Overview of Future YMP Total Systems Performance Assessment Modeling Plans

Presentation to:
Nuclear Waste Technical Review Board (NWTRB)

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Office of Civilian Radioactive Waste Management

Yucca Mountain Project

Preview

- **Overview:**
  - **Major drivers for TSPA-SR/LA**
  - **Key findings of the TSPA-VA Peer Review Panel Report; NRC review comments**
- **Philosophy and scope of TSPA-SR/LA iterations, PMRs and AMRs**
- **Implications of design changes**
- **Schedule for TSPA SR/LA**
- **Support materials**

Programmatic and Regulatory Drivers TSPA-SR/LA

- Work to be performed in compliance with governing procedures and requirements
- Responsive to review comments on VA
- Implementation of proposed EPA standards, NRC regulatory requirements, and DOE guidelines
- NRC IRSR acceptance criteria (and draft Yucca Mountain Review Plan)

Major Technical Drivers
TSPA-SR

- Interpretation of TSPA-VA results
- Comments received on TSPA-VA
  - NRC
  - NWTRB
  - Performance Assessment Peer Review Panel
  - ACNW
  - Nye County
- Changes in
  - repository and waste package designs
  - process models
- Focus on key information to complete post closure safety case

Key Findings of the PA Peer Review Panel on TSPA-VA

- **TSPA-VA and TSPA-SR have significantly different objectives. Recognition of this distinction should be an important element of a path forward.**
  - **Objective of TSPA-VA was determining "probable behavior" *(intent of congress = site performance would meet existing standards)***
  - **Objective of TSPA-SR (& LA) will be to show with reasonable assurance that the repository complies with regulatory requirements; expected performance meets standards**
- **Use of simplified bounding analyses may be necessary to achieve the desired level of confidence (for TSPA-SR & LA)**

Key Findings of the PA Peer Review Panel on TSPA-VA

(continued)

- "For cases in which it is feasible to improve either the component models or their underlying data, the Panel recommends that efforts be made to implement such improvements wherever such changes would affect the overall assessment."
- "Where conservative bounding analyses do not result in unduly pessimistic estimates of the total system performance, the Panel recognizes that it may not be cost-effective to spend additional time and effort refining the assessments and making them more realistic."

Key Findings of the PA Peer Review Panel on TSPA-VA

(continued)

- **"For those issues for which, by virtue of their complexity, it is not feasible to produce more realistic models supported by data, the Panel recommends that a combination of bounding analyses and design changes be applied."**

NRC Staff Review of TSPA-VA

Comments on TSPA-VA note general agreement between the DOE and NRC approaches with five major areas where significant differences exist

- **Unclear whether sufficient data on waste package corrosion, under conditions applicable to the potential repository, can be acquired to demonstrate compliance with NRC requirements**
- **Data and models of the quantity and chemistry of dripping water are inadequate to describe the process of dripping under ambient and thermally-altered conditions**

NRC Staff Review of TSPA-VA

(continued)

- The saturated zone has not been sufficiently characterized to the proposed 20-km receptor location to adequately assess its contribution to performance.
- Volcanic disruption analyses and supporting documents:
  - » not necessarily representative, based on insufficient data and assumptions which are inconsistent with those used elsewhere
  - » NRC indicates that DOE plans for consequence analysis could resolve the issues

