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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: IN SITU THERMAL AND MECHANICAL TEST PROGRAM

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OVERVIEW

- Objectives
- Requirements/Information Needs
- Proposed Revised Test Program
- Conclusions

OBJECTIVE

Develop a revised in situ test program that

1. **Will address the specific Information Needs to a level of confidence to support the stepwise decisions inherent in the Program Approach.**

2. **Can be accomplished in a limited time frame to support technical site suitability and the initial License Application.**

3. **Will be limited in scope and focus on preclosure issues, while forming a basis for additional testing that will be required for later licensing decisions.**

REQUIREMENTS/ INFORMATION NEEDS

Design — Title I Design for Initial License Application

- Rock-mass thermal properties and thermal expansion
- Rock-mass mechanical properties *
- Rock-mass scale fracture * properties
- Rock-mass strength *
- Material interactions *
- Thermal response of drifts – model validation

*at ambient and elevated temperature

REQUIREMENTS/ INFORMATION NEEDS CONTD.

Preclosure Performance Assessment

- Rock-mass thermal properties and thermal expansion
- Rock-mass mechanical properties *
- Rock-mass scale fracture properties *
- Rock-mass strength *
- Operation phase drift and intersection stability
- Temperature effects on rock thermal and mechanical properties

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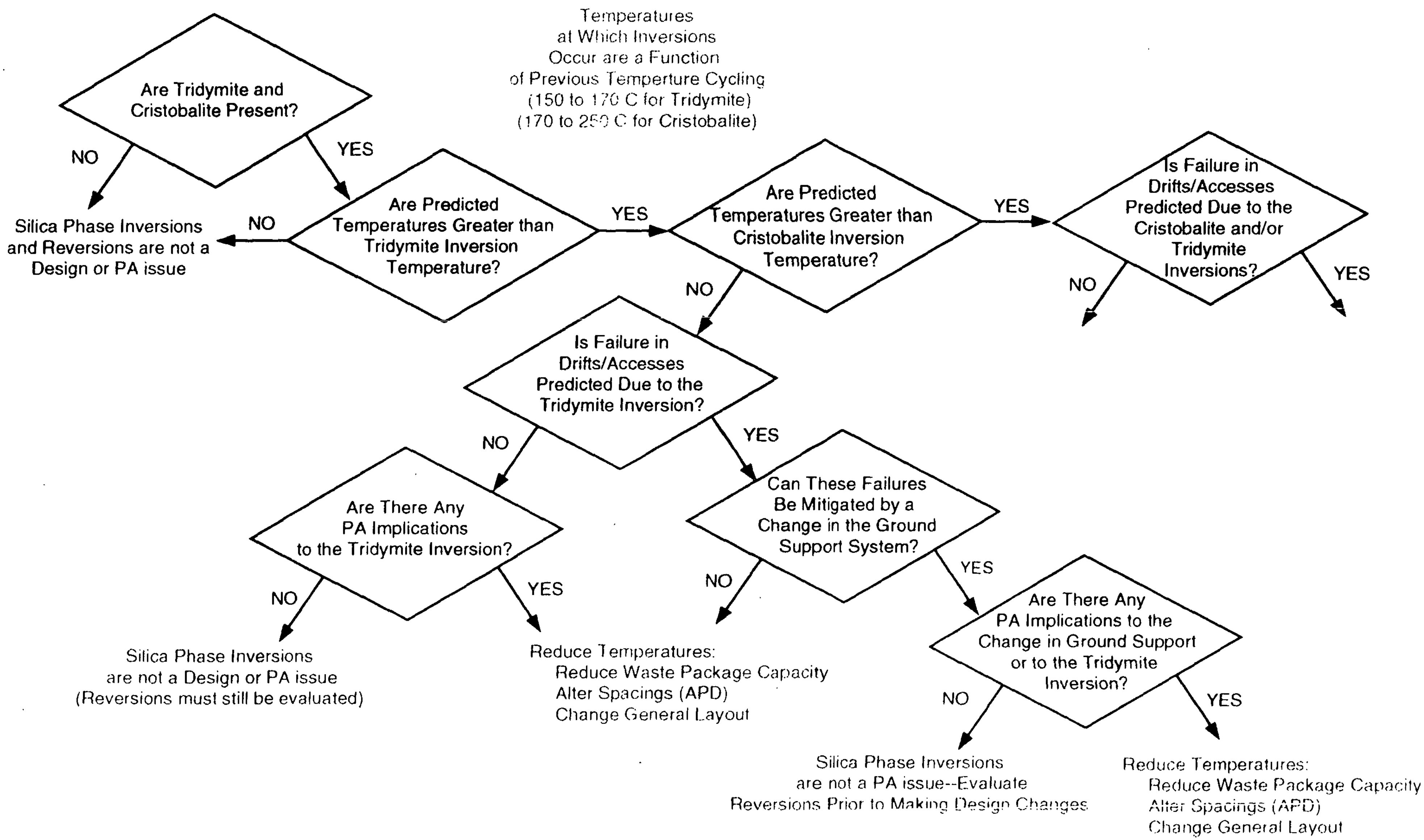
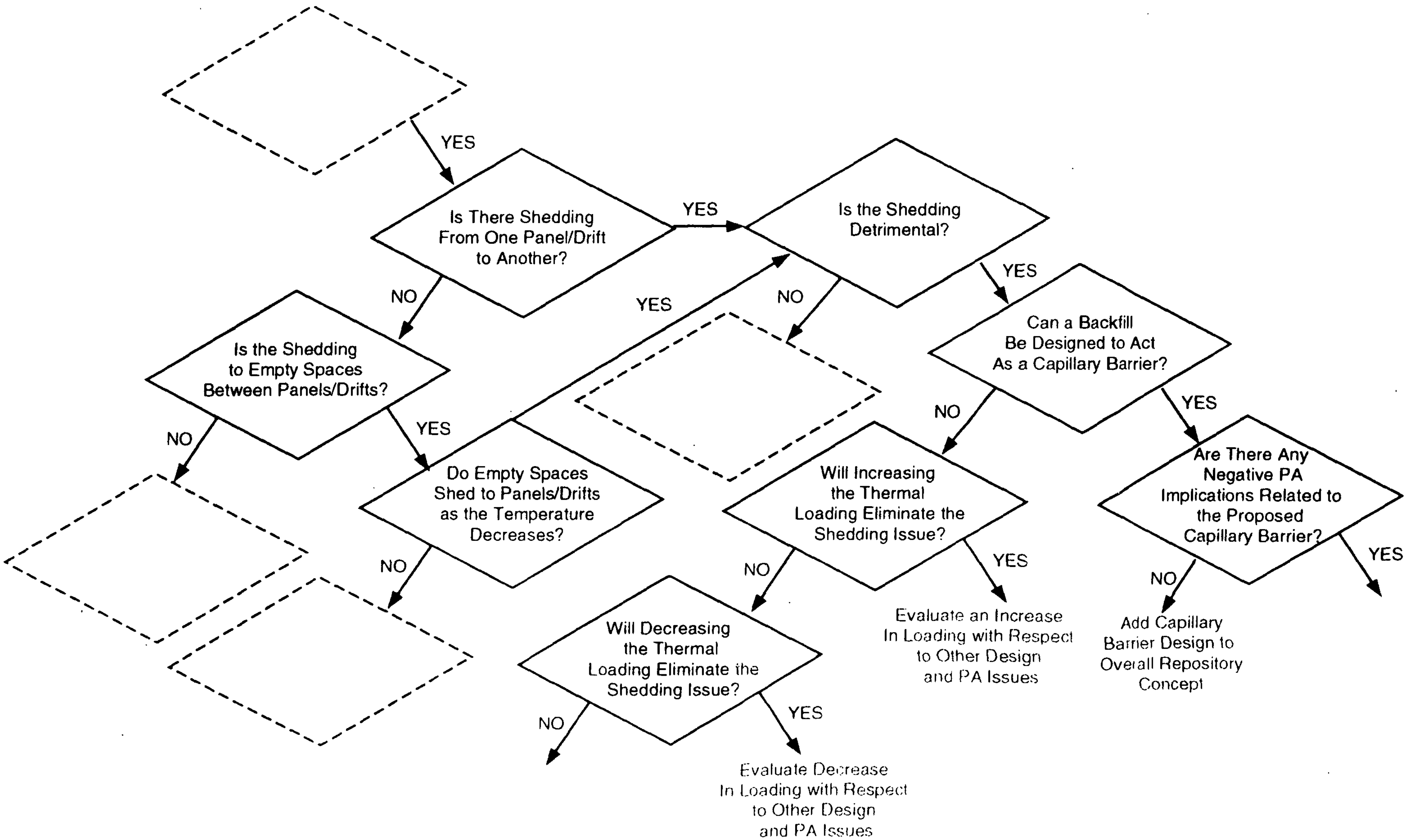
*ambient and elevated temperature

