MAY 11 1988

DGAL 5/4 M1 LIST/



MEMORANDUM FOR: Don Chery, Hydrology Section, HLTR
Dave Brooks, Geochemistry Section, HLTR
Rick Weller, Materials Engineering Section, HLTR
Philip Justus, Geology-Geophysics Section, HLTR
Mysore Nataraja, Geotechnical Engineering/Design Section, HLTR

FROM: Ronald L. Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management

SUBJECT: PROGRAM REVIEW FOR FIN A-1165, "TECHNICAL ASSISTANCE FOR PERFORMANCE ASSESSMENT," WITH SNL

A program review meeting for FIN A-1165, "Technical Assistance for Performance Assessment," with SNL, has been rescheduled from May 17-18, 1988, to May 24-25, 1988. I note that each of you has agreed to be the performance assessment lead and, in this context, I have already informed you of the high priority I accord to each of you attending the entire program review. The purpose of this memorandum is to provide you with a draft agenda for the program review and some background information with which I expect you to be familiar. This background information comprises (1) a copy of the FY88-89 Statement-of-Work for this project, (2) a copy of draft outline for each of the deliverables, developed by SNL for the previous project review of April 6-7, 1988, and (3) a copy of figures used by SNL for a presentation on the BWIP performance assessment demonstration, presented to NRC management at a program review of March 15-16, 1988.

Please note that SNL will also be providing a presentation on the BWIP performance assessment demonstration on May 23, 2:00-4:30, in room 2-F-21. A meeting announcement will be distributed to all DHLWM staff. I urge each of you, as well as your staff to attend this presentation.

Ronald L. Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management

Enclosures:
As stated

cc: w/enclosures
B.J. Youngblood, HLOB

DISTRIBUTION:

| | | |
|---|---|---|
| Central Files | REBrowning, HLWM | RLBallard, HLTR |
| JOBunting, HLSE | HLTR r/f | HLOB r/f |
| DGalson, HLOB | SCoplan, HLOB | JRandall, RES |
| FCostanzi, RES | ADuncan, HLOB | PBrooks, HLOB |
| RCodell, HLOB | DFehringer, HLSE | PDR & LPDR |
| CNWRA | LSS | |

8805180033 880511
PDR WMRES EXISANL
A-1165 DCD
SEE PREVIOUS CONCURRENCE

DH16
A-1165
WM11

| OFC | *HLOB | *HLOB | HLTR | | | |
|---|---|---|---|---|---|---|
| NAME | DGalson:km/cj: | SCoplan | RBallard | | | |
| DATE | 05/ /88 | 05/ /88 | 05/11/88 | | | |

~~DGAL 5~~/4 M1 LIST



MEMORANDUM FOR: Don Chery, Hydrology Section, HLTR
Dave Brooks, Geochemistry Section, HLTR
Rick Weller, Materials Engineering Section, HLTR
John Trapp, Geology-Geophysics Section, HLTR
Mysore Nataraja, ~~Rock Mechanics/Design Section, HLTR~~

FROM: Ronald L. Ballard, Chief
Technical Review Branch, ~~HLTR~~

SUBJECT: PROGRAM REVIEW FOR FIN A-1165, "TECHNICAL ASSISTANCE FOR PERFORMANCE ASSESSMENT", WITH SNL

A program review for FIN A-1165, "Technical Assistance for Performance Assessment", with SNL, has been scheduled for May 17-18, 1988, by Daniel Galson, the NRC Project Manager for this contract. I note that each of you have agreed to be the performance assessment lead for your Section and, in this context, I have already informed you of the high priority I accord to each of you attending the entire program review. The purpose of this memorandum is to provide you with a draft agenda for the program review and some background information with which I expect you to be familiar. This background information comprises (1) a copy of the FY88-89 Statement-of-Work for this project, (2) a copy of draft outline for each of the deliverables, developed by SNL for the previous project review of April 6-7, 1988, and (3) a copy of figures used by SNL for a presentation on the BWIP performance assessment demonstration, presented to NRC management at a program review of March 15-16, 1988.

Please note that SNL will also be providing a presentation on the BWIP performance assessment demonstration on May 16, 2:00-4:30, in room 2-F-17. A meeting announcement will be distributed to all DHLWM staff. I urge each of you, as well as your staff to attend this presentation.

Ronald L. Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management

DISTRIBUTION:

Enclosures:
As stated

cc w/enclosures:
B.J. Youngblood
P. Justus

| OFC | HLOB DAG | HLOB RBC | HLOB | | | |
|---|---|---|---|---|---|---|
| NAME | DGalson:km | SCoplan | RBallard | | | |
| DATE | 05/05/88 | 05/05/88 | 05/ /88 | | | |

w/ ltr dtd 5/11/88 A-1165
To: Alan Cherry
Fm: Ronald L. Ballard

AGENDA

DISCUSSION OF BWIP PA DEMONSTRATION

May 23, 1988
U.S. NRC, Rockville, MD
Room 2-F-21

Monday, May 23

2:00-4:30 Discussion of BWIP PA Demonstration
Introduction and Background - E.J. Bonano
Site Characteristics and Data Base - P. Davis
Discussion of Results - E.J. Bonano

DRAFT AGENDA
PROJECT REVIEW FOR A1165
May 24-25, 1988
U.S. NRC, Rockville, MD

Tuesday, May 24 ROOM 2 F-21

8:30 ~~9:00~~ OBJECTIVE OF A1165 - Dan Galson

8:45 ~~9:15~~ STATUS OF A1165 - P. Davis

9:00 ~~9:30~~ SUBTASK 1.1
- Assessing Compliance with the Regulations
  - NRC Requirements
    - Waste Package, EBS, GWTT
  - EPA Requirements
    - Individual Protection, Ground-Water Protection, Containment Requirements
- Overall Licensing Assessment Methodology
  - System Description
  - Scenario Development and Screening
  - Consequence Modeling
  - Uncertainty Analysis
  - Sensitivity Analysis
  - Quality Assurance
- Licensing Assessment Methodology Tracking System
  - Organizational Structure
  - Implementation

10:30 BREAK

10:50 SUBTASK 1.2

11:20 SUBTASK 1.3

12:00 LUNCH

1:00 SUBTASK 1.3 (continued)

1:30 SUBTASK 1.4

2:00 SUBTASK 2.1

2:15 SUBTASK 2.2

2:45 BREAK

3:00 SUBTASK 2.3

3:45 SUBTASK 2.4

4:30 SUBTASK 2.5

5:00 ADJOURN

Wednesday, May 25

Room 4-B-11

| | |
|---|---|
| ~~9:00~~ 8:30 | COMPARISON OF UNCERTAINTY AND SENSITIVITY ANALYSIS TECHNIQUES FOR GROUND-WATER FLOW AND TRANSPORT MODELS |
| ~~9:45~~ 9:30 | SUBTASK 2.6 |
| 10:30 | BREAK |
| 10:50 | SUBTASK 3.1 |
| 11:00 | SUBTASK 3.2 |
| 11:30 | CODE MAINTENANCE |
| 12:00 | LUNCH |

Room 4-B-13 as needed

| | | |
|---|---|---|
| 1:00 | QA AND ASSESSMENT STRATEGY MEETING - Alan Duncan, Dan Fehringer<br>EJB, PAD, DPG, MTG, IJH, CPH, LLP, KKW | |
| 2:00 | PROBABILITY AND STATISTICS MEETING - Dick Codell<br>EJB, PAD, DPG, MTG, IJH, CPH, LLP, KKW | |
| 2:45 | BREAK | |
| 3:00 | HYDROLOGY, TRANSPORT AND CLIMATOLOGY - Don Chery<br>EJB, PAD, DPG, MTG, IJH, LLP | MATERIALS SCIENCE - Rick Weller<br>KKW |
| 3:30 | | ROCK MECHANICS - Mysore Nataraja<br>KKW |
| 4:00 | GEOCHEMISTRY - Dave Brooks<br>EJB, DPG, LLP | GEOLOGY - John Trapp<br>PAD, MTG, KKW |
| 5:00 | ADJOURN | |

EJB: Tito Bonano
PAD: Paul Davis
DPG: David Gallegos
MTG: Mike Goodrich
CPH: Charlene Harlan
IJH: Irv Hall
LLP: Laura Paul
KKW: Krishan Wahf

# LIST OF SANDIA STAFF AND CONTRACTORS WORKING IN FIN A1165

## Tasks 1 & 2

| SNLA STAFF | CONTRACTORS |
|---|---|
| P. Davis | K. Wahl, GRAM, Inc. |
| E. Bonano | R. Guzowski, Remote Sensing, Inc. |
| I. Hall | M. Goodrich, GRAM, Inc. |
| L. Paul | J. Helton, Arizona State U. |
| D. Gallegos | D. von Winterfeldt, U. Southern CA |
| C. Harlan | R. Keeney, U. Southern CA |
| G. Wilkinson | G. Apostolakis, UCLA |
| R. Cranwell | S. Hora, U. Hawaii |

## Task 3

| SNLA STAFF | CONTRACTORS |
|---|---|
| P. Davis | K. Wahl, GRAM, Inc. |
| E. Bonano | R. Guzowski, Remote Sensing, Inc. |
| R. Cranwell | R. Bras, MIT |
| | G. Apostolakis, UCLA |

## Task 4

| SNLA STAFF | CONTRACTORS |
|---|---|
| C. Harlan | M. Goodrich, GRAM, Inc. |

## Task 5

| SNLA STAFF | CONTRACTORS |
|---|---|
| P. Davis | K. Wahl, GRAM, Inc. |
| E. Bonano | R. Guzowski, Remote Sensing, Inc. |
| R. Cranwell | |
| C. Harlan | |
| I. Hall | |
| L. Shipers | |

## Task 6

No activity in this task yet.

# PERFORMANCE ASSESSMENT

**IDENTIFICATION OF IMPORTANT PROCESSES AND EVENTS**

(SCENARIO DEVELOPMENT)

**EVALUATION OF LIKELIHOOD OF OCCURRENCE**

(SCENARIO PROBABILITY)

**EXAMINATION OF EFFECTS**

(MODEL/COMPUTER CODE DEVELOPMENT)

**ESTIMATION OF CONSEQUENCES**

(CONSEQUENCE ANALYSIS)

**CONSIDERATION OF UNCERTAINTIES**

(UNCERTAINTY ANALYSES)

**ASSESS COMPLIANCE WITH REGULATIONS**

(REGULATORY COMPLIANCE ASSESSMENT)

# WHY DO PERFORMANCE ASSESSMENTS?

**EPA ( §191.3 CONTAINMENT REQUIREMENTS)**

**"DISPOSAL SYSTEMS ... SHALL BE DESIGNED TO PROVIDE A RESPONABLE EXPECTATION, BASED UPON** *PERFORMANCE ASSESSMENTS* **, ... ."**

**NRC**

**"THE COMMISSION WILL EVALUATE COMPLIANCE WITH THE CONTAINMENT REQUIREMENTS BASED ON A** *PERFORMANCE ASSESSMENT* **."**

**NOTE**

**PERFORMANCE ASSESSMENTS NEED NOT PROVIDE** *COMPLETE ASSURANCE* **. ONLY A** *REASONABLE EXPECTION* **IS REQUIRED**

86AA6000.04

# PERFORMANCE ASSESSMENTS ALSO USEFUL FOR

- ASSISTING IN RULEMAKING
- IDENTIFYING IMPORTANT PROCESSES AND PARAMETERS
- DIRECTING DATA GATHERING AND FUTURE RESEARCH
- ASSISTING IN DEVELOPMENT OF CONCEPTUAL MODELS

86TAA6000.09

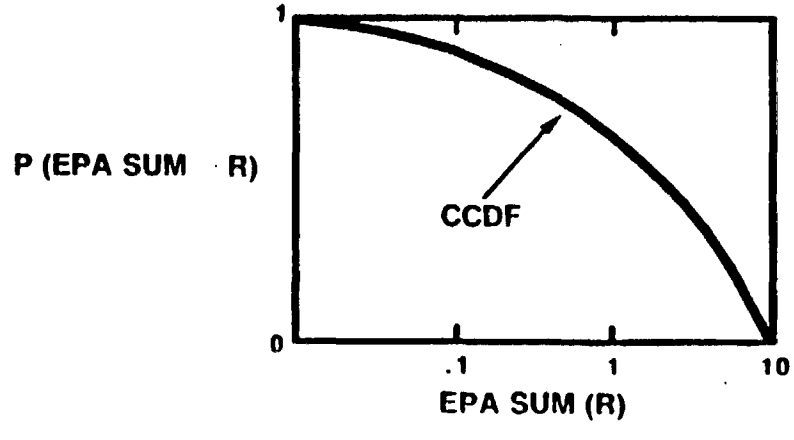
# PERFORMANCE ASSESSMENT

- IDENTIFIES PROCESSES AND EVENTS THAT MIGHT AFFECT DISPOSAL SYSTEM
- EXAMINES EFFECTS OF PROCESSES AND EVENTS ON PERFORMANCE OF DISPOSAL SYSTEM
- EXTIMATES RELEASES OF RADIONUCLIDES, CONSIDERING ASSOCIATED UNCERTAINTIES, CAUSED BY PROCESSES AND EVENTS
- INCORPORATES RELEASE ESTIMATES INTO AN OVERALL PROBABILITY DISTRIBUTION

86TX6000.38

# ASSESSING COMPLIANCE WITH CONTAINMENT REQUIREMENTS (§ 191.13) OF EPA STANDARD (40CFR191)

EPA - "THE AGENCY ASSUMES THAT, WHENEVER PRACTICABLE, THE IMPLEMENTING AGENCY WILL ASSEMBLE ALL OF THE RESULTS OF THE PERFORMANCE ASSESSMENTS TO DETERMINE COMPLIANCE WITH § 191.13 INTO A 'COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION' THAT INDICATES THE PROBABILITY OF EXCEEDING VARIOUS LEVELS OF CUMULATIVE RELEASE."




