STEPS TOWARDS THE SAFE STORAGE AND DISPOSAL OF THE RADIOACTIVE WASTE IN LITHUANIA

P. Poskas, J. E. Adomaitis, R. Poskas
Lithuanian Energy Institute, Nuclear Engineering Laboratory
3 Breslaujos St., 44403 Kaunas-35, Lithuania

ABSTRACT

This paper describes the set of practical actions performed and planned that shall bring storage and disposal of radioactive waste in Lithuania in compliance with the radioactive waste management principles of IAEA and with the good practices in force in EU Member States.

There are two radioactive waste storage sites in Lithuania: one at the Ignalina NPP (INPP) site mainly for storage of radwaste from INPP operation, and other one at Maisiagala site where Radon type repository was built in 1963 for disposal of the institutional waste. A new interim storage facility is under construction at the INPP site, where cemented spent ion exchange resins and sediments will be stored awaiting disposal in a Near Surface Repository. In the frame of the pre-decommissioning support projects, a new Solid Waste Management and Storage Facility will be built in order to characterize, treat, condition and interim store the retrieved operational waste accumulated in the existing storage facilities as well as the future operational and decommissioning waste. The central institutional waste processing and buffer storage facility will be constructed at Maisiagala site.

Safety assessment of existing storage facilities at INPP and Maisiagala sites is an important tool contributing to the evaluation and demonstration of the overall safety of these facilities. Safety assessments also create the basis for the safety arguments presented to nuclear regulators, public and other interested parties in respect of the safety of existing facilities, the measures to upgrade existing facilities and development of new radioactive waste storage and disposal facilities.

The paper emphasizes the proposed concepts for a Licensed Landfill for very low-level waste, an engineered Near Surface Repository for short-lived low- and intermediate-level waste and their integration into existing Lithuania's infrastructure. These projects have to guarantee the fulfillment of both Western standards and Lithuanian regulations and licensing requirements. The paper reflects also the progress of the development of these repositories.

INTRODUCTION

There is only one nuclear power plant in Lithuania – Ignalina NPP. The INPP operates two similar units with design power rating of 1500 MW(e) and present power level of about 1250 MW(e) each. They were commissioned (first grid connection) in 1983 and 1987 respectively and provide approximately 70-80 per cent of the electricity produced in Lithuania. The original design lifetime was projected out to 2013-2017. The National Energy Strategy adopted 10 October 2002 by the Lithuanian Parliament establishes that the first unit of INPP will be shutdown before the year 2005, and second unit in 2009 if funding for decommissioning is available from European Union (EU) and other donors. Decommissioning of the INPP Unit 1 is to be planned and implemented in accordance with the Immediate Dismantling Strategy.

From the beginning of INPP operation all generated solid and solidified radwaste is collected and stored at the solid and bituminized radwaste storage facilities, respectively. After closure of Lithuanian institutional radwaste storage facility at Maisiagala site, all institutional waste from Lithuanian small producers are transported to INPP and stored in solid radwaste storage facility too.

Except for compaction of combustible low-level waste and cutting of long metallic pieces from reactor core and other high-active components, there are no conditioning processes for solid radioactive waste at INPP now. Solid waste is stored in four storage buildings in bulk. These storage buildings are above ground concrete structures and have a total storage capacity of 29,000 m^3 solid waste. This Soviet type storage facility is not acceptable for long-term storage according to modern-day Lithuanian and EU standards. Long-term safety analysis of these storage buildings was performed and the waste retrieval concept was suggested. The stored waste should be retrieved for characterization, classification and conditioning. Now this facility is under the licensing process as interim storage facility for a period of ten years. In the frame of the pre-decommissioning support projects, a new Solid Waste Management and Storage Facility will be built in order to characterize, treat, condition and interim store the retrieved operational waste accumulated in the existing storage facility as well as the future operational and decommissioning wastes of the same types. This facility will be in operation in 2007. Short-lived and long-lived waste including spent sealed sources will be stored in new interim storage facility. The INPP decommissioning process will generate large volumes of very low, low, intermediate and high-level radioactive waste. It is generally considered necessary to have a Licensed Landfill for very low level waste (VLLW) in operation in 2007 and a Near Surface Repository (NSR) for short-lived low- and intermediate-level waste (LILW) in operation in 2010. It was decided that interim storage facility should be built in stages (modular design) for storing operational short-lived waste. It will be the possibility for future extensions in order to provide storage of waste packages generated during decommissioning after 2010, if necessary. The new interim storage facility should be also capable of storing the unprocessed long-lived waste. Therefore new interim storage facility will be designed for 50 years operation.

A Licensed Landfill for VLLW will be build at INPP site. Now feasibility study, preparation of the licensing requirements and tendering documents are going on.

