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

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: THERMAL ANALYSES - EFFECT OF SPENT FUEL RECEIPT CHARACTERISTICS

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THERMAL RESPONSE STUDY

A STUDY WAS CONDUCTED COMPARING THERMAL RESPONSE OF OLDEST FIRST AND LEVELIZED ENERGY SPENT FUEL RECEIPTS

OBJECTIVE: TO DETERMINE WHETHER THE POSTCLOSURE PERFORMANCE OF WASTE PACKAGES IN AN UNSATURATED REPOSITORY CAN BE ENHANCED BY LIMITING THE POTENTIAL FOR LIQUID WATER TO CONTACT THE CONTAINERS FOR EXTENDED PERIODS UTILIZIING DECAY ENERGY MANAGEMENT ("HEAT TAILORING") TECHNIQUES

AVAILABLE "HEAT TAILORING" TECHNIQUES

- "RECEIPT TAILORING" - CONTROLS WASTE STREAM CHARACTERISTICS TO PROVIDE LEVELIZED INTEGRATED ENERGY DEPOSITION OVER THE AREAL AND TEMPORAL EXTENT OF THE REPOSITORY

- "GEOMETRIC TAILORING" - MODIFY EMPLACEMENT PANEL GEOMETRY (DRIFT & HOLE SPACINGS) TO COMPENSATE FOR BOUNDARY EFFECTS AND VARIATION IN WASTE CHARACTERISTICS

- "PACKAGE TAILORING" - MODIFY PACKAGE LOADINGS AND POSITIONS TO COMPENSATE FOR BOUNDARY EFFECTS AT LOCAL SCALE

- WASTE FORM CONSIDERATION - ALLOW DIFFERENT TREATMENT OF SPENT FUEL AND DEFENSE HLW BASED ON WASTE CHARACTERISTICS

SCOPE OF THE STUDY

IDENTIFY AND ANALYZE THE REPOSITORY-SCALE THERMAL EFFECTS OF SPENT FUEL RECEIPT SCENARIOS THAT MAY BE MORE EFFECTIVE THAN "OLDEST FUEL FIRST" IN MEETING THE STUDY OBJECTIVE

APPROACH TO THE STUDY

- SELECT BASE CASES FOR ANALYSIS
  - OLDEST FUEL FIRST RECEIPT CASE
  - "PREFERRED" RECEIPT CASE
- SELECT "OPTIMIZATION" PARAMETER
  - LEVELIZED INTEGRATED ENERGY (kW ∘ YR/MTU)
- IDENTIFY SENSITIVITY CASES
  - INVENTORY OPTIONS
  - NON-COMMINGLED WASTE FORM OPTIONS
- DEFINE ASSUMPTIONS
- PERFORM ANALYSES

SUMMARY OF ASSUMPTIONS USED IN STUDY

- 1988 DRAFT MISSION PLAN AMENDMENT RECEIPT SCHEDULE
- 1987 EIA HISTORICAL AND PROJECTED DISCHARGES - NO NEW ORDERS
- SIMPLIFIED 20 PANEL REPOSITORY WITH COMMINGLED SNF AND DHLW
- AREAL POWER DENSITY APPROXIMATELY SAME AS SCP-CDR (57 kW/ACRE)
- ALL SNF PACKAGED INTACT IN "HYBRID" CONFIGURATION - 3 PWR AND 4 BWR ASSEMBLIES PER PACKAGE
- VERTICAL EMPLACEMENT - ONE PACKAGE PER HOLE - MINIMUM HOLE SPACING
- THERMAL EFFECTS ANALYZED AT 300 YEARS AFTER CLOSURE (2353)

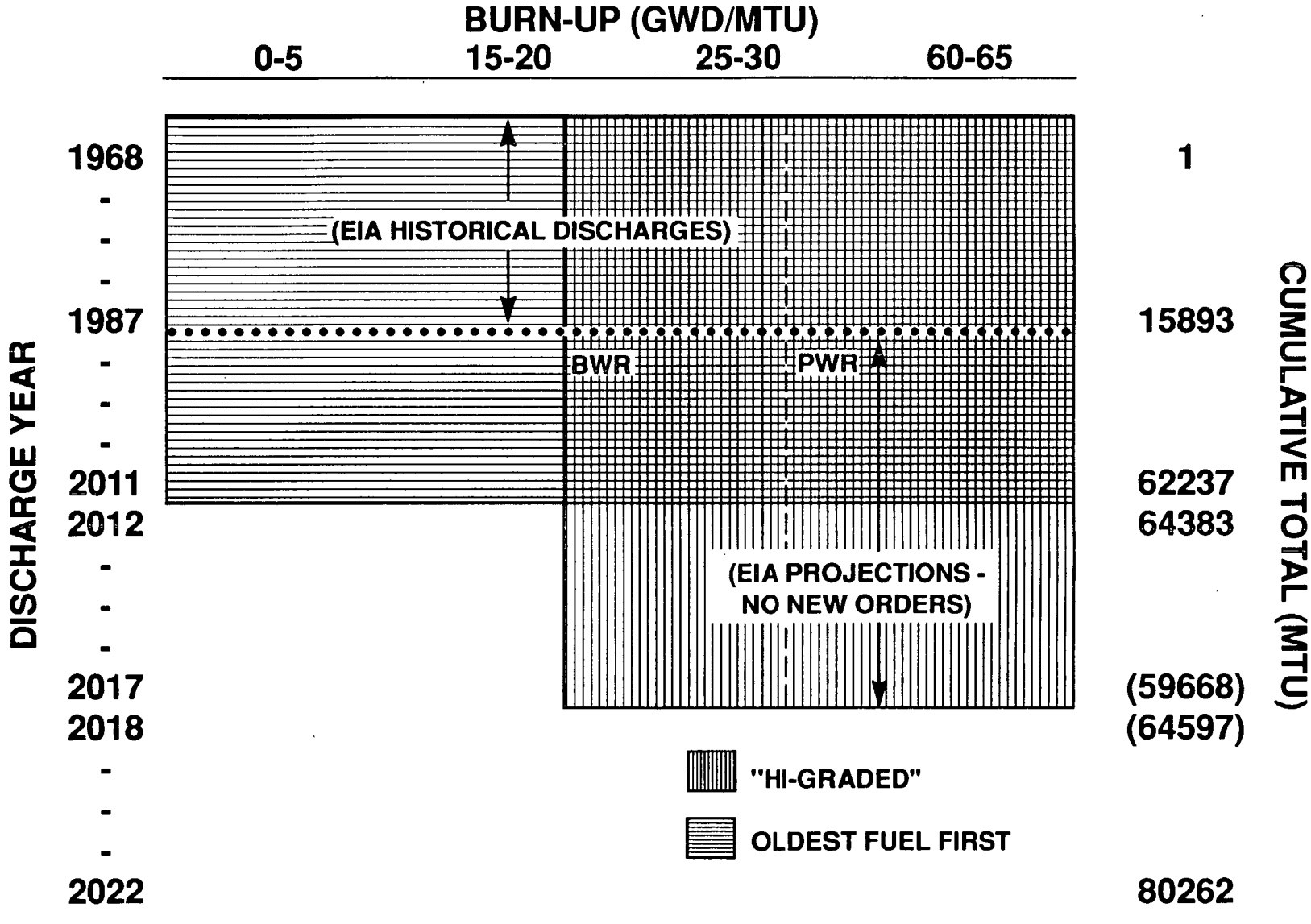
WASTE ACCEPTANCE SCHEDULE
ALL QUANTITIES IN METRIC TONS OF HEAVY METAL

	MRS facility			First repository			Total acceptance by the system	
Year	Spent fuel received	In storage	Spent fuel shipped	Spent fuel	High-level waste	Inventory	Annual	Cumulative
2003[A]	1200	800	400	400		400	1200	1,200
2004	1200	1600	400	400		800	1200	2,400
2005	2000	3200	400	400		1,200	2000	4,400
2006	2000	4300	900	900		2,100	2000	6,400
2007	2700	5200	1800	1800		3,900	2700	9,100
2008	2700	5200	2700	3000[B]	400	7,300	3400	12,500
2009	2700	5200	2700	3000	400	10,700	3400	15,900
2010	2700	5200	2700	3000	400	14,100	3400	19,300
2011	2700	5200	2700	3000	400	17,500	3400	22,700
2012	2700	5200	2700	3000	400	20,900	3400	26,100
2013	2700	5200	2700	3000	400	24,300	3400	29,500
2014	2700	5200	2700	3000	400	27,700	3400	32,900
2015	2700	5200	2700	3000	400	31,100	3400	36,300
2016	2700	5200	2700	3000	400	34,500	3400	39,700
2017	2700	5200	2700	3000	400	37,900	3400	43,100
2018	2700	5200	2700	3000	400	41,300	3400	46,500
2019	2700	5200	2700	3000	400	44,700	3400	49,900
2020	2700	5200	2700	3000	400	48,100	3400	53,300
2021	2700	5200	2700	3000	400	51,500	3400	56,700
2022	2700	5200	2700	3000	400	54,900	3400	60,100
2023	2700	5200	2700	3000	400	58,300	3400	63,500
2024	2700	5200	2700	3000	400	61,700	3400	65,100
2025	2620	5120	2700	3000	180	64,880	3100	68,000
2026		2420	2700	2700		67,580		70,000
2027			2420	2420		70,000		70,000
Total	57,620		57,620	63,020	6980[B]	70,000		70,000