86TZ6000.33

# CONTAINMENT REQUIREMENT OF EPA STANDARD IS PROBABILISTIC

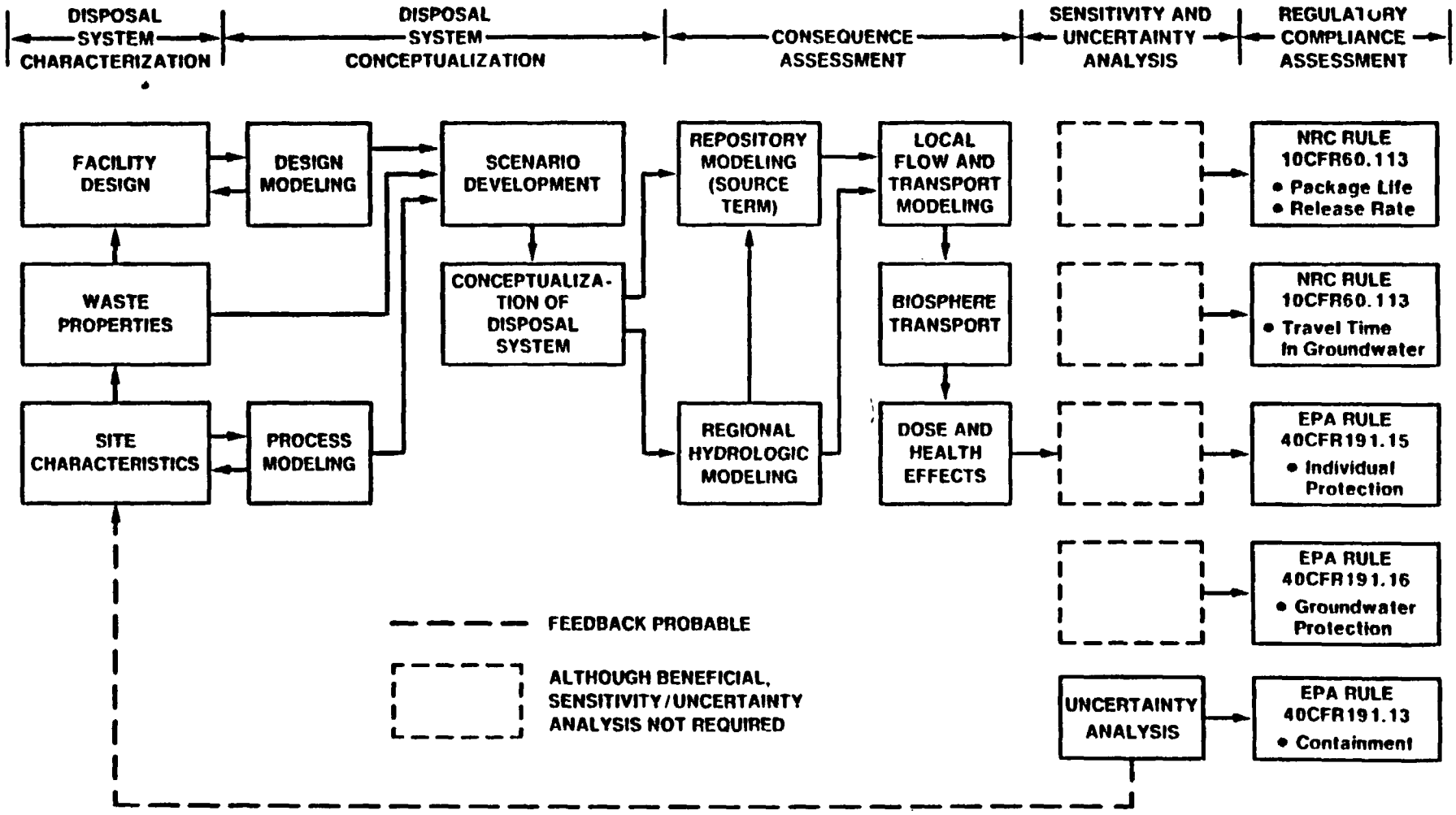
IF $P(R) > 0.1$, THEN RELEASE MAY BE X CURIES

IF $0.1 > P(R) > 0.001$, THEN RELEASE MAY BE 10 X CURIES

IF $0.001 > P(R)$, THEN RELEASE IS UNREGULATED

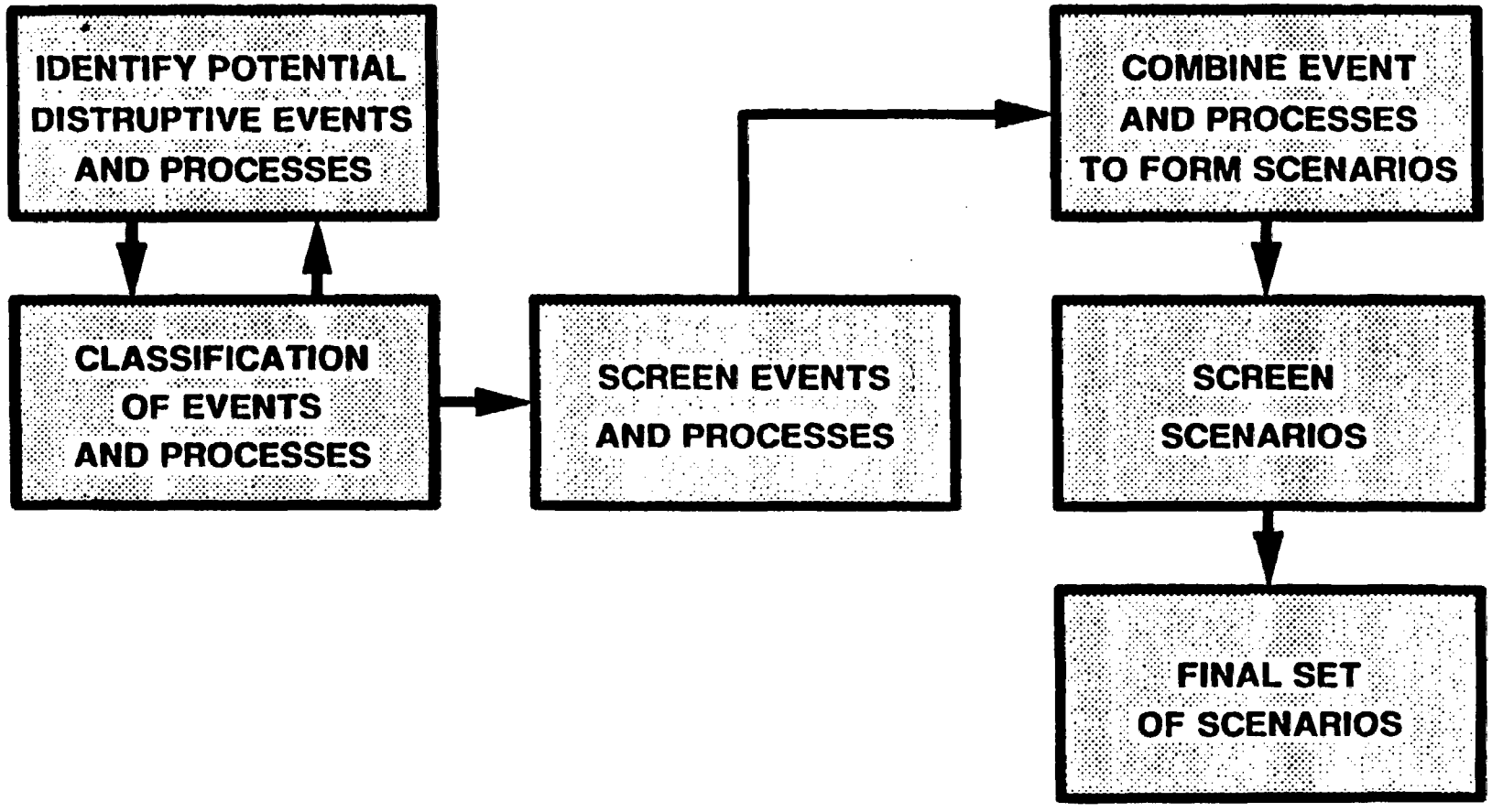
87TZ6000.12

# PERFORMANCE ASSESSMENT FOR DEEP GEOLOGICAL WASTE DISPOSAL



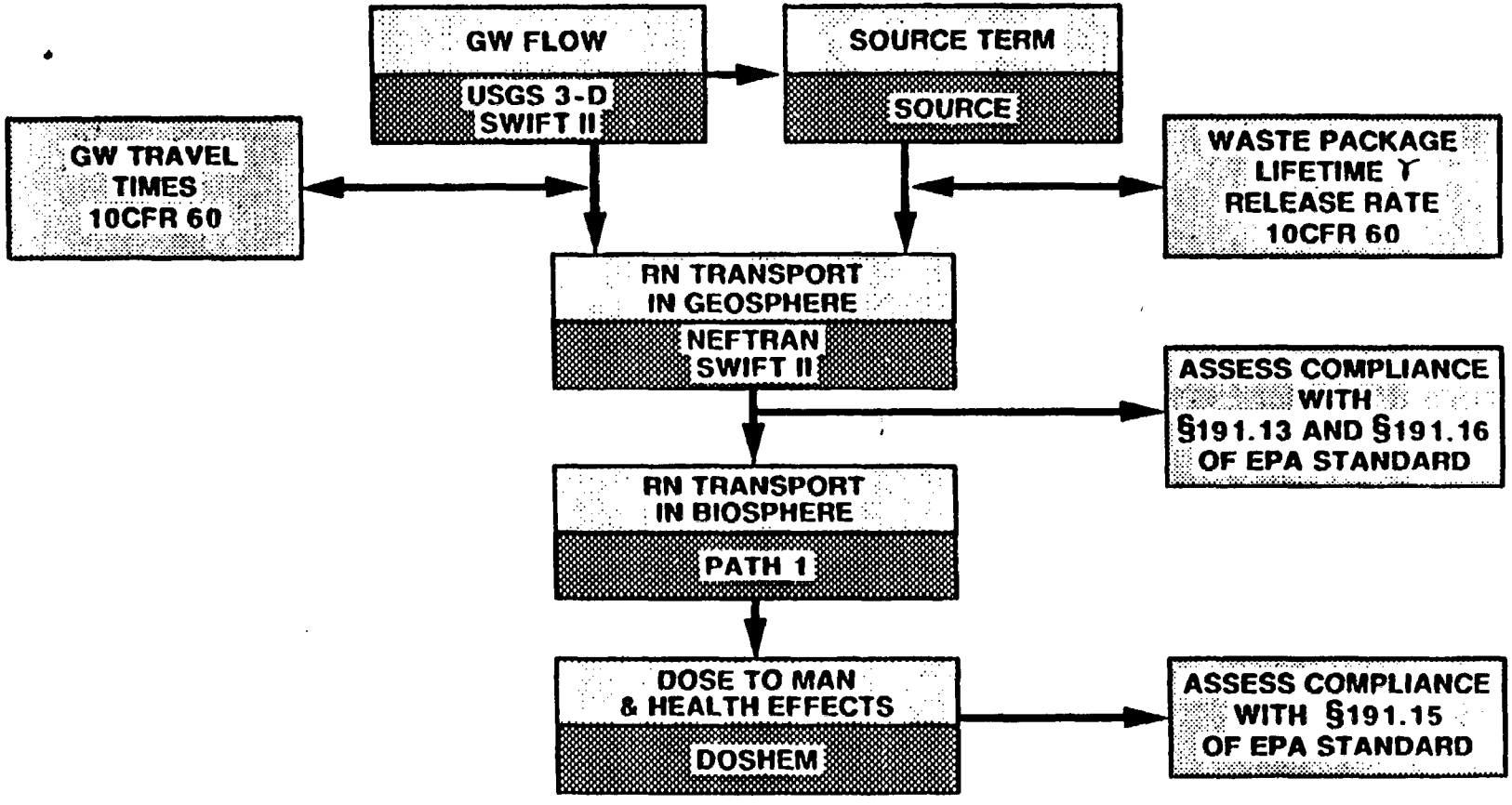

87TZ6000.17

# SCENARIO DEVELOPMENT AND SCREENING METHODOLOGY




86TAA6000.16

# CONSEQUENCE MODELING




T86A6000.22

# CONSEQUENCE MODELLING

## GROUND-WATER FLOW

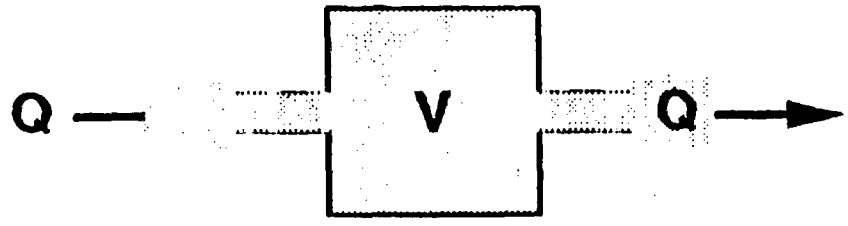
### USGS CODE

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

### SWIFT II

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

# MIXING CELL MODEL




$Q\Delta t << V$

FOR CONSTANT LEACH RATE:

