Department of Energy
Chicago Operations Office
Salt Repository Project Office
505 King Avenue
Columbus, Ohio 43201-2693

June 26, 1984

John J. Linehan, Section Leader
Salt Section
Repository Projects Branch
Division of Waste Management, MS 623-SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Linehan:

SUBJECT: TRANSMITTAL OF MEETING SUMMARY OF JUNE 14-15, 1984 PERFORMANCE ASSESSMENT BRIEFING BY NRC FOR DOE/SRPO

Enclosed for your information is the meeting summary of the June 14-15, 1984 performance assessment briefing by NRC for the DOE/SRPO.

Sincerely,

J. O. Neff

J. O. Neff
Program Manager
Salt Repository Project Office

SRPO:LAC:2949B

ST# 679-84

Enclosure: June 14-15, 1984 Meeting Summary of Performance Assessment Briefing by NRC for DOE/SRPO with enclosure
1. list of attendees
2. agenda
3. viewgraphs and handouts
4. list of NRC documents

cc: R. Johnson, NRC, with enclosure
T. Verma, NRC, with enclosure
L. Casey, SRPO, with enclosure
W. Bennett, DOE-HQ, with enclosure
C. Newton, DOE-HQ, with enclosure
D. Alexander, DOE-HQ, with enclosure
L. Rickertson, Weston, with enclosure
M. Foley, PNL, with enclosure
P. Hofmann, ONWI, with enclosure
D. Dawson, ONWI, with enclosure

Meeting Summary of the NRC Performance Assessment
Briefing for DOE-SRP
June 14-15, 1984
Silver Spring, Maryland

Background and Facts

NRC, DOE/SRPO, contractor representatives, and a contractor representative from the State of Utah met at the NRC offices in Silver Spring, Maryland on June 14-15, 1984 to discuss the NRC codes, models, data, and documents related to performance assessment of a geologic repository in salt. A list of the actual attendees for both June 14 and 15 are in enclosure 1. The agenda (enclosure 2) was followed and completed. The topics chosen for discussion on June 15, 1984 include the following:

1. The extent to which "PRA" will be used for determining compliance with the EPA standard
2. Quality assurance for models and codes
3. Performance assessment needs for the SCP
4. Clarification of uncertainty analysis techniques
5. Unsaturated flow modeling needs
6. "Validation" of models

Viewgraphs and handouts provided during the meetings give more detail about the meeting and are given in enclosure 3. The performance assessment documents, which NRC made available for DOE/SRPO's review during the meeting, are listed in enclosure 4.

The meeting minutes, which consist primarily of observations and action items, were drafted before the close of the meeting, read, and signed by J. Linehan and M. Logsdon of NRC and J. Neff and L. Casey of DOE. What follows here is the typed and edited version of the signed draft.

Action Items

- SRPO requests NRC send SRPO copies of Sandia's letter reports related to approaches to probabilistic risk assessment, computational approaches to calculating complementary cumulative distribution functions, and problems with these approaches.

- SRPO requests NRC send SRPO copies of Sandia procedures for tracking computer code changes.

- SRPO agreed to have these meeting minutes typed and sent to meeting participants and the salt states.

- SRPO requests NRC send SRPO a copy of the QA section of the Sandia contract.

- SRPO requests NRC re-examine their distribution system and take appropriate steps to ensure SRPO receives published reports.

- SRPO requests NRC develop a listing of reports in preparation analogous to SRPO's catalog of ongoing products.

Observations

- Of the performance assessment reports collected by NRC for DOE viewing on June 14, 1984, SRPO had received only about half.

- The list of reports NRC provided DOE on June 14, 1984 was incomplete with respect to the reports in the room as well as reports mentioned in Sandia's presentation on June 15, 1984. Therefore, SRPO is not confident that NRC has identified to us all published reports relevant to performance assessment.

- The Utah contractor (the only state representative present) declined the offer to make observations in these meeting minutes.

- DOE observed that a system for NRC to apprise the Department of future staff positions, contractor reports would be very helpful for all parties concerned.

- The NRC staff considers that the final EPA standard will likely require that a license application include a probabalistic assessment of releases to the accessible environment. However, the staff considers that we will use the results of the probabalistic assessments as part of the--not the entire--basis for the staff finding on compliance with 10 CFR 60.112.

- NRC does not limit DOE use of NRC-developed models, codes or scenario analysis. DOE must choose and defend its approaches to demonstrating compliance.

- The staff considers that DOE should explicitly describe the level of verification and validation that has been achieved for a model when the results are presented in reports.

PERFORMANCE ASSESSMENT
SKIPPING FOR DOE SRPO
June 14, 1989

Name	Affiliation	Phone
Mark J. Logsdon	NRC/NMSS/WMRP	427-4785
Steven C Sneider	PNL	509-376-8321 FTS 449-8321
Michael G Foley	PNL	FTS 444-8635
Carl Newton	DOE/HQ	233-4851
Sanford Bloom	Battelle - ONWI	614 424 7834
Larry Ruckertsen	Weston	(301) 963-6228
Veek Verma	NRC/Columbus	FTS 976-5916
Ben Ross	Disposal Safety Inc.	202-293-3993
Atef Elzeftawy	NRC/HQ	FTS 427-4675
Leslie Peeters	NRC/NMSS/WMRP	(301) 427-4653
Everett Wick	NRC/NMSS/WMEG	(301) 427-4111
Tim Johnson	NRC/NMSS/WMEG	301-427-4088
Steve Smykowski	NRC/NMSS/WMEG	301-427-4735
Scott Grace	NRC/SALT Perf. Assess	LC
David Dawson	ONWI	FTS 976-7803
John T. Greeves	NRC	427-4734
M. J. Wise	NRC	427-4795
JF Kircher	ONWI	FTS 976-4871
Paul Davis	SNLA	(505) or FTS 846-5421
Emilie Charles	State of Utah Office	202-624-7704
Robert L. Johnson	NRC - Salt Project	427-4785
Maxine Dunkelman	NRC/NMSS/WMRP/GWTP	427-4685
G.E. Raines	ONWI	FTS 976-7832
Leslie A. Casey	DOE/SRPO	FTS 976-5916
Peter L. Hoffmann	ONWI	FTS 976-5683
John Linehan	NRC/SALT	FTS 427-4179
Jeff Neff	DOE/SRPO	FTS 976 5916
Pauline Brooks	NRC/WMRP/Salt	FTS 427-4380
Donald Alexander	DOE HQ	FTS 252-5596

Performance Assessment
Briefing for DOE-SRPO June 15, 1987

NAME	AFFILIATION	JOB TITLE / FUNCTION
Mark J. Logsdon	NRC/NMSS/WMRP	Performance Assessment
Robert L. Johnson	NRC/NMSS/WMRP	Salt Project Manager
Leslie A. Casey	DOE/CH/SRPO	Regulatory & Systems Project Manager
Robert M. Cranwell	SANDIA NAT. LAB	Performance Assessment
GILBERT E. Raines	Battelle/ONWI	" "
D. M. DAWSON	ONWI	REGULATORY
Ted A. HOFMANN	ONWI	Hyr Systems "
John F Kircher	ONWI	Hyr Test Assess
M J Wise	NRC	
Benjamin Ross	Disposal Safety Inc.	consultant to Utah
Teek Verma	NRC/Columbus	Senior Onsite-Salt
Charles H Peterson	NRC/WMEG	Licensing Rep Engineering Branch - Waste Policy Salt
MICHAEL G FOLEY	PNL	Manager - Performance Assessment Scientific Support - acrium
STEVEN C SNEIDER	PNL	DM - PASS
Walt Kelly	NRC/WMGT	Geochemistry-Salt
Paul DAVIS	SANDIA NATL. LABS	Performance Assessment
Maxine Dunkelman	NRC/NMSS/WMRP/BWIP	AA, Geology
Frederick Ross	NRC/GT	Hydrogeologist-Salt
Bill Dam	NRC/GT	Geochemistry-Salt
JOHN LINEHAN	NRC/NMSS/WMRP	SECTION LEADER
RICHARD Lee	NRC/NMSS	SALT Project Geology
William H. Ford	NRC/NMSS/WMGT	Geohydrologist-Salt
SCOTT GRACE	NRC/WMRP	Performance Assess-Salt
Atef Elzeftawy	NRC-HQ/NTS-WMRP	Perform. Assess.
Don Alexander	DOE/HQ	Performance Assessment
Edward R. Wiot	WESTON	Licensing
Steve Smykowski	NRC/WMEG	Design Rock Mech - SALT
Barbara O. Cooke	NRC/WMGT	Hydrology - Salt
Dick Codell	" "	" "

AGENDA
PERFORMANCE ASSESSMENT BRIEFING
FOR DOE-SRP

John Linehan (NRC), Chairman

Date: June 14-15, 1984

Time: June 14 1:00 p.m. - 3:00 p.m.
June 15 8:30 a.m. - 4:00 p.m.

