Gary Simmons

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Minister of Energy-Mines-Resources

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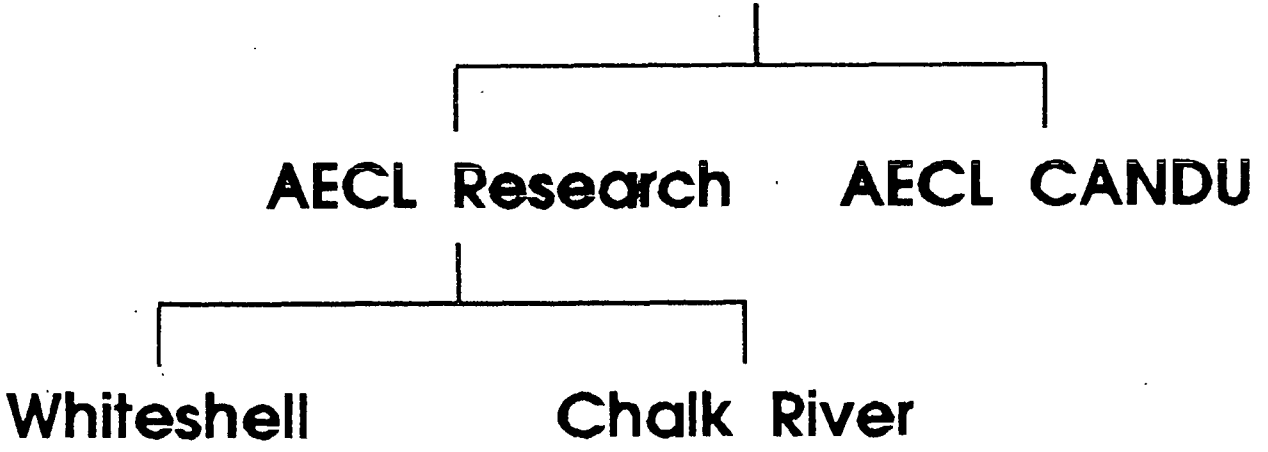
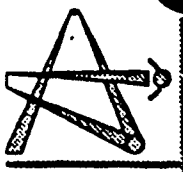


