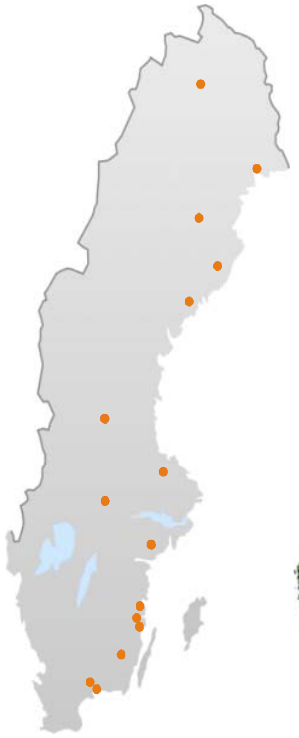
Present status of the Swedish nuclear waste management programme

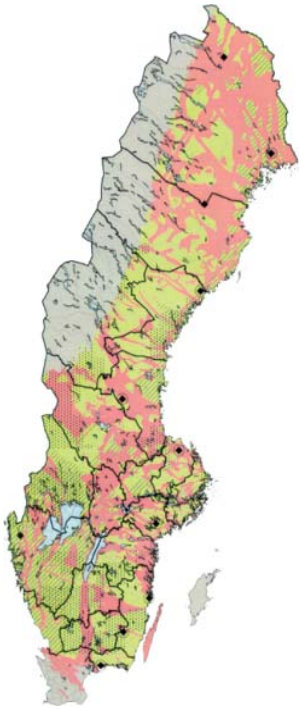
Kastriot Spahiu, SKB

Siting of the repository for spent nuclear fuel

Knowledge accumulation

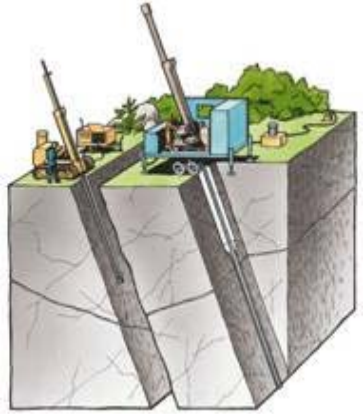
Siting process



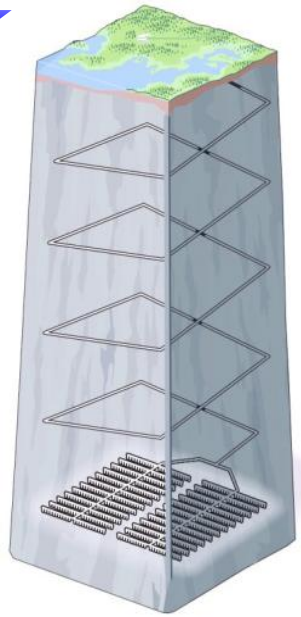


Hultsfred
Malå
Nyköping
Oskarshamn
Storuman
Tierp
Älvkarleby
Östhammar

Oskarshamn (Laxemar)
Östhammar (Forsmark)



