Robert Browning/Michael Bell
MS 623SS

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PDR-1
LPDR-Wm-10(2)

Basalt Waste Isolation Project

Top-Level Strategy for Site Characterization

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2595

Strategy Team Members

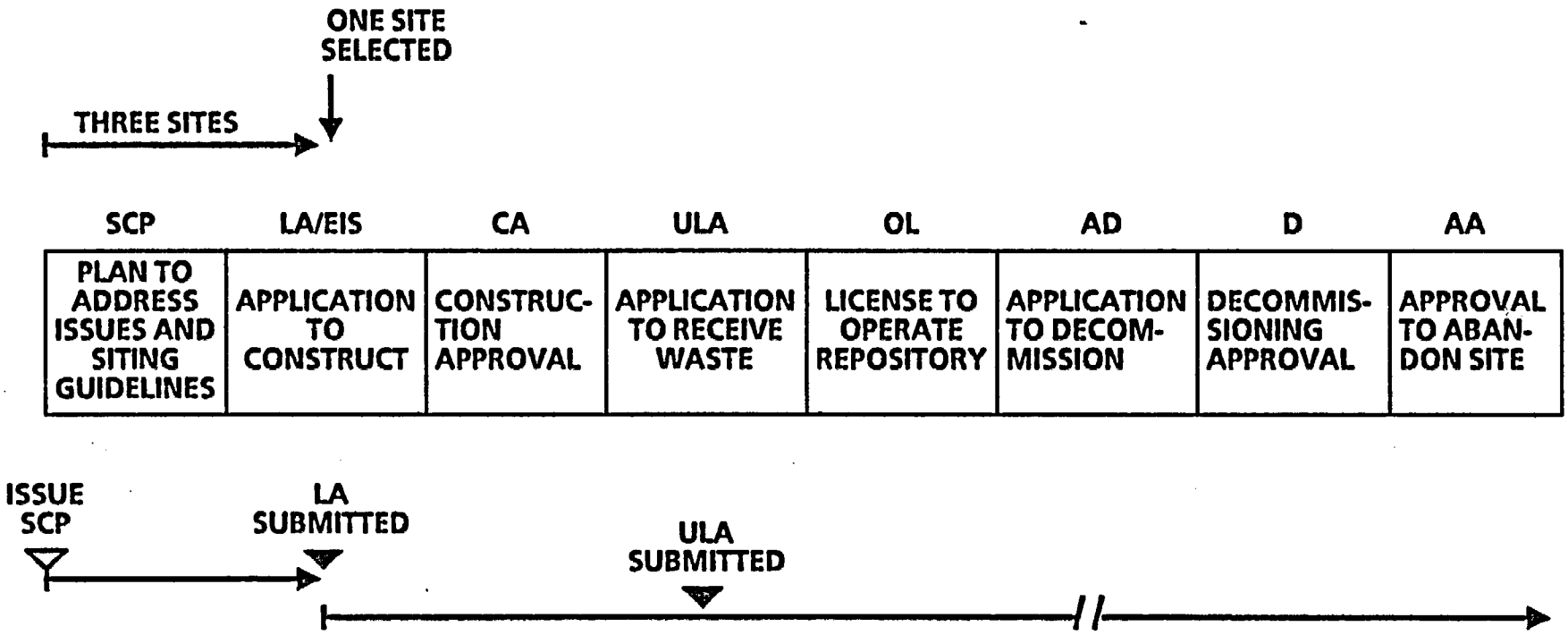
Westinghouse Personnel

- H. Babad - Principal Scientist
- J. D. Bazemore - Staff Engineer
- D. J. Brown - Chief Scientific Advisor
- J. A. Caggiano - Staff Scientist
- D. J. Carrell - Manager
- E. L. Fisk - Staff Engineer
- R. E. Gephart - Staff Hydrologist
- R. J. Gimera - Consultant
- D. I. Herborn - Principal Engineer
- E. H. Randklev - Staff Engineer
- B. Sagar - Principal Scientist

