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Performance Assessment - Status of Art and Practice

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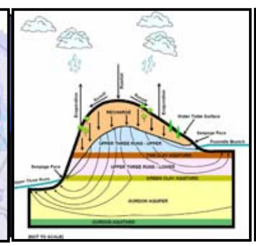
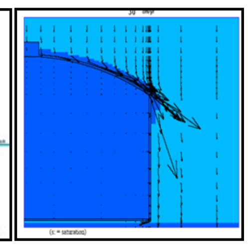
05 March 2009



High-Level Waste Corporate Board

Phoenix, Arizona USA

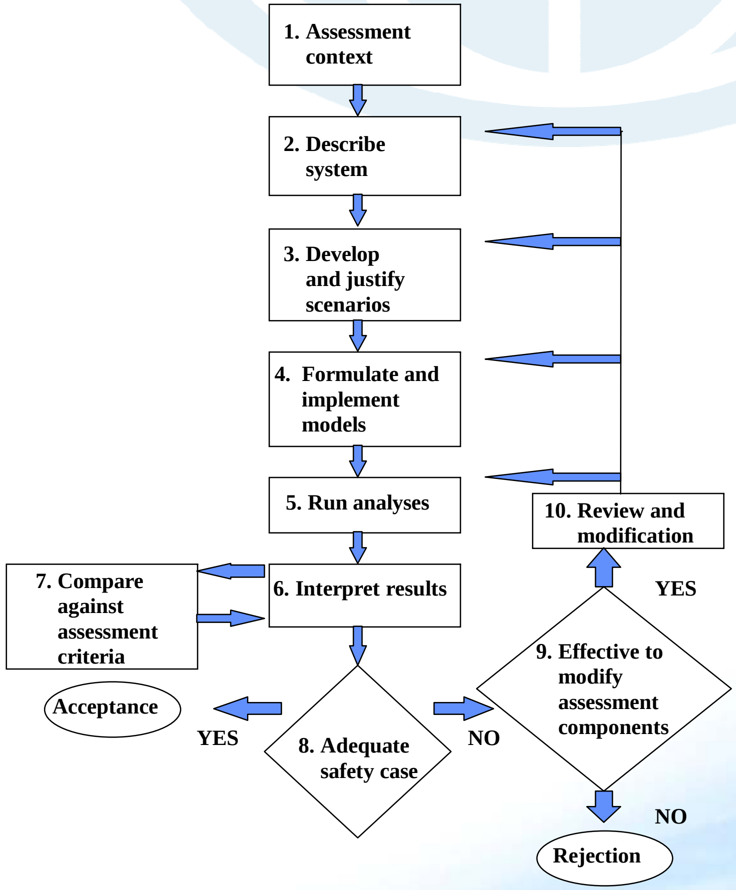
SRNL-MS-2009-00036

EM Office of Environmental Management
safety ✧ performance ✧ cleanup ✧ closure

Background

- **Performance (Safety) Assessment Process has a long history of successful use around the world**
- **Relatively good agreement about fundamental process, technical approaches continually evolving**
- **Essential blend of regulatory and science and engineering**
- **Managing uncertainties associated with complex systems over long time frames is primary challenge**

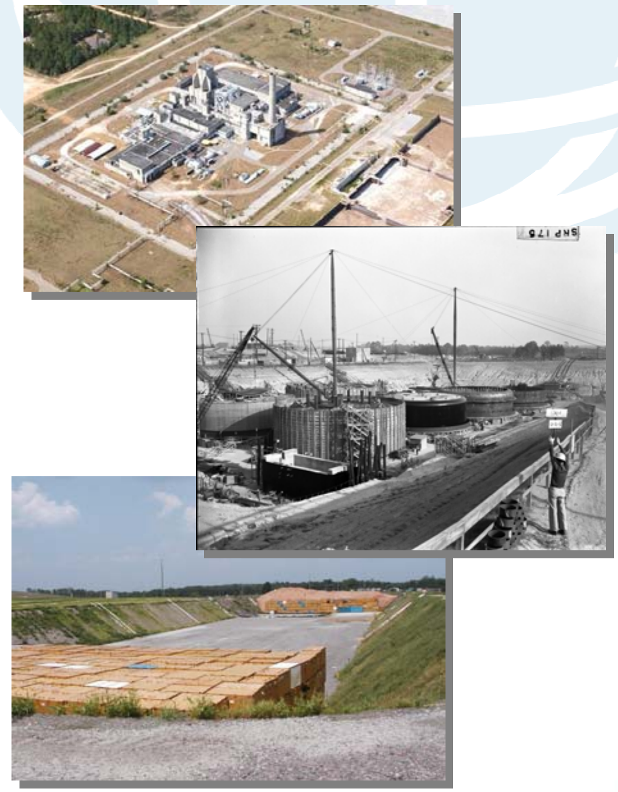
Emphasize iterative process rather than calculations



