




Repository Design Alternatives

Presented to:
Nuclear Waste Technical Review Board

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Introduction: Repository Design Alternatives

- The Reference Design, and features and alternatives under consideration are described in the VA
- Intent is to consider broad suite of alternative design features and repository designs
- Ultimate goal is to provide an acceptable repository design for SR and LA

Alternative Design Features Derived from Performance Criteria:

- Orientation, geometry, layout, and depth of the facility, and related barriers that contribute to isolation
- Safe operation of underground openings and retrievability option maintained
- Reduce potential for movement or fracturing
- Prevention and mitigation of releases
- Engineered barriers
- Thermal load
- Waste package
- Waste form criteria
- Other radioactive wastes
- Worker and operational safety
- Monitoring postclosure related behavior

Categories of Criteria

Alternatives Categories	Performance Related Criteria
Containment within the Engineered Barrier System	Engineered Barriers
	Waste Package
	Waste Form Criteria
	Other Radioactive Wastes
Other Engineered Enhancements	Orientation, Geometry, Layout, and Depth of the Underground Facility, and Facility Related Engineered Barriers that contribute to Containment and Isolation
	Reduce Potential for Deleterious Rock Movement or Fracturing Around Openings
Integrated Effects of Thermal Loading	Thermal Load
	Underground Facility Ventilation
Waste Package Production and Emplacement Operations	Worker Operational Safety
	Monitoring Postclosure Related Behavior
Deferred Closure	Safe Operation of Underground Openings and Retrievability Option Maintained

Design Features for Alternatives Categories

Category 1. Containment in EBS

- Waste package Materials
  - 1 Corrosion resistant material or 2 corrosion resistant materials
  - Ceramics
- Barriers
  - Drip Shield
  - Richard's Barrier
  - Diffusive Barrier or Getter under the WP
  - Backfill
- Internals
  - Canisterized assemblies
  - Additives/fillers
- Emplacement Mode
  - Angled (herringbone) horizontal ceramic lined borehole
  - Vertical Emplacement

Category 2. Other Engineered Enhancements

- Metal-lined drift
- Unlined drift
- Near-field rock treatment during construction
- Surface Modification
  - Alluvium
  - Drainage

Design Features for Alternatives Categories

(continued)

Category 3. Integrated Effects of Thermal Loading

- Waste Package Size
- Thermal Load
- Aging (pre-emplacement)
- Blending (for thermal or criticality considerations)
- Ventilation (pre and post closure)
- Waste Package Spacing (e.g., Line Load)
- Temperature Limits (cladding credit, zeolites, rock wall and surface temperatures)
- Rod Consolidation
- Backfill
- Drift Spacing
- Drift Diameter

Category 4. Waste package Production and Emplacement Operations

- Waste handling building waste package production line capacity and throughput
- Waste package closure/shield material thickness inter-relationships
- Waste package fabrication processes
- Emplacement Mode
- Accessibility to waste packages (shielding for personnel access; - self shielding)

Category 5. Retrieval Period and Deferred Closure

- Underground features, ground support and maintenance
- Timing of repository closure

Design Features

- Design features independent of specific alternative design were identified for each alternatives category
  - Could potentially improve performance for Reference Design or alternative design concept
- Design studies needed to investigate potential for performance enhancement

Design Features for Alternative Design Concepts

- Certain design features are best implemented in feature specific alternative design concepts
  - Generally reflect different layouts or a different basis for the disposal concept

