

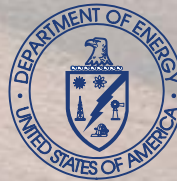
# Repository Safety Strategy

## Introduction

Presentation to:  
**Nuclear Waste Technical Review Board (NWTRB)**

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**U.S. Department of Energy  
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Waste Management**

**Yucca  
Mountain  
Project**

# Repository Safety Strategy and the Postclosure Safety Case

- **Repository Safety Strategy is the plan to develop the postclosure safety case appropriate for each stage of decision making**
- **It starts from the current postclosure safety case and an assessment of**
  - **Current confidence in the safety case**
  - **Confidence needed for the next level of decision making**

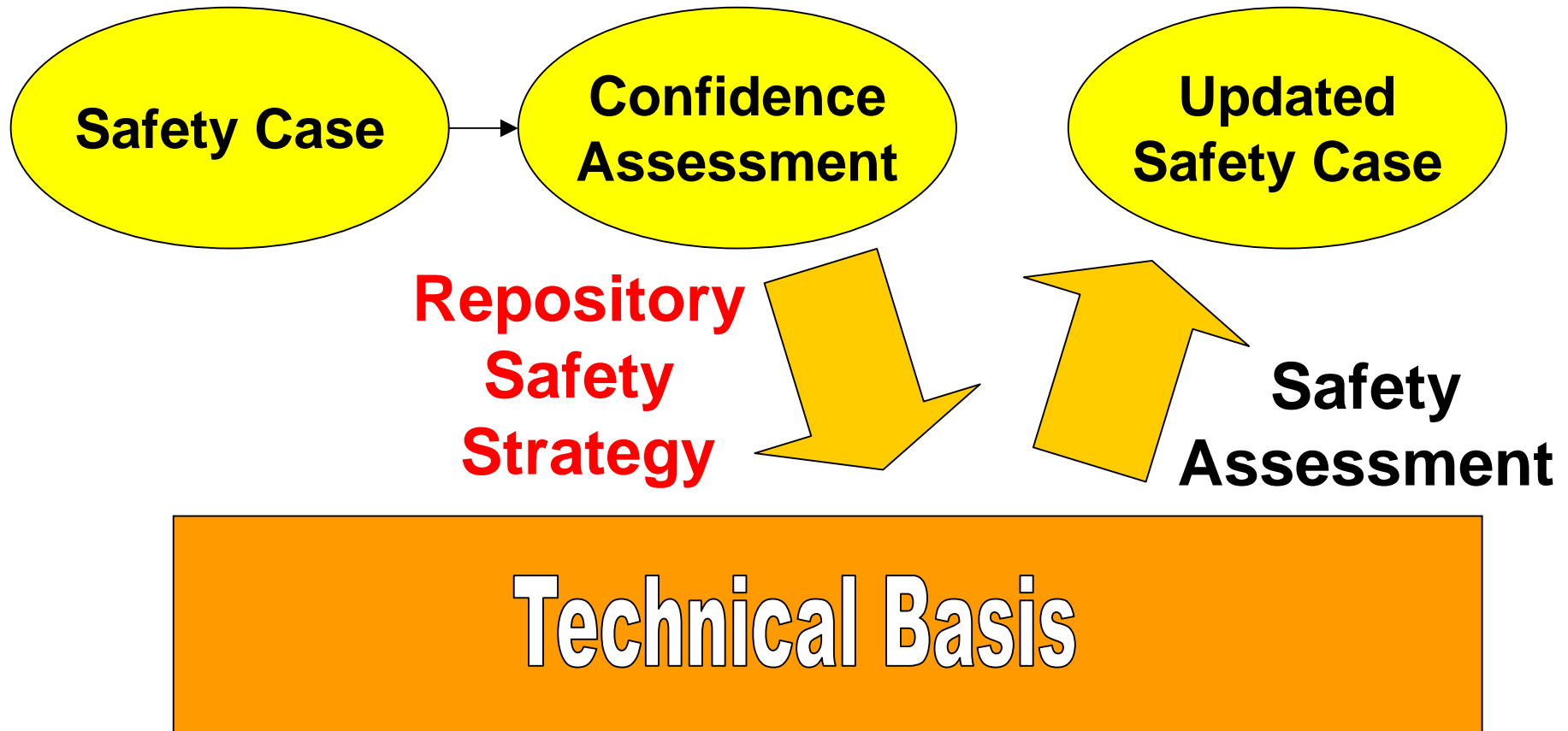
# Evolution of Repository Safety Strategy

- **Revision 1**
  - Based on information from initial site characterization
  - Specific hypotheses to be tested in further characterization
- **Revision 2**
  - Based on updated information and VA system concept
  - Initial site-specific proposal for safety case
  - Identified 19 principal factors and need to evaluate design enhancements
- **Revision 3**
  - Based on updated information and SR design enhancement
  - Updates list of factors and proposal for safety case
  - Focuses on 7 principal factors and plans to simplify remaining factors where appropriate

