WASTE MINIMIZATION POLICY AT THE ROMANIAN NUCLEAR POWER PLANT

V. Andrei, Nuclearelectrica National Company (SNN) and
I. Daian, Cernavoda Nuclear Power Plant (Romania)
33, Magheru Blvd., sector 1
Bucharest
Romania

ABSTRACT

The radioactive waste management system at Cernavoda Nuclear Power Plant (NPP) in Romania was designed to maintain acceptable levels of safety for workers and to protect human health and the environment from exposure to unacceptable levels of radiation. In accordance with terminology of the International Atomic Energy Agency (IAEA), this system consists of the "pretreatment" of solid and organic liquid radioactive waste, which may include part or all of the following activities: collection, handling, volume reduction (by an in-drum compactor, if appropriate), and storage. Gaseous and aqueous liquid wastes are managed according to the "dilute and discharge" strategy.

Taking into account the fact that treatment/conditioning and disposal technologies are still not established, waste minimization at the source is a priority environmental management objective, while waste minimization at the disposal stage is presently just a theoretical requirement for future adopted technologies.

The necessary operational and maintenance procedures are in place at Cernavoda to minimize the production and contamination of waste. Administrative and technical measures are established to minimize waste volumes. Thus, an annual environmental target of a maximum 30 m^3 of radioactive waste volume arising from operation and maintenance has been established. Within the first five years of operations at Cernavoda NPP, this target has been met. The successful implementation of the waste minimization policy has been accompanied by a cost reduction while the occupational doses for plant workers have been maintained at as low as reasonably practicable levels. This paper will describe key features of the waste management system along with the actual experience that has been realized with respect to minimizing the waste volumes at the Cernavoda NPP.

INTRODUCTION

Romania has only one nuclear power plant located at Cernavoda on the Danube River, about 70 Km from the Black Sea Coast. One of the five CANDU 6 – Canadian type reactors planned to be built in Cernavoda site is in commercial operation, with a gross capacity of 706 MWe, which has been in operation since December 2, 1996. The reactor supplies about 10% from the country's annual energy demand.

The CANDU system is designed so that the most radioactive materials produced during operation are contained within the systems that produce them. The small quantities of liquid and gaseous waste produced are characterised by the presence of tritium as tritiated water or water vapours and occasionally as tritiated organic compounds.

The radioactive waste management system in place at Cernavoda Nuclear Power Plant (NPP) was designed to reduce the risk level of radiation exposure for the technical personnel and to protect the public and prevent any contamination of the environment. This is one of the reasons why the waste minimization has to be considered a key part of waste management policies at the nuclear power plant. The current waste management system does not include any treatment (except a precompaction, if appropriate) conditioning, storage in conditioned forms or disposal. Therefore, the waste minimization means reduction to the extent possible and feasible of primary waste that are generated before any of the previous mentioned steps to be available and effective.

Waste minimization is practical more as preference action of the management of the plant than due to regulatory, economic or public acceptance constraints, since no specific regulations are in place and the public perception is one of favoring nuclear power.

WASTE MINIMIZATION AT CERNAVODA NPP

Steps to reduce the production, distribution and retention of fission and activated corrosion products and to minimise the total volume of waste generated at the CANDU plant were made by the designer (1) and include:

-minimization of the rate of fuel failure during operation (less than 0.1% due to fuel manufacturing technology, fuel handling);

-selection of material with low activant content (e.g., with low cobalt and antimony content);

-selection of the chemical regime of the reactor coolant to minimize corrosion products and their deposition and accumulation.

However, radioactive waste generation cannot be avoided and a quantity of waste is produced. The projected emissions for CANDU 6 reactors are:

	Projected Emission at End-of-Life for a CANDU 6 (2)	Projected Maximum Emission at End-of-Life for a CANDU 6 (2)
Gaseous effluents	242×10^{12} Bq/a	396×10^{12} Bq/a
Liquid effluents	135×10^{12} Bq/a	185×10^{12} Bq/a
Solid waste	42 m^3/a	

The objectives are to be below the projected emissions and in no normal case to override projected maximum emissions.