Decision on site
2009



Study sites
1977-1985

General siting studies
1990s

Feasibility studies
1992-2001

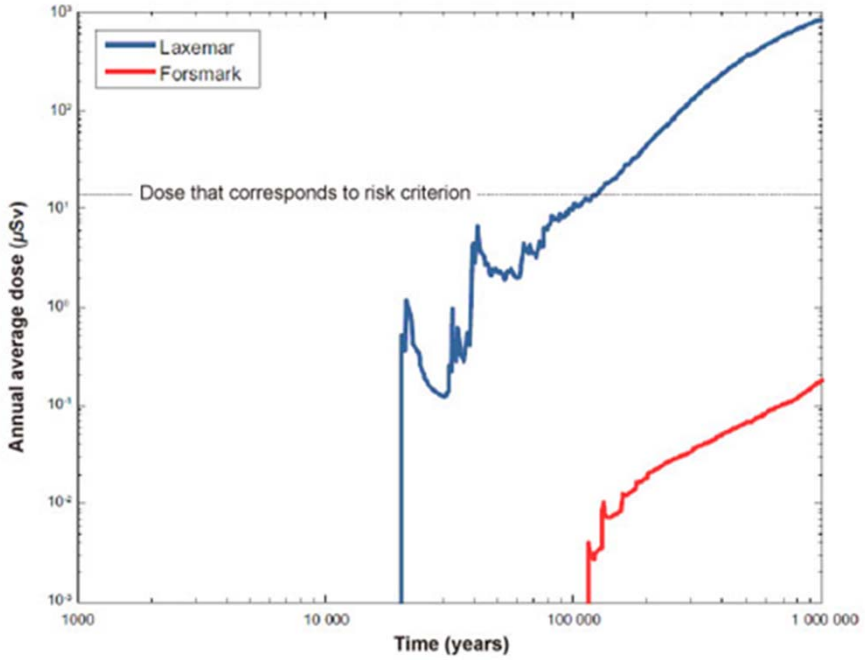
Site investigations
2002-2007

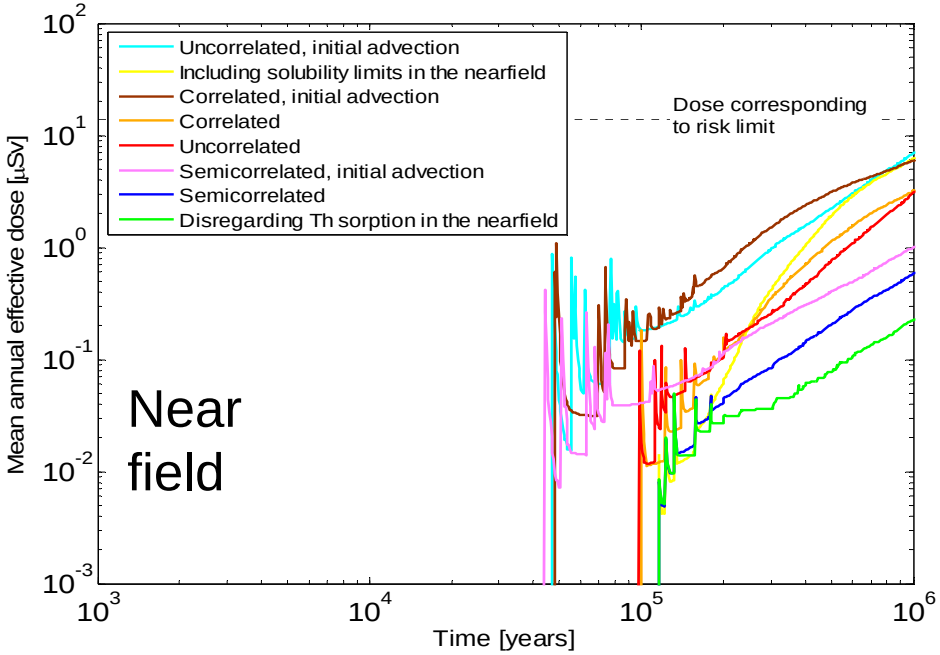
Licensing
ca. 2011-2020

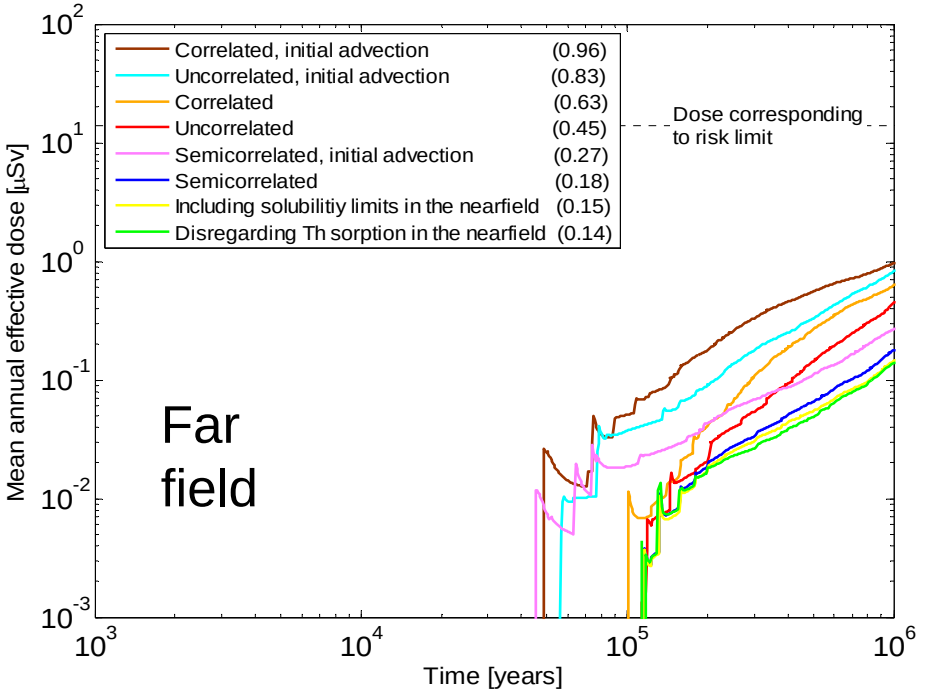
Construction
ca. 2020-2030

Doses; corrosion scenario

