

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

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

**SUBJECT: WASTE PACKAGE PLAN
IMPLEMENTATION**

PRESENTER: DR. LESLIE JARDINE

**PRESENTER'S TITLE
AND ORGANIZATION: TECHNICAL PROJECT OFFICER
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, CALIFORNIA**

**PRESENTER'S
TELEPHONE NUMBER: (415) 423-5032**

AUGUST 28-29, 1990

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OUTLINE

1. INTRODUCTION TO WASTE PACKAGE PLAN (WPP)

2. WPP DIRECT IMPLEMENTATION ACTIVITIES

- **ENGINEERING AND SYSTEM STUDIES**
- **MATERIALS CHARACTERIZATION AND TESTING**
- **NEAR-FIELD ENVIRONMENT CHARACTERIZATIONS**
- **WASTE FORM CHARACTERIZATIONS**

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WASTE PACKAGE PLAN: BACKGROUND

- **AT MARCH 19-20, 1990 DENVER MEETING, DOE OFFERED TO PRESENT WASTE PACKAGE PLAN**
- **DOE-YMPO APPROVAL OBTAINED**
- **THE WASTE PACKAGE PLAN IS NOW BEING IMPLEMENTED**

WASTE PACKAGE PLAN OBJECTIVES

- **DESCRIBE WASTE PACKAGE PROGRAM OF THE YMP**
- **DESCRIBE ESSENTIAL ELEMENTS OF THE PROGRAM, INCLUDING OBJECTIVES, TECHNICAL PLAN, AND MANAGEMENT APPROACH**
- **ESTABLISH THE TECHNICAL APPROACH AGAINST WHICH OVERALL PROGRESS CAN BE MEASURED**
- **PROVIDE GUIDANCE FOR WASTE PACKAGE PROGRAM ACTIVITIES**

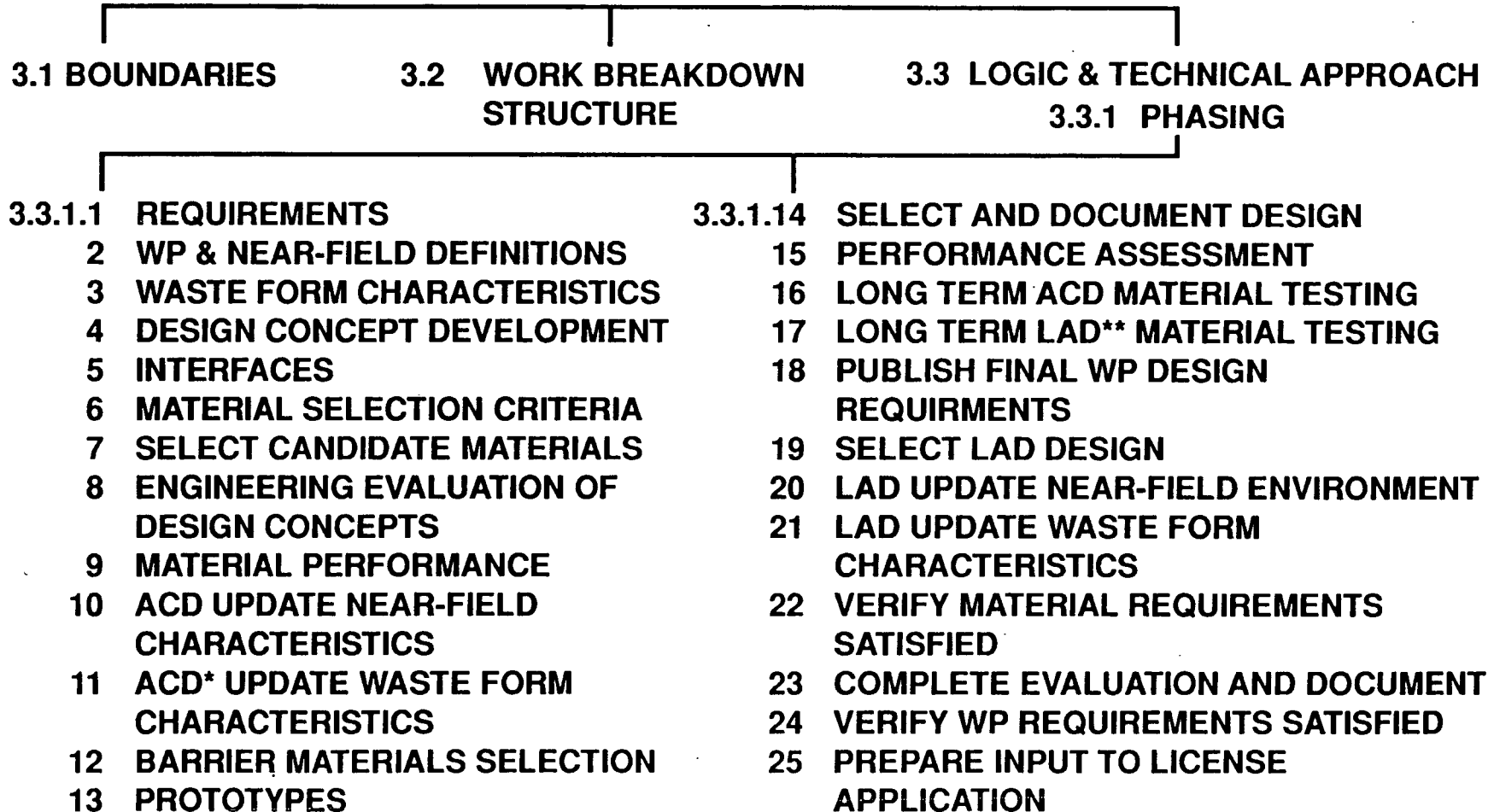
ORGANIZATION OF THE WASTE PACKAGE PLAN

- 1.0 INTRODUCTION**
- 2.0 MISSION NEED AND OBJECTIVES**
- 3.0 TECHNICAL PLAN**
- 4.0 RISK ASSESSMENT**
- 5.0 MANAGEMENT APPROACH**
- 6.0 ACQUISITION STRATEGY**
- 7.0 PROJECT SCHEDULE**
- 8.0 RESOURCES PLAN**
- 9.0 CONTROLLED ITEMS**
- 10.0 SCHEDULED DECISION POINTS**

