EDA-II
Detailed Description and Future Plans

Presentation to:
Nuclear Waste Technical Review Board (NWTRB)

Presentation by:
James A. Blink
M&O/LLNL
Lead, Integrated Design Performance Review

Beatty, Nevada
June 29-30, 1999

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

Yucca Mountain Project

Outline

- **EDA II Description**
  - **Underground facility**
  - **Waste package**
  - **Other engineered components**
- **EDA II Plans**
  - **Design evolution**
  - **Scientific program changes**

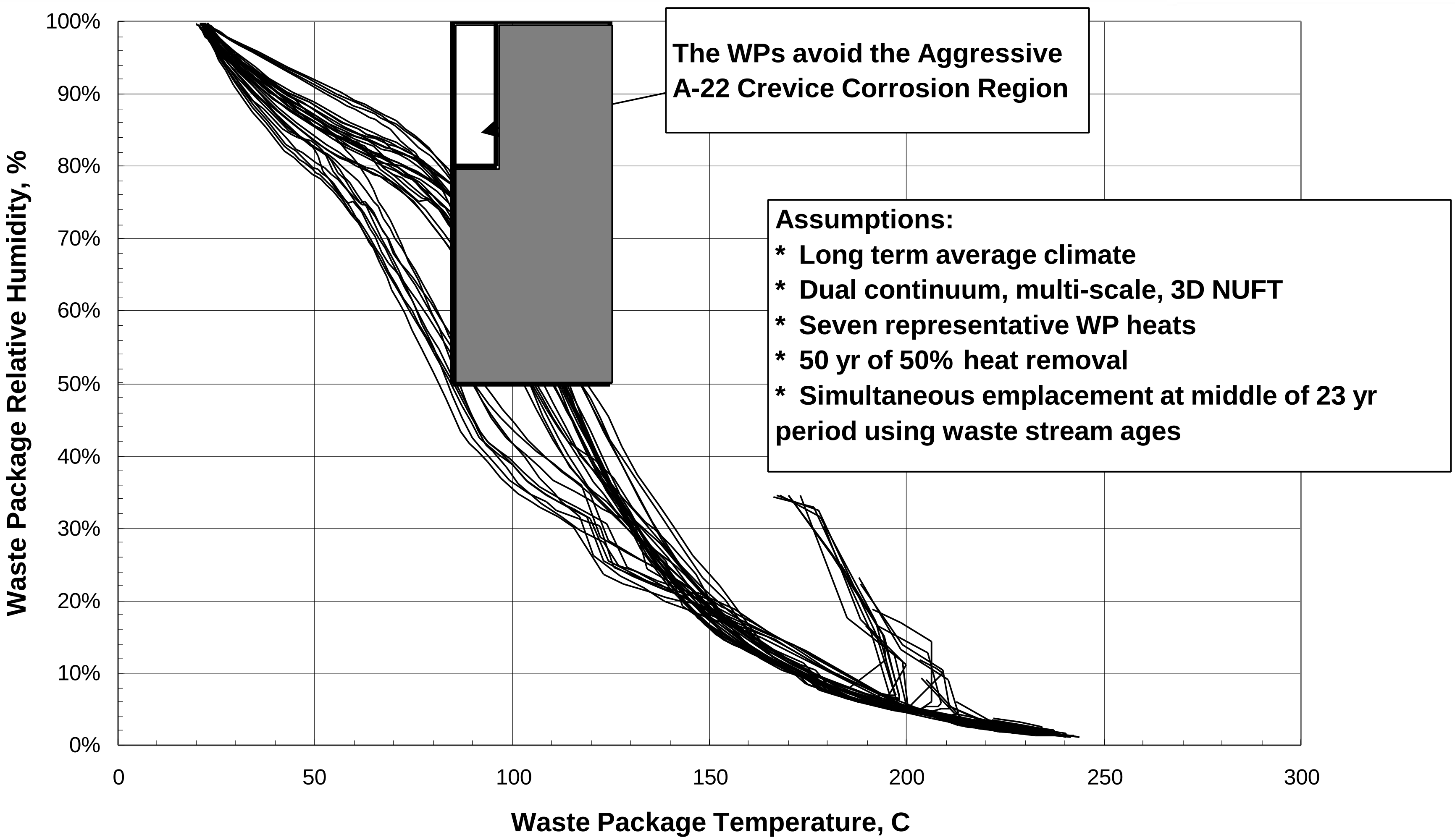
EDA II Underground Facility

- **Line Loading and blending**
  - **Reduce axial temperature variations**
- **Aggressive pre-closure ventilation**
  - **Reduces peak temperatures**
- **Wide drift spacing (81 m) facilitates shedding**
  - **Only a small fraction of the pillar is heated above boiling**