NRC Staff Review of TSPA-VA

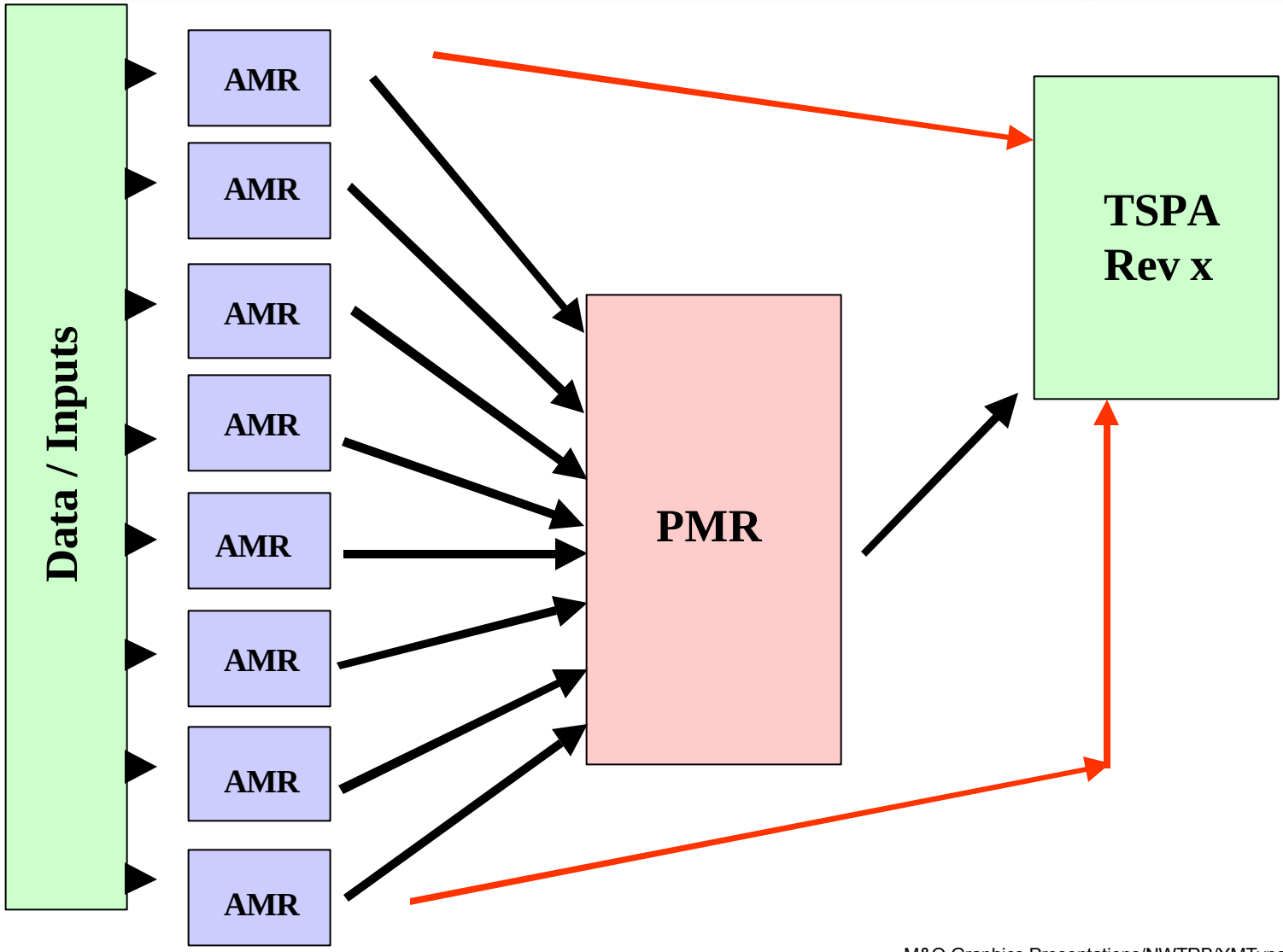
(continued)

- **Implementation of QA Program has raised the issue of whether data/products will be acceptable and appropriately qualified**

