IGD-TP Exchange Forum 5

Managing uncertainties

Assessment Timescales and Complementary Safety Arguments

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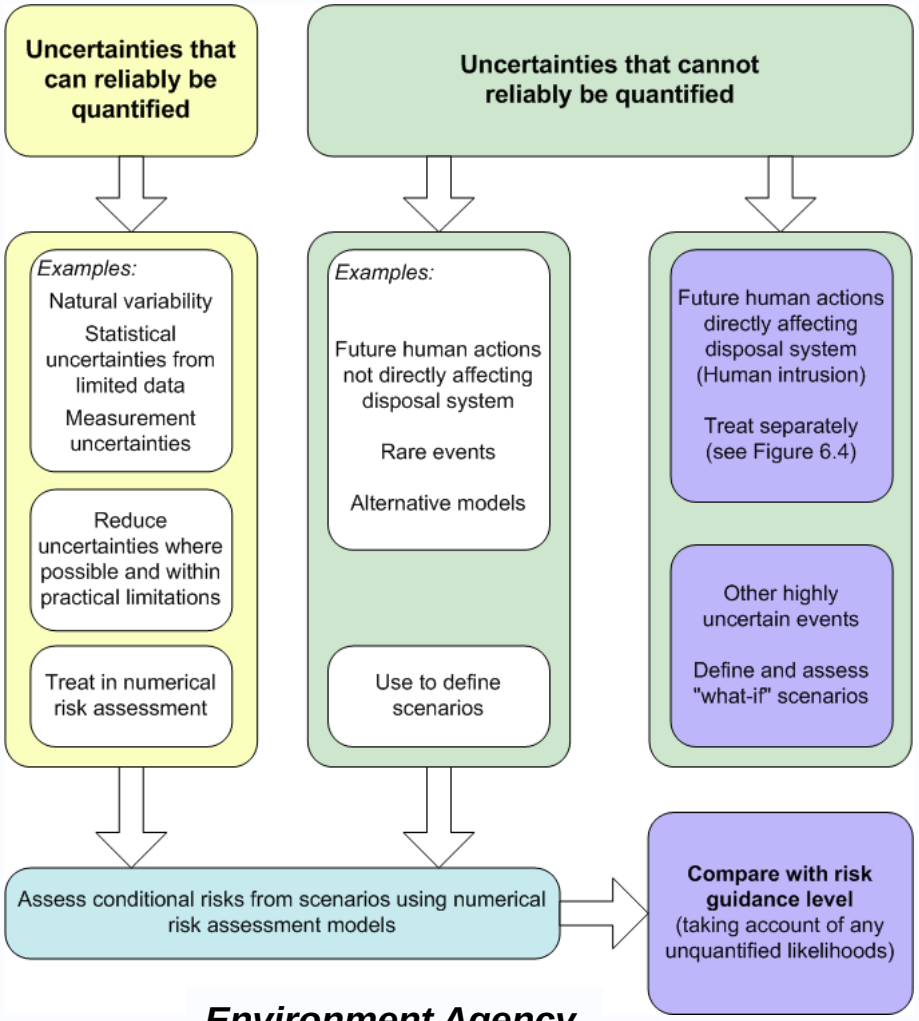
Two types of uncertainties

- **Uncertainties generally increase with time and some events may lead to large increases in uncertainty**
- **UK guidance: *"…an important distinction can be made between two types of uncertainties: those that can reliably be quantified and those that cannot"***
- **Will have very different approaches to treatment in a safety case and management**
- **Need complementary lines of argument**



Environment Agency et al. 2009

Safety assessment timescales

- FEPs that could lead to changes in the characteristics of the main components of a disposal system
  - FEPs that could give rise to significant increases in uncertainty; extent to which these are time-dependent
- Three generic periods
  1. Near-field transient (re-saturation of near-field occurs)
  2. Disposal system stability
  3. Biosphere and geosphere evolution
- Length of (1) and (2) depends highly on disposal concept
  - Different for different waste types in same host rock
- Global cooling leads to increasing uncertainties in biosphere
  - Glacial conditions cause significant hydrological changes

