Challenges in Operation Disposal Facilities for Low- and Intermediate- Level Radioactive Waste in the Czech Republic over the Years

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Introduction

Radioactive Waste Repository Authority (SÚRAO)

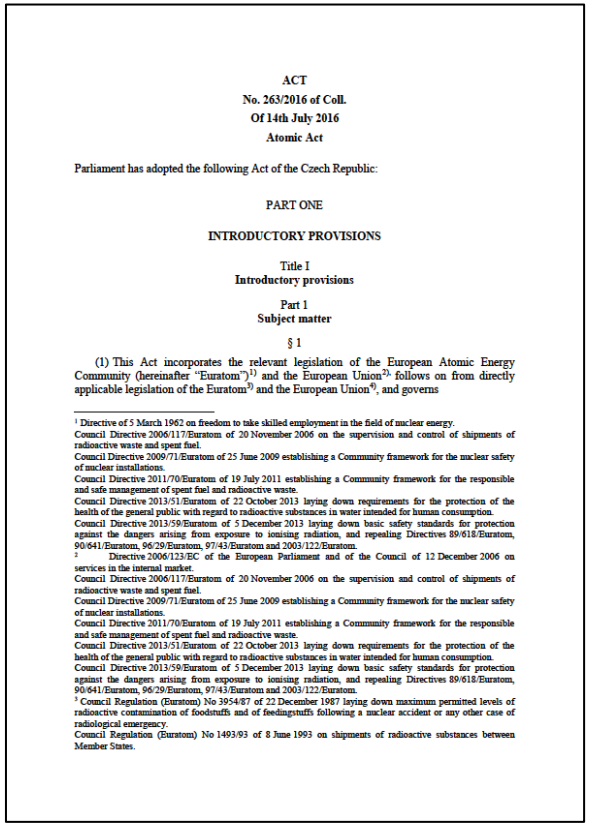
- Established by the Ministry of Industry and Trade in 1997 by Atomic Act No. 18/1997 Coll. as a state organization responsible for the safe disposal of all RW in the Czech Republic

- **Key activities are:**
  - operation of low- and intermediate-level waste repositories;
  - disposal of all existing and future RW;
  - development, construction and operation of a deep geological repository.
- **Other activites are**:
  - monitoring of the impact of RW repositories on the local environment;
  - maintaining records of accepted radioactive waste and its producers;
  - administering payments made by radioactive waste producers to the Nuclear Account;
  - verification of decommissioning costs as a part of decommissioning plan;
  - management of RW transported to the Czech Republic from abroad which cannot be returned to the country of origin or orphan sources management.

Legal Framework

Atomic Act No. 263/2016 Coll., as amended defines and governs:

a) the conditions for the peaceful uses of nuclear energy,
b) the conditions for performing activities in exposure situations,
c) radioactive waste management and spent fuel,
d) the type-approval of certain products in the area of peaceful utilization of nuclear energy and ionising radiation and the conditions for shipment of radioactive or fissile materials, radioactive waste or spent fuel,
e) radiation situation monitoring,
f) radiation extraordinary event management,
g) the conditions for security of nuclear installations, nuclear materials and sources of ionising radiation,
h) the requirements for ensuring the non-proliferation of nuclear weapons,
i) the exercise of state administration in the area of the peaceful utilization of nuclear energy and ionising radiation.



ACT
No. 263/2016 of Coll.
Of 14th July 2016
Atomic Act

Parliament has adopted the following Act of the Czech Republic:

PART ONE

INTRODUCTORY PROVISIONS

Title I
Introductory provisions

Part 1
Subject matter

§ 1

(1) This Act incorporates the relevant legislation of the European Atomic Energy Community (hereinafter "Euratom")[1)] and the European Union[2)] follows on from directly applicable legislation of the Euratom[3)] and the European Union[4)], and governs

[1] Directive of 5 March 1962 on freedom to take skilled employment in the field of nuclear energy.
Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel.
Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations.
Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.
Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption.
Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.
[2] Directive 2006/123/EC of the European Parliament and of the Council of 12 December 2006 on services in the internal market.
Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel.
Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations.
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[3] Council Regulation (Euratom) No 3954/87 of 22 December 1987 laying down maximum permitted levels of radioactive contamination of foodstuffs and of feedingstuffs following a nuclear accident or any other case of radiological emergency.
Council Regulation (Euratom) No 1493/93 of 8 June 1993 on shipments of radioactive substances between Member States.