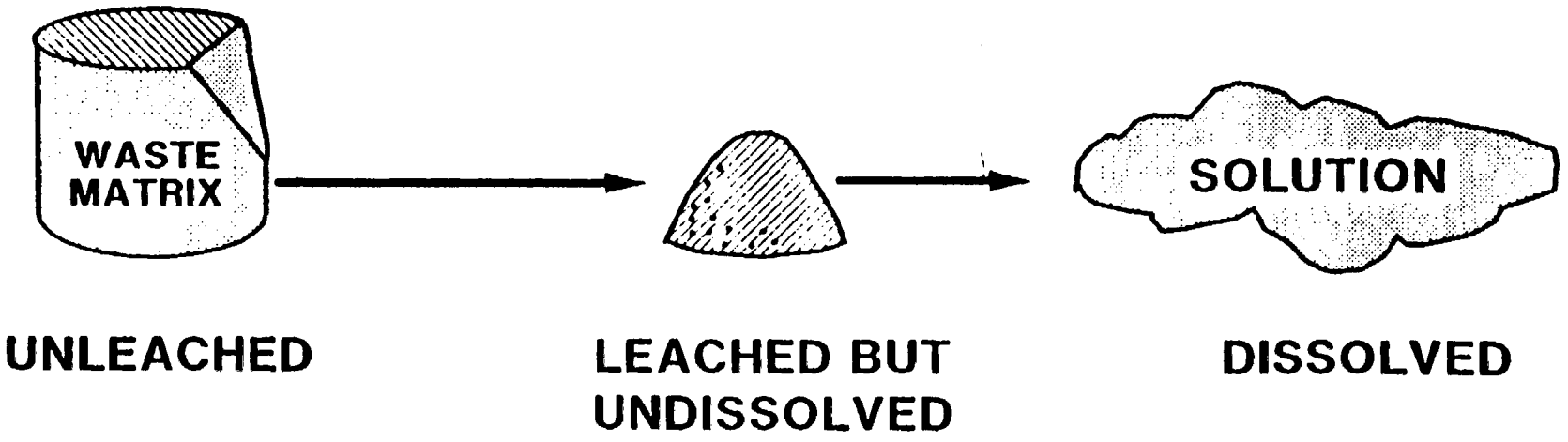
CONCENTRATION OF OUTFLOWING RADIONUCLIDES

$$= C(t) = \frac{\lambda_L M_o}{Q} \left(1 - e^{-Q/Vt}\right)$$

TF6000.43

Sandia National Laboratories

# MIXING CELL INVENTORY




TY6000.49

# THREE LEACH MODELS

## A. CONSTANT

$$\frac{dM}{dt} = \lambda_L M_o$$

$M_o$ = INITIAL MASS

$\lambda_L$ = CONSTANT

## B. EXPONENTIAL (USED BY EPA)

$$\frac{dM}{dt} = \lambda_L M(t) = \lambda_L M_o e^{-\lambda_L t}$$

TF6000.33

Sandia National Laboratories

## C. EMPIRICALLY DEFINED TIME AND TEMPERATURE-DEPENDENT MODEL

$$\frac{dM}{dt} = nK(T)t^{n-1}$$

n = CONSTANT ($0 < n < 1$) THAT IS CHARACTERISTIC OF THE REACTION MECHANISM

K = TEMPERATURE-DEPENDENT RATE CONSTANT

t = TIME ELAPSED SINCE ONSET OF LEACHING

TF6000.34

Sandia National Laboratories

# CONSEQUENCE MODELLING

## RADIONUCLIDE TRANSPORT IN GEOSPHERE

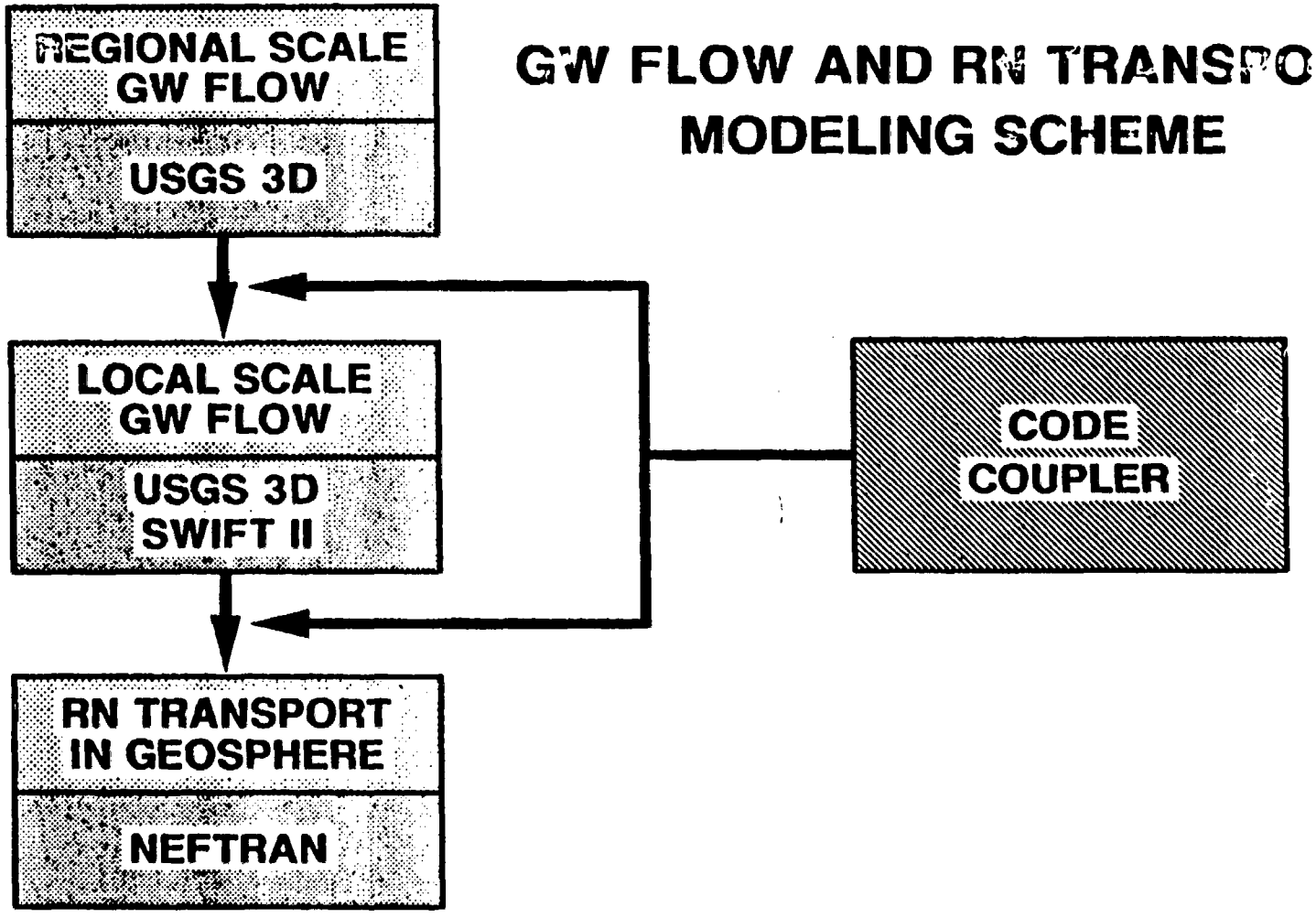
### SWIFT II

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

### NEFTRAN

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

# GW FLOW AND RN TRANSPORT MODELING SCHEME




86TA6000.20

# CONSEQUENCE MODELLING

## RADIONUCLIDE TRANSPORT IN BIOSPHERE

### PATH I

**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

# CONSEQUENCE MODELLING

## DOSE TO MAN AND HEALTH EFFECTS

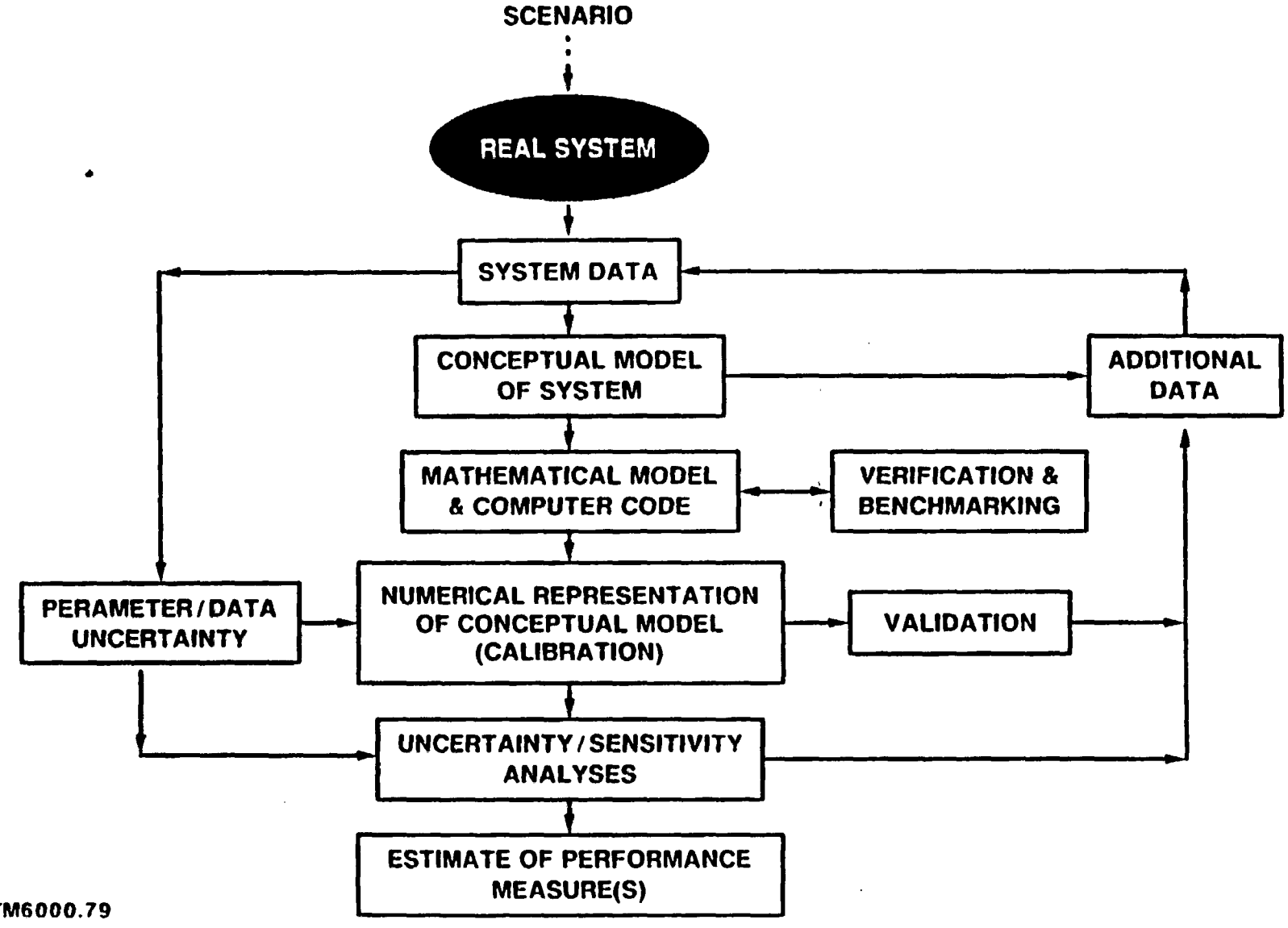
### DOSHEM

- 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

# UNCERTAINTY AND SENSITIVITY ANALYSES

## DEFINITIONS

- UNCERTAINTY ANALYSIS
  - AN ANALYSIS TO DETERMINE THE VARIATION OR IMPRECISION IN THE RESULTS OF A PERFORMANCE ASSESSMENT RESULTING FROM THE COLLECTIVE VARIATION IN THE COMPONENTS OF THE ASSESSMENT
- SENSITIVITY ANALYSIS
  - AN ANALYSIS TO DETERMINE THE MAIN CONTRIBUTORS TO THE VARIATION OR IMPRECISION IN THE RESULTS OF A PERFORMANCE ASSESSMENT