Place: June 14: 8th floor conference room
June 15: 1st floor conference room
U. S. Nuclear Regulatory Commission
Willste Building
7915 Eastern Avenue
Silver Spring, MD 20910

Purpose: Brief SRPO on NRC codes and models, data, and documents on performance assessment

June 14, 1984

1:00 p.m.	Introduction	
	- Attendees	J. Linehan (NRC)/J. Neff (SRP)
	- Purpose/Objectives	J. Linehan (NRC)
1:30 p.m.	- Overview of NRC Performance Assessment Documents	M. Logsdon (NRC)
	- NRC's Benchmarking Contract	P. Brooks (NRC)
1:45-5:00 p.m.	SRPO Review of NRC Documents	NRC Staff for Clarification

June 15, 1984

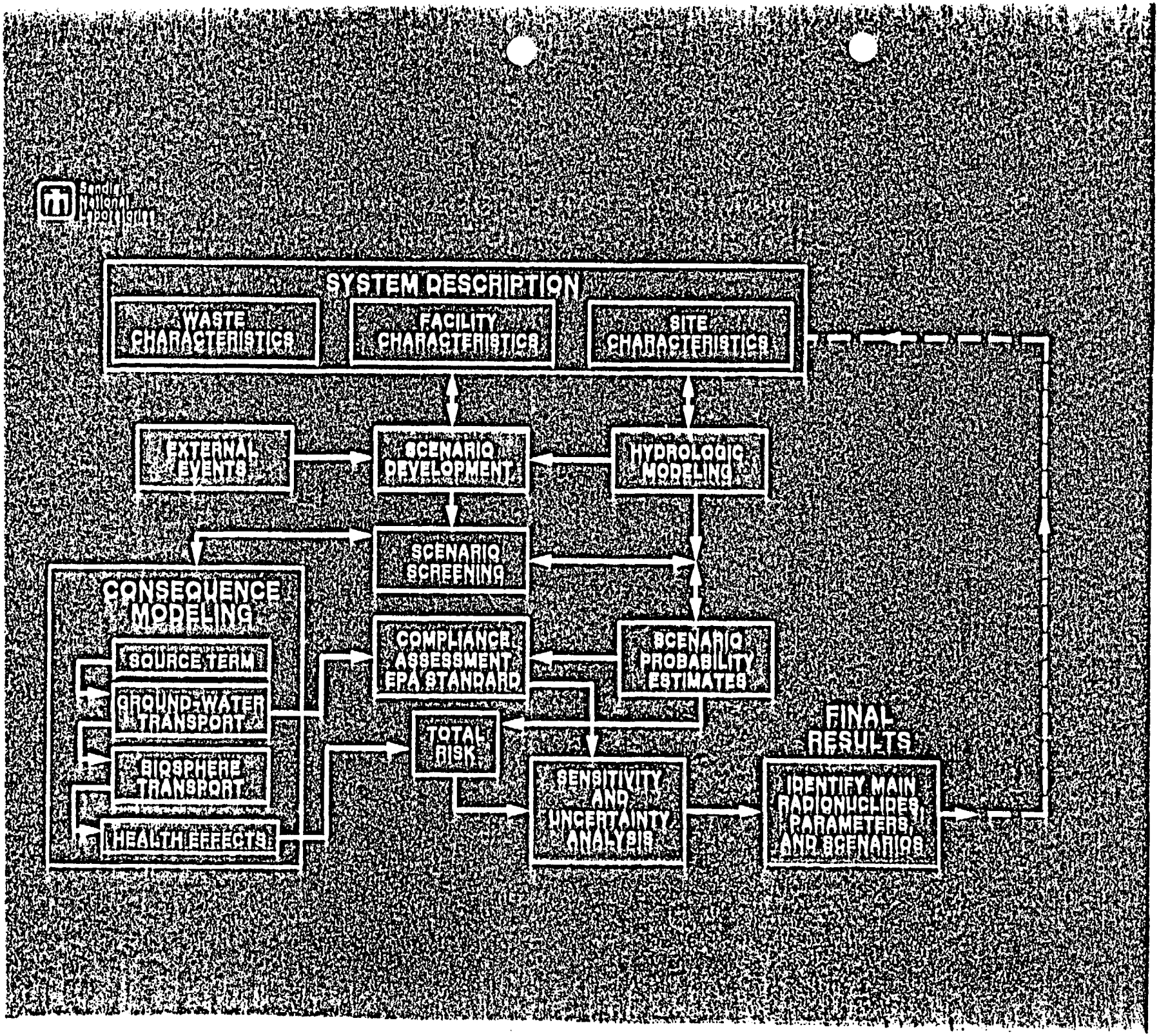
8:30 a.m.	Overview of Performance Assessment in Licensing - DOE/NRC Roles and Responsibilities - Key Definitions - Nature of Technical Findings - Program Logic - Information Needs for Performance Assessment	M. Logsdon (NRC)
9:15 a.m.	Break	
9:30 a.m.	Overview of Sandia Risk Assessment Methodology	R. Cranwell (SNL)
10:15 a.m.	Discussion: Topics TBD Proposed: Methodology; Uncertainty; Model/Code QA	
12:00 p.m.	Lunch	
1:00 p.m.	Discussion: Topics TBD Proposed: WP/Release Rate Assessment	
3:00 p.m.	Preparation of Meeting Notes	
4:00 p.m.	Adjourn	

METHODOLOGY FOR PERFORMANCE ASSESSMENT OF RADIOACTIVE WASTE REPOSITORIES

CONTENTS OF METHODOLOGY

- Methods for selecting and screening scenarios.
- Codes for simulating physical processes and estimating consequences.
- Probabilistic and statistical techniques for use in estimates of risk and sensitivity/uncertainty analysis.
- Procedures for utilizing codes and techniques to express consequences, system risk and compliance with regulatory standards.

Vugraphs of R. Cranwell of Sandia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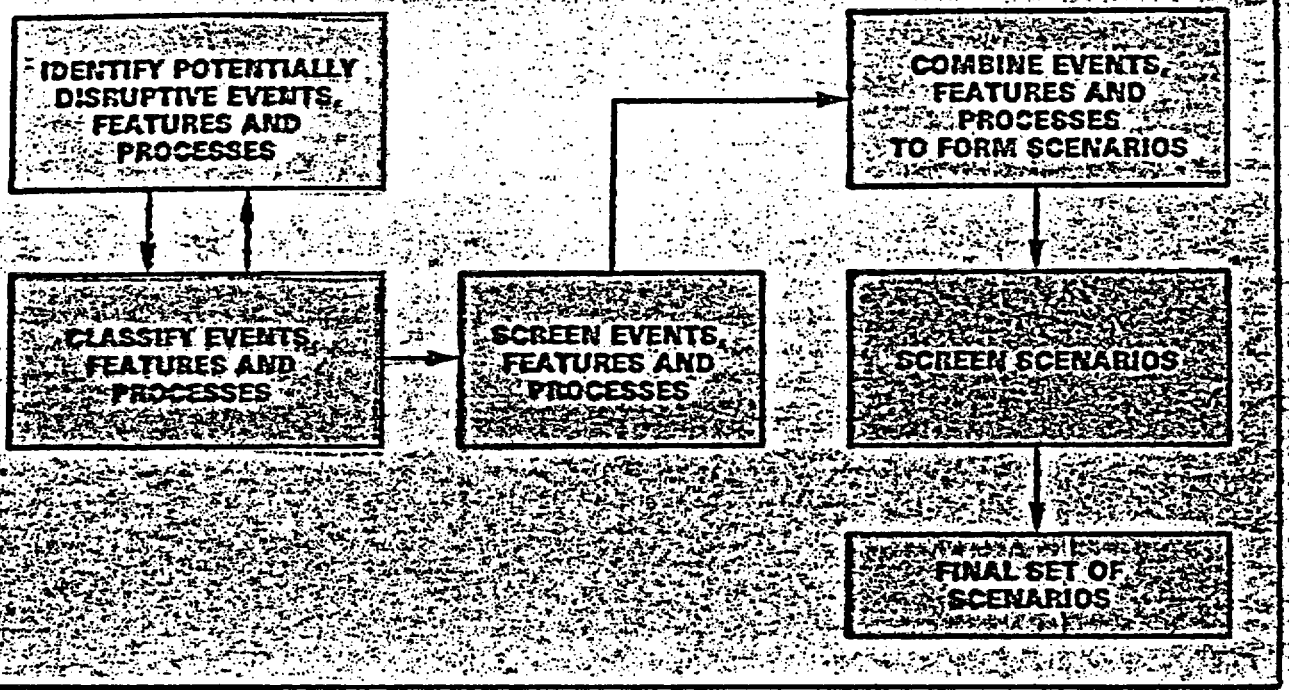
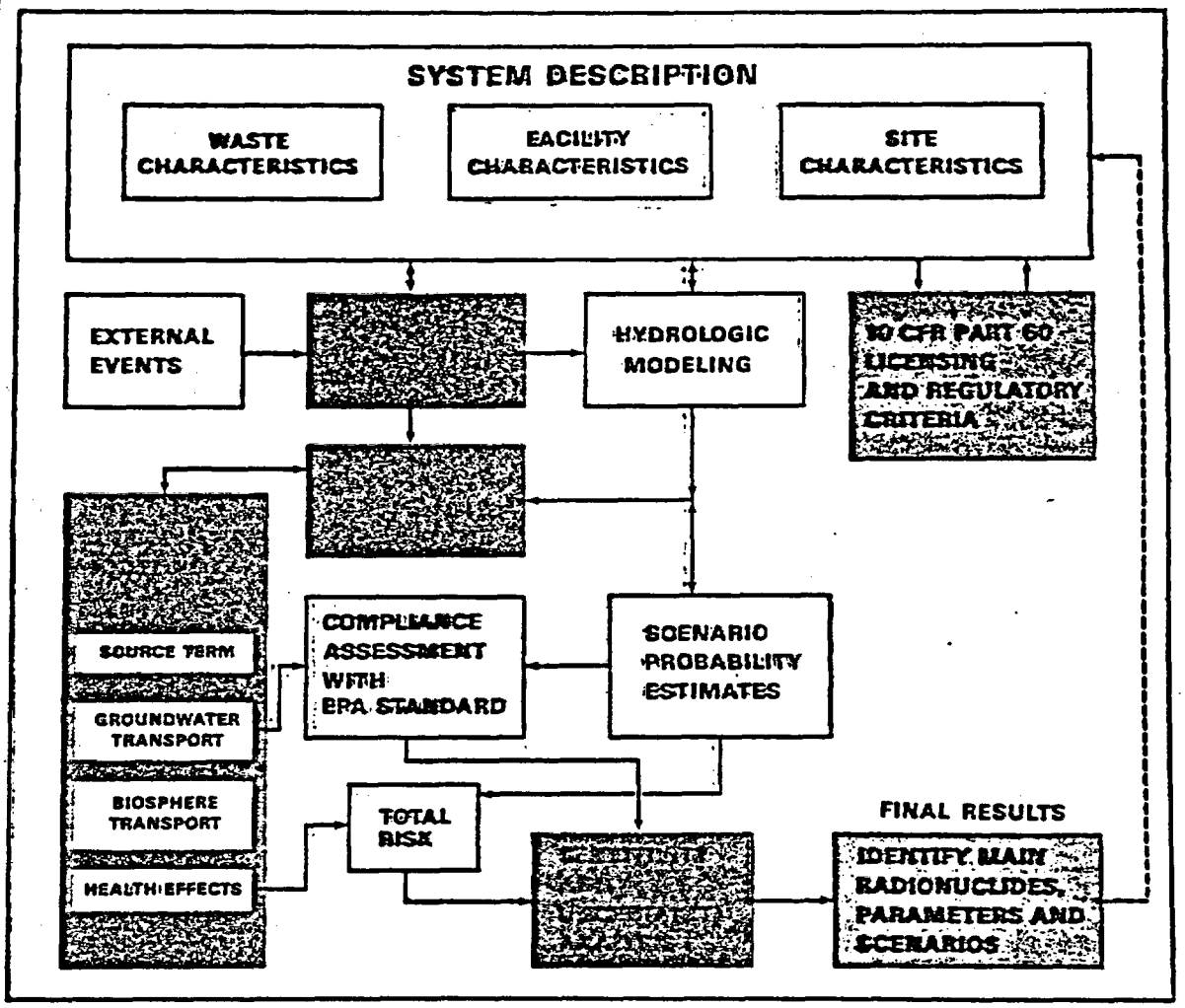
SYSTEM DESCRIPTION
WASTE CHARACTERISTICS
FACILITY CHARACTERISTICS
SITE CHARACTERISTICS
EXTERNAL EVENTS
SCENARIO DEVELOPMENT
HYDROLOGIC MODELING
SCENARIO SCREENING
CONSEQUENCE MODELING
SOURCE TERM
GROUND-WATER TRANSPORT
BIOSPHERE TRANSPORT
HEALTH EFFECTS
COMPLIANCE ASSESSMENT EPA STANDARD
SCENARIO PROBABILITY ESTIMATES
TOTAL RISK
SENSITIVITY AND UNCERTAINTY ANALYSIS
FINAL RESULTS
IDENTIFY MAIN RADIONUCLIDES, PARAMETERS, AND SCENARIOS

