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

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: DESIGN APPROACH - WASTE CHARACTERISTICS & INVENTORY, AREAL POWER DENSITY, AND LAYOUT DEVELOPMENT

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PRESENTER'S TITLE AND ORGANIZATION: TECHNICAL STAFF, GEOMECHANICAL ANALYSIS AND TESTING DIVISION
SANDIA NATIONAL LABORATORIES
ALBUQUERQUE, NEW MEXICO

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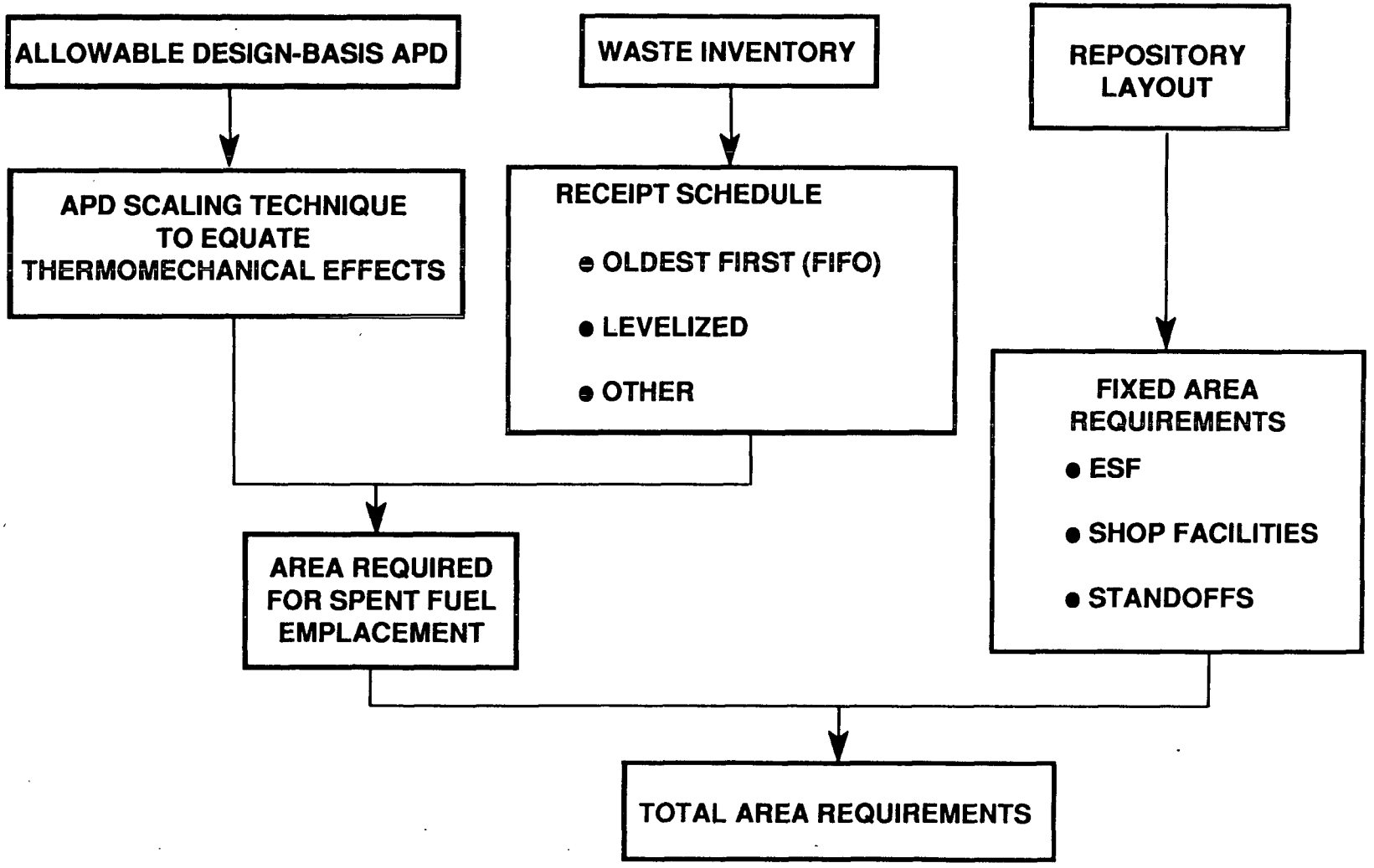
DETERMINATION OF AREA AND LAYOUT REQUIREMENTS



ORNL CHARACTERISTICS DATABASE

ASSEMBLIES DATABASE

- PHYSICAL DESCRIPTION OF INTACT FUEL ASSEMBLIES
- PHYSICAL DESCRIPTION OF SPENT FUEL DISASSEMBLY HARDWARE
- RADIOLOGICAL DESCRIPTIONS OF SPENT FUEL DISASSEMBLY HARDWARE

NON-FUEL ASSEMBLY HARDWARE DATABASE

- PHYSICAL DESCRIPTION OF NFA HARDWARE
- IDENTIFICATION OF TYPES OF FUEL ASSEMBLIES WHICH UTILIZE THE HARDWARE
- IDENTIFICATION OF REACTORS WHERE HARDWARE IS USED
- RADIOLOGICAL DESCRIPTION OF DISCHARGED NFA HARDWARE

HIGH LEVEL WASTE DATABASE

- PHYSICAL , CHEMICAL, AND RADIOLOGICAL PROPERTIES OF HIGH LEVEL WASTE

ORNL CHARACTERISTICS DATABASE

(CONTINUED)

RADIOLOGICAL DATABASE

- DATA ABOUT RADIONUCLIDES AT DIFFERENT BURNUPS AND DECAY TIMES
- ADDITIONS COVERING:
  - CALCULATED INTEGRATED HEAT RELEASE
  - PHOTON AND NEUTRON DATA

QUANTITIES DATABASE

- QUANTITIES OF LWR SPENT FUEL ASSEMBLIES
- INCLUDES BOTH HISTORICAL AND PROJECTED DATA THROUGH 2037
- DATA TAKEN DIRECTLY FROM OFFICIAL INFORMATION PROVIDED BY THE ENERGY INFORMATION ADMINISTRATION AND PACIFIC NORTHWEST LABORATORIES

TOTALS AND CALCULATED INTEGRAL HEAT RELEASE DATABASE SYSTEM

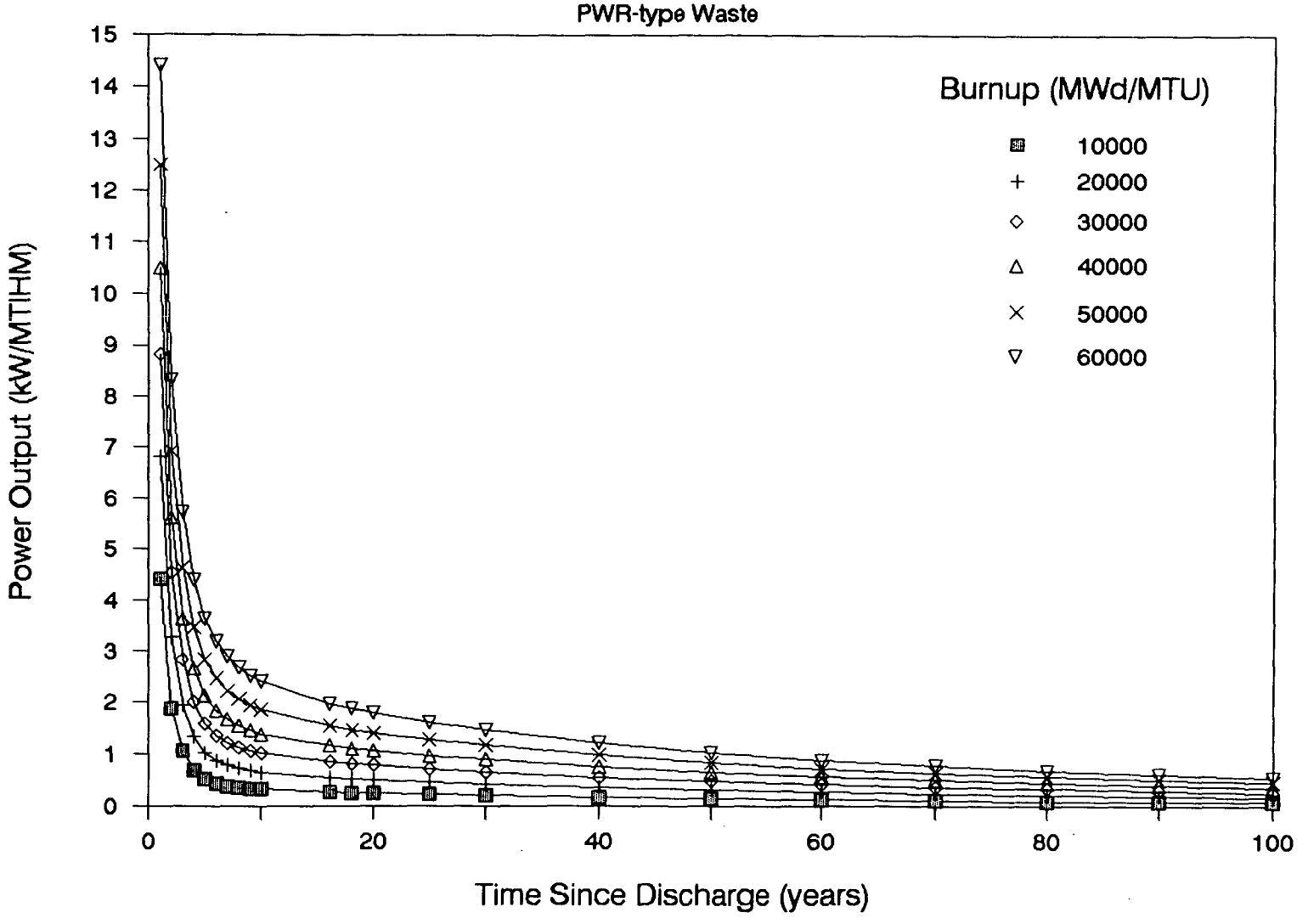
- PROVIDES DATA ON THE TOTAL RADIOACTIVITY (CURIES) AND HEAT OUTPUT (WATTS) FROM LWR SPENT FUEL AS A FUNCTION OF TIME AFTER DISCHARGE FROM THE REACTOR

