

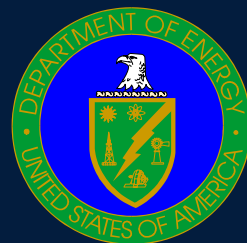


Work Remaining to Complete SR/LA

**Presented to:
Nuclear Waste Technical Review Board**

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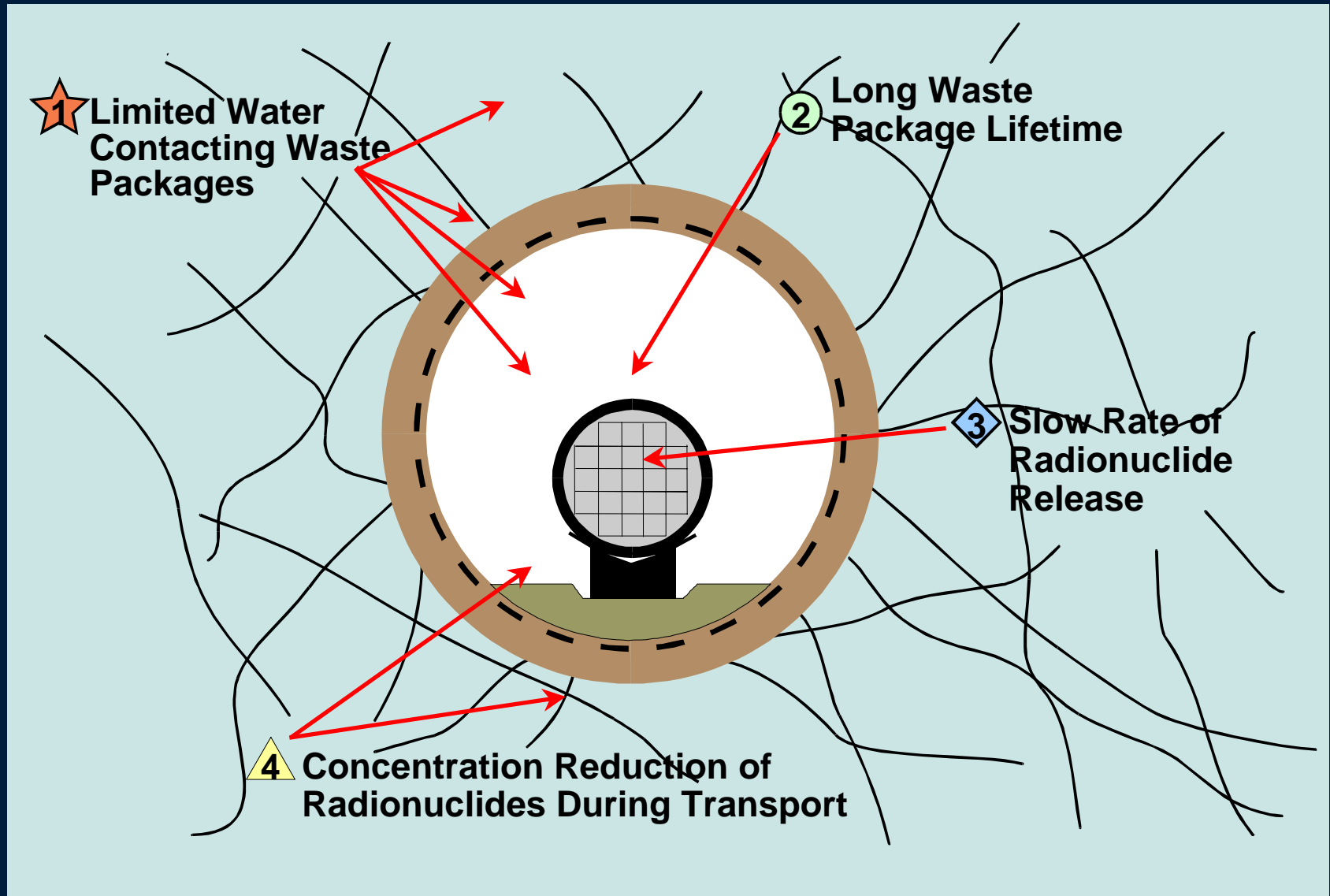