FROM DOE ORDER 4700.1

SECTION 3 OF THE WASTE PACKAGE PLAN

3.0 TECHNICAL PLAN

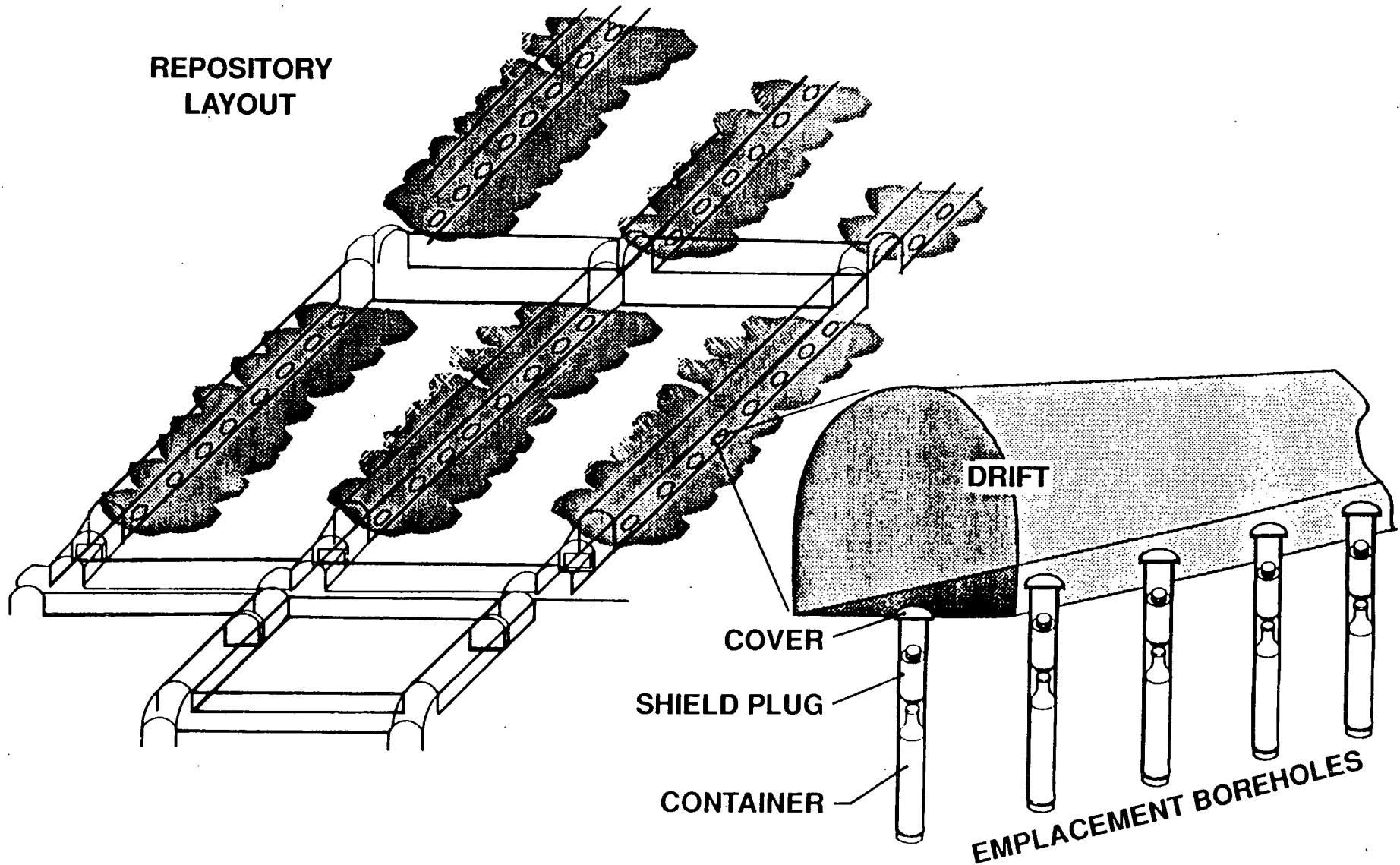


* ADVANCED CONCEPTUAL DESIGN

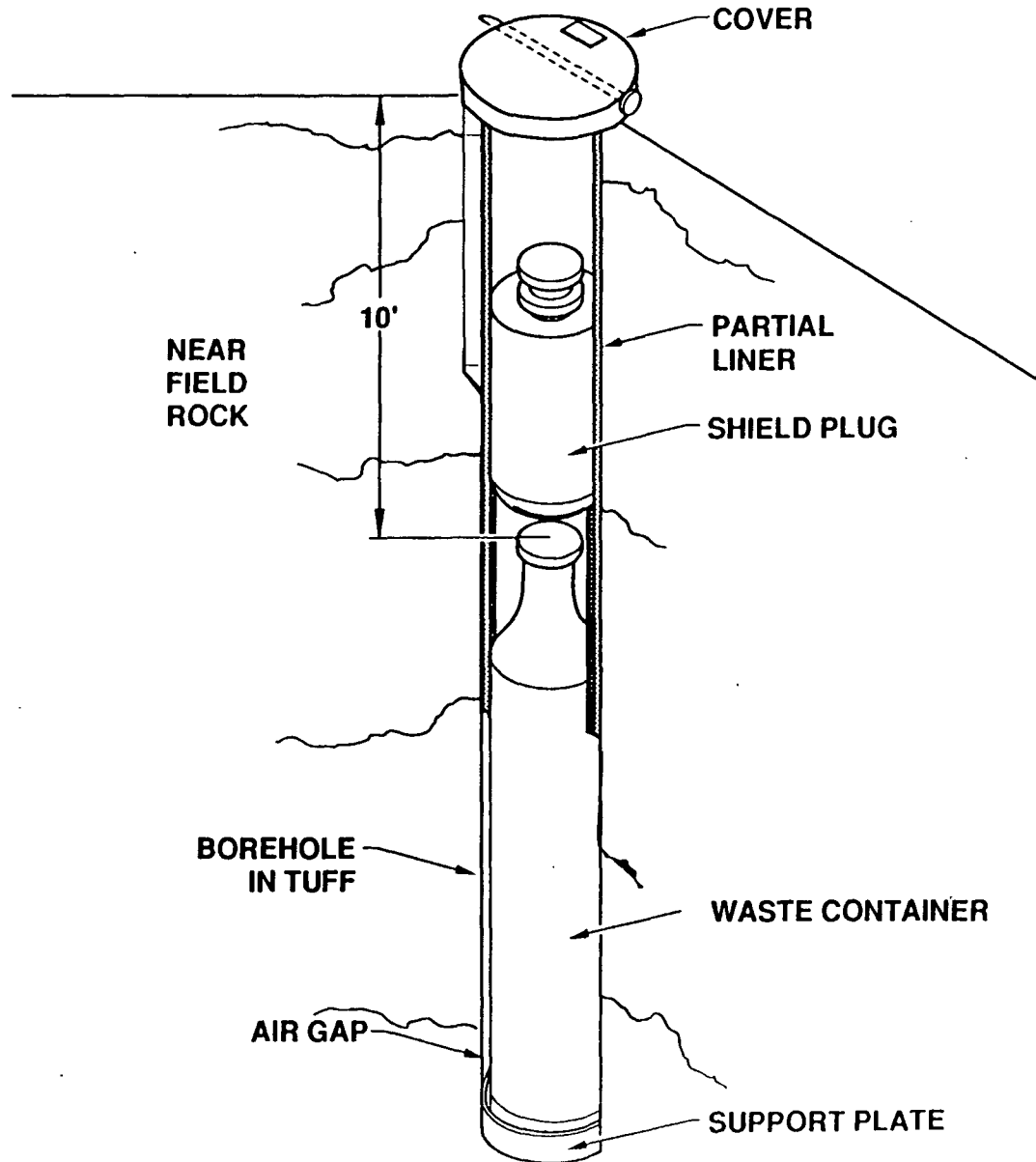
** LICENSE APPLICATION DESIGN

THE NEAR-FIELD ENVIRONMENT IS A LARGE FRACTION OF THE UNDERGROUND REPOSITORY

REPOSITORY
LAYOUT