- ORIGEN CODE USED IN CALCULATIONS

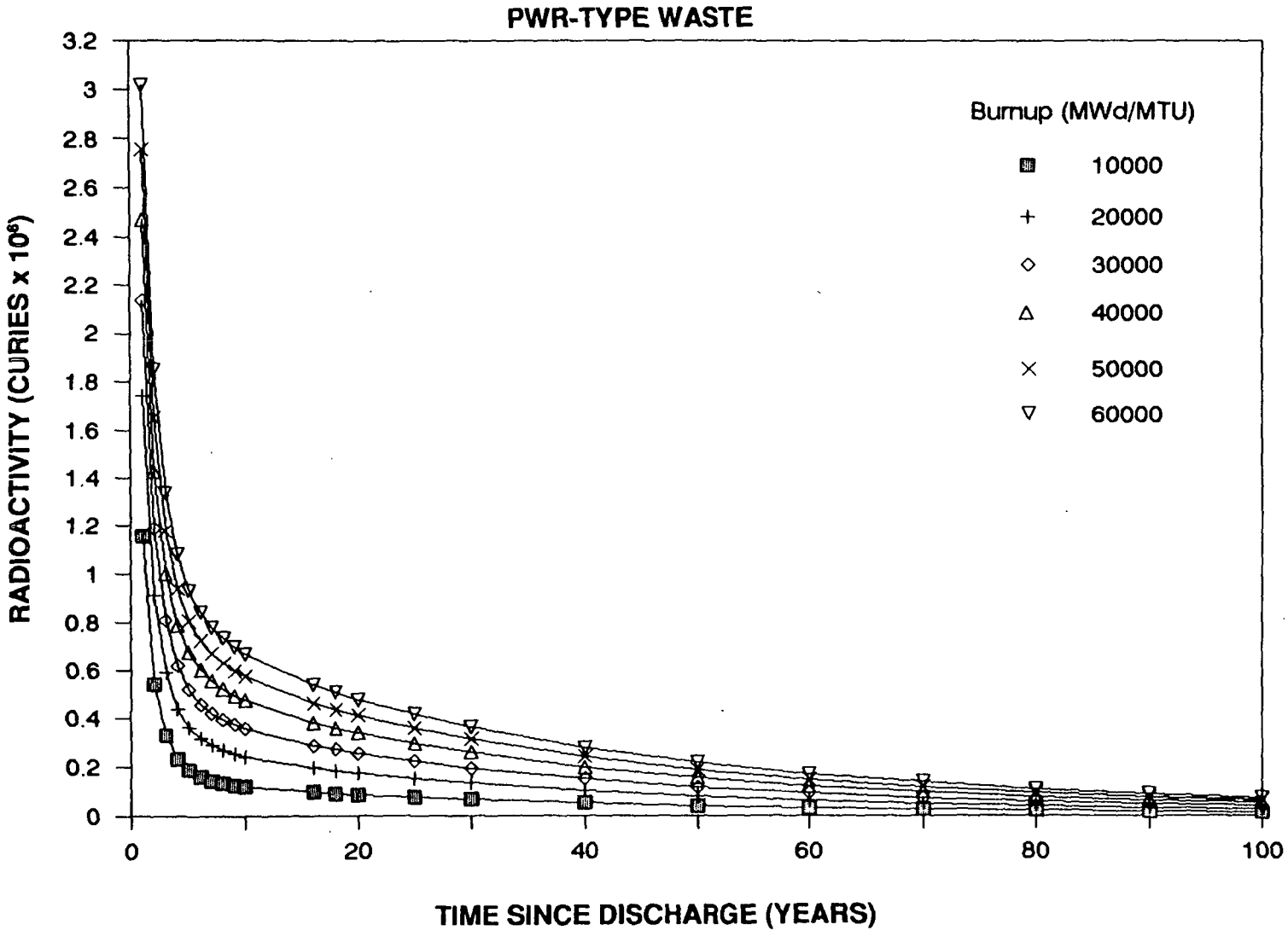
  - ORIGEN2 CODE PERFORMS TWO MAJOR COMPUTATIONAL FUNCTIONS, ISOTOPE GENERATION AND ISOTOPE DEPLETION, BOTH WITHIN THE CORE OF AN OPERATING REACTOR AND AFTER SHUTDOWN

- CALCULATIONS ARE BASED ON ONE MTIHM

THERMAL DECAY CHARACTERISTICS



RADIOLOGICAL CURVE



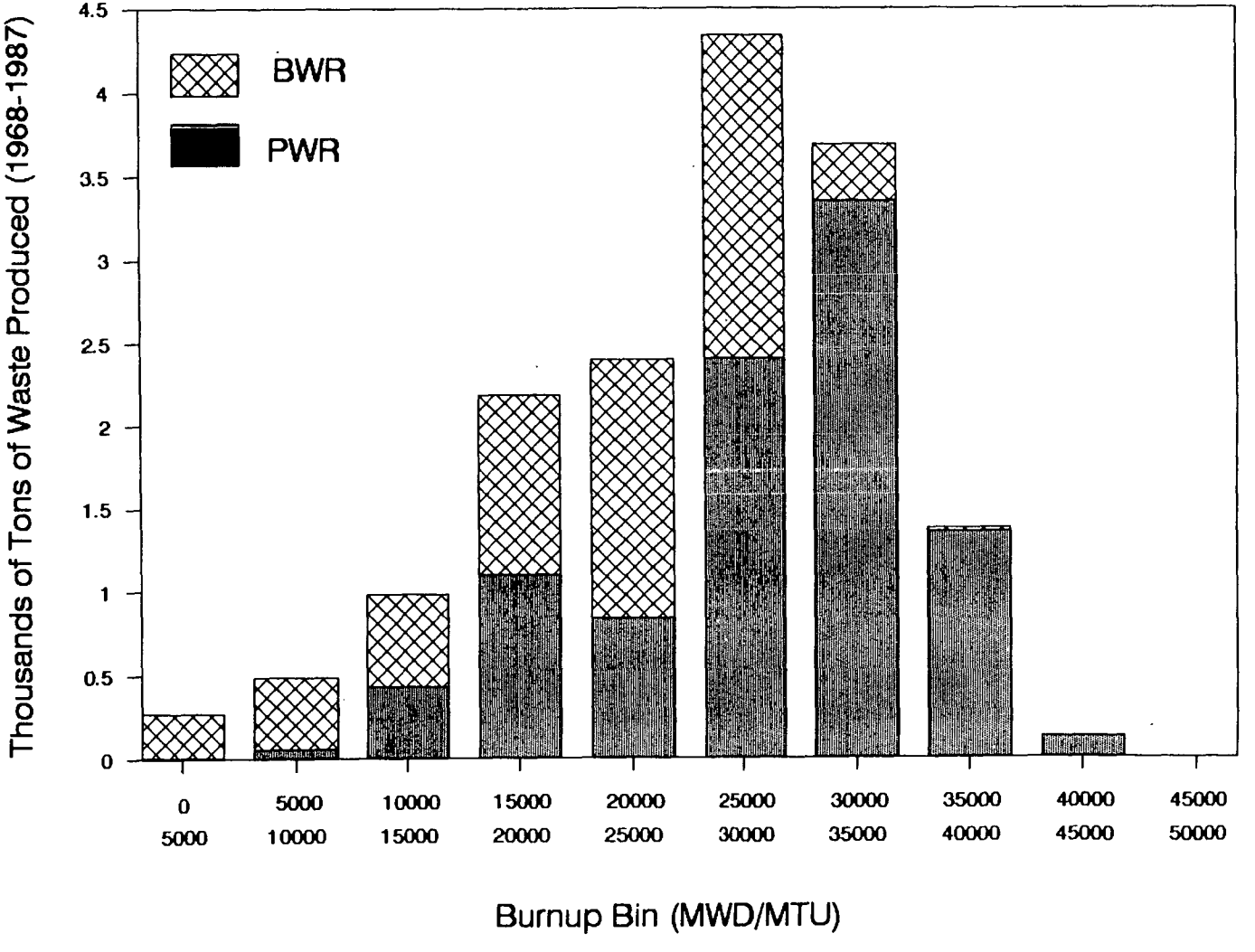
ORNL HISTORICAL AND PROJECTED WASTE INVENTORIES

- HISTORICAL INVENTORY (1968 THROUGH 1987) REPRESENTS APPROXIMATELY 16,000 TONS OF WASTE

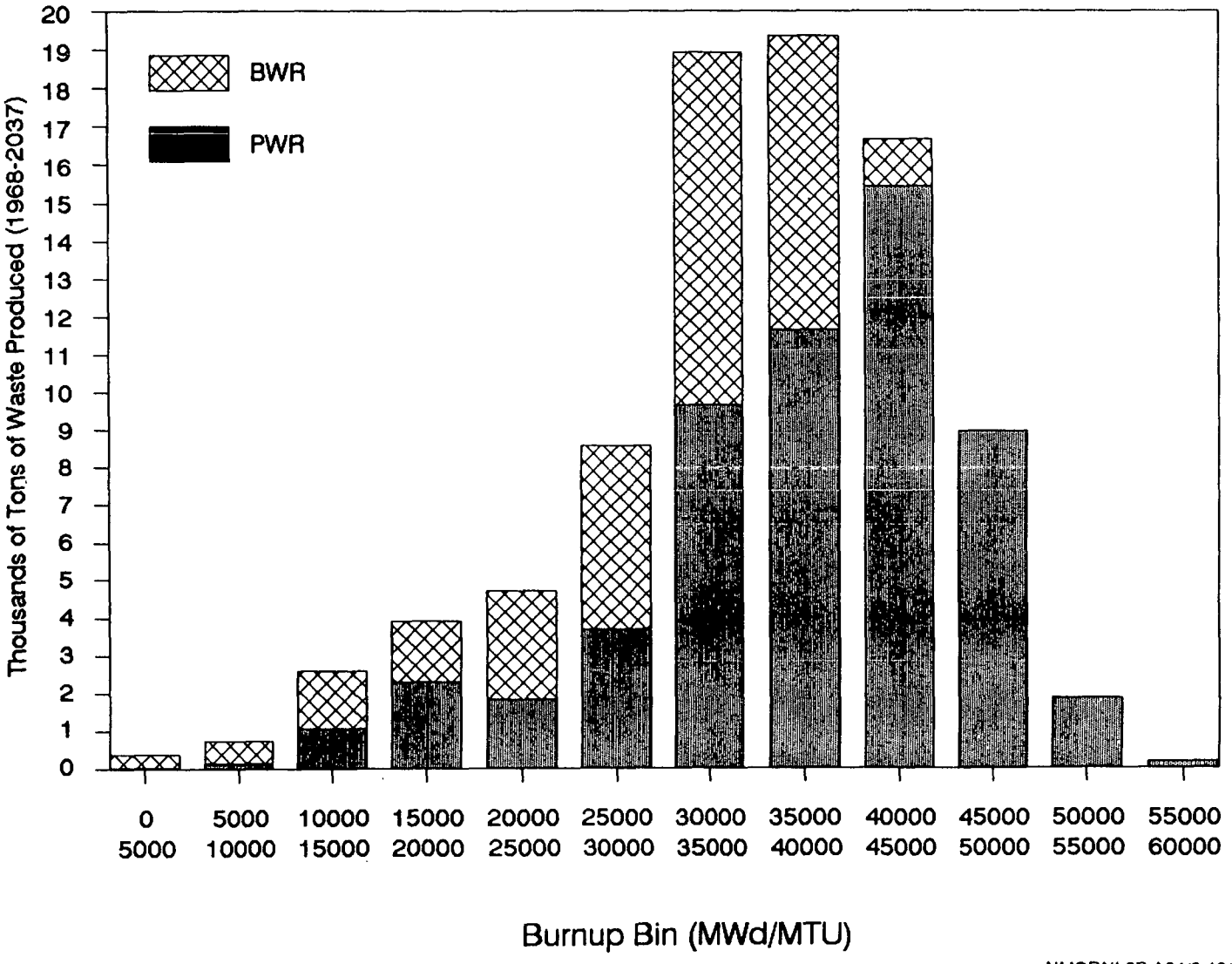
- THE ONLY INVENTORY PROJECTION SCENARIO INCLUDED IN THE ORNL CHARACTERISTICS DATABASE IS THE "NO NEW ORDERS-EXTENDED BURNUP" CASE

- BASED ON THE ORNL PROJECTIONS, AN INVENTORY OF 87,000 TONS OF WASTE WILL BE AVAILABLE AT THE END OF DISCHARGE YEAR 2037

