Safety Case workshop
Tokyo 9-10 July 2009

Safety Case, Safety Strategy and Strategic Environmental Assessment:
An international perspective

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- Regulatory setting
- Balancing requirements
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- Limitations of experience transfer to Japan
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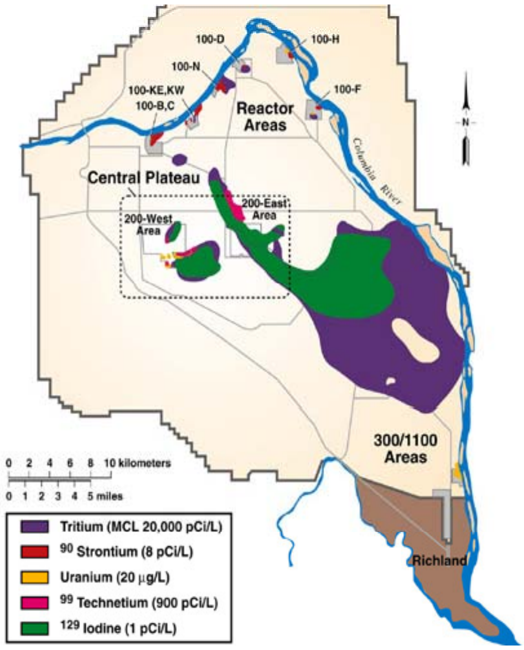
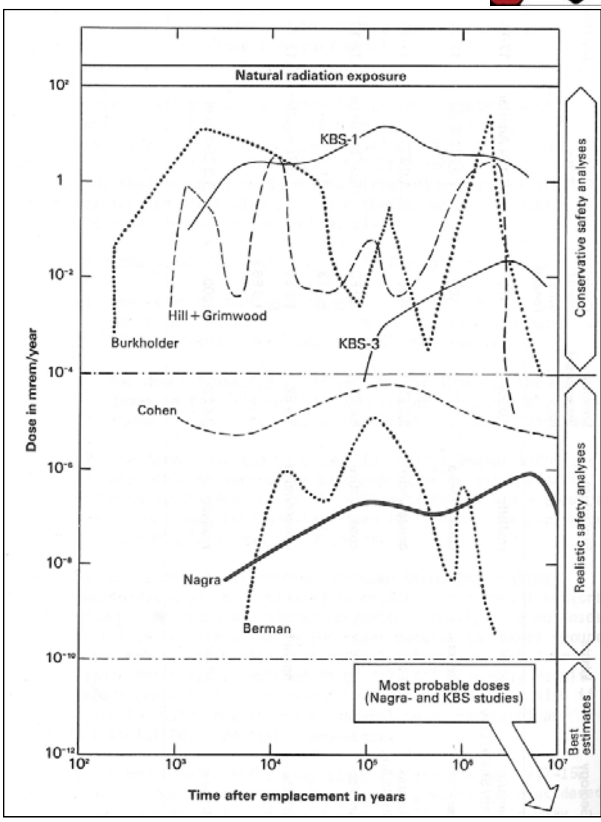
Historical background

- In the early days safety concern was mainly for operators: especially during the Cold War period, even these were rather lax



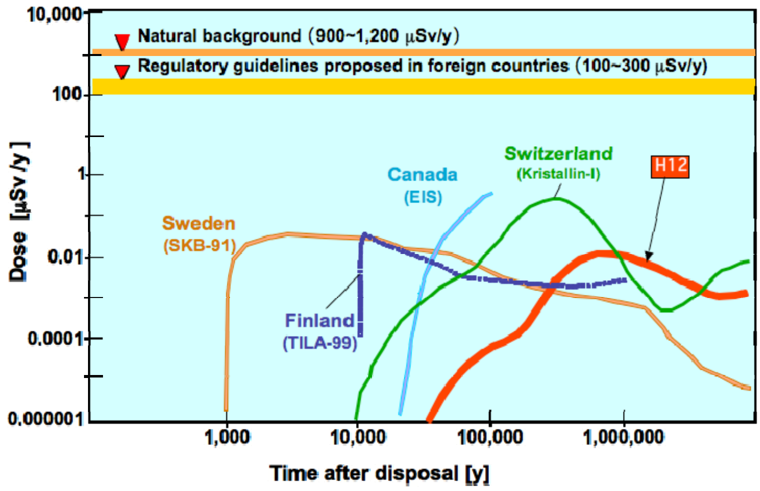
Historical background

- In the early days safety concern was mainly for operators: especially during the Cold War period, even these were rather lax
- Prior to the '70s, even concepts for deep geological disposal of HLW were associated with only rather qualitative evaluations of long term safety