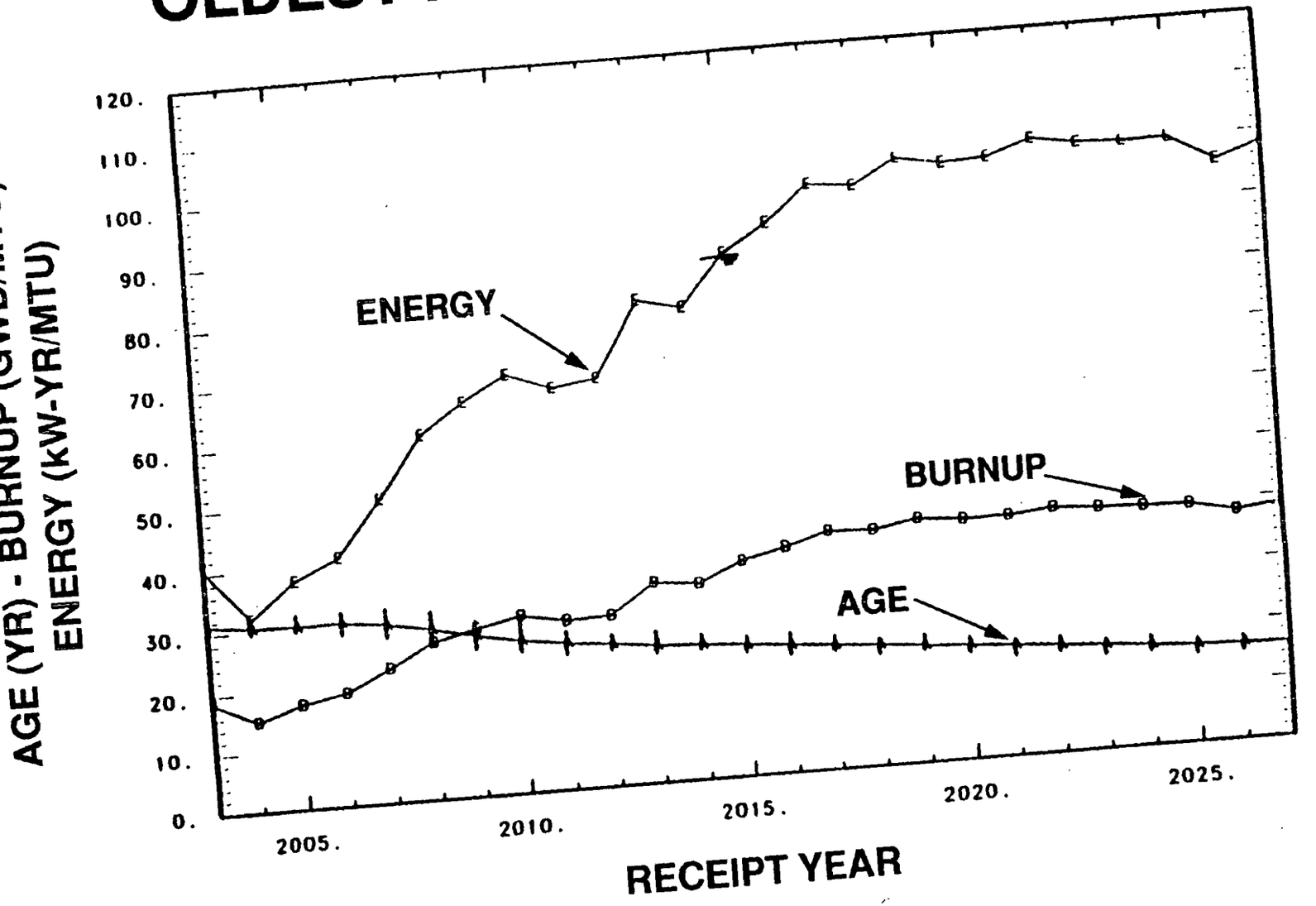
[A]It may be possible to start limited waste acceptance at the MRS facility before the year 2003. This cannot be determined until engineering studies have been completed and additional siting information is available.

[B]In years when waste acceptance at the repository does not match shipments from the MRS facility, the difference is attributable to shipments from nearby reactors directly to the repository.