State Enterprise Radioactive Waste Management Agency (hereafter referred to as "RATA") has been founded in 2001 implementing the resolution of the Government. A conceptual design of a NSR for short-lived LILW has been prepared in 2002. RATA has initiated a project aiming at identification of at least two sites where a NSR could be established. Siting process has been started in 2003.

OVERVIEW OF RADWASTE STORAGE AT IGNALINA NPP

Classification of the solid radioactive waste

The radiological classification of solid radioactive waste (SRW) at INPP is based on surface dose rate (at a distance of 10 cm from the surface), specific activity and surface contamination. The radiological classification of SRW in force at INPP is given in Table I 1.

Table I Radiological Classification of Solid Radioactive Waste at Ignalina NPP

Waste Group	Surface dose rate*	Specific activity, Bq/kg		Surface contamination, particles/cm^2 min	
	mSv/h	β-activity	α-activity	β-activity	α-activity
Low Level Waste (LLW)					
1	1.0×10^{-4} – 0.3	7.4×10^{4} – 3.7×10^{6}	7.4×10^{3} – 3.7×10^{5}	5.0×10^{2} – 1.0×10^{4}	5.0 – 1.0×10^{3}
Intermediate Level Waste (ILW)					
2	0.3 – 10	3.7×10^{6} – 3.7×10^{9}	3.7×10^{5} – 3.7×10^{8}	1.0×10^{4} – 1.0×10^{7}	1.0×10^{3} – 1.0×10^{6}
High Level Waste (HLW)					
3	> 10	> 3.7×10^{9}	> 3.7×10^{8}	> 1.0×10^{7}	> 1.0×10^{6}

* Radiation at a distance of 10 cm from the surface of the waste

A new radiological classification for solid waste, issued by State Nuclear Safety Inspectorate (hereafter referred to as "VATESI") 2, is reproduced hereafter in Table II. SRW should be further classified according to the treatment method applied at INPP in the following categories: combustible, non-combustible, compactable, non-compactable and non-treatable waste.

Table II New Radiological Classification of Solid Radioactive Waste

Waste Group	Definition	Surface dose rate	Conditioning	Disposal method
0	Exempt waste (EW)		Not required	Management and disposal as per requirements set in 2
Short-lived low and intermediate level waste*				
A	Very low level waste (VLLW)	≤0.5 mSv/h	Not required	Very low level waste repository (Landfill Facility)
B	Low level waste (LLW-SL)	0.5-2 mSv/h	Required	Near surface repository
C	Intermediate level waste (ILW-SL)	>2 mSv/h	Required	Near surface repository
Long-lived low and intermediate level waste**				
D	Low level waste (LLW-LL)	≤10 mSv/h	Required	Near surface repository (cavities at intermediate depth)
E	Intermediate level waste (ILW-LL)	>10 mSv/h	Required	Deep geological repository
Spent sealed sources				
F	(SSS)		Required	Near surface or deep geological repository***

* Containing beta and/or gamma emitting radionuclides with half-lives less than 30 years, including Cs^{137}, and/or long lived alpha emitting radionuclides with measured and/or calculated, by using approved methods,

activity concentration less than 4000 Bq/g in individual waste packages on condition that an overall average activity concentration of long lived alpha emitting radionuclides is less than 400 Bq/g per waste package.

** Containing beta and/or gamma emitting radionuclides with half-lives more than 30 years, not including Cs^{137}, and/or long lived alpha emitting radionuclides with measured and/or calculated, by using approved methods, activity concentration more than 4000 Bq/g in individual waste packages on condition that an overall average activity concentration of long lived alpha emitting radionuclides exceeds 400 Bq/g per waste package.

*** Depending on acceptance criteria applied to sealed sources.

It should be mentioned that, in this paper, reference is often made to the old solid waste classification. Indeed the operational wastes have been accumulated and are still being accumulated in existing storage facilities on the basis of this old classification. To comply with the new classification, the nuclide composition must be considered and must comply with the radiological Waste Acceptance Criteria (WAC) set forth for the different final disposal possibilities. Really the new solid radwaste classification system will be implemented with installation of new radwaste treatment facilities.

Solid and solidified radwaste storage facilities

The INPP solid radwaste storage facility consists of four buildings, namely building No. 155, No. 155/1, No. 157 and No. 157/1. This facility is Soviet type facility designed for the interim storage of low and intermediate level radioactive waste arising as a consequence of operation of NPP. Since September 1990 institutional waste from Lithuanian small producers is stored in this facility too 1.

