



Managing End of Life of Radioactive Sources

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National approach to the classification of DSRS and Radioactive Waste



Sealed sources are classified into 5 categories according to the *Act on the Safe Use of Nuclear Energy* (IAEA Safety Guide RS-G-1.9, 2005)



Radioactive Waste – 3 main categories according to *Regulation on the safe management of RW* (in accordance with Safety Guide “Classification of Radioactive Waste” GSG-1, IAEA, 2009):

<u>Category 1</u>	<u>Category 2</u>	<u>Category 3</u>
<ul style="list-style-type: none"> Exempt waste (EW) Very short lived waste (VSLW) Very low level waste (VLLW) 	<ul style="list-style-type: none"> Low level waste (LLW) Intermediate level waste (ILW) 	<ul style="list-style-type: none"> High level waste (HLW).

Disused source (DSRS) means a sealed source which is no longer used or intended to be used for an activity/practice for which an authorisation has been issued but which continues to require safety management



National policy for RAW and DSRS management



The policy of Republic of Bulgaria in the field of the management of RAW and DSRS is laid down in the national legislation – Act on the safe use of nuclear energy (ASUNE), Act on environmental protection, Act on health and the respective regulations.

The policy is based on the ethical obligation to avoid any undue burden on future generations and is mainly reduced to:

- The management of RAW is regulated by the state and it is carried out only if the regulatory body (Bulgarian Nuclear Regulatory Agency, BNRA) has issued a license;
- The waste generators are responsible for the safe management of the RAW up till the waste is transferred to the state represented by State Enterprise Radioactive Waste (SERAW);
- There is a state monopoly on the RAW management activities – the management of RAW outside the sites of their generation is assigned to SERAW;
- The generators of RAW meet the costs of their management including disposal according to the principle “The polluter pays”;
- The import of RAW in Bulgaria is prohibited with exception of special cases determined in ASUNE (repatriation of sealed sources produced in Bulgaria and radioactive waste generated from processing of materials made as a service in favor of Bulgaria or Bulgarian legal entity);
- The management of orphan sources is responsibility of the state;
- Application of the principle of return some categories radioactive sources back to the supplier/manufacturer after the end of their use;
- Processing of RAW is done in timely manner for producing a waste form suitable for safe storage and disposal in the shortest period of time after their generation;
- RAW generated in the Republic of Bulgaria shall be disposed of on Bulgarian territory, except in case of an agreement in force for the use of a facility for disposal of RAW in another country.



National strategy for SF and RAW management



The National Strategy for SF and RAW management is in fact the National Program of the Republic of Bulgaria for SF and RAW management in accordance with to Directive 2011/70/Euratom;

In the strategy are outlined the responsibilities of the competent state authorities and license holders. The strategy includes an Action plan, which outlines the goals, tasks and deadlines for the implementation of key targets;

According to the currently **acting strategy (2015 - revision)** long lived and high activity DSRS should be **capsulated, conditioned and stored long term together with ILW and HLW waiting for deep geological disposal**. It is expected that **the rest of the DSRS have disposal route in the National disposal facility (NDF)**;

In the **latest draft revision (02/2022)** of the Strategy, it is foreseen that SERAW will **consider the opportunities to implement borehole disposal** – with development of a concept by 2023 and packaging/conditioning of DSRS by 2030.



Bulgarian Nuclear Regulatory Agency



Bulgarian Nuclear Regulatory Agency (BNRA) is established more than 60 years ago with the main functions to regulate the activities involving the safe use of radiation sources, nuclear energy and management of radioactive waste. The Agency is headed by a Chairperson:

- Manages the Agency and represents it before third parties
- Issuance, amendment, suspension and revocation of authorisations
- Issuance and withdrawal of individual licenses to work at nuclear facilities
- Supervision of the fulfilment of safety requirements and standards and the conditions of the authorisations and implementation of enforcement measures
- Preparing drafts of statutory instruments
- Coordination of the implementation of national obligations, established in the respective conventions and EU legislation
- Providing the individuals, legal persons and state bodies with objective information related to nuclear safety and radiation protection

According to the Act on Safe Use of Nuclear Energy BNRA is an independent state body belonging to the executive power.