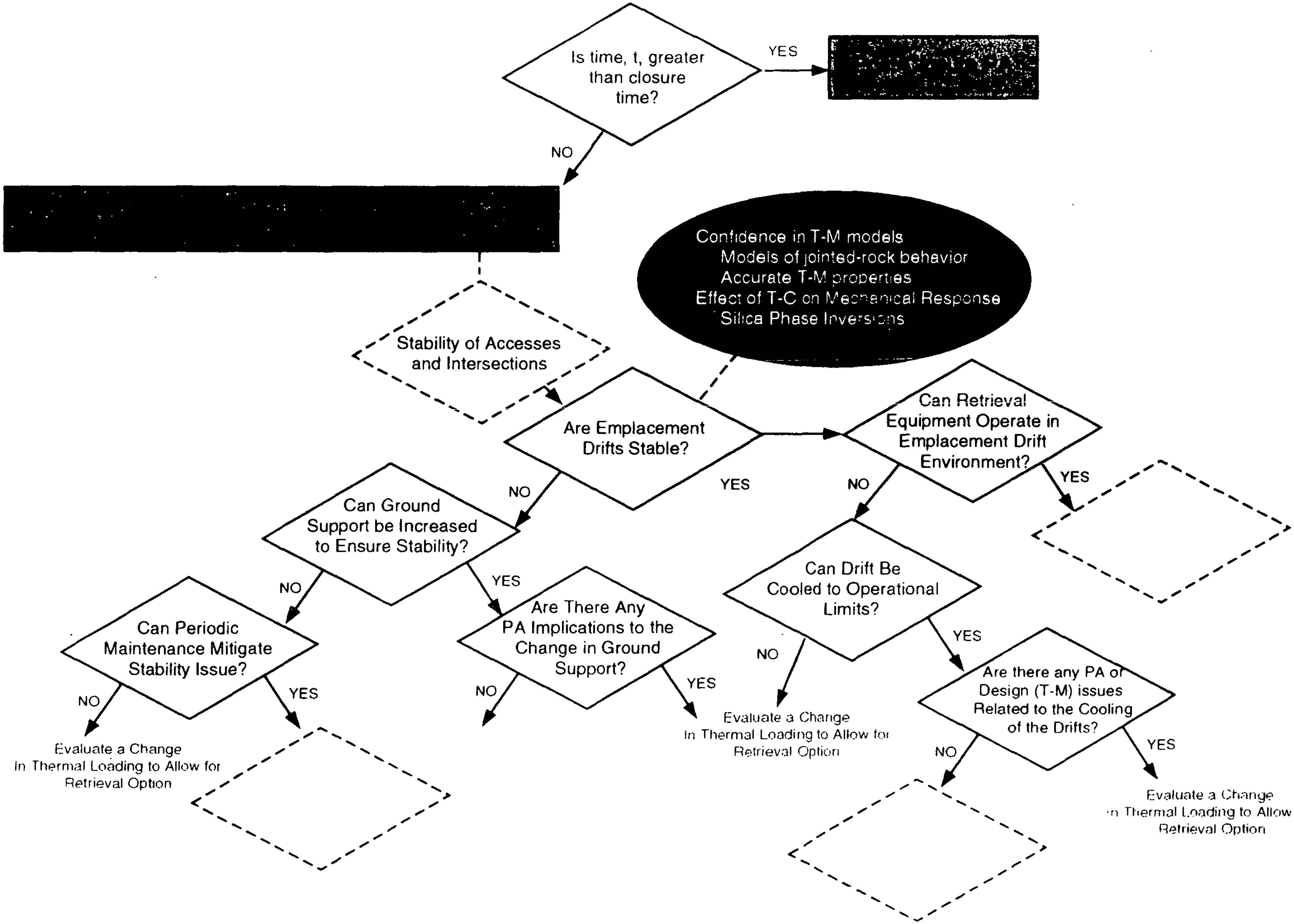
Silica Phase Transformations (Near-Field)



