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RADIOACTIVE WASTE MANAGEMENT AT NUCLEAR POWER PLANT CERNAVODA

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Abstract.

Many human activities generate waste, but people are worried about wastes produced in nuclear power plants (NPPs). Their concern is an unjustified fear toward the hazards from radioactive waste, probably because in any country generating electric power by NPPs a lot of attention is paid to relevant parties involved in radioactive waste management. Significant attention is also given to the management of radioactive waste at the Cernavoda NPP. The general approach required for the collection, handling, conditioning and storage of radioactive wastes, while maintaining acceptable levels of safety for workers, members of the public and the environment, is conceptually established. The overall programme provides the necessary facilities to adequately manage solid radioactive waste from Cernavoda NPP Unit 1 and will be capable of expansion when other units are brought into service.

1. Introduction

The Cernavoda Nuclear Power Plant in Romania was designed for 5 Units of 700 MWe to be powered with CANDU 6 PHW reactors. The first Unit was commissioned in Cernavoda on 2 December 1996 and since then, it has been successfully operating becoming an important component of the energy sector. The radioactive waste management has the following major characteristics: plant operation at all times ensures that radioactive wastes are minimised, procedures are established to ensure that radiation doses to operating staff and members of the public are in accordance with ALARA and contamination from collection, transportation and storage of wastes is eliminated, all staff is trained and qualified to carry out their responsibilities.

2. Radioactive Waste Management

For CANDU pressurized heavy water design, the origin of the waste can be classified into the following groups:

(a) Fuel fission products: Cs-134, Cs-137, I-131, Sr-89, Sr-90, Ce-141, Ba-140
(b) System material activation products: Zn-65, Co-60, Fe-59, Cr-51, Zr-95, Nb-95, Mn-54, H-3, C-14
(c) System fluid activation products.

The radionuclides in all these categories remain predominantly at their place of origin, but may be transported and ultimately reach one or more parts of the active waste management system. Facilities are provided for collection of all radioactive gaseous, liquid and solid wastes. The design of these facilities is such that radiological exposure of operating staff and the public is well within the limits recommended by the International Commission on Radiological Protection (ICRP).

2.1. Solid Radioactive Waste Management System

Based on the radiation dose measured at the outside surface of the packages, solid radioactive waste are classified as:

- type 1 – packages having a dose under 2 mSv/h
- type 2 – packages having a dose between 2 mSv/h and 125 mSv/h
- type 3 – packages having a dose exceeding 125 mSv/h.

During plant operation and as a consequence of maintenance and decontamination activities the following types of solid radioactive waste are obtained and then handled, processed (if required) and temporarily stored:

- spend resins,
- used filters and filter cartridges,
- solid low-activity waste and medium activity waste.

2.1.1 Spent resins are obtained from the various purification systems of the process fluids. When taking them out of these systems, the direct contact radiation dose is usually higher than 10 mSv/hour. Therefore, special protection and shielding measures have been provided for their transportation, handling and storage. Storage of spent resins is in three vaults made of reinforced concrete lined with epoxy, located in the basement of the Service Building, in the proximity of the Reactor Building. The capacity of each vault is of 200 m^3.

2.1.2 Used filter cartridges unloaded from the process systems are directly carried to the Interim Storage Facility. Transportation of filter cartridges is performed by means of suitably shielded containers.

2.1.3 Solid Low Active Wastes are produced from various operations, which are daily performed in the plant. They consist mainly of materials from decontamination and maintenance operation, protection clothes and metallic parts, as well as contaminated materials and equipment. In the plant, waste collection points in the form of labelled containers are established. Compaction is the only processing method, which is applied by pressing of compressible waste directly into standard stainless steel drums of 220 l. Tritium samples are taken before pressing. In case of tritium concentration being higher than 5 µSv/h, the waste is dried. It is forbidden to store wet waste. Non-compressible waste is broken into smaller pieces if possible and packed in standard stainless steel drums of 220 l.

2.1.4 Medium Level Activity Solid Wastes, type 2 and type 3: except used filter cartridges and spent resins, which have a processing system as described before, solid medium active wastes consist of activated reactor components or other highly contaminated materials. These wastes, which are produced in small quantities and only under special circumstances, are placed and packaged in stainless steel drums to be transferred to the Solid Radioactive Interim Waste Facility as type 2 and type 3 packages.

2.1.5 A *Solid Radioactive Waste Interim Storage Facility* is located within the Cernavoda NPP exclusion zone and security fence, with easy access of vehicles transporting radioactive wastes, minimizing the need for additional security mechanism to assure its integrity. It is designed for temporary storage of solid radioactive wastes produced from Cernavoda NPP operation, except spent ion resins, spent fuel and reactivity control mechanism bars. There are three structures as follows:

- warehouse, for type 1 and type 2 wastes, packaged in stainless steel drums;
- concrete structure, for spent filter cartridges (type 2 and type 3 wastes);
- concrete structure, for large and highly contaminated pieces (type 3 wastes).