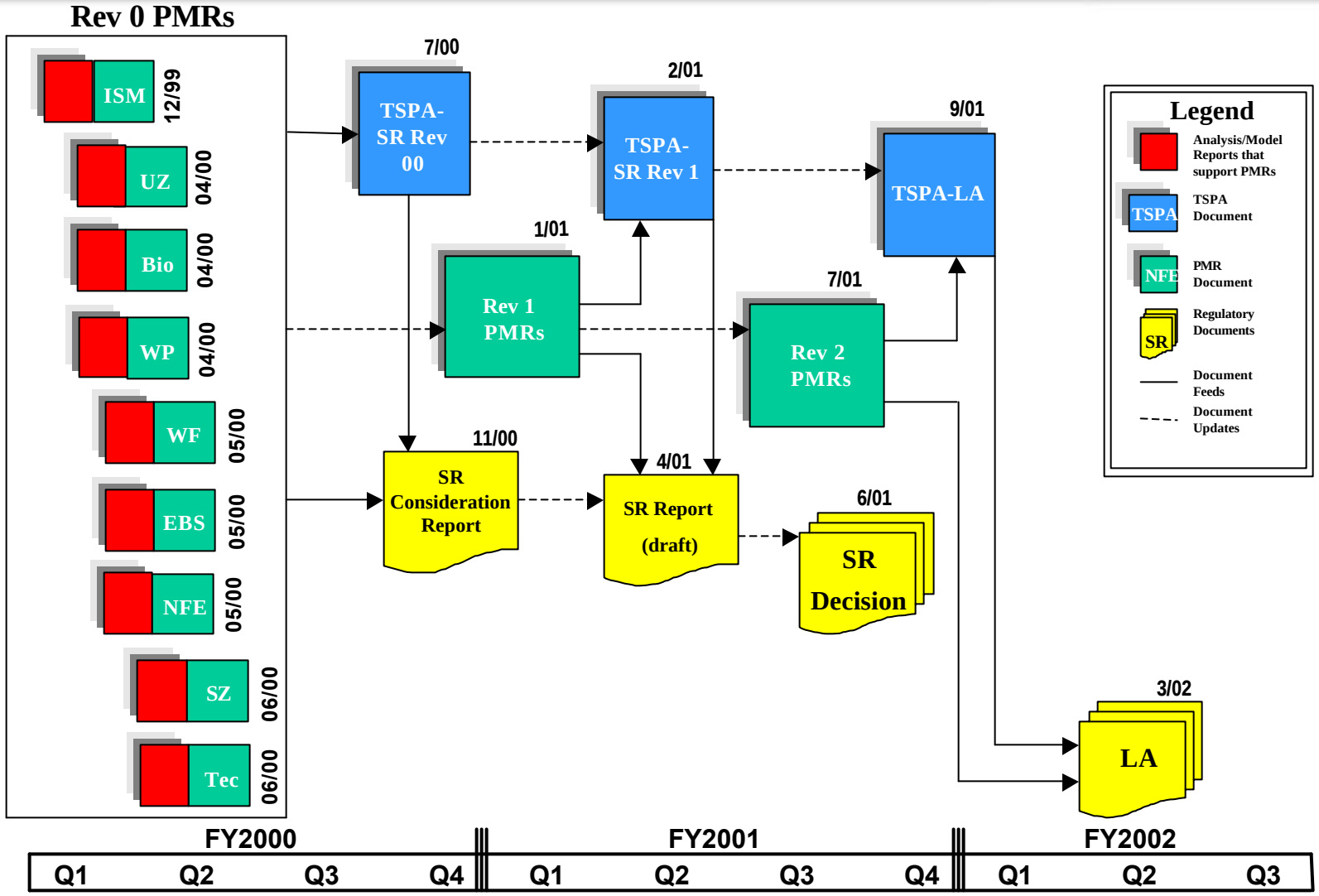
Philosophy of Future TSPA Iterations

- **Initial TSPA iterations (-91, -93, -95) were scoping in nature, and non-Q**
- **TSPA-VA and all future TSPA documents will have needed controls placed on all data, models, software, analyses, and documentation**
  - **enhances reader review of documentation by improving traceability**
  - **any changes will be controlled under the change control process, which includes conducting impact analyses**
- **TSPA-SR Rev. 00 forms the fundamental controlled basis to which incremental changes may be made**

Analysis Model Reports, Process Model Reports



Linkage of Major Programmatic SR/LA Milestones



TSPA-SR Overall Scope

- **Develop process models, abstraction models and TSPA model**
  - **Incorporate features most significant to performance**
  - **Include uncertainty in conceptual models and parameters**
- **Identify and screen relevant features, events, and processes (FEPs);** ***see support material***

TSPA-SR Overall Scope
(continued)

- Conduct analyses using process, abstraction and total-system models in accordance with applicable QA controls for data, models, and software
- Document analyses and technical basis in the TSPA-SR Rev 00 and Process Model Reports
- Provide the basis for the suitability evaluation for the Site Recommendation