Evolution of "Safety Cases"

- During the '80s and '90s a wide range of integrated safety assessments were carried out to demonstrate long-term safety of geological repositories: this proceeded in parallel to development of associated regulatory guidelines in many countries



Evolution of "Safety Cases"

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- With growing openness after the fall of the "iron curtain" and increasing environmental activism, there was a recognised need to communicate safety arguments to a wider range of stakeholder groups - leading to increasing use of the term "safety case"


Safety cases for the deep disposal of radioactive waste: where do we stand?

B. Frinash, C. Pescatore, H. Umeki

Radioactive Waste Management

POST-CLOSURE SAFETY CASE FOR GEOLOGICAL REPOSITORIES

NATURE AND PURPOSE

NUCLEAR ENERGY AGENCY

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Safety Case definitions

There is no standardised terminology here, e.g.:

- A safety case is a collection of arguments, at a given stage of repository development, in support of the long-term safety of the repository. A safety case comprises the findings of a safety assessment and a statement of confidence in these findings. It should acknowledge the existence of any unresolved issues and provide guidance for work to resolve these issues in future development stages (NEA, 1999)
- The safety case is an integration of arguments and evidence that describe, quantify and substantiate the safety, and the level of confidence in the safety, of the geological disposal facility (IAEA Safety Standards for Geological Disposal)
- A formal compilation of evidence, analyses and arguments that quantify and substantiate a claim that the repository is safe.The safety case may be seen as analogous, in some respects, to a legal case, in which multiple lines of evidence are produced, and for which the quality of each line of evidence must be evaluated to allow a judgement to be reached on the adequacy of the case to support a positive outcome of the decision at hand (IGSC Safety case brochure)

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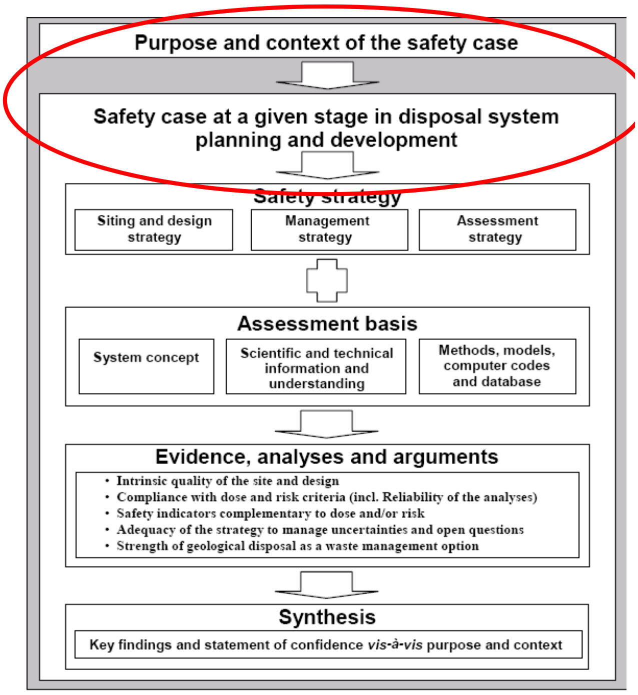
Safety Case components

General consensus that:

- **Boundary conditions / context are specific to national programmes and change with time**



