# End of Life Management of Sealed Radioactive Sources in Jordan

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**Panel discussion at Vienna Center for Disarmament and Non-Proliferation (VCDNP) , Wednesday, 17 July 2019**

# Jordan Overview



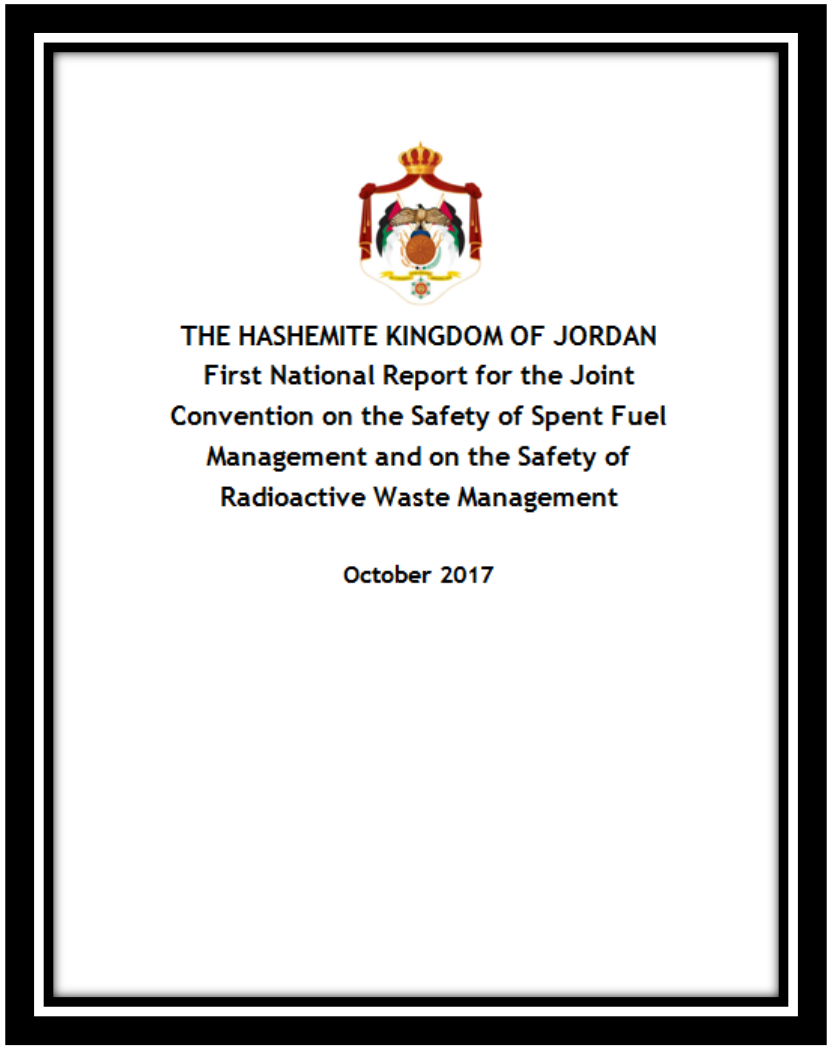



- Capital: Amman
- Area: 89,341 $km^2$
- Population: 10 million
- Climate: Mediterranean & Arid Desert
- The country spends more than 20% of its GDP on energy imports

# Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

- Jordan has signed the Joint Convention on the Safety of SNF Management and on the Safety of RWM on April **2016**. The Convention has been ratified and entered into force on July 2016.

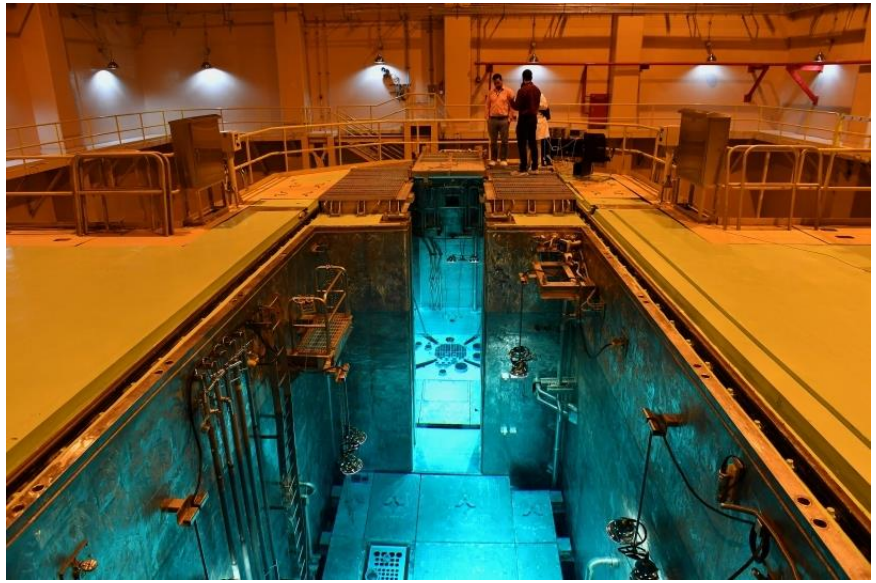
- The first National Report of Jordan was submitted for the sixth Review Meeting to the Convention, which took place in **2018** at the IAEA Headquarters in Vienna.



