

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

**PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: ROLE OF PERFORMANCE ASSESS-
MENT IN PRIORITIZATION OF SITE
CHARACTERIZATION PROGRAM**

PRESENTER: DR. JEAN L. YOUNKER

**PRESENTER'S TITLE
AND ORGANIZATION:**

**SENIOR STAFF GEOLOGIST
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
TECHNICAL & MANAGEMENT SUPPORT SERVICES
CONTRACTOR FOR THE
YUCCA MOUNTAIN PROJECT OFFICE
U.S. DEPARTMENT OF ENERGY**

**PRESENTER'S
TELEPHONE NUMBER: (702) 794-7650**

MAY 16-17, 1989

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

**PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: ROLE OF PERFORMANCE ASSESS-
 MENT IN PRIORITIZATION OF SITE
 CHARACTERIZATION PROGRAM**

PRESENTER: DR. JEAN L. YOUNKER

**PRESENTER'S TITLE
AND ORGANIZATION:**

**SENIOR STAFF GEOLOGIST
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
TECHNICAL & MANAGEMENT SUPPORT SERVICES
CONTRACTOR FOR THE
YUCCA MOUNTAIN PROJECT OFFICE
U.S. DEPARTMENT OF ENERGY**

**PRESENTER'S
TELEPHONE NUMBER: (702) 794-7650**

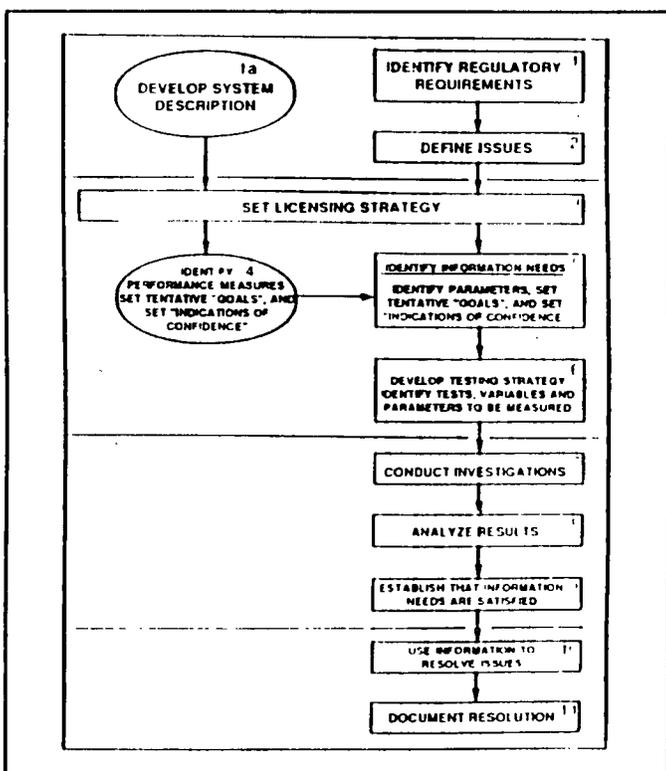
MAY 16-17, 1989

SCOPE OF PRESENTATION

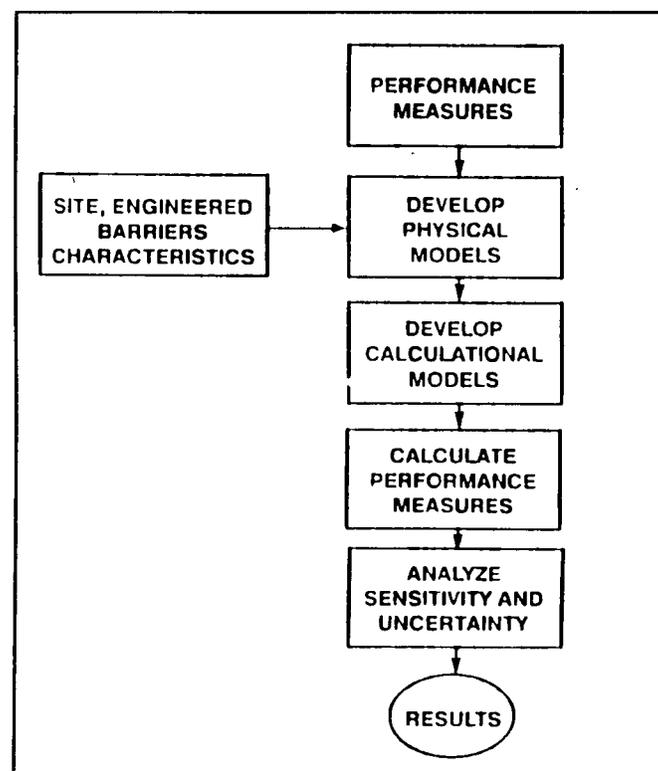
- **INTERFACE FROM PERFORMANCE ASSESSMENT TO THE SITE CHARACTERIZATION PROGRAM**
- **RELATION OF THE SITE PROGRAM TO ISSUE RESOLUTION STRATEGIES**
- **USE OF PERFORMANCE ALLOCATION TO GUIDE THE SITE TESTING PROGRAM**
- **EXAMPLES OF FLOWDOWN FROM PERFORMANCE MEASURES TO SITE STUDIES AND ACTIVITIES**

