IGD-TP Exchange Forum 5

Managing uncertainties

Assessment Timescales and Complementary Safety Arguments

Kalmar, Sweden

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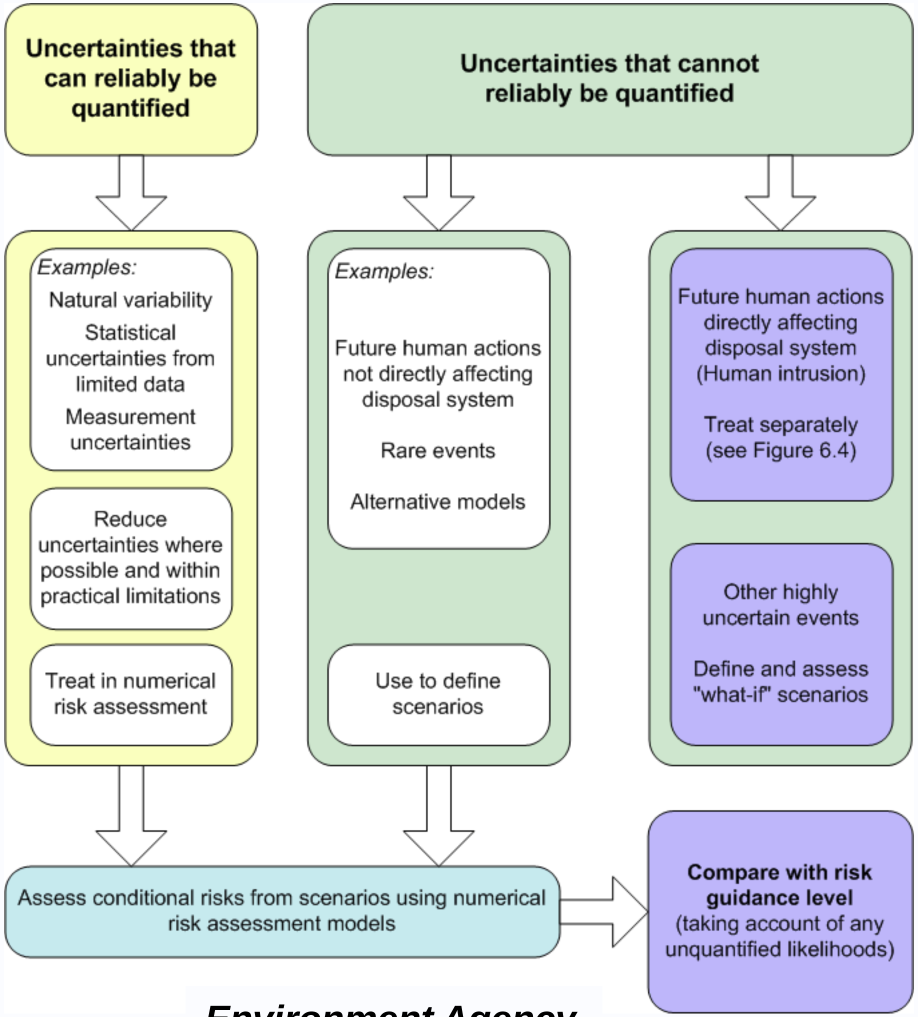
Two types of uncertainties

- **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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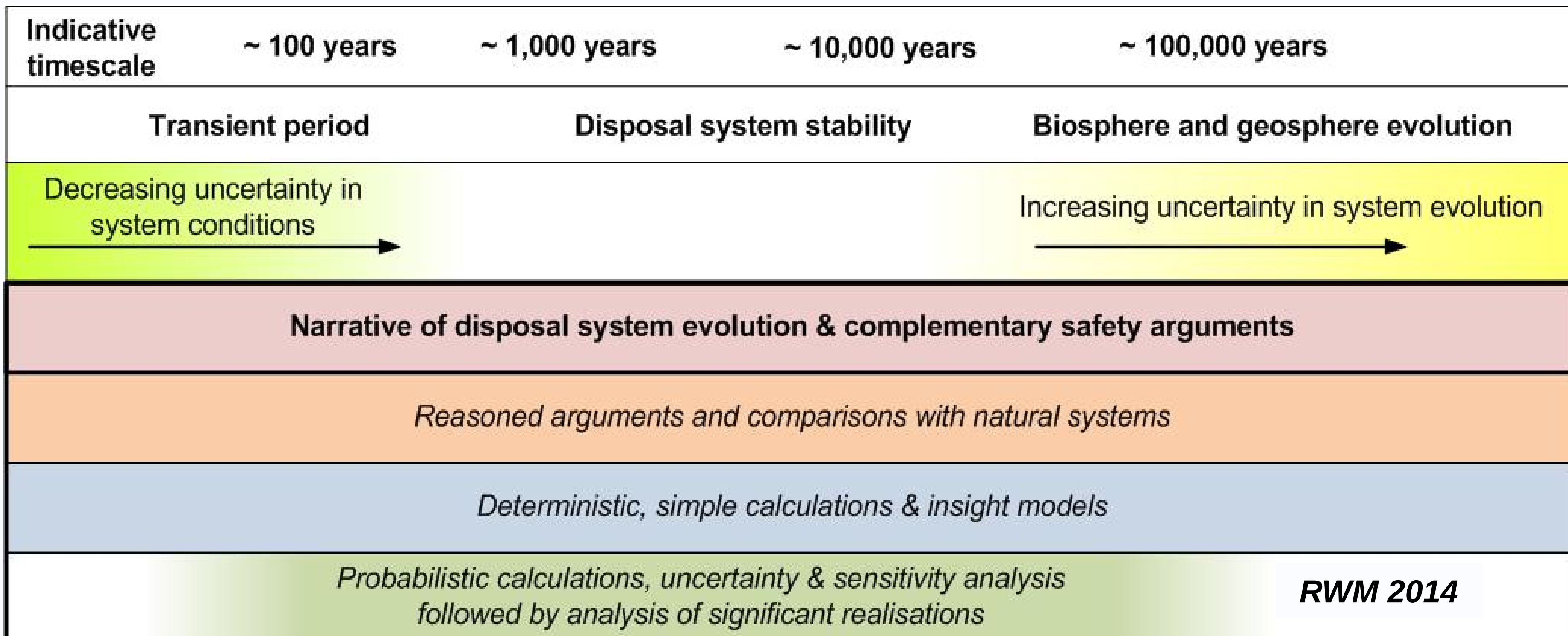
Constructing a safety case