# Jordan Nuclear Program

- Jordan currently does not have any NPP.

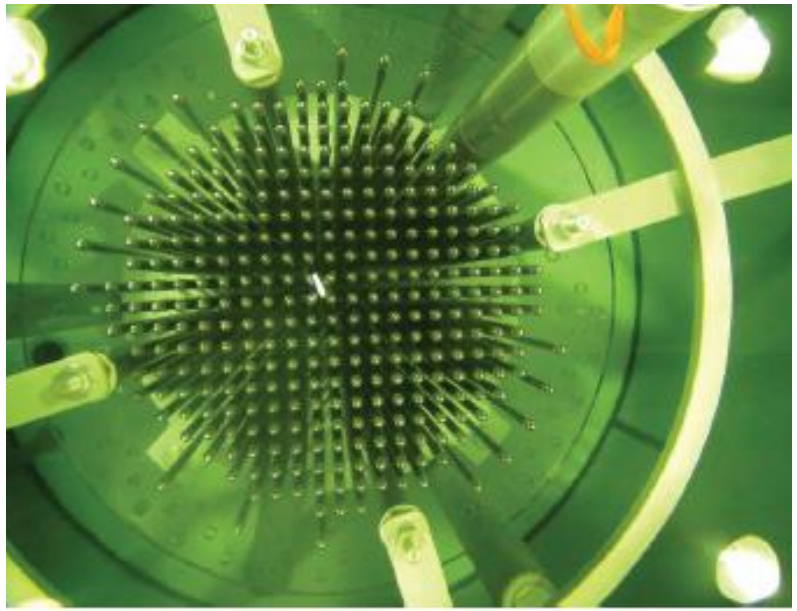
- Jordan Research and Training Reactor has reached its first criticality in April 2016.
  - Operational License was obtained on  November 2017.





# Jordan Subcritical Assembly (JSA)

- Jordan’s first Nuclear facility.
- Located at Jordan University of Science and Technology.
- Designed and constructed for the purpose of education, training, and experimental research.
- Commissioned in June 2013





# Radioactive Waste Generation Activities

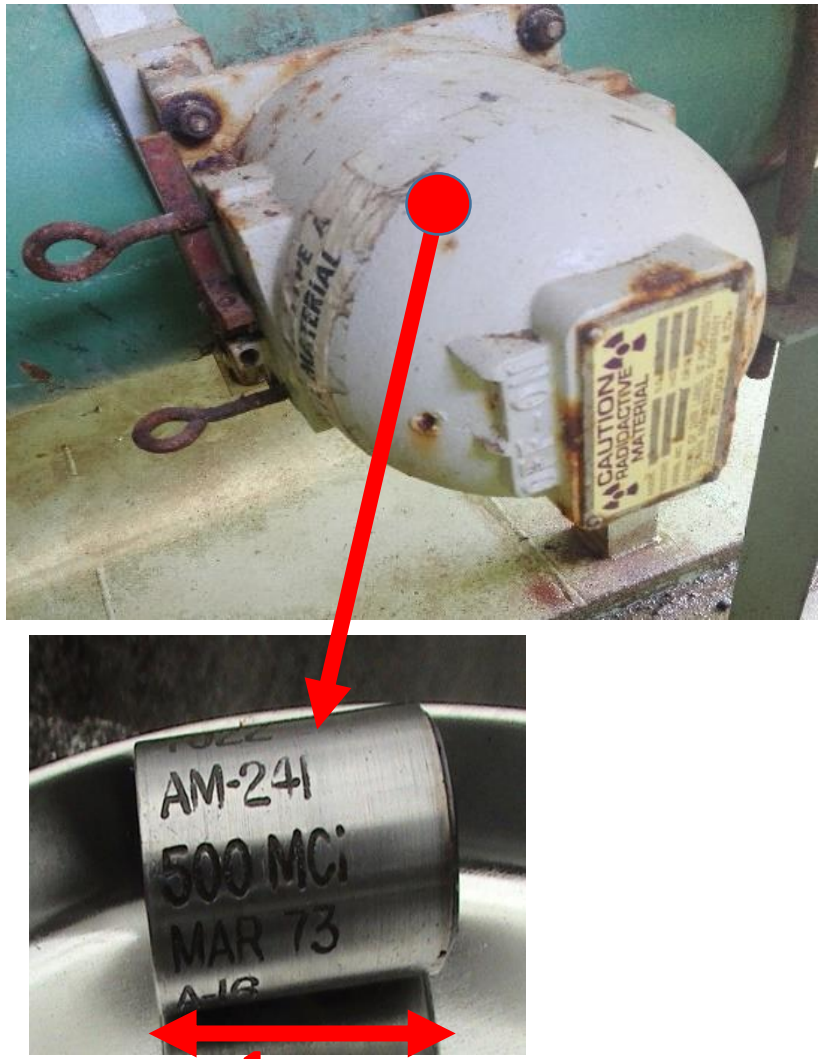
- The radioactive waste considered here is generated by the following activities

