KYT Seminar: Overall Safety of Nuclear Waste Disposal (KYT OMT Project)
VTT CNS, 25.10.2019

“Overall safety and safety case in nuclear waste disposal”

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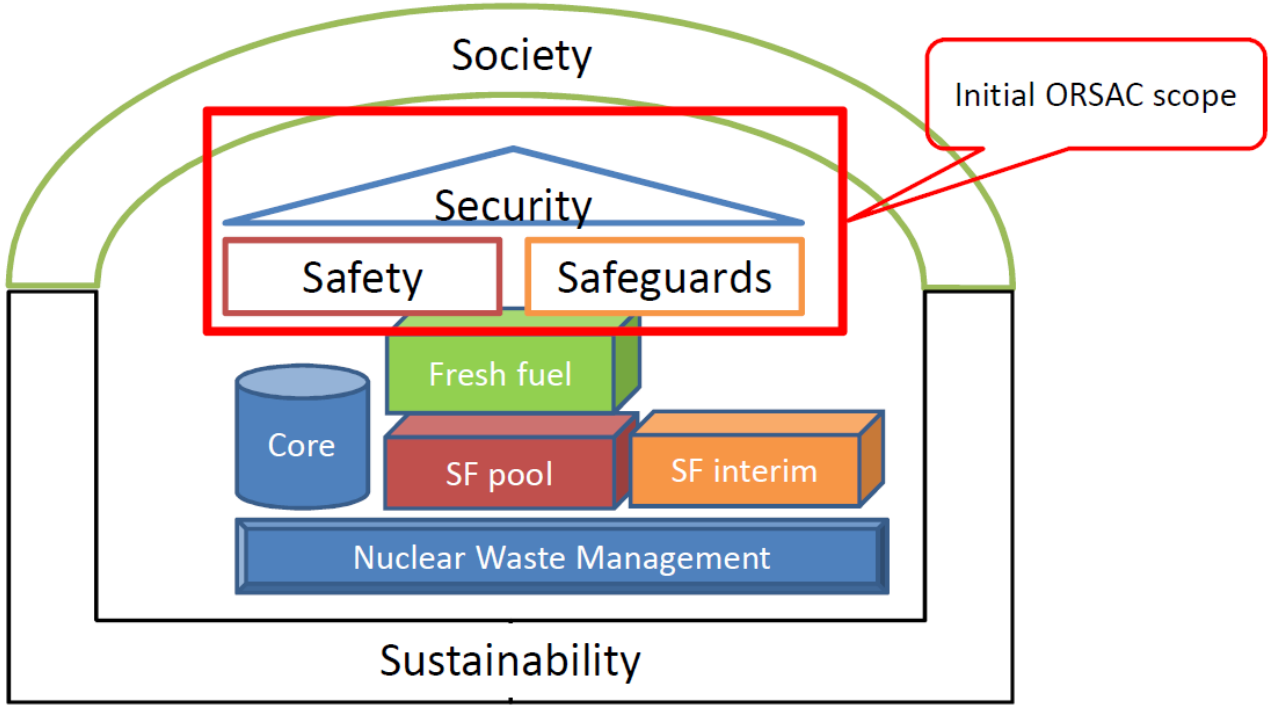
Contents

- Points from ORSAC work in SAFIR2018
  - Overall Safety Conceptual Framework – ORSAC
    - Juhani Hyvärinen et al.
- Organisational aspects in overall safety
  - Marja Ylönen’s presentation!
- Points from safety case
  - Function
  - Contents
  - Features
    - Scenarios in SYSMET presentations!
- Conclusions
  - Need to expand safety case? <= ORSAC considerations