Scope and Content of Future TSPA Iterations

***TSPA-SR Rev. 00 for SR Considerations Report**

- **Screen FEPs using regulatory criteria**
- **Use controlled models, analyses, software and data**
- **Evaluate total-system performance incorporating uncertainty and using probabilistic case runs**
- **Conduct stylized human intrusion scenario analysis**
- **Perform limited subsystem performance evaluations**

**** SR Consideration Report, 11/00, completed for hearings***

Scope and Content of Future TSPA Iterations

(continued)

TSPA-SR Rev. 01 for Site Recommendation Report

- Respond to comments on Rev. 00
- Revise Rev 00 analyses with applicable, significant changes in models or data (including qualification of TBV information)
- Conduct subsystem performance evaluations
- Conduct specific multiple barrier analyses
- Document results and interpretation in accordance with regulatory acceptance criteria

Scope and Content of Future TSPA Iterations

(continued)

TSPA-LA

- Respond to comments on TSPA-SR Rev. 01 (especially NRC sufficiency comments) should
  - » the Secretary recommend the site to the President,
  - » the President accepts recommendation, passes along to Congress for consideration, and
  - » Congressional action required to go forward to LA
- Revise Rev. 01 analyses where applicable; incorporate any significant changes in models or data (includes qualification of additional TBV information)

Expected Changes to TSPA Models in Response to LADS

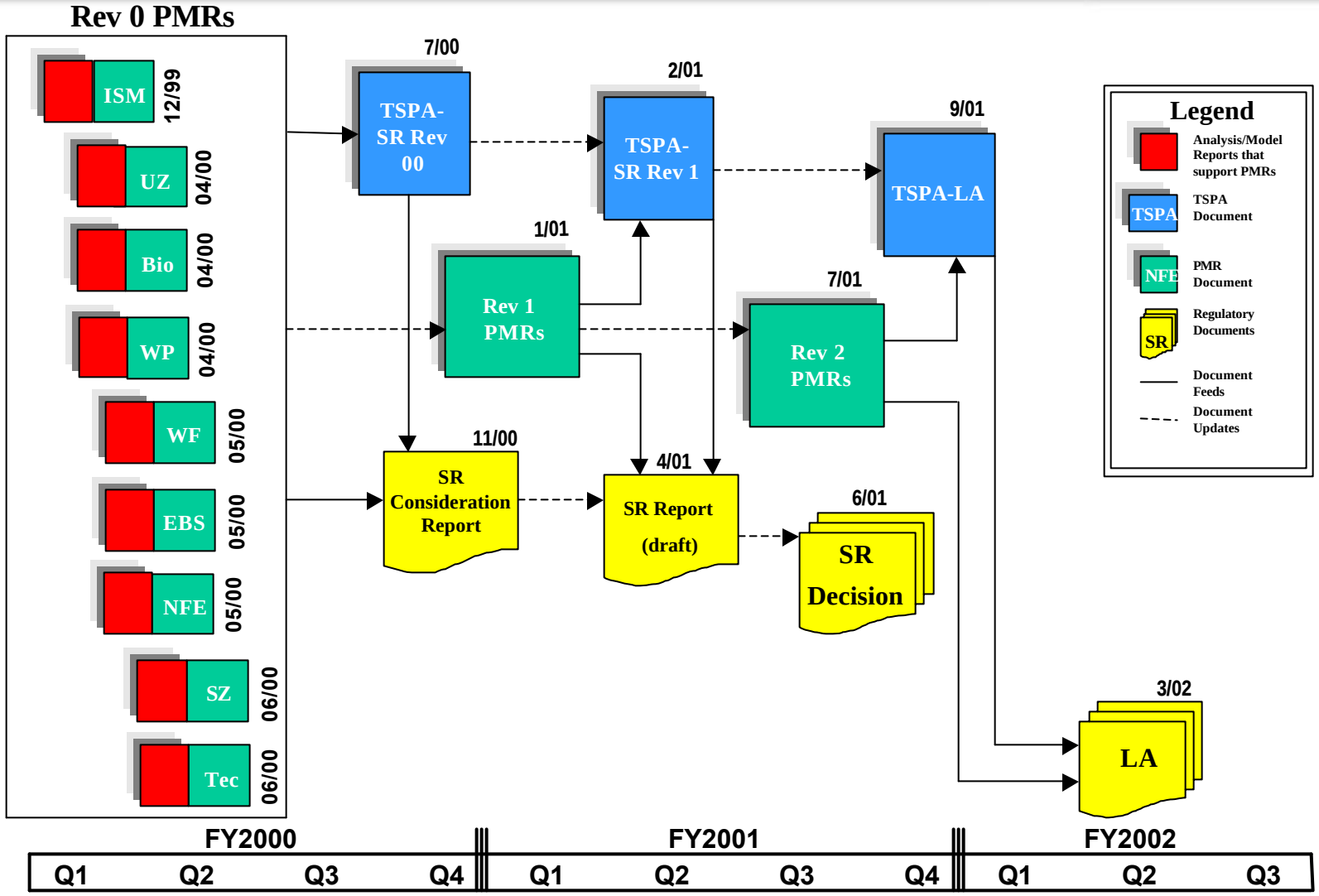
- **Changes are anticipated in the engineered system components and the representation of coupled processes**
  - **Different waste package design and materials**
  - **Altered in-drift chemistry**
  - **System changes as a result of changed design features (backfill, invert, drip shield, steel ground support, reduced concrete)**
  - **Smaller zone in host rock undergoing change due to thermal effects for lower temperature designs**
- **In general, effects on natural system models are expected to be minimal compared to the VA case.** ***Work in progress.***