Courtesy: IAEA

Growing Use of Performance Assessment

- **PA traditionally focused on disposal**
- **More challenging D&D, Remediation, Tank Closure, NEPA, etc. assessments becoming PA-like**
  - Need to take credit for more features
- **EM Senior Management has recognized potential risks associated with inconsistency**



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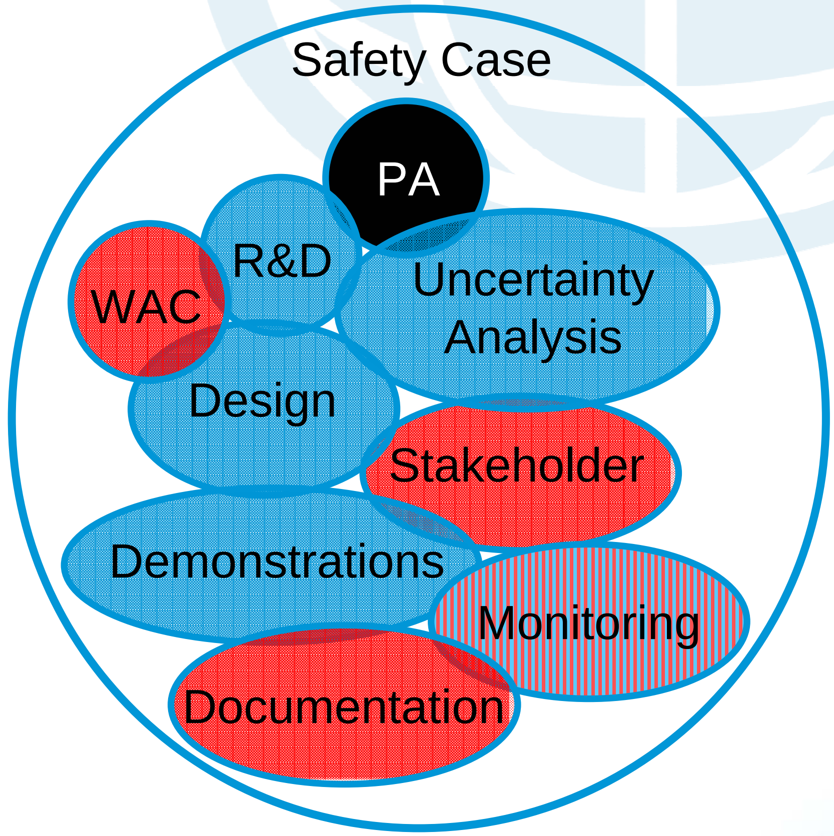
Contents

- **Perspective**
- **Existing Guidance and Common Principles**
- **Trends, Technical Advances and Challenges**

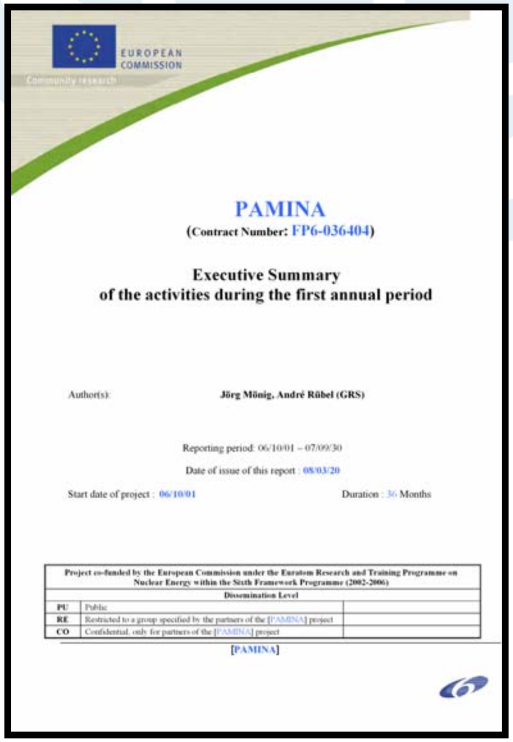
Perspective - Concept of "Safety Case"

- **IAEA, Nuclear Energy Agency and others**
- **Reflects use of performance assessment as only one part of a package used to support decisions**
  - *"The purpose of computing is insight, not numbers"* – Richard Hamming
- **Uncertainties can be managed in many different ways in addition to modeling**



Example International Activities

- **New IAEA project, PRISM, to address development of a safety case for near surface disposal facilities**
  - Follow-on to NSARS, ISAM and ASAM
  - Lead for development of task for management of uncertainties
- **European Commission Project named PAMINA**
  - Sensitivity analysis
  - Management of uncertainties


EUROPEAN COMMISSION
Community research

PAMINA
(Contract Number: FP6-036404)

Executive Summary
of the activities during the first annual period

Author(s): Jörg Mönig, André Rübel (GRS)

