Strål
säkerhets
myndigheten
Swedish Radiation Safety Authority

Review of the proposed repository system

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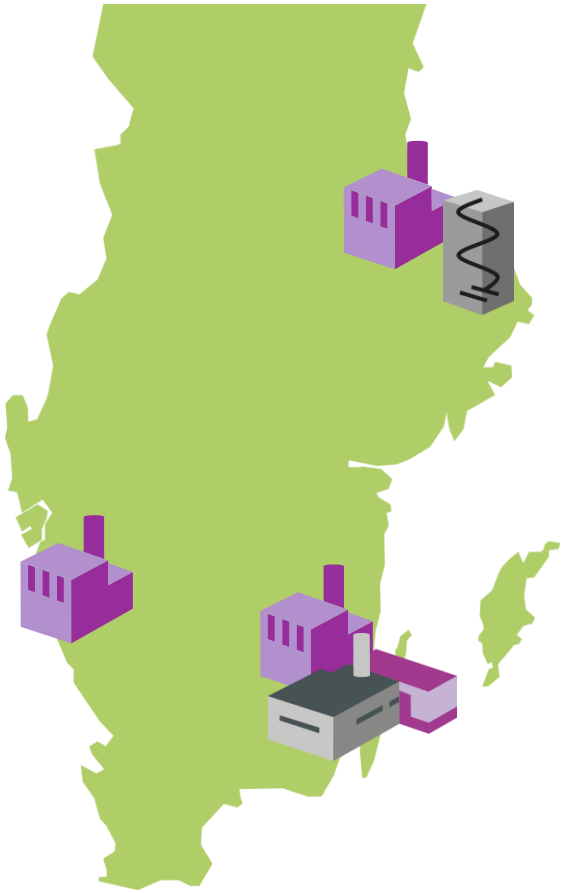
Proposed concept for disposal of spent nuclear fuel