- *Historical or legacy waste*
- *Sources used in medical, agricultural, industrial or research activities*



# Disused Sealed Radioactive Sources









**Density meter at the Arab Potash Company In Jordan**

# Disused Sealed Radioactive Sources











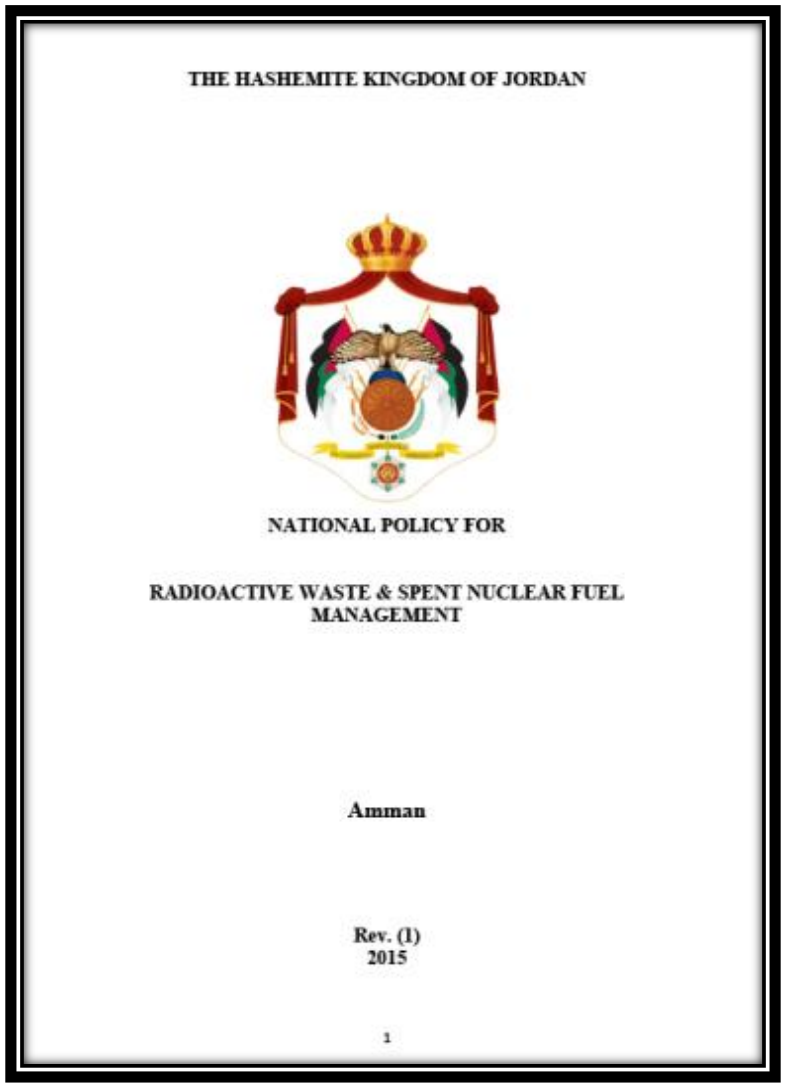
**Teletherapy unit in a Hospital in Jordan**

# National Policy for Radioactive Waste and Spent Nuclear Fuel Management

- Approved and implemented **2015**

**The management options for disused sealed radiation sources include:**

- Return of the disused sealed radiation sources to the supplier;
- Management of the DSRS in the national specialized facilities for radioactive waste management in the Kingdom of Jordan such as the national centralized storage and treatment facilities (CSF) at Jordan Atomic energy Commission (JAEC);
- Finding an international or regional solutions for the DSRS management and disposal options.


THE HASHEMITE KINGDOM OF JORDAN

NATIONAL POLICY FOR

RADIOACTIVE WASTE & SPENT NUCLEAR FUEL MANAGEMENT

Amman

Rev. (1)
2015

1

# Radioactive Waste Management Facilities

There are three main sites hosting radioactive waste processing and storage facilities:

- Centralized Storage Facility at JAEC HQ site
- Radioactive waste Treatment Facility at JRTR site
- The historical RW storage pit at Sewaqa waste management site.

