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

PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: PERFORMANCE ASSESSMENT
OF YUCCA MOUNTAIN IN
SUPPORT OF THE COMPARATIVE
SITE ANALYSIS

PRESENTER: DR. PAUL GNIRK

PRESENTER'S TITLE AND ORGANIZATION: PRINCIPAL CONSULTANT
RE/SPEC INC.

PRESENTER'S TELEPHONE NUMBER: (505) 293-2000

MAY 16-17, 1989
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INTRODUCTION

- FROM SEPT. 1985 - MAY 1986, DOE CONDUCTED A COMPARATIVE EVALUATION OF 5 REPOSITORY SITES BY MULTIATTRIBUTE UTILITY ANALYSIS (DECISION-AIDING METHODOLOGY)

- PURPOSE OF COMPARATIVE EVALUATION WAS TO AID DOE IN THE SELECTION OF THREE SITES FOR CHARACTERIZATION FOR DEVELOPMENT AS THE FIRST REPOSITORY

- AFTER REVIEWING THE APPLICATION OF THE DECISION-AIDING METHODOLOGY ON THREE SEPARATE OCCASIONS, THE NAS-BOARD OF RADIOACTIVE WASTE MANAGEMENT ENDORSED THE APPLICATION IN A LETTER FROM FRANK PARKER TO BEN RUSCHE IN APRIL 1986
IN INTRODUCTION

(CONTINUED)

IN LATE MAY 1986, DOE SELECTED THREE SITES, INCLUDING THE YUCCA MOUNTAIN SITE, FOR DETAILED CHARACTERIZATION.

IN DECEMBER 1987, CONGRESSIONAL LEGISLATION DECREED THAT ONLY THE YUCCA MOUNTAIN SITE WOULD BE CHARACTERIZED.

THIS PRESENTATION WILL FOCUS ON THE POSTCLOSURE PERFORMANCE ASSESSMENT OF THE YUCCA MOUNTAIN SITE THAT WAS CONDUCTED IN SUPPORT OF THE DECISION METHODOLOGY APPLICATION, AND NOT ON THE COMPARATIVE EVALUATION ITSELF.
DEVELOPMENT OF TECHNICAL INFORMATION

METHODOLOGY LEAD GROUP AND TECHNICAL SPECIALISTS

STEP 1: ESTABLISH CHARACTERISTICS OF HOST-ROCK SETTINGS FOR SITES

STEP 2: ESTABLISH REPOSITORY AND SITE CHARACTERISTICS

STEP 3: IDENTIFY AND SCREEN POSTCLOSURE SCENARIOS

STEP 4: PERFORM POSTCLOSURE ANALYSES FOR EXPECTED CONDITIONS

STEP 5: PERFORM PRECLOSURE ANALYSES FOR EXPECTED CONDITIONS

APPLICATION OF MULTIATTRIBUTE UTILITY ANALYSIS

METHODOLOGY LEAD GROUP AND OGR MANAGEMENT

STEP 1: ESTABLISH SITING OBJECTIVES PER 10 CFR PART 960

STEP 2: DEVELOP INFLUENCE DIAGRAMS AND PERFORMANCE MEASURES

STEP 3: VERIFY INDEPENDENCE CONDITIONS AMONG PERFORMANCE MEASURES

STEP 4: DEVELOP SINGLE-ATTRIBUTE UTILITY FUNCTIONS

STEP 5: DETERMINE SCALING FACTORS

STEP 6: SCORE SITES AGAINST PERFORMANCE MEASURES

STEP 7: CALCULATE UTILITIES, CONDUCT SENSITIVITY STUDIES, AND RANK-ORDER SITES

METHODOLOGY LEAD GROUP
FACTORS THAT INFLUENCE NUMBER OF POSTCLOSURE HEALTH EFFECTS

(DOE/RW-0074)
POST-WASTE-EMPLACEMENT PERFORMANCE FACTORS FOR SITE

RADIONUCLIDE RELEASE FROM ENGINEERED BARRIER SYSTEM

MEASURE OF AMOUNT OF RADIONUCLIDES DISSOLVED INTO GROUND WATER DURING A SPECIFIED TIME PERIOD, BASED ON GROUND-WATER FLOW AND GROUND-WATER CHEMISTRY

$$F = \sum \frac{Q C_i}{R L_i}$$

WHERE:

$Q =$ TOTAL VOLUME OF GROUND WATER CONTACTING WASTE (CUBIC METERS PER 1,000 MTHM)