The current radioactive waste management system at Cernavoda NPP is based on the experience and current approach in all CANDU plants. The Cernavoda NPP is provided with facilities for proper management of gaseous, liquid and solid radioactive waste.

Because the CANDU reactor uses heavy water as moderator and coolant, which is a very expensive product, most of the D_2O that is spilled is recovered using a complex cleaning and upgrading system. Performance of repairs of leaks from pipes and equipment is done as quickly as possible, in order to reduce the potential for possible contamination, generation of waste and loses of heavy water.

The aqueous radioactive waste, originated from laundrey, decontamination and general cleaning activities, are collected in five tanks of 50 m^3 capacity each of them, decontaminated if necessary (using an ion exchange column and a filter) and released by dilution in the cooling water evacuation channel within the limits approved by the Regulatory Body.

The gaseous waste are collected by different ventilation systems, decontaminated if appropriate (using one or a combination of pre-filter, HEPA filter and charcoal filter) and released through the plant's exhaust stack within the limits approved by the Regulatory Body. The heavy water vapours, contaminated with tritium and other radionuclides, are collected and recovered using dedicated systems. This is another measure to limit exposure of personnel and gaseous emissions and minimize waste generation.

At Cernavoda plant we have implemented the system of upper limits for the release approved by the Regulatory Body, called Derived Emission Limits (DELs). The DEL (3) is derived from the regulatory equivalent dose limits by analytical models of all significant environmental pathways to an individual in the most heavily exposed group (the "critical group"). DELs are site-specific annual limits, which are set for each radionuclide.. In order to determine the total station release, the % DEL emissions for all nuclides and each effluent pathway are added up. The operating limits of a total of 5%DEL are established to control the annual releases that contribute significantly to the dose received by the member of the critical group.

The plant's objective is to minimize the emissions and to reduce, at a feasible extent the exposure of members of the public. For this reason an operating target of 1% DEL for released radioactivity was considered a good administrative practice. Effluents monitoring results (4) from the first four years of Cernavoda NPP operation (Table I) show that the released gaseous and liquid radioactive waste activities are kept well bellow the operational target of 1%DEL.

Table I. Annual releases in relation to DELsfor Cernavoda NPP

	1997	1998	1999	2000
Liquid emissions (%DEL)	6.18E-02	1.16E-01	3.25E-02	8.09E-02
Gaseous emissions (%DEL)	5.00E-01	4.42E-01	4.17E-01	6.41E-01

The solid radioactive wastes are clasified (5) in five categories: compactable, non-compactable, spent resins, spent filters and spent fuel. The bulk of the radioactive solid wastes are safely managed within the plant facilities. The compactable and non-compactable radioactive wastes are packaged in stainless steel drums and stored in the concrete building of the Solid Radioactive Waste Interim Storage Facility (SRWISF), located within the inner fence of the plant. The spent filters cartridges and large metallic items are stored in concrete holes of a special concrete structure belonging to the SRWISF. The design capacity of the SRWISF is for 18 years/reactor. The spent resins are stored in three concrete vaults located in the service building. Each storage vault has a capacity of about 200 m^3, together covering 15-20 years of the plant operation lifetime. The organic liquids and other types of radioactive waste packaged in stainless steel drums are stored in the service building basement. During the first years of operation the solid waste volumes were kept at relatively low levels (4) well bellow or closed to typical waste volumes generated by others CANDU plants (Table II).

Table II. Annual volumes of solid waste at Cernavoda NPP

Waste type	Typical volumes forCANDU 6 unit	Volumes from Cernavoda NPP Unit 1 (m^3)			
		1997	1998	1999	2000
Compactable	22 m^3	9.46	14.96	16.5	12.01
Non-compactable	9 m^3	1.98	1.32	4.84	3.96
Spent resins	7 m^3	10.07	5.86	5.76	8.42
Spent filters	3 m^3	0.42	0.00	0.01	0.26

Other types of separately collected waste include solids/liquids mixture textiles and papers soaked with organic compounds and organic liquids.