INTERFACE FROM PERFORMANCE ASSESSMENT TO SITE PROGRAM

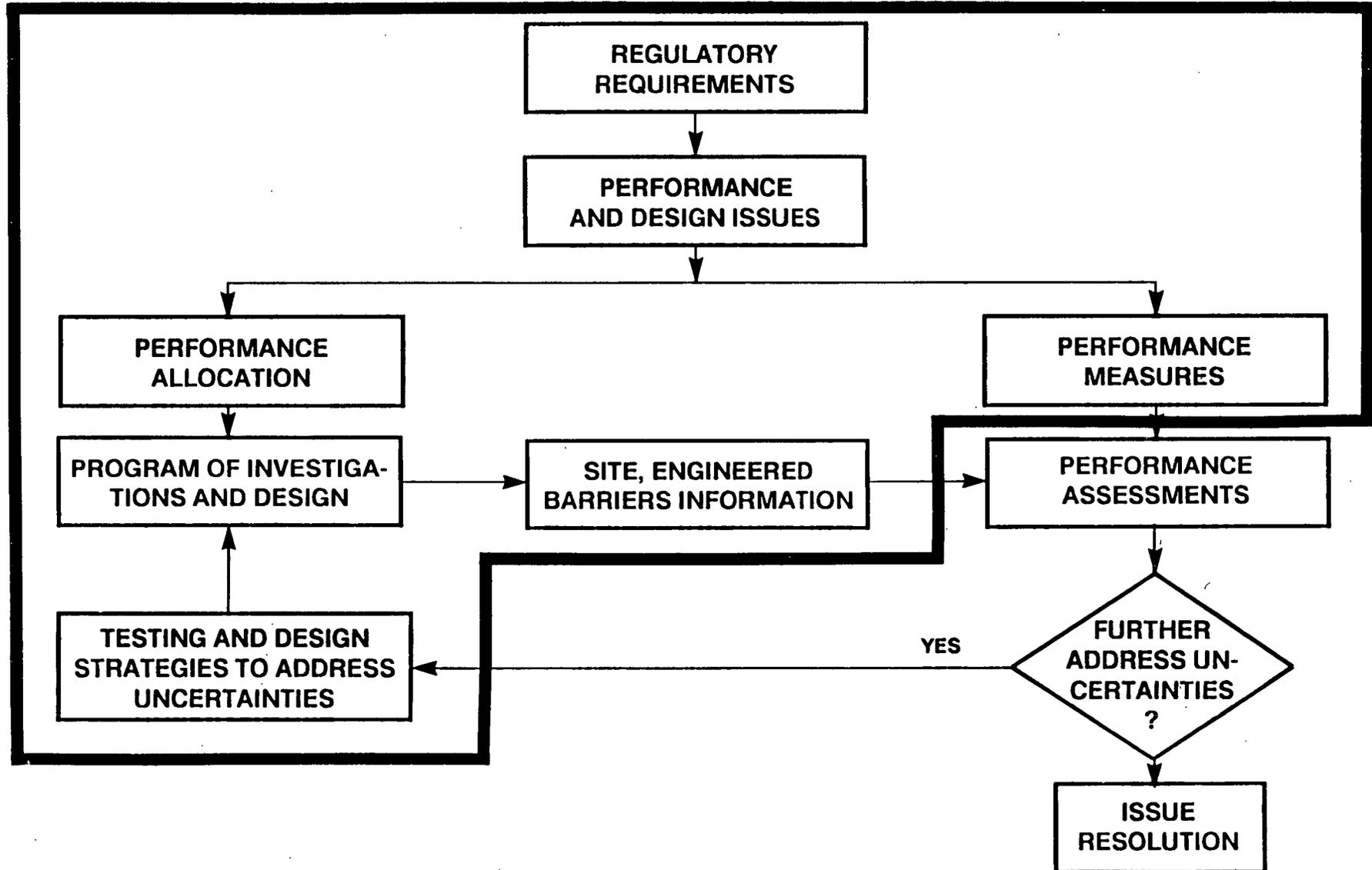
SITE CHARACTERIZATION PLAN STUDY PLANS



PERFORMANCE ASSESSMENT STRATEGY PLAN (PASP) IMPLEMENTATION PLAN (PAIP)