Nuclear power plants in Sweden



Power plant

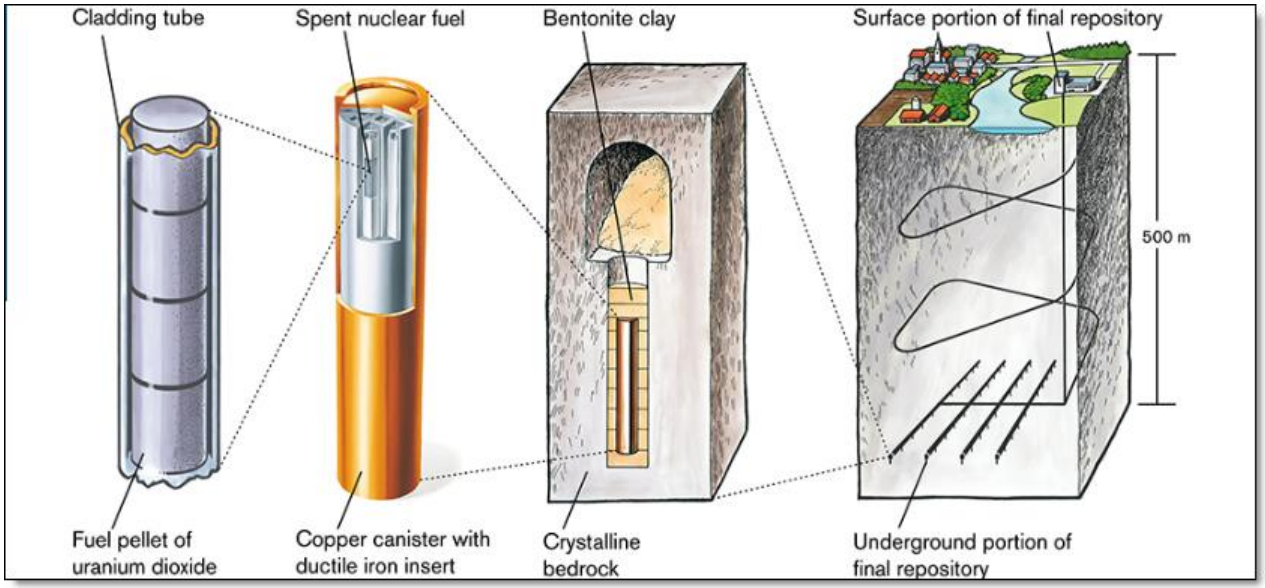
Planned repository

Interim storage high-level waste
Planned encapsulation facility

NPP owners responsibility

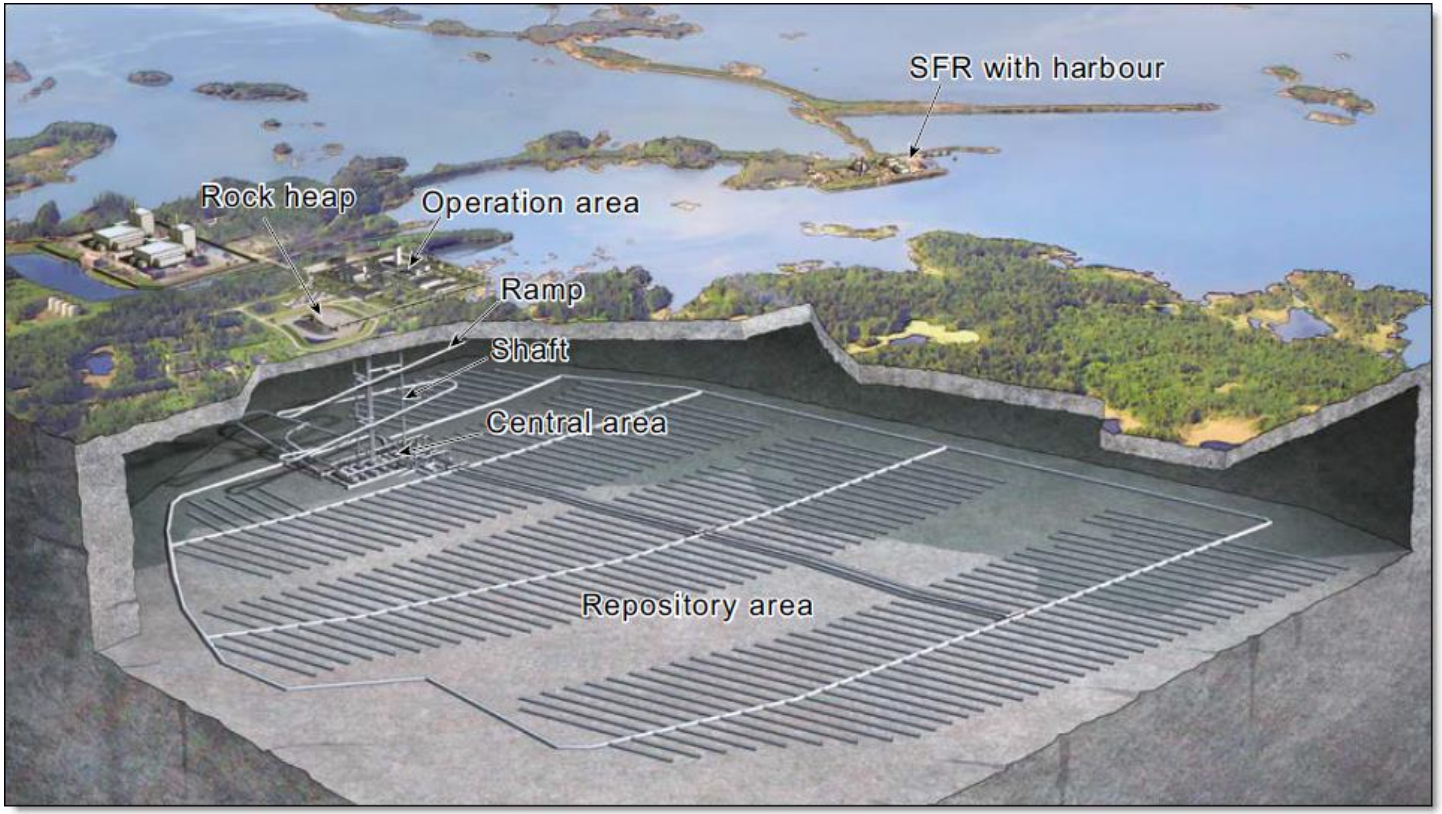
- Clear rules
  - Owners of NPP’s are responsible for method and financing
  - No new reactors without a safe concept for waste management (Nuclear Activities Act 1984:3).
- Joint company
  - Swedish nuclear fuel and waste management company (SKB) is owned by the nuclear companies and the assignment is to handle radioactive waste and spent nuclear fuel.

