II. EXPLORATORY STUDIES FACILITY (ESF)

The design status of the ESF is as follows:

- Title I design completed and submitted to DOE Headquarters.
- Approval received to begin limited Title II design prior to ESAAB approval of project baseline.
- ESF designers, Raytheon Services Nevada (RSN), have completed a readiness review to start Title II design.
- RSN's Title II engineering plan approved.
- Title II design has begun on road and pads for first access.

The following milestones are in place for FY 92:

- ESAAB approval of the Title I cost and schedule - Dec. 91
- Complete RFP for construction contractor - Feb. 92
- Receipt of data from the soil and rock properties surface-based testing program - Feb. 92
- 50% ESF design review (roads and pads) - March 92
- 90% ESF design review (roads and pads) - July 92

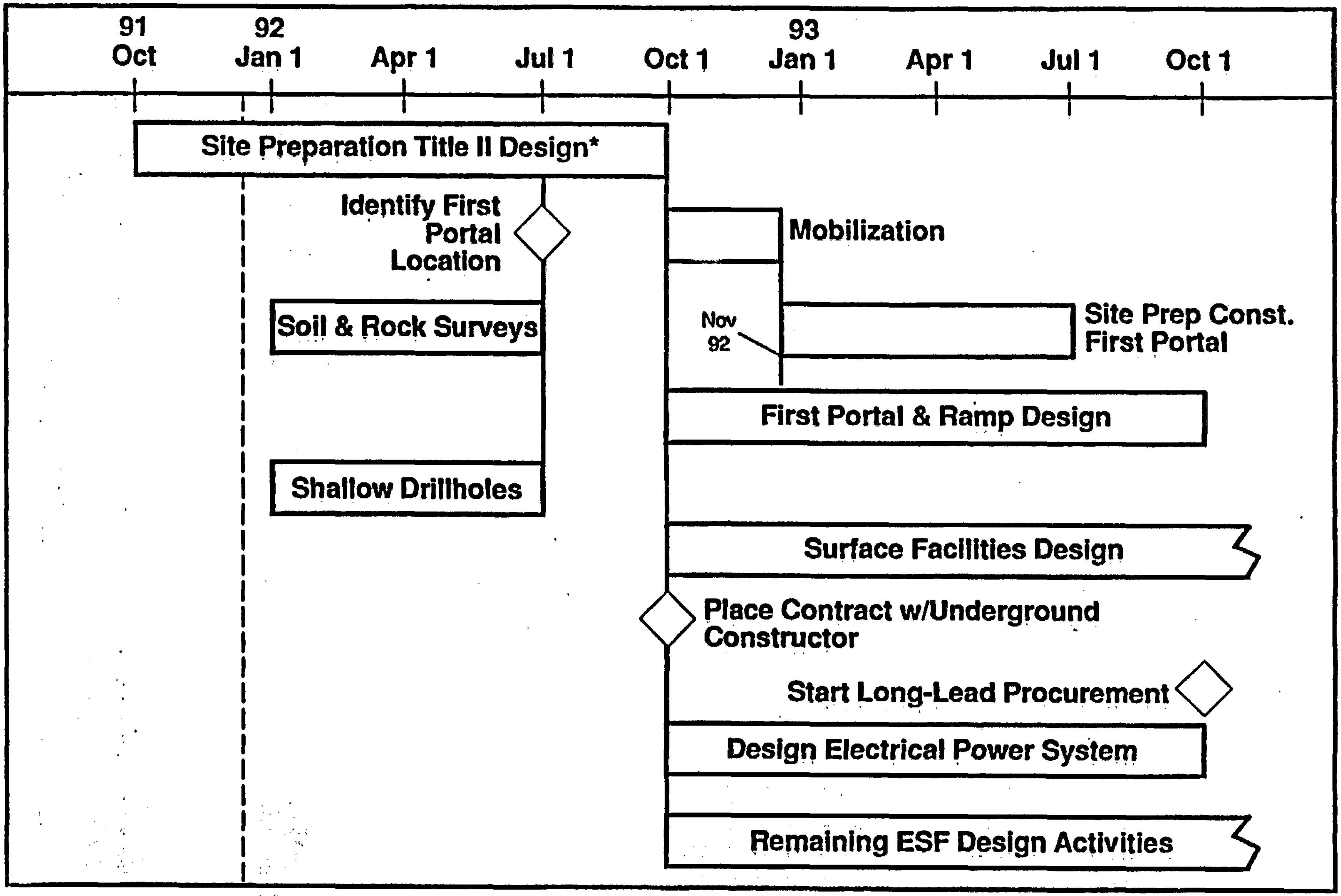
NRC staff will be invited to observe the 50% and the 90% design review.

The Title II design packages that are scheduled for FY 92 completion are:

- Site preparation of surface and portal - first access (WBS 1.2.6.2.1.1.)
- First access ramp highwall, portal pad and portal (WBS 1.2.6.3.1.1.)
- Surface utilities and communications systems (WBS 1.2.6.2.2.1.) is scheduled for partial completion in FY 92.

A chart showing PROPOSED (emphasis DOE's) ESF design/ construction activities for FY 92 and 93 is insert (2). All planned activities are dependent on sufficiant funds forthcoming in the FY 93 and FY 94 budgets.

PROPOSED ESF DESIGN/CONSTRUCTION ACTIVITIES FY 1992 & 1993



* INCLUDES

- PORTAL DESIGN SUFFICIENT FOR BLASTING
- AREA DESIGN SUFFICIENT FOR BLASTING AND SITE GRADING
- TOPSOIL AND SUBSOIL STORAGE
- WASTE WATER DISPOSAL
- POTABLE AND INDUSTRIAL WATER DISTRIBUTION
- ELECTRICAL SUBSTATION ENVELOPE
- FACILITY LAYOUTS
- BUILDING ENVELOPES

PEDCAFP.GERTZ/12-05-91/2

(Insert 2)

III. EARLY SITE SUITABILITY EVALUATION (ESSE)

The final ESSE report will be submitted to the Project Office in early January 1992 for approval to release. It is planned that the peer review comments/response package will be printed as a separate document.

The preliminary conclusions of the scientists who conducted the early site suitability evaluation are:

A. Qualifying conditions of DOE siting guidelines:

- 9 of 24 qualifying conditions are present and new information is unlikely to change this conclusion.
- 15 of 24 qualifying conditions are likely to be present but further information is needed.

B. Disqualifying conditions of DOE siting guidelines:

- 14 of 18 disqualifying conditions are not present and new information is unlikely to change this conclusion.
- 4 of 18 disqualifying conditions are not likely to be present but further information is needed.

  Inserted are the preliminary conclusions described above. (3)

The planned DOE actions after receipt of the final report are:

- Final ESSE report and peer review report are due to DOE in late January, 1992.
- Public will be given the opportunity to comment on the final report in early 1992.
- All comments will receive written responses.

Inserted are the names, organization and area of expertise of the ESSE core team (4) and the peer review panel (5). Also attached is a time chart for the ESSE activity. (6)

PRELIMINARY CONCLUSIONS OF EARLY SITE SUITABILITY EVALUATION

DOE Siting Guideline	Conclusion
Postclosure Guidelines	
Postclosure system: EPA & NRC standards can be met	Condition is likely to be present
Geohydrology	
QC: Compatible with waste containment & isolation	Condition is likely to be present
DC: <1000 year ground-water travel time	Condition is not likely to be present
Geochemistry	
QC: Compatible with waste containment and isolation	Condition is likely to be present
Rock Characteristics	
QC: Accommodate thermal, chemical, mechanical stresses	Condition is likely to be present
Climatic Changes	
QC: No unacceptable releases due to climate change	Condition is likely to be present
Erosion	
QC: No unacceptable releases due to erosion	Condition present: new information unlikely to change conclusion
DC: Burial cannot be >200m	Condition not present: new information unlikely to change conclusion
Dissolution	
QC: No unacceptable releases due to dissolution	Condition present: new information unlikely to change conclusion
DC: Loss of isolation due to dissolution expected	Condition not present: new information unlikely to change conclusion
Tectonics	
QC: No unacceptable releases due to tectonics	Condition is likely to be present
DC: Fault movement expected to cause loss of waste isolation	Condition not present: new information unlikely to change conclusion
Human Interference: Natural Resources	
QC: Interference due to resources will not lead to unacceptable releases	Condition is likely to be present
DC1: Significant pathways exist from previous mining	Condition not present: new information unlikely to change conclusion
DC2: Mining activities expected to lead to loss of waste isolation	Condition not present: new information unlikely to change conclusion
Human Interference: Site Ownership and Control	
QC: DOE can obtain land ownership and rights	Condition present: new information unlikely to change conclusion

(Insert 3-a)

(3)

PRELIMINARY CONCLUSIONS OF EARLY SITE SUITABILITY EVALUATION

DOE Siting Guideline	Conclusion
Preclosure Guidelines: Radiological Safety	
System: radiological safety standards can be met	Condition is likely to be present
Population Density	
QC1: Doses to highly populated areas meet limits	Condition present: new information unlikely to change conclusion
QC2: Doses to public in unrestricted areas meet limits	Condition present: new information unlikely to change conclusion
DC1: Population density too high	Condition not present: new information unlikely to change conclusion
DC2: Adjacent area with >1,000 population	Condition not present: new information unlikely to change conclusion
DC3: DOE cannot develop emergency preparedness program	Condition not present: new information unlikely to change conclusion
Site Ownership and Control	
QC: DOE can obtain land ownership and rights	Condition present: new information unlikely to change conclusion
Meteorology	
QC: Conditions will not lead to unacceptable releases	Condition present: new information unlikely to change conclusion
Offsite Installations and Operations	
QC: Offsite facilities will not lead to unacceptable releases	Condition is likely to be present
DC: Irreconcilable conflicts expected with atomic energy defense activities	Condition not present: new information unlikely to change conclusion

(Insert 3-b)

PRELIMINARY CONCLUSIONS OF EARLY SITE SUITABILITY EVALUATION

DOE Siting Guideline	Conclusion
Preclosure Guidelines: Environment-Socioeconomic Impacts-Transportation	
System Guideline: Public and environment can be protected	Condition is likely to be present
Environmental Quality	
QC: Environmental quality adequately protected	Condition is likely to be present
DC1: Environment cannot be protected and impacts cannot be mitigated	Condition is not likely to be present
DC2: Facilities located in federally protected areas	Condition not present: new information unlikely to change conclusion
DC3: Irreconcilable conflicts with protected areas expected	Condition is not likely to be present
Socioeconomic Impacts	
QC: Impacts can be offset by reasonable mitigation or compensation	Condition is likely to be present
DC: Water quality/quantity expected to be significantly impacted	Condition is not likely to be present
Transportation	
QC1: No conflicts due to location of access routes	Condition is likely to be present
QC2: Technology adequate to develop system	Condition is likely to be present
QC3: Extreme performance standards not required	Condition is likely to be present
QC4: No unacceptable risks or environmental impacts	Condition is likely to be present

(Insert 3-c)

ESSEJY5P.125.NWTRB/11-4-91

PRELIMINARY CONCLUSIONS OF EARLY SITE SUITABILITY EVALUATION

DOE Siting Guideline		Conclusion
Ease and Cost of Siting, Construction, Operation, and Closure		
System Guideline:	Technology available to accommodate site conditions	Condition is likely to be present
Surface Characteristics		
QC:	Technology available for terrain & flood control	Condition present: new information unlikely to change conclusion
Rock Characteristics		
QC1:	Adequate rock thickness and lateral extent	Condition is likely to be present
QC2:	Conditions will cause no undue hazards to personnel	Condition present: new information unlikely to change conclusion
QC3:	Technology available to accommodate conditions	Condition present: new information unlikely to change conclusion
DC:	Significant risk to health and safety expected	Condition not present: new information unlikely to change conclusion
Hydrology		
QC1:	Conditions allow repository development	Condition present: new information unlikely to change conclusion
QC2:	Liners and seals will function as intended	Condition present: new information unlikely to change conclusion
QC3:	Technology available to accommodate hydrology	Condition present: new information unlikely to change conclusion
DC:	Technology not available for ground-water conditions expected	Condition not present: new information unlikely to change conclusion
Tectonics		
QC:	Technology adequate for expected conditions	Condition is likely to be present
DC:	Technology not available to accommodate expected fault movement or ground motion	Condition not present: new information unlikely to change conclusion

(Insert 3-d)

ESSE CORE TEAM

JEAN L. YOUNKER	T&MSS	TASK MANAGER
ROBERT C. MURRAY	T&MSS	DEPUTY TASK MANAGER & PEER REVIEW CHAIRMAN
WILLIAM B. ANDREWS	T&MSS	TRANSPORTATION
LYNDON B. BALLOU	LLNL	ROCK PROPERTIES, ENGR SYSTEMS
JAN A. DOCKA	WESTON	PETROLOGY
ARTHUR A. DUCHARME	SNL	RISK ASSESSMENT/SEISMIC HAZARD
WILLIAM W. DUDLEY	USGS	SURFACE CHARACTERISTICS
GREGORY A. FASANO	T&MSS	ENVIRONMENTAL QUALITY
RICHARD J. HERBST	LANL	GEOCHEMISTRY
DWIGHT T. HOXIE	USGS	CLIMATE
STEVEN R. MATTSON	T&MSS	NATURAL RESOURCES
MICHAEL A. REVELLI	LLNL	ENGINEERED SYSTEMS
LAWRENCE D. RICKERTSEN	WESTON	TOTAL SYSTEM PERFORMANCE
LES E. SHEPHARD	SNL	HYDROLOGY
BRUCE R. JUDD	DECISION ANALYSIS COMPANY	CONSENSUS BUILDING, EXPERT ASSESSMENTS
JANE R. STOCKEY	DOE/HQ	TECHNICAL MONITOR
JEREMY M. BOAK	DOE/YMP	TECHNICAL MONITOR

(Insert 4)

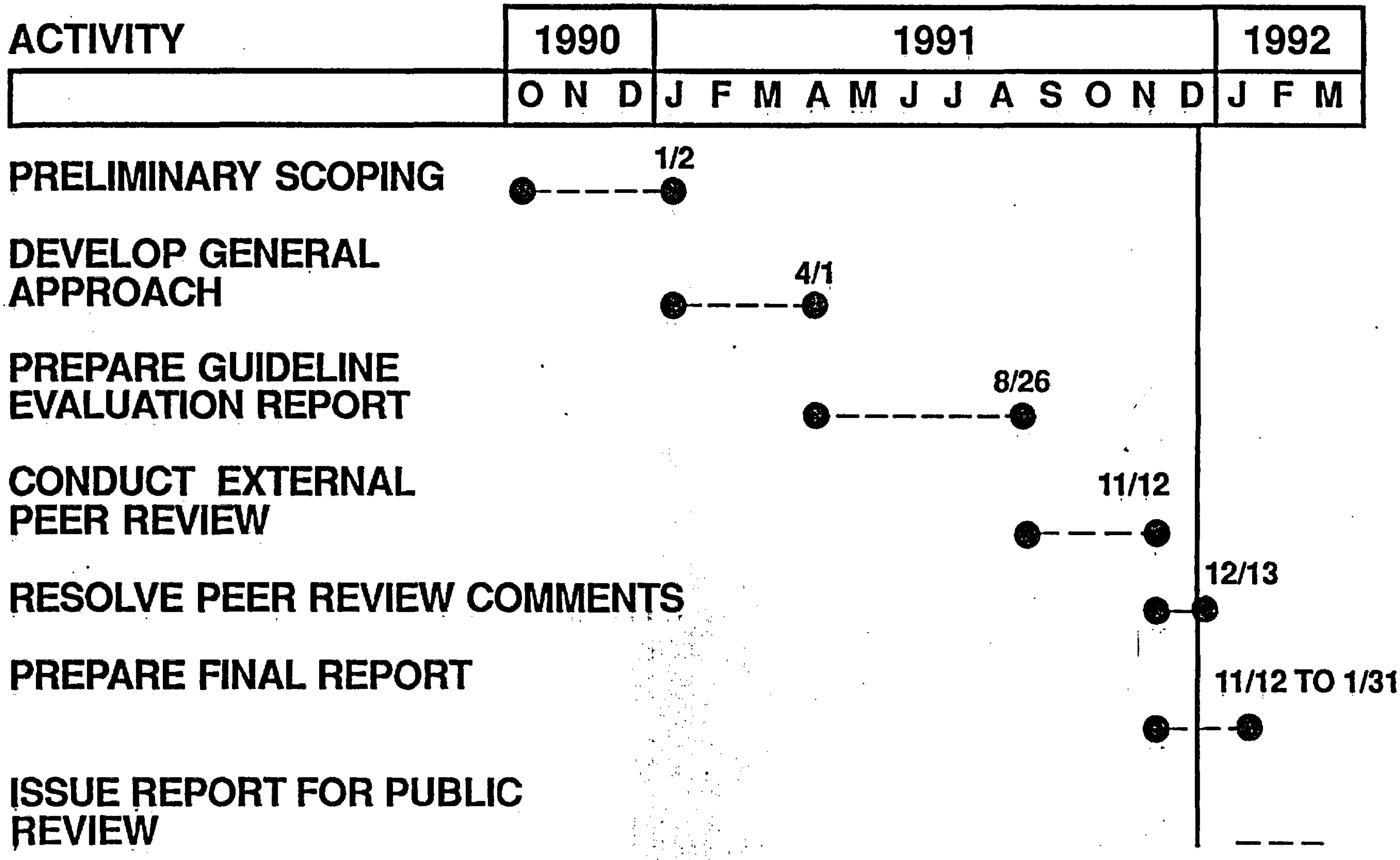
ESINT5P.125/10-7-91

PEER REVIEW PANEL FOR THE EARLY SITE SUITABILTIY EVALUATION

NAME	ORGANIZATION	SPECIALTY
Stan L. Albrecht	Brigham Young University	Socioeconomic Impacts
Walter J. Arabasz	University of Utah	Tectonics/Seismic Hazards
John H. Bell	University of Nevada, Las Vegas	Health Physics & Radiological Safety
F. William Cambray	Michigan State University	Structural Geology & Tectonics
Steven W. Carothers	Southwest Environmental Consultants, Inc.	Environmental Quality
James Drever	University of Wyoming	Geochemistry
Marco T. Einaudi	Stanford University	Economic Geology
Donald E. French	Private Consultant	Petroleum Geology
Kip V. Hodges	MIT	Tectonics - General
Robert H. Jones	Private Consultant	Transportation Impacts
David K. Kreamer	University of Nevada, Las Vegas	Hydrology
William G. Pariseau	University of Utah	Rock Characteristics - Engineering Geology
Thomas A. Vogel	Michigan State University	Tectonics - Volcanology
Thompson Webb, III	Brown University	Climatic Change

(Insert 5)

EARLY SITE SUITABILITY EVALUATION (ESSE) TASK



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(Insert 6)

IV. A DRILLING AND CORING SYSTEM FOR OBTAINING NATURAL STATE SAMPLES FROM THE UNSATURATED ZONE

The need to obtain natural state core from the unsaturated zone at Yucca Mountain from depths greater than 1000 feet was a problem to the DOE Yucca Mountain Project because the technology to do this did not exist. The normal method of coring using water (drilling mud) was not satisfactory for site characterization. To solve this problem, DOE contracted Lang Manufacturing of Salt Lake City, Utah, to design the dry core drilling system and build a drill rig to use it. The result is the LM-300 drilling rig that will be used to drill and core UZ-16 to the water table.

On October 29, 1990, Dr. Uel S. Clanton, Chief Site Investigations Branch, DOE-YMP prepared, with Roy C. Long, a Drilling Engineer on Dr. Clanton's staff, a presentation showing how this drilling and coring system works. The presentation is in the form of viewgraphs that are self explanatory.

Attached are the viewgraphs showing the LM-300 drill rig and the dry coring system that was developed for this project. (7)

V. MEETINGS

Three meetings were attended during the month of November, 1991. These were:

- Secretary of Energy Advisory Board Task Force on Civilian Radioactive Waste Management — Nov. 6-7, 1991, Oakland, CA
- Workshop on Ground Water Travel Time in the Saturated Zone — Nov. 13-14, 1991, Tucson, AZ
- Total System Performance Assessment Review — Nov. 18-19-20, 1991, Las Vegas, NV

U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

YUCCA MOUNTAIN PROJECT

A DRILLING AND CORING SYSTEM FOR OBTAINING NATURAL STATE SAMPLES FROM THE UNSATURATED ZONE

AUTHORS:

DR. UEL S. CLANTON, ROY C. LONG

PRESENTED BY:

DR. UEL S. CLANTON

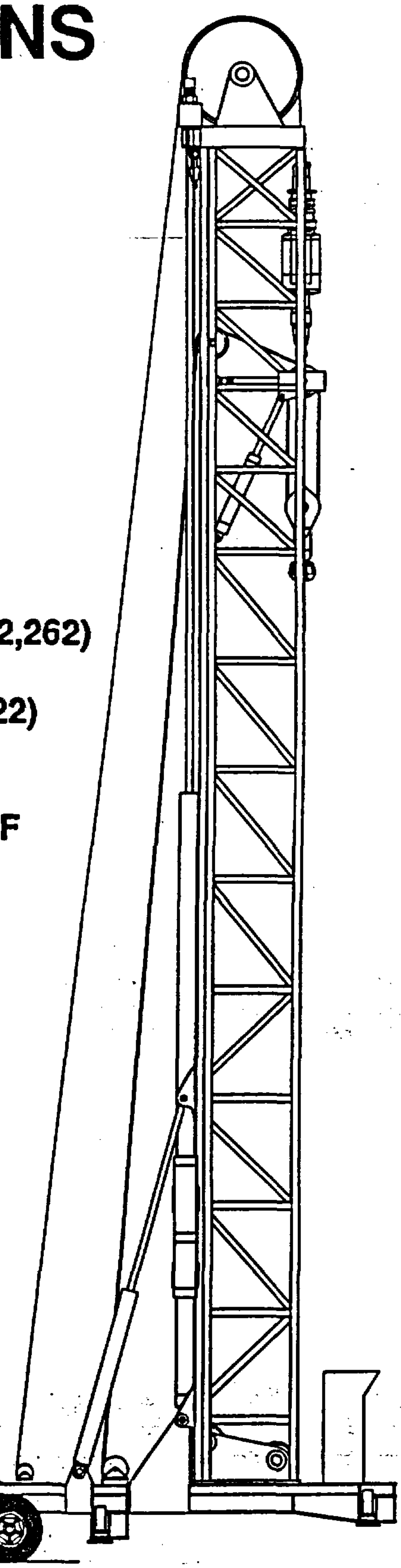
CHIEF, SITE INVESTIGATIONS BRANCH YUCCA MOUNTAIN PROJECT

U.S. DEPARTMENT OF ENERGY, LAS VEGAS, NEVADA

OCTOBER 29, 1990

(Insert 7-a)

LM-300
RIG SPECIFICATIONS

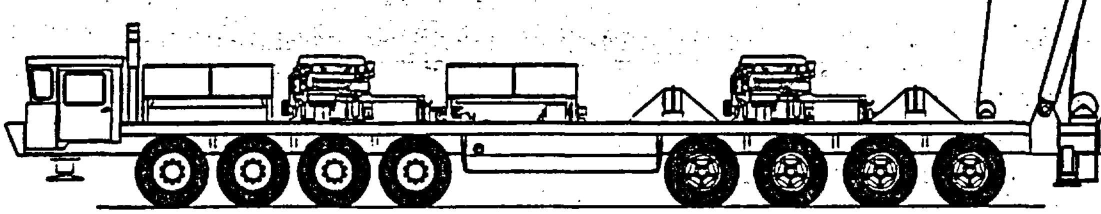


RIG DIMENSIONS:

- OVERALL HEIGHT W/MAST ERECT - 84'
- OVERALL WIDTH - 10'
- OVERALL HEIGHT W/MAST IN TRANSPORT POSITION - 16'2"
- LENGTH OF MAST - 80'6"

DRILLING CAPABILITIES:

- PRIMARY AND SECONDARY POWER FOR HYDRAULIC/ DRIVE SYSTEMS - 2 CUMMINS KTA19, 600 HP EACH
- POWER TO TOPHEAD DRIVE - 371 HP
- TORQUE - 250,000 IN. LBS (262,262)
- MAX. MAST LOAD - 300,000 LBS
- PULLBACK CAPABILITY - 238,500 LBS (260,022)
- PULLDOWN CAPABILITY - 30,000 LBS (31,075)
- MAIN HOIST - LONGYEAR 600, 4 SPEED W/3000' OF 1/4" LINE
  - CAPACITY 70,000 LB (107,814)
  - TRAVEL SPEED 108 FPM (144)
- PIPE HANDLING WINCH RATING - 5,000 LBS (6,806)
- WIRELINE WINCH - CAPACITY 400 LBS (1253)
  - TRAVEL SPEED 150 FPM (341)
- MAX. TUBULAR LENGTH - 40'
- MAX. TUBULAR DIAMETER - 60"



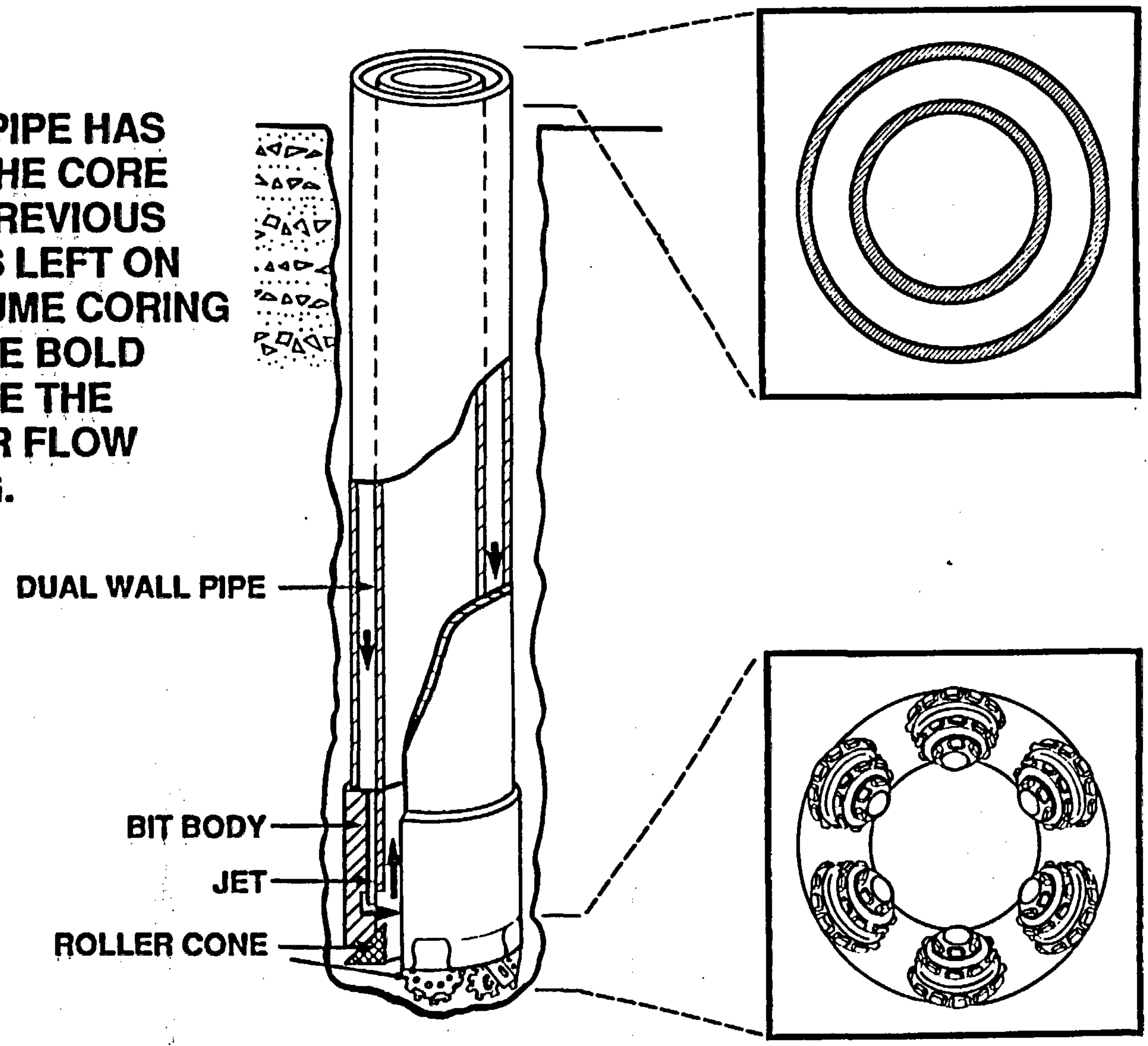
OVERALL LENGTH WITH TAG AXLES 99' 9-1/2"

PARENTHESES = ACTUALS

OSTLMA5P.A39/10-11-90

DUAL WALL DRILLING/CORING SYSTEM
DRAWING NO. 1

THE DUAL WALL PIPE HAS REAMED DOWN THE CORE TRACK FROM A PREVIOUS CORE RUN AND IS LEFT ON BOTTOM TO RESUME CORING OPERATIONS. THE BOLD ARROWS INDICATE THE DIRECTION OF AIR FLOW DURING REAMING.



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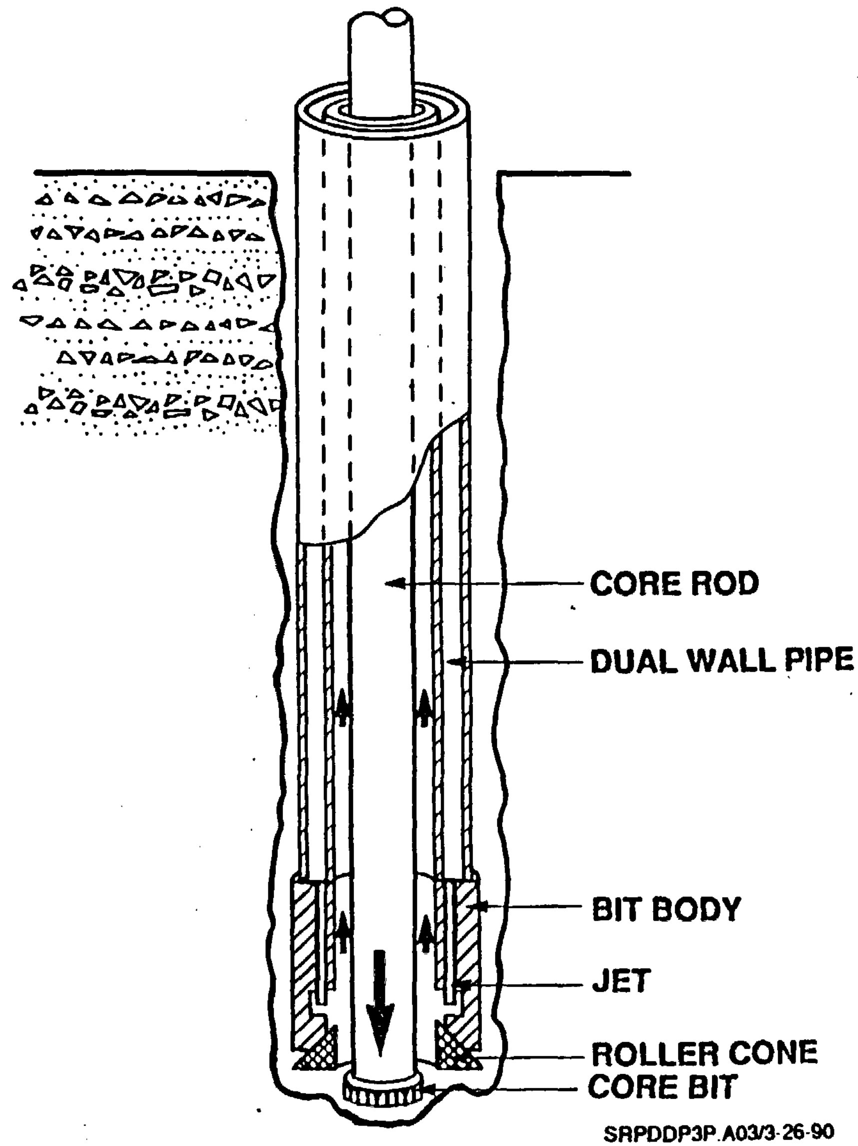
(Insert 7-c)

DUAL WALL DRILLING/CORING SYSTEM
DRAWING NO. 2

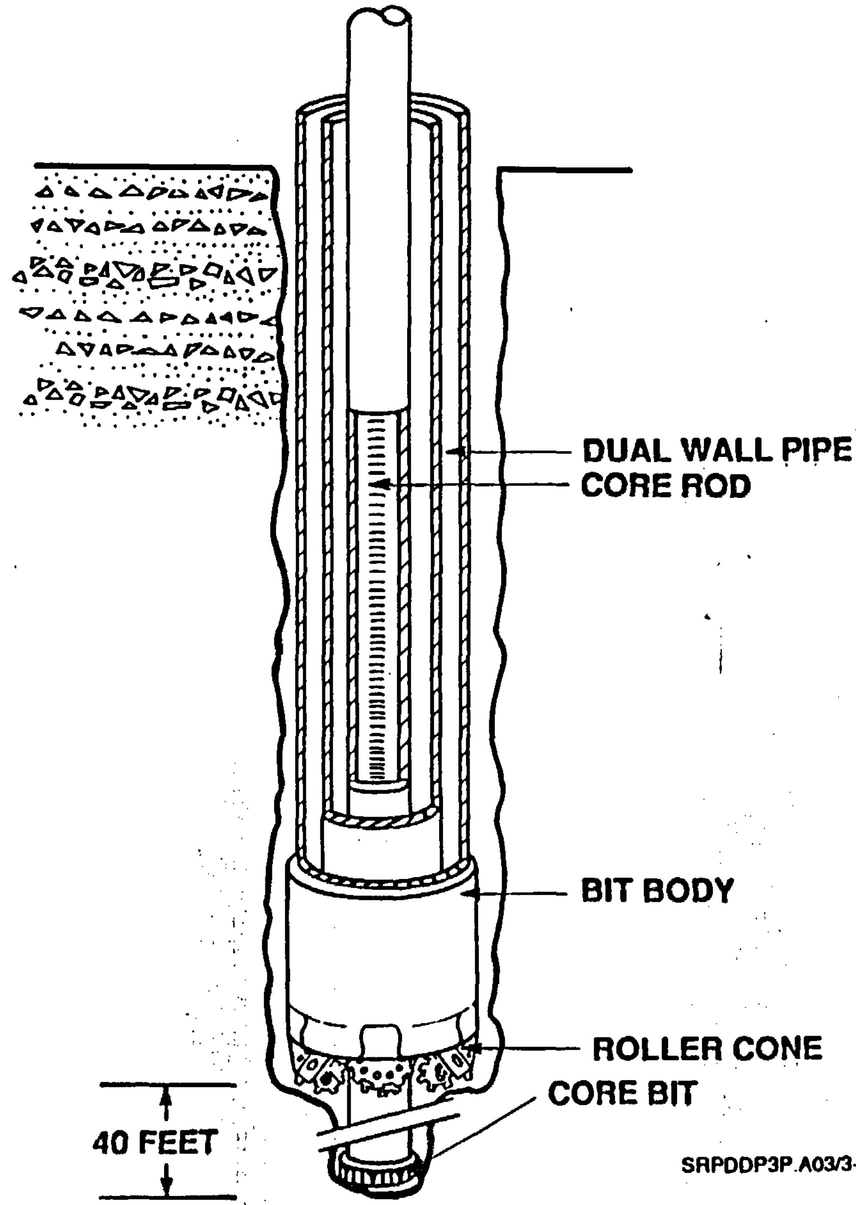
THE CORE ROD IS RUN IN THE HOLE INSIDE THE DUAL WALL PIPE. THE DRILLPIPE ACTS AS A PROTECTIVE CASING TO PROTECT THE CORE ROD FROM THE FORMATION AND TO PROTECT THE FORMATION FROM THE HIGH PRESSURE AIR AND CUTTINGS PRODUCED BY THE CORING OPERATION. ARROWS INSIDE AND ADJACENT TO CORING ASSEMBLY INDICATE DIRECTION OF AIR FLOW DURING CORING OPERATIONS.



(Insert 7-d)

DUAL WALL DRILLING/CORING SYSTEM DRAWING NO. 3

CORING OPERATIONS ARE COMMENCED AND THE CORE ROD IS ADVANCED 40 FEET AHEAD OF THE DUAL WALL PIPE IN 10 FOOT INCREMENTS (10 FOOT CORES). THE CORES ARE RETRIEVED BY CONVENTIONAL WIRELINE WHILE THE CORE ROD IS LEFT IN THE HOLE FOR THE DURATION OF THE 40 FOOT CORE RUN. THE 40 FOOT LIMIT IS USED TO PREVENT THE MORE FLEXIBLE CORE ROD FROM INITIATING A DEVIATION IN THE BOREHOLE AND CAUSING THE DRILLPIPE TO FOLLOW A DEVIATED PATH RESULTING IN BINDING OF THE DUAL WALL PIPE.



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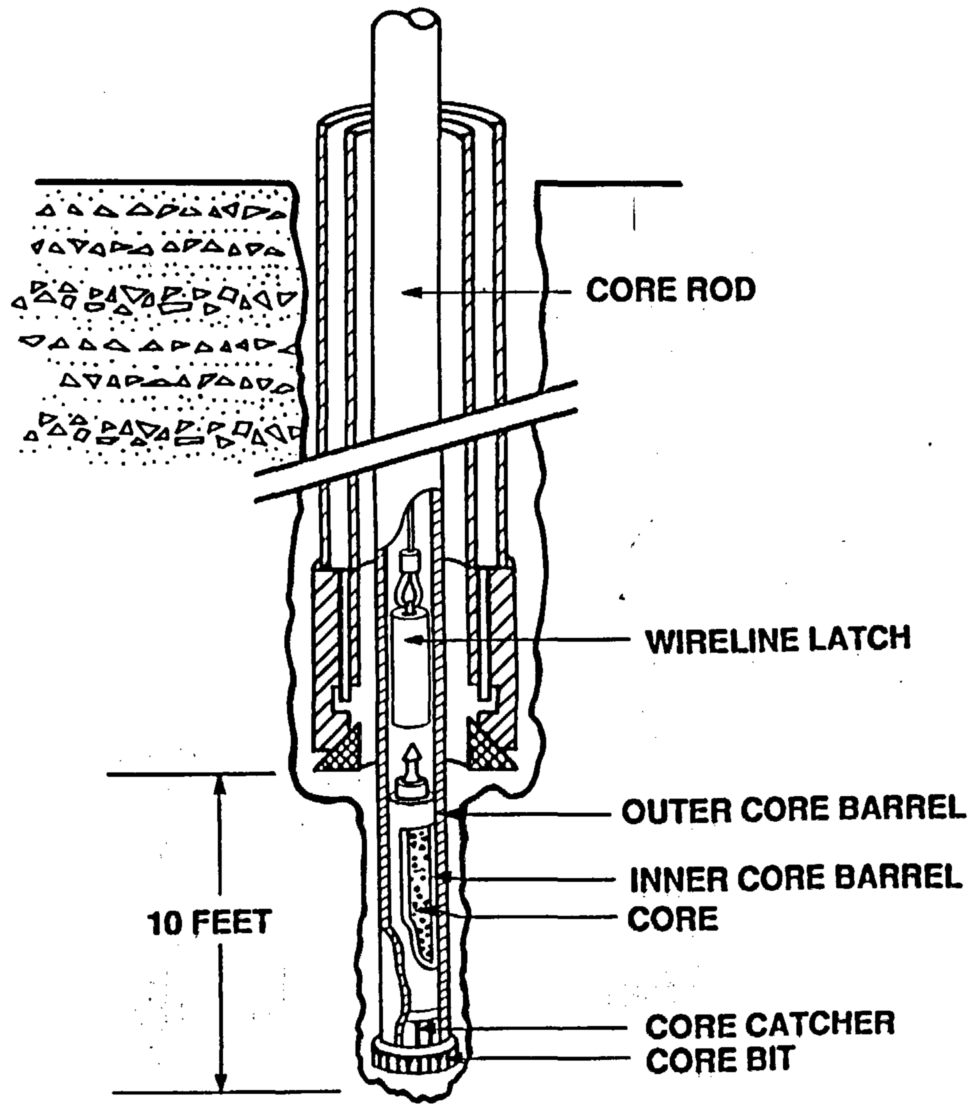
(Insert 7-e)

DUAL WALL DRILLING/CORING SYSTEM
DRAWING NO.4

AT THE END OF EACH 10 FOOT CORED INTERVAL THE CORE ROD IS PICKED UP SLIGHTLY AND THE CORE IS BROKEN BY THE CORE CATCHER JUST ABOVE THE CORE BIT. THE CATCHER IS A DEVICE WHICH ALLOWS THE CORE TO ENTER THE INNER BARREL BUT PREVENTS IT FROM BACKING OUT. A WIRELINE LATCH (OVERSHOT) IS THEN RUN INSIDE THE CORE ROD AND THE TOP OF THE INNER BARREL IS "CAUGHT" WITH THE WIRELINE.



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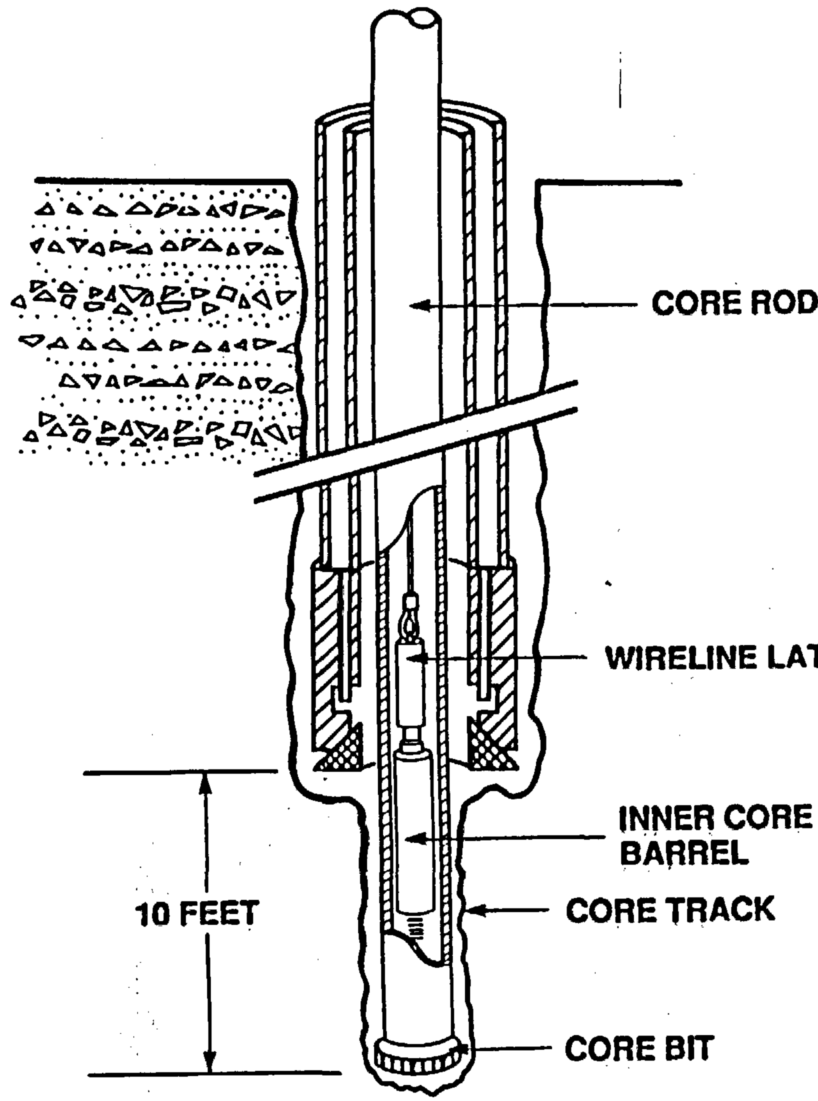
(Insert 7-f)

DUAL WALL DRILLING/CORING SYSTEM
DRAWING NO. 5

AFTER THE CORE IS BROKEN, THE INNER BARREL (WITH CORE HELD IN BY THE CORE CATCHER) IS PULLED OUT OF THE HOLE BY WIRELINE. A NEW (EMPTY) INNER BARREL IS THEN RUN IN HOLE, LATCHED INTO THE OUTER BARREL, AND THE WIRELINE IS REMOVED. THIS SEQUENCE IS REPEATED EACH TIME THE CORE TRACK IS ADVANCED 10 FEET.



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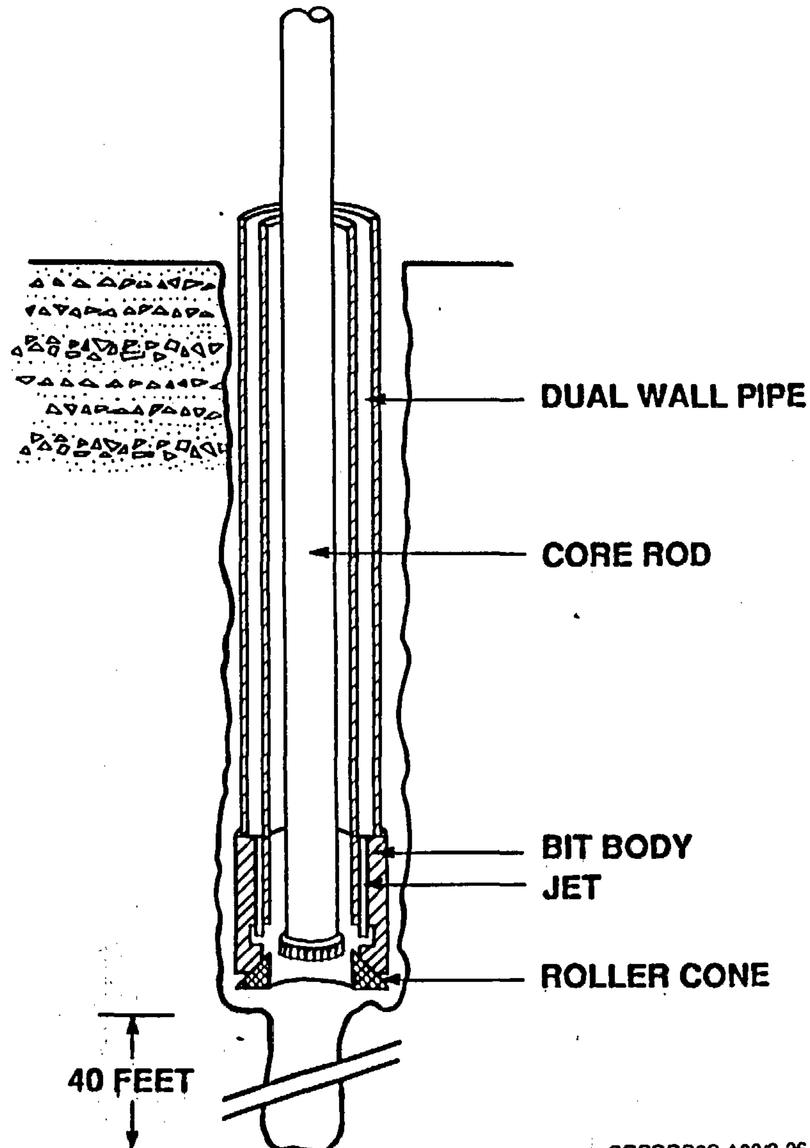
(Insert 7-8)

DUAL WALL DRILLING/CORING SYSTEM
DRAWING NO. 6

THE CORING STRING IS PULLED OUT OF THE HOLE AT THE END OF THE 40 FOOT CORE RUN IN PREPARATION FOR REAMING DOWN THE CORE TRACK WITH THE DUAL WALL PIPE.



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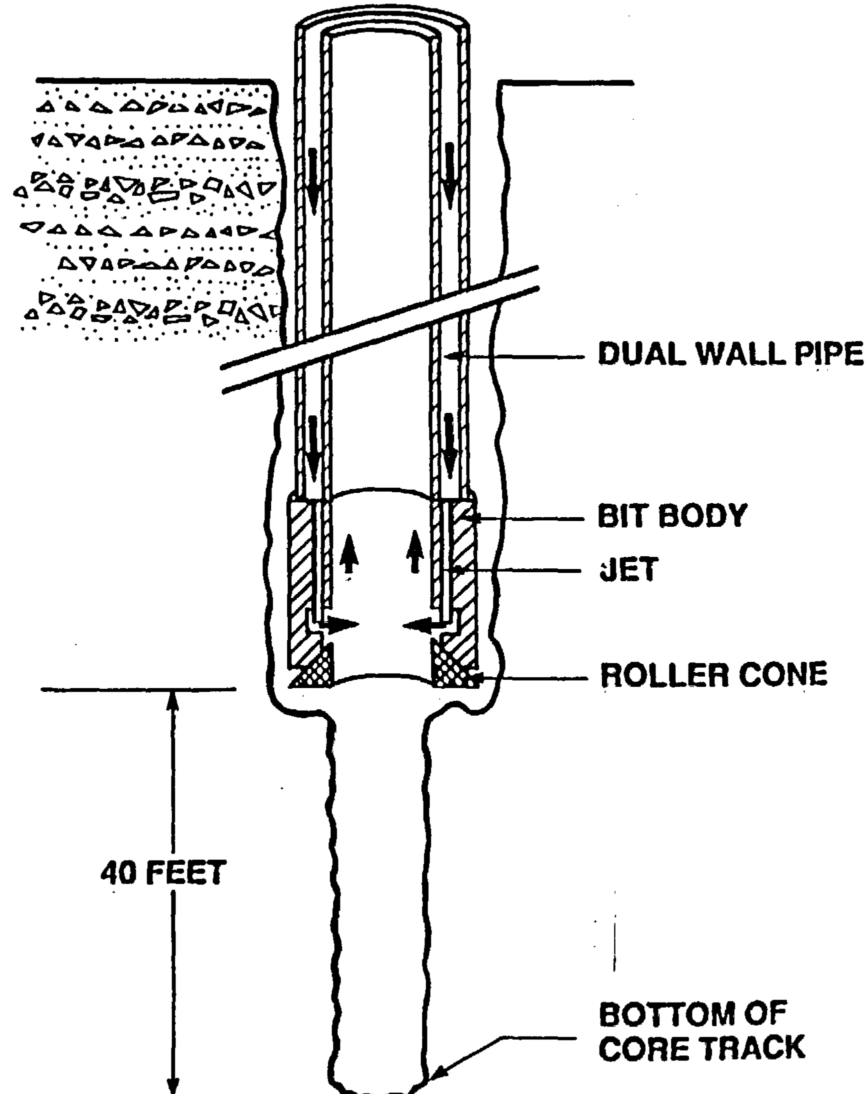
(Insert 7-h)

DUAL WALL DRILLING/CORING SYSTEM
DRAWING NO. 7

ONCE THE CORING ASSEMBLY IS OUT OF THE BOREHOLE, IT IS DRILLED/REAMED WITH THE DUAL WALL DRILL STRING TO THE BOTTOM OF THE CORE TRACK. THE FORMATION IS PROTECTED FROM CONTAMINATION NORMALLY ASSOCIATED WITH DRILLING BY CIRCULATING THE CUTTINGS UP THE CENTER OF THE DUAL WALL PIPE. CONTAMINATED FORMATION CAUSED BY THE CORING OPERATION IS REMOVED WHEN THE CORE TRACK IS REAMED DOWN. THE BOLD ARROWS INDICATE THE DIRECTION OF AIR FLOW DURING REAMING.