The buildings of the INPP solid radwaste storage facility are reinforced concrete structures above ground. The building No. 155 was constructed in 1982–1983. The building has served as interim storage of combustible group 1 waste. The building was filled with a raw waste (in bulk) and closed in the middle of 1990. An additional water-protection layer of asphalt on top of the building's metal roof was constructed in the same year. The building No. 155/1 was constructed at the beginning of 1990. The first two sections were filled up with a raw combustible group 1 waste and closed by the end of 1990. The third, and last section was used for compacted waste (bales). Now these buildings are closed up and no waste loading is performed.
The building No. 157 was constructed in 1983–1984 and serves as interim storage for group 1 and group 2 wastes of categories combustible/incombustible and group 3 waste. In the period from 1987 to 1990 all sections adapted for group 1 and group 2 wastes had been filled up with a raw waste and closed. This building has additional radiation protection shielding from concrete elements along the outer walls of sections 1 and 4 and on the roof of the same sections now. The reason for construction of additional shielding in 1990–1997 was that activity of group 3 waste loaded into building No. 157 at the beginning of INPP operation appeared to be higher than predicted. This lead to increase of radiation fields along group 3 waste sections above permissible levels. At present only incombustible group 3 waste is being loaded into the sections 1 and 4. The building No. 157/1 was constructed in 1989 as an extension of building No. 157. At present it is the operating facility for storage of the combustible and incombustible raw group 1 and group 2 wastes. Compacted bales and sealed sources are stored in this building also and separately from raw waste 3.

The solidified waste storage facility, building No. 158, is designed for the interim storage of bituminized radwaste arising as a product of radioactive liquid waste treatment at INPP. The bituminized radioactive waste (bitumen compound) is produced by two bitumen units at the liquid waste treatment facility (building No. 150) and transported to the storage facility by specially designed pipelines. The facility is a two-storey building with supporting walls and biological shielding from concrete blocks. The foundation is from monolithic reinforced concrete slabs. The first floor contains 11 canyons with an effective volume of 2000 m^3 each. One canyon has an effective volume of 800 m^3. The second floor contains a servicing hall, pipe-shaped communication channels with pipelines and instrumentation rooms.

Safety assessment and licensing

The VATESI has issued the license for operation of the INPP Unit 1 but has specified in the licensing conditions that the detailed safety analysis must be performed for existing solid and bituminized radwaste storage facilities. At present all INPP radwaste storage facilities (except spent fuel storage facility) are not licensed for long-term storage.

In 1998 Swedish company SKB with participation of the Lithuanian Energy Institute and other organizations has performed the long-term safety assessment (for hundreds of the years) of the existing solid radwaste storage buildings. The analysis lead to the conclusion that the buildings are neither acceptable for final disposal nor there is any reasonably available engineering solution to convert them into final disposal. It was recommended that the waste already stored in these buildings should be retrieved and packaged according to internationally accepted methods. So, it was decided to license this facility first of all as storage facility because the retrieval of the waste is foreseen after 2007 3.

To meet INPP licensing requirements the project has been initiated with the aim to prepare safety analysis reports (SARs) for authorization of the storage of solid and solidified radwaste in existing facilities for ten years. The SARs project has been completed by SKB (Sweden). ES-Konsult, Lithuanian Energy Institute and SWECO have been subcontractors to SKB.
A systematic survey of risks in the facilities to identify various disturbances was made by studies of international documents and following the flow of wastes and personnel in the facility, also by considering functions in the facilities with a potential of risks. The inventory of disturbances is divided in categories: external natural, external man-induced, internal man-induced and equipment or component failure.

The initiating event lists have been completed by using NUREG 1407 and GAN Guidelines for the In-Depth Safety Assessment of Operational NPP Units with WWER and RBMK Type Reactors. These lists are a starting point for screening out negligible initiating events with regard to their potential for damaging the storage facilities. IAEA Safety Series 118 is also considered for completeness.

An extensive work has been performed to find all data needed for SARs project. It was appeared that the some of most important data are not available (i.e. structural design calculations), are incomplete or have a rather high degree of uncertainty (i.e. inventory data). Lack of information on design has resulted necessity for additional structural analysis. Uncertainties in activity inventory, presence of waste management activity, lack of data on waste and constructional material characteristics resulted uncertainties in shielding analysis. These issues have complicated performance of safety assessments.

Number of recommendations has been provided to improve safety of the solid and bituminized waste storage facilities. General conclusions of the SARs were that after implementation of all recommendations existing facilities could be used as interim storages for already accumulated and future operational waste for a period of ten years. Ignalina NPP approved the plan for implementation of these recommendations, and at the moment most of them are already implemented.

The SARs were delivered to VATESI for licensing to operate the radwaste storage facilities for a ten years period. VATESI in its turn asked International Atomic Energy Agency (IAEA) for assistance to organize an independent review of the SARs. IAEA formed a team with members from Germany, UK and IAEA. In the review by IAEA a number of issues to be clarified were identified. The final report on supplements to the SARs has been prepared and delivered to VATESI. It is expected that licenses for the operation of solid and solidified waste storage facilities will be issued soon.