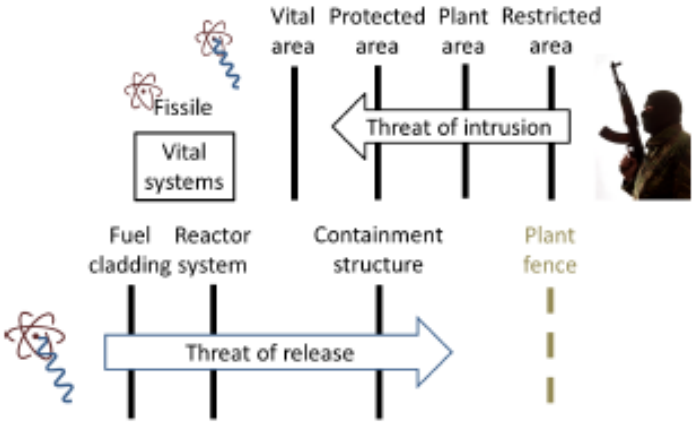
What can overall safety mean?
5S view



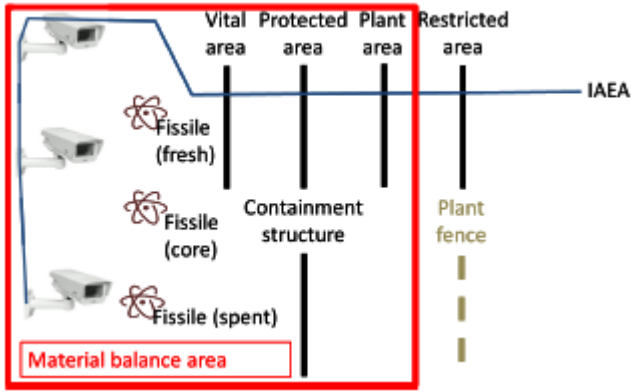
Source: Juhani Hyvärinen

Points from ORSAC: S->2S->3S

- ORSAC was developed for NPPs
- Safety - security (againist unlawful access, damage, theft) – safeguards (against other than peaceful purposes)



Release barriers vs. Security zones



Material balance area vs. Security zones

Main points* in ORSAC framework considered most relevant for NWM

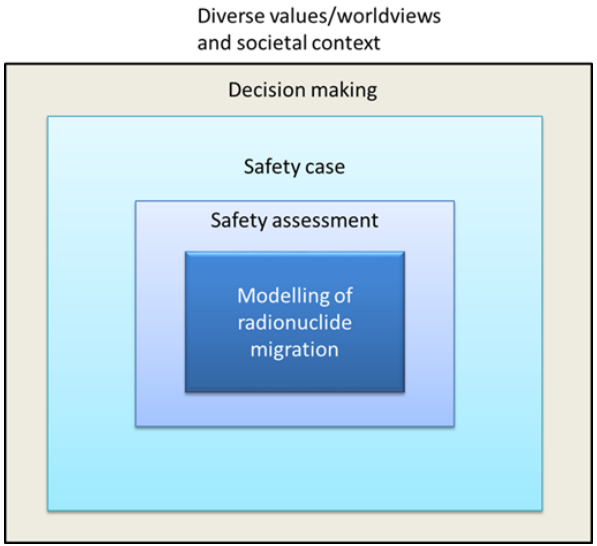
- Defence in depth philosophy
  - Fundamental nuclear safety concept
  - Evolution with nuclear accidents
- Top down (big picture in mind)
- NPP = a system of systems
- Nuclear community = organisation of organisations
  - Shared beliefs and feelings
  - Complementary responsibilities
  - Subconscious assumptions?
    - (over)confidence in own excellence??

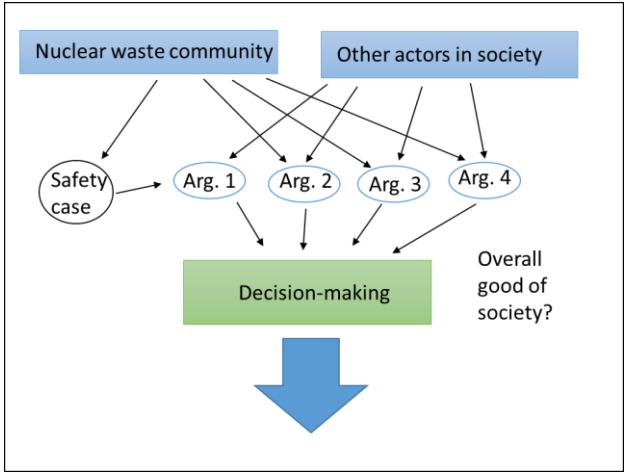
*N.B. ORSAC is for NPPs

Function of safety case in licencing

Licencing of major nuclear waste management facilities in Finland is granted by Government. Safety case is needed for licencing

