Long-Term Safety Assessment for the planned Bulgarian Surface Disposal Facility for Low- and Intermediate Level Waste from NPP Operation and Decommissioning

B. Haverkamp

DBE TECHNOLOGY GmbH, Peine, Germany

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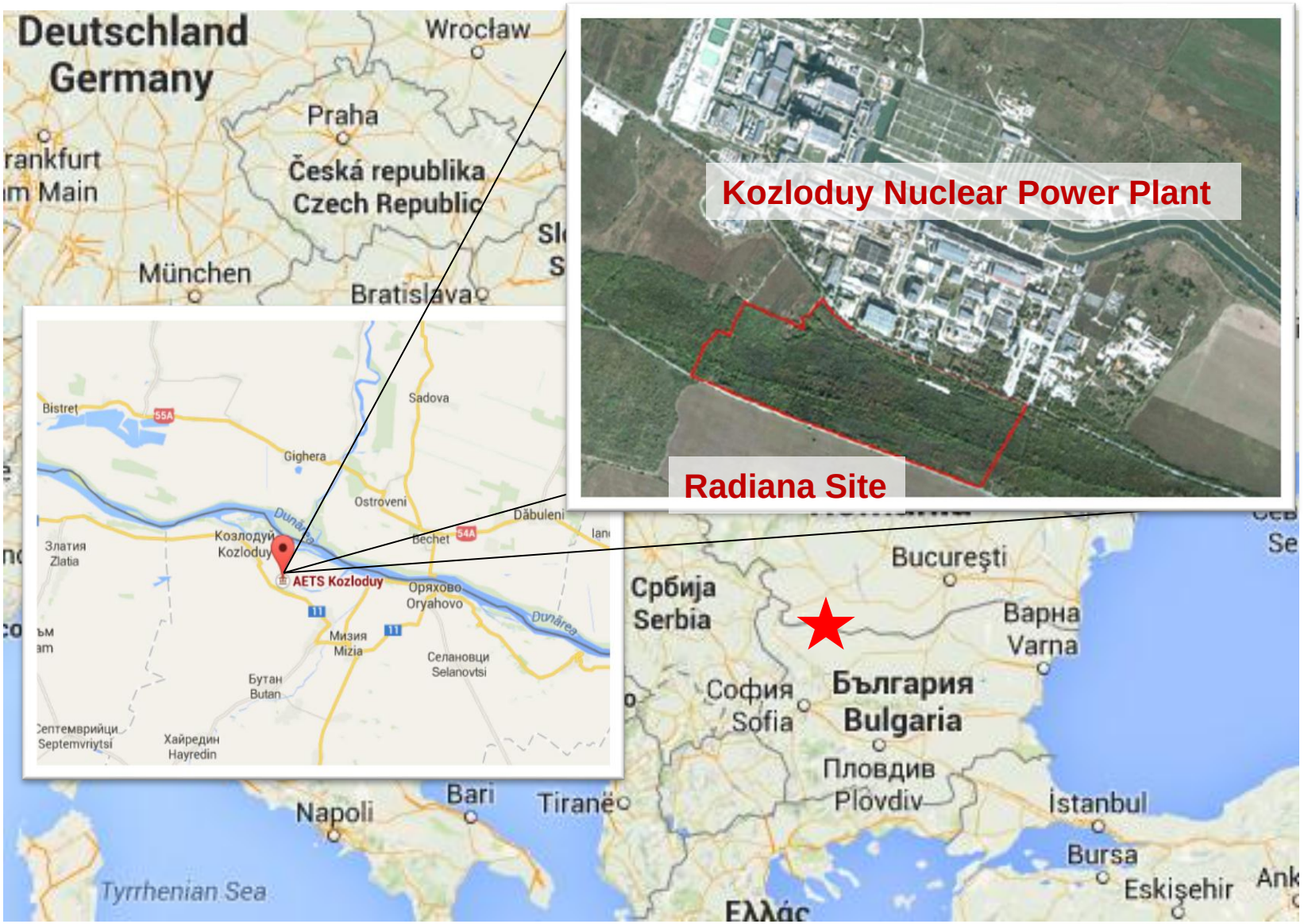
KIDSF-Project: Technical Design and ISAR Preparation for National Disposal Facility (LLW & ILW), Bulgaria

assigned to Consortium of

Westinghouse Electric Spain SA, DBE Technology GmbH (Germany) und ENRESA (Spain) with support by local Sub-contractor EQE Bulgaria AD

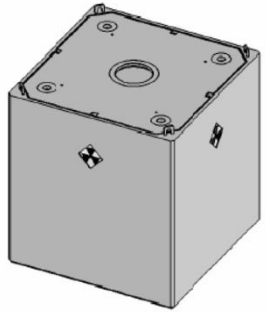
- **Objective of the project:**
  - Technical planning, including the preparation of the Intermediate Safety Assessment Report, of the NDF for LILW in Bulgaria.
  - Preparation of main documents for construction license
- **Scope of work of DBE TECHNOLOGY GmbH:**
  - Project management.
  - L-T-Safety Assessment and Environmental Impact Assessment.
  - Detailed technical design of the selected option.