Main associated decrees:

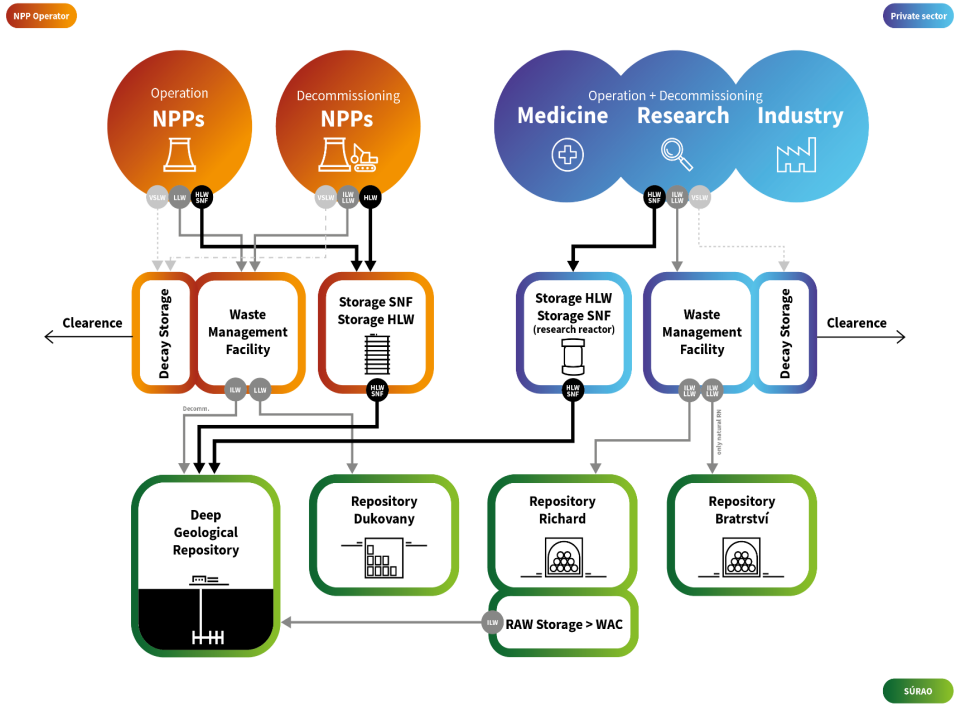
Decree No. 359/2016 Coll., on details of ensuring radiation extraordinary event management
Decree No. 360/2016 Coll., on radiation situation monitoring
Decree No. 361/2016 Coll., on security of nuclear installation and nuclear material
Decree No. 375/2016 Coll., on selected items in the nuclear area
Decree No. 378/2016 Coll., on siting of a nuclear installation
Decree No. 422/2016 Coll., on radiation protection and security of a radioactive source
Decree No. 21/2017 Coll., on assuring nuclear safety of a nuclear installation
Decree No. 408/2016 Coll., on management system requirements of persons ensuring radiation protection of the registrant
Decree No. 162/2017 Coll., on the requirements for safety assessment according to the Atomic Act
Decree No. 258/2016 Coll., on requirements for assurance of quality and technical safety and assessment and verification of conformity of selected equipment
Decree No. 377/2016 Coll., on the requirements for the safe management of radioactive waste and on the decommissioning of nuclear installations or category III or IV workplaces
Decree No. 379/2016 Coll., concerning the approval of some products in the field of peaceful use of nuclear energy and ionising radiation and the carriage of radioactive or fissile material