$C_i =$ MAXIMUM CONCENTRATION OF EACH KEY RADIONUCLIDE BASED ON SOLUBILITY, INVENTORY, ETC. (CURIES PER 1,000 MTHM)

$R L_i =$ RELEASE LIMIT FOR EACH RADIONUCLIDE BASED ON TABLE 1 OF APPENDIX A OF 40 CFR PART 191 (CURIES PER 1,000 MTHM)
POST-WASTE-EMPLACEMENT
PERFORMANCE FACTORS FOR SITE

(CONTINUED)

• RADIONUCLIDE TRANSPORT THROUGH NATURAL BARRIERS

— MEASURE OF TRAVEL TIME OF KEY RADIONUCLIDES THROUGH NATURAL BARRIERS FROM ENGINEERED BARRIER SYSTEM TO ACCESSIBLE ENVIRONMENT, BASED ON CHEMICAL AND PHYSICAL RETARDATION CHARACTERISTICS OF ROCK AND GROUND-WATER TRAVEL TIME

\[ T_i = R_i T \]

WHERE:

\( R_i \) = RETARDATION FACTOR FOR KEY RADIONUCLIDES (DIMENSIONLESS)

\( T \) = GROUND-WATER TRAVEL FROM ENGINEERED BARRIER SYSTEM TO ACCESSIBLE ENVIRONMENT (YEARS)
ILLUSTRATION OF RELATIONSHIP BETWEEN MEDIAN RADIONUCLIDE TRAVEL TIME AND FRACTION OF RELEASED RADIONUCLIDES REACHING ACCESSIBLE ENVIRONMENT

CUMULATIVE DISTRIBUTION WITH 100,000-YR MEDIAN

CUMULATIVE DISTRIBUTION WITH 200,000-YR MEDIAN

CUMULATIVE PROBABILITY, P(T ≤ t)

T_i, RADIONUCLIDE TRAVEL TIME (YEARS)
RELATIONSHIPS TO AID JUDGMENTAL ESTIMATION OF CUMULATIVE RELEASES TO THE ACCESSIBLE ENVIRONMENT DURING THE FIRST 10,000 YEARS AFTER REPOSITORY CLOSURE (DOE/RW-0074)

EXAMPLE COMBINATION OF SITE CHARACTERISTICS

<table>
<thead>
<tr>
<th>CUMULATIVE RELEASES</th>
<th>SCORE</th>
<th>WASTE FORM DISSOLUTION</th>
<th>KEY RADIONUCLIDE TRAVEL TIME</th>
<th>ESTIMATED RELEASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0001</td>
<td>10</td>
<td>EXTREMELY LOW</td>
<td>EXCELLENT</td>
<td>&lt;1</td>
</tr>
<tr>
<td>0.001</td>
<td>8</td>
<td>EXTREMELY LOW</td>
<td>VERY GOOD</td>
<td>~3</td>
</tr>
<tr>
<td>0.01</td>
<td>6</td>
<td>VERY LOW</td>
<td>GOOD</td>
<td>~10</td>
</tr>
<tr>
<td>0.1</td>
<td>4</td>
<td>LOW</td>
<td>GOOD</td>
<td>~30</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>HIGH</td>
<td>POOR</td>
<td>~100</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>EXTREMELY HIGH</td>
<td>VERY POOR</td>
<td>~1,000</td>
</tr>
</tbody>
</table>
CUMULATIVE RELEASES TO ACCESSIBLE ENVIRONMENT AS A FRACTION OF EPA RELEASE LIMITS FOR 10,000 YEARS

\( T_1 \) -- MEDIAN TRAVEL TIME OF KEY RADIONUCLIDES FROM EBS TO ACCESSIBLE ENVIRONMENT (YEARS)
GENERAL STEPS IN THE SCREENING AND DEVELOPMENT OF SCENARIOS
(DOE/RW-0074)

PRE-WASTE-EMPLACEMENT SITE CHARACTERISTICS AND CONDITIONS

PERTINENT PERFORMANCE MEASURES

ESTABLISH NOMINAL CASE

EXPECTED CHANGES TO SITE CONDITIONS

SITE FACTORS AFFECTING RELEASE FROM ENGINEERED BARRIER SYSTEM AND TRANSPORT THROUGH NATURAL BARRIERS

UNEXPECTED FEATURES AND DISRUPTIVE PROCESSES AND EVENTS

SCREEN FEATURES, PROCESSES, AND EVENTS IN TERMS OF IMPACTS ON SITE FACTORS

NEGligible IMPACT

SCREENED OUT

POSSIBLE IMPACT

SCREEN FEATURES, PROCESSES, AND EVENTS IN TERMS OF PROBABILITY OF OCCURRENCE

NEGligible PROBABILITY

SCREENED OUT

PROBABILITY > 10^-4 IN 10,000 YR.