OVERVIEW OF INSTITUTIONAL RADWASTE STORAGE IN LITHUANIA

Inventory of sources

Now small producers in Lithuania are generating only a few m^3 of radioactive waste per year. The principal users of sources in non-power applications in Lithuania can be split up into a few categories, namely: industry, hospitals, education and research, and others.
Sealed sources constitute the largest part of the all sources used. The charge eliminators constitute the largest part (about 47%) of sealed sources (except those in smoke detectors). Dominating nuclides are Pu-239, H-3 and Cs-137. Calibration sources constitute the second biggest part of sealed sources (35%). Dominating nuclides are Cs-137, Sr-90+Y-90 and Co-60. The overall number of sealed sources, ranges of their activity and dominating nuclides are given in Table III 4.

Table III. Main Nuclides, Activity and Number of Sealed Sources (except those in smoke detectors) in Lithuania

Nuclide	Activity, Bq	Number
Pu-239	2.0E+01 - 1.8E+07	116
Pu-239	2.0E+08 - 4.3E+10	7,417
Sr-90+Y-90	1.0E+01 - 8.2E+05	677
Sr-90+Y-90	1.2E+06 - 1.3E+10	782
Cs-137	1.0E+01 - 3.7E+05	79
Cs-137	1.0E+06 - 5.3E+13	475
Co-60	2.3E+02 - 9.0E+06	122
Co-60	1.9E+07 - 5.3E+11	121
Co-60	1.7E+14 - 2.5E+14	8
Ir-192	4.0E+11 - 3.1E+12	53
Pm-147	5.5E+07 - 2.8E+09	54
Pu-Be	1.1E+10 - 2.5E+10	30
Eu-152	5.0E+03 - 1.3E+05	34
Other	3.0E+01 - 6.5E+11	336
Total		10,304

Existing repository at Maisiagala and safety assessment

The existing disposal facility for radioactive waste from research, medicine and industry at Maisiagala was built in the early 1960's according to a concept typical of those applied in the former Soviet Union at that time. Maisiagala facility received institutional waste from 1963 until 1988, when the facility was closed. The overall volume of the sub-surface vault is about 200 m^3. At the end of the disposal period the vault was filled to about 60% with waste. It was then filled up with concrete and sand, covered with concrete blocks coated with bitumen and asphalt and finally covered with a 1.5 to 2 m layer of sand 4.

SKB (Sweden) with participation of Lithuanian Energy Institute has performed assessment of the long-term safety of the existing facility. The evaluation of the present situation included detailed descriptions of the site conditions, the repository and the inventories of radioactivity as well as an assessment of the long-term safety, if no measures were undertaken (the "zero alternative"). Based on the evaluation, alternatives for improving the situation have been defined.

The radioactive waste consists of calibration instrument, chemical compounds, charge eliminators, high-activity gamma sources, smoke detectors, etc., the dominating nuclides being H-3, Co-60, Sr-90, Cs-137 and Pu-239. Mostly radioactive waste in Maisiagala is buried in a chaotic way without containers. During the burial, radioactive waste was constantly inter-layered with concrete. There are also two stainless steel containers about 0.01 m^3 each and three spent sealed sources with their biological shielding.

The existing structure was not specifically designed according to modern safety requirements to serve as a long-term disposal facility. Documentation of the materials used and of the work performed is insufficient to evaluate the facility. Furthermore, the current status of the structure is not known. Low activities of tritium above background have been detected in water samples close to the repository.

In the safety assessment of the "zero alternative" it is assumed that water from precipitation flows through the facility and reaches the groundwater. A reference well is used as the recipient. The dose calculations show that, if no measures are taken, doses to individuals of the public from ingestion of water from the reference well will exceed the Lithuanian dose limit by orders of magnitude during the first several hundred years. Doses result mainly from release of H-3 and Cs-137 activity.

It was concluded that "zero alternative" is not a safe disposal option. Two alternative concepts for providing a higher safety of long-term disposal of the already stored wastes were defined, a surface barrier concept and a retrieval concept. The surface barrier concept in the form of a multi-layer earth cover is based on international experience. This solution would require the construction of a concrete dome over the existing structure to provide the necessary load-bearing capacity for the multi-layer earth-cover seal to remain intact over hundreds of years.

The difficulty with the surface barrier concept is the high plutonium content of some stored waste, estimated to about $6\ 10^9$ Bq/m^3 or 3000 Bq/g. This value exceeds the Lithuanian limit for near surface disposal of 400 Bq/g by almost one order of magnitude. The poor knowledge of the kind and activity of the waste deposited during the first ten years of the repository's existence must also be seriously considered.

Based on SKB's experience from Paldiski in Estonia, it was proposed that the already stored waste would be retrieved. The retrieval option would require that a simple shelter building would be erected and supplied with electricity, water, ventilation and equipment. The dose obtained in the retrieval operation is estimated to 2 mmanSv. In contrast to the barrier concept, the retrieval concept would allow the waste to be characterized, documented and, after interim storage at INPP, disposed of according to Lithuanian requirements.

