YUCCA MOUNTAIN PROJECT

Studies

Status of DOE's Evolving Waste Containment and Isolation Strategy

Presented to:
Nuclear Waste Technical Review Board

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Background: 1996 Update to the Top-Level Strategy for Yucca Mountain

- Briefed to NWTRB in July 1996 and draft "Highlights" distributed
- Basis for 1996 update to the top-level strategy from 1988 Site Characterization Plan
  - Improved site understanding
  - Larger, more robust waste package design with increased attention to thermal loading
  - Improved performance predictions
  - Evolving regulatory framework: dose vs. release

Utility of Waste Containment and Isolation Strategy

- Provides framework for combining natural and engineered components of the repository in a system that will meet performance requirements
- Serves as a useful guide for improving design and prioritizing site testing to enhance confidence in performance

Current Concept of Waste Containment and Isolation Strategy

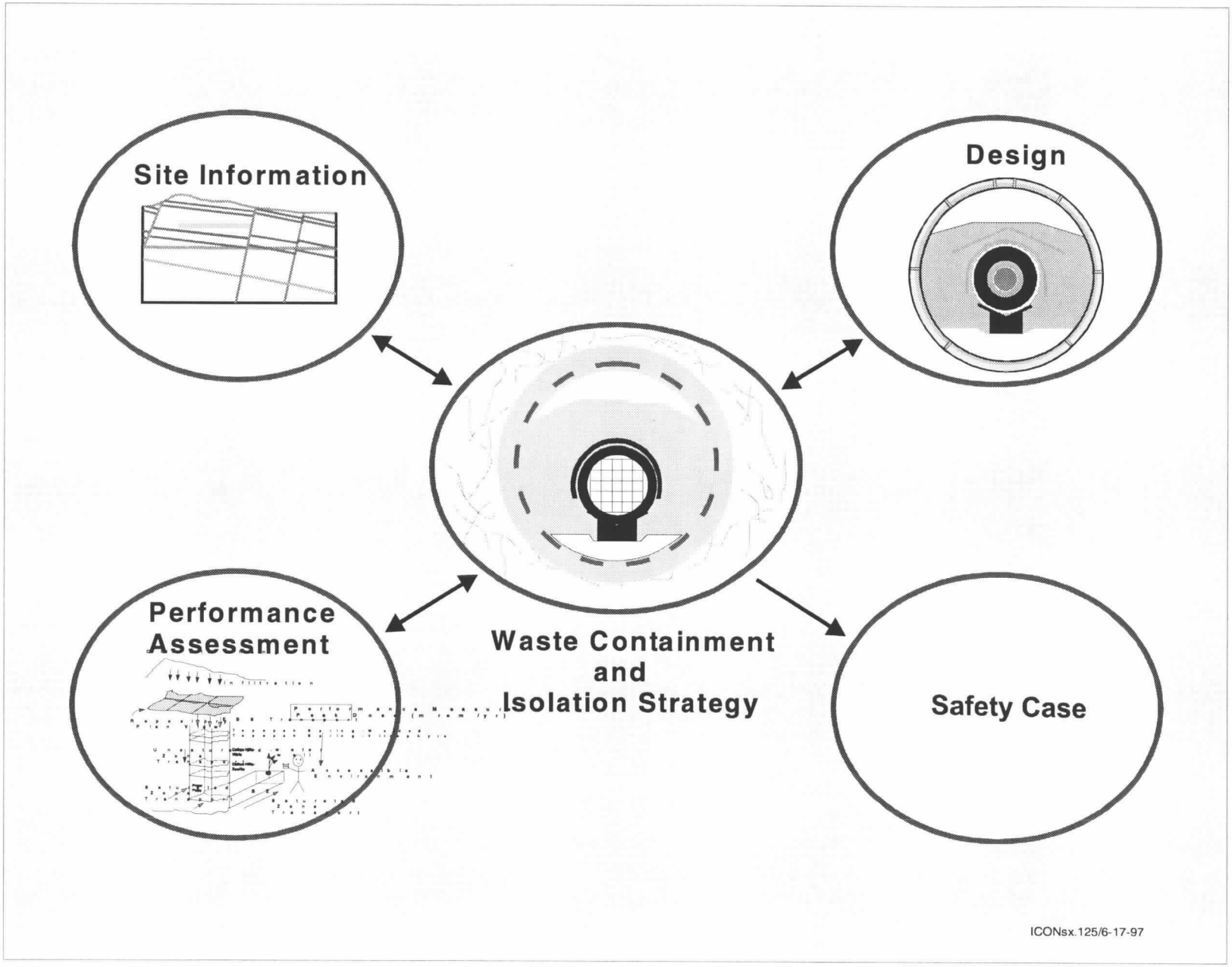
Approach

- Identify site and design features that, when considered in combination, are sufficient to meet performance requirements
  - Iterations of design and performance assessment have identified design options
  - Performance assessment models updated on basis of improved site and engineering understanding

