U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Operational Flexibility and Repository Design

Presented to:
Nuclear Waste Technical Review Board

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YUCCA MOUNTAIN PROJECT

Outline

- Reasons for examining operational flexibility of the repository design
- SRCR/SR design
- Considerations in establishing operational flexibility
- Controlling drift thermal response
  - Selecting operational variables
    - Staging receipt/emplacement
    - Waste package spacing
    - Ventilation duration
  - Repository operating curves
    - Trade-offs between variables
- Summary

Reasons for a Flexible Repository Design

- **Program objective is to have a resilient SRCR/SR design**
- **To accommodate future:**
  - **Policy decisions**
  - **Alternative technical objectives**
  - **New information**
  - **Other considerations**

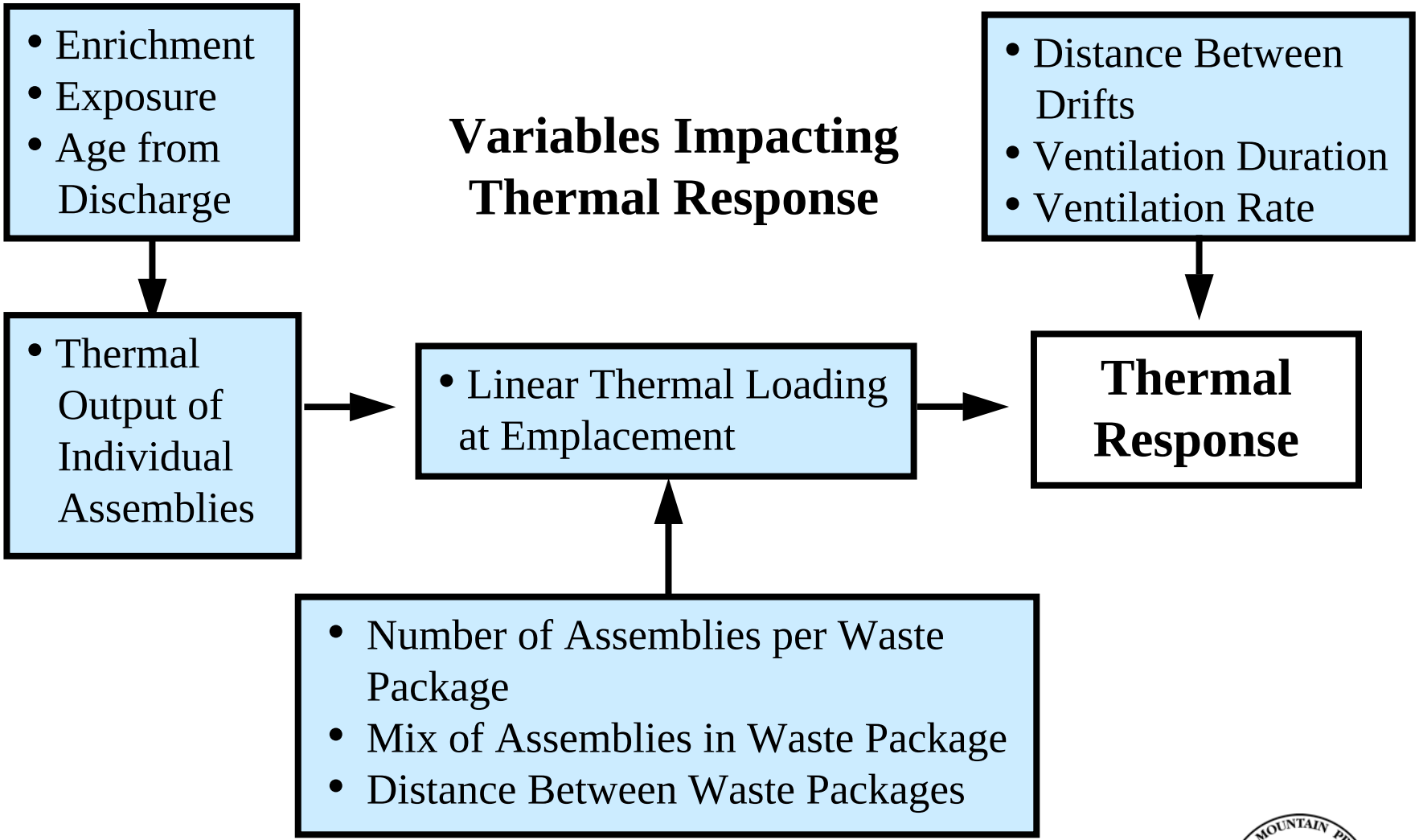
SRCR/SR Design

- **Design requirements**
  - **cladding to remain below 350°C**
  - **water to drain between drifts**
- **Design features**
  - **81m between drifts**
  - **~7.6 kW avg. waste package power**
  - **~1.5 kW/m avg. linear power density at emplacement**
  - **15 m^3/s ventilation rate**
  - **drip shield**
  - **avg. 26 years old fuel at receipt**

