

Slovenia's Journey in Institutional Radioactive Waste Management

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ABSTRACT

Since 1999 ARAO – Agency for Radwaste Management is responsible for the institutional radioactive waste management in Slovenia. This encompasses the entire process, from collecting waste at users' premises to transporting it to the Central Storage Facility, operation of the facility, and finally, treating and conditioning the stored waste.

This paper chronicles the progressive evolution of public services since their establishment, with numerous modifications and upgrades undertaken to enhance the efficiency of the institutional radioactive waste management public service. The initial challenge of renovating the facility and obtaining operational permits was paramount to the overall improvement process. Significant progress has been also made in other areas, ranging from the implementation of a modern business information system to the dismantling and conditioning of devices containing sealed radioactive sources, compression, repackaging of solid radioactive waste and solidification of liquid radioactive waste.

Throughout these processes, it has become evident that the sharing of knowledge among a properly trained and motivated staff is the linchpin for the success of any modification or improvement.

Following the introduction of radioactive waste collection, transportation, and processing services, the focus in the last decade has shifted towards exploring avenues for reducing waste volume. This objective has been pursued through waste processing, clearance, recycling, and reuse. Presently, the challenge at hand revolves around preparing the waste stored in the Central Storage Facility for final disposal.

Keywords: *institutional radioactive waste management, operational experiences, knowledge sharing*

1 INTRODUCTION

ARAO – Agency for Radwaste Management was established by the Government of the Republic of Slovenia in 1991 with the purpose of ensuring the safe and permanent disposal of radioactive waste within Slovenia's borders. In 1999, the government empowered ARAO as the provider of the mandatory public service for managing institutional radioactive waste. That same year, ARAO took over the responsibility for managing and operating the Central Storage Facility for Radioactive Waste (CSF) from the previous operator. This facility serves to store low- and intermediate-level radioactive waste generated from medical, industrial, and research activities, collectively known as institutional radioactive waste. Construction of the CSF began in 1984, and it became operational in 1986. The CSF, covering an area of 250 m² with a storage capacity of 115 m³, was built in accordance with regulations governing such facilities in the former Yugoslavia in the 1980s. Due to its poor condition upon takeover, ARAO initiated a comprehensive program of renovation, modernization, and operational optimization to ensure safe and sustainable management of radioactive waste.

The International Atomic Energy Agency (IAEA) places a strong emphasis on capacity building in its member states [1]. The IAEA believes that building national capacities is essential for countries to use nuclear science and technology safely and securely for peaceful purposes, such as energy

production, health care, and environmental monitoring. The IAEA's position underscores the importance of ensuring that member states have the knowledge, skills, and resources to utilize nuclear technology while adhering effectively and safely to international standards and safeguards.

Capacity development starts from the principle that people are best empowered to realize their full potential when the means of development are sustainable – home-grown, long-term, and generated and managed collectively by those who stand to benefit [2].

ARAO recognized the importance of capacity building and sustainable development, prompting it to start transferring best practices to Slovenia and establishing its own service with in-house personnel, which are necessary for the safe handling of radioactive waste.

2 DEVELOPMENT OF THE PUBLIC SERVICE

Upon assuming control of the facility from the previous owner in 1999, ARAO immediately began preparations for its reconstruction and modernization. This included conducting a thorough inventory and characterization of the existing radioactive waste (Figure 1) stored in the Central Storage Facility (CSF), with the support of external experts. Simultaneously, minor maintenance work was carried out, along with the procurement of equipment and a complete renovation of the facility's hydro-isolation in 2001 (Figure 2). Additionally, a smaller auxiliary assembly building was constructed to accommodate storage needs and provide office space.



Figure 1: Characterization of radioactive waste stored in CSF in 2000



Figure 2: Renovation of the facility's hydro-isolation in 2001

A significant reconstruction of the CSF took place during 2004-2005 (Figure 3), involving the renewal of the floor, walls, installations, and the implementation of essential systems such as ventilation, fire protection, and technical security. Throughout this phase, ARAO diligently worked on documentation to obtain a license to operate a nuclear facility, with a primary focus on the Safety Report.



Figure 3: Reconstruction works of the CSF during 2004-2005

In 2005, with the establishment of conditions for the transportation of radioactive substances, ARAO took over the transportation operations, which had previously been outsourced. The following years, from 2005 to 2008, presented a three-year trial operation of the facility, culminating in the acquisition of an operating license valid for ten years in 2008. During this time, extensive efforts were made to inventory and characterize the radioactive waste stored in the CSF, with the assistance of foreign experts and European Union funds. These campaigns focused on repackaging, sorting, and characterizing of stored radioactive waste, significantly improving radiological conditions within the CSF. Additionally, software was developed to support radioactive waste management processes, ensuring efficient record-keeping and operational efficiency.

In 2012, ARAO introduced methods for dismantling and conditioning ionization smoke detectors, as well as compressing compressible radioactive waste. The subsequent year presented the introduction of a method for treating liquid radioactive waste, involving its solidification to prevent dispersion within the CSF during storage.

In 2017, the management of disused sealed radioactive sources categories 3-5 became a focus, with campaigns initiated for the disassembly and conditioning of these devices (Figure 4). These campaigns involve separating the radioactive part, which is stored in the CSF, from the non-radioactive part, which can be disposed of conventionally. In recent years, efforts have also been directed towards seeking solutions for the export of radioactive material from the CSF abroad for recycling purposes.



