SÚRAO | RADIOACTIVE WASTE REPOSITORY AUTHORITY

Czech Disposal Canister Programme

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WG-2 Canister Design
IGD-TP, Cordoba 10/2016

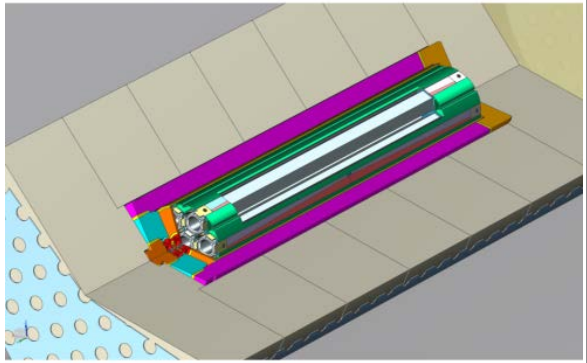
Content:

1. RD canister programme
2. Ideas / topics of interest
3. Cooperation - services

Disposal canister R&D

Current status of R&D:

- Canister design (double-walled, internal inbuild)
- Experimental approval of candidate materials
- Manufacturing the prototype: diameter 1:1, 1/2 the length

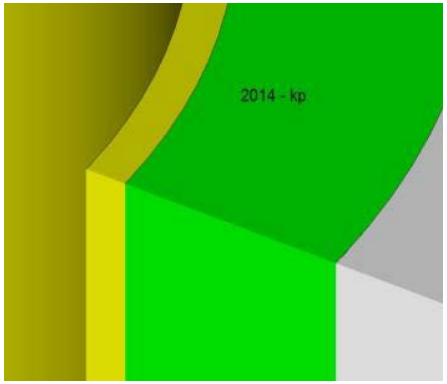


Candidate materials:

Carbon steel	EN 10222-4 P285QH, (ASTM A106 /A106M -15 Grade B)
Stainless steel	EN 10088-2, 1.4462 (AISI 317 LN); Austenitic-feritic stainless steel EN 10088-2, 1.4404 (AISI 316L); Austenitic stainless steel
Copper	EN1652, Cu-OF, CW008A, (ASTM B152M – 13, UNS C10100)
Titanium alloy	ASTM B 265-15, Grade 7

Canister design

Two concepts of design:

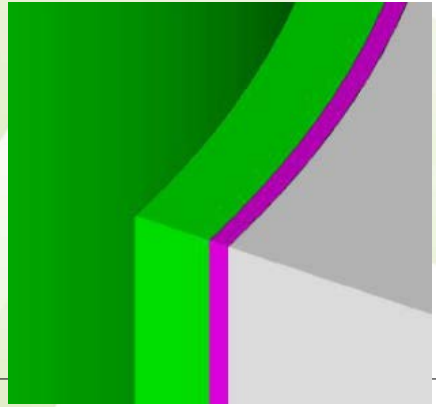


Corrosion acceptable

- ✓ Outer shell - Carbon steel
- ✓ Inner shell- Stainless steel

Corrosion resistant

- ✓ Outer shell - Copper / Titanium alloy
- ✓ Inner shell- Carbon steel



		Corrosion acceptable			Corrosion resistant		
Canister type		VVER 440	VVER 1000	„new unit“ (AP 1000)	VVER 440	VVER 1000	„new unit“ (EPR 1600)
	Dimension [mm]						
Internals	Spacing	170	300	275	170	300	275
Inner shell	Inner Ø	535	721	745	535	721	730
	Outer Ø	555	741	765	661	889	898
	Thickness	10	10	10	63	84	84
Outer shell	Inner Ø	565	751	775	661	889	898
	Outer Ø	805	1025	1049	671	899	908
	Thickness	120,0	137,0	137	5	5	5
Bottom	Thickness	180,0	206,0	206	113	120	120
Lid	Thickness	280,0	280,0	280	150	150	150

Canister design

Requirements

- Legislative requirements Decree No.317/2002 Coll. (criticality, mechanical resistance, radiation protection)
- Temperature <95°C,
- Pressure 20MPa

Calculations

- Inventory
- Criticality
- Radio-shielding
- Mechanical
- Thermo

Canister design

- Double walled
- Internal inbuild

Experimental approval

Aerobic corrosion experiments

Influence of contact with bentonite

- Material tested: – **carbon steel**
- Conditions: Ca-Mg bentonite, dry density 1.6g.cm^{-3} , saturated with synthetic granitic water, temperature 70°C, pressure 5MPa

