Operational Experiences and Challenges in Managing Spent Nuclear Fuel from Research Reactors EWA and MARIA in Poland

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Introduction

Global Energy Challenges

- Increasing focus on sustainable energy solutions
- Need for effective management of SNF

Poland's Context

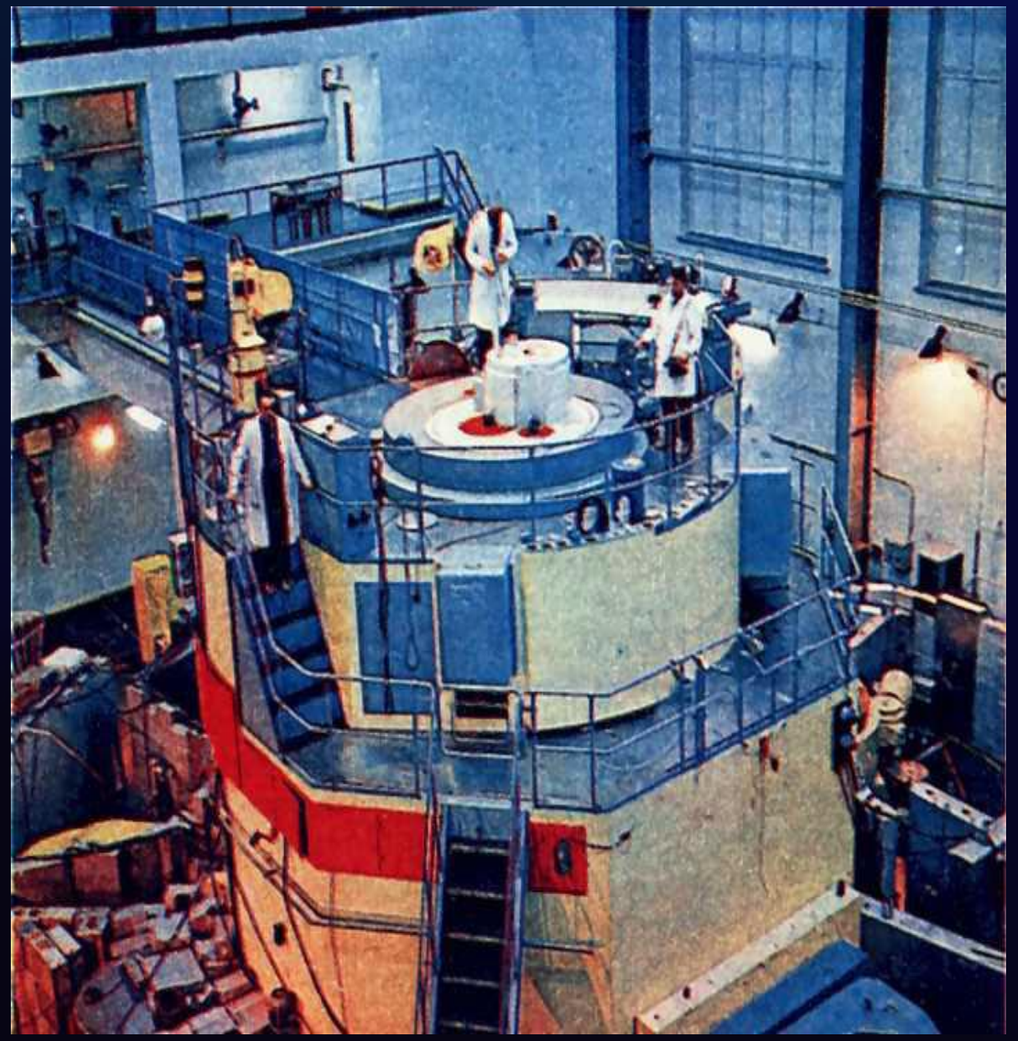
- Activities focused on research reactors:
    - **EWA Research Reactor**
        - Launched: 1958
        - Shut down: 1995
    - **MARIA Research Reactor**
        - Operational since: 1974
        - Currently operational

SNF has been generated from the operation of two research reactors named EWA and MARIA.

