

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

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

**SUBJECT: DERIVING SITE-SPECIFIC
PERFORMANCE AND DESIGN
REQUIREMENTS FROM
10 CFR PART 60**

PRESENTER: DR. MICHAEL D. VOEGELE

**PRESENTER'S TITLE
AND ORGANIZATION: TECHNICAL DIRECTOR
SCIENCE APPLICATIONS INTERNATIONAL CORP.
LAS VEGAS, NEVADA**

PRESENTER'S

MARCH 19-20, 1990

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DERIVING SITE-SPECIFIC PERFORMANCE AND DESIGN REQUIREMENTS FROM 10 CFR PART 60

- **PERFORMANCE OBJECTIVES**
- **ADDITIONAL REPOSITORY DESIGN CRITERIA**
- **SEALING DESIGN CRITERIA**
- **WASTE PACKAGE DESIGN CRITERIA**
- **PERFORMANCE CONFIRMATION CRITERIA**

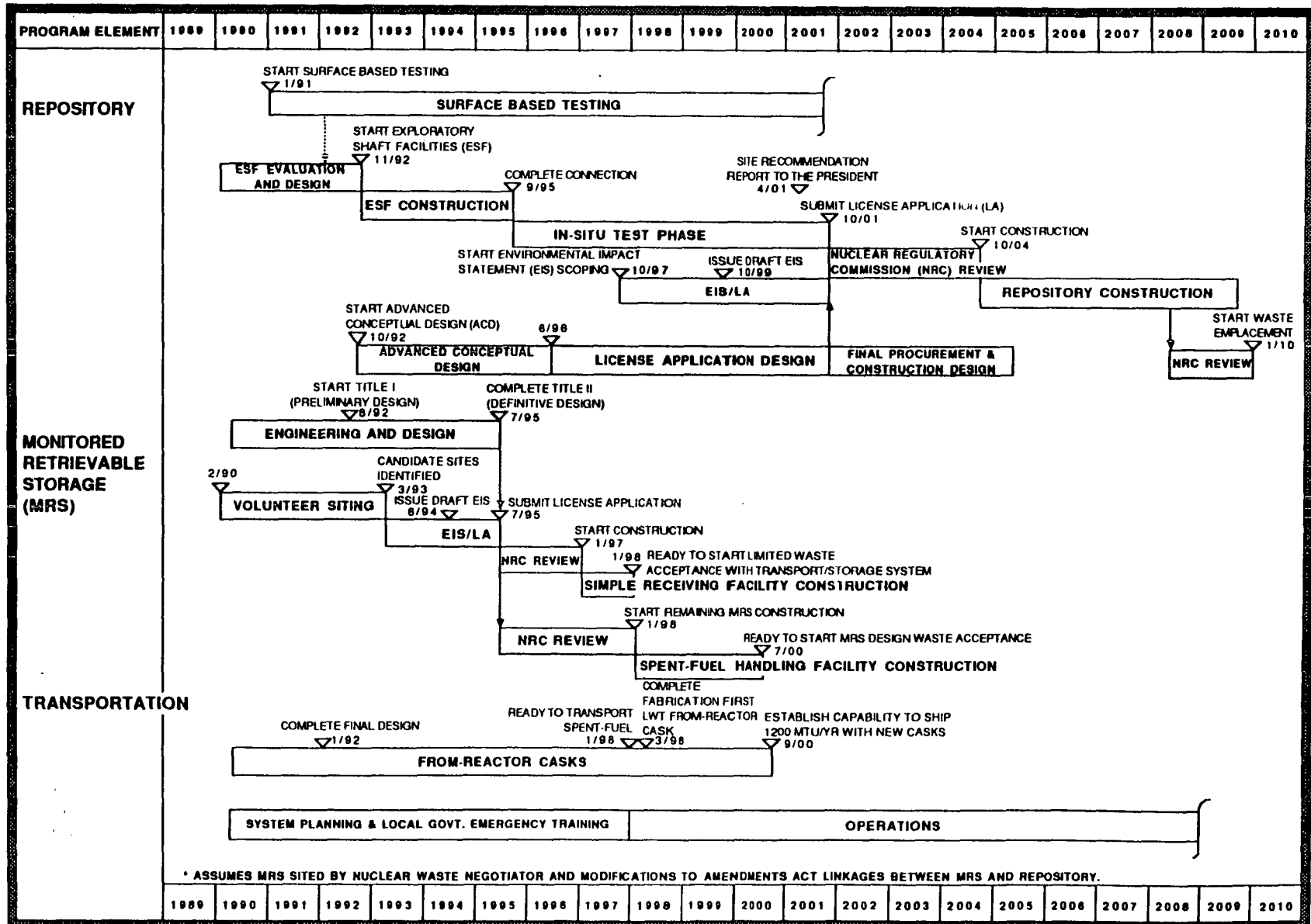
OVERVIEW OF PRESENTATION

- **STAGES IN LICENSING PROCESS**
- **PROCESS FOR TRANSLATING REQUIREMENTS INTO DATA NEEDED FROM SITE CHARACTERIZATION**
- **PART 60 TECHNICAL CRITERIA AND SITE SPECIFIC INTERPRETATION**
- **SUMMARY OF TECHNICAL CRITERIA AND INTERRELATIONSHIPS**
- **EXAMPLE OF SPECIFIC CRITERIA IN DESIGN DOCUMENTS**