Current Concept of Waste Containment and Isolation Strategy

(Continued)

- Select a subset of site/design features to develop a cost-effective repository system design that meets/exceeds performance requirements
- Develop safety case based on this design
- Iterate, as necessary, to incorporate new site and design information


Site Information
Design
Performance Assessment
Waste Containment and Isolation Strategy
Safety Case
ICONsx.125/6-17-97

Postclosure Repository System: Safety Case

- Prevent/delay radionuclide releases
- Mitigate transport after release
- Utilize 10 CFR 60 concept of multiple barriers: conservatism, redundancy, margin
  - Engineered barriers to compensate for uncertainties in natural barrier performance
  - Natural barriers to compensate for uncertainties in engineered barrier performance

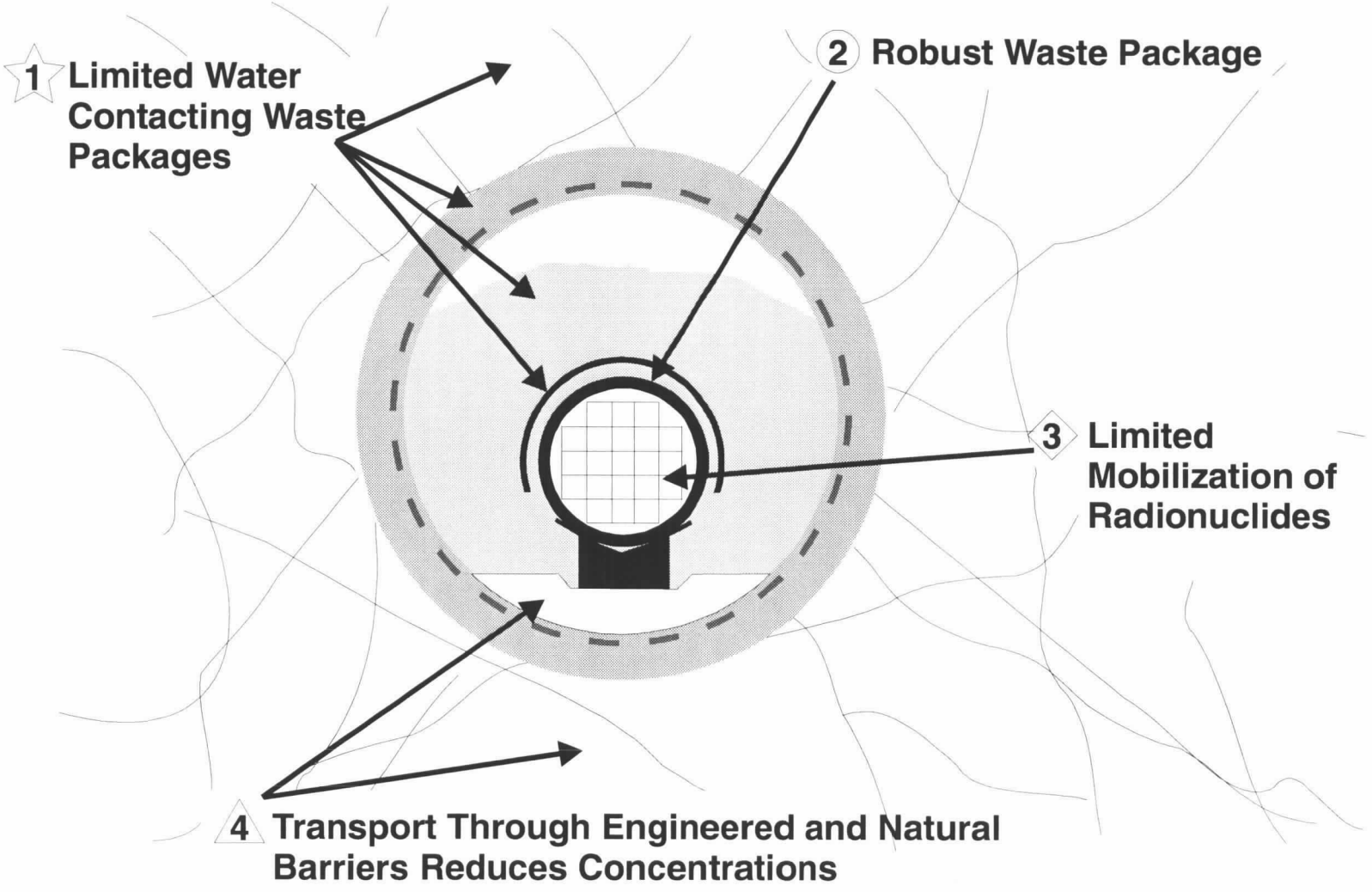
Operating Without an EPA Standard

- Utilize interim performance standard
  - Requirement: expected annual dose to an average individual in a critical group living 20 km from the repository shall not exceed
    - » 25 mrem from all pathways and all radionuclides during the first 10,000 years after closure
  - Goal: provide sufficient defense in depth to ensure repository will satisfy requirement
    - » Conduct analyses beyond 10,000 years to gain insight into longer-term performance
    - » For this period, the expected annual dose to an individual in a critical group living 20 km from the repository should be below the 10,000 year requirement

Evolving Waste Containment and Isolation Strategy

1. Limited water contacting waste packages
2. Robust waste packages
3. Limited mobilization of radionuclides from the waste form
4. Radionuclide concentrations reduced during transport through engineered and natural barriers

Evolving Waste Containment and Isolation Strategy



Refinement of Strategy: Improved Site Understanding

- Recent evidence for higher percolation flux and better definition of heterogeneities
  - Average percolation flux through potential repository host rock from 1 to 10 mm/yr
  - Seepage into repository drifts is likely to be less than that, and will be variable in space and time
  - Thermal effects may redistribute moisture with slow return to ambient conditions over several thousand years (depends on percolation flux)
  - Degree of reduction in radionuclide concentrations during transport likely to remain uncertain

Refinement of Strategy

(Continued)

- Selection of site/design features depends on their expected contribution to performance and related uncertainties
- Improved understanding of moisture conditions and better definition of spatial and temporal variability
