U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: SUMMARY OF THREE STUDIES RELATED TO FUTURE DEVELOPMENT OF THE ESF
- Calico Hills System Study
- Calico Hills Early Access Option
- North Ramp Extension Alternative Activity

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SALT LAKE CITY, UTAH
JULY 11-12, 1995
Introduction

- The three activities were an effort by DOE to address
  - The need to reduce uncertainties associated with CHn performance and the ability to do so based on drilling and drifting
  - ESF operational and configuration options that would enhance access to areas of the proposed repository horizon and the CHn unit earlier than is currently planned
  - Major uncertainties, as defined by the waste isolation and containment strategy
Introduction
(continued)

- As a result, the activities
  - Provide a basis for the DOE to use in evaluating benefits of operational and configurational options for access to the western portion of the repository horizon and the CHn unit
  - Provide options for early access to the western repository block and CHn unit
Program Plan Schedules

Major Milestones

1996
- Complete MGDS ACD (3/97)
- Issue DEIS (9/98)
- Complete WP Title I Design (9/97)
- TSS Evaluation (9/98)
- Complete Daylight 1st GDF TBM at South Portal (5/97)
- Start NRE (6/98)
- Complete 2nd GDF Access (9/96)
- Complete Calico Hills Access (6/97)
- Complete NRE (9/98)
- Complete Calico Hills Access 2002
- Complete Calico Hills Access (2/00)
- Complete Calico Hills Access (9/97)

Complete WP Title II Design (9/00)
Complete LA (6/01)

Complete WP Title I (9/98) Design (9/97)
Complete Evaluation WP Title I (9/98)
Publish ROD (8/00)
Complete MGDS LAD (9/00)
Issue FEIS (8/00)

ESF Milestones

1996
- Complete 1st GDF Access (4/96)
- Daylight TBM at South Portal (5/97)
- Start NRE (6/98)
- Complete 2nd GDF Access (9/96)

2002
- Complete Calico Hills Access
- Complete Calico Hills Access 2002
- Complete Calico Hills Access (2/00)
Summary of Calico Hills Systems Study
Calico Hills System Study Approach

- Establish data needs from the CHn unit
  - Role of fracture and matrix flow
  - Water chemistry and rock properties (retardation properties)
  - Matrix diffusion

- Evaluate exploration options for accessing the CHn unit considering
  - Scientific understanding with additional data
  - Confidence in scientific understanding
  - Cost and schedule
  - Test interference and impact to waste isolation

- Assess benefits of acquiring data in the context of the remanded EPA standard and potential alternative standards
Calico Hills System Study Process

Characteristics That Could Impact CHn Performance

Data Needs Related To These Characteristics

Calico Hills Unit Features and Desirable Exploration Attributes (handed off to engineers for options)

Multi-Attribute Access Options

Utility Analysis

Scientific Understanding/Confidence

Access Options

Cost

Schedule

Qualitative

Test Interference, Waste Isolation Impacts, etc.
Relative Scientific Understanding

- CHn exploration options were evaluated
  - Multi-attribute utility analysis based on expert judgments
    » value of 22 tests for improving scientific understanding of seven processes, features, and events that could significantly impact performance of the CHn
    » ability of seven different exploratory alternatives to field the 22 tests
    » importance of the seven processes, features, and events that could significantly impact performance
Exploration Options

• Program Plan
  • Modified base case without boreholes
    – Moderate drifting option
    – Access from north ramp
    – Multiple fault accesses
  • Modified case with boreholes
  • Minimum excavation with boreholes
    – Minimal drifting option
    – Access from south portal
    – One fault accessed
Exploration Options
(Continued)

- Extensive excavation with boreholes
  - Targets all major faults within or adjacent to the repository footprint
  - Extensive north-south drifting
  - Significant east-west drifting
  - Access from south portal

- Extensive excavation accessing Ghost Dance fault at CHn prior to accessing at TSw

- Extensive excavation; includes raised base for second egress
Confidence in Scientific Understandings

- Developed five-step confidence scale "If additional data were to significantly change expectations of CHn performance, it would be:"
  - Not surprising - Level 1
  - Mildly surprising - Level 2
  - Surprising - Level 3
  - Very surprising - Level 4
  - Extremely surprising - Level 5
Relative Scientific Understanding with Assessment of Confidence

Confidence

| Opt. 5 - Ext Exc w BH | 3.65 |
| Opt. 3 - Mod Base Case w BH | 3.32 |
| Opt. 4 - Min Excavation w BH | 3.01 |
| Opt. 2 - Mod Base Case w/o BH | 2.10 |
| Opt. 1 - BH Only | 2.42 |

Date (Year Beginning)