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Probabilistic calculations

- Probabilistic calculations of dose and risk would be appropriate for the disposal system stability period
- Extension into the near-field transient period appropriate if there are releases of radionuclides to the geosphere
  - Requires reliable quantification of uncertainties relating to re-saturation
- Extension into the biosphere and geosphere evolution period appropriate if the uncertainties can be reliably quantified for a specific disposal concept and site

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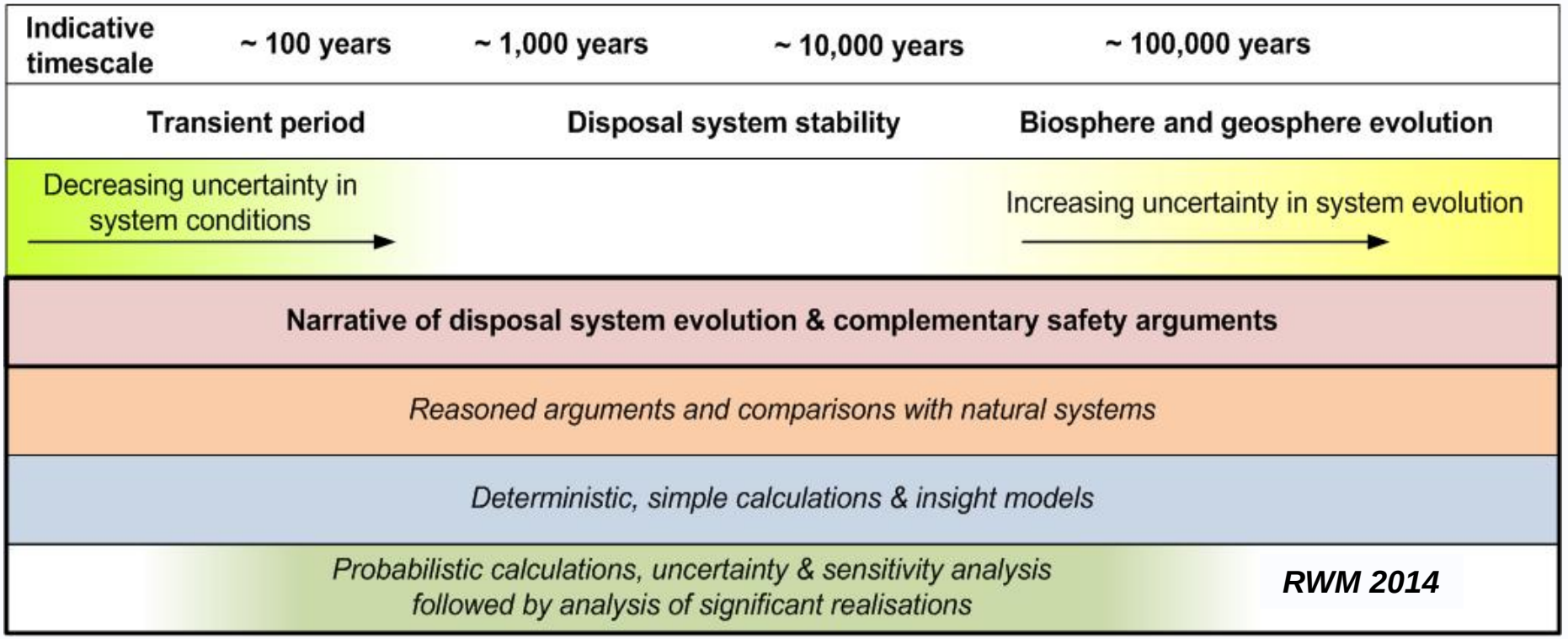
Constructing a safety case