Location of NDF



Main Features of Disposal facility

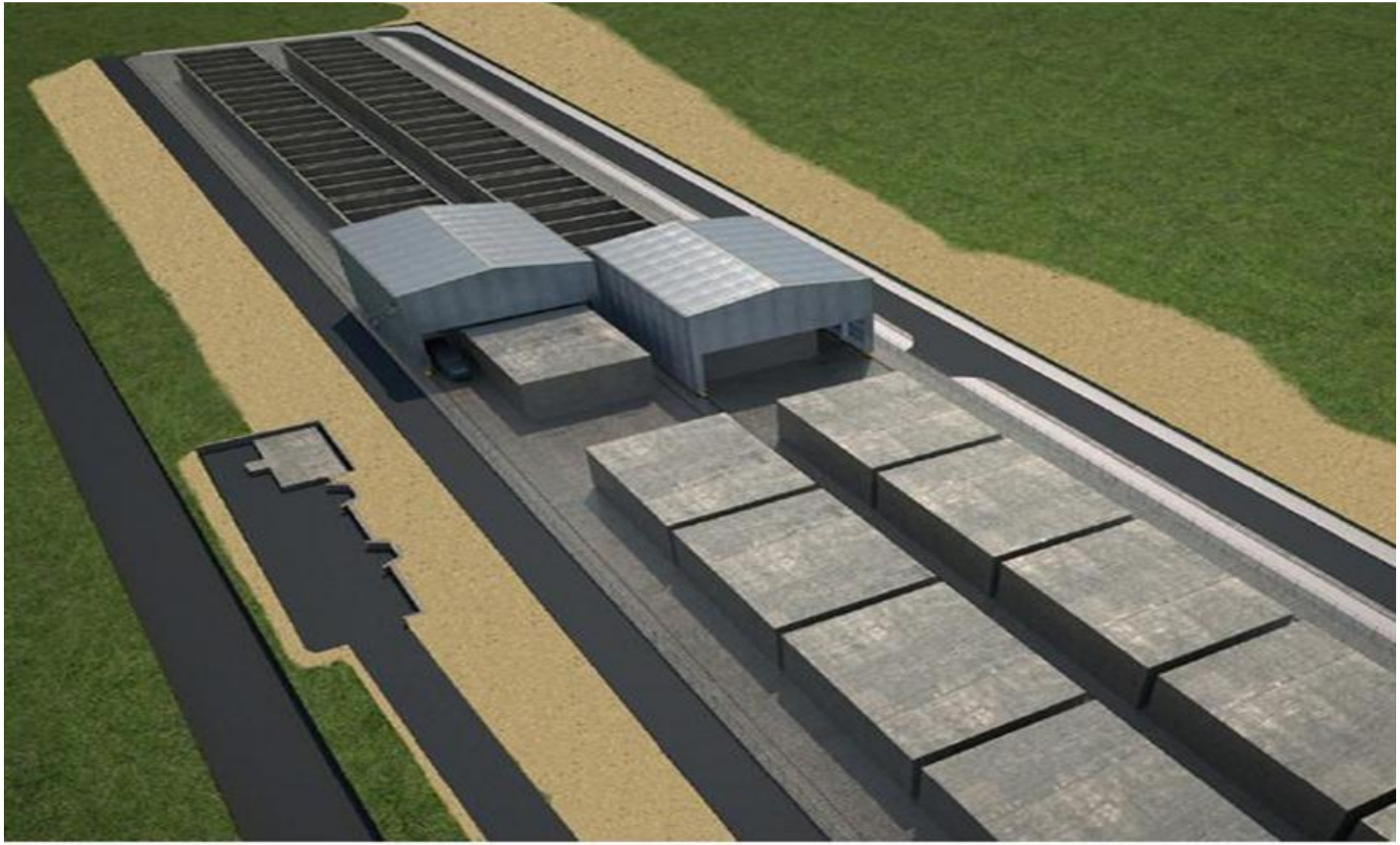
- Conceptual Design of NDF closely related to El Cabril Repository in Spain
- Vault type repository (66 vaults)
- Waste will be conditioned in 2 x 2 x 2 m concrete containers