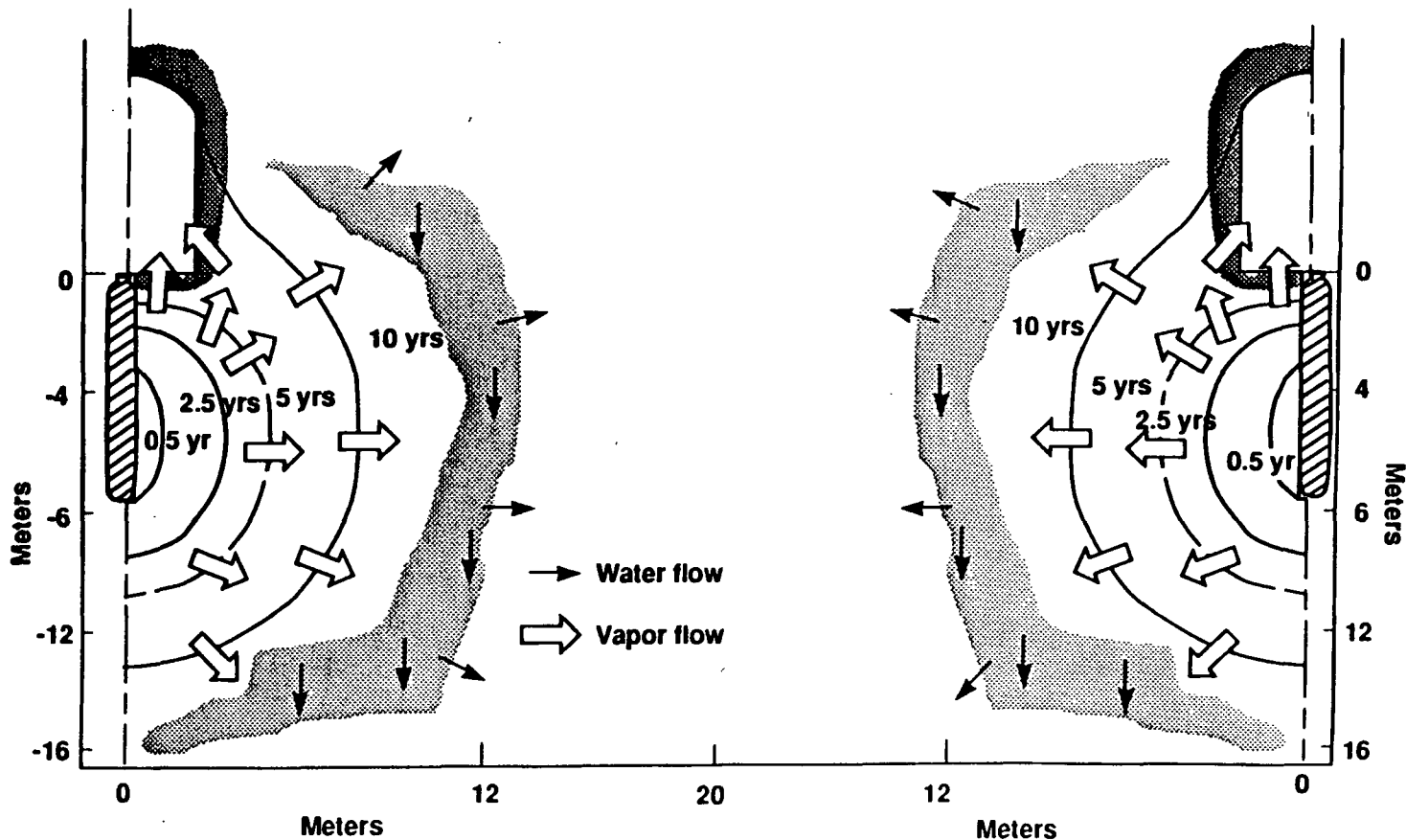


REFERENCE CONFIGURATION FOR VERTICAL EMPLACEMENT

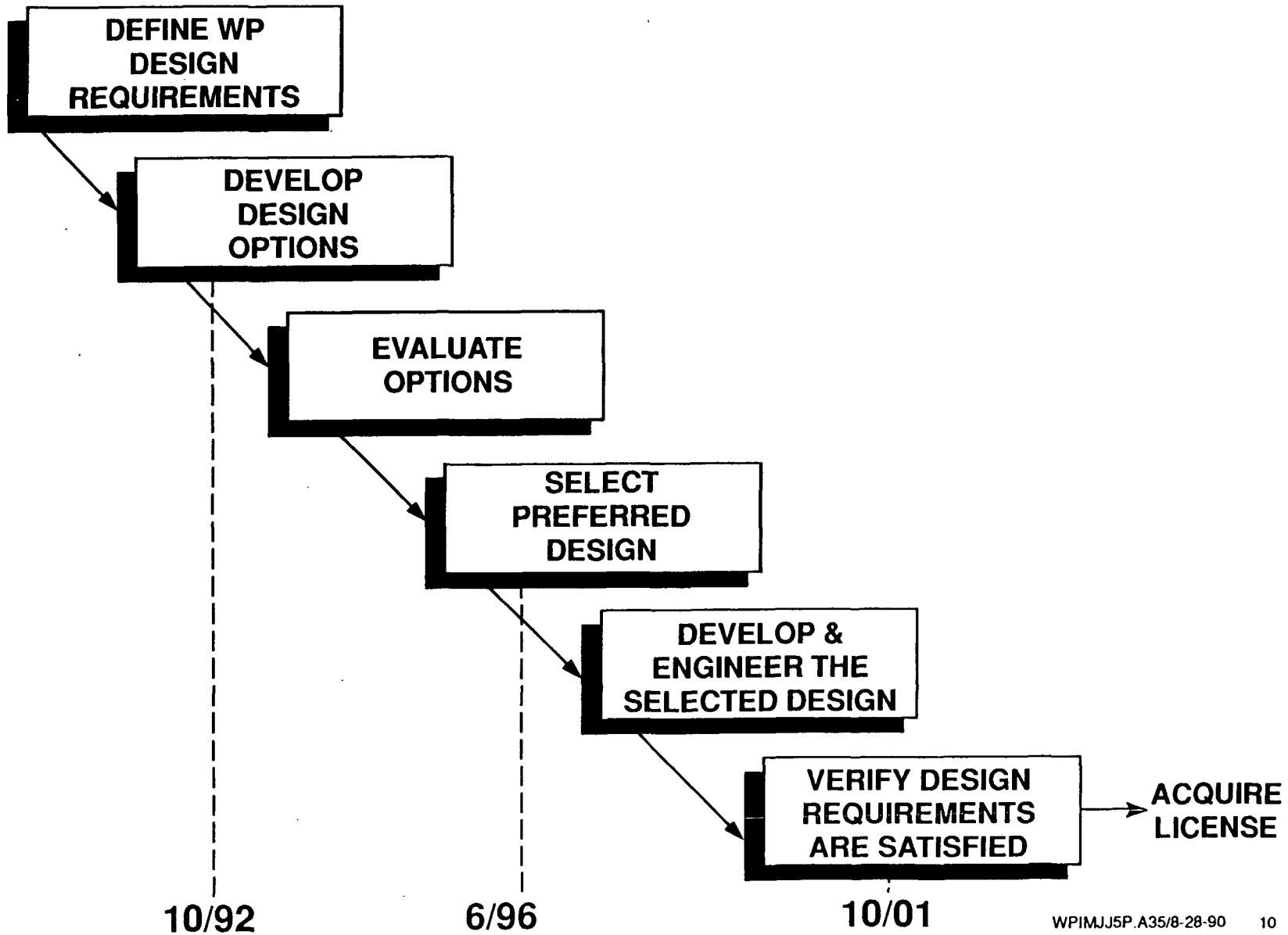


BOUNDARY OF BOILING POINT ISOTHERMS FIRST EXPANDS AND LATER CONTRACTS

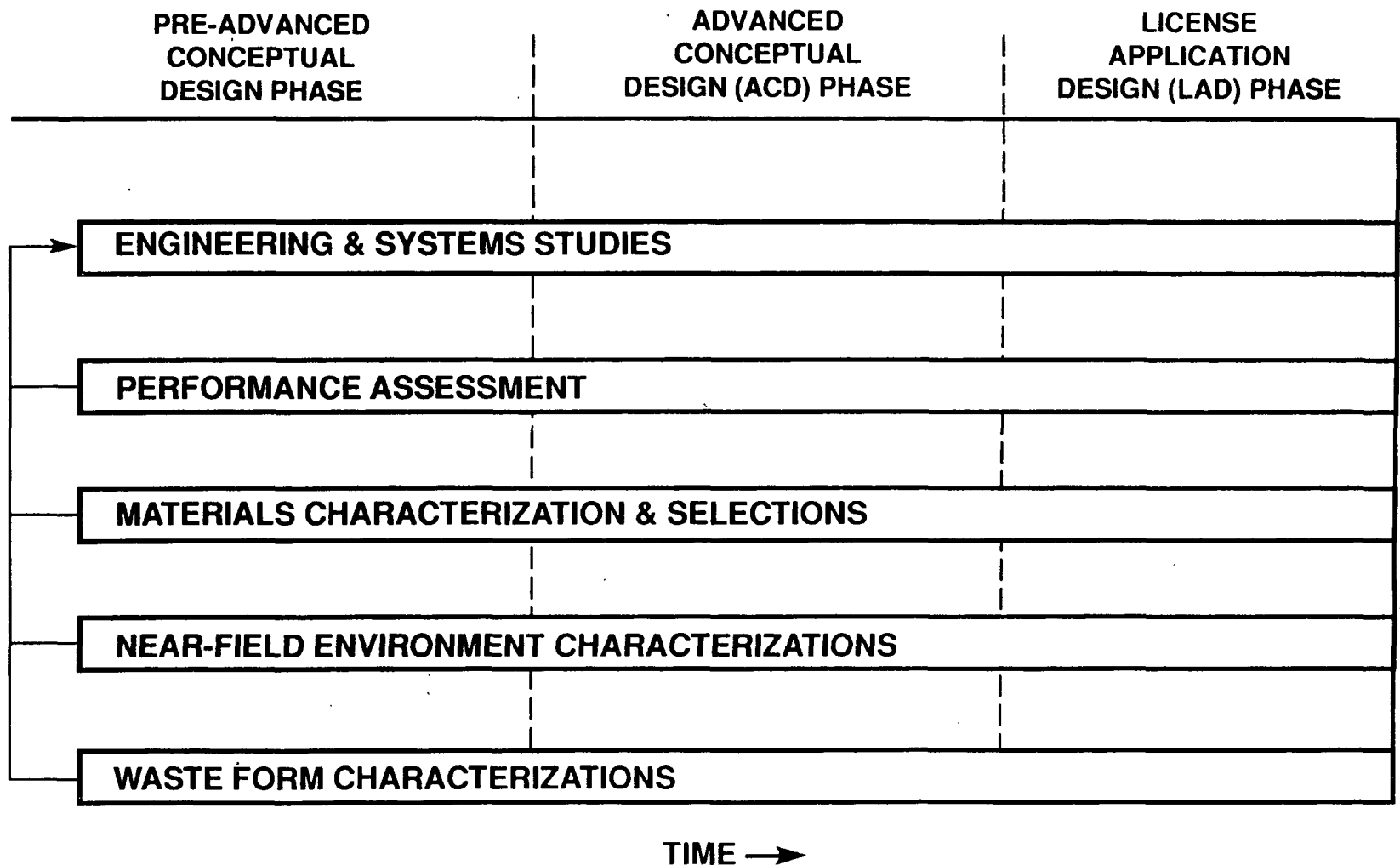
ASSUMES SPENT FUEL EMPLACED 8 YEARS AFTER DISCHARGE



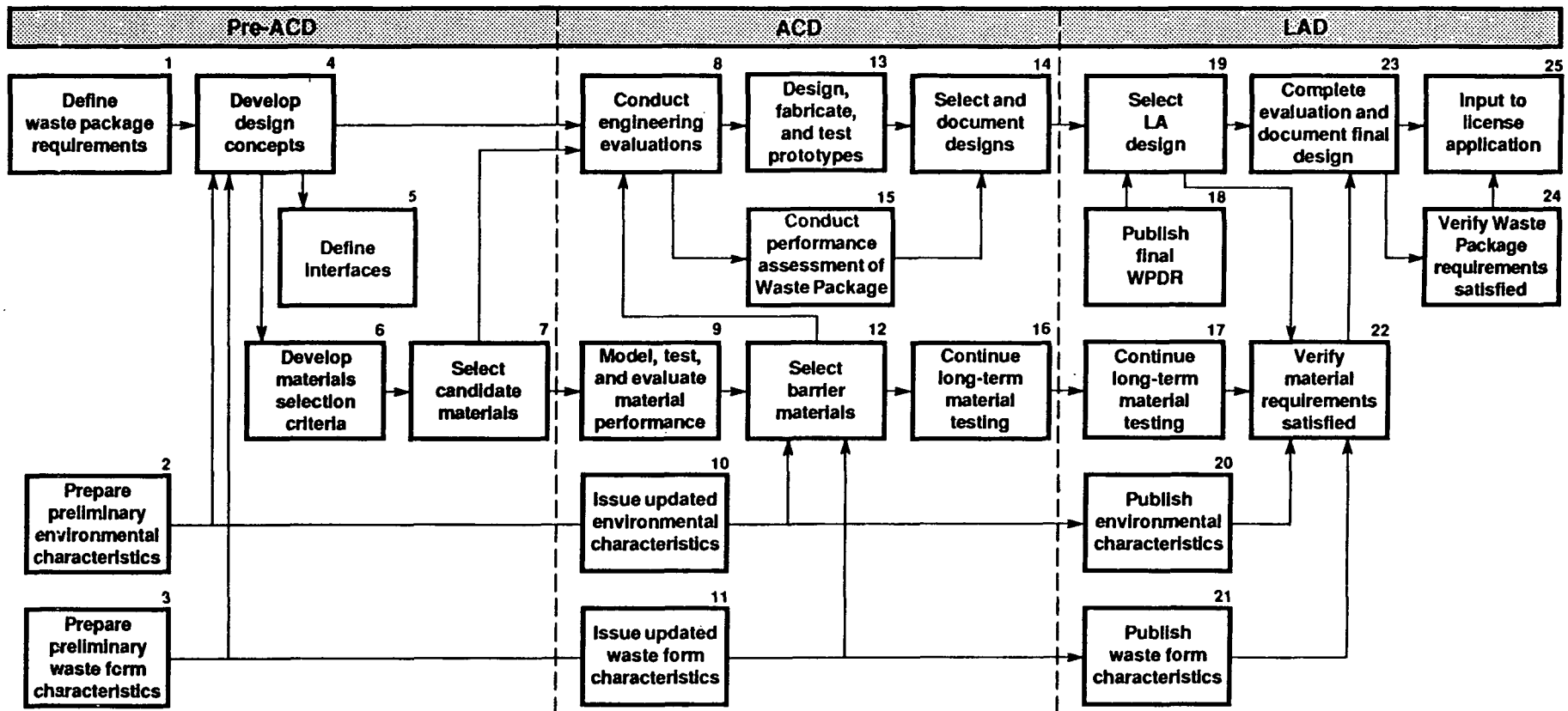