- **“Narrative” of disposal system evolution, supported by complementary safety arguments and calculations**
- **Timescales for probabilistic calculations**



Complementary safety arguments

- **Deterministic and/or probabilistic PA calculations of dose and risk**
- **“Additional” safety arguments that complement those derived from PA calculations**
  - **Support safety case, especially at longer times**
  - **Wastes still present a hazard**
  - **Uncertainties increasingly large and difficult to quantify**

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Categories of argument

- Arguments for the EBS / components thereof
- Arguments for the geological barrier
  - Period when the evolution of the EBS becomes increasingly uncertain (e.g. >10^4 - 10^5 years)
  - Geosphere is most important barrier ensuring continued isolation and containment
- Arguments for continuing safety
  - Period when large-scale geological processes, such as uplift, erosion and tectonics, may have significantly affected EBS / geosphere properties (e.g. >10^5 - 10^6 years)
- "Acceptable practices"
  - Consideration of hazard longevity and comparison to other industrial practices

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Arguments for the EBS and geological barrier ($<10^6$ y)

- Continuing existence of favourable properties that ensure isolation and containment
- Potential impacts of climatic change can be understood
  - Deterministic sensitivity analyses based on understanding of the possible response of a specific disposal concept
- Calculate performance indicators for which site-specific reference values can be derived for naturally occurring radionuclides:
  - Release of activity to the biosphere or fluxes across planes
  - Radiotoxicity flux to the biosphere
  - Concentrations or total fluxes of radionuclides in ecosystems
  - Fluxes of safety-relevant radionuclides
- Consider naturally occurring radionuclides in evaluating potential for dissolution and re-precipitation of waste-derived radionuclides
  - U, Th and daughters

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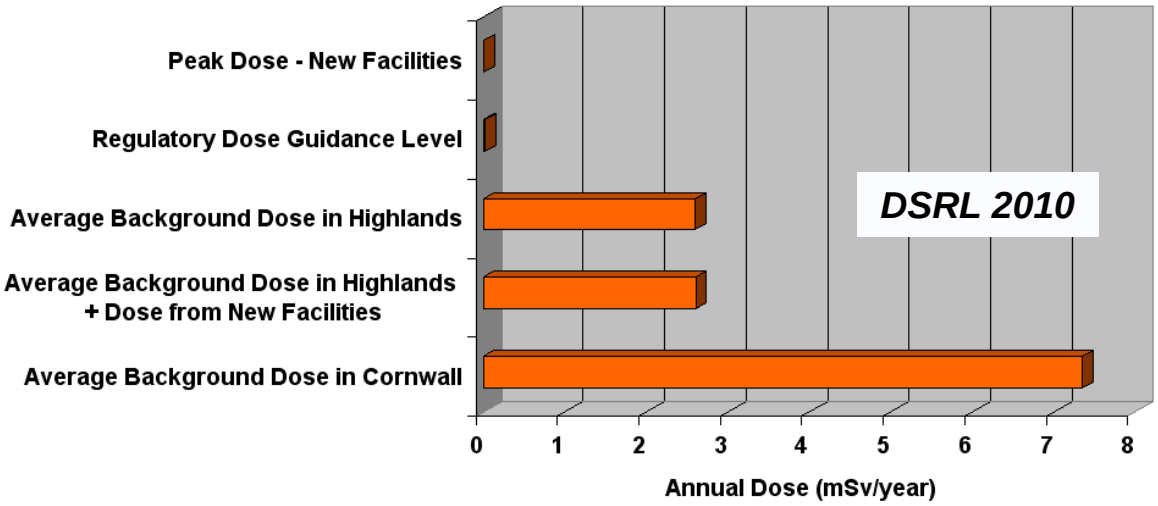
Arguments for continuing safety (>10^6 y)