SCENARIO DEVELOPMENT AND SCREENING



DEPICTION OF BOREHOLE SCENARIO AT HYPOTHETICAL BEDDED SALT SITE

METHODOLOGY FOR PERFORMANCE ASSESSMENT OF RADIOACTIVE WASTE REPOSITORIES



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- 3-DIMENSIONAL
- FINITE DIFFERENCE
- PROCESSES CONSIDERED:
  1. FLUID FLOW

- 3-DIMENSIONAL
- FINITE DIFFERENCE
- PROCESSES CONSIDERED:
  1. FLUID/HEAT FLOW
  2. BRINE MIGRATION
  3. RADIONUCLIDE TRANSPORT

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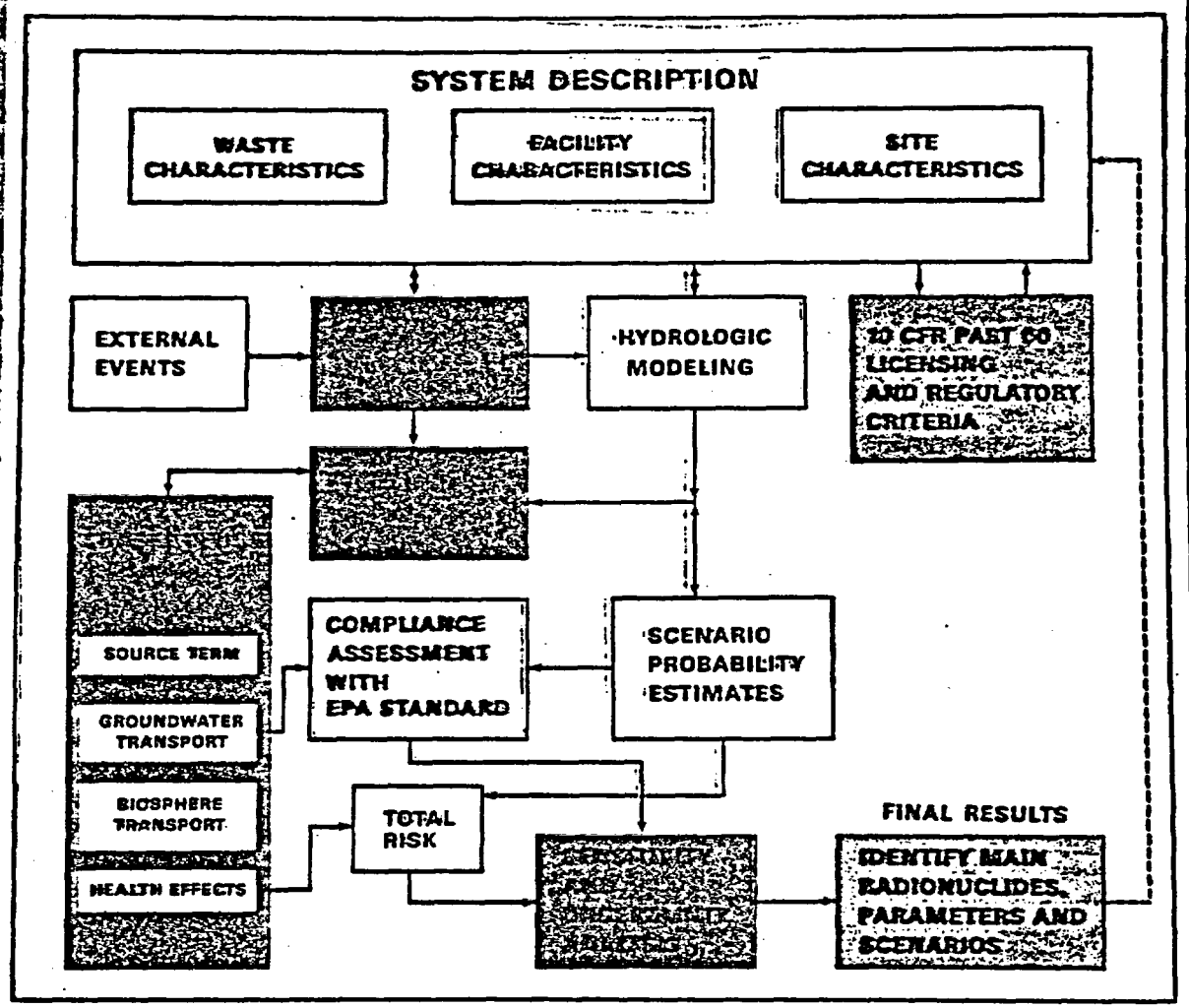
METHODOLOGY FOR PERFORMANCE ASSESSMENT OF RADIOACTIVE WASTE REPOSITORIES



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SOURCE TERM

- Leach and/or solubility-limited source rates
- Radionuclide-dependent solubility limits
- Time-dependent failure of waste package
- Mixing and dilution effects within repository

RADIONUCLIDE TRANSPORT IN GROUNDWATER

- Transport of decay chains
- Radionuclide-dependent retardation factors
- Time-efficient models

RADIONUCLIDE TRANSPORT IN BIOSPHERE AND HEALTH EFFECTS

- Distribution and accumulation of radionuclides in surface environment
- Human exposures via ingestion, inhalation and external
- Dose and risk (i.e. cancer fatalities) estimates for average individual and populations

- 3-DIMENSIONAL
- FINITE DIFFERENCE
- PROCESSES CONSIDERED:
  1. FLUID/HEAT FLOW
  2. BRINE MIGRATION
  3. RADIONUCLIDE TRANSPORT

- QUASI MULTI-DIMENSIONAL
- SEMI-ANALYTIC
- PROCESSES CONSIDERED:
  1. FLUID FLOW
  2. RADIONUCLIDE TRANSPORT

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ENVIRONMENTAL TRANSPORT

- DETERMINES CONCENTRATIONS IN
  1. GROUND WATER
  2. SOIL
  3. SURFACE WATER
  4. SEDIMENTS

TRANSPORT TO MAN

- DETERMINES HUMAN UPTAKE BY
  1. INGESTION
  2. DIRECT EXPOSURE
  3. INHALATION

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- CALCULATES RADIATION DOSE FROM INTERNAL AND EXTERNAL EXPOSURES
  - 70-YEAR INTAKE / 70-YEAR DOSE COMMITMENTS
- ESTIMATES PROBABILITIES OF LATENT SOMATIC EFFECTS AND GENETIC EFFECTS TO FUTURE POPULATIONS
  - BEIR, 1972