Reporting period: 06/10/01 – 07/09/30

Date of issue of this report : 08/03/20

Start date of project : 06/10/01 Duration : 36 Months

Project co-funded by the European Commission under the Euratom Research and Training Programme on Nuclear Energy within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
RE	Restricted to a group specified by the partners of the [PAMINA] project	
CO	Confidential, only for partners of the [PAMINA] project	

[PAMINA]

Perspective – Dose Limits

100,000 mrem – Dose leading to ~5% chance of Fatal Cancer (UNSCEAR)

10,000 mrem/yr – IAEA mandatory intervention

5,000 mrem/yr – Worker dose standard

1,000 mrem/yr – IAEA reference level for intervention for cleanup situations

360 mrem/yr – US Average dose all sources (NCRP)

100 mrem/yr – All sources limit (IAEA practices, DOE)

25 mrem/yr – NRC and DOE LLW

15 mrem/yr – EPA Radiation (40 CFR 191)

10 mrem/yr – Air (atmospheric) (40 CFR 61)

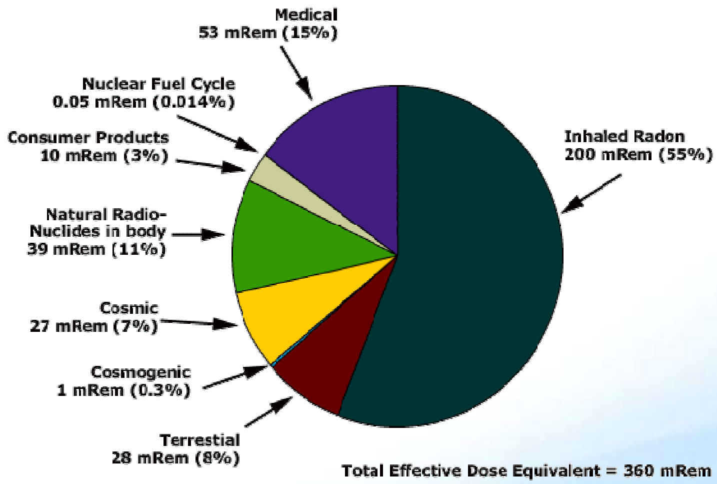
4 mrem/yr – Drinking Water (40 CFR 141)

1 mrem/yr – IAEA Exemption/Clearance

One Transcontinental round trip flight - 5 mRem

Note: Air crew average (300 mrem/yr) From UNSCEAR (2000)

Typical Annual Sources of Public Exposure



Graphics from NCRP Report No. 93

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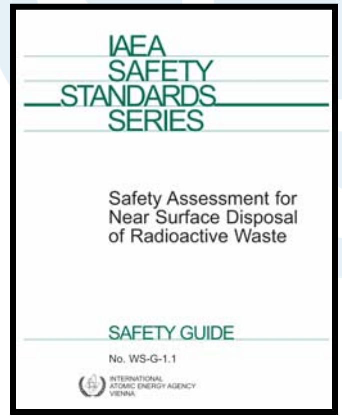
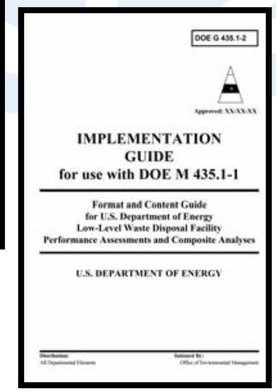
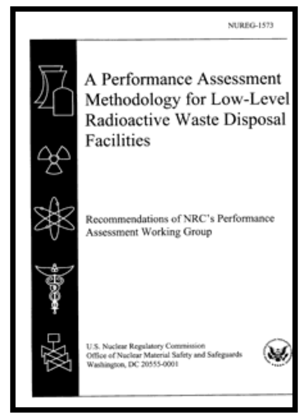
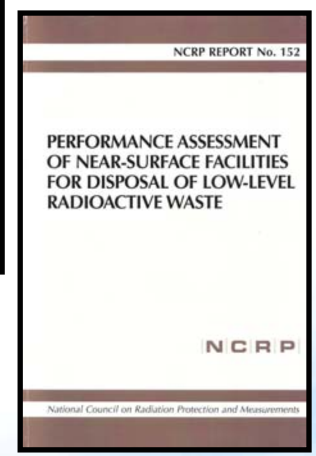
Examples Performance Assessment Guidance

- **International Atomic Energy Agency**
  - Requirements and Guides, Technical Reports
- **U.S. Department of Energy**
  - DOE Manual 435.1-1 and Associated Guides
- **U.S. Nuclear Regulatory Commission**
  - NRC Staff Recommendations
- **National Council on Radiation Protection and Measurements**
  - Scientific Committee Report
- **Others**









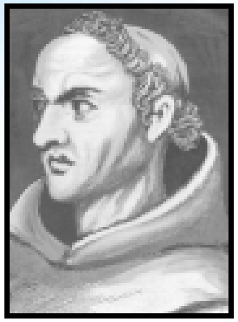
Examples of Common Principles

- **PA is a tool to support decision-making**
- **Detailed approaches need to be site- and decision-specific, but general agreement on basic principles:**
  - Multi-Disciplinary
  - Complexity – Need for tension between simplicity and realism
  - Iterative and Graded Approach
  - Sensitivity Analysis
  - Role of the Source Term

Multi-Disciplinary

PA

How Much Complexity is Appropriate?

