PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: PRECLOSURE PERFORMANCE ASSESSMENT

PRESENTER: DR. LESLIE JARDINE

PRESENTER'S TITLE AND ORGANIZATION: TECHNICAL PROJECT OFFICER
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LIVERMORE, CALIFORNIA

PRESENTER'S TELEPHONE NUMBER: (415) 423-5032

ARLINGTON, VIRGINIA
MAY 20-21, 1991
ELEMENTS OF PRESENTATION

- HISTORY OF REPOSITORY PRECLOSURE PERFORMANCE ASSESSMENTS

- GENERAL METHODOLOGY

- RESULTS OF METHODOLOGY APPLICATION
  - SURFACE FACILITIES
  - SOURCE TERMS
  - FEEDBACK TO DESIGN PROCESS

- OTHER APPLICATION RESULTS
  - UNDERGROUND FACILITIES
  - DOSE UNCERTAINTY ANALYSES

- CONCLUSIONS
SUMMARY OF ACCIDENT ANALYSES PERFORMED TO DATE FOR REPOSITORIES

- PRELIMINARY STUDIES OF POTENTIAL ACCIDENTS AT REPOSITORIES HAVE BEEN PERFORMED BY NUMEROUS ORGANIZATIONS

- ANALYSES HAVE EXAMINED VARIOUS SITES AND REPOSITORY FACILITY DESIGNS INCLUDING TUFF, BWIP, WIPP, SALT (GENERIC), AND SALT (DEAF SMITH)
SUMMARY OF ACCIDENT ANALYSES PERFORMED TO DATE FOR REPOSITORIES

- A LARGE VARIETY OF POTENTIAL ACCIDENTS HAVE BEEN ASSESSED INCLUDING:
  - EARTHQUAKES
  - FLOODS
  - TORNADOS
  - AIRCRAFT IMPACTS
  - UNDERGROUND NUCLEAR EXPLOSIONS (UNE)
  - HOIST CAGE DROPS
  - TRANSPORTER COLLISIONS/CRASHES
  - FUEL HANDLING ACCIDENTS
  - CRANE DROPS (CASK, CONTAINER, FUEL ASSEMBLY)

- ALL CATEGORIES OF EVENTS THAT HAVE SIGNIFICANT CONSEQUENCES HAVE LIKELY BEEN IDENTIFIED
SUMMARY OF ACCIDENT ANALYSES PERFORMED TO DATE FOR REPOSITORIES

- Potential offsite dose consequences are much less than reactors and reprocessing plants due to handling of aged spent fuel:
  - Less decay heat
  - Fewer short-lived, high specific activity gases or volatile isotopes
  - Less intrinsic energy available to disperse radioactive material
LWR'S:
FRACTION OF FULL POWER (THERMAL)
VS. TIME AFTER SHUTDOWN

TIME AFTER SHUTDOWN

FRACTION OF FULL POWER (THERMAL)

TIME AFTER SHUTDOWN (SECONDS)
LWR'S:
FRACTION OF FULL POWER (THERMAL)
VS. TIME AFTER SHUTDOWN

TIME AFTER SHUTDOWN

- YEARS
- DAYS
- HOURS

TIME AFTER SHUTDOWN (SECONDS)

- REACTORS
- REPROCESSING PLANT
- REPOSITORY

PREPA.125.NWTRB/5-20-91
HISTORY OF YUCCA MOUNTAIN PRECLOSURE
PERFORMANCE ASSESSMENTS: ACCIDENTS

1. TOTAL FACILITY: SLTR 86-1005 (6/86)
2. UNDERGROUND FACILITY: SAND 88-7061
3. ESF CONVERSION: SAND 88-7010 (8/88)
4. PRELIMINARY Q-LIST: SLTR 86-1008 (7/86)
5. Q-LIST UPDATE: ESF: SAND 89-7002, SAND 89-7024
6. SEISMIC (SEE NEXT PAGE)

