

# Copper corrosion studies in the Finnish Research Programme on Nuclear Waste Management

Copper corrosion seminar (KYT)  
2.11.2017

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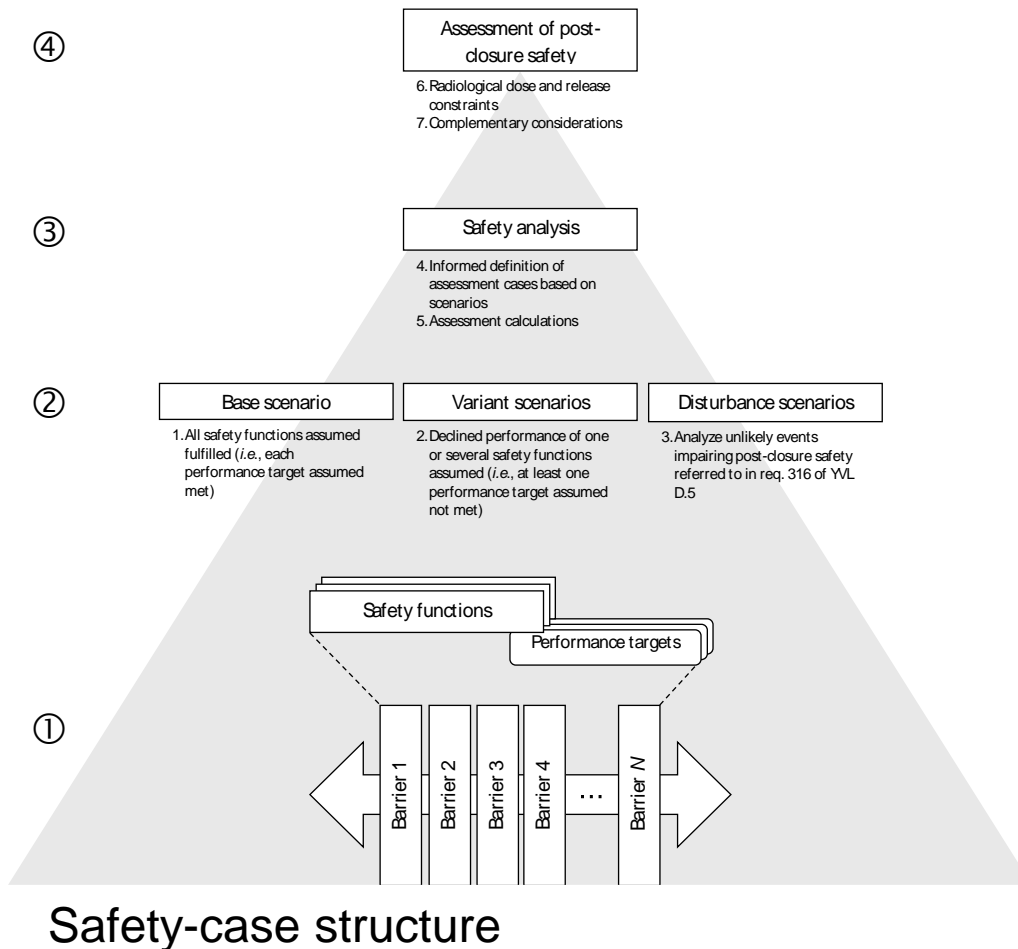
# Role of the Finnish Research Programme on Nuclear Waste Management (KYT)

- Nuclear Energy Act 11.12.1987/990
  - “...research aimed at ensuring that the authorities have such sufficient and comprehensive nuclear engineering expertise and other facilities at their disposal that are needed for comparisons of the various ways and methods of carrying out nuclear waste management.”
- Projects must be safety research and increasing and maintaining competence/expertise related research.
- Projects must concentrate on disposal of nuclear waste or safety significant topics on the area of nuclear waste management.
  - Eg. research related to performance of metals does not directly create nuclear waste management specific expertise, however, buffer or post closure safety case related research creates nuclear waste management specific expertise.
  - Projects increasing or maintaining of expertise specific to nuclear waste management should be prioritized.

# Role of the Finnish Research Programme on Nuclear Waste Management (KYT)

- Projects must not be directly research, which is part of Posiva's tasks ie. the research and research methods will be alternative and look at the topics from new / different perspectives.
  - It is not easy to define and decide which is part of Posiva's tasks
  - Topics that are clearly related to development of KBS-3 concept or alternative manufacturing processes should be Posiva's tasks
  - Research related to open safety issues can benefit the regulator and Posiva, especially in such cases when Posiva is also doing research on the same area eg. copper corrosion studies.