Nuclear fuel waste Management in Canada



THE CANADIAN NUCLEAR FUEL

WASTE MANAGEMENT PROGRAM

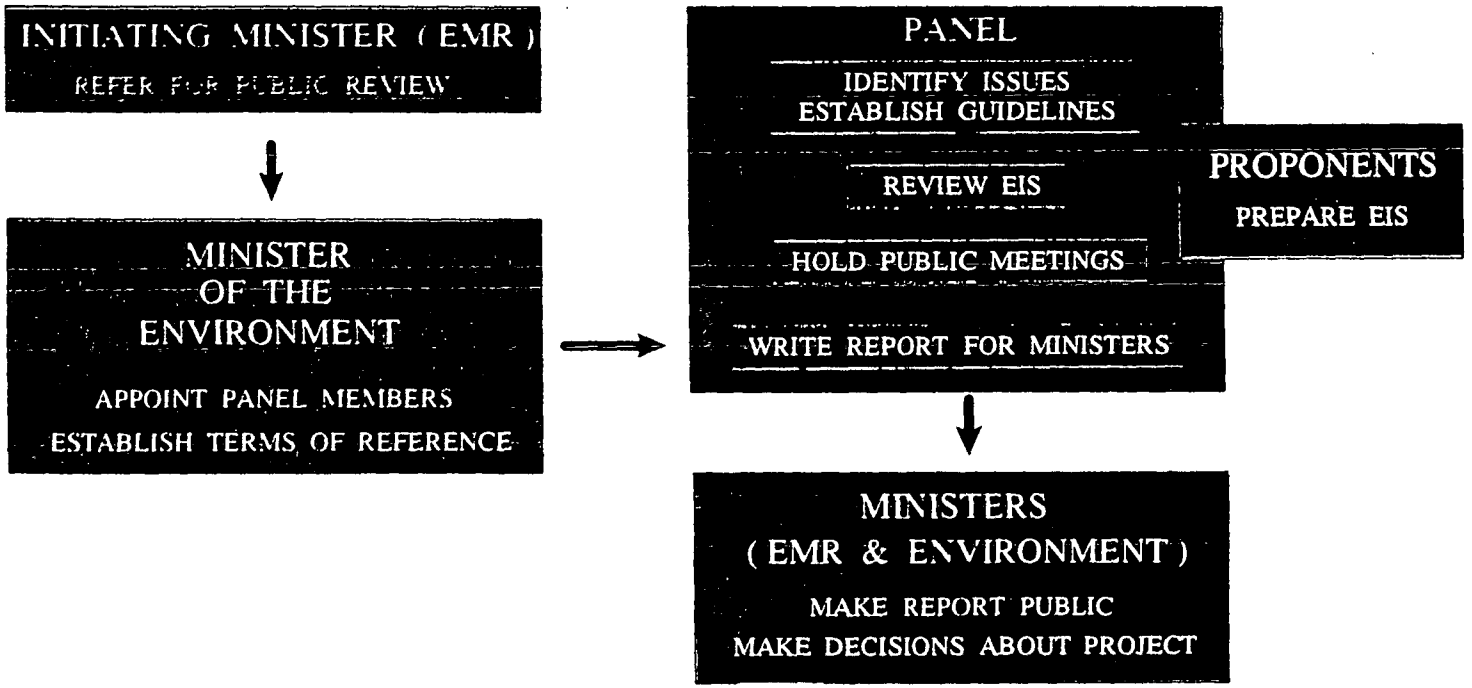
CONDUCTS RESEARCH TO DEVELOP

AND DEMONSTRATE THE TECHNOLOGY

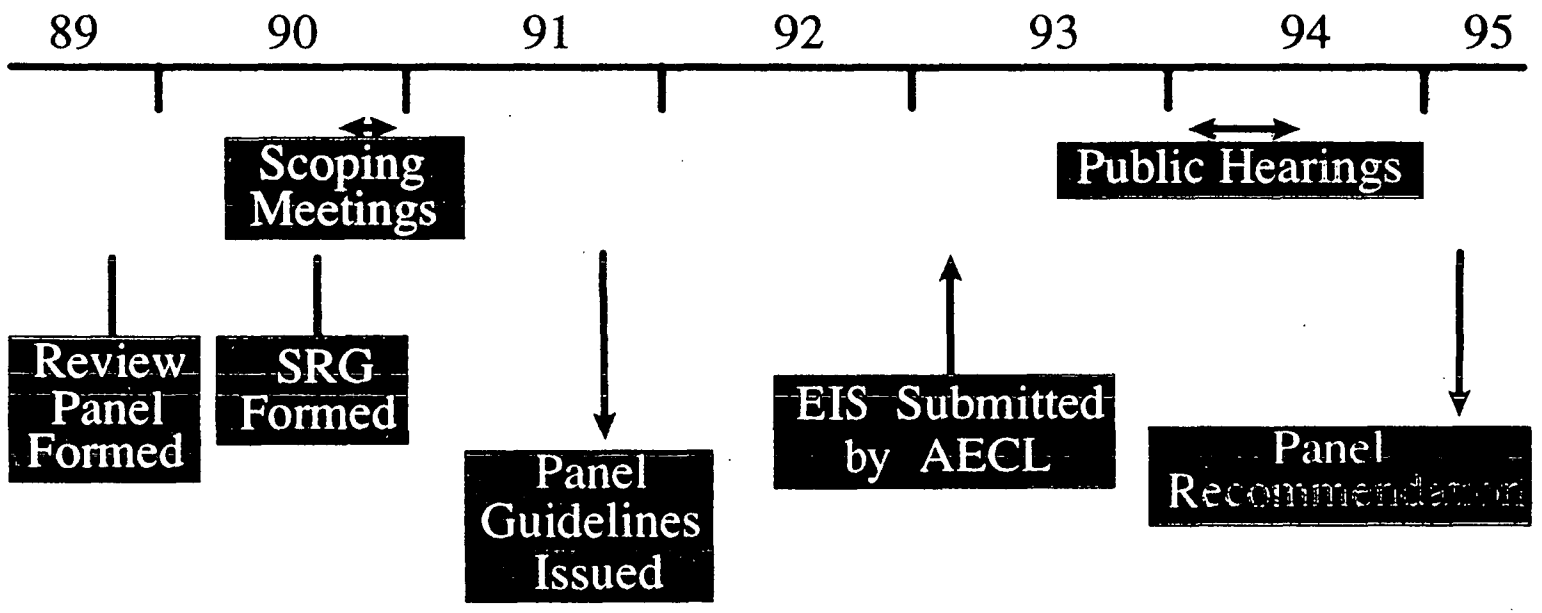
FOR SAFE, DEEP GEOLOGICAL DISPOSAL

OF NUCLEAR FUEL WASTES.

ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS



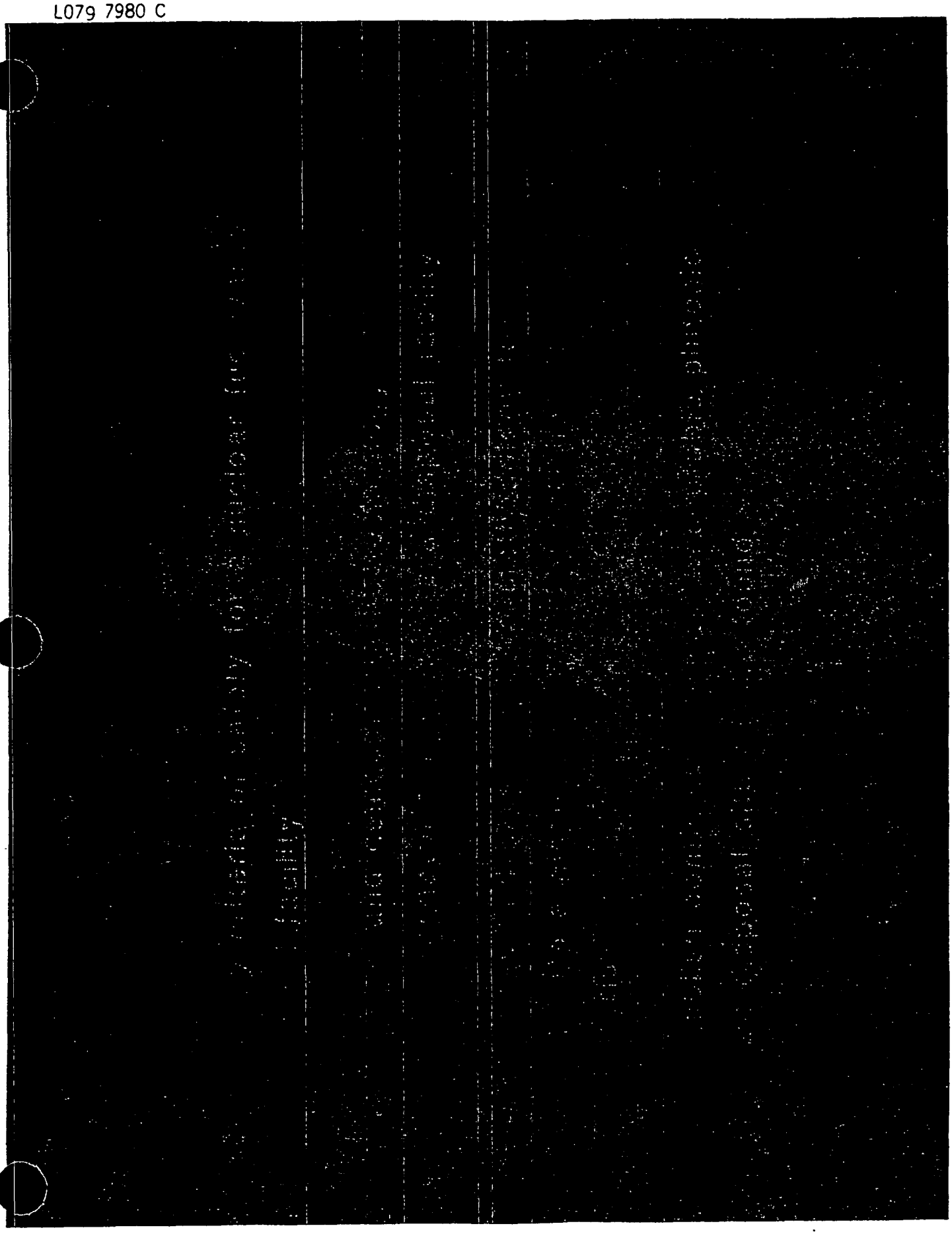
Environmental Assessment & Review Process



May 1991

POLAROID

L079 7980 C



OBJECTIVES OF RADIOACTIVE WASTE DISPOSAL

1. MINIMIZE ANY BURDEN PLACED ON FUTURE GENERATIONS,

2. PROTECT THE ENVIRONMENT, AND

3. PROTECT HUMAN HEALTH

TAKING INTO ACCOUNT SOCIAL AND ECONOMIC FACTORS.

(AECB, R-104)

GENERAL REQUIREMENTS

Individual risk of fatal cancer must not exceed one chance in a million per year.

Assume a group of people located where and when the risks are likely to be the greatest.

Demonstrate compliance with the risk requirements for at least 10,000 years.