# Centralized Storage Facility (CSF)

- CSF was licensed in 2010.

- It is located at the premises of JAEC headquarters; and is tasked with the safe and secure storage of disused and orphan RW sources, as well as other RW.









# The Radioactive Waste Management Site at Sewaqa

- An underground well engineered facility in which a historical RW are stored





# The Radioactive Waste Management Site at Sewaqa

- The storage pit designed to store radioactive waste in three levels.

- Each level can accommodate up to 25 drums of 200 L capacity.





# JRTR Radioactive-Waste Treatment Facility (RTF)

- Located at the JRTR site for treatment and temporary storage of RW from JRTR.
- The RTF operating license was issued on March 2019.








# Challenges

**The physical security system and measures at the Sewaqa site (Legacy sources) are not adequate to the level of anticipated threat.**

**Requirements to overcome this challenge**

- Ensure elimination of deficits of safety and security so to achieve full compliance with the requirements of the national legislation and recognized international standards on safety and security of radioactive material.

- Transfer the radioactive waste represented by disused sealed radioactive sources (DSRS), which are packaged in different types of containers and currently stored at Sewaqa waste management site to the CSF at JAEC.

# Actions

JAEC collaborated with the IAEA to conduct an expert mission to assess the current situation for the DSRS at Sewaqa site in Jordan.

- The inventory was checked
- Dose rates were measured
- Retrieval option was studied








IAEA
International Atomic Energy Agency

Jordan Atomic Energy Commission

# Actions

- Collaborate with the European Union to develop a feasibility study for the transfer of radioactive waste which are currently stored at Sewaqa waste management site.
  - Four different options were evaluated from both technical and financial point of view.
  - The feasibility study concluded that retrieval of radioactive waste stored at Sewaqa site and its transfer to CSF for processing, characterization and storage in dedicated storage facilities CSF/RTF is the most technically and economic sound option and therefore, is recommended for implementation by the JAEC.




NRG TÜVNORD

# Challenges

**The large volume of the DSRS in their storage form at the CSF**

**Requirements to overcome this challenge**

- Significantly reduce the volume by dismantling / removal of the radionuclides from their original shield containers or devices / equipment

- keeping the radioactive sources in Source Conditioning Capsules (SCCs) suitable for handling, storage and transport.

# Actions

JAEC collaborated with the IAEA in an expert mission to conduct a **consolidation operation** for the DSRS located at the CSF.