CONSTRUCT SET OF POTENTIALLY SIGNIFICANT SCENARIOS
PHENOMENA THAT ARE POTENTIALLY RELEVANT TO RELEASE SCENARIOS (DOE/RW-0074)

EXPECTED CONDITIONS

- Brine-inclusion migration
- Buoyancy and convective cells
- Changes in rock characteristics
- Climate changes
- Corrosion
- Diagenesis
- Geochemical changes
- Geohydrology changes
- Localized rock fracturing
- Sea-level changes
- Thermal effects
- Thermomechanical effects

UNEXPECTED FEATURES

- Extreme changes in rock characteristics, geo-hydrology, or geo-chemistry, induced by excavation or heat generated by waste
- Undetected features, such as faults, shear zones, breccia pipes, dikes, gas pockets, boreholes
PHENOMENA THAT ARE POTENTIALLY RELEVANT TO RELEASE SCENARIOS (DOE/RW-0074)

DISRUPTIVE PROCESSES AND EVENTS

- BRINE POCKETS
- DEPOSITION
- DIAPIRISM
- DISSOLUTION
- EPEIROGENY
- EROSION
- METEORITE IMPACT
- SEVERE-WEATHER PHENOMENA
- SURFACE-WATER CHANGES
- TECTONIC ACTIVITY
  - FAULTING
  - MAGMATIC ACTIVITY
- HUMAN INTERFERENCE
  - DRILLING
  - GROUND-WATER WITHDRAWAL
  - INJECTION
  - IRRIGATION
  - MILITARY ACTIVITIES
  - MINING
  - RECHARGE
  - UNDERGROUND STORAGE
- PREMATURE FAILURE OF WASTE PACKAGES
- INCOMPLETE SEALING OF THE SHAFTS AND THE REPOSITORY
# POSTCLOSURE SCENARIOS FOR THE YUCCA MOUNTAIN SITE (DOE/RW-0074)

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>PROBABILITY (in 10,000 yrs)</th>
<th>EXPECTED CONSEQUENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPECTED CONDITIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNEXPECTED FEATURES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXTRUSIVE MAGMATIC EVENT DURING FIRST 500 YEARS</td>
<td>0.8 TO 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10^{-10} TO 0.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10^{-10} TO 10^{-6}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10^{-10} TO 10^{-4}</td>
<td></td>
</tr>
<tr>
<td>REPOSITORY-INDUCED DISSOLUTION OF HOST ROCK</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>ADVANCE OF A DISSOLUTION FRONT</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>LARGE FAULT MOVEMENT INSIDE CONTROLLED AREA BUT OUTSIDE REPOSITORY</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>SMALL-FAULT MOVEMENT INSIDE CONTROLLED AREA BUT OUTSIDE REPOSITORY</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>SMALL-FAULT MOVEMENT WITHIN REPOSITORY</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>SMALL-FAULT MOVEMENT OUTSIDE CONTROLLED AREA</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>LARGE-FAULT MOVEMENT OUTSIDE CONTROLLED AREA</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>INTRUSIVE MAGMATIC EVENT</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>LARGE-SCALE EXPLORATORY DRILLING</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>SMALL-SCALE EXPLORATORY DRILLING</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
<tr>
<td>FAILURE OF SHAFT AND REPOSITORY SEALS</td>
<td>NOT CREDIBLE</td>
<td></td>
</tr>
</tbody>
</table>
## SOLUBILITY FACTORS FOR SPENT FUEL IN THE SUBSURFACE ENVIRONMENT AT THE YUCCA MOUNTAIN SITE

(DOE/RW-0074)

### Radionuclide Solubility Limit (PPM)

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Solubility Limit (PPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-14, Tc-99, I-129 Cs-135</td>
<td>LARGE</td>
</tr>
<tr>
<td>Np-237, Sr-90 WASTEFORM (UO$_2$) Ra-226</td>
<td>MODERATE TO SMALL (&lt;1,000 TO 1)</td>
</tr>
</tbody>
</table>