Source: R-104, AECB

CANADIAN NFWMP DISPOSAL CONCEPT

DEEP GEOLOGICAL DISPOSAL IN PLUTONIC ROCK

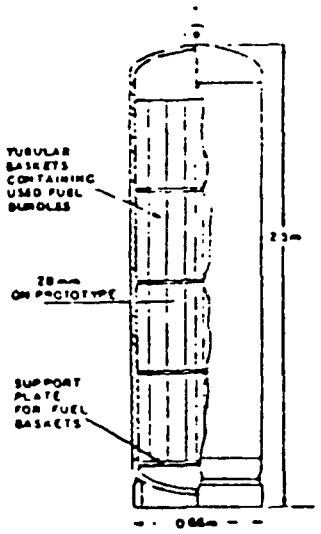
500 TO 1000m REFERENCE DEPTH

MULTIPLE BARRIER SYSTEM COMPRISING:

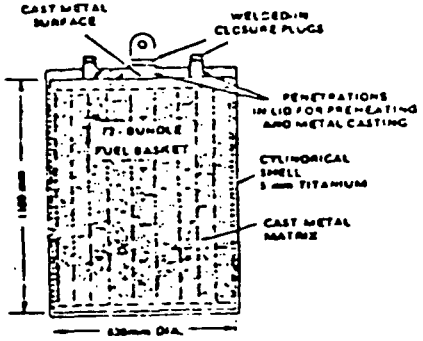
- STABLE WASTE FORM
- CORROSION-RESISTANT CONTAINER
- ENGINEERED EXCAVATIONS SEALED WITH LOW CONDUCTIVITY SEALING MATERIALS
- GEOSPHERE

CANDU FUEL BUNDLE

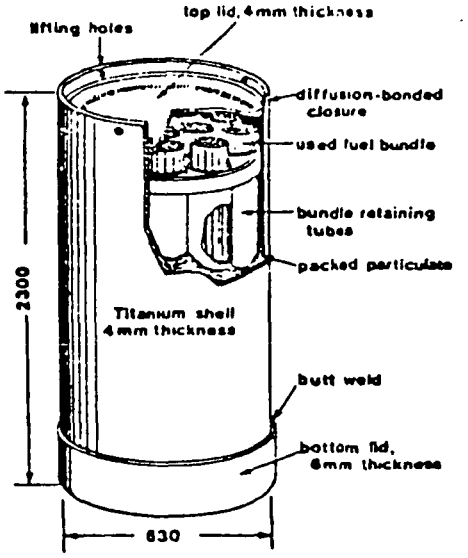
TIME (Years)	RADIOACTIVITY (Gbq/Bundle)	[illegible]
0	150,000,000	37,100
1	680,000	[illegible]
10	64,000	4.3
100	6,800	1.1
1000	380	0.4



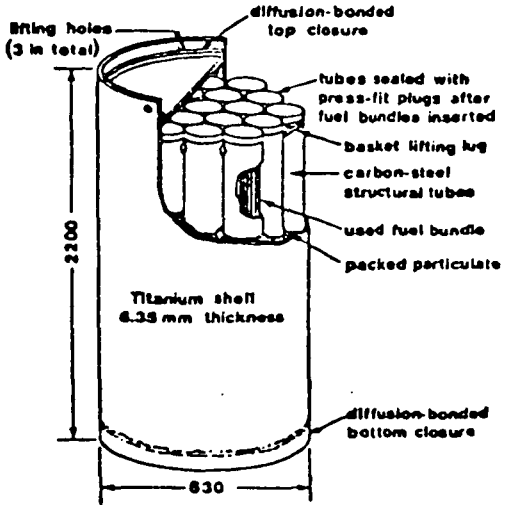
DESIGN DETAILS OF 316 L STAINLESS STEEL STRESSED-SHELL PROTOTYPE CONTAINER



CONCEPTUAL DESIGN OF A METAL-MATRIX SUPPORTED-SHELL CONTAINER



DESIGN DETAILS OF A PACKED-PARTICULATE SUPPORTED-SHELL FUEL ISOLATION CONTAINER



DESIGN DETAILS OF THE PROTOTYPE STRUCTURALLY-SUPPORTED SHELL FUEL ISOLATION CONTAINER

Figure 8: Stressed- and Supported-Shell Disposal Container Designs

CONTAINER DEVELOPMENT
THERMAL CONSIDERATIONS

1. TITANIUM - REFERENCE DESIGN
   - GRADE 2 IS FIRST OPTION AND GRADE 12 IS ALTERNATE
   - PREFERRED FOR WELDED CONSTRUCTION
   - < 100°C TO ENSURE CREVICE CORROSION DOES NOT INITIATE

2. OXYGEN FREE COPPER - ALTERNATE DESIGN
   - OXYGEN-FREE AND PHOSPHOROUS DEOXIDIZED
   - < 100°C UNIFORM AND PITTING CORROSION
     - WITH NO PHASE SEPARATION

3. OTHER MATERIALS CONSIDERED
   - IRON-BASED MATERIALS - GAS GENERATION
   - STAINLESS STEELS - CREVICE AND PITTING CORROSION IN
     - SALINE GROUNDWATER CONDITIONS
   - NICKEL-BASED ALLOYS - PERFORMANCE IN SALINE CONDITIONS
     - NOT SUFFICIENTLY WELL UNDERSTOOD

