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

PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: WASTE PACKAGE
DESIGN ASSESSMENTS - CRITICALITY AND STRUCTURAL ANALYSES

PRESENTER: DR. LESLIE JARDINE

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

MARCH 19-20, 1990
# POTENTIAL CONFIGURATIONS FOR CRITICALITY CALCULATIONS

<table>
<thead>
<tr>
<th>CONFIGURATION NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NOMINAL CONFIGURATION - DRY</td>
</tr>
<tr>
<td>2</td>
<td>NOMINAL CONFIGURATION - FLOODED</td>
</tr>
<tr>
<td>3</td>
<td>NOMINAL CONFIGURATION - PARTIAL FLOODING</td>
</tr>
<tr>
<td>4</td>
<td>STRUCTURE GONE - RODS UNIFORMLY SPACED - DRY</td>
</tr>
<tr>
<td>5</td>
<td>STRUCTURE GONE - RODS UNIFORMLY SPACED - FLOODED</td>
</tr>
<tr>
<td>6</td>
<td>CONTAINER PARTIALLY GONE - OPTIMAL REARRANGEMENT OF RODS - FLOODED</td>
</tr>
<tr>
<td>7</td>
<td>STRUCTURE AND CLAD GONE - PILE OF PELLETS - DRY</td>
</tr>
<tr>
<td>8</td>
<td>STRUCTURE AND CLAD GONE - PILE OF PELLETS - FLOODED</td>
</tr>
<tr>
<td>9</td>
<td>STRUCTURE AND CLAD GONE - PELLETS DISINTEGRATED TO POWDER - DRY</td>
</tr>
<tr>
<td>10</td>
<td>CLAD AND DISINTEGRATED PELLETS (POWDER) OPTIMALLY MIXED - FLOODED</td>
</tr>
<tr>
<td>11</td>
<td>STRUCTURE AND CLAD GONE - PELLETS DISINTEGRATED TO POWDER - FLOODED</td>
</tr>
</tbody>
</table>

**NOTES:** STRUCTURE IS DEFINED AS THE CONTAINER AND CANISTER; ANALYZED CONFIGURATIONS ARE SHOWN IN ITALICS

**REF:** UCRL-53595
CONFIGURATION 6 - PARTIAL CONTAINER FAILURE

- OPTIMUM ROD REARRANGEMENT
- FLOODED

Pitch = .561 in.

Container (space frame)
carbon steel

Fuel rods (close-packed triangular pitch)
# RESULTS OF CRITICALITY ANALYSES

<table>
<thead>
<tr>
<th>CONFIGURATION NUMBER</th>
<th>CONFIGURATION</th>
<th>FUEL ENRICHMENT (wt% U\textsuperscript{235})</th>
<th>$k_{\text{eff}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NOMINAL CONFIGURATION - DRY</td>
<td>4.5</td>
<td>0.37</td>
</tr>
<tr>
<td>2</td>
<td>NORMAL CONFIGURATION - FLOODED</td>
<td>4.5</td>
<td>0.69</td>
</tr>
<tr>
<td>6</td>
<td>CONTAINER PARTIALLY GONE - OPTIMAL REARRANGEMENT OF RODS - FLOODED</td>
<td>4.5</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>CLAD AND DISINTEGRATED PELLETS (POWDER) OPTIMALLY MIXED - FLOODED</td>
<td>4.5</td>
<td>1.16</td>
</tr>
</tbody>
</table>

CODE - KENO-IV

$k_{\text{eff}} =$ EFFECTIVE NEUTRON MULTIPLICATION FACTOR

REF: UCRL-53595
NUCLEAR CRITICALITY CONSIDERATIONS  
(10 CFR 131)

CONCLUSIONS

- MUST BE ALLOWED TO TAKE CREDIT FOR BURN-UP TO SATISFY REQUIREMENTS

- MAY NEED TO INCORPORATE POISONS INTO CONTAINER DESIGNS TO SATISFY REQUIREMENTS

- BOTH OF THESE ALTERNATIVES REQUIRE REGULATORY INTERACTIONS AND PERHAPS REGULATORY CHANGES
STRUCTURAL CONSIDERATIONS

- HANDLING & EMBOLACEMENT OPERATIONS
- RETRIEVAL OPERATIONS
- ACCIDENT ANALYSES
FINITE ELEMENT MESH FOR RETRIEVAL STRESS CALCULATION

Load

Canister center line

Canister assumed to be locked in borehole at this location
CALCULATED STRESS CONTOURS DURING RETRIEVAL

- 92,500 lb.
- 30,000 psi (max stress)
- 24,000 psi

Canister cross section
Canister center line

REF: UCRL-53595
CALCULATED CANISTER DEFORMATION FOR A SIMULATED DROP TEST

REF: UCRL-53595