



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



Development of Technical Basis Documents for Post-Closure Performance Assessment

Presented to:
Nuclear Waste Technical Review Board

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Outline

- **Background**
- **Development of Technical Bases for Post-Closure Performance Assessment**
- **Organization of Technical Basis Documents**
 - **Process model groups**
- **Conclusions**

Background

- **In the May 2003 Board Meeting, DOE summarized the integrated technical basis for the unsaturated zone seepage, the in-drift thermo-hydro-mechanical environment, and waste package material performance**
- **The Board noted that an updated written description of the presentations from the May Board meeting would make the Project's approach to ensuring safety more transparent and understandable (June 30, 2003 letter to Margaret Chu)**
- **The DOE is developing such written descriptions**
- **These are called "Technical Basis Documents"**

Development of Technical Bases

- **Perform scientific/engineering work (design, testing, model refinement and validation, and analyses)**
 - focus on addressing NRC/DOE Key Technical Issue Agreements
- **Document scientific/engineering work in technical products**
 - scientific notebooks/data analysis
 - analysis/model reports
 - calculations/drawings
- **Utilize scientific/engineering work to assess pre-closure safety and post-closure performance**
- **Abstract work from technical products into integrated Technical Basis Documents**
 - Document technical bases consistent with NRC's Yucca Mountain Review Plan

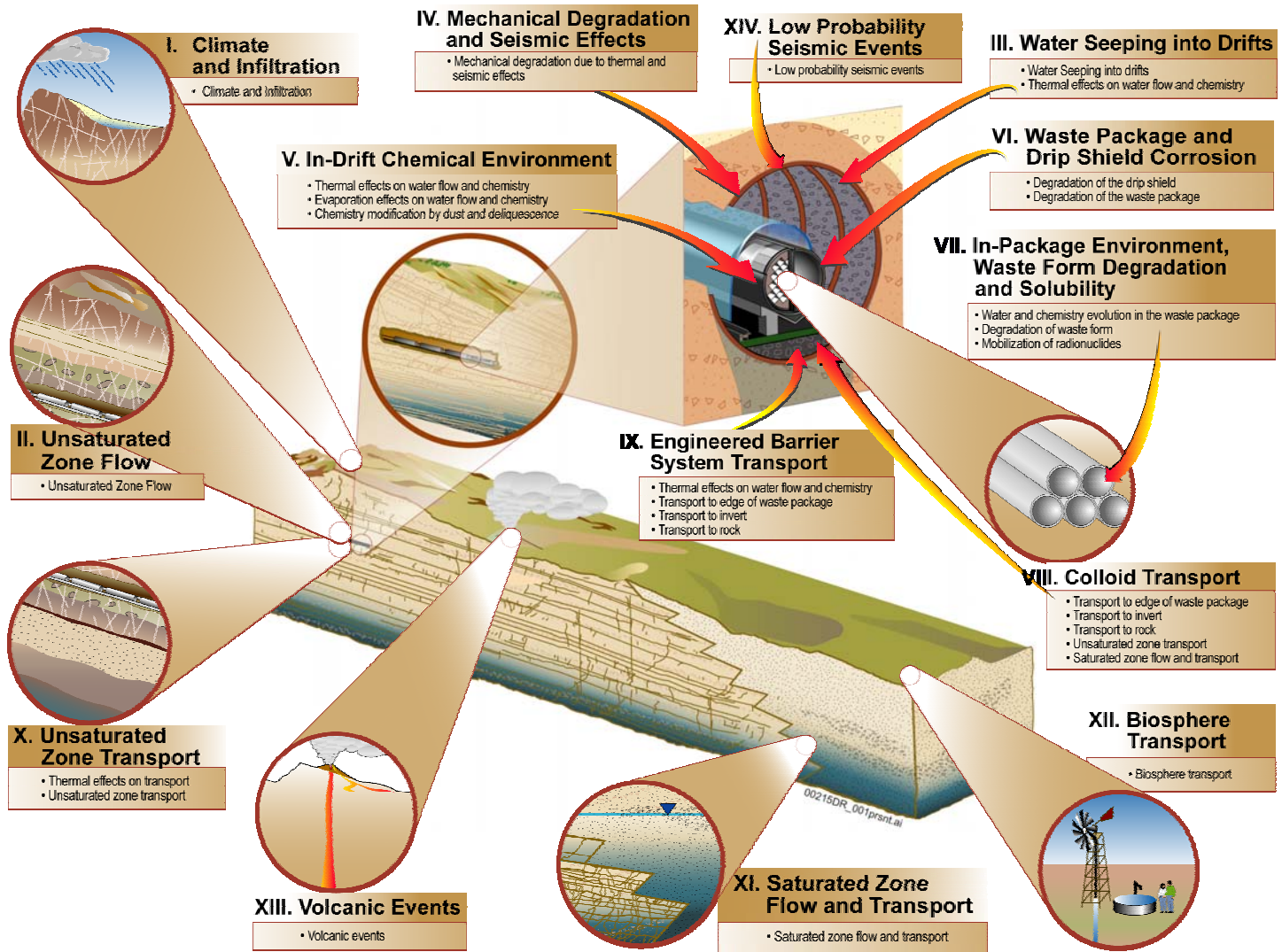
Methods Considered to Organize Development of Technical Basis Documents