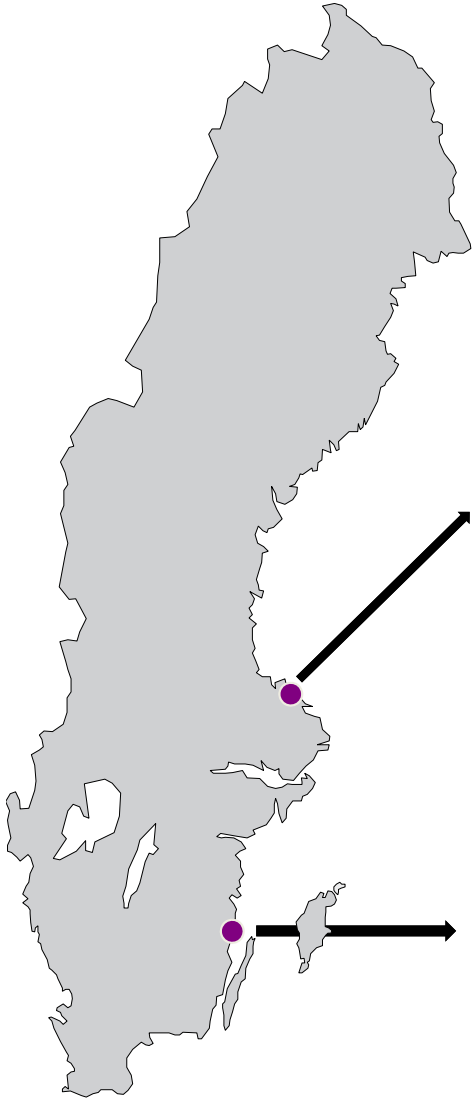
- Failure times and positions from corrosion analyses; flow related transport data from hydro analyses
- A number of probabilistic cases to explore impact of uncertainties related to erosion, corrosion, transport
- All cases dominated by Ra-226 at 1Myr
- Case with highest consequences used to demonstrate compliance.