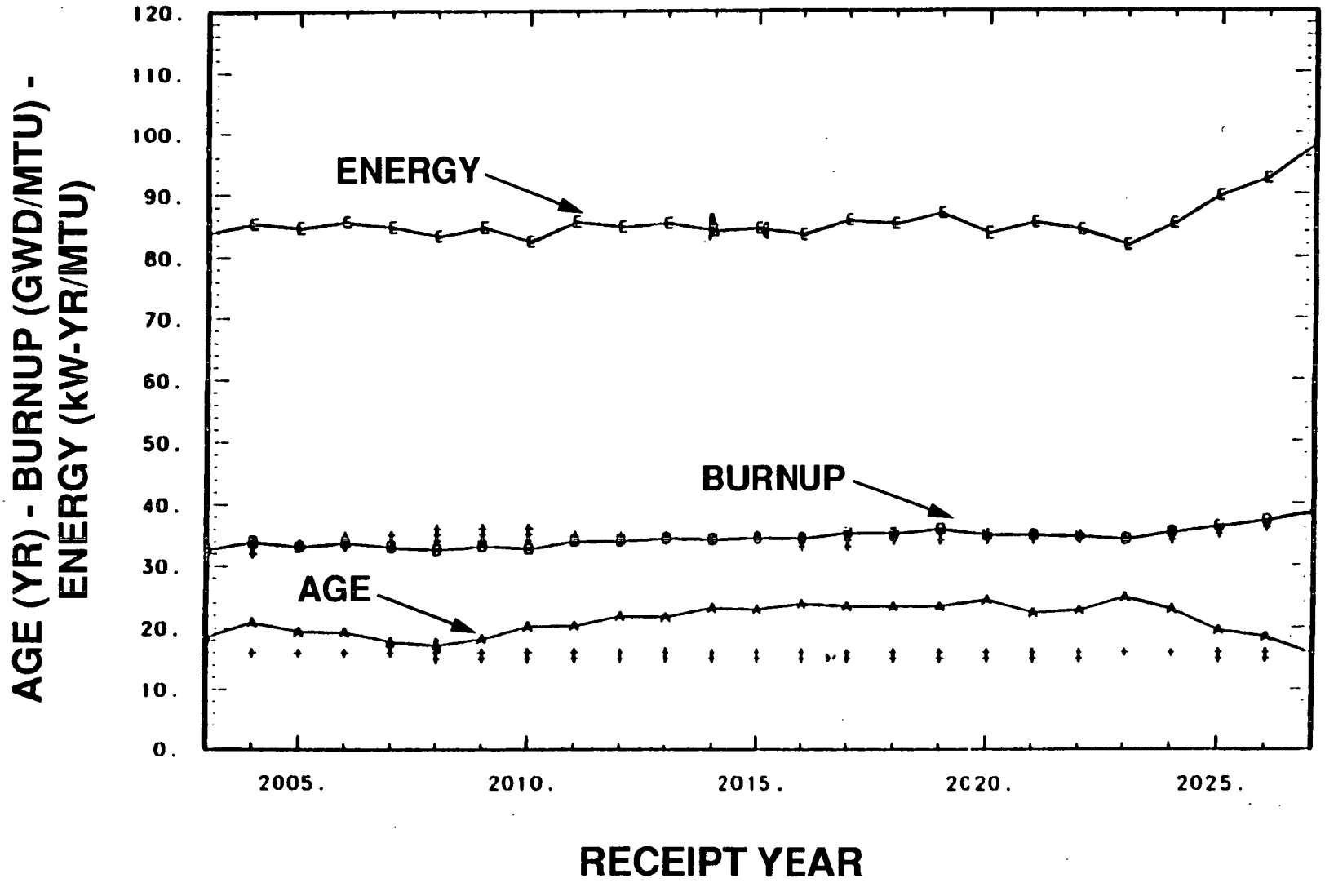
INVENTORY OPTIONS



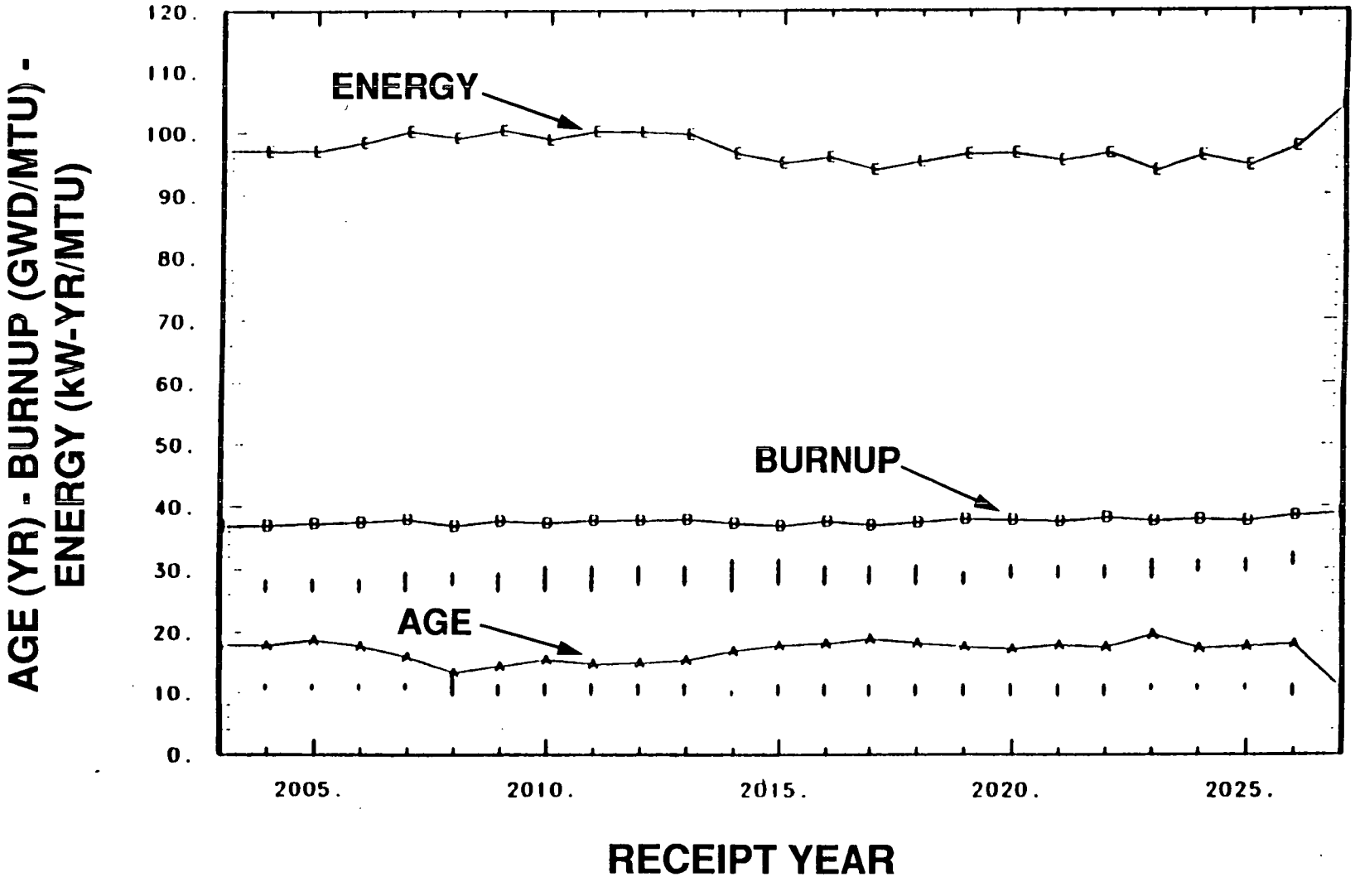
"OLDEST FUEL FIRST" SCENARIO



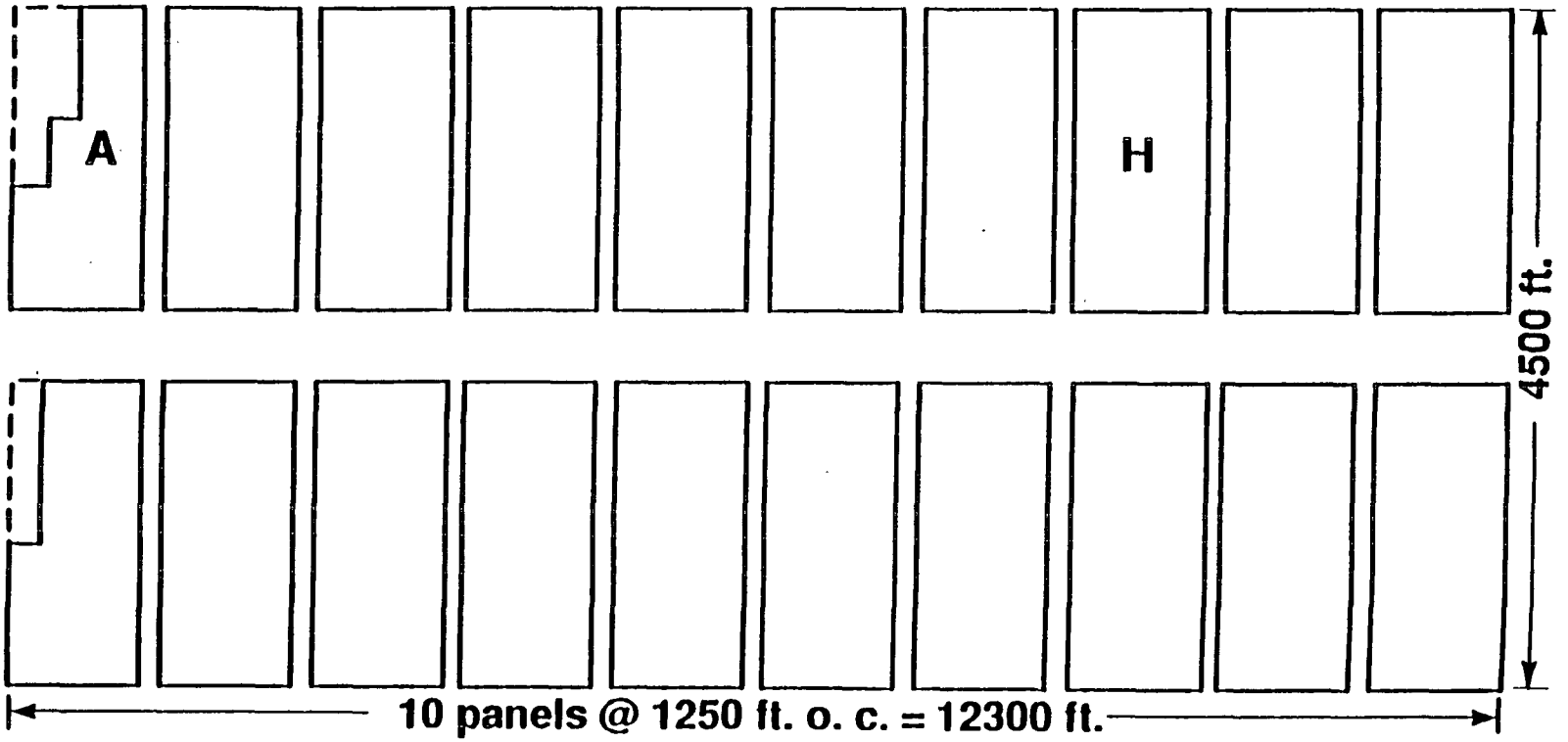
"PREFERRED" RECEIPT SCENARIO



LEVELIZED "HI-GRADED" RECEIPT SCENARIO

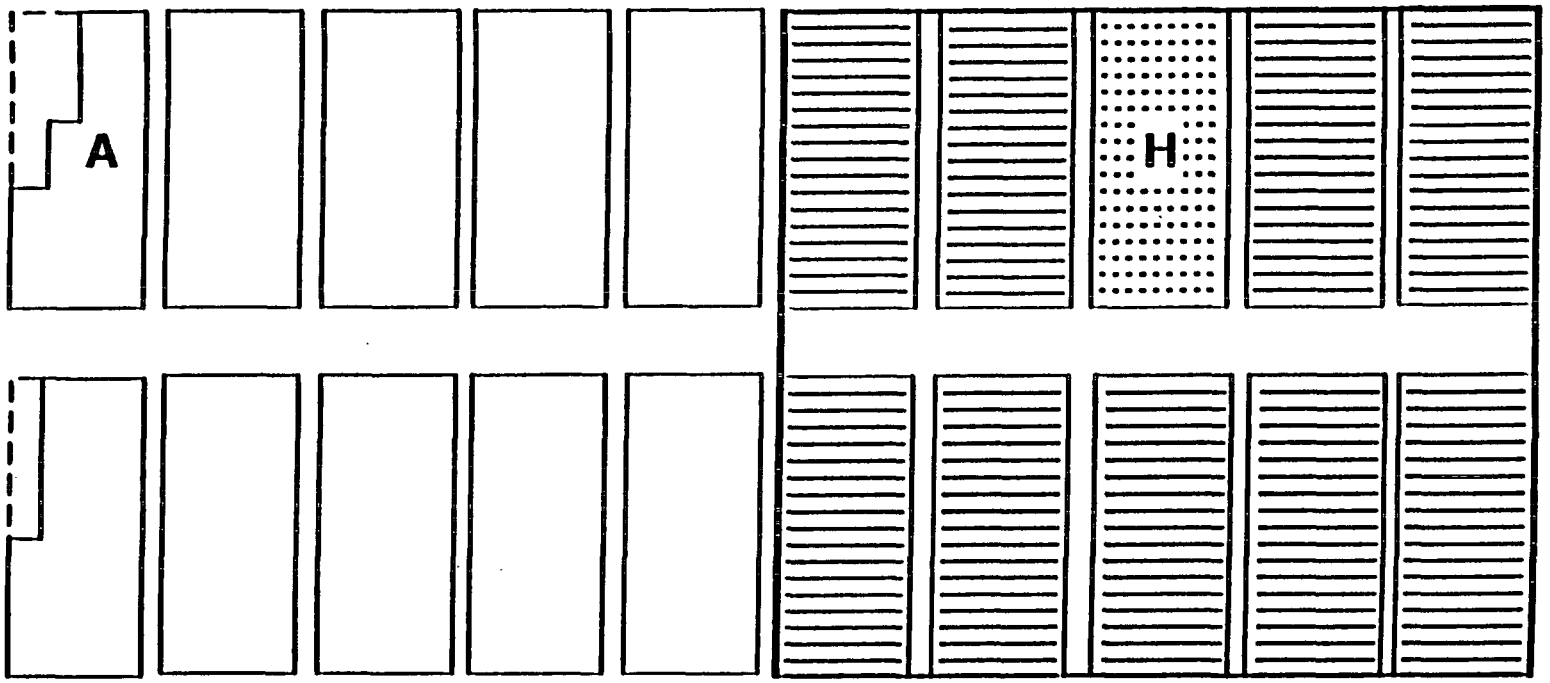


MODELED REPOSITORY LAYOUT

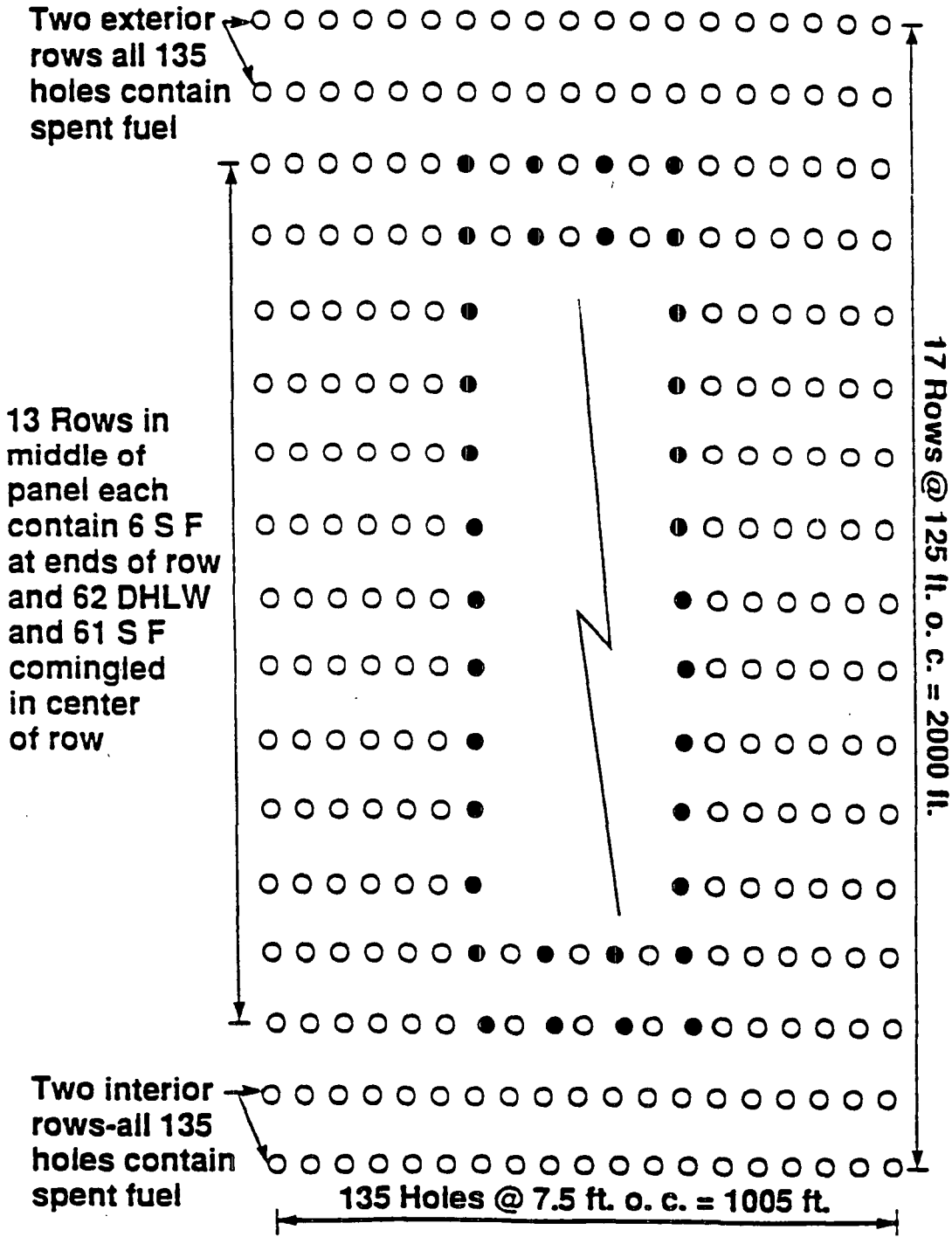