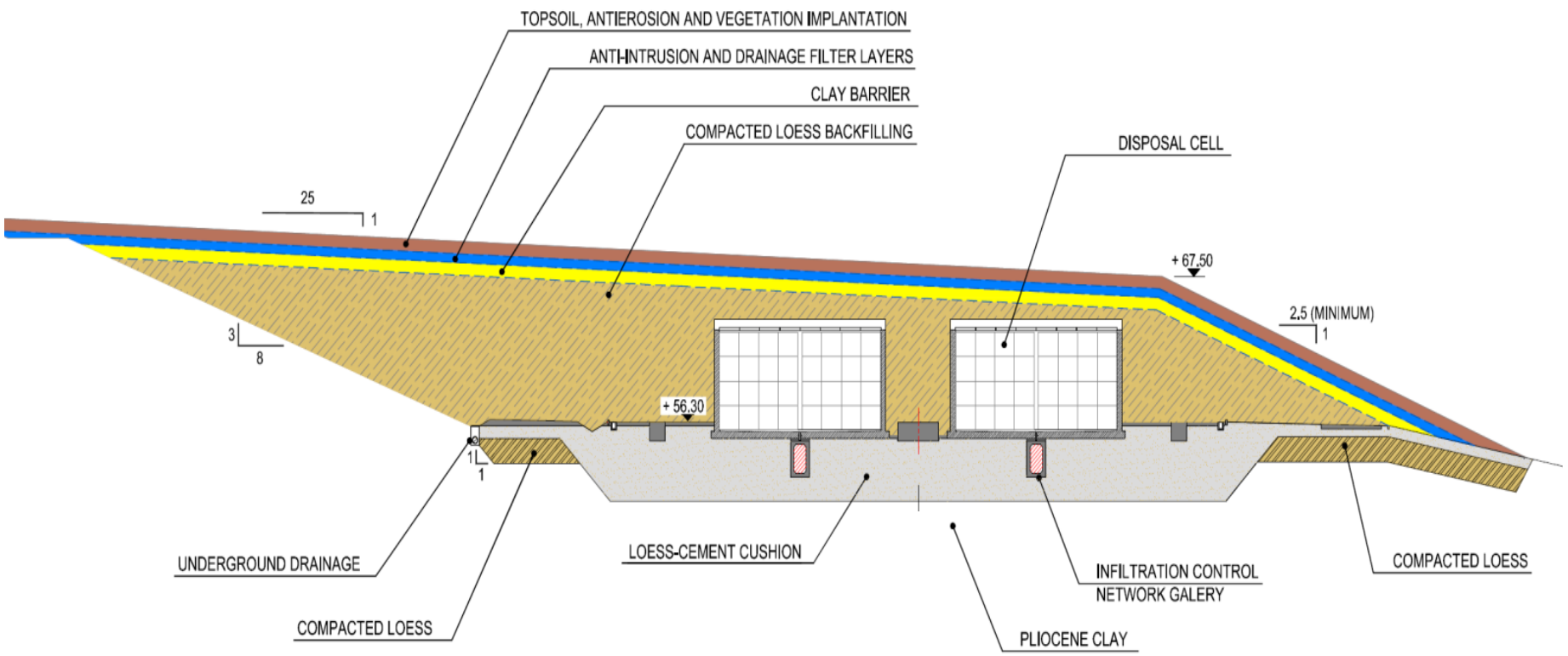
- Vaults will contain 4 x 8 x 9 containers
  Total: 19000 containers with 150000 m³ conditioned waste
- Filled vaults will be closed with concrete slab and a temporary sealing cover to prevent infiltration until the end of operation
- After end of operation the repository will be closed by constructing an engineered cover with an integral clay layer as main sealing

Artist View of the NDF

NDF Disposal Vaults



Repository Final Cover



NDF – Projected Inventory

Radionuclide	Initial total activity (Bq)	Radionuclide	Initial total activity (Bq)	Radionuclide	Initial total activity (Bq)
Ac-227	0.0 E+00	I-129	8.6 E+07	Ra-226	0.0 E+00
Ag-110m	1.7 E+12	Mn-54	1.1 E+12	Sr-90	3.4 E+11
Am-241	1.3 E+10	Nb-94	3.3 E+09	Tc-99	1.8 E+09
C-14	2.7 E+12	Nb-95	3.5 E+11	Th-229	0.0 E+00
Cm-242	9.8 E+07	Ni-63	4.4 E+12	Th-230	0.0 E+00
Cm-244	3.0 E+09	Np-237	0.0 E+00	U-233	1.8 E+07
Co-58	7.7 E+11	Pa-231	0.0 E+00	U-234	1.0 E+08
Co-60	1.5 E+13	Pb-210	0.0 E+00	U-235	1.8 E+07
Cs-134	2.0 E+13	Pu-238	5.2 E+09	U-236	0.0 E+00
Cs-137	1.4 E+14	Pu-239	4.35 E+09	U-238	5.3 E+07
Fe-55	1.4 E+13	Pu-240	4.35 E+09	**Σ α emitters**	**3.0E+10**
Fe-59	7.9 E+11	Pu-242	3.7 E+07	**Σ Total**	**2.0 E+14**