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(Insert 7-1)

A. Secretary of Energy Advisory Board Task Force on Civilian Radioactive Waste Management

In May, 1991, Secretary of Energy James D. Watkins established the Task Force on Civilian Radioactive Waste Management under the auspices of the Secretary of Energy Review Board. The Task Force has been asked to:

- Identify the factors that affect the level of public trust and confidence in its programs.
- Assess the effectiveness of alternative financial, organizational, legal, and regulatory arrangements in promoting public trust and confidence.
- Consider the effects on other programatic objectives, such as cost and timely acceptance of waste, or those alternative arrangements.
- Provide the Secretary with recommendations and guidance for implementing those recommendations.

In September, 1991, the Secretary expanded the Task Force's scope to include the program to manage wastes from the defense program (the above from the Advisory Board's meeting notice).

This was a public meeting held in the DOE office in Oakland, California.

Mr. Daniel Metlay, DOE Task Force Director invited a group of DOE and local government organizations to speak on the problems and concerns of the public and and how those problems and concerns are being addressed. Inserted is the agenda for the meeting and the Task Force membership roster. (8)

Since Mr. Metlay invited DOE representatives from Rocky Flats, OakRidge, Richland and the Nevada Operations Office to describe the programs these activities have emplaced to address public concerns, I was surprised and very disappointed that the Yucca Mountain Site Characterization Project Office was excluded. As is well known, YMPO has a very active public interaction program. As can be seen from the agenda, the State of Nevada and

AGENDA
SECOND MEETING
SECRETARY OF ENERGY ADVISORY BOARD
TASK FORCE ON CIVILIAN RADIOACTIVE WASTE MANAGEMENT
OAKLAND, CALIFORNIA

November 6, 1991

8:30 AM -- 11:45 AM	Task Force discussion ■ Activities overview ■ Commissioned papers -- Mr. Craig Thomas -- Dr. Jack Citrin ■ National Academy of Sciences workshop ■ National Academy of Public Administration workshop ■ Case studies ■ Description of waste management organizations
11:45 AM -- 12:00 PM	Public comments
12:00 PM -- 1:00 PM	Lunch break
1:00 PM -- 4:45 PM	Presentations by representatives of Nevada state and local governments and groups ■ Mr. Robert Loux, Nevada Nuclear Waste Project Office ■ Mr. Elgie Holstein and Mr. Phillip Niedzielski-Eichner, Nye County ■ Mr. Dennis Bechtel, Clark County ■ Mr. Vernon Poe, Mineral County ■ Ms. Judy Treichel, Nevada Nuclear Waste Task Force
4:45 PM -- 5:00 PM	Public comments
5:00 PM	Adjourn

November 7, 1991

8:00 AM -- 12:00 PM	Presentations by representatives of the Department of Energy Field Offices ■ Mr. Robert Nelson, Jr., Manager, Rocky Flats ■ Mr. William Adams, Assistant Manager for Environment and Waste Management, Oak Ridge ■ Mr. Ron Izatt, Program Manager, Environmental Assurance, Policy, and Permit Program, Richland ■ Mr. Bruce Church, Assistant Manager for Environment, Safety and Health, Nevada
12:00 PM -- 1:00 PM	Lunch break
1:00 PM -- 3:00 PM	Presentations by Nevada local governments and groups ■ Mr. Mike Baughman, Lincoln County ■ Mr. Hugh Anderson, Nevada Nuclear Waste Study Committee
3:00 PM -- 3:15 PM	Public comments
3:15 PM -- 4:30 PM	Task force discussion
4:30 PM	Adjourn

(Insert 8-a)

Secretary of Energy Advisory Board
Washington, DC 20585

MEMBERS OF THE SECRETARY OF ENERGY ADVISORY BOARD TASK FORCE ON CIVILIAN RADIOACTIVE WASTE MANAGEMENT

Ms. Barbara Barry
Director
Rocky Flats Program
Colorado Department of Health
Denver, CO 80220

Dr. William Bishop
Vice President
Desert Research Institute
Las Vegas, NV 89120

Mr. William Eichbaum
Vice President
World Wildlife Fund
Washington, DC 20037

Mr. Robert Fri
President
Resources for the Future
Washington, DC 20036

Ms. Kristine Gebbie
Secretary of Health
State of Washington
Olympia, WA 53706

Dr. Donald Kettl
Professor, Political Science
University of Wisconsin
Madison, WI 53706

Dr. John Landis
Senior Vice President
Stone and Webster Engineering Corporation
Boston, MA 02325

Dr. Todd La Porte, Chair
Professor, Political Science
University of California
Berkeley, CA 94720

Mr. David Lester
Executive Director
Council of Energy Resource Tribes
Denver, CO 80202

Mr. Gene Lucero
Partner
Sidley & Austin
Los Angeles, CA 90071

Dr. Alfred Schneider
Professor, Nuclear Engineering
Georgia Institute of Technology
Atlanta, GA 30338

Mr. Mason Willrich
Chief Executive Officer
PG&E Enterprises
San Francisco, CA 94106

Mr. Michael Wilson
Member
Florida Public Service Commission
Tallahassee, FL 32399

Dr. Mayer Zald
Professor of Sociology and Social Work
University of Michigan
Ann Arbor, MI 48109

local Government bodys were included and gave their views. Mr. Church from DOE NVO only spoke on the weapons program at the NTS. Also, the only speaker whose remarks were cut short by the Task Force Moderator was the representative of the Nevada Nuclear Waste Study Committee, the only public organization that spoke in favor of the Yucca Mountain Study.

The major criticism of this meeting as expressed by the non-DOE participants was that the meeting was held outside the State of Nevada in a DOE facility, thus limiting public participation. I notice that the next meeting of the Task Force is in Washington, D.C.

B. Workshop on Ground-Water Travel Time in the Saturated Zone

Enclosed is the agenda and a partial list of participants.

The important message, at least to me, that came out of this workshop is that the saturated zone is an important component of the hydrologic system at Yucca Mountain and that the story will not be complete unless the saturated zone is understood and incorporated into the total system. Until now, the emphasis has been almost totally on the unsaturated zone.

As the understanding of the saturated zone matures, there will be additional workshops on this subject.

C. Total System Performance Assessment Review

At the beginning of this meeting, Abe Van Luik (Intera-M&O) cautioned all present that the various models that would be discussed were not mature enough to yield answers. Further, the participants were told that they would not be held accountable for the content of their presentations. Only Weston and EPRI furnished handouts.

Abe Van Luik will prepare a summary of the meeting to be available in January and a full report will be ready by summer, 1992.

Two points were apparent to me after listening for three days:

- The models presented are still a long way from describing earth processes in a useable way. The participants seem confident that these problems will be resolved.

- The second point relates strongly to the first - there still does not seem to be any real cooperation between the modelers and the data gatherers and interpreters. This meeting was attended primarily by statisticians, mathematicians and computer scientists. Very few attendees work on site characterization. It seems logical that for a model to do its job, the modeler must know what the interpreter needs and the data gatherer must know what the modeler needs. This is undoubtedly an over simplification but it is the impression that meetings such as this leave with an observer.

There are no new issues that this office has identified that have not been brought to management's attention.

cc: w/encs.: K. Stablein, 4H3, J.E. Latz
cc: w/o encs.: J. Roberts, C.P. Gertz, R.E. Loux, C. Pflum, J. Martin, G. Cook, D.M. Kunihiro, D. Weigel, J. Linehan, 4H3; B.J. Youngblood, 4H3; R. Bernero, 6A4; H. Thompson, 17G21; H. Denton, 17F2; S. Gagner, 2G5; E. O'Donnell, NLS 260; J. Holonich, 17G21

Encs: Total System Performance Assessment Review Meeting Agenda, 11/18-20/91; Performance Assessments Supporting the Early Site-Suitability Evaluation, 11/18/91, (Rickertsen); EPRI HLW Performance Assessment Model, 11/18-20/91, (Shaw); EPRI High-Level Waste Performance Assessment Projects, Phase 2, 11/18/91, (McGuire); Attendance lists; Agenda, 11/13/91 (Tucson, AZ); Saturated Zone Workshop (Tucson, AZ list); Terms of Reference, Secretary of Energy Advisory Board, Task Force on Civilian Radioactive Waste Management, Oakland, CA w/Biography of Panel Members; Impact of Repository-Heat-Driven Hydrothermal Flow on Repository Performance: Benefits from High Repository Thermal Loading, TPO, 12/13/91; FY92 November Status Surface Based Testing Program

101 Convention Center Drive, Phase 2
Yucca Mountain Project Office
Large Conference Room
Las Vegas, 18-20 November 1991

Day 1

Topic	Speaker	Duration	Start
Introduction - Participants - Purpose of meeting	Dyer/Boak	20 min	1:30
Overview & Discussion of Golder work	Miller	40 min	1:50
Overview & Discussion of EPRI work	Shaw	40 min	2:30
Overview & Discussion of the "ESSE" total system evaluation	Rickertson	40 min	3:10
Overview & Discussion of LLNL system model	Halsey	40 min	3:50
Overview of Days 2 and 3			
- Overview of SNL work	Bingham	15 min	4:30
- Overview of PNL work	Eslinger	15 min	4:45
Adjournment			5:00

Day 2

Topic	Speaker	Duration	Start
Welcome for additional participants	Boak	15 min	8:45

Day 2 - continued

Topic	Speaker	Duration	Start
Overview - 6-step method, SCP process - reasons for simplification, the pyramid - CCDF construction method	Bingham	40 min	9:00
Break		20 min	9:40
Analysis Setup and Results			
- Basic data set (domain, boundary conditions, geohydrol. parameters, geochem.)	Dockery	15 min	10:00
- Development of Geohydrological parameter distributions	Kaplan	15 min	10:15
- Source term			
1) LLNL assumptions of source-term model	O'Connell	20 min	10:30
2) SNL source-term implementation	Wilson	20 min	10:50
3) PNL source-term implementation	Engel	20 min	11:10
- Geohydrologic & gas transport and results			
1) PNL detailed analysis (geohydrology)	Nichols	40 min	11:30
2) PNL detailed analysis (gas)	White	20 min	12:10
LUNCH		1 hour	12:30
- Geohydrologic & gas transport and results (continued)			
1) SNL abstract analysis (geohydrology)	Wilson	30 min	1:30
2) SNL abstract analysis (gas)	Wilson	30 min	2:00

Day 2 - continued

Topic	Speaker	Duration	Start
- Human-intrusion component and results			
1) PNL - detailed	Eslinger	30 min	2:30
2) SNL - abstract	Barnard	30 min	3:00
- Volcanism component and results			
1) SNL	Dockery	25 min	3:30
2) PNL	Murphy	15 min	3:55
BREAK		20 min	4:10
- Tectonics component and results (PNL)	Rohay	20 min	4:30
- Complete CCDF			
1) Construction of a combined CCDF (SNL)	Wilson	20 min	4:50
2) Construction of a combined CCDF (PNL)	Eslinger	20 min	5:10
Adjournment			5:30

Day 3

Topic	Speaker	Duration	Start
Analysis and Comparison			
- SNL sensitivity studies	Dockery	30 min	8:30
- PNL sensitivity studies	Eslinger	30 min	9:00
Comparison of abstract and detailed calculational results	Barnard/ Group	45 min	9:30
BREAK		15 min	10:15

Day 3 - continued

Topic	Speaker	Duration	Start
Comparison of abstract and detailed calculational results (continued)	Barnard/ Group	30 min	10:30
Dose Calculations			
- Methods & results (PNL)	Miley	1 hour	11:00
- Comparison with NRC & EPA methods (SNL)	Wilson	20 min	12:00
LUNCH		1 hour	12:20
- Lessons learned from abstraction (SNL)	Wilson	40 min	1:20
- Lessons learned from modeling done (PNL)	Eslinger	20 min	2:00
BREAK		20 min	2:20
Discussion and Summary			
- Alternate conceptual models	Andrews/Group	1 hour	2:40
- Structuring a total system assessment	Pahwa/Group	1 hour	3:40
Adjournment			4:40

PERFORMANCE ASSESSMENTS SUPPORTING THE EARLY SITE-SUITABILITY EVALUATION

Larry D. Rickertsen
Weston Technical Support Team

18 November 1991

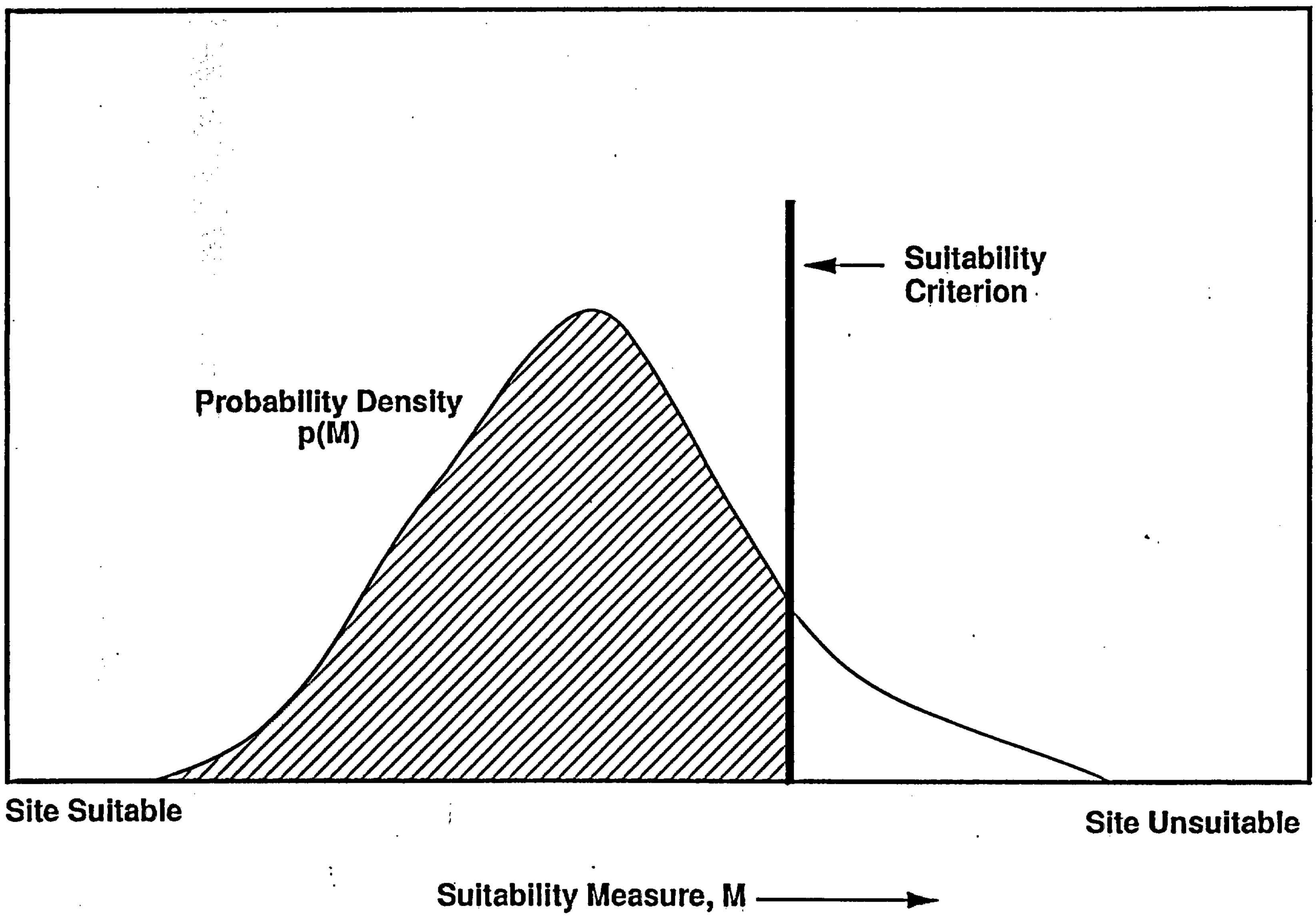
AGENDA

- OVERVIEW OF THE EARLY SITE-SUITABILITY EVALUATION (ESSE)
- OVERVIEW OF PERFORMANCE ASSESSMENT MODEL
- ESSE PA ANALYSES

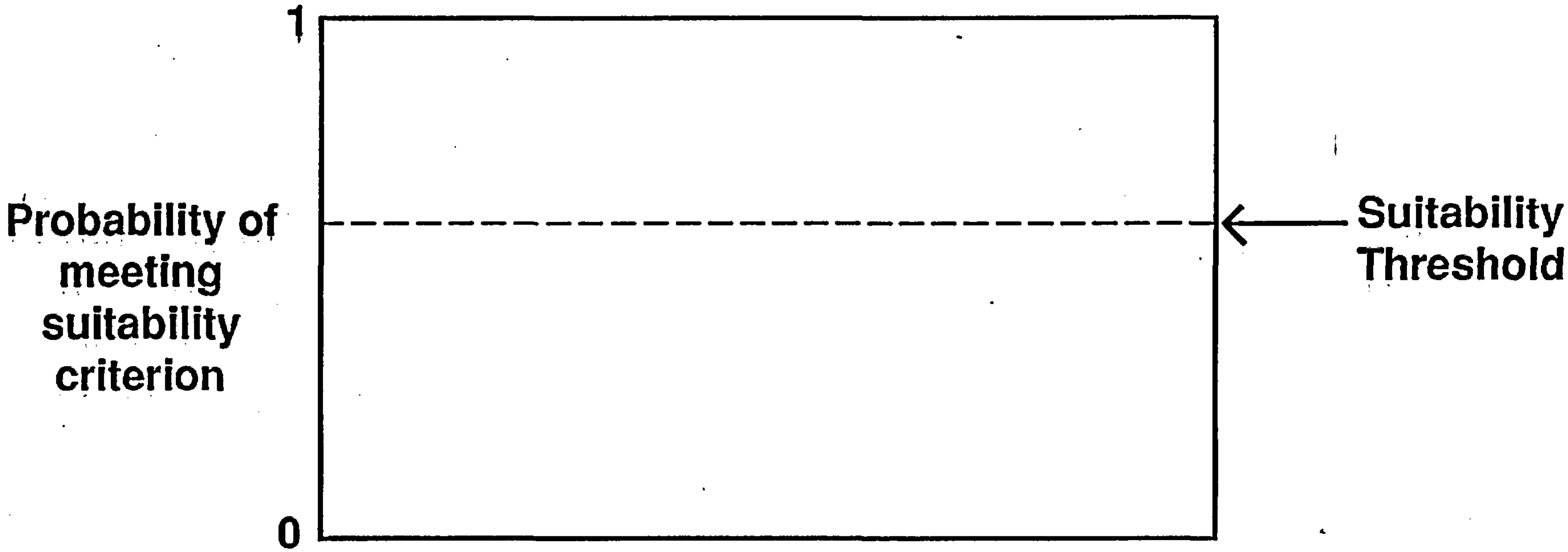
AGENDA

- ***OVERVIEW OF THE EARLY SITE-SUITABILITY EVALUATION (ESSE)***
- OVERVIEW OF PERFORMANCE ASSESSMENT MODEL
- ESSE PA ANALYSES

WHEN ARE SITE-SUITABILITY CRITERIA MET?

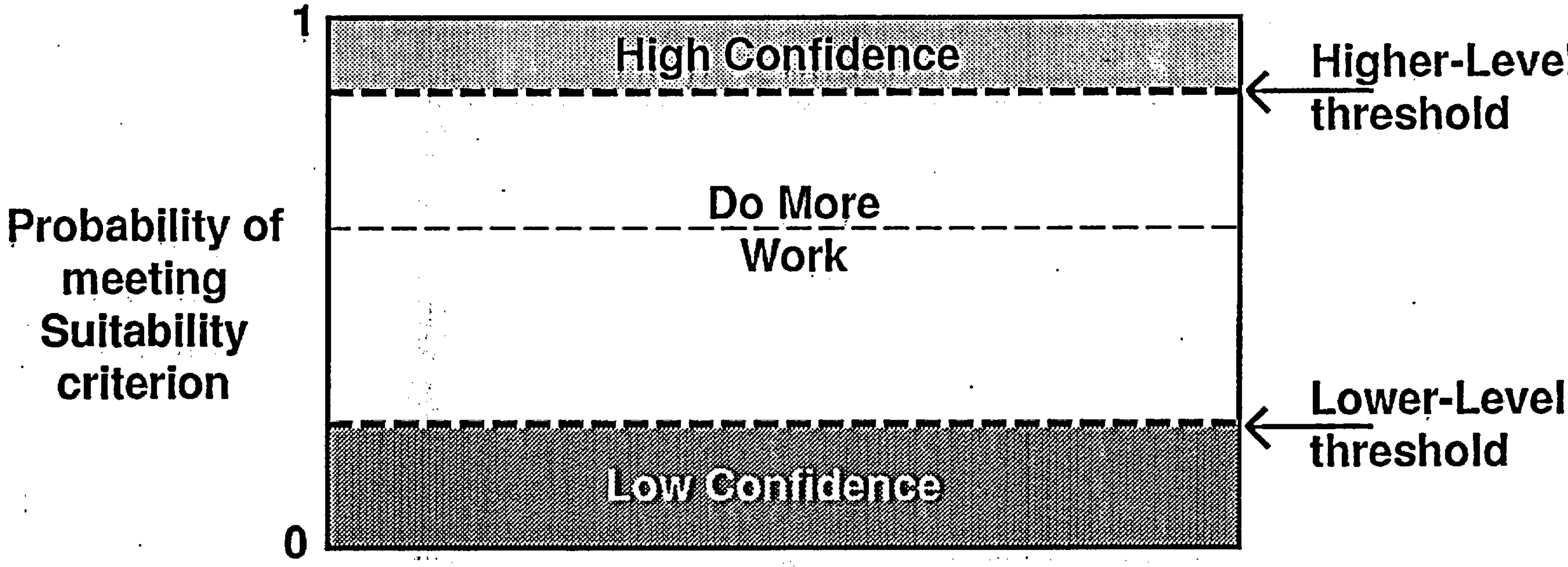


DEFINE SUITABILITY THRESHOLD



- If probability of meeting suitability criterion exceeds threshold, criterion is considered to be met.
- Selection depends upon regulatory criteria and other constraints.

DEFINE THRESHOLDS FOR ADDITIONAL WORK

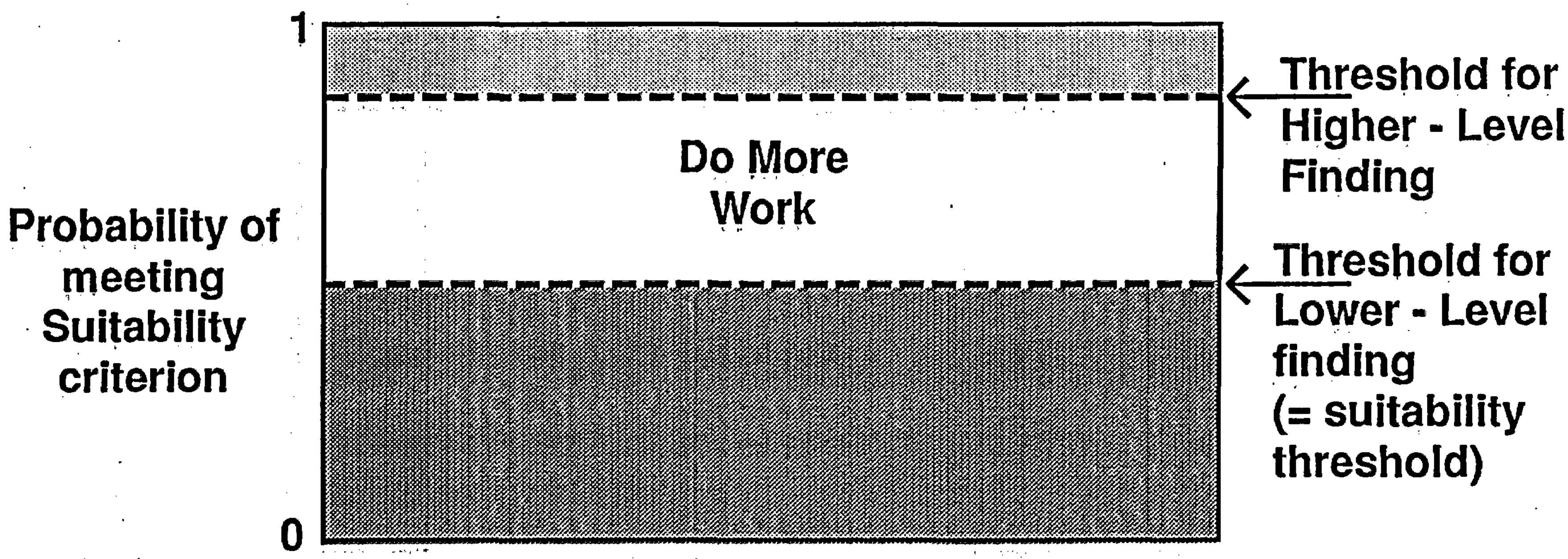


- High confidence means that additional work unlikely to reduce probability below suitability threshold.
- Low confidence means that additional work unlikely to increase confidence above suitability threshold
- Thresholds depend on decision-maker's values for relative importance of performance, cost, schedule etc.

ESSE SITING CRITERIA ARE SITING GUIDELINES OF 10 CFR PART 960

- Postclosure guidelines
- Preclosure guidelines
- Implementation guidelines

IMPLEMENTATION GUIDELINES DEFINE RELATIONSHIP OF SUITABILITY THRESHOLDS



POSTCLOSURE GUIDELINES

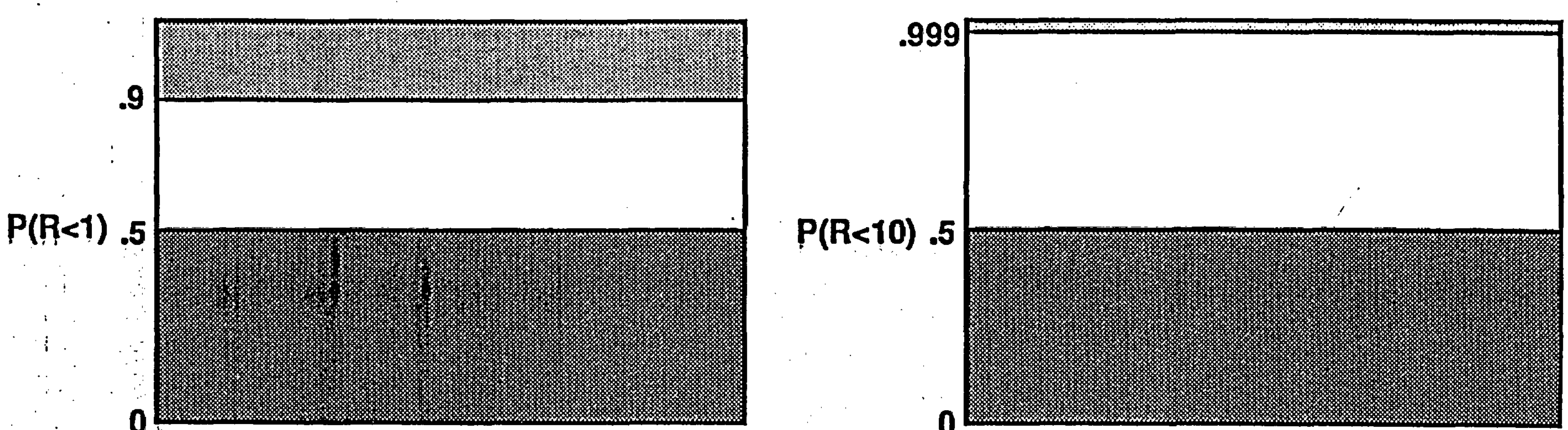
- System guidelines - Performance requirements from regulations
  - System performance (EPA standards)
  - EBS performance

- Technical Guidelines - Detailed geologic considerations that can disqualify site
  - Geohydrology
  - Geochemistry
  - Climate changes
  - Erosion
  - Dissolution
  - Tectonics
  - Human Interference

EARLY SITE-SUITABILITY EVALUATION

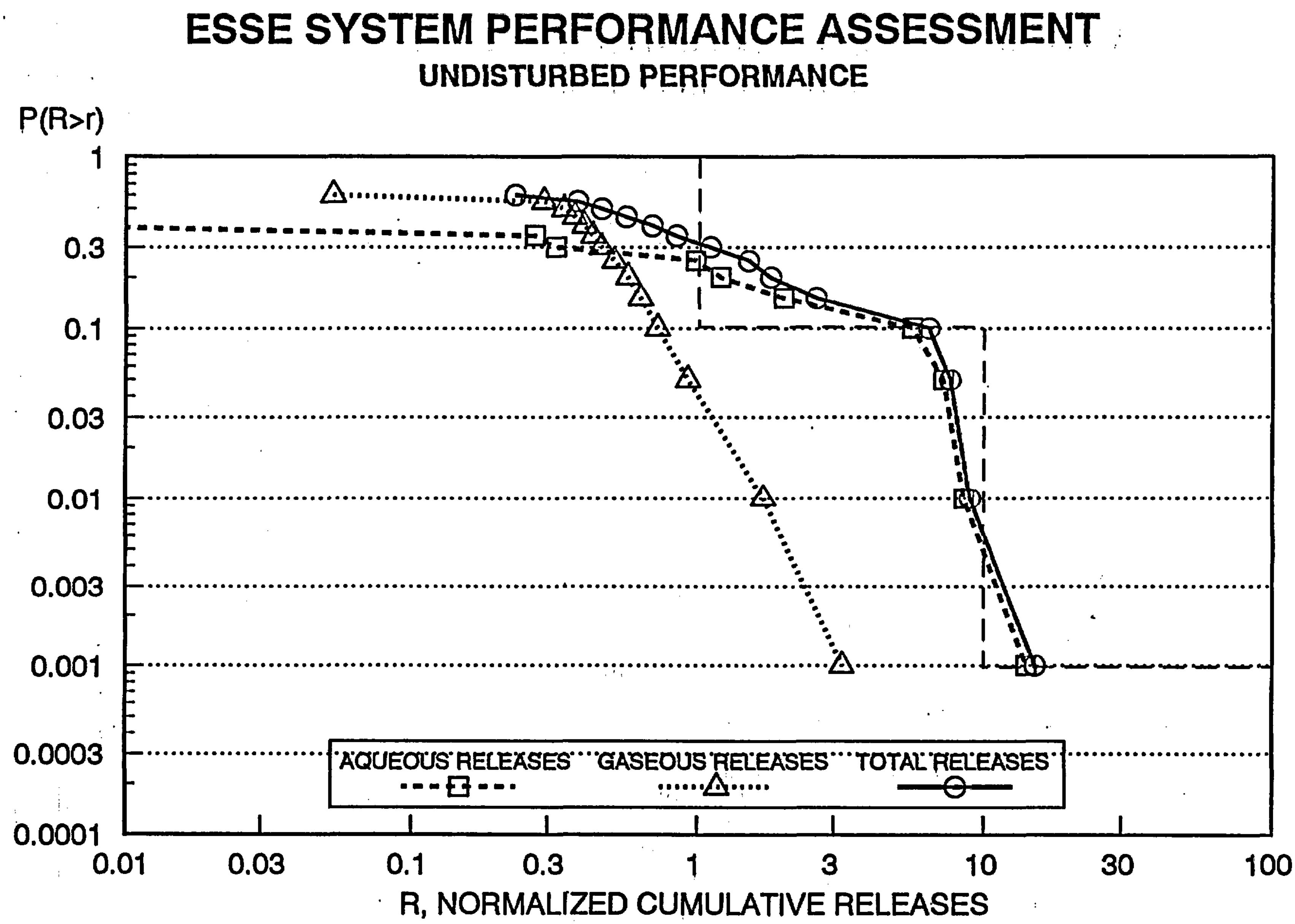
- Focus on features or conditions that indicate site unsuitable for repository development
- Examine current information to identify key issues for each guideline
- Evaluate importance of issues relative to system performance

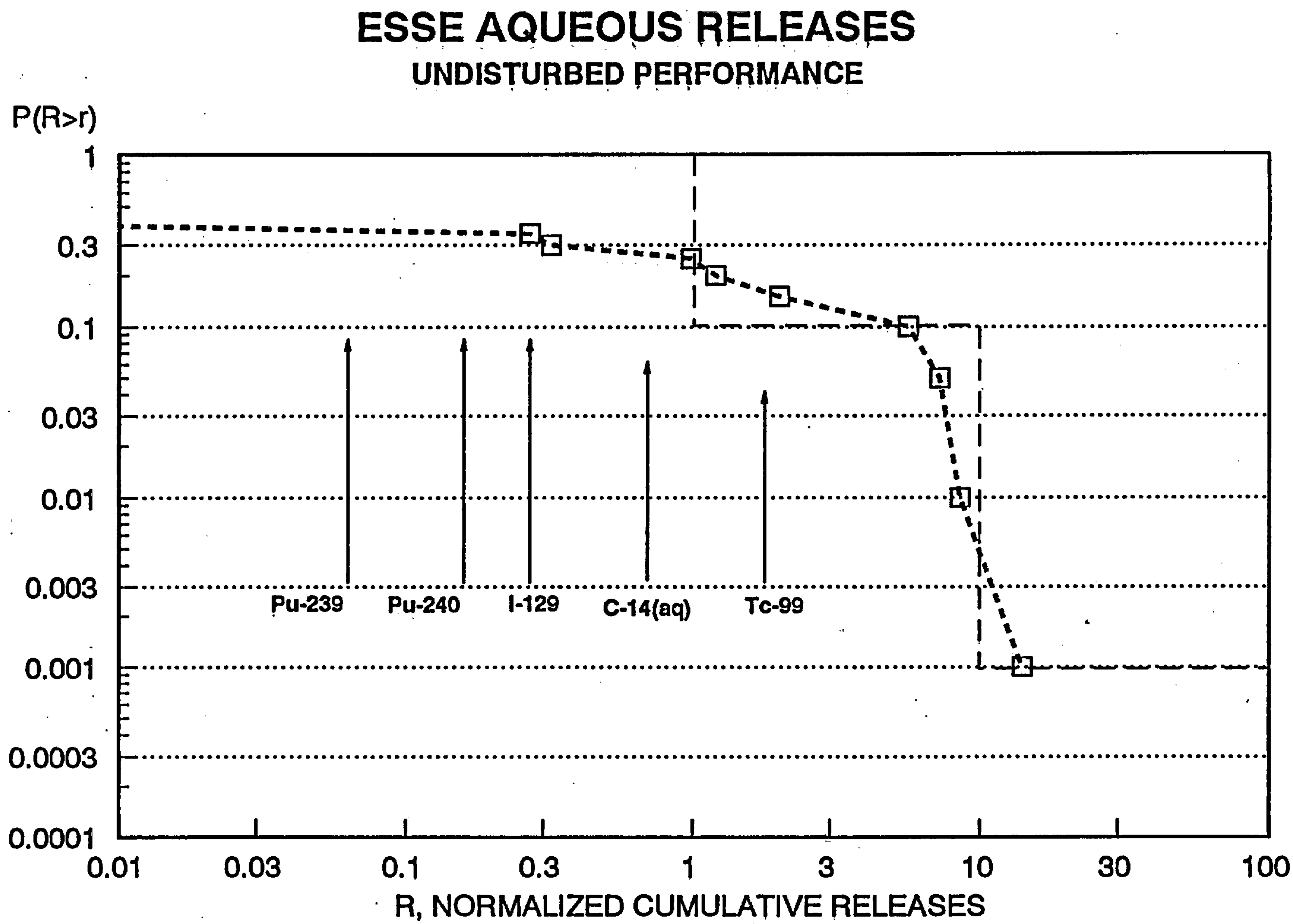
FOCUS OF POSTCLOSURE SYSTEM GUIDELINE IN ESSE IS NORMALIZED CUMULATIVE RELEASE, R

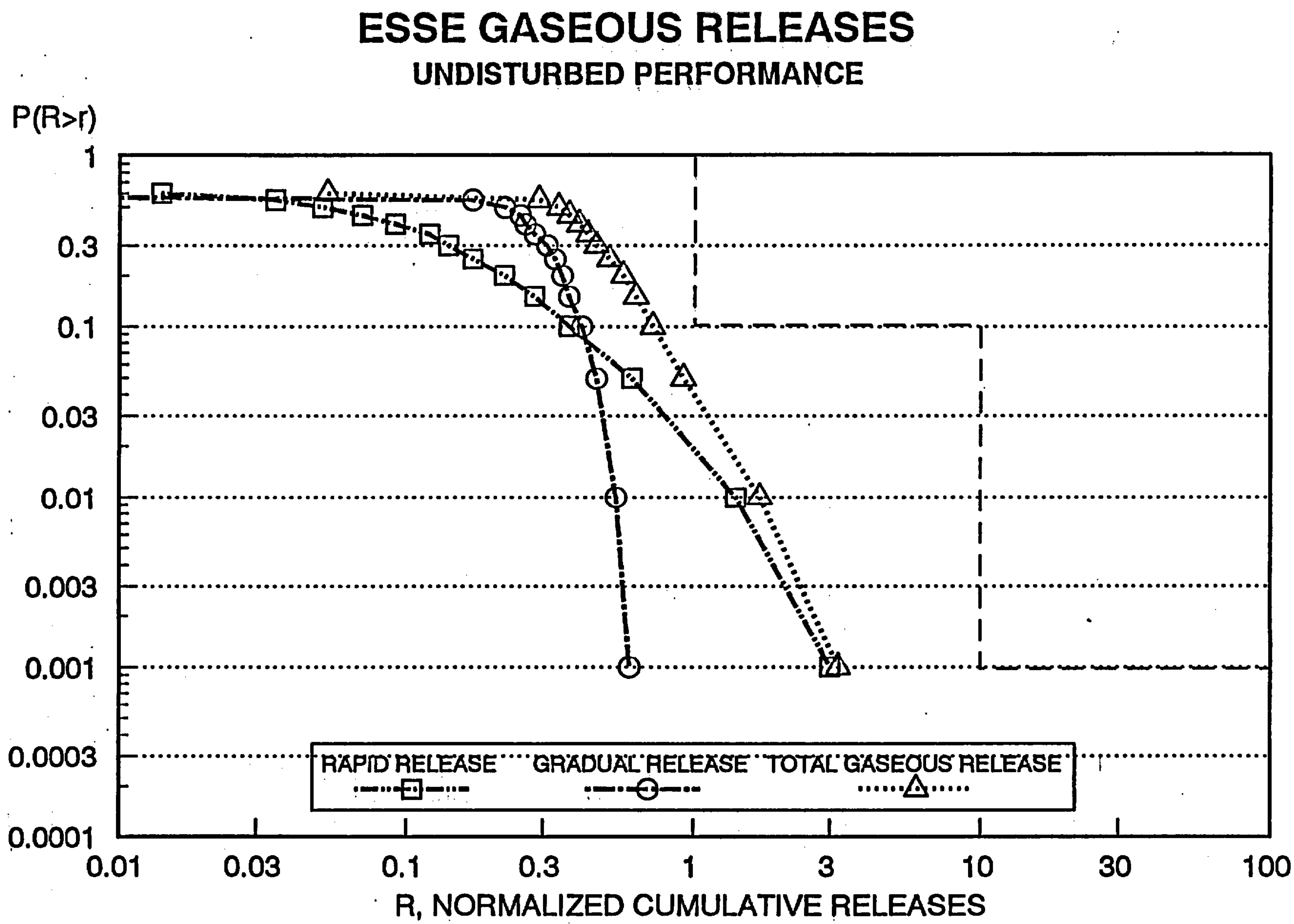


AGENDA

- OVERVIEW OF THE EARLY SITE-SUITABILITY EVALUATION (ESSE)
- ***OVERVIEW OF PERFORMANCE ASSESSMENT MODEL***
- ESSE PA ANALYSES

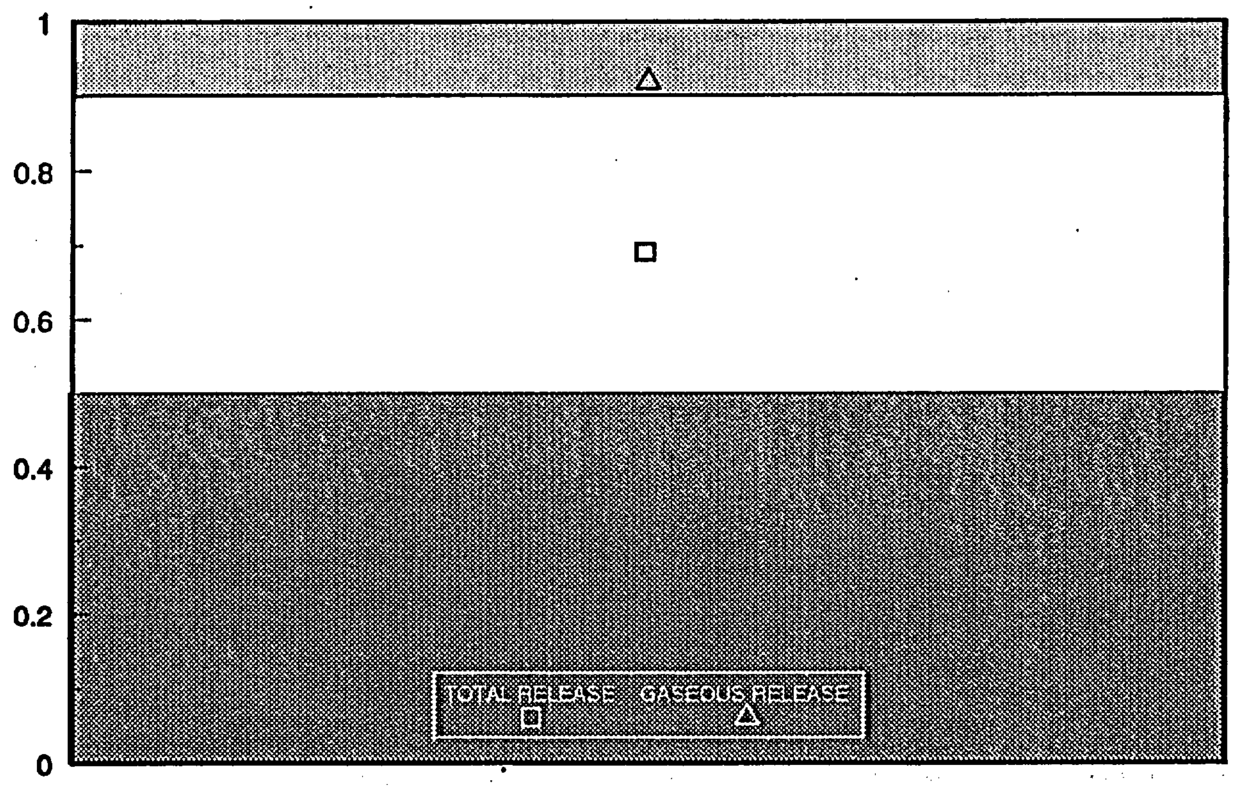

ESSE SYSTEM PERFORMANCE ASSESSMENT
UNDISTURBED PERFORMANCE
P(R>r)
1
0.3
0.1
0.03
0.01
0.003
0.001
0.0003
0.0001
0.01
0.03
0.1
0.3
1
3
10
30
100
R, NORMALIZED CUMULATIVE RELEASES
AQUEOUS RELEASES
GASEOUS RELEASES
TOTAL RELEASES


ESSE AQUEOUS RELEASES
UNDISTURBED PERFORMANCE
P(R>r)
1
0.3
0.1
0.03
0.01
0.003
0.001
0.0003
0.0001
Pu-239
Pu-240
I-129
C-14(aq)
Tc-99
0.01
0.03
0.1
0.3
1
3
10
30
100
R, NORMALIZED CUMULATIVE RELEASES

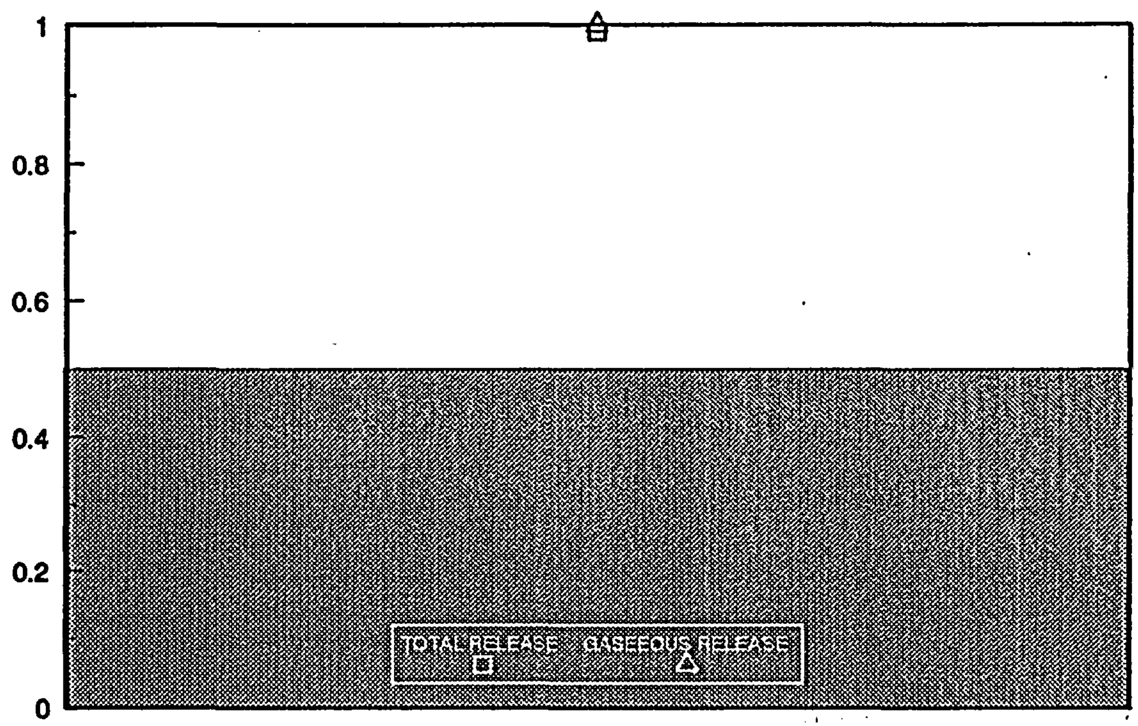


ESSE GASEOUS RELEASES
UNDISTURBED PERFORMANCE
P(R>r)
1
0.3
0.1
0.03
0.01
0.003
0.001
0.0003
0.0001
0.01
0.03
0.1
0.3
1
3
10
30
100
R, NORMALIZED CUMULATIVE RELEASES
RAPID RELEASE
GRADUAL RELEASE
TOTAL GASEOUS RELEASE

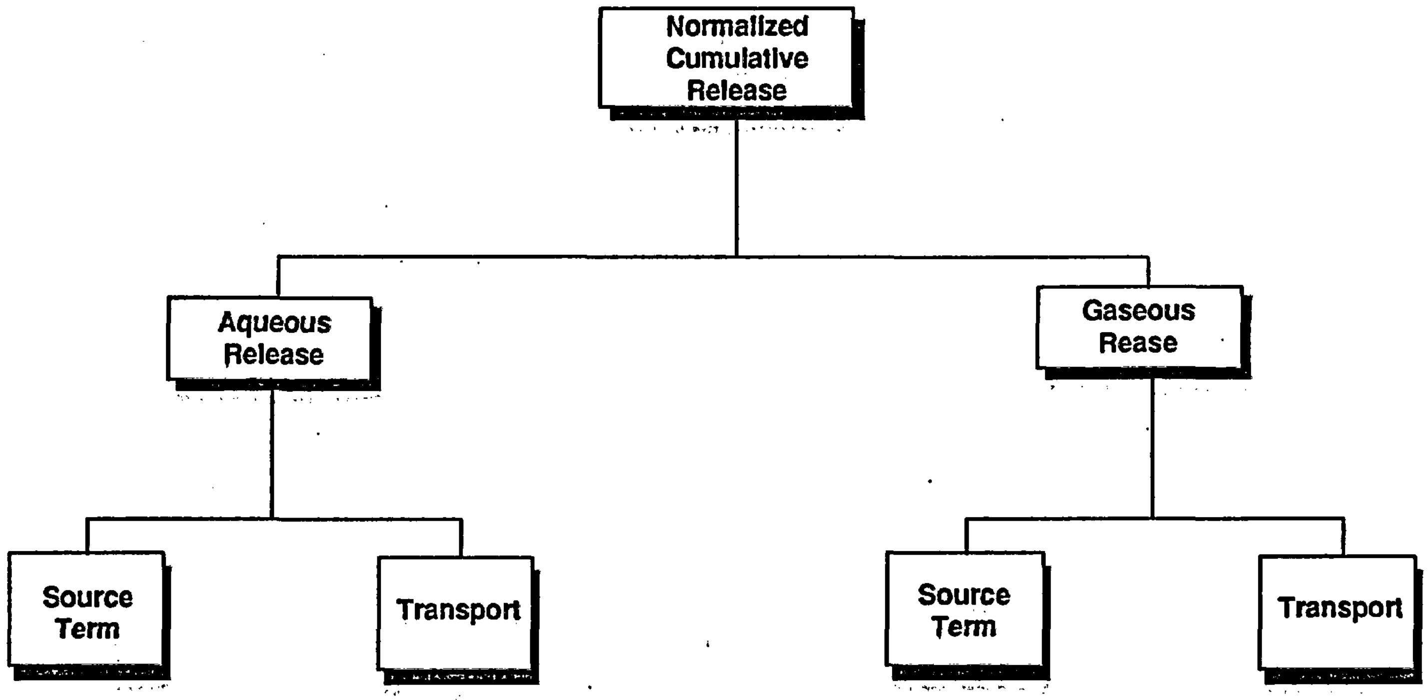
SITE SUITABILITY FOR FIRST CRITERION
P(R<1)