SCENARIO
REAL SYSTEM
SYSTEM DATA
CONCEPTUAL MODEL OF SYSTEM
ADDITIONAL DATA
MATHEMATICAL MODEL & COMPUTER CODE
VERIFICATION & BENCHMARKING
PERAMETER/DATA UNCERTAINTY
NUMERICAL REPRESENTATION OF CONCEPTUAL MODEL (CALIBRATION)
VALIDATION
UNCERTAINTY/SENSITIVITY ANALYSES
ESTIMATE OF PERFORMANCE MEASURE(S)

87TM6000.79

# USE OF METHODOLOGY IN REGULATORY PROCESSES

## NRC RULE (10CFR60)

- ASSESS IMPACT (ON EPA STANDARD) OF
  1) 300 - 1000 YEAR CONTAINMENT PERIOD
  2) $10^{-5}$ PARTS/YEAR RELEASE RATE
  3) 1000 YEAR GROUND-WATER TRAVEL TIME
- TECHNICAL SUPPORT IN DEVELOPMENT OF RATIONALE FOR
  1) DISTURBED ZONE
  2) GROUND-WATER TRAVEL TIME

## EPA STANDARD (40CFR191)

- ASSESS IMPORTANCE OF
  1) DECAY CHAINS
  2) LONGER REGULATORY PERIOD
  3) INDIVIDUAL EXPOSURES
- TEST IMPLEMENTATION OF STANDARD

86TA6000.21

# APPLICATIONS AND USES OF SNLA/NRC PERFORMANCE ASSESSMENT METHODOLOGY

## OVERALL METHODOLOGY

- HYPOTHETICAL BEDDED-SALT AND BASALT SITES (NUREG/CR-2452 AND NUREG/CR-4759)
- WIPP SITE (IN PROGRESS)

## MODELS/COMPUTER CODES

- GOVERNMENT AGENCIES AND NATIONAL LABORATORIES --- NRC, DOE, EPA, PNL, INEL
- UNIVERSITIES --- MIT, UA, NM TECH, U OF OKLAHOMA
- STATES --- MICHIGAN, ILLINOIS, MINNESOTA, VIRGINIA, NEW YORK
- PRIVATE INDUSTRY --- GOLDER, ADL, ROGERS ASSOC., WESTON, EBASCO, LATA, TASC, ACRES CORP., INTERA, GEOTRANS
- FOREIGN COUNTRIES --- GERMANY, JAPAN, KOREA, SWEDEN, UK, FINLAND

## SCENARIO DEVELOPMENT METHODOLOGY

- WIPP
- DOE SALT PROGRAM
- NEA/OECD
- SKI (PROJECT 90, SWEDISH NUCLEAR POWER INSPECTORATE)

# DISTRIBUTION OF LHS PROGRAM

## NATIONAL LABS AND GOV. AGENCIES

NRC
EPA - REGION X, SEATTLE
EPA - REGION VII, DENVER
EPA - CINCINNATI
NIH - ENVIR. MEAS. LAB
USDA - BOISE
ONWI - COLUMBUS
USGS - DENVER

SNL
ORNL
LANL
PNL
LLNL
BROOKHAVEN

US ARMY CONCEPTS ANALYSIS
DEFENSE LOGISTICS AGENCEY (DOD)
ST. OF CALIF., AIR RESOURCES BOARD
DOE AND CONTRACTORS - ROCKY FLATS
NESC - ARGONNE

[illegible] PROGRAM

[illegible]

FLORIDA INTERNATIONAL U.
LOUISIANA STATE [illegible]
[illegible]
NAVAL POSTGRADUATE SCHOOL
N.M. INST. OF MINING TECH.
TEXAS TECH
U.C. BERKELEY
[illegible]
U. OF GEORGIA
U. OF IDAHO
U. OF ILLINOIS
[illegible]

[illegible]

SCHENECTADY

GULF STATES UTILITIES - LOUISIANA

INTERA - AUSTIN

[redacted]

## FOREIGN GOV'T. AGENCIES

NAT. RAD. PROTECTION BOARD, ENGLAND
UNITED KINGDOM ATOMIC ENERGY AGENCY
FRENCH ATOMIC ENERGY COMMISSION
ISRAEL ATOMIC ENERGY COMMISSION

KERNFORSCHUNGSZENTRUM/KARLSRUHE, GERMANY
MINISTRY OF AGRICULTURE, ENGLAND
TECHNICAL RESEARCH CENTRE OF FINLAND
CATEDRA de TECHNOLOGIA NUCLEAR, SPAIN

[redacted]

AFRICAN DEVELOPMENT BANK
ALBERTA HOSPITAL - CANADA
CANTRO CONSULTANTS - CANADA
CENTRAL ELEC. GEN. BOARD - LONDON
DEPT. POWER AND ELEC. ENGR. - YU
NORWEGIAN TECHNICAL INSTITUTE
UNDP
CANADA - CANADA

# DISTRIBUTION OF LHS PROGRAM

## FOREIGN UNIVERSITIES

POLYTECH. OF THE SOUTH BANK - LONDON
U. OF CANTERBURY - NEW ZEALAND
U. OF IOANNINA -GREECE
U. OF GLASGOW - SCOTLAND

U. OF READING - ENGLAND
U. OF SASKATECHEWAN - CANADA
U. OF VESTERN AUSTRALIA
IMPERICAL COLLEGE - LONDON

# PERFORMANCE ISSUES PRE-CLOSURE

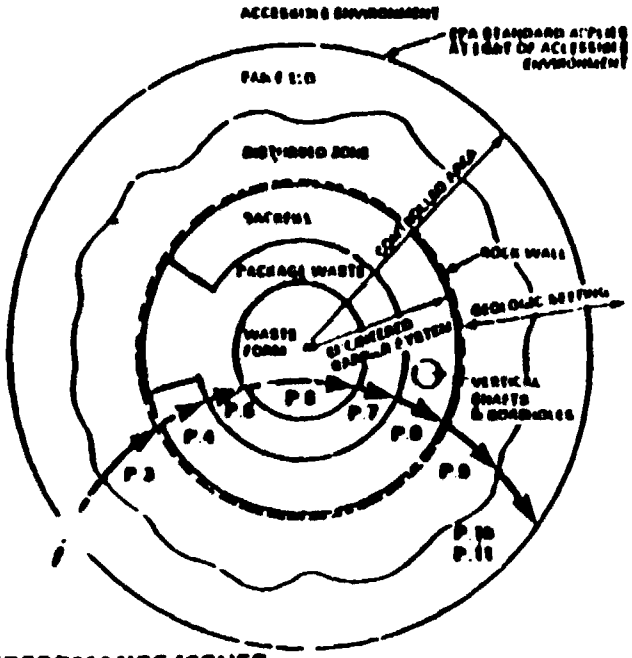
## Protection Against Radiation Exposures and Releases of Radionuclides

- Source Term
- Criticality
- Transport by Validation System
- Movement Through Environment
- Doses to Individuals

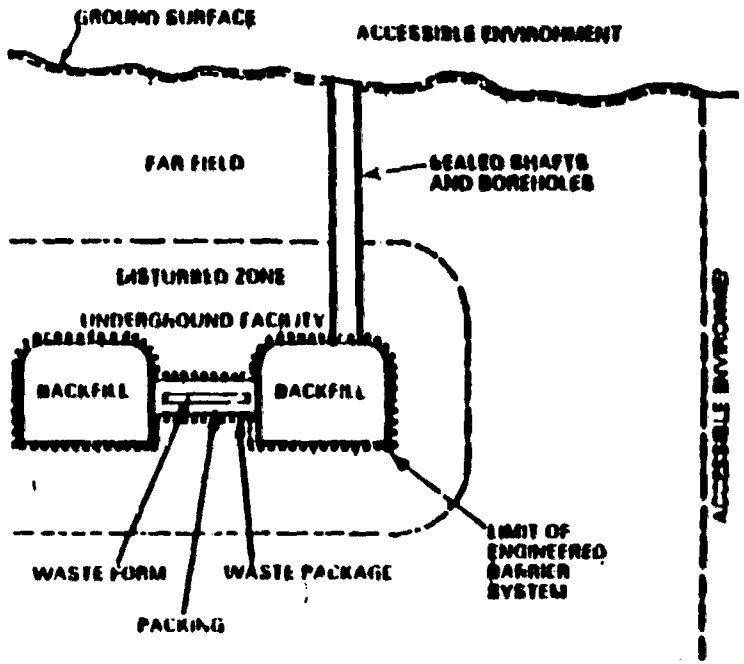
## Retrievability of Waste

- Structural Stability of Openings
- Non-degradation of Waste Packages
- Availability of Technology

## DIAGRAMMATIC PLAN VIEW (not to scale)




## DIAGRAMMATIC CROSS SECTION VIEW (not to scale)




## PERFORMANCE ISSUES

P.3 When and how does water contact the backfill?

P.4 When and how does water contact the waste package?

P.5 When and how does water contact the waste form?

P.6 When, how, and at what rate are radionuclides released from the waste form?

P.7 When, how, and at what rate are radionuclides released from the waste package?

P.8 When, how, and at what rate are radionuclides released from the backfill?

P.9 When, how, and at what rate are radionuclides released from the disturbed zone?

P.10 When, how, and at what rate are radionuclides released from the far field to the accessible environment?

P.11 What is the pre waste emplacement groundwater travel time along the fastest path of radionuclide travel from the disturbed zone to the accessible environment?

FIGURE 1 REPOSITORY SYSTEM ELEMENTS AND PERFORMANCE ISSUES RELATED TO LONG-TERM PERFORMANCE AFTER PERMANENT CLOSURE

# ORGANIZATION OF MODELING STRATEGY

- Identify Specific Performance Issues
- Describe Expected DOE Technical Analyses
- Describe Specific NRC Review Actions
- Describe Uncertainties which Might Affect NRC's Modeling Strategy

# NRC REVIEW ACTIONS

- Review of Data, Theory, and Approaches Used by DOE

- Perform Independent Analyses Using DOE or Third Party Codes

- Perform Independent Analyses Using Codes Developed for the NRC

NRC provides guidance to DOE on Performance Issues through Generic Technical Positions

# SNLA PARTICIPATION ON NRC REVIEW ACTIONS

- Participating in NRC Review Teams (e.g, BWIP Hydrologic Modeling and Geochemical Data)
- Review DOE Documents and Codes
- Development of Models/Codes for NRC Independent Analyses
- Performed Independent Analyses for NRC
- Assistance in Developing Generic Technical Positions
- Assistance in Developing SCP Review Guides

# SNLA PARTICIPATION IN DEVELOPMENT OF MODELS/CODES FOR NRC INDEPENDENT ANALYSES

- WHEN, HOW, AND AT WHAT RATE ARE RADIONUCLIDES RELEASEDFROM THE FAR-FIELD TO THE ACCESSIBLE ENVIRONMENT? (NEFTRAN, SWIFT).

- WHAT IS PRE-WASTE EMPLACEMENT GW TRAVEL TIME? (TOUGH, SWIFT).

- WHEN, AND HOW DOES WATER CONTACT BACKFILL & WASTE PACKAGE? (TOUGH CODE).

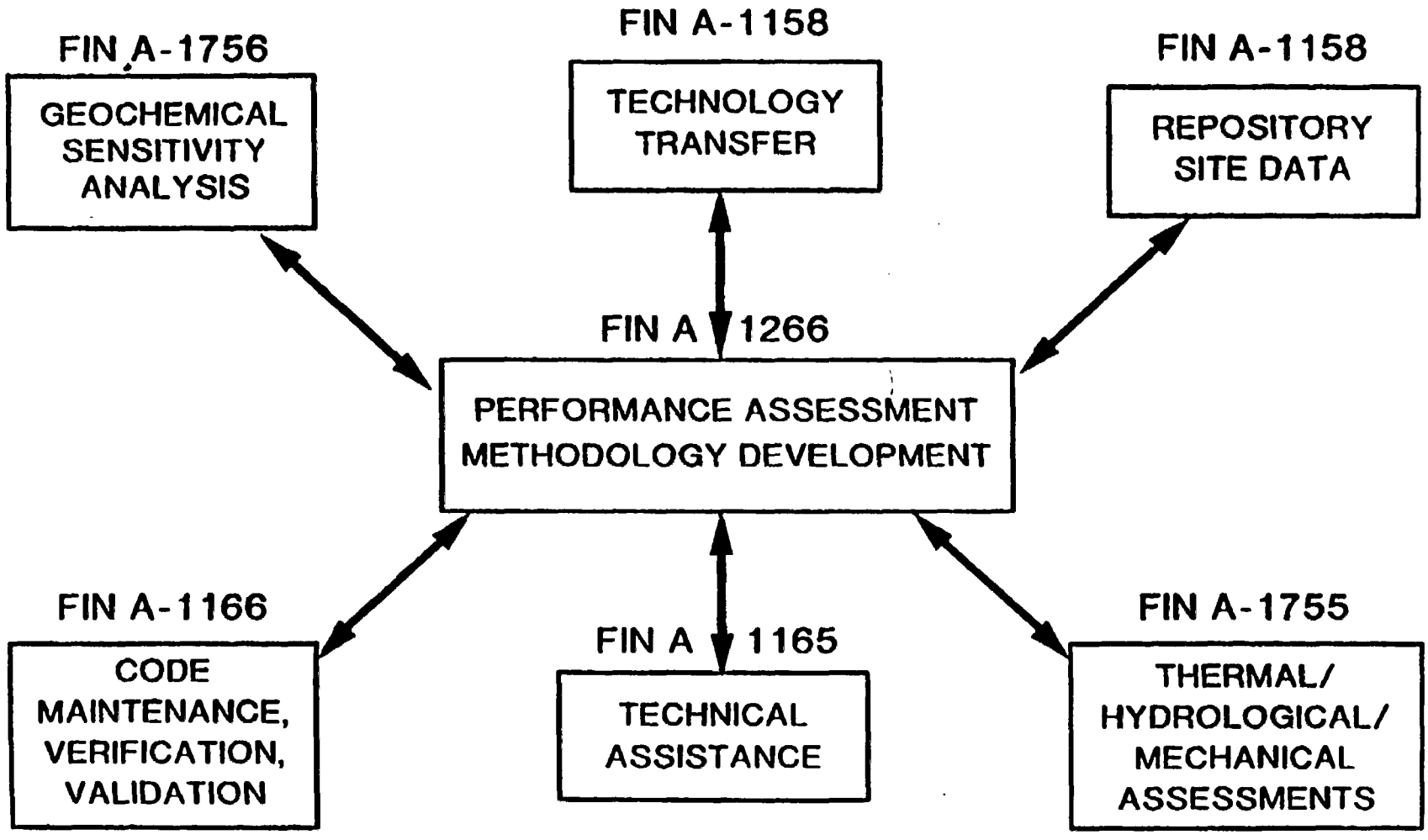
- WHEN, HOW, AND AT WHAT RATE ARE RADIONUCLIDES RELEASED FROM THE BACKFILL? (TOUGH, SWIFT).

