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Supplement of

Can a repository site be safer than safe? – Criteria and methods for a safety-oriented comparison of repository sites

Martin Navarro et al.

Correspondence to: Martin Navarro (martin.navarro@bfe.bund.de)

Can a repository site be safer than safe?

Criteria and methods for a safety-oriented comparison of repository sites

Federal Office for the Safety of Nuclear Waste Management

safeND Interdisciplinary research symposium on the safety of nuclear disposal practices

Martin Navarro*, Ingo Kock*, Gerd Frieling*, Thomas Beuth*

** formerly at GRS gGmbH*

SafeND 2021, session "*Site selection – methods and overviews*"

Selection steps

Federal Office for the Safety of Nuclear Waste Management

BGE

Entire federal territory

§ 13 site selection act

Subareas (Teilgebiete)

§ 14 site selection act

Siting regions (Standortregionen) for surface exploration

§ 16 site selection act

Favourable sites (günstige Standorte) for underground exploration

§ 18 site selection act

Suitable sites (geeignete Standorte) and **site proposal**

BASE

Independent examination of BGE's site proposal and site comparison. *§ 19 site selection act*

BASE assesses which is the site with the best possible safety.

Requires selection criteria
→ need for regulatory research

Safety-oriented regulatory criteria for site selection

- **Exclusion criteria** (Ausschlusskriterien) – *§ 22 StandAG*
- **Minimum requirements** (Mindestanforderungen) – *§ 23 StandAG*
- **Geoscientific weighing criteria** (geowissenschaftliche Abwägungskriterien) – *§ 24 StandAG*
  & **(unspecified) safety-oriented weighing** of criteria (sicherheitsgerichtete Abwägung)

Can the geoscientific weighing criteria narrow options down to one single site?

- Focus on geological setting (not on entire system)

→ Not all aspects of safety covered

➔ Additional criteria needed to find system with best possible safety

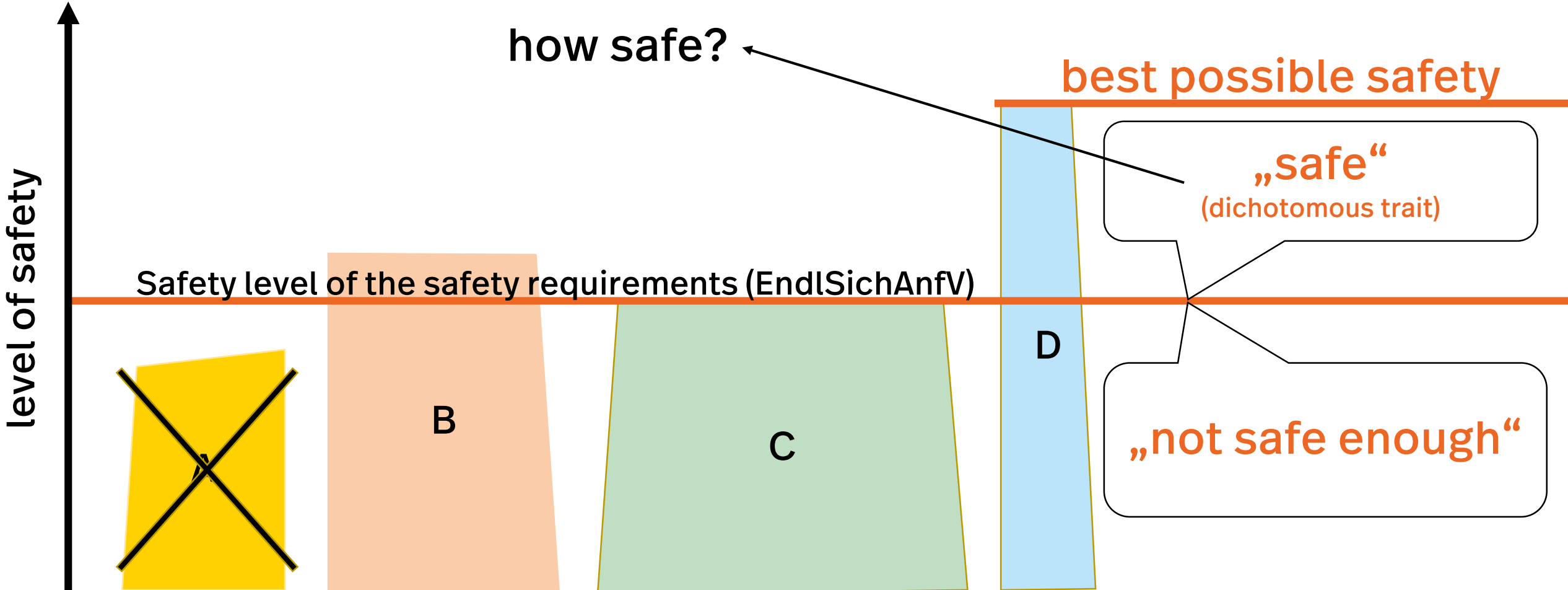
Conditions of the final selection step

The site with best possible safety might have to be selected from „high-quality“ sites that meet the regulatory requirements (EndlSichAnfV) thus being “safe” in this sense