10 CFR PART 60 STAGES IN THE LICENSING PROCESS

- **SITE CHARACTERIZATION STAGE**
- **CONSTRUCTION STAGE**
- **PERIOD OF OPERATIONS**
- **PERMANENT CLOSURE**

REFERENCE SCHEDULE FOR RESTRUCTURED PROGRAM

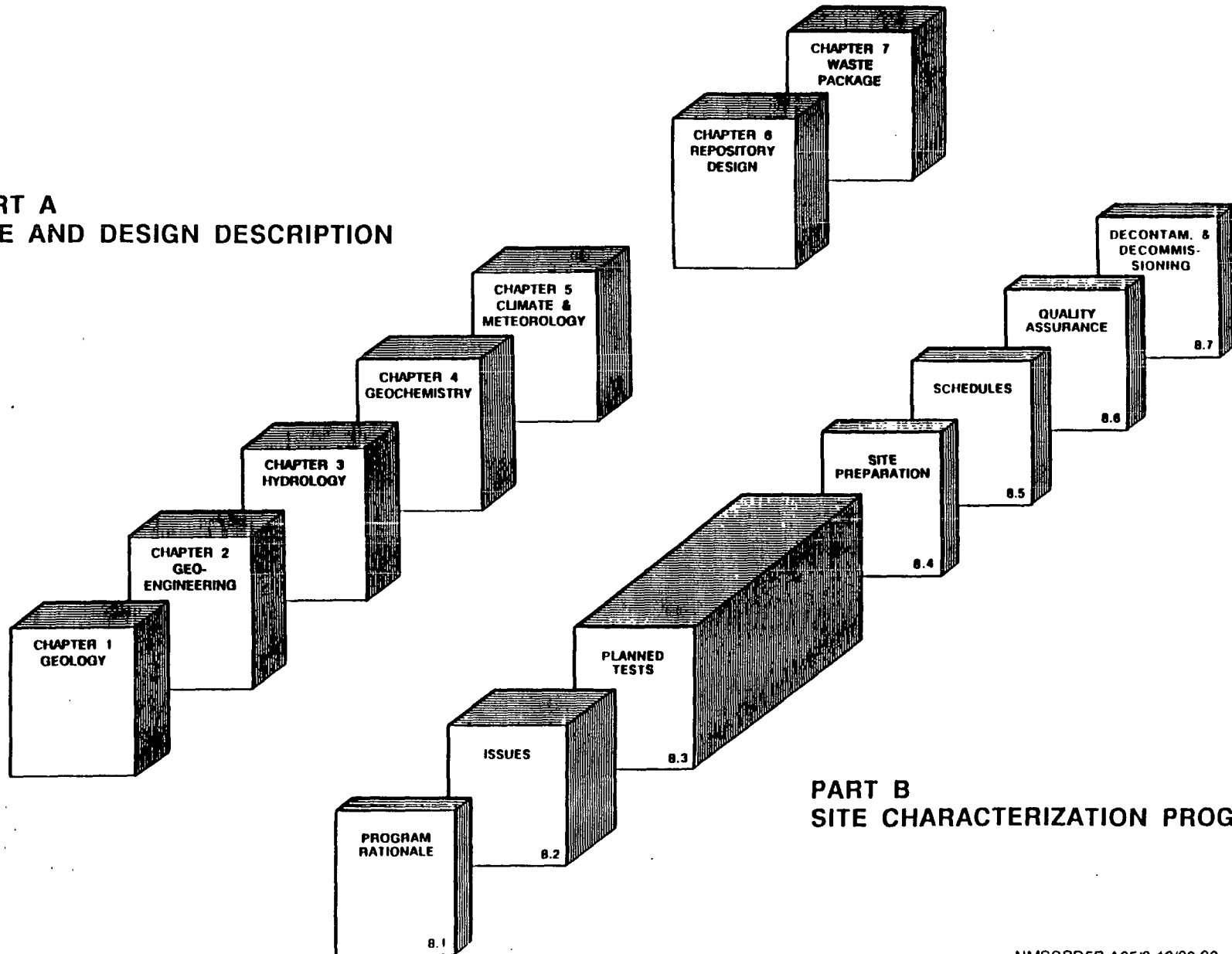


SITE CHARACTERIZATION PROGRAM PLANS DEVELOPED TO OBTAIN DATA TO ADDRESS THE TECHNICAL CRITERIA OF 10 CFR PART 60

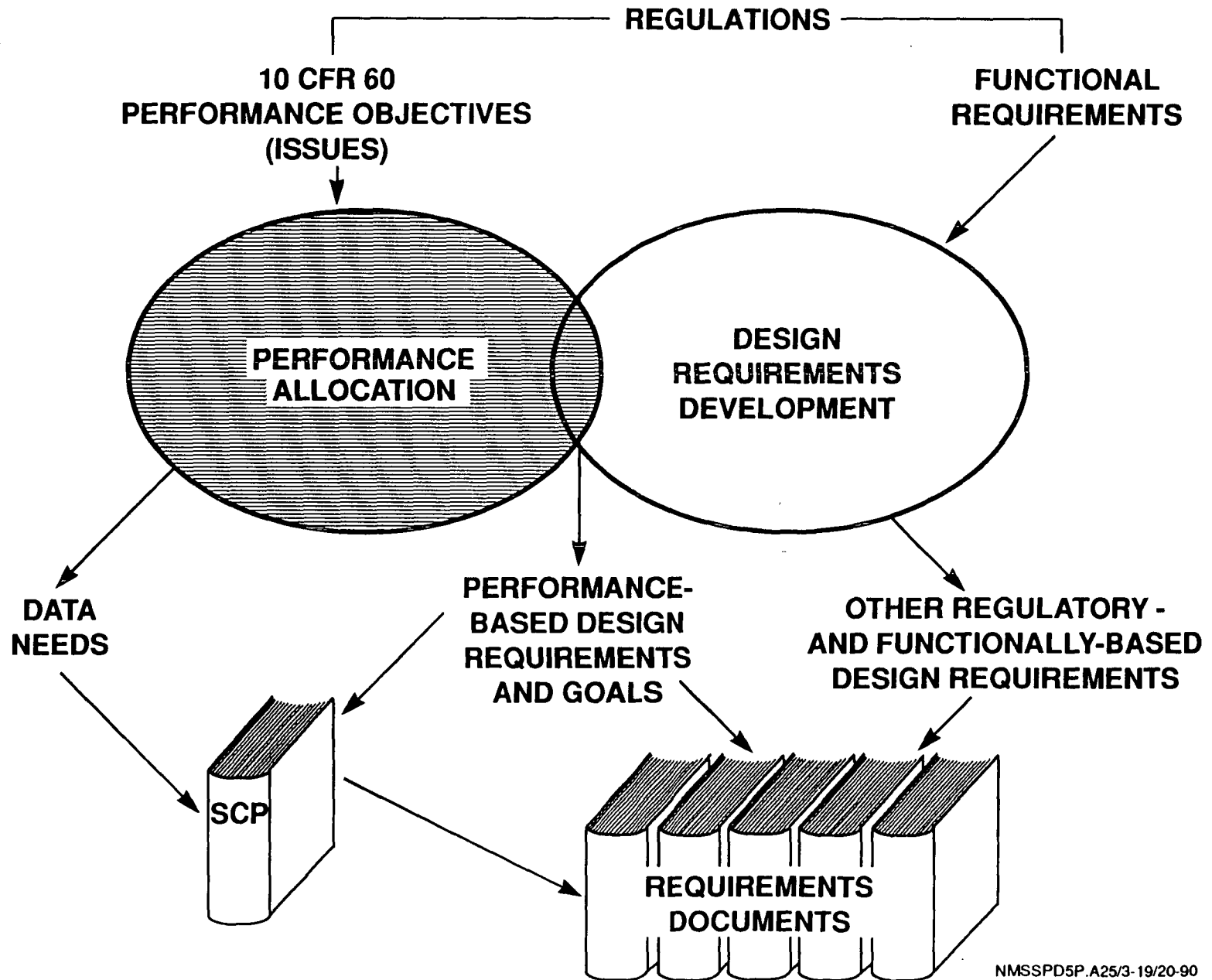
- **THE SCP ADOPTED A FORMAL ALLOCATION PROCESS TO DERIVE SITE DATA NEEDS FROM PERFORMANCE AND DESIGN REQUIREMENTS OF 10 CFR PART 60**
- **THE PERFORMANCE ALLOCATION PROCESS ALSO RESULTED IN THE DEFINITION OF DESIGN REQUIREMENTS**
- **CONCURRENTLY, CONCEPTUAL REPOSITORY AND WASTE PACKAGE DESIGNS WERE DEVELOPED BASED UPON COMPREHENSIVE REQUIREMENTS**