- WHEN, HOW, AND AT WHAT RATE ARE RADIONUCLIDES RELEASED FROM THE DISTURBED ZONE? (TOUGH, SWIFT).

WORK BEING DONE UNDER FIN A1266

TK6000.36

# NRC/SNLA PROGRAMS



# HISTORY OF PERFORMANCE ASSESSMENT METHODOLOGY DEVELOPMENT PROGRAM

- 1976 FIN A1192 - METHODOLOGY DEVELOPMENT FOR WASTE ISOLATION IN BEDDED SALT
  - OBJECTIVES
    - DEVELOP TOOLS SND TECHNIQUES NEEDED TO ASSESS LICENSE APPLICATION FOR BEDDED-SALT REPOSITORY
    - DEMONSTRATE USE OF TOOLS AND TECHNIQUES
- 1981 BEDDED-SALT METHODOLOGY COMPLETED AND DEMONSTRATED ON HYPOTHETICAL SITE (NUREG/CR-2452)
- 1982 FIN A1266 - METHODOLOGY DEVELOPMENT FOR WASTE ISOLATION IN ALTERNATE MEDIA
  - OBJECTIVE
    - EXTEND BEDDED-SALT METHODOLOGY TO BASALT, TUFF, DOMED SALT AND GRANITE

86TA6000.17

# FIN A1192 - MAJOR PRODUCTS

- COMPUTER PROGRAMS
  - SWIFT
  - NWFT / DVM
  - DNET
  - PATH 1
  - DOSHEM
  - LHS
  - STEP
- TECHNIQUES
  - SCENARIO SELECTION / SCREENING
  - STATISTICAL SAMPLING
  - SENSITIVITY / UNCERTAINTY ANALYSIS
  - SCENARIO PROBABILITIES

86TA6000.18

also include the performing organization's views as to the completeness of the topics discussed and any recommendations for additional meetings.

## 5.0 NRC-FURNISHED MATERIAL

The NMSS PM will furnish four items:

(1) reports produced under other contracts, as required,

(2) other NRC contractor products, as required,

(3) names and telephone numbers of NRC staff within each technical discipline that the performing organization can contact in fulfilling the requirements of this SOW, and

(4) addresses for distribution of reports as specified in Section 3.5 of this SOW.

In addition, for work performed in fulfilling the requirements of this SOW, the performing organization is authorized to charge computer time on the INEL computer system to a NRC-provided charge number.

## 6.0 PERIOD OF PERFORMANCE

The period of performance covered by the work specified in this SOW shall begin on the effective date of this agreement and continue through September 30, 1989.

## 7.0 TECHNICAL DIRECTION

Daniel A. Galson (FTS 427-4623) is designated the NMSS Project Manager (PM) for the purpose of assuring that the services required under this SOW are delivered in accordance herewith. All technical instruction to the performing organization shall be issued through the NMSS PM. As used herein, technical instructions are those which provide details, suggest possible lines of inquiry, or otherwise complete the general scope of work set forth herein. Technical instructions shall not constitute new assignments of work or changes of such nature as to justify an adjustment in cost or period of performance. Direction for changes in cost or period of performance will be provided by the DOE Operations Office after receipt of an appropriate SCEW (NRC Form 173) from the Office of Nuclear Material Safety and Safeguards.

If the performing organization receives guidance from the NMSS PM, or others, which is believed to be invalid under the criteria cited above, the performing organization shall immediately notify the NMSS PM. If the NMSS PM and the performing organization are unable to resolve the question within 5 days, the performing organization shall notify the DOE Operations Office.

## 8.0 QUALITY ASSURANCE

For all draft and final technical reports delivered under this agreement, the performing organization shall assure that an independent review and verification of all numerical computations and mathematical equations and derivations are performed by qualified contractor personnel other than the original author(s) of the reports. If the performing organization proposes to verify or check less than 100 percent of all computations and mathematical equations and derivations in the reports (such as might be the case when there are a large number of routine, repetitive calculations), the performing organization must first obtain written approval from the NMSS PM. Computer-generated calculations will not require verification if the computer program has already been verified. The NMSS PM has the option of auditing all documentation, including project correspondence, drafts, calculations, and unrefined data.

In addition, all reports, including those which do not contain numerical analyses, must be reviewed by the performing organization's management and approved with two signatures, one of which should be at a management level above that of the program manager. When revisions to reports are issued, a section must be included in the revised report for documentation of dates of, reasons for, and scope of all changes made since issuance of the performing organization's first report. All reports shall be annotated to indicate that the review and verification have been accomplished prior to their submission to the NRC; this may be accomplished by the use of a cover letter accompanying the report.

The NRC has the option of appointing a Peer Review Group to review draft reports and to make changes to the final report. The performing organization may recommend candidates for the Peer Review Group for approval by the NMSS PM. If there is dissent on the content of the final report, the dissenting party shall have the option of stating its viewpoints and findings in a section of the report.

## 9.0 DISPOSAL OF PROPERTY

Prior to closeout or termination of this project, a reconciled report shall be developed by the DOE to record available equipment and material purchased with NRC funds. This report should be developed as soon as possible after project completion or a termination decision has been made, but not later than 60 days after the termination date. The report should be submitted to the NRC's Division of Facilities and Operations Support, ARM, and to the NMSS PM.

## 10.0 DOE-ACQUIRED MATERIAL

The performing organization must notify the NMSS PM and the Office of Nuclear Material Safety and Safeguards (Attn: Director, PMDA) prior to acquisition of any capital, ADP, or word-processing equipment.

## 11.0 ESTIMATED LEVEL OF EFFORT

The estimated level of effort for this SOW is about 6.0 staff-years in FY88 and about 3.0 staff-years in FY89. The level of effort for subsequent years is yet to be determined. The estimated level of effort for each task of this SOW is provided under the task descriptions (Section 2).

Enclosures:
(1) Microform Specifications
(2) Development, Distribution and Submittal Requirements for Machine-Readable Contract Deliverables

Enclosure 1

# MICROFORM SPECIFICATIONS FOR DIVISION OF HIGH-LEVEL WASTE MANAGEMENT CONTRACTS

Microfiche used for submittal purposes shall conform to the following specifications.

(1) Microfiche containing source documentation shall conform to the NMA Type 1 format (ANSI/NMA MS.5) consisting of 98 frames arranged in 7 rows and 14 columns.

(2) The reduction ratio shall be 24:1 for all microfiche.

(3) The microfiche shall be standard 148 x 105 mm.

(4) The microfiche shall be one silver-halide master and one diazo placed in individual acid-free envelopes.

(5) Diazo duplicates may be either blue-black or black.

(6) The microfiche shall be titled in the following manner:

FIN No. Title of Report Date
Contract No.
NUREG/CR No.
Fiche No.

Fiche number refers to pagination information, e.g., 1 of 2, 2 of 2, etc.

(7) Title information shall be eye readable on a clear background.

(8) The submittal of microfiche containing proprietary material shall be coordinated with the Records Services Branch, Division of Information Support Services, ARM, U.S. Nuclear Regulatory Commission, Washington, DC, 20555, to set format and procedures for submittal.

(9) Foldouts, if any, shall be segmented and filmed in logical order.

(10) The first frame shall be blank, and the second frame shall contain the resolution target (NBS 1010A).

(11) Questions on microfiche specifications should be submitted in writing to the Records Services Branch, Division of Information Support Services, ARM, U.S. Nuclear Regulatory Commission, Washington, DC, 20555.

# MODELING STRATEGY DOCUMENT FOR HLW PERFORMANCE

- NRC Strategy for use of numerical models and computer codes for evaluating performance of HLW repositories

- Establishes overall philosophy and approach for development , evaluation, and application of numerical models and computer ocdes by NRC

- Identifies areas where NRC plans to perform independent analyses, and describes nature of analyses

# PERFORMANCE OBJECTIVES

## NRC RULE (10CFR60)

PRE-CLOSURE SAFETY REQUIREMENTS
- LIMITS RADIATION EXPOSURE
- RETRIEVABILITY OPTION

WASTE PACKAGE CONTAINMENT REQUIREMENT
- CONTAINMENT FOR MINIMUM OF 300 YEARS

RELEASE RATE REQUIREMENT
- RELEASE RATE AT NO MORE THAN $10^{-5}$ PARTS PER YR

GROUND-WATER TRAVEL TIME REQUIREMENT
- GW TRAVEL TO BE AT LEAST 1000 YEARS

## EPA STANDARD (40CFR191)

CONTAINMENT REQUIREMENT
- LIMITS RN RELEASES OVER 10,000 YEARS

INDIVIDUAL PROTECTION REQUIREMENT
- LIMITS ANNUAL DOSE TO PUBLIC FOR 1000 YEARS

GROUND-WATER PROTECTION REQUIREMENT
- LIMITS CONCENTRATION IN GW FOR 1000 YEARS

Subtasks

2.2.1 The performing organization shall deliver a formal report describing in detail recommended techniques for implementation of the EPA's containment requirement (40 CFR 191.13, incorporated by reference into NRC regulation 10 CFR 60.112). The report shall describe the bases behind the recommended techniques, and discuss possible alternate methodologies where these can be identified. In particular, the report shall (1) provide an acceptable statistical basis for generation of a Complementary Cumulative Distribution Function (CCDF), and (2) clarify any nonstatistical concepts (e.g., unanticipated processes and events) necessary to show compliance with 40 CFR 191.13 and 10 CFR 60.112. The report shall also describe the overall role of performance assessments in assessing compliance with 40 CFR 191.13 and 10 CFR 60.112, and provide a framework for consideration of the work outlined in the following parts of this task. This report shall make use of and build upon earlier work carried out under this SOW in this area, including (1) NUREG/CR-3235, "Technical Assistance for Regulatory Development: Review and Evaluation of the Draft EPA Standard 40 CFR 191 for Disposal of High-Level Waste" and (2) NUREG/CR-4510, "Assessing Compliance with the EPA High-Level Waste Standard: an Overview" (both by SNL).

2.2.2 The performing organization shall deliver a formal report, preliminarily identifying and evaluating the main sources of uncertainty and the techniques for quantifying and reducing these uncertainties. If more than one defensible method exists for dealing with these uncertainties, all should be considered. The performing organization shall evaluate the adequacy of the methods, including an assessment of the strengths and weaknesses of each method and recommendations as to preferred methods for consideration of uncertainties in assessing compliance with 40 CFR 191.13 and 10 CFR 60.112. If techniques for dealing with these sources of uncertainties have not been identified, or if the performing organization maintains that these uncertainties cannot be quantified, the performing organization shall recommend how to consider the uncertainty in addressing the requirements of these regulations.

2.2.3 The performing organization shall deliver a formal report identifying areas where formal use of expert judgement is needed or recommended in dealing with uncertainty, compile available techniques for elicitation and use of expert judgement, categorize issues, and show by example how expert judgement can be used to address identified issues.

2.2.4 The performing organization shall deliver a formal report describing methodologies for analyzing model uncertainty. The formal report shall include the following:

(1) an identification of areas of uncertainty and a ranking of these areas in order of importance,

(2) a description and evaluation of procedures for analyzing these uncertainties,

(3) an identification of research needed to reduce these uncertainties, including consideration of the possible uses of expert systems, and

(4) development of approaches to building confidence in models, including consideration of approaches to validation of performance assessment models.