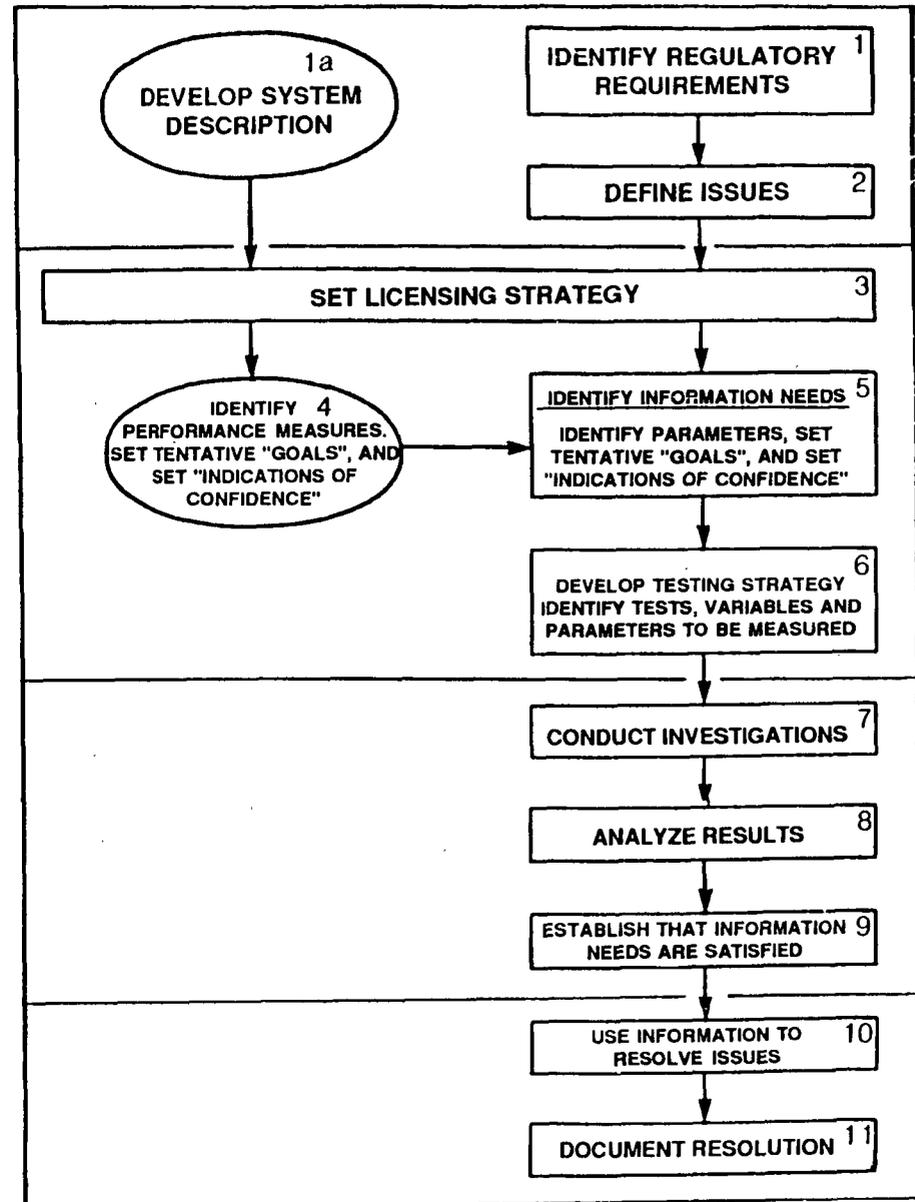


CONTENT OF SITE CHARACTERIZATION PLAN AND STUDY PLANS



ISSUE RESOLUTION STRATEGY

- ISSUE IDENTIFICATION
- PERFORMANCE ALLOCATION
- DATA COLLECTION AND ANALYSES
- ISSUE RESOLUTION



DOE ISSUES HIERARCHY

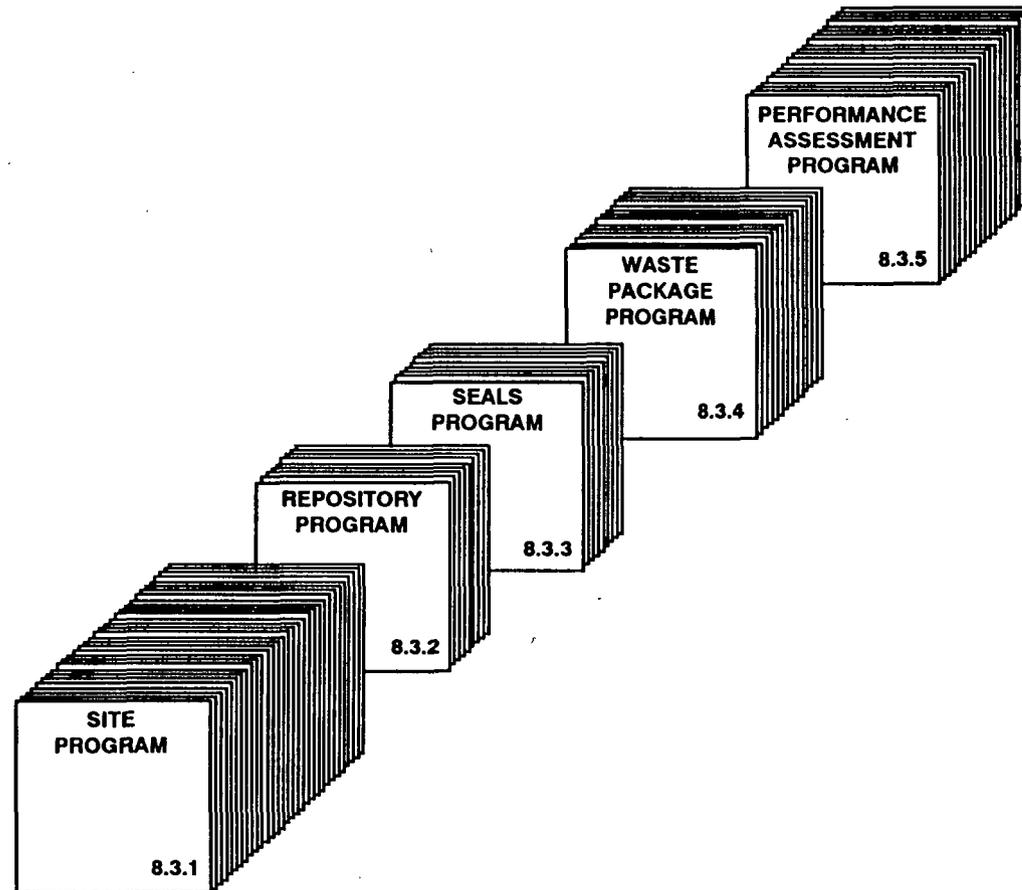
POSTCLOSURE PERFORMANCE ISSUES

- 1.1 CUMULATIVE RELEASE TO THE ACCESSIBLE ENVIRONMENT (40 CFR 191.13)
- 1.2 INDIVIDUAL PROTECTION (40 CFR 191.15)
- 1.3 GROUND-WATER PROTECTION (40 CFR 191.16)
- 1.4 CONTAINMENT BY WASTE PACKAGES (10 CFR 60.113)
- 1.5 RATE OF RELEASE FROM THE EBS (10 CFR 60.113)
- 1.6 GROUND WATER TRAVEL TIME (10 CFR 60.113)
- 1.7 SEALS SYSTEM PERFORMANCE
- 1.8 NRC SITING CRITERIA (10 CFR 60.122)
- 1.9 POSTCLOSURE SITING GUIDELINES (10 CFR 960.4)