REPOSITORY
CONCEPTUAL
DESIGN
1985

1991

7. AIRCRAFT SCENARIOS/CONSEQUENCES:
   SAND 90-7051, SLTR 87-7014
8. CRITICALITY EVALUATIONS: SLTR 87-7007 (5/88),
   SAND 89-7010
9. CONSEQUENCE UNCERTAINTY EVALUATION: SLTR 90-7002 (3/91)
10. PLATE OUT/DRY DEPOSITION: SLTR 87-7020
11. CONTAINER/FUEL ASSEMBLY DROPS: SAND 87-7082

NOTE: REPORTS ONLY

PREPA.125.NWTRB/5-20-91
HISTORY OF YUCCA MOUNTAIN PRECLOSURE
PERFORMANCE ASSESSMENTS: ACCIDENTS
(CONTINUED)

1. SEISMIC COST BENEFIT STUDY: SAND 88-1600 (3/89)
2. SEISMIC DESIGN STUDY: SLTR 87-7005 (11/87)
3. UNCERTAINTY ANALYSIS OF SEISMIC COST BENEFIT STUDY:
   SLTR 88-7012
4. WHB STRUCTURAL CAPACITY FOR FAULT DISPLACEMENTS:
   SLTR 87-7003 (11/87)
5. SEISMIC DESIGN MARGINS: SLTR 86-1018 (3/87)
6. LOAD COMBINATIONS/ALLOWABLE STRESSES WHB:
   SLTR 89-7002
7. SEISMIC MARGINS EVALUATION: SLTR 89-7005
8. SEISMIC JOINTS FOR WHB: SLTR 89-7008

9. SEE PREVIOUS PAGE

NOTE: REPORTS ONLY
ELEMENTS OF PRESENTATION

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 GENERAL METHODOLOGY

 RESULTS OF METHODOLOGY APPLICATION
  - SURFACE FACILITIES
  - SOURCE TERMS
  - FEEDBACK TO DESIGN PROCESS

 OTHER APPLICATION RESULTS
  - UNDERGROUND FACILITIES
  - DOSE UNCERTAINTY ANALYSES

 CONCLUSIONS
REPOSITORY DESIGN PROCESS

STEP 1: CONSTRUCT DESIGN BASES
STEP 2: DEVELOP FACILITY DESIGN
STEP 3: CONDUCT PERFORMANCE ASSESSMENT
STEP 4: REVISE DESIGN, IF NECESSARY, AND ITERATE
Repository Design Process

Scientific Investigations

Systems Engineering Process

NFER WFCR EMCR

SCP

Federal State Local

Design Codes Standards

Construct Design Bases

Feedback

Develop Facility Design

Conduct Performance Assessment

CD ACD

LAD FPCD

GR—WMSR SR, SDR ADR, WPDR
PRECLOSURE PERFORMANCE ASSESSMENT PROCESSES

- SYSTEMS MODELING & ANALYSES
- RADIOACTIVE RELEASE ANALYSES
- DOSE CONSEQUENCES ANALYSES
- REGULATORY COMPLIANCE ASSESSMENTS
PRECLOSURE METHODOLOGY

1. Development of Repository Compartments
2. Identification & Preliminary Screening of Initiating Events
3. Development of Event Trees (Accident Scenario Analysis)
4. Probability Assessment
5. Consequence Assessment
6. Quantify Event Trees
ELEMENTS OF PRESENTATION

- HISTORY OF REPOSITORY PRECLOSURE PERFORMANCE ASSESSMENTS

- GENERAL METHODOLOGY

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    - SURFACE FACILITIES
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- OTHER APPLICATION RESULTS
  - UNDERGROUND FACILITIES
  - DOSE UNCERTAINTY ANALYSES

- CONCLUSIONS
CENTRAL SURFACE FACILITIES AREA

- CENTRAL SUBSTATION & STANDBY GENERATOR
- MAIN SUBSTATION & STANDBY GENERATOR
- PERFORMANCE CONFIRMATION
- DECONTAMINATION
- WASTE HANDLING BLDG. #1
- WASTE HANDLING BLDG. #2
- WASTE TREATMENT
- GEOLOGIC REPOSITORY OPERATIONS AREA
- TRUCK PARKING AREA (216 TRUCKS)
- RAILCAR PARKING (70 CARS)
- VEHICLE WASH FACILITY
- MATCH LINE "A"
- MATCH LINE "B"