Information needs to reduce uncertainty in principal factors and design options

Alternative designs and design features

What we will know at SR/LA

Attributes of the Postclosure Repository Safety Strategy



Performance Allocation for Principal Factors and Design Options

Repository System Attributes	Principal Factors and Design Options	Priority For Technical Work
Limited water contacting waste packages	Precipitation and infiltration into the mountain	L
	Percolation to depth	L
	Seepage into drifts	L
	Effects of heat and excavation on flow	M
	Dripping onto waste package	L
	Humidity and temperature at waste package	L
	Water diversion by drip shield + backfill	H
Long waste package lifetime	Chemistry of water on waste package	L
	Integrity of outer carbon steel waste package barrier	L
	Integrity of inner corrosion-resistant waste package barrier	H
	Ceramic waste package coating	H
Low rate of release of radionuclides from breached waste packages	Seepage into waste package	L
	Integrity of spent fuel cladding	L
	Dissolution of uranium oxide and glass waste forms	L
	Neptunium solubility	L
	Formation of radionuclide-bearing colloids	M
	Transport through and out of waste package	L
Radionuclide concentration reduction during transport from the waste packages	Transport through unsaturated zone	M
	Flow and transport in saturated zone	M
	Dilution from pumping	L
	Biosphere dilution	L

Information Needs and Test/Analyses:

Water Diversion by Drip Shield and Backfill

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Limited water contacting waste packages	Precipitation and infiltration into the mountain	L
	Percolation to depth	L
	Seepage into drifts	L
	Effects of heat and excavation on flow	M
	Dripping onto waste package	L
	Humidity and temperature at waste package	L
	Water diversion by drip shield + backfill	H

Information Needs

- Flow properties of backfill
- Feasibility of design and emplacement
- Longevity

Tests and Analyses

- Test backfill/drip shield flow properties
- Material selection for drip shield
- Feasibility studies (prototype)
- Natural and man-made analogs

Information Needs and Test/Analyses: Effects of Heat and Excavation on Flow

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Limited water contacting waste packages	Precipitation and infiltration into the mountain	L
	Percolation to depth	L
	Seepage into drifts	L
	Effects of heat and excavation on flow	M
	Dripping onto waste package	L
	Humidity and temperature at waste package	L
	Water diversion by drip shield + backfill	H



Information Needs

- Moisture redistribution
- Effect on flow
- Mineral alteration/deposition

Tests and Analyses

- Drift-scale Heater Test
- Natural Analog Studies
- Modeling / testing mineral alteration
- Update drift-scale flow model

Information Needs and Test/Analyses: Integrity of Inner Corrosion - Resistant Waste Package

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Long waste package lifetime	Chemistry of water on waste package	L
	Integrity of outer carbon steel waste package barrier	L
	Integrity of inner corrosion-resistant waste package barrier	H
	Ceramic waste package coating	H

Information Needs

- Corrosion rate in crevices
- Thickness of oxide layer
- Phase transitions near grain boundaries

Tests and Analyses

- Corrosion testing under aggressive conditions
- Phase stability of CRM
- Model localized corrosion and phase stability

Information Needs and Test/Analyses: Ceramic Waste Package Coating

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Limited water contacting waste packages	Chemistry of water on waste package	L
	Integrity of outer carbon steel waste package barrier	L
	Integrity of inner corrosion-resistant waste package barrier	H
	Ceramic waste package coating	H

Information Needs

- Longevity
- Stability against phase transitions
- Long-term continuity of coating
- Reliability of spray coating
- Effects on underlying metal barrier
- Effectiveness of backfill protection

Tests and Analyses

- Review industrial experience
- Adhesive strength of coating and effect of thermal and handling loads
- Measure permeability and density
- Corrosion tests as function of thickness, structure, composition

Information Needs and Test/Analyses: Formation of Radionuclide - Bearing Colloids

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Slow release of radionuclides from breached waste packages	Seepage into waste package	L
	Integrity of spent fuel cladding	L
	Dissolution of uranium oxide and glass waste forms	L
	Neptunium solubility	L
	Formation of radionuclide-bearing colloids	M
	Transport through and out of waste package	L

Information Needs

Colloid stability under expected environmental conditions
 Sorption/desorption ratios
 Solubility constraints on colloid formation

Tests and Analyses

Laboratory studies of colloid formation and stability and their interactions with radionuclides

Information Needs and Test/Analyses: Transport Through Unsaturated Zone

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Radionuclide concentration reduction during transport from waste packages	Transport through unsaturated zone	M
	Flow and transport in saturated zone	M
	Dilution from pumping	L
	Biosphere dilution	L