Total area = 1270 Acres

MODELED REGION - PANEL H



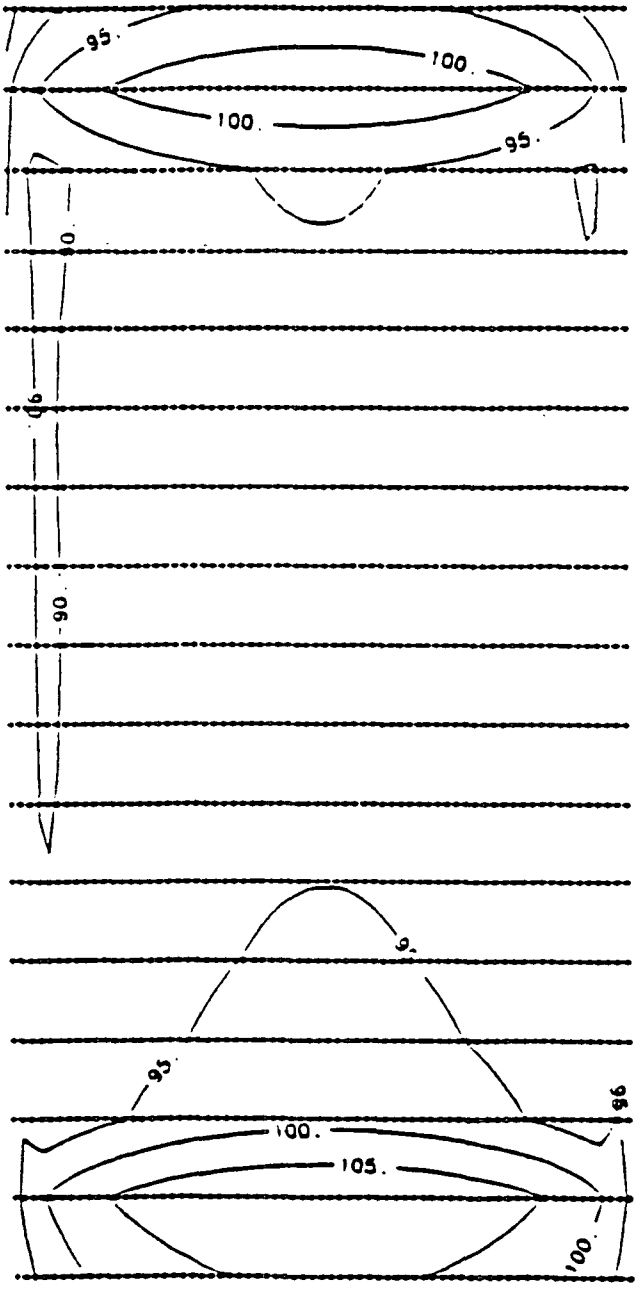
PANEL H



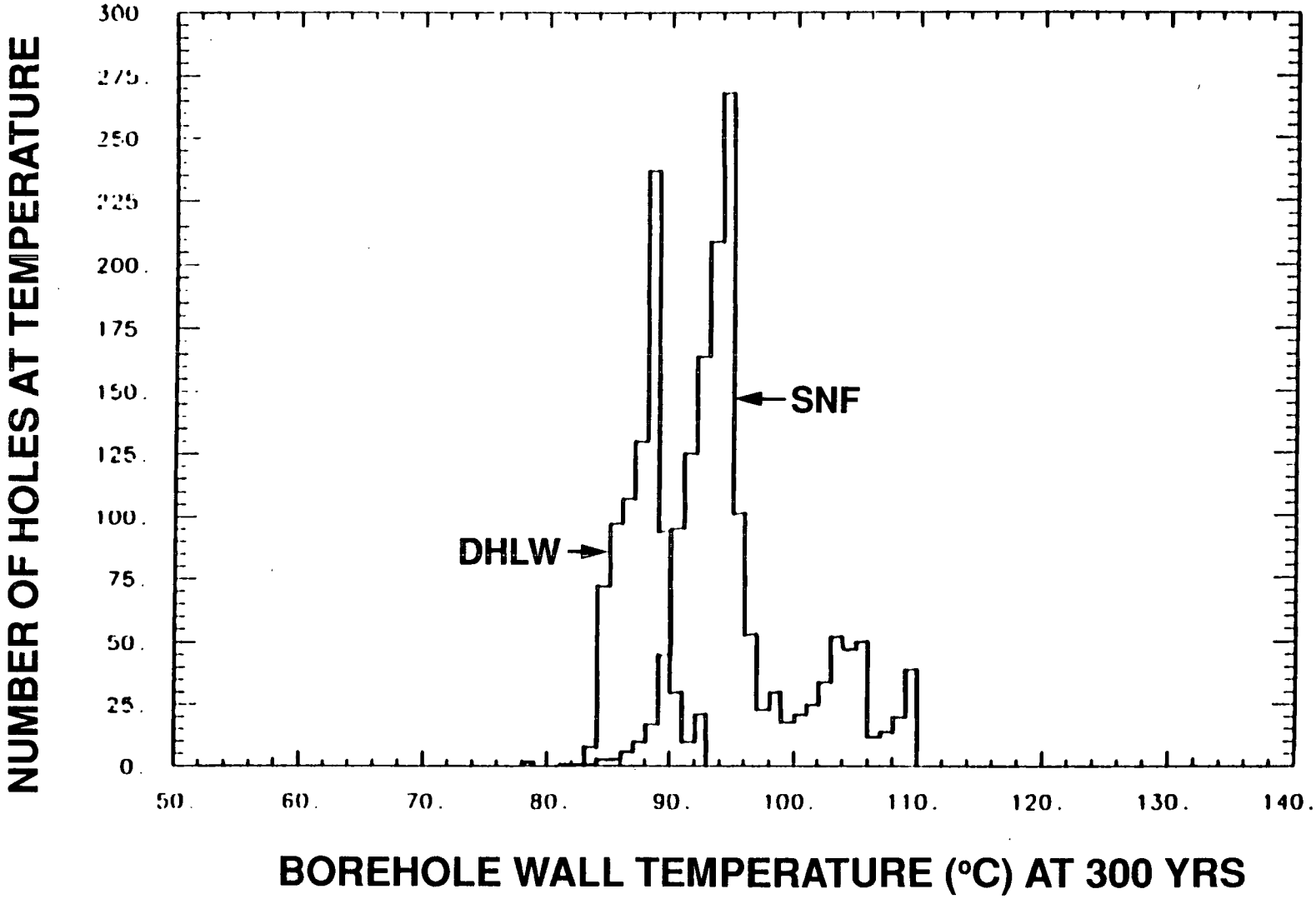
(Not to scale)

OLDEST FUEL FIRST - PANEL H (2014)

BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS

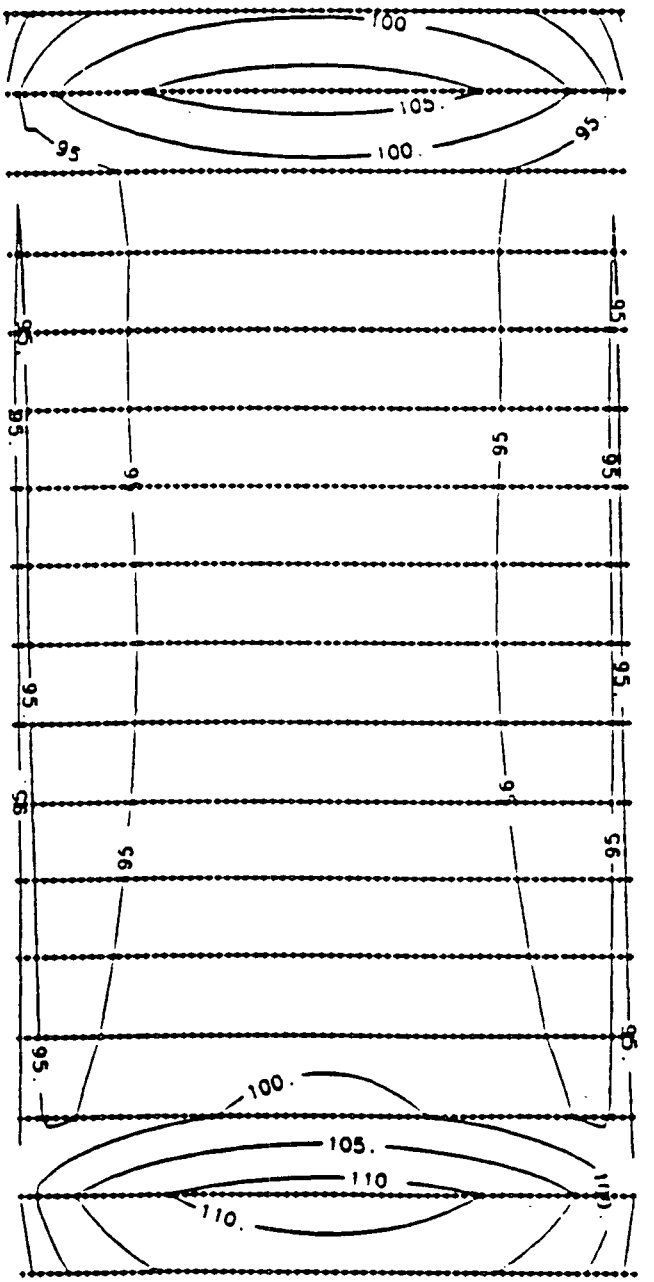


OLDEST FUEL FIRST - PANEL H (2014)