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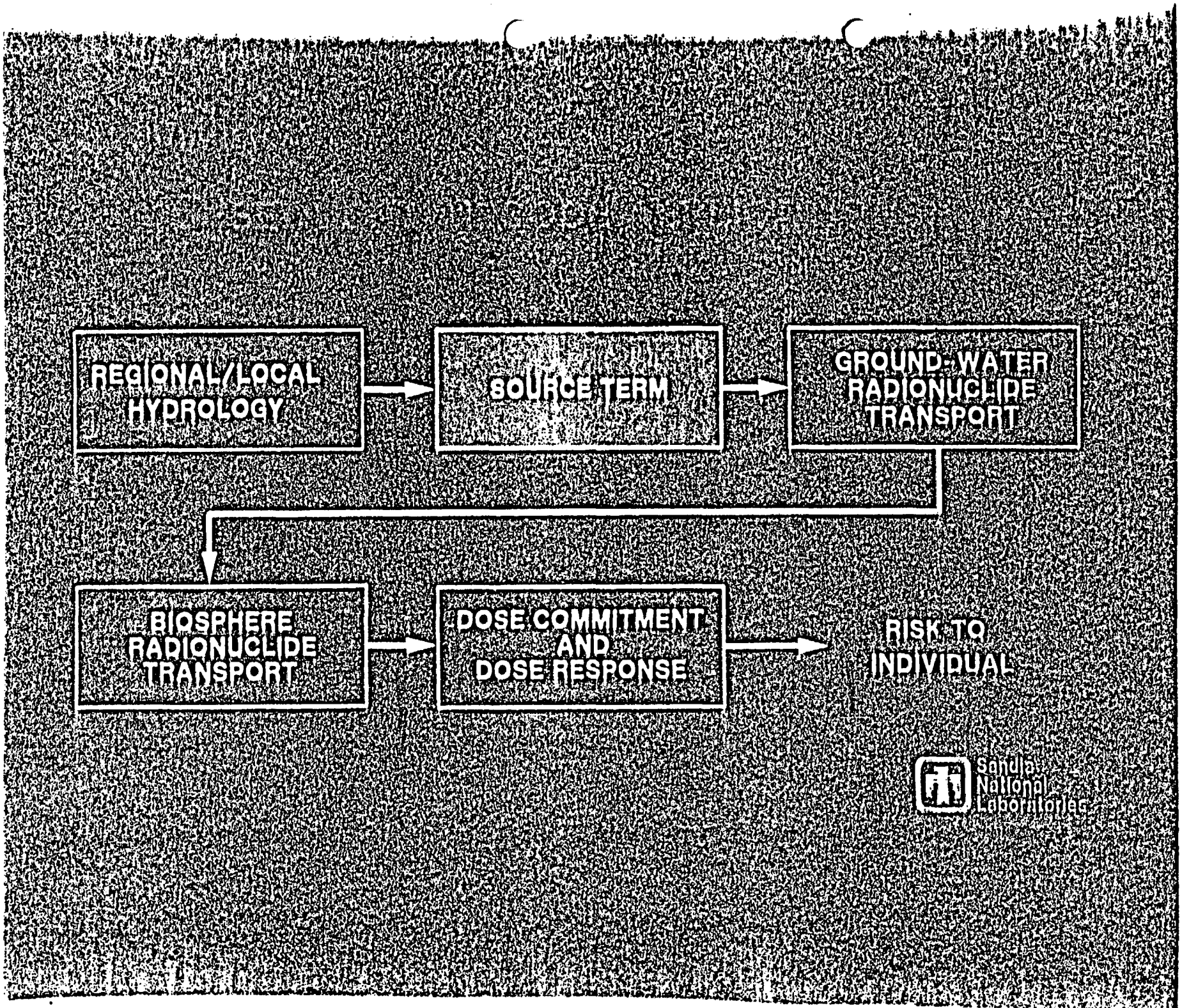
REGIONAL/LOCAL HYDROLOGY
SOURCE TERM
GROUND-WATER RADIONUCLIDE TRANSPORT
BIOSPHERE RADIONUCLIDE TRANSPORT
DOSE COMMITMENT AND DOSE RESPONSE
RISK TO INDIVIDUAL
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- DISCHARGE RATES (CURIES/DAY)
- INTEGRATED DISCHARGES (CURIES)
- RADIONUCLIDE CONCENTRATIONS IN ENVIRONMENTAL MEDIA
- DOSE COMMITMENTS (REM/YEAR)
- RISK OF ADVERSE HEALTH EFFECTS

Dynamic Network Model (DNET)

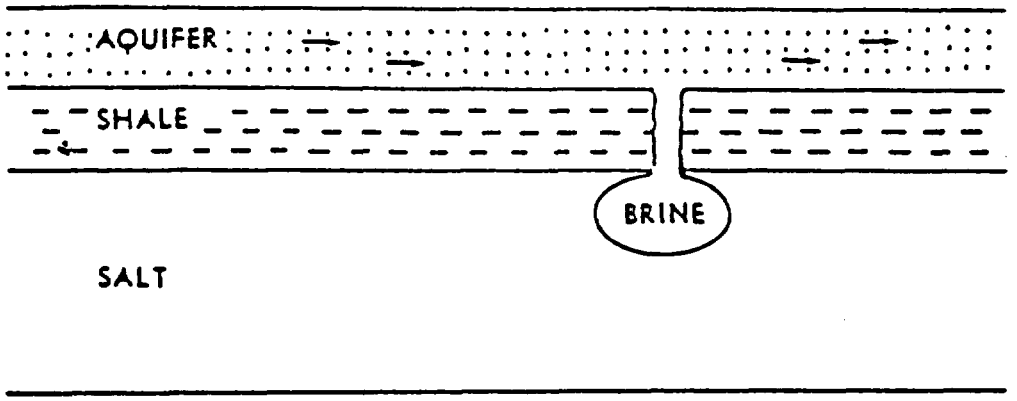
- Quasi Multi-Dimensional Network Model

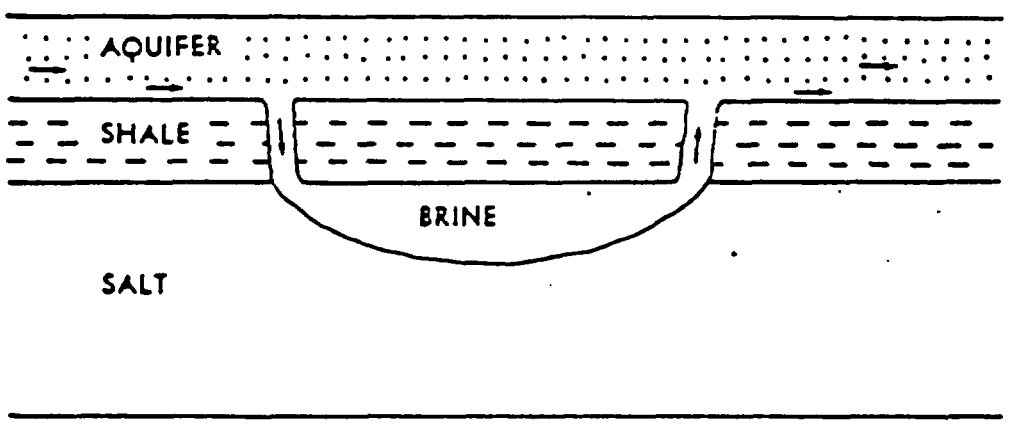
- Processes Considered Are

    1. Fluid Flow
    2. Heat Transport
    3. Salt Dissolution/Creep
    4. Thermal Expansion/Subsidence
    5. Fracture Formation/Closure

- Allows For Dynamic Changes In

    1. Fluid Properties
    2. Media Hydraulic Properties


AQUIFER
SHALE
BRINE
SALT


AQUIFER
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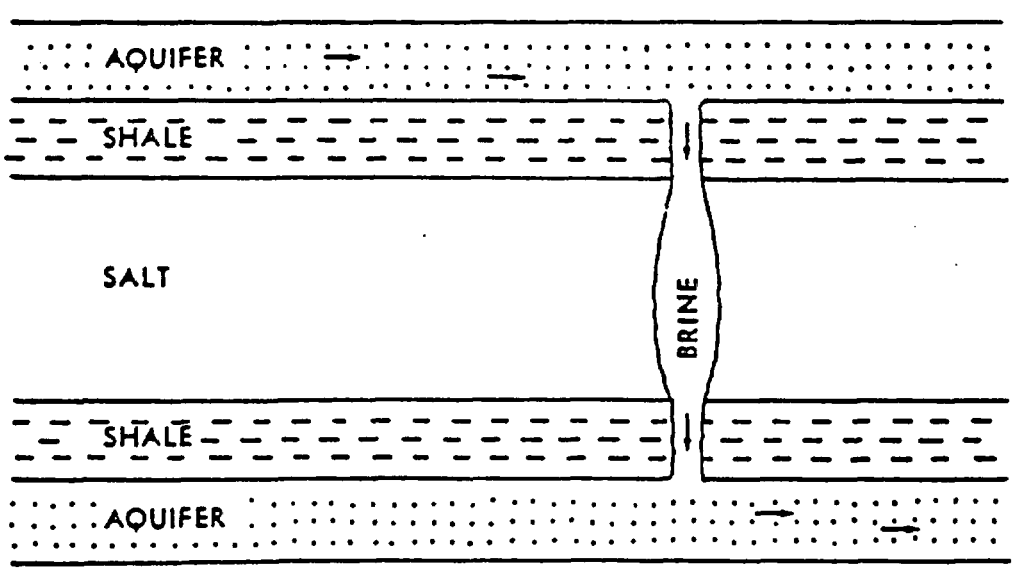
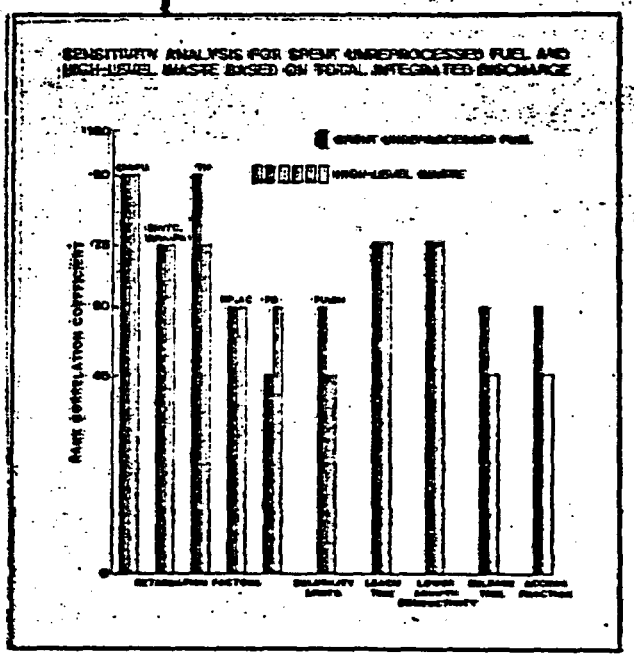