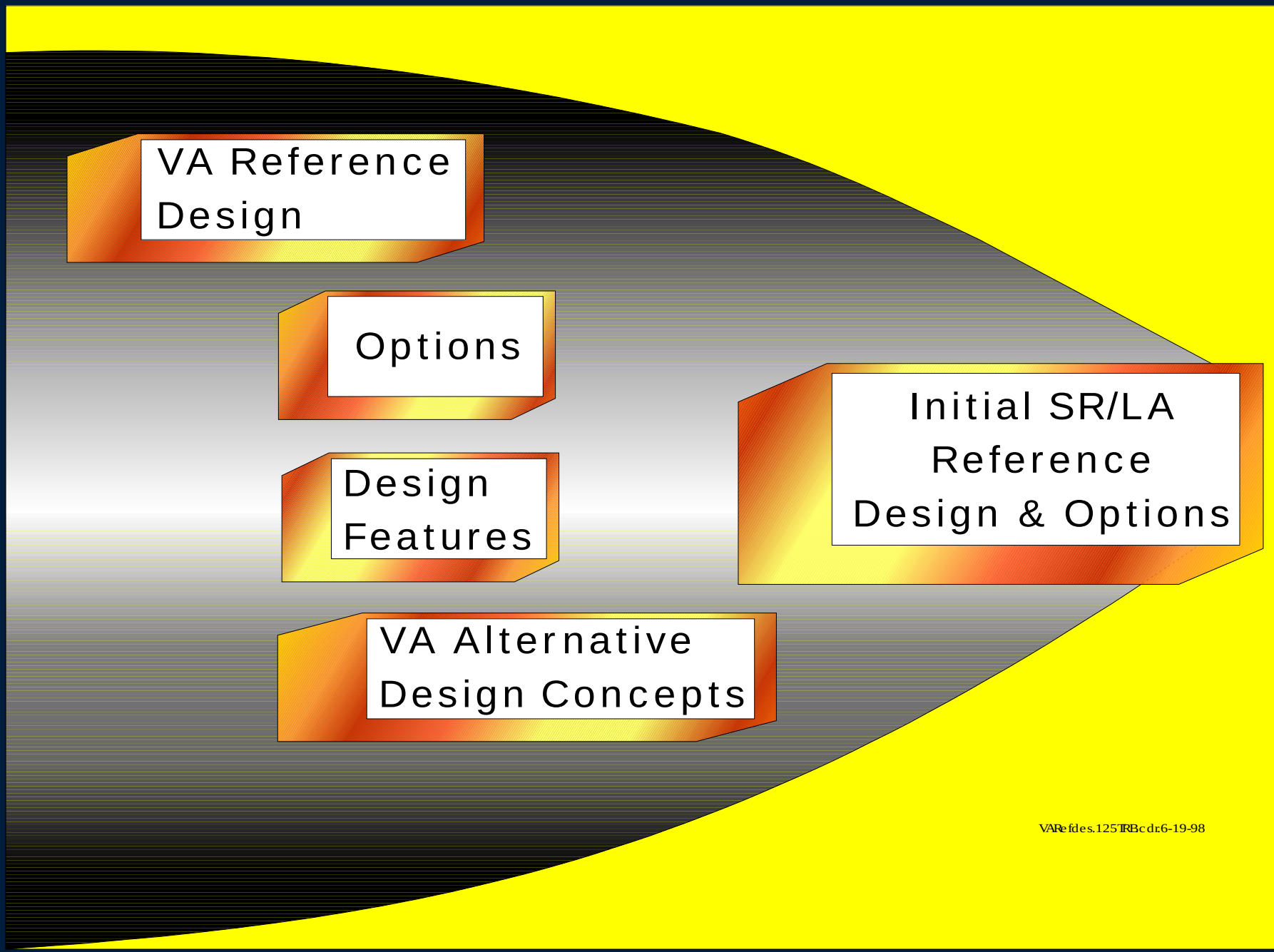
- Potential alternative design concepts that could be included in the Viability Assessment were identified

Alternative Design Concepts

- **Thermal Loading: Dictates area requirements, drift spacing, impact on zeolites, ground surface temperature**
- **Near-Field Thermal Limits: Dictates/influences waste package size, cladding temperature, drift diameter, waste package spacing**
- **Ventilation: Dictates drift layout, drift diameter, drift spacing**
- **Waste Emplacement Mode: Dictates/influences waste package size, waste package arrangements/spacing, drift diameter**

Viability Assessment Work Plans

- The VA will include descriptions of work plans for studies and evaluations of these features
- Design studies needed to evaluate performance and select reference design for SR/LA


VA Reference Design
Options
Design Features
VA Alternative Design Concepts
Initial SR/LA Reference Design & Options

Five Alternative Design Concepts

1. Waste Specific Containment Design

2. Low Thermal Load design

3. Continuous Ventilation Design

4. Enhanced Access Design

5. Modified Waste Emplacement Mode Design

1. Waste Specific Containment Design

- Unique container for each waste type
- Segregate waste into specific drifts designed to promote long-term survivability
- Surface facility design handles a number of different container types

Waste Specific Containment Design Concept

- **Surface Facility**
  - Possible need to handle assortment of container types
  - Possible need to support multiple production technologies
- **Subsurface Layout**
  - Layout similar to the Reference Design could be used
  - Also consider low thermal load configurations
- **Emplacement Drift-Scale Arrangement**
  - Within each drift, arrangement similar to the reference design
  - All containers in drift same type
  - Segregate wastes in areas selected to match performance characteristics suited to disposal of the fuel type
- **Waste package Configuration**
  - Each waste form would have its own container configuration