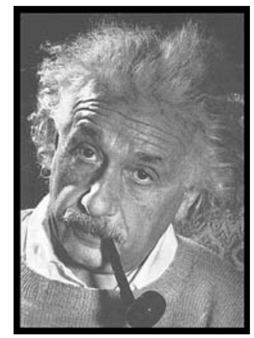


- **Occam's Razor (Principle of Parsimony) –** *"Pluralitas non est ponenda sine necessitas"*

  Use method involving less detail and assumptions that arrives at same conclusions

- **Einstein –** *"Everything should be made as simple as possible, but not simpler"*

  Need to address key processes (which processes are key??), Don't let over-conservatism change decisions



- **Seeking cost-effectiveness and defensibility directed at specific decision to be made**

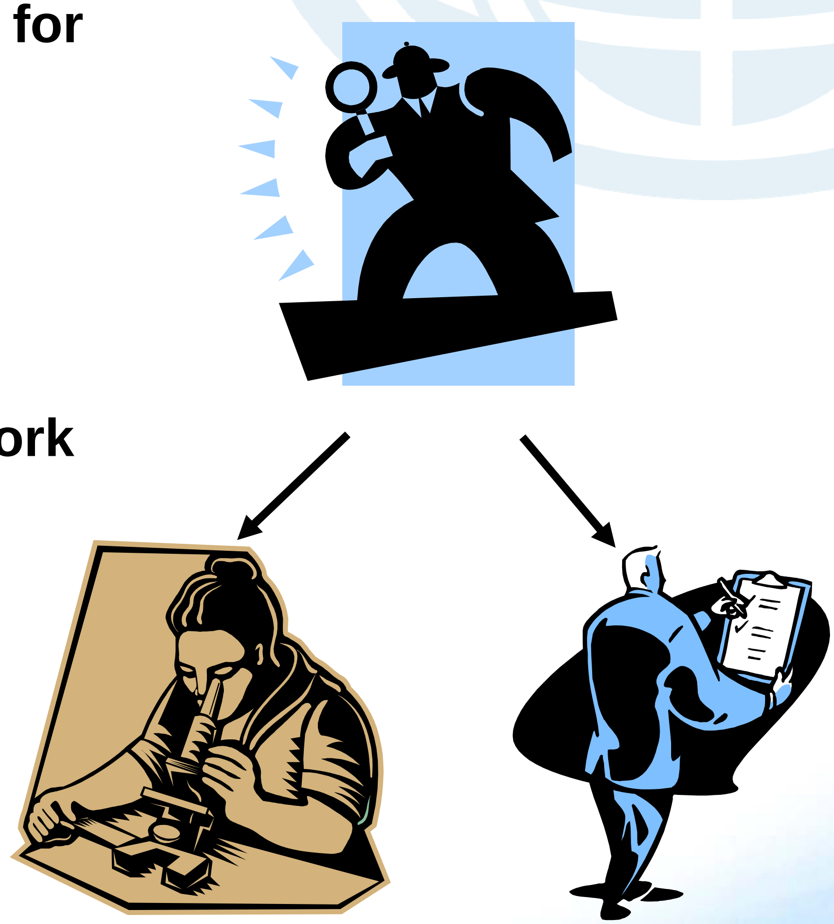
Iterative, Graded Approach

Modeling Detail	D&D, Remediation	PA
Screening (simplified, “bulletproof”)	***Typical***	***Typical***
Assessment (compliance, detail as needed)	***Occasional***	***Typical***
Process-specific (input for compliance model)	***Rarely***	***Typical***

Start simple, add complexity as needed for specific aspects of the problem.

Sensitivity “Importance” Analysis

- **Focus attention on parameters and processes of greatest interest for decision**
- **NCRP Committee adopted the term “Importance Analysis”**
- **Guide reviewers and also identify areas for additional work**



Role of Source Term

- **Drives the PA Process**
- **Contaminant-Specific**
  - Concentration averaging
  - Chemical/physical form
- **Facility-Specific**
  - Dimensions, barriers
  - Barrier degradation
- **Site-Specific**

Material Composition

container lifetime?

resins?

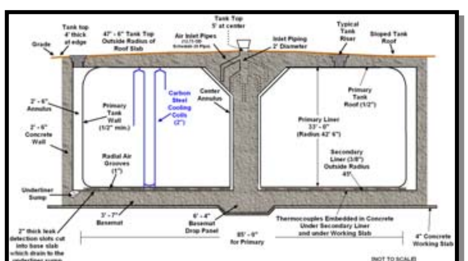
concrete?

enhanced mobility?

activated metal?

solubility?

gaseous release?