AQUIFER
SHALE
SALT
BRINE
SHALE
AQUIFER

UNCERTAINTY ANALYSIS

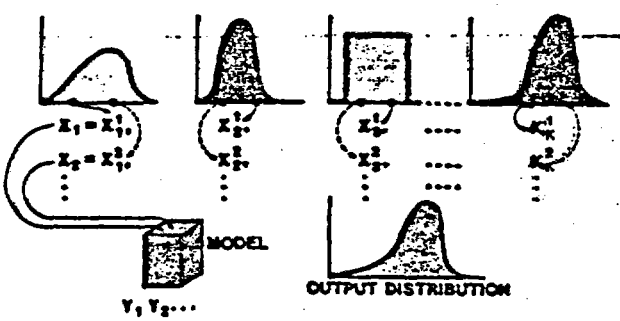
- Computer code/modal
  - code/model verification and field comparisons
- Model input values
  - variables with ranges and distributions
- Future events
  - scenario probabilities

SENSITIVITY ANALYSIS

- Importance of input parameters for compliance with regulatory standards
- Importance of input parameters with time and scenario



- Model input parameters treated as random variables
- Selection of input values by statistical sampling
- Distribution of model output



- ASSESS IMPACT OF CONTAINMENT PERIOD (CANISTER LIFE), RELEASE RATES AND GROUND-WATER TRAVEL TIME
- SUPPORT DEVELOPMENT OF TECHNICAL RATIONALE

- ASSESS IMPACT OF DECAY CHAINS
- ASSESS IMPACT OF LONGER REGULATORY PERIODS
- ASSESS IMPACT OF INDIVIDUAL EXPOSURES
- TEST IMPLEMENTATION OF PROPOSED STANDARD

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- SAMPLES FROM ENTIRE RANGE
- DIRECT ESTIMATE OF OUTPUT DISTRIBUTION
- CORRELATION BETWEEN INPUT VARIABLES
- PARTIAL CORRELATION PLOTS OVER TIME

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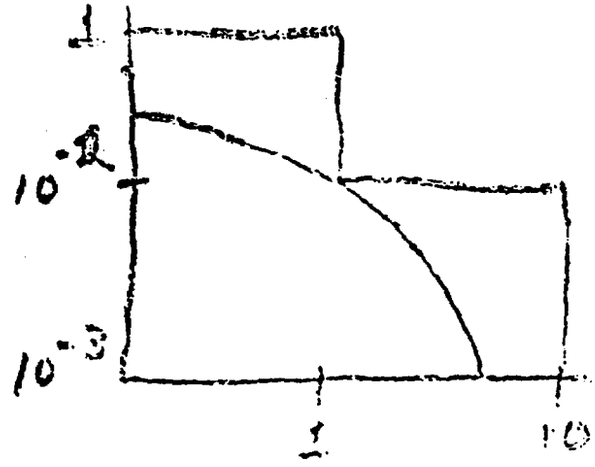
GENERATION OF CCDF

$$R = \sum_i \frac{R_i}{RL_i}$$

$$P(R \geq R) = \sum_{\text{Scenarios}} P(R \geq R | S_i) P(S_i)$$



$$P(R \geq R | S_i) \approx \frac{\#\text{ input vectors} \geq R}{\#\text{ input vectors}}$$

REPORTS AND PRODUCTS

- BEDDED SALT RISK METHODOLOGY FINAL REPORT (NUREG/CR-2452)

- SCENARIO SELECTION AND SCREENING PROCEDURE REPORT (NUREG/CR-1667)

- SWIFT USER'S MANUAL AND SELF-TEACHING CURRICULA (NUREG/CR-2324/1968)

- NWFT/DVM USER'S MANUAL AND SELF-TEACHING CURRICULA (NUREG/CR-2081)

- DNET USER'S MANUAL AND SELF-TEACHING CURRICULA (NUREG/CR-2343/2391)

- PATHWAYS-TO-MAN USER'S MANUAL AND SELF-TEACHING CURRICULA (NUREG/CR-1636/2394)

- DOSIMETRY AND HEALTH EFFECTS REPORT AND SELF-TEACHING CURRICULA (NUREG/CR-2166/2422)

- SENSITIVITY ANALYSIS TECHNIQUES SELF-TEACHING CURRICULA (NUREG/CR-2350)

PRELIMINARY RECOMMENDATION FOR BENCHMARKING IN THE WASTE PACKAGE AREA

WAPPA	Overall waste package performance assessment (radiation, thermal, mechanical stresses, corrosion, and leaching process modules).
ANSYS	Thermal and mechanical analyses.
ANISN	Estimation of radiation field around a cylindrical waste package.
HEATING 6	Thermal analysis, phase change analysis
COVE 1	Creep buckling.

OTHER CODES WITH USEFUL FEATURES

HYDRA	Thermal analysis of intact fuel assemblies
BUCKLE BOSOR5 STAGS	Creep buckling
WECAN	Thermal and structural analysis

NRC Contract FIN B6985 "Benchmarking of Computer Codes and Licensing Assistance"
CorSTAR (formerly Teknekron) June 14, 1984

SRP uses

WAPPA

ANISN

HEATING 5

WECAN

OVERVIEW OF PERFORMANCE ASSESSMENT IN LICENSING

MARK J. LOGSDON

BRIEFING FOR SRPO ON NRC PERFORMANCE ASSESSMENT PROGRAM

JUNE 14-15, 1984

Silver Spring, MD

DOE'S JOB

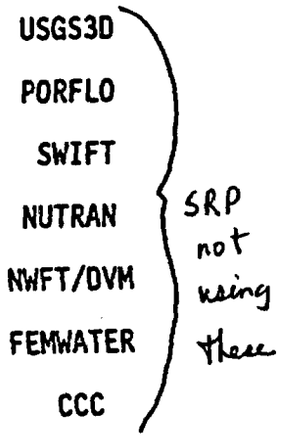
- DOCUMENT FULL LICENSING/PERFORMANCE ASSESSMENT DEMONSTRATING COMPLIANCE WITH 10CFR60

- PRODUCE COMPLETE AND QUANTITATIVE IDENTIFICATION AND CHARACTERIZATION OF UNCERTAINTIES:
  - BASIC PHENOMENA AND PROCESSES
  - CONSTITUTIVE RELATIONSHIPS AND SIMPLIFYING ASSUMPTIONS
  - PARAMETERS AND VARIABLES-DATA GATHERING AND ANALYSES

- DOCUMENT COMPLETE TECHNICAL DEFENSE W.R.T. INSIGNIFICANCE OF UNCERTAINTIES BASED ON:
  - HARD DATA AND EACTS
  - DETAILED CONSIDERATION OF ALTERNATIVE INTERPRETATIONS

- SUPPORTING FACTS AND DATA COLLECTED UNDER QUALITY ASSURANCE PROGRAM AND DOCUMENTED

CODES BEING EXERCISED FOR REPOSITORY SITING



SRP

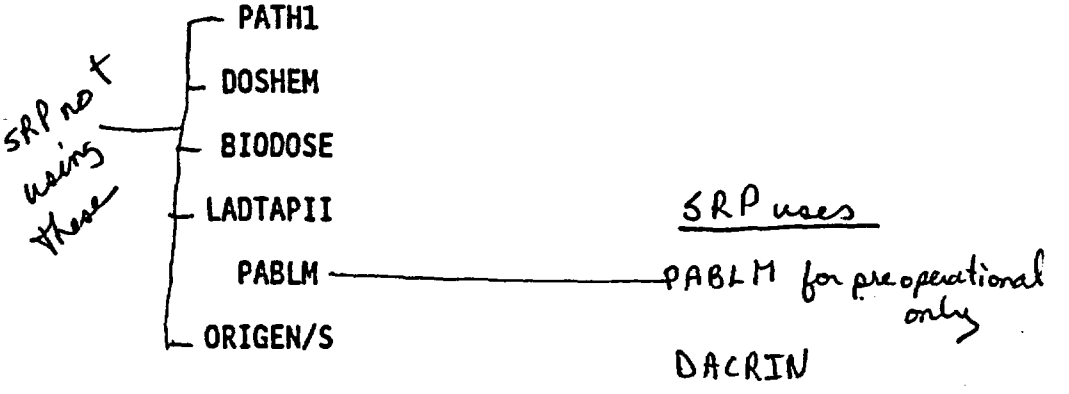
SWENT

FE3GDW

CFEST

NRC Contract FIN B6985 "Benchmarking of Computer Codes and Licensing Assistance"
CorSTAR (formerly Teknekron) June 14, 1984