The structures are designed to ensure that the radiation level at 1 m from any surface of fully loaded structure will not exceed 25 μSv/h, and to assure wastes retrieving. A solid radioactive waste monitoring programme is part of the plant environmental monitoring programme that includes also sampling for airborne particulate and tritium through continuous monitoring:

- ground water sampling for gross beta-gamma and tritium activity (monthly),
- atmospheric radiation monitoring facilities equivalent to an environmental monitoring station,
- contamination surveys of any areas used for loading waste when wastes are transferred to the facilities.

2.2. Liquid Waste Management System

There is a plant system, which provides facilities for collection, storage, sampling, purification and disposal of aqueous radioactive liquid waste from the NPP process systems operation as well as from the maintenance, repair and decontamination operations. The waste collected by this system is finally discharged for dilution into the discharge duct of the circulating water from condensers, providing all the necessary measures for entering the Danube-Black Sea Channel. The discharged radioactive material concentrations should satisfy the requirements of the Derived Emission Limits for Cernavoda NPP - U1 and monitoring programme.

2.3. Organic Liquid Radioactive Waste Management System

Organic liquid radioactive wastes consisting of spent radioactive oils, spent solvents, liquid scintillation cocktails or solid/liquid mixtures, cannot be processed through the Liquid Radioactive Waste System because of their environmental impact. Sources of liquid organic waste are the decontamination area, lubricating oils from pumps and motors used in Zones 1 and organic solvents from the laboratories. Each type of this waste is segregated directly from the source, then collected in standard stainless steel 220 l drums and temporarily stored in the basement of the Service Building.

2.4. Gaseous Radioactive Waste Management System

Radioactive gaseous wastes in the plant have the following sources: fission products from fuel elements, neutron activation products of stable elements from process fluids and gases in neutron fields. Expected radionuclides from plant operation are noble gases, Iodine, particulate and Tritium. The radionuclides taken over by ventilation are filtered (particulate and Iodine) or dried (Tritiated water vapors) and exhausted through the ventilation stack in a controlled manner. The radioactive gaseous releases are continuously monitored by the Gaseous Effluent Monitor (GEM). This system will alarm for total activity discharged and for high rate discharge ensuring that the release limits are not exceeded.

3. Conclusions

Compared with other NPPs, the volume of radioactive waste produced at the Cernavoda NPP is relatively low (Table 1).

Table 1: Radioactive waste volumes produced at Cernavoda 1 NPP.

Waste type	Volume (m3)					
	1996	**1997**	**1998**	**1999**	**2000**	**2001**
Compressible Solid	2.86	9.46	14.96	16.5	12.01	14.96
Non-compressible solid	0.44	1.98	1.32	4.84	3.96	9.24
Flammable solid	0.44	1.10	1.98	1.10	1.54	1.54
Organic liquid	1.10	1.76	3.3	5.28	6.16	1.76
Spent resins	4.23	10.07	5.86	5.76	8.42	5.36
Filters	0.01	0.42	0	0.01	0.26	0.02

Through the experience accumulated and the volume of relevant information gathered, the practice for minimizing the generation of solid radioactive wastes will be continued, knowing the sources of generation of the most critical quantities of waste. The first objective followed is to maintain the volume of radioactive waste at less than 30 m^3 per year for solid radioactive waste, and for the rest the production is to be very strictly controlled. Also, separation of radioactive wastes containing long lived radionuclides must be pursued. The characterization of radioactive wastes by spectrometric methods will be performed by specialized firms. The long-term strategy includes plans for disposal of all wastes arising from plant operation, correlated with the waste strategy at the national level. The present facilities (interim storage) could allow their keeping for 15 years from now. But until then, it will be treated by the Institute for Nuclear Research. ICN Pitesti started to develop treatment and conditioning technologies for organic liquid waste.

References

[1] STATION DOCUMENTATION (approved by CNCAN).

[2] LEGAL FRAME: LAW 111/1998: SAFETY OPERATION OF NUCLEAR FACILITIES.

[3] The Radioactive Waste Management Concept for Cernavoda NPP, RD-01364-RP1.

[4] Radiation Protection Regulation, RD-01364-RP2.

[5] Solid Radioactive Waste Management Concept, RD-01364-RP1.

[6] Operating Manual- Interim Storage, OM-79100.

[7] Environment Monitoring Program, RD-001364-RP7.