SRCR/SR Design
(Continued)

- **Operational features**
  - **0.1m distance between waste packages**
  - **50 year preclosure period**
  - **0 years staging**
- **In the last drift loaded:**
  - **Post closure wall temperatures about 200°C**
  - **Evaporation fronts advance ~12m**

Considerations in Establishing Operational Flexibility



Initial Screening to Identify Operational Features

- **Enrichment**
  cannot be changed by the Program
- **Exposure**
  cannot be changed by the Program
- **Age from discharge**
  addressed by staging receipt/emplacement

= Parameter not available for change, less significant, or equivalent to another parameter

= Parameter which can be operationally controlled

Initial Screening to Identify Operational Features

(Continued)

- **Number of assemblies per Waste Package**
  changing distance between Waste Packages has equivalent effect
- **Blending dissimilar assemblies in Waste Package**
  blending of similar assemblies already in SR design basis
- **Distance between Waste Packages**

= Parameter not available for change, less significant, or equivalent to another parameter

= Parameter which can be operationally controlled

Initial Screening to Identify Operational Features

(Continued)

- **Distance between drifts**
  - ***for reasonable variations around SR design basis value, has relatively little impact on predicted drift wall temperatures***
- **Ventilation duration**
- **Ventilation rate**
  - ***staging equivalent to 100% ventilation efficiency; therefore, impact bounded***

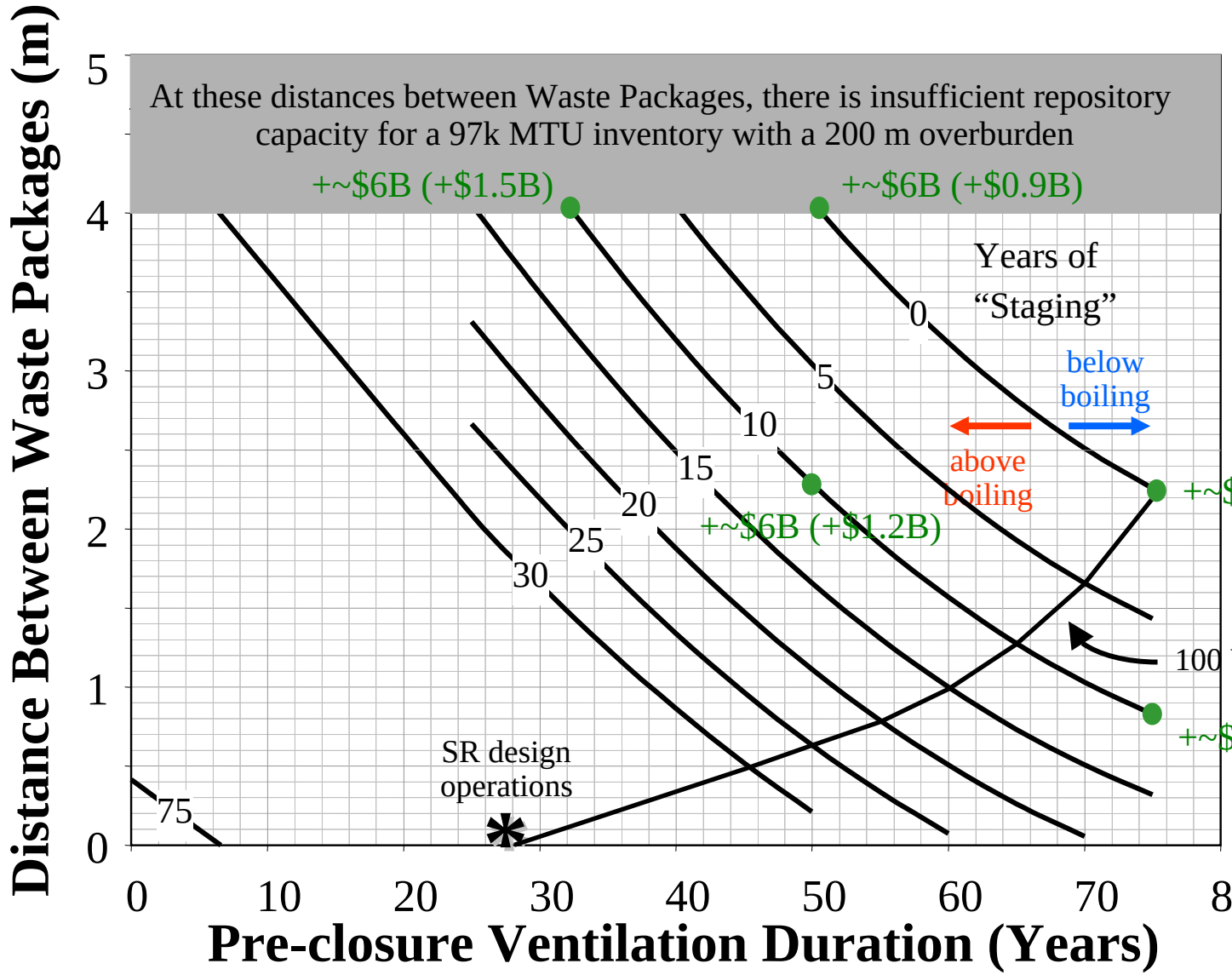
= Parameter not available for change, less significant, or equivalent to another parameter