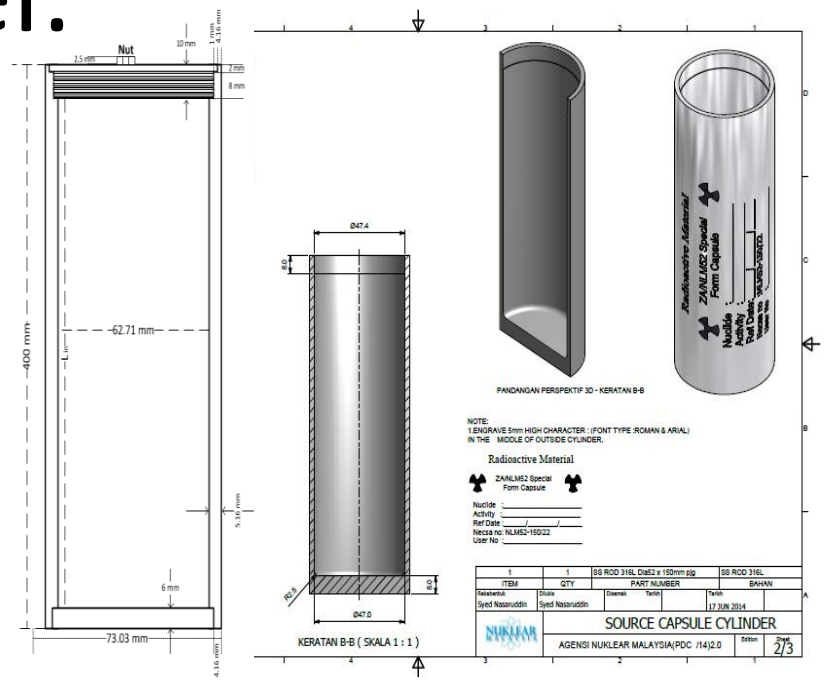


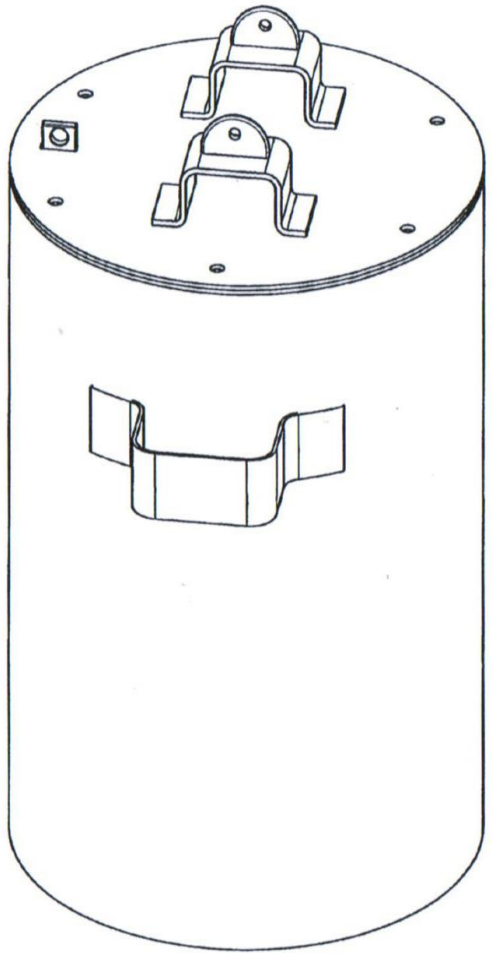
IAEA
International Atomic Energy Agency

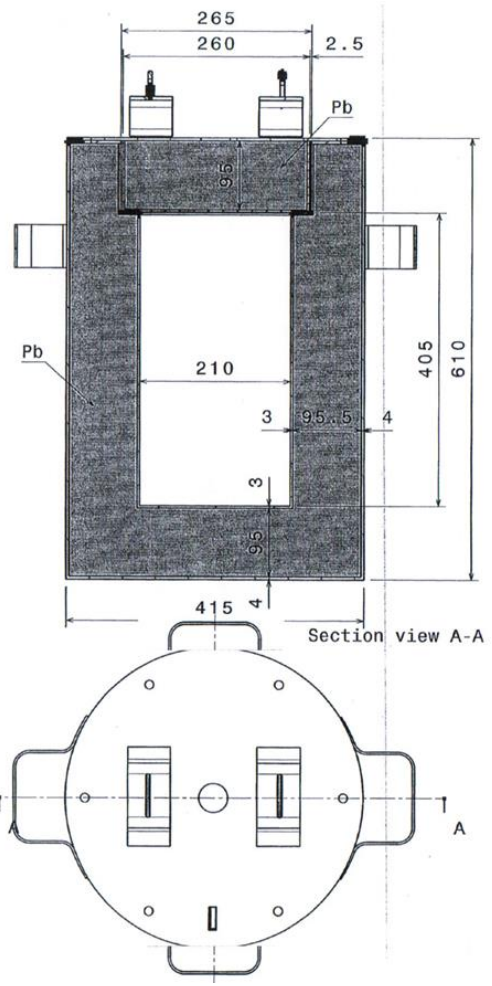
هيئة الطاقة الذرية الأردنية
Jordan Atomic Energy Commission

# Consolidation of Cat III-V Sources

Design and fabrication of the storage capsules container.





# Consolidation of Cat III-V Sources





# Consolidation of Cat III-V Sources

## Preparations for the working area





# Consolidation of Cat III-V Sources

Extract the Sources from waste package (Drums)