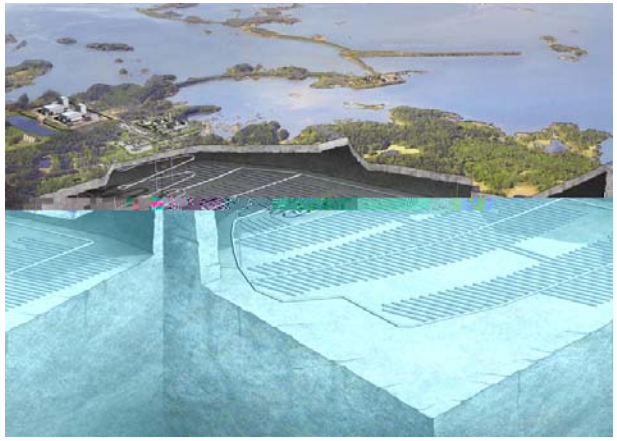






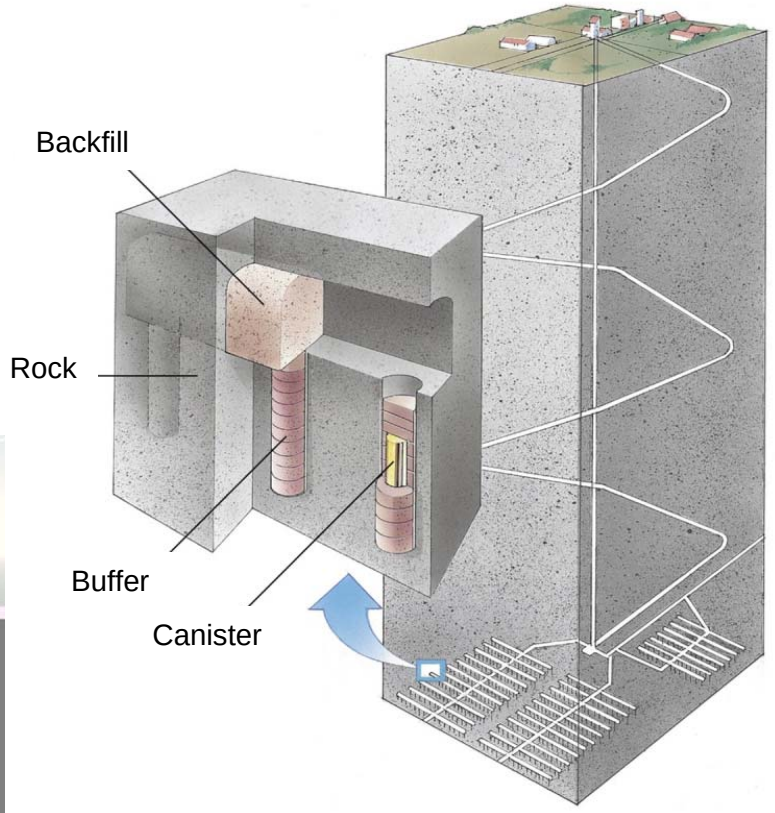
License application submitted March 2011 for





Spent Fuel Repository at Forsmark

Encapsulation plant in Oskarshamn



SKB is applying

- To continue **interim storage** of spent nuclear fuel and reactor core components. The amount of spent nuclear fuel may reach a maximum of 8000 metric tons (calculated as uranium).
- To **construct and operate** a facility (Clink) to **store** spent nuclear fuel and core components and for **encapsulation** of spent nuclear fuel. Capacity of approximately 200 canisters per year.
- To **construct and operate** a facility for **final disposal** of spent nuclear fuel and nuclear waste (construction material in the fuel assemblies)
  - Final disposal of the spent fuel that is currently stored in Clab and
  - future fuel that will arise from operating the ten reactors that currently have a permit to operate
- Final disposal according to **the KBS-3 method** with vertical placement of the canisters (KBS-3V)
- **Water operations** that are needed to build and operate the facilities.
- Storage for excavated **rock aggregate.**

Licensing review according to Nuclear Act and Environment Code

SKB's three applications

One according to Environmental Code

Two according to Nuclear Act

Review/Court hearings

Nacka tingsrätt
Sveriges domstolar

Review

Strålsäkerhetsmyndigheten
Swedish Radiation Safety Authority

Approves or disapproves

Osthammars kommun – en del av Roslagen

Oskarshamns kommun

Decides

Regeringskansliet

Permit and conditions

Nacka tingsrätt
Sveriges domstolar

Approves Safety Report

Strålsäkerhetsmyndigheten
Swedish Radiation Safety Authority

The reviewing of SR-Site

- The Swedish government has requested an independent NEA review, focused on SR-Site, to support SSM's review
- The NEA review conclusions
  - "From an international perspective, SKB's post-closure radiological safety analysis report, SR-Site, is sufficient and credible for the licensing decision at hand. SKB's spent fuel disposal programme is a mature programme - at the same time innovative and implementing best practice - capable in principle to fulfil the industrial and safety-related requirements that will be relevant for the next licensing steps."
  - "Another challenge for the future will be to both enhance and broaden the basis for the scientific evidence supporting long-term safety. To that effect, additional research and more detailed calculations will be needed for the safety cases supporting the next licensing steps."