= Parameter which can be operationally controlled

Non-Boiling Operations Considerations

- **A first-order parametric study has been conducted to determine feasibility of operating with the average drift wall below 96°C**
- **Staging, increasing waste package spacing, and increasing ventilation duration can be adjusted to keep the drift wall below 96°C**
- **Some hot spots do exist**
  - **where in-drift components contact drift invert**
  - **opposite high power Waste Packages**

Repository Operating Modes



Avg. age of CSNF at receipt = 26 yrs.

Costs in 1999$
( ) = NPV

Summary

- **This initial assessment indicates that the SRCR/SR design is flexible and resilient enough to operate such that the drift wall stays below the boiling point of water**
- **Refinements that will improve this assessment:**
  - **3D, instead of 2D, calculations**
  - **specific, rather than average, decay curves**

Potential Path Forward

- **SRCR/SR**
  - **Design discussion will include operational flexibility for boiling to non-boiling modes**
  - **TSPA will consider partial pillar above boiling as the base operation mode**
  - **TSPA at SR will contain sensitivity studies to address non-boiling operation mode**
- **Other**
  - **Review the multiple operations mode approach with NRC**
  - **Review Program impacts of the identified operational features**
  - **Perform refined technical analyses**
  - **Evaluate scenarios**

Backup Material

Rough Cost Estimates

	SR Design	Option	Option	Option	Option	Option
Waste Package Spacing (m)						
first drift	**0.1**	**1.5**	**2.3**	**0.1**	**1.5**	**2.3**
last drift	**0.1**	**2.3**	**4**	**0.8**	**2.3**	**4**
Preclosure Period (years)	**56**	**105**	**80**	**105**	**80**	**62**
Staging Period (years)	**0**	**0**	**0**	**10**	**10**	**10**
Total Drift Length (km)	**74**	**100**	**120**	**80**	**100**	**120**
Cost Over SR Design Basis (billions of 1999$)	**---**	**+5.4**	**+5.7**	**+5.1**	**+5.6**	**+6.2**
Breakdown (billions of 1999$)						
Subsurface Infrastructure: ~$30M/add'l km	**---**	***+0.8***	***+1.4***	***+0.2***	***+0.8***	***+1.4***
Subsurface Operations: ~$12M/add'l km + ~21M/add'l yr + ~0.3M/add'l km-add'l yr)	**---**	***+1.8***	***+1.4***	***+1.2***	***+1.0***	***+0.8***
(Continuous) Drip Shield: ~$40M/add'l km	**---**	***+1.0***	***+1.8***	***+0.2***	***+1.0***	***+1.8***
Surface, PC, and Program Operations: ~$35M/add'l yr	**---**	***+1.7***	***+0.9***	***+1.7***	***+0.9***	***+0.2***
Decommissioning	**---**	***+0.1***	***+0.2***	***0***	***+0.1***	***+0.2***
Staging Capital: ~$40K/MTU	**---**	***0***	***0***	***+0.7***	***+0.7***	***+0.7***
Operations to Unload Staging Area: ~$100M/yr	**---**	***0***	***0***	***+0.9***	***+0.9***	***+0.9***
Program Operations during Unloading: ~$20M/yr	**---**	***0***	***0***	***+0.2***	***+0.2***	***+0.2***