ORGANIZATION OF THE SCP

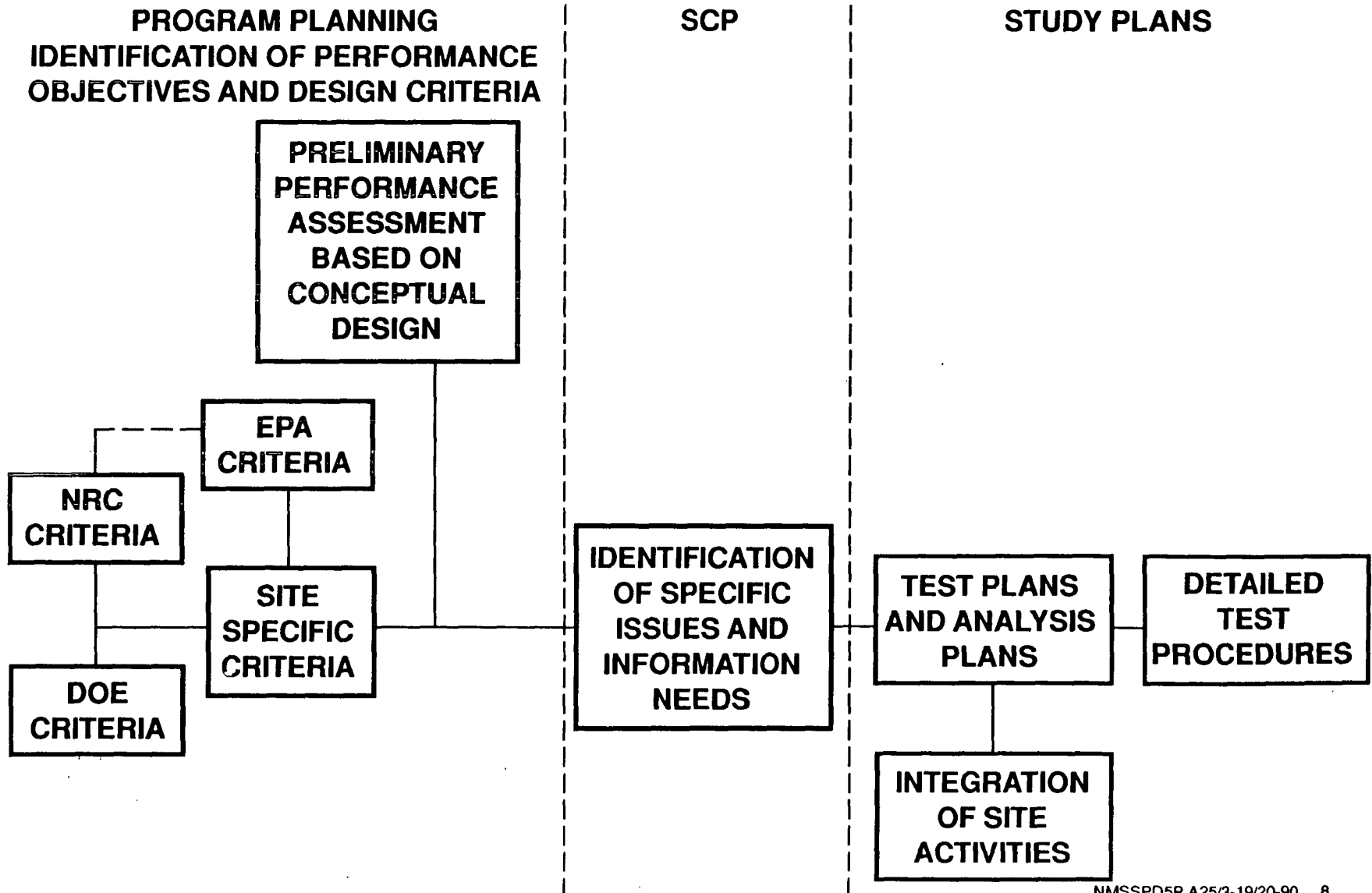
PART A SITE AND DESIGN DESCRIPTION



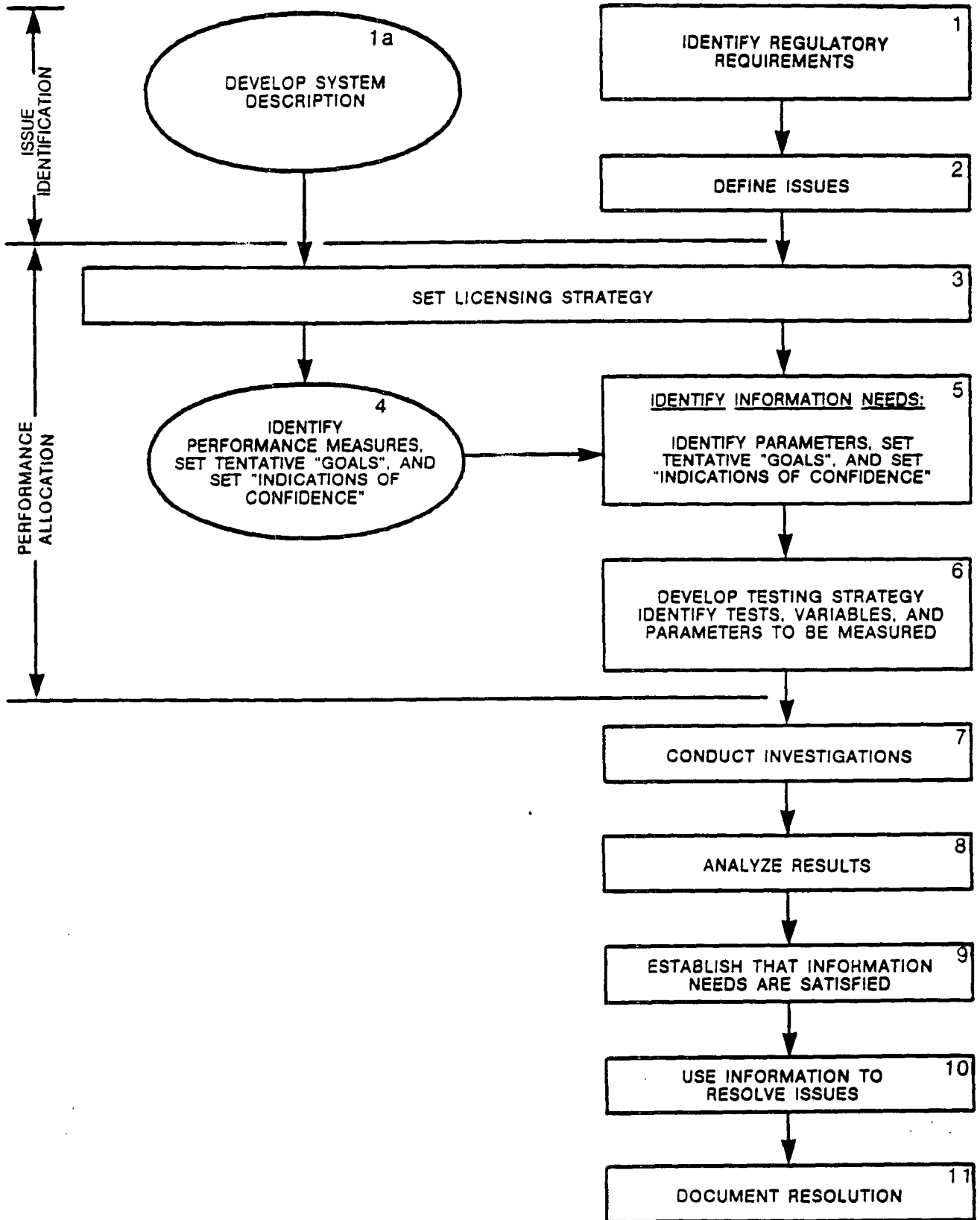
DERIVATION OF DESIGN REQUIREMENTS



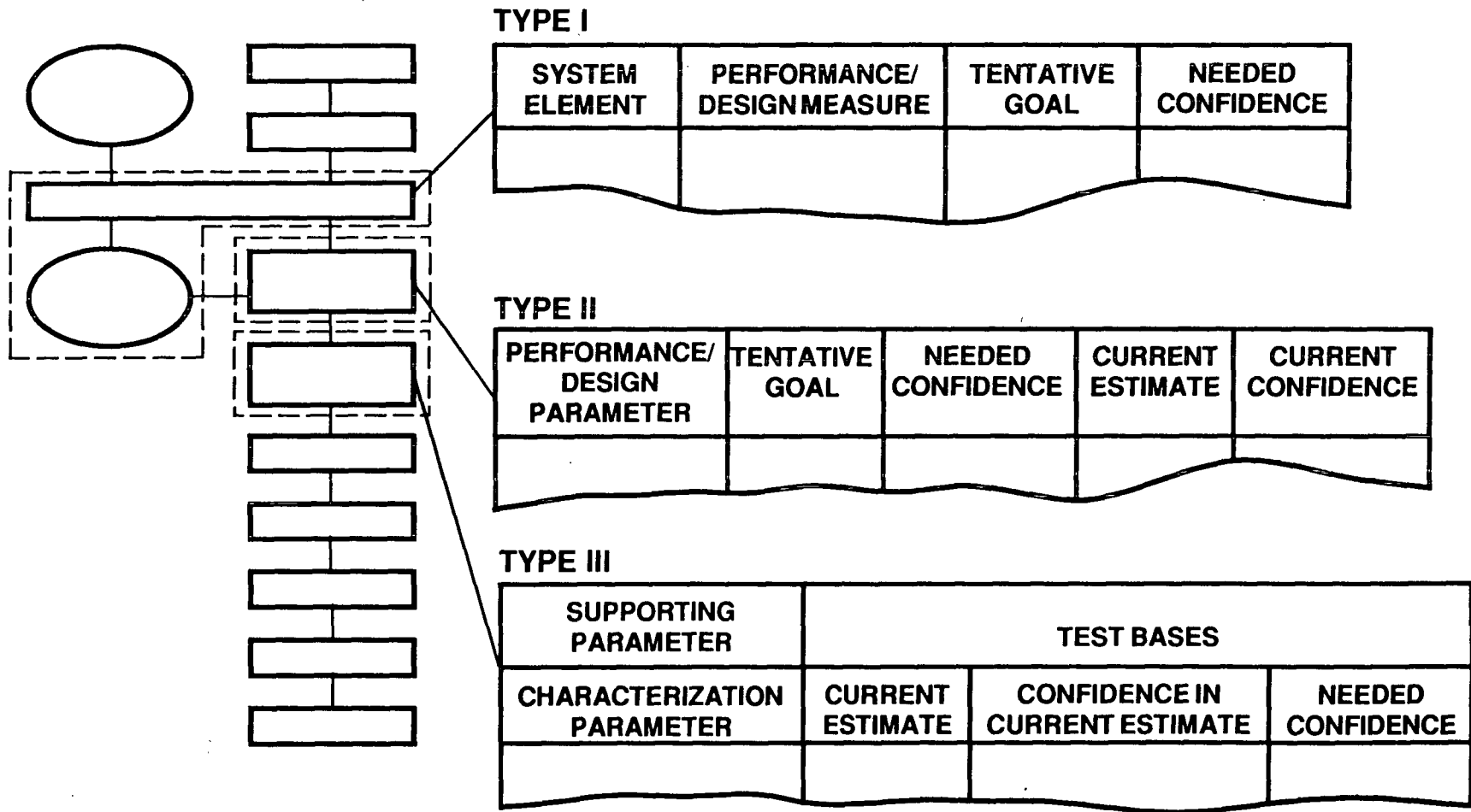
ISSUE DEVELOPMENT: NUREG 0960 (BWIP DSCA)



ISSUE-RESOLUTION STRATEGY



PERFORMANCE ALLOCATION TABLES



TECHNICAL CRITERIA FOR DISPOSAL OF HIGH-LEVEL WASTE IN GEOLOGIC CRITERIA (10 CFR 60 SUBPARTS E AND F)

I. PERFORMANCE OBJECTIVES

LAND OWNERSHIP AND CONTROL

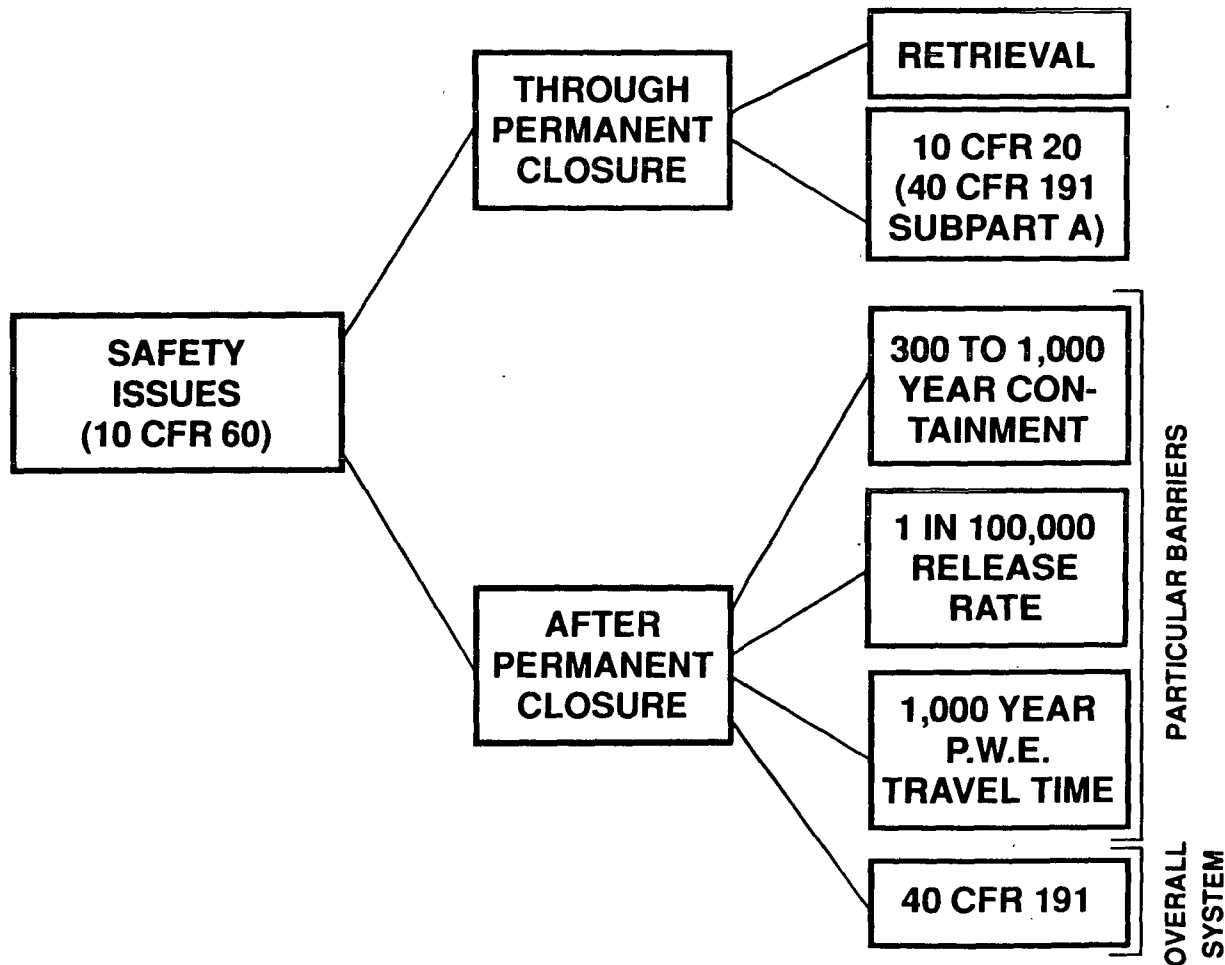
SITING CRITERIA

**II. DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY
OPERATIONS AREA**

**III. DESIGN CRITERIA FOR THE WASTE PACKAGE AND ITS
COMPONENTS**

IV. PERFORMANCE CONFIRMATION REQUIREMENTS

I. PERFORMANCE OBJECTIVES (10 CFR PART 60)



I. PERFORMANCE OBJECTIVES (AFTER PERMANENT CLOSURE)

OVERALL SYSTEM PERFORMANCE OBJECTIVE:

**SYSTEM RELEASES TO THE ACCESSIBLE ENVIRONMENT
CONFORM TO STANDARDS WITH RESPECT TO
BOTH ANTICIPATED PROCESSES AND EVENTS AND
UNANTICIPATED PROCESSES AND EVENTS**

PERFORMANCE OF PARTICULAR BARRIERS:

**ENGINEERED BARRIER SYSTEM SHALL BE DESIGNED
ASSUMING ANTICIPATED PROCESSES AND EVENTS**

DESIGN CRITERIA

(10 CFR 60.131 - 60.135)

SCOPE OF DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY OPERATIONS AREA (10 CFR 60.130)