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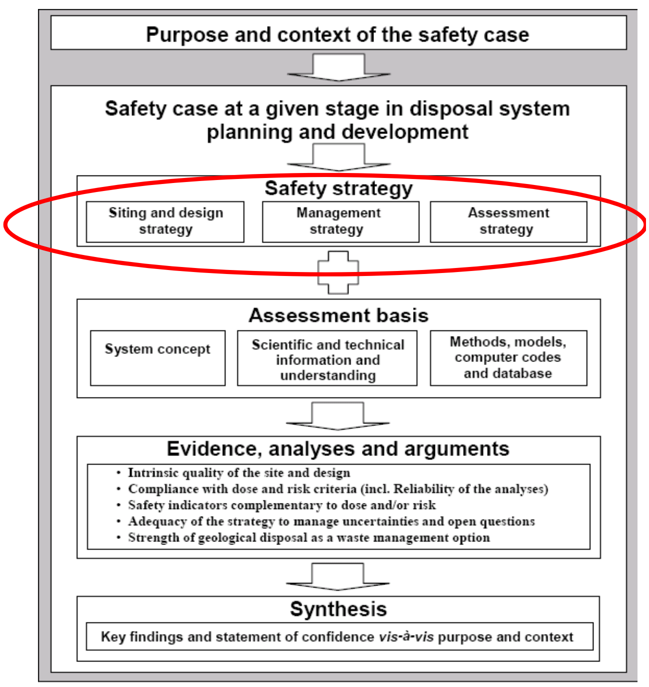
- Boundary conditions / context are specific to national programmes and change with time
- **Safety strategy is a fundamental component, which also varies considerably between programmes**



Safety Case components

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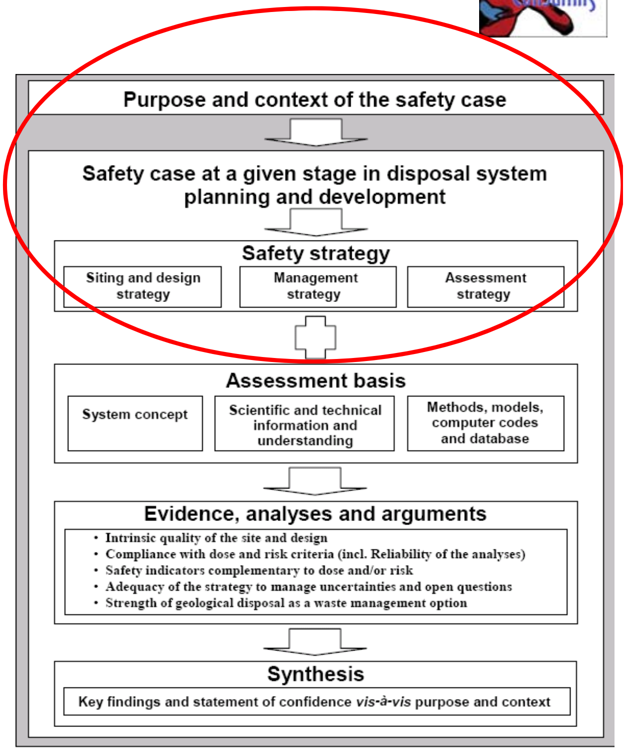
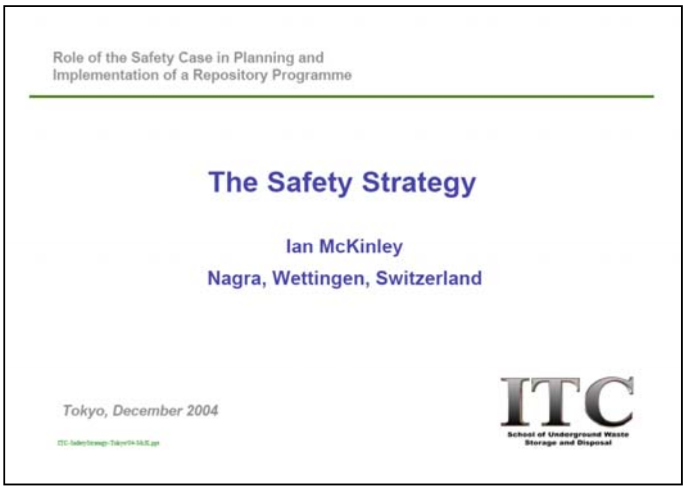
- Boundary conditions / context are specific to national programmes and change with time
- **Safety strategy** is a fundamental component, which also varies considerably between programmes
- **Early focus on post-closure safety was OK for generic feasibility demonstration, but a wider context has to be examined when projects become site-specific and move closer to licensing**



Safety Strategy Definition

- **The art of managing a programme to effectively and efficiently produce safety cases as required for project milestones which satisfy the requirements of all stakeholders**

(ITC Safety Case course, Toyko, 2004)



Safety Strategy Definition

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(ITC Safety Case course, Toyko, 2004)