ORNL HISTORICAL WASTE INVENTORY (1968-1987)



ORNL HISTORICAL AND PROJECTED WASTE INVENTORY (1968-2037)

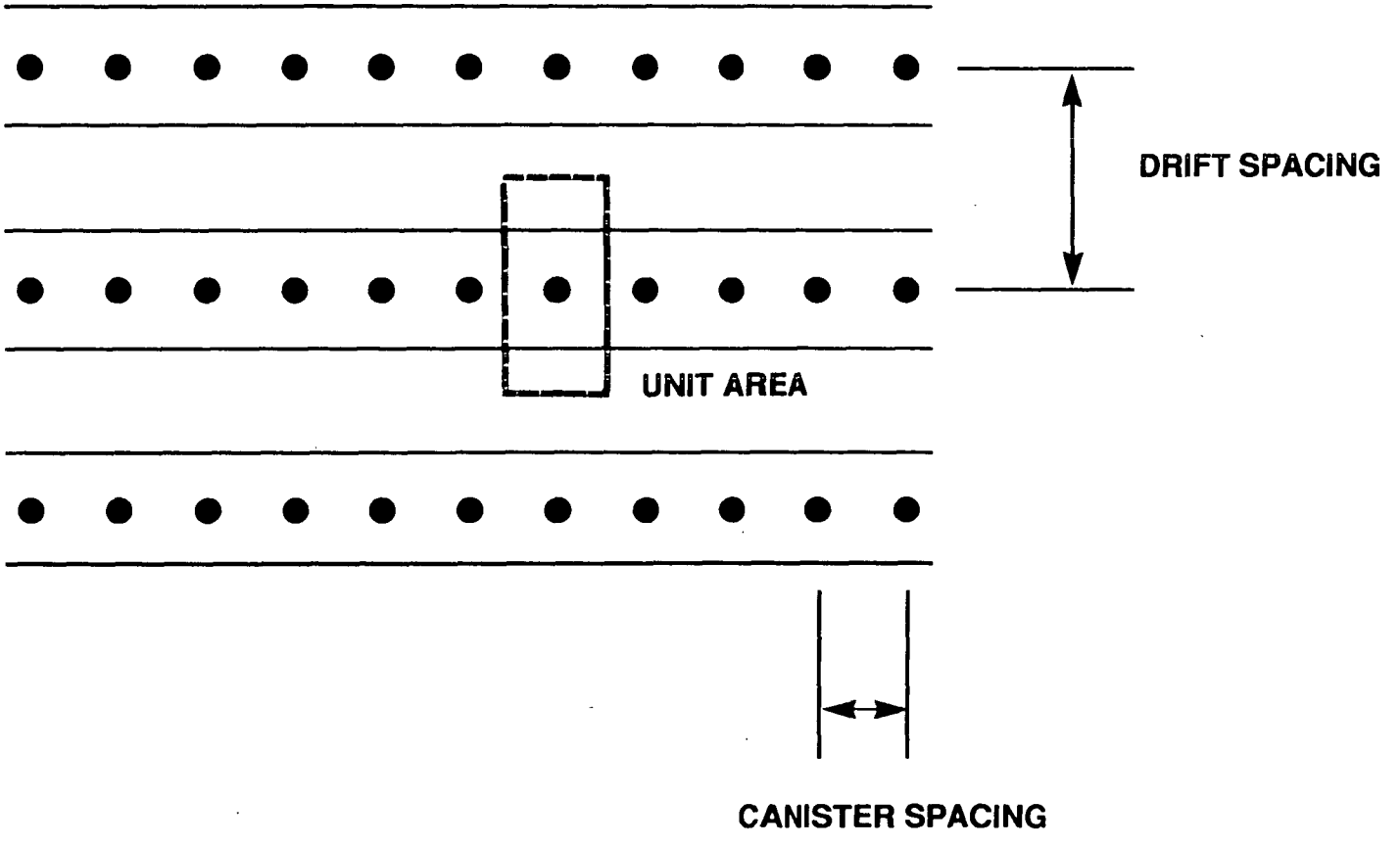


ORNL CHARACTERISTICS DATABASE

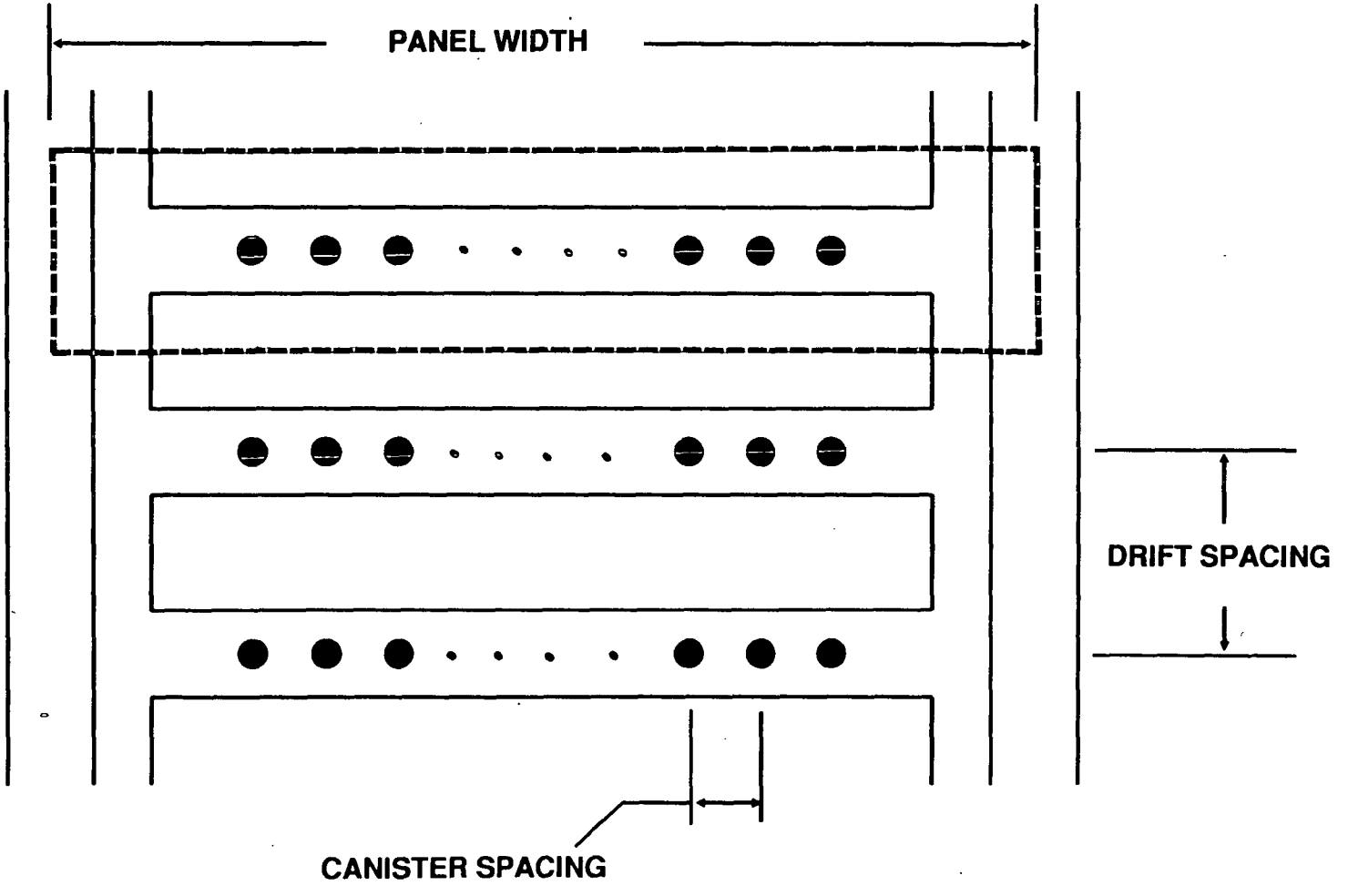
SUMMARY

- PHYSICAL DESCRIPTION INFORMATION PROVIDED BY FUEL ASSEMBLY MANUFACTURER
- RADIOLOGICAL DESCRIPTIONS ESTIMATED USING ORIGEN2 COMPUTER CODE BASED ON MANUFACTURER SUPPLIED INFORMATION
- NEXT SCHEDULED UPDATE IN JULY 1990, THEREAFTER ON AN ANNUAL BASIS
- UNSCHEDULED UPDATES AS REQUIRED

LOCAL AREAL POWER DENSITY (LAPD) = INITIAL LOADING / UNIT AREA



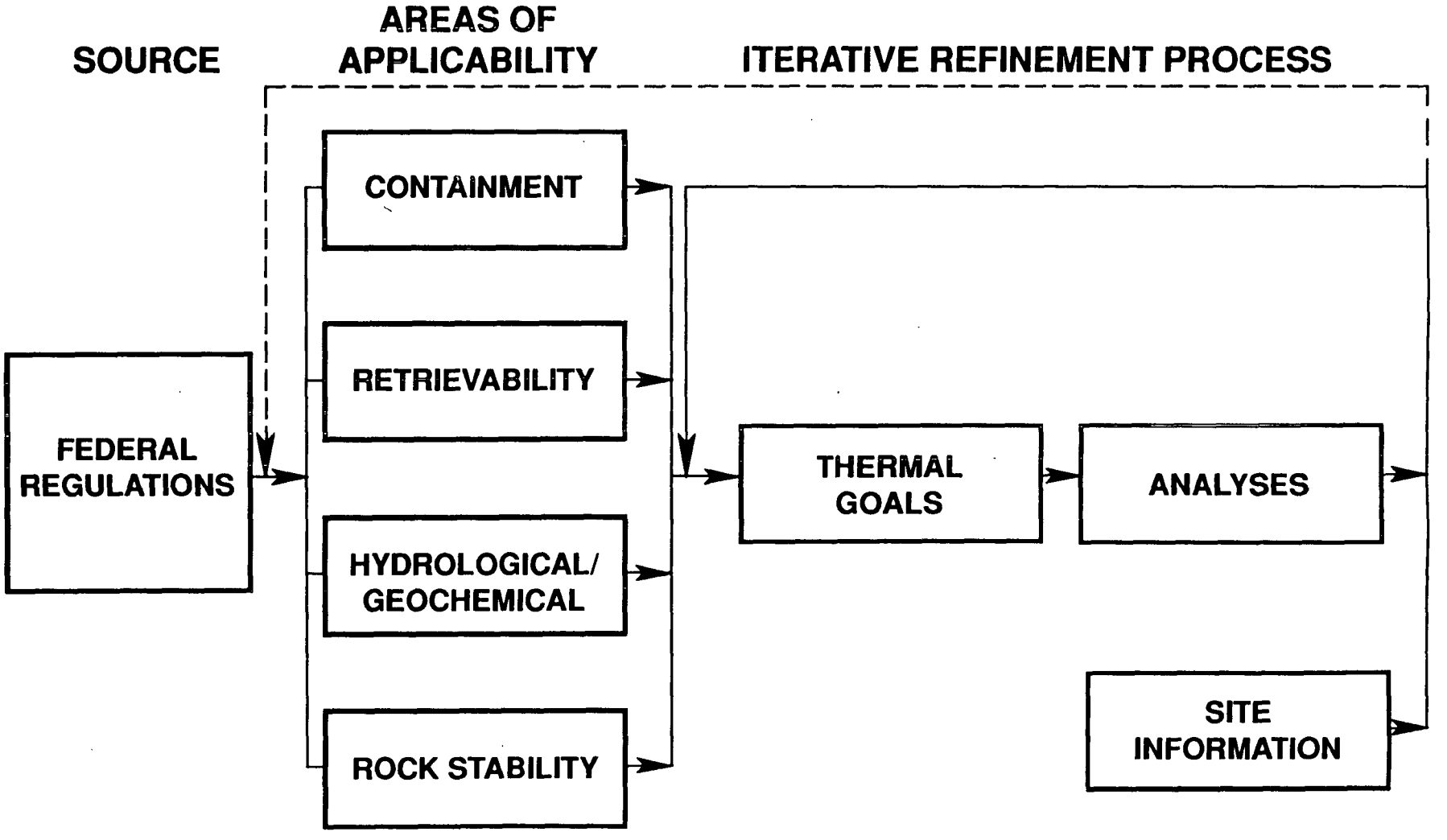
AREAL POWER DENSITY (APD) = INITIAL LOADING / UNIT AREA



AREAL POWER DENSITY (APD)