Michael Sailer, Chairman of the NEA review team

Radiation safety authority – KBS-3 licensing review

- 277 requests for explanation or additional information up to March 2013
  - Additional requests received through November 2014
- Continuous dialogue SKB-SSM
- SKB answers provided gradually
  - Major deliveries
    - April, June and December 2013
    - February, July and September 2014
- SSM initial review completed and in – depth review started
- In-depth review of encapsulation plant on hold awaiting SKB response to SSM's review report
- January/March 2015: SKB response on encapsulation plant including interim storage of 11000 tons. Comprehensive supplement on canister issues.

Strål säkerhets myndigheten
Swedish Radiation Safety Authority

- **Critical issues**
  - Canister corrosion and mechanical stability
  - Slow water saturation of bentonite
  - Safety principles for encapsulation plant
  - Content needed in EIS (alternatives,…)

SKB

Environmental Court – KBS-3 licensing review

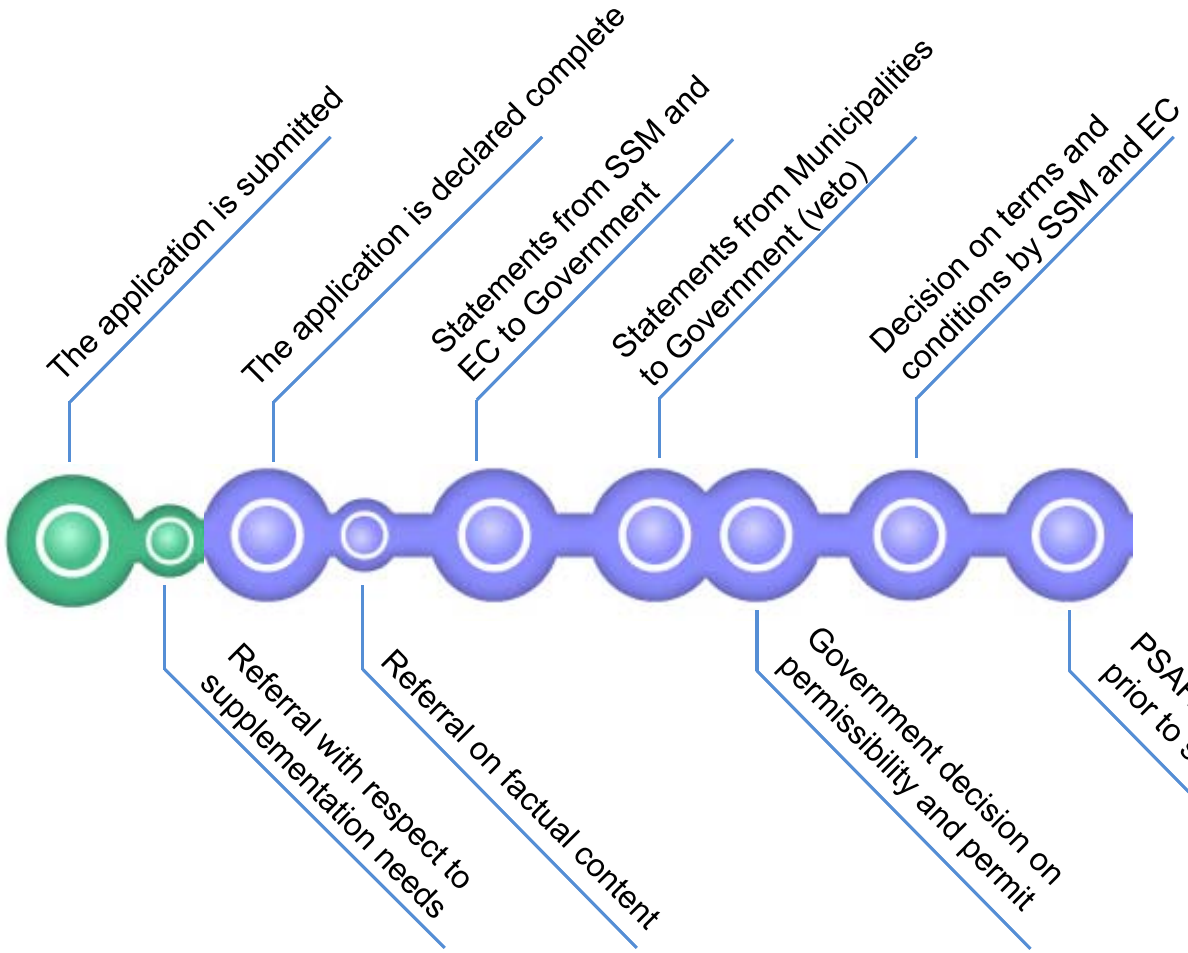
- 2012: Court asked about requests for additional information/explanation
- 350 questions/requests sent to court by stakeholders
- April 2013 SKB responses sent to court (600 pages)
- Autumn 2013 reviewers reactions on SKB answers
- September 2014 SKB provides additional responses and statements
- March 2015 SKB provides updated information on encapsulation plant and interim storage capacity (11000 tons) This is an additional petition that will have to be submitted for review.