Our task in this case:

Select the safest site from a set of “safe” sites!

Identifying the safest site among “safe” sites



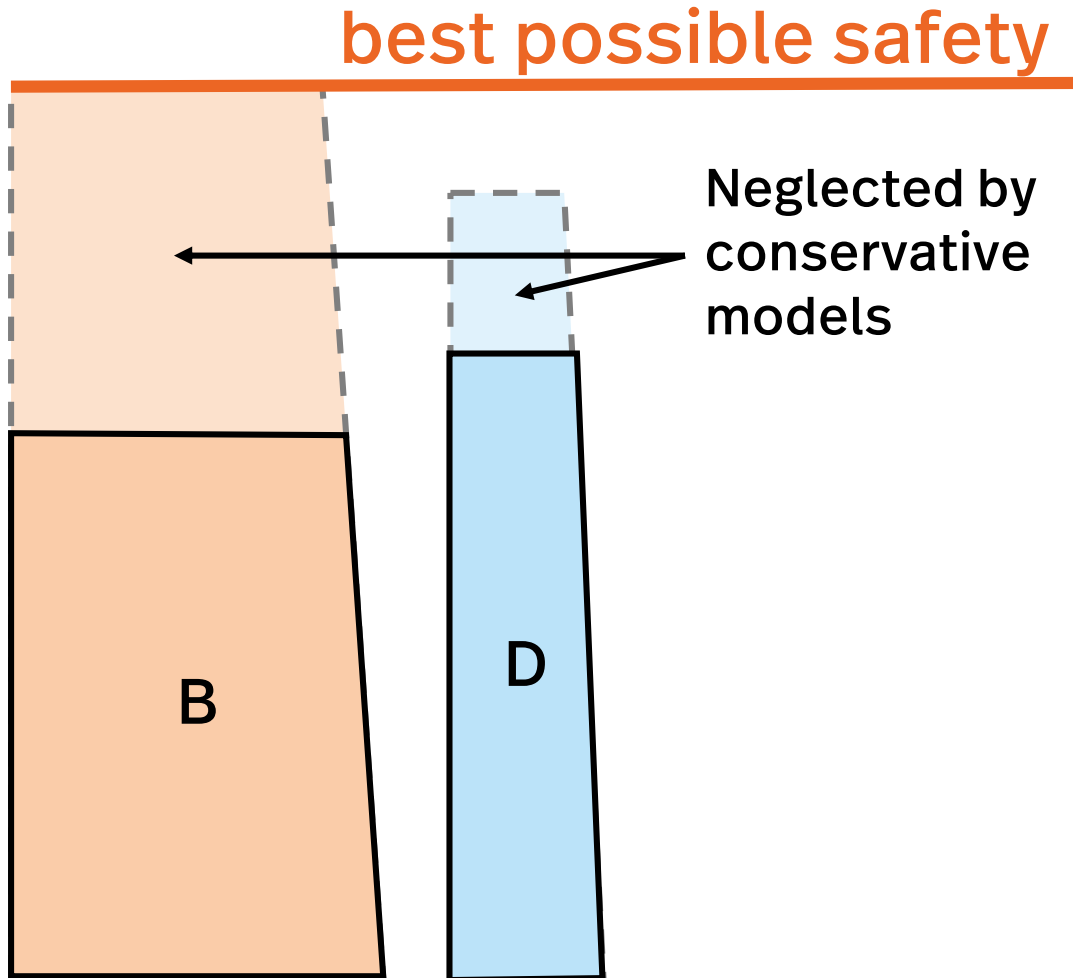
Use dose or containment indicators as safety measures?

- Calculated by models
- Models are always conservative (pessimistic) and we don't know how conservative

➔ We only see a minimum safety

➔ A system that appears to be less safe in the calculations could be the safest!

No suitable measures of safety!



Criteria needed to compare the safety of sites!