A CLASSIC SYSTEMS ENGINEERING APPROACH WILL BE USED



WASTE PACKAGE PLAN LOGIC AND TECHNICAL APPROACH DESIGN PHASES



FLOW DIAGRAM OF WASTE PACKAGE PROGRAM



WPPFLOW.038/8-4-90

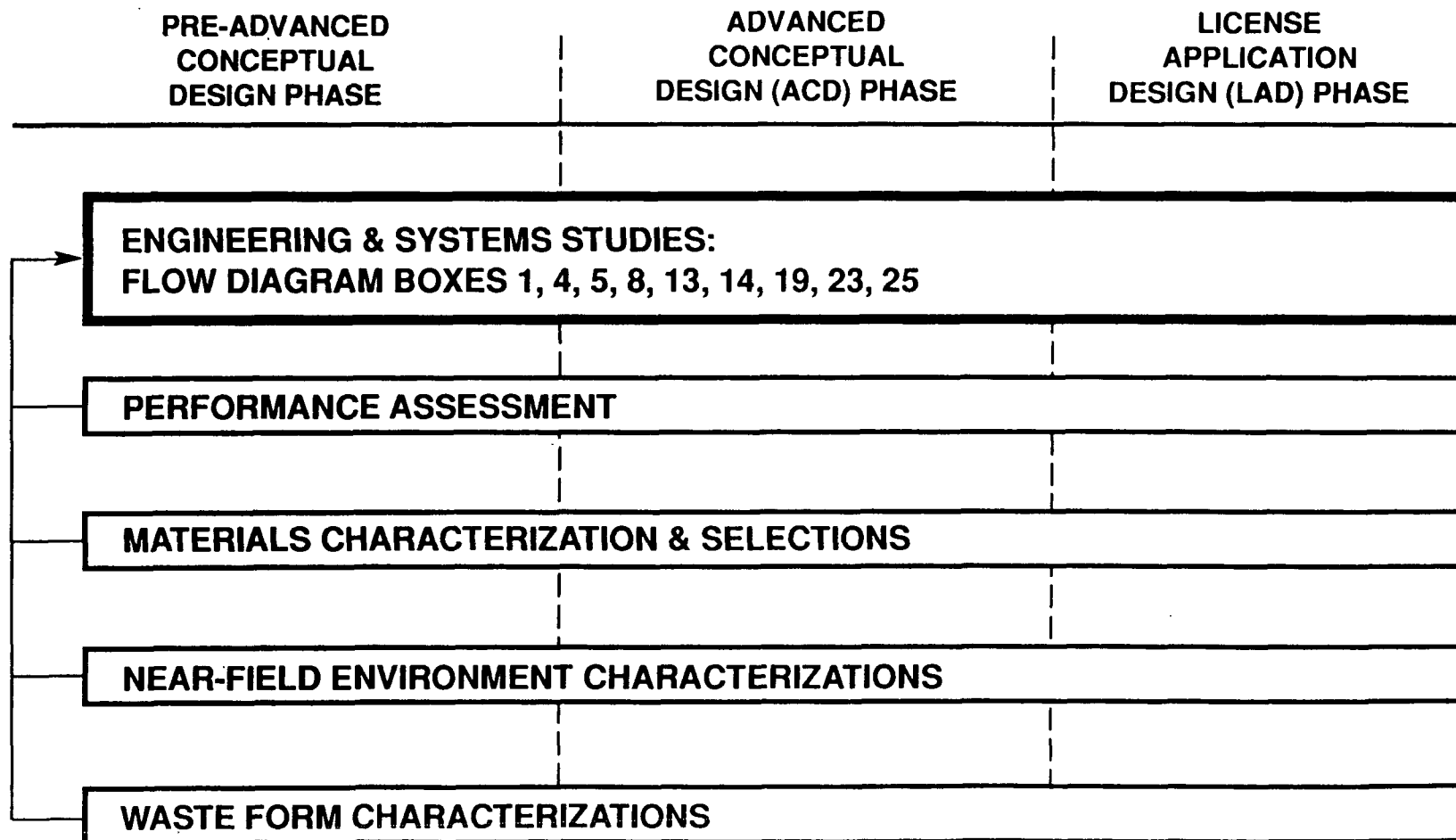
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WASTE PACKAGE PLAN LOGIC AND TECHNICAL APPROACH DESIGN PHASES