Presentation Summary

- Introduction
- Background
  - Timeline
  - Judgments, Assumptions, Philosophy
- Strategy Development
  - Mechanics
  - Matrix
  - Selection Process
- Recommended Strategy
- Conclusions

Strategy Timeline



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Key Documentation Requirements

SCP

- Must outline work that leads to high confidence that regulatory and technical issues can be resolved (+ or -)
- Top-level strategy helps to integrate issues approach

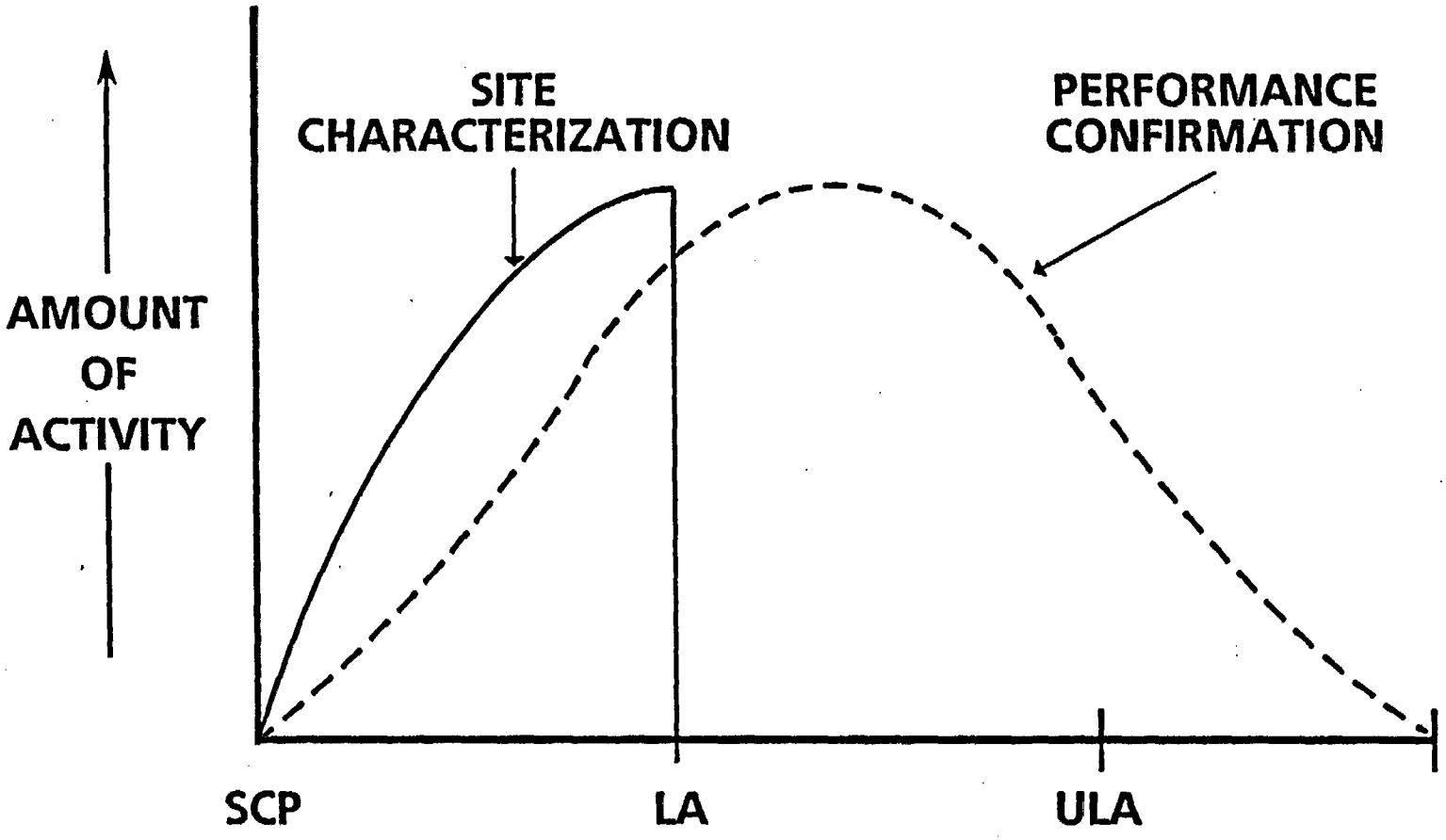
