RADIOACTIVE WASTE MANAGEMENT PROGRAM ACTIVITIES IN CROATIA

Renata Matanić
Hrvatska elektroprivreda (HEP)
10000 Zagreb, Ulica grada Vukovara 37, Croatia

Abstract

The concept of radioactive waste management in Croatia comprises three major areas: management of low and intermediate level radioactive waste (LILRW), spent fuel management and decommissioning. All the work regarding radioactive waste management program is coordinated by Hazardous Waste Management Agency (APO) and Croatian Power Utility (HEP) in cooperation with other relevant institutions. Since the majority of work has been done in developing low and intermediate level radioactive waste management program, the paper will focus on this part of radioactive waste management, mainly on issues of site selection and characterization, repository design, safety assessment and public acceptance. A short description of national radioactive waste management infrastructure will also be presented.

1. INTRODUCTION

Without any nuclear power plant in its territory nor any other nuclear fuel cycle facility, Croatia definitely can not be described as a typical nuclear country. But, as once part of the same country, Croatia financed the construction of the Krško nuclear power plant (NPP) in neighboring Slovenia, thus becoming a joint owner of the plant which has been operating under a special agreement between the two states ever since. Co-ownership of a nuclear power plant and its own radioactive waste give Croatia an obligation of establishing radioactive waste management program. Whether or not this program becomes effective and in what extent will probably depend on future agreements with Slovenia, but still the radioactive waste stored at interim storage facilities in Croatia should somehow be dealt with.

Croatia has been working on the low and intermediate level radioactive waste repository project for more than a decade now, preparing preliminary proceedings and background materials required for repository construction. First steps have been taken in all the main fields of activity, from siting procedure and repository design to the very important issue of public acceptance.

2. LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTE DISPOSAL PROJECT

2.1. Radioactive waste – sources, quantities and types

It is assumed that the majority of low and intermediate level radioactive waste to be disposed in future repository will consist of waste from the Krško NPP. The quantities of waste generated during the plant's lifetime together with the waste from decommissioning and dismantling process are estimated to be about 18.000 m^3. At the present moment, waste from

normal operation of the plant is being processed and stored in temporary storage on site. By the end of 1999 there were approx. 2090 m^3 of stored waste with total activity of $2{,}655\times10^{13}$ Bq, containing drums with evaporator bottoms, spent resins, supercompacted waste, compatible waste, spent filters and other wastes. Figure 1 shows low level solid radioactive waste production in Krško NPP. The trend of reducing the volume of low level waste production started with the completion of supercompacting campaign in 1995 and continued as new waste processing procedures were implemented.