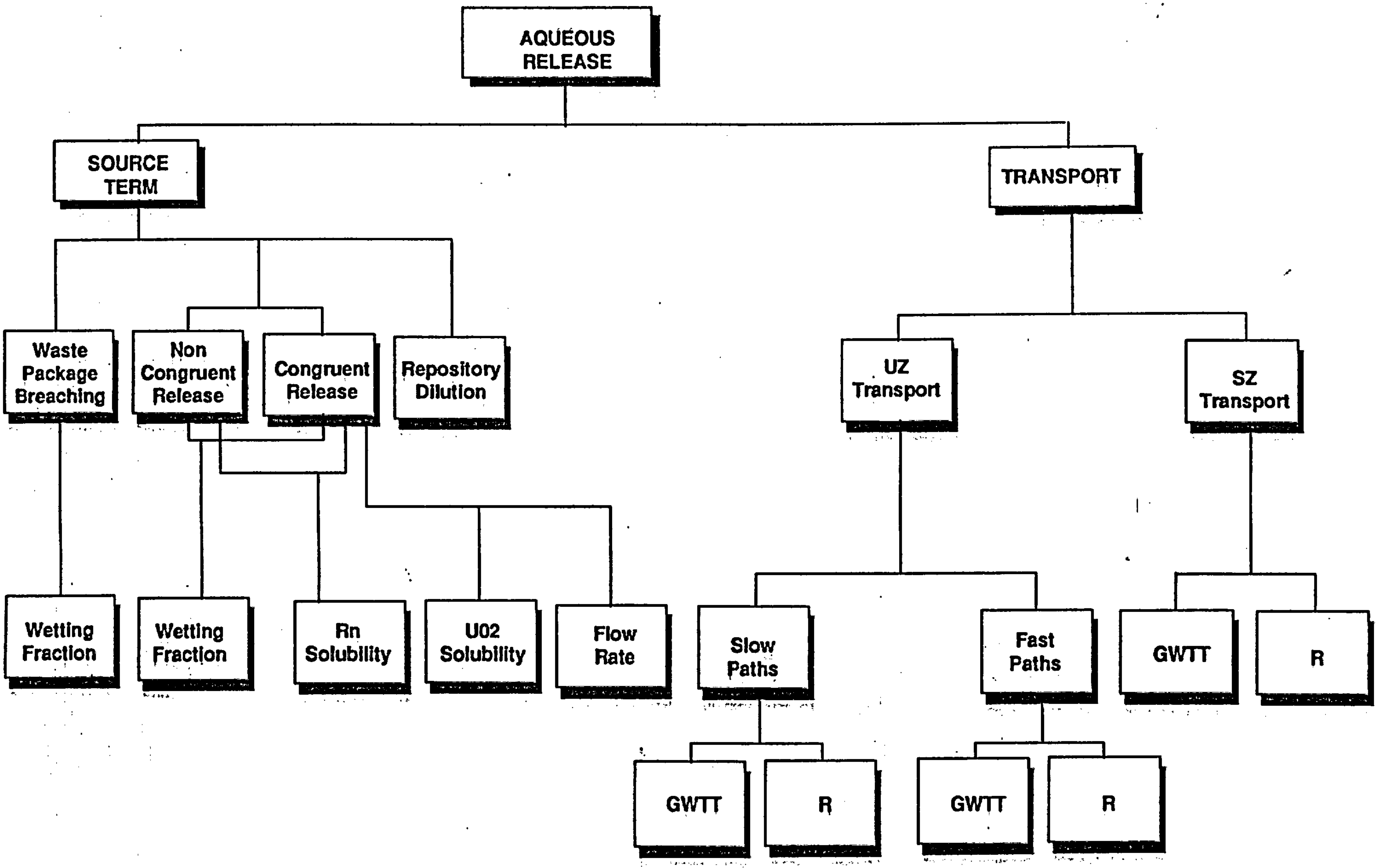
SITE SUITABILITY FOR SECOND CRITERION
P(R<10)



ESSE PERFORMANCE ASSESSMENT MODEL

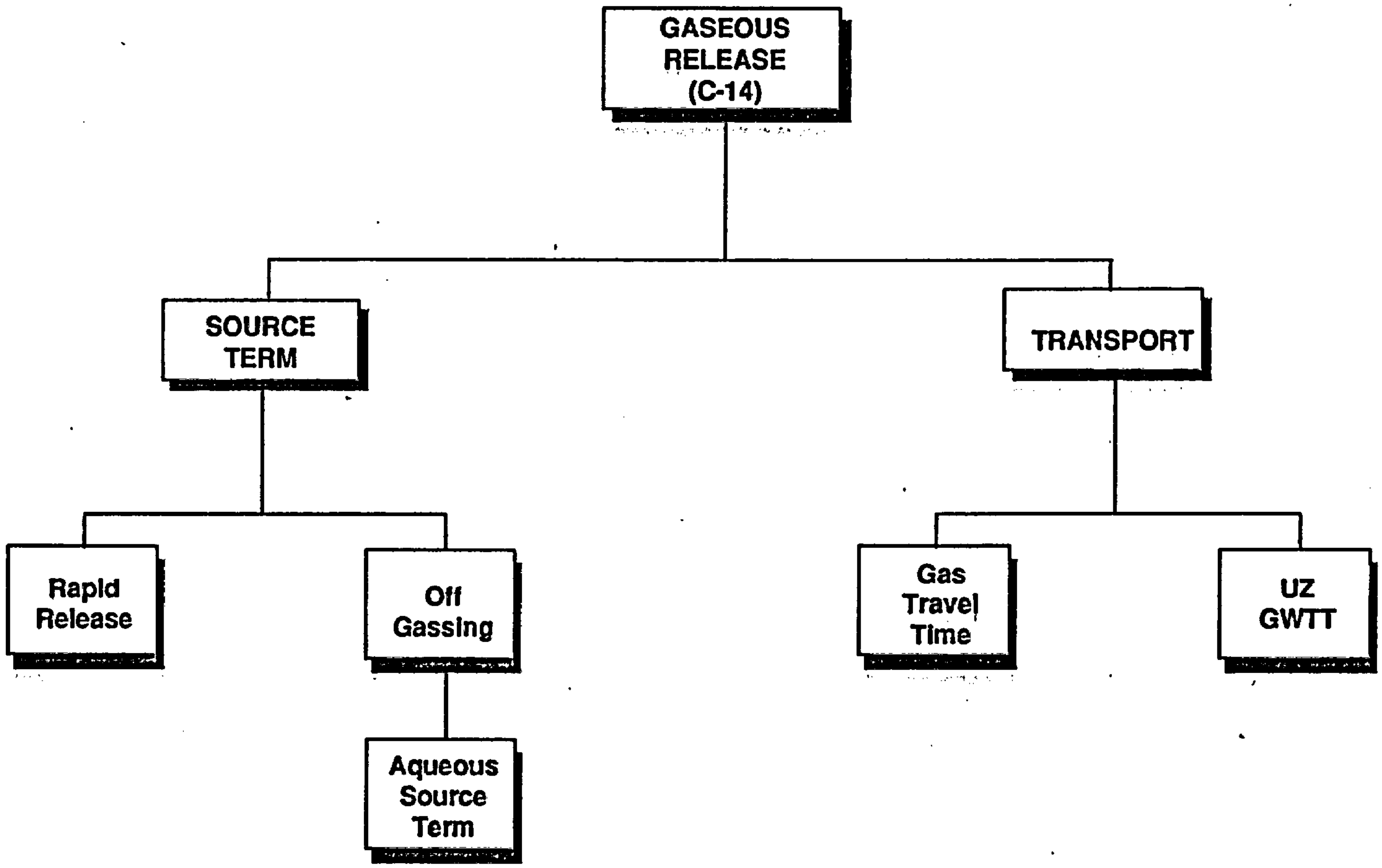


ESSE AQUEOUS RELEASE MODEL



ESSEQRM

ESSE GASEOUS RELEASE MODEL



ESSE PERFORMANCE ASSESSMENT MODEL

Aqueous Release	Basis
Waste package breach time	Design goal
Congruent leach rate	Estimated from flux and UO2 solubility
Non congruent leach rate	Data for UO2
Rn solubility limit	Current information on radionuclides
EBS exposure	Fraction of flux in fractures in TS
UZ GWTT	Calculated in 1D from site properties
Effective UZ retardation	Estimated from matrix or fracture properties
SZ GWTT	Estimated from analyses of SZ
Repository dilution	Calculated from geometry and SZ GWTT
Gaseous Releases	
Rapid release fraction	Data for spent fuel
Gradual release fraction (off- gassing)	Estimated from partitioning coefficients
Gas travel time	Estimates by Ross et al considering heat
Off gas travel time	Gas travel time and small fraction of GWTT

PARAMETERS FOR UNDISTURBED CASE

Inventories

All inventories are specified in terms of an initial (t=0) inventory multiplied by an appropriate exponential decay term.

Aqueous Source Term

WP loading	2.3 MTHM
Awp, WP area	0.33 m2
q, flux past WP	Exponential distribution with mean = 1 mm/yr
Ks	Exponential distribution with mean = .62 mm/yr
Fracture porosity	0.00041
P(fracture flow)	0 if q < Ks, 1 if q > Ks
Twp, breach time	100,000 years if no flow in fractures Normal distribution with mean = 1000 yrs, s.d.= 350 yrs if flow in fractures
Usl, UO2 sol. lt.	Log is uniformly distributed from -4 to -3
Noncongruent lch rt	Log of normal distribution with mean = -7 and s.d = .0405

Gaseous Source Term

Rapid rls fraction	Log of normal distribution with mean of -3.7 and s.d. of 1.1
Offgassed fraction	Uniform distribution from .05 to 0.1

Element Properties

Element	Log S.L.	Log Rslow	Rfast
U	Uniform(-4,-3)	Uniform(.7,.15)	1
Am	Uniform(-9.7,-6.7)	Uniform(2,4)	1.4
C	0	0	1
I	0	0	1
Np	Uniform(-4.7,-3)	Uniform(.7,2)	1
Pu	Uniform(-7.3,-5.5)	Uniform(2,3.2)	1.1
Tc	0	Uniform(0,1)	1.1

Travel Time

Tsz, SZ GWTT	Log Tsz distributed uniformly between 2.1 and 3.6
Repos dilution	0.5/Tsz
Tuz, UZ GWTT	Tslow with prob. 0.82, Tfast with Pfast = 0.18
Tslow	Lognormal distr. with mean=20K yrs and s.d.=10K yrs
Tfast	Exponential distribution with mean of 1 year
Tgas	Uniform distribution from 2000 to 6000 years
Toffgas	Tuz*Uniform(0,.1)*(1+Uniform(0,1))+Tgas

PARAMETERS FOR ISSUES

Increased flux

q	Exponential distribution with mean = 1.5 mm/yr
Tslow	Lognormal with mean = 12K yrs and s.d. = 6K yrs
Pfast	0.21

Water table rise

Tslow	Lognormal with mean = 16K yrs and s.d. = 10K yrs

Flux concentration

q, flux	Exponential distribution with mean = 10 mm/y for 5 % of the repository area and exponential distribution with mean = 0.5 mm/yr for 95 % of the area
Tuz	T1 with a prob = 0.05 and T2 with a prob = 0.95
T1	Tslow is lognormal with mean = 4K yrs and s.d. = 2K yrs and Pfast is 0.75
T2	Tslow is lognormal with mean = 28K yrs and s.d. = 14K yrs and Pfast is 0.15

Colloidal plutonium

R(plutonium)	Log of R distributed uniformly between -.3 and 3.2

Ground-water modeling uncertainty

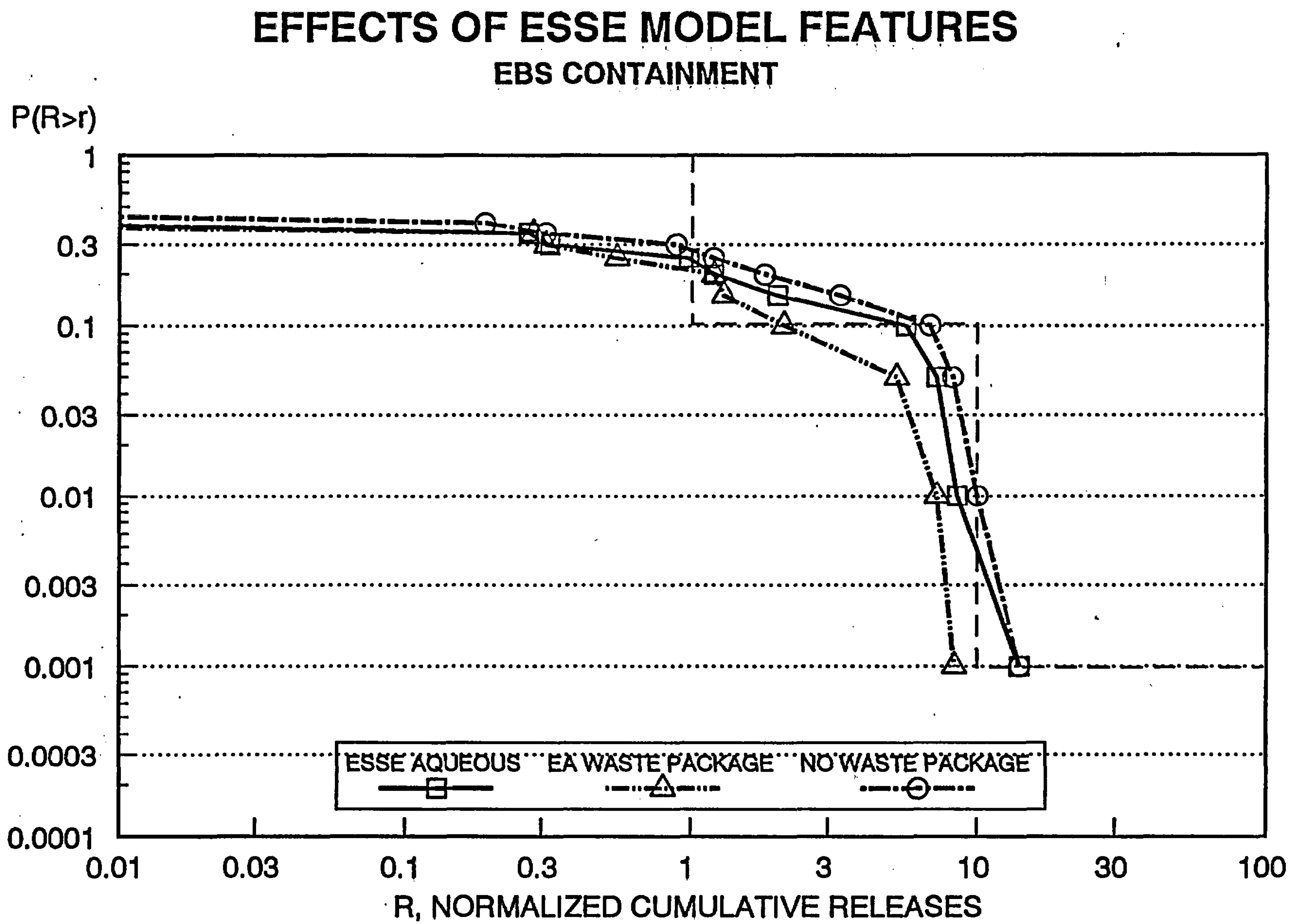
Tslow	Log of mean distributed uniformly between 3.3 and 5.3, log of s.d distributed uniformly between 3 and 5
Pfast	Log distributed uniformly between -1.36 and -.12

Source-term modeling uncertainty

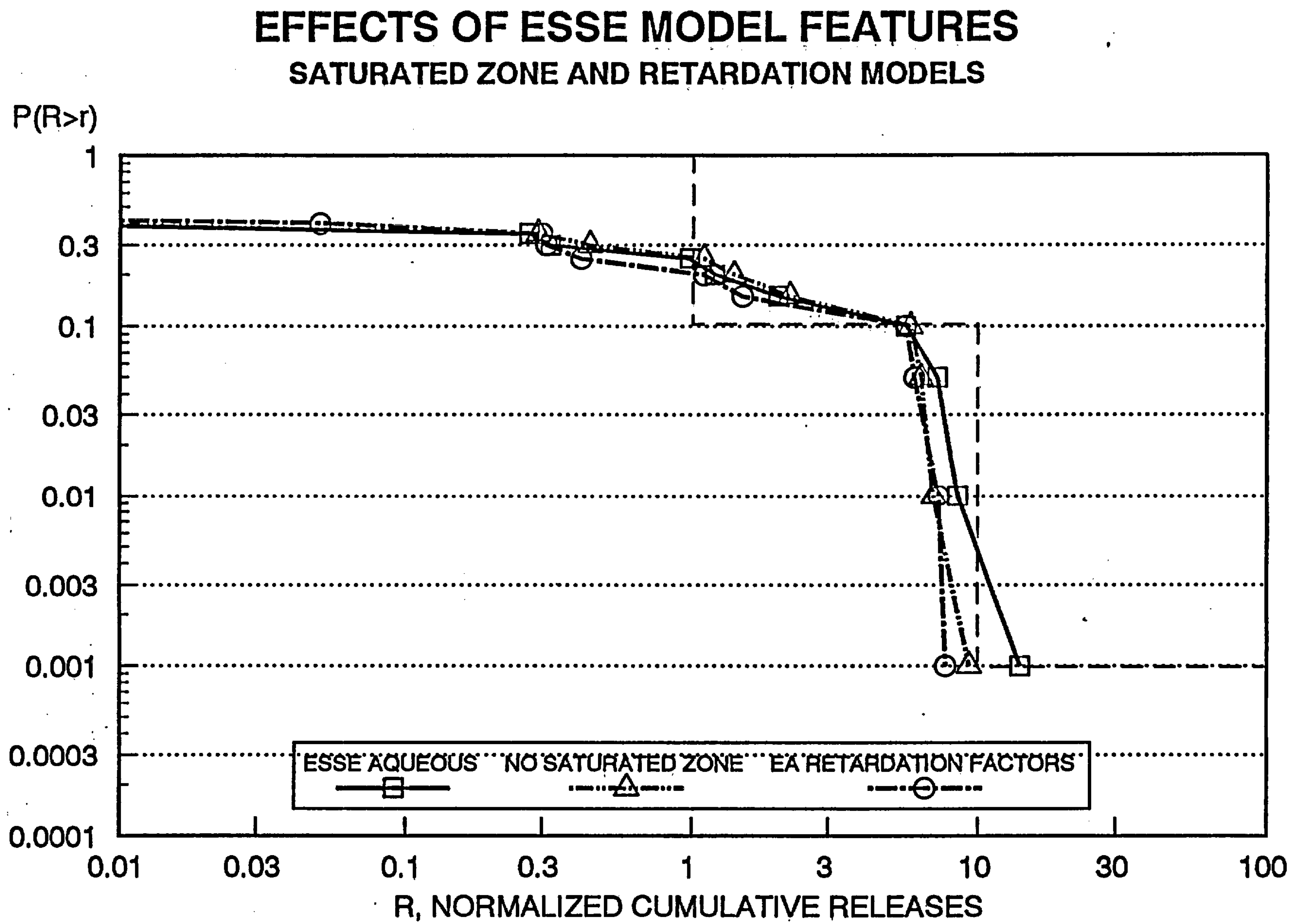
Flux, q	Log of mean uniformly distibuted between -5 and -1
Pwetting	Uniformly distributed between 0 and 1
UO2 S.L.	Log uniformly distributed between -6 and -1
N.C. lch rate	Logs of mean and s.d. uniformly distributed 2 units above and below the reference values

Human intrusion

Distribution for undisturbed releases plus releases calculated by Wilson for drilling through repository (Memorandum by Bernard et al. of June 23, 1991)

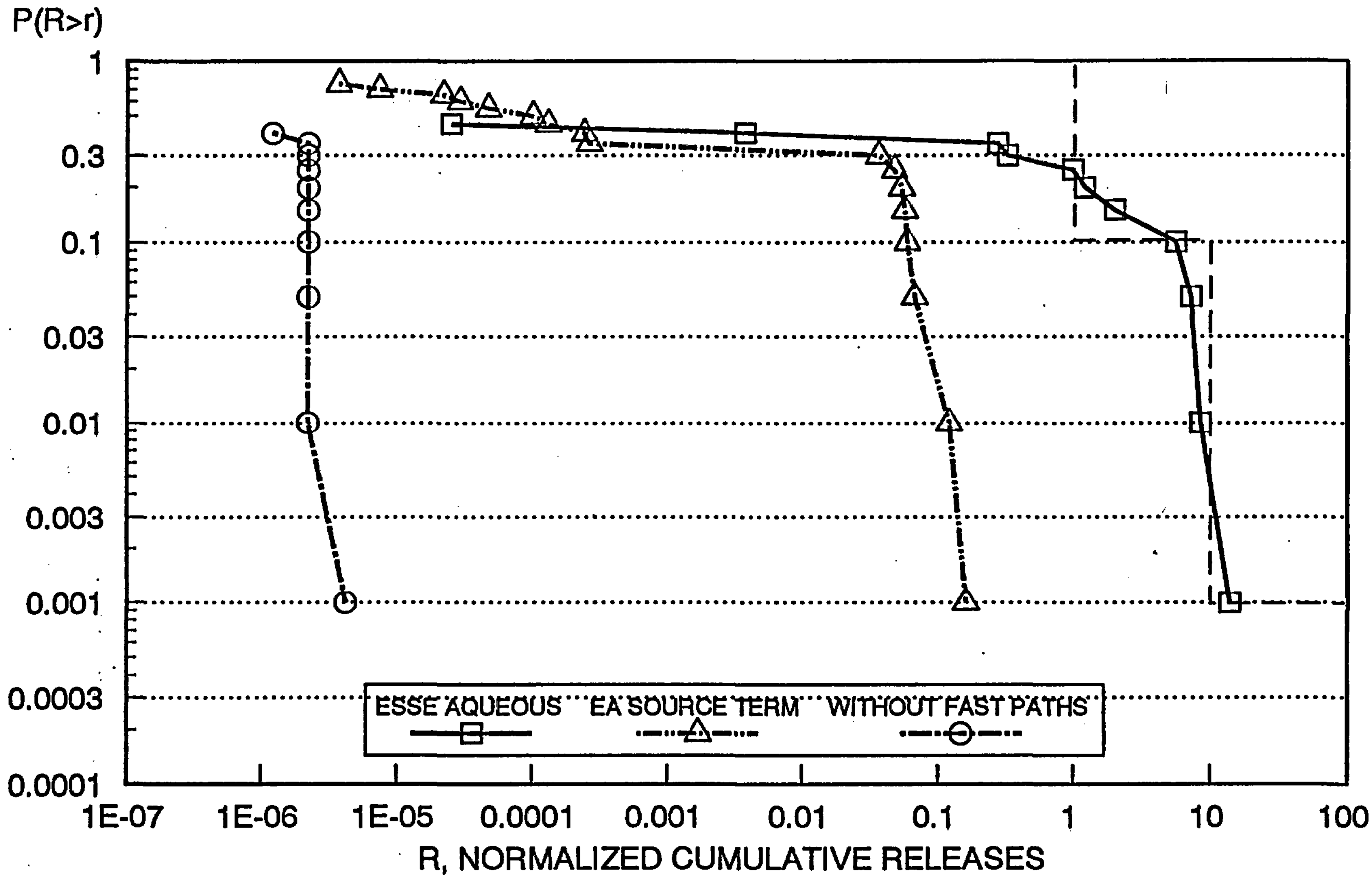


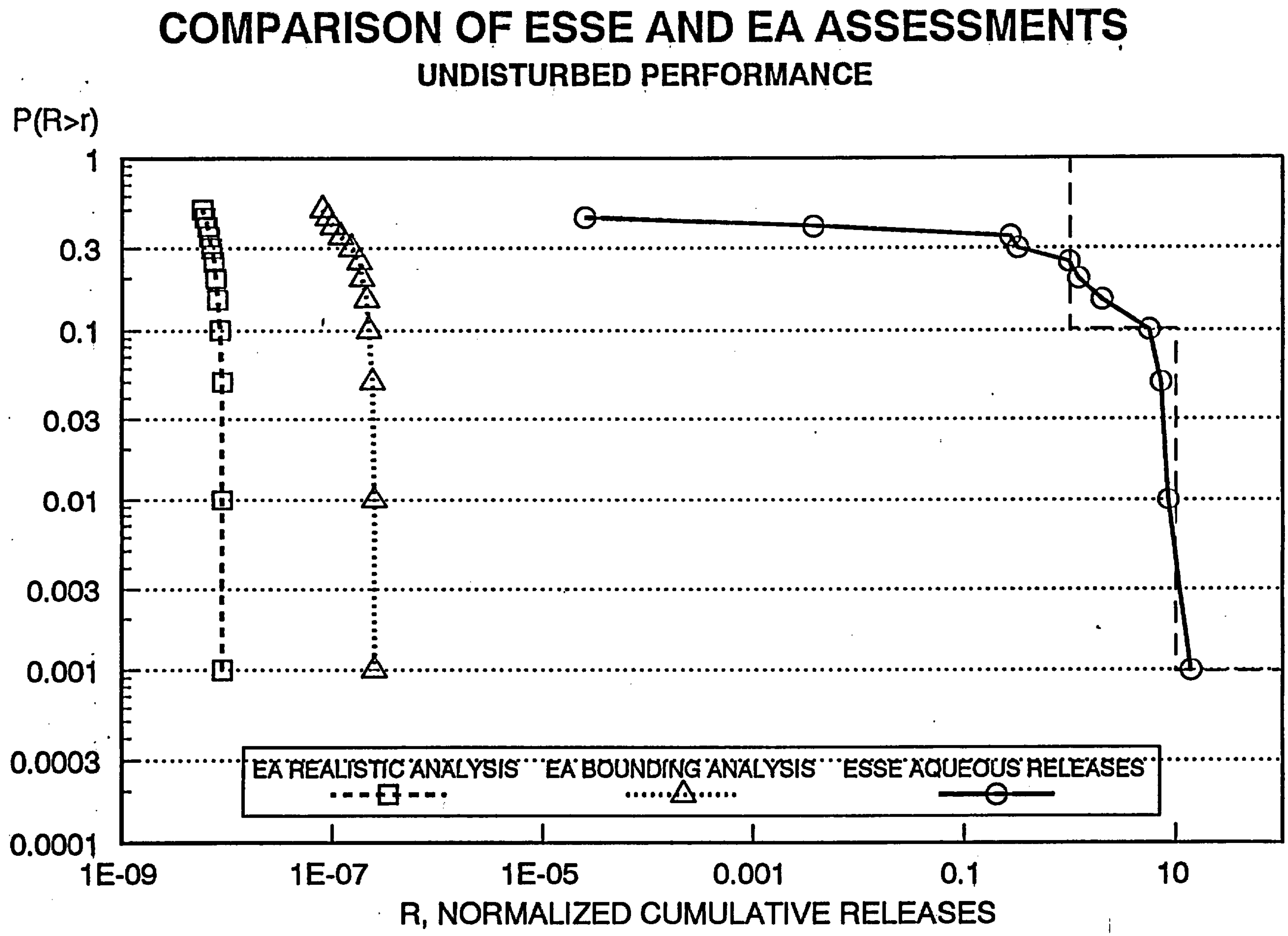
EFFECTS OF ESSE MODEL FEATURES
EBS CONTAINMENT
P(R>r)
1
0.3
0.1
0.03
0.01
0.003
0.001
0.0003
0.0001
0.01
0.03
0.1
0.3
1
3
10
30
100
R, NORMALIZED CUMULATIVE RELEASES
ESSE AQUEOUS
EA WASTE PACKAGE
NO WASTE PACKAGE


EFFECTS OF ESSE MODEL FEATURES
SATURATED ZONE AND RETARDATION MODELS
P(R>r)
1
0.3
0.1
0.03
0.01
0.003
0.001
0.0003
0.0001
0.01
0.03
0.1
0.3
1
3
10
30
100
R, NORMALIZED CUMULATIVE RELEASES
ESSE AQUEOUS
NO SATURATED ZONE
EA RETARDATION FACTORS

EFFECTS OF ESSE MODEL FEATURES

SOURCE TERM AND FAST PATH MODELS





COMPARISON OF ESSE AND EA ASSESSMENTS
UNDISTURBED PERFORMANCE
P(R>r)
1
0.3
0.1
0.03
0.01
0.003
0.001
0.0003
0.0001
1E-09
1E-07
1E-05
0.001
0.1
10
R, NORMALIZED CUMULATIVE RELEASES
EA REALISTIC ANALYSIS
EA BOUNDING ANALYSIS
ESSE AQUEOUS RELEASES

AGENDA

- OVERVIEW OF THE EARLY SITE-SUITABILITY EVALUATION (ESSE)
- OVERVIEW OF PERFORMANCE ASSESSMENT MODEL
- ***ESSE PA ANALYSES***

ISSUES IDENTIFIED IN TECHNICAL GUIDELINE EVALUATION

<u>Geohydrology</u>

- Effect of "fast paths" (e.g. heterogeneity; episodic infiltration; topography; perching)
- Modeling uncertainty (e.g. 2D vs 1D modeling)

<u>Geochemistry</u>

- Colloidal transport of plutonium

<u>Climate Changes</u>

- Potential water table rise
- Potential increase in flux

<u>Postclosure tectonics</u>

- Occurrence of faults
- Local concentration of flux due to new paths
- Modification to water table

<u>Human Interference</u>

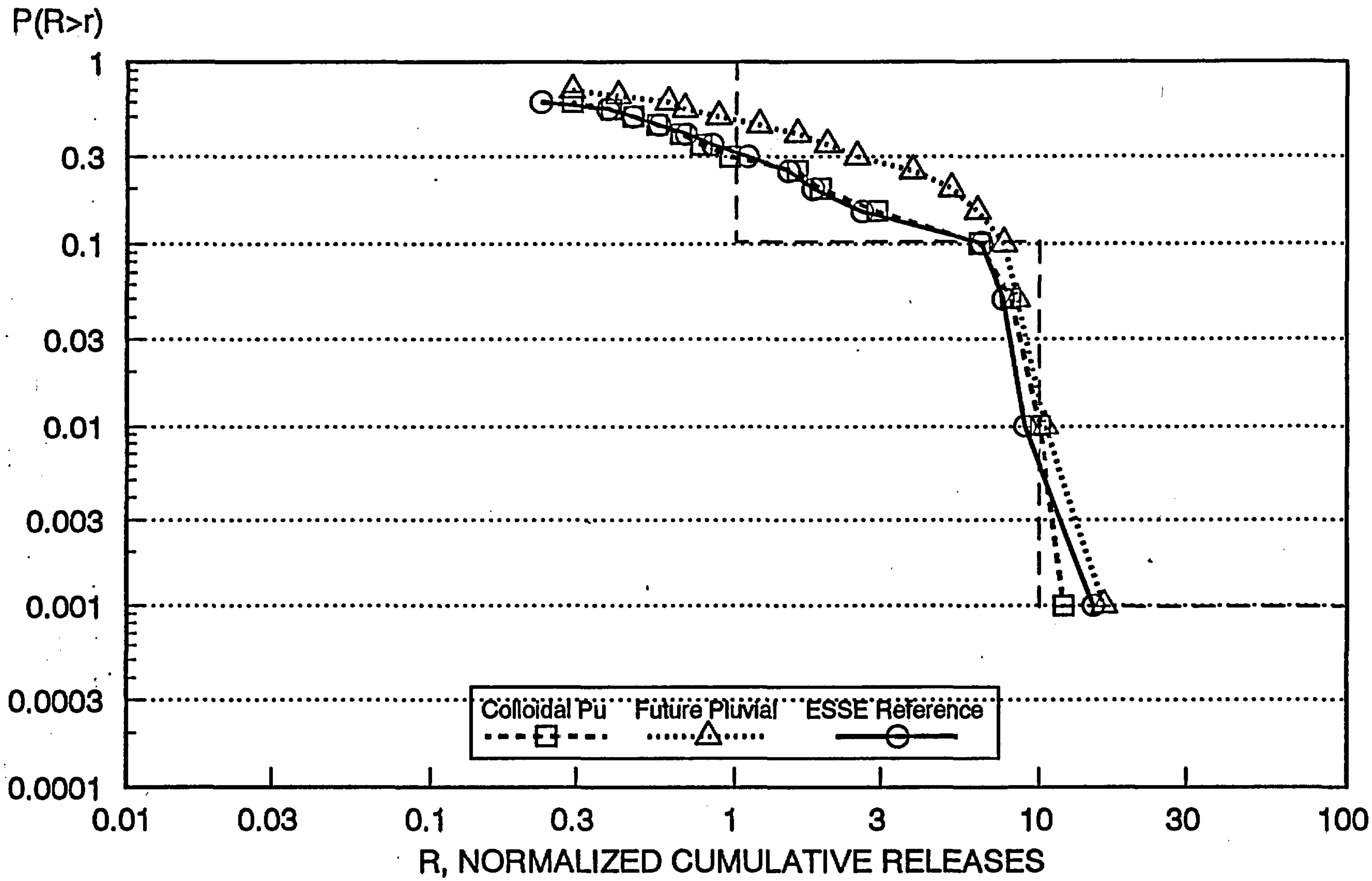
- Potential for future exploration

<u>Others</u>

- Potential for gaseous release

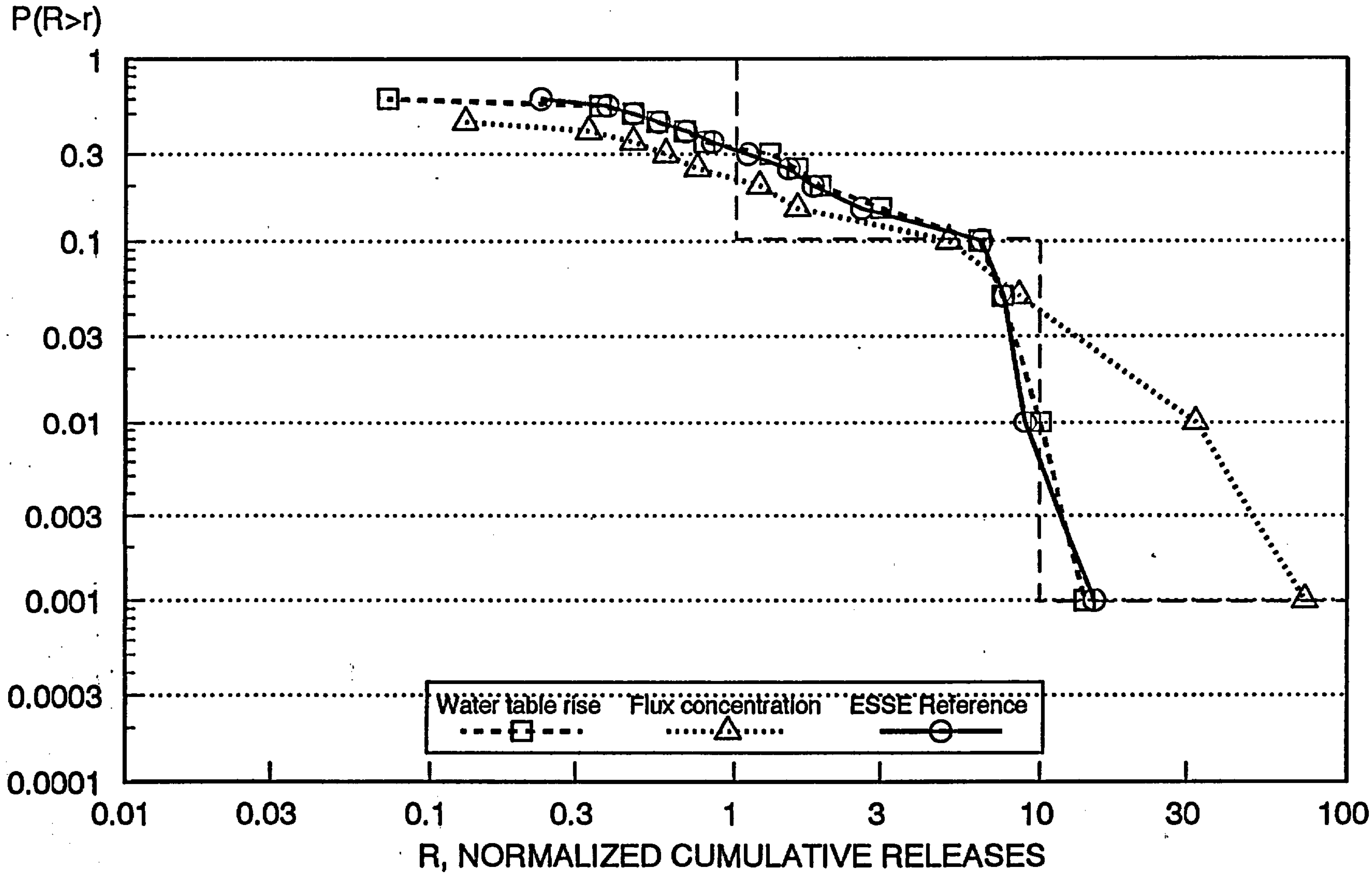
EVALUATION OF TECHNICAL GUIDELINE ISSUES

GEOCHEMISTRY AND CLIMATE CHANGES



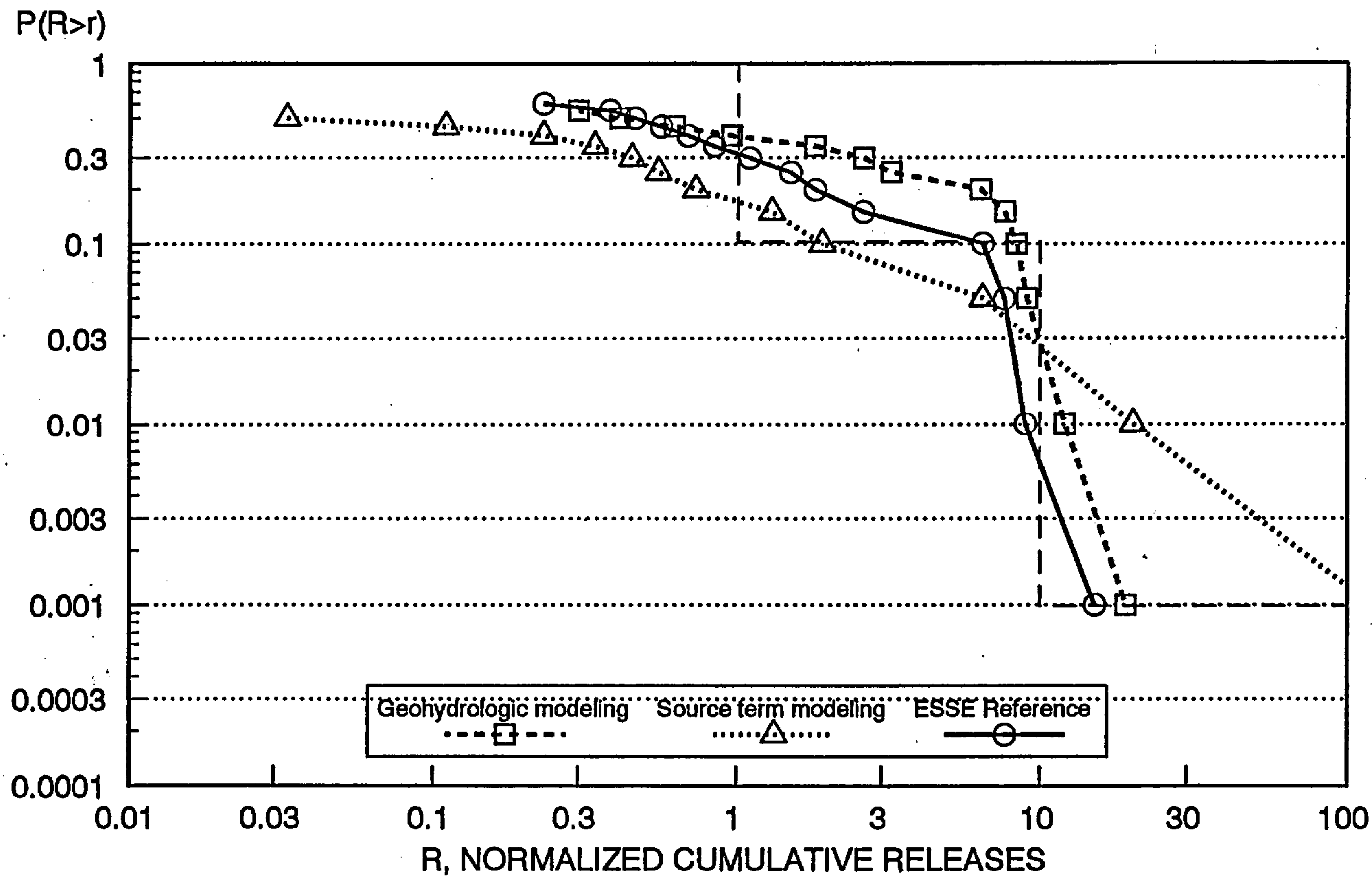
EVALUATION OF TECHNICAL GUIDELINE ISSUES

TECTONIC EFFECTS ON GEOHYDROLOGY



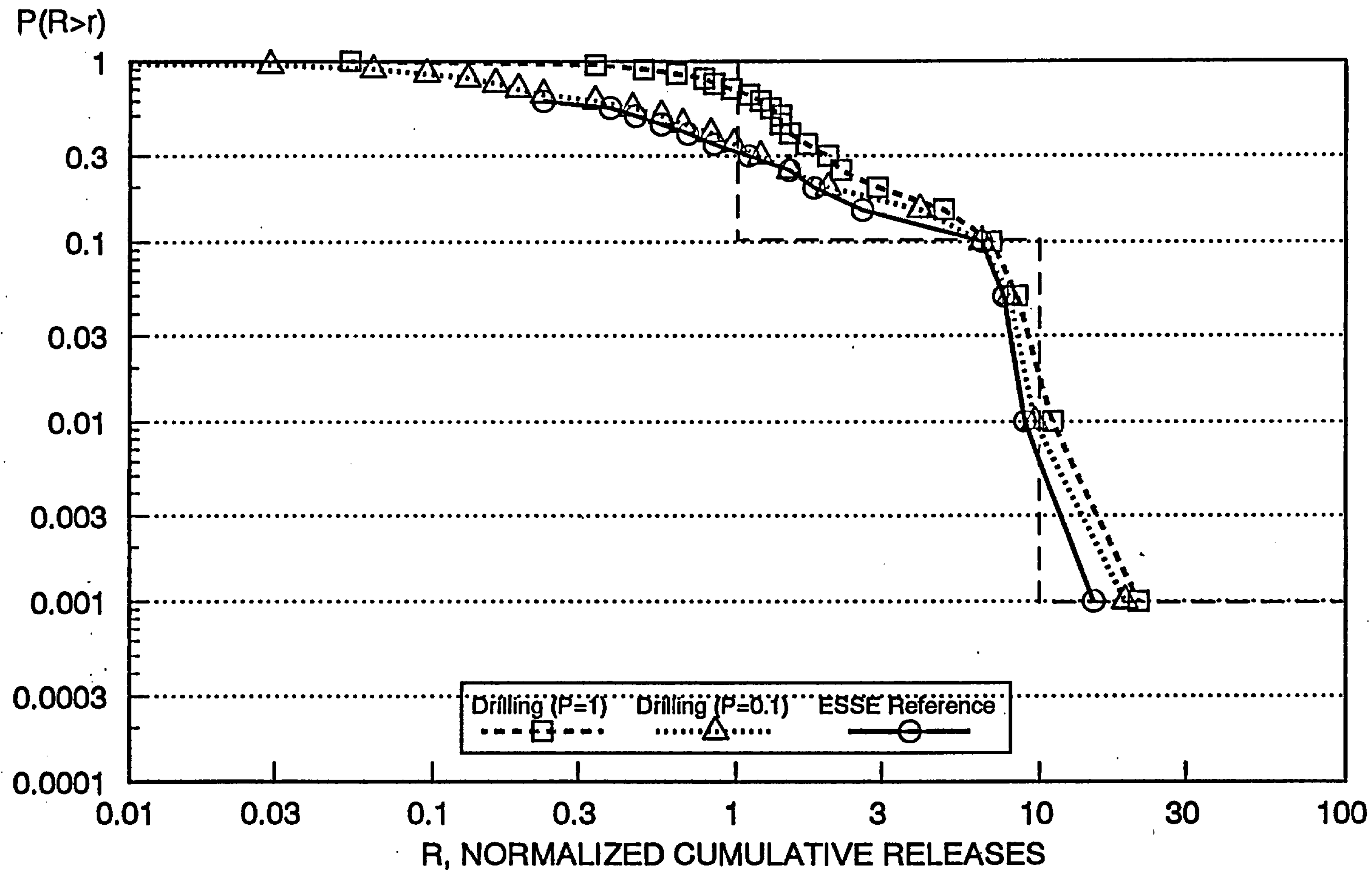
EVALUATION OF TECHNICAL GUIDELINE ISSUES

GEOHYDROLOGIC AND SOURCE TERM MODELING



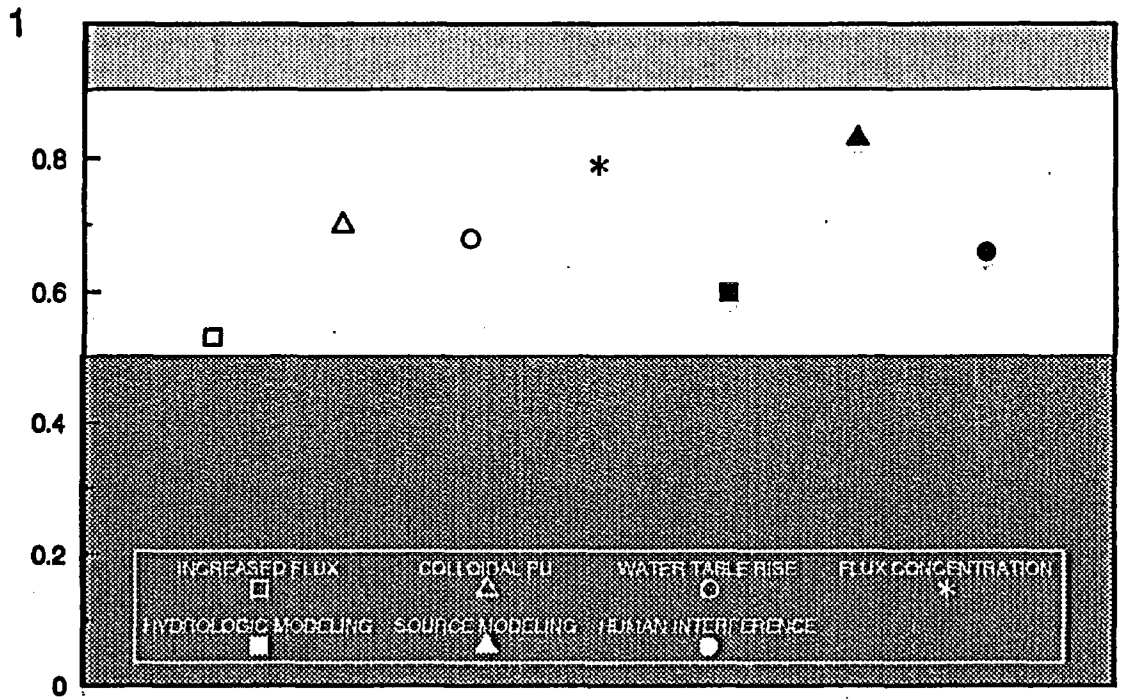
EVALUATION OF TECHNICAL GUIDELINE ISSUES

HUMAN INTERFERENCE



SITE SUITABILITY FOR FIRST CRITERION
P(R<1)

1



CONCLUSIONS

- CURRENT INFORMATION INDICATES NO FEATURES OR CONDITIONS AT YUCCA MOUNTAIN THAT MAKE IT UNSUITABLE
- MOST IMPORTANT ISSUE FOR SYSTEM PERFORMANCE IS PRESENCE OF FAST PATHS; EARLY TESTS SHOULD FOCUS ON THESE
- GASEOUS RELEASE ALONE CAUSES SITE TO BE MARGINALLY LICENSABLE, EVEN IF NO FAST AQUEOUS PATHS
- CONCLUSIONS REGARDING SITE SUITABILITY DO NOT DEPEND ON ENGINEERED BARRIERS

EPRI

EPRI HLW Performance Assessment Model

Total System Assessment Review Meeting

November 18-20, 1991
Las Vegas, NV

Robert A. Shaw
EPRI

EPRI HIGH–LEVEL WASTE PERFORMANCE ASSESSMENT PROJECT PHASE 2

Presentation of

PRELIMINARY MODEL DESCRIPTION AND RESULTS

by

ROBIN K. MCGUIRE

Risk Engineering Inc.

at

DOE – Las Vegas, NV

November 18, 1991

EPRI/NPD

EPRI HLW Project Objectives

- To develop an integrated methodology for early site performance assessment and to identify and prioritize crucial issues

- To involve DOE in this methodology development and its implementation

HLW&SFS

EPRI/NPD

EPRI High Level Waste Project
Methodology Development Team

Name	Affiliation	Expertise
Michael J. Apted	Intera Sciences	
Daniel B. Bullen	Georgia Tech	Waste Package
Stuart Childs	Cascade Earth Sciences, Ltd.	Infiltration
Neville Cook	Univ. of Calif, Berkeley	Rock Mechanics
Kevin Coppersmith	Geomatrix Consultants	Seismic Geology
Ralph L. Keeney	Univ. of Southern California	Risk/Decision Analysis
John M. Kemeny	University of Arizona	Rock Mechanics
Austin Long	University of Arizona	Climatology
Robin K. McGuire	Risk Engineering	Risk Analysis
F. Joseph Pearson, Jr.	Consultant	Geochemistry
Benjamin Ross	Disposal Safety, Inc.	Gaseous Transport
Frank W. Schwartz	Ohio State University	Hydrology
Michael Sheridan	State Univ. of NY, Buffalo	Volcanology
Robert A. Shaw	EPRI	Project Manager
J. Carl Stepp	EPRI	Seismology & Geophysics
Robert F. Williams	EPRI	HLW Sciences
Robert Youngs	Geomatrix Consultants	Geotechnical Engineering
Delbert S. Barth	UNLV/ERC	Observer
Russ Dyer	Department of Energy	Observer