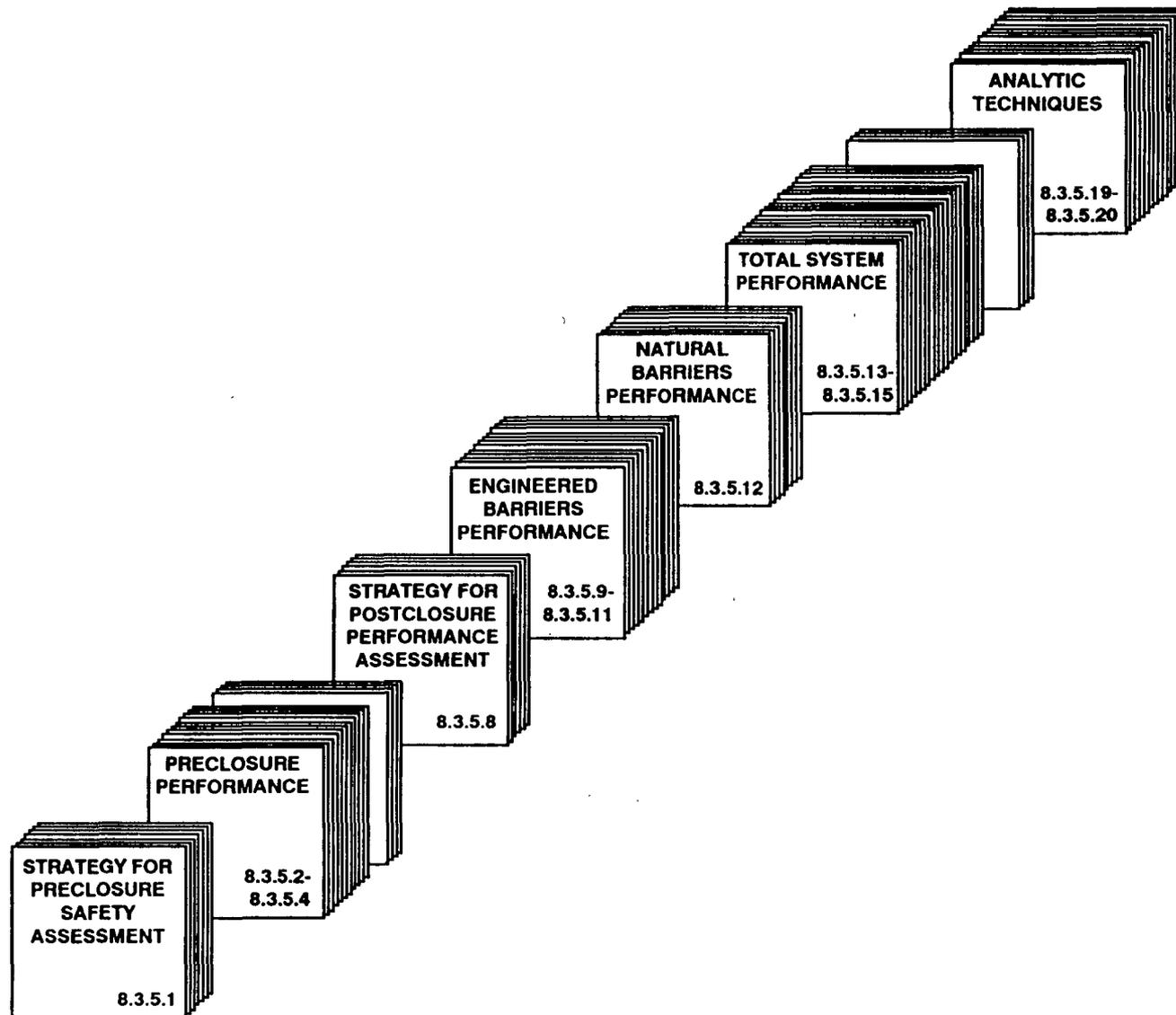
PRECLOSURE PERFORMANCE ISSUES

- 2.1 DOSE TO PUBLIC FROM ROUTINE OPERATIONS (10 CFR 60.111(a))
- 2.2 DOSE TO WORKERS FROM ROUTINE OPERATIONS (10 CFR 60.111(a))
- 2.3 DOSE TO PUBLIC FROM ACCIDENTS
- 2.4 RETRIEVABILITY (10 CFR 60.111(b))
- 2.5 PRECLOSURE SITING GUIDELINES (10 CFR 960.5)