2. Low Thermal Load Design

- **Emplacement scheme limits emplacement drift rock temperature to less than 100°C**
- **Underground layout and surface facility design modified accordingly**

Low Thermal Load Repository Design Concept

- **Surface Facility**
  - Smaller capacity waste package likely
- **Subsurface Layout**
  - Layout would encompass 2,500 acres
  - Additional site characterization could be required
  - Area required possibly mitigated through ventilation
- **Emplacement Drift-Scale Arrangement**
  - Reference design configuration utilizing in-drift emplacement
  - Possibly reduce the drift size from Reference Design
- **Waste Package Configuration**
  - Desirable to reduce the maximum waste package capacity
  - Container would not be shielded for human access

3. Continuous Ventilation Design

- Continuous ventilation is provided during pre-closure
- Continued after human presence in the repository is discontinued

Continuous Ventilation Design Concept

- **Surface Facility**
  - **Surface facility design likely similar to Reference Design or low thermal load alternative design**
- **Subsurface Layout**
  - **Likely require several additional airshafts**
  - **Natural Ventilation Pressure (NVP) could supplement preclosure ventilation, and provide postclosure ventilation**
- **Emplacement Drift-Scale Arrangement**
  - **Arrangement likely similar to that of the VA reference design**
- **Waste Package Configuration**
  - **Configuration likely similar to that of the VA reference design**

4. Enhanced Access Design

- **Self-shielded Waste Package design**
- **Eliminates most underground remote handling operations**

Enhanced Access Design Concept

- **Surface Facility**
  - Potentially required to handle and close a thicker walled waste package needed for shielding
  - Likely the increased number of containers would require a higher throughput capability
- **Subsurface Layout**
  - Can employ a high thermal load
  - The ventilation requires several additional airshafts
- **Emplacement Drift-Scale Arrangement**
  - Temperature would be maintained at or below approximately 50°C
  - Radiation level would be low enough for human access
- **Waste Package Configuration**
  - Self-shielded container
  - Shielded transporter not required

5. Modified Waste Emplacement Mode Design

- Waste Packages emplaced in a configuration where the repository natural or engineered barriers provide shielding
- Includes vertical or horizontal emplacement in the floor or sidewall of the emplacement drift and trench emplacement in the floor

Modified Waste Emplacement Mode Design Concept

- **Surface Facility**
  - Likely small capacity containers
  - Likely increase in the total number of spent fuel containers
- **Subsurface Layout**
  - Low or moderate thermal loading could be used for this option
- **Emplacement Drift-Scale Arrangement**
  - Multiple possibilities for the emplacement mode
- **Waste Package Configuration**
  - Likely incorporate multiple barrier concept with smaller capacities

Summary

- VA describes design work to be completed between the VA and LA
  - Identified alternative design features and concepts as aid to develop work plans
- Work will continue into fiscal year 1999 to more fully develop the design features and alternatives
  - Performance predictions
  - Projected costs
- An initial design will be selected in FY 1999 to carry forward to support SR and LA
  - Based on strategies for design margin and defense in depth

Backup slides

Attributes Of The VA Reference Design

Surface Facility

- Waste handling facility has five parallel processing lines
  - Three handle commercial spent fuel that did not arrive in canister
  - Two handle wastes that are already in canisters
  - Throughput capacity for large waste package concept
    - » 500 to 550 waste packages per year

Attributes Of The VA Reference Design
(continued)

Subsurface Layout

- Thermal loading in what is considered a high range
  - Very low level of continuous ventilation after emplacement
  - Approximately 157 kilometers of drifting
  - Emplacement area totals approximately 741 acres
  - Layout can be developed in a single contiguous block
  - Two vertical airshafts and two ramps provide access from surface

Attributes Of The VA Reference Design
(continued)

Emplacement Drift-Scale Arrangement

- Waste Packages in a 5.5 meter diameter drift on metal supports
- Drifts are not backfilled at closure
- No postclosure ventilation is planned
- No human access is planned, under normal conditions

Waste Package Configuration

- Large Waste Packages with two metallic barriers
  - Capacity of 21 PWR or 44 BWR spent fuel assemblies
  - Smaller 12 PWR and 24 BWR containers are utilized for assemblies which exceed thermal or criticality
  - Waste Package not shielded for Personnel Access