Bulgarian Nuclear Regulatory Agency



LEGAL FRAMEWORK

A comprehensive legal and regulatory framework has been gradually developed and implemented according to international safety and security requirements and EU legislation

- Act on the Safe Use of Nuclear Energy, ASUNE;
- Regulation on the Procedure for Issuing Licences and Permits for the Safe Use of Nuclear Energy;
- Regulation on Radiation Protection;
- Regulation on the safe decommissioning of nuclear facilities;
- Regulation on the safe management of radioactive waste;
- Regulation for the procedure for assessment, collection, spending and control of the financial resources and definition of the amount of contributions due on the “Radioactive waste” Fund
- Regulation for the procedure for assessment, collection, spending and control of the financial resources and definition of the amount of contributions due on the “Nuclear facilities decommissioning” Fund (For more please see: <http://www.bnra.bg/>)

INTERNATIONAL INSTRUMENTS

The state has ratified the international conventions related to nuclear safety/security/safeguards and nuclear liability.



State Enterprise Radioactive Waste



SERAW – only national operator for management of RAW established in 2004 according to the Act on the safe use of nuclear energy

The specialized divisions (SD) are nuclear facility's and national strategic site

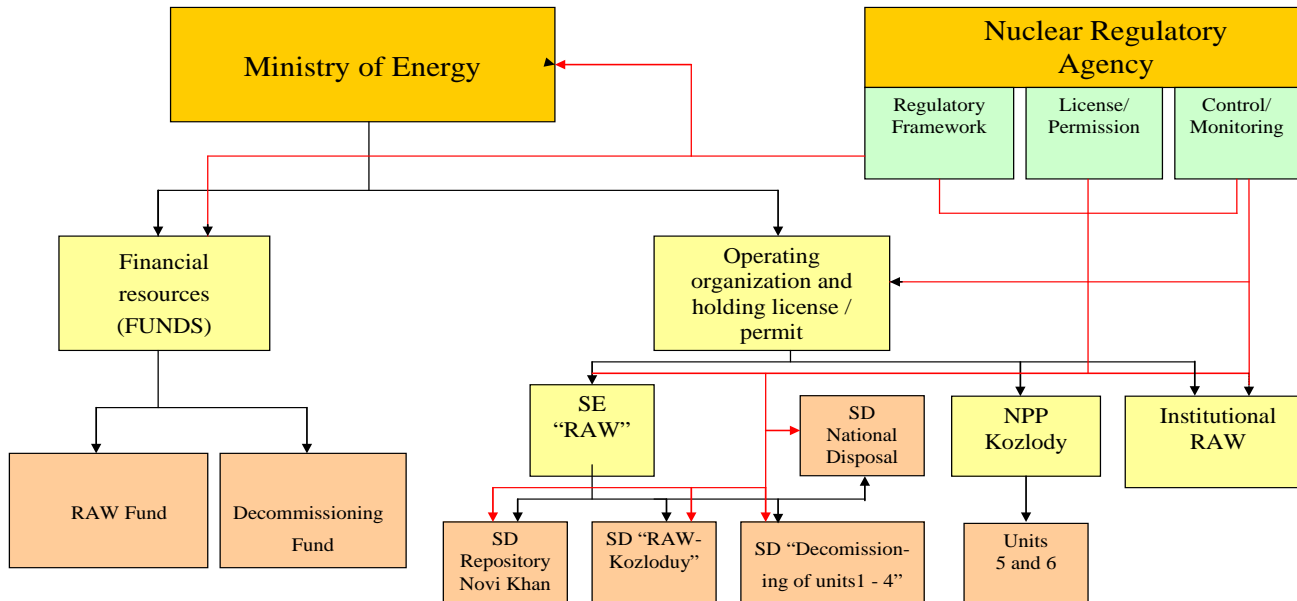
- SD “PHRAW-Novikhan” - management of RAW from nuclear applications in the industry, science, medicine, etc.
- SD “RAW Kozloduy” - management of RAW generated from the operation of nuclear facilities
- SD “Decommissioning of unit 1-4” - management of RAW at decommissioning of shutdown nuclear facilities
- SD “National Disposal” - National Disposal Facility (under construction)