- **Limited duration and volume of rock heated above boiling (50 yr closure)**
  - **Reduces uncertainty associated with altered flow paths and water chemistry**
  - **Additional thermal management (later closure, higher ventilation, wider drift spacing, etc.) can result in no rock heated above boiling**

EDA II Waste Package

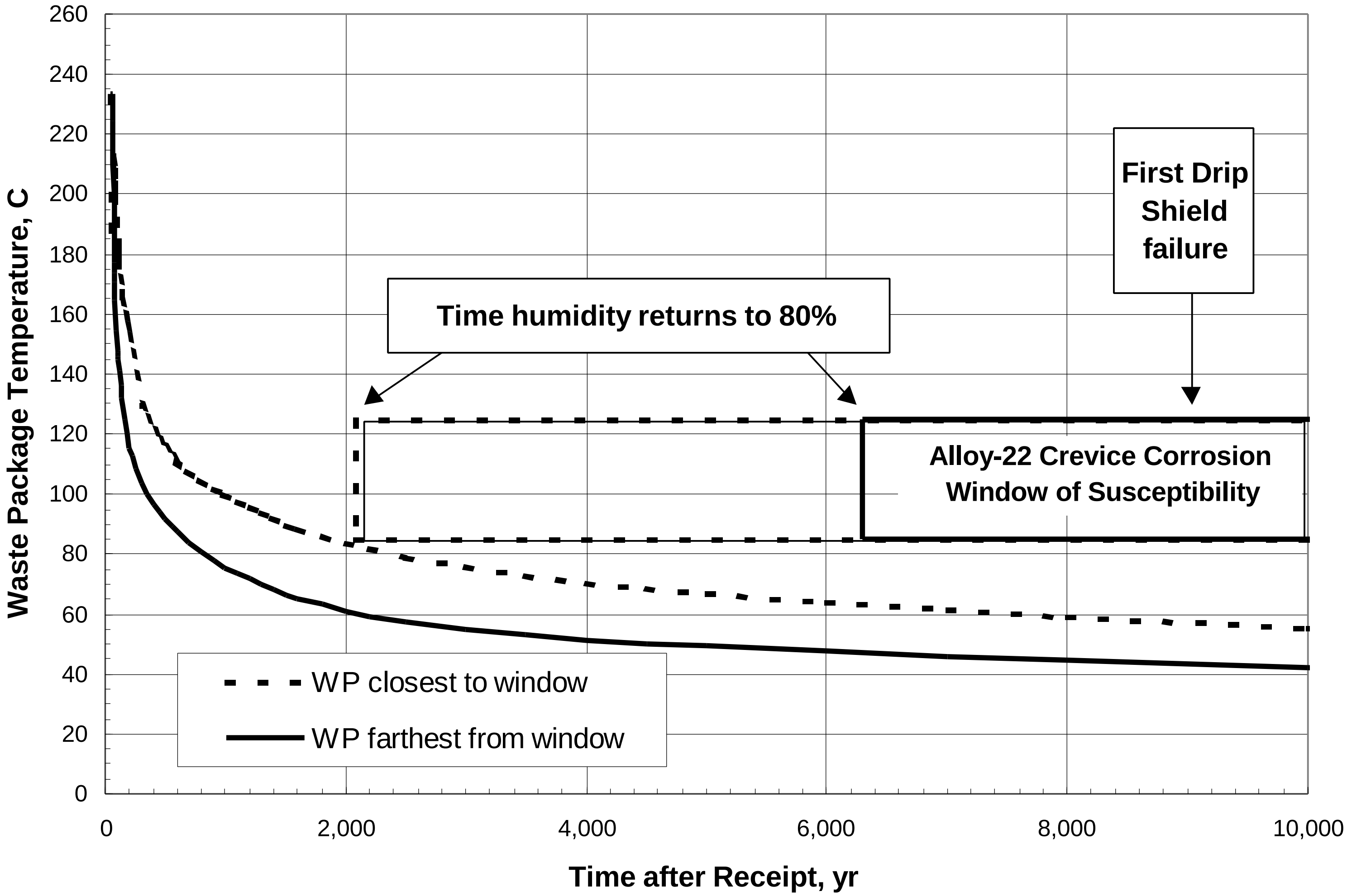
- **2 cm of Alloy 22 corrosion resistant material over 5 cm of stainless steel structural material**
  - **No oxide wedging uncertainty from confined carbon steel**
  - **Structural strength for the life of the CRM (>10^5 yr) compared to carbon steel lifetime (< 10^4 yr) for the VA WP**
  - **Thermal management (ventilation, blending, areal mass loading) avoids the Alloy 22 crevice corrosion window of susceptibility**