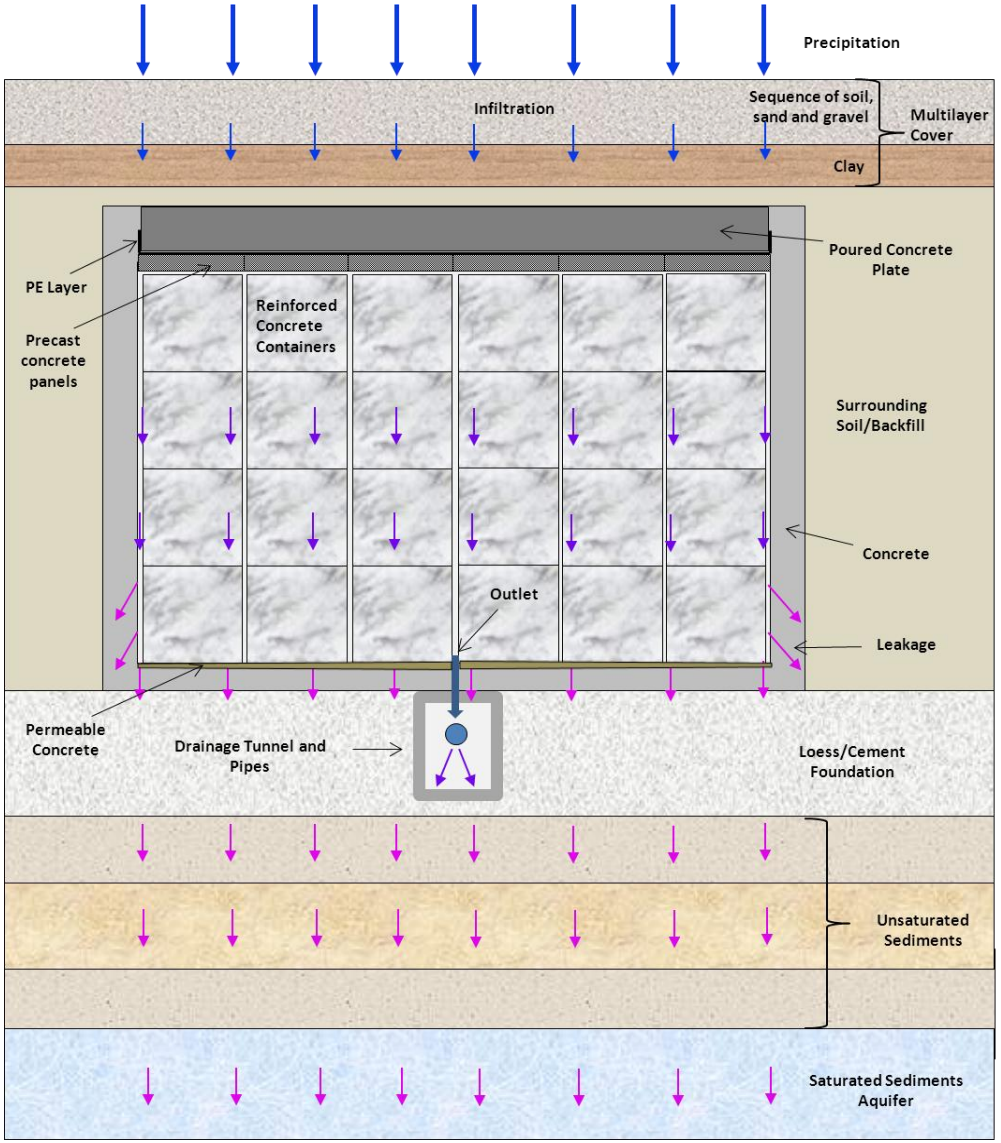
Scenarios Considered for Long-term SA

- For the normal long-term evolution of the NDF, the only release pathway for radionuclides that has been identified as relevant is the groundwater pathway.
- The same is valid for the alternative or accident scenarios that have been developed for the long-term assessment, apart from the human intrusion scenarios.
- Scenarios selected for the long-term assessment:
  - Normal evolution (groundwater use via well)
  - Human intrusion (Road Construction - and Residential Scenario)
  - Earthquake
  - Climate change (change towards wet or dry climate)
  - Crash of airplane