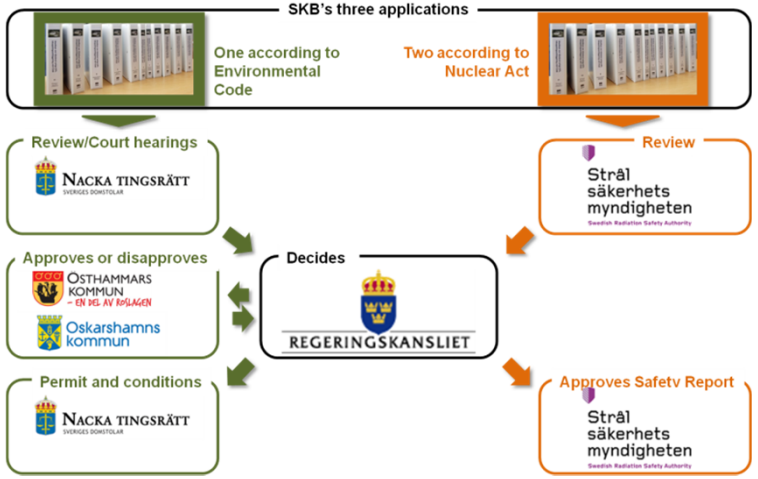
NACKA TINGSRÄTT
SVERIGES DOMSTOLAR

Main review comments on SKB applications

- Scope of Environmental Code Application and Environmental Impact Assessment
  - Level of detail with respect to nuclear safety issues
- Scope of documentation of other disposal methods
  - Deep boreholes
  - Spent fuel as a resource
- Site selection
  - Close to nuclear power plants.
  - Inland site – regional groundwater flow.
- Long term safety issues
  - Canister integrity
  - Detailed technical issues – mainly from SSM
- “Conventional” environmental consequences
  - Discharges to water
  - Consequences for endangered species and nature values
  - Consequences from traffic, noise from operations
  - Management of rock from excavation

Licensing process





PSAR – Preliminary safety report, SSM – Radiation Safety Authority, EC – Environmetal Court

The role of P&T in the Swedish nuclear waste management programme

Could transmutation affect the nuclear waste programme of Sweden? Perhaps…

- if the development of P&T is successful within the next 25-30 years and
- scaled P&T facilities are in operation soon afterwards, and
- if there has been a full change in the Swedish legislation, accepting new types of reactors and reprocessing, and
- if there are investors willing to finance the construction of P&T facilities and new reactors in Sweden,
- or if these services are offered by foreign companies, THEN….

How would transmutation affect the nuclear waste programme of Sweden?

- Encapsulation and deposition of spent fuel would end, instead there will be partitioning (P) and some of the product elements introduced to (fast) reactors for transmutation (T) and power production.
- Deposited canisters with their content of spent fuel might become recovered from the repository.
- The spent fuel repository in Forsmark would be transformed into a repository for the high level waste from P&T.
- Safety assessment would have to deal with similar issues as for the spent fuel repository.