Anaerobic corrosion experiments

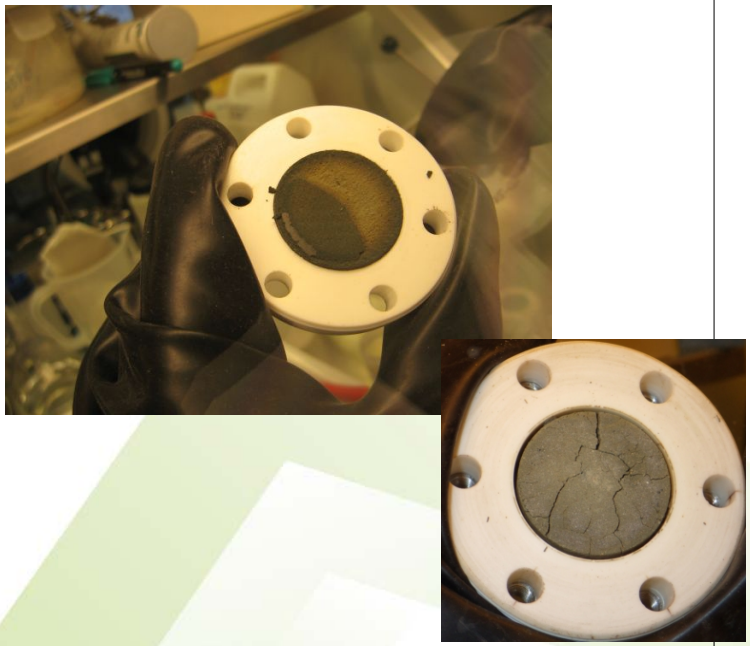
Influence of ionizing radiation

- Material tested: – **carbon steel, Cu, Ti-alloy**
- Conditions: samples were placed in synthetic bentonite pore water, temperature 90°C, emitter ^{60}Co, absorbed dose approx. 2.5 kGy/a, dose rate 0.3Gy.h^{-1}

Experimental approval

Influence of contact with bentonite

- Materials tested: – **carbon steel, Cu, Ti-alloy**
- Conditions: Ca-Mg bentonite, dry density 1.6g.cm^{-3} , saturated with synthetic granitic water, temperature 70°C



Influence of different bentonite suspension and temperature conditions

- Material tested: – **carbon steel, Cu**
- Conditions: synthetic bentonite pore water, increased concentration of Cl-, SO42- (3x, 33x, 100x initial concentration – 558.1mg/l Cl- and 2325mg/l (SO4)2-), temperature 40, 70, 90°C

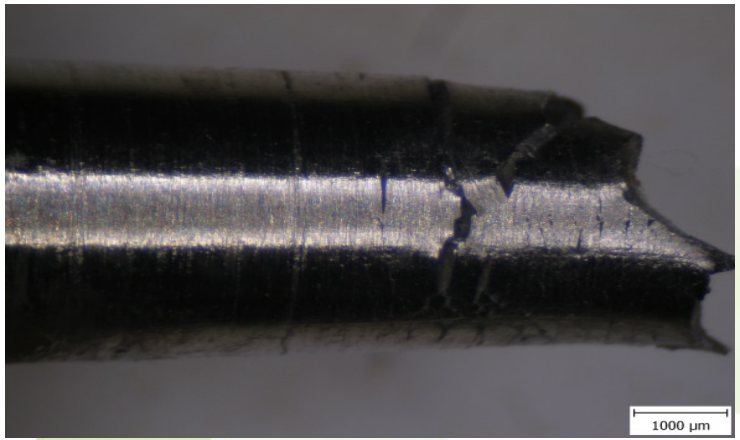
Experimental approval

Stainless steel corrosion

- Materials tested: – **stainless steel EN 1.4462 , EN 1.4404**
- Conditions: synthetic bentonite pore water
  - ✓ DGR conditions
  - ✓ Critical concentration of Cl^-
  - ✓ Corrosion cracking

Galvanic corrosion

- Conditions: synthetic bentonite pore water
- Materials tested: **carbon steel / Cu**
  carbon steel / Ti-alloy
  carbon steel / stainless steel