  - Used as input to sensitivity analyses on total system performance
  - Sensitivities allow refinement of site and design features included in strategy

☆1 Limited Water Contacting Waste Packages

Natural barriers

- Semi-arid, unsaturated-zone setting limits net infiltration
- Diversion of some downward percolating flux above repository is likely

Engineered barriers

- Drift wall provides capillary barrier against seepage under certain flow conditions
- Heat from waste reduces available moisture for some time period
- *Engineered diversion of seepage entering drifts may be feasible*

② Robust Waste Packages

- Use of corrosion-resistant inner barrier and corrosion-allowance outer barrier prolongs life of packages
- Galvanic processes may offer protection to inner barrier
- *Potential for use of ceramic coating on waste packages may prolong life*
- Use of backfill
  - *May offer mechanical protection for diversion system and packages*
  - Could limit advective flow to waste packages

3 Radionuclide Mobilization

- For some radionuclides, solubilities limit mobilization
- Cladding reduces waste form surface area exposed
- Long containment time limits alteration of waste forms
- Limiting impact of engineered materials on water chemistry may be useful to reduce mobilization

⚠4 Radionuclide Transport Through Engineered and Natural Barriers

Engineered barriers

- *Potential for additives to material beneath waste package (invert) to delay transport*
- Use of backfill reduces potential for advective flow

Natural barriers

- Matrix diffusion in both unsaturated and saturated zones reduces concentrations
- Sorption will be effective for some radionuclides
- Concentrations will be reduced when UZ flow reaches water table
- Mixing and dispersion during transport lead to dilution
- Additional mixing occurs at point of water withdrawal

Analyses of Disruptive Processes and Events

- Early site screening considered the probability of significant disruptive processes and events
- Current approach is to analyze features/events/processes on basis of likelihood and potential effects
- Total system performance assessment is used to evaluate consequences for limited number of features/events/processes

Summary

- **Development of Waste Containment and Isolation Strategy provides an iterative basis for establishing the safety case**
  - **Accommodates evolving understanding of site processes and conditions**
  - **Allows systematic evaluation of design features to determine their performance benefits**
  - **Provides flexibility to deal with uncertain regulatory framework**