Information Needs

- Lab tests of non-reversible sorption to colloids
- Filtration effects
- Advective and diffusive transport characteristics
- Better representation of fault zones and spatial variability

Tests and Analyses

- Lab tests
- Field tests at Busted Butte
- Evaluation of radionuclide transport at former DOE weapons facilities
- Update UZ flow and transport model to reflect new field data

Information Needs and Test/Analyses: Flow and Transport in Saturated Zone

Repository System Attributes	Principal Factors and Design Options	Priority for Technical Work Before LA
Radionuclide concentration reduction during transport from waste packages	Transport through unsaturated zone	M
	Flow and transport in saturated zone	M
	Dilution from pumping	L
	Biosphere dilution	L

Information Needs

- Large scale bulk flow characteristics
- Refined models
- Flux and particle velocity

Tests and Analyses

- Cross-hole tests
- Aquifer parameters in alluvial and tuff aquifers
- Local/regional model interface
- Tests in wells in carbonate aquifer down gradient from YM
- Analysis of hydrochemistry data
- Update model of transport in the SZ

Information needs to reduce uncertainty in principal factors and design options

Alternative designs and design features

Status at SR/LA

Information Needs: Design Alternatives and Features

- **The Repository Design Alternatives Working Group developed**
 - **5 design alternatives to the VA design**
 - **A list of design features - some are independent of any specific design alternative**
 - **Preliminary information needs for the design alternatives and features**

Related Information for the Enhanced Access Design Alternative Concept

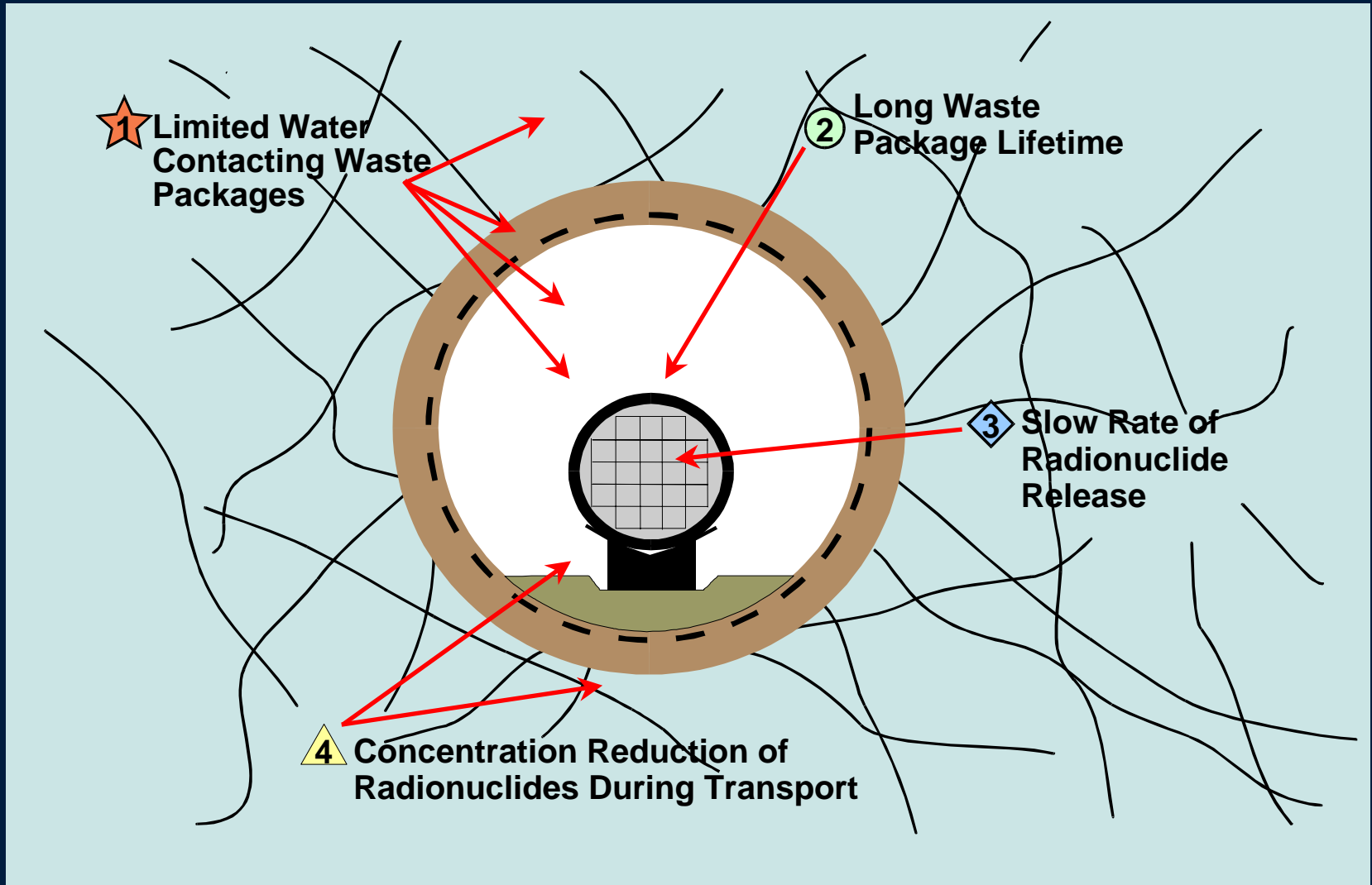
- 1. Selection of shielding material; production technologies, radiation levels and attenuation versus material thickness for different materials**
- 2. Parameters related to performance of shielding as corrosion allowance material, general pit and crevice corrosion**
- 3. Inspection technologies (including performance confirmation) in radiation environment, estimated system life and estimated maintenance schedule**
- 4. Viability of shielding as a drip shield**
- 5. Drift size, ground support, drift stability, time relationships, costs versus drift size for excavation and different ground support**
- 6. Enhanced access through shielded access vehicle, reliability, costs, survivability with breakdown in emplacement drift**