HLW&SFS

EPRI/NPD

Methodology Development Team
1991 Activities

- Performance Assessment Model
  - Model gaseous transport
  - Time-dependent calculations
  - Model precipitation / evaporation / infiltration
  - Expand engineered barrier systems analysis
  - Include temperature dependence

HLW&SFS

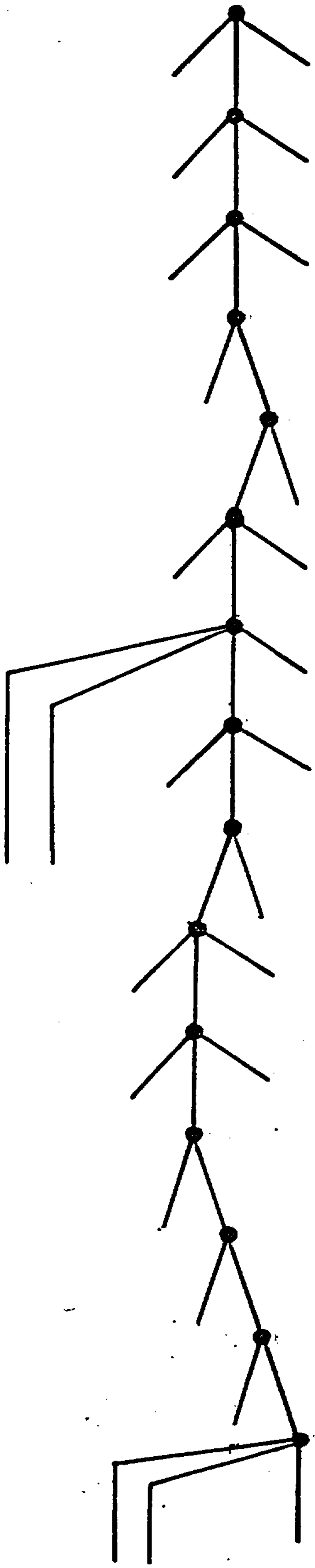
EPRI/NPD

Pilot Workshops

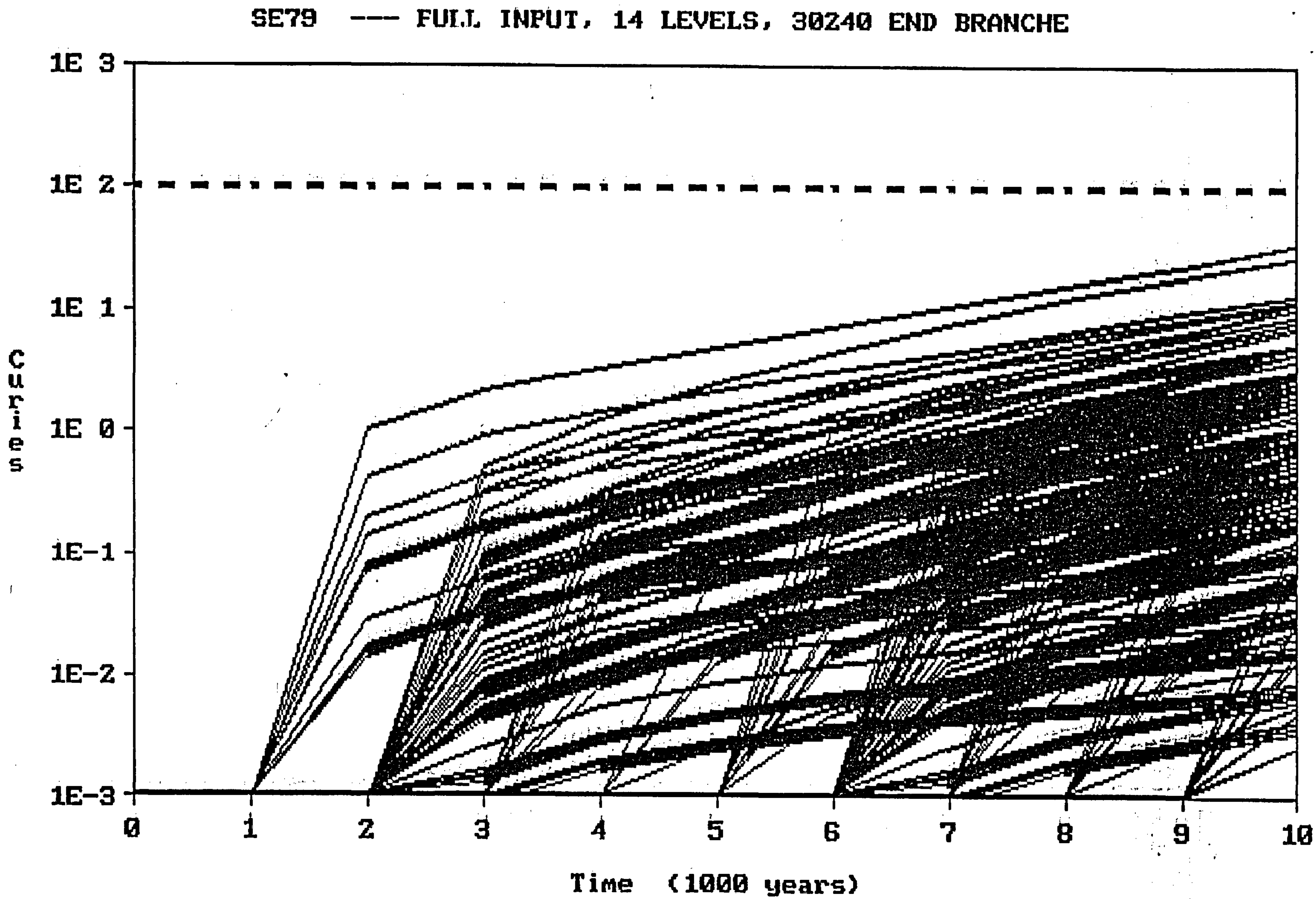
First one held November 14-15, 1991
Topic: Seismic Area in Performance Assessment Model
Quantify uncertainties using expert judgement
Develop a strategy for using available information
Conduct workshops (second in March 1992)
Report on workshops
Incorporate results in performance assessment model

HLW&SFS

EPRI PERFORMANCE ASSESSMENT LOGIC TREE



1. FLUX
2. LATERAL REDISTRIBUTION OF FLUX
3. ΔWT | FLUX
4. FRACTURE–MATRIX COUPLING
5. SATURATED FLOW VELOCITY
6. MATRIX RETARDATION
7. VOLCANOES
8. ΔWT | VOLCANOES
9. EARTHQUAKES
10. ΔWT | EARTHQUAKES
11. HEAT PULSE
12. BOREHOLE FRACTURES | HEAT PULSE
13. CONTAINER PERFORMANCE | HEAT PULSE
14. WASTE AND ELEMENT SOLUBILITY
15. HUMAN INTRUSION


SE79 --- FULL INPUT, 14 LEVELS, 30240 END BRANCHE
1E 3
1E 2
1E 1
1E 0
1E-1
1E-2
1E-3
Curies
0
1
2
3
4
5
6
7
8
9
10
Time (1000 years)

Key issues for describing net infiltration are:

1. Variability of Climate. Climate input to infiltration calculations are external but direct. Austin Long supplied probability distributions for:

   - Annual precipitation
   - Fraction of precipitation falling in the summer months (May - October)
   - Annual air temperature.

2. Spatial variability of net infiltration. This issue was addressed in two steps:

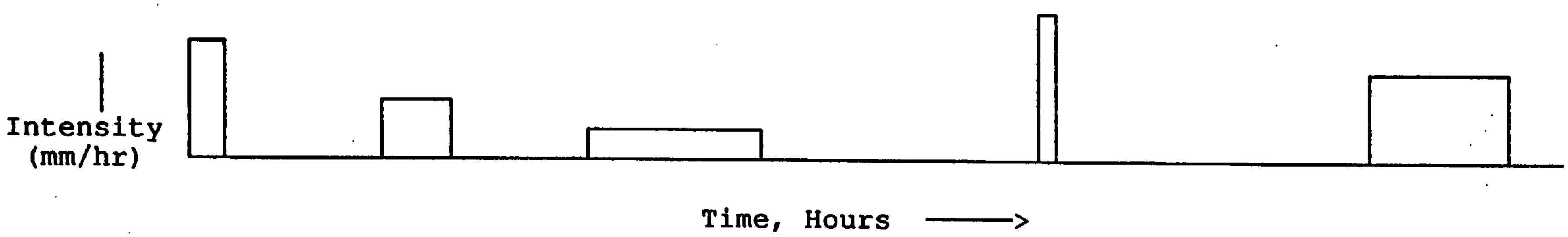
   - Development of hydrologic/soil/topographic land units
   - Procedure for integrating net infiltration fluxes over the project area

3. Physical/biological processes for vertical flow. These were primarily addressed in an offline model of water flow:

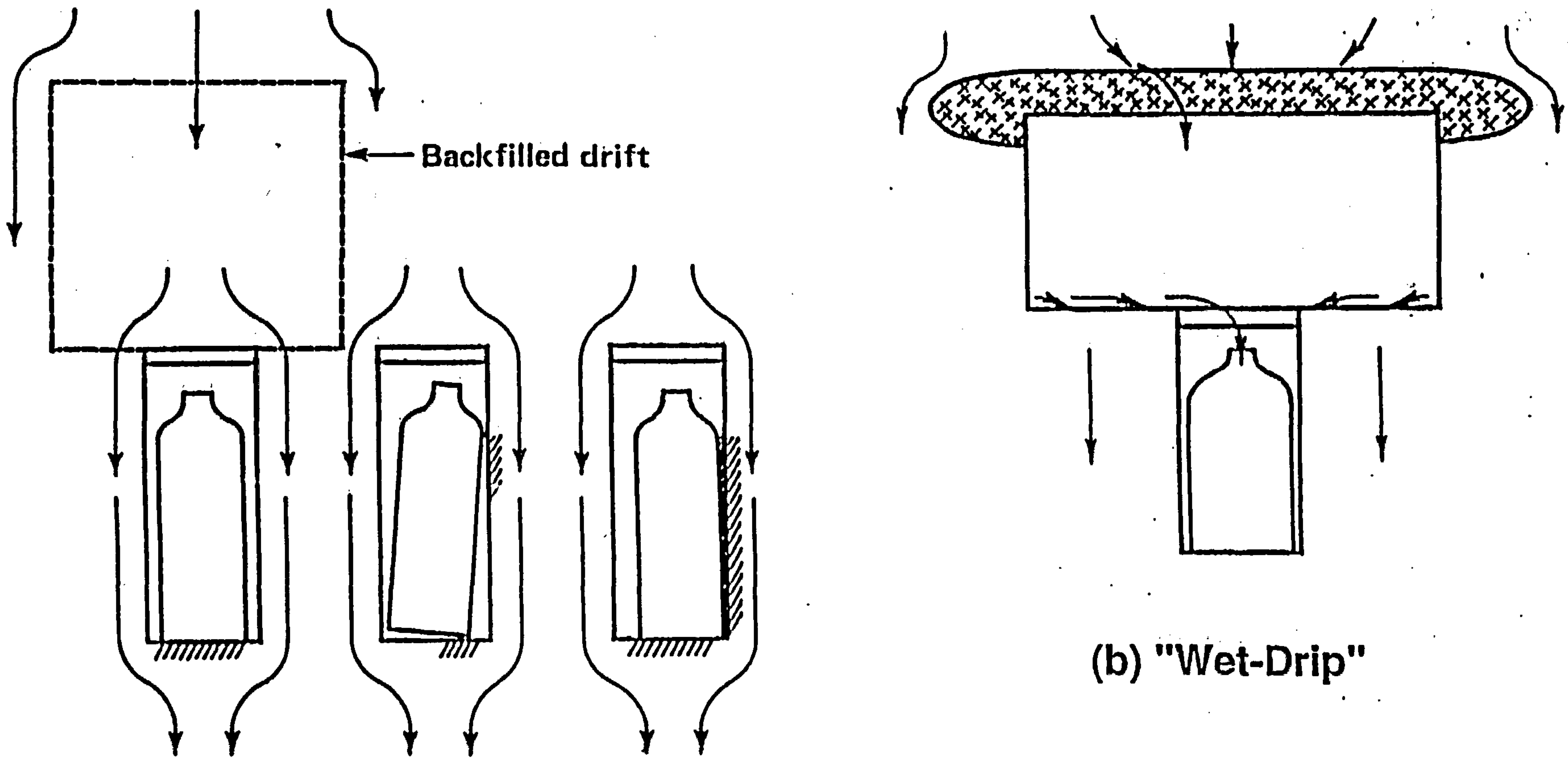
   - Unsaturated zone water flow through the soil matrix
   - Plant canopy water uptake and surface water runoff
   - Plant canopy growth
   - Development of daily climate regimes from annual characterizations.

Fig 3

PRECIPITATION EVENT MODEL ILLUSTRATION



SCHEMATIC OF EBS RELEASE MODES
(O'Connell and Drach, 1986, UCRL-53761)



(a) "Dry" and "Wet-Continuous"

(b) "Wet-Drip"

INTERA

Assumptions/ Simplifications

- Two Groups of Radioelements Identified;
  - "Insoluble"/ Solubility-Limited Radioelements (e.g., Cs, Sn, U, Np, Pu, Am),
  - "Soluble"/ Reaction-Rate Limited Radioelements (e.g., Se, Tc, I, C) ,

- Initial "Gap" Portions ~ 2% of Total Inventory,

- "Wet-Drip", "Moist/ Wet-Continuous" and "Dry" Modes

"Wet-Drip" Mode Assumes:

- Entire Water Flux Directed into Waste Packages,
- Filled Bathtub Geometry

"Moist/ Wet-Continuous" Mode Includes:

- Radioactive Decay in Waste Form and During Migration (Decay-Chain Ingrowth Excluded),
- Sorption by Tuff,
- Diffusion or Convection-Diffusion in Porous Tuff,
- Degree of Hydrologic Saturation (Moist or Wet),

- Calculate Steady-State Release Rates (No Transients),
  - Attenuation from Radioactive Decay + Sorption,
  - No Sorption Delay to Reach Final Release Rates,
  - Current Yucca Mountain Waste-Package Design Has No Buffer/Backfill Barrier for Sorption,
  - Relatively Short Pathway (3 cm),
  - Uncertain Aggregate Properties of Crushed Tuff,

- Geometry Simplification (Equivalent Sphere),

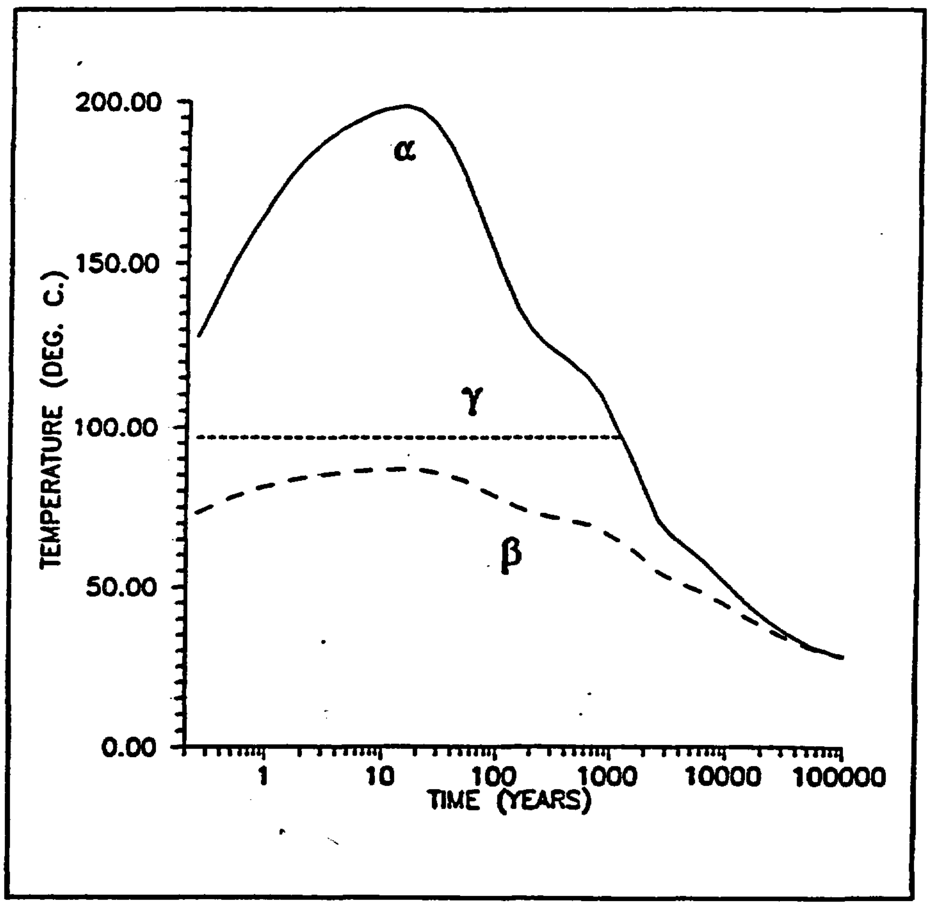
- No Credit for Partially Failed Containment.

"Dry" Mode - Only Gaseous C-14 Can Escape.

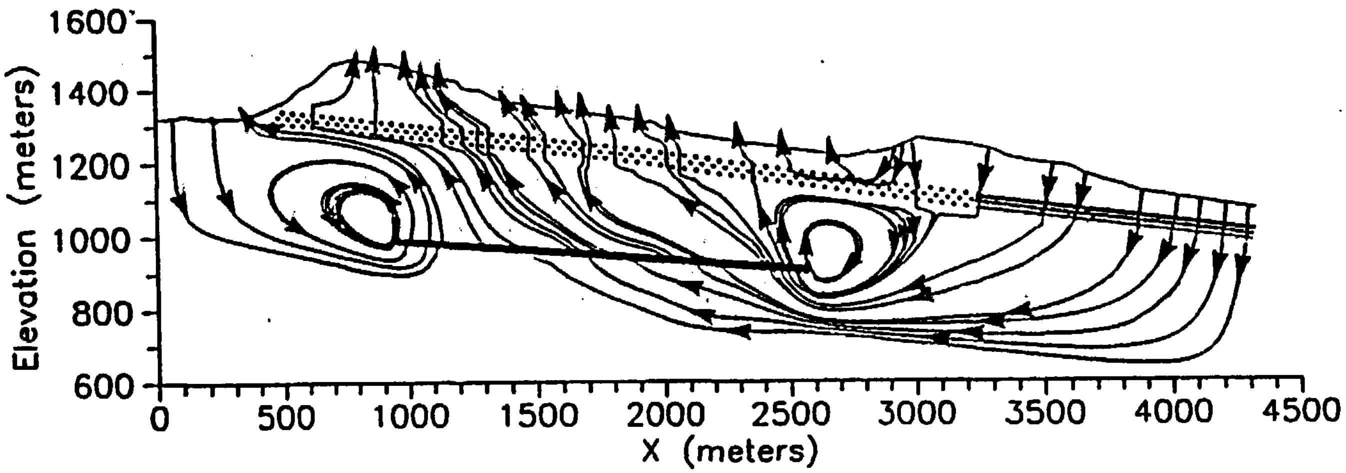
INTERA

Proposed Three Cases

- Hot - most canisters at Nitao temperatures
- Warm - most canisters reach boiling point only; some hotter
- Cold - maximum temperature 87°C

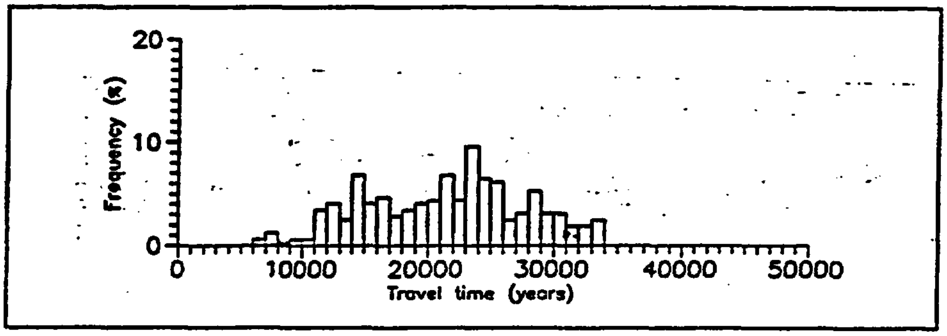


Calculated Path Lines



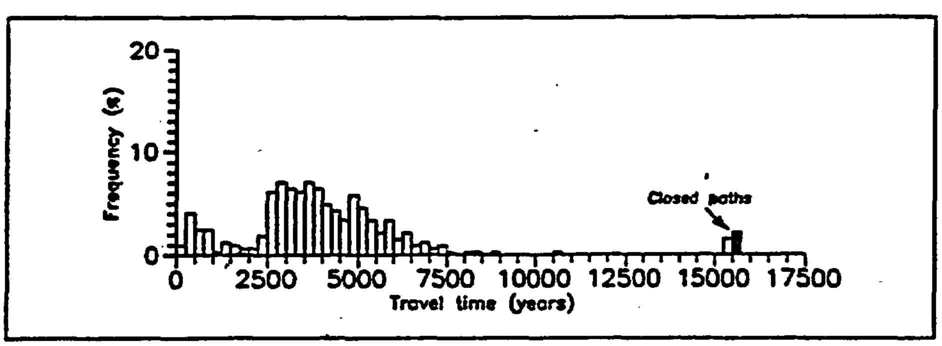
100× permeability contrast, repository temperature 57° C

Histogram of ^{14}C Travel Times

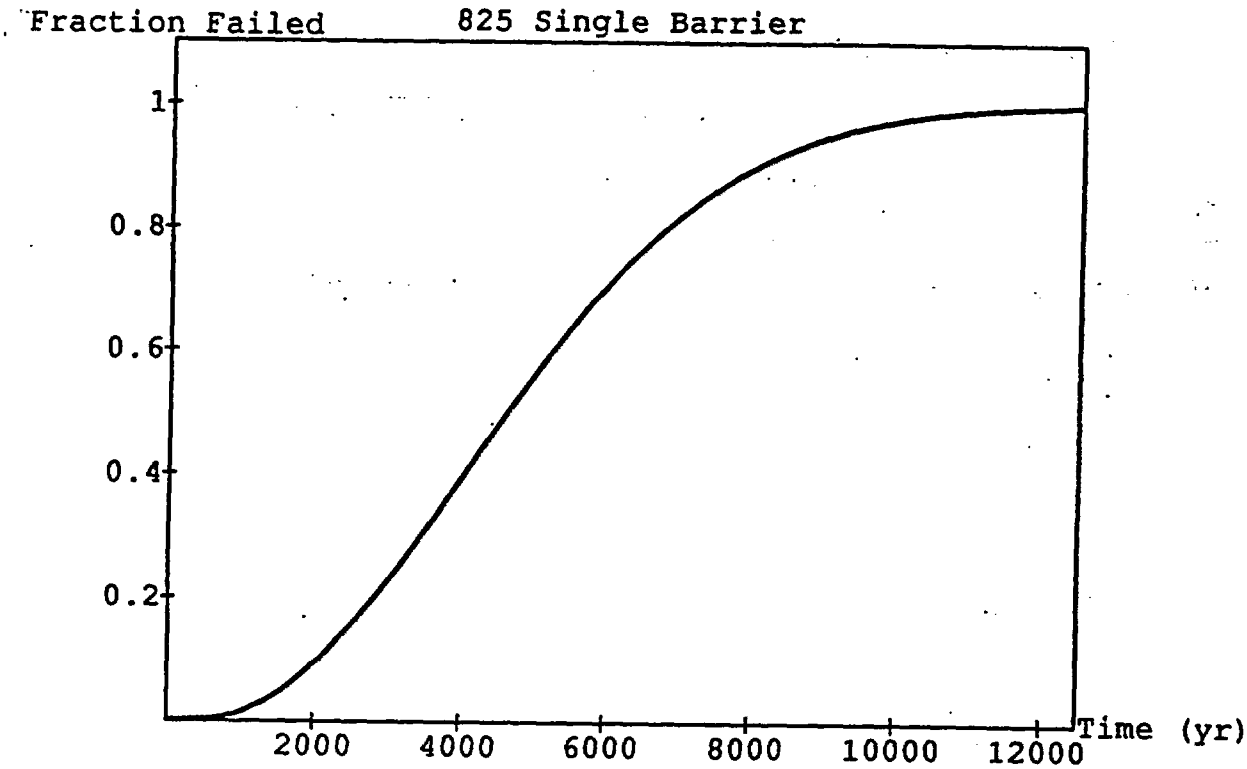


100× permeability contrast, repository unheated

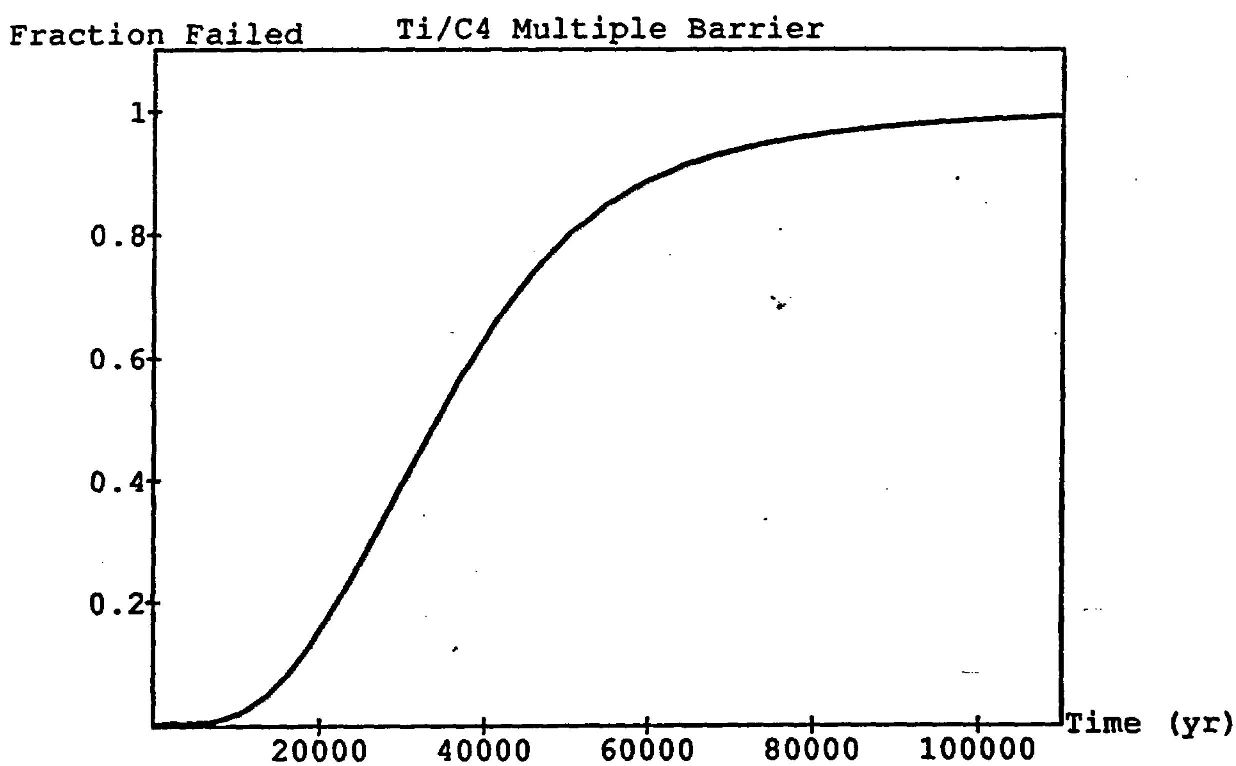
Histogram of ^{14}C Travel Times



100× permeability contrast, repository temperature 57°C



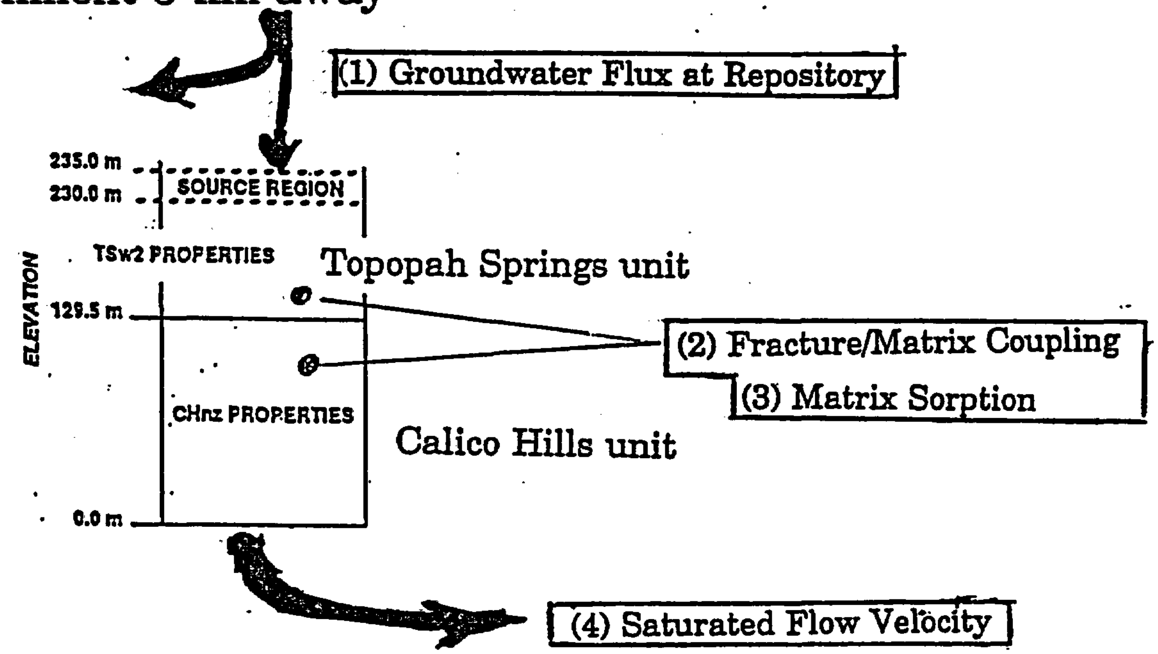
Fraction Failed
825 Single Barrier
1
0.8
0.6
0.4
0.2
2000
4000
6000
8000
10000
12000
Time (yr)



Fraction Failed
Ti/C4 Multiple Barrier
1
0.8
0.6
0.4
0.2
20000
40000
60000
80000
100000
Time (yr)

Logic Tree For Groundwater System

- groundwater system defined from the repository down to the water table and laterally to the accessible environment 5 km away



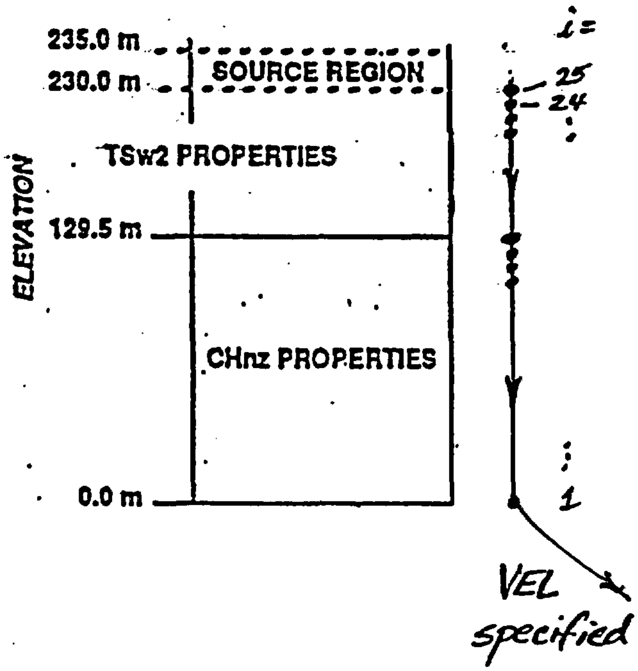
* depth to water table and timing of flux changes determined upstream in the logic tree

* depth to the water table changes tomorrow

* flux can be changed once during simulation

* diverted flow along faults does not encounter waste

- model provides ψ at a series of locations 10m apart



Darcy equation

$$v_c = (K_*/\theta)\text{grad}(\psi + z)$$

Weak Coupling

$$\theta_{CHnz} = 4.6\text{x}10^{-3}$$

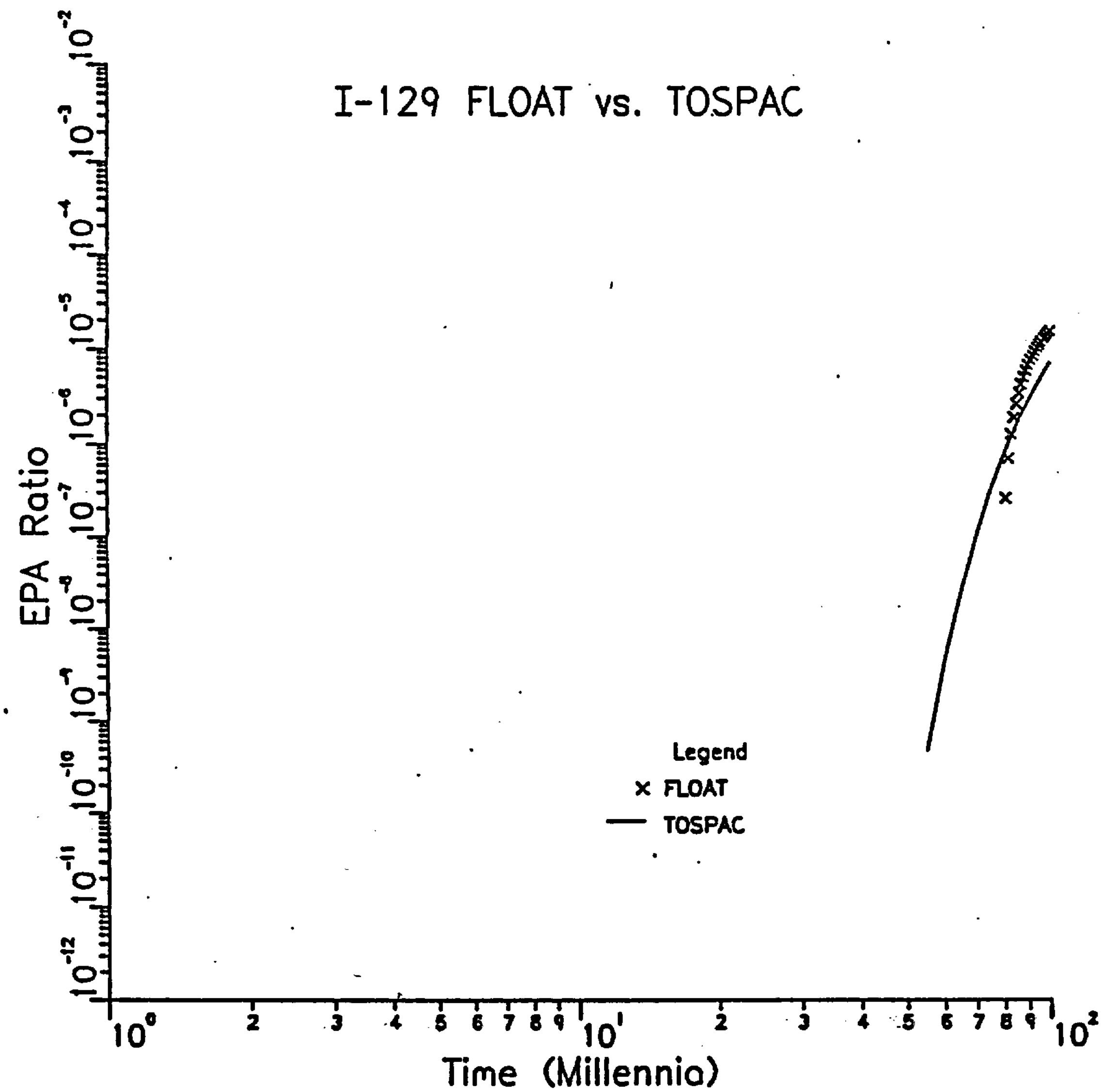
$$\theta_{TSw2\text{-}3} = 18.0\text{x}10^{-3}$$

- transport model uses a moving particle approach to calculate mass outflow at the accessible environment

- accounts for transport of a single constituent subject to advection, sorption, radioactive decay, loading

- each particle defined by z-position and attached mass or activity of nuclide

(c) Strong Coupling - Infiltration Rate 0.5 m/ma



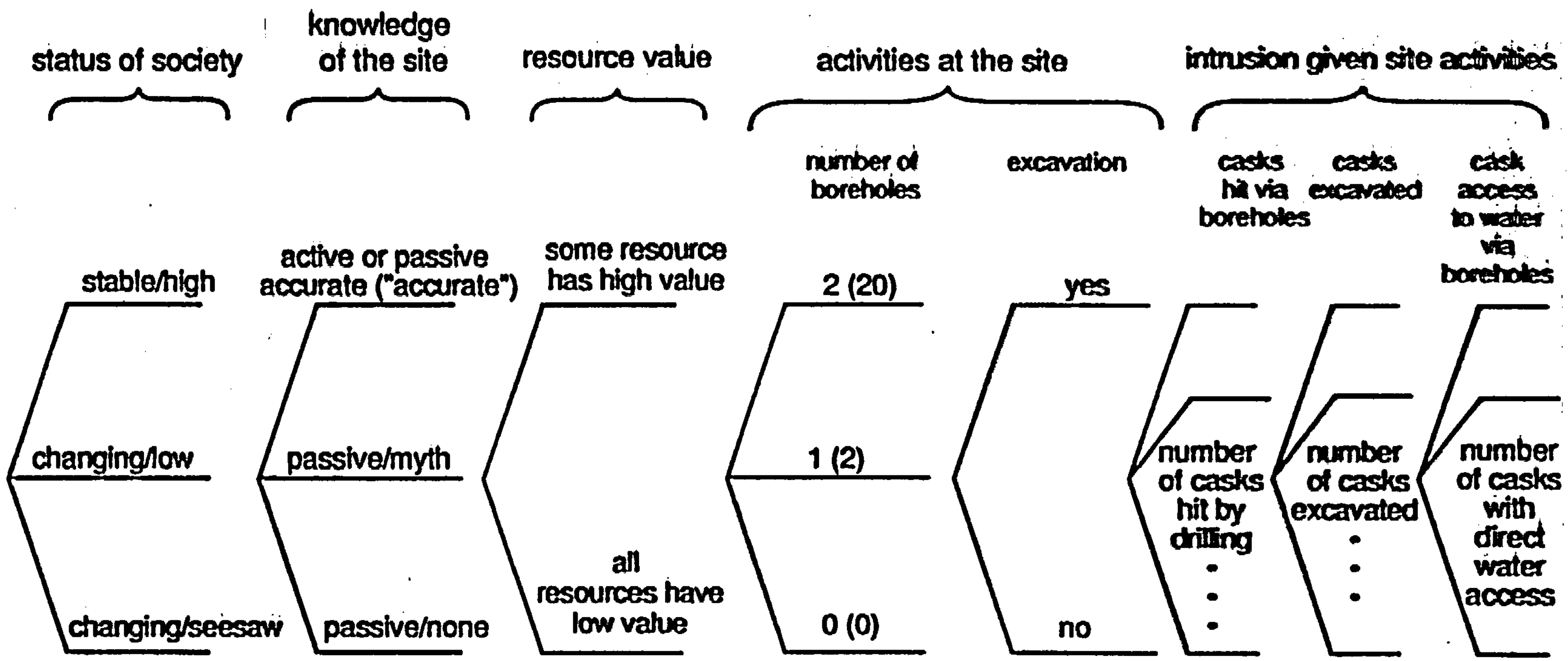
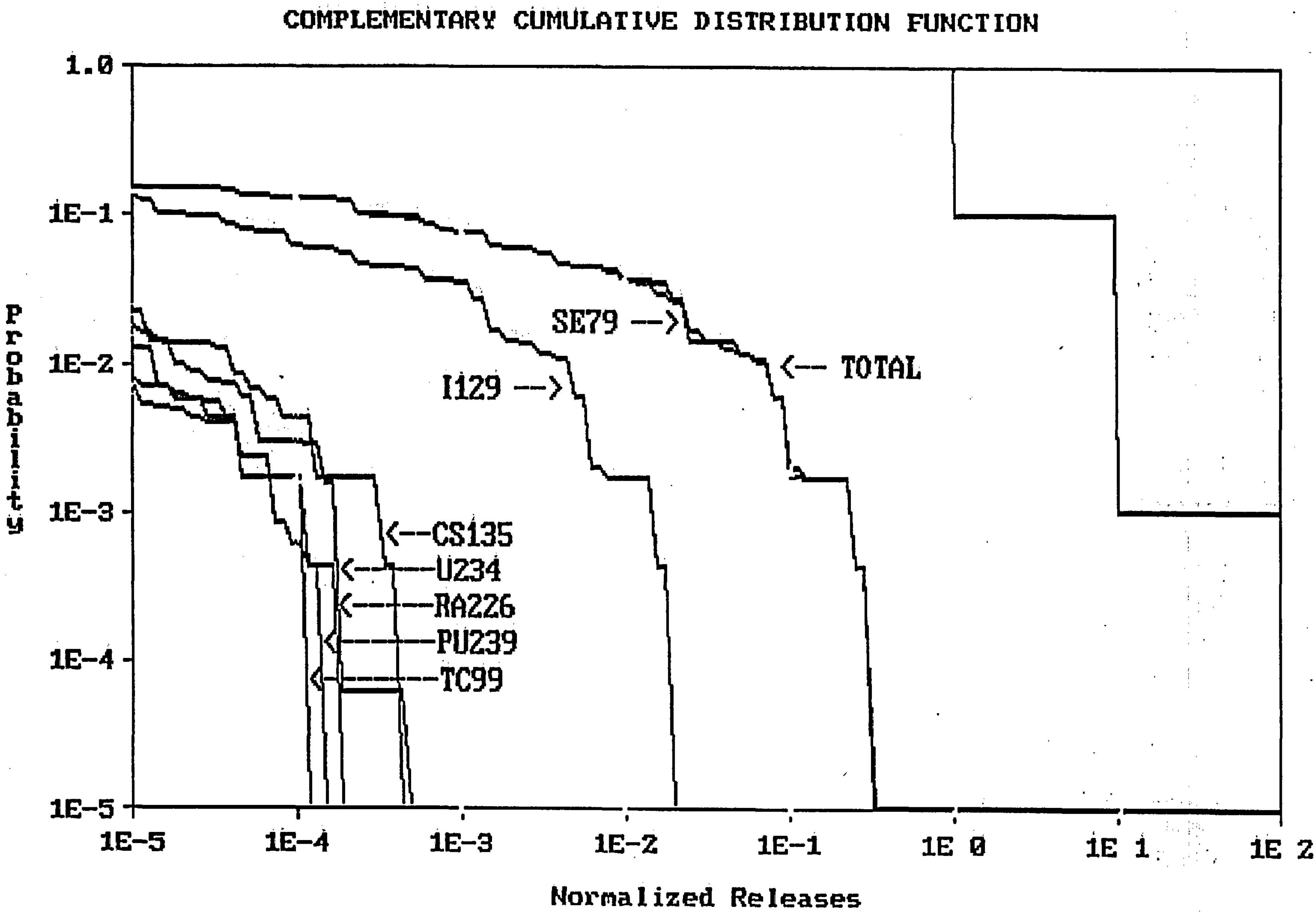
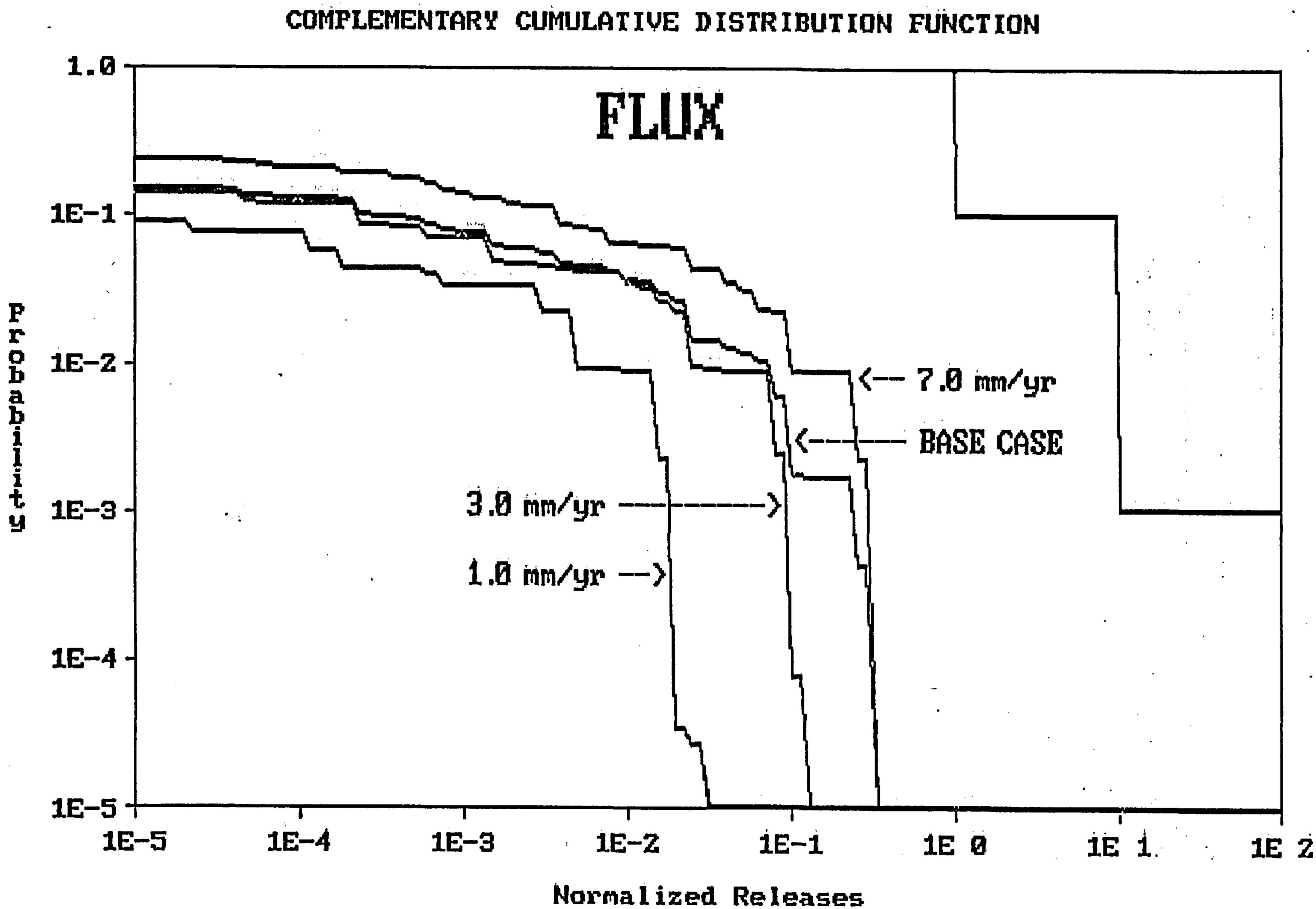


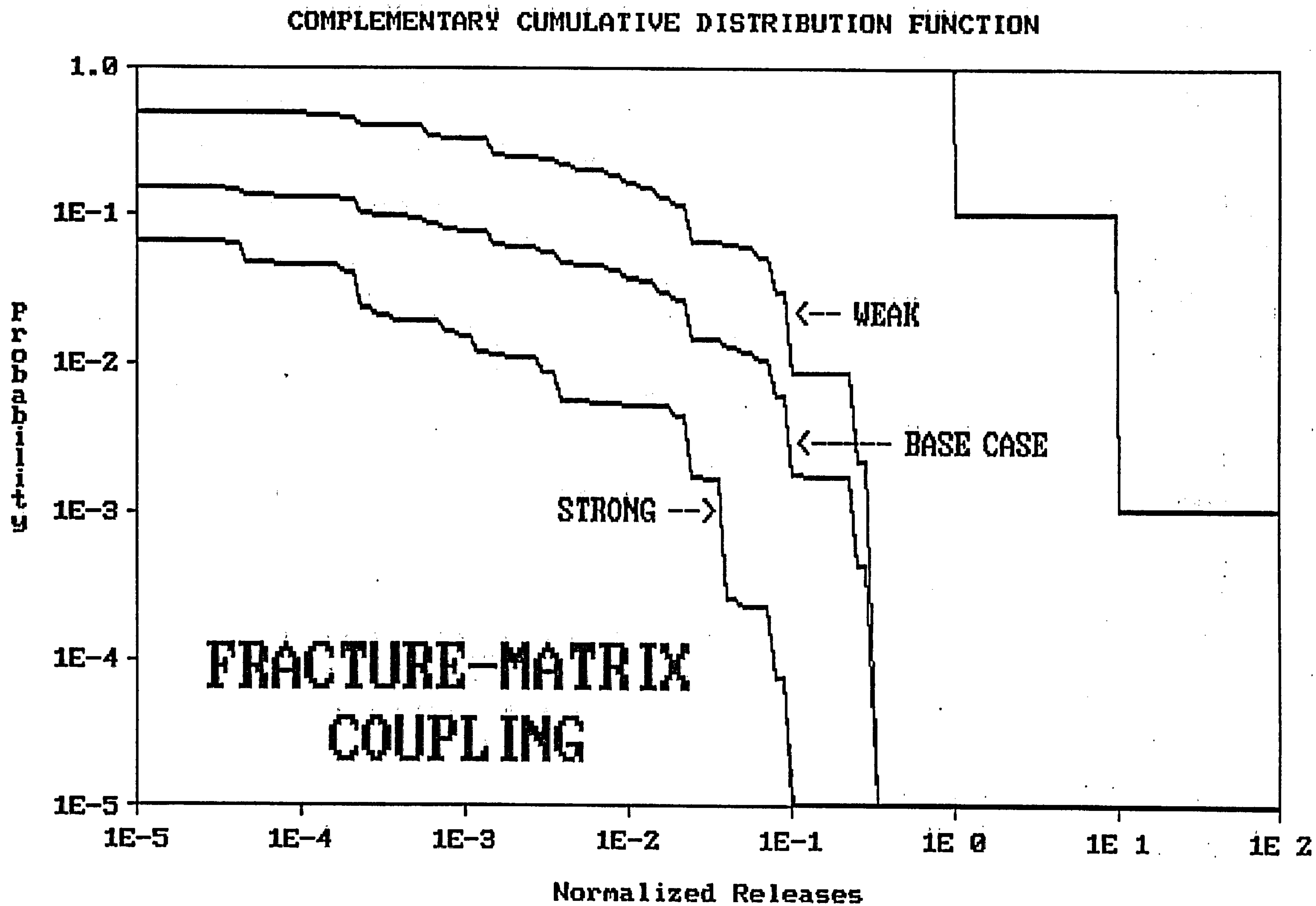
Figure 2. Model for Inadvertent Human Intrusion at Yucca Mountain

(note: the first number of boreholes is for the 1000 year period until the year 3000; the number in parentheses indicate number of boreholes from 3000 to 12000 A.D.)