To control the solid waste arising an operational target of 30 m^3 per year was set up. During the first years of operation we did not face any problems in meeting the target. We expect that once the years pass, some efforts will be needed for a better planning and improved maintenance procedures that will result in keeping waste generation below the desired target. Currently, some technical measures are combined with administrative practices. Thus, the measure to provide stores for equipment, tools, etc. which are slightly contaminated but suitable for reuse is accompanied by a better training of the operators to ensure awareness in the field of radioactive waste generation and minimization. The operators receive that information while they attend annual refreshment courses on radiological protection.

The requirement for waste minimization practices is not strongly applied mostly due to the relatively low waste arisings but also because the solutions for waste disposal (including treatment and conditioning of waste) are not assessed in detail with regard to technical, safety and, not lastly, the economic aspects. One of the main issues is to avoid a conflict between minimization and safe working practices. Our experience shows that a good planning and good procedures allowed us to keep the occupational doses for operators at minimum levels. Any new practice should preserve this result for the radiological protection of workers.

WASTE MINIMIZATION POLICY AND PROJECTED PRACTICES

Waste minimization continues to be a priority of the plant management.

A new Romanian regulation, transposing the European Union Directive 96/29/Euratom on basic safety standards for radiological protection, offers a new perspective for waste minimization. It represents an important step for establishing exemption levels. The objective is that introducing monitoring and segregation practices to classify as much as possible of waste as exempt materials.

The unconditional clearance of solid materials is also considered. Thus, decontamination procedure are applied to reduce to minimum contamination on various pieces of equipment in order to be able to treat them as non-radioactive materials. These materials are stored separately.

In the absence of any specific regulation related to waste minimization our intention is to propose case by case procedures to Regulatory Body for approval of exemption or clearance levels for different types of radioactive waste. These may include information on clear waste source identification, engineering

judgement, waste measurements, identification of final destination of waste, etc. We expect an iterative process with Regulatory Body. Progress and new international standards in the field of exemption and clearance levels for different types of radioactive waste might be beneficial for our work.

Attention will be paid to the way in which materials are used along with their quantities. It has been noticed that some accidental work practices, if they are avoided, could result in some waste minimization. It is necessary to eliminate bad practices that could conduct result in oposite situation (i.e. an increase of waste volume): excessively packed equipment, presence of unnecessary objects during maintenance work execution, over estimation of solvents and paint quantities, etc. Procedures will be prepared to cover this aspect in the respect of waste minimization.

The introduction of new waste minimization practices will make the enhancement of personnel training more prominent. Operators will receive instructions on new waste minimization practices as a matter of course.

Waste minimization policies and practices are directly related to the identification of waste destinations and the applicability of the adopted technical solutions.

As per the IAEA Safety Series 111-F, the waste management system at Cernavoda NPP addresses the first step of the effective management "pretreatment". This includes, as presented previously, collection, precompaction (if appropriate) and a period of interim storage. The other steps, i.e., treatment, conditioning and disposal, are addressed in the long-term policy.

A long-term policy issue (5) is that the short-lived low and intermediate level wastes will be disposed of in a future surface repository. Treatment and/or conditioning technical solutions for processing the waste in order to get it in a waste form accepted either for long term storage or disposal are still under consideration. Thus, currently, the waste minimization at disposal is only a theoretical policy aspect. It is expected that the availability of the treatment process options and their applicability might induce development of new waste minimization practices at the plant. However, the plant's operation objective of establishing exempt levels is an objective for waste minimization for disposal, too.

CONCLUSIONS

The Romanian nuclear power plant, which operates one CANDU-6 Canadian type reactor has had relatively low radioactive waste arising after five years of operation.

Waste minimization at the source represents a priority environmental management objective and basically consists of establishing operational target limits for all types of generated radioactive waste well bellow regulatory limits. Waste minimization practices and administrative measures are also applied to avoid the increasing of the future waste arisings.

The technical solution for treatment, conditioning and disposal of waste are not yet fully established and waste minimization at disposal is only a theoretical aspect. However, projected practices for plant's operation such as the approval of exemption and clearance levels, demonstrate perspective view in waste minimization.

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