Trends and Advances

- **Emphasis on Consistency**
  - Technical Forums, PA Community of Practice
- **Regulatory Review at End –> Scoping at Beginning and throughout PA process**
- **Deterministic –> Probabilistic –> Hybrid**
  - Integrating Platforms
  - Abstraction/Upscaling
  - Distributions
- **Compliance Monitoring –> Performance Monitoring**
- **Technical Approaches**

Consistency Issues

- **Expansion of activities involving PAs has resulted in involvement of multiple regulators and DOE organizations**
  - Preferred approaches, scenarios, etc.
- **PAs and PA-like analyses distributed among different contractors and DOE Offices at a DOE Site, and within individual contractors**
- **Can be legitimate differences in waste forms, barriers, and geohydrology**
- **Need for awareness of activities at a site and complex-wide level**

EM LLW Disposal, One Site Office

States

LLW

NE

EPA

Multiple DOE Offices

EM

In-Situ Decommissioning

NNSA

NRC

Multiple Contractors

Tank Closure

CERCLA Cells

Example DOE-EM Activities to Improve Consistency

Administrative	Technical
Consistency Requirements added to LFRG Review Criteria (identify/explain differences)	**Probabilistic Sensitivity and Uncertainty Analysis Forum**
Support for Scoping with Regulators	**Forum on Development of Input Distributions**
Proposal for updates to DOE Order 435.1 and associated manuals and guides	**Forum on Monitoring Activities**
Increasing technical staff involvement in LFRG PA reviews (peer review and sharing of approaches)	**EM-11 and EM-23 cooperation on In-Situ Decommissioning**
Supporting development of assessment consistency teams at Sites	**EM-11 and EM-21 cooperation on Cementitious Barriers CRADA**

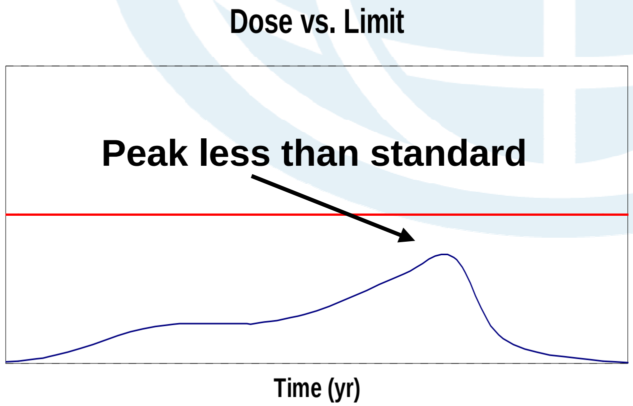
PA Community of Practice and PA Assistance Teams discussed in a separate presentation.

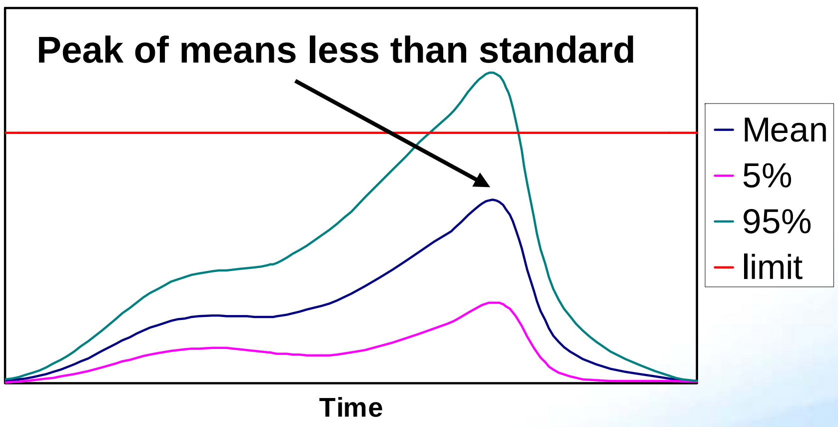
Scoping

- **Change in paradigm from regulatory review upon completion of assessment**
- **Open discussions with regulators at beginning of PA process**
- **Formal, documented approach**
- **Work to resolve technical issues**
- **Present and discuss approaches, conceptual models, scenarios, etc.**
- **Discuss relationship with other assessment activities**