If it is deemed to be expedient by the NMSS PM, the last item may alternatively be addressed in a separate letter report.

2.2.5 The performing organization shall deliver a formal report describing in detail and discussing the basis behind a methodology that can be used for scenario development and screening. This work shall build upon the work identified in Task 3 and previous contractor work in this area (e.g., NUREG/CR-1667, "Risk Methodology for Geologic Disposal of Radioactive Waste: Scenario Selection Procedure", by SNL). The report shall include recommended guidelines for the use of expert judgement in scenario development and selection (see also subtask 2.3). A letter report shall be subsequently submitted that includes an analysis of the need for considering the time dependency of potentially disruptive events and processes in scenario analysis.

2.2.6 The performing organization shall deliver a formal report identifying the sources of data and parameter uncertainty, describing in detail methodologies for analyzing these uncertainties, and recommending research needed to reduce these uncertainties. This formal report shall be based on a series of letter reports, submitted separately and prior to the formal report, that cover three topics:

(1) the advantages, disadvantages and recommended uses of existing methodologies for analyzing data and parameter uncertainty,

(2) the procedures to be used to obtain from site characterization data the information required by these methodologies, and

(3) the use of expert judgement to estimate information needed to implement these methodologies (see also subtask 2.3).

2.2.7 The performing organization shall assist the NRC staff in the development of Technical Positions and other guidance to the DOE on matters related to assessing compliance with 40 CFR 191 and 10 CFR 60. Assistance will be performed as directed by the NMSS PM in writing. Technical Positions requiring development will be based primarily on products delivered under Tasks 2 and 3 of this SOW. Assistance will be required for approximately two Technical Positions per year.

## 2.3 Task 3: Identifying and Analyzing Quantitative Techniques for Assigning Probabilities of Occurrence to Potentially Disruptive Events and Processes

### Objectives

2.3.0 The objective of this task is to identify and analyze quantitative techniques for estimating probabilities of occurrence of potentially disruptive events and processes, including natural, repository-induced, and human-induced events and processes. Methods for estimating probabilities of occurrence of potentially disruptive events and processes

will be investigated not only for events and processes common to all sites (e.g., erosion), but also for events and processes particular to a specific site or medium (e.g., brine migration). Work done under this task shall be compatible with DHLWM's Technical Position on the classification of anticipated and unanticipated events and processes. The estimated level of effort for this task is about 0.8 staff-years in FY88 and 0.3 staff-years in FY89; product scheduling information is provided in Section 3.4 of this SOW.

Subtasks

2.3.1 The performing organization shall submit a formal report that consists of a literature review in which the quantitative techniques for estimating probabilities of occurrence of potentially disruptive events and processes are identified and evaluated. If more than one technique exists for an event or process, all should be considered. The evaluation should include an assessment of the strengths and weaknesses of each technique. If reviews of specific techniques have been published, these should be referenced and summarized. In addition, the sources of uncertainty associated with these events and processes should be identified.

2.3.2 The performing organization shall develop a second formal report that provides recommendations as to which probabilistic methodologies are applicable to specific events and processes under particular sets of conditions. If a technique for estimating the probability of occurrence for a particular event or process has not been identified, the performing organization shall describe what needs to be done to develop a technique. If the performing organization maintains that the probability of occurrence for a particular event or process cannot be quantified, the performing organization shall recommend how to consider the event or process in addressing the requirements of the EPA's containment requirement (40 CFR 191.13).

## 2.4 Task 4: Maintenance and Configuration Management of Performance Assessment Computer Codes

Objective

The objective of this task is to provide for a program of computer code maintenance and configuration management for codes developed for the NRC's HLW performance assessment program, so as to provide NRC access to a series of codes that can be used in making licensing decisions. Maintenance as used here includes (1) the discovery, investigation, and correction of code errors and deficiencies, (2) code improvements that will be of assistance to the NRC in its implementation of the codes, and (3) interaction with NRC staff in order to assist the NRC in using the codes. This task includes maintenance and configuration management of codes both at the performing organization and at a facility with which the NRC has an established time-sharing computer-usage agreement. All work performed under this task shall use the procedures provided in NUREG/CR-4369, "Quality Assurance (QA) Plan for Computer Software Supporting the U.S. Nuclear Regulatory Commission's High-Level Waste

Management Program" (by SNL), and shall meet the specifications provided in NUREG-0856, "Final Technical Position on Documentation of Computer Codes for High-Level Waste Management," as well as applicable specifications (see Enclosure 2) of the NRC's Office of Administration and Resources Management (ARM). The estimated level of effort for this task is about 0.5 staff-years in FY88 and 0.3 staff-years in FY89.

Subtasks

2.4.1 The performing organization shall maintain SWIFT, SWIFT II, NWFT/DVM, DNET, NEFTRAN, DOSHEM, LHS, STEPWISE REGRESSION, USGS 3D, TOUGH, and any other computer codes needed for the NRC's HLW performance assessment program, the maintenance of which is agreed to in writing by the performing organization and the NMSS PM. In accordance with the guidelines specified in this SOW, standardized versions of these codes shall be implemented, if necessary, and maintained on the performing organization's own computer system and on a second computer system at a facility with which the NRC has an established time-sharing computer-usage agreement. This second system shall be that of the Idaho National Engineering Laboratory (INEL), unless an alternative is specified in writing by the NMSS PM. Codes maintained at INEL shall be accessible to all NRC staff and contractors, and shall be in a format that allows users to execute, read, and copy codes, but that precludes alteration of maintained codes. The standardized version of each code maintained shall be identical, except for system-dependent coding, to the most recent version that was delivered to the NRC under a code development contract.

2.4.2 For each code maintained, the performing organization shall select and propose to the NMSS PM a set of standard problems that cover the range of important capabilities of the code. As new major capabilities of the codes are introduced, the performing organization shall propose to the NMSS PM new standard problems that exercise these capabilities. Upon approval of the NMSS PM, the performing organization shall run these standard problems as tests when new code versions are released or when major changes are made to existing versions. Input and output data shall be sent to the NRC on a medium specified by the NMSS PM.

2.4.3 Through interaction with NRC and other users, including those within the performing organization, and through a program of testing, the performing organization shall seek out errors and possible improvements in the codes. Upon concurrence of the NMSS PM, code changes shall be incorporated within the standardized versions of the respective codes maintained at the performing organization and at INEL. A listing of all changes made should be transmitted with the next monthly progress report.

2.4.4 The performing organization shall respond to the NMSS PM's requests and questions concerning suspected code errors or deficiencies, possible improvements, behavior of the codes, instructions for input, and system implementation. The performing organization's response to such requests and questions shall consist of code changes, clarified instructions for use, or an explanation of an approximate schedule for action being taken. Responses to the NMSS PM's requests and questions shall be provided in the next monthly progress report. The performing organization shall also keep the NMSS PM informed of any problems or deficiencies of which it becomes

aware, and shall inform the NMSS PM of any action being taken to correct these problems or deficiencies. If the performing organization makes code changes that affect the validity or completeness of existing documentation, those pages affected shall be revised and sent to the NMSS PM.

2.4.5 When major modifications are made to a code, including those made by other NRC contractors, or when updates become cumbersome, the performing organization shall release a new version of the code on a medium specified by the NMSS PM. The performing organization shall install the new version of the code on the INEL computer system in place of the previously maintained standard version. The performing organization shall rerun on the new version all standard problems approved under subtask 4.2. At the time the new version of a code is released, the performing organization shall submit a letter report that includes the new version number, a summary of changes made, and a description and analysis of any differences in the results of standard problems from previous versions of the code.

## 2.5 Task 5: Technical Assistance for SCP Review

### Objectives

The objectives of this task are threefold: (1) to develop internal staff guidance for review of the draft consultation SCP's and final SCP's in the performance assessment area, (2) to review selected parts of the draft and final SCP's, and (3) to review NRC staff comments on the draft and final SCP's in selected areas. Review guidance developed will be used by NRC technical staff in performing reviews in their technical areas and by the performing organization in its review of selected parts of the draft and final SCP's. Funding is being provided initially only for the first objective of this task, described in detail in subtask 5.1. At the time a draft or final SCP is received by the NRC, however, the performing organization will be requested to increase the resources devoted to this task by an amount to be specified by the NMSS PM. It is understood that this may result in delays on work in progress under other tasks within this SOW, requiring modifications to these tasks. Any modifications necessary will be negotiated by the NMSS PM and the performing organization at such time that additional work is requested under this task. The estimated level of effort for subtask 5.1 is about 0.3 staff-years in FY88; product scheduling information is provided in Section 3.4 of this SOW.

### Subtasks

2.5.1 The performing organization shall provide assistance, in the form of one or more letter reports, in developing generic technical guidance for review of the draft and final SCP's, as part of an overall SCP Review Plan being developed by the NRC. Assistance shall be provided in the following areas as they relate to performance assessment:

(1) generation of the CCDF needed to demonstrate compliance with the EPA's containment requirement (40 CFR 191.13, NRC regulation 10 CFR 60,

(2) scenario development and screening,

(3) assignment of probabilities to scenarios,

(4) modeling (including code management) and model uncertainty,

(5) data collection methodologies and data uncertainty,

(6) sensitivity analysis,

(7) the formal use of expert judgement,

(8) investigations relating to preclosure safety assessments (emphasis will be on long-lead time investigation and on accident analyses),

(9) performance allocation and issues resolution procedures and their application in the SCP's, and

(10) performance confirmation.

2.5.2 The performing organization shall review the draft and final SCP's in selected areas. These areas will be selected by the NMSS PM and may include, but are not limited to, any of the areas described in subtask 5.1.

2.5.3 The performing organization shall review NRC staff comments on the draft and final SCP's as requested by the NMSS PM.

2.5.4 The performing organization shall use specific codes as directed by the NMSS PM in support of the objectives of this task.

## 2.6 Task 6: Short-Term Technical Assistance

Objective

The objective of this task is to provide, on relatively short notice, general technical assistance on HLW matters relating to Tasks 1 through 5 that would not be provided in the normal course of work to complete the specific products outlined in these tasks. An important aspect of this task is to ensure that the performing organization is provided with resources to transfer HLW repository performance assessment skills and knowledge to the CNWRA. The estimated level of effort for this task is approximately 0.3 staff-years for both FY88 and FY89.

Subtasks

2.6.1 The performing organization shall, as directed by the NMSS PM, attend meetings with, provide codes and documents to, and assist in training of, CNWRA staff for work under any of the first five tasks of this SOW. In particular, it is anticipated that the Task 4 work will be transferred to the CNWRA early in FY89.

2.6.2 The performing organization shall evaluate NRC, NRC-contractor, DOE, DOE-contractor, EPA, and other major national and international

performance assessment programs, reports, and codes as to their technical quality, and applicability and usefulness to the NRC's performance assessment program. Approximately 8-10 reviews per year will be conducted, as requested by the NMSS PM, with recommendations from the performing organization.

## 3.0 REPORTING REQUIREMENTS

The types of reports required are (1) monthly letter status reports and (2) technical reports, as defined in NRC Manual Chapter 1102 and this SOW. Both technical letter and formal reports shall be submitted in draft for NRC review and comment prior to being issued. Directions for changes to reporting schedules will be provided by the DOE Operations Office after receipt of an appropriate SOEW (NRC Form 173) from the Office of Nuclear Material Safety and Safeguards (NMSS).

### 3.1 Monthly Letter Status Reports

By the 15th of each month, the performing organization shall submit five copies of a letter report that summarizes by task the following six items:

(1) performing organization and subcontractor work performed during the previous month, milestones reached, and findings and results important to the NRC's HLW program,

(2) subcontractor reports received that month, and abstracts and papers prepared by project personnel (with complete copies enclosed),

(3) meetings attended (listing personnel, costs for each individual, date, place, purpose and summary of meeting, and conclusions or agreements reached with other attendees),

(4) potential or actual contractual problem areas and their impacts (if the schedule has slipped or if the budget will be exceeded, this shall be stated and the reasons explained),

(5) the personnel time expenditures during the previous month with performing organization and subcontractor time expenditures listed separately, and

(6) costs for each task in SK, listed separately (a) during the previous month, (b) cumulative to date (fiscal year and total), and (c) projected by month for the current fiscal year. The first monthly report shall provide the initial projections, and subsequent reports shall indicate either revised projections or "no change in the cost and uncosted obligation projection."

### 3.2 Technical Letter Reports

3.2.1 Several technical letter reports for recording plans and results are required by this SOW. The format of these reports shall be as specified for interim contractor reports in paragraph 18 of the Terms and Conditions, NRC Manual Chapter 1102, and, with the exception of journal

publications and conference papers, shall be written in a manner consistent with NUREG-0650, "Technical Writing Style Guide."

3.2.2 All letter reports shall be delivered to the NMSS PM in draft for review and comment. The draft shall have been edited and reviewed by the performing organization and, with the possible exception of a few minor editing corrections, shall be ready to be issued as a final letter report if the NRC has no comment.

3.2.3 The NMSS PM will provide comments, if any, to the performing organization within 6 weeks of receipt of the draft letter reports. Such comments will be for the purpose of improving the readability and comprehension of the report only. The conclusions of the report are those of the performing organization only.