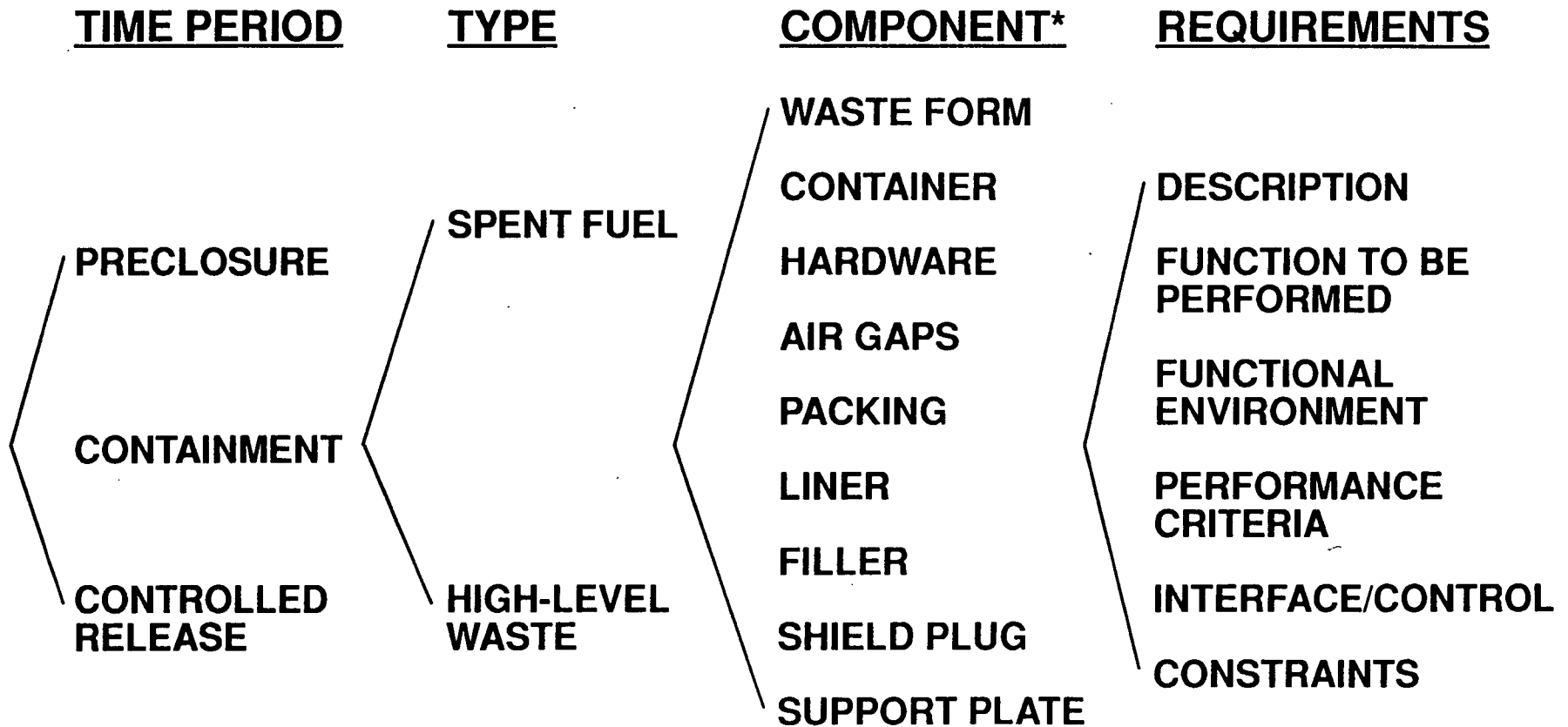


TIME →

OBJECTIVES: ENGINEERING & SYSTEMS STUDIES

- **DEFINE BOTH DESIGN REQUIREMENTS AND DESIGN CONCEPT SELECTION FACTORS**
- **DEVELOP ALTERNATIVE DESIGN CONCEPTS**
- **EVALUATE CONCEPTS AGAINST REQUIREMENTS AND SELECTION FACTORS TO ESTABLISH ACCEPTABLE DESIGN SOLUTIONS**
- **FOR SELECTED CONCEPTS, DEVELOP INCREASED DESIGN DETAILS AND CONDUCT ENGINEERING ANALYSES**
- **FABRICATE AND TEST PROTOTYPE COMPONENTS**
- **CONTINUE DESIGN, SYSTEM STUDIES AND DESIGN ANALYSES OF WP/EBS TO DEVELOP LICENSE APPLICATION DESIGN**

INFORMATION STRUCTURE OF SPECIFIC WASTE PACKAGE DESIGN REQUIREMENTS (WPDR)

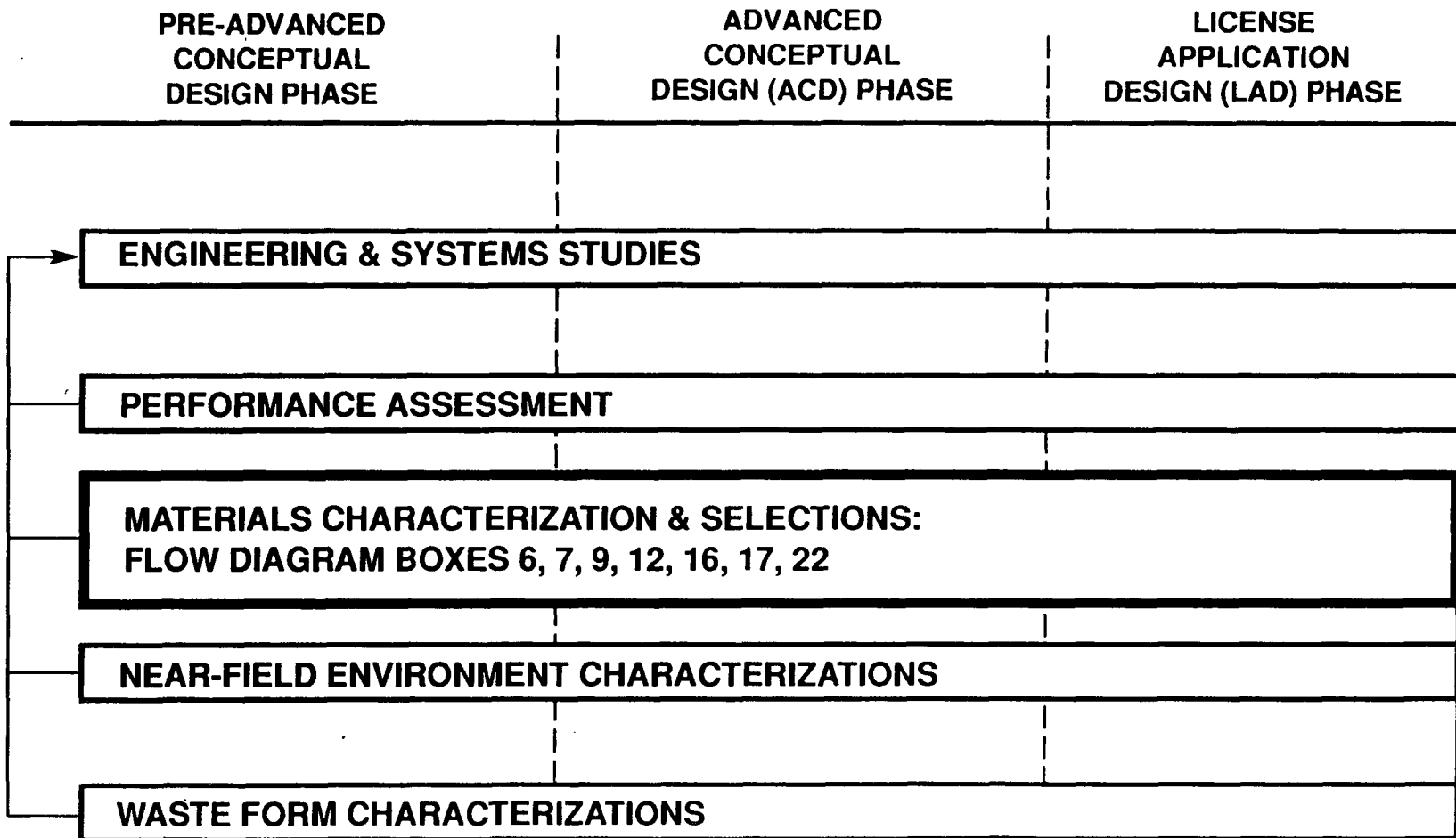


*DESIGN CONCEPT-SPECIFIC

SUMMARY OF ENGINEERING & SYSTEM STUDIES PRE-ACD FISCAL YEAR 1990-1992 ACTIVITIES

- **DEVELOP METHODOLOGY AND CRITERIA FOR EVALUATING AND SCREENING ACCEPTABLE DESIGN CONCEPTS**
- **DEVELOP ACCEPTABLE DESIGN CONCEPTS AND REDUCE TO TWO OR MORE TO BE FURTHER EVALUATED DURING ACD**
- **DEVELOP AND BASELINE SPECIFIC WPDRs (FOR SELECTED DESIGN CONCEPTS)**
- **DEFINE PHYSICAL AND FUNCTIONAL INTERFACES WITH OTHER WASTE MANAGEMENT SYSTEMS COMPONENTS**
- **CONTINUE EBS/WP AND REPOSITORY-SCALE THERMAL ANALYSES, INCLUDING ANALYSIS OF LOW TEMPERATURE EBS/WP ALTERNATIVES**
- **CONTINUE NUCLEAR CRITICALITY ANALYSES**