Since September 1990 institutional waste is transported to the radioactive waste interim storage facility, located on-site and operated by the INPP. Over the years, until October 2000, the disused radioactive sealed sources were dumped, together with other wastes, into various storage areas of Buildings 155/1, 157 and 157/1 and they can be found in some compartments with all groups of waste. Low-intensity sources can be found packed in different kind of non-shielded packages mixed with other waste. Packing types include boxes (metal, wood, plastic, cardboard), drums, containers or plastic bags, etc. High-intensity sources are packaged into individual shielded containers or several sources have been packaged into one shielded container. These shielded containers can also be found mixed with other waste. In storages with Group 3 waste also unpacked sources can be found.

Beginning October 2000, the disused sources have been stored separately from other waste in the compartment 18/3 in Building 157/1 reserved for this waste. All sources (>17,000 pieces), still in their own-shielded packages, are loaded into 4 shielded cylindrical stainless steel containers for storage, which are then placed in the storage compartment 5.

SOLID AND SOLIDIFIED RADWASTE STORAGE PLANS

Lithuanian Government approved the Strategy on Radioactive Waste Management 6 in 2002. It defines activities for management of solid and liquid radioactive waste, and spent nuclear fuel at Ignalina NPP as well as radioactive waste from small producers 7.

Objectives of the Lithuanian strategy on radioactive waste management are to:

- strive for implementation of proper radioactive waste management policy;
- develop the radioactive waste management infrastructure based on modern technologies;
- create the effective financing system for radioactive waste management;
- provide for the set of practical actions that shall bring management of radioactive waste in the Republic of Lithuania in compliance with the radioactive waste management principles of IAEA and with the good practices in force in EU Member States.

The tasks of this strategy are to:

- improve the legal basis for radioactive waste management;
- modernize a system of radioactive waste management at INPP and to implement the new radioactive waste classification system according to the Requirements 2;
- be ready for the management of radioactive waste which will result from the INPP decommissioning providing the plant with necessary radioactive waste management facilities;
- modernize the management infrastructure for radioactive waste generated by small producers.

Radioactive waste at Ignalina NPP

The radioactive wastes (spent nuclear fuel excluded) to be dealt with at INPP are operational or post-operational waste and further decommissioning waste:

- Liquid waste, i.e.:
  - Miscellaneous liquid wastes: equipment drains, floor drains, laundry drains, laboratory drains, spent cleaning and decontamination solutions, etc;
  - Spent ion exchange resins and perlite (filters aid) mixtures;
  - Sludge and sediments;
  - Evaporators concentrates;
  - Oils and organic liquids.
- Solid waste, of the combustible or non-combustible type, i.e.:
  - Already accumulated waste in Buildings 155, 155/1, 157 and 157/1 (operational waste and waste received from external small producers);
  - Future operational and decommissioning waste.

The liquid waste is driven off and concentrated in an evaporation unit. The evaporator concentrate is fed to one of two bituminization units. The bitumen compound, having a salt concentration of about 40%, is thereafter transported as a bulk mass in a piping system to the bituminized waste storage facility. Now this facility is under the licensing process as storage facility for a period of ten years. Lithuanian Strategy on Radioactive Waste Management indicates that investigations shall be performed and it shall be decided whether the bituminized radwaste storage facility can be converted into a repository or not. Depending on the decision, the bituminized radwaste storage facility shall be licensed as a repository or the bituminization technology shall be transformed in such a way that waste forms are enclosed into suitable containers as required for storage, transport and disposal in the near surface repository.

Erection of a cementation facility of spent ion exchange resins, perlite mixtures and sediments as well as a new interim storage facility is now in progress. This cementation facility is expected to be operational in 2004. The liquid waste will be mixed with binding agent in an optimum ratio by a continuous operating cementation unit and directly filled into 200 l drums. After capping the drums will be loaded into a storage container (8 drums per container) or, if necessary, this container will be put into a shielding container. The throughput capacity of the cementation unit will be 450 m^3/year. The waste package interim storage facility for storage time of 60 years is designed for a capacity of minimum 10 years of cementation plant operation.

In the frame of the pre-decommissioning support projects, a new Solid Waste Management and Storage Facility (SWMSF) will be built under the Grant Agreement between the EBRD as administrator of a grant fund provided by the Ignalina International Decommissioning Support Funds and Lithuanian Government. Tendering process has been started in 2003. The SWMSF will be built in order to characterize, treat, condition and interim store the retrieved operational waste accumulated on the site as well as the future operational and decommissioning wastes of the same types. The SWMSF will comprise, among others, the capabilities for size reduction, super compaction, incineration, packaging, immobilization and interim storage.