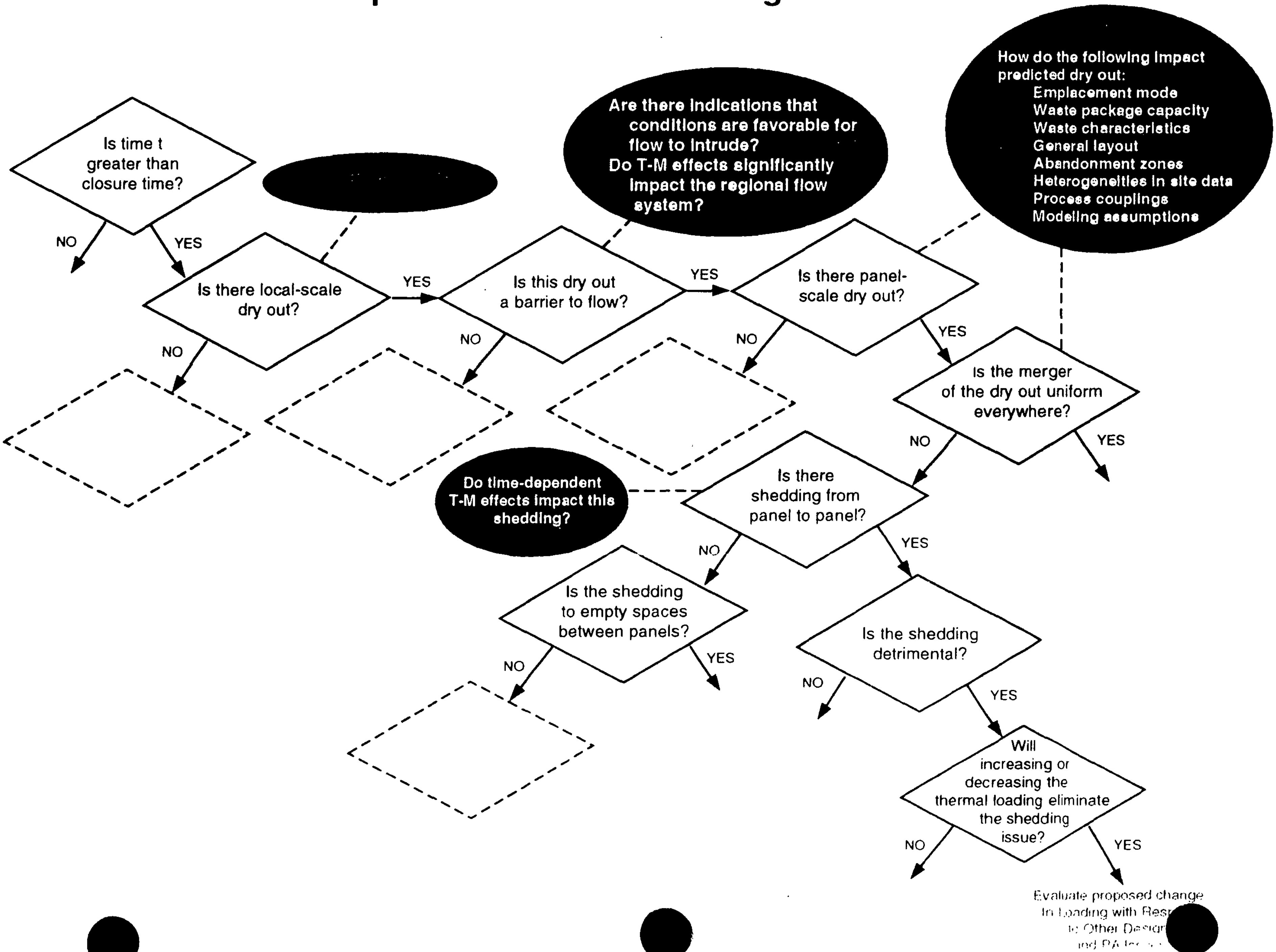
Determination of Backfill Properties



Excerpt From Thermal Loading Decision Tree (Pre-Closure)



Excerpt From Thermal Loading Decision Tree



REQUIREMENTS/ INFORMATION NEEDS CONTD.

Waste Package — Title II Design

- Rock-Mass thermal properties (including backfill)
- Near-field environment – focus on containment period
- Drift stability under thermal loads – focus on containment period

REQUIREMENTS/ INFORMATION NEEDS CONTD.

Postclosure Performance Assessment "Bounding" estimates

- Rock-mass thermal properties
- Temperature effects on rock mass thermal and mechanical properties
- Hydrologic properties – ambient and disturbed conditions
- Conceptual model/hypotheses testing — T-M-H-C coupling
  - heat transfer
  - vapor movement
  - fracture flow

SUMMARY OF INFORMATION NEEDS AND CUSTOMERS

Information Needs	Customers			
	Design	Pre PA	Post PA	Waste Pack
Rock-mass thermal properties*	Yes	Yes	Yes	Yes
Rock-mass thermal expansion	Yes	Yes		
Rock-mass mechanical properties*	Yes	Yes		
Mechanical properties of fractures*	Yes	Yes		
Rock-mass strength	Yes	Yes		
Temperature effects on rock T-M-H-C properties		Yes	Yes	
Drift response/stability under thermal conditions	Yes	Yes		Yes
Near-field T-M-H-C environment	Yes			Yes
Hydrologic properties*			Yes	
Conceptual model/hypoth testing			Yes	
Materials interactions	Yes			