LA

- Must demonstrate that regulatory and technical issues can be resolved and EPA requirements can be met to allow construction of a repository

ULA

- Must demonstrate performance with sufficiently high confidence and enable the NRC to make a finding of reasonable assurance to allow receipt of waste

Characterization and Confirmation Transition



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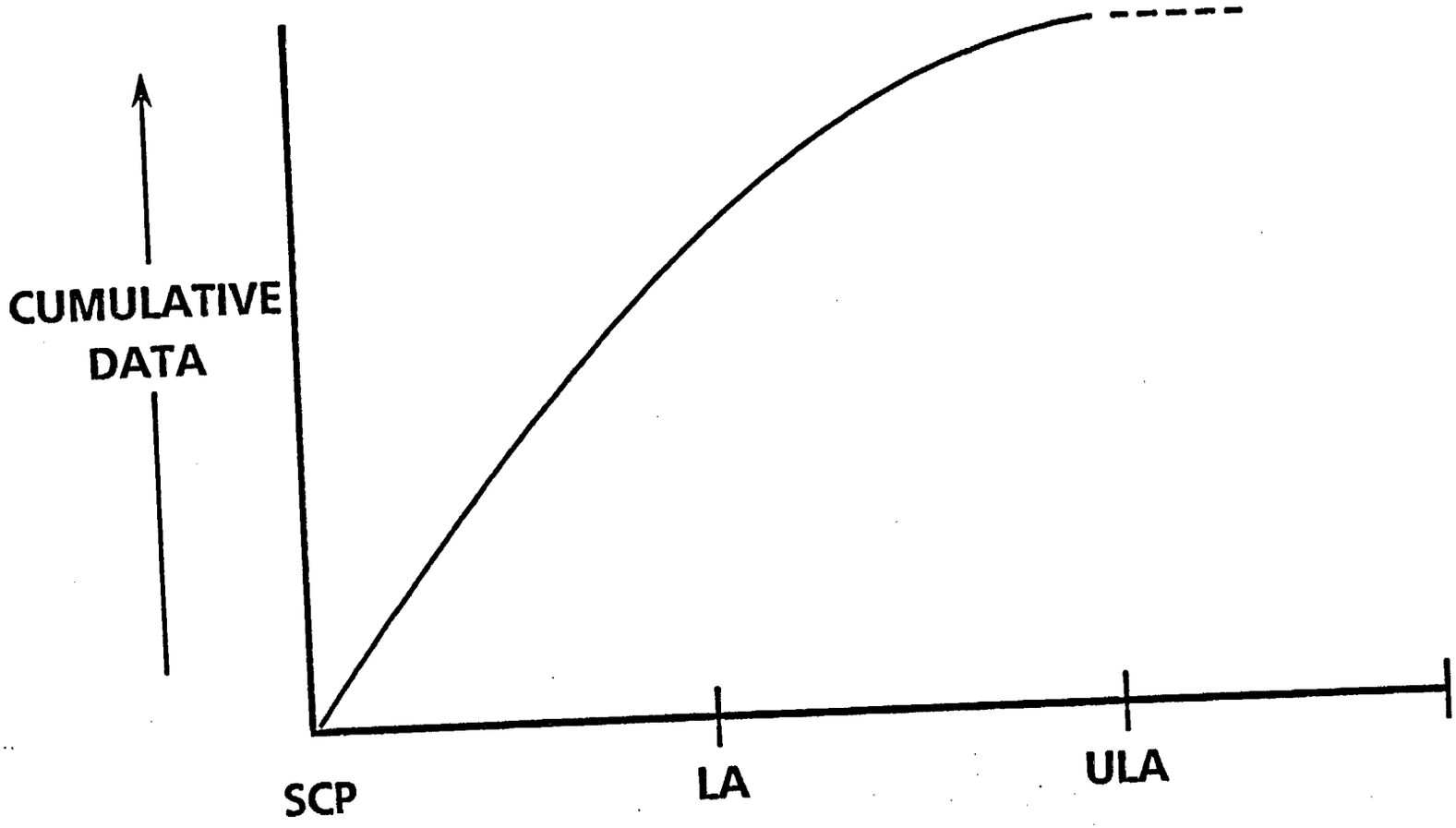
Characterization and Confirmation Transition (cont.)