EWA Research Reactor: General data

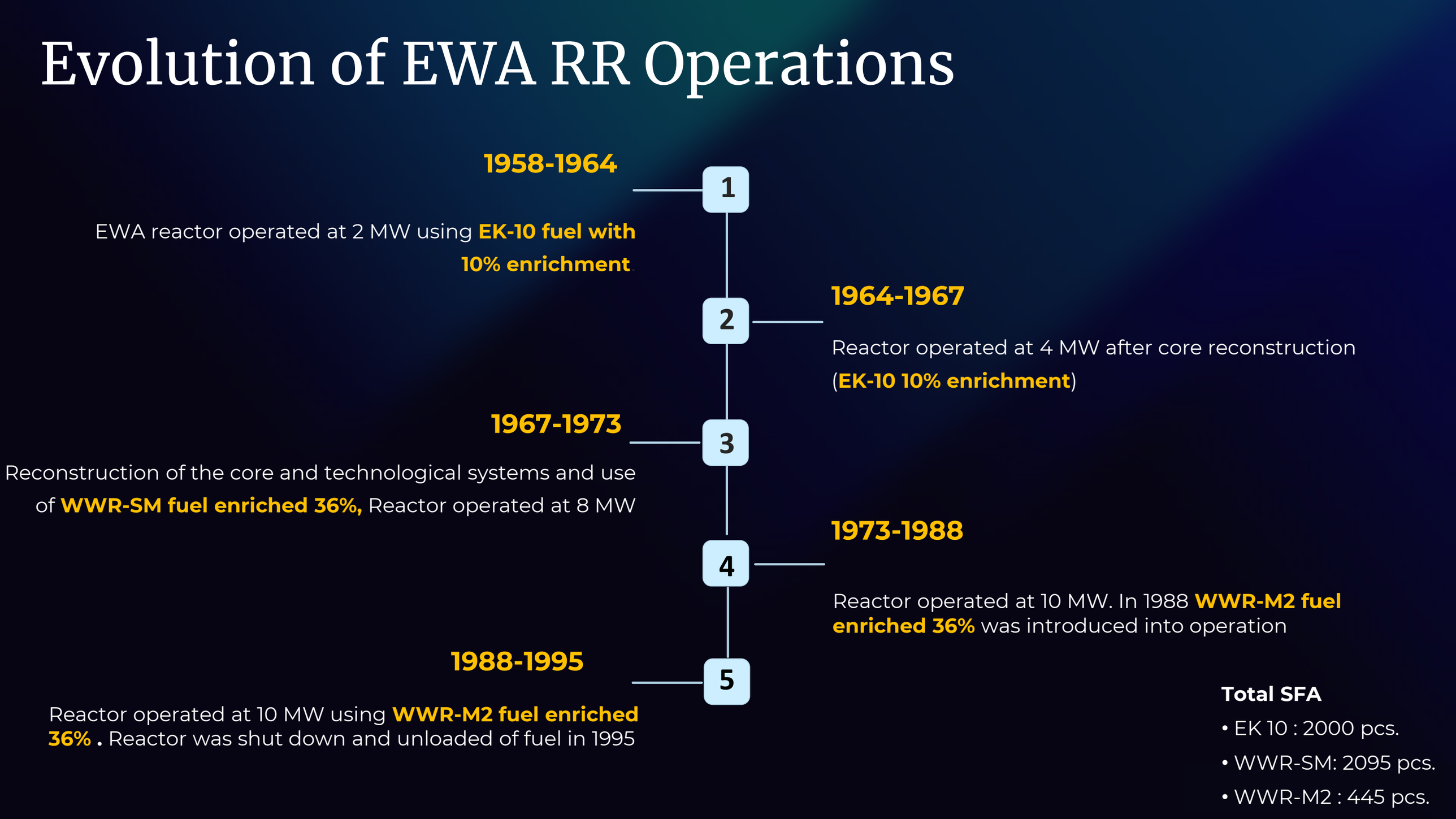
The name EWA is an acronym: **E**xperimental, **W**ater, **A**tomic

- 2 MW pool type reactor with **EK 10 Fuel**
- used for isotopes production and physical experiments in horizontal channels



1974

Evolution of EWA RR Operations



Total SFA

- EK 10 : 2000 pcs.
- WWR-SM: 2095 pcs.
- WWR-M2 : 445 pcs.