*Properties needed as a function of temperature

OTHER CONSTRAINTS

- Time
- Location
- Construction Methods

PROPOSED TEST PROGRAM

- **Axisymmetric Heater Tests**
- **Heated Block Test**
- **Thermal Stress Test**
- Plate Loading Test

SUMMARY OF INFORMATION NEEDS AND TESTS

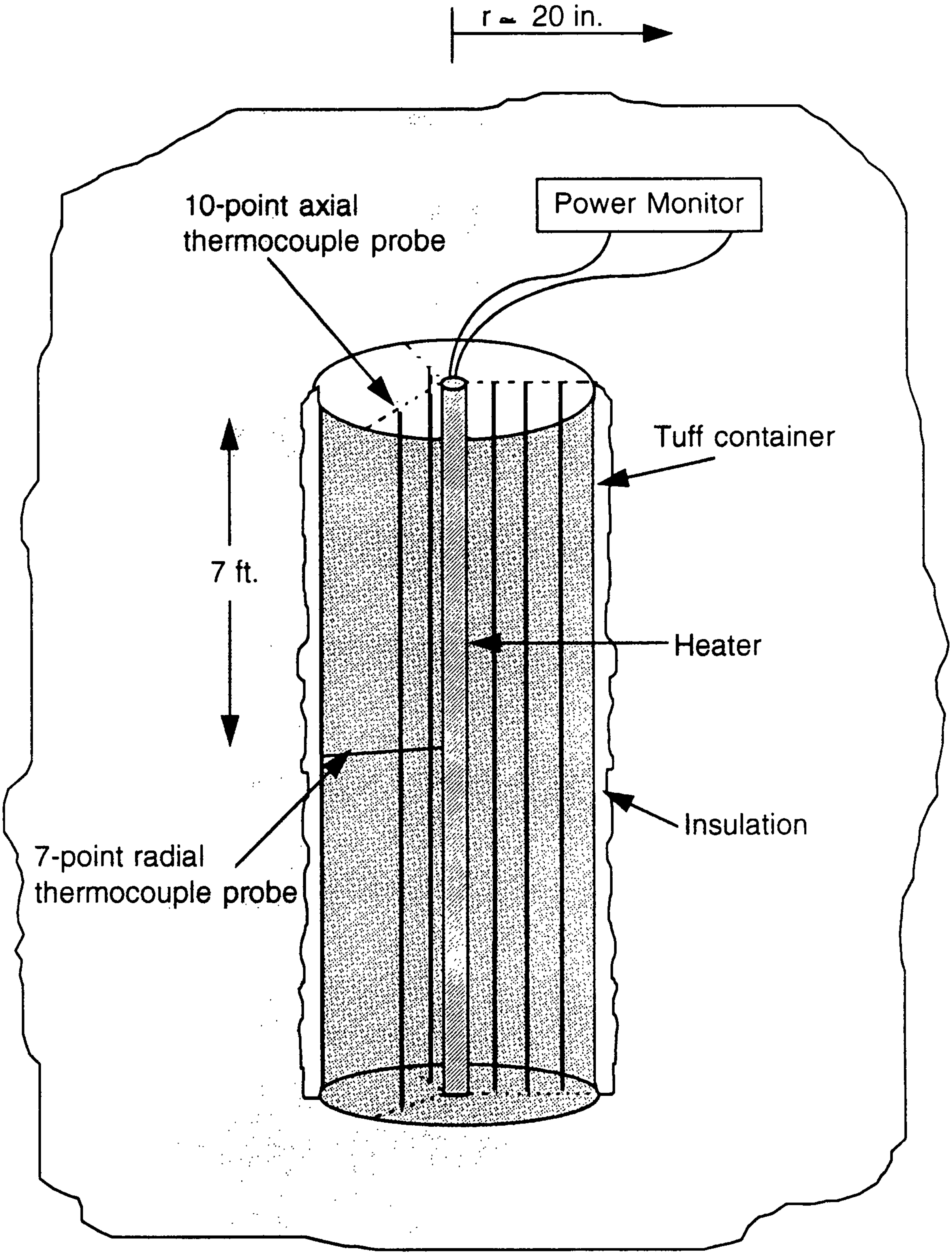
Information Needs	Test Axs. Heater	 Heated Block	 Thermal Stress
Rock-mass thermal properties*	Yes	Yes	
Rock-mass thermal expansion	Yes	Yes	
Rock-mass mechanical properties*		Yes	
Mechanical properties of fractures*		Yes	
Rock-mass strength*		Yes	
Temperature effects on rock T-M-H-C properties	Yes	Yes	
Drift response/stability under thermal conditions			Yes
Near-field T-M-H-C environment	Yes	Yes	Yes
Hydrologic properties*	Yes	Yes	Yes
Conceptual model/hypoth testing	Yes	Yes	Yes
Materials interactions			Yes