WASTE PACKAGE PLAN LOGIC AND TECHNICAL APPROACH DESIGN PHASES

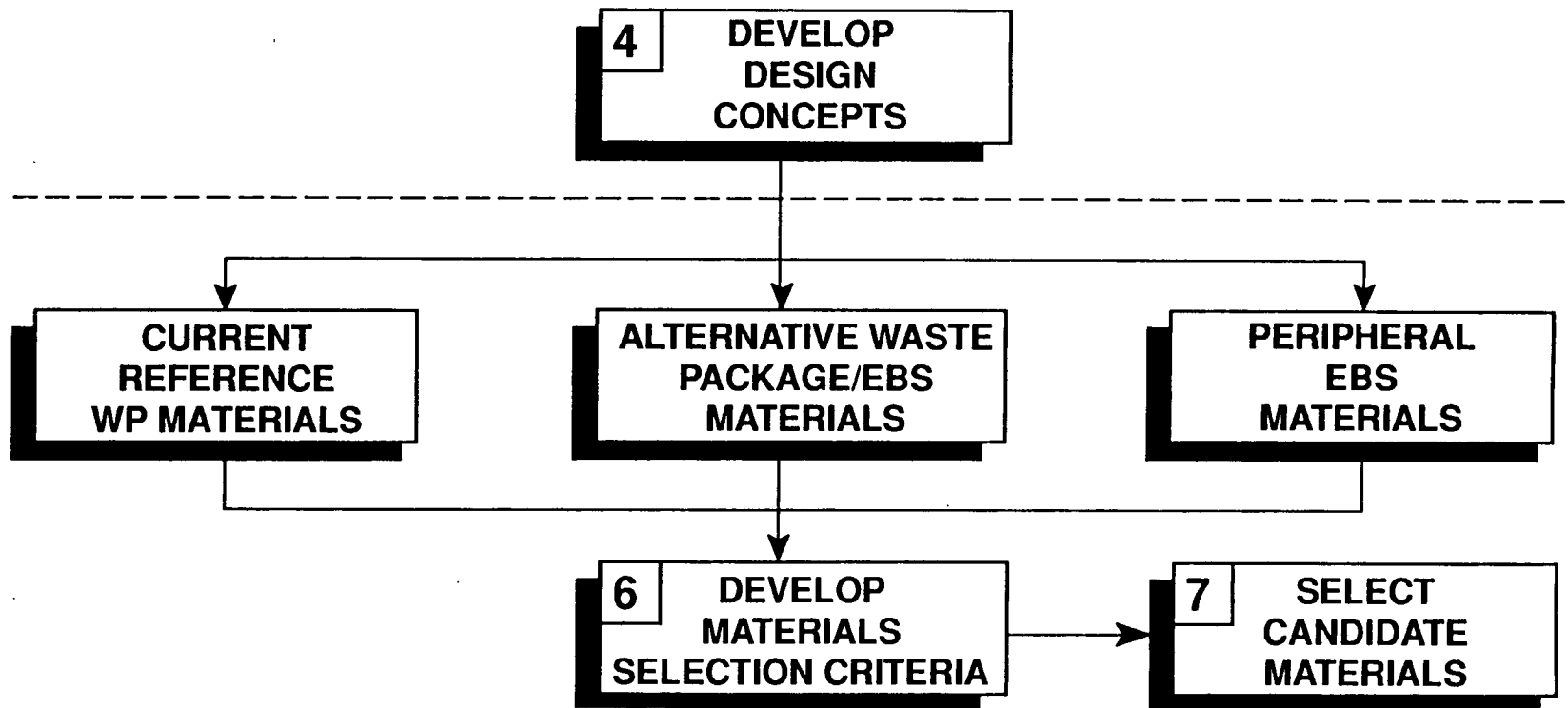


TIME →

OBJECTIVES: MATERIALS CHARACTERIZATION & SELECTIONS

- **DEVELOP METHODOLOGY AND CRITERIA TO SELECT MATERIALS**
- **SELECT MATERIALS AND FABRICATION PROCESSES FOR CONCEPTS AND COMPONENTS FOR ENGINEERING EVALUATIONS**
- **IDENTIFY THE MOST LIKELY MODES OF COMPONENT DEGRADATIONS AFTER EMPLACEMENT**
- **DEVELOP MODELS FOR PREDICTION OF COMPONENT LIFETIMES**
- **PERFORM MATERIALS TESTING REQUIRED TO SUPPORT MATERIALS SELECTION AND MODEL DEVELOPMENT**
- **DEVELOP MODELS AND DATA TO SUPPORT PERFORMANCE ASSESSMENTS, SITE SUITABILITY DETERMINATIONS, AND OTHER APPLICATIONS**

MATERIALS CHARACTERIZATION & TESTING APPROACH DURING PRE-ACD PHASE



- SINGLE METAL, THIN-WALL

- CERAMICS, COATINGS, BIMETALLICS, THICKER WALLED, FILLERS, OTHERS

- BOREHOLE LINERS, COVERS, SHIELD PLUGS, ETC.

WASTE PACKAGE REFERENCE CONCEPTUAL DESIGN

WALL THICKNESS

- **THICKNESS OF 1-3 cm AS PRESENTED IN THE NWTRB MEETING JANUARY 18-19, 1990 ARE BASED ON PAST EVENTS, ANALYSES, AND CONSTRAINTS THAT ARE BEING REEXAMINED**

- **REEXAMINATIONS WILL BE BASED ON**
 - **CURRENT AND DIFFERENT DESIGN CONCEPTS**
 - **SPECIFIC ASSOCIATED WASTE PACKAGE AND EBS MATERIALS**
 - **UNDERGROUND (SERVICE) NEAR-FIELD ENVIRONMENT AS ESTABLISHED FROM SITE CHARACTERIZATION PROGRAM ACTIVITIES**
 - **APPROPRIATE EXPERIMENTAL TESTS AND FAILURE MODE DEGRADATION MODELING**
 - **SUBSEQUENT DESIGN PHASES BEYOND CONCEPTUAL DESIGN**

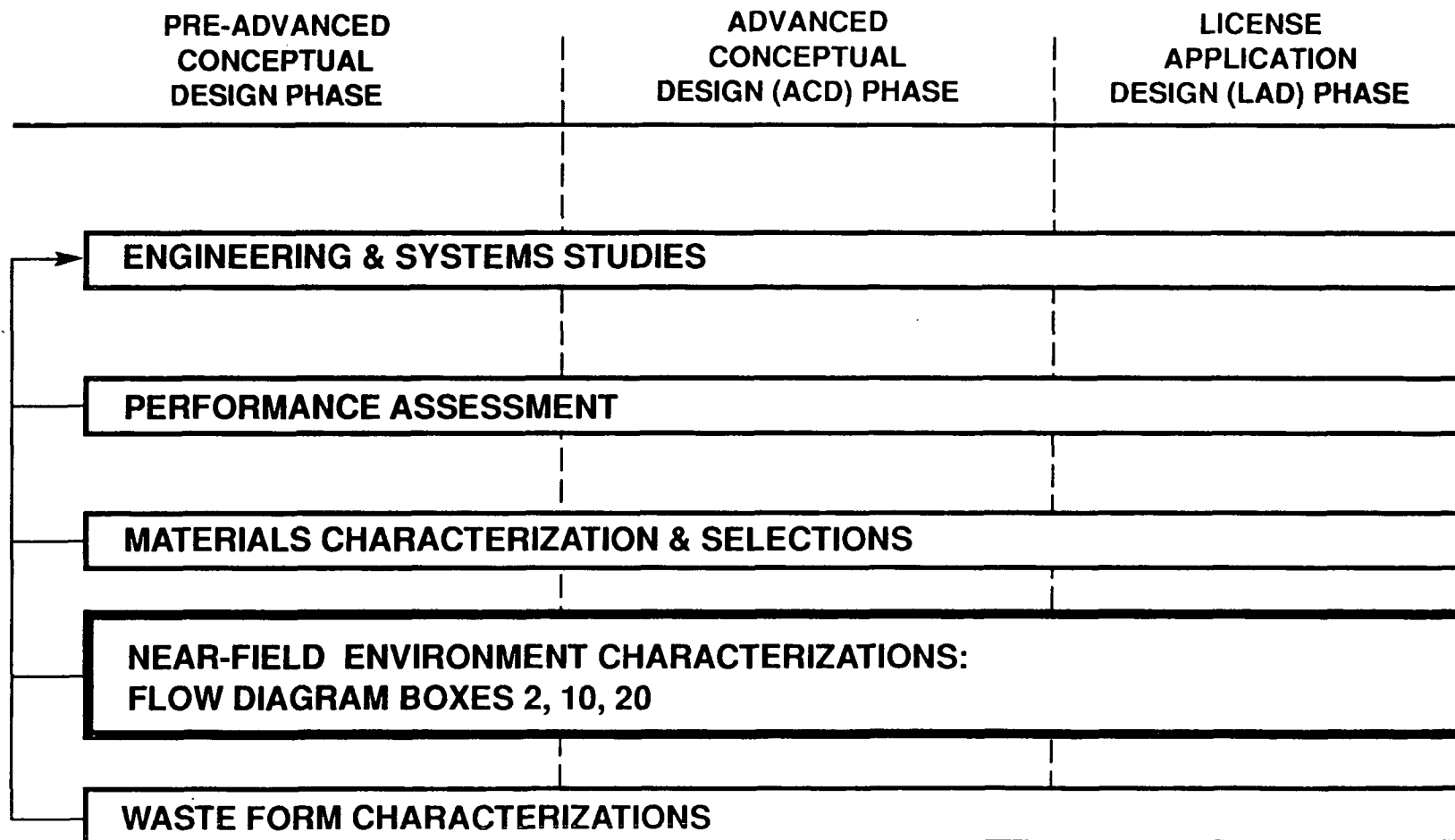
WASTE PACKAGE REFERENCE CONCEPTUAL DESIGN

(CONTINUED)