SCP SECTION 8.3 STRUCTURE



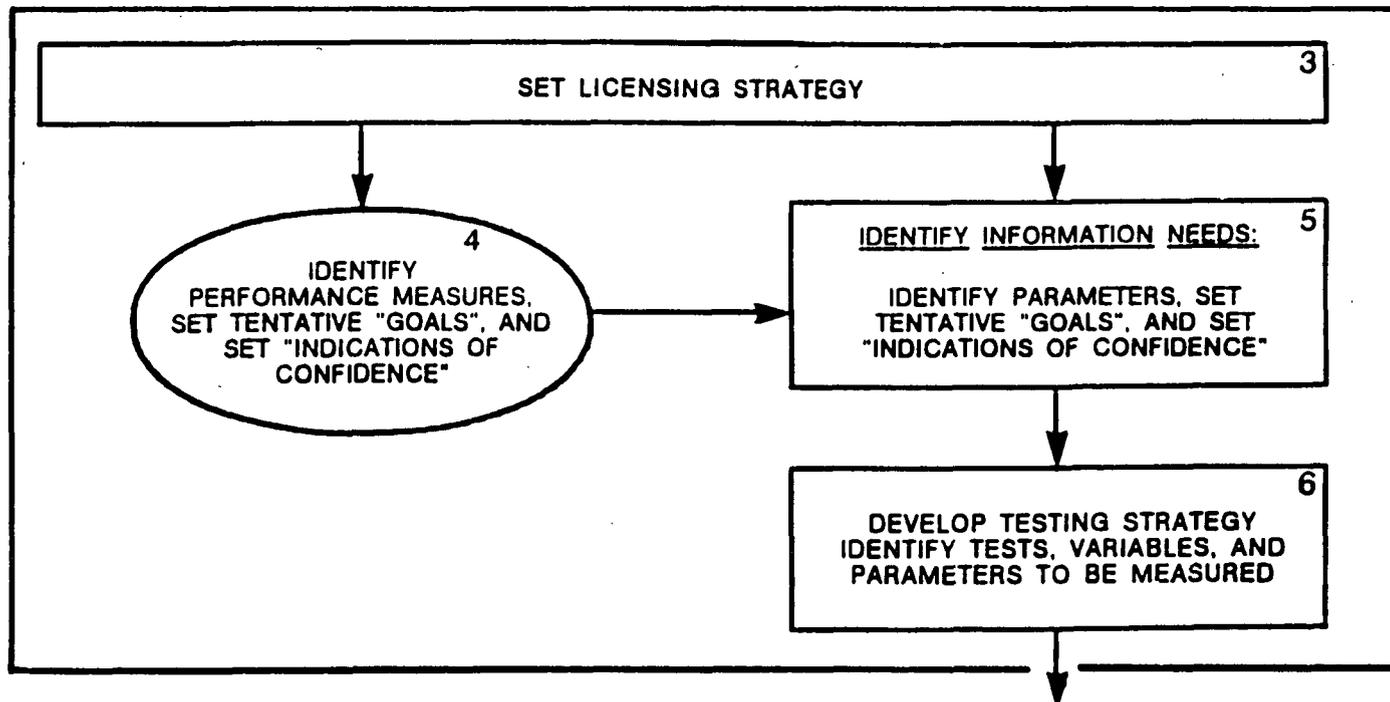
SCP PERFORMANCE ASSESSMENT PROGRAM STRUCTURE



ROAD MAP TO PERFORMANCE ISSUE RESOLUTION STRATEGIES IN THE SCP

TOTAL SYSTEM PERFORMANCE	SCP SECTION
1.1 CUMULATIVE RELEASE TO ACCESSIBLE ENVIRONMENT (CCDF)	8.3.5.13
1.2 INDIVIDUAL PROTECTION (INDIVIDUAL DOSE)	8.3.5.14
1.3 GROUND-WATER PROTECTION (CONCENTRATION)	8.3.5.15
ENGINEERED BARRIERS PERFORMANCE	
1.4 CONTAINMENT BY WASTE PACKAGES (CONTAINER LIFETIME)	8.3.5.9
1.5 RATE OF RELEASE FROM THE EBS	8.3.5.10
1.7 SEALS SYSTEM PERFORMANCE	8.3.5.11
NATURAL BARRIERS PERFORMANCE	
1.6 GROUND-WATER TRAVEL TIME	8.3.5.12
PRECLOSURE RADIOLOGICAL SAFETY	
2.1 DOSE TO PUBLIC FROM ROUTINE OPERATIONS	8.3.5.2
2.2 DOSE TO WORKERS FROM ROUTINE OPERATIONS	8.3.5.3
2.3 DOSE TO PUBLIC FROM ACCIDENTS	8.3.5.4

ISSUE RESOLUTION STRATEGY: PERFORMANCE ALLOCATION



ISSUE RESOLUTION STRATEGY

STEP 3

- **DEVELOP PRELIMINARY SITE DESCRIPTION INCLUDING RANGE OF CONCEPTUAL MODELS CONSISTENT WITH AVAILABLE DATA**
- **DEVELOP PRELIMINARY DESIGNS FOR REPOSITORY AND ENGINEERED BARRIERS**
- **DEFINE ELEMENTS OF NATURAL AND ENGINEERED SYSTEMS TO BE RELIED UPON IN MEETING REGULATORY REQUIREMENTS**

(E.G. - UNSATURATED ZONE ROCK UNITS; ZEOLITES ALONG FLOWPATHS; WASTE PACKAGE)

- **IDENTIFY PROCESSES RELATED TO THOSE ELEMENTS THAT MUST BE UNDERSTOOD TO PREDICT BEHAVIOR OF THE NATURAL AND ENGINEERED SYSTEMS**

(E.G. - UNSATURATED-ZONE FLUX AND FLOW MECHANISMS; THERMODYNAMIC STABILITY OF ZEOLITES; CORROSION MECHANISMS AND RATES)

PERFORMANCE MEASURES AND GOALS

STEP 4

- **PERFORMANCE MEASURES**

- USING PREVIOUS PERFORMANCE ASSESSMENTS AND SENSITIVITY STUDIES, DEFINE PARAMETERS (E.G. MEASURES) THAT DESCRIBE THE BEHAVIOR OF THE NATURAL OR ENGINEERED BARRIER SYSTEM OR SUBSYSTEMS

- **PERFORMANCE GOALS**

- VALUE OR LIMIT FOR A MEASURE OR PARAMETER DERIVED FROM PREVIOUS SENSITIVITY STUDIES OR PROFESSIONAL JUDGEMENT
- USED TO GUIDE AND FOCUS THE SITE TESTING PROGRAM
- COULD CHANGE WITH NEW SITE DATA AND FURTHER SENSITIVITY STUDIES

- **CURRENT/NEEDED CONFIDENCE**

- INDICATION OF THE IMPORTANCE OF REDUCING UNCERTAINTY IN PARAMETER OR MEASURE

STEP 5

IDENTIFY INFORMATION NEEDS

DETERMINE INFORMATION NEEDED TO CALCULATE PERFORMANCE MEASURES

- **HIERARCHY OF PARAMETERS NEEDED TO CALCULATE THE MEASURE**
- **SITE CONCEPTUAL MODELS**
- **PROCESS/MECHANISTIC MODELS**
- **CALCULATIONAL MODELS/CODES**

STEP 5

(CONTINUED)

USING AVAILABLE SITE DESCRIPTION, PERFORMANCE ASSESSMENT CALCULATIONS, AND SENSITIVITY STUDIES

- **DEFINE PARAMETERS NEEDED AT LEVEL OF DETAIL ADEQUATE TO INTERFACE WITH SITE TESTING PROGRAM**
- **DEVELOP GOALS AND ESTIMATES OF CURRENT/NEEDED CONFIDENCE FOR SITE PARAMETERS**