- **Not explicitly defined in many programmes - especially those longer established, where strategy has gradually evolved over time**
- **Due to emphasis on "all stakeholders", can be a key to establishing dialogue - especially with local communities**

Regulatory setting

- **Provides fundamental constraints on the composition of the safety case**
- **Significant national differences even with regard to post-closure safety, e.g.:**
  - **total system performance (S, SF, CH,...) vs requirements on individual barriers (US)**
  - **cut-off times for PA: strict limit (e.g. old YMP), transfer from quantitative analysis to alternative indicators (e.g. revised YMP), no cut-off (e.g. CH)**
  - **treatment of special scenarios (e.g. human intrusion for WIPP)**

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  - treatment of special scenarios (e.g. human intrusion for WIPP)
- Varying extent of specific regulations for operational safety
  - radiological
  - conventional
- Variations in extent to which other regulations are specified, e.g.:
  - environmental impacts (e.g. via EPA in US)
  - requirements specified by international conventions (e.g. marine releases)

Special regulatory situations

- Site-specific regulations (e.g. WIPP, YMP)
- Treatment of legacy waste disposal sites (especially associated with military programmes)
- Variations of regulations with time - especially associated with sites that require formal re-licensing (e.g. Drigg, SFR, La Hague)

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- Treatment of legacy waste disposal sites (especially associated with military programmes)
- Variations of regulations with time - especially associated with sites that require formal re-licensing (e.g. Drigg, SFR, La Hague)
- Regulatory "grey areas" - e.g. undersea disposal in coastal areas with access from land
- Conflicting regulatory requirements (e.g. retrievability vs. safeguards)
- Regulatory requirements that are inappropriate (e.g. ALARA) or make compliance impossible (e.g. dose limits for erosion scenarios)

...Regulations

- Still evolving in most programmes (or may not even be specified as yet)
- May change significantly - giving major problems for the implementer (e.g. treatment of cut-off times at YM) and requiring a change of safety strategy and / or safety case
- Even when regulations exist, they may not be applied consistently (between different radwaste disposal sites, between different nuclear facilities, between repositories for handling different types of toxic waste,...)

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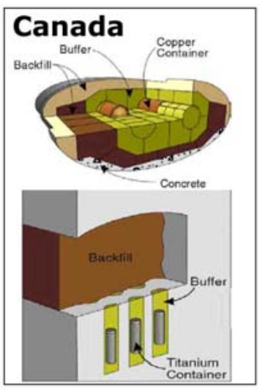
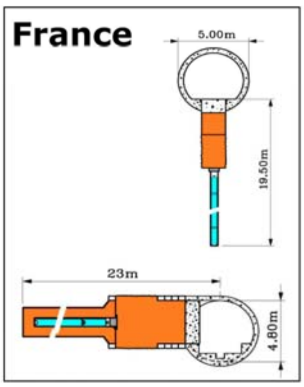
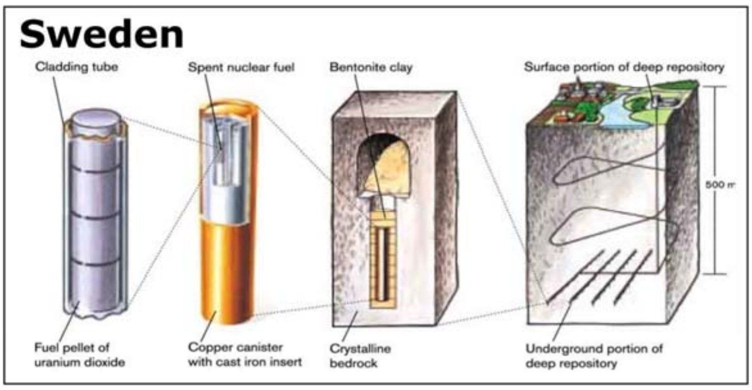
- Even when regulations exist, they may not be applied consistently (between different radwaste disposal sites, between different nuclear facilities, between repositories for handling different types of toxic waste,...)
- **IAEA is attempting to harmonise this situation (also moves by EU), but progress to date very limited**
- **Problems with inflexibility / over prescription (e.g. waste removal at WIPP - "...a triumph of compliance over common sense!")**

Balancing requirements

- **Focusing on long-term safety misses many key issues that need to be considered for a real project - in particular balancing of different requirements**
- **Until recently, there has been little open discussion on holistic management of repository projects**