- WASTE RECEIVING AND INSPECTION AREA
- WASTE ENTRY
- SECURITY STATION #3

- FIRE STATION
- MEDICAL CENTER
- MOTOR POOL SERVICE STATION
- SECURITY STATION #1
- COMPUTER BLDG.
- ADMINISTRATION
- MOCK-UP

- GENERAL SUPPORT FACILITIES AREA
- SECURITY STATION #2/HEALTH PHYSICS STATION #3

- MATERIALS AND PERSONNEL ENTRY

- SECURITY STATION #4

- HEALTH PHYSICS STATION #4

- GATE 1
- GATE 2
- GATE 3
DEVELOPMENT OF EVENT TREES AND ACCIDENT SCENARIOS

• INTERNAL EVENTS
  - SCREENED OUT 46 INITIATING EVENTS
  - DEVELOPED 12 EVENT TREES INTO 58 SCENARIOS
  - DEVELOPED 16 FAULT DIAGRAMS

• EXTERNAL EVENTS
  - SCREENED OUT 45 INITIATING EVENTS
  - ONLY SEISMIC EVENT WAS EVALUATED FURTHER
  - DEVELOPED 9 EVENT TREES INTO 91 SCENARIOS
INTERNAL INITIATING EVENTS DEVELOPED INTO EVENT TREES
PART 1

COMPARTMENT AREA

- ACCESS AREA
- RECEIVING & INSPECTION AREA
- CASK RECEIVING & PREPARATION
- UNLOADING HOT CELL

INTERNAL INITIATING EVENT

- TRAIN FALLS OFF BRIDGE
- TRAIN COLLISION
- CRANE DROPS CASK
- CRANE DROPS FUEL ASSEMBLY
- CRANE DROPS DHLW CANISTER
- CONTAINER CUTTING MACHINE FAILURE
- MALFUNCTION OF CONSOLIDATION SYSTEM

CONSOLIDATION HOT CELL
INTERNAL INITIATING EVENTS
DEVELOPED INTO EVENT TREES
PART 2

COMPARTMENT AREA
- WHB TRANSFER TUNNEL
- PACKAGING HOT CELL
- SURFACE STORAGE VAULT

INTERNAL INITIATING EVENT
- TRANSFER/STORAGE CART ACCIDENT
- CRANE DROPS UNSEALED CONTAINER
- CONTAINER TRANSFER MACHINE (CTM) DROPS CONSOLIDATED FUEL CONTAINER
- CTM DROPS DHLW CONTAINER

UNDERGROUND EMPLACEMENT AREA
- RUNAWAY TRANSPORTER
REPOSITORY SOURCE TERMS

SPENT FUEL

- RELEASES OF GASES, VOLATILES, AND PARTICULATES:
  - FROM GAP WHEN CLADDING BREACHED
  - FROM PULVERIZATION DURING IMPACTS (BRITTLE FRACTURE)

VITRIFIED HIGH-LEVEL WASTE

- RELEASES OF PARTICULATES:
  - FROM PULVERIZATION DURING IMPACTS (BRITTLE FRACTURE)

- NO RELEASE OF GASES OR VOLATILES
# Repository Source Terms:
Potential Radionuclide Releases via Air Immersion and Inhalation Dose Pathways

<table>
<thead>
<tr>
<th>Gases</th>
<th>Volatiles</th>
<th>Particulates: Spent Fuel &amp; Glass</th>
</tr>
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<tr>
<td>Kr - 85</td>
<td>I - 129</td>
<td>Pu - 238, 239, 240, 241</td>
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<tr>
<td>H - 3</td>
<td>Cs - 134, 137</td>
<td>Am - 241</td>
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<tr>
<td>C - 14</td>
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<td>Sr - 90</td>
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<td>Cm - 244</td>
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<tr>
<td></td>
<td></td>
<td>Cs - 134, 137</td>
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<tr>
<td></td>
<td></td>
<td>Pm - 147</td>
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</tbody>
</table>
SUMMARY OF YUCCA MOUNTAIN ACCIDENT ANALYSES