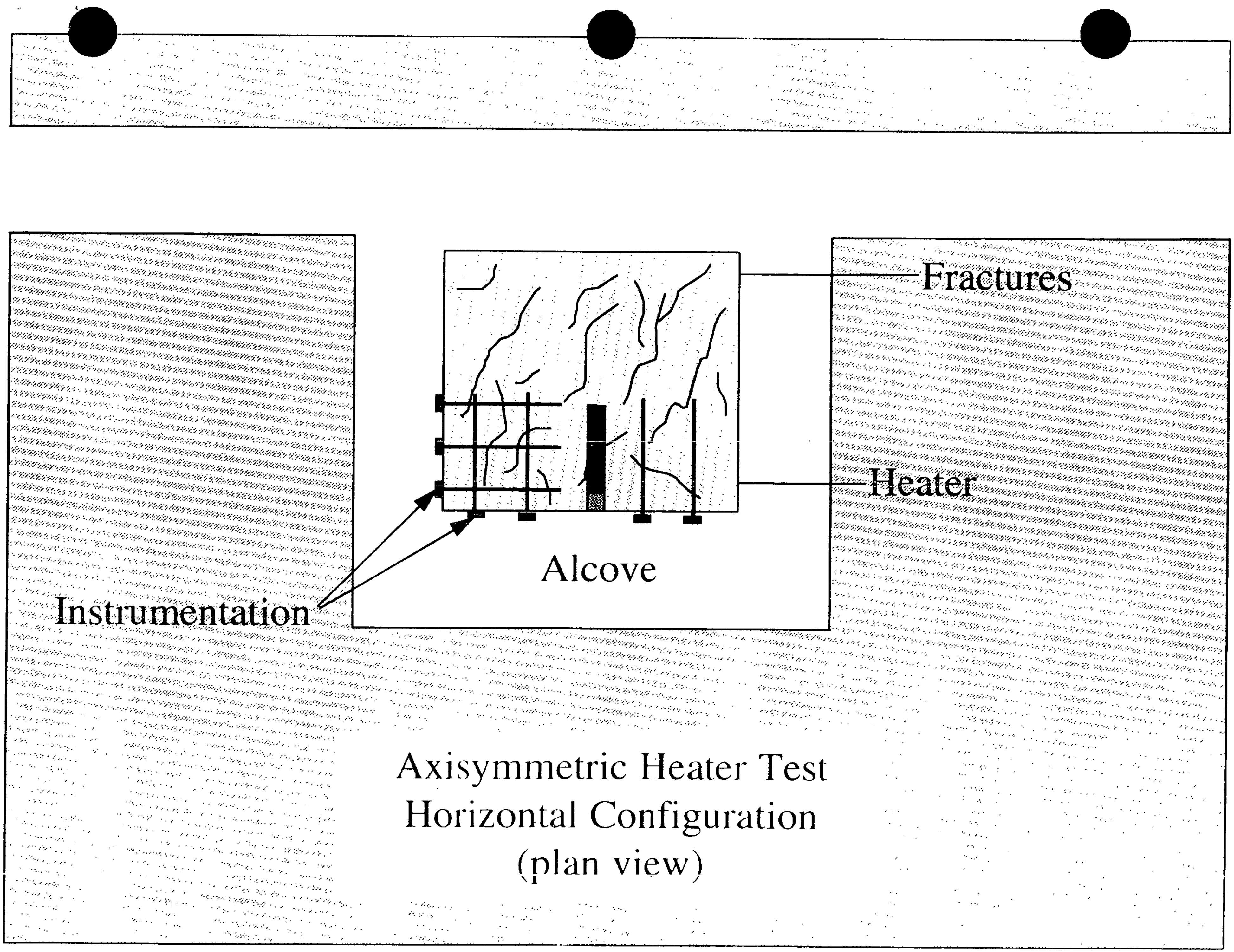
*Properties needed as a function of temperature

AXISYMMETRIC HEATER TEST

- Thermal Properties — TSw 1 and TSw 2
- Model Validation — thermal and coupled T-H
- Permeability changes
- Drying front
- Fracture flow
- Horizontal and vertical configurations
- Ideal geometry