STEP 6

DEVELOP TESTING STRATEGY

- **COMPILE SET OF PARAMETERS REQUESTED**
- **DOCUMENT GOALS AND CURRENT/NEEDED CONFIDENCE**
- **CONSIDER CONSTRAINTS ON TESTING DUE TO POTENTIAL FOR IMPACTS ON SITE**
- **DEVELOP PLANS FOR LABORATORY AND FIELD STUDIES**

RESULTS OF PERFORMANCE ALLOCATION ARE PRESENTED IN TABLES IN THE SCP

SYSTEM ELEMENT	PERFORMANCE/ DESIGN MEASURE	TENTATIVE GOAL	NEEDED CONFIDENCE

PERFORMANCE/ DESIGN PARAMETER	TENTATIVE GOAL	NEEDED CONFIDENCE

CHARACTERIZATION PARAMETER	CURRENT ESTIMATE	CONFIDENCE IN CURRENT ESTIMATE	NEEDED CONFIDENCE

}

**PERFORMANCE
& DESIGN
SECTIONS
8.3.2-8.3.5**

}

**SITE PROGRAM
SECTION 8.3.1**

CRITERIA FOR PRIORITIZATION OF SITE PROGRAM RESULTING FROM PERFORMANCE ALLOCATION

- **THE NEEDED CONFIDENCE FOR PARAMETERS TO BE DETERMINED BY THE STUDY OR ACTIVITY IS HIGH**
- **THE STUDY OR ACTIVITY CHARACTERIZES A PRIMARY BARRIER**
- **THERE IS A SUBSTANTIAL DIFFERENCE BETWEEN THE CURRENT AND NEEDED CONFIDENCE FOR THE PARAMETER [I.E. CURRENT = LOW OR MEDIUM; NEEDED = HIGH]**
- **THERE IS A STRONG TIE BETWEEN THE PARAMETERS PROVIDED BY THE STUDY/ACTIVITY AND THE PERFORMANCE REQUIREMENTS**
- **THERE IS A STRONG TIE BETWEEN THE STUDY/ACTIVITY AND THE DESIGN REQUIREMENTS**