RELATIVE RATIO OF DOSE RECEIVED BY CRITICAL ORGANS NORMALIZED TO THE ORGAN RECEIVING THE HIGHEST DOSE

- Thyroid: 0.002
- Lung: 0.01
- Red Bone Marrow: 0.08
- Liver: 0.21

RELATIVE RATIO NORMALIZED TO BONE SURFACE FOR 10 YEAR SPENT FUEL
PROMINENT ISOTOPIC CONTRIBUTORS TO BONE SURFACE DOSE FOR 10 YEAR AGED PWR SPENT FUEL

Pu239: 5.1%
Pu240: 8.4%
Pu238: 28.9%
Pu241: 23.7%
Am241: 25.8%
Cm244: 7.6%
Sr90: 0.21%
EVENT TREE FOR A CRANE DROPPING A FUEL ASSEMBLY IN THE UNLOADING HOT CELL

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<th>CLADDING RUPTURE</th>
<th>LOSS OF HVAC</th>
<th>FAILURE TO START</th>
<th>LOSS OF STANDBY</th>
<th>PROB. (YEAR⁻¹)</th>
<th>DOSE(mrem)</th>
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<tr>
<td></td>
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<td>HVAC</td>
<td>HVAC</td>
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<td>Kr85</td>
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<td></td>
<td></td>
<td></td>
<td>PARTICULATES</td>
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<td>GAP</td>
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<td>PULV.</td>
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</tbody>
</table>

| (1)           | 1(-8) | 7.4(-2) | 4.1(+1) | 6.3(+1) | 1.1(+2) |
| (2)           | 1(-9) | 7.4(-2) | 4.1(+1) | 6.3(+1) | 1.1(+2) |
| (3)           | 1(-6) | 7.4(-2) | 4.1(-3) | 1.4(-1) | 2.2(-1) |
| (4)           | 1(-1) | 7.4(-2) | 4.1(-3) | 1.4(-1) | 2.2(-1) |
| (5)           | 0.0   | 0.0     | 0.0     | 0.0     | 0.0     |

PREPA.125.NWTRB/5-20-91
SURFACE STORAGE VAULT: CTM DROPS
FUEL ROD CONTAINER

<table>
<thead>
<tr>
<th>CONTAINER BREACH</th>
<th>RADIATION ALARM FAILS</th>
<th>FILTRATION SYSTEM FAILS</th>
<th>PROBABILITY (1/YEAR)</th>
<th>TOTAL DOSE (mrem)</th>
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<tbody>
<tr>
<td>YES</td>
<td>5 x 10^-5</td>
<td>1 x 10^-3</td>
<td>2.5 x 10^-4</td>
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<tr>
<td>NO</td>
<td>1 x 10^-2</td>
<td></td>
<td>5 x 10^-10</td>
<td>230</td>
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<tr>
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<td></td>
<td></td>
<td>5 x 10^-7</td>
<td>0.22</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1 x 10^-2</td>
<td>0.0</td>
</tr>
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ACCIDENT ASSESSMENT RESULTS

OFFSITE DOSE (mrem)

- Symbols represent accident assessment results.
- The graph shows the distribution of offsite dose in mrem.
- Data points are marked with solid circles and open triangles.
DOMINANT SCENARIOS