- HISTORICAL DESIGN-BASIS APD IS 57 kW/ACRE AS ESTABLISHED IN THE UNIT EVALUATION STUDY (JOHNSTONE ET AL., 1984)
- BASED ON WASTE CONCENTRATION THAT PRODUCED EMPLACEMENT DRIFT FLOOR TEMPERATURES ON THE ORDER OF 100° C
- BECAUSE OF CHANGES IN THE REPOSITORY VENTILATION DESIGN, THE 100° C EMPLACEMENT DRIFT FLOOR TEMPERATURE IS NO LONGER A CONSTRAINT

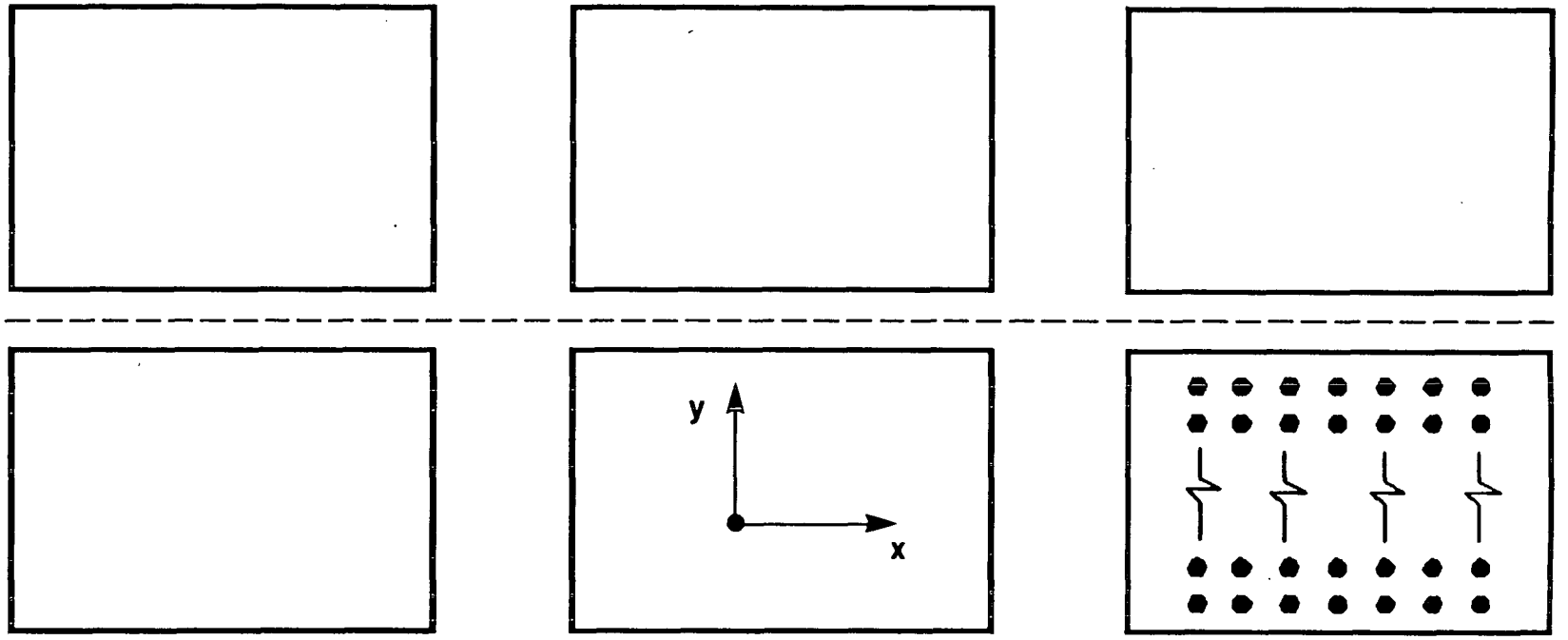
THERMAL DESIGN GOAL DEFINITION PROCESS



SCP THERMAL GOALS

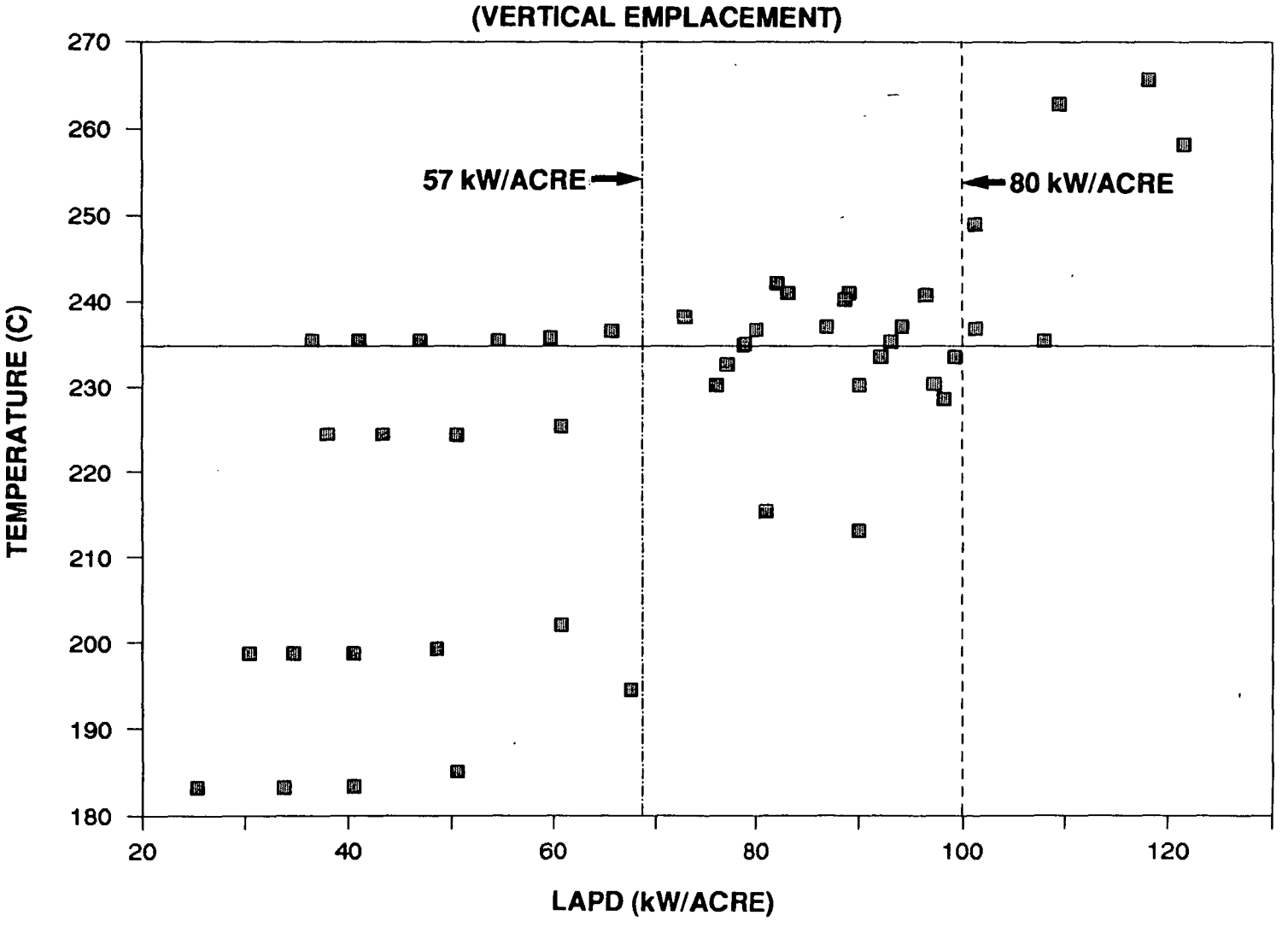
PERFORMANCE MEASURE	GOAL
CLADDING INTEGRITY	CONTAINER CENTERLINE $T < 350^{\circ}$ C BOREHOLE WALL $T < 275^{\circ}$ C
NEAR-FIELD ROCK MASS INTEGRITY	ONE METER FROM BOREHOLE $T < 200^{\circ}$ C
ACCESS DRIFT WALL TEMPERATURE	$T_{wall} < 50^{\circ}$ C FOR 50 YEARS
TEMPERATURE CHANGE IN ADJACENT STRATA	TSw2 - TSw3 INTERFACE $T < 115^{\circ}$ C
SURFACE ENVIRONMENT	TEMPERATURE CHANGE $< 6^{\circ}$ C
LIMIT CORROSIVENESS OF CANISTER ENVIRONMENT	MAXIMIZE TIME SPENT ABOVE BOILING IN BOREHOLE ENVIRONMENT