Main Assumptions Normal Evolution Scenario

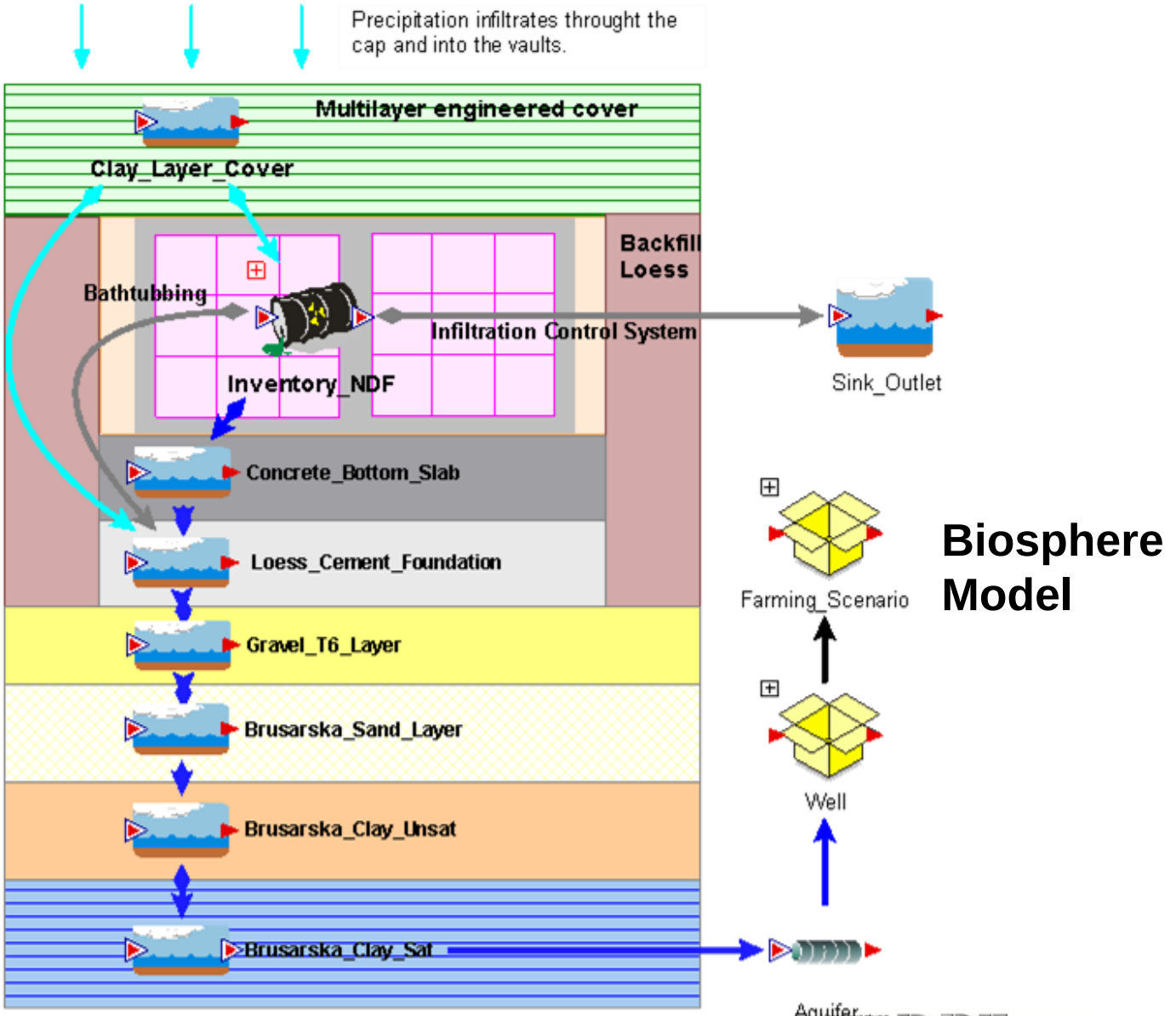
- Climate conditions remain essentially the same as today.
- Closure of the repository will be followed by a period of 300 yr of active institutional control (with maintenance of engineered cover)
- After the end of institutional control, the infiltration control system will be backfilled and sealed.
- It is assumed that the total inventory is accessible to infiltrating water from the time of failure of the containers (aver. lifetime 60 yr)
  - No radionuclides are bound in any kind of waste matrix
  - All infiltration supposed to mix with complete waste volume.
- Geosphere conditions will remain as today.
- Construction, closure and performance of technical barriers will be according to design.