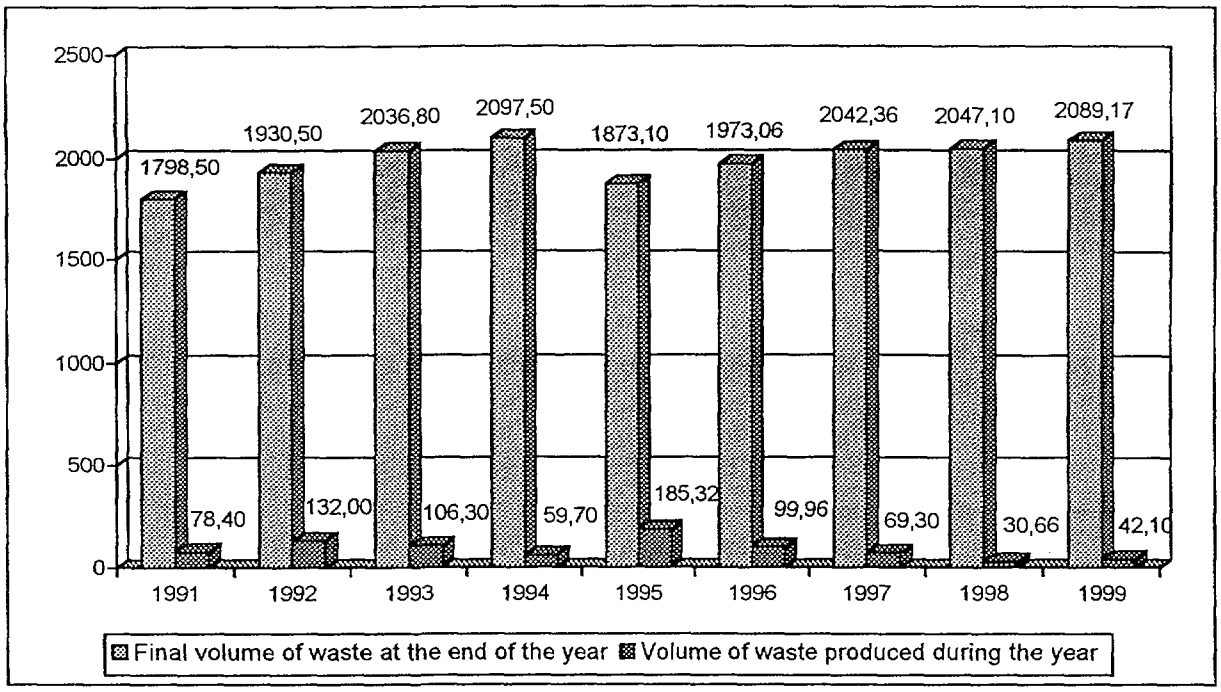

FIG. 1. Volume of low level solid radioactive waste (m^3) produced in Krško NPP

All activities concerning low and intermediate level waste from the Krško NPP are carried out at the NPP site. All the processes and procedures are within the scope of responsibility of the NPP and of Slovenian governmental bodies.

Radioactive waste in Croatia is generated in various nuclear applications, mainly in medicine, industry and research activities. The total amount of that waste is about 80 m^3 with annual growth rate not exceeding 6 m^3. Gross activity measures 2.3×10^{12} Bq. The waste consists of radionuclides ^{152,154}Eu from lightning rods, ^{241}Am from smoke detectors, ^{192}Ir, ^{90}Sr and ^{85}Kr from measurement and processing in industry, and ^{137}Cs, ^{60}Co and ^{226}Ra from medical applications. There are 31 users of open radiation sources in medical institutions producing liquid waste, in which only ^{3}H and ^{14}C cause disposal problems.

There are some 500 institutions authorized to handle radiation sources in Croatia. The main requirements for handling, storage and waste management responsibilities have been defined by regulations regarding protection from radiation exposure and handling of radioactive materials and supervised by the Ministry of Health, Sanitary Inspectorate Section. Presently, there are three ways of covering the waste storage process. Short lived waste is stored at the place of origin until its activity falls to background level after which it is considered nonradioactive waste. Spent radiation sources are returned to the producer or, as other long lived waste, transferred and stored at one of two temporary storage facilities located at two national research institutes in Zagreb.

2.2. Site selection and characterization

Actual radioactive waste repository siting process began in 1988 with the task to (a) establish methodological concept of the siting procedure, (b) define site selection criteria, (c) perform a survey of the entire territory and (d) identify a few candidate sites. Methodology and site selection criteria have been prepared by a group of experts and confirmed by IAEA Waste Management Advisory Programme experts, then verified by the Croatian Government, passed through the necessary parliamentary procedure and presented to the public in 1992. Site selection criteria involved 10 exclusionary and 28 comparative criteria. Exclusionary criteria referred to hydrology (risk of flooding), seismotectonics (earthquake capability), neotectonics (distance to active faults), litology and geomorphology (type of rocks, slope dynamics), hydrogeology (circulation of groundwater), demography (population density), mining and ore exploitation, nature preservation, cultural heritage protection and special use. Comparative (weighted) criteria were classified into six subject groups - radioactive waste transport, meteorology and hydrology, geology and seismology, demography, land use and environmental protection issues.

As a result of an exclusionary survey of the territory, seven potential regions meeting the selection criteria were selected. Each of these regions was screened applying the comparative criteria and 34 potential sites were identified. Further comparison of the sites promoted 4 potential sites into preferred locations shown on Fig. 2.

FIG. 2. Preferred sites selected for final LILRW repository in 1997

Two preferred sites were abandoned due to political and public pressure in 1997, while the remaining sites were left awaiting for governmental approval prior to actual

characterization. During 1999, Trgovska gora, one of the proposed sites for future low and intermediate level radioactive waste repository, has been approved by Croatian Parliament and included into the new Physical Plan of the Republic of Croatia. Table I shows siting process and planned activities in a chronological order.