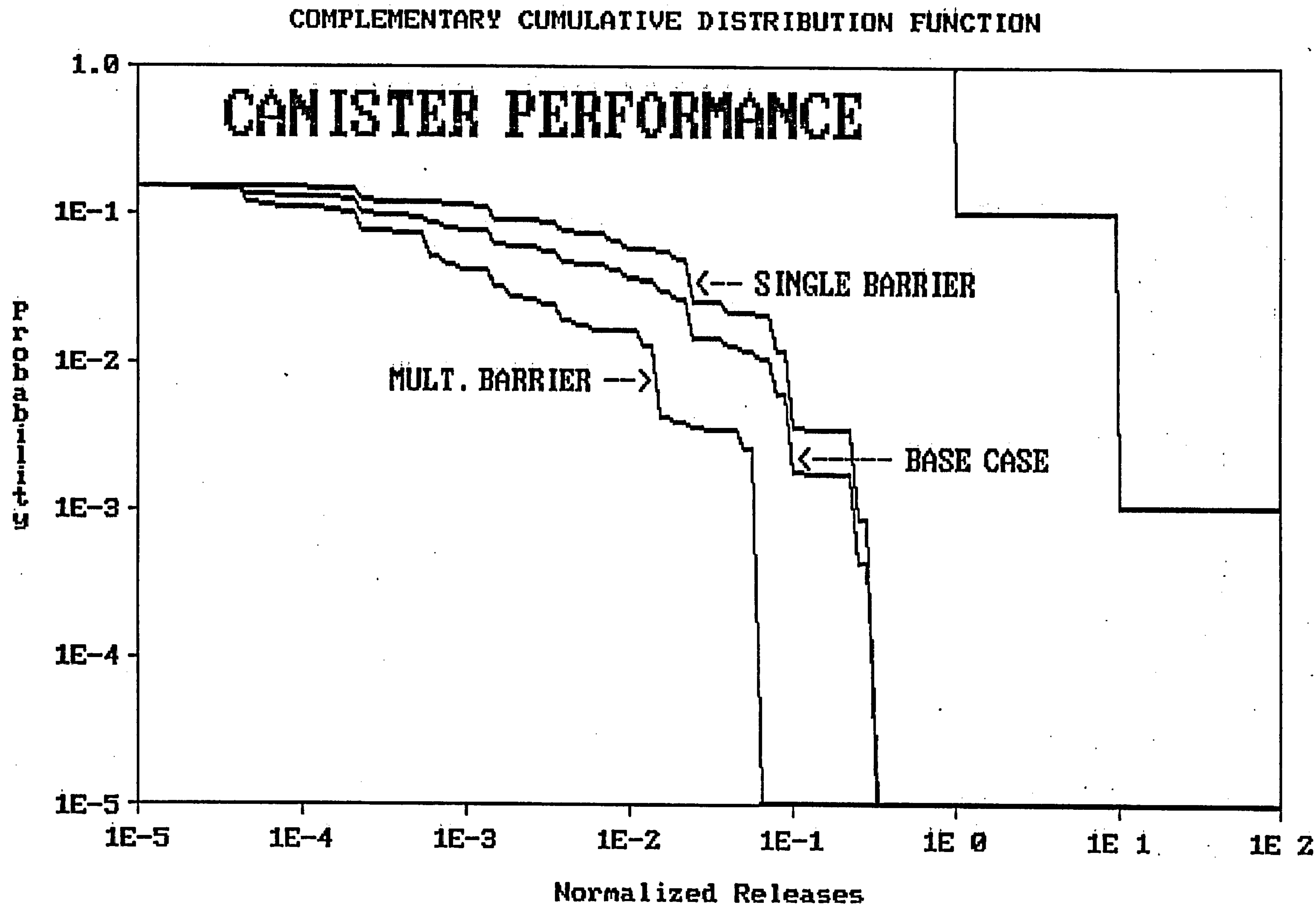


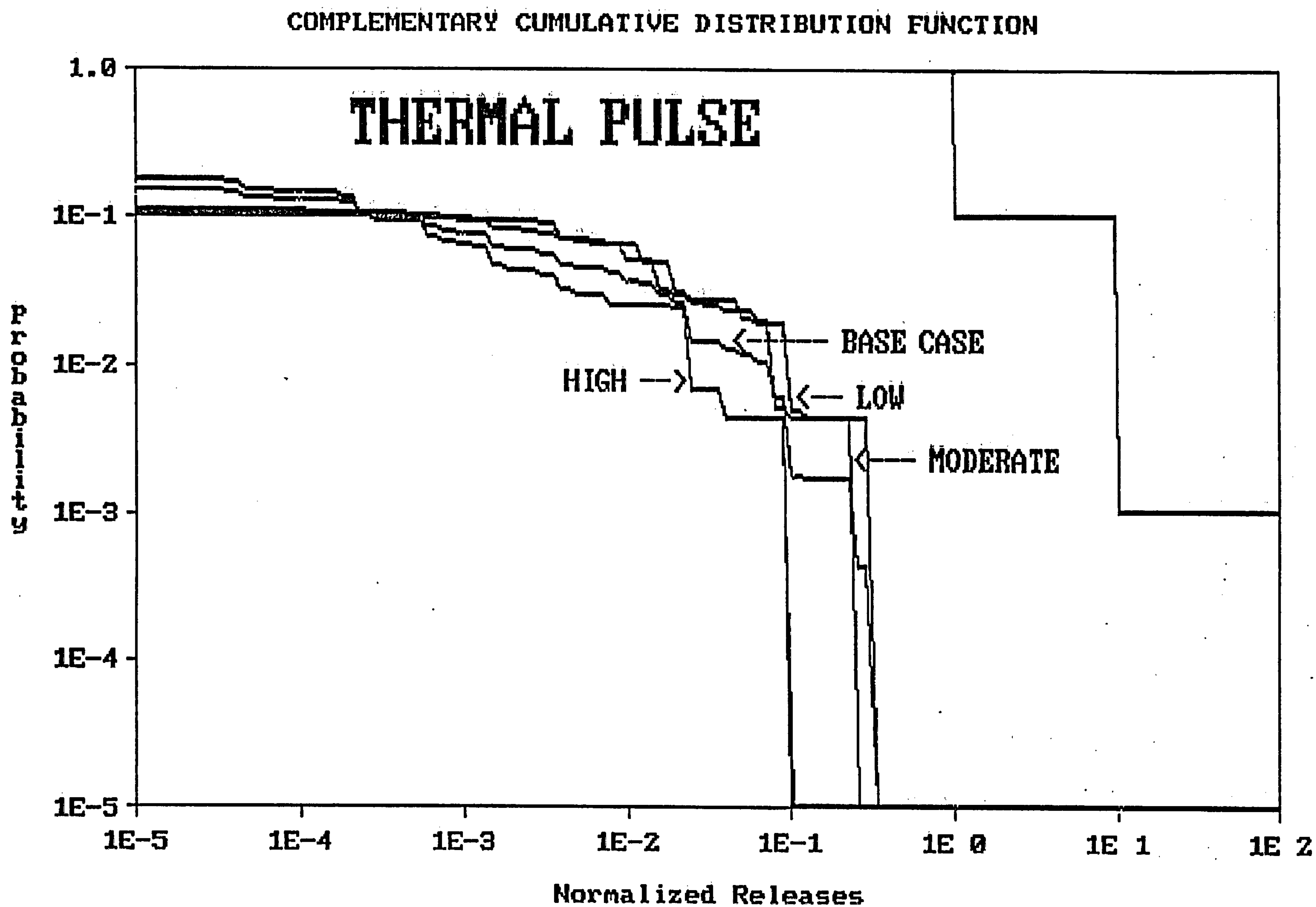
COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION
1.0
1E-1
1E-2
1E-3
1E-4
1E-5
Probability
SE79 -->
<-- TOTAL
I129 -->
<--CS135
<----U234
<------RA226
<------PU239
<-------TC99
1E-5
1E-4
1E-3
1E-2
1E-1
1E 0
1E 1
1E 2
Normalized Releases

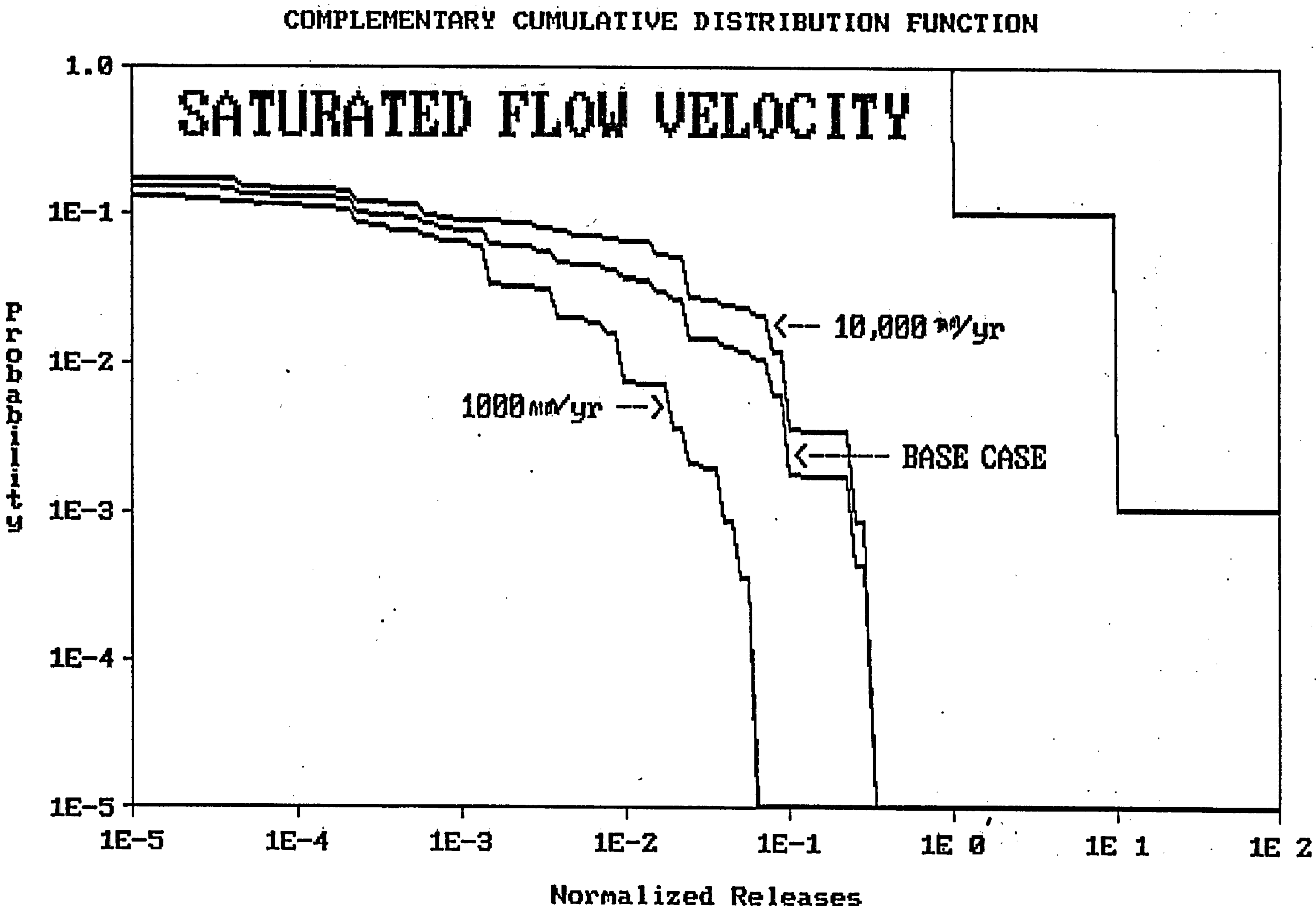

COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION
FLUX
1.0
1E-1
1E-2
1E-3
1E-4
1E-5
Probability
<-- 7.0 mm/yr
<------ BASE CASE
3.0 mm/yr --------->
1.0 mm/yr -->
1E-5
1E-4
1E-3
1E-2
1E-1
1E 0
1E 1
1E 2
Normalized Releases



COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION
1.0
1E-1
1E-2
1E-3
1E-4
1E-5
Probability
<-- WEAK
<------ BASE CASE
STRONG -->
FRACTURE-MATRIX
COUPLING
1E-5
1E-4
1E-3
1E-2
1E-1
1E 0
1E 1
1E 2
Normalized Releases


COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION
CANISTER PERFORMANCE
<-- SINGLE BARRIER
MULT. BARRIER -->
<---- BASE CASE
1.0
1E-1
1E-2
1E-3
1E-4
1E-5
Probability
1E-5
1E-4
1E-3
1E-2
1E-1
1E 0
1E 1
1E 2
Normalized Releases


COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION
THERMAL PULSE
1.0
1E-1
1E-2
1E-3
1E-4
1E-5
Probability
BASE CASE
HIGH
LOW
MODERATE
1E-5
1E-4
1E-3
1E-2
1E-1
1E 0
1E 1
1E 2
Normalized Releases


COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION
SATURATED FLOW VELOCITY
1.0
1E-1
1E-2
1E-3
1E-4
1E-5
Probability
<-- 10,000 m/yr
1000 m/yr -->
<----- BASE CASE
1E-5
1E-4
1E-3
1E-2
1E-1
1E 0
1E 1
1E 2
Normalized Releases

Meeting: TOTAL SYSTEM P.A. REVIEW

Location: DOE Rm. 202

Date: 11/18/91 Time: 1:30 PM

Attendee	Company	Phone	Attendee	Company	Phone
1. ABE VAN LUIK	INTERA (M&O)	(702) 794-7[illegible]	26. Michael Wilson	SNL	(505) 846-9868
2. Deborah Jerez	WCFS (M&O)	202 488 [illegible]	27. Everett Springer	LANL	(505) 667-9836
3. Tom Blejwas	SNL	505-844-9160	28. Jim Gansemer	LLNL	510 422-7553
4. James Blink	LLNL	(702) 794-7157	29. David Prestholt	NRC-LV	702 388 6125
5. Bob Andrews	INTERA (M&O)	512-346-2000	30. W. NICHOLS	PNL	(509) 376-8247 FTS 444-8247
6. Larry Rickertsen	WESTON/RAEC	202-646-6760	31. Mark White	PNL	(509) 372 0056
7. CLIFF NORONHA	WESTON	202-646-6768	32. Paul W. Eslinger	PNL	509-376-2797
8. ALBIN BRANDSTETTER	SAIC	702-794-7279	33. Dwight Hoxie	USGS	(303) 236-5019
9. Julie Canepa	LANL	FTS-843-4109	34. Bruce Judd	Decision Analysis Co	(415) 857-2007
10. Holly Dockery	SNL	(505) 844-1756 FTS 844-1756	35. Paul Kaplan	SNL	(505) 844-1786
11. Bill O'Connell	LLNL	(510) 422-8789	36. STEVEN R MATTSON	SAIC	702-794-7615
12. SURESH PAHWA	INTERA/M&O	702-794-7696	37. PAUL L. CLOKE	SAIC	702-794-7823
13. Bill HALSEY	LLNL	510 423-1133 FTS 543-1133	38. Claudio PESCATORE	BNL	(516) 282-2731
14. U-Sun Park	SAIC	702-794-7643 FTS 544-7643	39. Jerry Boak	YMPO	702-794-7588
15. Bob Shaw	EPRI	415 855 2026	40. Joseph WANG	LBL	(510) 486-6753 FTS 451-6753
16. ROBIN K. MCGUIRE	REI	303-278-9800	41. Felton Bingham		(505) 844-8816 FTS
17. Tom Buscheck	LLNL	510-423-9390 FTS 543-9390	42. ROGER STAEHLE		612 482 9493
18. S.S. SAREEN	TRW	(703) 934-7625	43. Michael O. Cloninger		702-794-7847
19. David Stahl	B&W (M&O)	(702) 794-7778 FTS 544-7778	44. Jane Stockey		202-586-
20. Tom PIGFORD	Univ. Calif.	510-642-6469	45. Ian Miller		(206) 883-0777
21. Robin N. Datta	M&O/WCFS	(702) 794-1832	46.		
22. Alan Lamont	LLNL	(510) 423-2575	47.		
23. JOHN FLUECK	UNLV	(702) 597-4124	48.		
24. Ralston Barnard	SNL	(505) 845-8403	49.		
25. Laurence S. Costin	SNL	(505) 844-0397	50.		

Meeting: TOTAL SYSTEM ASSESSMENT

Location: YMP/LSV Rm. 202

Date: 11/19/91 Time: 8:45 AM

Attendee	Company	Phone
1. ABE VAN LUIK	(INTERA/M&O)	(702) 794-7441
2. Mark White	(PNL)	(509) 372-0086
3. WILL NICHOLS	(PNL)	FTS 444-8247 (509) 376-8247
4. ALVIN BRANDSTETTER	(SAIC)	FTS 544-7279
5. Bob Andrews	(INTERA/M&O)	512-346-2000
6. [illegible]	LLNL	510-422-8789
7. [illegible]	LLNL	510 422 7553
8. Tom Blejwas	SNL	505-844-9160
9. CLIFF NORONHA	WESTON	202-646-6768
10. Felton Bingham	SNL	FTS (505) 844-8816
11. SURESH PAHWA	INTERA/M&O	702-794-7696
12. IAN MILLER	GOLDER	(206) 883-0777
13. Larry Rickertsen	Weston/RACC	202-646-6960
14. Ralston Barnard	SNL	(505) 845-8403
15. Lynn Lewis	LLNL	(510) 422-8979
16. Holly Dockery	SNL	(505) 844-1756
17. Jerry Boak	DOE/YMPO	702-794-7588
18. Paul Kaplan	SNL	505 844-1786
19. MARK MURPHY	PNL	(509) 376-8337
20. Paul W. Eslinger	PNL	(509) 376-2797
21. Laurence S. Costin	SNL	(505) 844-0397
22. U-Sun Park	SAIC	702-794-7643
23. Russ Dyer	DOE	702-794-7586
24. Joseph WANG	LBL	510-486-6753
25. Bob Shaw	EPRI	415-855-2026
26. ROBIN K. McGUIRE	RE	303-278-9800
27. David Stahl	BRO (M&O)	FTS 544-7778 (702) 794-7778
28. Jim Duguid	INTERA (M&O)	703 934-2481
29. JOHN FLUECK	UNLV	702-597-4124
30. Robin N. Datta	M&O/WCFS	(702) 794-1832
31. S. SAREEN	TRW	(703) 934-7625
32. R.W. STAEHLE	U of Minn	612 482 9493
33. Tom Pigford	Univ. Calif.	510-642-5469
34. Dave Langstaff	DOE-RL	(509) 376-1069
35. Michael Wilson	SNL	(505) 846-9868
36. Bill Nelson	M&O	(702) 794-1880
37. RALPH HAAK	RSN	702-794-7083
38. Paul Prestholt	NRC-LV	702 388 6125
39. Terri Miley	PNL	(509) 375-2601
40. Dave Engel	PNL	(509) 375-2307
41. Ken Eggert	LANL	505 667 5200
42. Bill HALSEY	LLNL	FTS 543-1133 510-423-1133
43. Dwight Hoxie	USGS	FTS 776-5019 (303) 236-5019
44. Paul L. Cloke	SAIC	(702) 794-7823
45. Michael Cloninger	DOE	(702) 794-7847
46. Claudio PESCATORE	BNL	(516) 282-2731
47.		
48.		
49.		
50.		

Meeting: TSPA Day 3

Location: YMP/LSV   Rm. 202

Date: 11/10/91   Time: 8:30A

Attendee	Company	Phone	Attendee	Company	Phone
1. ABE VAN LUIK	INTERA/M&O	702 794-7441	26. Paul Prestholt	NRC-LV	702 388 6125
2. Tom Blejwas	SNL	505-844-9160	27. Jim Gansemer	LLNL	510 422 7553
3. Felton Bingham	SNL	FTS (505) 844-8816	28. Laurence Costin	SNL	505 844-0397
4. Ian Miller	Golder	(206) 883-0777	29. JOHN FLUECK	UNLV	702-597-4124
5. Russ Dyer	DOE	(702) 794-7586	30. Paul Kaplan	SNL	505 844-1786
6. Larry Rickertsen	WESTON/RAEE	202 646-6760	31. Bill HALSEY	LLNL	510 423-1133
7. Holly Dockery	SNL	505-844-1756	32. Paul L. Cloke	SAIC	702-794-7823
8. Jerry Boak	DOE/YMPO	702-794-7588	33. Mark White	PNL	509 372 0086
9. R W Barnard	SNL	505-845-8403	34. Bob Andrews	INTERA/M&O	512-346-2000
10. Paul W. Eslinger	PNL	509-376-2797	35. ALBIN BRANDSTETTER	SAIC	702-794-7279
11. Michael Wilson	SNL	(505) 846-9868	36. Lynn Lewis	LLNL	510-422-8949
12. S. SAREEN	TRW	(703) 934-7625	37. Dave Engel	PNL	509 375-2307
13. SURESH PAHWA	Intera/M&O	702-794-7686	38. Terri Miley	PNL	(509) 375-2601
14. U-Sun Park	SAIC	702-794-7643	39. Will Nichols	PNL	FTS 444-8247 (509) 376-8247
15. Tom Pigford	Univ. Calif.	510-642-1494	40. MARK MURPHY	PNL	(509) 376-8337
16. Joseph Wang	LBL	510-486-6753	41.		
17. BOB SHAW	EPRI	415 855 2026	42.		
18. ROBIN K. McGUIRE	REI	303-278-9800	43.		
19. Robin N. Datta	M&O/WCFS	(702) 794-1832	44.		
20. Jim Duguid	INTERA/M&O	703-934-2931	45.		
21. Dave Langstaff	DOE-RL	509-376-1669	46.		
22. Bill Nelson	INTER/M&O	(702) 794-1880	47.		
23. RALPH HAAK	RSN	702-794-7083	48.		
24. Everett Springer	LANL	505-667-9836	49.		
25. CLIFF NORONHA	WESTON	202-646-6768	50.		

AGENDA

Yucca Mountain Site-Characterization Project
Hydrologic Integration Task Force
(HITF)

Workshop on Ground-Water Travel Time
in the Saturated Zone

Radisson Suite Hotel Tucson
6555 East Speedway
Tucson, Arizona 85710
(602) 721-7100

November 13, 1991
Salon A

8:00 A.M.	**Welcome and introduction** Dwight Hoxie, U.S. Geological Survey (USGS)
	Opening remarks John Czarnecki, USGS, Chairman, HITF
Session I:	**Conceptual Models for the Site Saturated-Zone Geohydrologic System** Moderator: George Barr, Sandia National Laboratories (SNL)
8:30 A.M.	**Factors that may affect ground-water flow direction and magnitude at Yucca Mountain, Nevada** John Czarnecki, USGS
9:15 A.M.	**A geologic hypothesis for the large hydraulic gradient at Yucca Mountain, Nevada** Chris Fridrich, U.S. Department of Energy (DOE)
10:00 A.M.	**BREAK**
10:30 A.M.	**A conceptual model for the large hydraulic gradient, Yucca Mountain, Nevada** Richard Luckey, USGS

11:00 A.M.	**Developing framework-based conceptual and numerical models for ground-water systems** Claudia Faunt and E.D. Gutentag, USGS
11:30 A.M.	**Geologic considerations for modeling potential flow pathways in the saturated zone** Richard Spengler, USGS
12:00 P.M.	**LUNCH** - Salon C
Session II:	**Geohydrologic Data Needs and Availability** Moderator: Claudia Newbury, DOE
1:00 P.M.	**Flow and transport in fractured rocks: field tests and modeling** Kenzi Karasaki, Lawrence Berkeley Laboratory (LBL)
1:30 P.M.	**Fracture data needs for ground-water flow modeling at Yucca Mountain** Elisabeth Ervin, USGS
2:00 P.M.	**Pumping-test analysis in dual-porosity aquifers** Nick Saines, Harza Engineering
2:30 P.M.	**Saturated-zone hydrochemistry and data needs** Bill Steinkampf, USGS
3:00 P.M.	**BREAK**
3:30 P.M.	**Sr isotopes in ground waters, southern Nevada** Zell Peterman, USGS
4:00 P.M.	**DISCUSSION**
5:00 P.M.	**ADJOURN**

November 14, 1991
Garden Court

Session III:	**Ground-Water Travel Time (GWTT) in the Site Saturated Zone** Moderator: Dwight Hoxie, USGS
8:00 A.M.	**GWTT in the saturated zone: results from the Environmental Assessment (1986)** Dwight Hoxie, USGS
8:30 A.M.	**GWTT in the unsaturated zone: lessons learned** Paul Kaplan, SNL
9:00 A.M.	**GWTT and tortuosity: a parameter for scaling field and laboratory tests** Todd Rasmussen, University of Arizona
9:30 A.M.	**Saturated-zone heterogeneity and GWTT** Dwayne Chesnut, Lawrence Livermore National Laboratory (LLNL)
10:00 A.M.	**BREAK**
10:15 A.M.	**Impacts of the conceptual models on data development and GWTT calculations**
12:00 P.M.	**SUMMARIZE AND ADJOURN**

ONSITE QUESTIONAIRE - HYDROLOGY INTEGRATION TASK FORCE (HITF)
WORKSHOP ON GROUNDWATER TRAVEL TIME IN THE SATURATED ZONE

1. Was this workshop a worthwhile effort?
yes____ no____ sort-of____

2. What did you gain from it?

3. Would additional interactions on this same topic be beneficial?
yes _____ no _______

4. Why did you attend?

5. How could it be improved?

6. What other topics would you like to see addressed in this sort of format?

7. Are there other types of interaction that you would prefer?
yes____ no, this was just fine____ none, this was a waste of time_____
If yes, what kinds of interactions would you prefer?

8. The HITF charter is attached along with a list of the membership; what can we do for you?

9. Additional comments?

CURRENT HITF MEMBERSHIP

John Czarnecki, Chairman - USGS
Bill Dudley, USGS
George Barr - SNL
Tom Buscheck - LLNL
Everett Springer - LANL
Levi Kroitoru - Weston (for OGD/Analysis & Verification Division)
Chris Fridrich - YMP/RSED
Claudia Newbury - YMP/RSED (WBS manager)

CHARTER FOR THE HYDROLOGY INTEGRATION TASK FORCE (HITF)

The HITF is chartered to provide a Project forum for the consideration of issues relative to both saturated and unsaturated zone hydrologic investigations, model development, and performance assessment. Issues related to:

- o prioritization of activities and studies based on regulatory requirements;
- o consistency between near- and far-field and saturated and unsaturated models;
- o support of the test and evaluation process;
- o prioritization of tasks, funding and deliverables;
- o support of peer reviews;
- o credibility of performance models;
- o sharing of information or data;
- o combining of resources; and
- o concerns of individual hydrology Principal Investigators will be brought to the HITF. Through consideration of those issues, the HITF will develop recommendations to Regulatory and Site Evaluation Division/Technical Analysis Branch for synthesis of the existing hydrologic program, or possible redirection or reprioritization of hydrologic investigations.

The HITF will consist of a representative from:

- o each of those project participants who conduct research in the field of hydrology, including both site investigations and performance assessment;
- o the Management and Operation integrator for hydrology;
- o the Office of Geologic Disposal Yucca Mountain Site Characterization Project Office, and others who may be appointed by the Project Manager.

The chairmanship of the HITF will rotate on an annual basis, beginning with the representative of the U.S. Geological Survey.

The HITF will submit its recommendations to the U.S. Department of Energy representative appointed as the Project Work Breakdown Structure Manager for the hydrology task.

The HITF will meet on at least a quarterly basis.

Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization Project

J. Russell Dyer, Director (Acting)
Regulatory and Site Evaluation Division

Claudia M. Newbury
Work Breakdown Structure Manager

Robert W. Craig
for John P. Czarnecki, Chairman

ENCLOSURE

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TERMS OF REFERENCE
SECRETARY OF ENERGY ADVISORY BOARD
TASK FORCE ON CIVILIAN RADIOACTIVE WASTE MANAGEMENT

INTRODUCTION

The Department of Energy recognizes that the resolution of outstanding institutional issues, such as access to sites, social and economic impacts, and organizational design, is as critical to the ultimate success of the civilian radioactive waste management program as the resolution of outstanding technical issues. No institutional issue commands as much attention and is as widely regarded as pivotal and far-reaching as the question of public trust and confidence. It is, for example, a common theme in reviews by organizations such as the National Academy of Sciences, the Congressional Office of Technology Assessment, and the Nuclear Waste Technical Review Board.

Although numerous oversight and advisory bodies are examining the technical foundations of the program, there is currently little systematic analysis and guidance on developing the institutional framework for managing radioactive waste in a manner that ensures public trust and confidence. Such analysis and guidance would be helpful not only to the existing policy-making organizations that are conducting many of the program's immediate activities but also in the on-going creation and design of the technical development and operating organizations that will play increasingly critical roles in the program's future. The objective of the Secretary of Energy Advisory Board (SEAB) Task Force of Civilian Radioactive Waste Management is to begin to undertake those institutional analyses and to suggest approaches for establishing public trustworthiness so as to facilitate progress toward the Department's satisfaction of its statutory obligations.

As detailed below, the Task Force should examine what is meant by "public trust and confidence" and describe the conditions that are important for ensuring it. The group should explore what additional steps the program might take to strengthen public trust and confidence in efforts to dispose of radioactive waste. The Task Force should investigate whether attempts to increase public trust and confidence affect other objectives such as timely waste acceptance and cost-effectiveness. Finally, the group should consider how its recommendations and guidance might be implemented.

STUDY OBJECTIVES

The Meaning and Development of Public Trust and Confidence

The phrase "public trust and confidence" is frequently used, but its meaning is rarely articulated with precision. Consequently, misunderstandings among parties with an interest in those ends may arise, and accusations of bad faith may be leveled, leading ironically to reduced trust and confidence. The Task Force should strive to develop a clear understanding of what it means for the radioactive waste management program to have public trust and confidence extended or withheld. The group should then analyze the factors and processes that cause it to be gained, maintained, lost, and reestablished. Among the questions the Task Force should address are:

- Whose trust and confidence is most critical? Why?

- What are the most important factors affecting the level of public trust and confidence in the program?

- What lessons has the program learned from the past? What can be done to build on past successes and avoid past failures?

Opportunities for Ensuring Public Trust and Confidence

The management of radioactive waste poses a number of challenges, which, in combination, may make the establishment and maintenance of public trust and confidence problematic. Hazardous materials must be processed and transported; the benefits of nuclear power are widely distributed, but many of the costs of waste management are geographically concentrated; political and technical accountability must be sustained over extended periods; a relatively large-scale technological system with a complex institutional infrastructure must be created; some errors may only arise in the far future, and others may be hard to detect. Based on the understanding and insights developed in the first phase of the study and through other means, the Task Force should consider questions such as these:

- How can the challenges that tend to make public trust and confidence in the radioactive waste management program problematic be addressed?

- Under what circumstances, if any, can alternative financial, organizational, and regulatory arrangements for the program promote public trust and confidence?

- Can the organizational structures and processes adopted for similar programs in other nations provide models for increasing the perceived trustworthiness of the U.S. program?

Consequences of Ensuring Public Trust and Confidence

Actions taken to ensure a significant reservoir of public trust and confidence may affect other program objectives such as the timely acceptance of waste, cost-effectiveness, and confidence in the program's schedule. Those other factors must be taken into account as any long-term implementation plan is developed. If trade-offs between conflicting goals have to be made, it is important that the stakes be clarified and the balancing of advantages and disadvantages of various approaches be done explicitly. To inform choices that will have to be made, the Task Force should investigate these questions:

- To what degree would additional efforts to foster public trust and confidence disrupt established program routines and organizational interactions?

- How would efforts to ensure high levels of public trust and confidence influence the timeliness and the cost of the radioactive waste management program?

- To what extent would initiatives to increase public trust and confidence affect or be affected by the regulatory regime for developing and licensing a repository?

Recommendations

Having assessed alternative approaches for ensuring public trust and confidence and having considered in general terms what the central advantages and disadvantages of each might be, the Task Force should present recommendations to the Secretary of Energy. Included in those recommendations should be guidance on what steps can be taken to implement them. In particular, the Task Force should note which actions can be taken under authority already vested in the Department, which actions require new authority, and which actions depend on the cooperation of other governmental and non-governmental entities.

In pursuing these objectives, the Task Force can

- Obtain the advice of recognized experts in organizational design;
- Examine program decisions and policies over the last decade that have strongly contributed to the current level of public trust and confidence;
- Solicit the views of informed and interested individuals both inside and outside of government;
- Secure information from DOE program offices and contractors that helps identify the characteristics of the policy-making, technical design and development, and operating organizations of the radioactive waste management system.

BIOGRAPHY

BARBARA L. S. BARRY is director of the Rocky Flats Program of the Colorado Department of Health. Ms. Barry previously spent 17 years with the Colorado Department of Highways, including the past eleven years as Manager of the Office of Environment, and two years as an Assistant Project Manager for NASA during the Skylab program. She is a member of the National Academy of Sciences Transportation Research Board Committee on Highways and Environment, as well as the NAS Panel on Hazardous Waste in Highway Rights of Way. Additionally, she is an Associate of the Environmental Law Institute in Washington, D.C.

BIOGRAPHY

WILLIAM P. BISHOP is vice president for research at the Desert Research Institute, the University of Nevada System, Las Vegas, NV. Formerly, he was a vice president of Science Applications International Corporation, and Deputy Assistant Administrator for Satellites at the National Oceanic and Atmospheric Administration. He has authored numerous articles and books, including "Nuclear Waste Management," in the Report of the Governor's Energy Task Force Committee on Nuclear Energy, Santa Fe, New Mexico; "Radioactive Wastes: Disposal Alternatives," proceedings of an Orientation Conference for Educators, Arizona State University; and "Observations and Impressions on the Nature of Radioactive Waste Management Problems," in Essays on Issues Relevant to the Regulation of Waste Management, U.S. Nuclear Regulatory Commission. He also authored a report to the Commission entitled, Proposed Goals for Nuclear Waste Management. Dr. Bishop was a National Merit Scholar and received the U.S. Nuclear Regulatory Commission Meritorious Service Award, the NASA "Spaceship Earth Award,", the NASA "Group Achievement Award," and the Department of Commerce Meritorious Service Award. He serves on the EPSCoR Planning Committee and is the Nevada Representative to the Coalition of EPSCoR States. He is a member of numerous organizations, including the American Association for the Advancement of Science, the American Astronautical Society, the American Institute for Aeronautics and Astronautics, and the American Nuclear Society.

BIOGRAPHY

WILLIAM M. EICHBAUM is vice president of the Environmental Quality Program at the World Wildlife Fund and The Conservation Foundation. He also is an adjunct associate professor at the State University of New York, Stony Brook, and at the University of Maryland Law School. Mr. Eichbaum previously was undersecretary in the Executive Office of Environmental Affairs for the Commonwealth of Massachusetts and Assistant Secretary of Environmental Programs in the Maryland Department of Health and Mental Hygiene. He has received awards and commendations from the Consumer Product Safety Commission, the National Association of Environmental Professionals, the Chesapeake Bay Foundation, and as a special honoree of the Izaak Walton League, he received the Chesapeake Bay Conservation Award. Mr. Eichbaum served on the Environmental Law Institute Board, the National Environmental Enforcement Council, and the State/EPA Committee (Advisory to the Administrator, Environmental Protection Agency).

BIOGRAPHY

ROBERT W. FRI is president of Resources for the Future, a non-profit research institute in Washington, DC. Mr. Fri formerly was president of Energy Transition Corporation and Deputy and Acting Administrator of the Energy Research and Development Administration, predecessor of the U.S. Department of Energy. He also served as Deputy Administrator and then Acting Administrator of the Environmental Protection Agency. Mr. Fri is a trustee of Science Service, Inc., director of the Environmental and Energy Study Institute and of the Atlantic Council of the U.S., and he serves on the Board of Directors of Transco Energy Company. He served as a member of the Department's Energy Research Advisory Board. He is a member of Phi Beta Kappa and Sigma Xi.

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KRISTINE GEBBIE, M.N., is Secretary of Health, Department of Health, for the State of Washington. In addition, she is an Adjunct Associate Professor at Oregon Health Science University and a member of the Institute of Medicine's AIDS Oversight Committee. Ms. Gebbie formerly was Administrator of the Oregon Health Division and a member of the Presidential Commission on the Human Immunodeficiency Virus Epidemic. She also served as Chairperson of the Secretarial Panel for the Evaluation of Epidemiological Research Activities for the U.S. Department of Energy. She has been president of the Association of State and Territorial Health Officials.

BIOGRAPHY

DONALD F. KETTL is a professor in the Department of Political Science and the Robert M. La Follette Institute of Public Affairs at the University of Wisconsin-Madison. He has held academic appointments at Vanderbilt University, the University of Virginia, and Columbia University. Dr. Kettl is the author of numerous articles and books, including Private Markets and Public Management (forthcoming), Deficit Politics: Public Budgeting in Institutional and Historical Context; and Government by Proxy: (Mis?)Managing Federal Programs. He is an active member of the American Political Science Association, whose Committee on Publications he will chair in 1992. He has consulted for a number of federal bodies, including the Committee on the Budget of the U.S. House of Representatives, the Food and Drug Administration, and the Securities and Exchange Commission. Dr. Kettl is a member of Phi Beta Kappa and currently serves on the editorial boards of Public Administration Review, Journal of Public Administration Research and Theory, and American Review of Public Administration.

BIOGRAPHY

JOHN W. LANDIS is senior vice president, director and president of subsidiaries of Stone & Webster Engineering Corporation, Boston, MA. His area of expertise is engineering physics. He coauthored the text, Nuclear Engineering, and has contributed articles to professional and trade journals. Formerly, Mr. Landis was president of Gulf General Atomic Company and of Power Systems Company, General Atomic Partnership, La Jolla, CA. He is the recipient of the General of Industry award from the State of Oklahoma, the Winston Churchill Medal of Wisdom and the Dwight D. Eisenhower Award of Honor from the Wisdom Society, an honorary Doctorate of Science degree and the George Washington Kidd award from Lafayette College, and the Lehigh Valley Favorite Son award from the State of Pennsylvania. He also was made an honorary citizen by the City of Dallas. Mr. Landis is a founding director of Central Fidelity Banks,]nc., Richmond, VA, a founding governor of National Materials Property Data Network, Inc., of Columbus, OH, Chancellor and past president of The American Society for Macro-Engineering, a founding director of the International Association of Macro Engineering Societies, and a past chairman of the American National Standards Institute and Fusion Power Associates. He served as Chairman of the Energy Research Advisory Board of the U.S. Department of Energy. Mr. Landis is a member of the National Academy of Engineering, a fellow and past president of the American Nuclear Society and the American Society of Mechanical Engineers, and a member of the International Association of Energy Economists, Phi Beta Kappa, Sigma Xi, Tau Beta Pi, Pi Delta Epsilon, and Omicron Delta Kappa.

BIOGRAPHY

TODD R. LA PORTE is professor of political science at the University of California, Berkeley, CA. He formerly served as associate director of the University's Institute of Governmental Studies. He was a Woodrow Wilson fellow at the International Center for Scholars at the Smithsonian Institution. He was a member of the National Academy of Sciences' panel on the agenda for Research on Human Factors in Commercial Nuclear Power Plant Operations, and he served on the Academy's Board on Radioactive Waste Management. He is a member of the National Academy of Public Administration.

BIOGRAPHY

DAVID A. LESTER is executive director of the Council of Energy Resource Tribes, Denver, CO. Formerly, he was commissioner of the Administration for Native Americans and chairman of the Intra-Departmental Council on Indian Affairs, U.S. Department of Health and Human Services. He is a member of the National Advisory Council for Minority Business, the National Council for Indian Opportunity, the National Congress for American Indians, Americans for Indian Opportunity, and American Indian Scholarships. Mr. Lester has received the Indian Council Fire Indian Achievement Award, the Americans for Indian Opportunity's Distinguished Services Peace Pipe Award, and the United Indian Development Association's Jay Silverheels Achievement Award.

BIOGRAPHY

GENE A. LUCERO, a specialist in environmental law, is a partner in the Los Angeles office of Sidley & Austin. He began his environmental practice as an Assistant Attorney General in the state of Colorado. He then spent two years as Deputy Regional Administrator of Region VII of the Environmental Protection Agency, headquartered in Denver, before moving on to become EPA's Director of the Office of Waste Programs Enforcement, a position he held between 1982 and 1988. Mr. Lucero was the principal author of the third edition of the Superfund Handbook and has authored and co-authored a number of articles on environmental law. He is a graduate of the University of California Boalt Hall School of Law in Berkeley and is licensed to practice law in California, Colorado, and the District of Columbia.

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ALFRED SCHNEIDER is professor emeritus of nuclear engineering at the Georgia Institute of Technology, Atlanta, GA. Formerly, he was director of nuclear technology at Allied-General Nuclear Services, where he was responsible for management of technical aspects of the design, licensing, and construction of the Barnwell Nuclear Fuel Plant. Currently, he is a consultant to the U.S. Department of Energy Chemical Engineering Panel, the U.S. Congress Office of Technology Assessment's Panel on the Management of Radioactive Wastes, Kimberly-Clark Corporation, and Westinghouse Electric Corporation. Dr. Schneider holds several patents and has authored numerous reports, publications and invited lectures. Dr. Schneider has served on the Board of the National Academy of Sciences Radioactive Waste Management Panel, the Criticality Review Panel for the Idaho Chemical Processing Plant, and the Waste Form Review and Selection Panel for Battelle Pacific-Northwest Laboratory. He currently serves on the Operations Readiness Review Board and the Technical Review Group for the West Valley Demonstration Project. He received the U.S. Navy Medal for Scientific Research in Antarctica and the Robert E. Wilson Award from the American Institute of Chemical Engineers. Dr. Schneider is listed in American Men and Women of Science. He is a member of the American Chemical Society, a fellow of the American Institute of Chemists, a member of the American Institute of Chemical Engineers, the American Nuclear Society, and Sigma Xi.

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MASON WILLRICH is president and chief executive officer of PG&E Enterprises, San Francisco, CA. Previously, he was executive vice president of Pacific Gas and Electric Company. Mr. Willrich also formerly was assistant general counsel at the US Arms Control & Disarmament Agency and a professor of law at the University of Virginia. He has authored several books and articles on energy policy and national security issues, including Radioactive Waste Management and Regulation. He is a member of the Council on Foreign Relations, the International Institute of Strategic Studies, and the American Society of International Law.

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MICHAEL WILSON is a member of the Florida Public Service Commission, Tallahassee, FL. Formerly, Mr. Wilson served as deputy public counsel of the Office of Public Counsel. He presently serves as chairman of the National Association of Regulatory Utility Commissioners' Subcommittee on Nuclear Issues - Waste and is a member of the Electric Power Research Institute Advisory Board.