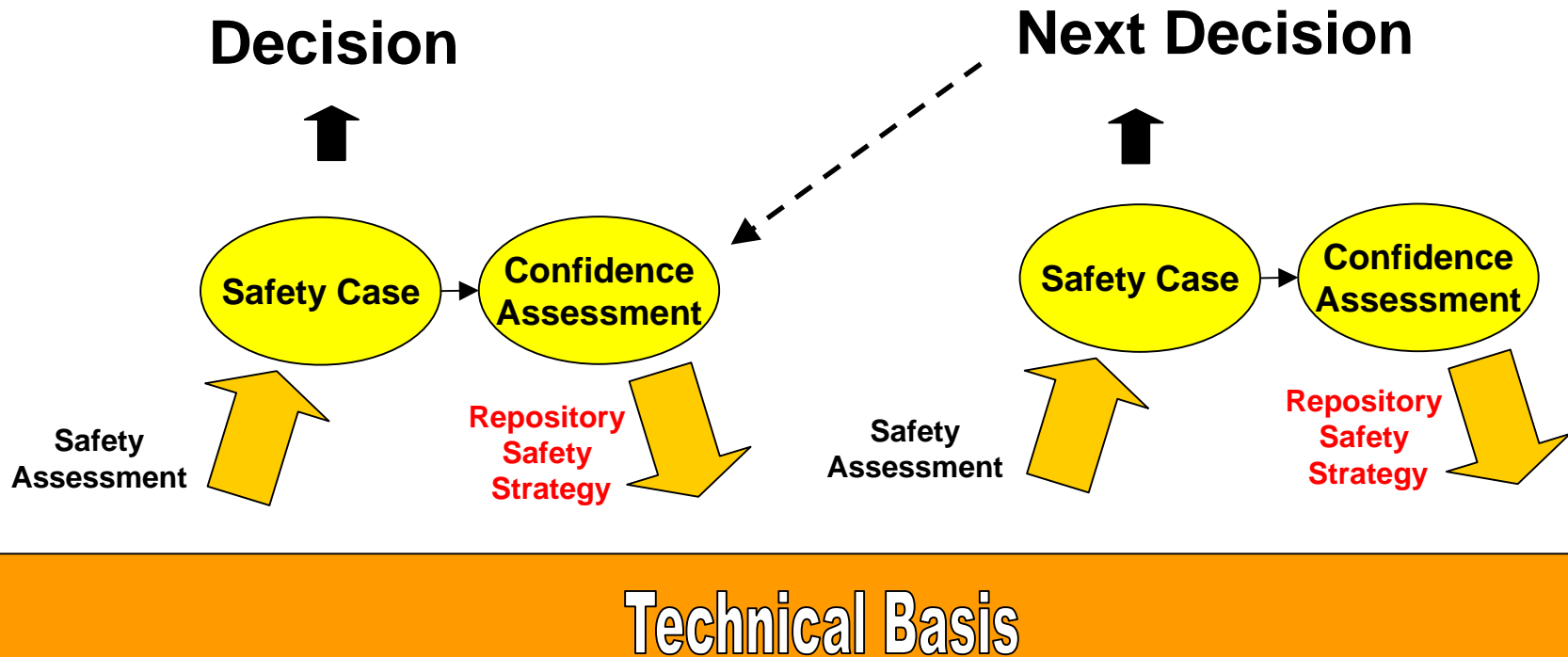
# Strategy Continues Development of Postclosure Safety Case

- **Assesses current and needed confidence considering input from oversight bodies, regulators, stakeholders and public on adequacy of the safety case**
- **Based on this assessment, it specifies plans to**
  - **Adjust the system concept (e.g., barriers relied on)**
  - **Obtain additional information (e.g, additional science)**
  - **Increase assessment capability (e.g., model development)**
- **Prioritizes remaining work, focusing on principal factors**
- **Updated safety case follows from safety assessment after adjustments and new information**

# Role of Repository Safety Strategy in Developing Postclosure Safety Case



# Confidence Cycles



# Repository Safety Strategy

## Postclosure Safety Case

- **Confidence in long-term safety is a crucial issue for the site recommendation and licensing decisions**
- **The postclosure safety case is the evidence to provide confidence sufficient for each stage of decision-making**
- **Repository decisions proceed as information is developed--consequently the safety case evolves**
- **Based on the current status of the safety case, the strategy proposes needed adjustments to that case, and prioritizes the work to get there**

# Nature of the Postclosure Safety Case



- **Pre-requisites**
  - System concept
  - Assessment of safety of that concept
- **Includes**
  - Status of technical basis for the safety assessment
  - Evaluation of safety margins
  - Formal statement of degree of confidence and description of approach to confidence for each aspect
- **Provides feedback to future development to address remaining issues**
- **Revisited whenever substantive new information is developed**