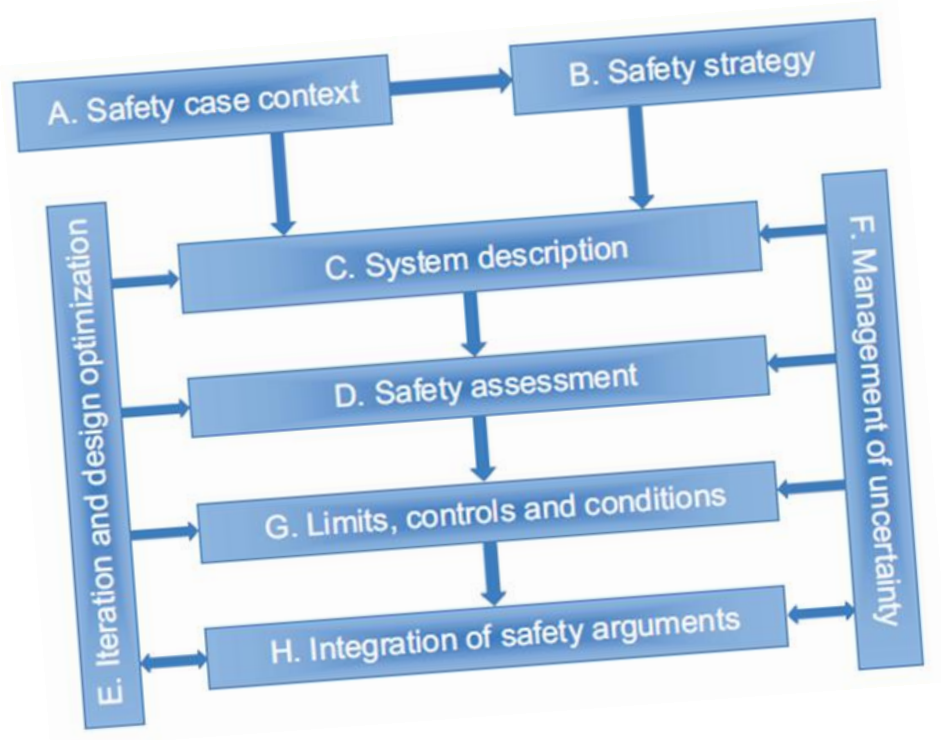
- Decision-in-Principle
- Construction Licence
- Operating Licence
  - Periodic updating (15 a)
- Closure Licence
- Burden of proof lies with the licence applicant / holder
- Review by STUK





Contents of safety case: what is it?

- IAEA: … “the collection of arguments and evidence to demonstrate the safety of a facility” (IAEA 2012)
- NEA: … “A safety case is the compilation of underlying evidence, models, designs and methods that give confidence in the quality of the scientific and institutional processes as well as the resulting information and analyses that support safety.” (NEA 2012)
- Posiva: … “portfolio of 8 main reports” (Posiva 2017)



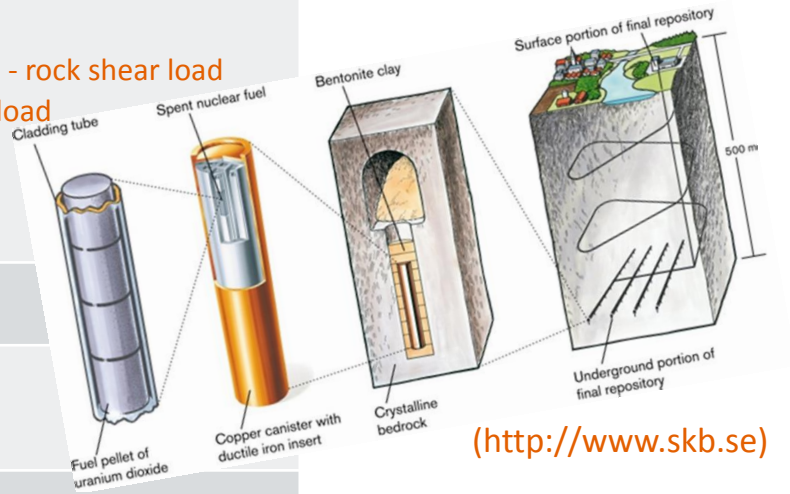
IAEA 2012

Review of safety case (YVL D.5)