# Consolidation of Cat III-V Sources

- Save Time
- Easy Access & Handling
- Enhance Safety





# Conditioning Process



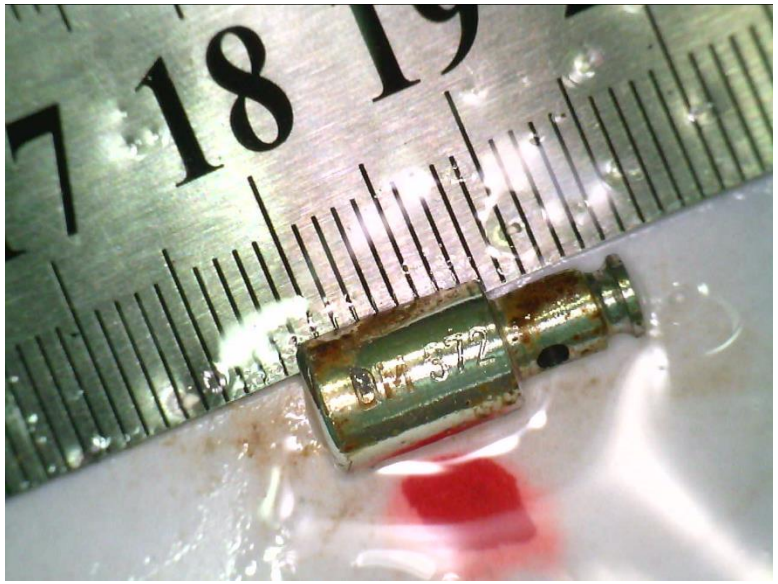






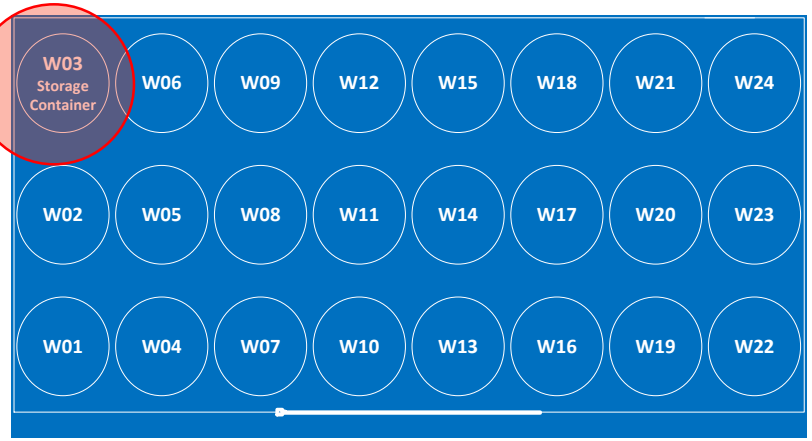






# Volume and Mass Reduction

# Storage Container Location

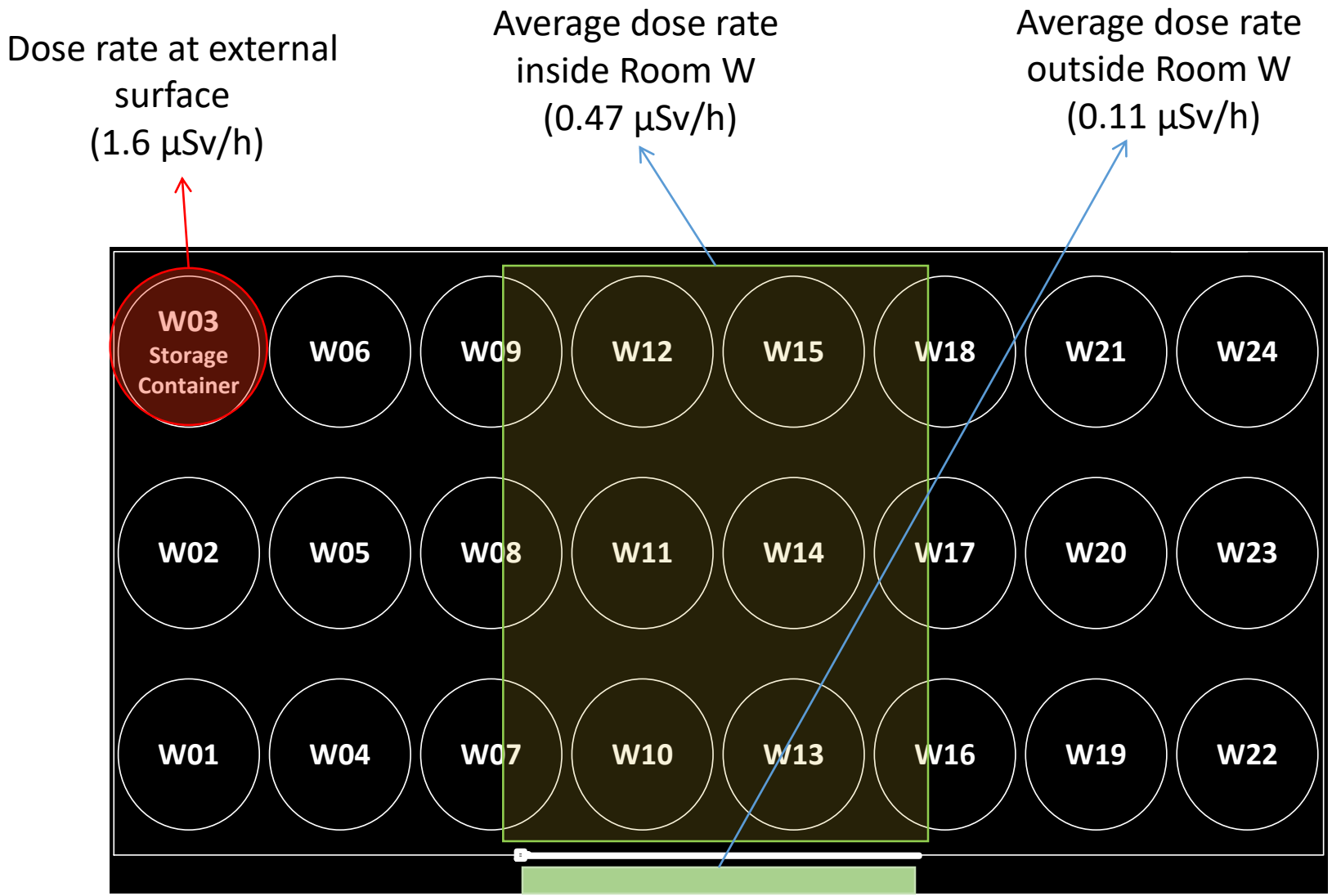








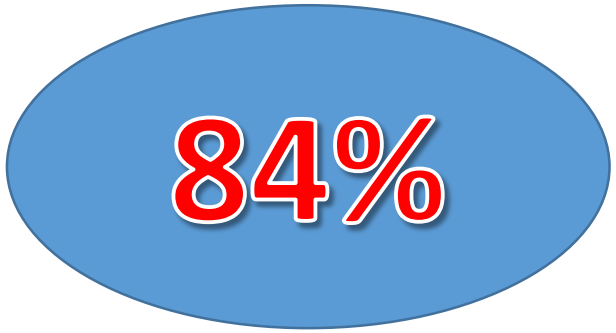