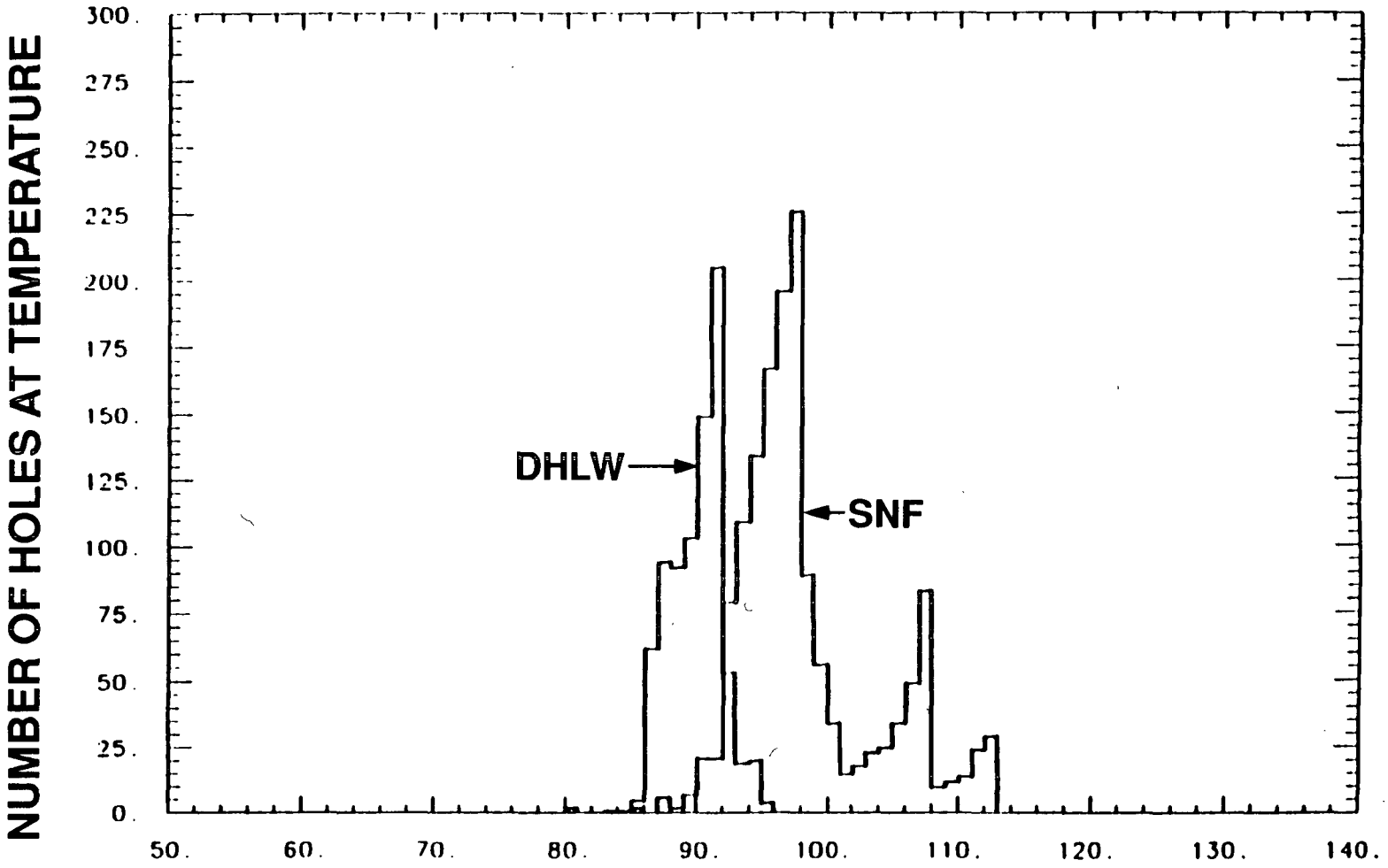


LEVELIZED ENERGY - PANEL H (2014)

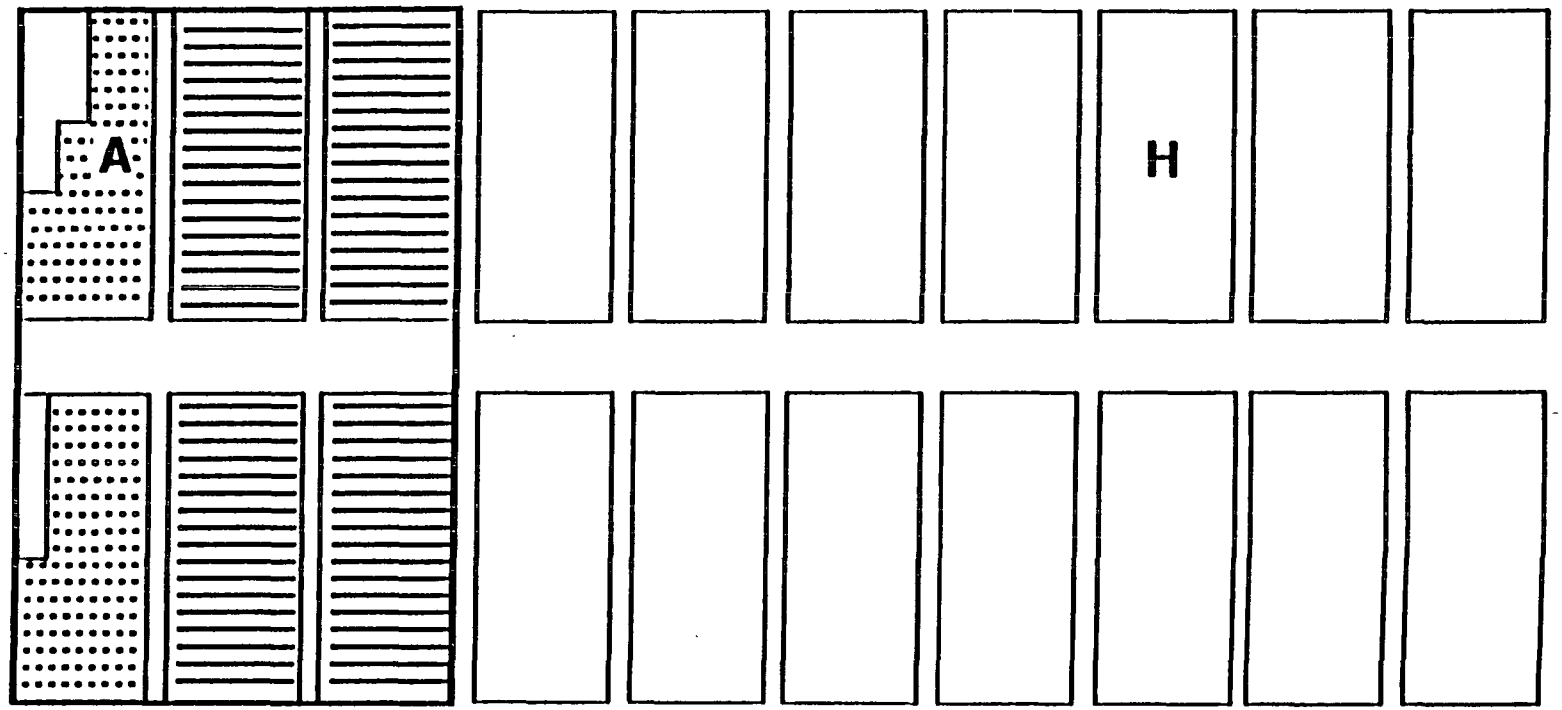
BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS



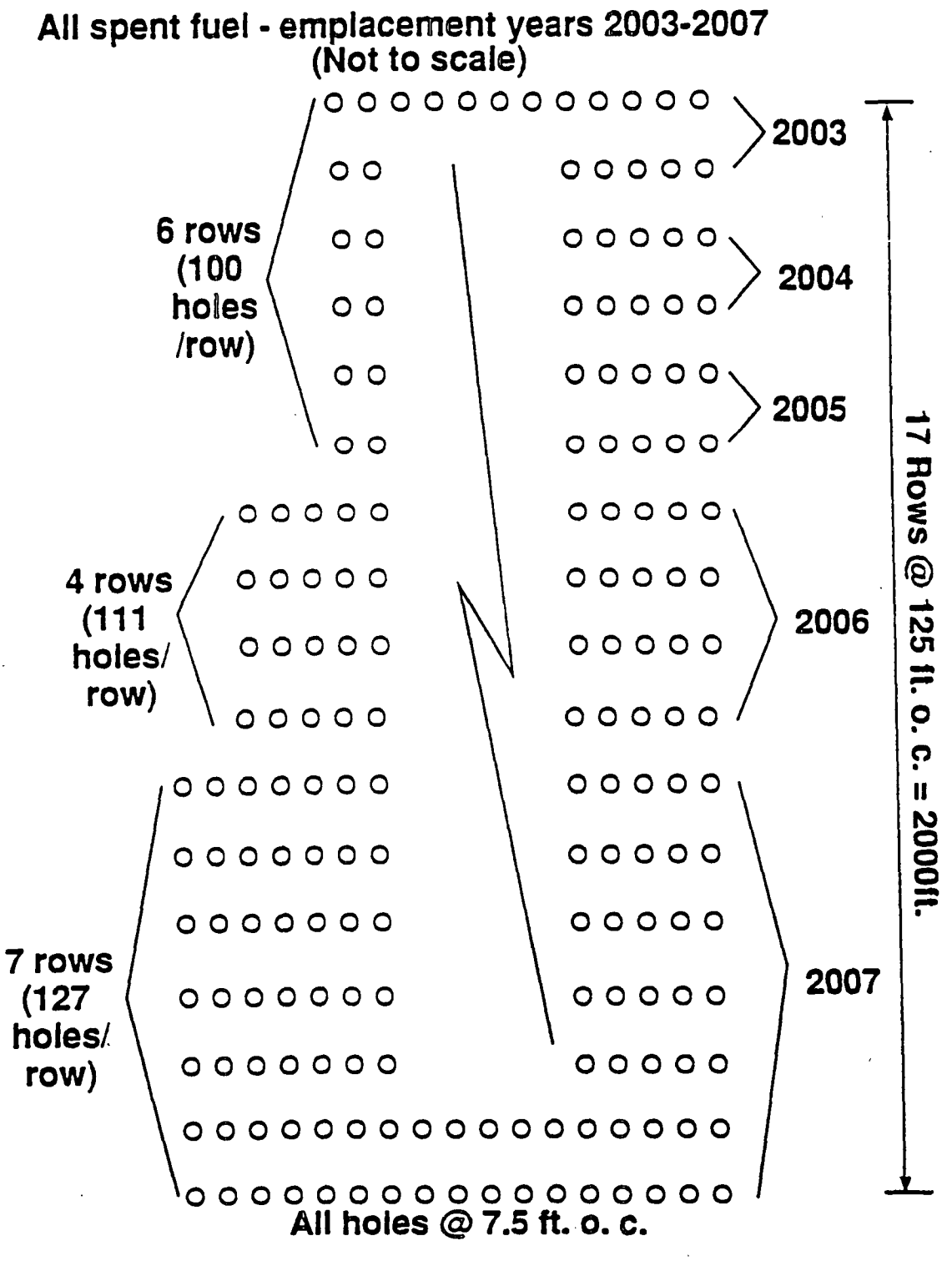
LEVELIZED ENERGY - PANEL H (2014)