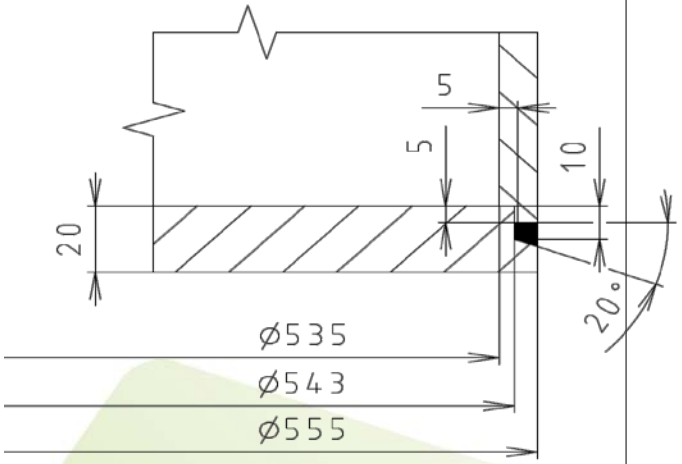
Embrittlement induced by hydrogen

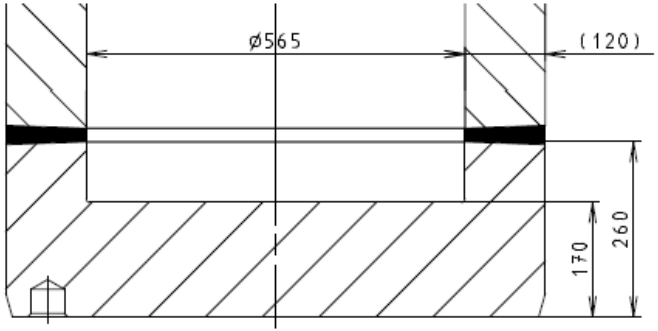
- Materials tested: **stainless steel, Ti-alloy**,
- Conditions: synthetic bentonite pore water

MaCoTe experiment (Grimsel Test Site, partners: Nagra, RWM, NWMO, SURAO)

Manufacturing the prototype

- Detail design drawings
- Technological procedure of manufacturing
  - Internals
  - Inner shell + lid
  - Outer shell + lid
  - Welding technology (welding dimension to 130mm)
  - Anealing of welds
  - Surface finishing
  - Leak test





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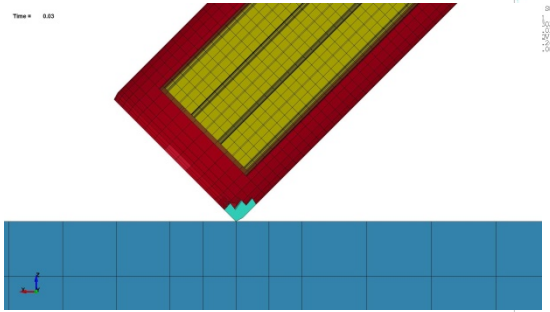
Ideas / topic of interest

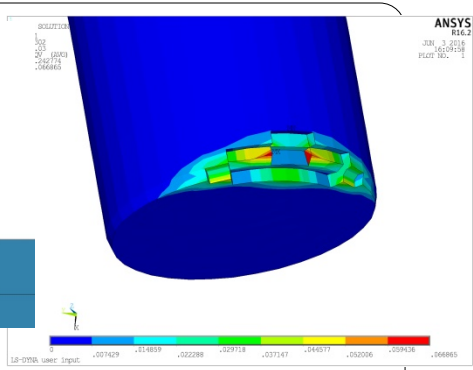
- **Full-scale demonstration test**
  - Handling technologies
  - Long term behaviour in the DGR conditions
- **Welding technology**
  - simulation of loaded canister with SNF- welding of the lid
- **Coating**
  - Technology of coating
  - Alternative coating (basalt ?)

Cooperation - services

Canister design

- Calculations (mechanical, thermo, shielding, criticality)
- Drop model calculations
- Detail design drawings

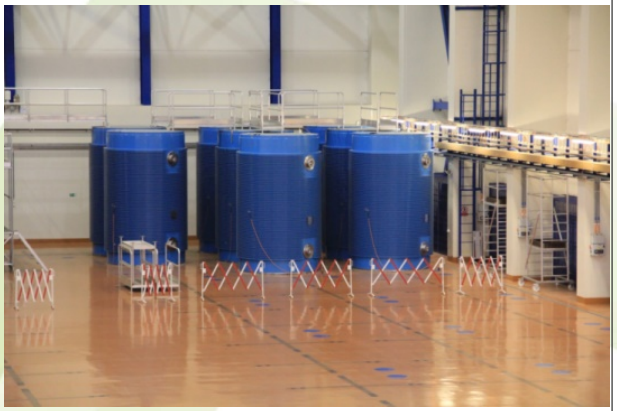




Demonstration of manufacturing technology

- Experience in the canister manufacturing (storage CASTOR casks)
- Patent on internal inbuild of the storage cask (SJS)

- Machining of canister components (body, bottom, lid)
- Welding
- Anealing of welds
- Surface finishing