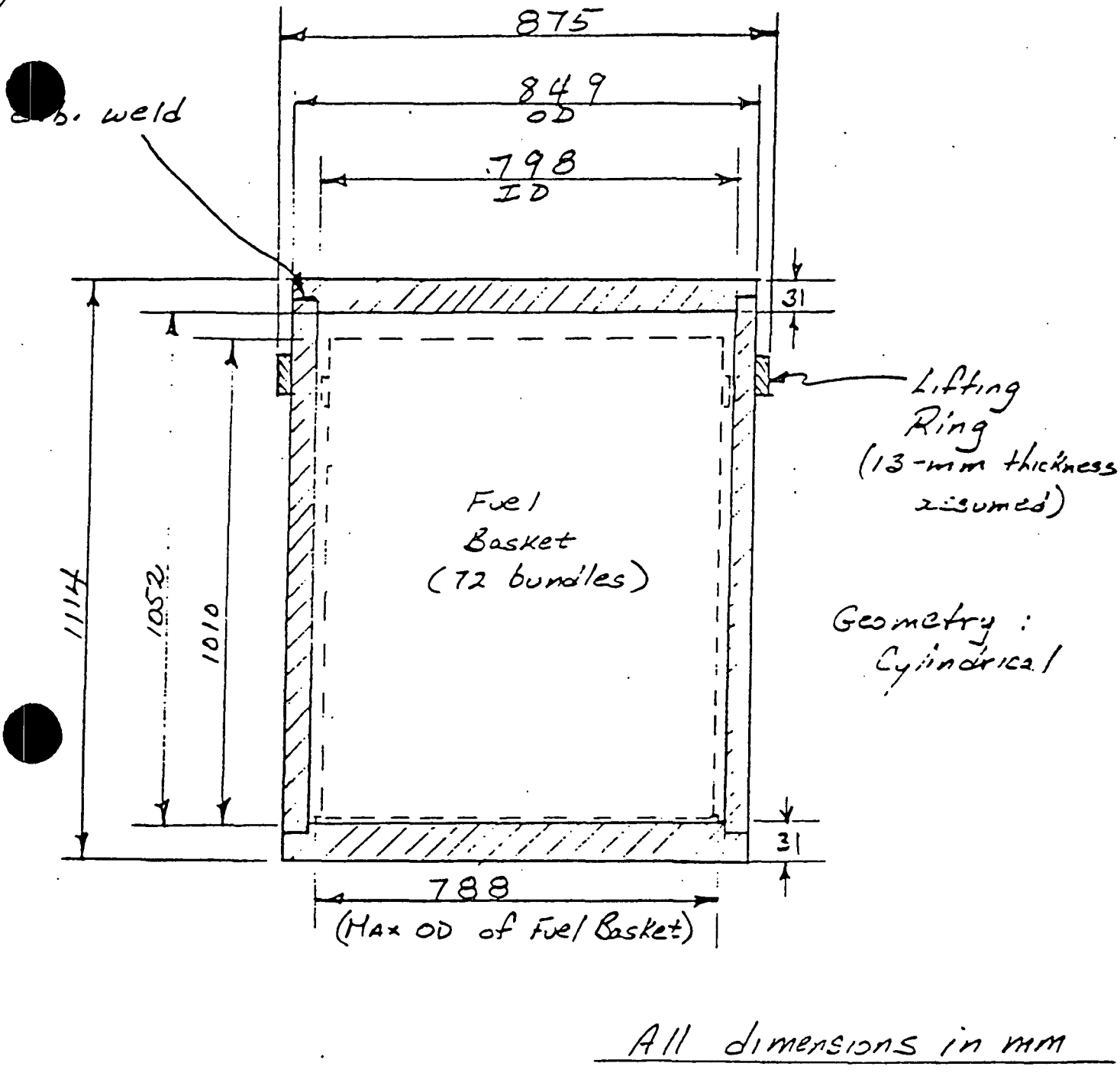
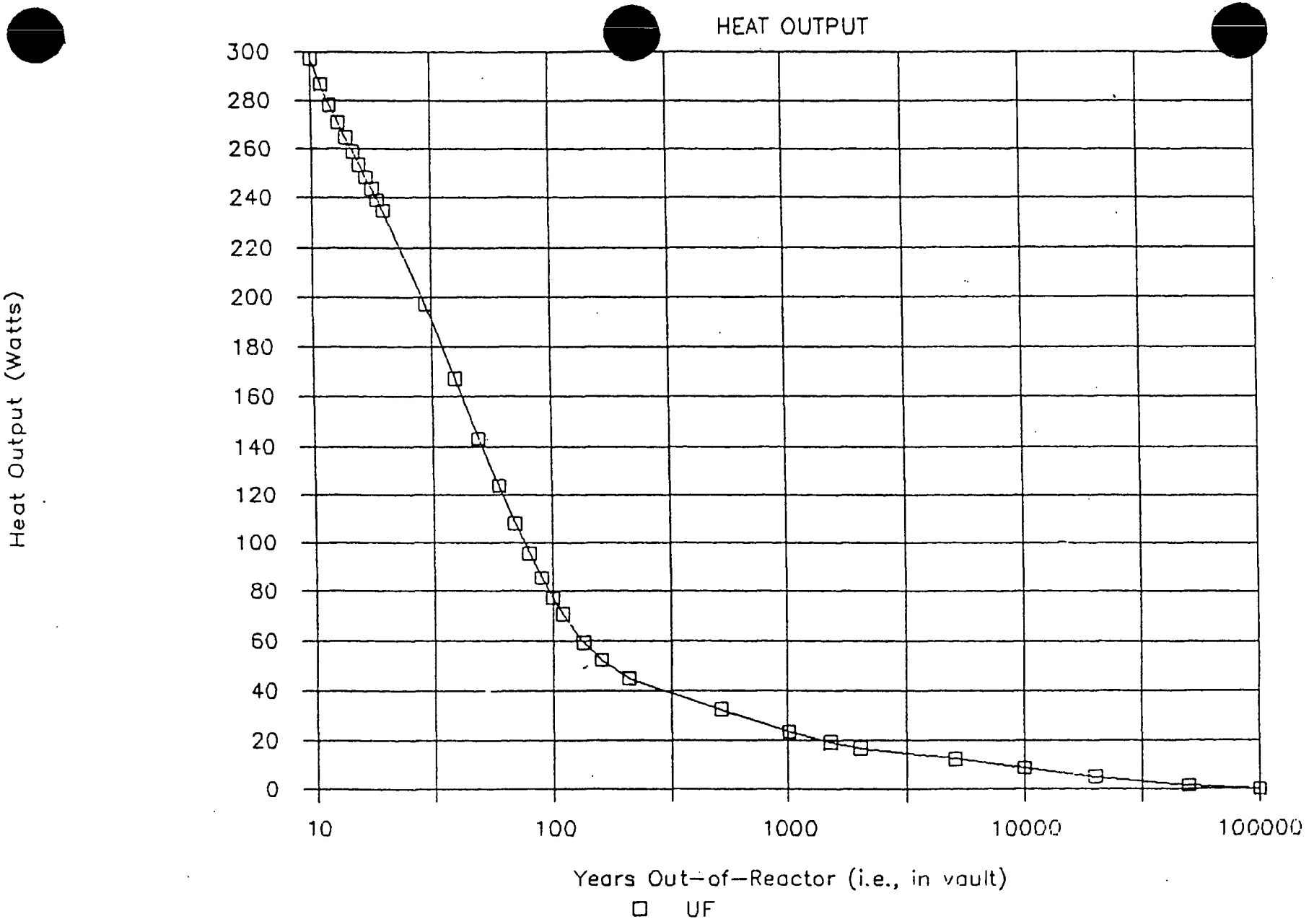
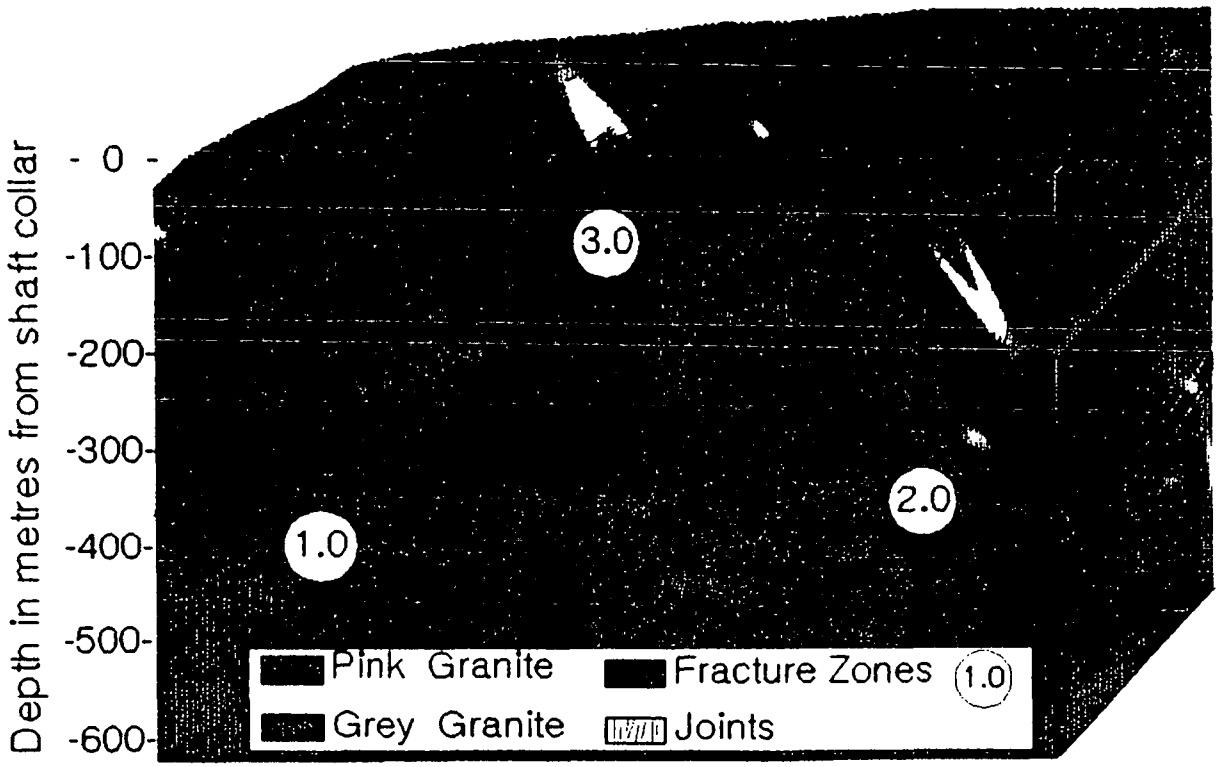