They should be …

- able to compare systems that may differ fundamentally with regard to host rock, geosystem, safety and repository concept
- safety-related
- related to the real system – e. g. independent from definitions
- operational (verifiable) – evaluation must be possible
- differentiating – should not yield same results for all sites
- acceptable – many should be able to agree
- intelligible – many should be able to understand
- scientifically justified

A demanding task!

BMU project 3607R02589 in joint project VerSi (2007 – 2010)

Carried out by GRS
Report: GRS-A-3536

Goals

- Criteria and evaluation methods for the final selection step
- Evaluation test for generic salt and claystone sites

Main ideas

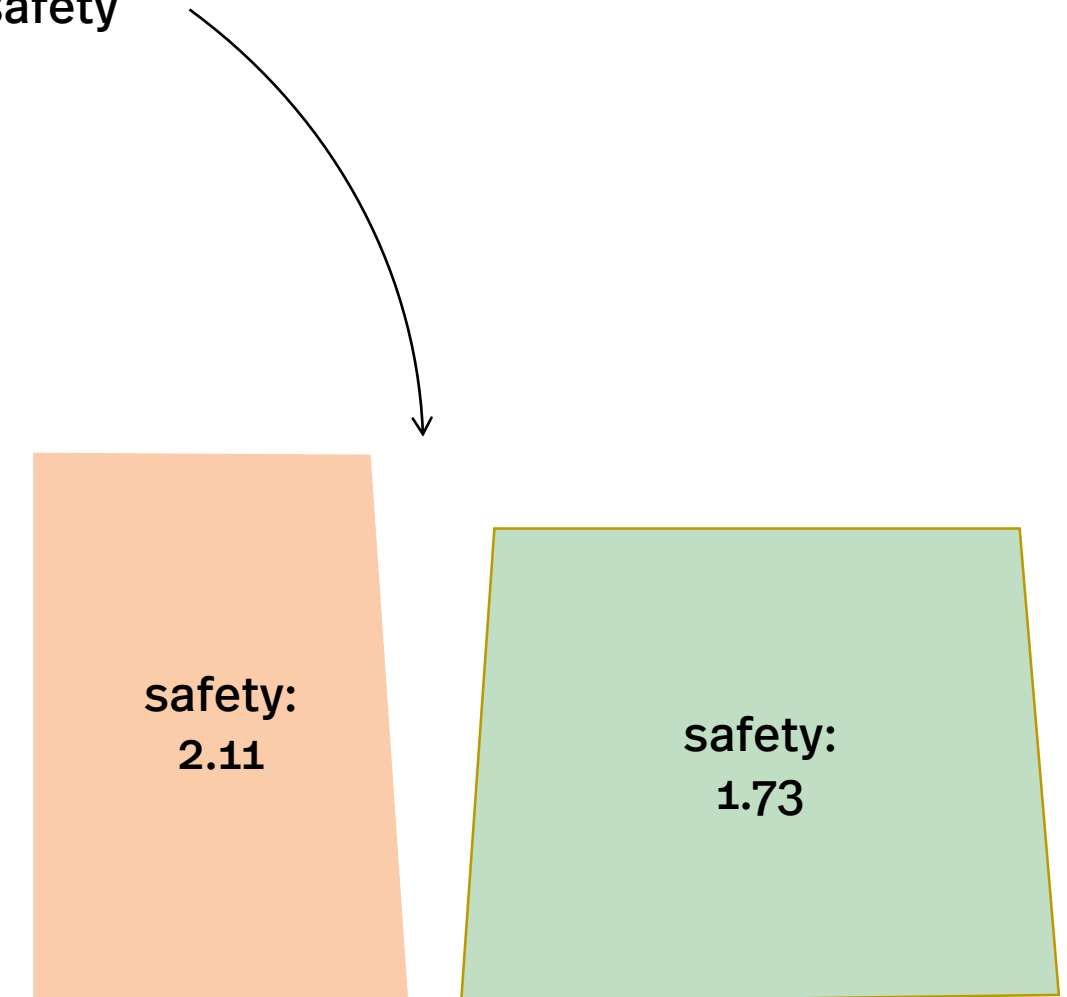
- The robustness of the system provides a suitable measure of safety for “safe” sites
- The robustness of the system can be derived from the robustness of safety functions

Analysing the system's safety related structure

The VerSi approach does not calculate numbers for safety which is not very transparent.