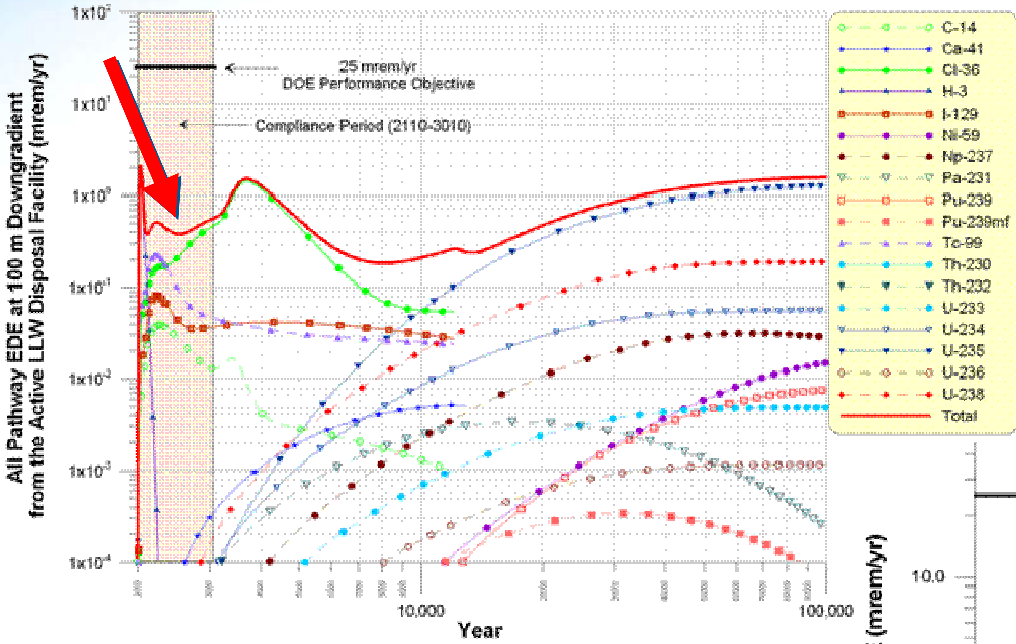
Deterministic -> Probabilistic -> Hybrid

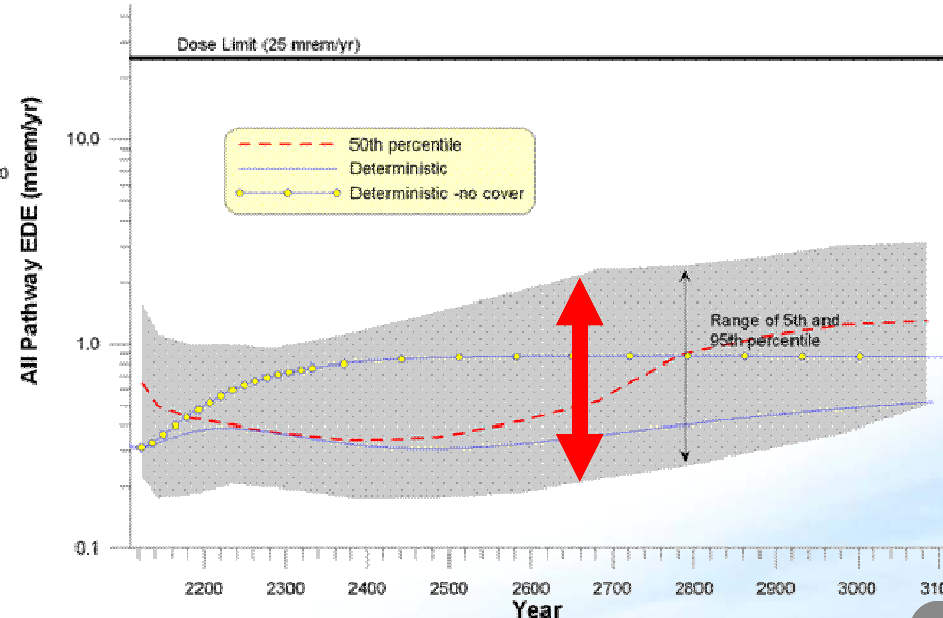
- **Agree on deterministic baseline case(s) to compare with deterministic standard (add sensitivity "what-if" cases)**
- **Use probabilistic approach to capture "what-if" questions and uncertainty analysis**
- **Multiple lines of reasoning**
- **Continuous improvement of both approaches**