Conceptual Repository Model



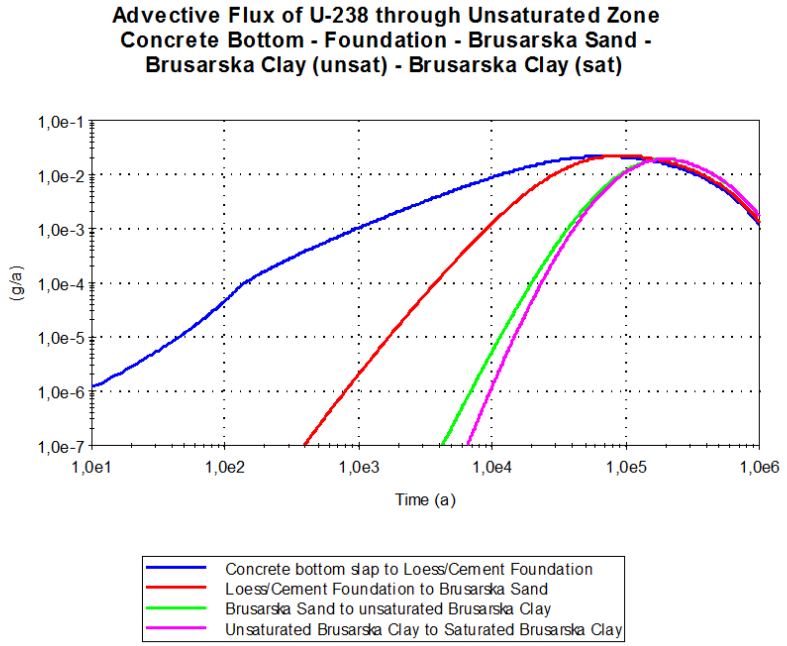
Examples Computer Model

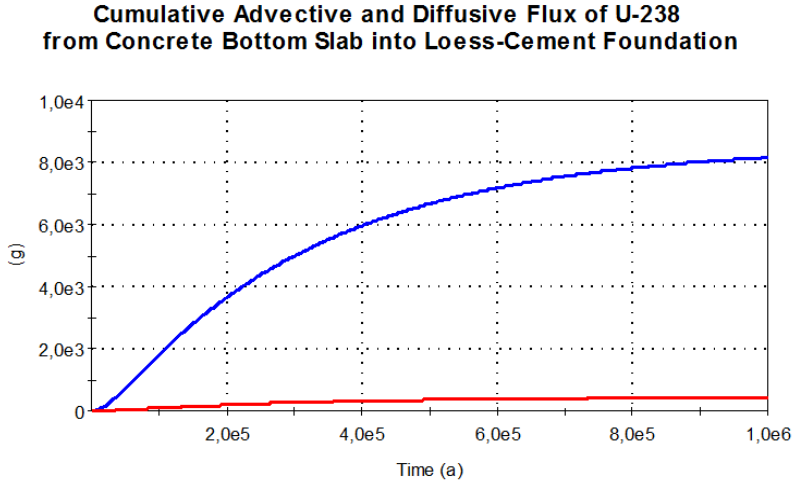
GoldSim Simplified Nearfield Model for NDF