It analyses the system's safety related structure
(it looks at safety functions of components)

- Shows why the system is robust (and thus safe)
- Allows to include additional arguments
  e. g. to draw a comprehensive picture
  of a system's safety reserves



Follow-up BMU projects VerSi II and III (carried out by GRS)

Versi II (05504/2) , 2014 – 2017, report: GRS-478

- Impact of retrievability
- Few methodical amendments
- Applicability to phase 1 of the site selection process

VerSi III (4719E03250), 2019 – 2021

- Data compilation for crystalline rock (updated for salt & claystone)
- Comprehensive description of criteria and the complex evaluation method

revealed gaps in the argumentation and a need for further R&D

Problem #1: Equal strictness of design requirements

Two systems with perfectly robust safety functions should be equally safe
(implicit assumption of VerSi)

But …

- Is this true if host rocks or concepts differ? Couldn‘t a robust clay concept be safer or less safe than a robust crystalline concept?
- Wouldn‘t an unambitious system design with slack criteria for safety function robustness appear to be more robust and thus safer?

VerSi tried to tackle this problem by demanding „equal strictness of design requirements“

Problem #1: Equal strictness of design requirements

However, VerSi did not explain …

- what „equal strictness of design requirements” exactly means
- how it is achieved or checked

➔ Difficult to establish a clear link between robustness and safety

➔ We can’t simply translate differences in robustness into differences in safety

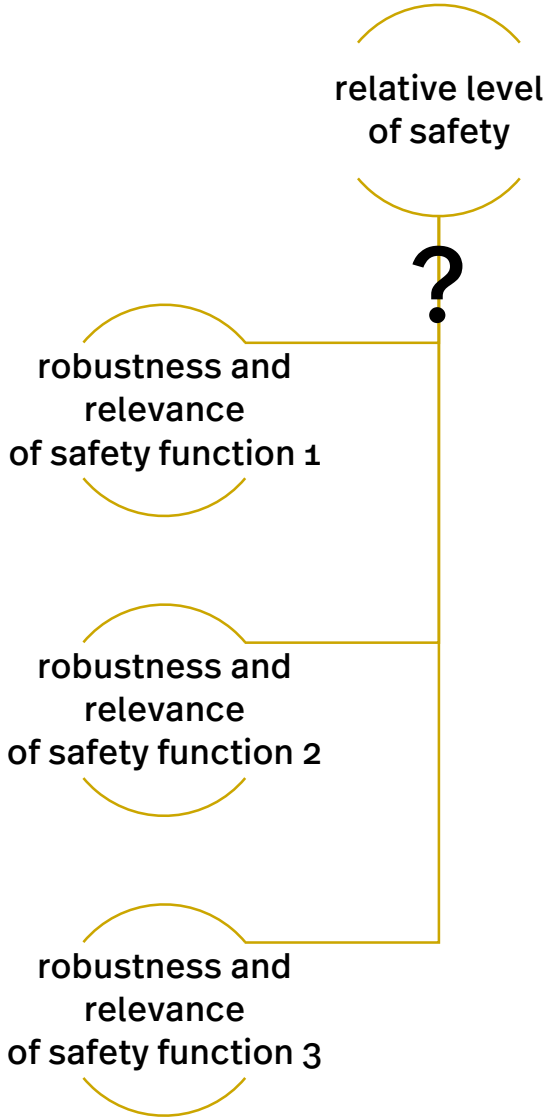
We are at least lacking a safety-related benchmark that makes sites comparable

Problem #2: No final aggregation

The VerSi method determines the robustness and relevance of safety functions as a basis for decision-making

It provides no guidance to the decision-makers on what to do with the individual robustness criteria in order to reach a decision

Can a justifiable procedure be found?



BASE project METIENS (2022 – 2024)

These problems will be addressed in BASE project METIENS.

Continues research of VerSi I, II, and III.

Goals

- Find criteria to find the site with best possible safety
- Refine and test evaluation method
- Develop aggregation procedure
  (probably using a verbal decision analysis)

METIENS

Methods, evaluation criteria and transparent decision processes for identifying a repository site with the best possible safety when data from underground exploration are available

***Met**hoden, Bewertungskriterien und transparente Entscheidungsprozesse zur **I**dentifikation eines **En**dlagerstandortes mit bestmöglicher **S**icherheit nach Vorliegen untertägiger Standortdaten*

Why „METIENS“ and not „VerSi IV“?

VerSi = Vergleichende Sicherheitsanalysen
= comparative safety analyses

But this approach has moved away from the initial idea of comparing safety analyses.

metiens (lat.) = measuring, estimating

Finding a measure for relative safety is what we need to do!

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