For the implementation of the RAW management activities the state enterprise develops an annual and 3-year plan-schedule for the subsequent processing and conditioning of the received and stored RAW from the nuclear facilities and from the SIR sites

The state-owned enterprise maintains a database of all accepted RAW

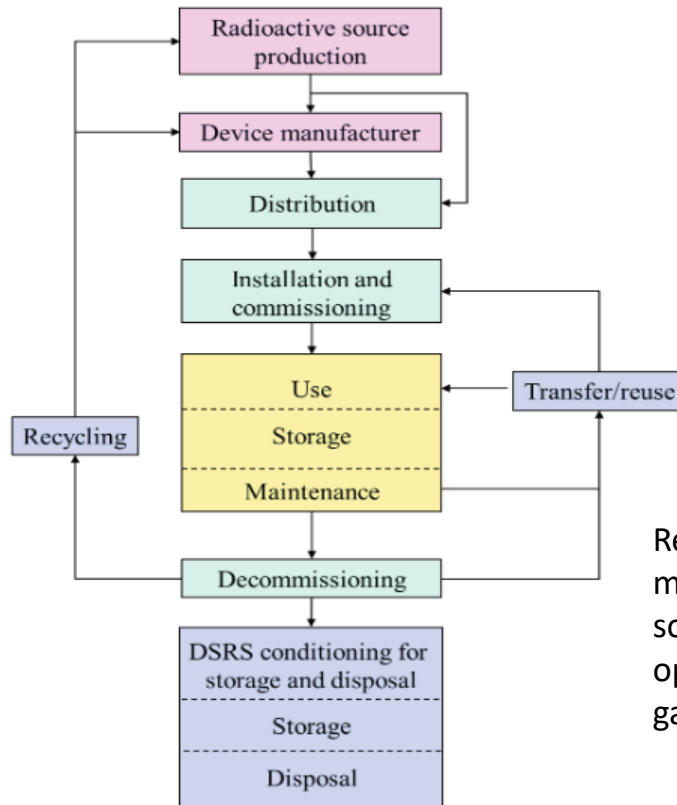


Structure and Organization of DSRS Management





DSRS Management options



- ✓ Transfer to another authorized user (re-used)
- ✓ Return to supplier/manufacturer
- ✓ Storage prior to disposal
- ✓ **Disposal**

Regulatory Guide for safe management of high-activity sealed sources during commissioning, operation and decommissioning of gamma irradiators, 2022



Re-use and other initiatives



Re-use of high activity sealed sources is carried out in Bulgaria. E.g. in 2021 Co-60 source from tele-therapy device in *Vratsa oncology center* was transferred to the *National Center of Radiobiology and Radiation Protection* to be reused for calibration purposes. In the past, sources from oncological practices were transferred between oncology centers or industrial irradiators.



SERAW is a partner to the **Office for Radiological Security, US National Nuclear Security Administration**. The program aims to improve physical protection of high activity sealed sources. As part of the collaboration, DRSRs from more than 30 sites in the country, were safely and securely transported and stored in the “Permanent Repository - Novihan”.



Storage of DSRS Category 1-2 in Specialized Division “Permanent Repository - Novi han” (SD “PRRAW-Novu Han”)



The Permanent Repository for Radioactive Waste is situated near the village of Novi Han. It was established in the late 50's and the early 60's. The repository was designed for storage of radioactive waste resulting from nuclear applications in accordance with the country's legislation in effect. The facility has undergone upgrades in the frame of EU PHARE Projects, GTRI, IAEA technical cooperation projects (supply of installations for processing of RAW, hot cell, storage sites). According to the National strategy and issued licenses, currently in Novi han repository are ongoing pre-decommissioning activities, with actual decommissioning expected to start in 2025.