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Judgments, Assumptions, Philosophy

- Due to concern for thermal period and short-lived isotopes, short-term containment should emphasize waste package performance
- Long-term isolation should emphasize natural system performance
- Compliance with NRC limits on site performance (i.e., EPA) and waste package containment are the most critical requirements
- Compliance with individual performance objectives on groundwater travel times and engineered barrier releases are subordinate
- Recommended case should take into account the synergism that exists between the natural and engineered systems
- Program should have flexibility in meeting EPA and NRC goals
- Full life-cycle cost was not considered, primary focus was on site characterization costs

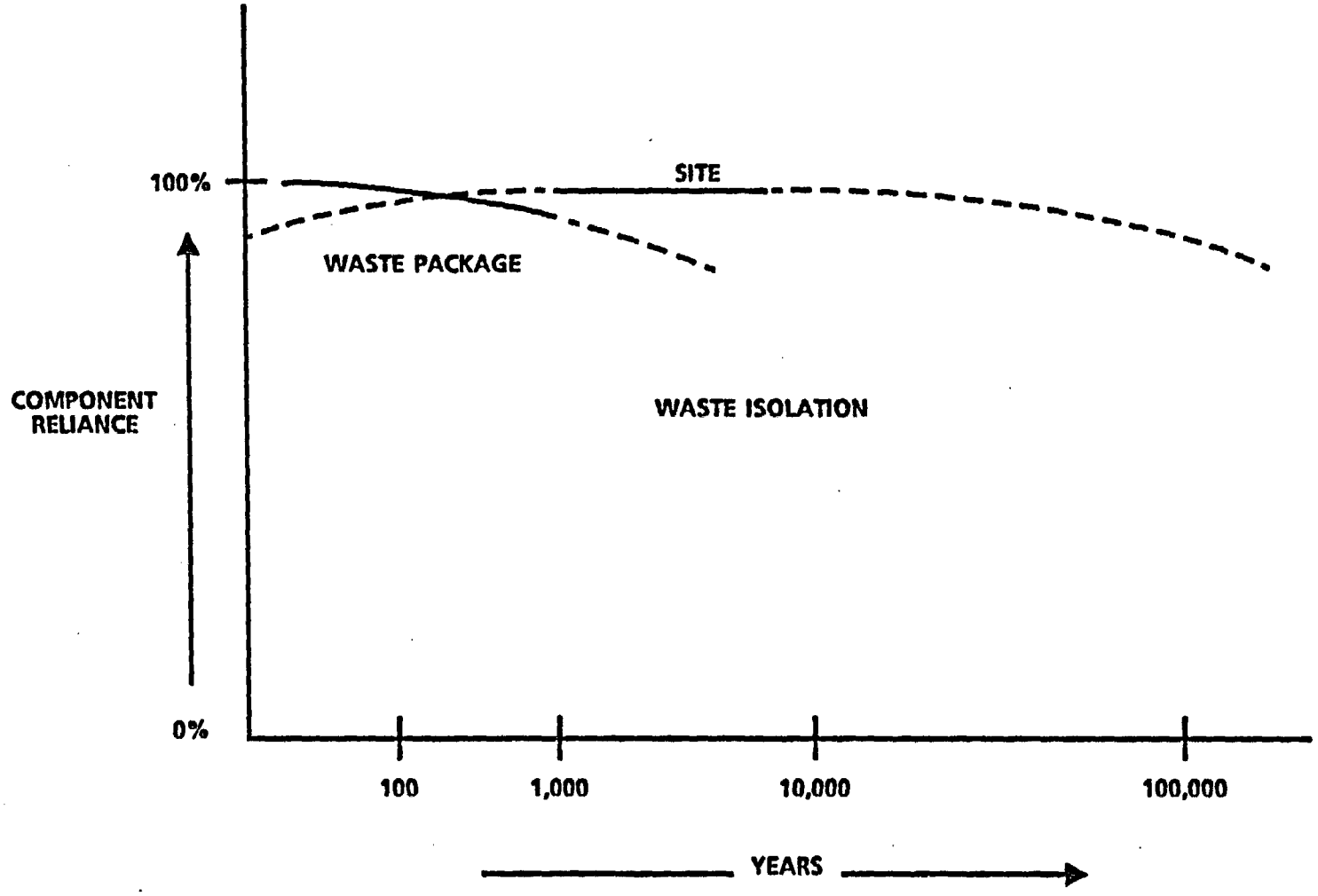
Judgments, Assumptions, Philosophy (cont.)