### Fractional Release Time Period (Years)

<table>
<thead>
<tr>
<th>Time Period (Years)</th>
<th>Fractional Release (PER m$^3$ OF gw PER 1,000 MTHM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 TO 1,000</td>
<td>5.3 X 10$^{-4}$</td>
</tr>
<tr>
<td>1,000 TO 10,000</td>
<td>2.2 X 10$^{-4}$</td>
</tr>
<tr>
<td>10,000 TO 100,000</td>
<td>9.4 X 10$^{-6}$</td>
</tr>
</tbody>
</table>
SITE CHARACTERISTICS AND PERFORMANCE FACTORS FOR EXPECTED CONDITIONS AT YUCCA MOUNTAIN (DOE/RW-0074)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RANGE OF PARAMETER VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Q</strong> - VOLUME OF WATER AVAILABLE FOR DISSOLUTION OF WASTE (m³/1,000 MTHM)</td>
<td>0 TO 44,000</td>
</tr>
<tr>
<td>( \sum \frac{C_i}{RL_i} ) (1,000 MTHM/m³)</td>
<td>2.2x10⁻⁸ TO 2.2x10⁻⁴</td>
</tr>
<tr>
<td><strong>F</strong> - RADIONUCLIDE RELEASE FROM ENGINEERED BARRIER SYSTEM*</td>
<td>0.001 TO 9.7</td>
</tr>
<tr>
<td><strong>T</strong> - MEDIAN GROUND-WATER TRAVEL TIME (YEARS)</td>
<td>42,000 TO 200,000</td>
</tr>
<tr>
<td><strong>R</strong> - RETARDATION FACTOR</td>
<td>100 TO 1,000</td>
</tr>
<tr>
<td><strong>T_i</strong> - MEDIAN RADIONUCLIDE TRAVEL TIME (YEARS)</td>
<td>4.3x10⁶ TO 2x10⁸</td>
</tr>
<tr>
<td><strong>WASTE PACKAGE LIFETIME (YEARS)</strong></td>
<td>3,000 TO 30,000</td>
</tr>
</tbody>
</table>

* MULTIPLE OF EPA RELEASE LIMITS FOR 10,000 YEARS
ESTIMATED RADIONUCLIDE RELEASES TO ACCESSIBLE ENVIRONMENT FROM YUCCA MOUNTAIN REPOSITORY (DOE/RW-0074)

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>JUDGEMENT</th>
<th>PROBABILITY</th>
<th>RADIONUCLIDE RELEASES *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 TO 10,000 YEARS</td>
</tr>
<tr>
<td>EXPECTED CONDITIONS</td>
<td>HIGH</td>
<td>~1</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>BEST JUDGEMENT</td>
<td>0.98</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>LOW</td>
<td>0.80</td>
<td>0.032</td>
</tr>
<tr>
<td>EXPECTED FEATURES</td>
<td>HIGH</td>
<td>10^{-10}</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>BEST JUDGEMENT</td>
<td>0.019</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>LOW</td>
<td>0.20</td>
<td>1</td>
</tr>
<tr>
<td>EXTRUSIVE MAGMATIC EVENT DURING FIRST 500 YEARS</td>
<td>HIGH</td>
<td>10^{-10}</td>
<td>0.0032</td>
</tr>
<tr>
<td></td>
<td>BEST JUDGEMENT</td>
<td>5X10^{-8}</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LOW</td>
<td>5X10^{-8}</td>
<td>10</td>
</tr>
<tr>
<td>EXTRUSIVE MAGMATIC EVENT AFTER FIRST 500 YEARS</td>
<td>HIGH</td>
<td>10^{-10}</td>
<td>0.0032</td>
</tr>
<tr>
<td></td>
<td>BEST JUDGEMENT</td>
<td>10^{-6}</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>LOW</td>
<td>10^{-4}</td>
<td>10</td>
</tr>
</tbody>
</table>

* MULTIPLE OF EPA RELEASE LIMITS FOR 10,000 YEARS

PROBABILITY:
- 0 TO 10,000 YEARS
- 10,000 TO 100,000 YEARS

NOTE: Only not volatile
### SUMMARY OF ESTIMATED RADIONUCLIDE RELEASES TO ACCESSIBLE ENVIRONMENT FROM REPOSITORY AT THE YUCCA MOUNTAIN SITE