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Impact of Repository-Heat-Driven Hydrothermal Flow on Repository Performance: Benefits from High Repository Thermal Loading

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Yucca Mountain Project - Project Mananger's/TPO Meeting
December 13, 1991

Impact of thermal loading on repository performance at Yucca Mountain

- Overview of Yucca Mountain hydrology
- Hydrothermal flow at the repository horizon
- Temperature profiles as a function of thermal load
- Impact of hydrothermal flow on temperature distribution
- Impact of thermal load on repository performance
- Impact of thermal load on hydrogeologic uncertainties
- Conclusions
- Appendix

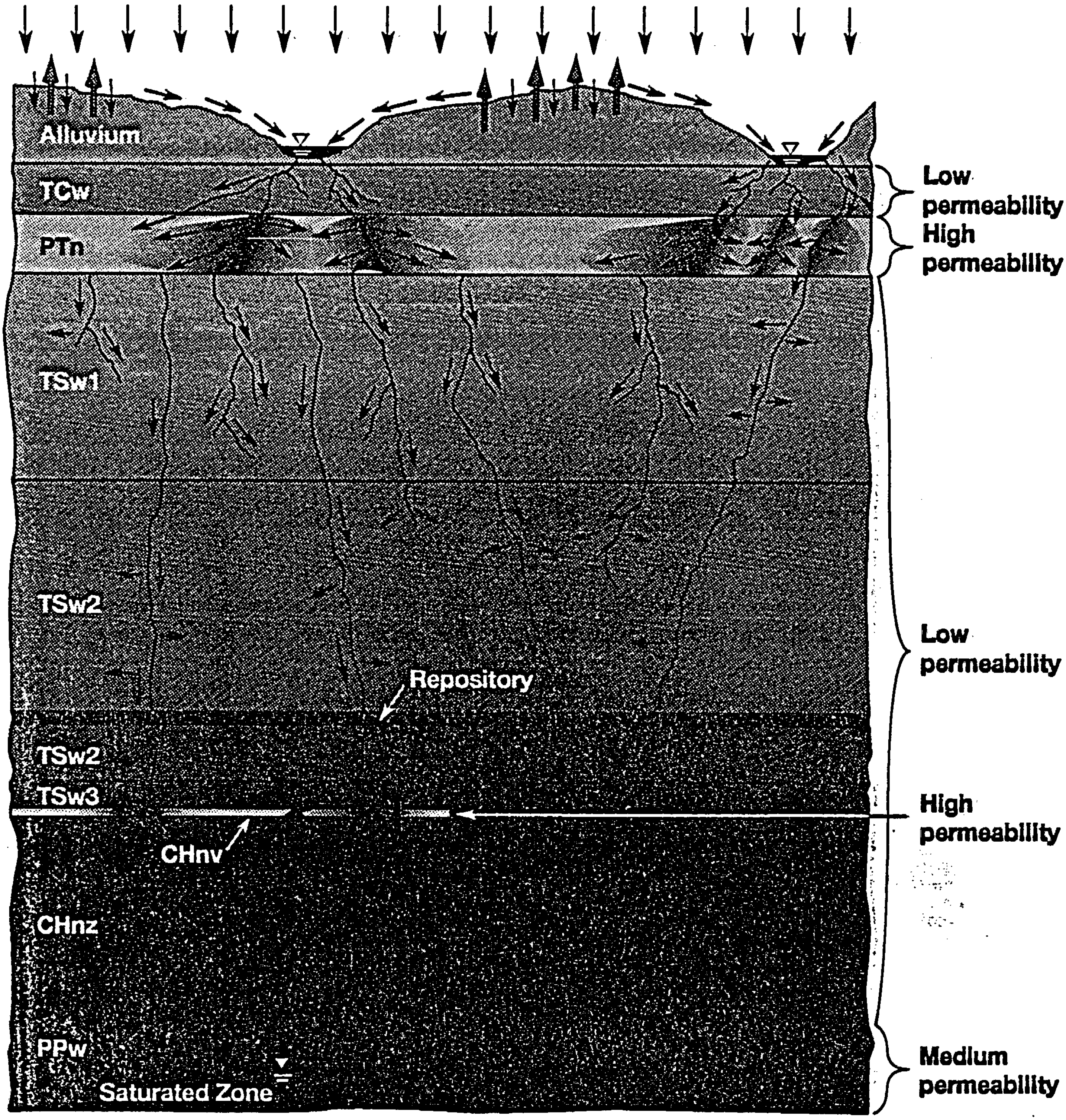
Overview of Yucca Mountain hydrology

- The key consideration is the impact of thermal load on fracture-dominated flow
  - Matrix-dominated flow will not result in significant vertical transport of radionuclides
  - Field evidence indicates fracture-dominated flow can occur to considerable depth
  - Fracture-dominated flow is only credible mechanism bringing water to waste packages and transporting radionuclides
- Boiling and dry-out greatly enhance fracture flow attenuation
  - These effects can reduce the impact of uncertainties

Factors mitigating liquid flow along preferential fracture pathways

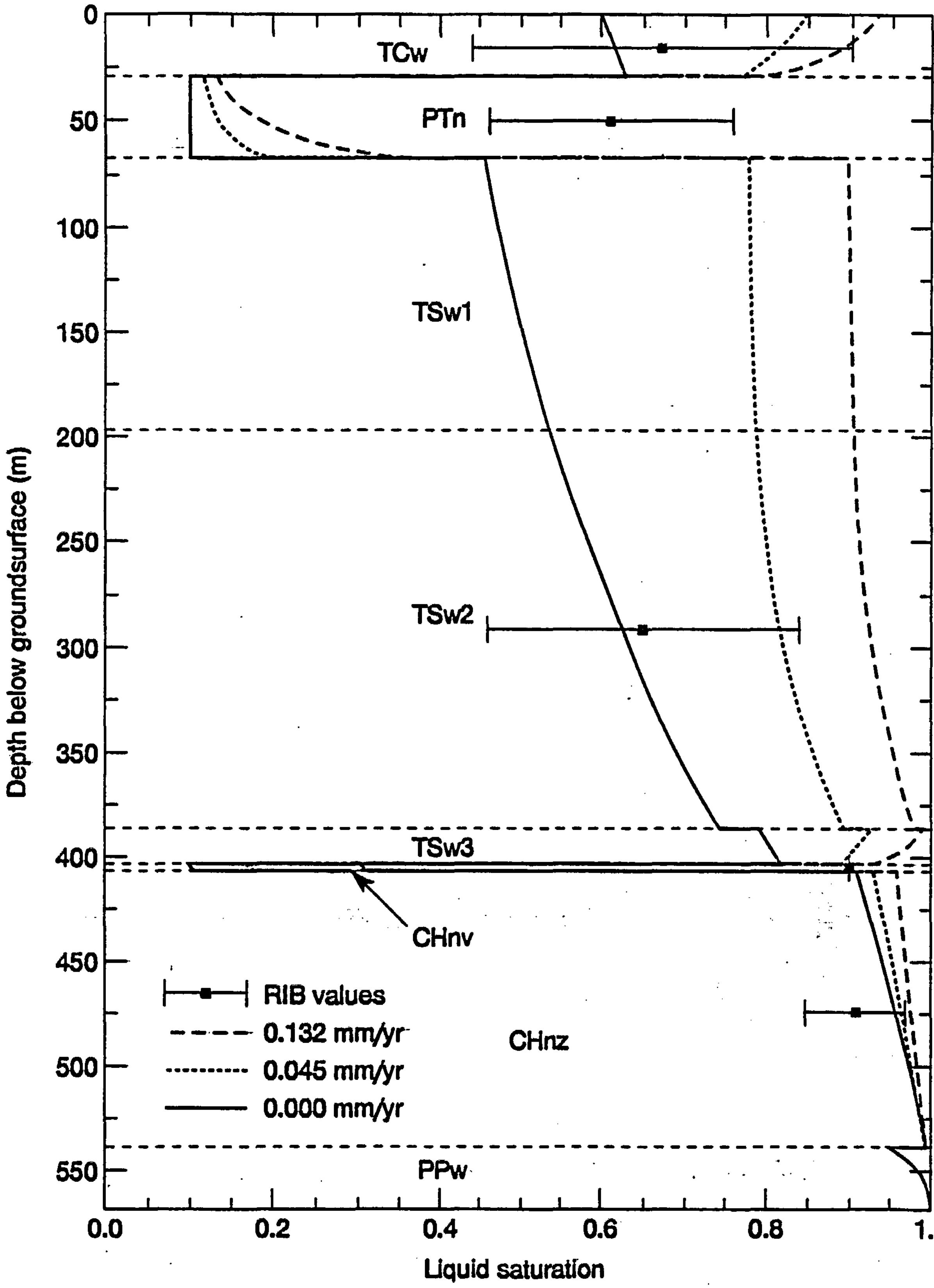
- Discontinuity in fracture networks
- Liquid-phase dispersion in fracture networks
- Fracture-matrix interaction
  - For low APD's, only matrix imbibition
  - For high APD's, boiling effects and enhanced imbibition due to dry-out

Episodic infiltration occurs as fracture-dominated flow in the low permeability units and matrix-dominated flow in the high permeability units



ES-TB-1 (3-30-91) FH

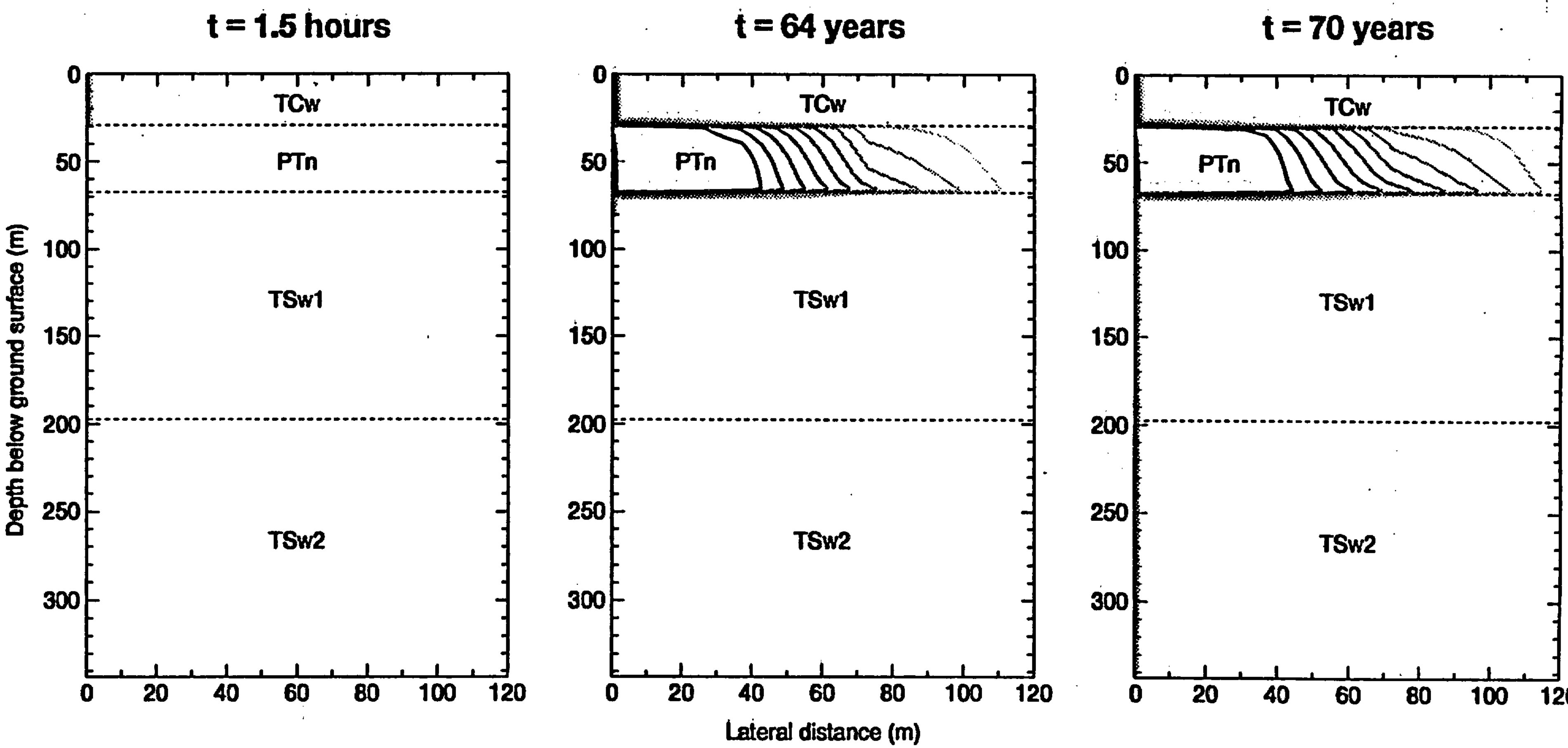
Liquid saturation profile obtained from several 1-D models of steady-state recharge flux versus saturations from the reference information base (RIB)



ES-TB-37 (6-10-91) IL

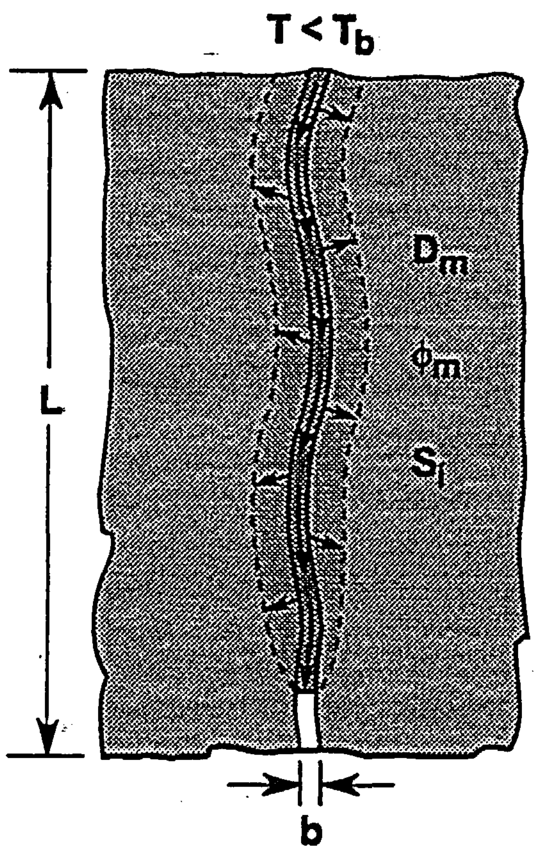
Above the repository, the travel time for liquid flow down a preferential fracture pathway is dominated by matrix flow into the vitric nonwelded Paintbrush tuff unit (PTn)

Dimensionless liquid saturation in the matrix resulting from a wetting event down a 100μm fracture



ES-TB-20 (10-5-91) IL

The travel time for a fracture front to penetrate a hydrostratigraphic unit is extremely sensitive to fracture aperture



D_m = matrix capillary diffusivity

ϕ_m = matrix porosity

S_i = initial matrix saturation

S_s = maximum matrix saturation

τ = tortuosity of fracture pathway

t = travel time

Flow period I

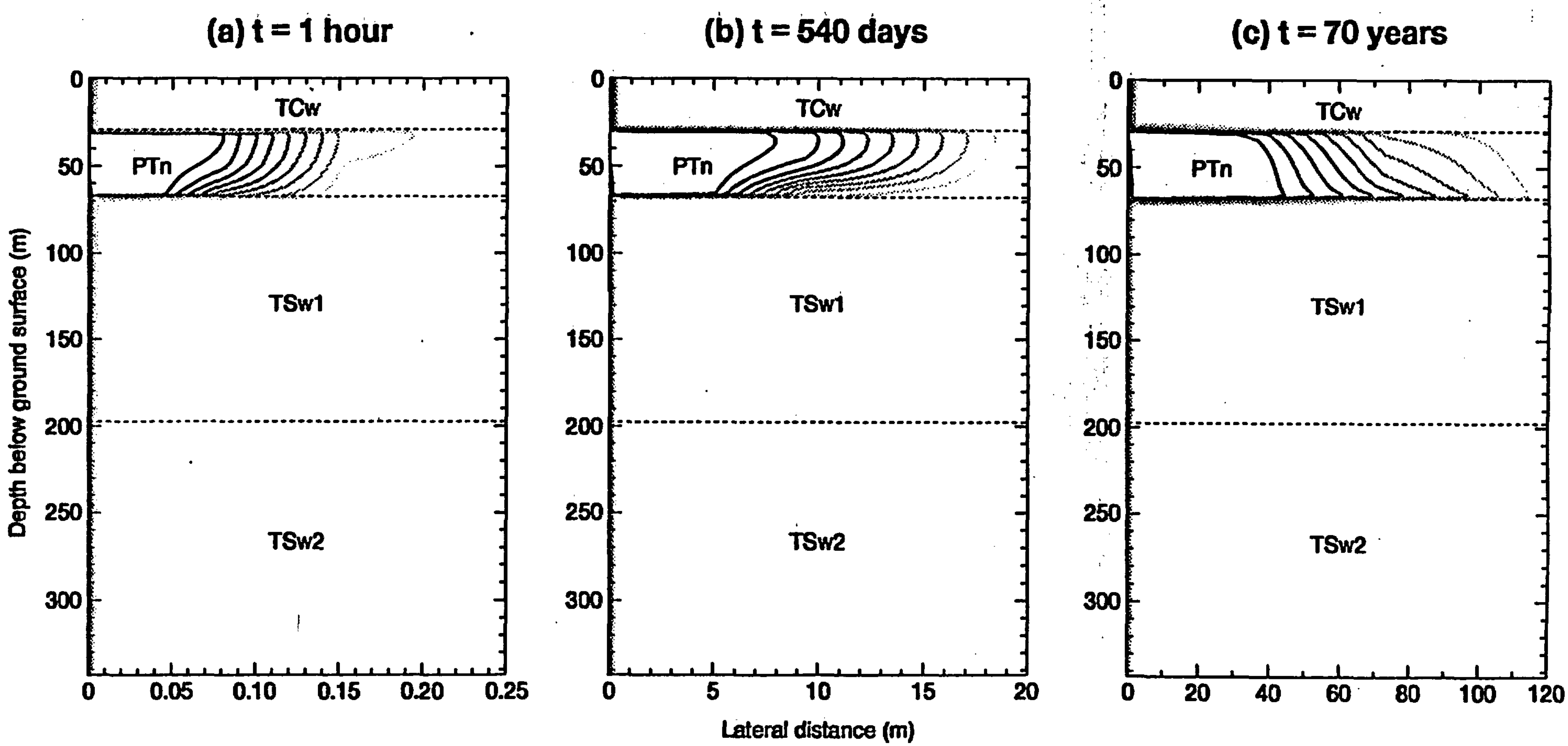
$$t \sim \frac{\tau L}{b^2}$$

Flow period II

$$t \sim \frac{D_m[\tau L \phi_m (S_s - S_i)]^2}{b^6}$$

The travel time for liquid flow down a preferential fracture pathway is extremely sensitive to the hydraulic aperture of the fracture

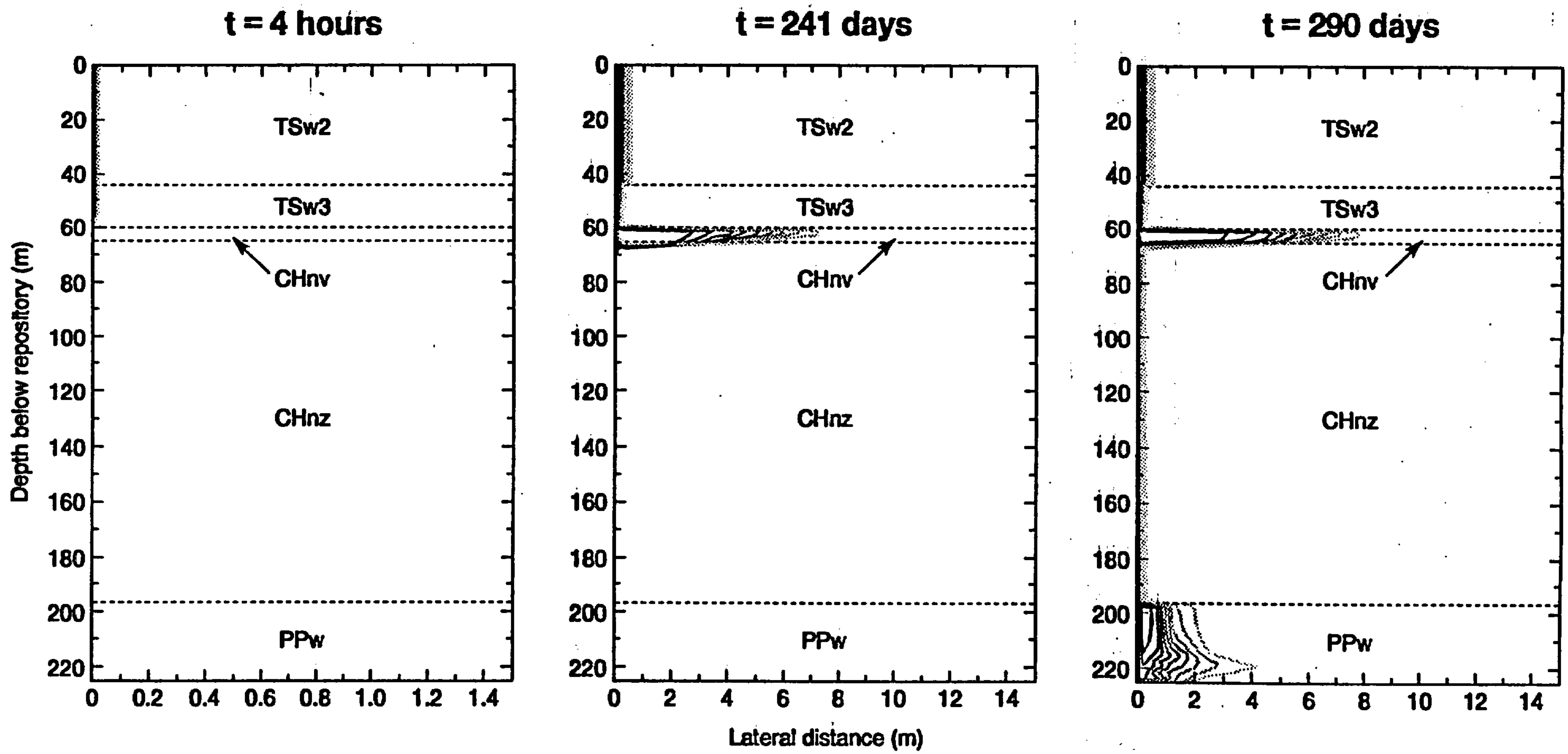
Dimensionless liquid saturation in the matrix resulting from a wetting event down (a) a 1000μm fracture, (b) a 200μm fracture, and (c) a 100μm fracture



ES-TB-3 (10-19-91) IL

Below the repository, the travel time for liquid flow down a preferential fracture pathway is dominated by matrix flow into the vitric nonwelded Calico Hills unit (CHnv)

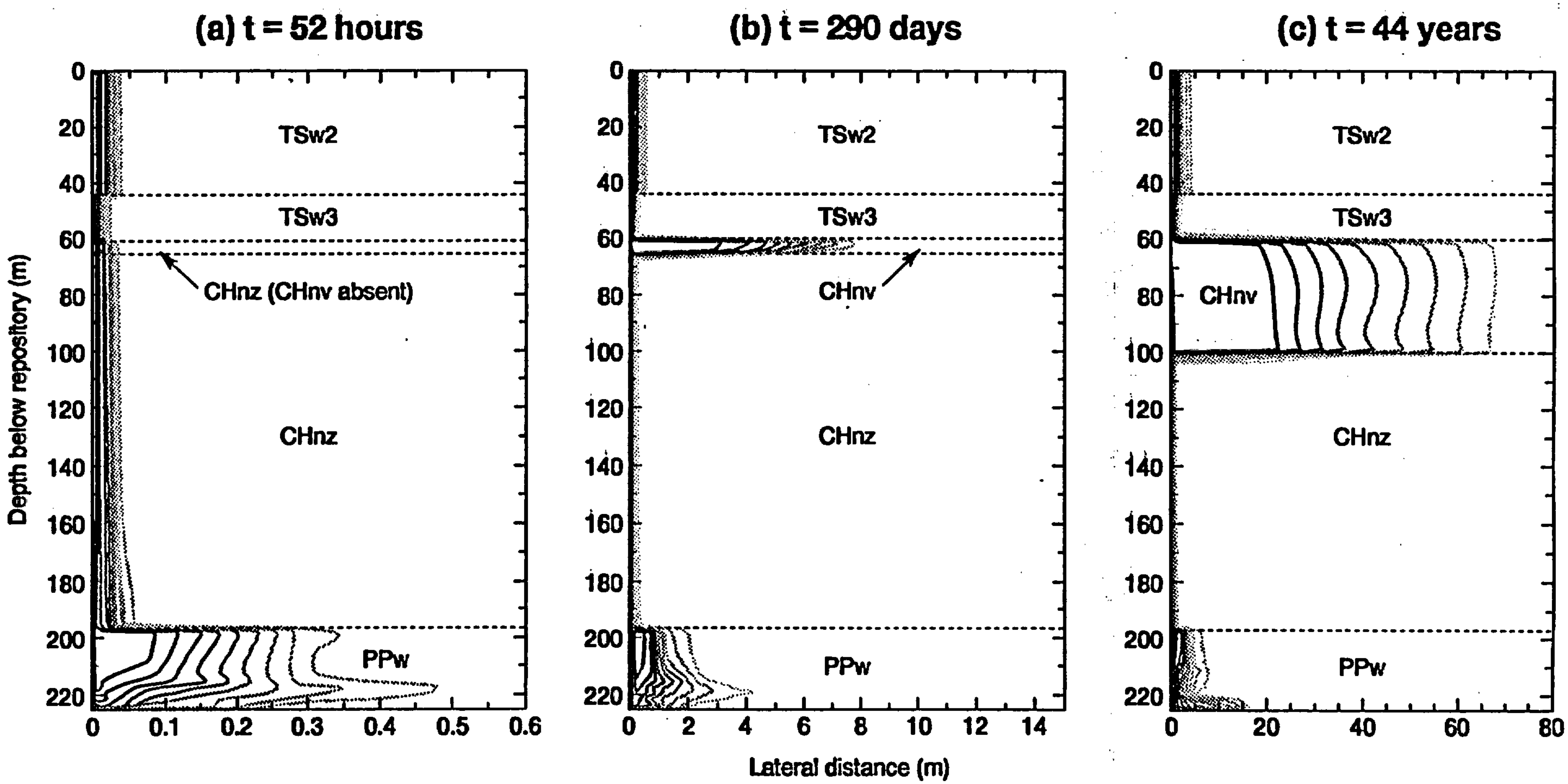
Dimensionless liquid saturation in the matrix resulting from a wetting event down a 100μm fracture



ES-TB-18 (10-5-91) IL

Below the repository, the travel time for liquid flow down a preferential fracture pathway is dominated by the thickness of the vitric nonwelded Calico Hills unit (CHnv)

Dimensionless liquid saturation in the matrix resulting from a wetting event down a 100μm fracture for cases where the CHnv is (a) absent, (b) 4.6-m-thick, and (c) 40-m-thick

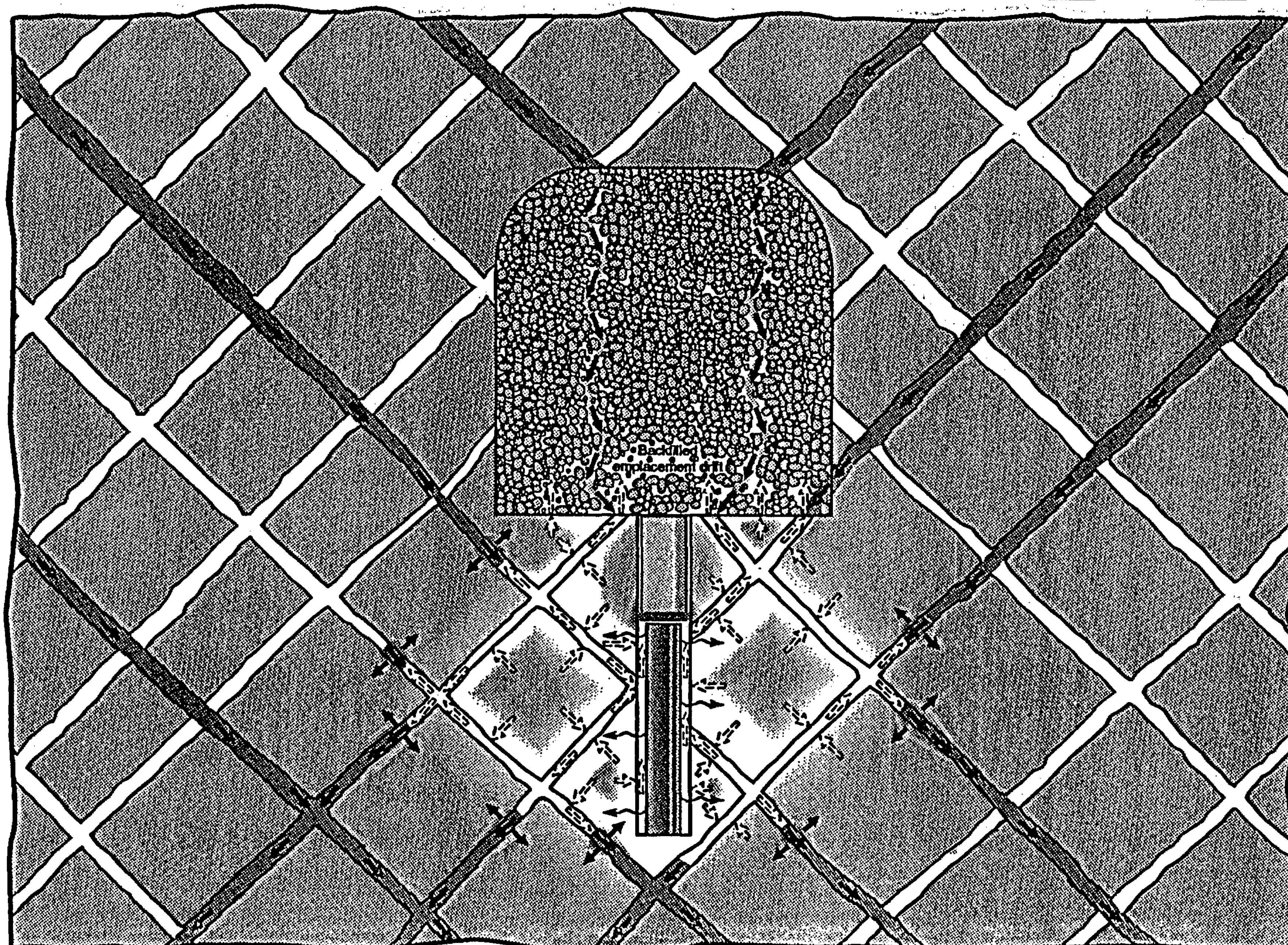


ES-TB-19 (10-5-91) IL

Hydrothermal flow at the repository horizon

- Unsaturated, fractured tuff promotes rock dry-out by boiling
- Volume of dry-out zone dominated by thermal load and thermal properties
- Fracture-matrix properties of host rock promote rapid condensate drainage
- Volume of dry-out zone can be enhanced by alternative emplacement configurations
- The numerical models used in this study are very conservative in predicting the dry-out volume

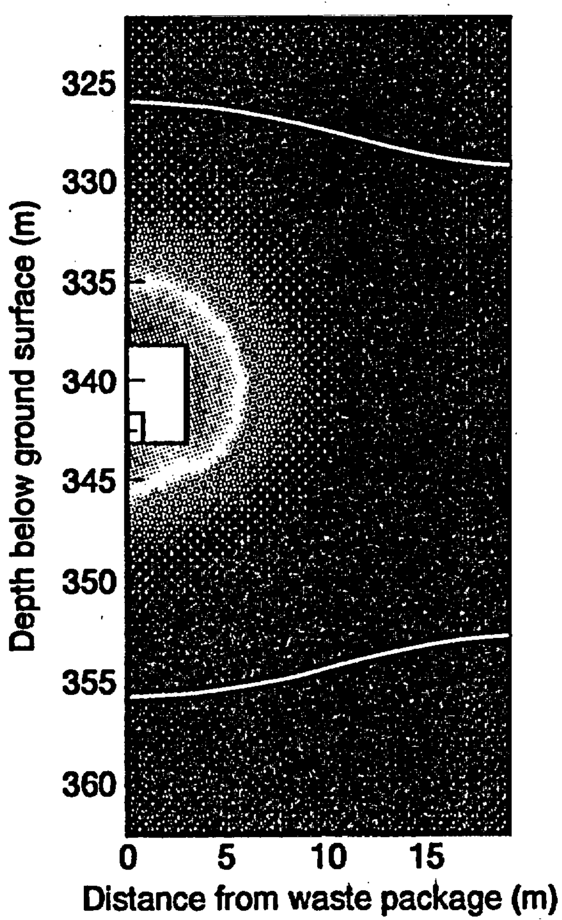
Under hydrothermally perturbed conditions, boiling will mitigate episodic fracture flow from reaching the waste package (for up to 1000 years for a repository heat loading rate of 57 *kw/acre*) (Buscheck and Nitao, 1991)



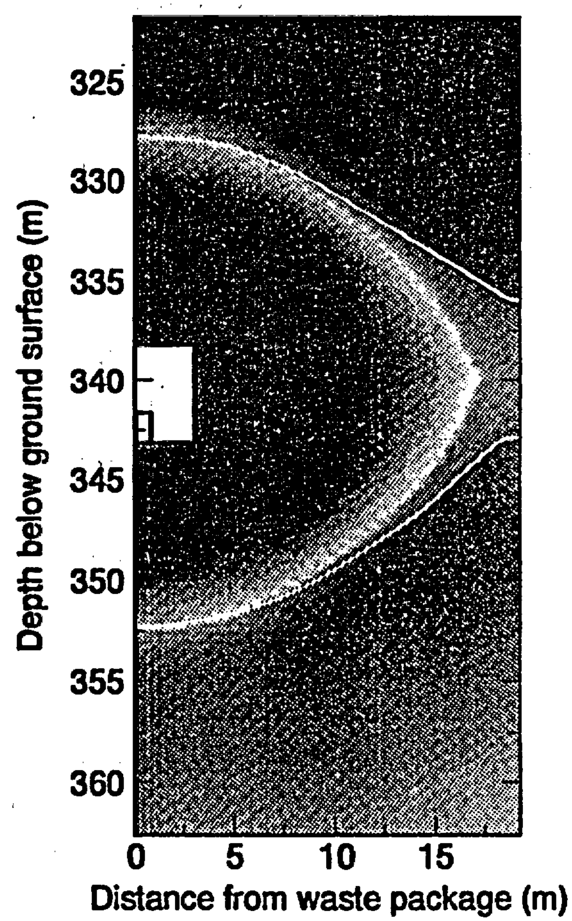
ES-TB-7 (4-20-91) IL

The bulk permeability data for Topopah Spring tuff (TSw2) at the repository horizon is much greater than the threshold bulk permeability for significant rock dry-out

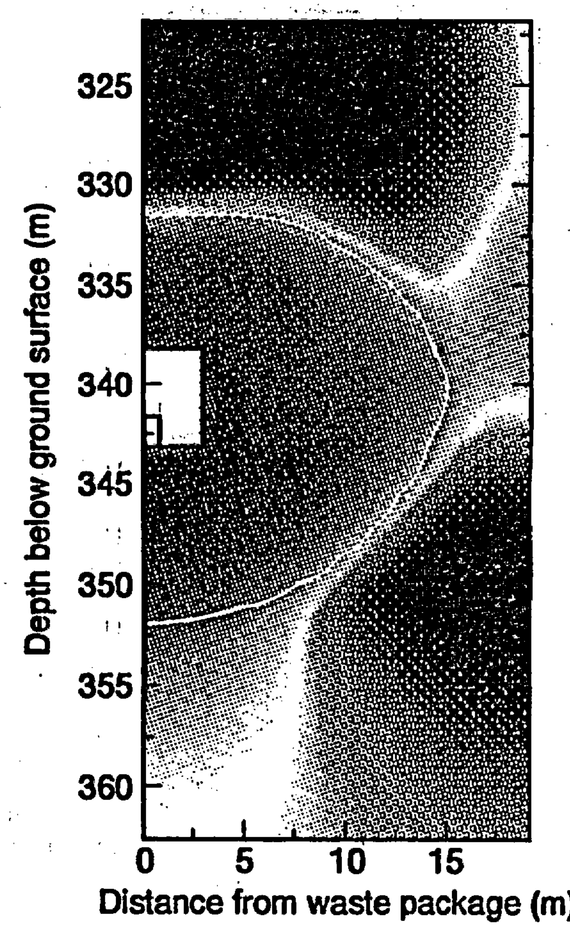
Dimensionless liquid saturation for 30-yr-old fuel, an APD of 57 kW/acre, a drift spacing of 38.4 m, and a recharge flux of 0.0 mm/yr at t = 60 yr (the boiling point isotherm, T_b is shown in yellow)



$k_b = 1.9 \times 10^{-18}$ m^2



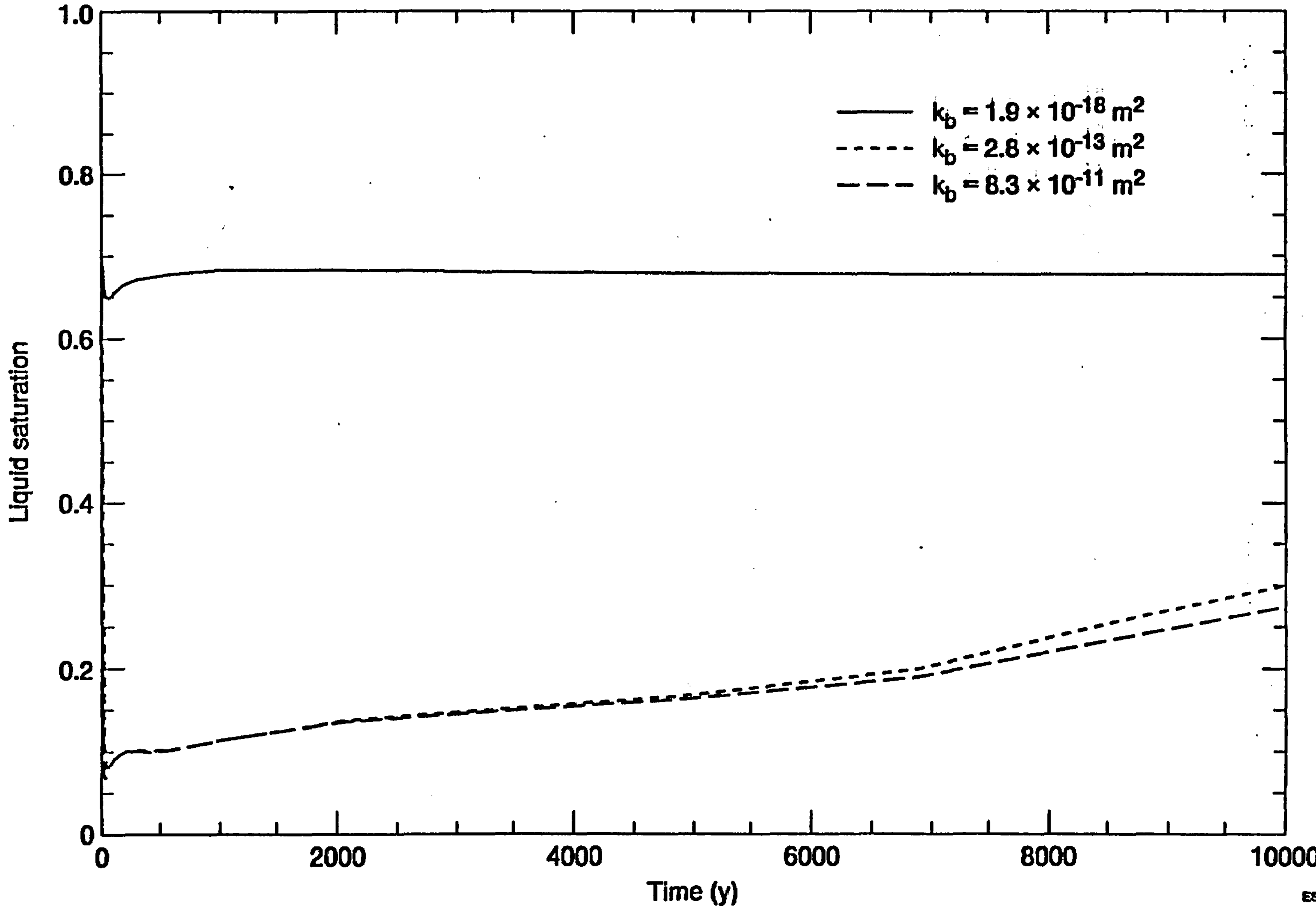
$k_b = 2.8 \times 10^{-13}$ m^2



$k_b = 8.3 \times 10^{-11}$ m^2

The existing bulk permeability data for Topopah Spring tuff (TSw2) at the repository horizon is much greater than the threshold bulk permeability for significant rock dry-out

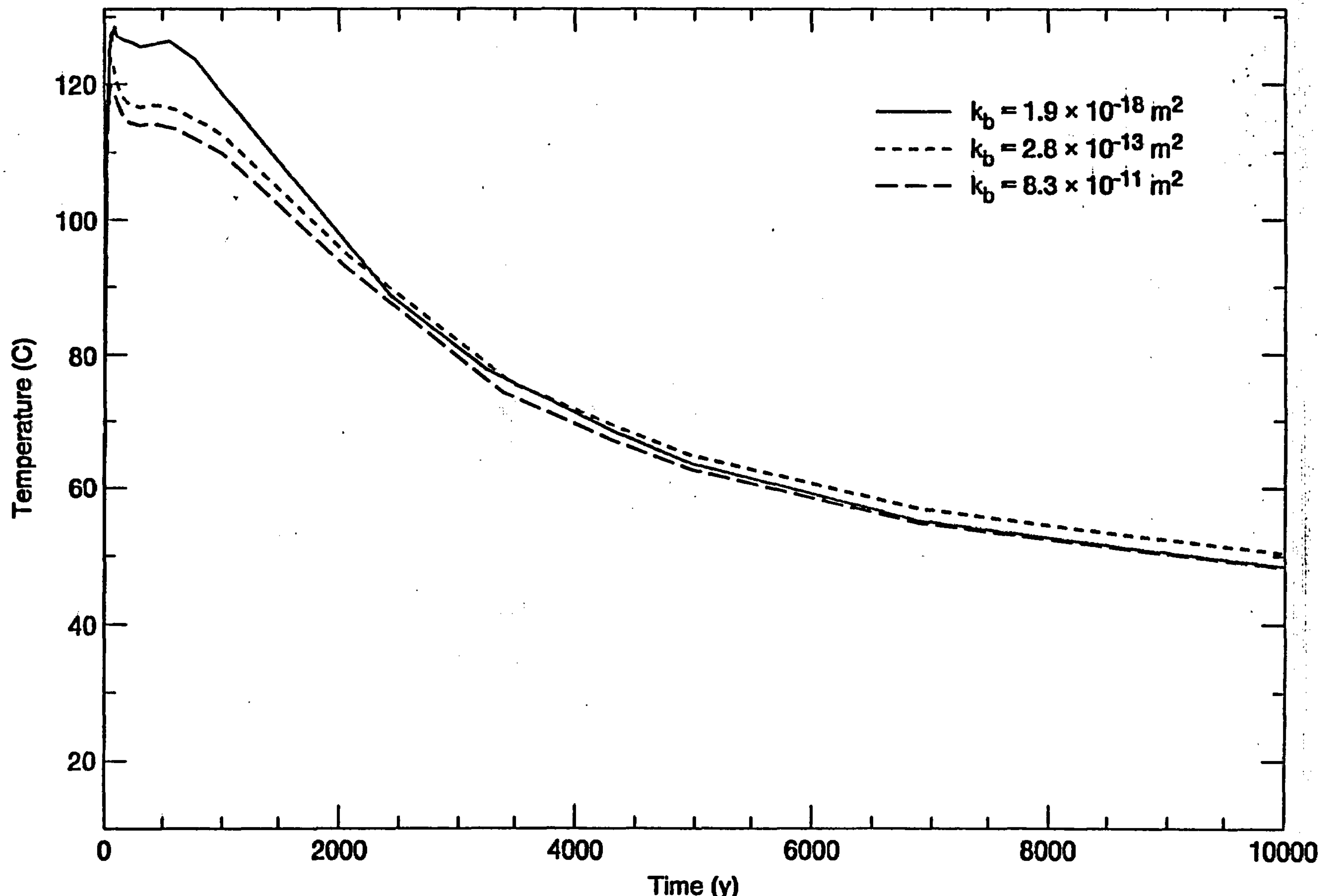
Liquid saturation history at drift wall for drift emplacement for an APD of 57 kW/acre, 30-yr-old fuel, and a recharge flux of 0.0 mm/yr



ES-TB-24 (10-7-91) IL

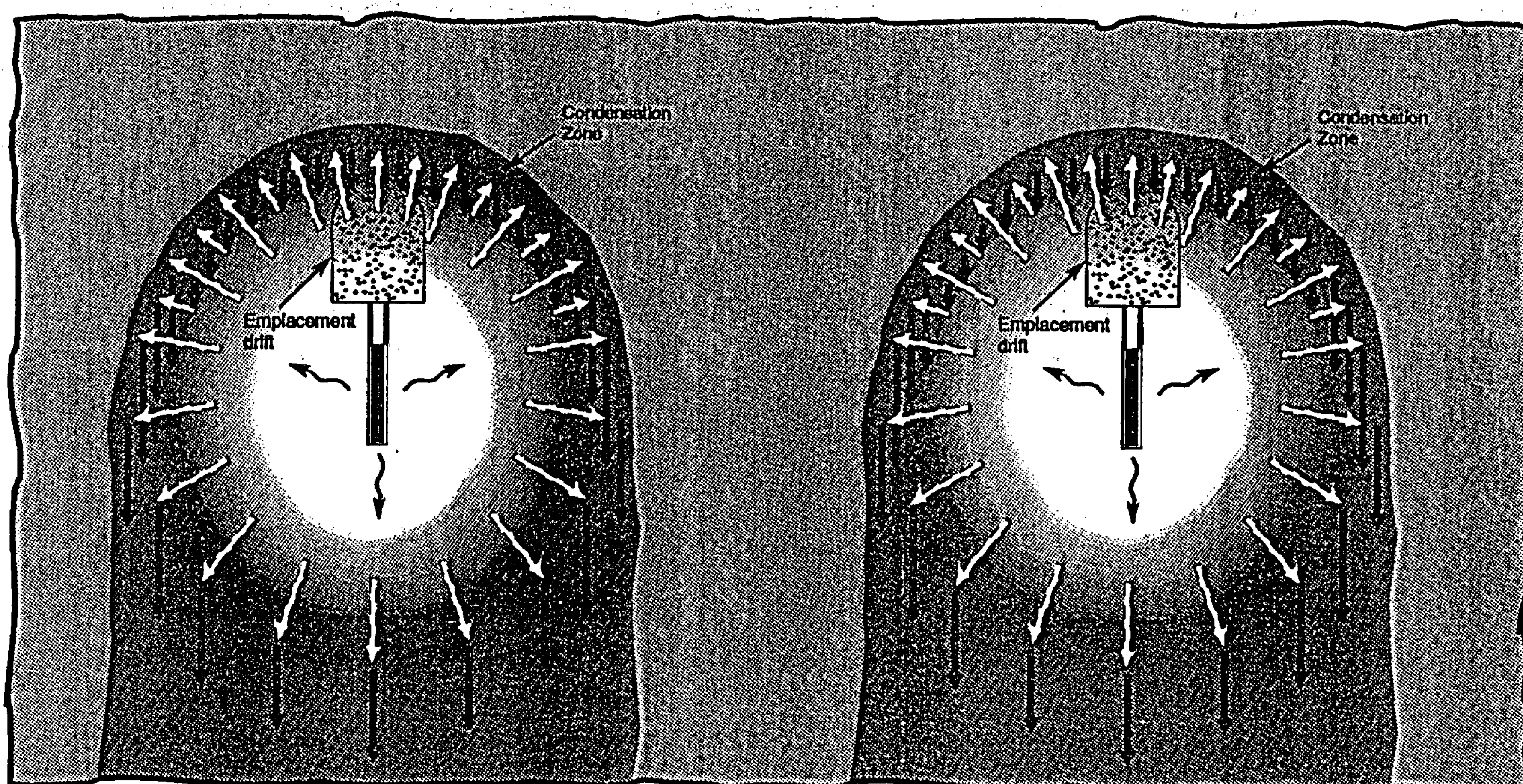
Near-field temperatures are relatively insensitive to the bulk permeability of the fractured host rock

Temperature history at drift wall for drift emplacement for an APD of 57 kW/acre, 30-yr-old fuel, and a recharge flux of 0.0 mm/yr



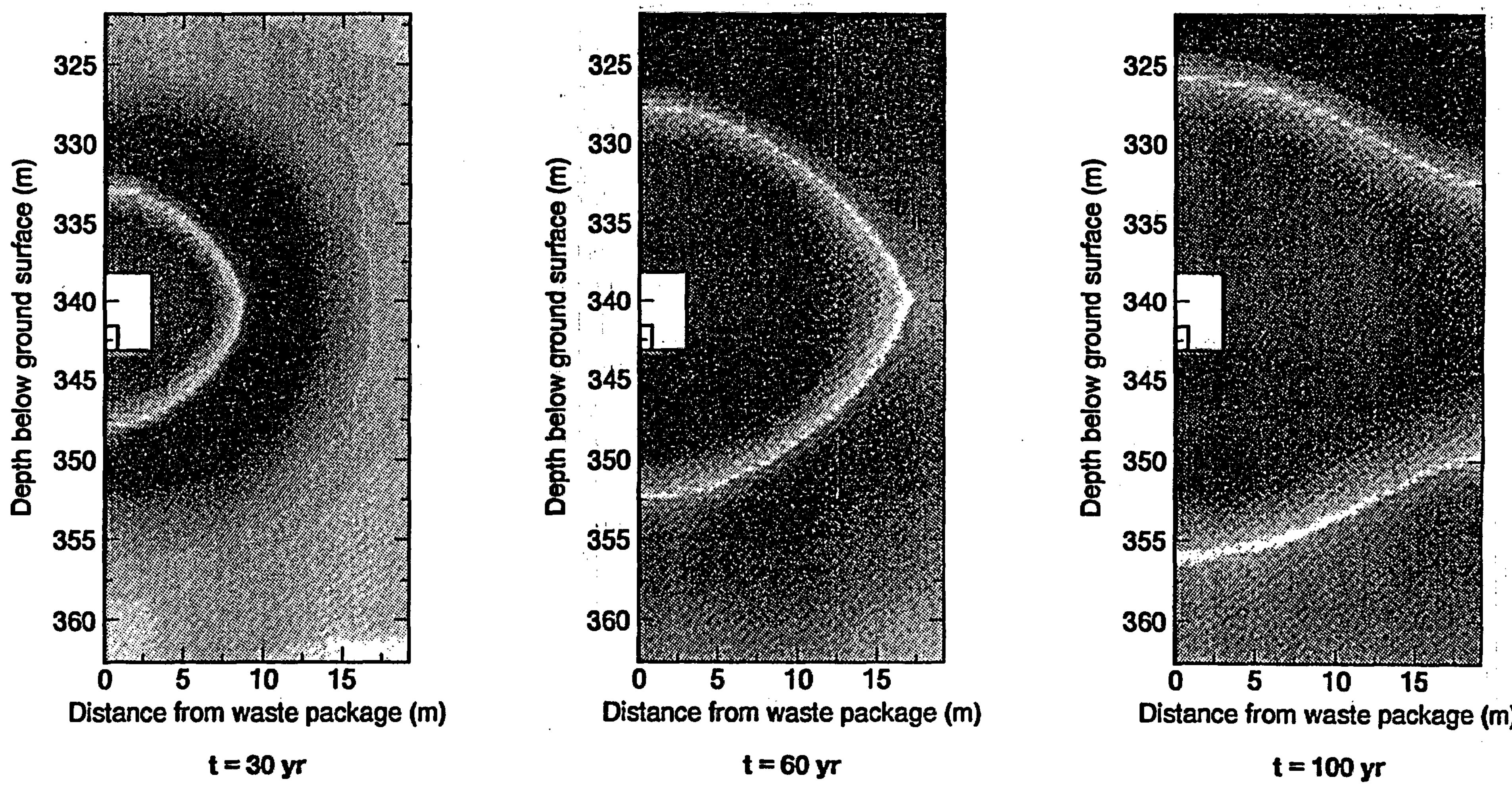
ES-TB-25 (10-7-91) IL

A "hydrothermal umbrella" is established along each of the emplacement drifts due to condensate being shed off of the sides of the boiling zone



The shedding of condensate between emplacement drifts will continue until the boiling zones coalesce approximately 80 years after emplacement

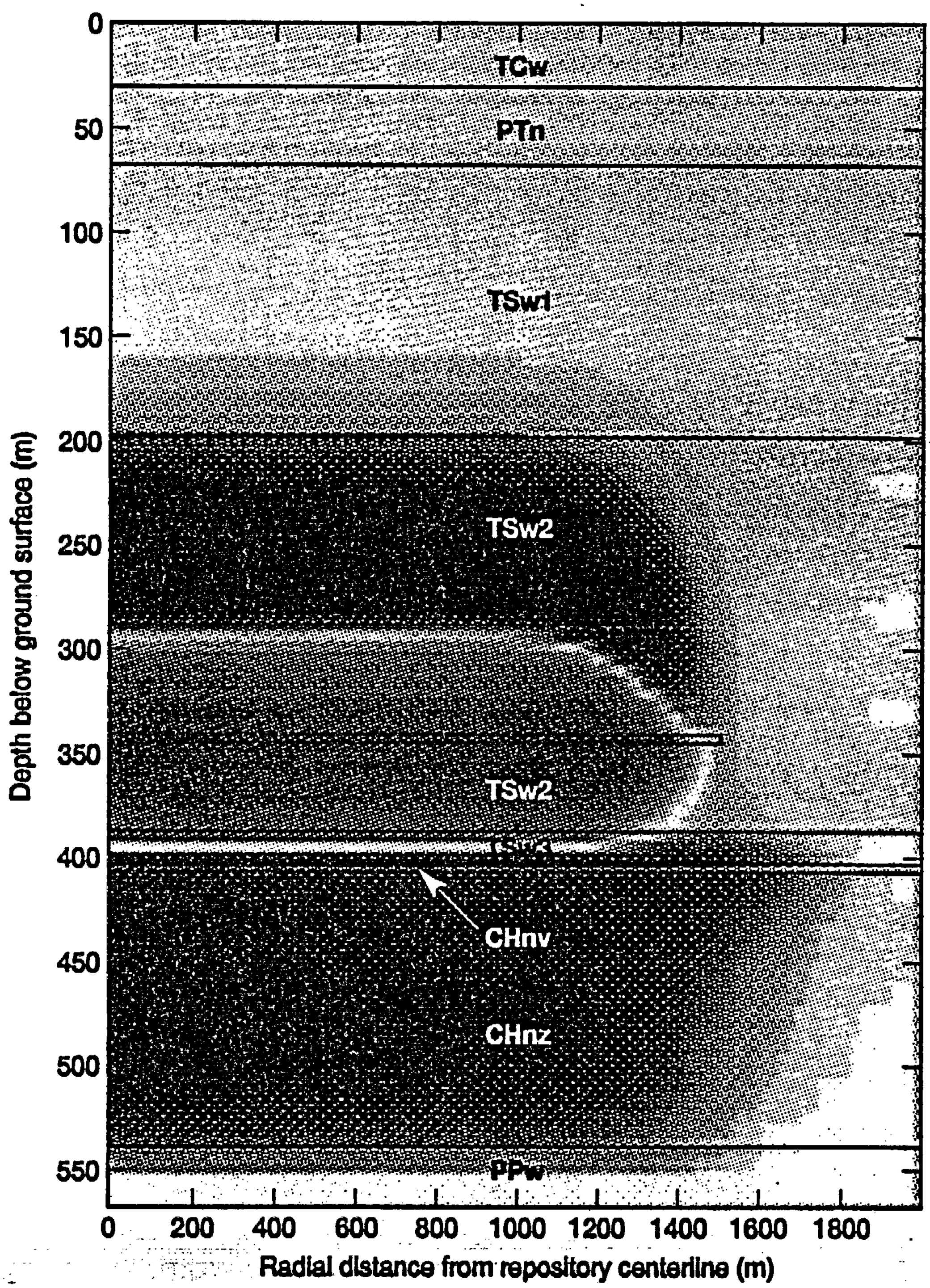
Dimensionless liquid saturation for 30-yr-old fuel, an APD of 57 kW/acre, a drift spacing of 38.4 m, and a recharge flux of 0.0 mm/yr