Proposed disposal concept



Source: SKB

Repository area

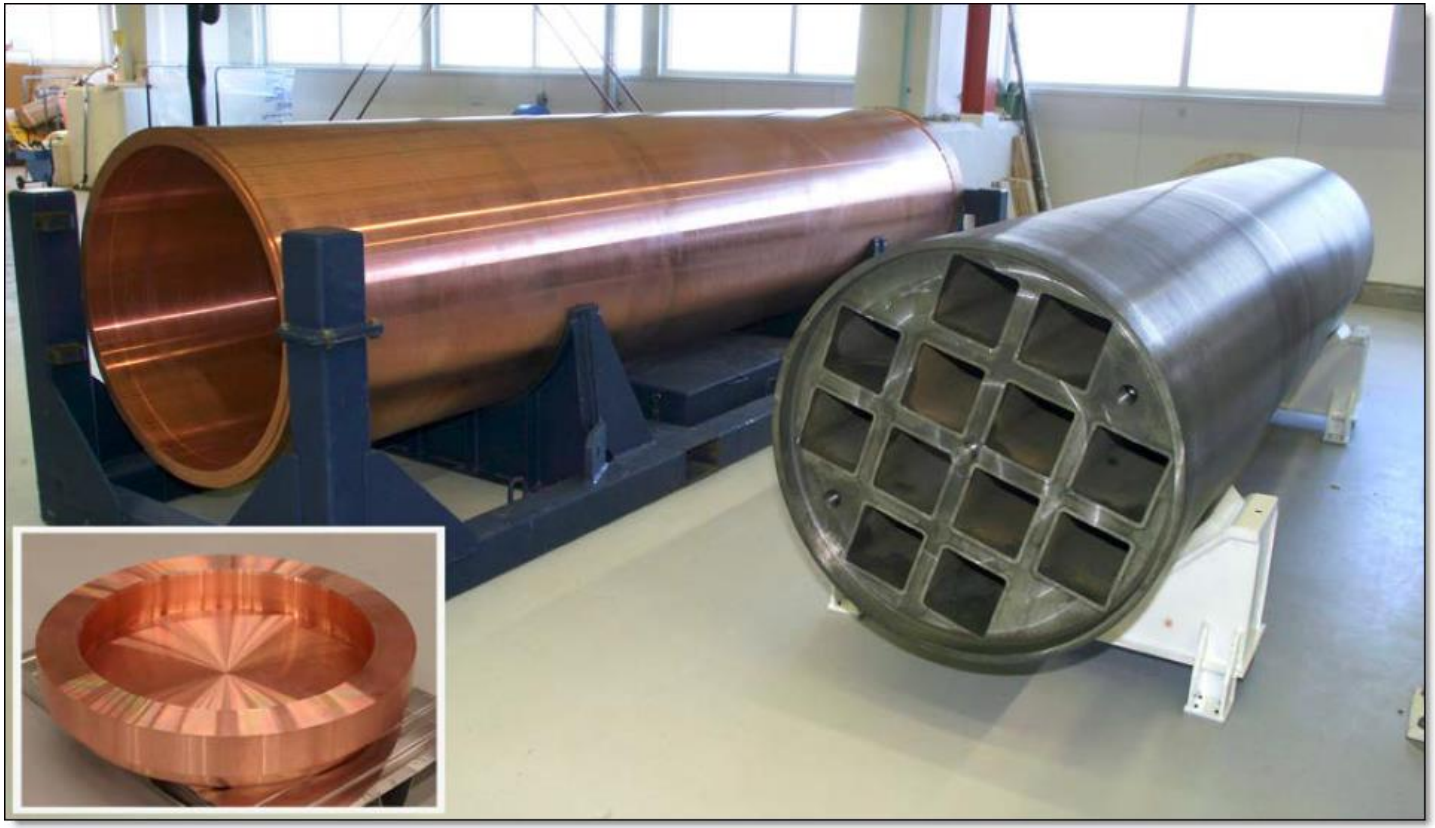


Source: SKB

Geology in Sweden

- Mostly granitic or gneissic rocks
- Some limestone (considered not suitable to host a repository)
- No clay or salt deposits