<table>
<thead>
<tr>
<th>SYSTEM AREA</th>
<th>PROBABILITY/YEAR</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASK RECEIVING/</td>
<td></td>
<td>DROP CASK</td>
</tr>
<tr>
<td>PREPARATION</td>
<td>$5 \times 10^{-6}$</td>
<td>CRANE FALLS ON CASK</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-8}$</td>
<td>CASK FALLS ON CASK</td>
</tr>
<tr>
<td>UNLOADING</td>
<td>$1 \times 10^{-6}$</td>
<td>DROP FUEL ASSEMBLY</td>
</tr>
<tr>
<td>HOT CELL</td>
<td>$5 \times 10^{-7}$</td>
<td>STRUCTURE PIECE FALLS ON FUEL</td>
</tr>
<tr>
<td></td>
<td>$1 \times 10^{-6}$</td>
<td>EQUIPMENT FALLS ON FUEL</td>
</tr>
<tr>
<td>CONSOLIDATION</td>
<td>$5 \times 10^{-7}$</td>
<td>STRUCTURE PIECE FALLS ON FUEL</td>
</tr>
<tr>
<td>HOT CELL</td>
<td>$1 \times 10^{-6}$</td>
<td>EQUIPMENT FALLS ON FUEL</td>
</tr>
<tr>
<td>PACKAGING</td>
<td>$1 \times 10^{-6}$</td>
<td>DROP UNSEALED CONTAINER</td>
</tr>
<tr>
<td>HOT CELL</td>
<td>$1 \times 10^{-6}$</td>
<td>EQUIPMENT FALLS ON UNSEALED CONTAINER</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-7}$</td>
<td>STRUCTURE PIECE FALLS</td>
</tr>
<tr>
<td>HOT CELL TRANSFER TUNNEL</td>
<td>$5 \times 10^{-7}$</td>
<td>STRUCTURE PIECE FALLS ON FUEL</td>
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<tr>
<td>STORAGE VAULT</td>
<td>$3 \times 10^{-8}$</td>
<td>DROP SEALED CONTAINER</td>
</tr>
</tbody>
</table>

DOSE CONSEQUENCE (mrem)
PACKAGING HOT CELL
## Packaging Hot Cell Scenarios

<table>
<thead>
<tr>
<th>Initiating Event</th>
<th>Probability (Per Year)</th>
<th>Offsite Dose (mrem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane Load Drop</td>
<td>$1 \times 10^{-9}$</td>
<td>1100</td>
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<tr>
<td>Falling Equipment - Seismic</td>
<td>$1 \times 10^{-9}$</td>
<td>1100</td>
</tr>
<tr>
<td>Falling Structure - Seismic</td>
<td>$5 \times 10^{-7}$</td>
<td>300</td>
</tr>
</tbody>
</table>

PREPA 125.NWTRB/5-20-91
## Dominant Scenarios

<table>
<thead>
<tr>
<th>System Area</th>
<th>Probability/Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cask Receiving/Preparation</td>
<td>$5 \times 10^{-4}$</td>
<td>• Drop Cask</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-4}$</td>
<td>• Crane Falls On Cask</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-4}$</td>
<td>• Cask Falls On Cask</td>
</tr>
<tr>
<td>Unloading</td>
<td>$1 \times 10^{-4}$</td>
<td>• Drop Fuel Assembly</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls On Fuel</td>
</tr>
<tr>
<td></td>
<td>$1 \times 10^{-4}$</td>
<td>• Equipment Falls On Fuel</td>
</tr>
<tr>
<td>Consolidation</td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls On Fuel</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$1 \times 10^{-4}$</td>
<td>• Equipment Falls On Fuel</td>
</tr>
<tr>
<td>Packaging</td>
<td>$1 \times 10^{-4}$</td>
<td>• Drop Unsealed Container</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$1 \times 10^{-4}$</td>
<td>• Equipment Falls On Unsealed Container</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls On Fuel</td>
</tr>
<tr>
<td>Transfer Tunnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Vault</td>
<td>$3 \times 10^{-4}$</td>
<td>• Drop Sealed Container</td>
</tr>
</tbody>
</table>