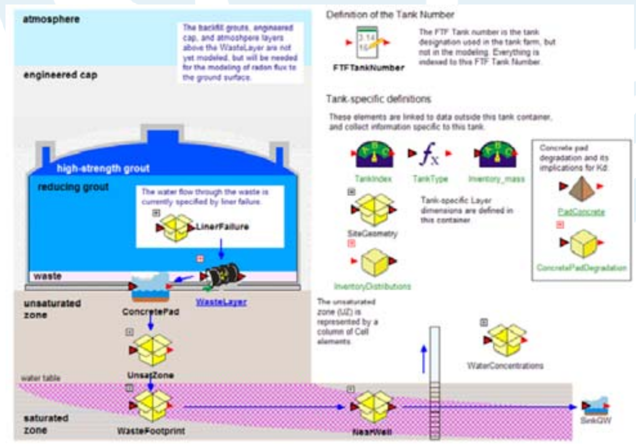
Hybrid Approach – Idaho Example

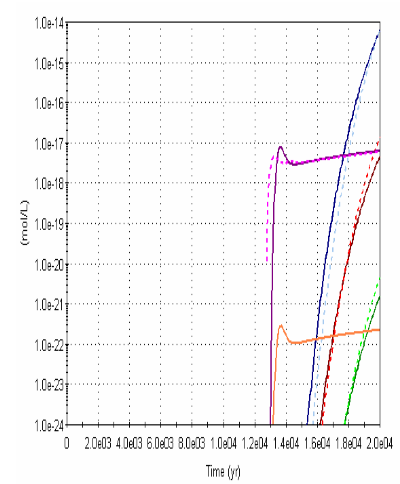




Probabilistic/Hybrid Approaches

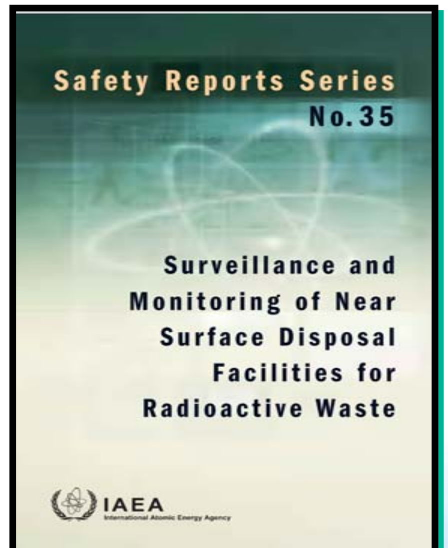
- **Increased Use of Integrating Platforms**
  - Large number of realizations encourages use of integrated model
  - Many different platforms (GoldSim, Ecolego, FRAMES, AMBER, RESRAD update)
- **Input Distributions**
  - Increased data requirements (defense)
  - Risk Dilution (potentially non-conservative)
- **Abstraction/Upscaling/Benchmarking**
  - Alternative to multiple realizations with detailed transport model
  - Very challenging part of move to probabilistic





Compliance Monitoring –> Performance Monitoring

- **Monitoring and surveillance can serve multiple roles (e.g., establish baseline, public safety, managing uncertainty)**
- **Challenges for comparisons of environmental monitoring and surveillance activities with PA results (e.g., timing, not predictions)**
- **There are needs for a broader view of *monitoring* as a means to manage uncertainties in performance assessments (“data collection”)**

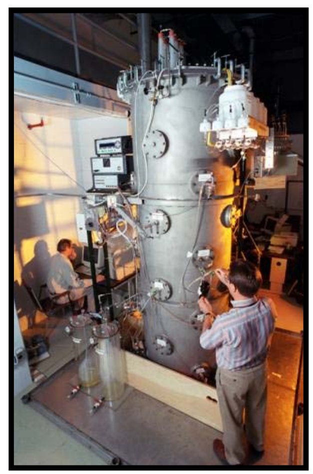

Safety Reports Series
No.35

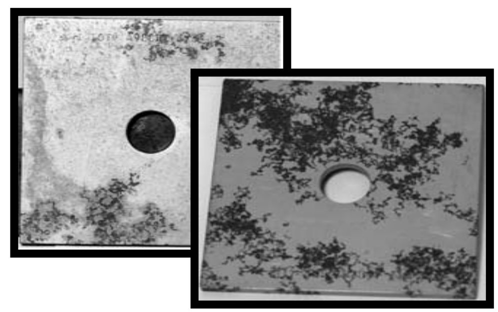
Surveillance and Monitoring of Near Surface Disposal Facilities for Radioactive Waste

IAEA

Performance Monitoring

- **Need to think more broadly about what constitutes “monitoring” for situations where migration is not expected for long times**
- **Link to indicators identified in PA calculations and models**
- **NRC monitoring interested in as-built properties (measurable)**
- **Experiments, field studies, etc. can be used as surrogates to build confidence in assumptions**