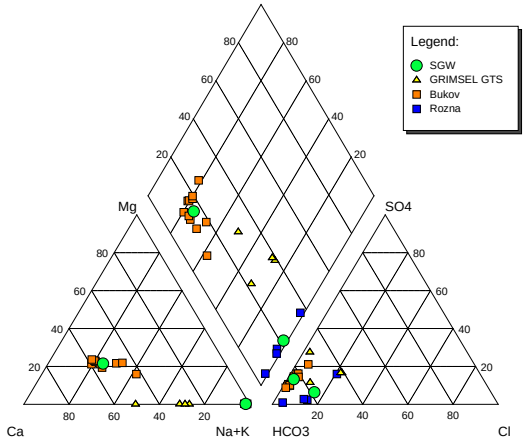
Cooperation - services

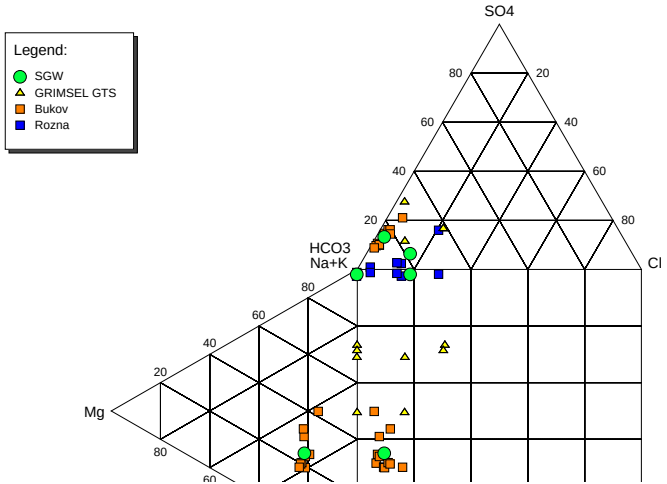
- **Experimental approval**

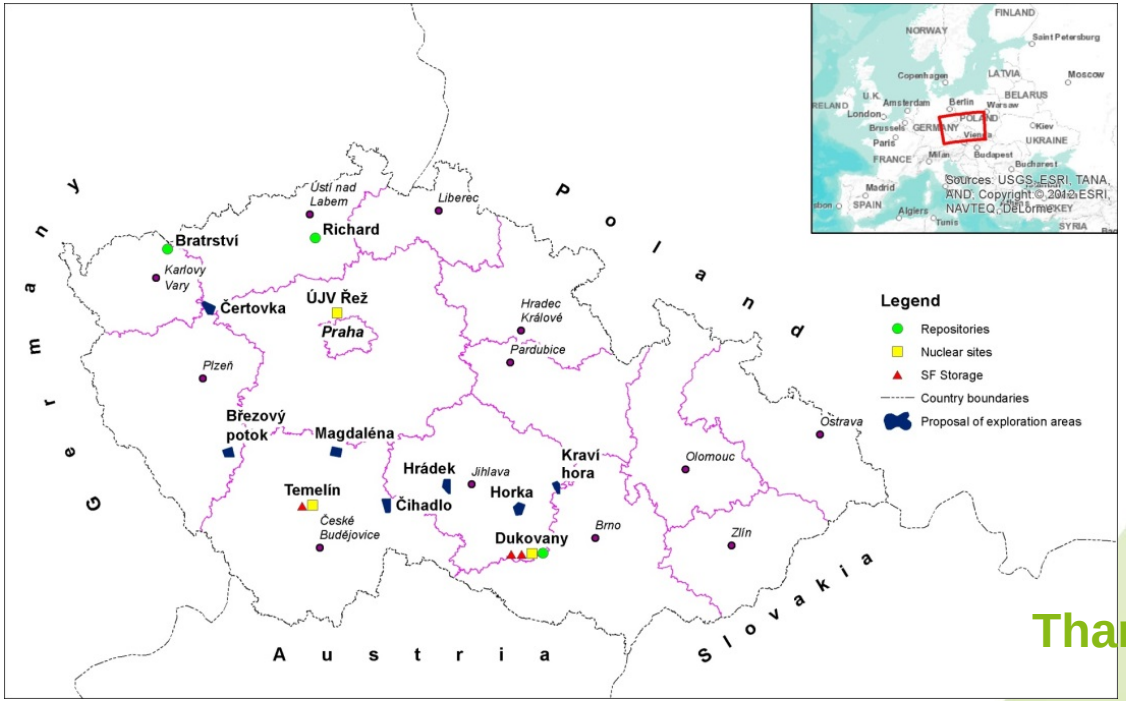
Laboratory conditions (glove boxes, ionizing radiation)

In-situ – URL Bukov (corrossion tests, full-scale tests)

	URL Bukov (600 m)	Rozna (below 1000m)	Grimsel Test Site
pH	8.23	9.44	9.6
Na [mg/l]	16.53	89.42	15.9
K [mg/l]	2.14	0.67	0.15
Mg [mg/l]	8.32	0.67	0.013
Ca [mg/l]	34.59	1.32	5.08
Sr [mg/l]			0.161
F [mg/l]		9.93	6.26
Cl [mg/l]	3.32	18.7	5.5
SO4 [mg/l]	20.98	10.47	5.5
HCO3 [mg/l]	168.66	163.52	25.62
CO2 suma [mg/l]			<7E-10







Thank you for your attention

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