

How safety concepts can be rejected for reasons of safety

An outcome of the METIENS project

Safety levels are not everything

In the German site selection procedure, the site with the best possible safety is found by successively rejecting candidate sites (or regions). **Site selection**, therefore, is a problem of **site rejection**.

Thinking about how to reject sites, we normally direct our attention to the **level of safety**: for example, sites can be rejected if their level of safety does not satisfy regulatory requirements or if there are sites with a higher level of safety. Ascertaining safety levels, however, is a challenging task. It requires comprehensive safety assessments and site characterizations. Moreover, when comparing sites, a reliable evaluation of safety level differences might not always be possible.

However, there are safety-related arguments for site rejection that do not refer to safety levels. In particular, **we may reject sites if we do not accept their way of achieving safety**. This argument is worth looking at because it provides us with a safety-related reason for rejecting sites that does not require site characterizations. The argument can even be used to reject safety concepts as a whole for reasons of safety.

The rejected principle of dilution and dispersion

A well-known example for this argument is the rejected principle of *dilution and dispersion*. Although dilution and dispersion does take place in repository systems, it is a common notion that dilution and dispersion should not be the general safety concept.

Dilution-and-dispersion concepts are not acceptable **even if they provided a sufficient level of safety**. This shows that the argument does not refer to safety levels. Still, it connects with safety. More precisely, it refers to the **system-specific conditions under which safety is achieved**.

Rejecting safety concepts as a whole

Some preferences may turn out to be preferences for safety concepts, as the following hypothetical examples show:

- “We particularly trust technical barriers because they are easier to characterize than geological barriers” (should favour crystalline concepts)
- “We do not trust statements about the long-term behaviour of technical barriers” (should favour salt and clay concepts)

If such preferences exist, they can probably be **elicited early on** in the site selection procedure because they do not rely on site characterizations.

When to use it

Arguments for rejecting safety concepts are probably strongest if they relate to safety levels. However, if comparisons of safety levels are not possible for whatever reason, safety concepts might, instead, be justified by consensual preferences for the system-specific conditions under which safety is achieved. Since these preferences relate to safety, they still have a high potential of providing convincing arguments for concept rejections.

probably preferable			
Type of criterion or indicator	not related to safety	related to safety, but not to safety levels	related to safety levels
General rationale for site rejection	Difficult to implement technically (etc.)	Unacceptable way of achieving safety	Absolute: Not safe enough Relative: Less safe

The likelihood that safety level comparisons are not possible is higher the less similar the compared sites or concepts are (Navarro 2025). **Checking whether cross-conceptual safety level comparisons are impossible and eliciting conceptual preferences**, therefore, offers a promising way of deciding between strongly dissimilar safety concepts.

Generalizing the argument

To put it simply, **we may reject sites if we do not like their way of achieving safety**. For example, we might feel uncomfortable with repository systems that will likely suffer from certain environmental impacts (glaciation, seismic activity etc.) or that are connected to certain types of uncertainty that are difficult to handle.

Requirements regarding the way of achieving safety do not imply that the rejected site has an insufficient level of safety. They only express **positive or negative conceptual preferences** for certain ways of implementing a disposal facility and, thus, achieving safety. For this reason, they can be called **conceptual requirements** (Navarro 2025).

Conceptual requirements are **subjective**. Thus, they can only be acceptable if they are **consensual** and if decision-makers accept the risk that the rejected sites could have a high level of safety.

Hence, there are limits to the usage of conceptual requirements. Still, they remain powerful tools for site rejection because they may express arbitrary conceptual preferences.

Moreover, they help supporting consensual exclusion criteria. For instance, if we were unsure whether a certain exclusion criterion really proves insufficient safety, we may as well repurpose it as a conceptual requirement.

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This is an amended version of the poster presented at the safeND 2025 symposium.



References
Navarro (2025): Foundations of site selection procedures for deep geological repositories: An argument-based model to explain how site rejection decisions can be justified by inaccurate operationalizations and assessments of long-term protection. *Frontiers in Nuclear Engineering*, Volume 4 – 2025. <https://doi.org/10.3389/fnuen.2025.1664370>.