EWA RR: Decommissioning Overview

Initiation of Decommissioning:
Began in 1997

IAEA Classification:
Reached "End of Phase 2" in 2002
All nuclear fuel and irradiated elements removed, eliminating radiological hazards

Current Status:
No radioactive emissions into the environment
Renovation of the biological shield building completed
Offices adapted for the Radioactive Waste Management Plant (RWMP)

Future Plans:
Further decommissioning work suspended
No plans for "green grass" state (Phase 3) due to potential use of biological shield for dry storage of SNF from the MARIA reactor

MARIA Research Reactor: General data

MARIA RR:

- Type: High-flux pool-type reactor
- Nominal Thermal Power: 30 MWt

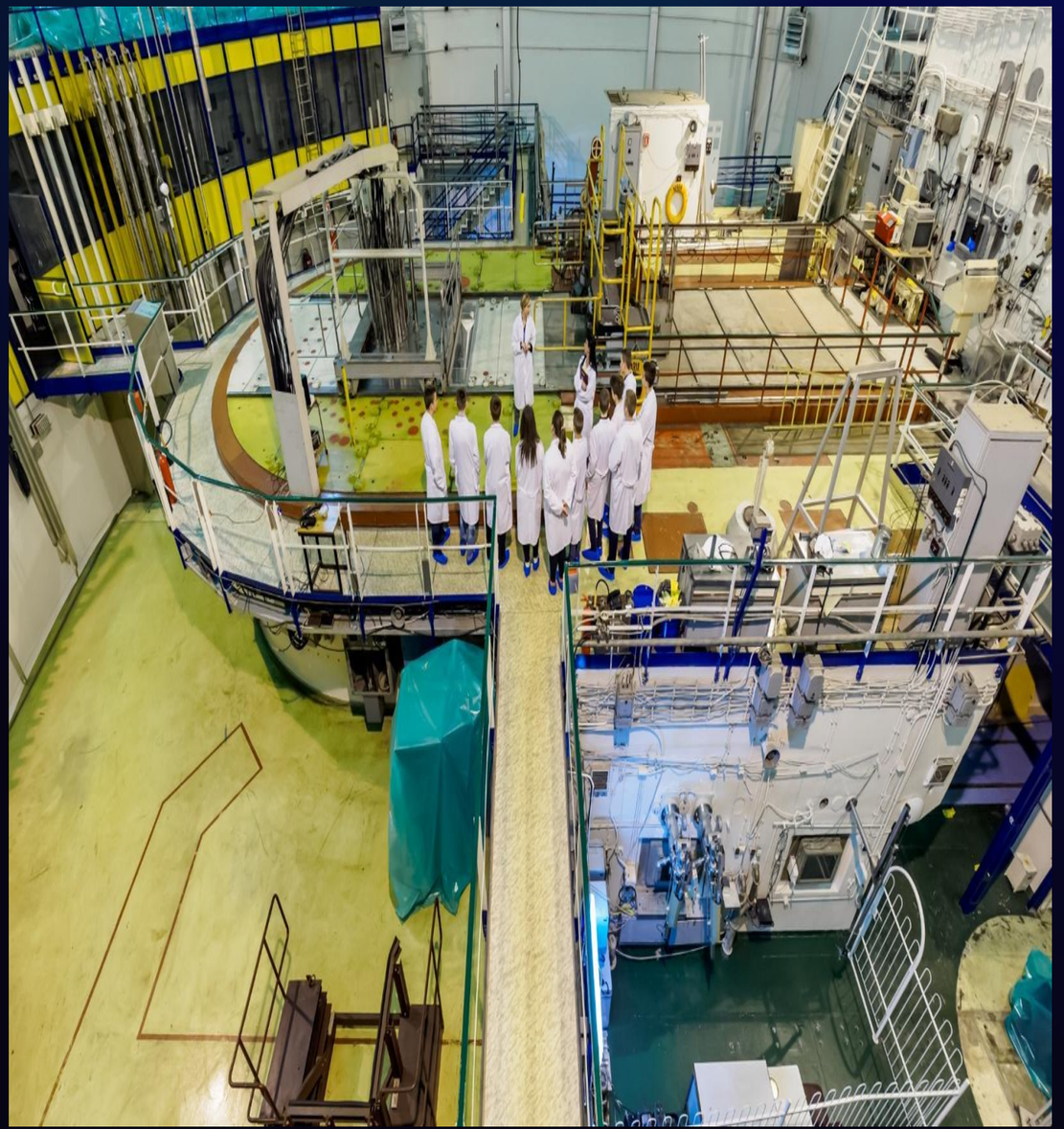
National Centre for Nuclear Research (NCBJ)