CURRENT BASES

- **REFERENCE THICKNESS 1 TO 3 cm CONSISTENT WITH**
 - **THICK ENOUGH FOR MECHANICAL LOADS (HOT & DRY)**
 - **THICK ENOUGH FOR CORROSION ALLOWANCE (HOT & DRY)**
 - **1 cm (3/8 in.) IS STANDARD MILL STOCK (SCHEDULE 40)**
 - **IS READILY WELDABLE**

WASTE PACKAGE PLAN LOGIC AND TECHNICAL APPROACH DESIGN PHASES



TIME →

OBJECTIVES: NEAR-FIELD ENVIRONMENT CHARACTERIZATIONS

- **CHARACTERIZE NEAR-FIELD GEOCHEMISTRY: WATER CHEMISTRIES, MINERAL ALTERATIONS, RADIONUCLIDE INTERACTIONS, ETC.**
- **DEVELOP FLUID FLOW AND TRANSPORT MODELS (HYDROLOGIC) BASED ON MECHANISTIC UNDERSTANDINGS OF PHENOMENA OF NEAR-FIELD ENVIRONMENT AND GEOCHEMISTRY, INCLUDING RADIONUCLIDES**
- **CHARACTERIZE THE RESPONSE OF THE NEAR-FIELD ROCK TO MECHANICAL, GEOCHEMICAL, AND THERMAL LOADS BY MODELING AND R&D TESTS**

OBJECTIVES: NEAR-FIELD ENVIRONMENT CHARACTERIZATIONS

(CONTINUED)

- **CONDUCT FIELD PROTOTYPE TESTS TO DEVELOP/
PROVE INSTRUMENTATION AND DATA ANALYSIS/
INTERPRETATION TECHNIQUES TO TRAIN PERSONNEL,
AND TO DEVELOP AND VERIFY PROCEDURES FOR
WP/EBS AND NEAR-FIELD ENVIRONMENT TESTS**
- **CONDUCT EXPLORATORY SHAFT FACILITY (ESF)
TESTS FOR WASTE PACKAGE, EBS AND NEAR-FIELD
ENVIRONMENT**
- **DEVELOP MODELS AND DATA TO SUPPORT
PERFORMANCE ASSESSMENTS, SITE SUITABILITY
DETERMINATIONS, AND OTHER APPLICATIONS**

PRELIMINARY ENVIRONMENT CHARACTERISTICS REPORT (BOX 2) (PRE-ACD MAJOR DELIVERABLE)

**INITIAL REPORT WILL BE BASED ON WHAT IS CURRENTLY
KNOWN ABOUT SITE**

1. INTRODUCTION

- NEAR-FIELD ENVIRONMENT GEOLOGIC SETTING
- HYDROLOGIC PROPERTIES
- THERMAL PROPERTIES
- MECHANICAL ATTRIBUTES (GEOMECHANICS) PROPERTIES
- MAN-MADE MATERIALS

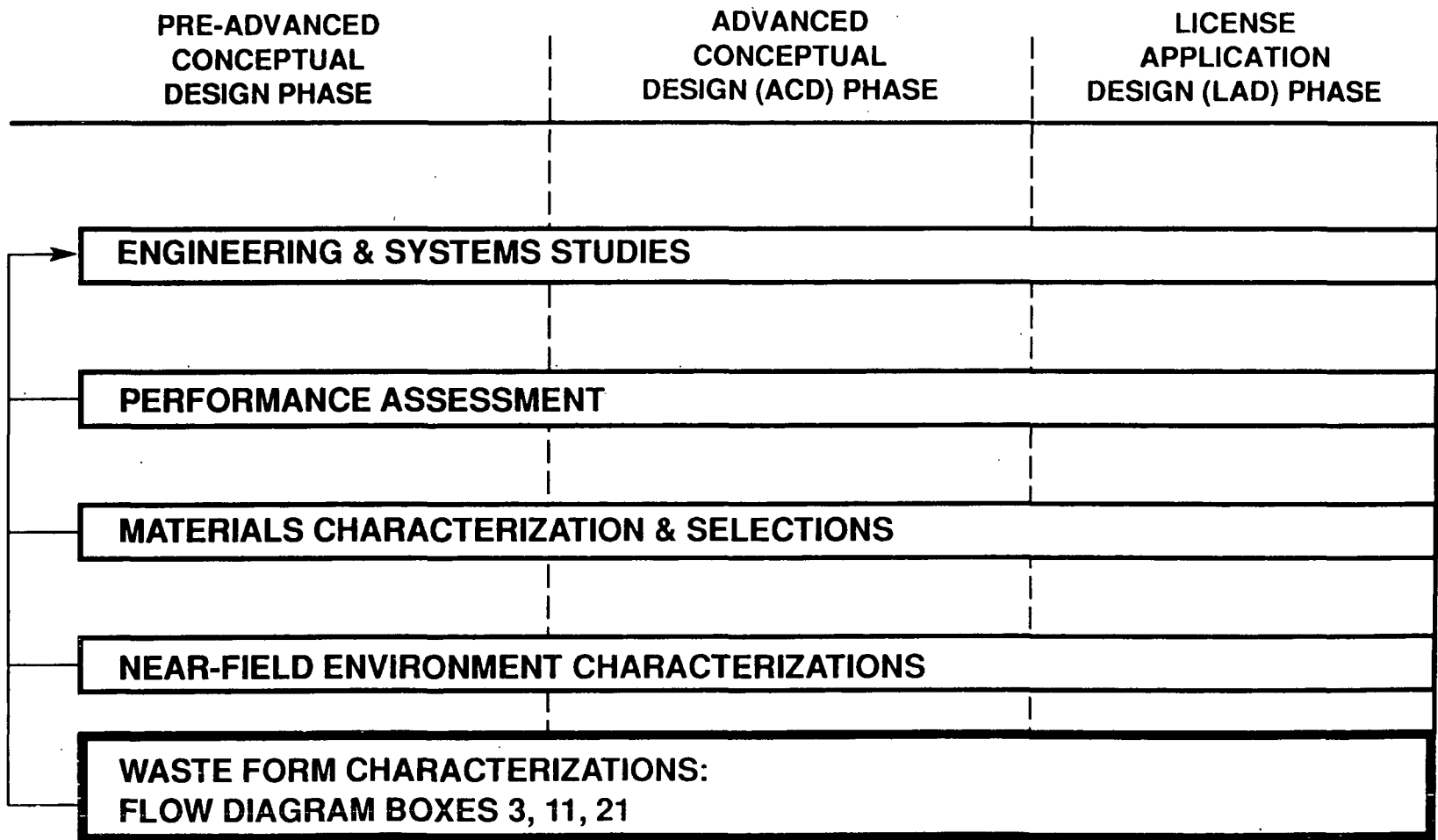
2. EFFECTS OF EMPLACED WASTES

- ANTICIPATED THERMAL HISTORY
- THERMAL EFFECTS
- RADIATION EFFECTS
- ROCK-WATER INTERACTIONS
- INDUCED ELECTRIC FIELDS
- MAN-MADE MATERIAL INTERACTIONS
- MECHANICAL ATTRIBUTES (GEOMECHANICS)
- HYDROTHERMAL CONDITIONS
- GEOCHEMICAL CONDITIONS

3. RECOMMENDED DATA NEEDS

NOTE: REPORT WILL BE BASELINED AND UPDATED AS SITE CHARACTERIZATION ACTIVITIES PROCEED

WASTE PACKAGE PLAN LOGIC AND TECHNICAL APPROACH DESIGN PHASES



TIME →

OBJECTIVES: WASTE FORM CHARACTERIZATION

- **SUMMARIZE WASTE FORM DATA NEEDED FOR ENGINEERING SYSTEMS STUDIES AND PERFORMANCE ASSESSMENTS**
- **DEVELOP PREDICTIVE MODELS FOR THE RELEASE OF RADIONUCLIDES FROM THE WASTE PACKAGES AND NEAR-FIELD ENVIRONMENT THAT INCORPORATE THE EFFECTS OF**
 - **WASTE FORM DEGRADATION**
 - **WASTE PACKAGE COMPONENT INTERACTIONS**
 - **NEAR-FIELD ENVIRONMENT INTERACTIONS, INCLUDING RADIATION EFFECTS**
- **INSURE THAT THE DATA REQUIRED BY THE MODELS ARE AVAILABLE**

OBJECTIVES: WASTE FORM CHARACTERIZATION

(CONTINUED)

- **VALIDATE THE MODELS AND DATA USING NATURAL ANALOGUES, LABORATORY EXPERIMENTS, AND PEER REVIEWS**
- **DEVELOP MODELS AND DATA TO SUPPORT PERFORMANCE ASSESSMENTS, SITE SUITABILITY DETERMINATIONS, AND OTHER APPLICATIONS**

WASTE FORM CHARACTERIZATION REPORT (BOX 3) (PRE-ACD MAJOR DELIVERABLE)