- The strategy must be supported by the relationship of the dominant and subordinate issues
- Subjective judgment of team members is sufficient to develop initial top-level strategies for management consideration
- Initially, the program will have simple models, limited data, and confidence levels ranging from low to high, but the level of reasonable assurance will be low. Program development should lead to more complex models, an extensive data base at relatively high confidence levels and the reasonable assurance level must be high
    - Where appropriate, confidence is defined as a quantitative measure that depends on:
        - Statistically distributed data (e.g., probability distribution functions)
        - Conceptual and verified analytical models

Judgments, Assumptions, Philosophy (cont.)

- Demonstrating reasonable assurance is a qualitative judgment that will depend on such concepts as:
  - Defense-in-depth using diverse barriers
  - Diverse testing methods for a parameter
  - Diverse analysis methods for predicting performance
  - Margin between predicted results and regulatory limits
  - Technical consensus

Balanced Performance



Top-Level Strategy Criteria

- Postclosure issues-strategy will require more data and understanding than the preclosure issues-strategy
- Issue-strategies require an integrated approach
- Compliance of total system performance to EPA requirements controls the program (i.e., resolution of Issue 1.1)
- Issue 1.9 will be addressed by separate analysis using the site characterization data base
- Program should be based on technical credibility and quality of work while minimizing schedule/cost impacts