Formation:

- Merger of the Institute for Nuclear Problems and IEA POLATOM on September 1, 2011

Role:

- Operator of the MARIA research reactor, Poland's only operational reactor



MARIA Reactor and Fuel Conversion

- Operational **since 1974,** currently active
- Modernization break from **1985-1993**
- Fuel enrichment was decreased from 80% to 36% **(1999 to 2002)**
- Shipment of SNF **type MR** from MARIA reactor to 19a nuclear facility **(1999 to 2002)**
- Conversion from high-enriched uranium (HEU) to low-enriched uranium (LEU) as part of the Global Threat Reduction Initiative (GTRI) program **in 2014**

Fuel Enrichment

Gradual conversion from 36% to below 20% U-235 in 2014

Conversion Program-cooperation with ANL, USA

Associated with the GTRI close collaboration with Argonne National Laboratory, USA

SNF Management Strategy - historical context

Initial Assumptions:

- Responsibility for SNF management was believed to rest with fuel suppliers (Soviet Union)
- Early plans included returning SNF to supplier post initial cooling in wet storage

Post-1991 Changes:

- Dissolution of the Soviet Union necessitated a reevaluation of SNF management strategy
- New political realities in Eastern and Central Europe required adaptation of existing frameworks
- Difficulties with costs, legal complexities, and technical
- Decision to adopt long-term storage (biological shield of the former EWA RR)