FIGURE 2: Thick-Wall, Packed-Particulate (TEC-1) Container


HEAT OUTPUT
Heat Output (Watts)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
10
100
1000
10000
100000
Years Out-of-Reactor (i.e., in vault)
UF

UFHEAT.WRI

URL GEOLOGICAL SECTION



[91GEOC]

DISPOSAL VAULT
THERMAL & MECHANICAL DESIGN SPECIFICATIONS

MAXIMUM CONTAINER OUTER SHELL TEMP. - 100 °C

MAXIMUM BUFFER AND BACKFILL TEMP. - 100 °C

MAXIMUM DEPTH OF PERTURBED FISSURE ZONE - 100 m

MINIMUM AVERAGE STRESS/STRENGTH RATIO IN ROCK - 2

VAULT LEVEL EXTRACTION RATIO - ABOUT 0.25

NO ARTIFICIAL SUPPORT ON THE EMPLACEMENT BOREHOLE WALL

SURFACE TEMP. = 5 °C & GEOTHERMAL GRADIENT - 12 °C / km

IN SITU STRESSES AFTER HERGET (1980)

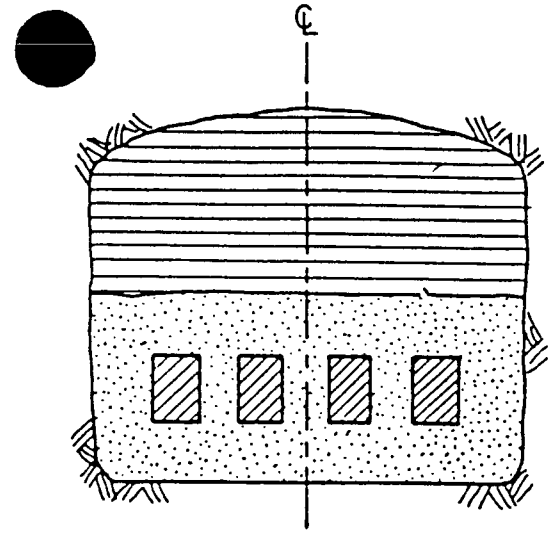
$s_v = 0.0265$ MPa/m $\qquad s_{ha}/s_v = (251.68 / z) + 1.14$

VAULT DEPTH = 1000 m

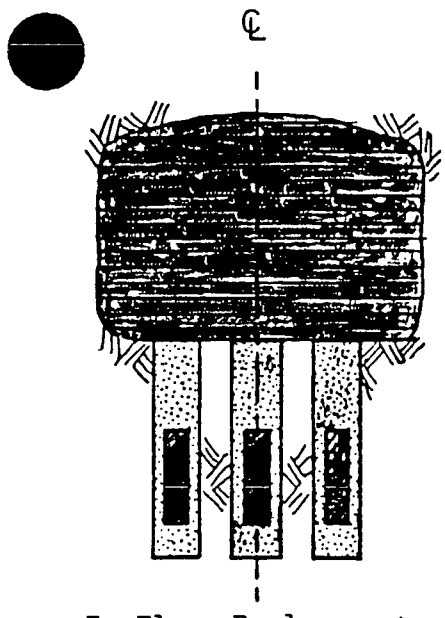
ROCK MASS PROPERTIES ARE BASED ON LABORATORY TESTS,

CLASSIFICATION SYSTEMS AND EMPERICAL FAILURE CRITERIA

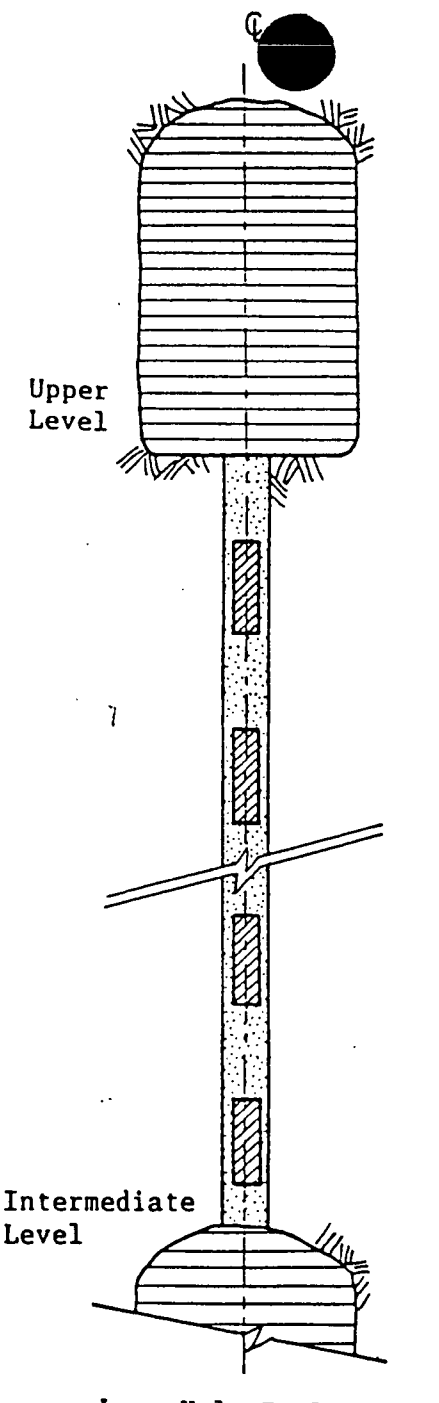
VLTEN9C



In-Room Emplacement
(Acres et al., 1980a, in press)