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>SITE CONDITIONS</th>
<th>FRACTIONAL RELEASE RATE FROM EBS (PER YEAR)</th>
<th>RADIONUCLIDE RELEASES *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>0 TO 10,000 YEARS</strong></td>
<td><strong>0 TO 100,000 YEARS</strong></td>
</tr>
<tr>
<td>MULTIATTRIBUTE UTILITY ANALYSIS OF NOMINATED SITES (DOE/RW-0074)</td>
<td>EXPECTED CONDITIONS</td>
<td>10^{-10} TO 10^{-3}</td>
<td>10^{-4}</td>
</tr>
<tr>
<td></td>
<td>HIGH BEST JUDGEMENT LOW</td>
<td></td>
<td>10^{-4}</td>
</tr>
<tr>
<td></td>
<td>ALL SCENARIOS (RELEASES WEIGHTED BY PROBABILITIES)</td>
<td>10^{-10} TO 10^{-3}</td>
<td>10^{-4}</td>
</tr>
<tr>
<td></td>
<td>HIGH BEST JUDGEMENT LOW</td>
<td>1.2X10^{-4}</td>
<td>3.4X10^{-3}</td>
</tr>
<tr>
<td>ENVIRONMENTAL ASSESSMENT FOR YUCCA MOUNTAIN SITE (DOE/RW-0073)</td>
<td>REFERENCE CASE (EXPECTED CONDITIONS WITH UPPER BOUND FLUX OF 5X10^{-4} M^2/M^2-yr)</td>
<td>2.5X10^{-9}</td>
<td>&lt;10^{-7}</td>
</tr>
<tr>
<td></td>
<td>PERFORMANCE-LIMITS CASE (EXPECTED CONDITIONS, BUT WITH SHORT WASTE-PACKAGE LIFETIME AND HIGH RELEASE RATES CONSIDERED NOT REALISTIC)</td>
<td>10^{-6}</td>
<td>&lt;2X10^{-6}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10^{-5}</td>
<td>&lt;2X10^{-5}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10^{-4}</td>
<td>&lt;2X10^{-4}</td>
</tr>
</tbody>
</table>

* MULTIPLE OF EPA RELEASE LIMITS FOR 10,000 YEARS
CONCLUSIONS

ORDERLY AND DOCUMENTED PROCESS, USING A GROUP OF TECHNICAL SPECIALISTS, WAS ORGANIZED AND IMPLEMENTED TO:
- IDENTIFY AND SCREEN DISRUPTIVE SCENARIOS ON BASIS OF EXPECTED IMPACT AND PROBABILITY OF OCCURRENCE
- ESTIMATE RADIONUCLIDE RELEASES TO THE ACCESSIBLE ENVIRONMENT ON BASIS OF SITE CHARACTERISTICS (PERFORMANCE FACTORS)

RESULTS OF THE PROCESS INDICATED THAT:
- THE RELEASES ARE PROJECTED TO BE VERY SMALL AND WELL WITHIN THE EPA LIMITS FOR 10,000 YEARS
- THE SCENARIO OF "UNEXPECTED FEATURES" WAS FOUND TO HAVE THE HIGHEST PROBABILITY OF OCCURRENCE AMONG THE SET OF SCENARIOS CONSIDERED DISRUPTIVE
- THE RELEASES BOUNDED THOSE REPORTED IN THE ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE
CORRESPONDENCE BETWEEN THE SITE SCORING SCALE AND THE PERFORMANCE MEASURE FOR THE 10,000-YEAR POST CLOSURE SITING OBJECTIVE (DOE/RW-0074)

OBJECTIVE:
MINIMIZE THE TOTAL NUMBER OF HEALTH EFFECTS ATTRIBUTABLE TO THE REPOSITORY DURING THE FIRST 10,000 YEARS AFTER CLOSURE

PERFORMANCE MEASURE:
CUMULATIVE RELEASES OF RADIONUCLIDES TO THE ACCESSIBLE ENVIRONMENT

SITE SCORING SCALE
CUMULATIVE RELEASES OF RADIONUCLIDES TO THE ACCESSIBLE ENVIRONMENT DURING THE FIRST 10,000 YEARS AS MULTIPLES OF THE EPA RELEASE
SITE CONDITIONS AND CHARACTERISTICS AFFECTING REPOSITORY-PERFORMANCE FACTORS (DOE/RW-0074)

CONDITIONS AFFECTING WASTE-PACKAGE LIFETIME

- THERMAL CONDITIONS
- MECHANICAL CONDITIONS (THERMOMECHANICAL STRESSES, GROUND MOVEMENT)
- VOLUME OF, AND REPLACEMENT RATE FOR, FLUIDS NEAR WASTE PACKAGE
- CORROSION RATE