- **Scale**
- **Process**
- **State variables**
 - **Temperature, pressure, chemistry, stress, hydrology (flux and saturation), radionuclide concentration**
- **Time**
- **Space**
- **Barrier**
 - **Sequential barriers identified by following the path of water and radionuclides through the system**

Mapping of Process and State Variables at Different Scales – Nominal Performance

Scale	Key Processes	Key State Variables
Repository scale	Climate and Infiltration Unsaturated zone flow	Water flux, saturation
Drift scale	Seepage and thermal effects Mechanical degradation Chemistry and thermal effects	Water flux, saturation, temperature, stress, chemistry
Waste package scale	Chemistry evolution in drifts Drip Shield degradation Waste package degradation	Water flux, temperature, stress, chemistry
Waste form scale	Water and chemistry evolution in the WP Degradation of waste form Mobilization of radionuclides Transport to edge of WP	Water flux, temperature, chemistry, radionuclide concentration
Drift scale	Transport to invert Transport to rock Thermal effects on transport	Water flux, saturation, temperature, chemistry, radionuclide concentration
Repository scale	Unsaturated zone transport	Water flux, chemistry, radionuclide concentration
Site scale	Saturated zone flow and transport Biosphere transport	Water flux, chemistry, radionuclide concentration

Fourteen Technical Basis Documents



Fourteen Technical Basis Documents (and Related Processes)

I. Climate and Infiltration

II. Unsaturated zone flow

III. Water Seeping into Drifts

- Water seeping into drifts
- Thermal effects on water flow

IV. Mechanical degradation and seismic effects

V. In-Drift chemical environment

- Thermal effects on water flow and chemistry
- Evaporation effects on in-drift water flow and chemistry
- Chemistry modification by dust and deliquescence

VI. Waste package and drip shield corrosion

- Degradation of the Drip Shield
- Degradation of the Waste Package

VII. In-package environment, waste form degradation and solubility

- Water and chemistry evolution in the waste package
- Degradation of waste form
- Mobilization of radionuclides

VIII. Colloid transport

- Mobilization of radionuclides
- Transport to edge of waste package
- Transport to invert
- Transport to rock
- Unsaturated zone transport
- Saturated zone flow and transport

IX. EBS Transport

- Thermal effects on water flow and chemistry
- Transport to edge of waste package
- Transport to invert
- Transport to rock