Operational Disposal Facilities

- SÚRAO operate 3 disposal facilities:
  - Repository Bratrství - near-surface DF, ILW/LLW, institutional RW only nature RN
  - Repository Richard - near-surface DF, ILW/LLW, institutional RW
  - Repository Dukovany - surface DF, LLW, operational RW

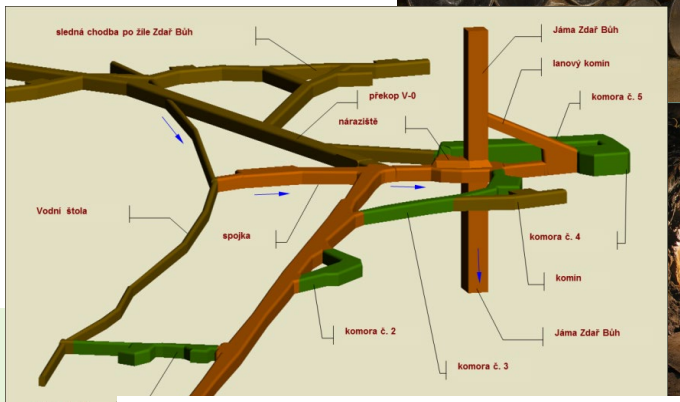
- Each DF has individual SC, Documentation and WAC

- Repository Richard has permanent and internal staff
- Repository Bratrství doesn´t have permanent staff, operated by staff of Repository Richard
- Repository Dukovany has permanent internal staff and is operated by a contractor

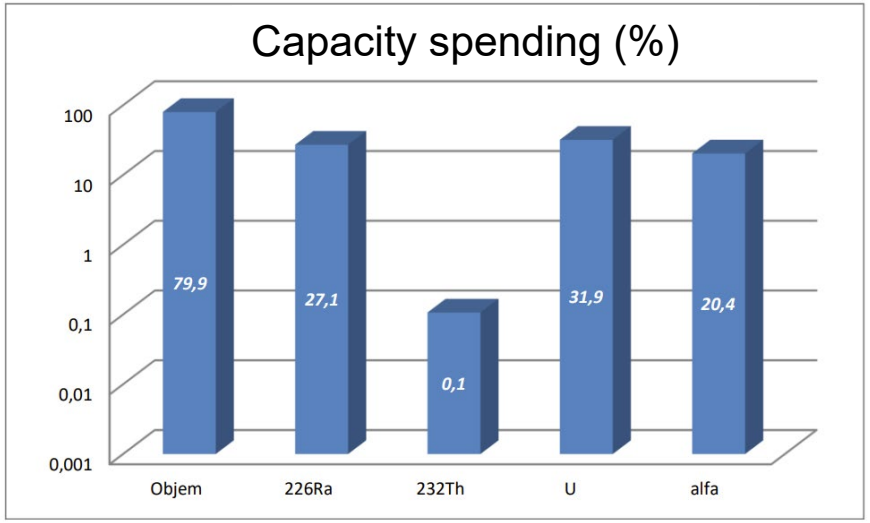


Repository Bratrství

- Originally silver mine since 16th century and since 19th century uranium ore mine
- Commissioned in 1974 as disposal facility (only 1 floor of the mine complex), 51 yrs of safe operation
- By SÚRAO operated since 2000
- Capacity 1 200 m^3 (almost spent), planned enlargement
- Disposal of institutional ILW/LLW containing only nature RN