Most of the decommissioning wastes (with the exception of the in-core highly activated components) exhibit the same physical-chemical-radiological characteristics as those of the operational waste. Following treatment/ conditioning/ packaging strategy is being considered for operational and decommissioning radwaste:

Class A waste i.e., Very Low Level Waste (VLLW) will include solid radioactive waste (SRW) that are allowed for Landfill disposal, provided that the radionuclides content comply with corresponding acceptance criteria. When possible (combustible type or PVC), they will be compacted by the existing bale press and wrapped in plastic bags. Should they be not acceptable for compaction, they could be disposed of in ISO half-height or another type containers. Class A waste, not allowed for Landfill disposal, will be managed as Class B waste.

Class B and C waste i.e., Low and Intermediate Level Waste – Short-Lived (LILW-SL) will include SRW in bulk, SRW in drums, pellets from super-compaction and incinerator containing compacted SRW and incinerator ashes. The waste material will be immobilized, will not contain free liquids, and voidage in the waste will be minimized by different volume reduction measures.

Class D and E waste i.e., Low and Intermediate Level Waste – Long-Lived (LILW-LL) will mainly consist of graphite and metallic SRW originating in the reactor core. Graphite will consist of shattered graphite sleeves originating from spent fuel channels and Control Protection System channels, of graphite bricks and sleeves resulting from the decommissioning. Metallic SRW will include zircaloy and various stainless steel alloys.

Class F waste i.e., Spent Sealed Sources will include various types of radioactive materials that are permanently sealed in a capsule or closely bounded and in a solid form. High-activity sources are typically packaged into shielded containers.

In the absence of WAC, it has been decided to package the long-lived waste of classes D, E and F without immobilization and to provide for a radiological characterization. The waste packages will be interim stored on the site and the package(s) to be used should be of a long lasting type, up to at least 50 years.

Interim storage facility will be built in stages (modular design) for storing conditioned operational short-lived waste (of classes A, B and C) and also shall be capable of storing the unprocessed long-lived waste (of classes D, E and F). It will be also possibility for future extensions in order to provide storage of waste packages generated during decommissioning after 2010, if necessary. The spent sealed sources and graphite waste independent of their radioactivity will be stored under the same conditions (unprocessed) as other long-lived waste. The design lifetime for this interim storage facility for short and long-lived waste will be 50 years.

Radioactive waste generated by small producers

The supervision of the existing "Radon" type institutional radwaste disposal facility near Maisiagala was entrusted to the RATA in 2002. RATA has applied for a PHARE project aiming for safety assessment and upgrading of Maisiagala repository. It is foreseen to prepare the specification of physical protection system, collect the data needed for safety analysis (summarize the waste inventory, make necessary ground drillings for sampling etc.). The project shall include the preparation of Safety Analysis Report, conceptual and detail design of the facility upgrading, and documentation for works, supply tenders and repository licensing.

It is necessary to note that remaining storage capacity at INPP facility is limited and will be fully loaded with INPP waste and newly generated institutional waste. Now the only reasonable solution would be upgrading of the Maisiagala disposal facility. Later on when the new storage facilities are built at INPP site retrieval option for Maisiagala repository could be discussed again.

RATA has decided to continue using INPP for interim storage of the institutional radioactive waste. Radioactive waste generated by small producers and failed enterprises, the waste without owner and the illegitimate radioactive waste shall be collected, treated and temporary stored at INPP storage facility until a new near surface repository is constructed. However, facilities for the processing of the waste and buffer storage before submittal to INPP are required. The present facilities at the Institute of Physics are inadequate and the current license expires in 2004 and is not likely to be renewed. Results of the Feasibility Study performed by SKB International Consultants (Sweden) with participation of Lithuanian Energy Institute are described in 4. This study has identified the process applied and equipment needed for a new central institutional waste processing and buffer storage facility. Preliminary safety assessment of proposed facility has been also performed.

The main purpose of processing institutional radwaste is to produce packaged waste that fulfils the requirements for handling, transport and storage. The generic acceptance requirements for disposal in a near surface repository of waste packages should also be fulfilled. Reference design of a new central institutional waste processing facility has been made based on the functional description of a facility needed for collection, processing and buffer storage of all Lithuania's institutional radwaste.

The area of the two-storey building is foreseen to be of around 400 m^2 with premises of around 1000 m^2. The facility will comprise area for processing of waste, personnel area, offices, buffer storage, auxiliary systems and communications. A small hot cell is also foreseen. The hot cell will be equipped with manipulators, operated from a radiation-shielded area outside the cell. A small concrete/cement mixing station for grouting of the waste inside the container if required after the nuclide scanning is foreseen. A buffer storage for disposal containers is also foreseen.