# Evolution of the Postclosure Safety Case



- **Original case in Site Characterization Plan -- general case based on preliminary assessment of roles of geologic and engineered barriers**
- **Basis for strategy for site characterization, design development, and model development**
- **Case has become more focused (and changed in some areas) as information has been acquired, design has evolved, and regulations have changed**

# Elements of the Postclosure Safety Case For a Yucca Mountain Repository



- **TSPA**
- **Design Margin and Defense-in Depth**
- **Disruptive Processes and Events**
- **Insights from Natural Analogues**
- **Performance Confirmation**

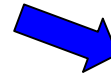
# Strategy for Safety Case to Support Site Recommendation Decision

- **TSPA-SR**
  - All factors potentially contributing to postclosure performance
  - Perform sensitivity and uncertainty analyses
- **Design Margin and Defense-in-Depth for SR**
  - Enhanced design
  - Assess contribution and significance of barriers
- **Disruptive Processes and Events**
  - Qualitative assessment of key scenarios
  - Quantitative inclusion of FEPs in overall TSPA
- **Insights from Natural Analogues**
  - Considered in context of each process model
- **Performance Confirmation**
  - PC Plan with sufficient detail for SR

# Reprioritizing to Meet Needs of Revised Postclosure Safety Case

## Revision 2 of Strategy

Key Attributes of Repository System	Principal Factors of VA System Design
Limited Water Contacting Waste Package	Precipitation and infiltration into mountain
	Percolation to depth
	Seepage into drifts
	Effects of heat and excavation on flow
Long Waste Package Lifetime	Dripping on waste package
	T, RH at waste package
	Chemistry on waste package
	Integrity of WP outer barrier
Low Rate Of Release of Radionuclides From Breached Waste Packages	Integrity of WP inner barrier
	Seepage into waste package
	Integrity of SNF cladding
	Dissolution of SNF and glass waste forms
	Neptunium solubility
	Formation of radionuclide-bearing colloids
Radionuclide Concentration Reduction During Transport from the Waste Packages	Transport through and out of EBS
	Transport through UZ
	SZ flow and transport
	Dilution from pumping
	Biosphere transport and uptake



## Revision 3 of Strategy

Key Attributes of System	Factors for Enhanced System Design
Water Contacting Waste Package	Climate
	Net infiltration into the mountain
	UZ flow above repository
	Seepage into drifts
	Coupled processes - effects on UZ flow
	Coupled processes - effects on seepage
	Environments on drip shield
	Performance of drip shield
Waste Package Lifetime	Environments on waste package
	Performance of waste package barriers
Radionuclide Mobilization and Release from the Engineered Barrier System	Environments within waste package
	CSNF waste form performance
	DSNF, Navy fuel, Pu disposition waste form performance
	DHLW glass waste form performance
	Solubility limits of dissolved radionuclides
	Colloid-associated radionuclide concentrations
	In-package radionuclide transport
	Transport through the drift invert
Transport Away from the Engineered Barrier System	Advective pathways in UZ
	Retardation of radionuclide migration in UZ
	Colloid-facilitated transport in UZ
	Coupled processes--effects on UZ transport
	Advective pathways in SZ
	Retardation of radionuclide migration in SZ
	Colloid-facilitated transport in SZ
	Dilution of radionuclide concentration
Biosphere transport and uptake	

# Assessing Safety Case Confidence at Each Stage of Decision Making

- **Assess robustness of the system concept**
  - Whether it favors safety
  - Whether it limits or mitigates uncertainty
- **Assess quality of the safety assessment**
  - Whether it explicitly accounts for uncertainty
  - Whether it incorporates multiple lines of evidence
- **Assess reliability of performance assessment**
  - Whether appropriate principles/criteria/procedures observed
  - Whether models have been adequately validated
  - Whether computational tools are free from error

# Approaches to Confidence Building in the Safety Case



- **Multiple lines of evidence**
  - **Performance assessment to indicate margins and importance of FEPs, scenarios, and sources of uncertainty**
  - **Qualitative assessments including insights from natural analogues and identification of multiple, diverse barriers**
- **Alternative interpretations and opposing views**
- **Accounting for phenomena relevant to safety**
- **Assurance that cases of significant consequence and uncertain likelihood can be dealt with**

# Continued Development of the Safety Case

- **Case will continue to be evaluated and presented throughout repository development**
  - Increased information about site and focus on factors most important to postclosure performance
  - Information from performance confirmation
  - Further changes in design--particularly those that would enhance performance, e.g.,
    - » Enhanced robustness of engineered barrier system
    - » Thermal design and performance
  - Changes in regulations and standards
- **Repository Safety Strategy will continue to be updated to support this development**