Scientific Understanding


Current confidence 1.35
10,000-yr Total Release

- TSPA '93
- 90% fracture flow in CHn
- 90% fracture flow in TSw
- 90% fracture flow in SZ
- 90% fracture flow in CHn; 90% fracture flow in TSw; 90% fracture flow in SZ; 90%ile UZ flux

Total Normalized Release to Accessible Environment

Probability of Exceeding

- $10^{-6}$
- $10^{-5}$
- $10^{-4}$
- $10^{-3}$
- $10^{-2}$
- $10^{-1}$
- $10^{0}$
- $10^{1}$
- $10^{2}$
Expected-Value Dose History, 90% fracture flow in TSw & CHn

- $^{237}$Np
- $^{99}$Tc
- $^{129}$I
- $^{79}$Se

Dose at Accessible Environment (rem/yr)

Time (yrs)
Expected-Value Release History

$99m\text{Tc}$ Release at Accessible Environment (Ci/yr)

- TSPA '93
- 90% fracture flow in TSw
- 90% fracture flow in CHn
- 90% fracture flow in TSw; 90% fracture flow in CHn

Time (yrs)

20000 40000 60000 80000 100000

0 3 6 9 12 15
Summary of Conclusions of the Calico Hills Systems Study

- There is no technical imperative to further explore the CHn unit to demonstrate compliance with the remanded EPA standard.

- Demonstrating compliance with a hypothetical standard for peak doses during the next 10,000 years likely would require reducing uncertainties about the performance of repository-system elements.
Summary of Conclusions
(continued)

- Further exploration of the CHn unit would contribute little to a demonstration of compliance with a hypothetical standard for peak doses during the next 100,000 years or longer because calculated doses over such time are insensitive to CHn properties.

- Additional exploration would support improved estimates of probability distributions for Ground Water Travel Time (GWTT) to the accessible environment, but may not permit the establishment of a lower bound on GWTT.
Summary of Conclusions
(continued)

• It would not be surprising, or would be only mildly surprising, if individual expectations for the performance of the CHn unit were to change significantly as additional data are collected.

• Minimal drifting plus drilling (Option #4) would be required to reach a confidence level where it would be surprising if additional data were to significantly alter expectations of CHn performance.
Introduction to Calico Hills Early Access Option
Calico Hills Early Access Option
Background

- A viable option has been developed for early access to the CHn unit that would provide comparable information to that from Options 3 & 4 of the Calico Hills Systems Study

- The option utilizes a shaft east of the repository block and a western drift in the CHn unit
Summary of North Ramp Extension Alternatives Activity
North Ramp Extension Alternatives
Activity Background

• The activity focused on acquiring information in the western repository block prior to TSS to address
  – Representativeness
  – Geologic and hydrologic features
  – Major uncertainty

• Early access to the CHn unit was not addressed
North Ramp Extension Alternatives
Activity Approach

- Describe a set of ESF/NRE options, based on a common set of assumptions, that addresses an earlier completion of an east-west drift

- Establish a set of evaluation criteria that will discriminate among the ESF/NRE options and rank their relative importance

- Evaluate the options against the criteria, then rank the options by their weighted scores, establishing the preferred options
ESF - North Ramp Extension
Alternatives

- Proceed with current ESF configuration and Program Plan schedule. Develop NRE in 1998
  - 1A: Procure an 18 ft TBM for the NRE and CHn drifting
  - 1B: Consolidated design schedule

- Develop early NRE based on current ESF configuration
  - 2A: Start NRE using D&B techniques after 25 ft TBM turns south from north ramp
  - 2B: Start NRE after 25 ft TBM passes second Ghost Dance fault access and stops. Use roadheader.
  - 2C: Same NRE start as 2B but purchase 18 foot TBM
  - 2D: Same NRE start as 2A but lease 18 ft TBM and run two headings concurrently
ESF - North Ramp Extension Alternatives

(continued)

- Excavate western drift to the Solitario Canyon fault in central portion of block after 25 ft TBM passes the second access to GDF and stops. Excavate Calico Hills (18 ft TBM) prior to restarting main TBM
  - 3A: Excavate at the repository horizon
  - 3B: Excavate cross drift below the repository horizon
ESF - North Ramp Extension Alternatives

(continued)

• Maintain Base Case Configuration for TSW, less NRE
  – 4A: Initiate CHn unit drifting in Solitario Canyon using D&B and roadheader techniques
  – 4B: Add western drift to Base Case in the CHn. Initiate excavation after second access to GDF
  – 4C: Initiate excavation to the CHn after passing the curve at the bottom of the north ramp. Use dual headings
  – 5: South Ramp turns west instead of east. CHn configuration same as Base Case.
Criteria and Options Ranking