Figure 4: Management of disused sealed radioactive sources categories 3-5 in 2017

Ionization smoke detectors are exported, several containers of depleted uranium have been exported, and so on. Initiatives such as waste segregation, repackaging, and optimization of storage

space have also been instrumental in enhancing the efficiency and sustainability of the public service. Such campaigns, routinely carried out in the past decade, have significantly contributed to volume reduction in the CSF (Figure 5).

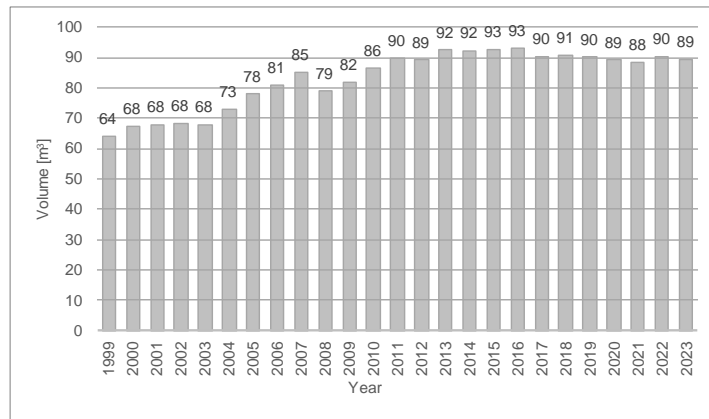


Figure 5: Annual net accumulation of radwaste stored in the CSF

All these activities contribute to reducing the amount of waste that needs to be stored in the CSF. These services are typically offered for a fee, but they are valuable because their objective is to promote a more circular economy in the use of radioactive materials. This, in turn, leads to cost savings in disposal since these wastes won't need to be disposed of within Slovenia. The next major challenge ahead of us is preparing waste from the CSF for disposal in the Low and Intermediate Level Waste Repository, which is currently under construction.

The facility's operation has been safely conducted since its renovation and licensing in 2008. Regular maintenance and numerous improvements, both administrative and technical, have been implemented to ensure continued safety and efficiency. Today it is an exemplary well-kept storage facility that serves its purpose (Figure 6). In 2018, following a successful periodic safety review, a new operating license was obtained, valid until 2028. The safety report was prepared in accordance with national regulations, practical guidelines, and international recommendations such as the IAEA General Safety Guide [3].



Figure 6: Today's view of the CSF and its interior

The responsibility for carrying out tasks related to the management and operation of the CSF primarily rests with three employees who are trained and appointed to the following roles: head of storage facility, radioactive waste management technologist, and facility equipment operator. They work closely with two radiation officers responsible for monitoring and supervising working areas and working methods, as well as for monitoring radioactivity in the environment. Occasionally, technical staff from other departments of ARAO also contribute to the development of technical tasks. It is particularly important that all documentation related to the CSF is prepared by the in-house staff

from the outset of assuming control of the facility. This ensures consistency and coherence in the documentation of the facility. The number of staff members working in this area has not increased.

3 BENEFITS AND LESSONS LEARNED

The growth of expertise within ARAO has brought great advantages. By operating autonomously, it has proven more sustainable, cost-effective, and it results in higher-quality outcomes compared to outsourcing services. Collaboration with external organizations has been productive but highlighted the importance of maintaining internal expertise. In the event of disruptions in waste export, the trained staff is prepared to process these sources locally.

Maintaining a diverse network of waste management experts and staying well-informed about available methods and services has proven highly beneficial. The experiences gained emphasize the importance of in-house knowledge and the value of maximizing the use of internal personnel and equipment.

4 CONCLUSION

Slovenia's efforts to manage radioactive waste, led by ARAO, show a careful and organized way of dealing with an important part of radiation safety and protecting the environment.

The ARAO's evolution since its inception in 1991 is a testament to its commitment to the safe and sustainable management of radioactive waste within the country. As ARAO prepares for the next periodic safety review, the agency remains focused on further enhancing its waste management practices and ensuring the safe and effective operation of the CSF for the next decade.

Through continuous improvements, capacity building, and knowledge sharing, ARAO has achieved remarkable advancements in waste processing, recycling, and volume reduction. The agency's initiative to develop internal expertise has proven invaluable, allowing for more sustainable, cost-effective, and high-quality outcomes compared to outsourcing services. Furthermore, the collaboration with external organizations has not only been productive but has also highlighted the importance of maintaining and nurturing internal expertise. This approach ensures preparedness for potential disruptions in waste export for recycling and the capability to handle disused sealed radioactive sources locally.

Maintaining a diverse network of waste management experts and staying well-informed about available methods and services have proven to be highly beneficial strategies. The experiences gained from these initiatives emphasize the significance of in-house knowledge and the value of maximizing the use of internal personnel and equipment.

In recent years, ARAO has shifted its focus towards waste volume reduction through innovative methods such as waste processing, clearance, recycling, and reuse. This shift reflects the agency's forward-thinking approach and commitment to sustainability.

In conclusion, Slovenia's institutional radioactive waste management journey serves as a model of effective and sustainable practices, underlining the importance of a systematic, well-managed approach to aspect of nuclear safety. The lessons learned, benefits reaped, and ongoing commitment to improvement demonstrate ARAO's dedication to ensuring the long-term safety and environmental protection of Slovenia and its people.

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