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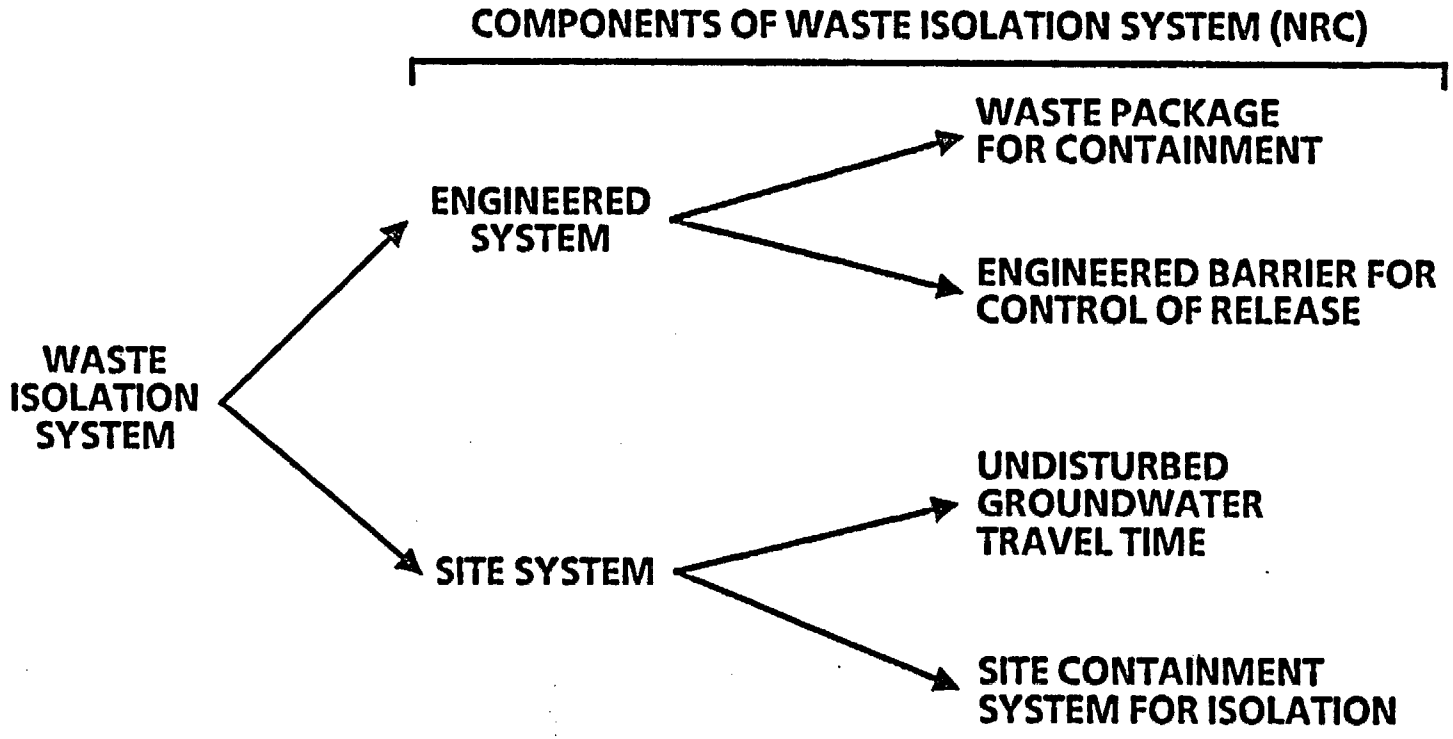
Process Used to Develop Strategy Options

- Identified components of waste isolation system
- Identified a performance measure for each component of matrix (row)
  - Waste package containment (time)
  - Engineered barrier release (rate)
  - Groundwater travel time (time)
  - Site containment (rock volume)
- Selected discrete values for each performance measure of matrix (column)
- Chose alternative strategies by selecting a combination of matrix cells and assigning confidence levels to the cells

Identification of Matrix Terms



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Strategy Matrix
Discrete Goals for Performance Measures

CONTAINMENT IN WASTE PACKAGE	C_1 300 yr (NRC MINIMUM, LESS THAN DOE DESIGN OBJECTIVE 1)	C_2 1,000 yr (NRC UPPER RANGE FOR MINIMUM, DOE DESIGN OBJECTIVE 1)	C_3 10,000 yr (MEETS EPA CONTAINMENT)	C_4 >>10,000 yr (NEAR STABLE MATERIAL)
RELEASE RATE FROM ENGINEERED BARRIERS* (10,000 yr)	R_1 1×10^{-3} INVENTORY/yr (NRC VARIANCE REQUIRED)	R_2 1×10^{-4} INVENTORY/yr (NRC VARIANCE REQUIRED)	R_3 1×10^{-5} INVENTORY/yr (NRC REQUIREMENT)	R_4 1×10^{-6} INVENTORY/yr (MORE STRINGENT THAN NRC REQUIREMENT)
PREEMPLACEMENT GROUNDWATER TRAVEL TIME	G_1 $\geq$1,000 yr (NRC REQUIREMENT)	G_2 5,000 yr (NRC REQUIREMENT PLUS MARGIN)	G_3 10,000 yr (MEETS 10 CFR 960 FAVORABLE CONDITION)	G_4 50,000 yr (MEETS 10 CFR 960 PLUS MARGIN)
SITE CONTAINMENT (LATERAL) (10,000 yr)	S_1 5 km (ACCESSIBLE ENVIRONMENT)	S_2 5-x km (BUFFER ZONE FOR PERFORMANCE MARGIN)	S_3 50 m (NOMINAL DISTURBED ZONE)	S_4 0 m (EDGE OF ENGINEERED BARRIER)
SITE CONTAINMENT (VERTICAL) (10,000 yr)	V_1 LAND SURFACE (960 m)	V_2 PRIEST RAPIDS (430 m)	V_3 VANTAGE INTERBED (140 m)	V_4 1st FLOW TOP (40 m)