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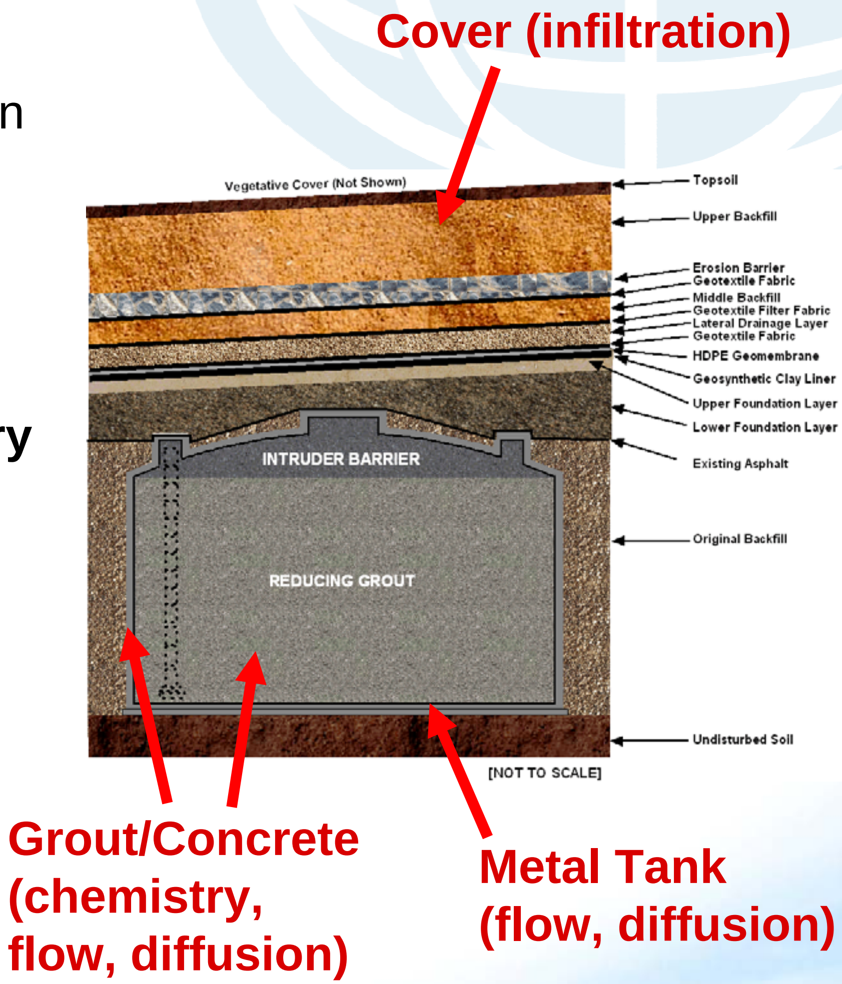
Examples of Technical Advances (Process-Level)

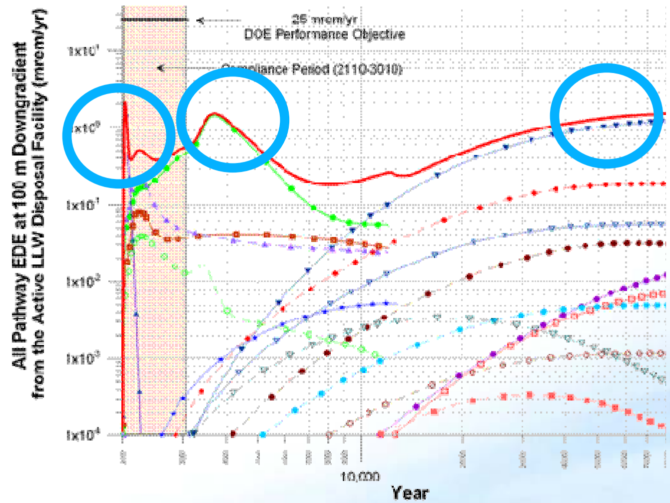
- **Improving models and data related to degradation of barriers**
  - Physical and Chemical Degradation
  - Corrosion
- **Approaches for abstraction**
  - INL, SRNL, LANL
- **Improving representation of chemistry and geochemistry for soils, barriers and waste forms**
  - Solubility
  - Improved K_ds
  - Coupled modeling
- **Improved understanding of probabilistic modeling for PA**



Example Challenges

- **Improve sharing of information and modeling approaches**
- **Input Distributions**
  - Defensibility, Risk Dilution
- **Abstraction**
  - Determining what is good enough
- **Probabilistic Sensitivity Analysis**
  - Distinguishing global sensitivity from sensitivity at peaks (time, location)
- **Monitoring**
  - Better job of using monitoring directed at managing uncertainties in models
- **Advanced Computing**
  - Effective balance of science and compliance

First 10,000 years	Sensitivity Index		
	Well A	Well B	All Wells
Tank X failure scenario	11	-	3.7
Vadose zone thickness	5.6	6.8	3.1
Pu Kd (sandy soil)	4.9	11	5.5
Saturated aquifer thickness	4.4	6.4	7.3
Pu Kd (clayey soil)	-	4.9	-



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Conclusions

- **PA is a mature process with widespread global experience**
- **Managing uncertainties in PA is a holistic process (safety case), not just probabilistic calculations**
- **Potential for inconsistency with growing use of PA-like assessments is a significant concern, needs to be addressed up-front and throughout process (improved sharing of information)**
- **Healthy tension between simplicity and realism in models. As complexity increases, data requirements increase and defensibility can become more difficult**
- **Technical advances are generally made in areas of greatest concern for a specific problem and decision to be made (e.g., barriers, chemistry)**
- **Challenges largely based on move to probabilistic approaches, but also need for new approach to monitoring**

Contact Information

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