- **Reference to analogous natural systems**
  - **The evolution of uranium mineralisation near the site or in similar geological environments (e.g. Cigar Lake)**
  - **Evidence from the geological history of the site and the surrounding region, or from similar geological environments**
  - **Naturally occurring radionuclide concentrations and evidence for changes during similar kinds of disruptive event (e.g. glaciation – secondary minerals)**
- **Compare impact of waste-derived radionuclides with naturally occurring counterparts**



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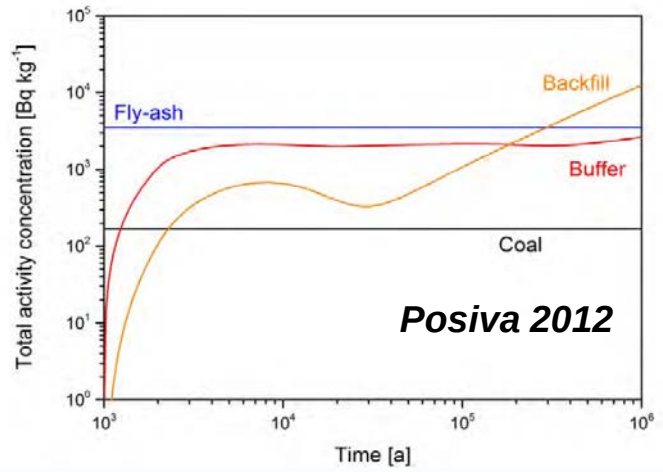
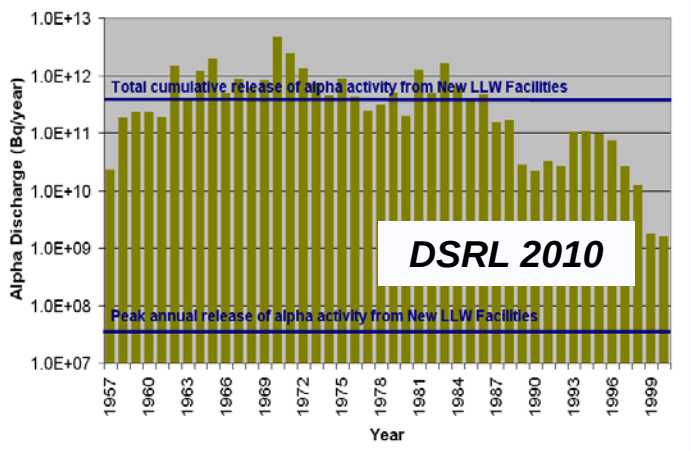
Acceptable practices

- **Level of risk deemed acceptable as part of realising the benefits of related industries in a cost-effective manner**
  - **Example: compare to impacts of NORM from other energy generation industries**
  - **Example: discharges from nearby nuclear site**
- **What benefit would be derived from alternative disposal strategies… and what would the costs be?**
- **Disposal in that form, in that type of facility, at that site represents the "best" solution**
  - **Nothing else can be done cost effectively to better ensure the safety of the environment in the far future**





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Achieving the IGD-TP vision 2025
Collaborative review/development work

1. **Assessment timescales – influence on structure/type of calculations**
   - ***Key outcome: common understanding and framework***
   - ***Key outcome: common consideration of scenarios at long timeframes***
2. **Complementary safety arguments – structured approach / review**
   - ***Key outcome: catalogue of examples that programmes can use***
3. **Compile / examine approaches to uncertainty management**
   - ***Key outcome: "uncertainty can be managed" – demonstration of how***
     - **Uncertainties treated in assessment; wider uncertainties that provide bounds**
     - **Quantifiable and unquantifiable uncertainties; epistemic and aleatory; etc.**
4. **Compile / examine approaches to presenting / discussing uncertainties**
   - ***Key outcome: improved presentation of uncertainty in safety cases***
     - **All significant uncertainties have been addressed; they do not jeopardise safety**
     - **Link to strategic choices on facility development**
     - **Link to forward programme**

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