**Information needs to reduce uncertainty in
principal factors and design options**

Alternative designs and design features

Status at SR/LA

Attributes of the Postclosure Repository Safety Strategy



Limited Water Contacting Waste Packages: Water Diversion by Drip Shield and Backfill (H)

- **Performance of drip shields and backfill**
 - **Performance of ceramic coating**
 - **Sensitivity to uncertainty in hydrologic properties of backfill**
 - **Degradation over time**

Limited Water Contacting Waste Packages: Effects of Heat and Excavation on Flow (M)

- Improved models for heat and excavation effects on flow
 - Redistribution of moisture (boiling/recondensation)
 - Changes in flow properties
 - Fracture permeability changes above/below repository

Long Waste Package Lifetime: Integrity of Inner Corrosion Resistant Barrier (H)

- **Definition of range of environmental conditions for waste packages**
- **Selection of appropriate waste package materials in context of overall performance allocation**
 - **Improved understanding of thermal stability**
 - **Confirmation of model predictions for crevice chemistry as a function of time**
 - **Increased confidence in behavior of passive films under range of environmental conditions**
 - **Potential for repassivation understood**

Long Waste Package Lifetime: Ceramic Waste Package Coating (H)

- **Basis for claiming waste packages can be reliably coated with ceramic material**
- **Confidence ceramic coated packages can be safely handled without damage**
- **Confirmation of the permeability or impermeability of ceramic coatings**
- **Adequate basis for predicting corrosion behavior**
 - **Effect of defects**

Slow Release of Radionuclides from Waste Package: Formation of Radionuclide-Bearing Colloids (M)

- **Updated models for radionuclide-bearing colloid transport**
 - **Improved understanding of colloid stability under range of expected conditions**
 - **Effect of secondary phases, corrosion products and concrete degradation products**
 - **Sorption/desorption ratios**
 - **Solubility constraints on formation**

Radionuclide Concentration Reduction During Transport: Transport Through Unsaturated Zone (M)

- **Updated models of unsaturated zone transport**
 - **Improved understanding of transport characteristics for radionuclides and colloids**
 - **Improved representation of advective/diffusive transport**

Radionuclide Concentration Reduction During Transport: Flow and Transport in Saturated Zone (M)

- **Updated models of saturated zone transport**
 - **Some improvement in bulk flow characteristics**
 - **Improved interface for regional and local model**
 - **Additional confidence on flux and velocity estimates**

Status at SR/LA

- **Technical basis will be sufficient to support Site Recommendation/License Application**
 - **Site processes/conditions will be adequately characterized to establish environmental conditions (including ranges) for repository and waste package design**
 - **Repository and waste package designs that will be tailored to environmental conditions**
 - **Updated TSPA with sensitivity analyses that explicitly address remaining uncertainties**

Back Up

**Design Concepts, Design Features
and Related Information**

*Excerpts from Volume 4 of the Viability
Assessment*