pool at the TRIGA Reactor Centre. The capacity of the spent fuel pool in Krško is sufficient for the next 5–7 years. There are possibilities for increasing the pool capacity for several years and feasibility studies are under way. The pool capacity at the TRIGA Reactor Centre covers the needs of the research reactor. It is sufficient for storing all elements from the research reactor.

5. Radioactive waste management

No specific national strategy or policy for the storage and disposal or radioactive waste has been developed yet. At least two open questions should be resolved before a consistent radioactive waste management strategy can be prepared:

- the question of a referendum on the earlier closure of the NPP at Krško that has been raised again and
- agreement with the joint owner concerning radioactive waste and spent fuel storage and disposal.

A few years ago, in 1991, a national Agency for Radwaste Management was founded by the Slovenian Government with the assignment to provide conditions for final disposal of radioactive waste in Slovenia.

The agency is financed from the state budget and should provide all preliminary studies, research and development, safety and environmental impact assessment and finally construction and operation of the LILW repository. It should also prepare a strategy for long-term spent fuel management. All its activities should be oriented towards the protection of human health and safety and should ensure that the quality of the environment would be maintained.

A similar agency with a similar assignment has been founded in Croatia as well. Although final agreement on ownership and other relevant questions connected with the NPP Krško has not been achieved yet, both countries have already started the siting process to select a suitable site for LILW disposal.

5.1. Siting of the low and intermediate level waste repository

The siting process in Slovenia started in 1990. Mainly as a result of economic and technical reasons it was limited only to a surface type of repository (Jeran et al., 1992). The siting was based on guidelines, including 43 obligatory criteria, divided into exclusion, comparison and preferential groups. In the final stage of the siting process field investigations were foreseen as well. Unfortunately the siting process was suspended in 1993 before its final phase owing to strong public opposition. All activities connected with this siting were stopped.

After this unpleasant experience the Agency for Radwaste Management is very carefully preparing to restart the siting process on the basis of new criteria that are being prepared. It is planned that this siting process will include both surface and underground repositories. Since public acceptance is the crucial moment in the whole siting procedure, it is planned that the process will be supported by a strong public information and educational campaign from the very beginning.

5.2. Spent fuel

The spent fuel management programme is under preparation. It is expected to be adopted by the government in the next few months.

In this programme a deferred decision is proposed for the spent fuel from the NPP at Krško. Short-term solutions for storing the spent fuel are also included. As a first step the extension of the existing capacity of the spent fuel pool in Krško is proposed and as a second step interim dry storage in casks.

If the NPP at Krško is to operate until the end of its lifetime the final decision on the disposal solution can be deferred until 2020. This gives enough time for different options including the possibility of reprocessing of spent fuel to be reconsidered. Meanwhile Slovenia will carefully follow the development of spent fuel management on an international level and the idea of regional repositories for high level waste that seems so attractive to countries with small nuclear programmes.

6. What can Slovenia learn or benefit from international community?

If the present status of the nuclear programme and radioactive waste management in Slovenia is compared with other European countries, it can be seen, that there are some similarities but there are also significant differences. Where can foreign experience be beneficial?

In preparing the strategy for radioactive waste management and disposal Slovenia certainly is taking countries with well-developed radioactive waste management systems as a model. However, because of some specific features in our nuclear programme (only one nuclear power plant, joint owners, small amounts of radioactive waste and spent fuel) it is not reasonable to expect that solutions and approaches from other European countries can be directly transplanted to our conditions. They can be useful, but our own situation should be taken into account in the first place.

In connection with possible applications of foreign experience different areas and aspects of radioactive waste management can be divided into three groups.

(1) Activities and areas where solutions should primarily be fitted to national objectives and needs. To this group the development of a system for radioactive waste management, structure of responsibilities and competent authorities and a system of financing these institutions and bodies can be allocated. Other examples and models can be useful, but each country should develop its own system in accordance with its legal framework, objectives and requirements and, of course, possibilities.

(2) Activities and areas where experience and models from other countries can be applied after some modifications. A large number of activities can be listed in this group such as design concepts and technical solutions for disposal of waste, acceptance criteria, siting, safety and environmental assessment, monitoring and surveillance, quality assurance, training and education of personnel, radiation protection. Public relations should also be mentioned. This is certainly a field where we have to learn as much and as rapidly as possible. To a certain extent the development and setting of a legal framework for nuclear activities can be ranked into this group as well. Efforts to adjust and harmonize our legal framework and practice in this field to European practice and IAEA recommendations have been especially strong since our independence. After proclaiming autonomy and independence Slovenia temporarily adopted all the laws of the former Yugoslavia that are not incompatible with the Slovene legal system. They will remain in force in the Republic of Slovenia until the appropriate legislation is adopted by its parliament. Several new acts are being prepared now and some drafts are already close to completion. It should also be mentioned that our constitution requires that national laws and other regulations shall be in accordance with generally accepted principles of international treaties by which Slovenia is bound.

(3) Activities and areas where we strongly depend on foreign experience and development. This group consists of activities related to research and development. In this field Slovenia almost entirely depends on the results of research and develop-

ment performed by other, more developed, countries. The projects and experiments necessary for new achievements and results in this field are beyond the ability of our country.

It has to be mentioned that the international community is relatively open for cooperation and exchange of information and experience. Several programmes and funds have been established in the last few years to help and assist countries such as Slovenia and some results can already be seen. We hope that such practice will continue and even strengthen in the future.

7. Conclusions

For countries generating low volumes of radioactive wastes the strategy for storage and disposal of these wastes may differ from strategies of those countries with large nuclear programmes. Although in principle each strategy should develop a management system that provides protection of human health and safety and maintains the quality of the environment, it also depends on national objectives and needs. For its implementation financial and manpower resources of individual country are also extremely important. Usually such countries cannot afford their own research and development, and therefore they strongly depend on the results and solutions applied in more developed countries.

The international community has been shown to be relatively open for the exchange of information and experience in this field and it is hoped that such practice will continue in the future.

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