TABLE I. MAIN EVENTS DURING SITE SELECTION PROCESS

year	event
1988-91	SITE SELECTION METHODOLOGY AND SCREENING CRITERIA DEFINED/APPROVED (CROATIA 56.538 km^2)
1993	7 POTENTIAL REGIONS (100-600 km^2) SELECTED
1993-94	POTENTIAL REGION SCREENING PROCESS FINISHED
1994	34 POTENTIAL SITES (2-20 km^2) CHOSEN
1995-96	SELECTED SITES COMPARISON
1997	4 PREFERRED SITES (2-10 km^2) SELECTED FOR SITE CHARACTERIZATION
	2 SITES ABANDONED DUE TO POLITICAL AND PUBLIC PRESSURE
1998	REMAINING 2 SITES WAITING FOR GOVERNMENT APPROVAL PRIOR TO ACTUAL CHARACTERIZATION
1999	TRGOVSKA GORA APPROVED
2000	DETAILED SITE CHARACTERIZATION
2002	FINAL DISPOSAL SITE (15-20 ha) SELECTED
2023	CLOSURE OF KRŠKO NPP – ca. 18000 m^3 OF LILRW AND DECOMMISSION WASTE

Governmental approval of proposed candidate site marks the end of site selection process and the beginning of actual site characterization. Specific data collected from the preferred microlocations will be needed to (a) perform an environmental impact statement required to proceed with construction, (b) assist in the facility design and (c) support long-term safety assessment. In order to achieve these objectives site characterization plan has been divided in two successive phases: preliminary characterization of the selected zones and detailed characterization at the local scale of the finally selected site.

Preliminary characterization activities are estimated to cover an area of 20-30 km^2 with an approximate duration of 2 years and result in (a) final selection of one or more sites, (b) support for the preliminary safety assessment based primarily on a regional model of groundwater flow and (c) support of the repository design and the feasibility of its construction. Detailed characterization, covering an area of 5-7 km^2 with an approximate duration of 3 years is expected to result in (a) support for the repository post-operational safety assessment studies, based on a local transport model for radionuclides dissolved in the groundwater, (b) support for final design of the repository and (c) verification of the seismotectonics, geomorphological and geotechnical characteristics supporting the feasibility of constructing the repository, at site scale.

2.3. Facility design

Regarding the characteristics of selected sites and radioactive waste (activities, quantities, forms), two options are being considered for final repository design. One of them is near surface engineered burial (similar to El Cabril, Spain) and the other subsurface disposal in horizontal tunnel structures. Conceptual and/or preliminary designs for both repository types have been prepared, waiting to be evaluated for the Trgovska gora sites.

All the requirements, criteria and recommendations of the IAEA for the facility designs were respected along with the local regulations. The essential requests were the maximum public and repository staff safety, the minimum personnel exposure in all the radioactive waste handling procedures and design flexibility, namely modular approach.

The repository is conceived to be a complex process plant for receival, treatment and final disposal of radioactive waste, including all the main and auxiliary systems, facilities and areas providing for safe and independent operation of the repository. Therefore, it is planned that, in addition to the final disposal unit and main building for receival, treatment and intermediate storage, the repository site includes a number of auxiliary and safety facilities such as the reinforced concrete (RC) containers fabrication and storage plant, workshops, electrical building, infrastructural facilities - roads, water supply, sewerage system, fire protection building, offices etc. The auxiliary facilities are separated from the main building in which the waste is handled and the final disposal units are separated from other facilities.

The disposal principle consists of setting up a system of successive - natural and engineered - barriers preventing the migration of radionuclides from radioactive waste into the environment. The low level radioactive waste isolation degree depends upon a disposal system which consists of reinforced concrete containers, above-ground units for final disposal of containers (or horizontal tunnels, in subsurface repository) and geology of the surrounding area. The system of successive barriers includes three different cement-based materials used in radioactive waste preparation for the final disposal - material for the waste drum sealing and waste immobilization, concrete for filling the space between the drums and the RC container walls, and concrete for containers. These three sorts of material with entirely different composition and function constitute, together with the radioactive waste, a technological entity.

Although the designed projects prevent any release of radioactivity into the environment (system of successive barriers), special attention will be paid to the repository monitoring as well, along with the long-term monitoring after closure.