MODELED REGION - PANEL A

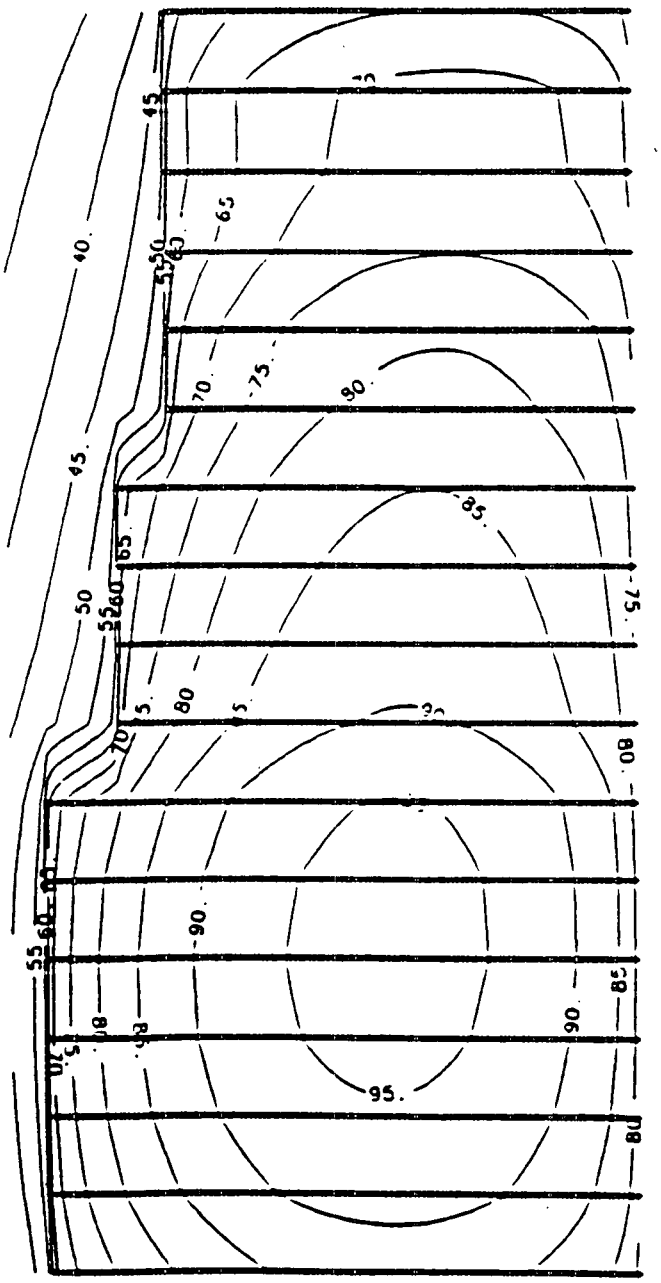


PANEL A

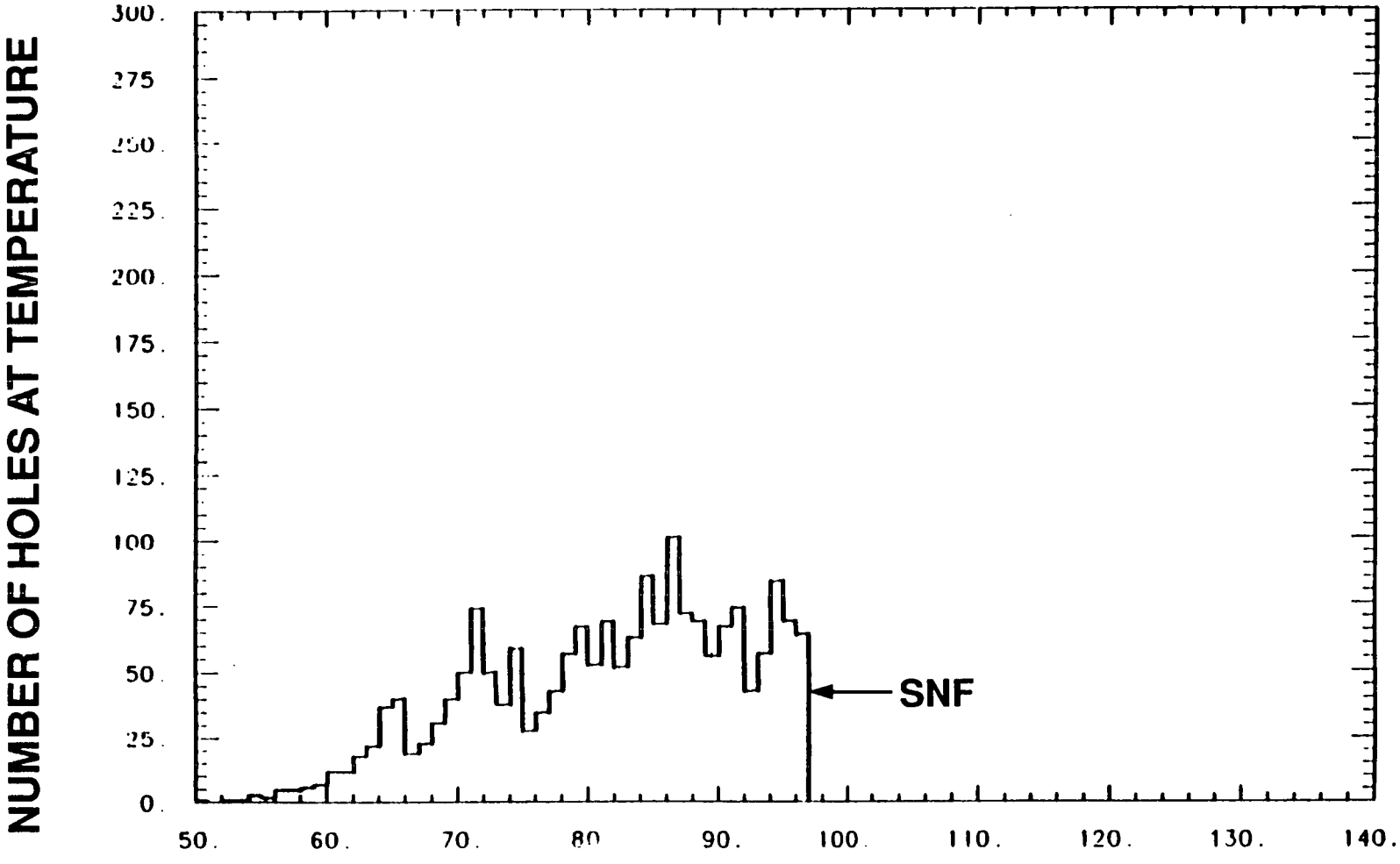


OLDEST FUEL FIRST - PANEL A (2003-07)

BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS

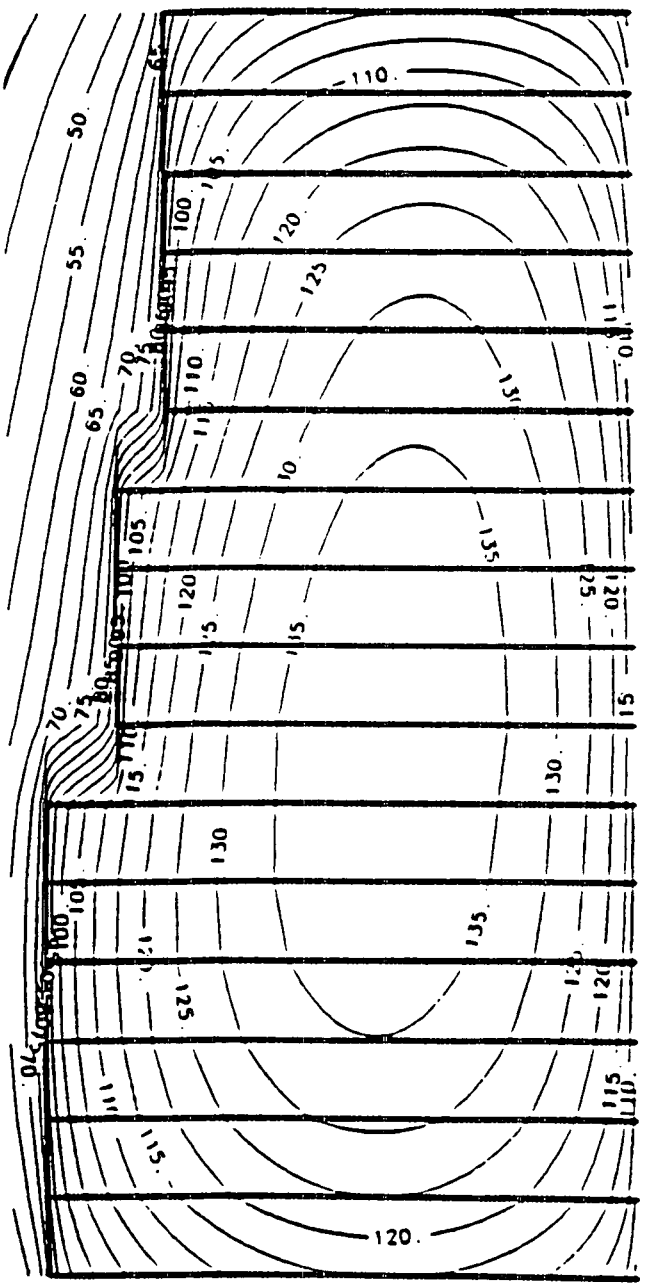


OLDEST FUEL FIRST - PANEL A (2003-07)