- **MINIMUM CRITERIA FOR THE DESIGN OF THE GEOLOGIC REPOSITORY OPERATIONS AREA**
- **DOE OBLIGATED TO PROVIDE SUCH DESIGN FEATURES NEEDED TO ACHIEVE PERFORMANCE OBJECTIVES**

DOE APPLICATION

- **DESIGN CRITERIA ADDRESS FEATURES OF THE DESIGN THAT ARE INCORPORATED TO MEET THE PERFORMANCE OBJECTIVES. PERFORMANCE ALLOCATION WAS USED TO SPECIFY HOW THE DESIGN CRITERIA HELP MEET THE PERFORMANCE OBJECTIVES**

II. DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY OPERATIONS AREA

- (A) GENERAL DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY OPERATIONS AREA**
- (B) ADDITIONAL DESIGN CRITERIA FOR SURFACE FACILITIES IN THE GEOLOGIC REPOSITORY OPERATIONS AREA**
- (C) ADDITIONAL DESIGN CRITERIA FOR THE UNDERGROUND FACILITY**
- (D) DESIGN OF SEALS FOR SHAFTS AND BOREHOLES**

II.(A) GENERAL DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY OPERATIONS AREA

SELECTED PART 60 CONCERNS

- **RADIOLOGICAL PROTECTION**
- **STRUCTURES, SYSTEMS, AND COMPONENTS
IMPORTANT TO SAFETY**

SITE-SPECIFIC INTERPRETATION

- **RELATIVELY STRAIGHTFORWARD DESIGN
CRITERIA FOR HANDLING RADIOACTIVE
MATERIALS**

II.(B) ADDITIONAL DESIGN CRITERIA FOR SURFACE FACILITIES IN THE GEOLOGIC REPOSITORY OPERATIONS AREA

SELECTED PART 60 CONCERNS

- **RADIATION EXPOSURE PROTECTION**
- **RADIATION CONTROL AND MONITORING**
- **WASTE TREATMENT**
- **DECOMMISSIONING**

SITE-SPECIFIC INTERPRETATION

- **BASELINE MONITORING**
- **SHIELDING EFFECTIVENESS**

II.(C) ADDITIONAL DESIGN CRITERIA FOR THE UNDERGROUND FACILITY

SELECTED PART 60 CONCERNS

- **CONTRIBUTE TO CONTAINMENT AND ISOLATION**
- **FLEXIBILITY TO ACCOMMODATE SITE-SPECIFIC CONDITIONS**
- **REDUCE POTENTIAL FOR DELETERIOUS ROCK MOVEMENT AND LIMIT POTENTIAL TO CREATE PREFERENTIAL PATHWAY**
- **EBS DESIGNED TO ASSIST GEOLOGIC SETTING IN MEETING PERFORMANCE OBJECTIVE**
- **PREDICTED THERMAL-MECHANICAL RESPONSE ALLOWS COMPLIANCE WITH PERFORMANCE OBJECTIVES**

II.(C) ADDITIONAL DESIGN CRITERIA FOR THE UNDERGROUND FACILITY

(CONTINUED)

SITE-SPECIFIC INTERPRETATION

- **SELECT LAYOUT THAT CONTRIBUTES TO
CONTAINMENT AND ISOLATION**
 - **SKIP AND ISOLATE UNFAVORABLE AREAS**
 - **ADJUST THERMAL LOADS FOR LOCAL CONDITIONS**
 - **LIMIT AMOUNT OF WATER TO CONTACT CONTAINER**

- **LIMIT WATER USAGE AND POTENTIAL
CHEMICAL CHANGES**
 - **CONTROL TYPE, QUANTITY, AND LOCATION OF MATERIALS**
 - **LIMIT WATER TO THAT REQUIRED FOR DUST CONTROL AND
EQUIPMENT OPERATIONS**

II.(C) ADDITIONAL DESIGN CRITERIA FOR THE UNDERGROUND FACILITY

SITE-SPECIFIC INTERPRETATION (CONTINUED)

- **LIMIT EXCAVATION-INDUCED PERMEABILITY CHANGES**
 - **BLAST CONTROL**
 - **SUBSIDENCE CONTROL**
 - **BACKFILLING**

- **THERMAL AND MECHANICAL RESPONSE**
 - **LIMIT TEMPERATURE CHANGES IN SELECTED BARRIERS**
 - **NO CONTINUOUS JOINT SLIP**
 - **BOREHOLE WALLS ABOVE BOILING TEMPERATURE FOR AT LEAST 300 YEARS**

II.(D) DESIGN OF SEALS FOR SHAFTS AND BOREHOLES

SELECTED PART 60 CONCERNS

- **SEALS DESIGNED SO SHAFTS AND BOREHOLES DO NOT BECOME PATHWAYS THAT COMPROMISE PERFORMANCE**
- **MATERIALS AND PLACEMENT METHODS SELECTED TO REDUCE PATHWAYS FOR GROUNDWATER OR RADIONUCLIDE MOVEMENT**

SITE-SPECIFIC INTERPRETATION

- **ENCOURAGE DRAINAGE AT BASE OF SHAFTS**
- **DAMS OR BULKHEADS, IF WATER-BEARING FEATURES ARE ENCOUNTERED**

III. DESIGN CRITERIA FOR THE WASTE PACKAGE AND ITS COMPONENTS

SELECTED PART 60 CONCERNS

- **PACKAGES DESIGNED SO THAT PROPERTIES OF WASTE PACKAGE, IN ITS ENVIRONMENT, DO NOT COMPROMISE WASTE PACKAGE FUNCTION OR REPOSITORY PERFORMANCE**
- **WASTE FORM SHALL BE SOLID, PLACED IN SEALED CONTAINERS**
- **PACKAGES NOT TO CONTAIN EXPLOSIVE OR REACTIVE MATERIALS OR FREE LIQUIDS**

III. DESIGN CRITERIA FOR THE WASTE PACKAGE AND ITS COMPONENTS

(CONTINUED)

SITE-SPECIFIC INTERPRETATION

- **CONTAINER-ENVIRONMENT INTERACTIONS IN PARTIALLY SATURATED MEDIA**
- **LIMIT PEAK TEMPERATURES OF WASTE PACKAGE COMPONENTS**
- **LIMIT QUANTITY AND CONTROL QUALITY OF WATER**
- **UTILIZE CONTAINER-BOREHOLE AIR GAP**