### Dose Consequence (mrem)

```
<table>
<thead>
<tr>
<th>System Area</th>
<th>Probability/Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>Cask Receiving/Preparation</td>
<td>$5 \times 10^{-4}$</td>
<td>• Drop Cask</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-4}$</td>
<td>• Crane Falls On Cask</td>
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<tr>
<td></td>
<td>$5 \times 10^{-4}$</td>
<td>• Cask Falls On Cask</td>
</tr>
<tr>
<td>Unloading</td>
<td>$1 \times 10^{-4}$</td>
<td>• Drop Fuel Assembly</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls On Fuel</td>
</tr>
<tr>
<td></td>
<td>$1 \times 10^{-4}$</td>
<td>• Equipment Falls On Fuel</td>
</tr>
<tr>
<td>Consolidation</td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls On Fuel</td>
</tr>
<tr>
<td>Hot Cell</td>
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<td>• Equipment Falls On Fuel</td>
</tr>
<tr>
<td>Packaging</td>
<td>$1 \times 10^{-4}$</td>
<td>• Drop Unsealed Container</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$1 \times 10^{-4}$</td>
<td>• Equipment Falls On Unsealed Container</td>
</tr>
<tr>
<td></td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls</td>
</tr>
<tr>
<td>Hot Cell</td>
<td>$5 \times 10^{-7}$</td>
<td>• Structure Piece Falls On Fuel</td>
</tr>
<tr>
<td>Transfer Tunnel</td>
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<td></td>
</tr>
<tr>
<td>Storage Vault</td>
<td>$3 \times 10^{-4}$</td>
<td>• Drop Sealed Container</td>
</tr>
</tbody>
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CASK RECEIVING AND PREPARATION AREA

Figure ES-1
TUFF REPOSITORY
WASTE HANDLING BUILDING
ISOMETRIC SKETCH
## CASK RECEIVING AND PREPARATION AREA SCENARIOS

<table>
<thead>
<tr>
<th>INITIATING EVENT</th>
<th>PROBABILITY (PER YEAR)</th>
<th>OFFSITE DOSE (mrem)</th>
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</thead>
<tbody>
<tr>
<td>CRANE LOAD DROP</td>
<td>$5 \times 10^{-6}$</td>
<td>300</td>
</tr>
<tr>
<td>FALLING EQUIPMENT - SEISMIC</td>
<td>$5 \times 10^{-8}$</td>
<td>300</td>
</tr>
<tr>
<td>FALLING CASK - SEISMIC</td>
<td>$5 \times 10^{-8}$</td>
<td>300</td>
</tr>
</tbody>
</table>
RECOMMENDATIONS - TO DESIGN PROCESS

- DEVELOP DESIGN ALTERNATIVE TO ROTATING UNSEALED CONTAINER
- DEVELOP PASSIVE DESIGN ALTERNATIVE TO REMOVE 25 FOOT CASK IMPACTS
- CONSIDER POTENTIAL SEISMIC AND FLOOD EFFECTS WHEN SELECTING CASK IMPACT ALTERNATIVES
ELEMENTS OF PRESENTATION

- HISTORY OF REPOSITORY PRECLOSURE PERFORMANCE ASSESSMENTS

- GENERAL METHODOLOGY

- RESULTS OF METHODOLOGY APPLICATION
  - SURFACE FACILITIES
  - SOURCE TERMS
  - FEEDBACK TO DESIGN PROCESS

- OTHER APPLICATION RESULTS
  - UNDERGROUND FACILITIES
  - DOSE UNCERTAINTY ANALYSES

- CONCLUSIONS
# SUMMARY OF UNDERGROUND SCENARIOS WITH OFFSITE DOSE LARGER THAN 100 mrem AND PROBABILITY GREATER THAN 10^-9/YR

<table>
<thead>
<tr>
<th>AREA</th>
<th>INITIATING EVENT FOR SCENARIO</th>
<th>PROBABILITY (1/yr)</th>
<th>DOSE (mrem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDERGROUND FACILITIES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WASTE RAMP</td>