EDA II (Backfill, No Aging)
Central estimate thermal hydrology calculation



Rev 001

EDA II (With Backfill, No aging)
The WPs avoid the Window of Susceptibility



Rev 001

EDA II EBS Components - 1

- **2 cm thick Ti-7 drip shield, with overlapping sections**
  - **Protects WP from seepage during the thermal pulse**
  - **Long life due to slow general corrosion**
    - » **First DS failure ~9,000 years**
    - » **Median failure time ~50,000 years**
  - **Provides some rock fall protection of the WP**
  - **Uses a different CRM than the WP**
    - » **Reduces the possibility of common mode failures**
  - **Limits the WP and invert to (slow) diffusive transport for a significant period**

EDA II EBS Components - 2

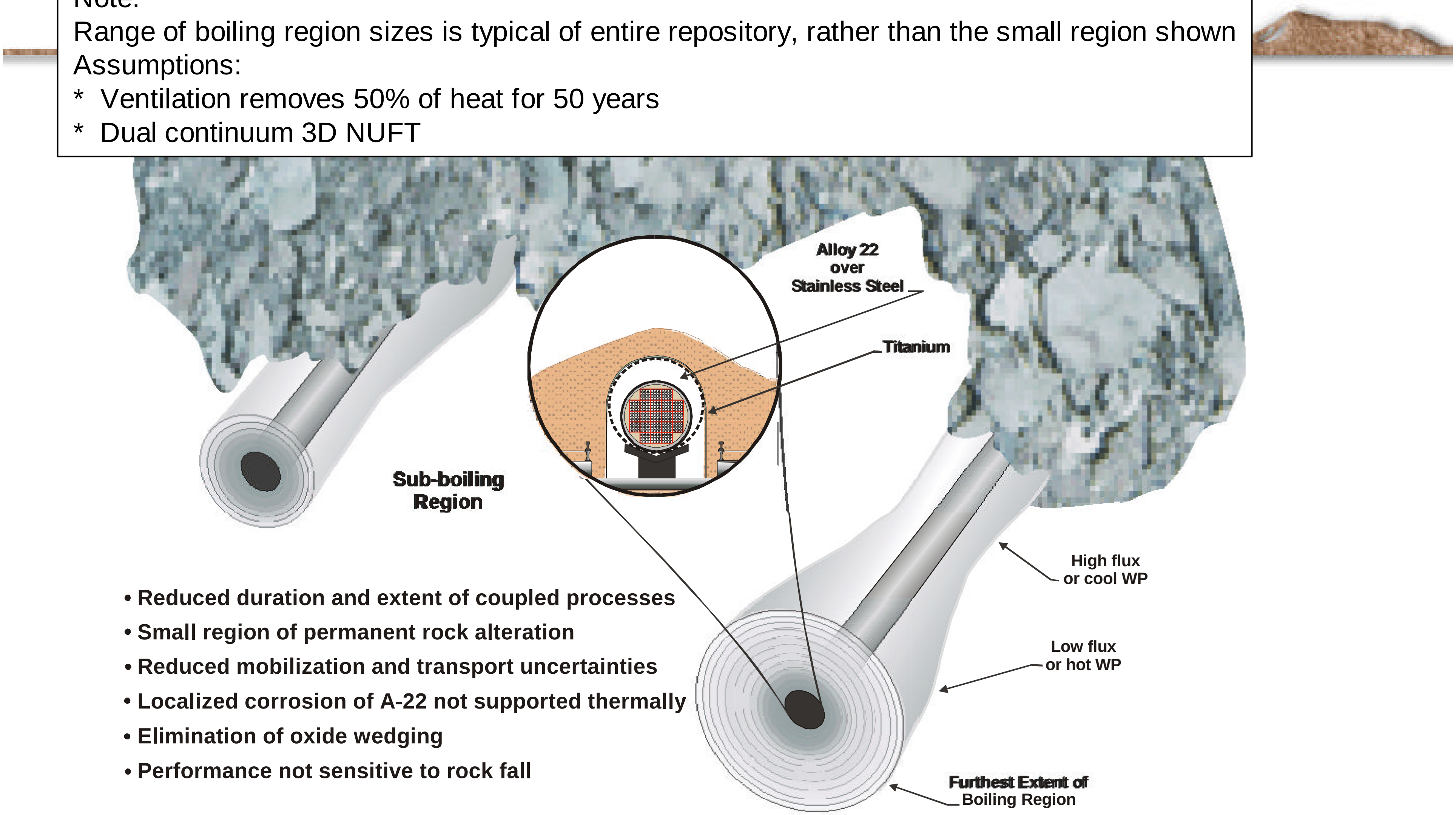
- **0.6 m deep backfill over the drip shields**
  - **Establishes postclosure geometry and environment for the EBS**
    - **Eliminates concerns about rockfall**
  - **Extends duration of low relative humidity**
    - **Reduced possibility of localized corrosion**
  - **Ideal material:**
    - **High thermal conductivity**
    - **Does not wick water to the drip shield or WP**
    - **Buffers water chemistry**
  - **Backfill over a breached (cracked) drip shield retains water due to capillary forces**
    - **Similar to a Richards Barrier**

EDA II EBS Components - 3

- **Steel ground support and invert structure**
  - **Type used will depend on ground conditions**
    - **Steel sets and lagging for difficult ground**
    - **Rock bolts and mesh for most ground**
  - **Reduces uncertainties in radionuclide mobilization and transport**
    - **By avoiding alkaline seepage water due to concrete**
  - **Ballast between (and potentially covering) invert steel beams**
    - **Tailor for drainage and slow radionuclide transport**
    - **Ideal properties for backfill also apply to the ballast**

Enhanced Design Alternative at 800 Years

Note:
Range of boiling region sizes is typical of entire repository, rather than the small region shown
Assumptions:
* Ventilation removes 50% of heat for 50 years
* Dual continuum 3D NUFT