*DOE DESIGN OBJECTIVES #2 AND #3 ARE APPLIED HERE AND ARE ALSO ONLY APPLICABLE TO A 1,000-yr CONTAINMENT PERIOD

Strategy Matrix
Discrete Goals for Performance Measures

CONTAINMENT IN WASTE PACKAGE	C_1	C_2 1,000 yr (NRC UPPER RANGE FOR MINIMUM, DOE DESIGN OBJECTIVE 1) (CONFIDENCE LEVEL = 90%)	C_3	C_4
RELEASE RATE FROM ENGINEERED BARRIERS* (10,000 yr)	R_1	R_2	R_3 1×10^{-5} INVENTORY/yr (NRC REQUIREMENT) (CONFIDENCE LEVEL = LOW)	R_4
PREEMPLACEMENT GROUNDWATER TRAVEL TIME	G_1	G_2 5,000 yr (NRC REQUIREMENT PLUS MARGIN) (CONFIDENCE LEVEL = LOW)	G_3	G_4
SITE CONTAINMENT (LATERAL) (10,000 yr)	S_1	S_2 5-x km (BUFFER ZONE FOR PERFORMANCE MARGIN) (CONFIDENCE LEVEL = 90%	S_3	S_4
SITE CONTAINMENT (VERTICAL) (10,000 yr)	V_1	V_2	V_3 VANTAGE INTERBED (140 m) (CONFIDENCE LEVEL = 90%)	V_4

*DOE DESIGN OBJECTIVES #2 AND #3 ARE APPLIED HERE AND ARE ALSO ONLY APPLICABLE TO A 1,000-yr CONTAINMENT PERIOD

Concept of Confidence Level in Terms of Probability

- Recommended strategy example

  $P\{C \geq 1{,}000\ yr \mid R_3, S_2, V_3 \text{ and model}\}^*$

  $P\{R \leq 1 \times 10^{-5}/yr \mid C_2, S_2, V_3 \text{ and model}\}^*$

  $P\{G \geq 5{,}000\ yr \mid S_2, V_3 \text{ and model}\}$

  $^*P\{\text{cumulative release at } S_2 \cap V_3 \leq 1 \text{ EPA limit} \mid C_2, R_3 \text{ and model}\}^*$

*Integrated approach to issues

Conclusions - Strategy Comparisons

- EPA site performance and NRC waste package containment were judged to deserve more effort and resources than requirements on release rates from engineered barriers and preemplacement site groundwater travel time
- Larger characterization cost and schedule impacts would result from increasing confidence levels in performance of natural versus engineered systems
- Reasonable assurance of isolation system performance was judged to be the most important attribute for strategy selection

Conclusions - Strategy Comparisons (cont.)

- The recommended strategy is preferred over that in the SCP because it integrates issues
- Extreme strategy cases have low probability of program acceptance
- The recommended case attempts to optimize:
  - Defense in depth
  - Balance between site and waste package
  - Program flexibility

Issue (Flow Diagram) for Top Level Strategy for Key Issue 1 (Issue 1.8 Emphasis)