<td>• TRANSPORTER COLLISION WITH FIRE</td>
<td>5 x 10^-9</td>
<td>220</td>
</tr>
<tr>
<td>PERFORMANCE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONFIRMATION AREA</td>
<td>• CONTAINER FALLS</td>
<td>5 x 10^-4</td>
<td>110</td>
</tr>
<tr>
<td>WASTE MAIN</td>
<td>• TRANSPORTER COLLISION WITH FIRE</td>
<td>5 x 10^-9</td>
<td>220</td>
</tr>
<tr>
<td>PANEL ACCESS DRIFT</td>
<td>• TRANSPORTER COLLISION WITH FIRE</td>
<td>5 x 10^-9</td>
<td>220</td>
</tr>
<tr>
<td>EMBLACEMENT DRIFT</td>
<td>• TRANSPORTER COLLISION WITH FIRE</td>
<td>5 x 10^-9</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>• CONTAINER FALLS</td>
<td>5 x 10^-4</td>
<td>110</td>
</tr>
</tbody>
</table>

REFERENCES: 1. PROCEEDINGS OF HLW CONFERENCE, LAS VEGAS, (p. 370), 1990
2. SAND 88-7061
EXAMPLE FROM UNCERTAINTY ANALYSES: CRANE DROP IN PACKAGING HOT CELL

REFERENCE

CUMULATIVE PROBABILITY

90% : 2800 mrem

INITIAL RESULTS (1985): 1100 mrem

50% : 320 mrem

10% : 19 mrem

OFFSITE DOSE (REM)
UNCERTAINTY RESULTS FOR CRANE DROPPING A CONTAINER OF CONSOLIDATED FUEL IN THE PACKAGING HOT CELL

<table>
<thead>
<tr>
<th>CLADDING RUPTURE</th>
<th>FAILURE TO START</th>
<th>LOSS OF STANDBY</th>
<th>PROB. (PER YR)</th>
<th>PARTICULATE DOSE (mrem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>HVAC</td>
<td>HVAC</td>
<td>PROB. 1985 PRSA</td>
<td>10% 50% 90%</td>
</tr>
<tr>
<td></td>
<td>1 x 10⁻²</td>
<td>1 x 10⁻²</td>
<td>(1) 1 x 10⁻⁹</td>
<td>1 x 10³ 1.9 x 10³ 3.2 x 10³ 2.8 x 10³</td>
</tr>
<tr>
<td></td>
<td>1 x 10⁻⁵</td>
<td>1 x 10⁻³</td>
<td>(2) 1 x 10⁻¹⁰</td>
<td>1 x 10³ 1.9 x 10³ 3.2 x 10² 2.8 x 10³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3) 1 x 10⁻⁷</td>
<td>2.0 2.8 x 10⁻³ 1.2 x 10⁻¹ 2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(5) 0.0</td>
<td>0.0 0.0 0.0 0.0</td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PREPA.125.NWTRB/5-20-91
ELEMENTS OF PRESENTATION

- HISTORY OF REPOSITORY PRECLOSURE PERFORMANCE ASSESSMENTS

- GENERAL METHODOLOGY

- RESULTS OF METHODOLOGY APPLICATION
  - SURFACE FACILITIES
  - SOURCE TERMS
  - FEEDBACK TO DESIGN PROCESS

- OTHER APPLICATION RESULTS
  - UNDERGROUND FACILITIES
  - DOSE UNCERTAINTY ANALYSES

- CONCLUSIONS
CONCLUSIONS

• OFFSITE DOSES FROM PRECLOSURE ACCIDENTS AT YUCCA MOUNTAIN ARE NOT LIKELY TO EXCEED THE 500 mrem VALUE USED TO DEFINE IMPORTANT TO SAFETY IN 10 CFR 60.2

• PRA TECHNIQUES CAN BE USED IN A CONCEPTUAL DESIGN PROCESS TO HELP SELECT DESIGN ALTERNATIVES AND IMPROVE SAFETY MARGINS

• CONDUCTING PRA:s AT CONCEPTUAL DESIGN STAGE MINIMIZES COST AND SCHEDULE IMPACTS
**CONCLUSIONS**

(CONTINUED)

- TECHNIQUES FOR APPLYING PERFORMANCE ASSESSMENTS IN SUBSEQUENT, MORE DETAILED DESIGN STAGES REQUIRE DEVELOPMENT

- RESULTS FROM PERFORMANCE ASSESSMENTS ARE USED TO ESTABLISH:
  - DESIGN ALTERNATIVES/MODIFICATIONS
  - DESIGN BASES ACCIDENTS
  - Q-LIST
  - R&D PRIORITIZATIONS/NEEDS
  - NECESSARY SITE CHARACTERIZATION NEEDS
  - REGULATORY COMPLIANCE/STRATEGIES