# Safety case and safety significance



- Safety objectives: containment and isolation.
- Post-closure safety functions are provided by engineered and natural barriers, and are achieved by means of physical or chemical properties or processes that contribute to containment and isolation [STUK Y/4/2016].
  - For example, such property and process could be 'limited corrosion'.
- A performance target refers to a measurable or assessable characteristic of a barrier [Guide YVL D.5].
  - Example of such characteristic could be corrosion rate.

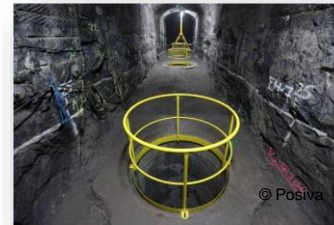
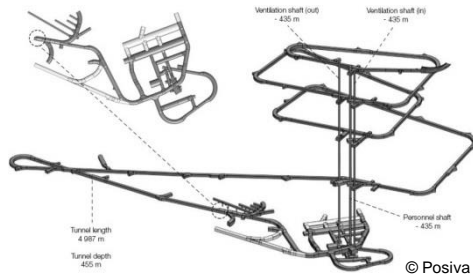
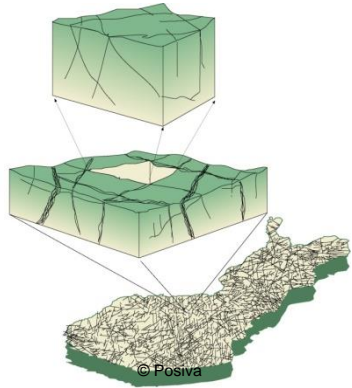
# Research focus in safety

- Canister corrosion mechanisms and the propagation of corrosion are influenced by many variables
  - temperature, ground water composition and the transport of the dissolved substances through the bentonite buffer
- Canister corrosion mechanisms and the factors affecting canister's corrosion resistance are fairly well-known.
- Research should be relevant to disposal of nuclear waste
  - Conditions: Temperature, ground water composition and the transport of the dissolved substances through the bentonite buffer
  - Reduce uncertainties or increase understanding of uncertainties
- Safety significance: Process is safety significant if it has an impact on safety, in other words impact on safety functions and containment
  - Especially if the process can be considered as a common-cause-failure mode

# Research focus in safety

- Difference between safety significant research and basic research ('nice-to-know')
  - How the results can be used?
  - Eg. effect of accelerated tests?
  - Relevance?
- The most important international copper corrosion studies are also followed up and verified in Finland, in cooperation with international partners.
- Debate is still going on if/and further research needs are related to certain mechanisms of corrosion.
- Copper corrosion research is still needed.
  - Cross-cutting issues

# 40 years' of development and oversight



**Test operation,  
 commissioning**

**Application for  
 the operating  
 license**

2016- 2023



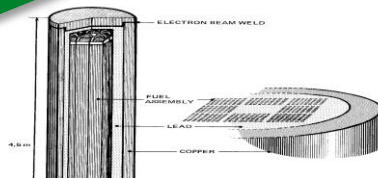
**Constructi  
 on license**

2001 - 2015



**Decision-  
 in-  
 Principle**

Late 1970' -  
 2000





**Transition from idealism**

”discovering a geologically superior site” **to realism**: ”selection of a societally favourable, geologically adequate site”

**Transition from issue based review** “we need to solve all scientific debates” **to safety based review** “we need be assured about safety”

From R&D to industrial process?

Progress is the way to learn and to address unknowns

# STUK's conclusion in the review of Posiva construction license application

- STUK's decision: Safety case for the disposal of spent nuclear fuel in Olkiluoto (1/H42252/2015),  
<https://www.julkari.fi/bitstream/handle/10024/127160/stuk-b197.pdf>
  - Req. #13: *"Before submitting an operating license application, Posiva must assess in more detail the safety significance of the factors that impair canister performance and related development needs (copper corrosion in pure oxygen free water; development of the CSM; copper corrosion at high chloride concentrations, the effect of nitrogen compounds from explosive residues on copper SCC and microbial effects on canister performance) by examining the effects of these factors and development needs and their related uncertainties on the performance targets more clearly than what was presented in the construction license application"*
- Posiva has described and justified the performance of the canister adequately at construction license phase.
- The key uncertainties regarding corrosion of copper:
  - Corrosion in oxygen-free water
  - Microbially induced corrosion
  - SCC
  - Corrosion caused by uncertainties related evolution of buffer

# On-going copper corrosion research in KYT

- The effect of reaction product layers on copper corrosion in repository conditions (REPCOR), Aalto university
- The effect of microbial activity on corrosion of copper in anoxic state of repository (BASUCA), VTT
- Microbially induced corrosion during the oxic stage of repository (MICOR) , VTT
- Mechanical strength of copper canister (MECHACOP), Aalto university
  - Sub task: mechanism of SCC