X. Unsaturated zone transport

- Thermal effects on transport
- Unsaturated zone transport

XI. Saturated zone flow and transport

XII. Biosphere transport

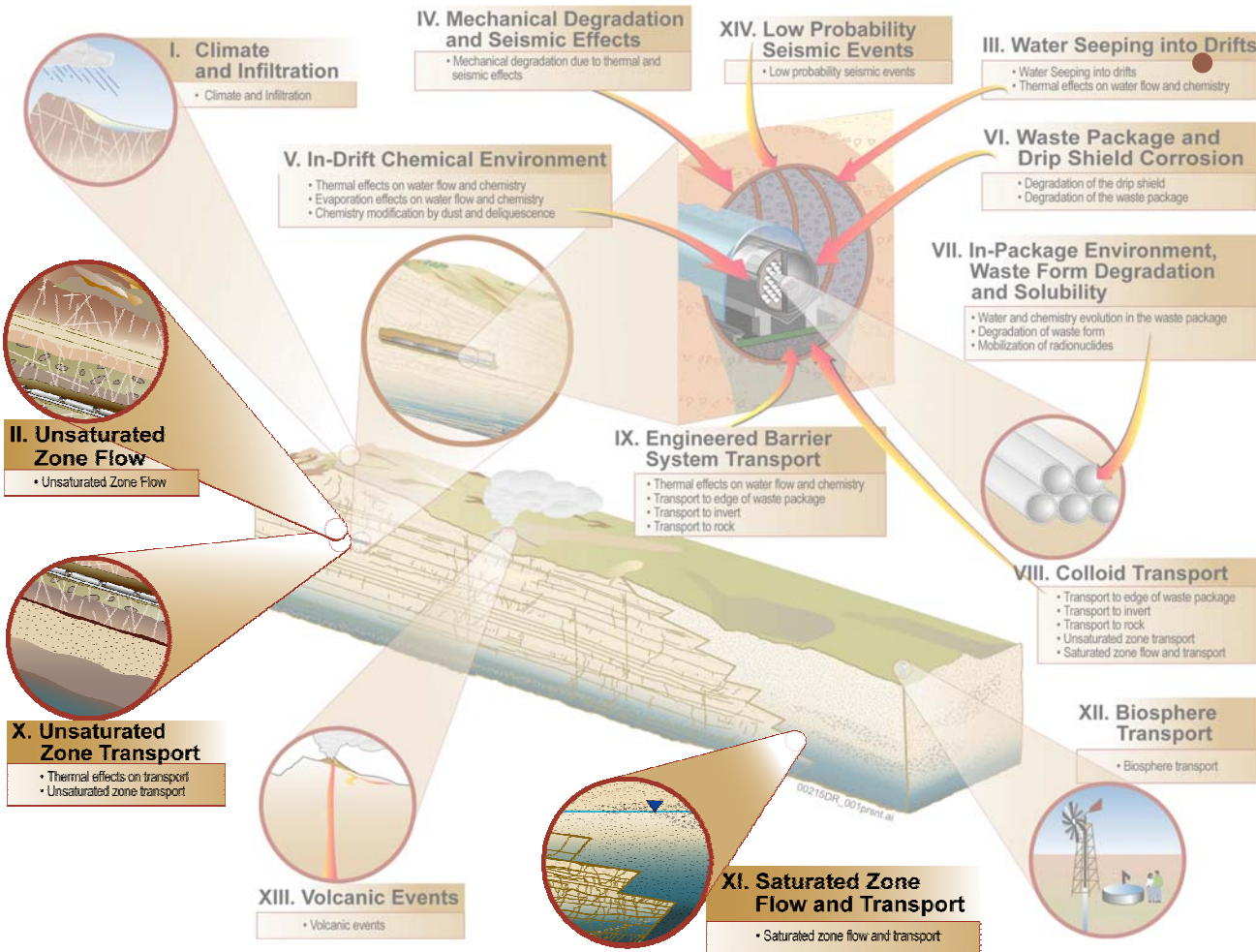
XIII. Volcanic events

XIV. Low probability seismic events

Conclusions

- **The Project is developing a set of Technical Basis Documents that describe the Yucca Mountain repository system components**
 - **The information in these documents provides a summary of the analyses (and their basis) that support the development of the postclosure safety case for the License Application**
 - **This information also responds to NRC/DOE Key Technical Issues (KTI) agreements related to each system component**
- **The goal of these documents is to provide a clear and transparent summary of the role of each component in the postclosure safety analysis and to respond to related KTI agreements in the context of this summary**
- **The Technical Basis Documents are planned to be delivered to NRC over the next 3 to 6 months**
 - **First ones are Biosphere, Saturated Zone and Colloids**