IV. PERFORMANCE CONFIRMATION REQUIREMENTS

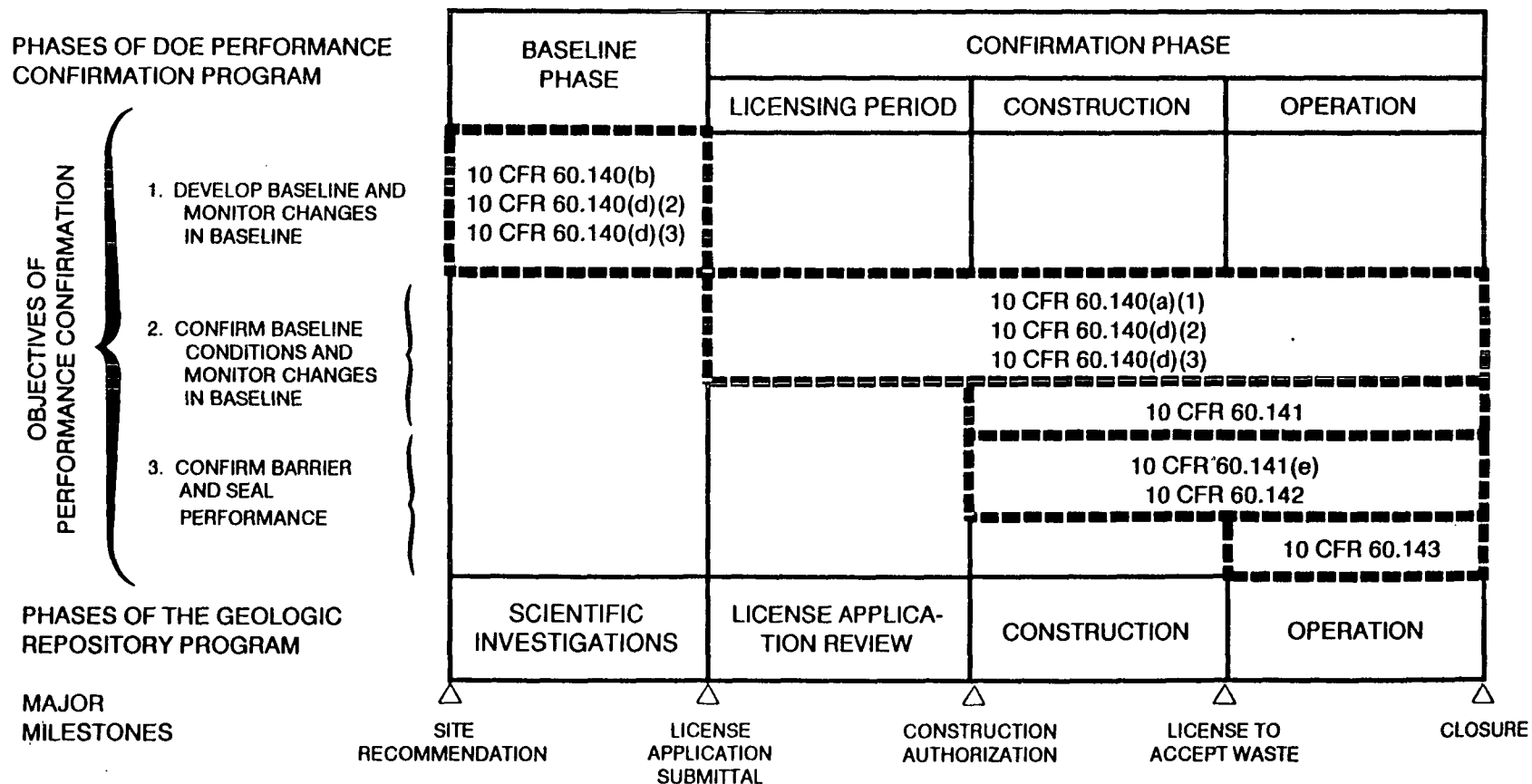
PART 60 CONCERNS

- **PROVIDE DATA THAT INDICATES:**
 - **ACTUAL SUBSURFACE CONDITIONS ARE WITHIN LIMITS ASSUMED IN LICENSING REVIEW**
 - **NATURAL AND ENGINEERED SYSTEMS ARE FUNCTIONING AS INTENDED AND ANTICIPATED**
- **CONFIRM GEOTECHNICAL AND DESIGN PARAMETERS**
- **DESIGN TESTING**
- **MONITORING AND TESTING WASTE PACKAGES**

IV. PERFORMANCE CONFIRMATION PROGRAM

(CONTINUED)

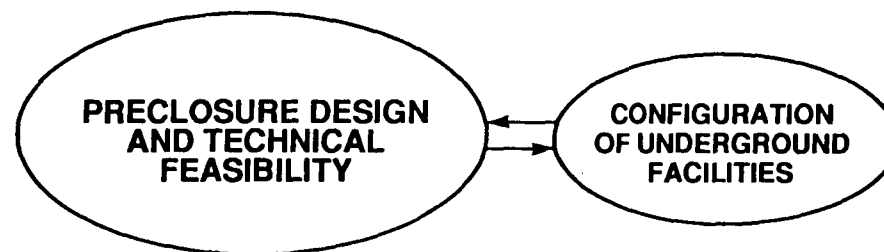
SITE-SPECIFIC INTERPRETATION



RELATIONSHIP BETWEEN DESIGN AND PERFORMANCE RELATED ISSUES

PRECLOSURE
DESIGN

POSTCLOSURE
DESIGN

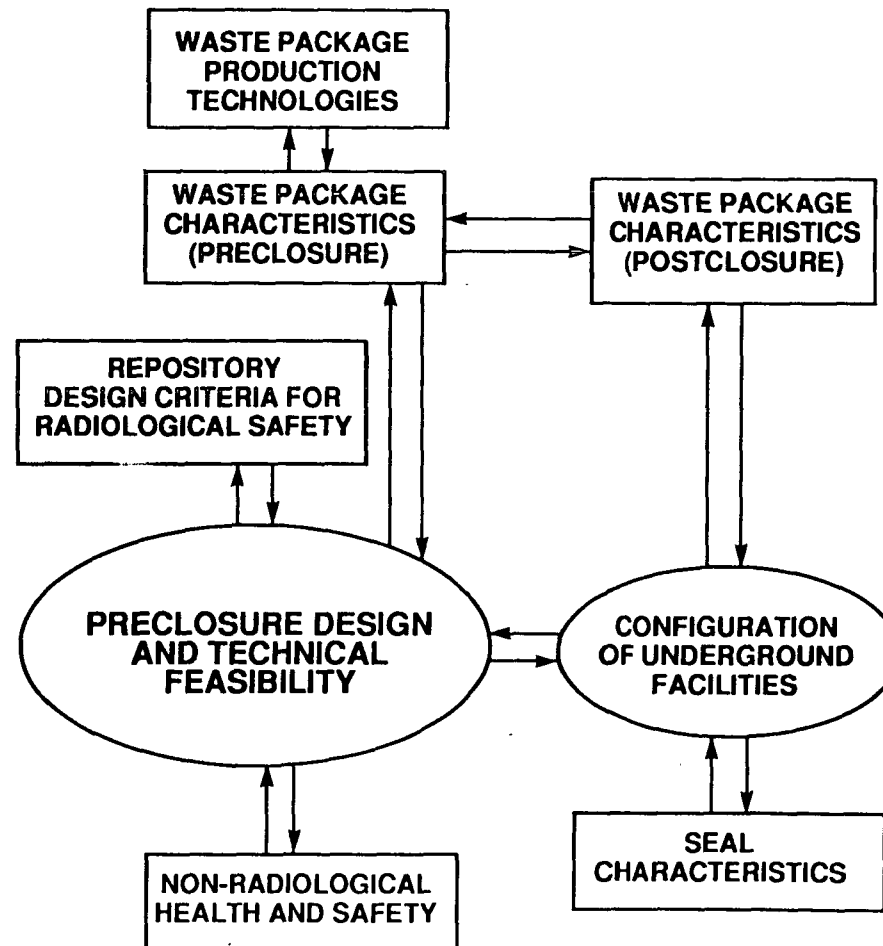


RELATIONSHIP BETWEEN DESIGN AND PERFORMANCE RELATED ISSUES

(CONTINUED)