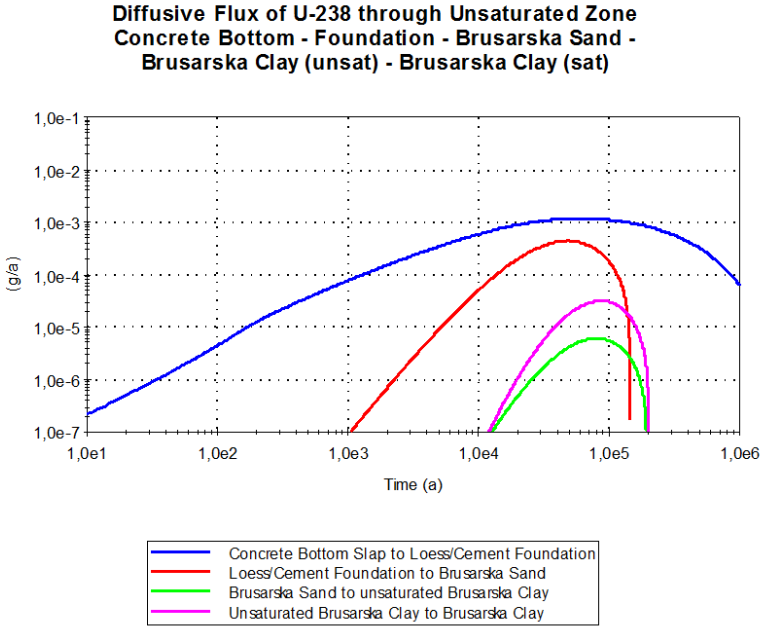
Biosphere Model

Interim Results - Long-Term Calculation



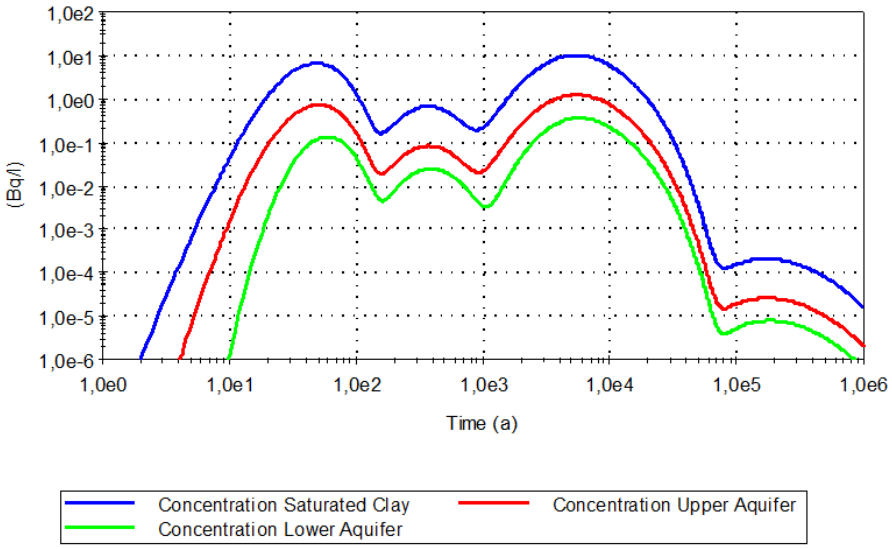


Relative Importance of Diffusive and Adjective Fluxes



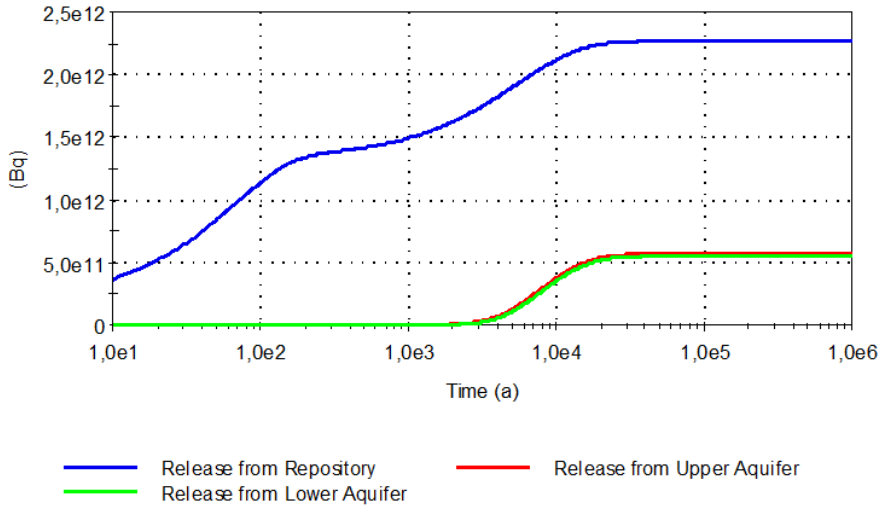
Interim Results - Long-Term Calculation

Total Activity Concentration along Groundwater Pathway
Saturated Clay - Upper Aquifer - Lower Aquifer