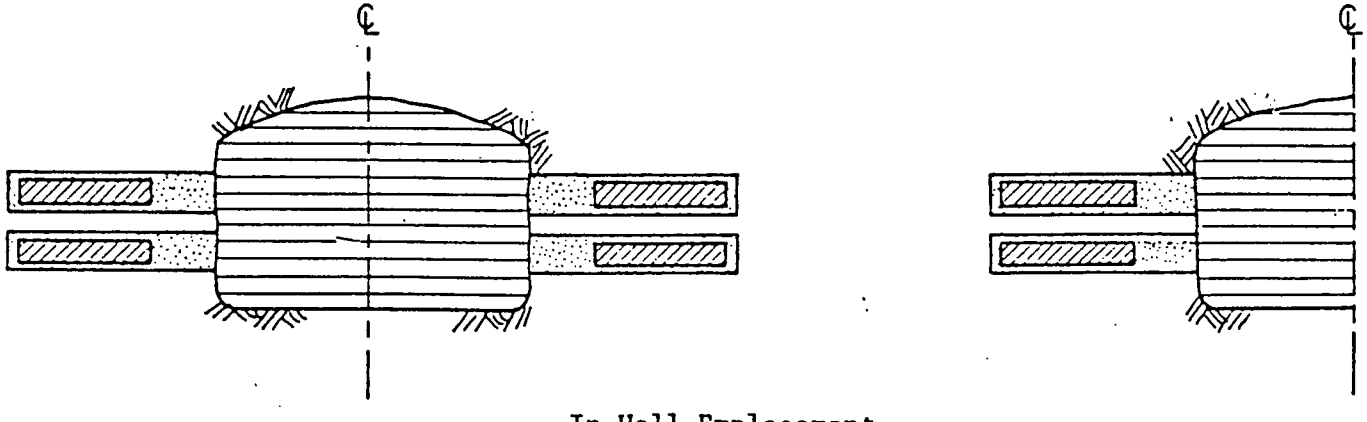


In-Floor Emplacement
(Wardrop et al., 1985)



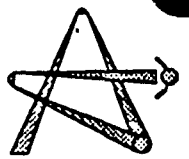
Long-Hole Emplacement
(Acres,)

LEGEND: Container Buffer Backfill



In-Wall Emplacement
(Tsui and Tsai, 1982)

FIGURE 4.3.3-6 Container Emplacement Alternatives Studied in the CNFWMP



SEALING MATERIALS
THERMAL CONSIDERATIONS

CLAY-BASED MATERIALS - REFERENCE DESIGN

- BUFFER - 50% NA-BENTONITE / 50% SAND @ 18% MOISTURE
- LOWER BACKFILL - 25% LAKE CLAY / 75% CRUSHED EXCAVATION MATERIAL @ 6% TO 8% MOISTURE
- UPPER BACKFILL - 20% NA-BENTONITE / 80% SAND

AT TEMPERATURES < 100°C NA-BENTONITE IS:

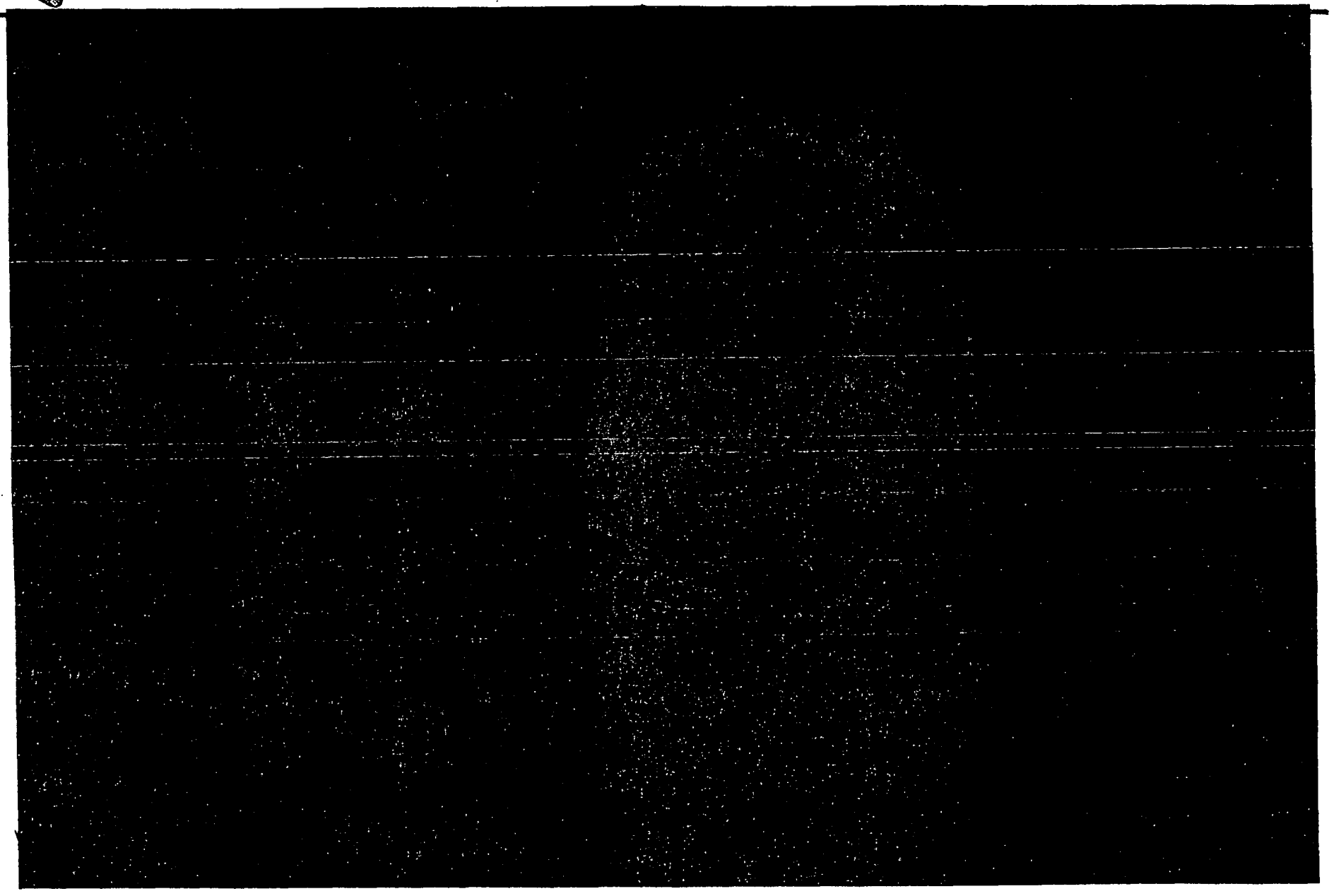
- NOT LIKELY TO BE THERMALLY ALTERED (MAINTAINS SWELLING PROPERTIES)
- NOT SUBJECT TO STEAMING (MAINTAINS SWELLING AND HYDRAULIC PROPERTIES) - MAY NOT AFFECT DENSE MATERIALS