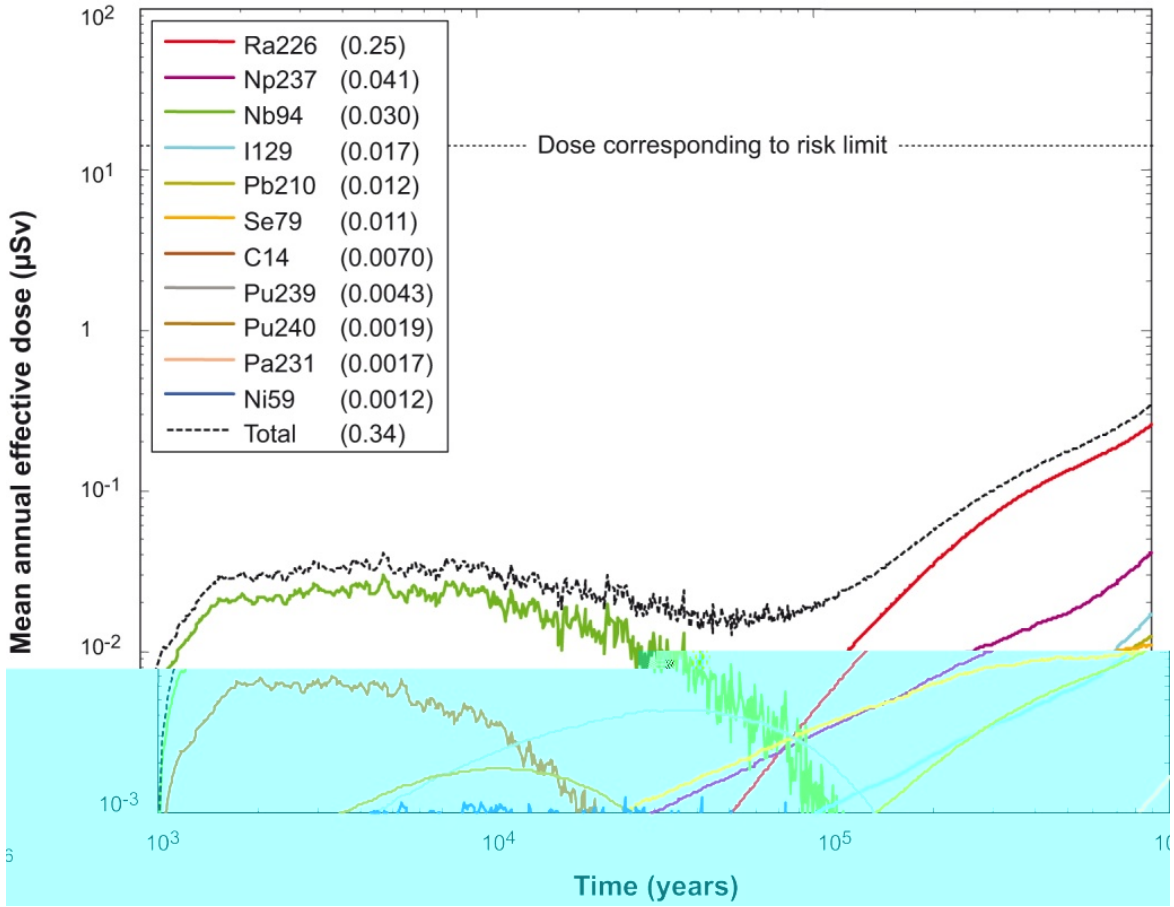
Benefits of the P&T research financed by SKB

- Mainly, it has bridged the generation gap in reactor technology science and, thereby, put Sweden in a good position for possible future expansion of the nuclear power production.
- Methods for partitioning of minor actinides have been developed.
- CHNO chemicals, burnable without ashes, have been developed for partitioning.
- Nitride-fuel is being developed for use in fast reactors and accelerator driven systems, ADS.

Thank you!

Doses; shear load scenario

- Pessimistically determined frequencies of canister failures from analyses of containment potential
- Pessimistically simplified near and far fields
  - No credit for geosphere retention
- Probabilistic consequence calculation
- Combination of shear failure and subsequent buffer erosion yield highest consequences – used to demonstrate compliance



Comparison of estimated dose for the corrosion scenario