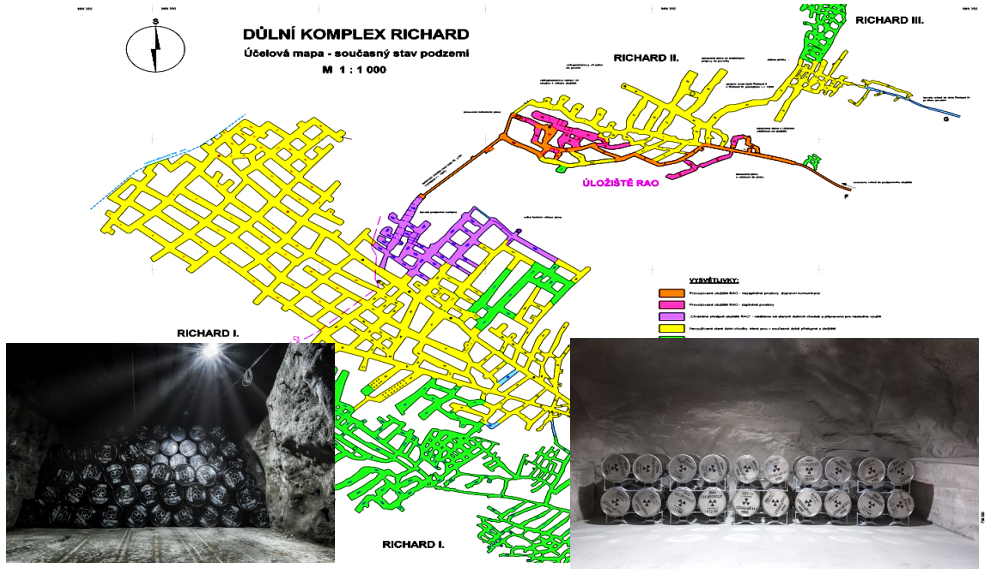


- RW is disposed of in steel drums in cemented form with a limited life time – high conservative approach
- Isolation function is provided by the cement/concrete backfill, degradation in SC model is considered to be started 100 yrs after DF closure
- Institutional control after closure is planned for 100 yrs
- Inventory in SC considered as disposed RW + future produced RW according to the volume capacity including the planned enlargement
- Transport of RN in biosphere in the SC is performed by the surface water flows
- The transport pathways to biosphere are agriculture crops irrigation, water for agriculture animals or fish consumption

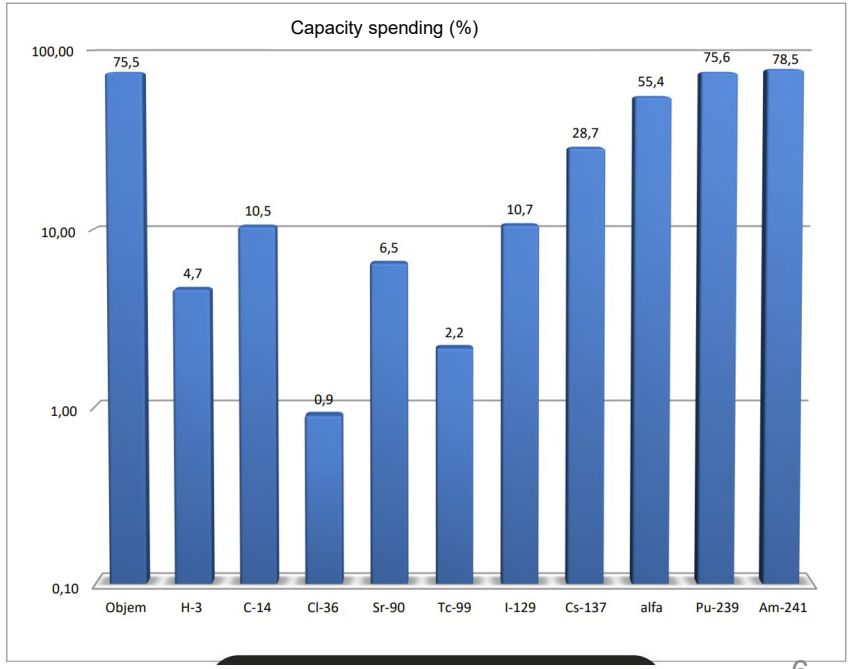


Repository Richard

- Originally lime stone mine since 19th century, during 2nd WW underground factory and after that a lime stone mine again
- Commissioned in 1964 as a disposal facility, 61 yrs of safe operation
- By SÚRAO operated since 2000
- Dedicated for disposal of institutional LLW/ILW
- Capacity about 12 650 m^3 (originaly 8000 m^3)
- Capacity (volume) enlargement is under preparation - using already excavated chambers and corridors