CEMENT-BASED SEALS

- GROUTS
- CONCRETE BULKHEADS

NOTE : CEMENT-BASED SEALS MAY BE STUDIED FOR BROADER USE WITH THE MULTI-PURPOSE CASKS

REFERENCE DISPOSAL VAULT DESIGN



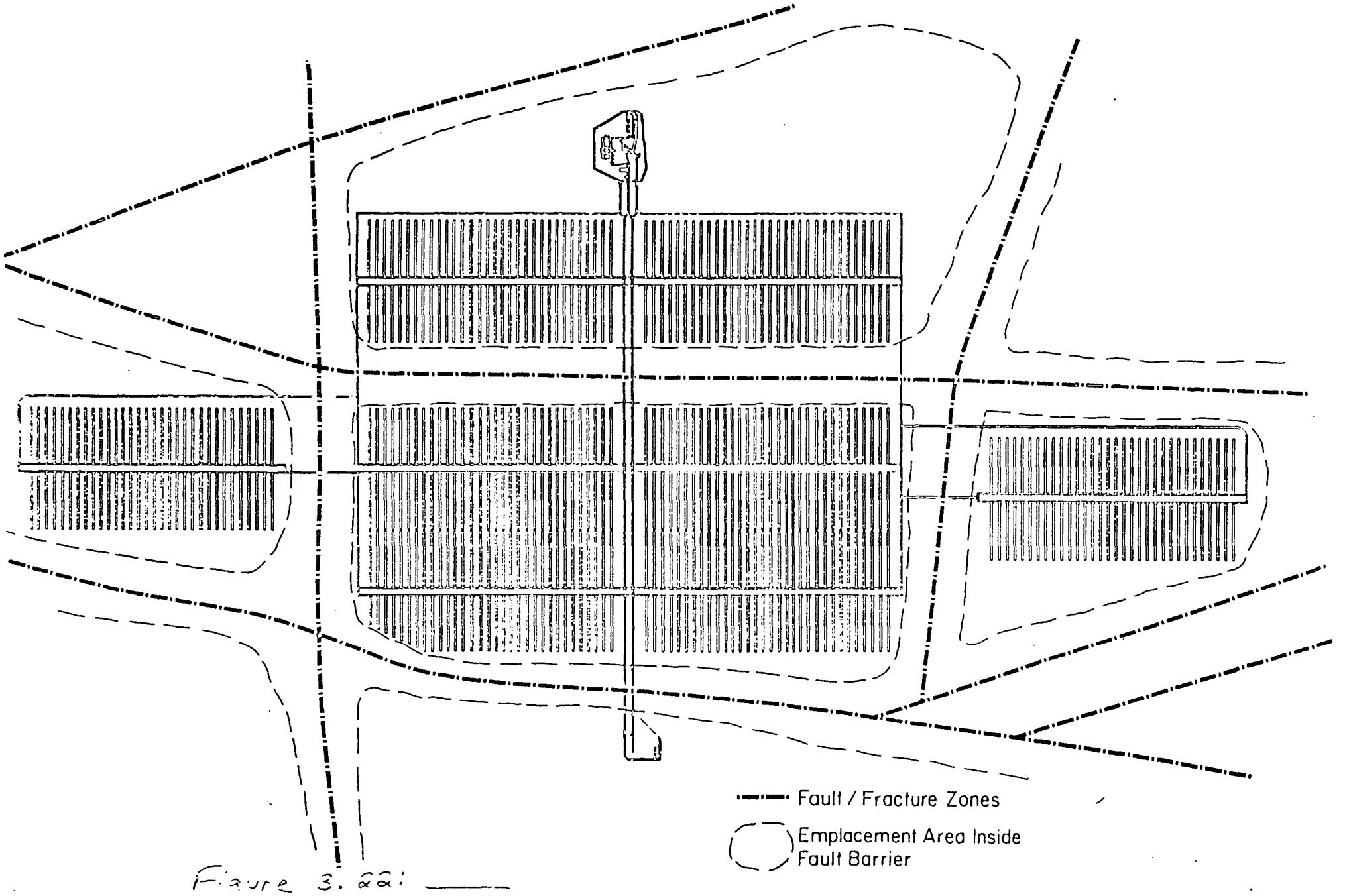

Fault / Fracture Zones
Emplacement Area Inside Fault Barrier

Figure 3.22:

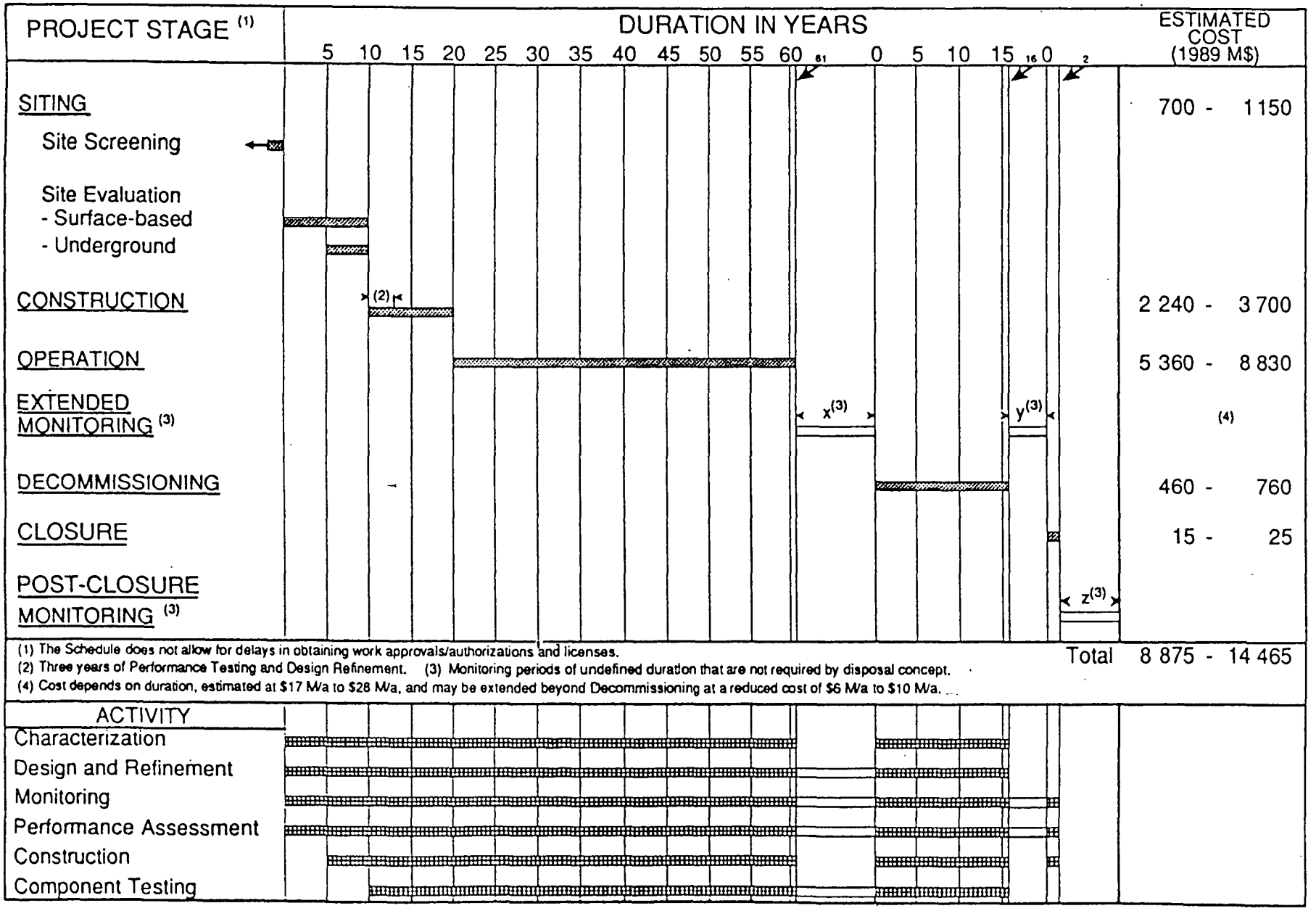


FIGURE 1: Used-Fuel Disposal Centre Schedule

Ref: EISUFDC3.DRW
Drawn 1991 Jan 24
Modified 1991 Mar 27
A. Rogowski

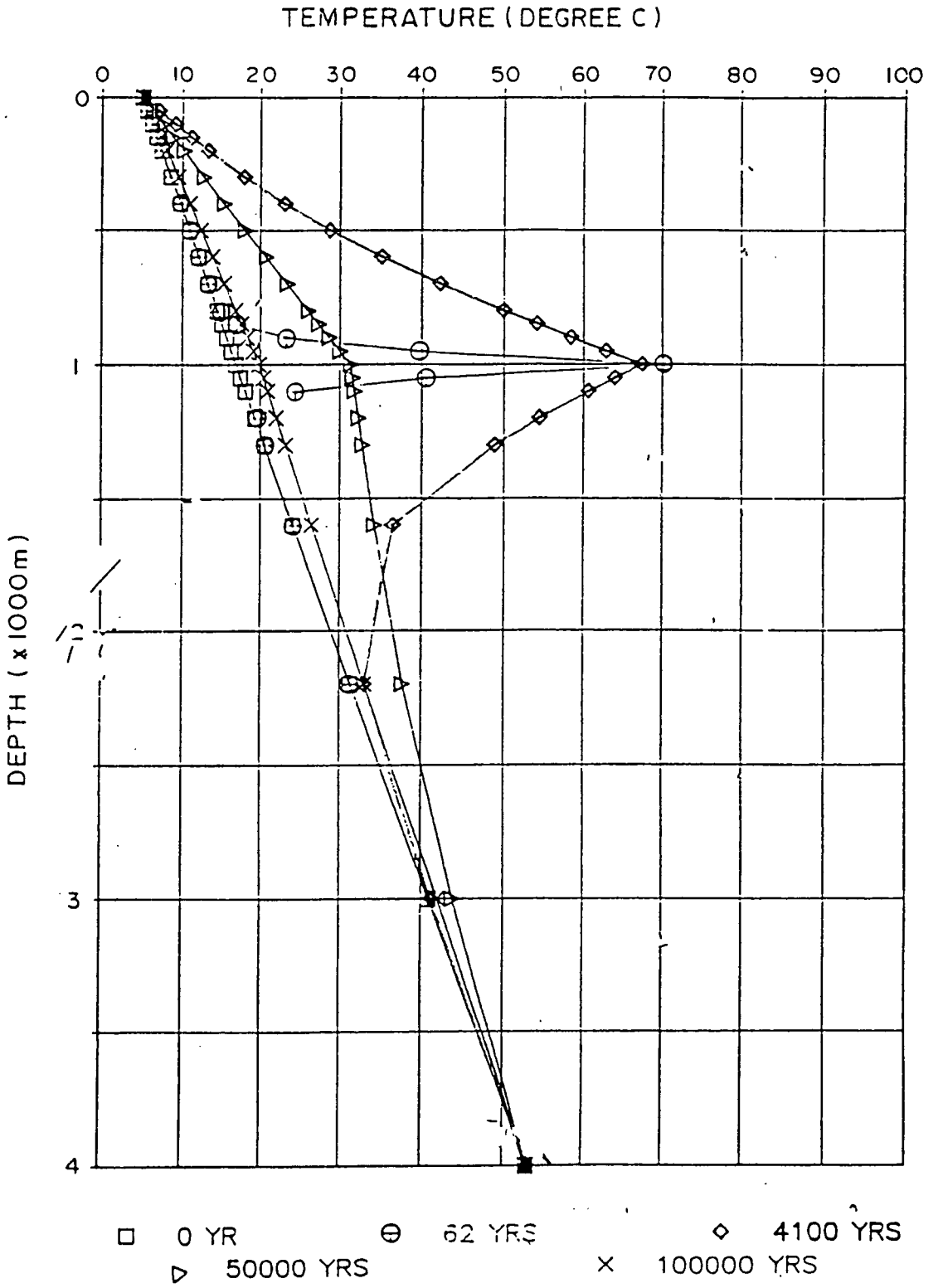


FIGURE 4.20 DISTRIBUTION OF TEMPERATURE WITH DEPTH ALONG CENTRELINE OF VAULT (AXISYMMETRIC CASE)