- **Criteria by order of importance:**
  - Primary testing requirement
  - Representativeness
  - Repository interface
  - Schedule
  - Cost
  - Cost/schedule impacts
  - Physical interference
  - Technical feasibility
  - Multiple use
  - Compliance with oversight concerns
  - Environmental impact
## Evaluation of Options Summary (3/31/95)

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Conclusions of the North Ramp Extension Alternatives Activity

- Early NRE using leased 18 ft TBM (Option 2D)
- Same configuration as base case
- Total cost - same as base case
- 18 ft and 25 ft TBM would operate concurrently (25 ft TBM may be held at 52+00, depending on funding)
- Begin/complete NRE - 1/96-6/96
- Daylight 25 ft TBM - 5/97 (unless deferred)
- Complete Calico Hills - 9/97 (depending on funding)
Results of the Three Studies

- Extensive drifting may not significantly enhance confidence or reduce uncertainty over limited drifting.
- Demonstrating CHn unit performance may be important, depending on the performance standard adopted by EPA and the amount of performance allocated to the CHn unit.
- The DOE has a set of options for drifting in the western block of the repository horizon and a viable option for drifting in the CHn that can provide information earlier than is currently scheduled in the Program Plan.
Calico Hills Systems
Study Background
Access Option Features/Attributes

<table>
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<tr>
<th>Access Option</th>
<th>Feature/Attribute</th>
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<tr>
<td></td>
<td>North-south distribution of features, properties &amp; conditions</td>
</tr>
<tr>
<td>Boreholes</td>
<td>✓ ✓ vert</td>
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</table>
| Extensive excavation  | ✓ ✓ ✓ horiz                                            | ✓ ✓ ✓ horiz                                            | ✓                         | ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ _.magnitude: 1.0
Modified Base Case Example

NORTH PORTAL

BOW RIDGE FAULT

SOUTH PORTAL

IMBRICATE FAULT ZONE

SUNDANCE FAULT

GHOST DANCE FAULT

CHN RAMP/DRIFT

SOLITARIO CANYON FAULT

GRAPHIC SCALE

167.68 m
(550)

167.68 ft
(550)

243.84 m
(800)

243.84 ft
(800)
Extensive Excavation Example
North Ramp Extension
Alternatives Background
ASSUMPTIONS

- Heater block testing will be initiated in TSW2 in early FY 97 (excavation of test area is complete in FY 96). The drift to TSW2 for heater block testing is separate from a NRE.

- Preclude Drill and Blast in central portion of the block.

- The NRE or east/west drift must be completed by May '98.

- To support TSS, there will be a total of 11 or 12 boreholes near or within the block:
  -- Concentrated along main drift.
  -- Less concentrated in the western portion of the block.

- Seismic studies will determine if any hidden major structures exist within the block.

- Ghost Dance Fault access is the top priority, followed by a NRE or east/west drift.

- Nonwelded tuff and vitrophyre must be segregated to meet environmental concerns.

- Daylighting the TBM at the South Portal is not a technical or programmatic requirement.

- A leased 18 ft TBM may result in significant savings (4-8 months) in construction of the NRE and CHn.
### COMPiled Rankings by Group Member

3-3-95

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<th>B</th>
<th>C</th>
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*Normalized Value to 10 (with 10 being the best)
ESF Layout
Options 1A, 1B, 2A, 2B, 2C, 2D
ESF Layout
Options 3A
ESF Layout Options 3B
Section A-A
Option 3B
ESF Layout
Options 4A
ESF Layout
Options 4B & 4C
Solitario Canyon Fault

Calico Hills Drifting

Ghost Dance Fault

Imbricate Fault Zone

Topopah Spring Main Drift

Drill Hole Wash Structure

North Ramp

Portal

ESF Layout Option 5

EXPSTUFA.CDR.124/4-3-95
## NORTH RAMP EXTENSION ALTERNATIVES

### COST ANALYSIS

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### SCHEDULE ANALYSIS

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**NOTES:**

1. All $ are given in FY1995 $.
2. Option 1A shows the actual $ required to design and construct the North Ramp Extension and Calico Hills.
10,000-yr Total Releases: Fracture Flow in CHn

Probability of Exceeding

0.01 0.1 1

Total Normalized Release to AE

$10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$ $10^{-2}$ $10^{-1}$ $10^{0}$ $10^{1}$ $10^{2}$

- 0% fracture flow in CHn
- 10% fracture flow in CHn
- 50% fracture flow in CHn
- 90% fracture flow in CHn
10,000-yr Total Releases: Fracture Flow in CHn

Probability of Exceeding

Total Normalized Release to AE