# Dose Rates at the Storage Area



# Consolidation of Cat III-V Sources

Total No. of Category (3-5) DSRS at the date of the mission was 220 stored in 35 Drums

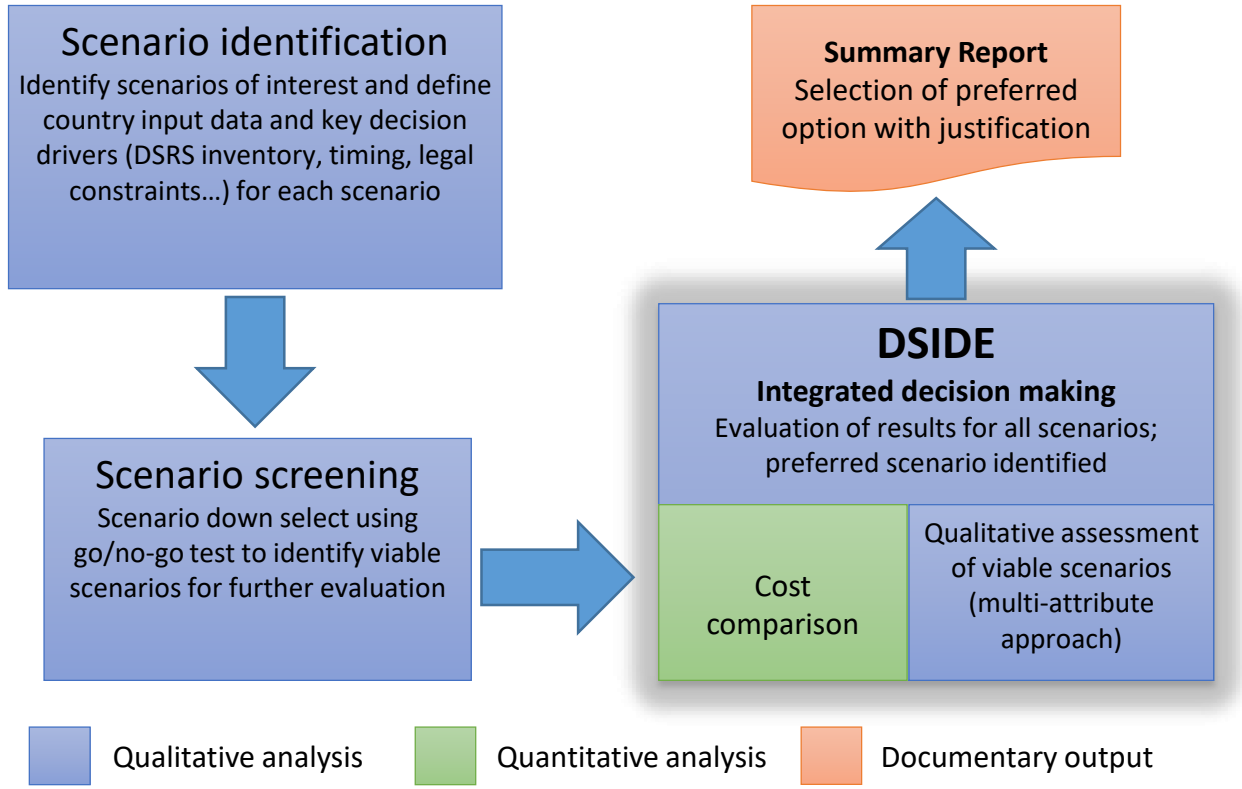
184 sources has been consolidated in one storage container



# DSRS End-of-life Options Evaluation

- JAEC collaborated with the IAEA to implement the Disused Sources Integrated Decision-making Evaluation (DSIDE) tool to Jordan radioactive waste inventory.