Copper canister with cast-iron insert



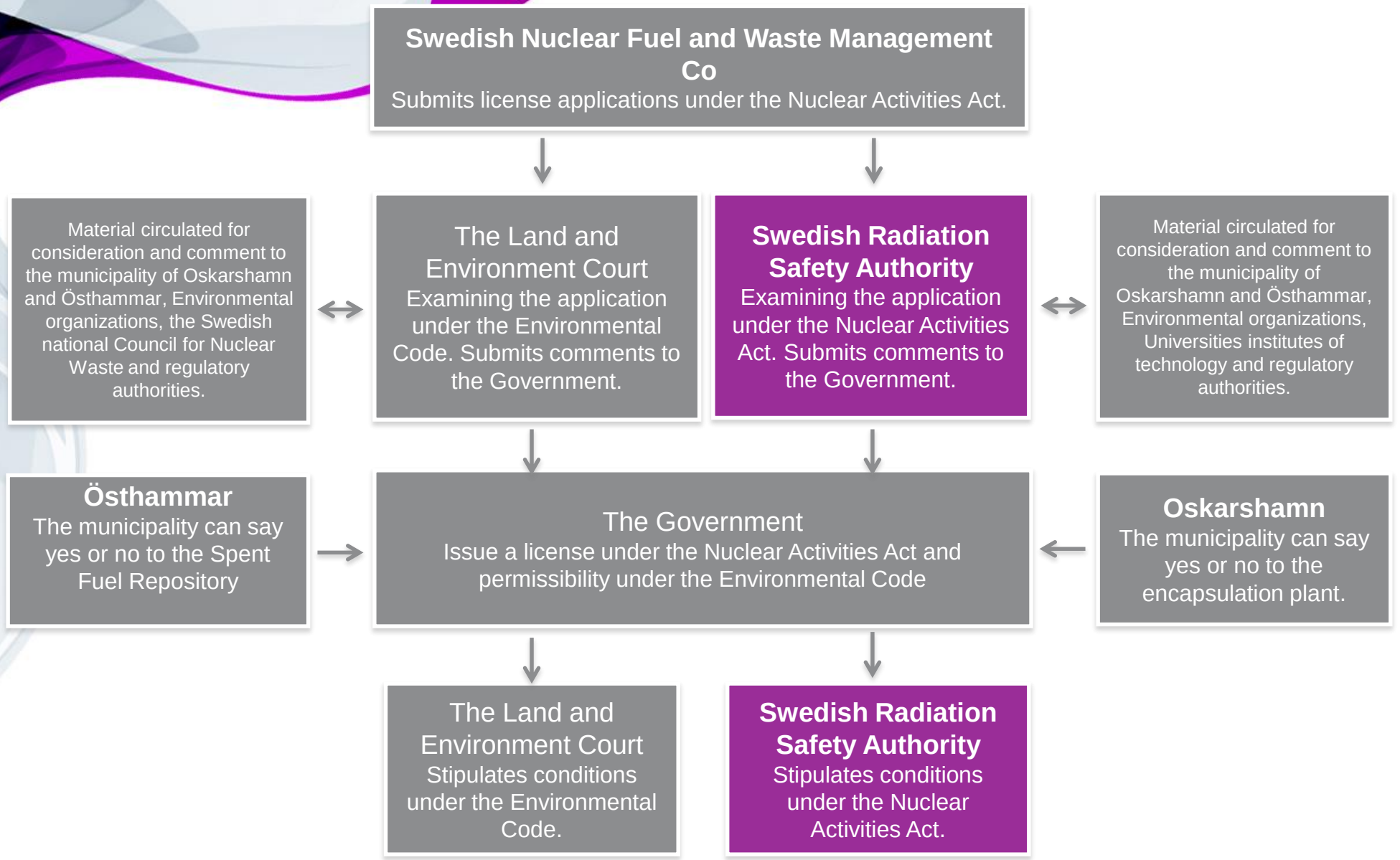
Source: SKB

The legal system

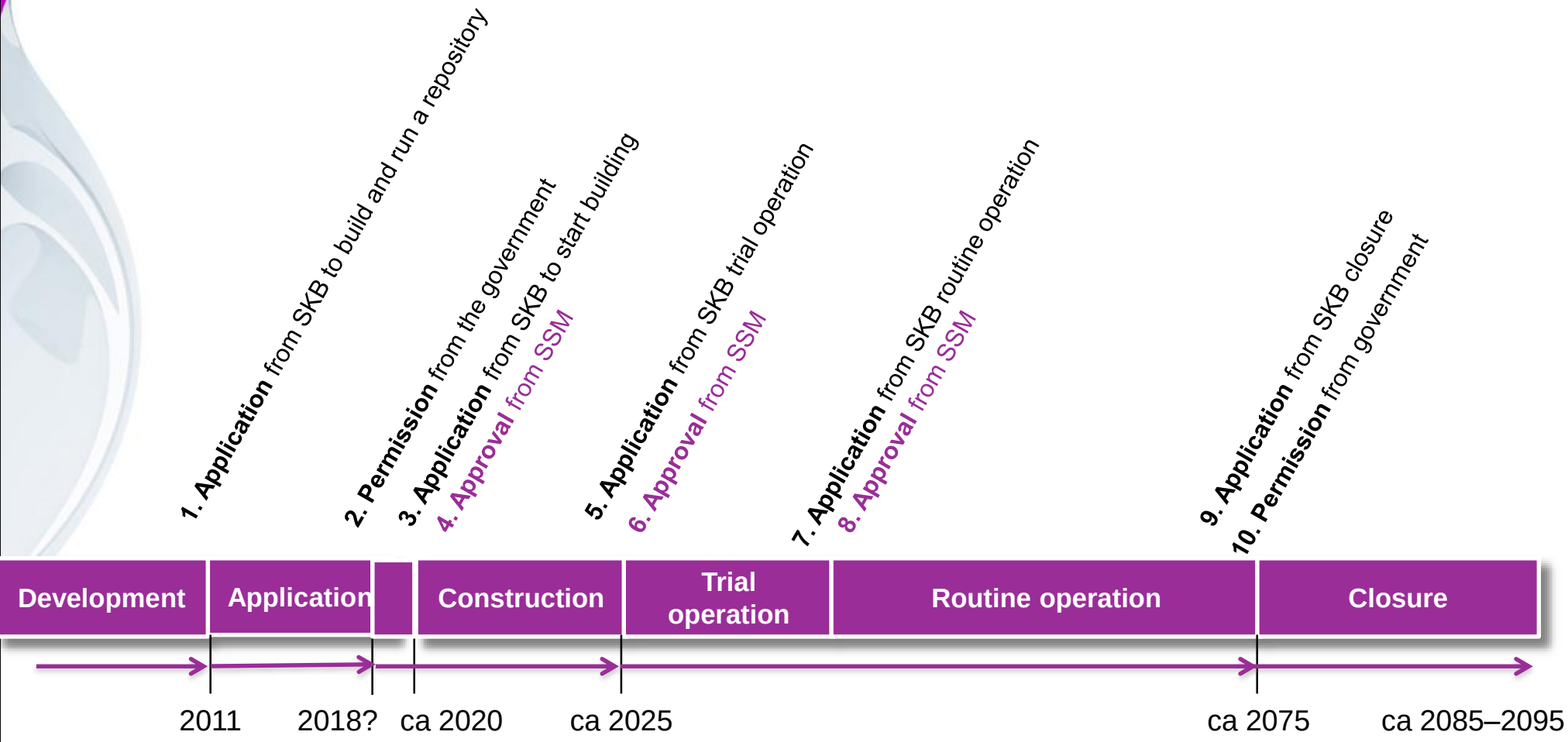
Choice of disposal concept

- According to law, the implementor is responsible for choosing a disposal concept. This includes both method and site.

- SSM is reviewing the proposed concept and should not propose another concept.