**INITIAL REPORT WILL BE BASED ON WHAT IS
CURRENTLY KNOWN ABOUT WASTE FORMS**

1. INTRODUCTION

2. WASTE FORM STRUCTURAL ATTRIBUTE DATA - SPENT FUEL

- **PWR AND BWR**
- **HARDWARE**
- **SIZES, WEIGHTS**

3. WASTE FORM RADIONUCLIDE CONTENT - SPENT FUEL

- **INVENTORIES**
- **BURNUPS AND AGES**
- **DECAY HEAT**
- **FISSION GAS, GRAIN SIZE**

4. WASTE FORM RADIONUCLIDE CONTENT - GLASS

- **INVENTORIES**
- **DECAY HEAT**
- **COMPOSITIONS**

WASTE FORM CHARACTERIZATION REPORT (BOX 3):

(CONTINUED)

5. REPOSITORY WASTE FORM RESPONSE - SPENT FUEL

- **OXIDATION**
- **DISSOLUTION**
- **CLADDING AND HARDWARE**

6. REPOSITORY WASTE FORM RESPONSE - GLASS

- **DISSOLUTION**

7. NET NEAR-FIELD REPOSITORY RELEASED RADIONUCLIDES

- **SURFACE ADSORBED**
- **POROUS TRANSPORT**

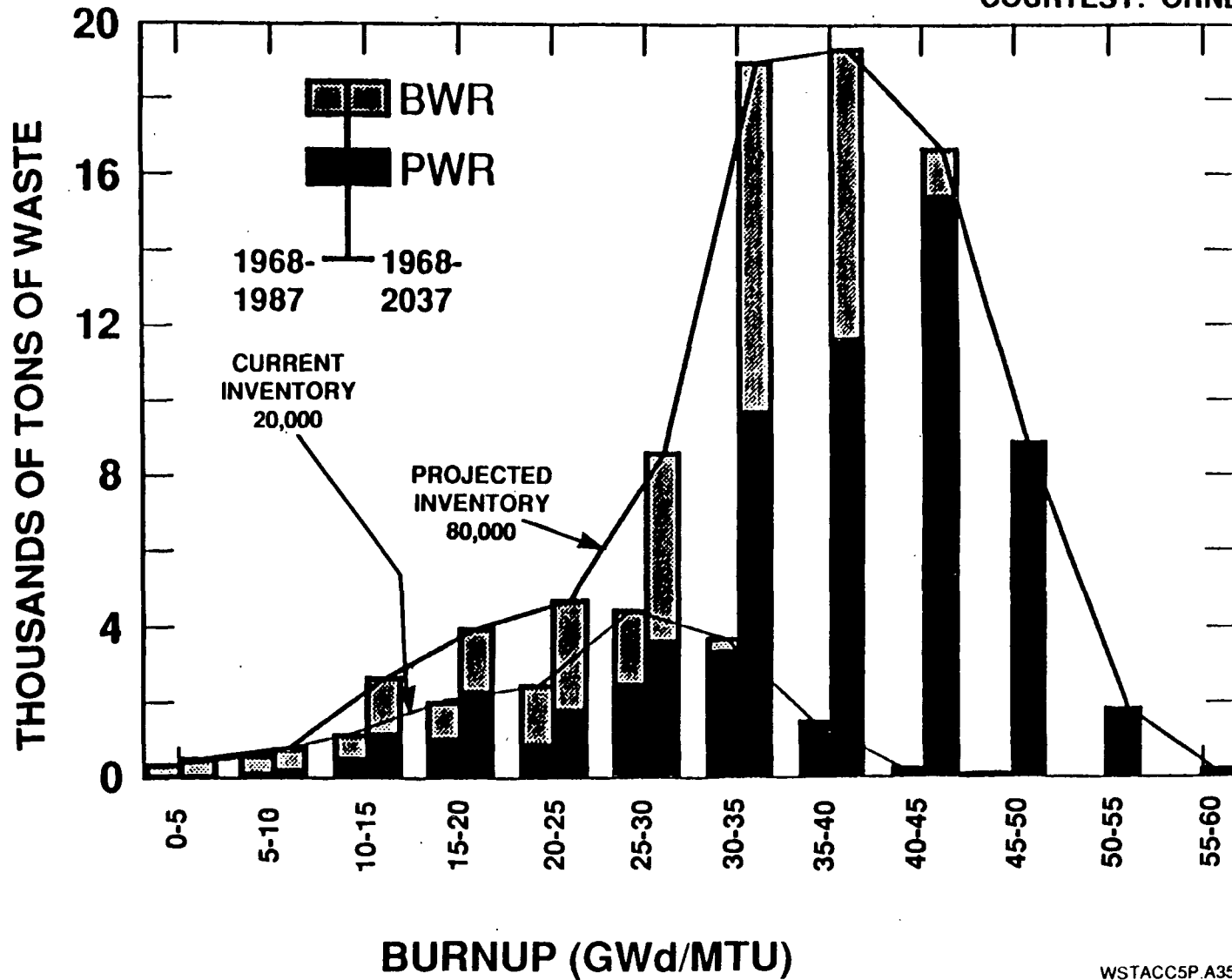
8. WASTE FORM RADIONUCLIDE CONTENT - SPECIAL CASES

- **DAMAGED SPENT FUEL**
- **RESEARCH REACTORS, HTGR, ETC.**

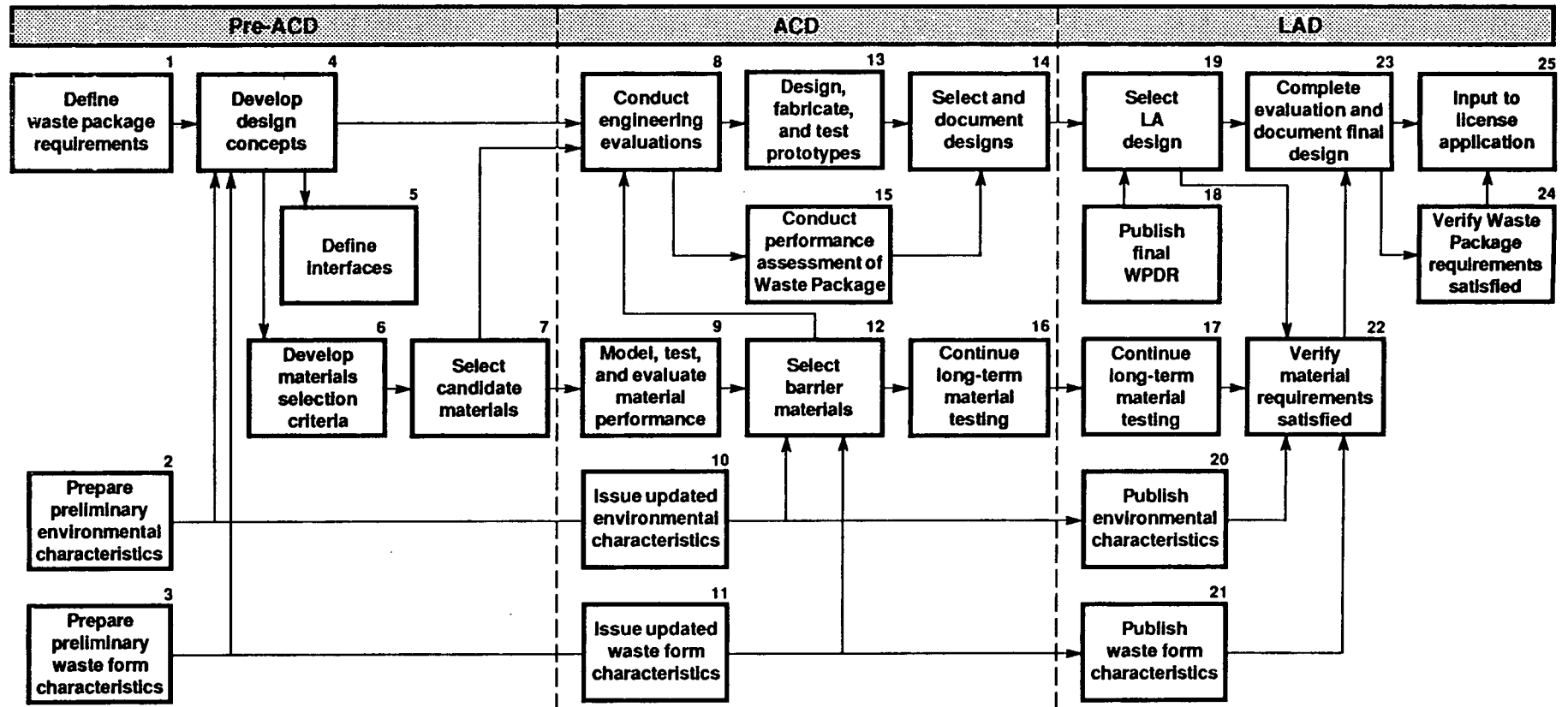
NOTE: REPORT WILL BE BASELINED AND UPDATED AS SITE CHARACTERIZATIONS PROCEED

SPENT FUEL INVENTORY- HISTORY AND PROJECTION

COURTESY: ORNL



FLOW DIAGRAM OF WASTE PACKAGE PROGRAM



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