- **"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

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

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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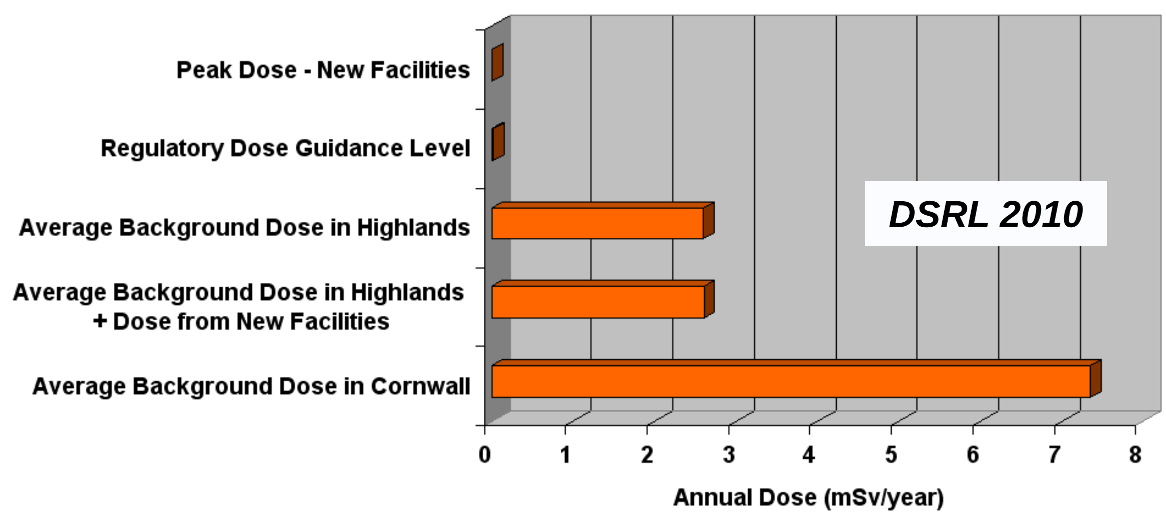
Arguments for continuing safety (>10^6 y)

- 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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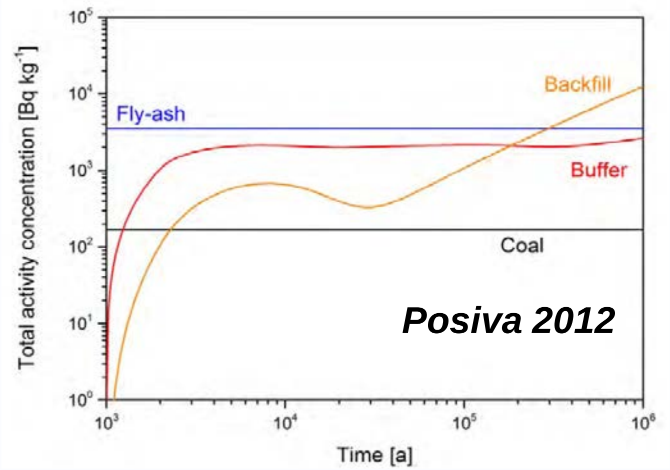
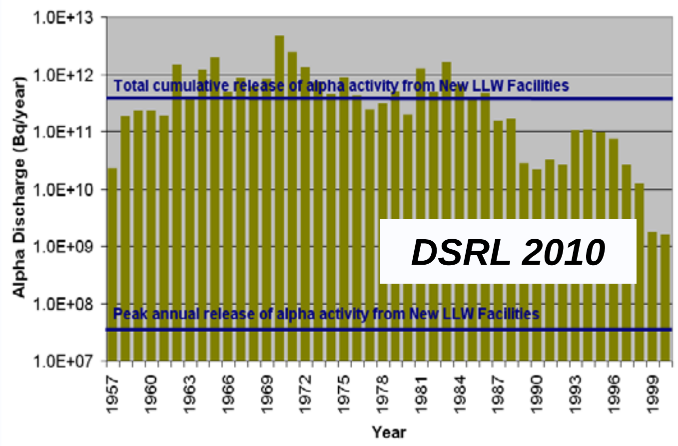
Acceptable practices

- 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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