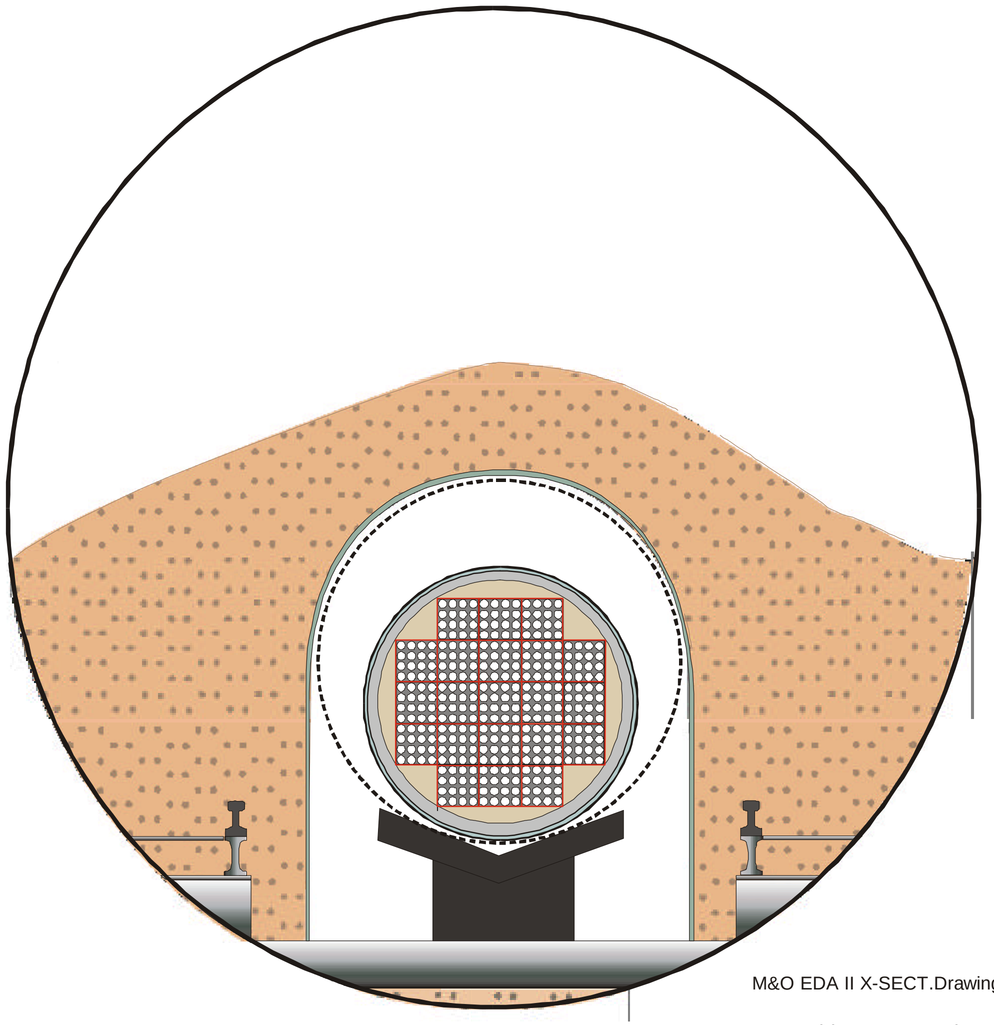


- Reduced duration and extent of coupled processes
- Small region of permanent rock alteration
- Reduced mobilization and transport uncertainties
- Localized corrosion of A-22 not supported thermally
- Elimination of oxide wedging
- Performance not sensitive to rock fall

M&O.Graphics.dwg.MAX EXTENT2.CDR/4-12-99

Rev 001

Engineered Barrier System of EDA II After Closure



M&O EDA II X-SECT.Drawing.cdr/6-22-99

EDA II has Operational Flexibility

Closure options for the initial design
Design changes offer additional options

Install Drip Shields (No Backfill)
Entire pillar remains below boiling
WP does not appreciably exceed boiling
Drip Shield susceptible to rock fall damage

Closure Option #3

Begin Emplacement

2010 **2060** **2210**

Closure Option #1

Closure Option #2

Install Drip Shields and Backfill
Heats <20% of pillar above boiling
Heats WP above boiling for 500-1500 yr
Not susceptible to rock fall damage

Install Drip Shields and Backfill
Entire pillar remains below boiling
Heats WP above boiling for short time
Not susceptible to rock fall damage