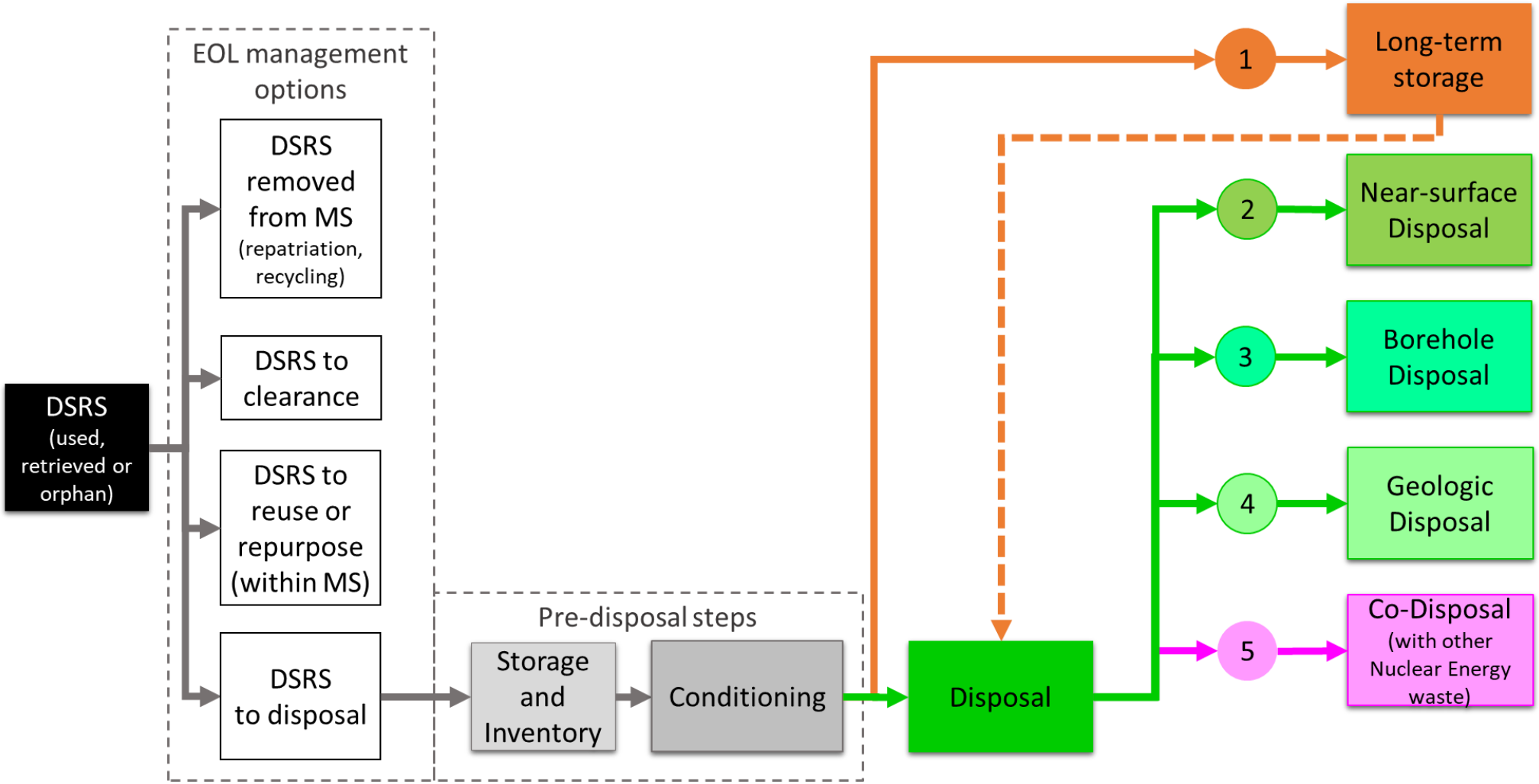
- DSIDE is a multi-attribute utility methodology and can be used to compare options for DSRS disposition, combining factors that are non-economic with the scenario cost estimates to determine the preferred option.



# Non-economic criteria

- Safety and Security
- Industrial and technical considerations
- Human resources
- Environmental Impact considerations
- Legal and institutional considerations
- Public acceptance
- Political support
- Regional and international partnerships

# The end-of-life management strategies



# Key Takeaways

- Jordan develops its radioactive waste management system including provisions in the national legislation, institutional structures and technical infrastructure required to cope with existing and anticipated future needs in radioactive waste.

- Jordan collaborated with different international institutions to ensure safe and responsible management of radioactive waste generated on its territory, such as IAEA, EU and the DOE.

- Recognizing that interim storage is not a permanent solution for long lived Sealed Radioactive Sources, Borehole Disposal provides a special designed option where SRS can be disposed permanently, economically and safely.