How TSPA Was Used to Support LADS

- **TSPA was used in the LADS exercise to develop and refine insight about the potential for each proposed feature or alternative to improve post-closure repository performance**
  - **The analyses were expected to estimate the change in timing, and magnitude of the dose rate for each design option**
  - **The level of detail of the PA analyses for LADS were consistent with the level of detail provided in the design concepts**
  - **The PA analyses for LADS were not expected to provide the detail required for a Safety Case, but were designed to help YMP determine the relative benefit that might be derived from each option***
  - **Additional data collection and/or analyses will be necessary to develop a defensible representation of selected options for use in future TSPAs**

All 5 EDAs exhibited better performance than VA case

Linkage of Major Programmatic SR/LA Milestones



Schedule of Major Inputs to SR Consideration Report Draft Rev 00

	Final
Analysis and Model Reports	7/99-2/00
Process Model Reports Rev. 00/01	10/99-6/0
TSPA-SR Rev. 00 Analyses	4/00
TSPA-SR Document Rev. 00	9/00
Preliminary Suitability Evaluation	11/00

Schedule of Major Inputs to SR Report (draft)

	Proposed
Analysis and Models Rev. 01	7/00
Process Model Reports Rev. 02/03	11/00
TSPA-SR Analyses for Rev. 01	1/01
TSPA-SR Rev. 01	2/01
Final Suitability Evaluation	3/01

Summary

- **TSPA-SR Rev. 00 will place all data, models, analyses, and software under baseline control**
- **TSPA-SR will have adequate, necessary, and sufficient information to provide technical basis for compliance evaluation**
- **In a timely manner, TSPA will integrate updated material and incorporate model and analysis modifications required to reflect selected new design**

Summary
(continued)

- **As recommended by the PA Peer Review Panel, the TSPA-SR will include**
  - **Conservative bounding analyses as appropriate**
  - **Combinations of bounding analyses and design changes for complex issues where it is not feasible to produce more realistic models**
  - **Limited improvement in component models (and underlying data) where such changes significantly affect the overall TSPA**

Implementing plans to prioritize work continues with analysis of principal factors and work required to serve as an adequate basis for SR/LA