The decision of closure option is one for future generations

EDA II operational flexibility details

The decision of closure option is one for future generations

Emplace Waste	Closure Option #1	Closure Options #2,3
2010	2060	~2210

Closure Option #1: Install drip shield & backfill after 50 yr

(assuming 50%of preclosure heat removed by ventilation, multi-scale NUFT)

- Peak Drift Wall (130-170ºC, median 158ºC), Peak WP (190-270ºC, median 241ºC)
- Peak Clad ~ 30ºC higher than WP (100 yr closure calc), well below 350ºC limit
- Fraction of pillar always sub-boiling (72-88%), deepest penetration ~ 800 yr

Closure Option #2: Install drip shield & backfill after ~200 yr

(assuming 80% of preclosure heat removed by ventilation, LDTH NUFT)

- Peak Drift Wall (96ºC), Peak WP T (125ºC), 2200 yr above 96ºC, 6500 yr above 80ºC

Closure Option #3: Install drip shield (no backfill) after ~200 yr

(assuming 80% of preclosure heat removed by ventilation, LDTH NUFT)

- Peak Drift Wall T (96ºC), Peak WP T (~100ºC)
- Must design drip shield to resist rockfall

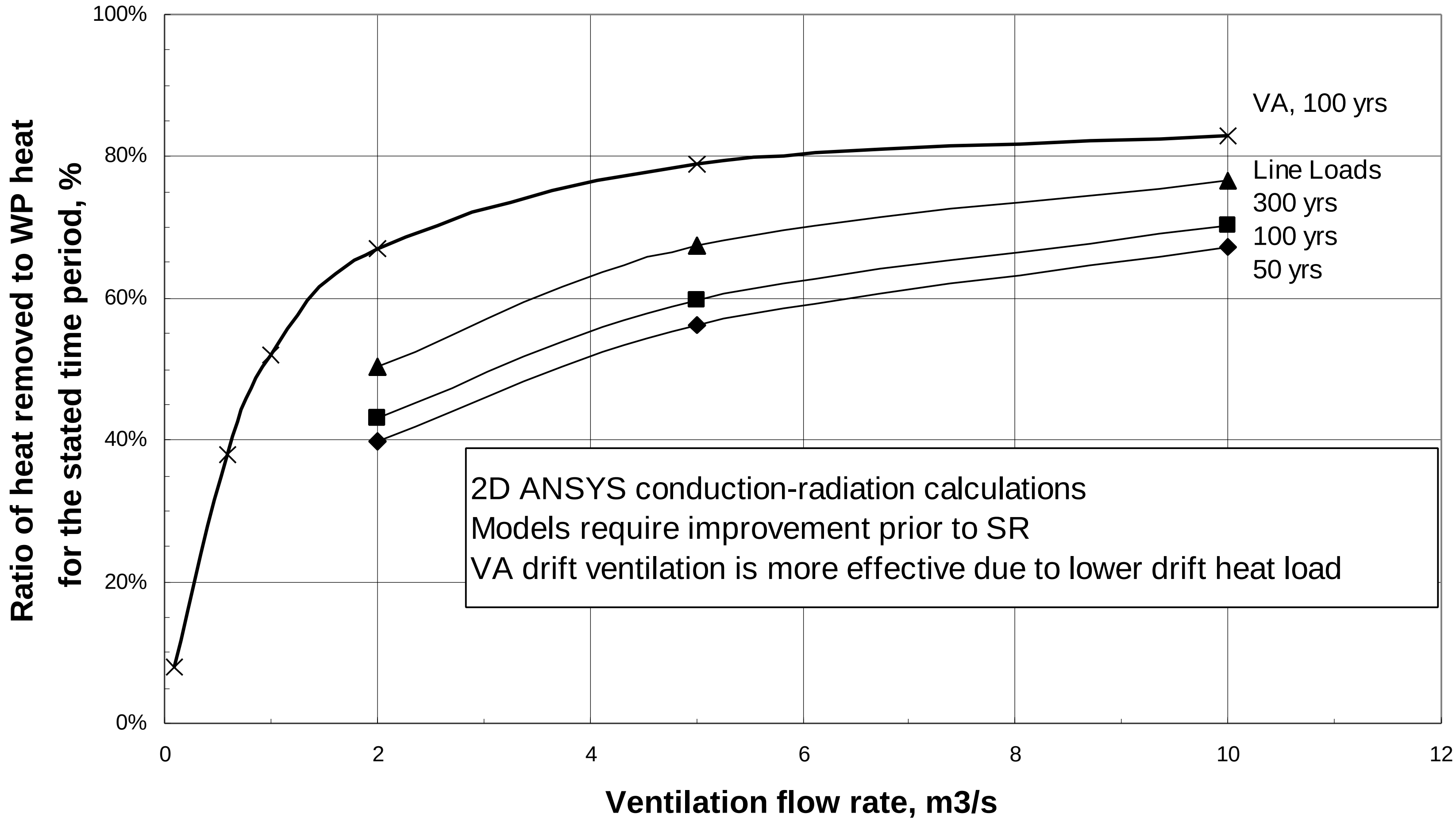
EDA II costs relative to the VA

- **Decreased excavation costs**
  - **Due to line loading**
- **WP is cost neutral**
- **Blending and ventilation increase construction costs**
- **Drip shields and backfill increase closure costs**
- **Overall**
  - **Construction and emplacement costs are about the same as VA**
  - **Monitoring and closure costs are higher than VA**

EDA II Emplacement Area

- **The upper block of the characterized area is adequate to emplace 70,000 MTHM (63,000 MTHM commercial)**

Heat Removal Efficiency via Ventilation



Rev 001

Drift Wall Temperature Sensitivity to Trades Among Ventilation Period, Ventilation Rate, and Drift Spacing

	Preclosure Peak Drift Wall Temperature	Ventilation Period, years						
		50	75	100	125	150	200	300
		Postclosure Peak Drift Wall Temperature, C						
60 MTU/acre, 50% heat removed (2-5 m3/s)	128	167		134	124	117	111	103
60 MTU/acre, 80% heat removed (10-15 m3/s)	**65**	140	122	109	103	99	**96**	