PERFORMANCE ALLOCATION EXAMPLES

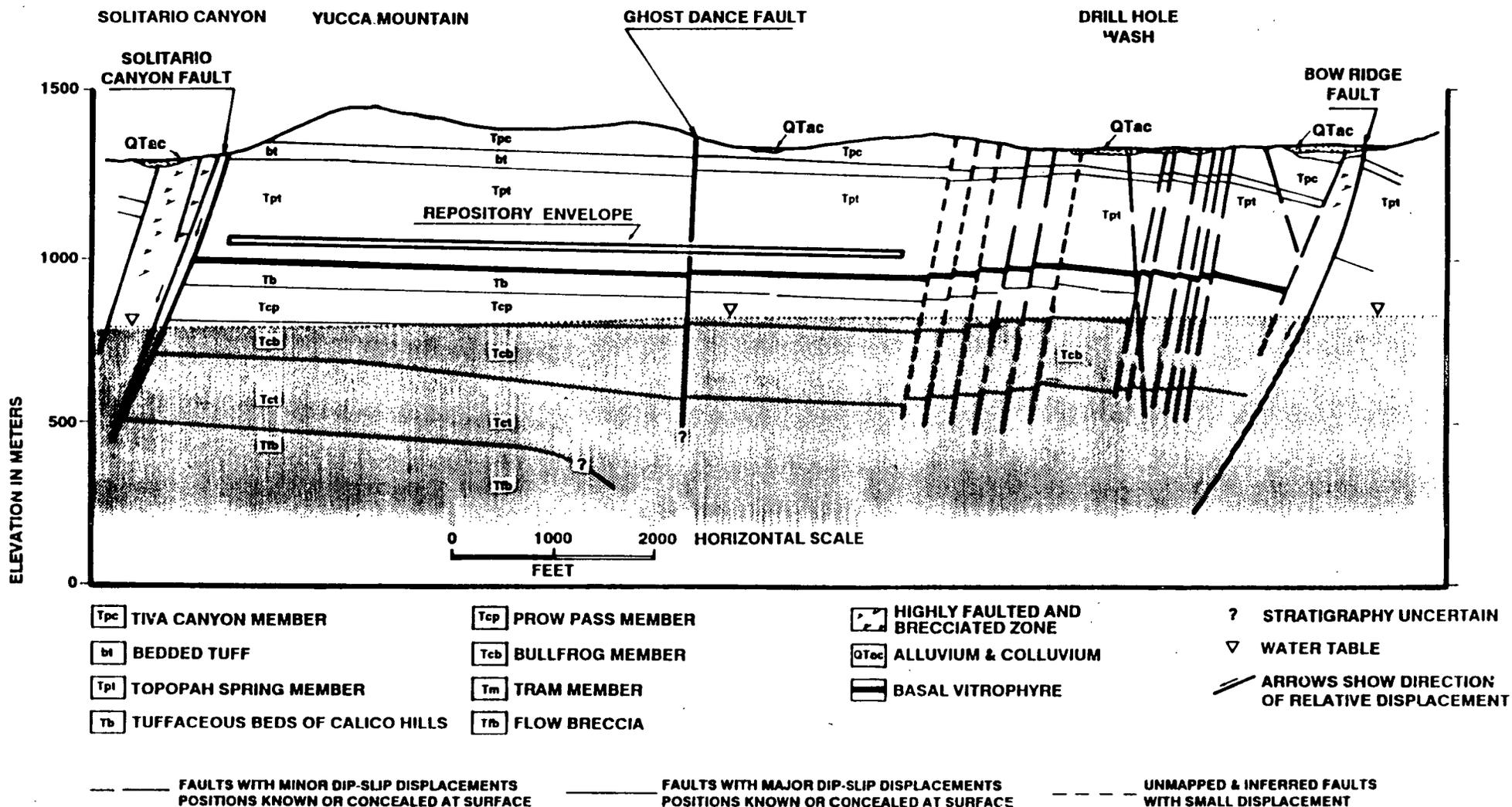
FLOWDOWN FROM PERFORMANCE REQUIREMENTS TO PLANS FOR SITE TESTING

**EXAMPLE 1: PRE-WASTE EMPLACEMENT GROUND-WATER
TRAVEL TIME/GEOHYDROLOGY PROGRAM**

**EXAMPLE 2: TOTAL SYSTEM PERFORMANCE/HUMAN
INTERFERENCE PROGRAM**

**EXAMPLE 3: TOTAL SYSTEM PERFORMANCE/POSTCLOSURE
TECTONICS PROGRAM**

EXAMPLE 1: GROUND-WATER TRAVEL TIME/GEOHYDROLOGY



LICENSING STRATEGY FOR GROUND-WATER TRAVEL TIME

- **HIGHEST PRIORITY ON CALICO HILLS UNIT
IN THE SATURATED ZONE**
- **LOWER PRIORITY ON OTHER UNITS IN
UNSATURATED ZONE**
- **LOWEST PRIORITY ON SATURATED ZONE**

EXAMPLE OF PERFORMANCE MEASURES FOR GROUND-WATER TRAVEL TIME

HYDROLOGIC COMPONENTS AVAILABLE	PERFORMANCE MEASURE	PERFORMANCE GOAL (YR)	NEEDED CONFIDENCE
TOPOPAH SPRING	GWTT	1,000	LOW
		10,000	VERY LOW
CALICO HILLS (VITRIC)	GWTT	1,000	HIGH
		10,000	LOW
CALICO HILLS (ZEOLITIC)	GWTT	1,000	HIGH
		10,000	LOW

EXAMPLE OF PERFORMANCE PARAMETERS FOR GROUND-WATER TRAVEL TIME

HYDROGEO- LOGIC UNIT	PERFORMANCE PARAMETER	ESTIMATED RANGE	TENTATIVE GOAL	NEEDED CONFIDENCE
TOPOPAH SPRING	q	<0.5 mm/yr	<0.5 mm/yr	LOW
	q/K _s	0.005 to 50	<0.85	LOW
	n _s	0.01 to 0.2	>0.05	LOW
	d	0 to 56 m	10 m (100%)	LOW
CALICO HILLS (VITRIC)	q	<0.5 mm/yr	<0.5 mm/yr	HIGH
	q/K _s	0.00005 to 5	<0.95	HIGH
	n _s	0.15 to 0.45	>0.2	HIGH
	d	0 to 160 m	>2.5 m (100%) >25 m (80%)	HIGH MEDIUM
CALICO HILLS (ZEOLITIC)	q	<0.5 mm/yr	<0.5 mm/yr	HIGH
	q/K _s	0.005 to 50	<0.9	HIGH
	n _s	0.2 to 0.4	>0.2	HIGH
	d	0 to 140 m	>2.5 m (100%) >25 m (80%)	HIGH MEDIUM

PARAMETERS PROVIDED BY THE UNSATURATED ZONE GEOHYDROLOGY PROGRAM

CALLS BY PERFORMANCE AND DESIGN ISSUES		PARAMETER CATEGORY	RESPONSE BY GEOHYDROLOGY CHARACTERIZATION PROGRAM	
<u>ISSUE</u>	<u>SCP SECTION</u>		<u>ACTIVITY PARAMETER</u>	<u>SCP ACTIVITY</u>
1.1, 1.5, 1.6, 1.12	8.3.5.13, 8.3.5.10, 8.3.5.12, 8.3.3.2	FLUID FLUX	FLUX, LIQUID AND GASEOUS PHASE GHOST DANCE FAULT ZONE	8.3.1.2.2.6.1
			FLUX, VOLUMETRIC, THROUGH FRACTURE/MATRIX NETWORKS	8.3.1.2.2.4.2
			FLUX, VOLUMETRIC, THROUGH THE TOPOPAH SPRINGWELDED UNIT	8.3.1.2.2.4.3
1.1, 1.4, 1.6, 4.4, 1.8, 1.9 1.5, 4.2	8.3.5.13 8.3.5.9, 8.3.5.12, 8.3.2.5, 8.3.5.17, 8.3.5.18, 8.3.5.10, 8.3.2.4	SYNTHESIS CHARACTER- ISTICS	FLOW PATHS, MOISTURE IN UNSATURATED ZONE	8.3.1.2.2.10.2
			GROUND-WATER TRAVEL TIME, FRACTURE/MATRIX ZONE	8.3.1.2.2.4.2
			MOISTURE FLUXES, FLOW PATHS, AND TRAVEL TIMES WITHIN THE UNSATURATED ZONE	8.3.1.2.2.10.1

PARAMETER TRACKED INTO APPROPRIATE STUDY

**8.3.1.2.2.4 STUDY: CHARACTERIZATION OF YUCCA
MOUNTAIN PERCOLATION IN THE
UNSATURATED ZONE--EXPLORATORY
SHAFT FACILITY STUDY**