Balancing requirements

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- Until recently, there has been little open discussion on holistic management of repository projects
- **A total system approach is, however, becoming increasingly common for major projects and, within the EU, leads to requirement for a Strategic Environmental Assessment (SEA) before project initiation**
  - **first consideration of SEA has been initiated only for very few repository projects (e.g. Posiva)**
  - **SEA requirements are becoming more common worldwide and increasingly discussed in Japan**

SEA definition

SEA is a process to ensure that significant environmental effects arising from policies, plans and programmes are identified, assessed, mitigated, communicated to decision-makers, monitored and that opportunities for public involvement are provided. Particular benefits of SEA include:

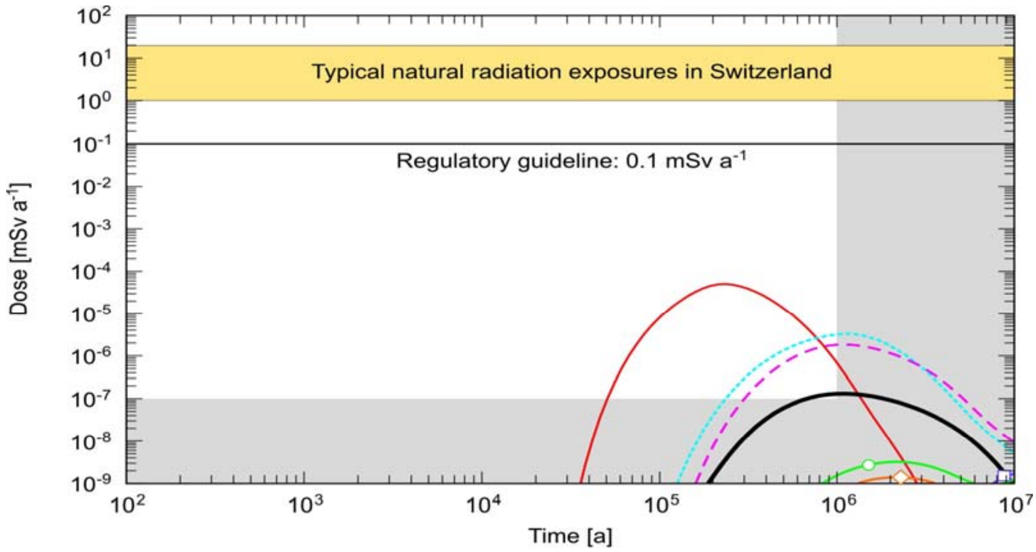
- Supporting sustainable development
- Improving the evidence base for strategic decisions
- Facilitating consultation with stakeholders

A particular form of SEA is being introduced by the European Union. This requires authorities in Member States to carry out strategic environmental assessment on certain plans and programmes that they promote.

(**http://www.sea-info.net/)**

Post-closure safety in perspective

- Assuring safety after repository closure is clearly important for acceptance of a project, but current repositories (especially for HLW) have huge safety reserves - maximum hypothetical risks are orders of magnitude below regulatory limits and occur only in the distant future



Post-closure safety in perspective

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- Construction and operation are complex and hazardous jobs (mainly conventional risks); design should reduce real risks to workers
- Costs are huge compared to hazard; principle of sustainability requires that use of valuable resources or other environmental impacts should be kept within reasonable bounds

How can requirements be balanced

- Parallel assessment groups for different requirements (e.g. YMP): requires very large workforce - potentially inefficient and misses opportunities for optimisation

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or

- Integrated assessment of requirements in a formal RMS or argumentation network (not yet implemented in any national programme - but demonstrated in other industries)

coupled to

- Expansion of definitions to ensure that all requirements are considered with appropriate weightings:
  - Safety Case
  - Safety Strategy

and/or

- Integrated assessment within a formal SEA

Safety strategy vs SEA

Safety strategy defines requirements / boundary conditions for:

- **Overall management structure / procedure**
- **Siting / site selection**
- **Repository concept development**
- **Performance / safety assessment**

Safety strategy vs SEA

Safety strategy defines requirements / boundary conditions for:

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SEA requires justification of a project, compared to all other options to manage the needs for which it was established:

- **Basically includes all the elements above, emphasising comparison of options and justification of choices**

Safety strategy / SEA

Requirements / boundary conditions for:

- Overall management structure / procedures
- Siting
- Repository concept development
- Performance / safety assessment

Management structure / procedures

A management structure should be set up which:

- Establishes & maintains a safety culture
- Establishes & maintains a quality management system
- Encourages openness and transparency
- Establishes credibility
  - Regionally
  - Nationally
  - Internationally

Safety culture & quality management

The entire undertaking of implementing a geological repository should be governed by a strong safety culture. This culture is maintained, in part, by having an efficient quality management system, which includes technical quality assurance or quality control elements.