REPOSITORY MODEL

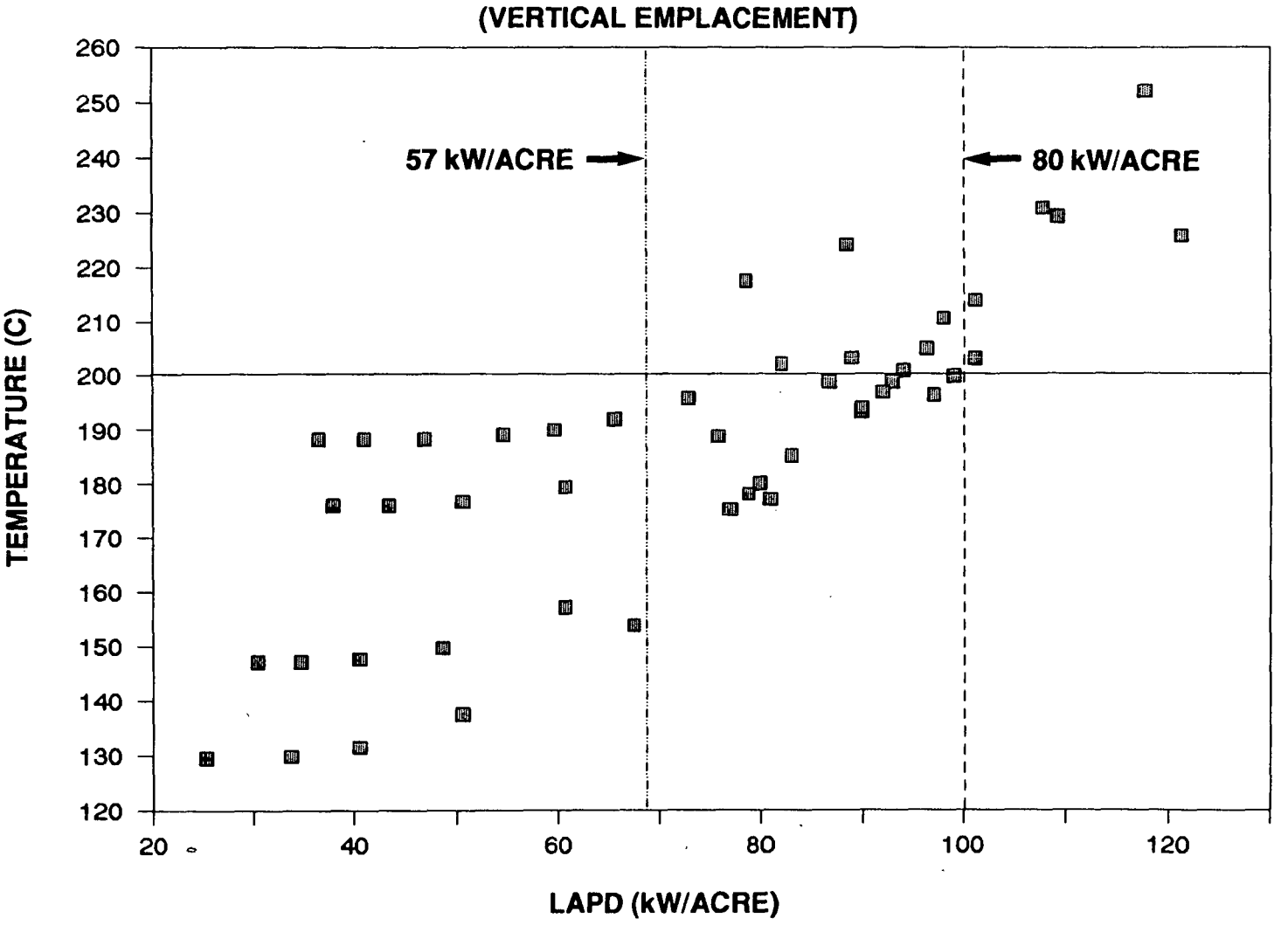


- ANALYTICAL SOLUTION (3-D LINEAR SUPERPOSITION OF HEAT-GENERATING POINTS AND CYLINDERS)
- SIMPLIFIED SIX-PANEL GEOMETRY
- FUEL MODELED AS 60% PWR AND 40% BWR (HYBRID CANISTERS) ASSUMED TO BE TEN YEARS OUT-OF-REACTOR
- SIMULTANEOUS EMPLACEMENT