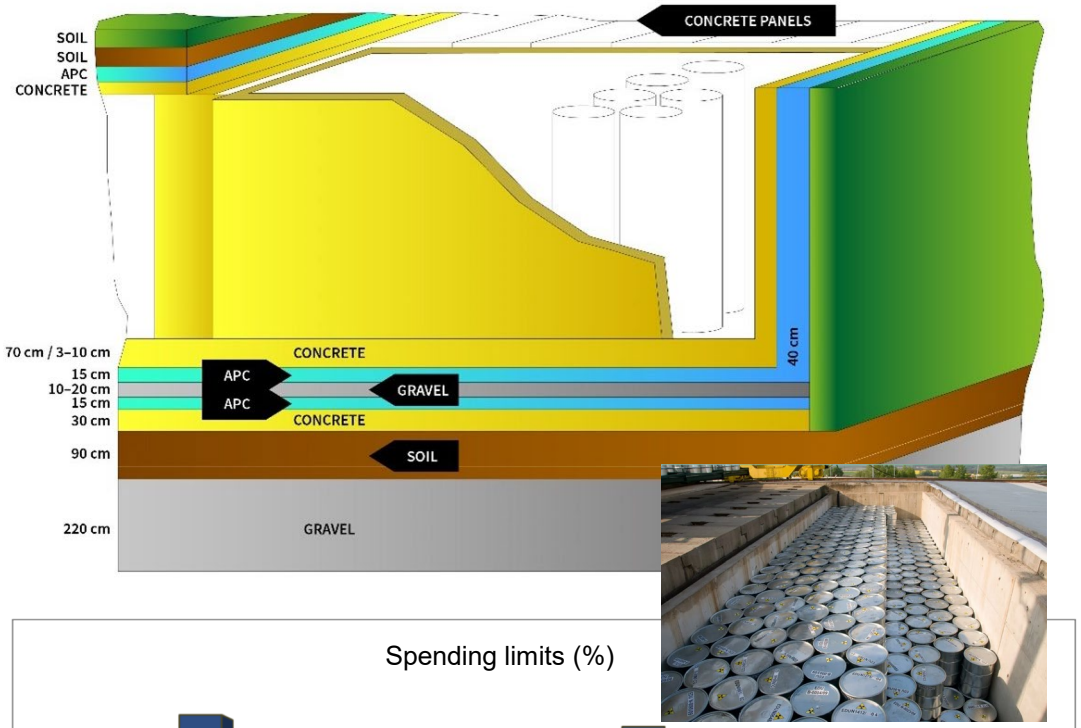


- RW is disposed of in steel drums in cemented form with a limited life time – high conservative approach
- Safety function is performed by the cement/concrete backfill, degradation in SC model is considered to be started 100 yrs after DF closure
- Institutional control after closure is planned for 100 yrs
- Inventory in SC considered as disposed RW + future produced RW according to the volume capacity including the planned enlargement
- Transport of RN in biosphere in the SC is performed by the underground water flow
- The pathways in biosphere are crops irrigation, water for agriculture animals from „agriculture well“, drinking water consumption