Swedish Nuclear Fuel and Waste Management Co
Submits license applications under the Nuclear Activities Act.
Material circulated for consideration and comment to the municipality of Oskarshamn and Östhammar, Environmental organizations, the Swedish national Council for Nuclear Waste and regulatory authorities.
The Land and Environment Court
Examining the application under the Environmental Code. Submits comments to the Government.
Swedish Radiation Safety Authority
Examining the application under the Nuclear Activities Act. Submits comments to the Government.
Material circulated for consideration and comment to the municipality of Oskarshamn and Östhammar, Environmental organizations, Universities institutes of technology and regulatory authorities.
Östhammar
The municipality can say yes or no to the Spent Fuel Repository
The Government
Issue a license under the Nuclear Activities Act and permissibility under the Environmental Code
Oskarshamn
The municipality can say yes or no to the encapsulation plant.
The Land and Environment Court
Stipulates conditions under the Environmental Code.
Swedish Radiation Safety Authority
Stipulates conditions under the Nuclear Activities Act.

Stepwise process



Our review

Regulatory requirements

General Laws: Nuclear Activities Act, Radiation Protection Act, Environmental Code

The regulations SSMFS 2008:21 and SSMFS 2008:37 addresses issues concerning repositories.

General rules; not regulating in detail.

Most important is the rule that a multi-barrier system shall contribute to containment, prevent or delay the spread of radioactive substances.

Those barriers must withstand processes that can influence their function.

The site with its geological setting is an important barrier.

SSM reviews if SKB have:

- Motivated method, construction and siting enough.
- Shown that the repository system can be built and operated as planned.
- Shown that future processes affecting long-term safety are evaluated and taken into account.

Review of long-term safety

- Repository evolution after closure
  – 1 000 years, 100 000 years and beyond
- External impact on the repository, for example earthquakes and glaciations
- Are all processes and scenarios evaluted and described in the application?

Challenges in the review

- One of the first repository applications in the world.
- Complex technical and scientific questions.
- Huge documentation.
- Parallell process by SSM and the Environmental Court.
- Stepwise process, difficult to determine level of information needed in the plans

Choice of copper

Structured development – RD&D program

SKB's work with choice of material

1970s	KBS-1 Titanium and lead (considered to have too short life time)
1978	KBS-2 Copper, casing 2 dm
1983	KBS-3 Copper, casing 1 dm
1992	Study of alternative canister materials. Canister with steel had shorter life time and were considered not suitable in perspective of long-term safety. Copper were considered easier to handle in the manufacturing process and considered able to withstand corrosion processes. Copper were choosen as the prefered material. Continued research and development work.
2009	Copper, casing 5 cm, able to withstand shear movement

SSM:s evaluation of the copper canister

Regulation SSMFS 2008:21 about engineered barriers.

Applicable requirement:

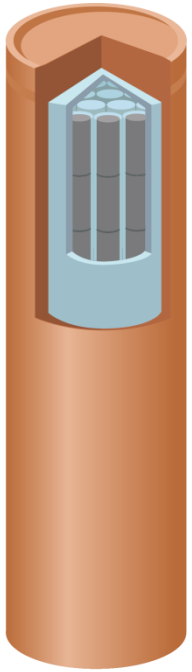
5 § A barrier must withstand processes affecting it after closure of the repository

Can the canister fulfill its function despite some uncertainties in copper performace? And meet regulatory requirements?

The canister

Canister sustainability

- Manufacturing, inspection and testing
- Mechanical integrity of canister and cast-iron insert
- Corrosion



Grafik: Solveig Hellmark

Canister construction and handling

- No industrial manufacturing yet
- Welding technique
- Underground laboratory
- Some special technical solutions to handle canister in the repository were developed
- SKB interact with Posiva to develop techniques

Corrosion processes

- General corrosion
- Localised corrosion
  - Pitting corrosion
  - Stress induced corrosion

Processes driven by air or water:

- With or without oxygen
- Sulphide

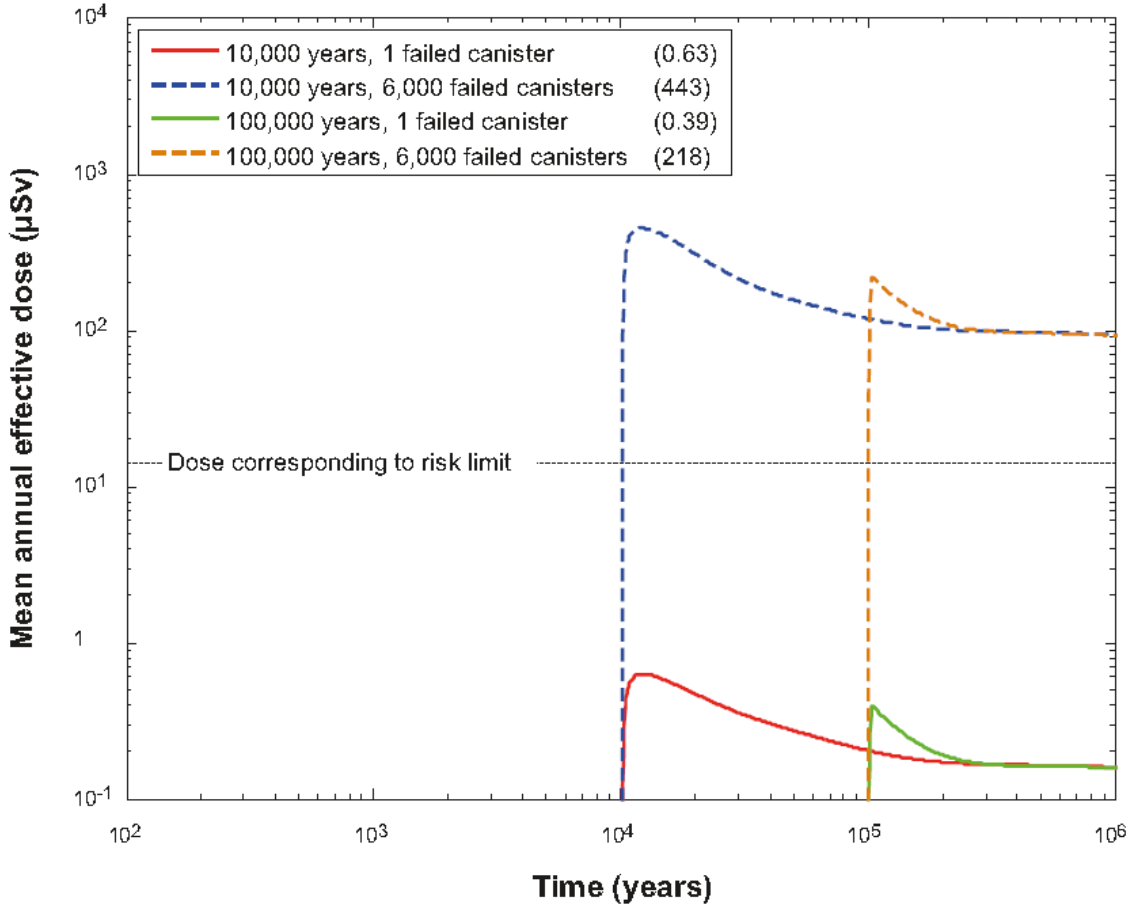
Processes takes place at different times and conditions.

Corrosion in oxygen free water

- New mechanism discovered by Professor Gunnar Hultquist in Sweden
- Much debated in society
- The mechanism itself exist but the implications for a repository are not yet solved.

The process of copper creep

- Slow process
- Buffer swelling pressure might cause the canister to deform unevenly
- Might cause a pin hole failure
- The effect of phosphouros in copper to prevent creep is not fully understood or evaluated



Consequence analyses TR-01-11, vol III

Canister failure with <u>intact buffer and rock</u>

”Dose corresponding to risk limit” SSMFS 2008:37 5 §

Challenges regarding the review of the canister

- No industrial experience in manufacturing the canister
- Large time-scales, 100.000 years and beyond
- Repository environment with unique conditions
- Several corrosion processes with uncertainties
- Considerations of some corrosion and creep processes

Buffer – Copper interaction

- Saturation time
- Uneven saturation
- Sulphides and microbes affecting the canister
- Will buffer properties remain over time?
- Intact or eroded buffer?

Considerations about natural resources

- Site situated in area with small iron and sulphide mineralisations
- The repository might be mistaken as an copper mineralisation in the future

Thank you!