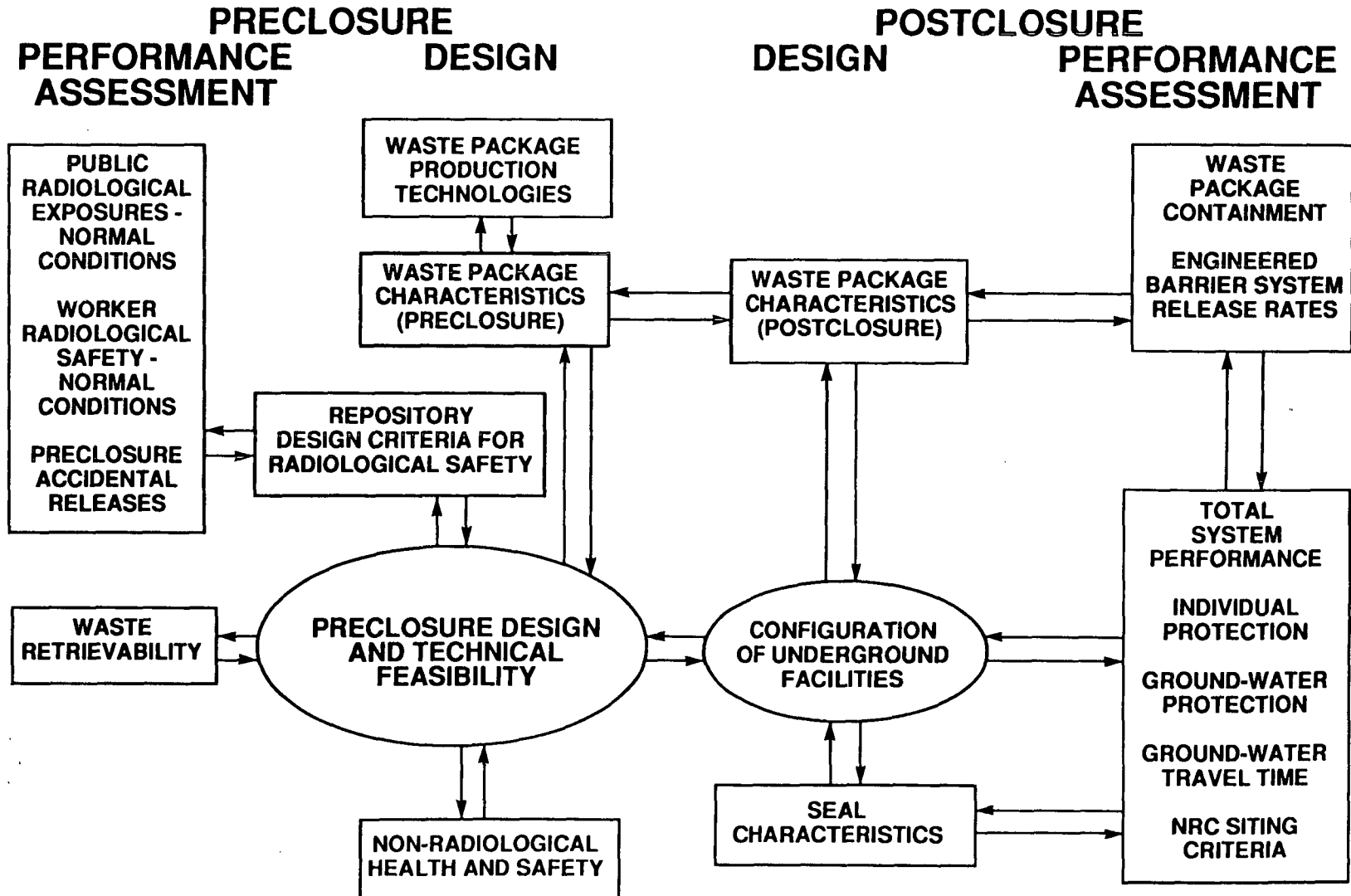
PRECLOSURE DESIGN

POSTCLOSURE DESIGN

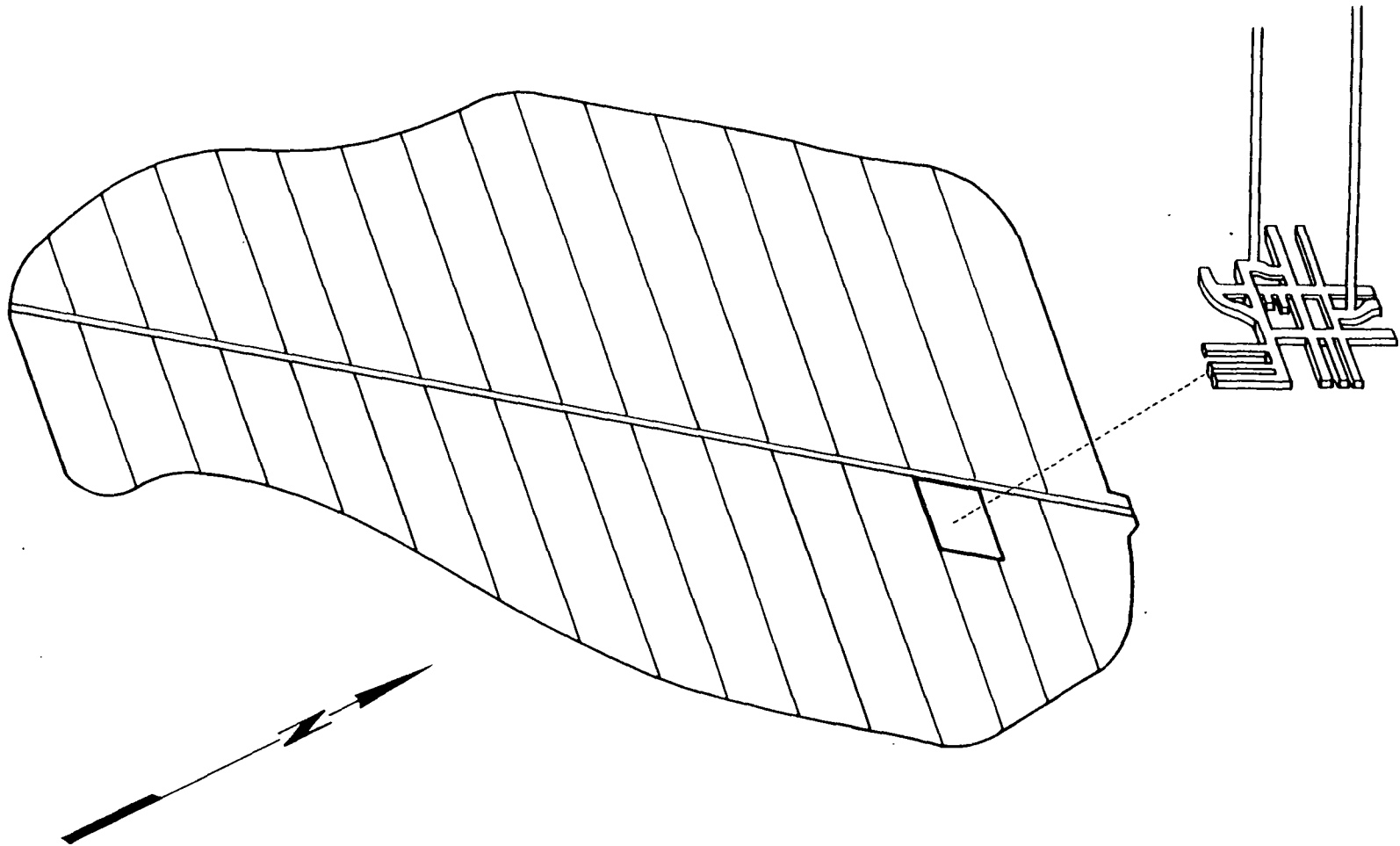


RELATIONSHIP BETWEEN DESIGN AND PERFORMANCE RELATED ISSUES

(CONTINUED)



PERFORMANCE RELATED DESIGN CRITERIA (EXAMPLES)



ESF-DESIGN CRITERIA (REPOSITORY INTERFACE)