High activity DSRS in their original shieldings are stored in reinforced concrete containers



Inventory of Category 1-2 DSRS stored in SD “PRRAW-Novi Han”



Category	Radionuclide	Quantity	Total activity*, Bq
Category 1	Co-60	3	1,14E+14
Category 2	Co-60	72	2,15E+14
	Cs-137	194	2,17E+15
	Pu-239-Be	1	1,15E+12
	Am-241-Be	1	6,94E+11

*As of 31 March 2023

Very few irradiators/teletherapy devices are left in use in the country due to the transfer to alternative technologies or becoming obsolete. Most of high activity radioactive sources currently in use have guarantee of return to the supplier (MDS Nordion, Canada, etc.).



Management of DSRS category 3-5 at SD “PRRAW-Novi Han” hot cell



The **hot cell** was commissioned in 2011 as part of EU PHARE Project. After dismantling of containers/devices with DSRS, the sealed sources are checked for surface contamination (leakage), the activity is measured and then are stored in assembly containers (separate for Co-60 and for Cs-137). Presently, more than 4000 sources have been retrieved from their original enclosure, while the scrap metal was released of regulatory control and recycled.



HOT CELL TECHNICAL DATA		
1	Maximum dimensions for DSRS (width x depth x height)	1 x 1 x 1,3 m
2	Maximum containers weight	4000 kg
3	Maximum load capacity of the internal hoist	500 kg
4	Maximal activity allowed for buffer storage and dismantling operations	500 TBq





Challenges in managing Sources category 1-2



Removing the sources from the original shielding in the hot cell with master-slave manipulators of Novi Han repository:

Key challenges:

- No prior experience of SERAW hot cell operators in dismantling irradiators/teletherapy machines (very few experienced professionals are left in the country, most of which are retired);
- Limited information - missing source removal instructions or maintenance manuals from the device manufacturer (drawings and other technical information is however available);
- Although all devices meet the hot cell activity limits, due to their physical dimensions and weight, some older irradiators cannot be positioned or maneuvered within the working cavity of the hot cell;
- There is no approved container for long term storage. SERAW presently is considering the opportunity to implement borehole disposal concept as a disposal option.



Additional complexities to be expected in case of source retrieval from the devices:

Rusted components, some containers could not be unscrewed, and possibly leaking Cs-137 source capsules;
Wrong source information in terms of number of sources, radionuclide and activity.

Repatriation – practiced in the past (before 1991), now this option is considered not cost-effective. The complicated procedure and the higher financial burden makes **the return to the supplier** less attractive than transfer to SERAW.



Disposal options for high activity sources in Bulgaria



Deep geological disposal facility

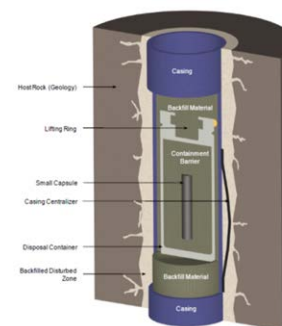
DGD is intended for ILW and HLW. It is expected to be commissioned by 2050 according to the Draft Strategy for the management of SF and RAW.

Borehole disposal system

SERAW considers the opportunity to implement borehole disposal for DSRS. A feasibility study for the implementation of BDC is currently under development.

Favorable factors for development of borehole disposal system in Bulgaria:

- Co-siting the borehole disposal facility with the near surface disposal facility is an option, which presents several advantages:
 - the site is already well characterised for the near surface disposal facility – has an issued license by BNRA for a disposal facility;
 - gaining public acceptance for the borehole disposal facility is expected to be easier, since many stakeholders have already been involved during the licensing and construction of the NDF;
- Available resources at SERAW – qualified staff, infrastructure and equipment for DSRS management, including hot cell at Novi han repository;
- Available technical support organizations – Institute of Geology, Institute of Metal Science, Equipment and Technologies with Hydro- and Aerodynamics Centre, companies with experience and equipment for drilling boreholes, etc.



Bulgaria (SERAW and BNRA) is taking part in IAEA CRP Standardized Framework for Borehole Disposal of DSRS.



Thank you for your attention