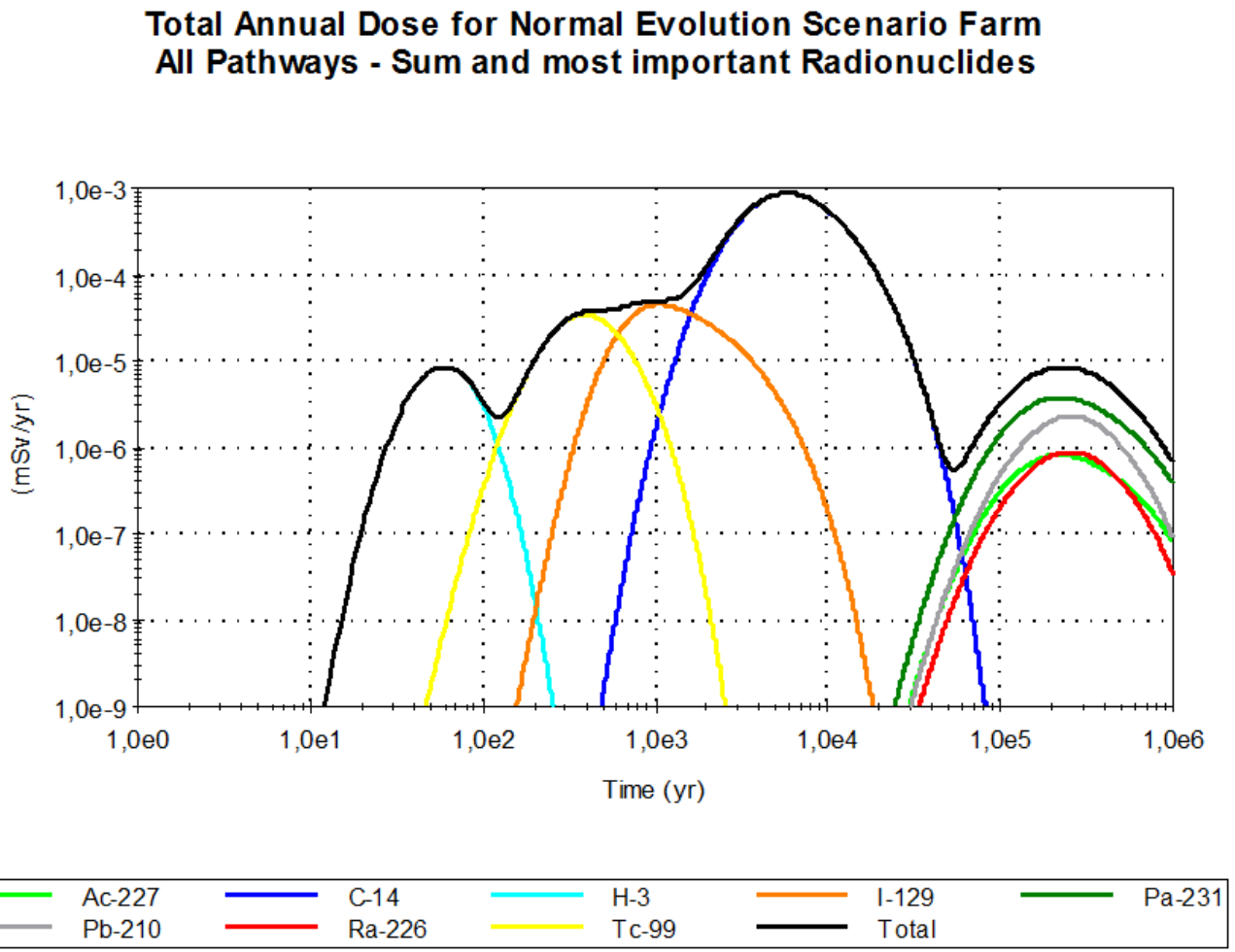


Release of Activity

Total Cumulative Release of Activity from
Repository, Upper Aquifer and Lower Aquifer



Total Annual Dose – Normal Evolution



Main results of Safety Assessment

- Peak dose rate with 0.87 µSv/a clearly below regulatory limit of 0.1 mSv/a
- Results of Sensitivity Analysis considering uncertainties show no critical boundary conditions or assumptions where changes are likely to have significant negative influence on radiological impact.
- Results of Alternative Scenarios are also clearly within regulatory limits:

Maximum Total Annual Dose for Scenario 1 to 5		
Scenario	Peak Dose	Time of peak dose
1 Normal Evolution	0.873 µS/yr	5820 yr
2.1 Human Intrusion – Resident and agriculture	38.7 µS/yr	300 yr
2.2 Human Intrusion – Road construction	3.16 µS/yr	300 yr
2.2 Human Intrusion – Drilling	0.634 µS/yr	300 yr
3 Earthquake	6.86 µS/yr	1450 yr
4.1 Dry climate	0.884 µS/yr	7960 yr
4.2 Wet climate	0.810 µS/yr	4210 yr
5.1 Explosion of car on road	Conservatively covered by 5.2	
5.2 Airplane Crash	5.73 µS/yr	2320 yr

Project on Construction assigned to consortium lead by NUKEM Technologies (Rosatom Group) in July 2016

License for Construction - 9th June 2017

Groundbreaking Ceremony - 26th August 2017

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Responsibility for Generations