Schematic View

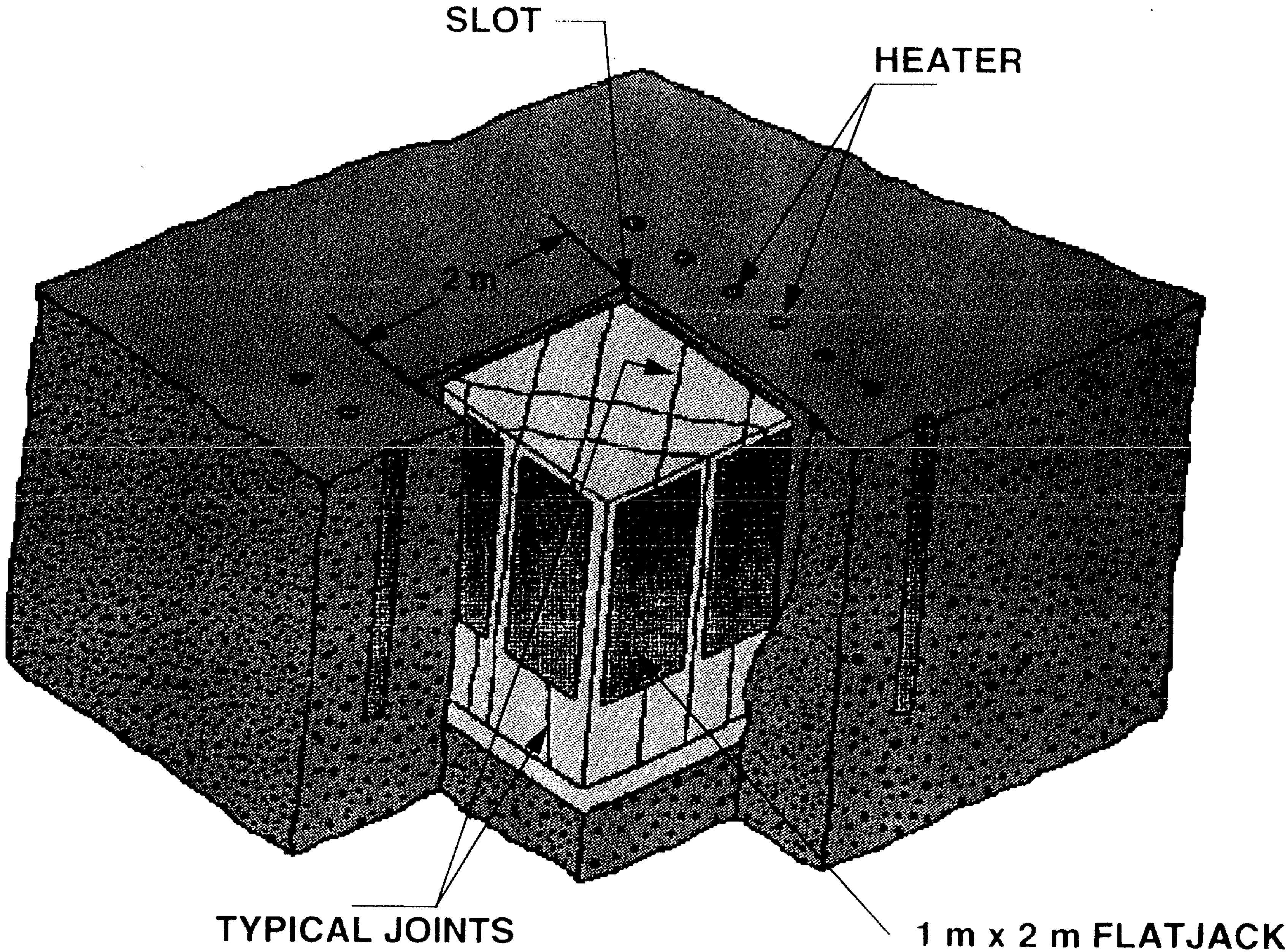




Axisymmetric Heater Test
Horizontal Configuration
(plan view)

HEATED BLOCK TEST

- Controlled boundary conditions
- Fracture properties
- Rock-mass deformation and strength
- Model validation coupled T-M-H effects
- Thermal expansion of rock mass