1

Initial Cooling

SNF cooled in wet storage

2

Reprocessing

Transfer to Russian Federation, Great Britain, or France considered

3

Long-Term Storage

Wet and dry storage in Poland adopted

SNF Management Strategy–Currently Approach

1

Stage 1: Wet Storage

10-50 years in wet storage facilities.
Reducing activity and heat production

2

Stage 2: Dry Storage

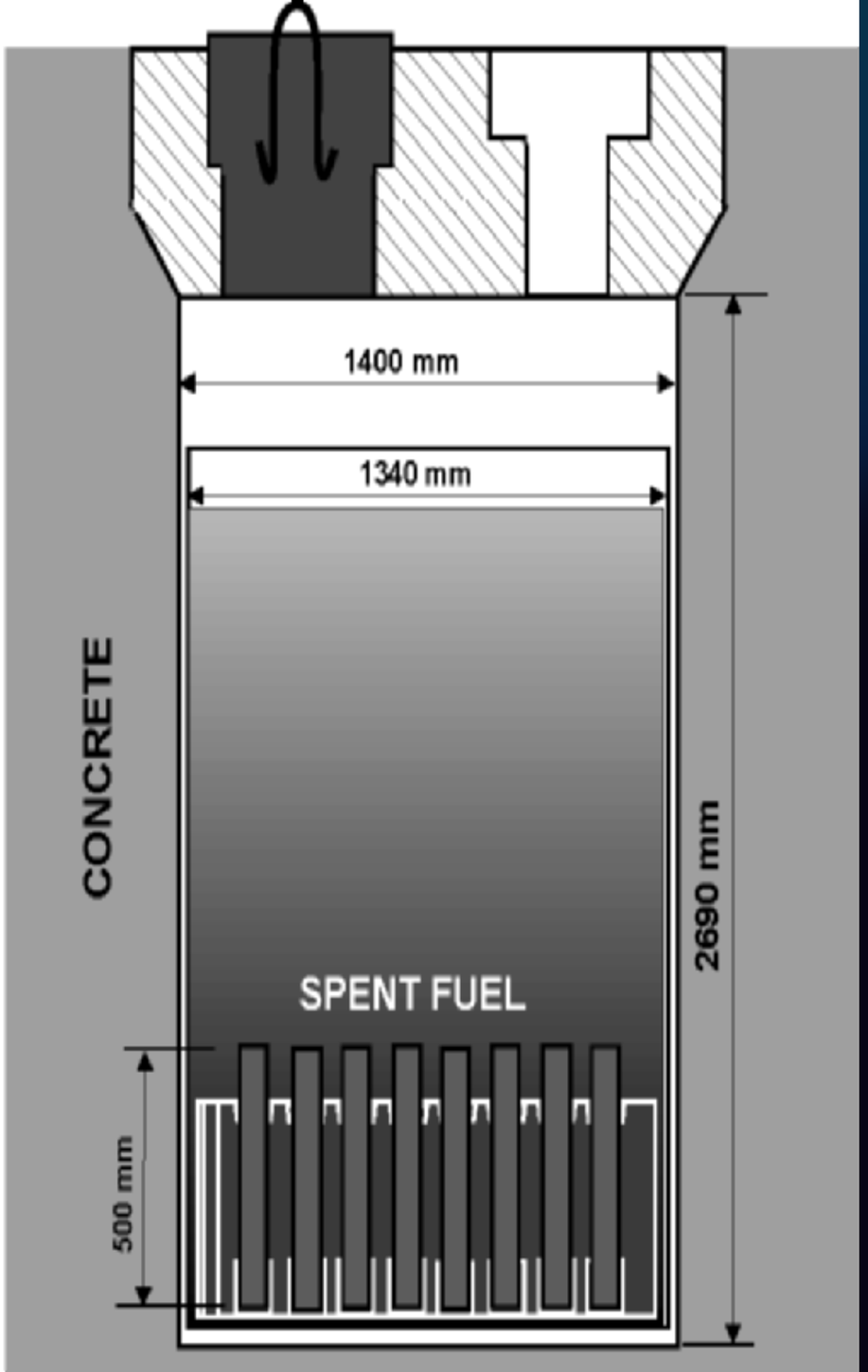
50-100 years in dry conditions

3

Stage 3: DGR Disposal

Disposal in a deep geological repository
Consider the retrieval option during the emplacement SNF process

The results of analyses conducted by the Ministry of Economy indicated that in Poland's situation, an open cycle would be more economically advantageous (from 30 to 50%) than a closed cycle. However, global trends in this area will be constantly monitored and, if necessary, if it is justified, appropriate changes will be introduced in the proposed solutions.



Wet Storage Facilities

Facility 19

Operational since 1959, stored EK-10 fuel rods. Currently is using for solid waste from EWA decommissioning

Facility 19A

Operational since 1968, stored WWR-SM and WWR-M2 SNF

Technological Pool

The MARIA reactor used fuel assemblies of the MR-5 and MR-6 types, which were placed in special channels ensuring their proper cooling. The MR assemblies from the MARIA reactor were stored in the reactor's technological pool

SNF from the EWA and Maria reactors was stored in wet storage facilities for about 50 years

Key Considerations for Wet Storage

1

Tightness of SFA

Ensuring the integrity of fuel element casings

2

Water Quality Monitoring

Parameters to monitor:

- pH
- Conductivity
- Radioactivity (isotopic composition)
- Chemical composition

3

Recent development

Post-2016: No SNF stored in facilities 19 and 19A.
Fuel Export: All SNF elements exported to the Russian Federation under the GTRI Program.