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Safety culture: **The assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.**

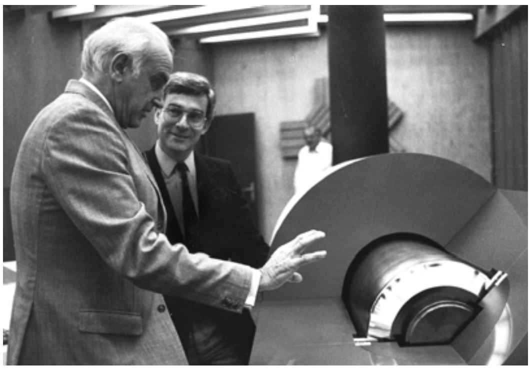
(definitions from NUMO, TR 04-03)

Openness and transparency

- Not characteristic of the nuclear industry
  - Security concerns
  - Commerciality
- Due to past failures, a key concern of the general public - especially where waste management was linked to military activities (e.g. US, Russia, UK, France) or where there is a very strong environmental movement (e.g. Germany)

Establishing credibility

- Technical credibility
  - Particularly challenging in complex, multidisciplinary field
  - Requires time to gain knowledge & experience
  - Incompatible with regular staff rotation
  - May require international exposure
  - Communication skills (academic) -> peer recognition
  - Examples of successes (e.g. Nagra, AECL) and failures (e.g. Nirex, YMP)



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  - Examples of successes (e.g. Nagra, AECL) and failures (e.g. Nirex, YMP)
- Personal credibility
  - Political sensitivity
  - Socioeconomic awareness
  - “Width & depth” of experience
  - Communication skills (general public)
  - Examples of successes (e.g. SKB, Posiva) and failures (e.g. Nagra, BFS)

Safety strategy / SEA

Requirements / boundary conditions for:

- Overall management structure / procedures
- Siting
- Repository concept development
- Performance / safety assessment

In practice, closely coupled

Siting / Repository concept development

General observations

- Siting / Site Characterisation and Repository Concept Development generally proceed iteratively
  - extreme example YMP
- Often advantage to clearly define staged procedure
  - implementation illustrated in SF and S (siting only!)
- Many options may be available; assess using a clear and transparent procedure
  - Top-down - potentially best method, but difficult to implement
  - Bottom-up - less efficient, but easier
  - Hybrid - common compromise
  - Applied rigorously to date only for siting (S, SF, CH (LLW)) - cases of failures when political interference (UK, US (HLW))
- Ensure that as much flexibility as possible is maintained
  - Discussed, but not yet implemented (e.g. NWMO, NDA)

Constraints on selecting designs / sites

- Legislation / regulations (previously discussed)
- Waste characteristics (NB difficulty HLW<SF<<TRU)
- Programme boundary conditions (inventories, implementation milestones)
- Geological setting(s) available (rock formations, tectonics, topography,...)
- Acceptance (increasingly seen as critical)
- Technical resources & experience (critical for smaller and “new nuclear” countries)
- Budget (critical for smaller countries and driver for regional / international options)

Fundamental siting options

Boundary Conditions → *Approach Options*

- Waste inventory
- Regulatory requirement
- Implementation milestones
- Socio-economic constraints
- Science & technology database

Basic concept → search for suitable sites (nomination)

or

Given site → search for suitable concepts

Performance / safety assessment (PA)

- Particular emphasis on post-closure PA
  - Key component of safety case (all advanced programmes)
  - Helps integrate RC & siting studies (limited application to date)
- Operational phase increasing priority (e.g. WIPP)
  - Radiological hazards
  - “Conventional” hazards
- Safety assessment should extend to all site activities
  - Characterisation from the surface (very little effort to date)
  - URL work (e.g. SF)
  - Construction (e.g. YMP)
- Integrate with Environmental Impact Assessment
  - Disturbances, use of resources, other costs (limited - e.g. SF)
- Holistic assessment allows optimisation