ES-TB-1 (9-28-91) IL

After 1000 years, boiling has resulted in a 100-m-thick dry-out zone, surrounded by a condensation zone, with condensation drainage extending to the water table

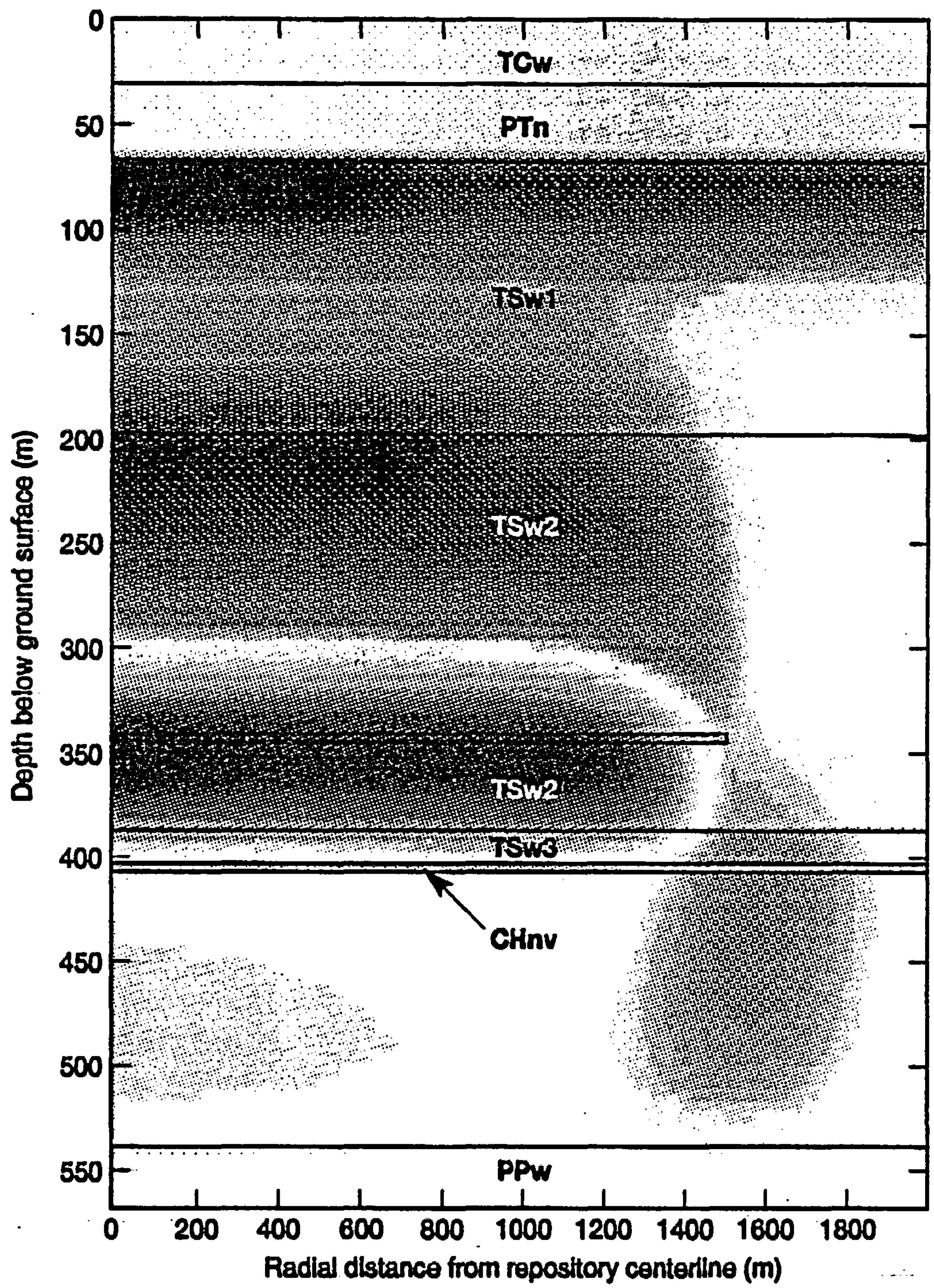
Dimensionless liquid saturation for 30-yr-old fuel, an APD of 57 kW/acre, a drift spacing of 38.4 m, and a recharge flux of 0.0 mm/yr



ES-TB-3 (9-21-91) IL

Although boiling ceased after 1800 years, most of the repository remains dry 5000 years after emplacement

Dimensionless liquid saturation for 30-yr-old fuel, an APD of 57 kW/acre, a drift spacing of 38.4 m, and a recharge flux of 0.0 mm/yr



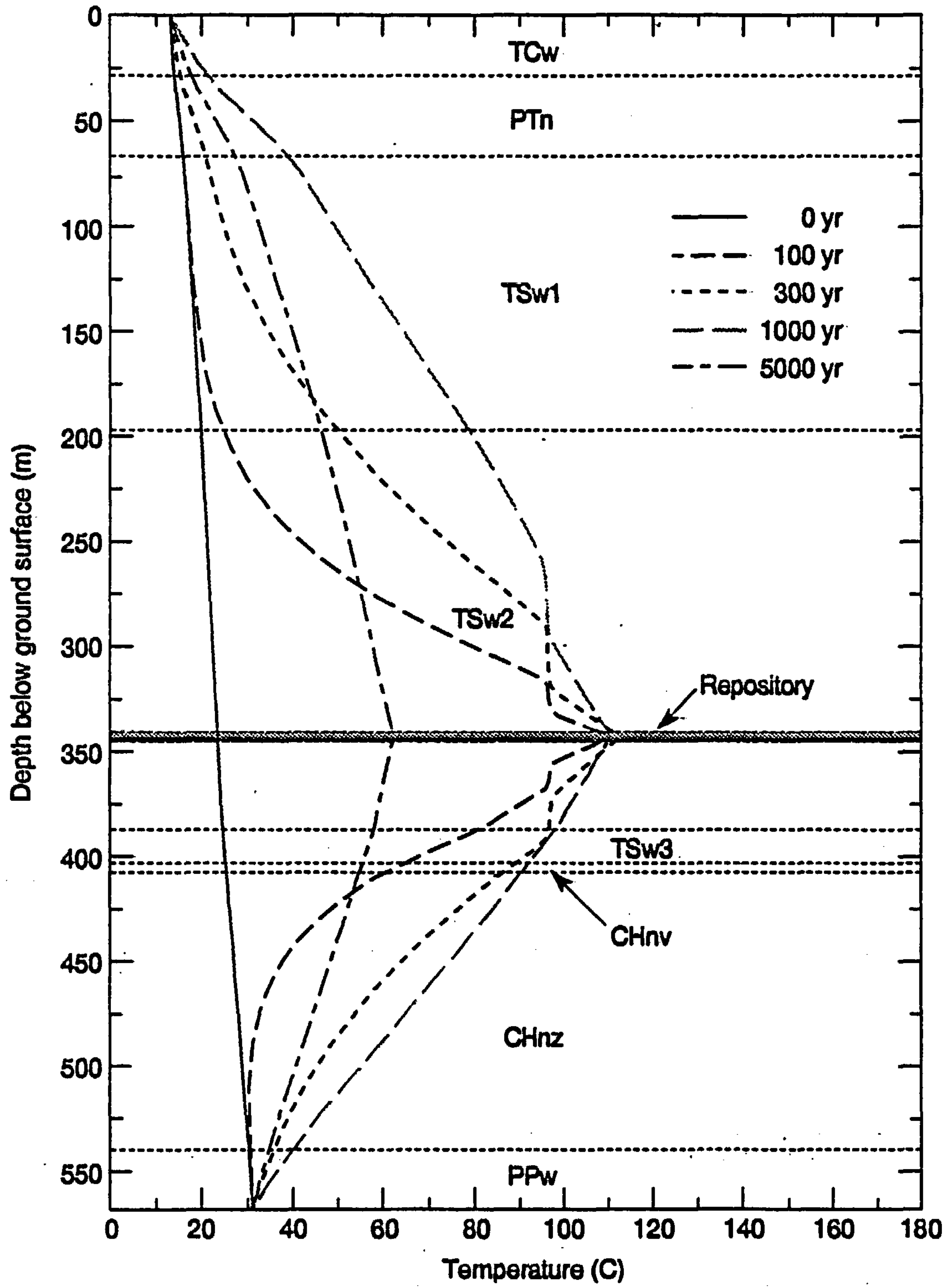
ES-TB-9 (9-27-91) IL

Temperature profiles as a function of thermal load

- Thermal disturbance reaches ground surface and water table within 300 years
- For given fuel age, temperature rise is linear in APD
- Repository temperatures are uniform within the inner two-thirds of repository area
- The emplacement drift-scale model (which accounts for local thermal load distribution) predicts temperatures similar to those in the inner two-thirds of the repository-scale model (which averages the thermal load)

Temperature profile is flattened at boiling zone (~ 96°C) and the temperature disturbance reaches ground surface 300 years after emplacement

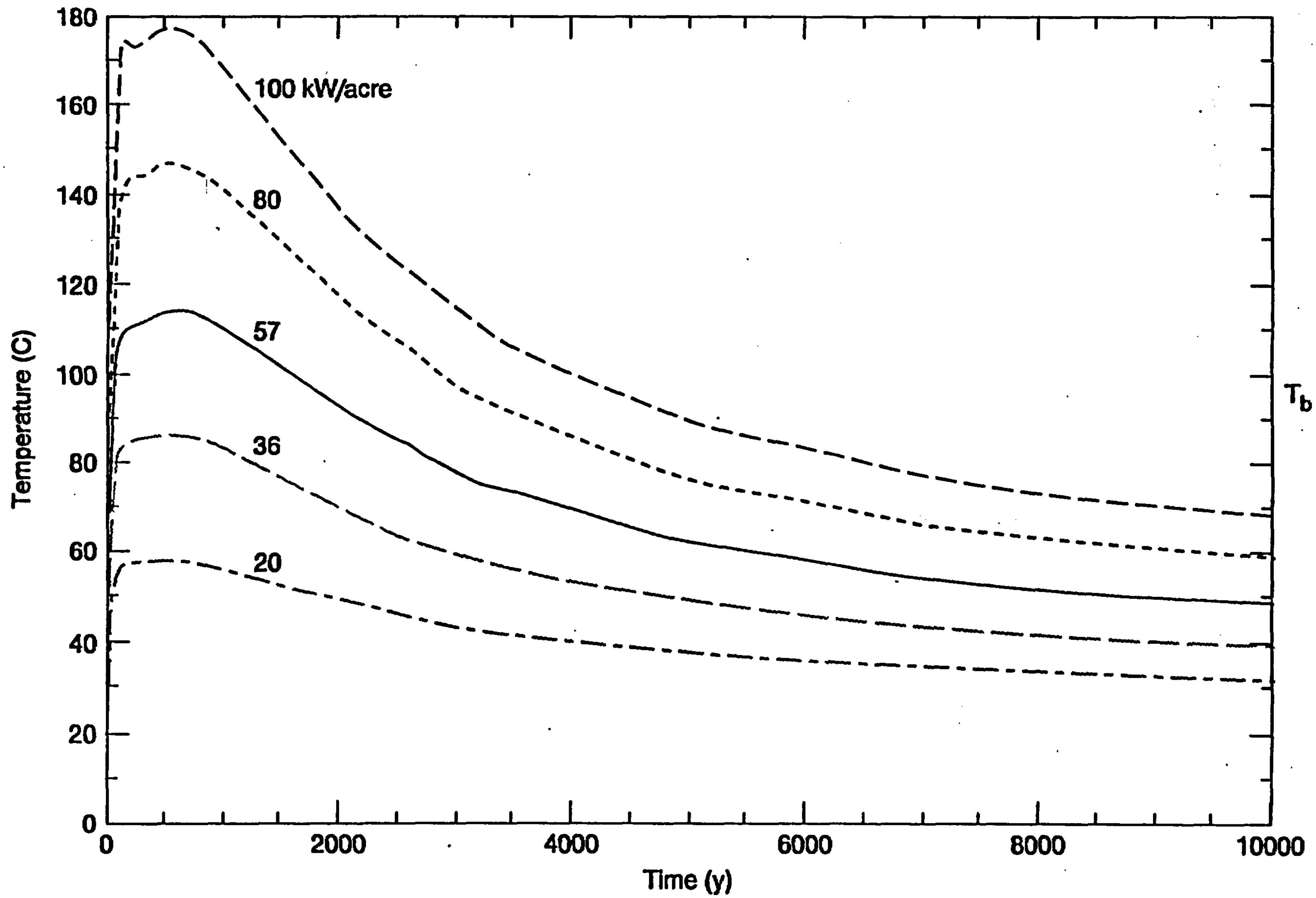
Temperature profile along repository centerline for 30-year-old fuel, an APD of 57 kW/acre, and a recharge flux of 0.000 mm/yr



ES-TB-9 (9-14-91) IL

For a given age fuel, temperature rise is proportional to APD

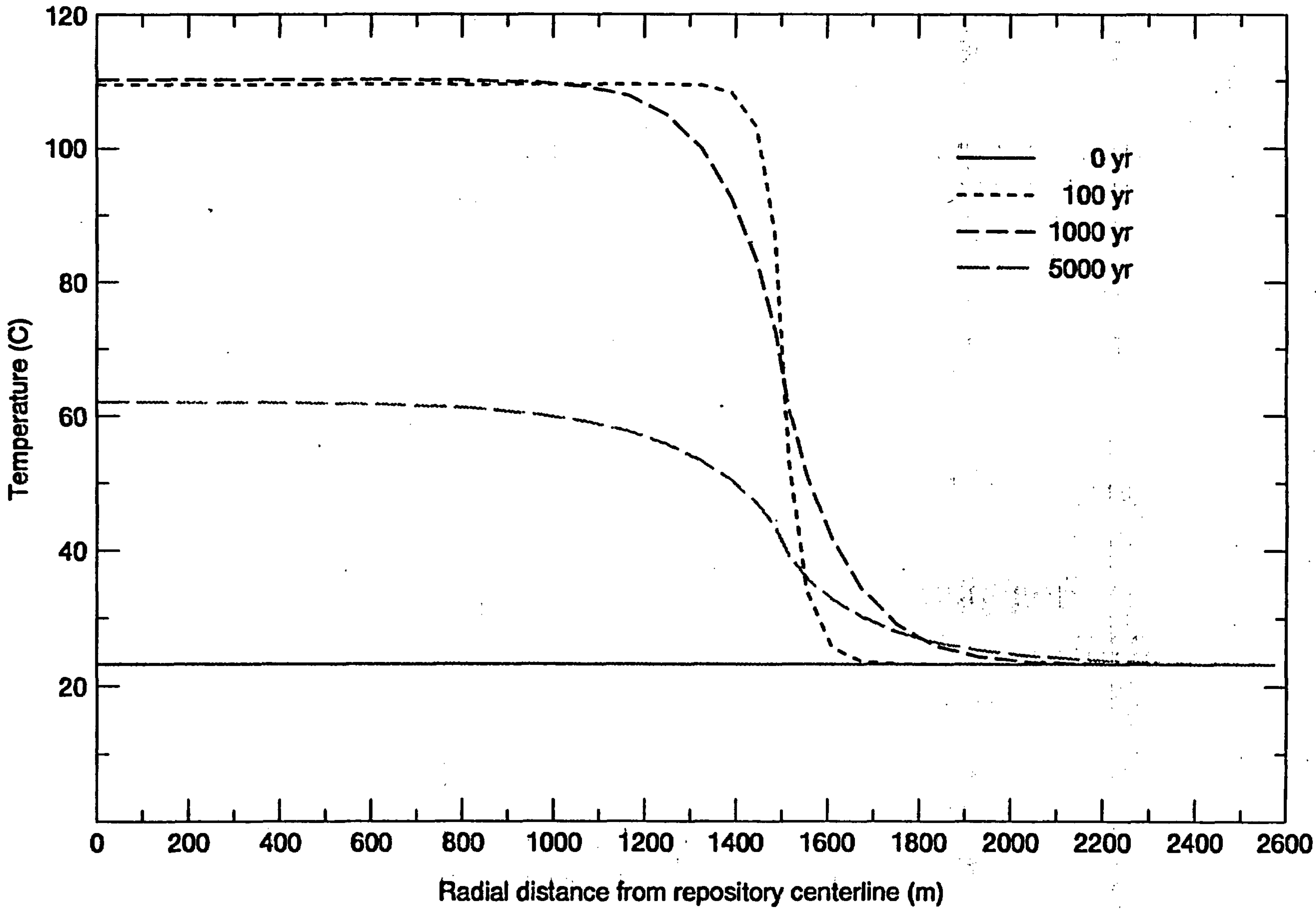
Temperature history at repository center for 30-yr-old fuel and a recharge flux of 0.0 mm/yr



ES-TB-17 (9-14-91) IL

Repository temperatures are uniform within the inner two-thirds of repository

Radial temperature profile at repository horizon for 30-year-old fuel, and an APD of 57 kW/acre, and a recharge flux of 0.0 mm/yr

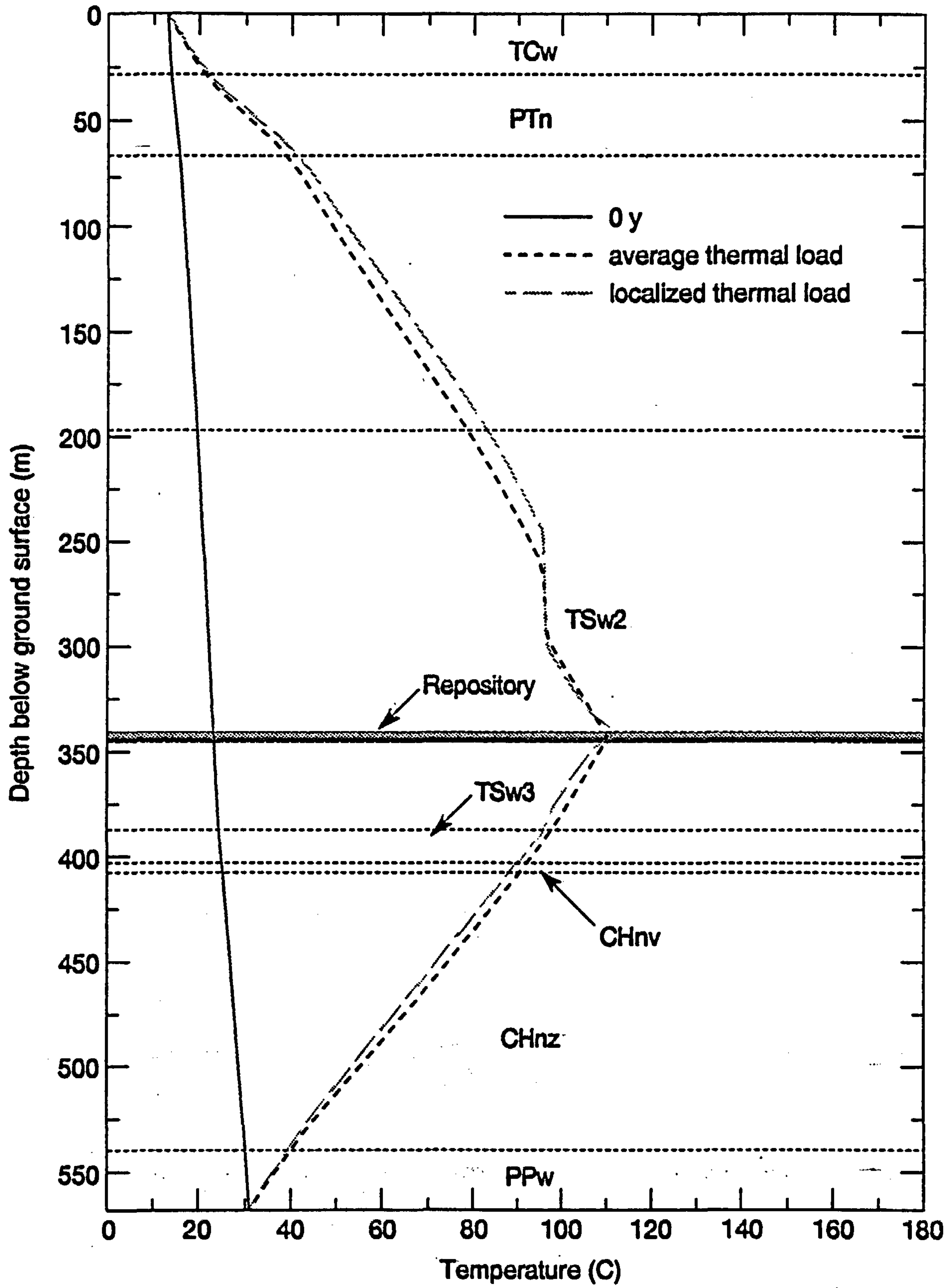


ES-TB-29 (9-23-91) ft.

Impact of hydrothermal flow on temperature field

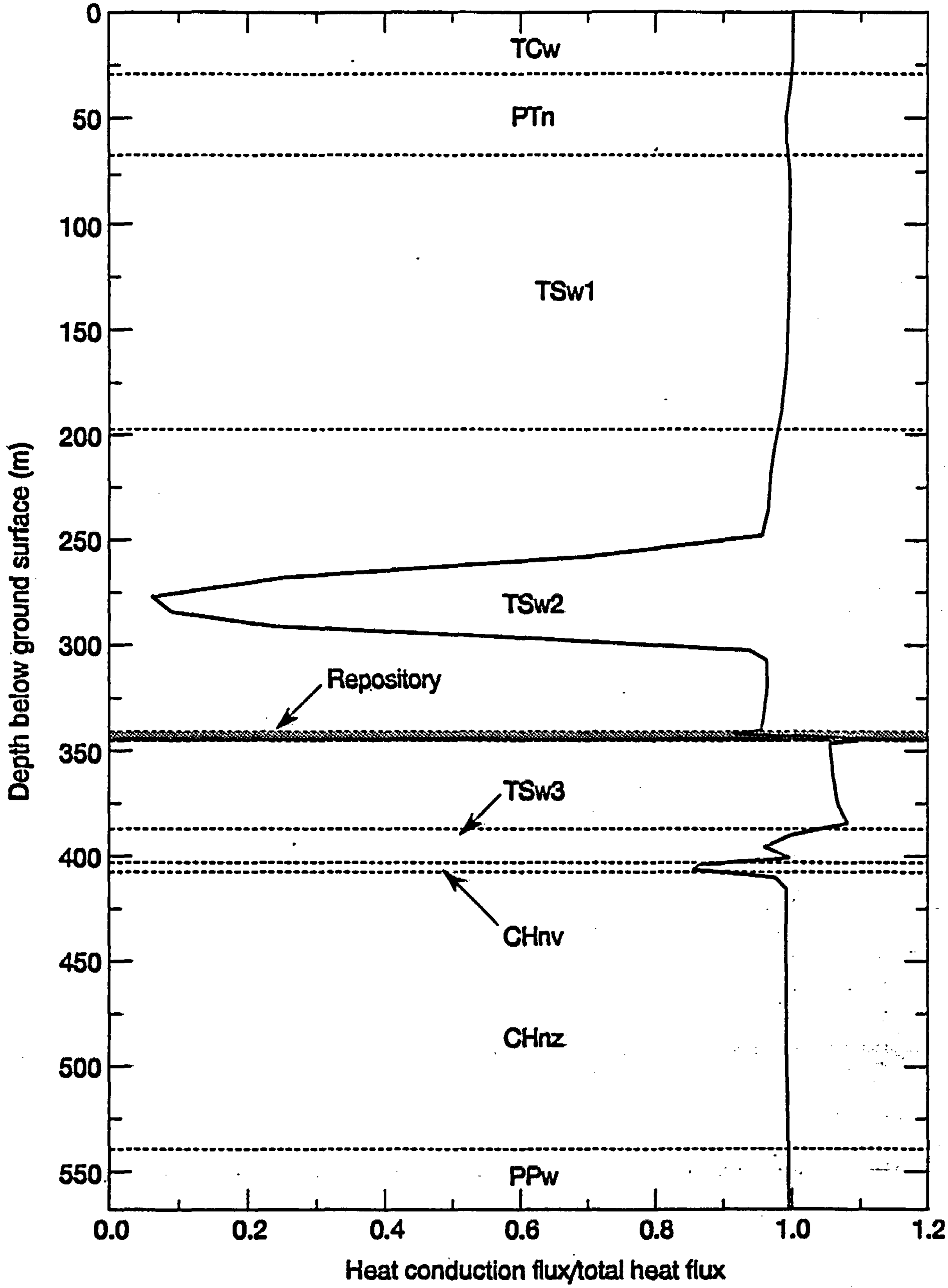
- For 30-year-old fuel and APDs up to 100 kW/acre, heat flow around the repository is dominated by heat conduction
- Temperatures in the vicinity of the waste packages decrease modestly with increasing recharge flux
- Boiling results in lower temperatures in the vicinity of the waste packages
- Heat conduction models yield
  - conservatively high temperatures in the vicinity of the waste packages
  - conservatively low temperatures with respect to the extent of the boiling zone
- Hydrothermal models predict higher temperatures in the Calico Hills units (CHnv and CHnz)

Vertical temperature profile along centerline of repository for 30-year-old fuel, an APD of 57 kW/acre, and a recharge flux of 0.0 mm/y at t = 1000 years for localized and averaged thermal loads



ES-TB-26 (9-23-91) IL

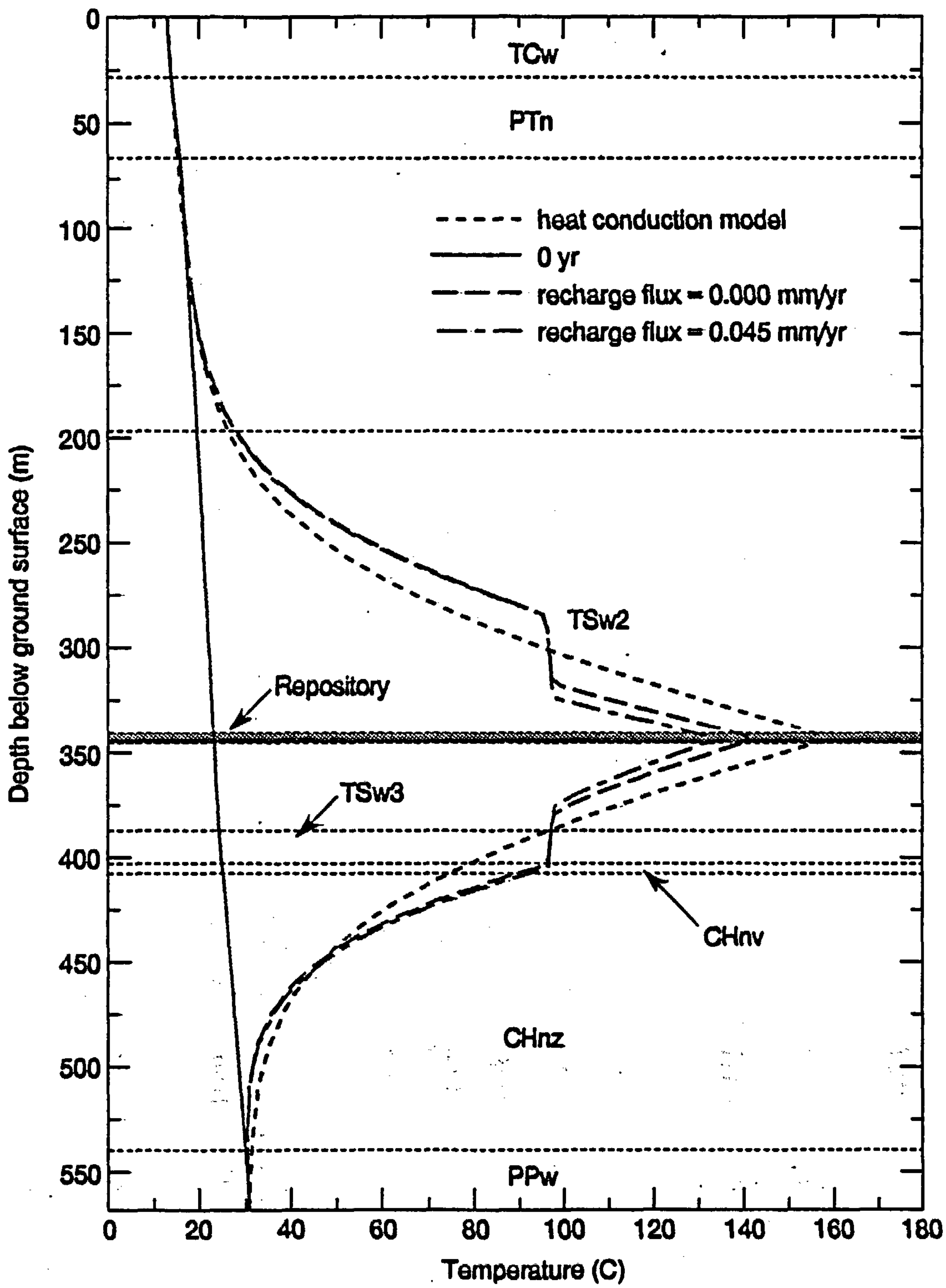
Ratio of heat conduction flux to total heat flux along repository centerline for 30-year-old fuel, an APD of 57 kW/acre, and a recharge flux of 0.0 mm/yr at t = 1000 yr



ES-TB-27 (10-7-91) IL

The heat conduction model yields conservatively high temperatures near the waste packages and conservatively low temperatures with respect to the extent of boiling

Temperature profile along repository centerline for 30-yr-old fuel, and APD of 57 kW/acre predicted by the hydrothermal and heat conduction models at t = 100 yr



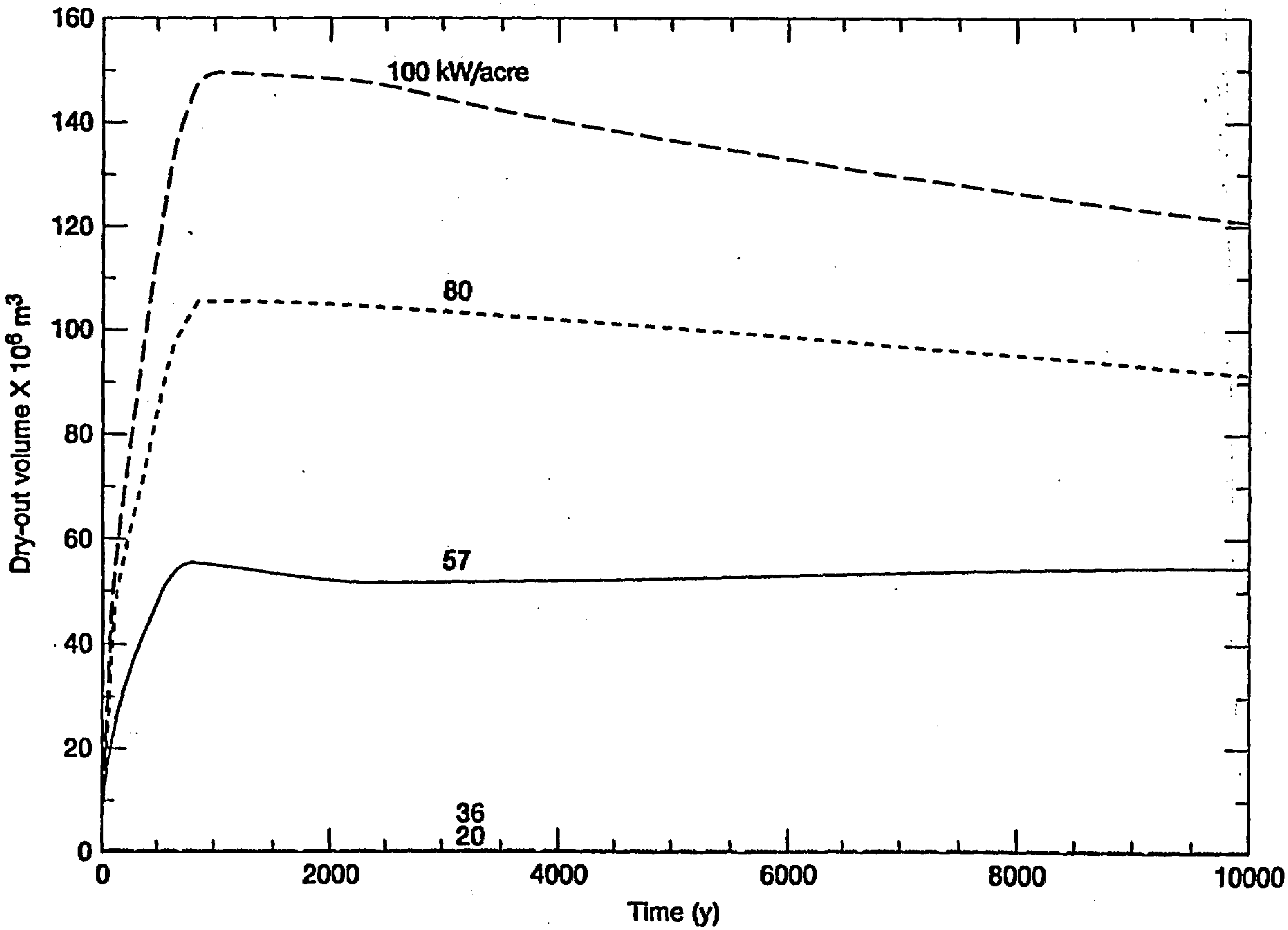
ES-TB-24 (9-23-91) IL

Impact of thermal load on repository performance

- The threshold for significant rock dry-out benefits occurs between 36 and 57 kW/acre for 30-yr-old fuel
- For low-to-medium APD's (20 to 40 kW/acre for 30-yr-old fuel) performance considerations remain with no dry-out benefits
- Substantial boiling and dry-out benefits occur for high APD's
  - Dry steam boiling conditions persist at the waste package for thousands of years
  - Rock dry-out benefits remain thousands of years after boiling ceases
- For drift emplacement, substantial dry-out benefits are obtained with minimal impact on waste package temperatures
- Even high APD's result in minimal temperature disturbance at ground surface
- Boiling conditions and rock dry-out greatly enhance fracture flow attenuation

For 30-yr-old fuel, the threshold APD for significant dry-out by boiling lies between 36 and 57 kW/acre

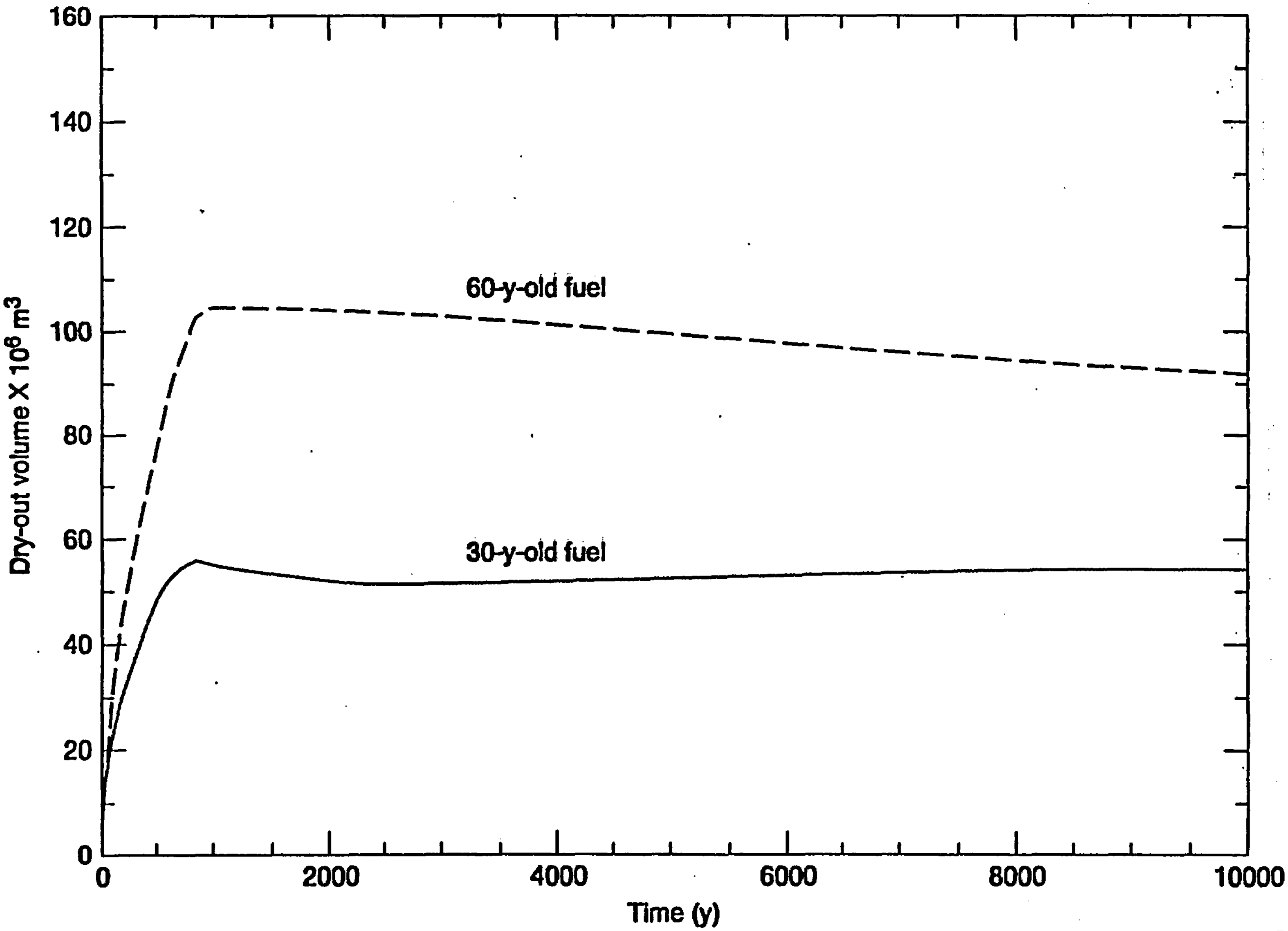
Dry-out volume of liquid water vs. time for 30-yr-old fuel, and a recharge flux of 0.0 mm/yr



ES-TB-21 (9-21-91) JL

For a given APD, dry-out benefits can be substantially increased using older age fuel

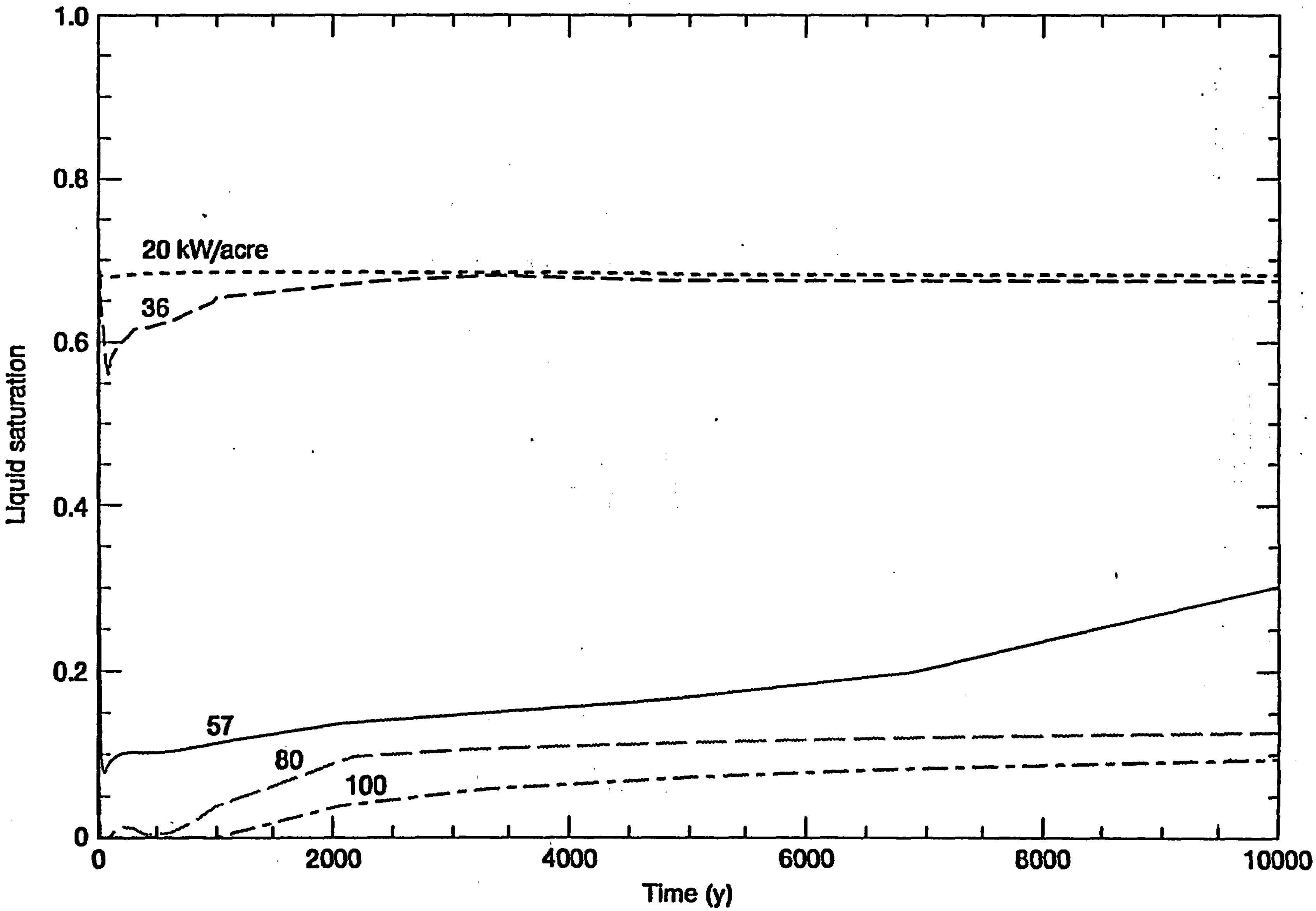
Dry-out volume of liquid water vs. time for an APD of 57 kW/acre, and a recharge flux of 0.0 mm/yr



ES-TB-20 (9-21-91) IL

For 30-yr-old fuel, the threshold APD for significant dry-out by boiling lies between 36 and 57 kW/acre

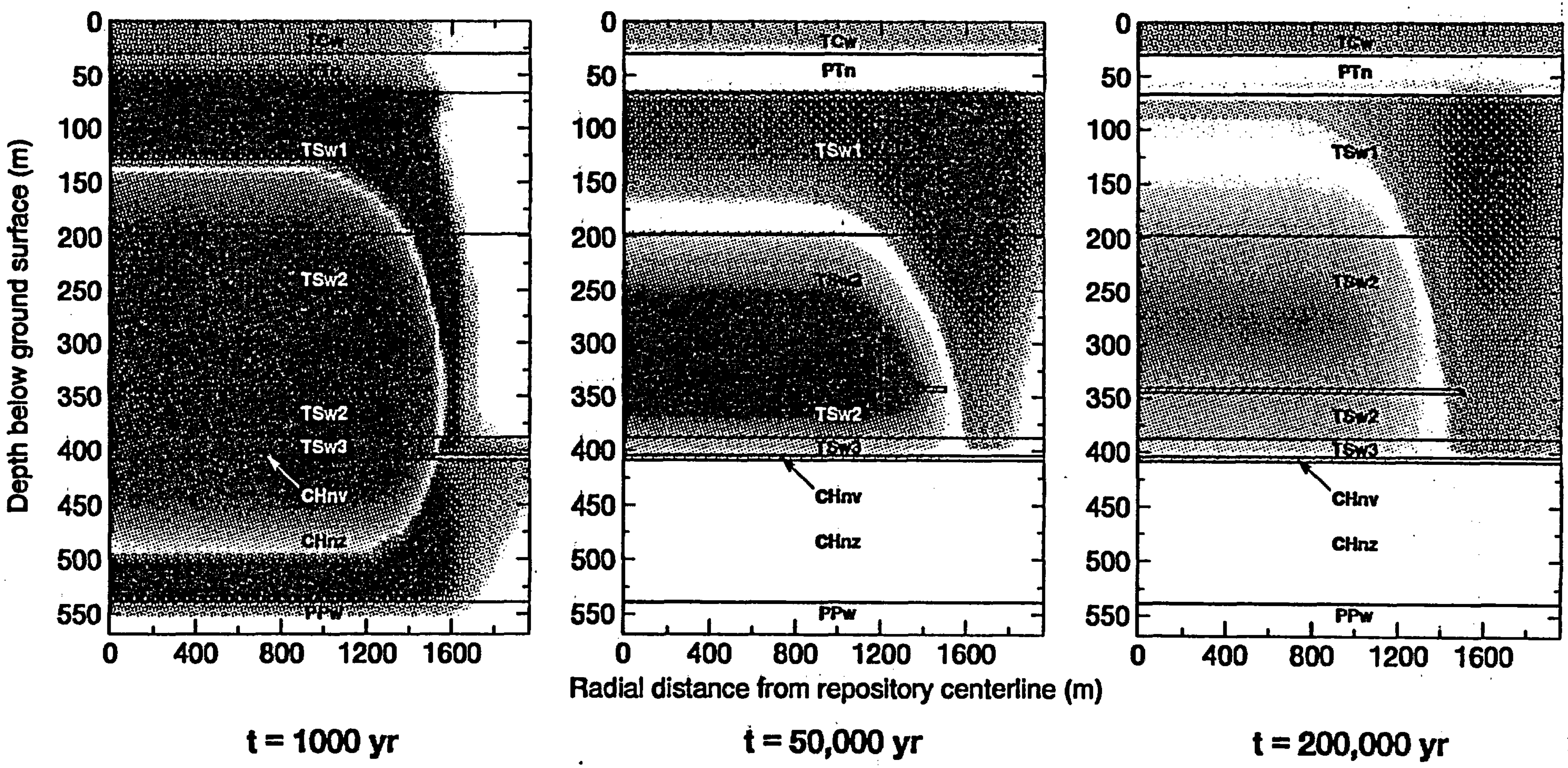
Liquid saturation history at drift wall for drift emplacement for 30-year-old fuel and a recharge flux of 0.0 mm/yr



ES-TB-36 (9-23-91) IL

Although boiling ceases after 10,000 yr, the re-wetting of the dry-out zone to ambient saturation conditions takes over 200,000 yr; during re-wetting, matrix-dominated flow will be directed towards the repository

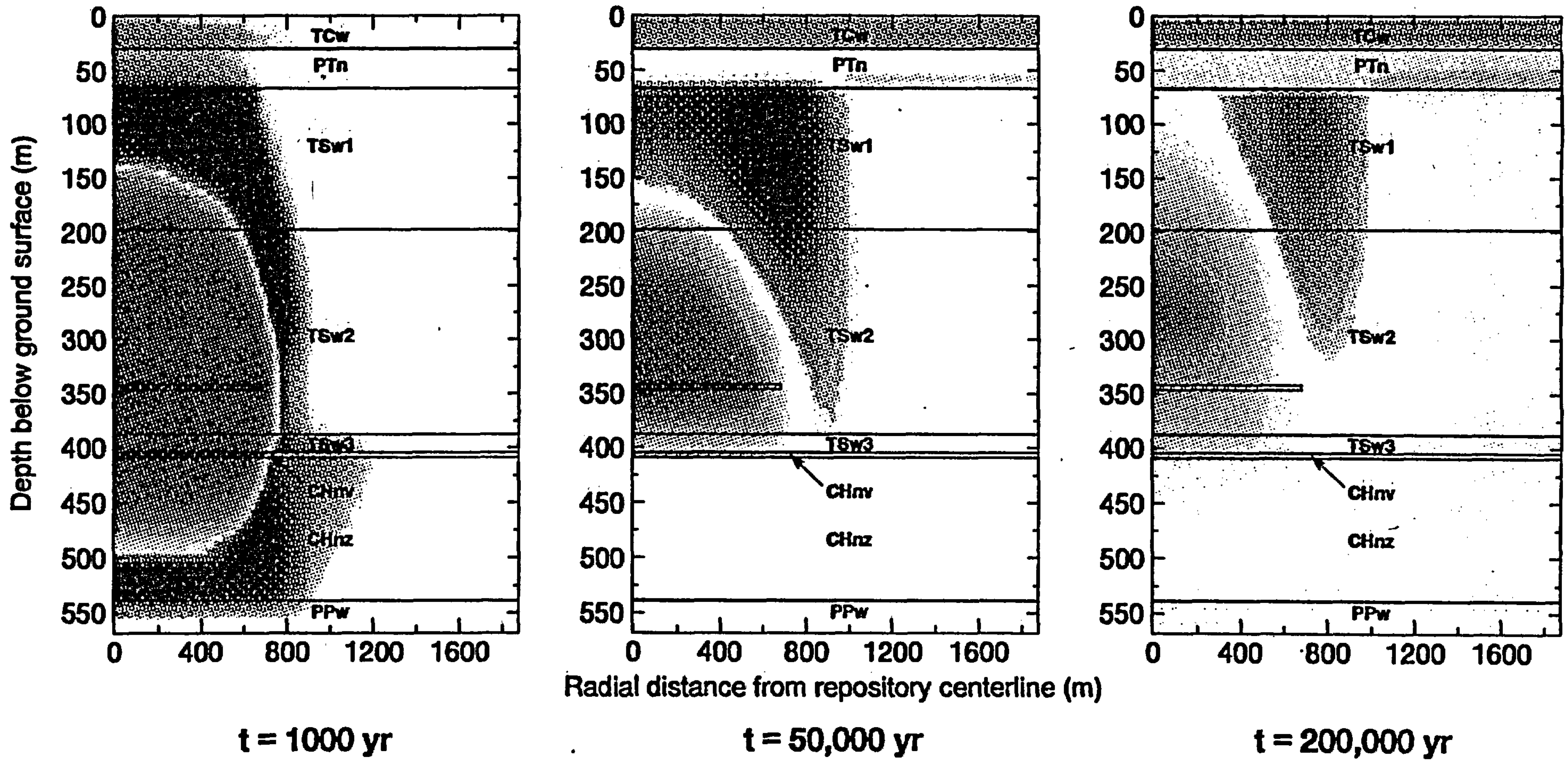
Dimensionless liquid saturation contours for 60-yr-old fuel, an APD of 114 kW/acre, a repository area of 1747 acres, and a recharge flux of 0.0 mm/yr