2.4. Safety assessment

The objective of conducting the safety assessment is to establish reasonable assurance that radioactive waste can be safely disposed of in Croatia, meaning that the regulatory requirements can be met. It is quite possible to assign such a general purpose to the preliminary safety assessment, due to the circumstances that not a single key feature of the disposal facility (including location and waste content) has yet been definitely determined. Bearing that facts on mind, safety assessment is being conceived as an iterative process improving as more specific data become available.

A preliminary safety assessment study has been made on the basis of preliminary project designs and generic disposal site parameters. Analysis of the different case scenarios using conservative assumptions where specific data not available showed that the risk levels from

some radionuclides that might have a significant impact on human health (^{3}H, ^{137}Cs, ^{90}Sr, ^{60}Co, ^{129}I, ^{59}Ni being analyzed) were estimated between 10^{-4} and 10^{-6} per year. The relevant regulatory limits in actual Croatian legislation differ in terms and concepts, but the level of required safety and protection is essentially in agreement with the present IAEA recommendations. According to the IAEA for likely events at the repository in the post-closure period "projections of doses or risks to members of the public" should not exceed "an appropriate fraction of the dose limit, 1 mSv/y or its risk equivalent (5×10^{-5} per year – fatal cancer risk).

At the present stage, because of site-specific data being unavailable and framework for safety assessment not clearly defined (including defining the exposure scenario, treatment of uncertainties and inadvertent intruders), the analysis can only be preliminary in nature, therefore unable to give any defensible support to future performance of the proposed repositories.

Experience of other countries having an operating repository points out hydrogeology to be the most important site acceptability related issue that will have an extraordinary importance in subsequent performance of safety analysis. Since the groundwater flow is the only foreseeable mechanism for the transfer of radioactivity to the environment in the case of engineered barrier failure, collecting the hydrogeological data and constructing the hydrogeological model of the zone(s) have been included as the first priority in planned activities.

2.5. Public acceptance

Public acceptance of radioactive waste disposal, especially site selection process has been proven a sensitive issue. Even though a considerable effort has been put into the creation of a positive public climate in terms of acceptance and understanding of the problem, the result was removal of three potential disposal sites from further investigations and, at best, neutral opinion towards the remaining one. It seems that the general public can theoretically accept radioactive waste disposal activities as environmental protection related, but practically "not in my back yard" effect obviously prevails. This has mainly been derived from both lack of information and doubts about available given information. Therefore, continuous dialogue with the media, providing full, complete and honest information remains one of the main ways of reaching the general public.

Contacting the media helps in providing general information to the public, but in that way it is not always possible to go into much details. In order to give some detailed information a number of activities has been taken. Among them are:

- issuing publications, brochures and bulletins
- updating web pages on Internet
- recording video tapes for public information and education
- organizing conferences, round tables and lectures
- organizing tours for particular groups (experts, journalists) to facilities of interest in Croatia and abroad
- building trust with environmental groups
- establishing an Information (Visitor) Center

Communicating with the public in a form of an information center is not as such a new approach as it is not a common practice in Croatia. The project of establishing such a center is among the first of that kind currently under way. One of the main purposes of the project is to inform and/or educate the public about related radioactive waste issues in a way of creating, supporting or changing opinions of different target groups. Target groups can generally be divided into two basic groups of school children/students and adults resulting in different strategies of presenting the relevant information. Depending on a target group, the purpose is to identify the Center either as a professional, responsible, objective, scientific-based institution or, in a case of younger groups, a place with a modern, attractive and interesting approach. The project is in the phase of selecting an adequate location for the Center.

3. RADIOACTIVE WASTE MANAGEMENT LEGISLATION AND REGULATORY BODIES

Radioactive waste management strategy was drafted in 1992 and updated in 1994, but has not yet passed through the necessary Parliamentary procedure. Radioactive waste management is regulated by the 1984 Law on Protection from Ionizing Radiation and Special Safety Actions in Nuclear Energy Implementation. Seventeen regulations and codes of practice had been based on this law. Waste categories, activity limits, the definition of a repository as a nuclear facility, and other basic definitions and management requirements are set out in these regulations. Several other laws and regulations, e.g. the Law on Health Protection and the Law on the Transport of Dangerous Goods, are also relevant for radioactive waste management.