8.3.1.2.2.4.1 ACTIVITY: INTACT FRACTURE TEST IN THE ESF

8.3.1.2.2.4.2 ACTIVITY: INFILTRATION TESTS IN THE ESF

ACTIVITY PARAMETER

SCP ACTIVITY

**FLUX, VOLUMETRIC THROUGH
FRACTURE/MATRIX NETWORKS**

8.3.1.2.2.4.2

⋮

EXAMPLE 2: TOTAL SYSTEM PERFORMANCE/ HUMAN INTERFERENCE PROGRAM

TOTAL SYSTEM PERFORMANCE MEASURE	INITIATING EVENT	PERFORMANCE PARAMETERS	TENTATIVE PARAMETER GOAL	CURRENT & NEEDED CONFIDENCE
EPPM	EXPLORATORY DRILLING INTERCEPTS A WASTE PACKAGE AND BRINGS UP WASTE WITH CORE OR CUTTINGS	PRESENCE AND READABILITY OF C-AREA MARKERS OVER 10,000 YR	> 50% CHANCE THAT MARKERS ARE READABLE OVER NEXT 10,000 YR	LOW/MEDIUM
		EXPECTED DRILLING RATE (NO. OF BORE-HOLES/km ² /YR) IN R-AREA OVER THE NEXT 10,000 YR	EXPECTED DRILLING RATE $\leq 3 \times 10^{-4}$ BOREHOLES/km ² /YR	LOW/LOW
		DISTRIBUTION OF DIAMETERS AND DEPTHS OF EXPLORATORY DRILLING	NO GOAL	LOW/LOW

EXAMPLE 2: TOTAL SYSTEM PERFORMANCE/HUMAN INTERFERENCE PROGRAM

CONTINUED

PERFORMANCE PARAMETERS	TENTATIVE GOAL	SITE PARAMETERS TO BE PROVIDED	STUDY OR ACTIVITY
PRESENCE AND READABILITY OF C-AREA MARKERS OVER 10,000 YR	> 50% CHANCE THAT MARKERS ARE READABLE OVER NEXT 10,000 YR	RATES OF EROSION, WEATHERING, DEPOSITION, IGNEOUS ACTIVITY, SEISMIC ACTIVITY AT MARKER LOCATIONS	LONG-TERM PROCESSES THAT COULD AFFECT MARKER STABILITY(8.3.1.9.1.1)
EXPECTED DRILLING RATE (NO. OF BOREHOLES/km ² /YR) IN R-AREA OVER THE NEXT 10,000 YR	EXPECTED DRILLING RATE $\leq 3 \times 10^{-4}$ BOREHOLES/km ² /YR RESOURCES	QUANTITIES, TONNAGES, AND GRADES OF KNOWN OR INFERRED	NATURAL RESOURCE ASSESSMENT OF YUCCA MOUNTAIN, NYE COUNTY, NV (8.3.1.9.2.1)
DISTRIBUTION OF DIAMETERS AND DEPTHS OF EXPLORATORY DRILLING	NO GOAL	TYPES OF KNOWN OR INFERRED RESOURCES AT YUCCA MOUNTAIN	VALUE OF RESOURCES (8.3.1.9.2) EFFECTS OF HUMAN INTERFERENCE (8.3.1.9.3)

EXAMPLE 3: TOTAL SYSTEM PERFORMANCE/ POSTCLOSURE TECTONICS PROGRAM

TOTAL SYSTEM PERFORMANCE MEASURE	INITIATING EVENT	PERFORMANCE PARAMETERS	TENTATIVE PARAMETER GOAL	CURRENT & NEEDED CONFIDENCE
EPPM	VOLCANIC ERUP- TION PENETRATES REPOSITORY/CAUSES DIRECT RELEASE	ANNUAL PROBAB- ILITY VOLCANIC ERUPTION THAT PENETRATES THE REPOSITORY	$< 10^{-6}/\text{YR}$	LOW/HIGH
		EFFECTS OF VOL- CANIC ERUPTION PENETRATING REPOSITORY, INCLUDING AREA OF REPOSITORY DISRUPTED	SHOW $< 0.1\%$ OF REPOSITORY AREA IS DISRUPTED WITH CONDI- TIONAL PROB- ABILITY OF $< 0.1\%$ OF BEING EXCEEDED IN 10,000 YR	LOW/MEDIUM

EXAMPLE 3: TOTAL SYSTEM PERFORMANCE/ POSTCLOSURE TECTONICS PROGRAM

PERFORMANCE PARAMETERS	TENTATIVE GOAL	SITE PARAMETERS TO BE PROVIDED	STUDY OR ACTIVITY
ANNUAL PROBABILITY VOLCANIC ERUPTION THAT PENETRATES THE REPOSITORY	$< 10^{-6}/\text{YR}$	LOCATION AND TIMING OF VOLCANIC EVENTS	VOLCANISM DRILL-HOLES (8.3.1.8.5.1.1)
			GEOCHRONOLOGY (8.3.1.8.5.1.2)
			GEOCHEM. SCORIA SEQUENCES (8.3.1.8.5.1.4)
		EVALUATION OF STRUCTURAL CONTROLS ON VOLCANISM	LOCATION/TIMING VOLCANIC EVENTS (8.3.1.8.1.1.1)
			GEOCHEMICAL CYCLES IN BASALT FIELDS (8.3.1.8.5.1.5)
		PRESENCE OF MAGMA BODIES IN VICINITY OF SITE	SUBSURF. GEOMETRY QUATERNARY FAULTS (8.3.1.17.4.7)
			EVALUATION OF DEPTH OF CURIE TEMP. ISOTH. (8.3.1.8.5.2.1)
	HEAT FLOW (8.3.1.8.5.2.3)		

SUMMARY

- **STRATEGIES FOR MEETING THE PERFORMANCE AND DESIGN REQUIREMENTS WERE DEVELOPED AND USED AS A GUIDE FOR THE SITE CHARACTERIZATION PROGRAM**
- **AS PART OF IMPLEMENTING THE STRATEGIES, PERFORMANCE ALLOCATION WAS USED TO DETERMINE THE PERFORMANCE MEASURES, GOALS AND CONFIDENCE NEEDED FOR EACH REQUIREMENT**
- **EXPANSION OF THE PERFORMANCE MEASURES INTO A HIERARCHY OF PARAMETERS ALLOWED A LINK TO BE ESTABLISHED WITH THE SITE PARAMETERS NEEDED FOR PERFORMANCE ASSESSMENT CALCULATIONS**