1. Description of the disposal system
2. Definition of barriers and long-term safety functions
3. Definition of performance targets for long-term safety functions
4. Definition of scenarios
5. Models and input data
6. Safety analysis and rare events impairing long-term safety
7. Treatment of uncertainties
8. Complementary considerations
9. Comparison of the outcome of the analyses with the safety requirements
10. Structure and documentation of the safety case
11. Quality of the safety case

Safety functions planned for KBS-3V

Release barrier	Safety function
Canister	SF1 Withstand corrosion SF2 Withstand mechanical loads SF3 Maintain sub-criticality
Buffer	SF4 Limit advective mass transfer SF5 Limit microbial activity SF6 Filter colloids SF7 Protect the canister from detrimental mechanical loads - rock shear load SF8 Protect the canister from detrimental loads – pressure load SF9 Resist transformation SF10 Keep canister in position SF11 Retain sufficient mass over life cycle
Backfill and plug in deposition tunnels	SF12 Keep the buffer in place SF13 Limit advective mass transfer
Closure	SF14 Reduce the risk of unintentional intrusion SF15 Avoid the formation of new preferential flow paths SF16 Keep the deposition tunnel backfill in place
Host rock and underground openings	SF 17 Isolation from the surface environment SF18 Favourable thermal conditions SF19 Mechanically stable conditions SF20 Chemically favourable conditions SF21 Favourable hydrogeological conditions with limited transport of solutes

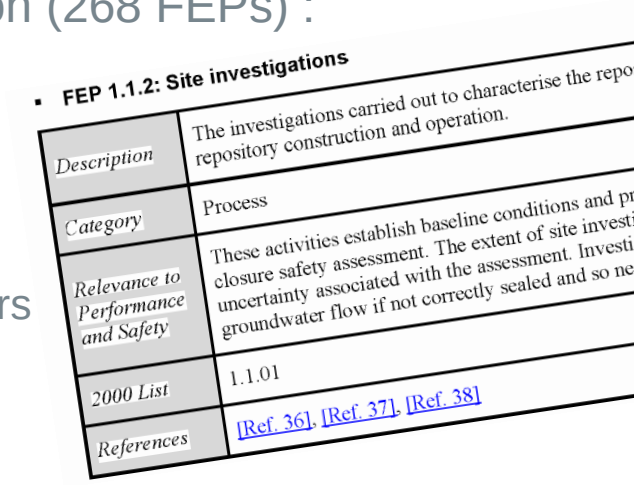


(http://www.skb.se)

Posiva SKB Report 01

Features, events, processes (FEPs)

- FEP's are essentially possible/thinkable safety-relevant things that could happen in or near the disposal facility
- International and national compilations
- NEA (2019) compilation (268 FEPs) :
  - external factors
  - waste package
  - repository
  - geosphere, and
  - biosphere related factors



FEP 1.1.2: Site investigations

Description	The investigations carried out to characterise the repo repository construction and operation.
Category	Process
Relevance to Performance and Safety	These activities establish baseline conditions and pr closure safety assessment. The extent of site investi uncertainty associated with the assessment. Investi groundwater flow if not correctly sealed and so ne
2000 List	1.1.01
References	[Ref. 36], [Ref. 37], [Ref. 38]