Support Materials

License Application Design Selection Enhanced Design Alternatives Design Values

DESIGN ELEMENT	EDA I	EDA II	EDA III	EDA IV	EDA V
Thermal Goals • Cladding	350°C	350°C	350°C	350°C	350°C
• Waste package surface			Cools to 80°C before relative humidity reaches 90%		
• Drift wall	96°C	200°C	200°C	200°C	225°C
• Drift environment				Keep drifts dry for thousands of years	Keep drifts dry for several thousand years
• Pillar temperatures		Keep centers of pillars below boiling (96°C)			
• Other goals				Limit gamma dose at waste package surface to 200 mrem/hr	
Areal Mass Loading (MTHM/acre)	45	60	85	85	150
Area (acres) for 70,000 MTHM	1,400	1,050	740	740	420
Line/Point Load	Point	Line	Line	Line	Line
Waste Package Size (PWR)	12	21	21	21	21
Drift Diameter (m)	5.5	5.5	5.5	5.5	5.5
Drift Spacing (m)	43	81	56	56	32
Preclosure Ventilation	50 years @ 2 to10 m^3/s	50 years @ 2 to 10 m^3/s	50 years @ 2 to10 m^3/s	50 years @ 2 to10 m^3/s	50 years @ 2 to 10 m^3/s
Waste package heat output at emplacement Maximum Average (PWR waste package) (CRWMS M&O 1999bb)	20% blending used to reduce maximum 6.7 kW 5.6 kW	20% blending used to reduce maximum 11.8 kW 9.8 kW	Limited blending 18.0 kW 9.5 kW for PWR	Limited blending 18.0 kW 9.5 kW	20% blending used to reduce maximum 11.8 kW 9.8 kW
Waste Package Material	2-cm Alloy-22 over 5-cm stainless steel	2-cm Alloy-22 over 5-cm stainless steel	a) 2-cm Alloy-22 over 5-cm stainless steel b) 2-cm Alloy-22 over 1.5-cm Ti-7 over 4-cm stainless steel	30-cm carbon steel	2-cm Alloy-22 over 5-cm stainless steel
Fillers	No	No	No	Integral filler	No
Backfill	No	Yes	No	Yes	No
Drip Shield	Yes	Yes	Yes	Yes	Yes
Total Waste Packages	15,903	10,039	10,213	10,213	10,039

EDA II/VA Design Comparison

Design Characteristics	EDA II	Viability Assessment Design
Areal Mass Loading	60 MTU/acre	85 MTU/acre
Drift Spacing	81m	28 m
Drift Diameter	5.5 m	5.5 m
Total Length of Emplacement Drifts	54 km	107 km
Ground Support	Steel	Concrete lining
Invert	Steel with sand or gravel ballast	Concrete
Number of Waste Packages	10,039	10,500
Waste Package Material	2-cm Alloy 22 over 5 cm stainless steel 316L	10 cm carbon steel over 2 cm Alloy-22
Maximum Waste Package Capacity	21PWR assemblies	21 PWR assemblies
Peak Waste Package Power (blending)	20% above average PWR waste package power	95% above average PWR waste package power
Drip Shield	2 cm Ti-7	none
Backfill	Yes	none
Preclosure Period	50 years *	50 years
Preclosure Ventilation Rate	2 to 10 cubic m /s	0.1 cubic m/s

The next three pages constitute a summary of DOE SR Planning Guidance to the M&O for TSPA work; schedules and rev. numbers are tentative pending outcome of negotiations and finalization of planning activities.

TSPA-SR Model Development, Analysis, and Documentation

Features, Events and Processes Database

- FEPs Database: List all FEPs included and excluded
  - Included FEPs: provide appropriate links to abstracted model documentation
  - Excluded FEPs: provide justification or link to abstraction model documentation where justification provided
  - FEPs Database production and revision
    - Rev. 0 to support TSPA-SR Rev. 0
    - Rev. 1 to support TSPA-SR Rev. 1; others as required