RATA has applied to the IAEA for support within its Technical Co-operation program for a project aiming for upgrading of institutional radwaste processing facility. This project proposal includes expert advice, equipment and training. Furthermore, RATA has applied for a PHARE project to establish the central institutional waste processing and buffer storage facility based on the Feasibility Study performed. Construction of the new facility at Maisiagala site will ensure the proper treatment and conditioning, and safe and secure buffer storage of the institutional radioactive waste.

PROJECTED DISPOSAL FACILITIES

Licensed Landfill

In most countries there is only one type of repository for short-lived waste – near surface repository. This often means, that the barrier system is given the isolating capacity required by the most demanding types of waste to be disposed of. As a consequence waste with only minor concentrations of radionuclides with short half-lives (< 30 years) are given an unjustified high level of protection, which means a spending of resources, which could be used in a more optimal way for other purposes. Therefore simple landfill repository has been foreseen in Lithuanian regulations 2.

It is generally considered necessary to have a Licensed Landfill for very low-level waste in operation in 2007 in order to avoid large and unnecessary costs for interim storage. A Licensed Landfill for very low-level waste will be build at INPP site in order to secure administrative control for at least the next 60 years. A project is being launched in order to develop a Licensed Landfill concept, associated WAC, licensing requirements and tendering documents. The following conditions valid for the Swedish landfill repositories can be used for guidance:

- The activity content of the waste to be disposed of must be known (In practice every waste package is measured with a gamma-spectrometer to determine the content of gamma-emitting radionuclides. The content of alpha- and beta- emitting radionuclides are estimated from an analysis of the reactor water).

- Only solid or solidified waste may be disposed of. Compressible waste shall be compacted prior to disposal to improve the characteristics of the waste packages.
- The concentration of radionuclides with a half-life longer than 5 years (Co^{60} included) shall not exceed 300 kBq/kg and the concentration of alpha emitting radionuclides shall not exceed 0.001 times the concentration of the gamma-emitting radionuclides.
- The total activity in the repository shall not exceed 100 GBq at any time.
- The surface dose rate of the waste packages to be disposed of shall not exceed 0.5 mSv/h.
- The waste shall be covered to prevent rain and surface water to penetrate into the disposed waste.

It is expected that the capacity of a Lithuania's Licensed Landfill will be 45,000 tons or 60,000 m^3. This means that the total activity of the Lithuania's landfill will exceed the total activity allowed in Sweden for this type repository by orders of magnitude. It is expected that in a Lithuania's landfill total activity inventory shall not exceed 10 TBq, total inventory of Cs-137 shall not exceed 1 TBq and total alpha activity inventory shall not exceed 10 GBq. Maximal Cs-137 activity concentration shall not exceed 40 Bq/g, maximal Co-60 activity concentration shall not exceed 300 Bq/g and maximal activity concentration shall not exceed 300 kBq/kg. Surface dose rate on packages shall not exceed 0.5 mSv/h and surface contamination shall not exceed 40 Bq/cm^2. The disposal costs are estimated to 200 - 240 EUR/m^3 (compare with disposal costs in a NSR, which are estimated to 2400 EUR/m^3).

Near Surface Repository

There is experience on disposal of short-lived LILW all over the world that meets internationally accepted safety standards and there is a general understanding that every country operating a nuclear power plant shall establish its own repository for LILW. As a result of the decision to close the two reactors at INPP before 2005 and in 2009, respectively, and to implement the immediate dismantling strategy the quantities of radioactive waste to be disposed of within the next 20-30 year period has increased significantly. This increases the need for the commissioning of a NSR as soon as possible. It is generally considered necessary to have a NSR for short-lived LILW in operation in 2010 in order to avoid large and unnecessary costs for interim storage.

The development of a NSR for short-lived LILW is included in the Radioactive Waste Management Strategy approved by the Government 7. Sweden has supported a project to develop a generic NSR concept that can be applied in Lithuania 8. Lithuanian authorities have approved the concept as a basis for the development of a NSR. This reference design shall be able to cover the expected needs in Lithuania for at least thirty years ahead.

The reference design for a NSR is based on the international state of the art in engineered near surface repository design. Basic principles of the Lithuania's NSR:

- Foundation should be on moraine (till), dense over-consolidated clay, or dense or densified sand;
- The basic design should be a cell-type construction founded on a low-permeable bed and surrounded by erosion-protected, low-permeable soil barriers;

- A ”hill”-type construction is preferable from the point of cost and since it will be saturated and percolated much less and much later than a repository located below the groundwater level;
- The engineered low-permeable clay material should be smectitic and of sedimentary origin or a clay moraine;
- No inspection galleries are proposed but the design principle allows for inclusion of such units in the cell system.

The reference repository is robust and is simple to design, construct, operate and close. The operation does not require sophisticated equipment. The design is modular and highly flexible as regards barrier design and overall geometry. The design can easily be adapted to various site conditions and the cell groups can easily be redesigned for different waste packages. The reference environment and the assumed site conditions are such that the siting of the repository is flexible. It is possible to establish, operate and close the repository with acceptable long-term safety characteristics on a variety of sites available in Lithuania. The preliminary safety assessment of the post-closure phase indicates that the passive systems and the barriers in the closed repository ensure long-term safety beyond the required 300 years.