Table of contents

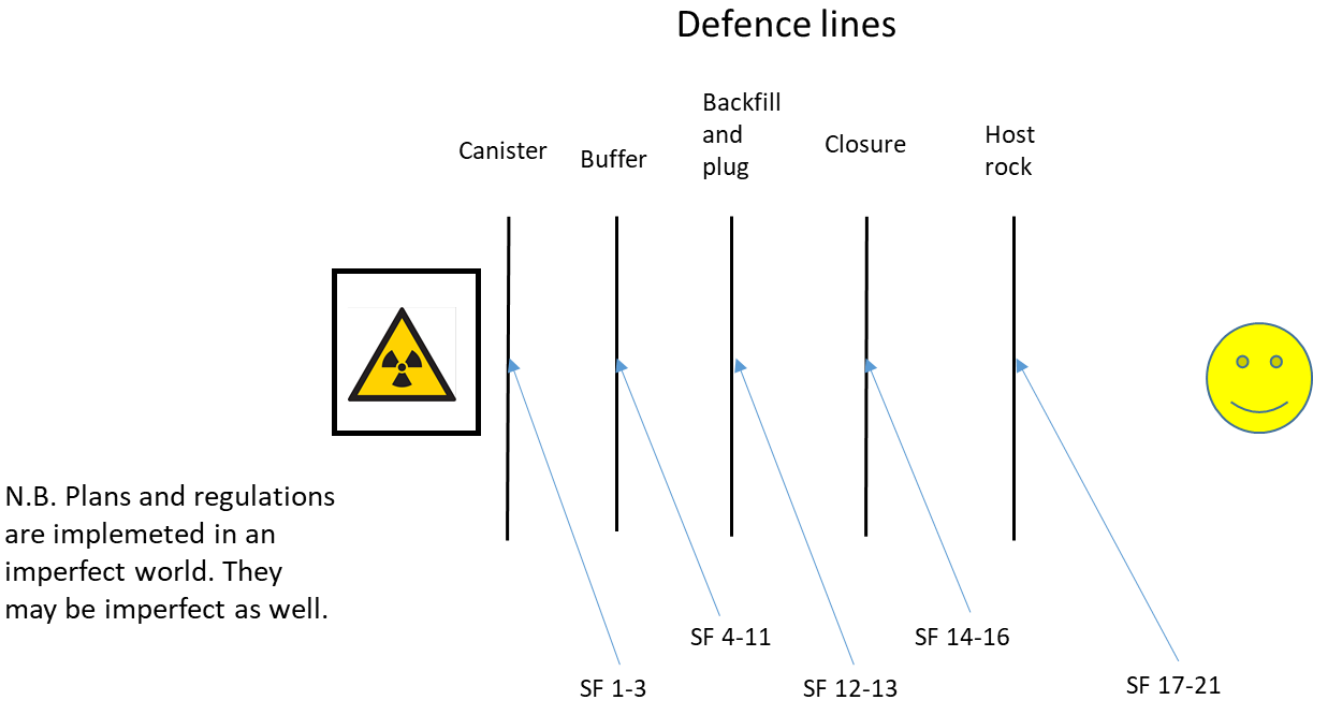
Safety case methodology – Need to expand after ORSAC considerations?

- Defence in depth philosophy
  - Used in disposal facility and safety case
- Top down (big picture in mind)
  - Used in safety case
- NPP as a system of systems
  - Nuclear waste repository is also a system of systems
- Nuclear community = organisation of organisations
  - Nuclear waste community is like nuclear community