CODES BEING EXERCISED FOR RADIOLOGICAL ASSESSMENT



NRC Contract FIN B6985 "Benchmarking of Computer Codes and Licensing Assistance"
CorSTAR (formerly Teknekron) June 14, 1984

CODES BEING EXERCISED FOR REPOSITORY DESIGN

Thermal	Geomechanical
ADINAT	ADINA
DOT	MATLOC VISCOT
SPECTROM 41 (?)	SPECTROM 11 (?)
SALT 4	SALT 4
STEALTH	STEALTH
HEATING	
COYOTE	

SRP using

HEATING 5

TEMP

Potentially STEALTH and SPECTROM series

NRC Contract FIN B6985 "Benchmarking of Computer Codes and Licensing Assistance"
CorSTAR (formerly Teknekron) June 14, 1984

NRC STAFF'S JOB

- PROPOSE FINDINGS TO ASLB

- BASE PROPOSED FINDINGS ON INDEPENDENT REVIEW

  1. INDEPENDENT DATA REVIEW

     - ESTABLISH RELIABILITY AND ACCURACY

  2. REVIEW DOE PERFORMANCE ASSESSMENT -- COMPLETENESS AND ADEQUACY OF:

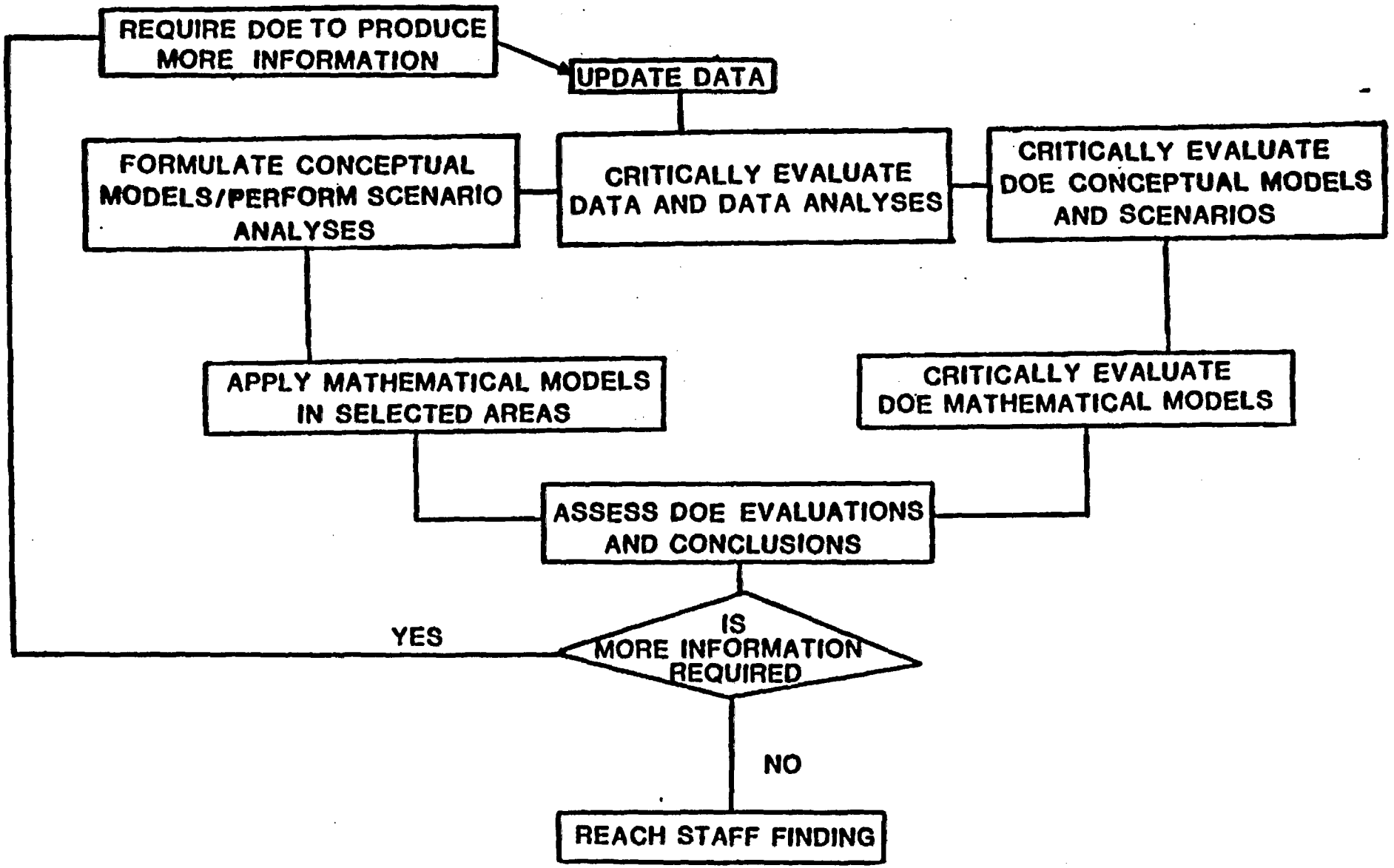
     - MODELS, MODEL INPUTS

     - UNCERTAINTY ASSESSMENTS

     - ALTERNATIVE INTERPRETATIONS

  3. INDEPENDENT PERFORMANCE ASSESSMENT IN SELECTED AREAS

- NRC STAFF CAN CARRY NONE OF DOE'S "WATER" IN PROVING ITS CASE. STAFF CANNOT MAKE UP FOR LICENSE APPLICATION DEFICIENCIES.



GENERAL PROCESS FOR LICENSING ASSESSMENTS

KEY DEFINITIONS

MODEL

- CONCEPTUAL MODEL
- MATHEMATICAL MODEL
- NUMERICAL MODEL
- COMPUTER CODE

PERFORMANCE ASSESSMENT

SCENARIO

SENSITIVITY ANALYSIS

UNCERTAINTY ANALYSIS

VALIDATION

VERIFICATION

That is, the staff expects that a classic probabilistic risk analysis (based on rigorous probablity determinations) of the repository may be neither possible nor necessary, and that determinations of compliance with the numerical criteria may depend in part on expert judgment for items such as conceptual models, scenarios, scenario probabilities, estimated parameter values, boundary locations, and uncertainties. For example, it is expected that numerical models will be used to estimate the consequences of specific scenarios, and will take into account the uncertainties associated with the behavior of the repository within those scenarios. However, it is expected that estimations of the probabilities of the occurrence of the scenarios, and the uncertainties associated with the data pertaining to the scenarios, will be based in part on expert judgment.

9.1.4 Definitions

Accessible environment. (1) the atmosphere, (2) land surfaces, (3) surface water, (4) oceans, and (5) the portion of the lithosphere that is outside the controlled area. The overall system performance for the geologic repository is calculated at this boundary (§60.2).

Computer code. A set of computer instructions for performing the operations specified in a numerical model.

Consequence analysis. A method by which the consequences of an event is calculated and expressed in some quantitative way, e.g., money loss, deaths, or quantities of radionuclides released to the accessible environment.

Controlled area. A surface location, to be marked by suitable monuments extending horizontally no more than 10 km in any direction from the underground facility, and the underlying subsurface, which area has been committed to use as a geologic repository and from which incompatible activities would be restricted following permanent closure (§60.2).

Disturbed zone. That portion of the controlled area whose physical or chemical properties have changed as a result of underground facility construction or from heat generated by the emplaced radioactive wastes such that the resultant change of properties may have a significant effect on the performance of the geologic repository. The minimum groundwater travel time is calculated between this boundary and the accessible environment (§60.133(a)(2)).

Engineered barrier system. The waste packages and the underground facility. The maximum radionuclide release rate is measured at this boundary (§60.113(a)(1)(ii)(B)).

Finding. A determination of compliance or noncompliance with a specific requirement. A finding addressing a numerical performance objective will be reached after the following are weighed: the results of a reliability analysis and the laboratory and field tests upon which it is based, expert opinion, and empirical studies.

Licensing assessment. An assessment of whether a license application complies with all of the requirements that it purports to meet. For this program it is the sum of the individual findings for each of the requirements of 10 CFR 60.

Mathematical model. A mathematical representation of a process, component, or system.

Model. A representation of a process, component, or system.

Numerical method. A procedure for solving a problem primarily by a sequence of arithmetic operations.

Numerical model. A representation of a process, component, or system using numerical methods.

Performance assessment. The process of quantitatively evaluating component and system behavior, relative to containment and isolation of radioactive wastes, to support development of a high-level waste repository and to determine compliance with the numerical criteria associated with the regulation (10 CFR 60).

Performance confirmation. The program of tests, experiments, and analyses that is conducted to evaluate the accuracy and adequacy of the information used to determine reasonable assurance that the performance objectives for the period after permanent closure can be met.

Quality assurance. Those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service, or that a product such as a mathematical analysis or a data measurement will be sufficiently free from error to serve its intended purpose.

Reliability. The probability that a system or component, when operating under stated environmental conditions, will perform its intended function adequately for a specified interval of time.

Reliability analysis. An analysis that estimates the reliability of a system or component.

Risk. A measure of the probability and severity of adverse effects (consequences); the expected detriment per unit time to a person or a population from a given cause.

Risk analysis. An analysis that combines estimates of the probabilities of scenarios with estimates of the consequences of those scenarios, while considering the uncertainties associated with both.

Scenario. An account or sequence of a projected course of action or events.

Scenario analysis. The process of identifying scenarios and estimating the probability of their occurrence.

Sensitivity analysis. An analysis in which one or more parameters are varied to observe their effects on the performance of a system or some part of it. Such an analysis requires definition of a system, the ranges of parameters over which the system is to be investigated, and the characteristics of the system which is to be observed.