VATESI with participation of RATA, Lithuanian Energy Institute and Swedish experts has established the generic Waste Acceptance Criteria (WAC) for disposal in a NSR 9). Development of WAC is in practice an iterative process concerning characterization of existing waste, repository development, safety and environmental impact assessment etc. The position in Lithuania with regard to the long-term management of LILW in the absence of finalized WAC and a NSR has been described in WM’03 Lithuanian Energy Institute’s paper 10.

RATA has initiated a project aiming at identification of at least two sites where a NSR could be established. Lithuanian Energy Institute with support of Sweden experts on behalf of RATA has established site selection criteria and identified desirable site features. Siting criteria are established on the basis of IAEA recommendations and a generic Lithuania’s NSR concept. Siting criteria are applicable to the territory of Lithuania, considering its geological, hydrogeological, geochemical, climatic and other environmental as well as social conditions.

It was decided to set up top-level site selection criteria, which were divided into four groups, namely, technical/safety criteria, environmental criteria, legal criteria and public acceptability criteria. Top-level technical/safety criteria are geotechnically stable site, small natural phenomenon impact on engineered barriers and transport risk level. Top-level legal criterion is to meet all applicable Lithuanian legal requirements and to conform to international agreements signed by Lithuania. Top-level public acceptability criterion is local, national and international acceptance.

Main criteria for geotechnical stability of a site (slope stability, erodability, settlement and liquefaction) have been set up. Safety factor $F_{\tan \varphi}$ for slope stability and shallow water flow critical speed v_{cr} for erodability have been established. Principal criterion for bottom bed is very low compressibility and main criterion for liquefaction is maximum earthquake magnitude. Main criteria on transport risk level are vicinity to major waste producer, Ignalina NPP, favorable infrastructure and logistics, and good isolation characteristics.

The siting process has been started in 2003. It is planned that the siting process will be systematic, predictable and transparent. In general it is desirable to determine the potential suitability or acceptability of a site as quickly as possible with use of minimum resources. Thus, those factors or criteria, which might result in the rejection of a site, have been identified early in the planning stage and investigated early in the area survey stage. The siting process will produce an acceptable site for the NSR facility, Safety Analysis Report, Environmental Impact Assessment and acceptance by decision makers and the public.

SUMMARY

Set of practical actions that shall bring storage and disposal of radioactive waste in Lithuania in compliance with the radioactive waste management principles of IAEA and with the good practices in force in EU Member States is described in the paper.

Safety analysis of the existing solid radwaste storage buildings at Ignalina NPP lead to the conclusion that the buildings are neither acceptable for final disposal nor there is any reasonably available engineering solution to convert them into final disposal. It was recommended that the waste already stored in these buildings should be retrieved and packaged according to internationally accepted methods. It was decided to license this facility as storage facility because the retrieval of the waste would start in 2008.

In the frame of the pre-decommissioning support projects, a new Solid Waste Management and Storage Facility (SWMSF) will be built by 2008. Tendering process has been started in 2003. The SWMSF will be built in order to characterize, treat, condition and interim store the retrieved operational waste accumulated on the site as well as the future operational and decommissioning wastes of the same types. The SWMSF will comprise, among others, the capabilities for size reduction, super compaction, incineration, packaging, immobilization and interim storage. In the absence of WAC, it has been decided to package the long-lived waste without immobilization.

Erection of a cementation facility of spent ion exchange resins and sediments as well as a new interim storage facility is now in progress. These facilities are expected to be operational in 2004.

RATA has applied for a PHARE project aiming for safety assessment and upgrading of Maisiagala repository. It is foreseen to prepare the specification of physical protection system, collect the data needed for safety analysis (summarize the waste inventory, make necessary ground drillings for sampling etc.). The project shall include the preparation of Safety Analysis Report, conceptual and detail design of the facility upgrading, and documentation for works, supply tenders and repository licensing.

RATA has decided to continue using INPP for interim storage of the institutional radioactive waste. However, facility for the processing of the waste and buffer storage before submittal to INPP is required. The central institutional waste processing and buffer storage facility based on the Feasibility Study performed will be constructed at Maisiagala site.

A Licensed Landfill for very low-level waste will be build at INPP site. A project is being launched in order to develop a Licensed Landfill concept, associated WAC, licensing requirements and tendering documents with intention to have this disposal facility in operation in 2007.

The reference design for a near surface repository for short-lived LILW has been performed and the siting process of the repository has started in 2003. It is intention to have a NSR in operation in 2010 in order to avoid large and unnecessary costs for interim storage.

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