CORRELATION OF CRITERIA DERIVED FOR ESF PHYSICAL ELEMENTS WITH 10 CFR 60 APPLICABLE REQUIREMENTS

	C O N C E R N	ESF PHYSICAL ELEMENTS									
		F A C I L	S I T E	U T I L S	S U R F F A C	I S T S H F T	2 N D S H F T	U G E X C	U G U T I L	U G T E S T	D E C O M
1 60.15(b) ..in situ explor at depth of wste emplacmnt	3					√	√	√		√	
2 60.15(d) (1) .. limit impacts on isol	1		√	√		√	√	√	√	√	√
(2) ...limit no. boreholes	3					√	√			√	
(3) ...boreholes/shafts in pillars	1					√	⊗	⊗		√	
	3									√	
(4) ...coord drilling with GROA											
3 60.16 ...issue SCP & receive comments on shaft											
4 60.21(c) (1) (ii) (D) ...comparative evaluation	1					√	√	√			
5 60.21(c) (1) (ii) (E) ...items imp. to safety											
6 60.21(c) (11) ...features to facilitate closure	1		√			√	√	√			√
7 60.72(a) ...maintain records											
8 60.72(b) ...types of records											
9 60.74 ...NRC defined tests	1									√	
	2					√	√	√	√	√	
	3									√	
10 60.111(a) ..Part 20 compliance											
11 60.111(b) (1) ..preserve the option of waste retrieval											
12 60.111(b) (3) ...retrieval schedule											
13 60.112 ...Total System Performance	1		√	√		√	√	√	√	√	√
14 60.113(a) (1) (i) ...sub. comp. cont & release rate	1							√	√	√	

CORRELATION OF CRITERIA DERIVED FOR ESF PHYSICAL ELEMENTS WITH 10 CFR 60 APPLICABLE REQUIREMENTS

	C O N C E R N	ESF PHYSICAL ELEMENTS									
		F A C I L	S I T E	U T I L S	S U R F A C E	I N S T R U C T I O N	2 N D S H F T	U G E X C	U G U T I L	U G T E S T	D E C O M
15 60.113(a) (1) (ii) (A) ...300 to 1000 yr W. Pkg.	1							√	√	√	
(a) (1) (ii) (B) ... 10 ⁻⁵ release rate	1							√	√	√	
16 60.130 ...other features to meet P.O.	1		√			√	√	√	√	√	
	2					√	√	√		√	
17 60.131(b) (1) ..SS/C imp. safety consider nat features											
18 60.131(b) (2) ..SS/C imp. safety prot dynamic											
19 60.131(b) (3) ...SS/C imp. safety prot fire/explosion											
20 60.131(b) (4) (i)...SS/C imp. safety maintain control											
21 60.131(b) (6) ...SS/C imp. safety inspect, test											
22 60.131(b) (9) ...compliance mining regulations											
23 60.133(a) (1) ...orientation contrib. to isol	1					√	√	√			
(2) ...disruptive events not spread	1		√	√		√	√	√	√		
	2		√			√	√	√	√		
24 60.133(b)ug facil flexible for site conditions	1							√			
	2					√	√	√	√		
	3					√	√	√	√		
25 60.133(c) ...retrieval of waste											
26 60.133(d) ...control water and gas	1		√	√		√	√	√	√	√	
	2					√	√	√	√	√	

CORRELATION OF CRITERIA DERIVED FOR ESF PHYSICAL ELEMENTS WITH 10 CFR 60 APPLICABLE REQUIREMENTS

	C O N C E R N	ESF PHYSICAL ELEMENTS									
		F A C I L	S I T E	U T I L S	S U R F A C E	I N T E R S H E L T	2 N D S H E L T	U G E X C	U G U T I L	U G T E S T	D E C O M
27 60.133(e) (1) ...retrievability											
60.133(e) (2) deleterious movement	1					√	√	√			
	2					√	√	√		√	
28 60.133(f) ...excavation effects	1		√			√	√	√			
	2		√			√	√	√			
29 60.133(g) ...ventilation											
30 60.133(h) ...ebs assist geol setting	1					√	√	√			√
31 60.133(i) ...thermal/mechanical loads	1					√	√	√		√	
32 60.137...performance confirmation	1							√		√	
	2		√			√	√	√	√	√	
33 60.140(b) ...start perf. con. during site char.											
34 60.140(c) ...apropriate monitoring pgm											
35 60.140(d) (1)...pgm not affect nat & eng bar meet P.O .	1									√	
36 60.141(a) ... surveil, mapping, testing											
37 60.141(b) ...monitor design											
38 60.141(c) ...req'd measurements											
39 60.141(d) ...comp. to orig design											
40 60.141(e) ...monitor therm/mech											
41 60.142(a) ...borehole/shaft seals											

**CORRELATION OF CRITERIA
DERIVED FOR ESF PHYSICAL
ELEMENTS WITH 10 CFR 60
APPLICABLE REQUIREMENTS**

	ESF PHYSICAL ELEMENTS										
	C O N C E R N	F A C I L	S I T E	U T I L S	S U R F F A C E	I N S H E T	2 N D S H E T	U G E X C	U G U T I L	U G T E S T	D E C O M
42 60.142(b) ...initiated early											
43 60.142(c) ...test backfill effect.											
44 60.142(d) ...seal effect.											
45 60.151 QA Program Applicability											
46 60.152 QA Pgm Basis											

ESF APPLICABLE CRITERIA FROM 10 CFR PART 60

1.18 REQUIREMENT: 60.133(i) THE UNDERGROUND FACILITY SHALL BE DESIGNED SO THAT THE PERFORMANCE OBJECTIVES WILL BE MET TAKING INTO ACCOUNT THE PREDICTED THERMAL AND THERMOMECHANICAL RESPONSE OF THE HOST ROCK, AND SURROUNDING STRATA, GROUNDWATER SYSTEM.

- 1.18.4.1 THE SHAFT LINER SHALL WITHSTAND PRESSURES EXERTED ALONG ITS LENGTH AND AROUND THE ENTIRE PERIMETER UNDER ANTICIPATED CONDITIONS, INCLUDING REACTION TO THERMALLY INDUCED STRESSES RESULTING FROM THERMAL LOADS**

- 1.18.6.2 THE ESF SHALL BE DESIGNED SUCH THAT THE THERMAL AND THERMOMECHANICAL EFFECTS OF ESF OPERATIONS AND TESTING DO NOT PRODUCE FAILURE OF INTACT ROCK, NOR GROSS ROCK MASS FAILURE, ALONG POTENTIAL PATHWAYS FROM THE REPOSITORY TO THE ACCESSIBLE ENVIRONMENT**

- 1.18.6.3 THE ESF SHALL BE DESIGNED SO THAT THE THERMAL AND THERMOMECHANICAL EFFECTS OF ESF OPERATIONS AND TESTING ON THE GROUNDWATER SYSTEM, DO NOT SIGNIFICANTLY INCREASE THE SATURATION OF THE HOST ROCK IN THE WASTE EMPLACEMENT AREA**

ESF APPLICABLE CRITERIA FROM 10 CFR PART 60

(CONTINUED)

1.14 REQUIREMENT 60.133(d): THE DESIGN OF THE UNDERGROUND FACILITY SHALL PROVIDE FOR CONTROL OF WATER OR GAS INTRUSION.

1.14.5.1 THE AMOUNT OF WATER USED IN CONSTRUCTION AND OPERATIONS, SHOULD BE LIMITED SO AS TO LIMIT THE EFFECTS ON THE CONTAINMENT AND ISOLATION CAPABILITY OF THE SITE

ESF APPLICABLE CRITERIA FROM 10 CFR PART 60

(CONTINUED)

1.2 REQUIREMENT: 60.15(d) TO THE EXTENT PRACTICAL, EXPLORATORY BOREHOLES AND SHAFTS IN THE GEOLOGIC REPOSITORY OPERATIONS AREA SHALL BE LOCATED WHERE SHAFTS ARE PLANNED FOR UNDERGROUND FACILITY CONSTRUCTION AND OPERATION OR WHERE LARGE UNEXCAVATED PILLARS ARE PLANNED.

1.2.5.2 THE EXPLORATORY SHAFTS SHALL BE LOCATED, TO THE EXTENT PRACTICABLE, WHERE SHAFTS ARE PLANNED FOR THE REPOSITORY FACILITY

1.2.6.1 EXPLORATORY BOREHOLES SHALL BE LOCATED SO THAT THEY DO NOT INTERSECT ANY UNDERGROUND OPENINGS