Currently open questions: social

Even though there has been some progress in developing concepts for involvement of stakeholders in the process of repository implementation, there are practical problems:

- Initiation of dialogue with non-technical groups
- Finding an appropriate level of public consultation
- Responding to committed opponents
- Communication of practical constraints on repository siting, construction, operation and closure
- Coordination of all organisations involved in implementation & regulation: clear role definition and assuring presentation of consistent messages.

Currently open questions: technical

A major problem has been managing the huge volumes of information included in safety cases (e.g. YMP). This leads to associated difficulties in:

- QA: even using multinational resources, systems are at the point of collapse (e.g. US DoE, Nagra, SKB,...)
- Multi-disciplinary coordination: depends on small numbers of highly experienced staff who are lost as age bulges pass through the nuclear industry (e.g. Nagra, SKB, AECL,...)
- Project optimisation: lack of a holistic management approach and long-term perspectives leads to inertia in terms of repository designs and implementation approaches (e.g. SKB, Posiva,...)
- R&D focusing / prioritisation: loss of overview leads to “reinventing wheels” and work on irrelevant topics (especially obvious from international conferences - Migration, MRS,...)

Transfer of international experience

- As there is no established nomenclature, it is useful to define "Safety Case" and "Safety Strategy" in a manner applicable to Japanese boundary conditions. Given recent developments, integrating these with the expectation of a need for a SEA seems sensible
- It is clear that developing a safety strategy /SEA is a top-level management task including both organisational and technical components
- Some of the organisational requirements – as usually implemented internationally – may be difficult to implement in Japan
- The main technical requirements are:
  - Resources of experienced manpower
  - A well structured approach to integrating site selection / characterisation with development of repository concepts and associated performance assessment

Expanded Safety Case definition

- To ensure that all relevant factors are considered in the selection of repository design or site variants, it is useful to expand definition of the Safety Case to explicitly acknowledge all the issues that need to be considered in a real construction project - better defined in Japan than elsewhere!

1	Long-term safety	**robustness of the post-closure safety case**
2	Operational safety	**conventional and radiological safety of construction, operation and decommissioning**
3	Engineering feasibility	**fundamental feasibility of construction and operation to defined quality levels**
4	Engineering reliability	**practicality of implementation in view of operational boundary conditions and robustness with regard to potential perturbations**
5	Site characterisation	**effort required to satisfy technical requirements for site characterisation and monitoring data**
6	Retrievability	**ease of retrieval after emplacement**
7	Environmental impact	**extent of all environmental impacts associated with repository implementation**
8	Socio-economic aspects	**factors contributing to costs and acceptance by all key stakeholders**

NUMO design factors

Safety strategy and the 2010 report

- A clearly established safety strategy is necessary – but not sufficient – for the expected demonstration of how NUMO will develop safety cases to support stepwise siting and eventual licensing of a repository
- This has to be set within an implementation plan, which should include the wide range of issues for any major construction project (often summarised in a SEA) and a clearly structured R&D programme

Implementation issues

- Need to demonstrate progress from H12 generic/idealized to site specific/optimized repository designs, safety case and site characterization plan
- Need to demonstrate stepwise implementation process
- Must establish open and transparent decision making process for key decisions, e.g., PI, DI and site selection
- Demonstrate active dialogue with stakeholders
- Presentation of internal standards, QA plans, and plans to show compliance with the guidelines
- Integration/coordination of HLW and TRU programmes: include perspective on future waste arisings

Conclusions

- It is widely recognised that, as repositories move towards implementation, a more extensive process of assessment is required than the past evaluations of post-closure safety
- A range of, sometimes contradictory, project requirements must be considered - which should lead to eventual optimisation by the consideration of trade-offs
- This process needs to be carefully explained to all stakeholders - ideally key groups would be involved in the decision-making process
- Regulators, implementers and supporting organisations should establish a clear nomenclature that facilitates communication of consistent messages and eases the process of assuring compliance with regulatory guidelines

Credits

- David McKie - video production & animation
- Ellie Scourse - technical support

Add animated DMM logo