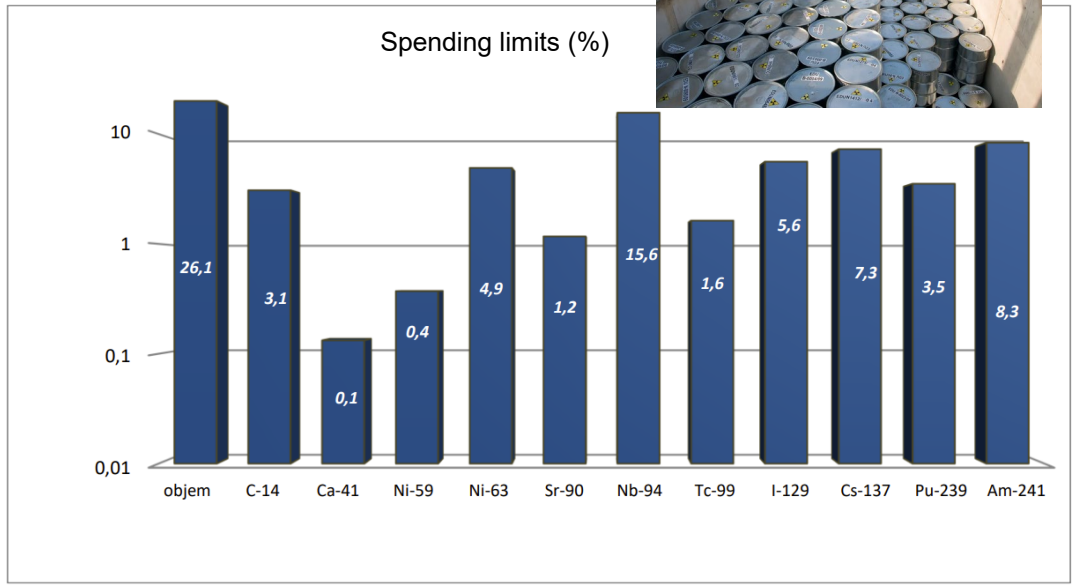


Repository Dukovany

- Surface disposal facility, concrete construction with Asphaltopolypropylen seeling, multibarirer system
- Situated in the area of NPP Dukovany
- Commissioned in 1995, 30 yrs of safe operation
- By SÚRAO operated since 2000
- Disposal of operational LLW, vault type, total capacity about 55 000 m^3, 112 vaults organised into 2 double rows (¼ of capacity already filled)



- RW is disposed of in steel drums in fixed or nonfixed form (cement, geopolymer or bitumen matrix), in SC model is considered total capacity of disposed RW and volume of backfill concrete – high conservative approach
- Safety function is performed by the cement/concrete backfill as well as by APC sealing, start of degradation in SC model is considered 300 yrs after DF closure
- Institutional control is planned for a period of 300 yrs after closure
- Inventory in SC considered as disposed RW + future produced RW according to the volume capacity of DF
- Transport of RN in biosphere in the SC is performed by the underground water flow, and the leakage of 14C close to the farm situated near DF, in parallel (SC also considers the introduction of 14C by the photosynthesis into the food cycle)
- The pathways in biosphere are crops irrigation, water for agriculture animals from „agriculture well“, drinking water consumption



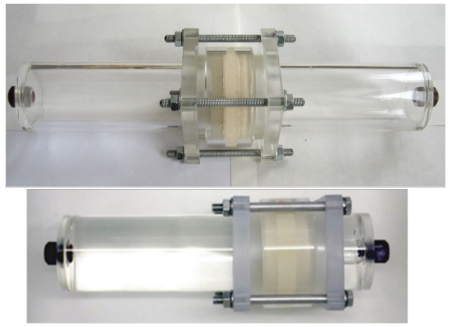
R&D and Technical Challenges in Bratrství Repository

2002

- Research and development of backfill material based on local conditions (porosity, permeability, mechanical strenght, corrosion processes)
- Basic requirements on backfill material:
  - low hydratation heat
  - environmental influence XA1, XC2
  - concrete of strength class C 30/37 according to EN 206

2023-
-2024

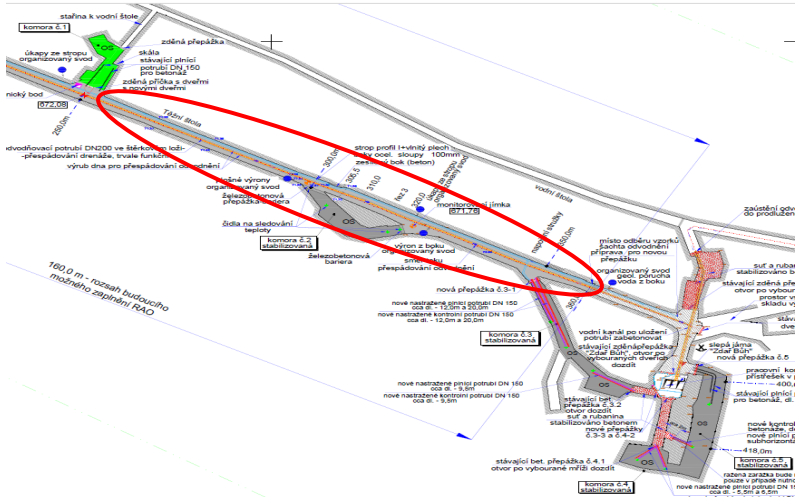
- Research and development of material used as construction material or barrier items (diffusion coeficients, sorption coeficients, hydraulic conductivity, gas permeability)
- Imputs for updated Safety Case