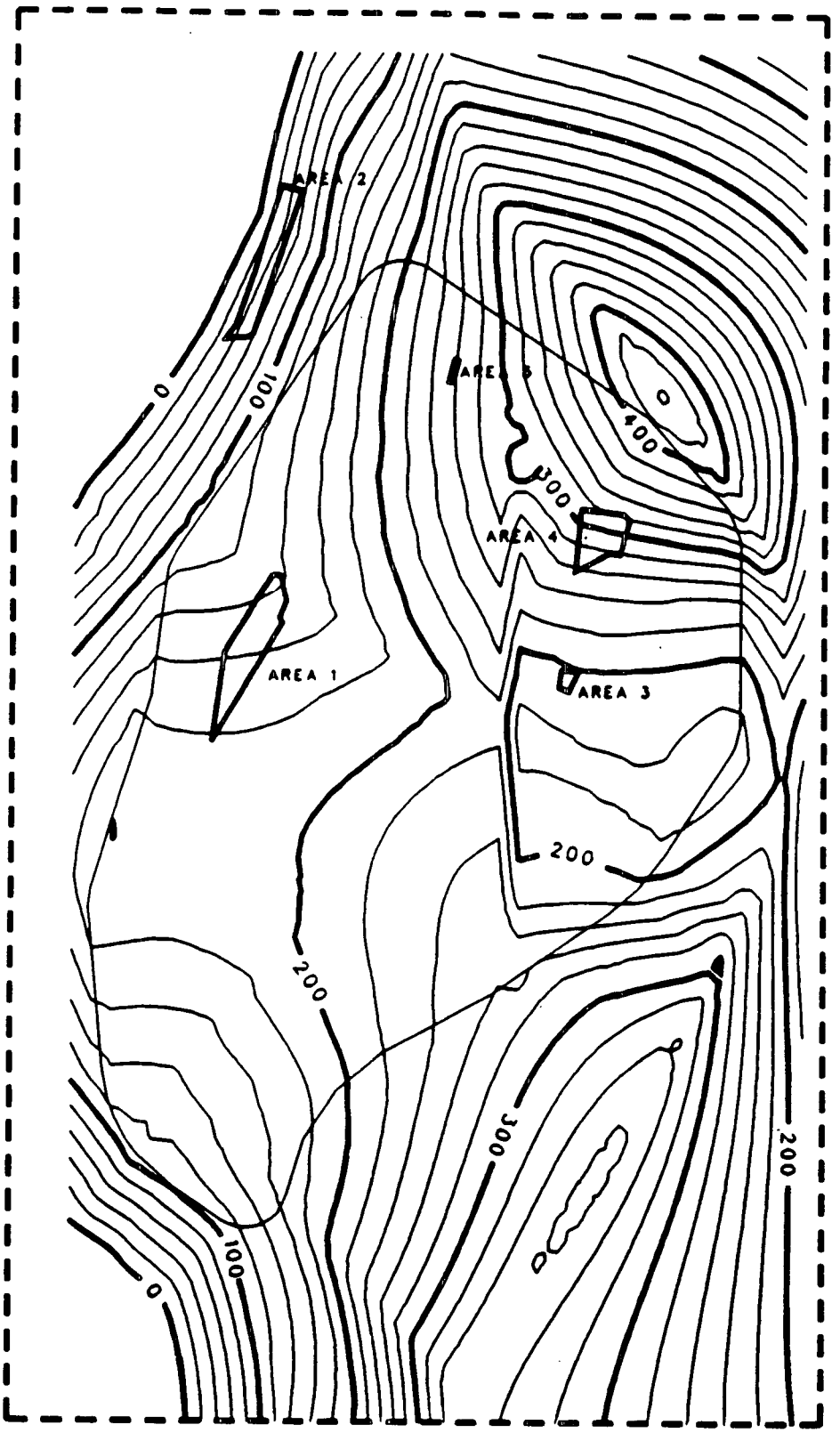
PEAK BOREHOLE WALL TEMPERATURE vs LAPD



PEAK ONE-METER TEMPERATURE vs LAPD



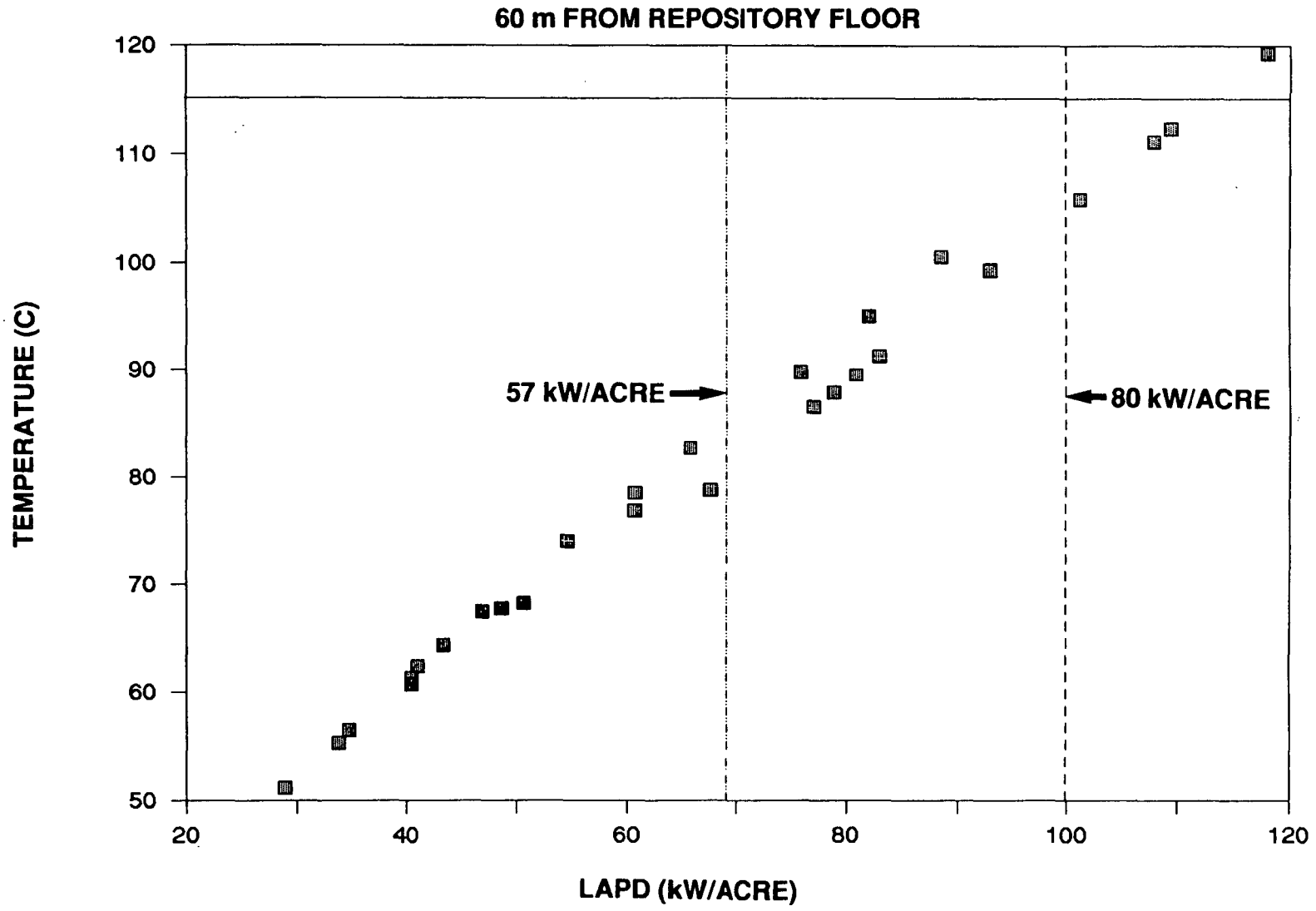
TSw3 STANDOFF



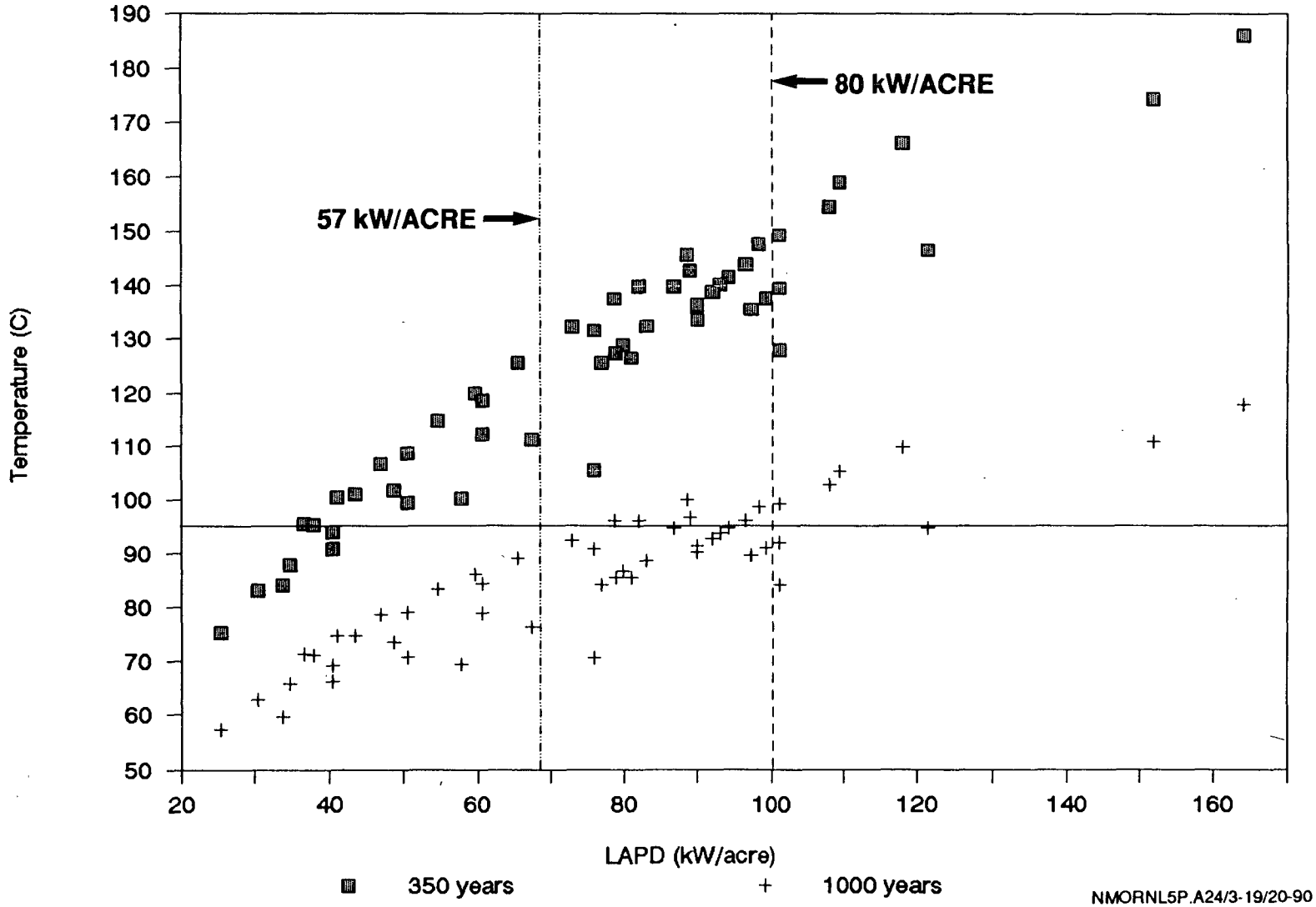
CONTOUR INTERVAL OF 20 FT

THICKNESS OF UNIT TWs2

TSw2/TSw3 INTERFACE PEAK TEMPERATURE



BOREHOLE WALL TEMPERATURE vs LAPD
(VERTICAL EMPLACEMENT)



APD SUMMARY

- HISTORICAL DESIGN-BASIS APD OF 57 kW/ACRE EASILY SATISFIES ALL CURRENT SCP THERMAL GOALS

- ADDITIONAL THERMAL CALCULATIONS INDICATE THAT THE DESIGN-BASIS APD COULD BE RAISED TO 80 kW/ACRE

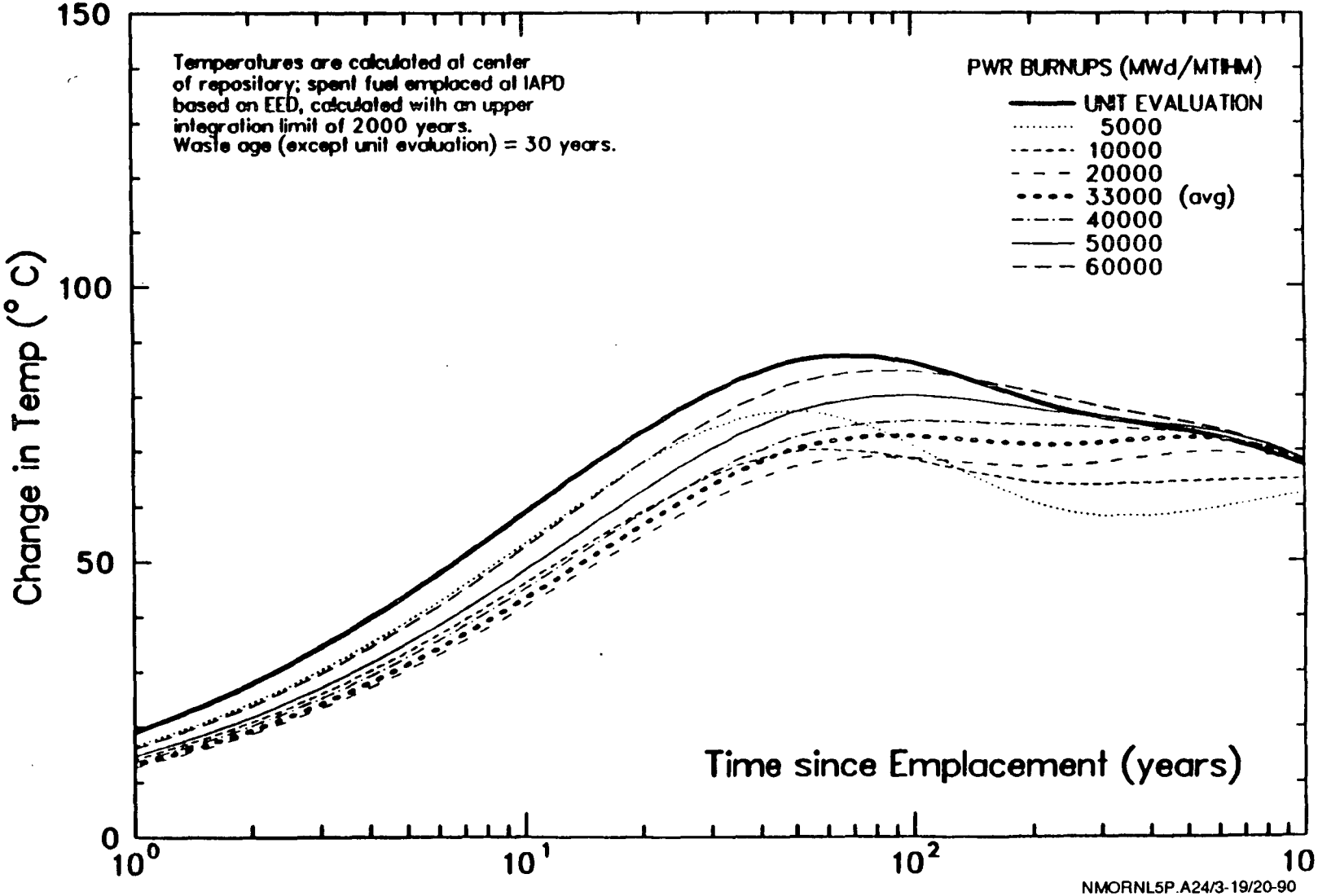
APD SCALING TECHNIQUES

THE TWO CURRENT METHODS OF SCALING WASTE EMPLACEMENT CONCENTRATIONS ARE:

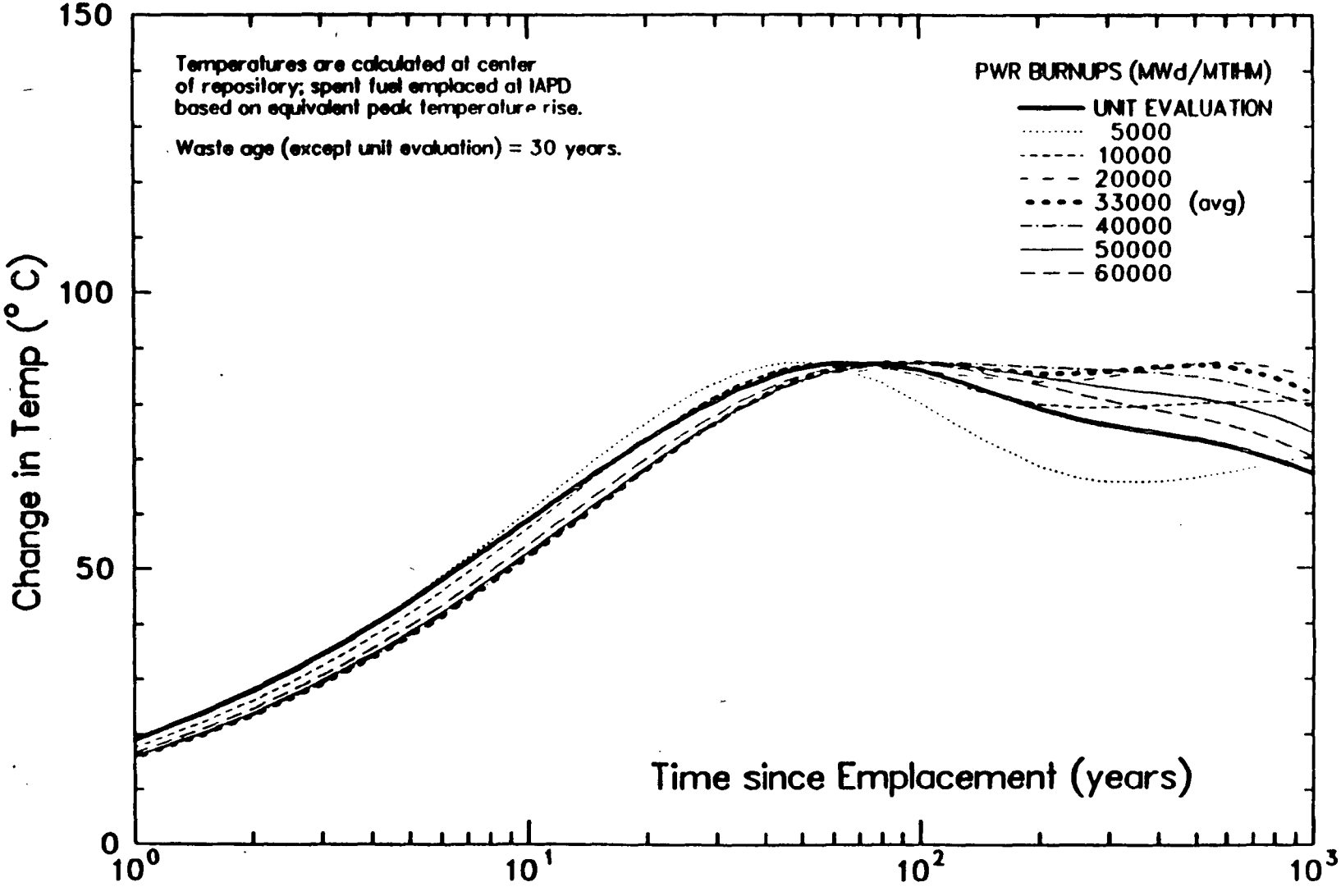
1. EQUIVALENT ENERGY DENSITY (EED) CONCEPT

2. EQUIVALENT PEAK TEMPERATURE RISE (EPTR) CONCEPT

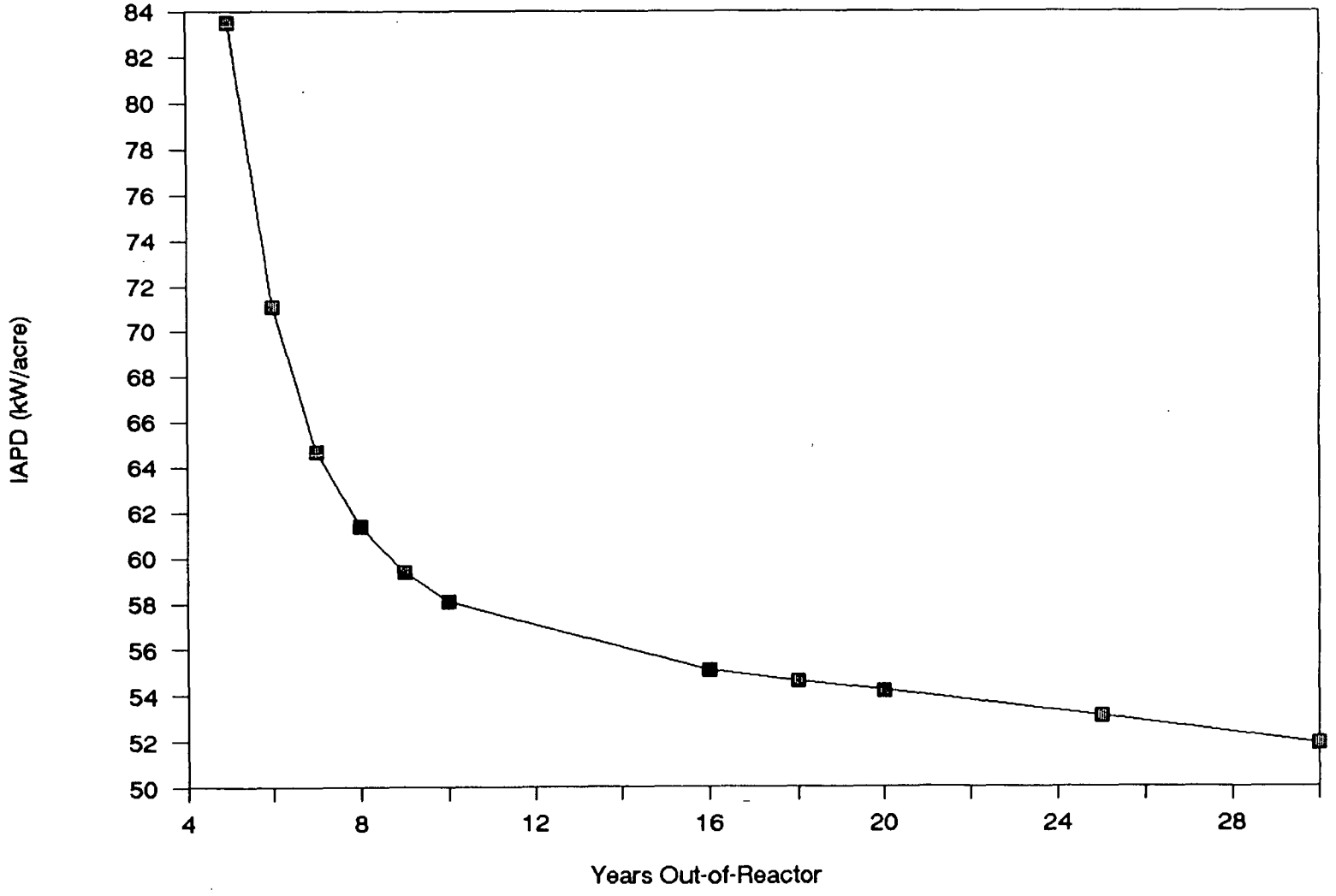
TEMPERATURE HISTORIES OBTAINED USING EQUIVALENT ENERGY DENSITY OF 30-YEAR-OLD PWR SPENT FUEL



TEMPERATURE HISTORIES OBTAINED USING EQUIVALENT THERMAL LOAD OF 30-YEAR-OLD PWR SPENT FUEL



INITIAL APD AS A FUNCTION OF WASTE AGE FOR PWR FUEL WITH A BURNUP OF 10,000 MWd/MTU FOR A DESIGN BASIS APD OF 57 kW/ACRE



WASTE RECEIPT SCHEDULES

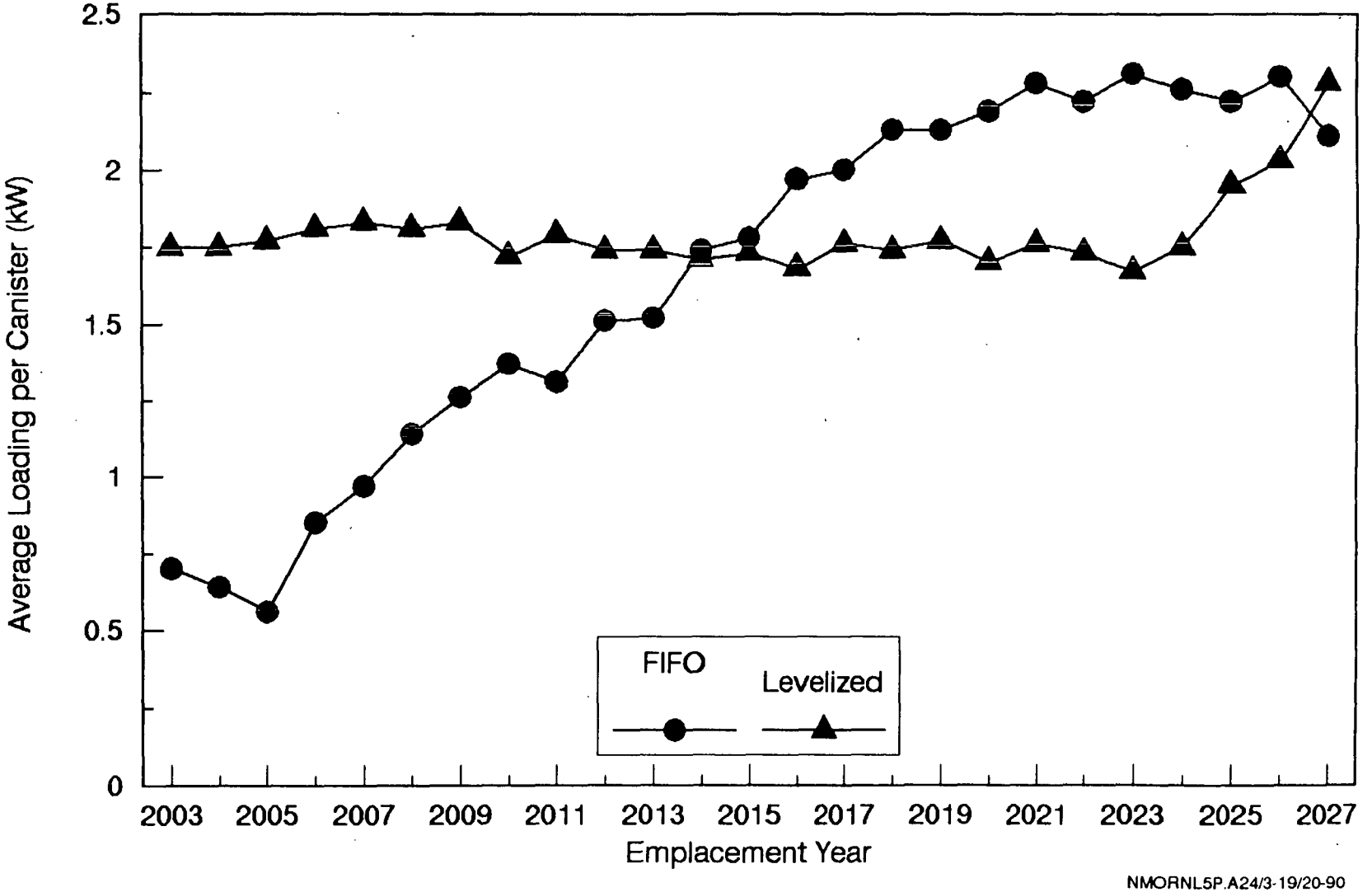
FIFO OR "OFF"

- THE DESIGN-BASIS OF THE SCP-CDR WAS "OLDEST FUEL FIRST," THAT IS, THE OLDEST (AND RELATIVELY LOW BURNUP) FUEL WOULD BE EMPLACED FIRST FOLLOWED BY PROGRESSIVELY YOUNGER (AND HIGHER BURN-UP) FUEL
- THE RESULTING WASTE STREAM EXHIBITS THE CHARACTERISTICS OF MONOTONICALLY DECREASING AGE AT EMPLACEMENT AND A CORRESPONDING INCREASE IN AVERAGE BURNUP

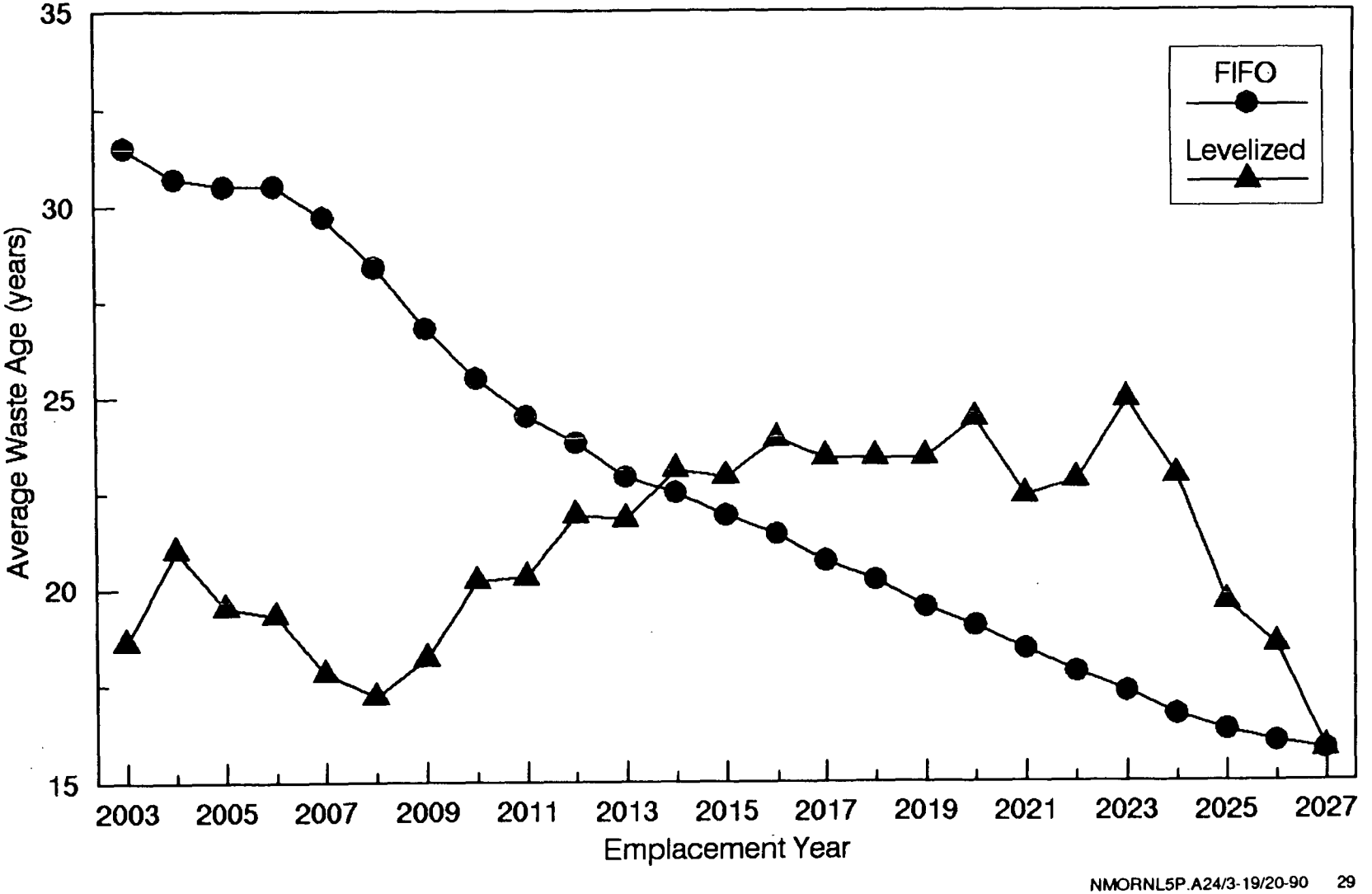
LEVELIZED

- A "LEVELIZED" RECEIPT SCHEDULE REFERS TO A WASTE STREAM THAT IS CHOSEN FROM THE AVAILABLE INVENTORY SUCH THAT THE WASTE EXHIBITS NEARLY LEVELIZED YEARLY ENERGY DENSITY AND AGE