3.2.4 Copies of letter reports shall be delivered to the NMSS PM within 6 weeks following receipt of the NRC's comments. If the NRC's comments will result in a major revision of a report and the letter report cannot be delivered within the required time period, then, within 2 weeks following receipt of the NRC's comments, the performing organization shall notify the NMSS PM in writing, giving the date the report can be delivered. At the same time, the performing organization shall provide an estimate of any cost or schedule impacts that would result from this major revision. The NMSS PM may request that technical letter reports be resubmitted in draft for review and comment.

3.2.5 Copies of subcontractor quarterly reports shall be sent to the NRC with the monthly letter status reports. All other subcontractor reports, journal publications, and conference papers funded by this SOW shall be delivered to the NRC as letter reports. Final drafts of journal publications and conference papers shall be delivered to the NRC as draft letter reports. These reports, publications, and papers shall be delivered to the NMSS PM within 6 weeks of the performing organization's receipt of them.

3.2.6 In addition to the reports set forth above, the performing organization shall make an effort to divide each subtask into a number of areas, each of which will be reported upon individually at appropriate points during the period of performance and which will be incorporated by reference into the subtask report. In carrying out this provision, the performing organization shall strive to present the information developed in the studies over a period of time and in a manner that will hasten receipt by the NRC and facilitate its review. The NMSS PM shall be notified prior to doing work on any such additional reports.

3.3 Formal Technical Reports

3.3.1 Several formal technical reports are required by this SOW. The format of these reports shall be as specified for formal technical reports in the Terms and Conditions, paragraph 18, NRC Manual Chapter 1102, and shall be written in a manner consistent with NUREG-0650, "Technical Writing Style Guide."

3.3.2 All formal reports shall be delivered to the NMSS PM in draft for review and comment, following the same procedures outlined for technical letter reports in Sections 3.2.2 to 3.2.4 of this SOW.

3.3.3 The performing organization shall provide a camera-ready copy of final formal reports to the NRC's Policy and Publications Management Branch, Division of Publication Services (ARM/DPS), who will notify the NMSS PM and request the PM to prepare and sign NRC Form 426A.

3.3.4 The performing organization shall provide a master microfiche of each final formal technical report to the the NRC's Records Services Branch, Division of Information Support Services (ARM/DISS), and a duplicate fiche to the Docket Control Center (DCC), Division of High-Level Waste Management (NMSS/DHLWM), as specified in Section 3.5 of this SOW.

3.4 Schedule of Deliverables

| ITEM AND TOPIC | REPORT TYPE | DRAFT DUE DATE |
|---|---|---|
| Monthly Status Reports | Letter | 15th of the following month |
| Technical Progress Reports | Letter | A |
| Subtask 1.1<br>Interim report: compilation of parameters and components of an overall licensing assessment methodology and development of a tracking scheme. | Letter | ~~1/31/88~~ 3/30/88 |
| Subtask 1.1<br>Critical parameters and components for licensing assessment. | Formal | ~~1/31/88~~ 6/30/88 |
| Subtask 1.2<br>Compilation, comparison, and evaluation of computer codes for licensing assessment. | Formal | 1/31/89 |
| Subtask 1.3<br>Modeling efforts needed to support a HLW repository license application. | Letter | ~~3/31/88~~ 4/30/88 |
| Subtask 1.3<br>Processes for which validated models will not exist at the time of a HLW repository license application. | Letter | ~~4/30/88~~ 6/30/88 |
| Subtask 1.3<br>Recommended approaches for evaluating the application of HLW disposal system models. | Letter | ~~7/31/88~~ 8/31/88 |
| Subtask 1.3<br>Review of the NRC's Modeling Strategy Document for HLW Performance Assessment. | Letter | 10/31/88 |
| Subtask 1.3<br>A technical basis for NRC review of HLW repository modeling programs. | Formal | 12/31/88 |

Subtask 1.4 Letter A
Performance assessment program reviews.

Subtask 2.1 Formal ~~6/30/88~~ 9/30/88
Recommended techniques for assessing compliance with the EPA's HLW repository containment requirement (40 CFR 191.13).

Subtask 2.2 Formal ~~3/31/88~~ 5/31/88
Identification, evaluation, quantification, and reduction of uncertainty in HLW repository performance assessments: a preliminary report.

Subtask 2.3 Formal ~~7/31/88~~ 10/31/88
Elicitation and use of expert judgement in dealing with uncertainty in HLW repository performance assessments.

Subtask 2.4 Formal ~~9/30/88~~ 11/30/88
Methods for analyzing uncertainty in HLW repository performance assessment models.

Subtask 2.4 Letter 9/30/88
Approaches to building confidence in HLW repository performance assessment models.

Subtask 2.5 Formal ~~3/31/88~~ 6/30/88
A methodology for scenario development and screening.

Subtask 2.6 Letter 5/31/88
Recommended methodologies for the analysis of data and parameter uncertainty in HLW repository performance assessment.

Subtask 2.6 Letter 3/31/88
Recommended procedures for obtaining data and parameter uncertainty from site characterization data.

Subtask 2.6 Letter ~~3/31/89~~ 5/31/88
The use of expert judgement to estimate data and parameter uncertainty.

Subtask 2.6 Formal 6/30/89
Identification, analysis, quantification, and reduction of data and parameter uncertainty in HLW repository performance assessment.

Subtask 3.1 Formal ~~1/31/88~~ 3/31/88
Techniques for estimating probabilities of events and processes affecting the performance of geologic repositories: a literature review.

Subtask 3.2 Formal ~~9/30/88~~ 10/31/88
Recommended techniques for estimating probabilities of events and processes affecting the performance of geologic repositories: assessing compliance with the EPA's containment requirement (40 CFR 191.13).

Subtask 4.5 Letter A
Reports on performance assessment computer code maintenance and QA.

| | | |
|---|---|---|
| Subtask 5.1<br>Criteria for use in reviewing performance assessment plans presented in the SCP's. | Letter | A |
| Subtask 6.2<br>Reviews of non-NRC performance assessment programs. | Letter | A |
| Subcontractor Reports, Journal Publications, and Conference Papers not included in the preceding reports | Letter | per schedule in Section 3.2.5 |

A: As requested by the NMSS PM.

## 3.5 Report Distribution

The following summarizes the required report distribution under this agreement. The NMSS PM shall provide the performing organization with current NRC mailing addresses for this distribution.

| Distribution | Monthly Ltr Status Reports | Meetings Workshops & Trip Rpts | Tech Ltr Draft/Fin Reports | Draft/ Final Reports | Final Formal Rpt Fiche* |
|---|---|---|---|---|---|
| NMSS PM | 1 | 1 | 1 | 1 | 0 |
| Off. of the Director, NMSS (Attn: PMDA) | 1 | 0 | 0 | 0 | 0 |
| HLWM Division Director | 1 | 1 | 1 | 1 | 0 |
| Operations Branch Chief, NMSS/DHLWM | 1 | 1 | 1 | 1 | 0 |
| Docket Control Center, NMSS/DHLWM | 5 | 5 | 5 | 5 | 1** |
| Records Services Branch, ARM/DISS | 0 | 0 | 0 | 0 | 1*** |
| Policy and Publications Management Branch, ARM/DPS | 0 | 0 | 0 | 1**** | 0 |
| Waste Management Branch Chief, RES/DE/WMB | 3 | 3 | 3 | 3 | 0 |

*Refer to Enclosure 1, Microform Specifications
**Duplicate fiche
***Master fiche
****Camera-Ready Copy of Final Report

## 3.6 Submission of Documents to the NRC's Public Document Room

All NMSS technical HLW project documents will be transmitted to the NRC's Public Document Room (PDR) and to appropriate Local Public Document Rooms (LPDR's) by NMSS/DHLWM. All administrative documents, e.g., financial reports, should be submitted separately from technical reports.

Proprietary documents must be properly identified by the performing organization in accordance with 10 CFR Part 2.790, Availability of Official Records, and will not be submitted to the PDR's. All project documents transmitted to the NMSS PM shall be clearly identified by FIN number.

## 4.0 MEETINGS AND TRAVEL

### 4.1 Technical Review Meetings

In each fiscal year, the performing organization shall provide for not more than two 2-day meetings with NRC staff and selected contractors to discuss study progress and results, one to be held at the performing organization's offices and one to be held at NMSS offices in Maryland. Such meetings will be scheduled by the NMSS PM at a time and location that will be convenient to the participants involved, and the performing organization will receive 10 working days advance notice with a complete agenda for these meetings. When possible, the technical review meetings shall be held sequentially with the coordination meetings discussed in Section 4.2. These meetings may be concurrent with or sequential to the quarterly program reviews discussed in Section 4.3.

### 4.2 Coordination Meetings

If needed, the performing organization, the performing organization's principal contractors (one person from each), and the NMSS PM shall attend 1-day (minimum) quarterly meetings to discuss program directions and potential problems and to coordinate the overall study effort. Such meetings will be scheduled by the NMSS PM at a time and location that will be convenient to the participants involved, and the performing organization will receive 10 working days advance notice with a complete agenda for these meetings. These meetings may be concurrent with or sequential to the technical review meetings discussed in Section 4.1 or the quarterly program reviews discussed in Section 4.3.

### 4.3 Quarterly Program Reviews

In each fiscal year, the performing organization shall provide for four 1-day management-level reviews, two to be held at the performing organization's offices and two to be held at NMSS offices in Maryland. These meetings will be oriented toward executive-summary program reviews.

### 4.4 Travel

In each fiscal year, the NMSS PM will be notified prior to all travel performed under this SOW. All foreign travel requires approval per NRC Manual Chapter 1511. Requests for foreign travel, including NRC Forms 279 and 445, must be submitted to the NMSS PM at least 45 days in advance of any foreign travel. Each meeting attended in fulfillment of the requirements of this SOW shall be documented in a trip report to be submitted to the NMSS PM. The trip report shall indicate the meeting's relationship to this SOW, and summarize topics discussed and any conclusions reached on the basis of the meeting. The trip report shall

# SUBTASK 1.3B
# DUE DATE: 6/30/88
## LETTER REPORT

PROCESSES FOR WHICH VALIDATED MODELS WILL NOT EXIST AT THE TIME OF A HLW LICENSE APPLICATION

# SUBTASK 1.3C
# DUE DATE: 8/31/88
## LETTER REPORT

RECOMMENDED APPROACHES FOR EVALUATING
THE APPLICATION OF HLW DISPOSAL SYSTEM MODELS

# SUBTASK 1.3E
# DUE DATE: 12/31/88
## FORMAL REPORT

TECHNICAL BASIS FOR NRC REVIEW OF HLW
REPOSITORY MODELING PROGRAMS

# SUBTASK 2.1
# DUE DATE: 9/30/88
## FORMAL REPORT

RECOMMENDED TECHNIQUES FOR ASSESSING COMPLIANCE WITH THE EPA'S HLW REPOSITORY CONTAINMENT REQUIREMENT (40 CFR PART 191.13)

# SUBTASK 2.2
# DUE DATE: 5/31/88
## FORMAL REPORT

IDENTIFICATION, EVALUATION, QUANTIFICATION, AND REDUCTION OF UNCERTAINTY IN HLW REPOSITORY PERFORMANCE ASSESSMENTS: A PRELIMINARY REPORT

# SUBTASK 2.3
# DUE DATE: 10/31/88
## FORMAL REPORT

ELICITATION AND USE OF EXPERT JUDGMENT IN DEALING WITH UNCERTAINTY IN PERFORMANCE ASSESSMENT FOR HLW REPOSITORIES

# SUBTASK 2.4A
# DUE DATE: 11/30/88
## FORMAL REPORT

METHODS FOR ANALYZING UNCERTAINTY IN HLW
REPOSITORY PERFORMANCE ASSESSMENT MODELS

# SUBTASK 2.4B
# DUE DATE: 9/30/88
## LETTER REPORT

APPROACHES TO BUILDING CONFIDENCE IN HLW PERFORMANCE ASSESSMENT MODELS

# SUBTASK 2.5
# DUE DATE: 6/30/88
## FORMAL REPORT

RISK METHODOLOGY FOR GEOLOGIC DISPOSAL
OF RADIOACTIVE WASTE:
SCENARIO SELECTION PROCEDURE

# SUBTASK 2.6A
# DUE DATE: 5/31/88
## LETTER REPORT

METHODOLOGIES FOR ANALYZING
DATA AND PARAMETER UNCERTAINTY

# SUBTASK 2.6B
# DUE DATE: 5/31/88
# LETTER REPORT

## USE OF EXPERT JUDGMENT TO ESTIMATE DATA AND PARAMETER UNCERTAINTY

# SUBTASK 2.6C
# DUE DATE: 6/30/89
## FORMAL REPORT

IDENTIFICATION, EVALUATION, QUANTIFICATION, AND REDUCTION OF UNCERTAINTY IN HLW REPOSITORY PERFORMANCE ASSESSMENTS: FINAL REPORT

# SUBTASK 3.1
# DUE DATE: 3/31/88
## FORMAL REPORT

TECHNIQUES FOR DETERMINING PROBABILITIES OF EVENTS AND PROCESSES AFFECTING THE PERFORMANCE OF GEOLOGIC REPOSITORIES: VOLUME 1--LITERATURE REVIEW

# SUBTASK 3.2
# DUE DATE: 10/31/88
## FORMAL REPORT

TECHNIQUES FOR DETERMINING PROBABILITIES OF EVENTS AND PROCESSES AFFECTING THE PERFORMANCE OF GEOLOGIC REPOSITORIES: VOLUME 2--RECOMMENDED TECHNIQUES

STATEMENT OF WORK

for

TECHNICAL ASSISTANCE FOR PERFORMANCE ASSESSMENT

FIN: A-1165-8 B&R NO.: 50-19-03-01

## 1.0 BACKGROUND

Regulations of both the NRC (10 CFR 60) and the Environmental Protection Agency (40 CFR 191, with which the NRC is required to assess compliance) place limits on the release and transport of radionuclides from high-level waste (HLW) packages located in deep geologic repositories to the accessible environment. These releases can be predicted over the long term only by means of models. These models must be based upon a sound understanding of the physical, chemical, and biological phenomena involved, must reflect gains in knowledge resulting from site characterization programs, and must employ data that are as representative of actual in situ conditions as is practicable to obtain. Conversely, site characterization programs must be directly linked to the data needs of models and computer codes - with the proviso that site characterization must not adversely affect the waste isolation capability of the site. Thus, the development, evaluation, and application of conceptual, mathematical, and numerical models and associated computer codes form the basis of both the Department of Energy's (DOE's) and the NRC's repository performance assessment programs.