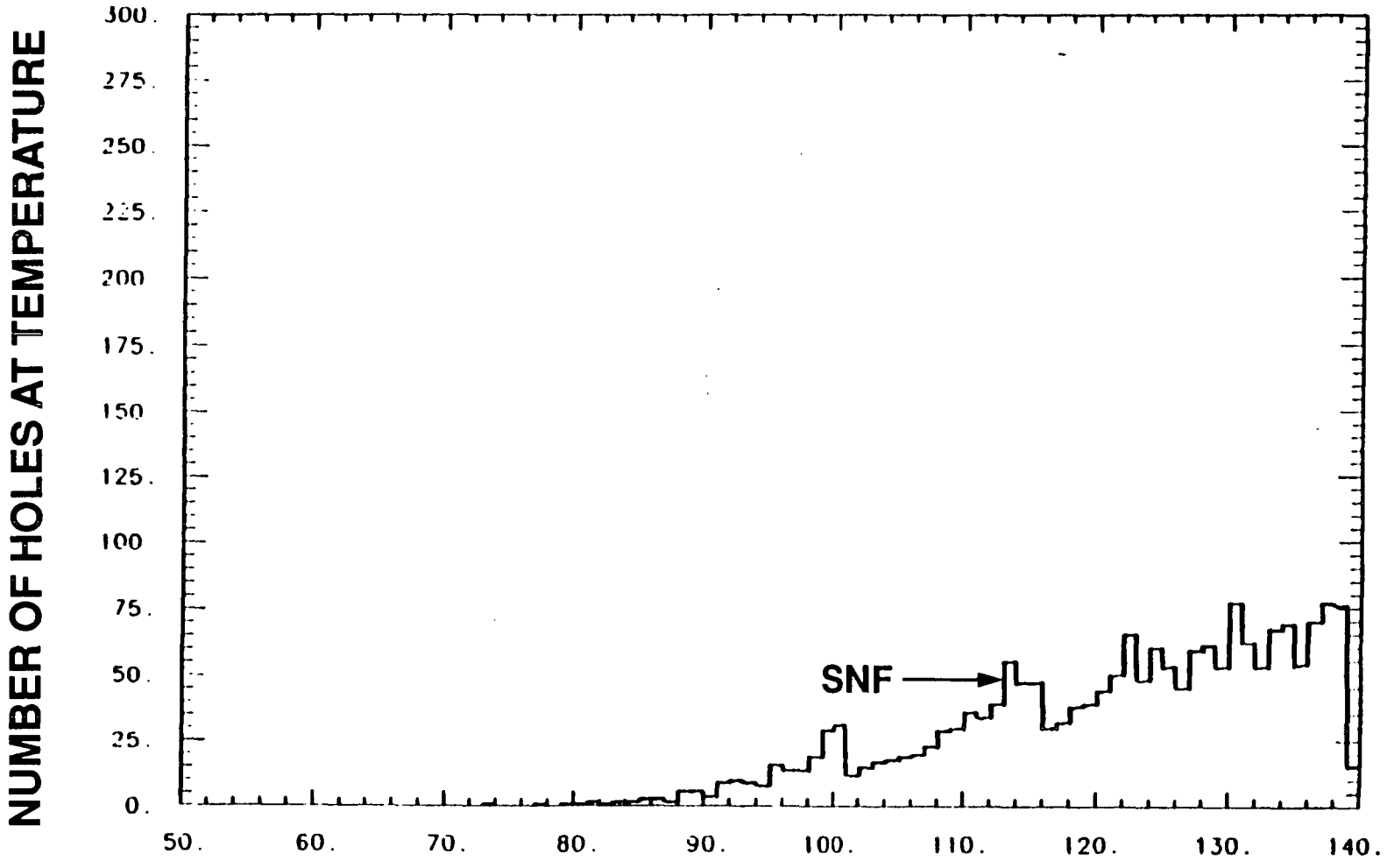


LEVELIZED ENERGY - PANEL A (2003-07)

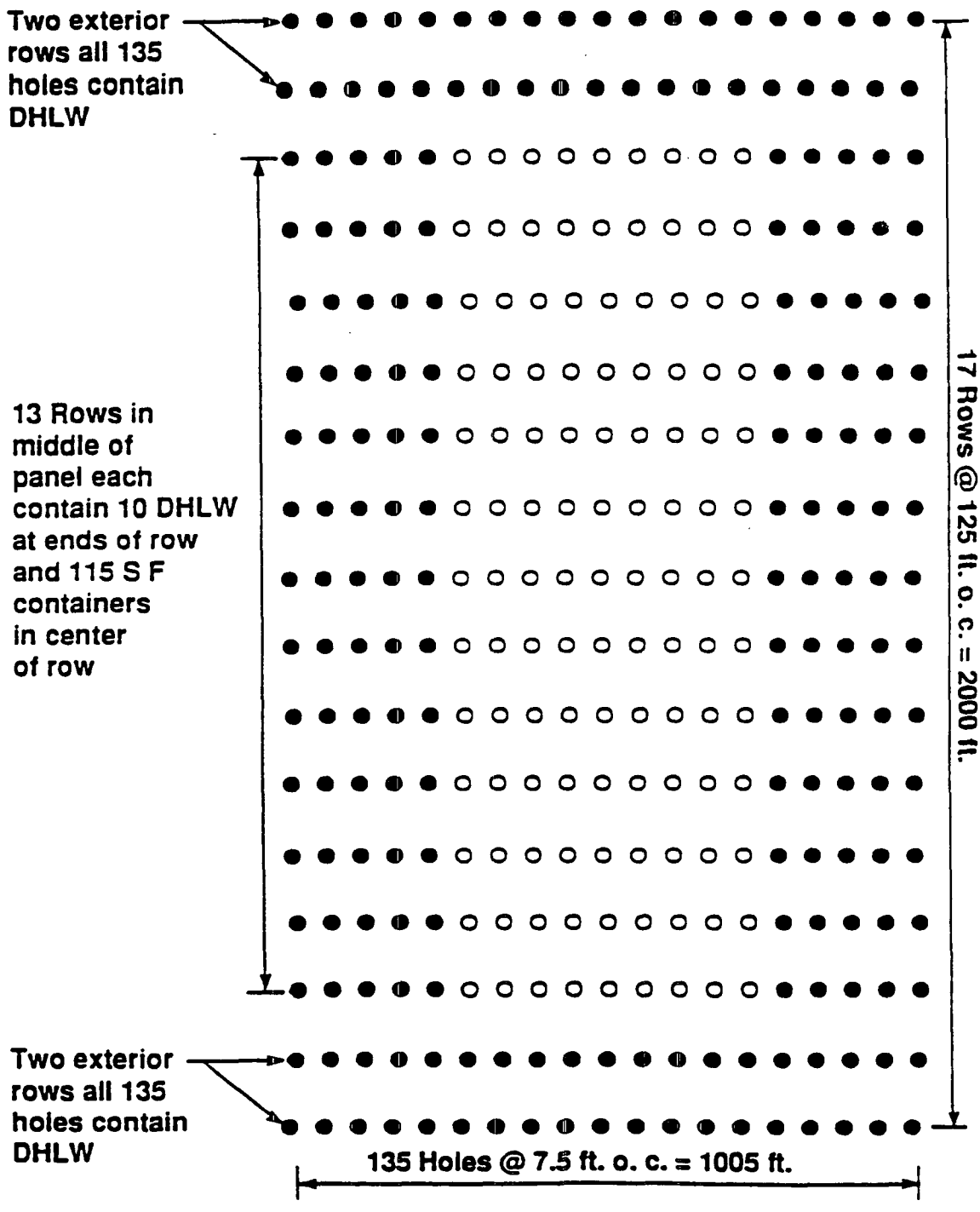
BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS



LEVELIZED ENERGY - PANEL A (2003-07)