Uncertainty analysis. An analysis that estimates the uncertainty in a system's performance resulting from the uncertainty of one or more factors associated with the system. Such an analysis requires definition of a system, description of the uncertainties in the factors that are to be investigated, and the characteristics of the system that is to be observed.

Underground facility. The underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals.

Validation. Assurance that a model as embodied in a computer code is a correct representation of the process or system for which it is intended.

Verification. Assurance that a computer code correctly performs the operations specified in a numerical model.

Waste form. The radioactive waste materials and any encapsulating or stabilizing matrix.

Waste package. The waste form and any containers, shielding, packing and other components surrounding the waste form. The minimum waste package containment time is calculated at this boundary (§60.113(a)(1)(ii)(A)).

9.2 Background

SCR Chapter 12 (SCR pages 12.1-1 through 12.1-3) identifies the following major issues related to performance after permanent closure:

(1) Are the pre-waste emplacement groundwater travel time near the repository sufficient to assure compliance with U.S. Nuclear Regulatory Commission technical criteria?

(2) Does the very near-field interaction between the waste package and its components, the underground facility, and the geologic setting compromise waste package or engineered system performance? (i.e., What is the maximum expected release rate from the engineered system?)

(3) What is the total amount (activity) of radionuclides potentially releasable to the accessible environment in a 10,000-year period, and is this amount in compliance with appropriate U.S. Environmental Protection Agency regulations?

In addition to discussing the above issues, this Draft SCA chapter addresses the following items:

(4) What are the performance assessment issues addressing either operational safety or retrievability? (The SCR states that this part of performance assessment will be addressed after completion of the repository conceptual design.)

(5) What are the performance assessment approaches and methods in use or under development, and are they appropriate for supporting repository development and for determining compliance with the numerical criteria?

FINDINGS REQUIRED BY 10 CFR 60

§60.111(a)	PRE-CLOSURE PROTECTION
§60.111(b)	RETRIEVABILITY
§60.112	EPA STANDARD
§60.113(a)(1)	CONTAINMENT FOR 300-1000 YEARS
	RELEASE RATE FOLLOWING THE CONTAINMENT
§60.113(a)(2)	GROUNDWATER TRAVEL TIME LEAST 1000 YEARS
§60.122	FAVORABLE/POTENTIALLY ADVERSE CONDITIONS
§60.131 -	DESIGN CRITERIA
§60.135	

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(1) Through Permanent Closure

§60.111(a), limiting radiation exposures and releases of radioactive material during operations. Numerical analyses may be used to estimate source terms for potential releases, transport of radionuclides by the repository ventilation system, movement of radionuclides through the environment, and the resulting doses to members of the public.

§60.2 also defines the term "important to safety" in terms of "engineered structures, systems, and components essential to the prevention or mitigation of an accident that could result in a radiation dose to the whole body, or any organ, of 0.5 rem or greater at or beyond the nearest boundary of the unrestricted area at any time until the completion of permanent closure." The use of numerical analyses for evaluating potential accident sequences is expected to be the same as described in the preceding paragraph.

§60.111(b), requiring that the option of waste retrieval be preserved during operations. Numerical analyses may include heat transport in the repository system, structural analyses for the waste packages and/or the underground facility, and estimates of waste package degradation.

FOR INTERNAL REVIEW AND COMMENT

AUTHOR DRAFT

(2) After Permanent Closure

§60.112, limiting releases of radioactive materials to the accessible environment after permanent closure to those permitted by the EPA standard (proposed 40 CFR 191). (The nature of the EPA standard is discussed in the following section.) Numerical analyses will include flow of groundwater into and through the repository system and transport of radionuclides from the waste form to the accessible environment as illustrated in Figure 1.

§60.113(a)(1)(ii)(A), requiring a minimum waste package containment time. Numerical analyses of waste package degradation may include structural analyses, extrapolations of corrosion data obtained by accelerated testing, and geochemical estimates of the waste package environment under the influence of heat and radiation.

§60.113(a)(1)(ii)(B), limiting the radionuclide release rate from the engineered barrier system. Numerical analyses may be used to extrapolate laboratory-generated leaching data, to estimate solubility-limited radionuclide releases, to evaluate containment by backfill materials, and for estimates of geochemical conditions in the engineered barrier system.

FOR INTERNAL REVIEW AND COMMENT

AUTHOR DRAFT

§60.113(a)(2), addressing the minimum pre-emplacement groundwater travel time from the disturbed zone to the accessible environment. Numerical analyses may include thermal or coupled thermal-hydrologic analyses to determine the physical extent of the disturbed zone, and groundwater flow analyses to estimate travel times.

§60.122, addressing favorable and potentially adverse siting conditions. Numerical analyses may include estimates of the effects of favorable or potentially adverse conditions on achieving compliance with any of the criteria discussed above.

For detailed discussions of the important terminology and points of consideration in the regulation, the reader should consult the Supplementary Information accompanying the publication of the Final Rule (48 FR 120, 28194 - 28229, June 21, 1983).

Nature of the Proposed EPA Standard

As discussed above, §60.112 establishes the EPA standard as the overall release limit for a repository system. The EPA standard is a probability-based standard. The containment requirements in the proposed EPA standard limit "reasonably foreseeable" and "very unlikely" releases

FOR INTERNAL REVIEW AND COMMENT

- ADDITIONAL RELEVANT SECTIONS

  60.21 CONTENT OF APPLICATION

  60.31 CONSTRUCTION AUTHORIZATION

  60.101 PURPOSE AND NATURE OF FINDINGS

  60.130 SCOPE OF DESIGN CRITERIA

- IMPORTANT TERMINOLOGY

  - REASONABLY FORESEEABLE/VERY UNLIKELY EVENTS AND PROCESSES
  - ANTICIPATED/UNANTICIPATED EVENTS AND PROCESSES
  - REASONABLE ASSURANCE