R&D and Technical Challenges in Bratrství Repository

2028--2030

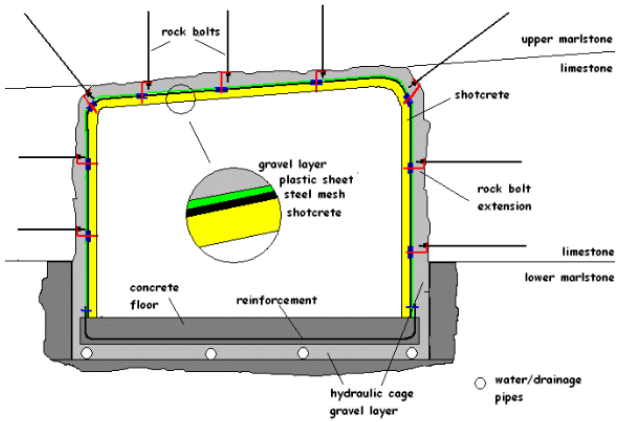
- Capacity enlargement, using the back part of entrance corridor
- Necesary to perform some technical modifications to transform corridor into disposal segment
- Safety Case analysis confirm enabling such activities
- Capacity enlargement (volume) represent 30 – 40 years of disposal



R&D and Technical Challenges in Richard Repository

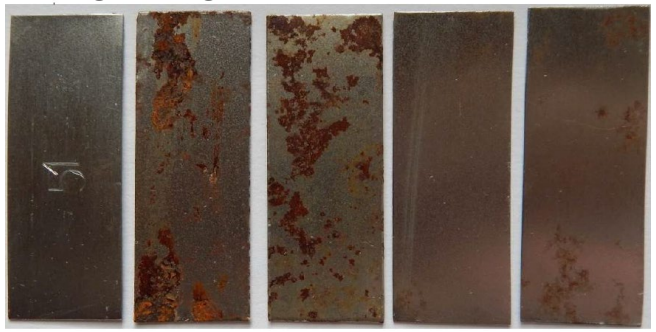
2005--2007

- Construction of „Hydraulic Cage“, concept of ensuring isolation of radionuclides from the accessible environment – a principle of forming preferential pathways for water
- A pilot program, developing the backfill concrete recipe (used till now)
- Historical RW recieved before 1999 was removed, conditioned according WAC and repacked and finally disposed in disposal chamber including the backfilling



2017

- Development of WP for Long term Storage
- Corrosion test of materials for WP construction in the environment of repository
- Storage regime for RW over the WAC, such RW is dedicated for disposal in DGR