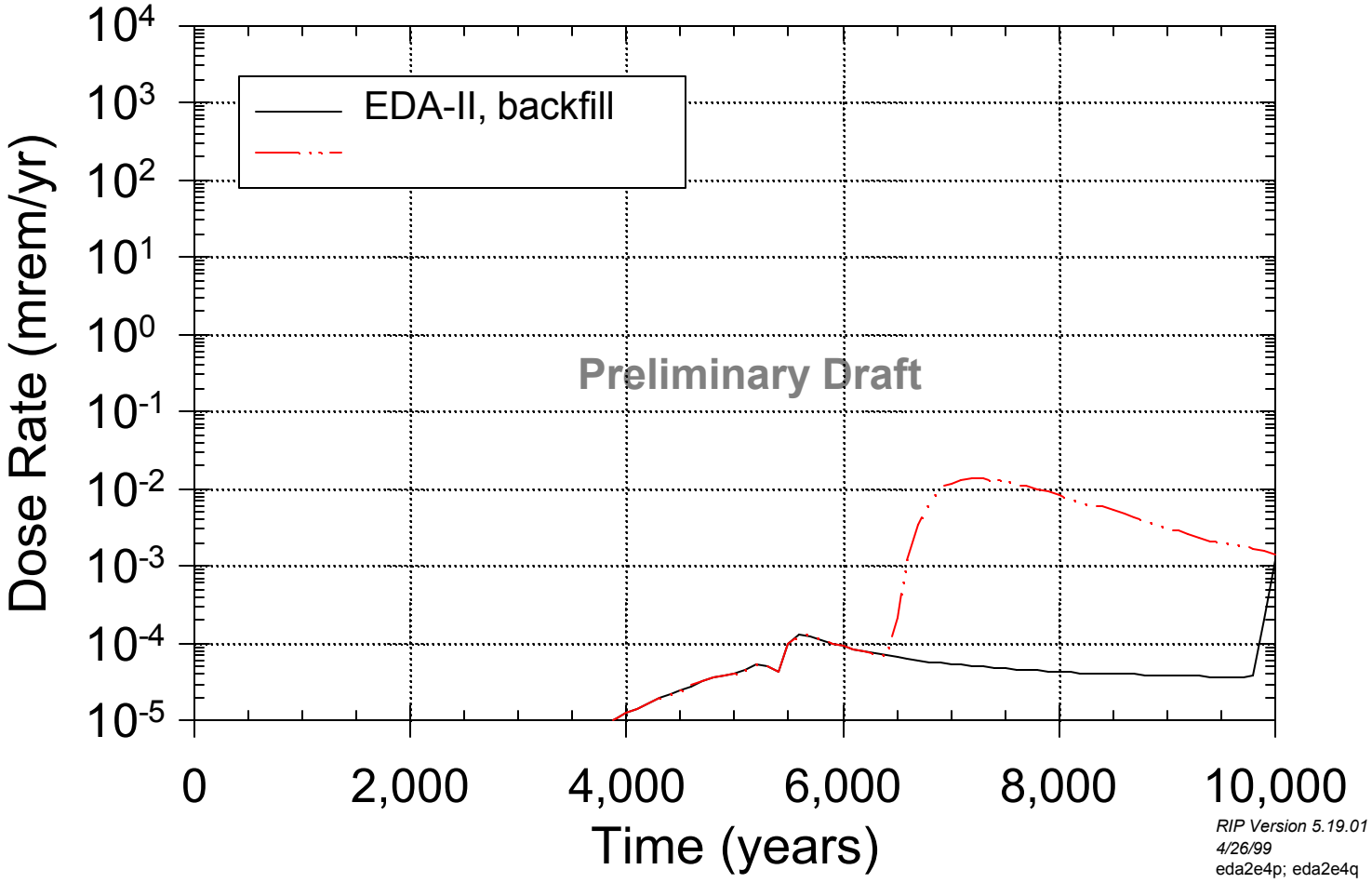
TSPA-SR Model Development, Analysis, and Documentation

- **List of deliverables**
  - **FEPs Database, Rev. 00** **04/01/00**
  - **TSPA Inputs to FEIS** **02/28/00**
  - **TSPA-SR, Rev. 00** **07/14/00**
  - **TSPA Inputs to FEIS** **07/28/00**
  - **FEPs Database, Rev. 01** **11/15/00**
  - **TSPA-SR, Rev. 01** **02/28/01**

TSPA-SR Model Development, Analysis, and Documentation

- **List of deliverables**
  - **FEPs Database LA** **6/31/01**
  - **TSPA-LA** **9/28/01**

EDA II, 50 Years Ventilation
10,000-yr Total Dose-Rate History
All Pathways, 20 km



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