ES-TB-20abc (12-11-91) IL

Although boiling ceases after 10,000 yr, the re-wetting of the dry-out zone to ambient saturation conditions takes over 200,000 yr; during re-wetting, matrix-dominated flow will be directed towards the repository

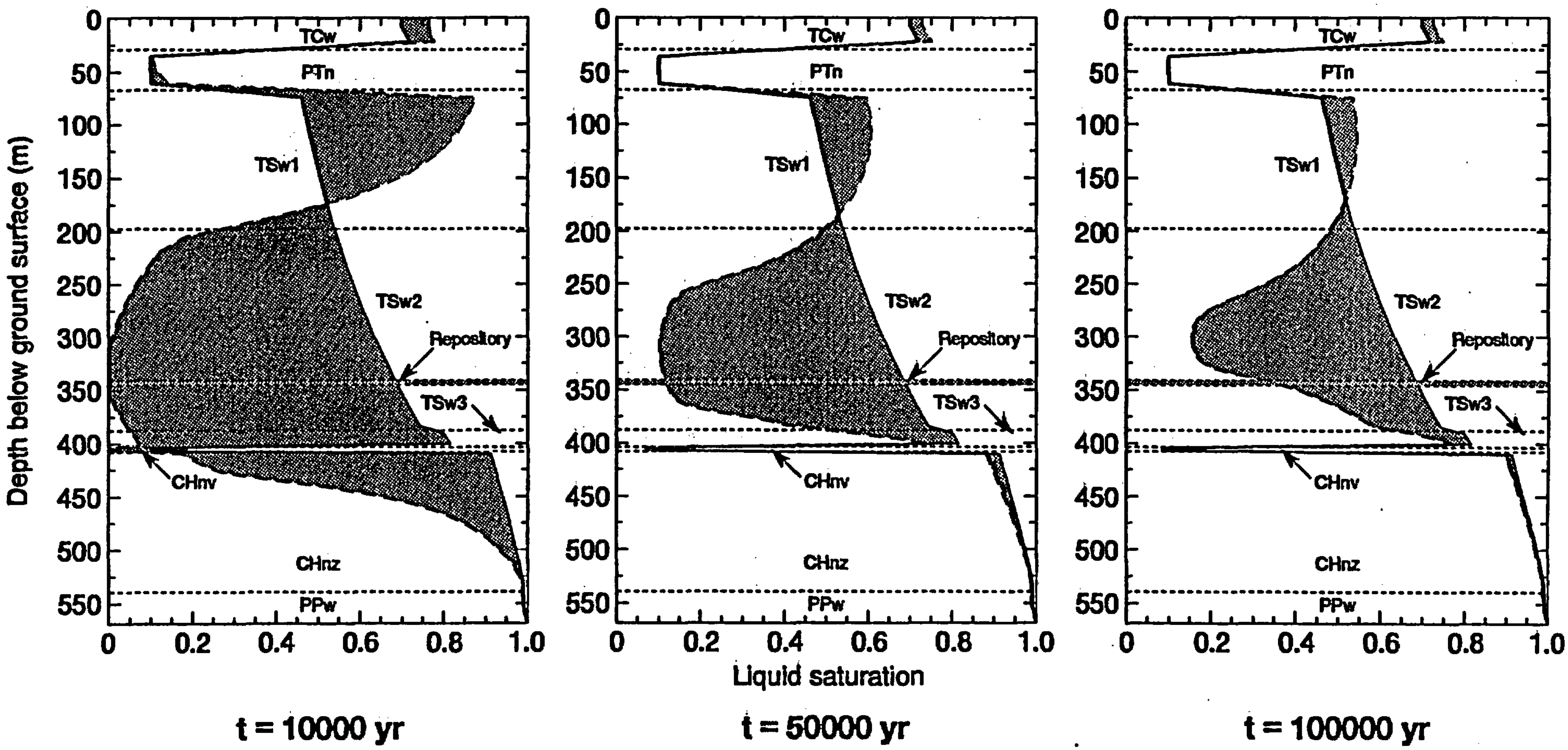
Dimensionless liquid saturation contours for 60-yr-old fuel, an APD of 114 kW/acre, a repository area of 348 acres, and a recharge flux of 0.0 mm/yr



ES-TB-21abc (12-11-91) IL

Although boiling ceases after 10,000 years, a large dry-out zone remains for over 100,000 years

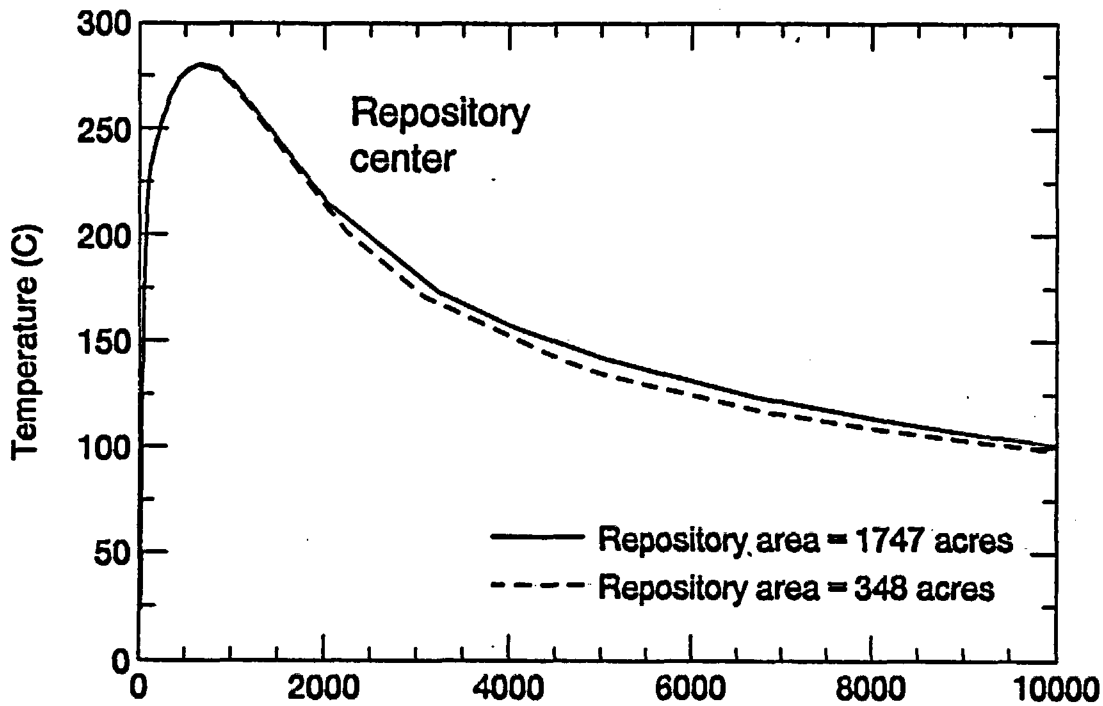
Liquid saturation profiles along repository centerline for 60-yr-old fuel, an APD of 114 kW/acre, and a recharge flux of 0.0 mm/yr

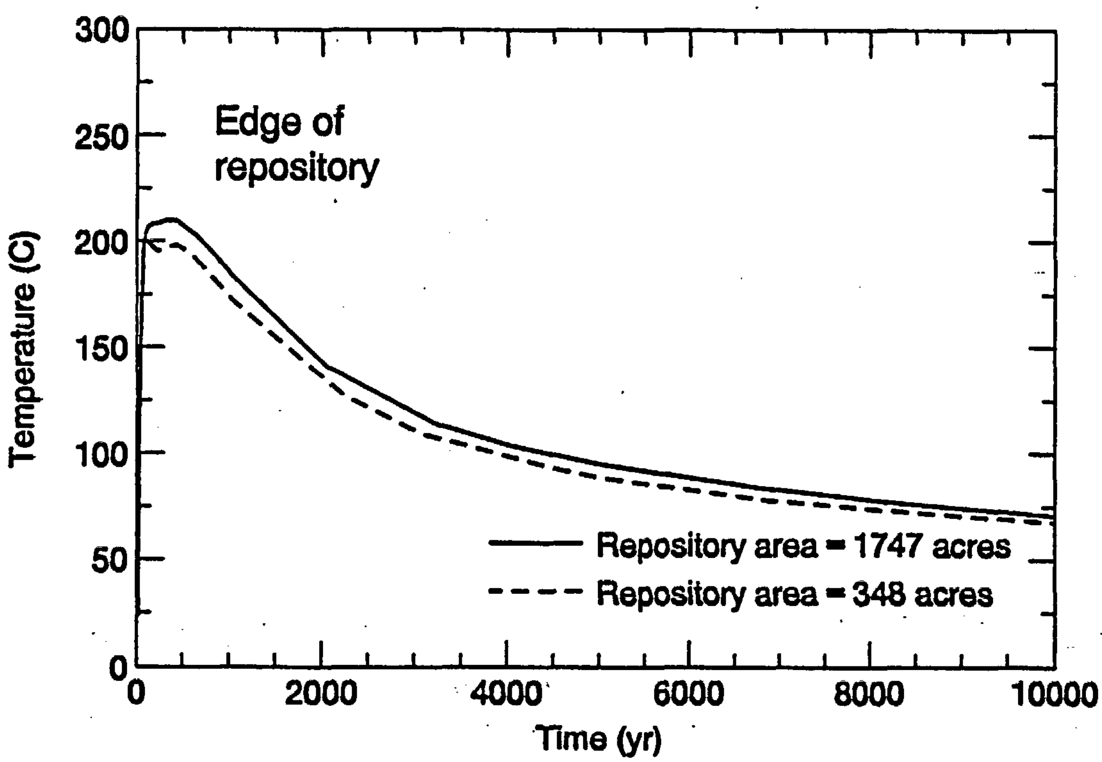


ES-TB-8abc (12-7-91) IL

The duration of dry steam boiling conditions is relatively insensitive to repository size

Liquid saturation history for 60-yr-old fuel, an APD of 114 kW/acre and a recharge flux of 0.0 mm/yr

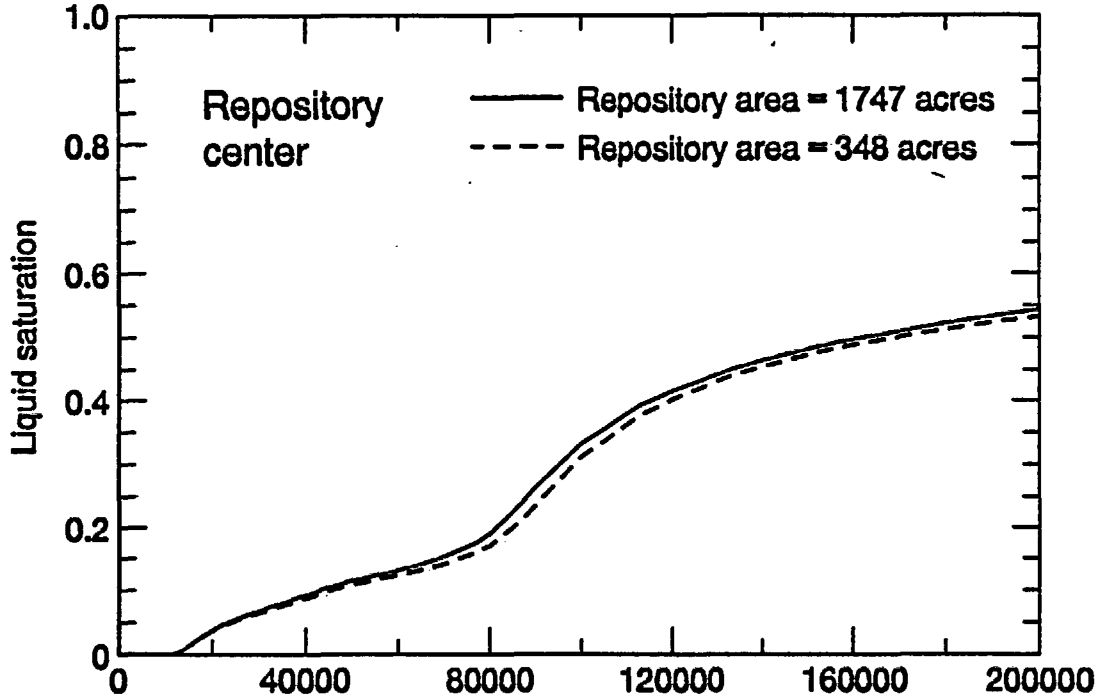


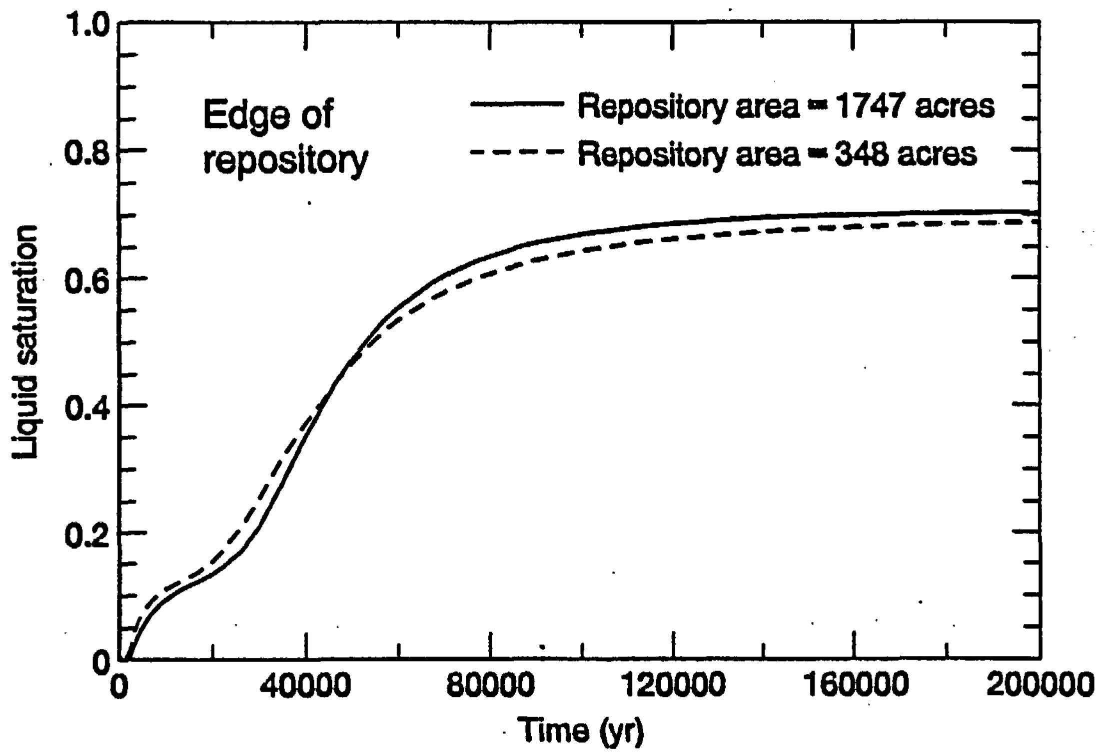


ES-TB-7ab (12-7-91) IL

The duration of repository dry-out is relatively insensitive to repository size

Liquid saturation history for 60-yr-old fuel, an APD of 114 kW/acre and a recharge flux of 0.0 mm/yr





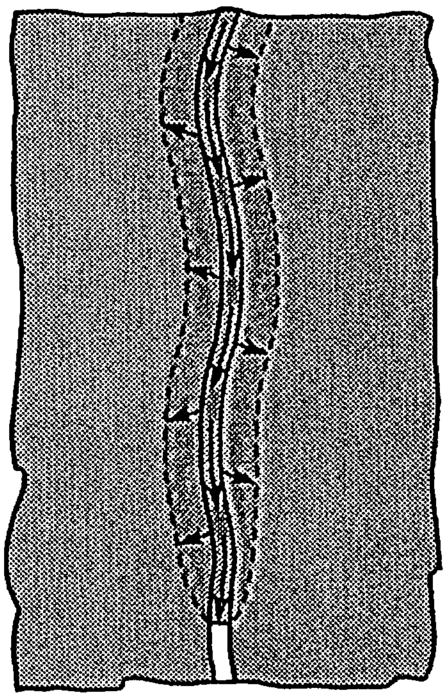
ES-TB-6ab (12-7-91) IL

Ground surface temperature effects

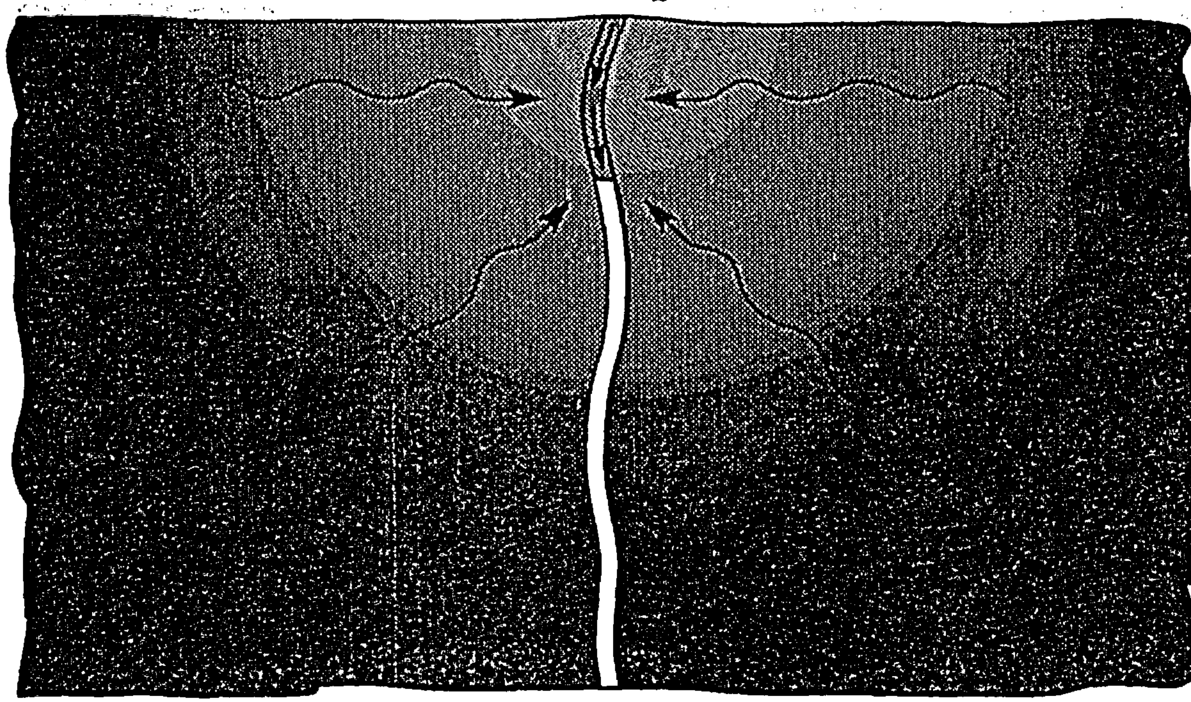
- For 30-year-old fuel and APDs up to 100 kW/acre, heat flux at the ground surface never exceeds 1.5 W/m^2
  - Therefore, the temperature rise at the ground surface should never exceed 1°C

Above the repository horizon, the attenuation of fracture flow will be much greater for boiling conditions than for sub-boiling conditions

$T < T_b$



$T > T_b$



V_m ≡ Matrix volume affecting fracture flow

$V_m (T < T_b) \sim \sqrt{D_{cap}}$

where D_{cap} ≡ capillary diffusivity

for TSw2, $D_{cap} \approx 2 \times 10^{-9} \frac{m^2}{s}$

$V_m (T > T_b) \sim \sqrt{D_{th}}$

where D_{th} ≡ thermal diffusivity

for TSw2, $D_{th} \approx 1 \times 10^{-6} \frac{m^2}{s}$

$$\therefore \frac{V_m (T > T_b)}{V_m (T < T_b)} \approx 22$$

ES-TB-22 (9-21-91) IL

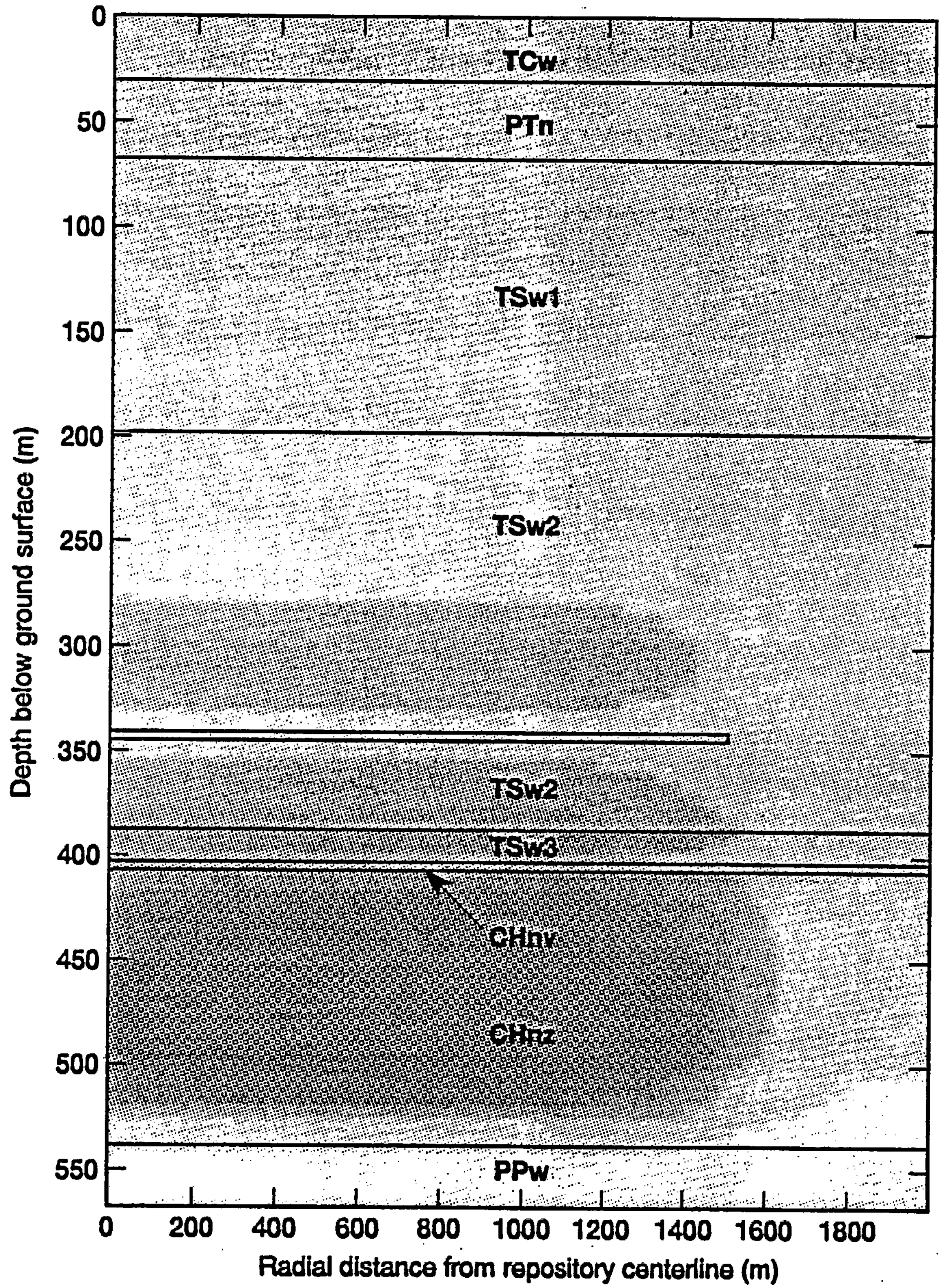
Impact of thermal load on hydrogeologic uncertainties

- For APD's as low as 20 kW/acre, the flow and transport properties of potential radionuclide pathways may be significantly altered

- The hydrologic performance of the repository is much less sensitive to hydrogeologic uncertainty at high APD's than at low APD's

Although boiling and dry-out benefits are negligible, condensation drainage extends all the way to the water table

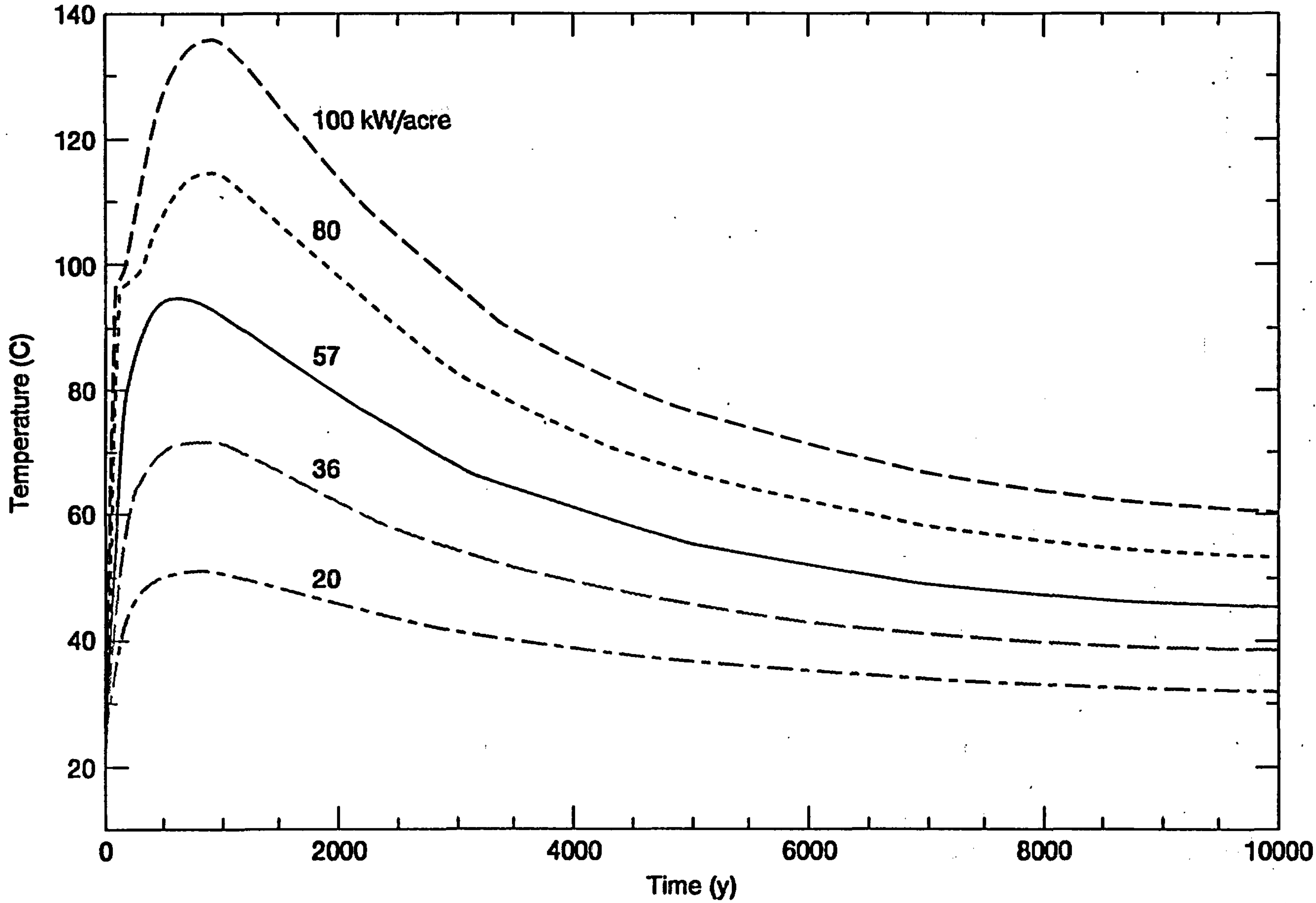
Dimensionless liquid saturation for 30-year-old fuel, an APD of 20 kW/acre, and a recharge flux of 0.0 mm/yr



ES-TB-7 (9-27-91) IL

For a given fuel age, temperature rise at the top of the Calico Hills (CHnv) is proportional to APD

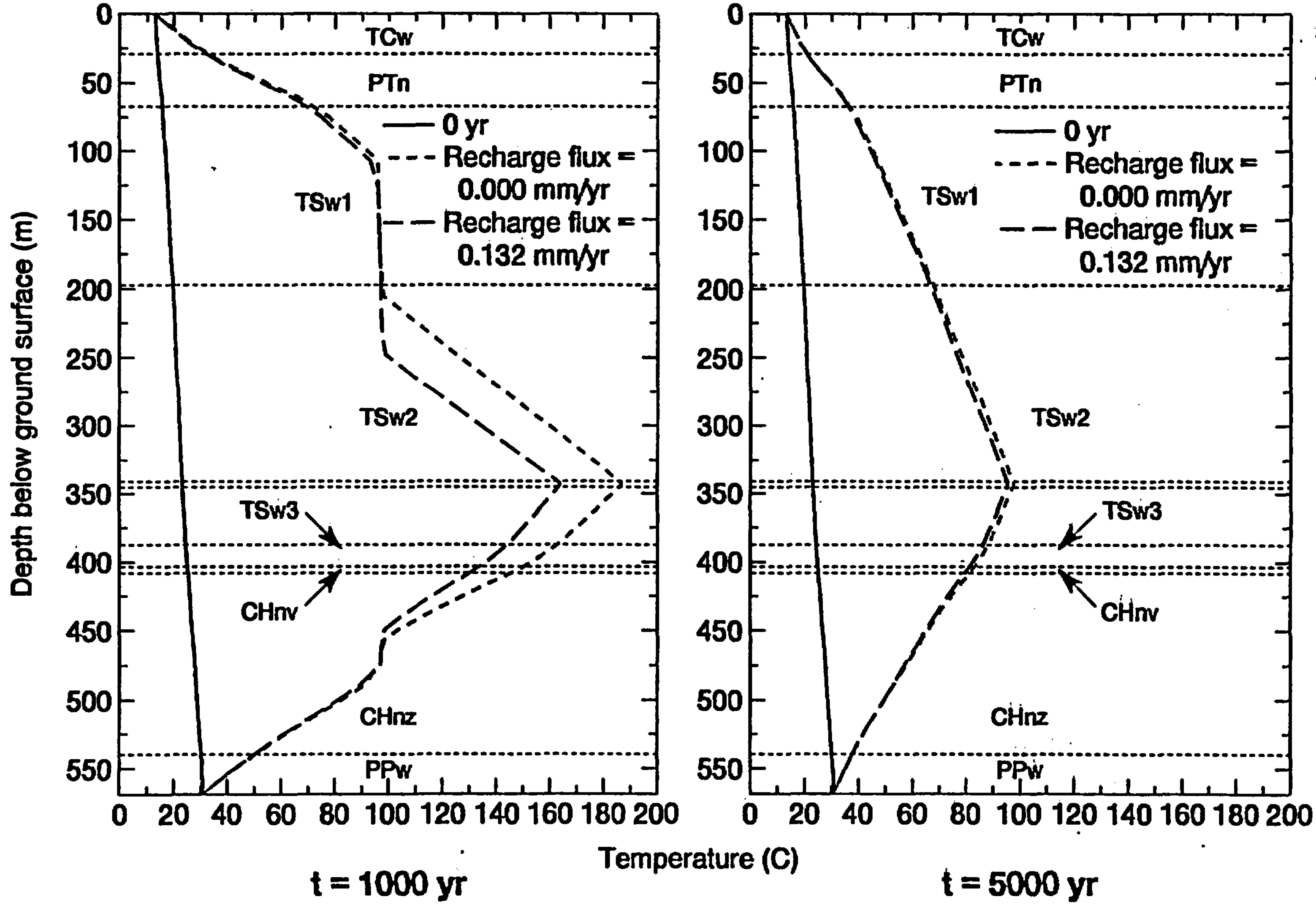
Temperature history at top of the CHnv, 60 m below the repository horizon for 30-yr-old fuel and a recharge flux of 0.0 mm/yr



ES-TB-15 (9-14-01) IL

The spatial extent of the boiling front is relatively insensitive to a wide range in effective infiltration flux and initial saturation

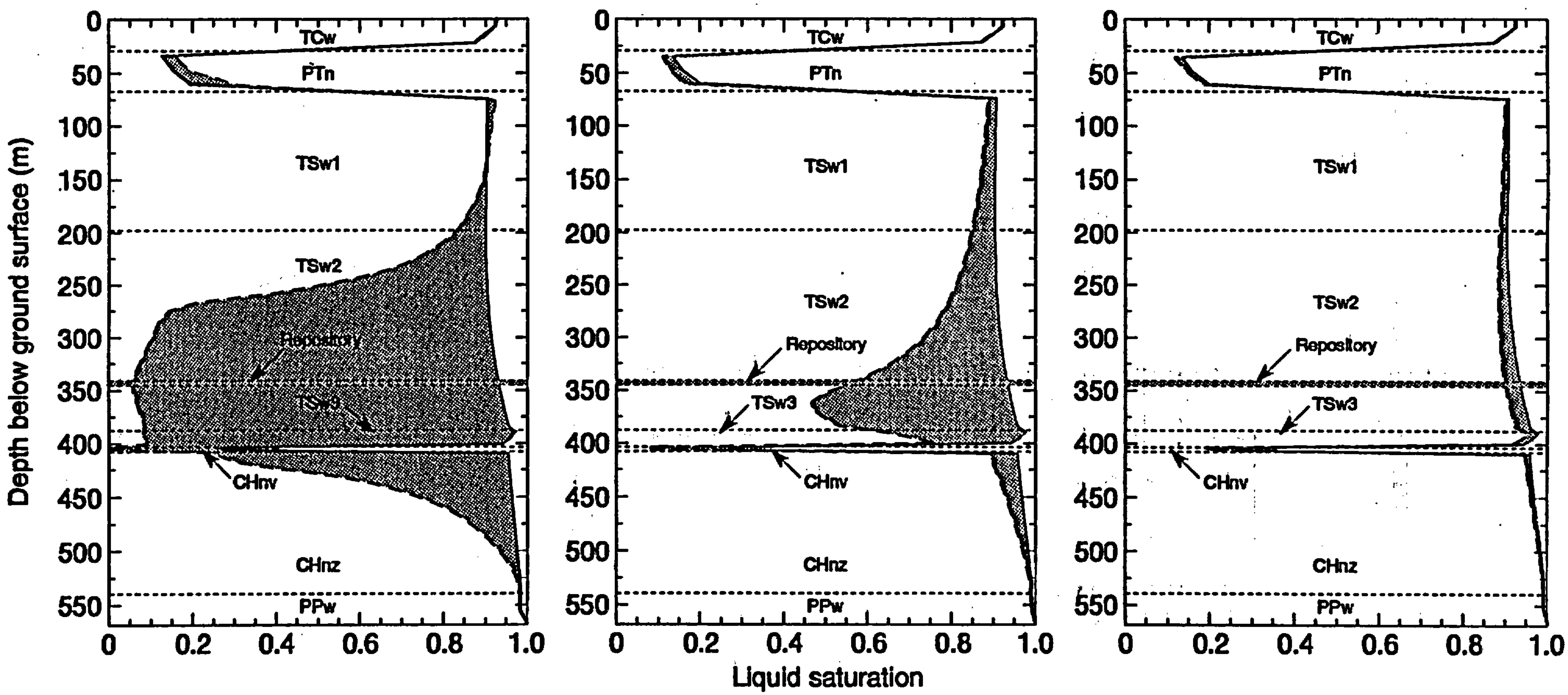
Vertical temperature profiles along repository centerline for 30-yr-old fuel and an APD of 114 kW/acre



ES-TB-11ab (12-7-91) IL

Although boiling ceases after 5000 years, re-wetting of the repository to ambient saturation takes 100,000 years even for very high initial saturation

Liquid saturation profiles along repository centerline for 30-yr-old fuel, an APD of 114 kW/acre, and a recharge flux of 0.132 mm/yr



t = 5000 yr

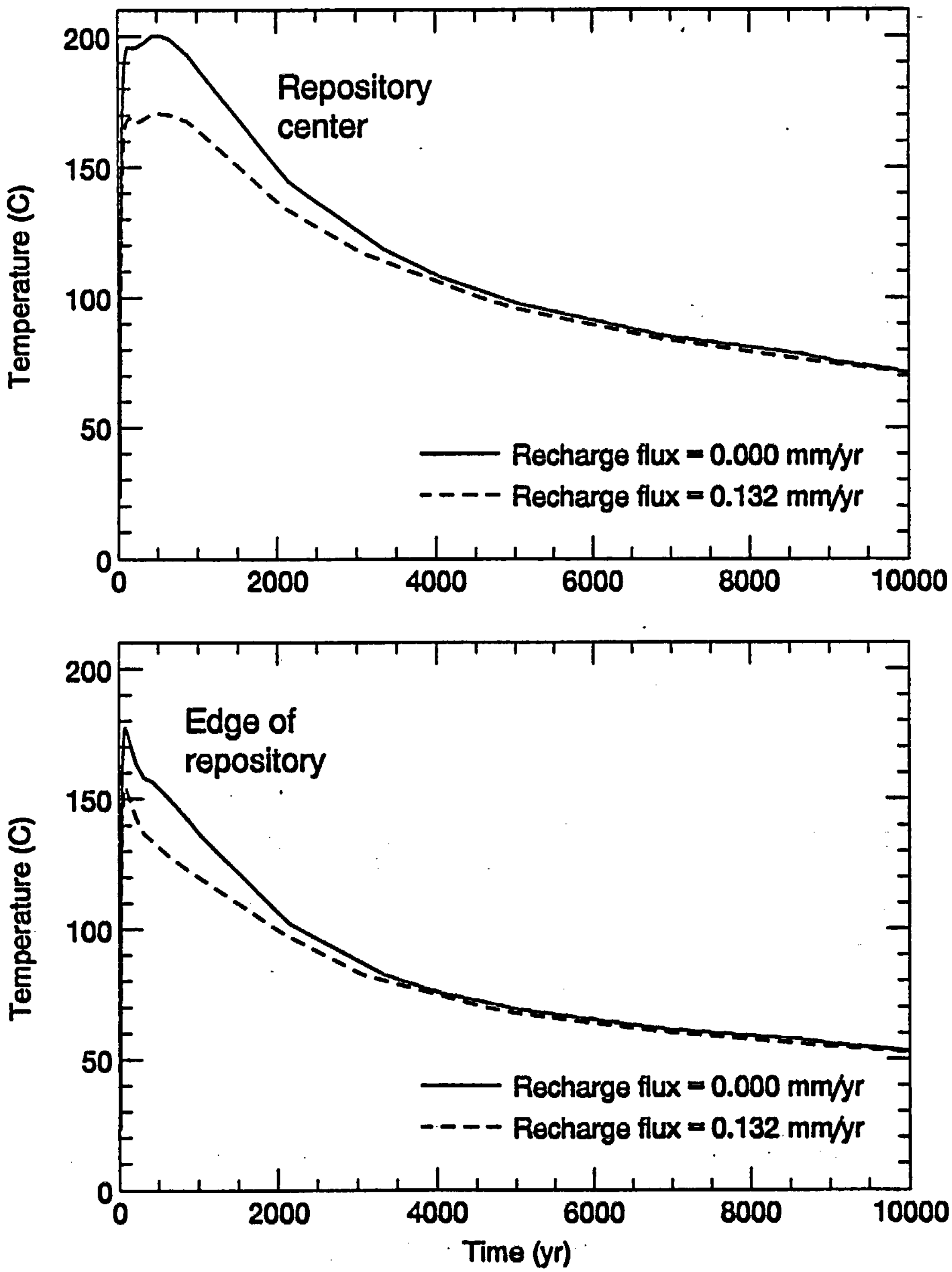
t = 50000 yr

t = 100000 yr

ES-TB-25abc (12-11-91) fL

The duration of dry steam boiling conditions is relatively insensitive to a wide range in effective infiltration flux and initial saturation

Temperature history for 30-yr-old fuel and an APD of 114 kW/acre



ES-TB-10ab (12-7-91) IL

Key hydrogeologic/geochemistry uncertainty considerations

- Zeolitization of the vitric nonwelded CHnv even at low APD's
- Alteration of flow and transport properties of fracture pathways in the zeolitized nonwelded CHnz even at low APD's
    - Impact on performance may be significant for low-to-medium APD's
    - Impact on performance is much less significant for high APD's

Key hydrogeologic/geomechanical uncertainty considerations

- Thermally-induced macro-fracturing near openings
  - may result in additional preferential pathways
  - may also result in increased liquid-phase dispersion in fracture networks
- Thermally-induced micro-fracturing out to the boiling front
  - may increase matrix capillary diffusivity, enhancing the impact of matrix imbibition on fracture flow attenuation
- Both macro- and micro-fracturing may enhance rock dry-out rate due to boiling

Conclusions

Impact of repository-heat-driven hydrothermal flow on site suitability/characterization

- Repository-heat-driven flow of vapor and liquid in fractures will dominate the ambient hydrological system
- Unsaturated, fractured tuff promotes rock dry-out by boiling and rapid condensate drainage
- Repository-heat-driven alteration of the properties of the natural barriers is possible even at low APD's
- Potentially negative impact of nonequilibrium fracture-matrix flow on site suitability is mitigated by boiling and rock dry-out effects
    - Nonequilibrium fracture-matrix flow is beneficial to condensate drainage and rock dry-out at higher APDs
- Site suitability findings may vary significantly depending on repository thermal loading

Conclusions

Impact of repository-heat-driven hydrothermal flow on total systems performance

- For higher APD's and older age fuel, boiling benefits persist for thousands of years; rock dry-out benefits persist for 100,000 years or longer
  - Promoting more favorable waste package conditions
  - Greatly enhancing fracture flow attenuation
  - Reversing the direction of matrix-dominated flow back towards the repository
- Duration of boiling conditions and dry-out effects are dominated by thermal load and thermal properties
- Repository performance at higher APD's is much less sensitive to hydrogeologic variability/uncertainty
- Potential performance problems remain at lower APD's with minimal dry-out benefits

Conclusions

Impact of repository-heat-driven hydrothermal flow on ESF testing

- Critical performance issues cannot be entirely resolved by ambient property measurements
- Questions concerning the potential for repository-heat-driven alteration of the natural barriers can be addressed by heater tests at multiple hydrostratigraphic horizons
- Hypothesis testing of the dominance of heat conduction on repository boiling and dry-out performance can be addressed by relatively large-scale heater tests at the repository horizon
- Testing under boiling conditions provides a better experimental basis for model validation
- More likely to adequately resolve uncertainties associated with high APDs than with low APDs

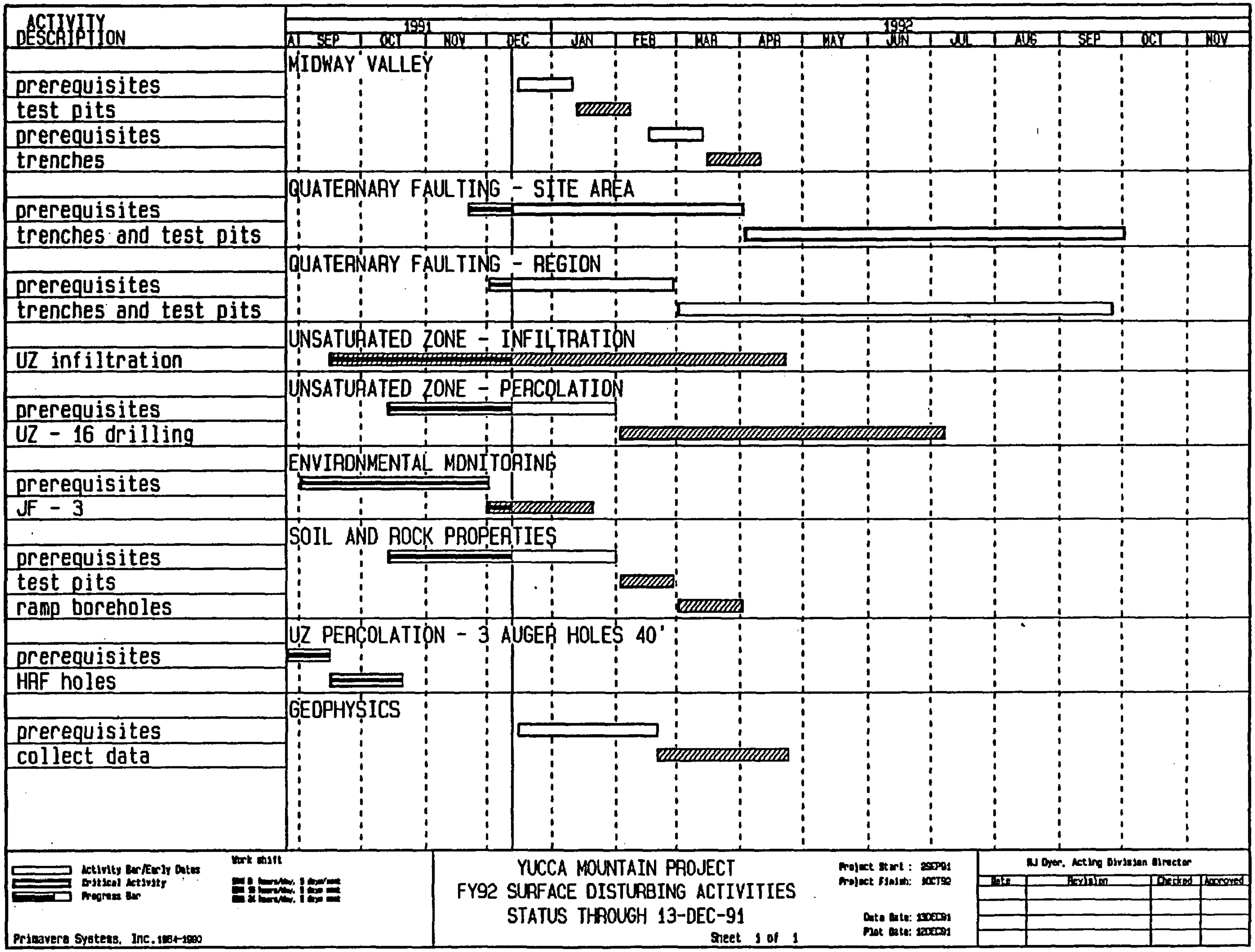
Appendix

Normalized area required for repository as a function of initial APD and spent fuel age (areas are divided by area for the reference SCP-CDR design)					
	20 kW/acre	36 kW/acre	57 kW/acre	80 kW/acre	100 kW/acre
10-yr-old fuel	2.85	1.57	1.00	0.71	0.57
30-yr-old fuel	1.81	1.00	0.64	0.45	0.36
60-yr-old fuel	1.14	0.63	0.40	0.29	0.23
100-yr-old fuel	0.73	0.40	0.25	0.18	0.15

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
REGULATORY AND SITE EVALUATION DIVISION

FY92 NOVEMBER STATUS
SURFACE BASED TESTING PROGRAM

JR Dyer, Acting Division Director
GD Roberson, Acting Deputy Division Director



Primavera Systems, Inc. 1984-1990

YUCCA MOUNTAIN PROJECT
FY92 SURFACE DISTURBING ACTIVITIES
STATUS THROUGH 13-DEC-91

Sheet 1 of 1

Project Start : 2SEP91
Project Finish: 30CT92

Data Date: 13DEC91
Plot Date: 12DEC91

RJ Dyer, Acting Division Director

Date	Revision	Checked	Approved

MIDWAY VALLEY

Planned start date:	*In progress*
Status:	*First trench has been excavated mapped and backfilled* *Job package is being revised for additional excavation scheduled restart early FY92*
Concerns:	*WBS responsibility is shifting from SNL to USGS*
Solutions:	*Ensure no interruption of work*

QUATERNARY FAULTING
SITE AREA

Planned start date:	*April 1992*
Status:	*TPP to be initiated 12/91*
	Awaiting detail work *description from Principal Investigator*
	Study plan transmitted to NRC for Phase I review
Concerns:	*None*
Solutions:	*None*

QUATERNARY FAULTING REGION

Planned start date:	*March 1992*
Status:	*Awaiting study plan from USGS*
Concerns:	*Study plan is not complete*
Solutions:	*Ensure completion of study plan*

PALEOENVIRONMENT

Planned start date:	*After FY92*
Status:	*No trenching anticipated in FY92*
Problems:	*None*
Solutions:	*None*

UNSATURATED ZONE
NATURAL INFILTRATION

Planned start date: *September 1991*

Status: *Test planning and job packages completed*

Drilling temporarily suspended until early January

Completed N54, N55

Concerns: *Penetration rate slower than expected*

Solutions: *Improved bits are in use*

Procurement of new rig in progress

Need info on tracer - how, why gaseous tracers in drilling air

UNSATURATED ZONE PERCOLATION

UZ - 16 (VSP2)

Planned start date: *TBD - early CY92*

Status: *TPOs input to TPP and JP requested by 12/24*

Concerns: *Completion of technical and administrative prerequisites to continue drilling activities at the site*

Solutions: *Task force assembled to concentrate on above concerns*

ENVIRONMENTAL MONITORING
JF - 3

Planned start date:	*Initiated site prep in November 1991*
Status:	*NTS rig on site and work began on schedule*
Concerns:	*Drilling progress behind schedule*
Solutions:	*Planning to start two shifts per day*

SOIL AND ROCK PROPERTIES
RAMP BOREHOLES

Planned start date:	*February 1992*
Status:	*Study plan currently being reviewed by NRC*
	Test planning and job packages being developed
Concerns:	*Design of drill pad and access road*
Solutions:	*Combine management and technical reviews*
	Develop standard design products

HYDROLOGIC RESEARCH FACILITY HOLES

Planned start date:	*September 1991*
Status:	*Complete*
Concerns:	*None*
Solutions:	*None*

GEOPHYSICAL REFLECTION SURVEY

Planned start date:	*February 1992*
Status:	*Test Planning Package to be initiated 12/91* *All data collection to be performed by subcontractor through RFP*
Concerns:	*Ensure compliance with environmental requirements*
Solutions:	*Effective coordination*