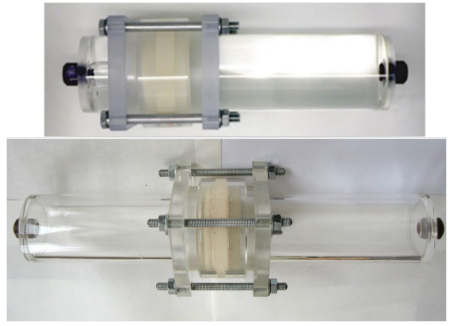


R&D and Technical Challenges in Richard Repository

2023--2024

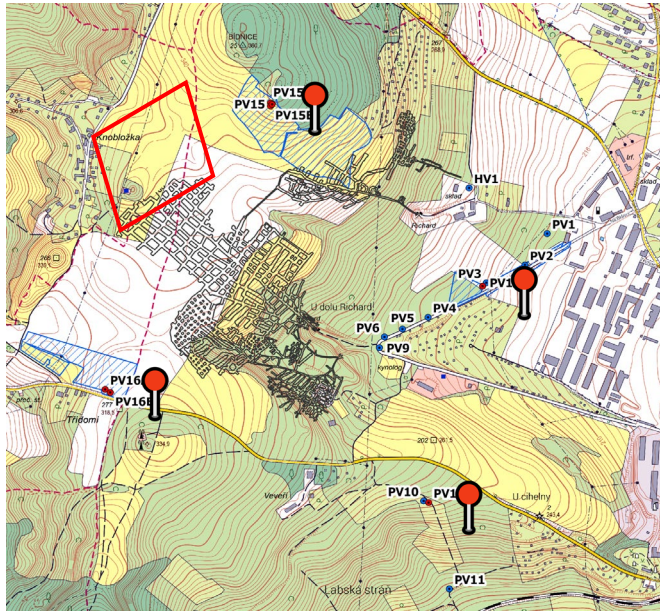
- Research and development of material used as construction material or barrier items (diffusion coeficients, sorption coeficients, hydraulic conductivity, gas permeability)
- Imputs for updated Safety Case




2025

- Expanding the network of monitoring drillholes, improvement of hydrogeology model
- Ensuring the refining imputs for Safety Case model



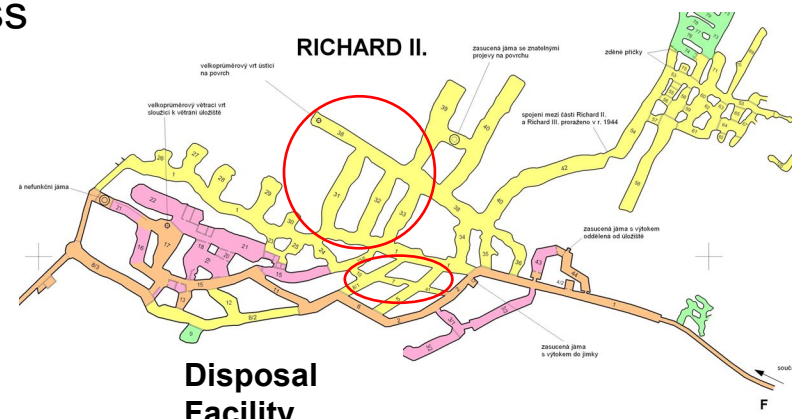
R&D and Technical Challenges in Richard Repository

2026

- Rock and rubble removement from already excavated area
- Technical challenge, removement material from Nuclear instalation, legislative requirements

2027-
-2029

- Reconstruction of prepared chambers for disposal, capacity enlargement
- Licencing process



Disposal Facility

R&D and Technical Challenges in Dukovany Repository

2004--2005
- Material research and experimental processing of RW into geopolymer matrix
- Experimental work performed by external sources, initiated by operator of NPP
- Additional Safety Case analysis and WAC determination

2023
- Moving of Portal Crane installed in Dukovany repository
- 28 vaults completely filled and backfilled in row D (1/4 of total disposal capacity)
- Necessity of crane movement to row C

R&D and Technical Challenges in Dukovany Repository

2023--2024

- Research and development of material used as construction material or barrier items (diffusion coeficients, sorption coeficients, hydraulic conductivity, gas permeability)
- Imputs for updated Safety Case





Conclusions

- R&D activities contribute to the safe operation of disposal facilities and compliance with legislative requirements in nuclear safety.
- R&D activities are used to refine Safety Analyses and Safety Cases (long-term safety).
- The results of updated Safety Cases confirm the previous conservative approach and ensure an accurate description of the installation, local conditions, construction materials, and determination of lifetime (as corrosion processes).
- Updated Safety Cases and safety analyses (e.g., Operational Safety) also serve as input for the Periodic Safety Assessment currently under preparation (a legislative requirement every 10 years).

Thank You for Your Attention

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