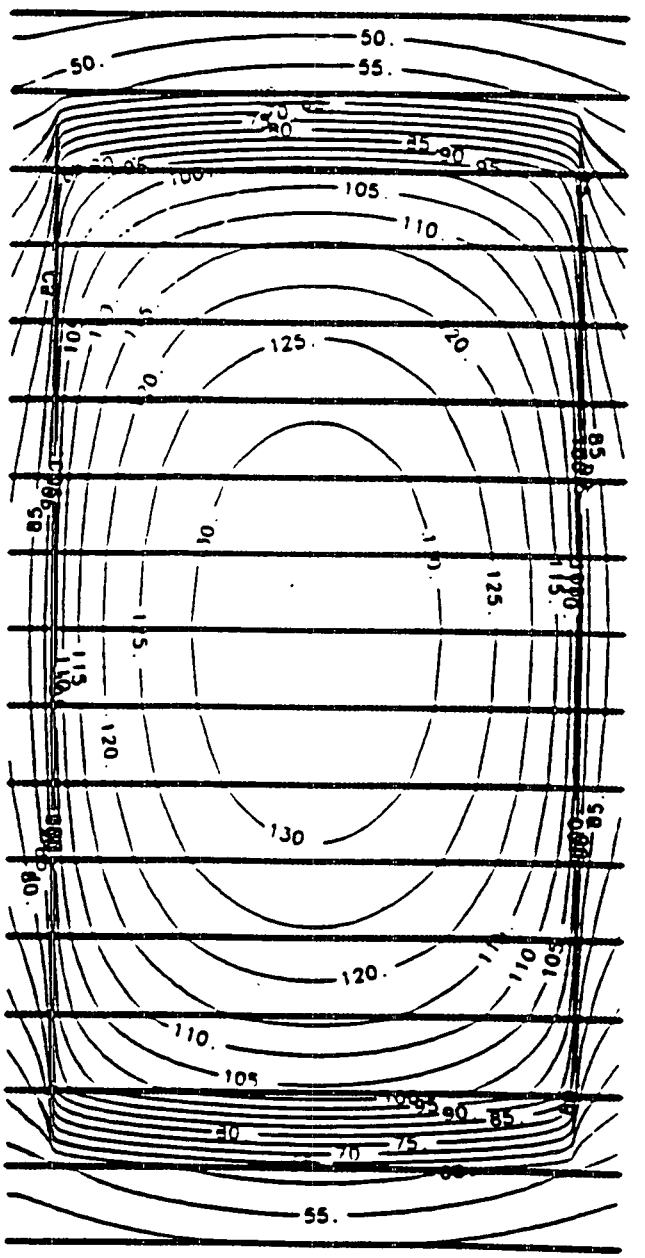
PANEL H - NON-COMMINGLED



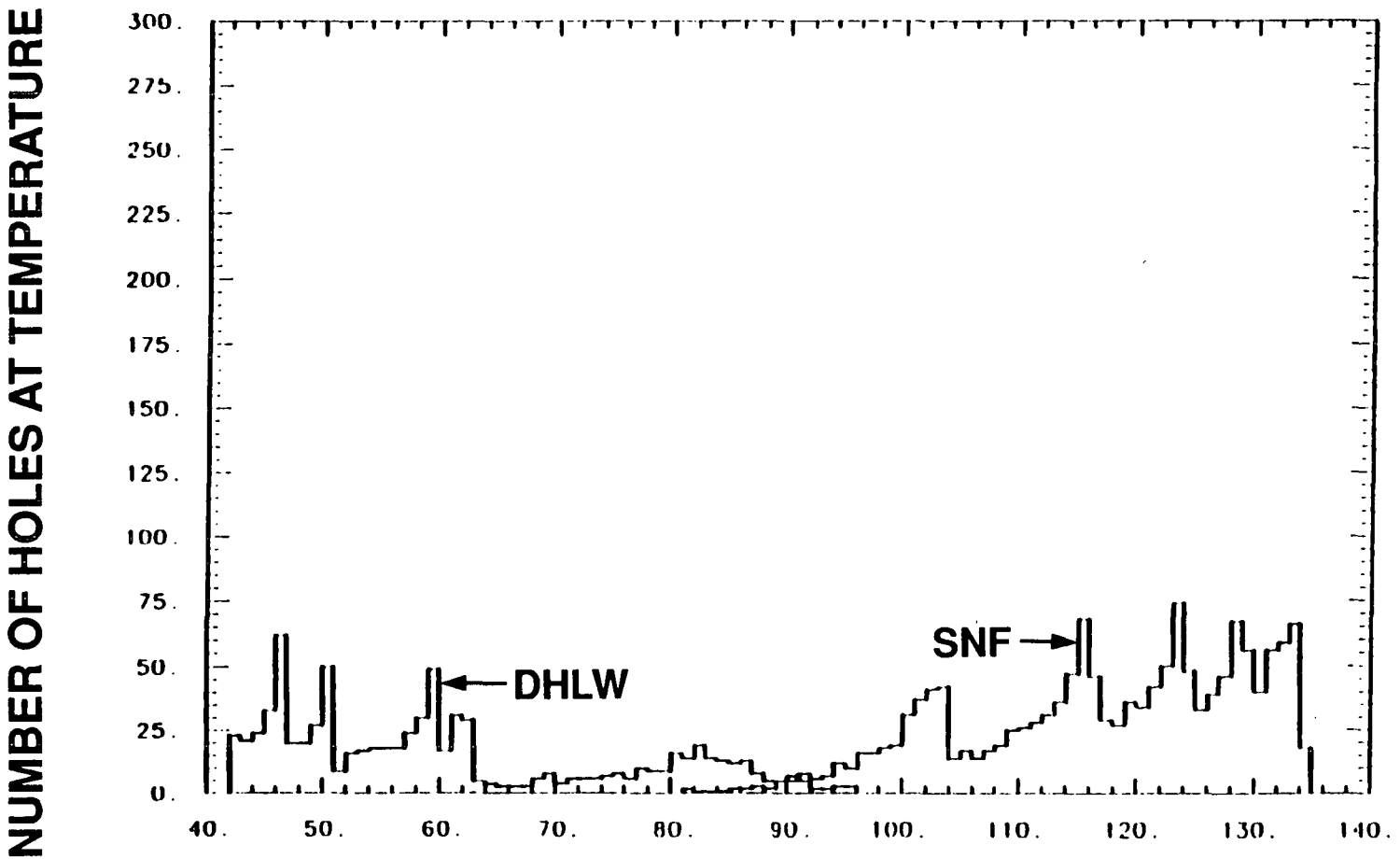
(NOT TO SCALE)

OLDEST FUEL FIRST - PANEL H (2014) NON-COMMINGLED

BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS

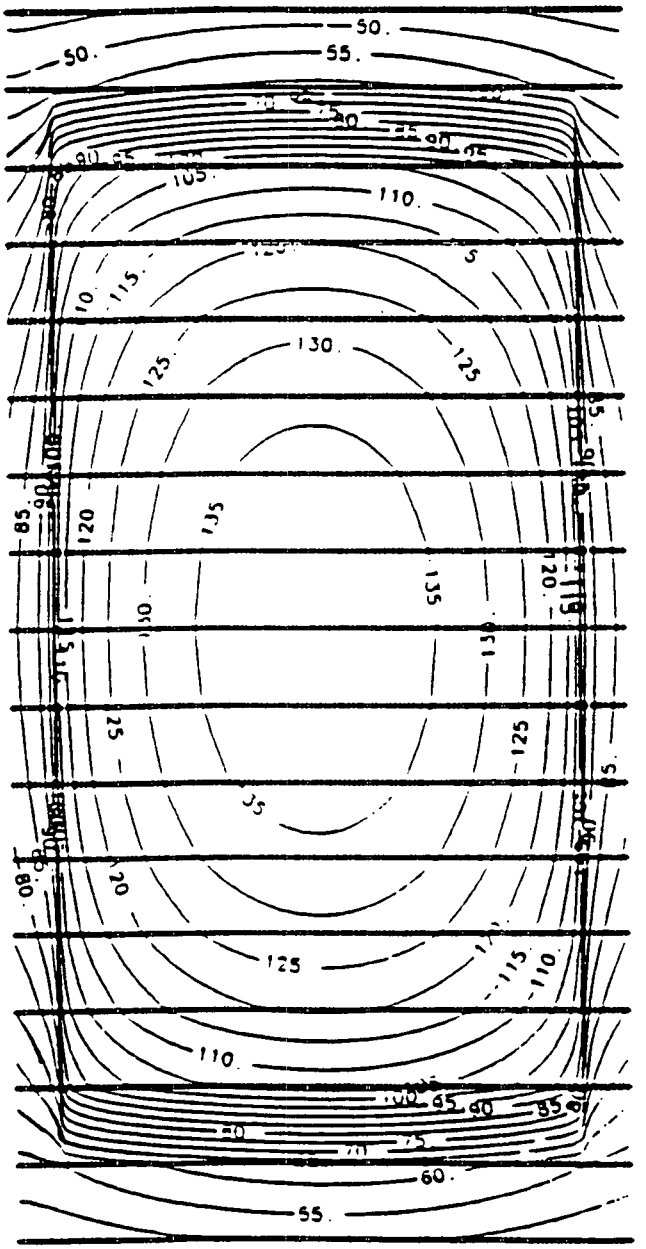


OLDEST FUEL FIRST - PANEL H (2014)
NON-COMMINGLED

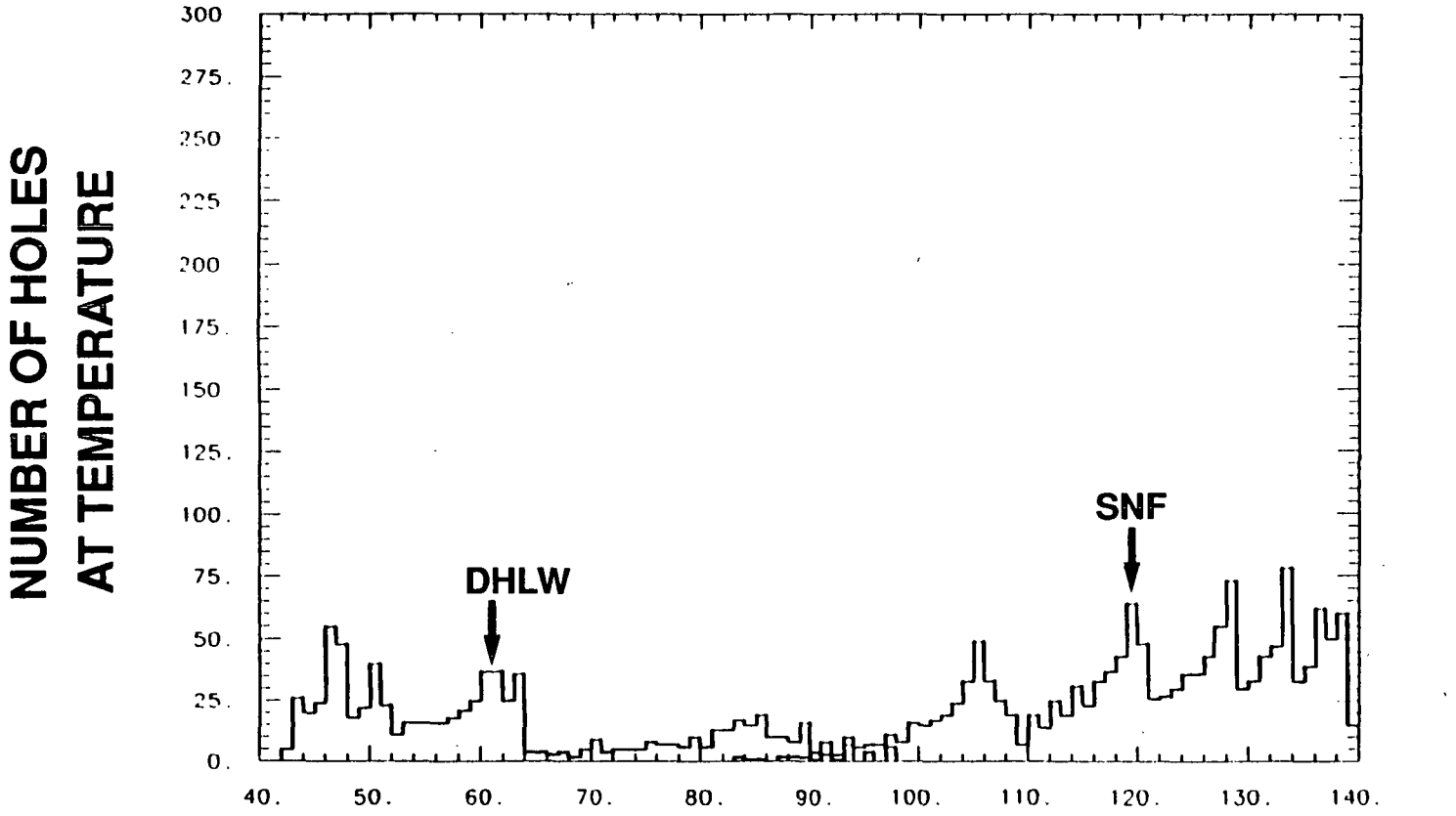


LEVELIZED ENERGY - PANEL H (2014) NON-COMMINGLED

BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS



LEVELIZED ENERGY - PANEL H (2014)
NON-COMMINGLED
BOREHOLE TEMPERATURE DISTRIBUTION AT 300 YEARS



PRELIMINARY CONCLUSIONS FROM THE THERMAL RESPONSE STUDY

- LEVELIZED RECEIPTS PRODUCE SIGNIFICANTLY HIGHER BOREHOLE TEMPERATURES THAN "OFF" FOR THE EARLY YEARS (10-12)

- CONVERSELY, "OFF" IS BETTER IN MOST LATER YEARS, BUT:
  - WE CAN'T HAVE IT BOTH WAYS
  - "OFF" THERMAL RESPONSE STRONGLY DEPENDS ON REALIZING THE EXTENDED BURNUP PROJECTIONS

- BOUNDARY EFFECTS ARE SIGNIFICANT, AND CAN BE COMPENSATED FOR BY "GEOMETRIC TAILORING" - NOT OPTIMIZED IN THIS STUDY

- ALTERNATIVE STRATEGIES FOR EMPLACEMENT OF DHLW ARE POSSIBLE AND CAN BE BENEFICIAL IN ENHANCING THERMAL RESPONSE