SLOT
HEATER
2 m
TYPICAL JOINTS
1 m x 2 m FLATJACK

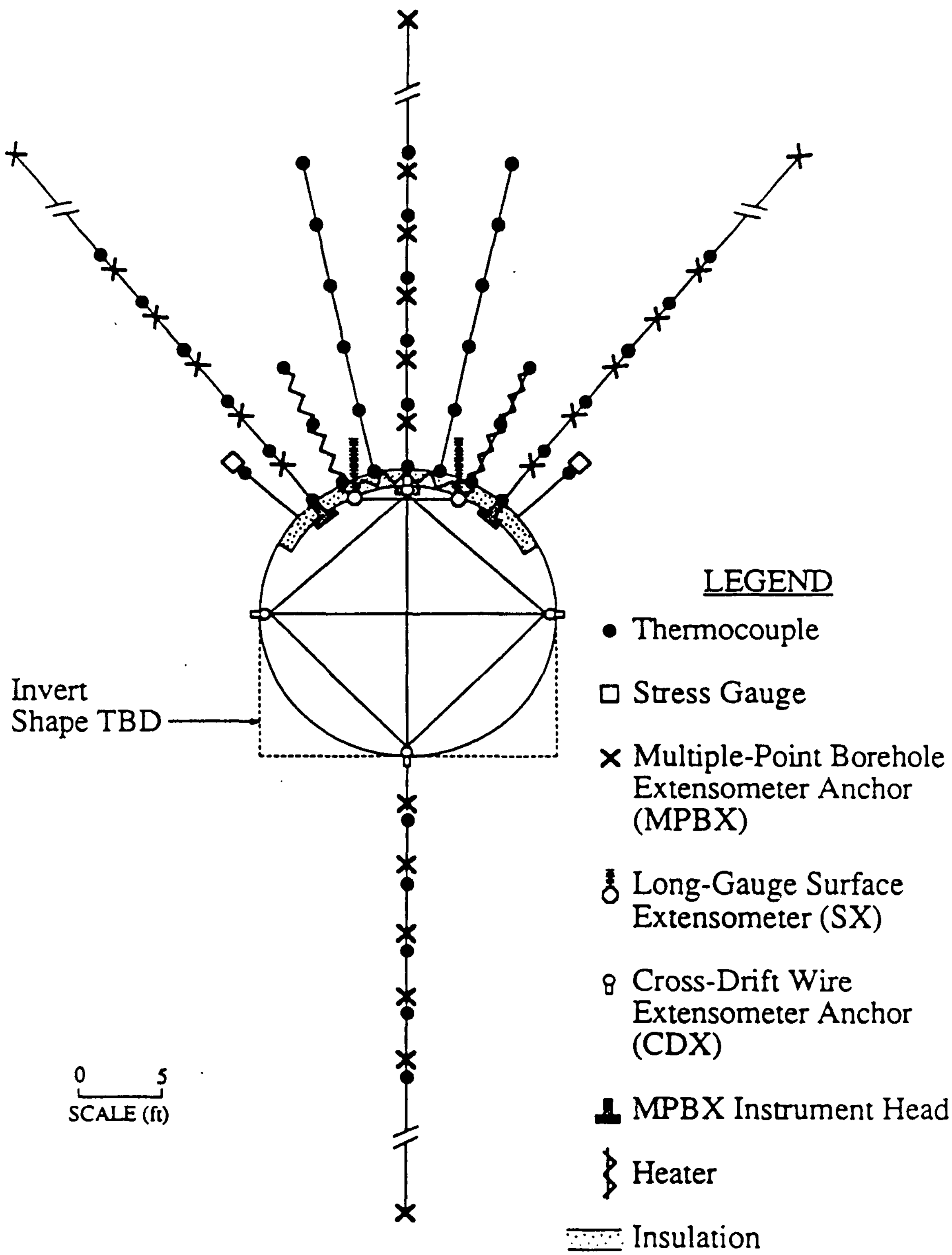
THERMAL STRESS TEST

- Demonstration of rock-mass behavior on emplacement room scale
- Simulates in-drift emplacement problem
- Thermal overdrive
- Short time scale
- Rock-ground support interaction

THERMAL STRESS TEST CONTD.

- Geochemical effects of manmade materials
- Near-field environment during containment period
- Room-scale conceptual model validation for T-M-H processes
- Thermal and mechanical effects on rock-mass permeability

Thermal Stress Test



SUMMARY AND CONCLUSIONS

- Test program is being modified to meet the needs of the Program Approach

- Additional testing will be required to support later licensing decisions

SUMMARY AND CONCLUSIONS CONTD.

- **The proposed thermal/mechanical tests will provide**
  1. **The data and information needs required by the PA for site suitability and the initial License Application.**
  2. **Can be fielded within the allowable time windows to provide the information for technical site suitability and the initial License Application.**
  3. **Are simple and flexible enough to fit within the construction and operational constraints of the ESF during early construction period.**
  4. **Are consistent with the SCP performance allocation process and will directly feed the thermal-load decision process.**