LOCAL FLUID CONDITIONS AFFECTING THE RATE OF RELEASE FROM THE ENGINEERED-BARRIER SYSTEM

- GROUND-WATER FLUX THROUGH THE HOST ROCK OR SEEPAGE INTO REPOSITORY
- NUMBER OF PACKAGES EXPOSED TO WATER

LOCAL CHEMICAL CONDITIONS AFFECTING THE RATE OF RELEASE FROM THE ENGINEERED-BARRIER SYSTEM

- RADIONUCLIDE SOLUBILITY
- WASTE-FORM DISSOLUTION RATE
- THERMAL EFFECTS ON LEACH RATES AND LOCAL CHEMICAL CONDITIONS


## Participants in Postclosure Performance Assessment for Comparative Site Evaluation (DOE/RW-0074)

### Methodology Lead Group

<table>
<thead>
<tr>
<th>Geologic Disposal</th>
<th>Decision Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOM LONGO* (DOE-OGR)</td>
<td>LEE MERKHOFER (APPLIED DECISION ANALYSIS)</td>
</tr>
<tr>
<td>PAUL GNIRK (RE/SPEC)</td>
<td>RALPH KEENEY** (UNIV. SOUTHERN CALIFORNIA)</td>
</tr>
<tr>
<td>21 YEARS OF COMBINED EXPERIENCE IN GEOLOGIC DISPOSAL OF RADIOACTIVE WASTES</td>
<td>29 YEARS OF COMBINED EXPERIENCE IN DECISION ANALYSIS AND RISK ASSESSMENT</td>
</tr>
</tbody>
</table>

* MLG LEAD  ** JAN. - APRIL 1986

### Ad Hoc Technical Advisory Group

| FELTON BINGHAM (SANDIA NATIONAL LABORATORY) | BUDI SAGAR (ROCKWELL-HERFORD OPS.) |
| JAMES CAMPBELL (INTERA TECH.)              | WENDALL WEART (SANDIA NATIONAL LABORATORY) |

31 YEARS OF COMBINED EXPERIENCE IN GEOLOGIC DISPOSAL OF RADIOACTIVE WASTES, INCLUDING PERFORMANCE ASSESSMENT

### Post Closure Technical Specialists

<table>
<thead>
<tr>
<th>ALLEN JELACIC*** (DOE-OGR)</th>
<th>JEFF KIMBALL (WESTON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAY RHODERICK (DOE-OGR)</td>
<td>SAM PANNO (WESTON)</td>
</tr>
<tr>
<td>GLEN FAULKNER (USGS–DOE–OGR)</td>
<td>MARTHA PENDLETON (WESTON)</td>
</tr>
<tr>
<td>KENNETH CZYSCKINSKI (WESTON)</td>
<td>LARRY RICKERTSEN (WESTON)</td>
</tr>
<tr>
<td>WILLIAM HEWITT (WESTON)</td>
<td>DAVID SIEFKEN (WESTON)</td>
</tr>
<tr>
<td>ROBERT JACKSON (WESTON)</td>
<td>ROBERT JACKSON (WESTON)</td>
</tr>
</tbody>
</table>

62 YEARS OF COMBINED EXPERIENCE IN GEOLOGIC DISPOSAL OF RADIOACTIVE WASTES, PLUS 26 YEARS OF COMBINED EXPERIENCE IN GEOLOGY, GEOPHYSICS, HYDROLOGY, GEOCHEMISTRY, GEOTECHNICAL ENGINEERING, SAFETY ASSESSMENT, AND NUMERICAL MODELING

*** LEAD
SITE CONDITIONS AND CHARACTERISTICS AFFECTING REPOSITORY-PERFORMANCE FACTORS (DOE/RW-0074)

CONDITIONS AFFECTING GROUND-WATER MOVEMENT TO ACCESSIBLE ENVIRONMENT

- ROCK CHARACTERISTICS THAT DETERMINE GROUND-WATER PATHWAYS
- HYDRAULIC PROPERTIES
- HEAD GRADIENTS
- UNSATURATED FLOW CHARACTERISTICS
- CONSTRAINTS DUE TO REGIONAL FLOW CONDITIONS

CONDITIONS AFFECTING RETARDATION

- SORPTION
- PRECIPITATION
- PHYSICAL RETARDATION
- DISPERSION

OTHER CONDITIONS AFFECTING RADIONUCLIDE-TRAVEL TIME

- DIFFUSION TRANSPORT
- TRANSPORT OF GASES