50 MTU/acre, 50% heat removed (2-5 m3/s)	126	159		120	110	104	**97**	
50 MTU/acre, 80% heat removed (10-15 m3/s)	**65**	137	112	100	**93**	**88**	**84**	

NUFT line source, drift scale, thermal hydrologic (LDTH) calculations
Full multi-scale NUFT calculations would produce lower temperatures

M&O Recommendations for Design Refinement

- Establish a design basis heat output for WPs
- Revise the modular design and construction study to reflect EDA II, including blending and subsurface modular construction
- Compare costs and benefits of ventilation and other thermal management techniques, including segregating waste types in separate drifts
- Presume 50 year pre-closure period, but do not preclude longer periods of ventilation

M&O Recommendations for Design Refinement

(continued)

- **Eliminate small PWR/BWR WP designs, use derating for small fraction of SNF assemblies that cannot be placed in a full, large WP**
- **Use a WP design with Alloy 22 over Stainless Steel, and continue testing and modeling of these materials**
- **Consider canisterization of SNF without intact zirconium-based cladding. Consider improvement of HLW pour canisters**

M&O Recommendations for Design Refinement

(continued)

- **Use a steel ground support and a steel invert with granular ballast**
- **Develop a drip shield design, using Ti-Gr7 as an initial material. Defer optimization of DS design until after LA**
- **Evaluate EDA II without backfill as an alternative to the recommended design (this has been completed)**

SR Design and Science Activities

- **The M&O has been reevaluating the scientific and engineering data and models to be used in TSPA-SR, based on EDA II**
  – **This work is subject to revision, depending on DOE's selection of the SR/LA initial design**
- **Status of Drift Scale Testing and other science programs will be presented later in the agenda**

Summary

- EDA II was recommended by the M&O to the DOE
  - Reduced uncertainty
  - Calculated dose rate is well below the screening criterion
  - Flexible to react to performance confirmation data without causing extensive redesign or construction costs