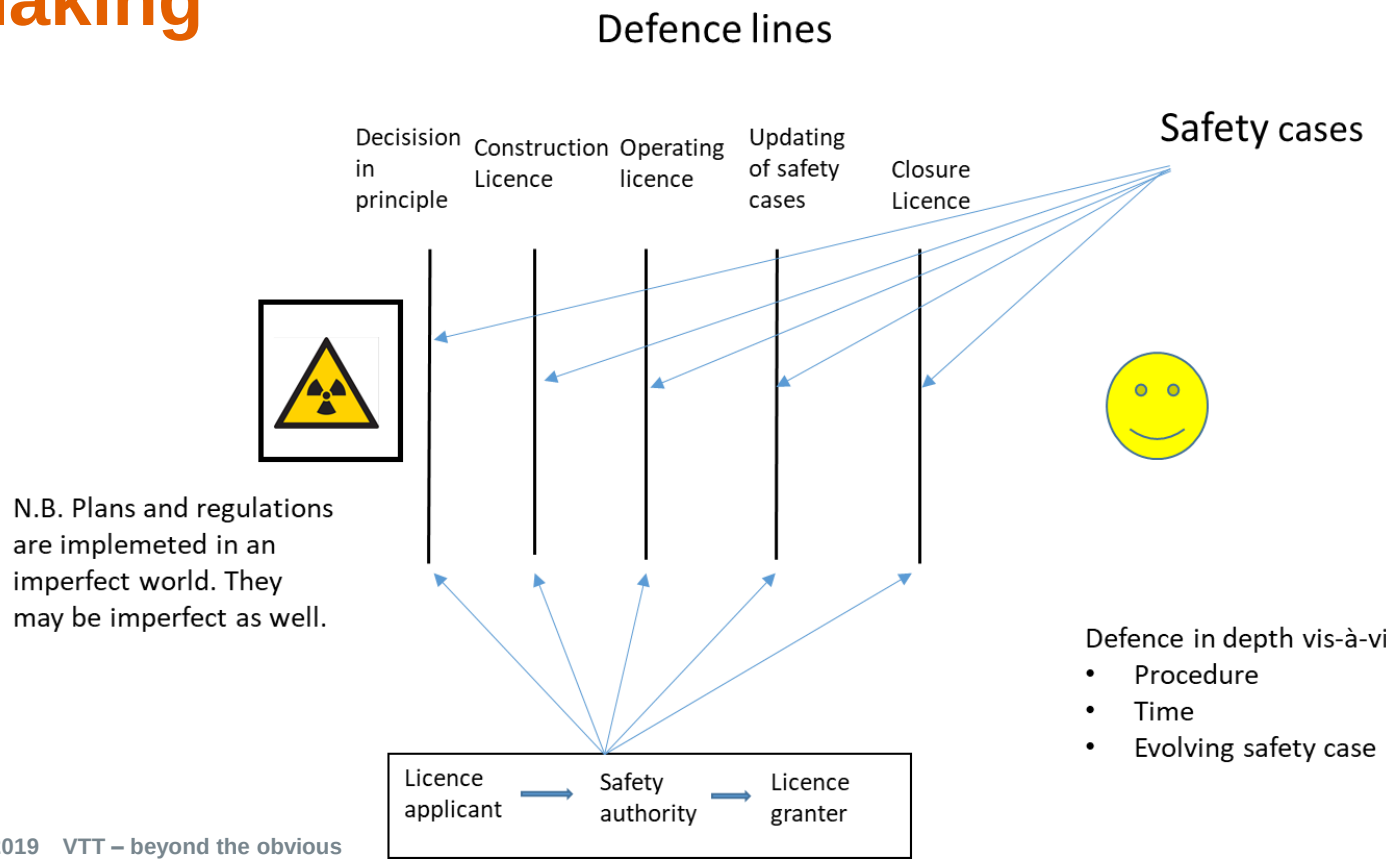
- Organisational points can be currently discussed in
  - Scenarios (external FEPs)
  - Quality of safety case (STUK review point 11 includes management system)

Is this enough?

Defence in depth in release barrier system for nuclear waste disposal (KBS 3V)



Defence in depth in NWM decision making



Defence in depth vis-à-vis

- Procedure
- Time
- Evolving safety case

Thank you!

- Good reading about overall safety and safety case

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- Posiva & SKB, 2017, Safety functions, performance targets and technical design criteria for a KBS 3V repository. Conclusions and recommendations from a joint SKB and Posiva working group. Posiva SKB Report 01, 116 p.
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- Rasilainen, K., Vuori, S., Olin, M., Ahonen, L. & Suksi, J. 2013, Management of spent nuclear fuel. Safety case as a tool of research and decision making, VTT Technology 92, 52 p. + app. 2 p. (in Finnish) (https://www.vtt.fi/inf/pdf/technology/2013/T92.pdf)
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