FROM NUREG - 0960
APRIL 1983

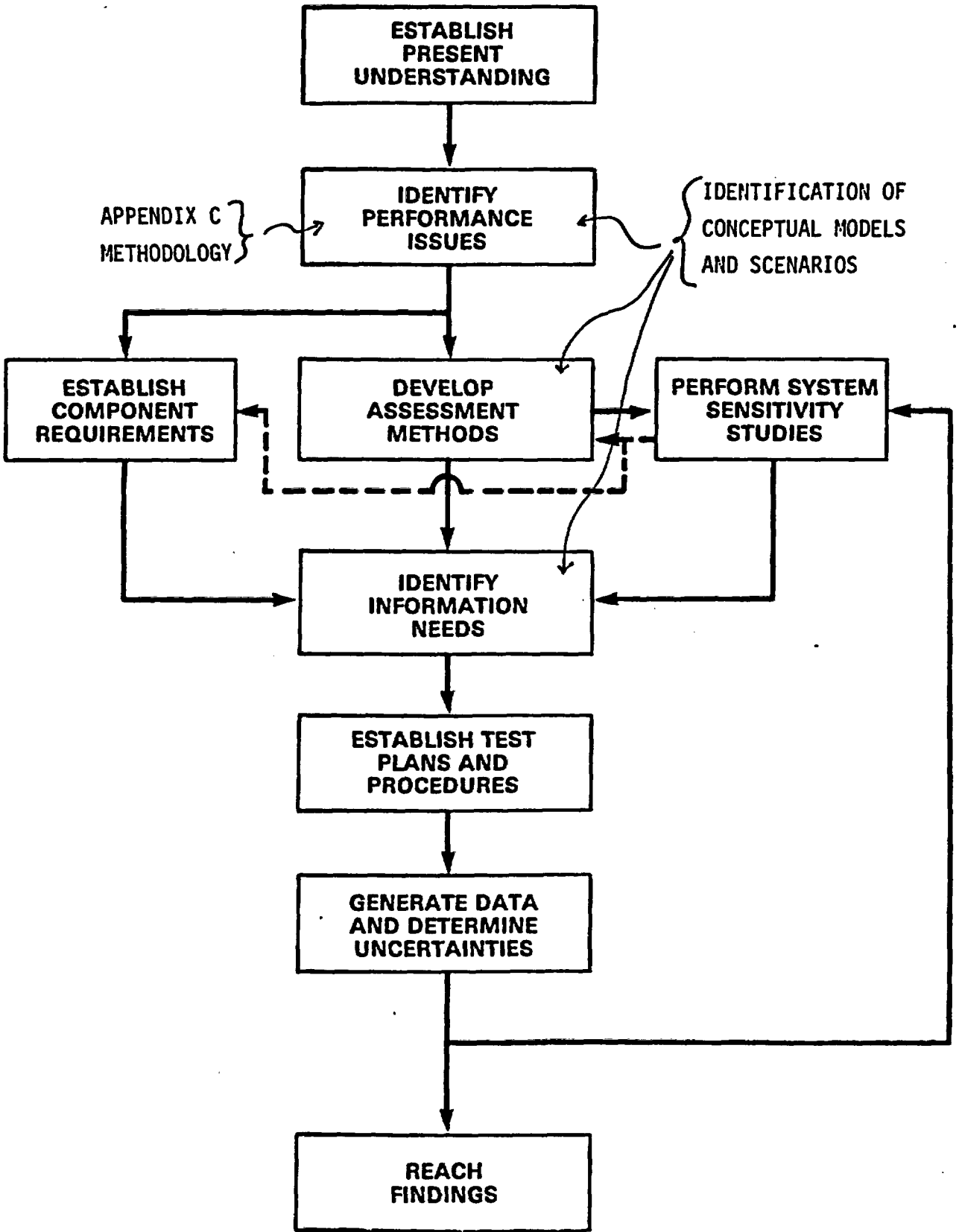


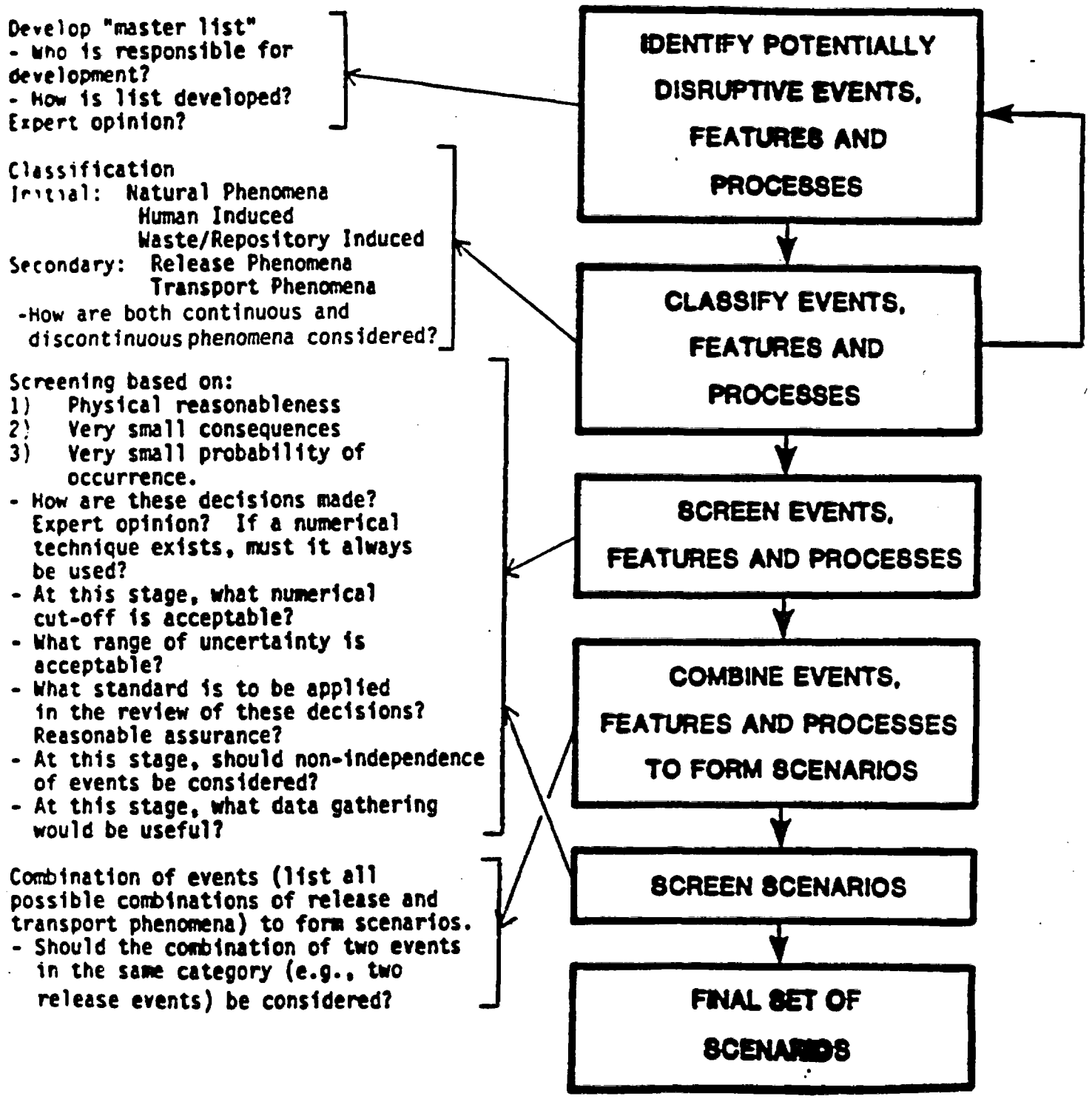
Figure 9.1 Site characterization - program logic

MAJOR PERFORMANCE-RELATED QUESTIONS

- SPATIAL AND TEMPORAL SCALES
- PHYSICAL AND CHEMICAL PROPERTIES OF THE ENVIRONMENT
- TYPES, PROBABILITIES AND NATURES OF CHANGES
  - NATURAL
  - HUMAN-INDUCED
  - REPOSITORY-INDUCED
- EFFECTS OVER TIME OF CHANGES

TECHNICAL RATIONALE

- o TECHNICAL APPROACH TO PREDICTIONS OR BOUNDS
- o CONCEPTUAL MODELS
- o SCENARIOS
- o MATHEMATICAL MODELS
  - QA
- o UNCERTAINTIES
  - BASIC PHENOMENA
  - CONSTITUTIVE RELATIONSHIPS
  - MODELS, CODES, COMPUTATIONS
  - DATA


Develop "master list"
- Who is responsible for development?
- How is list developed? Expert opinion?
IDENTIFY POTENTIALLY DISRUPTIVE EVENTS, FEATURES AND PROCESSES
Classification
Initial: Natural Phenomena
Human Induced
Waste/Repository Induced
Secondary: Release Phenomena
Transport Phenomena
-How are both continuous and discontinuous phenomena considered?
CLASSIFY EVENTS, FEATURES AND PROCESSES
Screening based on:
1) Physical reasonableness
2) Very small consequences
3) Very small probability of occurrence.
- How are these decisions made? Expert opinion? If a numerical technique exists, must it always be used?
- At this stage, what numerical cut-off is acceptable?
- What range of uncertainty is acceptable?
- What standard is to be applied in the review of these decisions? Reasonable assurance?
- At this stage, should non-independence of events be considered?
- At this stage, what data gathering would be useful?
SCREEN EVENTS, FEATURES AND PROCESSES
COMBINE EVENTS, FEATURES AND PROCESSES TO FORM SCENARIOS
Combination of events (list all possible combinations of release and transport phenomena) to form scenarios.
- Should the combination of two events in the same category (e.g., two release events) be considered?
SCREEN SCENARIOS
FINAL SET OF SCENARIOS

QUALIFICATION OF NUMERICAL MODELS AND COMPUTER CODES

- o RELIABILITY OF CONSTRUCTION: QUALITY ASSURANCE
  - DOCUMENTATION
  - CERTIFICATION
  - DESCRIPTION OF ASSUMPTIONS AND LIMITATIONS
- o NUMERICAL ACCURACY
  - VERIFICATION
- o PHYSICAL REASONABLENESSS
  - BENCHMARKING AGAINST RANGE OF POTENTIAL CONDITIONS/PROBLEMS
- o SITE-SPECIFIC APPLICABILITY
  - "VALIDATION"

NRC/DOE SRPO ASSESSMENT BRIEFING

NRC PERFORMANCE ASSESSMENT DOCUMENTS

to be available for comment

I. Internal NRC Documents

8/1/84 → A. Draft Generic Technical Position on Licensing Assessment Methodology - April 30, 1984

7/15/84 → B. Draft Modeling Strategy Document - May 9, 1984

C. NUREG-0960 BWIP DSCA - Chapter 9: Performance Assessment
Appendix C: Issues
Appendix D: Groundwater
Travel-Time Sensitivity Study

D. NUREG-0856 Final Technical Position on Documentation of Computer Codes for High-Level Waste Management

* send to SRP

II. Contractor Documents

A. Sandia National Laboratories

	Designation	Description
*	NUREG/CR-1667	Scenario Selection Procedures
*	NUREG/CR-3353	Preliminary Scenarios - Basalt
	NUREG/CR-3111 (2 Vol.)	Assessment of 10CFR60
	NUREG/CR-3235 (6 Vol.)	Evaluation of Draft EPA Standard
	NUREG/CR-3129	Bedded Salt RSD
*	NUREG/CR-2324	SWIFT - User's Guide
*	NUREG/CR-2081	NWFT/DVM - User's Guide
*	NUREG/CR-2343	DNET User's Manual
*	NUREG/CR-3378	NWFT/DVM Verification
*	NUREG/CR-2350	Sensitivity Analysis Techniques - Self-Teading Manual
*	UNDES	Document Reviews DOE and International Programs (yellow cover, FY83)

B. CorSTAR/Teknekron

	Designation	Description
	NUREG/CR-2782	Summary of Siting Models
*	NUREG/CR-3066	Parameters and Variables - Siting
	NUREG/CR-3097	Benchmark Problems - Siting
	NUREG/CR-3209	Summary of Radiological Assessment Codes
	NUREG/CR-3160	Parameters and Variables - Radiological Assessment

	NUREG/CR-3451	Benchmark Problems - Radiological Assessment
	NUREG/CR-3450	Summary of Repository Design Models
	NUREG/CR-3586	Parameters and Variables - Design
*	NUREG/CR-3636	Benchmark Problems - Design
*	NUREG/CR-3699	Summary of Codes - Waste Package

C. Additional Contractor Reports: Waste Package/Engineered Barriers

	Designation	Description
	GAI/EB I/4	Engineered Barriers (Basalt) - Technical Overview
	GAI/EB 3/4	Engineered Barriers - Bedded Salt
	BNL-NUREG/CR-0997R	Waste Package Reliability
	BNL-NUREG/CR-3091	Review of Waste Package Verification Tests
*	SAND 82-0596	~~Reviews of DOE on~~ Risk Assessment Methodology for HLW: Assessing Compliance w/ the EPA Draft Std. including Uncertainties
*	NUREG 0997R	Draft Technical Position on Waste Package Reliability
*		Evaluation of Engineered Barrier Design and Performance for a HLW Repository in Bedded Salt (Golder) January '84
*	NUREG/CR-2452	Bedded Salt Risk Methodology