The national radioactive waste regulatory framework in Croatia is rather complicated. The Ministry of Health, Sanitary Inspectorate Section, is the competent national authority for radiation protection issues, including many aspects of radioactive waste management. The ministry is the responsible body for issuing all types of licenses and permits for use, handling, transport, export-import of radioactive materials and radioactive waste and of all similar activities. Nuclear Safety Department in the Ministry of Economy, is the competent national authority in the field of nuclear facility siting, construction, startup, operation and closure; this competence extends to matters related to planned LILRW repository. The former State Directorate for the Protection of Nature and Environment (the Ministry of Environmental Protection and Zoning as of 2000) is competent body for issues related to radioactive waste repository siting regarding potential environmental damage, environmental restoration actions, cleanup of contaminated sites, environmental impact studies, etc. The Ministry of Planning, Construction and Housing (transformed during 2000) as well as Ministry of Internal Affairs have responsibilities for specific radioactive waste management activities such as transport of radioactive waste, import-export, release of effluents and transport, and facility safety planning. Problems common to all the ministries are the lack of expert staff and very limited budgets for regulatory tasks.

4. FINAL REMARKS

Taking into account the political uncertainties and specific circumstances accompanying the radioactive waste management program, the actual work is progressing at a reasonable pace. Since the proposed repository sites must be approved by the Government (included into the Physical Plan) prior to any fieldwork activities, gathered results although preliminary in nature form a solid base for future works. It should be noted that a great help has been received through International Atomic Energy Agency (IAEA) as technical assistance for different phases of the repository project, including evaluation of siting criteria, public relations

strategy and preliminary project design evaluation. There are number of problems and tasks yet to be solved, naming only some:

- defining the legal system as transparently as possible, i.e. establishing a clear framework of duties and responsibilities for involved ministries and responsible bodies
- establishing the mechanism for financing the national radioactive waste program, since the program has been financially supported by the power utility alone
- encouraging and strengthening all kinds of public relations and education
- developing even better contacts with the international radioactive waste management community

REFERENCES:

[1] KUČAR-DRAGIČEVIĆ, S., SUBAŠIĆ, D., LOKNER, V., "National radwaste management infrastructure – An important factor in planning an L/ILW repository", Proceedings of an International Symposium on Experience in the Planning and Operation of Low Level Waste Disposal Facilities organized by the International Atomic Energy Agency and held in Vienna, 17-21 June 1996

[2] Nuclear Power Plant Krško Performance Indicators for the year 1998, prepared by Independent Safety Engineering Group – Krško, January 2000

[3] SCHALLER, A., "Site selection for LILRW repository in Croatia", special edition of "APO-News", October 1997 (in Croatian)

[4] SCHALLER, A., LOKNER, V., KUČAR-DRAGIČEVIĆ, S., SUBAŠIĆ, D., "Characterization Plan for L/ILW Repository Candidate Sites in Croatia", International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Conference Proceedings, Dubrovnik, Croatia, 1998

[5] KUČAR-DRAGIČEVIĆ, S., ŠKANATA, D., SCHALLER, A., "The tunnel concept of low and intermediate level radwaste repository and results of safety analysis", First Meeting of the Nuclear Society of Slovenia, Bovec, 11.-12.6.1992 (in Croatian)

[6] KUČAR-DRAGIČEVIĆ, S., ŽARKOVIĆ, V., SUBAŠIĆ, D., "Surface-type repository for low and intermediate level radioactive waste in the Republic of Croatia", 2nd Regional Meeting: Nuclear Energy in Central Europe, Portorož, Slovenia, 11.-14. September 1995

[7] LEVANAT, I., LOKNER, V., "Safety Assessment Context for Croatian Low and Intermediate Level Radioactive Waste Repository", International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Conference Proceedings, Dubrovnik, Croatia, 1998

[8] ŠKANATA, D., ŠINKA, D., MEDAKOVIĆ, S., "Risk assessment of radioactive waste disposal facilities", International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Conference Proceedings, Dubrovnik, Croatia, 1998

[9] ČERSKOV-KLIKA, M., STROHAL, P., SUBAŠIĆ, D., "The role of public informing on radioactive waste management", International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Conference Proceedings, Dubrovnik, Croatia, 1998

[10] ASTUDILLO, J., MAYOR, J.C., "Preliminary plan for the characterisation of zones in support of the safety assessment of a future L/ILW disposal facility in Croatia", April 1998