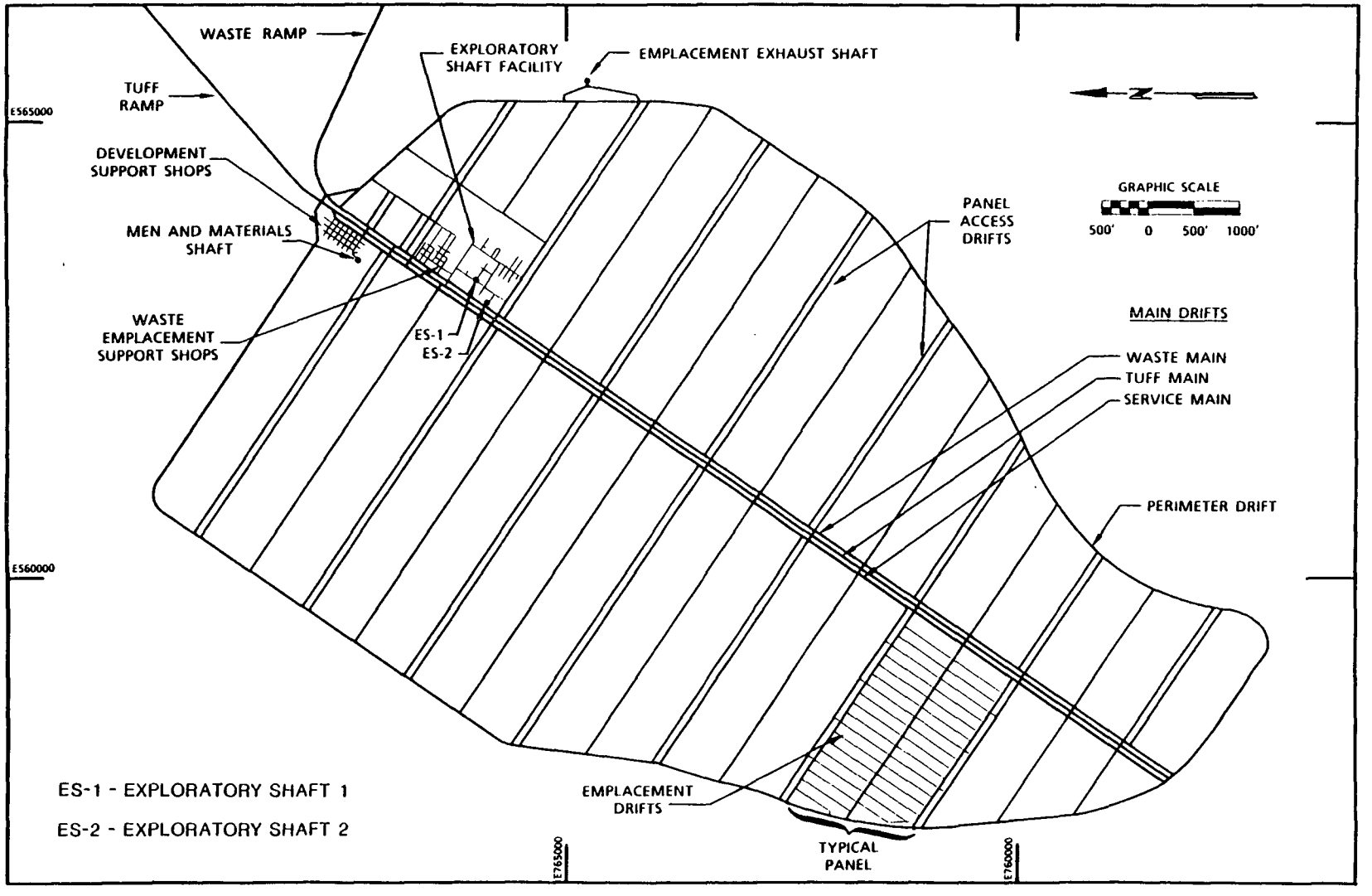
YEARLY AVERAGE CANISTER LOADING FOR FIFO AND LEVELIZED EMPLACEMENT



AVERAGE AGE OF WASTE RECEIVED AT REPOSITORY FOR FIFO AND LEVELIZED EMPLACEMENT



SCP/CDR REPOSITORY LAYOUT



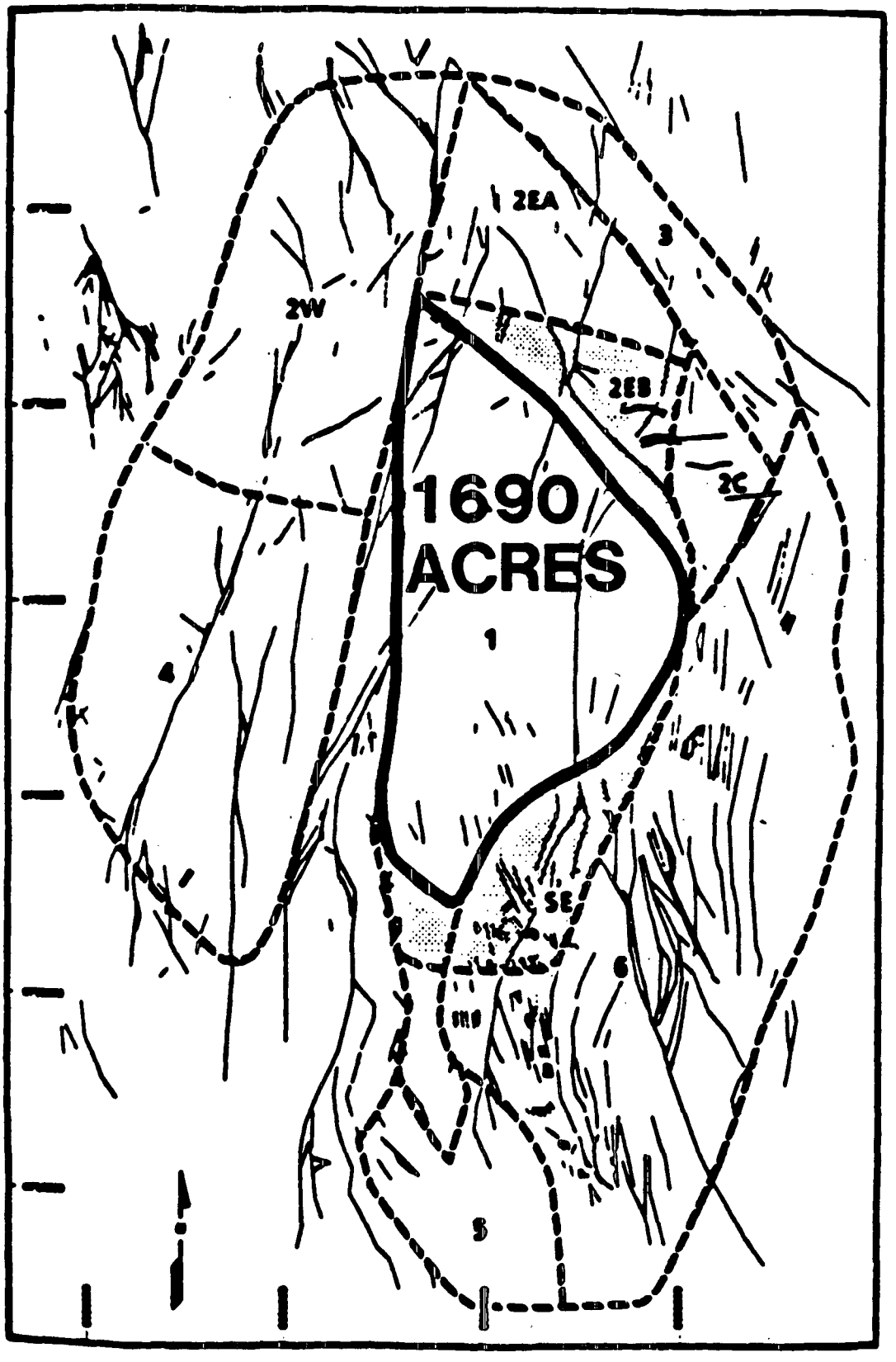
AREA REQUIREMENTS FOR A 2003 EMPLACEMENT START DATE

(FOR VERTICAL EMPLACEMENT)

DESIGN-BASIS APD (kW/acre)	RECEIPT SCHEDULE							
	FIFO				LEVELIZED			
	SF	DHLW	FIXED	TOTAL	SF	DHLW	FIXED	TOTAL
57	1157	93	182	1432	1147	93	182	1422
80	826	93	182	1101	818	93	182	1093

* Areas listed are in acres

PROPOSED EXTENSION TO PRIMARY AREA



FACTORS THAT IMPACT AREA REQUIREMENTS

APD

- THE HIGHER THE ALLOWABLE DESIGN-BASIS APD, THE LESS AREA THAT IS REQUIRED FOR WASTE EMPLACEMENT

DELAYED START DATE

- AS THE EMPLACEMENT START DATE BECOMES LATER, THE FUEL INVENTORY AGES, THEREBY PRODUCING LESS HEAT. UP TO A POINT, THEREFORE, AREA SAVINGS IN WASTE EMPLACEMENT CAN BE GAINED BY ADDITIONAL AGING. A POINT OF DIMINISHING RETURNS EXISTS, HOWEVER, AT WHICH IT IS NOT PHYSICALLY POSSIBLE (BASED ON EXTRACTION RATIO LIMITS AND GEOMETRIC CONSTRAINTS ON CANISTER-TO-CANISTER SPACINGS) TO EMPLACE THE AGED (COLDER) WASTE AT THE REQUIRED INITIAL APD

EFFECT OF AGING WASTE ON YEARLY AVERAGE CANISTER LOADING FOR A FIFO EMPLACEMENT SCHEDULE