The purpose of this SOW is, through the evaluation and application of models and computer codes[1], to assist the NRC staff (1) in their review of the DOE's site characterization programs, (2) in providing guidance to the DOE during and prior to site characterization (the prelicensing phase), (3) in identifying any NRC research needed to investigate and model physical processes and, ultimately, (4) in reviewing the DOE's license application for a HLW repository. Previous work under this SOW has consisted primarily of the publication of several major reports, and the completion of numerous reviews, analyses, and summaries of documents that address discrete aspects of overall systems performance assessment. The two reports published under this SOW that have had the greatest impact on the NRC's mission are NUREG/CR-3235, "Technical Assistance for Regulatory Development: Review and Evaluation of the Draft EPA Standard 40 CFR 191 for Disposal of High-Level Waste" (Vols. 1-6), and NUREG/CR-4510, "Assessing Compliance with the EPA High-Level Waste Standard: an Overview" (both by Sandia National Laboratories). The former report affected the direction taken in developing the EPA's regulation 40 CFR 191, and, in turn, the development of the NRC's regulation, 10 CFR 60, whereas the latter report laid the guidelines for what will be involved in the NRC's assessment of compliance with 40 CFR 191 and 10 CFR 60. The current SOW has been substantially revised to close out completed work items and to improve its focus by adding requests for a number of specific technical products that will serve in part to ease the future transfer of performance assessment technical assistance contract work to the Center for Nuclear Waste and Regulatory Analyses (CNWRA) being established by the NRC.

[1]Note: The principal NRC research project addressing the development of performance assessment models and codes is FIN A-1266, "Development of a Methodology for Risk Assessment of Nuclear Waste Isolation in Alternative Geologic Media" (with Sandia National Laboratories).

## 2.0 WORK REQUIRED

### 2.1 Task 1: Providing Assistance to the NRC in the Evaluation and Implementation of a Licensing Assessment Methodology

Objective

2.1.0 The objective of this task is to provide technical assistance to the NRC in the evaluation and implementation of a licensing assessment methodology. Within the framework of this SOW, this entails ensuring that the individual technical components (or methodologies) of the NRC's overall systems performance assessment methodology are consistent, complete, and adequately integrated with regard to the overall methodology. In previous years, a large number of potential component parts have been evaluated under this task, with the performing organization providing recommendations for improvements in individual methodologies and identification of areas for which greater integration or further development are needed, and of generic issues (e.g., uncertainty, see Task 2, Section 2.2) that need to be addressed. The four subtasks described below require this previous work to be continued, but, more importantly, require parallel efforts in three related areas: (1) the compilation of all parameters and components of an overall performance assessment methodology for the purpose of tracking, and the identification of those parameters considered to be of crucial importance to the overall methodology, (2) a compilation, comparison and evaluation of the principal codes in each technical area of the overall methodology, and (3) the establishment of a technical basis for NRC staff review of the DOE's modeling efforts used to support a license application. Satisfactory completion of this task will require a working knowledge of all major current and past NRC, DOE and international programs. The estimated level of effort for this task is about 1.2 staff-years in FY88 and 0.6 staff-years in FY89; product scheduling information is provided in Section 3.4 of this SOW.

Subtasks

2.1.1 The performing organization shall deliver an interim subtask report in the form of a letter report that identifies all of the technical components of an overall systems assessment methodology, and all of the parameters that require consideration in each of these technical areas. This report shall also include a methodology for tracking the status (e.g., developmental areas, data needs, associated uncertainty) of codes and parameters. A final formal report shall subsequently be delivered that includes and builds upon the information in the interim report by identifying those components and parameters considered to be of most importance to the overall methodology, and providing the reasoning behind the given ranking of parameters. The arguments provided should be based in part on sensitivity analyses and verification and validation needs.

2.1.2 The performing organization shall deliver a formal report that compiles, compares, and evaluates the technical adequacy of the principal codes in each component area identified in subtask 1.1. The limitations and advantages of each code shall be described. The report shall include an analysis of the capabilities for sets of codes to be integrated into a

consistent, comprehensive systems performance assessment methodology. Finally, the performing organization shall include recommendations as to technical areas where developmental work is most urgently required.

2.1.3 The performing organization shall deliver a formal report that recommends a technical basis for NRC staff review of the DOE's modeling program. This report shall build upon the Division of High-Level Waste Management's (DHLWM's) draft "Modeling Strategy Document for HLW Performance Assessment", and shall recommend a modeling approach for the NRC staff that makes use of the information provided in subtasks 1.1 and 1.2. In providing the basis for the formal report required by this subtask, four letter reports shall be delivered that address the following subjects:

(1) identification of modeling efforts needed to support a license application,

(2) identification of processes for which validated models will not exist at the time of a license application,

(3) recommended approaches for evaluating the assumptions, data representativeness, and appropriateness of model application for models used by the DOE, and

(4) review of DHLWM's Modeling Strategy Document.

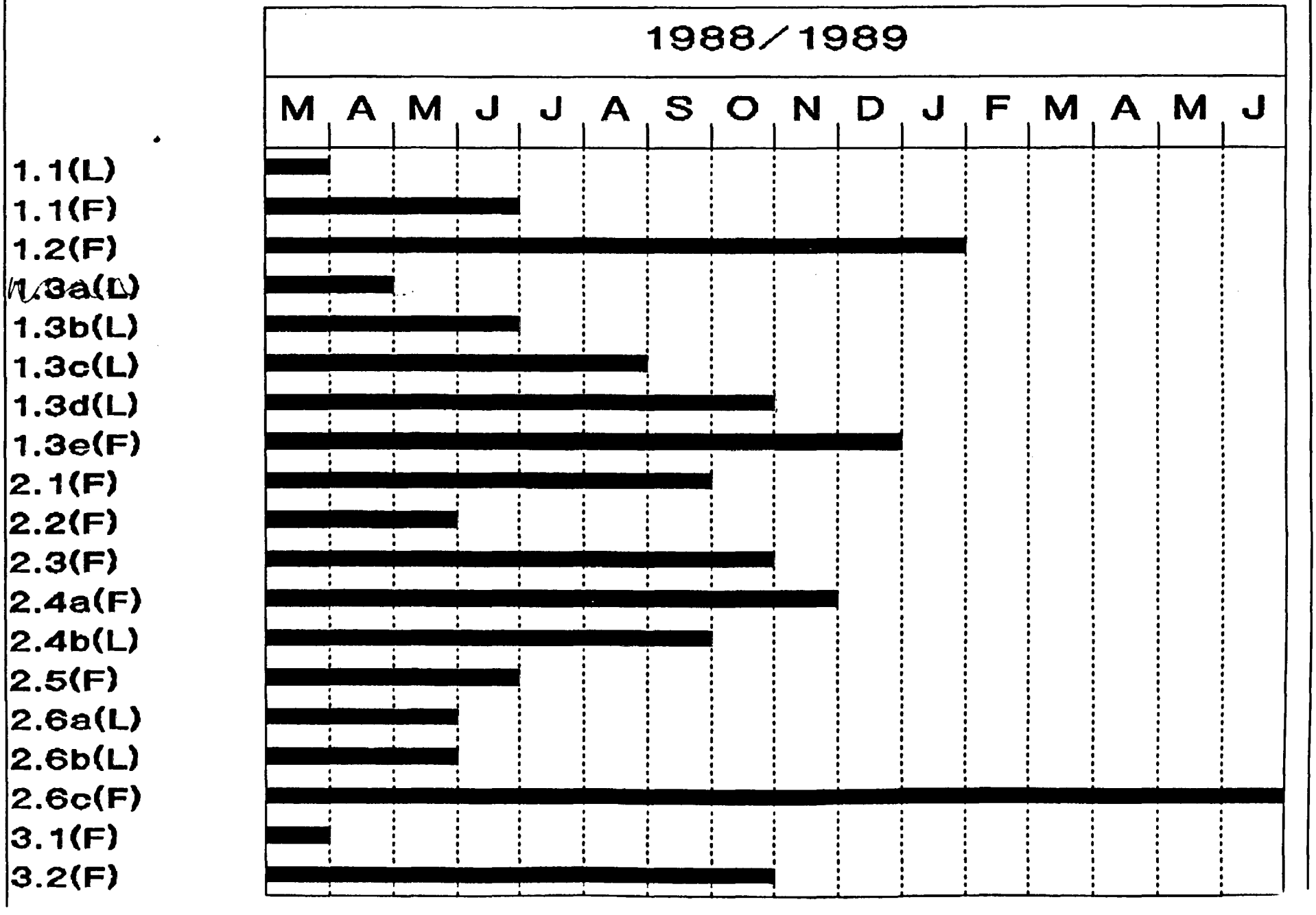
2.1.4 The performing organization shall evaluate, as directed by the NMSS PM, the adequacy of current and past NRC programs in fulfilling the requirements of a particular methodology. In conformance with the objectives outlined in Section 2.1.0, the performing organization shall assess the products contributing to the methodology and shall document any inconsistencies or omissions. The performing organization shall report these findings in a letter report, and shall include recommendations for improved integration of products.

## 2.2 Task 2: Identification and Analysis of Uncertainties Associated With HLW Repository Performance Assessments

### Objective

2.2.0 The objective of this task is to identify, analyze, and recommend generic methodologies for treating uncertainties associated with performance assessments of HLW repositories. Specifically, the main sources of uncertainty in systems performance assessments of HLW repositories are (1) scenario uncertainty, (2) modeling uncertainty, and (3) parameter and data uncertainty. Much of the work under this task shall need to build upon and make use of previous NRC staff and contractor products in this area. The NMSS PM will provide these products to the performing organization; several references to key work are, however, provided in the subtask descriptions below. The estimated level of effort for this task is about 2.9 staff-years in FY88 and 1.5 staff-years in FY89; product scheduling information is provided in Section 3.4 of this SOW.

# DUE DATES FOR A1165



**SUBTASK 1.1**

**DUE DATE: 6/30/88**

**FORMAL REPORT**

*COMPONENTS OF AN OVERALL LICENSING ASSESSMENT METHODOLOGY*

# SUBTASK 1.2
# DUE DATE: 1/31/89
## FORMAL REPORT

COMPILATION, COMPARISON, AND EVALUATION OF COMPUTER CODES USED IN LICENSING ASSESSMENT

3.0 COMPARISON OF CODES
- 3.1 Ground Water Flow
  - 3.1.1 Processes Simulated
  - 3.1.2 Applicable Media
  - 3.1.3 Numerical Method
  - 3.1.4 Available Documentation
  - 3.1.5 Current Implementation
- 3.2 Radionuclide Transport
  - 3.2.1 See 3.1 Above
- 3.3 Thermomechanical
  - 3.3.1 See 3.1 Above
- 3.4 Biosphere Transport and Dose Calculations
  - 3.4.1 See 3.1 Above
- 3.5 Waste Package
  - 3.5.1 See 3.1 Above
- 3.6 Inventory
  - 3.6.1 See 3.1 Above
- 3.7 Release Rates From EBS
  - 3.7.1 See 3.1 Above

4.0 EVALUATION OF CODES
- 4.1 Verification Tests
- 4.2 Benchmark Tests
- 4.3 Validation Tests
- 4.4 Efficiency
- 4.5 Other Evaluation Criteria

5.0 RECOMMENDED TECHNICAL AREAS WHERE DEVELOPMENTAL WORK IS REQUIRED

6.0 SUMMARY AND CONCLUSIONS

# SUBTASK 1.3A
# DUE DATE: 4/30/88
## LETTER REPORT

MODELLING EFFORTS NEEDED TO SUPPORT
A HLW REPOSITORY LICENSE APPLICATION