Introduction to Subsequent Briefings



This afternoon we will focus on three Technical Basis Documents that are under development:

II. Unsaturated Zone Flow

X. Unsaturated Zone Transport

XI. Saturated Zone Flow and Transport

Backup Slides

- **Technical Basis Documents are one vehicle for communicating with NRC staff the key aspects of the post closure performance assessment basis to be presented in the License Application**
- **They are also used as an integration tool for addressing Key Technical Issue Agreement responses**
- **The following slides map the Technical Basis Documents to:**
 - a. The Yucca Mountain Review Plan Model Abstraction groups**
 - b. The NRC Key Technical Issue groups**

Correlation of YMRP Abstraction Groups with Technical Basis Documents

YMRP Abstraction Group	Technical Basis Documents
1. Degradation of Engineered Barriers	VI. Waste package and drip shield Corrosion
2. Mechanical Disruption of Engineered Barriers	IV. Mechanical degradation and seismic effects XIV. Low Probability seismic effects
3. Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms	III. Water Seeping into drifts V. In-Drift chemical Environments VII. In-package environment
4. Radionuclide Release Rates and Solubility Limits	VII. Waste form degradation and solubility VIII. Colloids IX. EBS Transport
5. Climate and Infiltration	I. Climate and infiltration
6. Flow Paths in the Unsaturated Zone	II. Unsaturated zone flow
7. Radionuclide Transport in the Unsaturated Zone	X. Unsaturated zone transport
8. Flow Paths in the Saturated Zone	XI. Saturated zone flow and transport
9. Radionuclide Transport in the Saturated Zone	XI. Saturated zone flow and transport (see above)
10. Volcanic disruption of Waste Packages	XIII. Volcanic disruptive events
11. Airborne Transport of Radionuclides	XIII. Volcanic disruptive events (see above)
12. Concentration of Radionuclides in Ground Water	XI. Saturated zone flow and transport (see above)
13. Redistribution of Radionuclides in Soil	XII. Biosphere transport (see below)
14. Biosphere Characteristics	XII. Biosphere transport

Correlation of NRC Key Technical Issues with Technical Basis Documents

NRC Key Technical Issue	Technical Basis Documents
Unsaturated Flow and (USFIC)	I. Climate and Infiltration II. Unsaturated zone flow III. Water Seeping into Drifts IV. Saturated Zone Flow and Transport
Thermal Effects on Flow (TEF)	II. Unsaturated zone flow III. Water Seeping into Drifts IV. Mechanical degradation and seismic effects VII. In-package environment, waste form degradation and solubility
Repository Design and Thermal Mechanical Effects (RDTME)	IV. Mechanical degradation and seismic effects
Engineered Near Field Environment (ENFE)	III. Water Seeping into Drifts IV. Mechanical degradation and seismic effects V. In-Drift chemical environment VI. Waste package and drip shield corrosion VII. In-package environment, waste form degradation and solubility IX. EBS Transport
Container Life and Source Term (CLST)	IV. Mechanical degradation and seismic effects V. In-Drift chemical environment VI. Waste package and drip shield corrosion VII. In-package environment, waste form degradation and solubility
Radionuclide Transport (RT)	VIII. EBS Transport X. Unsaturated zone Transport XI. Saturated zone Flow and Transport XII. Biosphere Transport
Igneous Activity (IA)	XII. Biosphere Transport XIII. Volcanic Events
Structural Deformation and Seismicity (SDS)	IV. Mechanical Degradation and seismic effects XIV. Low Probability Seismic Effects
Total System Performance Assessment and Integration (TSPAI)	All, especially related to TSPAI 2.01 and 2.02