Transition to Dry Storage: Enhancing Safety

SNF MR

MR spent fuel capsule closing process were performed in hot chamber of MARIA reactor. SNFs were stored in helium-filled capsules in the MARIA reactor's technological pool

SNF EK-10, WWR

Encapsulation of EK-10 and WWR SNF was launched in 2008. By the end of 2009, EK-10 SNF rods were encapsulated into stainless steel capsules.

DRY STORAGE

Wet storage should not exceed 50 years due to corrosion. Dry storage involves placing dried fuel in airtight capsules filled with inert gas. Encapsulated SNF elements were shipped to the Russian Federation

Global Threat Reduction Initiative (GTRI) Program

In 2004, as part of the American Global Threat Reduction Initiative (GTRI) and a positive response from Poland to the project of returning fuel stored in Poland from research reactors to the producer country (Russian Research Reactor Fuel Return), as well as a declaration of the US government on financial participation in the project, its implementation began in 2009.

Challenges of the GTRI Program

Technical Challenges

1. Creation of Technical Base

- Ensuring safe reloading of spent nuclear fuel into transport containers suitable for public road transport in Poland and abroad.

2. Safe Storage Conditions

- Establishing secure, periodic storage for fuel containers, including physical protection measures at:

  - at Swierk Centre, -Shipping yard, - Airport

Organizational Challenges

1. Technology Development

- Developing technology for reloading fuel into ŠKODA and TUK transport containers at RWMP facilities.

2. Safety Report Preparation

- Creating a Safety Report for the reloading of MR, EK-10, and WWR spent fuel to obtain necessary permissions from the President of the PAA.

3. Quality Assurance Program

- Establishing a quality assurance program related to the export of SNF.

4. Certification Acquisition

- Obtaining certification from the President of the PAA for the use of ŠKODA and TUK containers for transport within Poland.

5. International Arrangements

- Coordinating with IAEA and EUROATOM to establish conditions for monitoring the reloading of fuel into transport containers.

The successful implementation of the GTRI program in Poland hinged on overcoming these technical and organizational challenges to ensure the safe and efficient export of SNF

Transportation of SNF: Ensuring Security

1

2009-2016

Eight transports of SNF were carried out to the Russian Federation.
Each transport required permission from the National Atomic Energy Agency (NAEA).

2

Different types of transport

Seven transports were by land and sea, while the eighth was by land and air.

3

International Cooperation

International experts and anti-terrorist units supervised the operation.

Disposal of Spent Nuclear Fuel

Current Status

- Research and Planning Stage: Disposal of SNF is still in the early phases.
- No Identified Location: A deep geological repository (DGR) has yet to be established

Historical Attempts to Identify DGR Locations

1. 1997-1999 Strategic Government Program:
   - Conducted preliminary studies on potential DGR sites.
   - Findings:
     - Granite bedrock deemed unsuitable due to fractures.
     - Identified homogeneous clay rock deposits and three salt domes for further study.

2. 2014 Polish Underground Research Laboratory (PURL):
   - Initiated further studies on DGR locations.
   - Objective: Continue research from the late 1990s.
   - Status: Work suspended due to delays in nuclear power plant launch and lack of funding.

Future Plans

- National Plan for Management of Radioactive Waste: A DGR for radioactive waste, including SNF, is planned.
- Aligns with the Polish Nuclear Power Program, the key document for nuclear sector development. Management Strategy for SNF:
  - Preference for an open fuel cycle: Disposal of spent nuclear fuel in a DGR.
  - Potential for a closed fuel cycle in future strategies, involving processing of SNF.

SUMMARY

Growing Interest in Nuclear Power

Further improve SNF management strategy to ensure safety for people and environment

Energy strategy

SNF is a key element of Poland's energy strategy

Transport, storage and disposal SNF must be carefully managed to minimize risk to people and environment

International Collaboration

Collaboration with international organizations helped shape and improve SNF management practices in Poland. Thanks to GTRI our country gained experience and developed a proper technology for handling with SNF