

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

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

**SUBJECT: ESF THERMOMECHANICAL
EXPERIMENTS**

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**PRESENTER'S TITLE
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Objectives of Exploratory Studies Facility (ESF) Thermomechanical Experiments

- **Verify fundamental physical model assumptions about the coupled thermal and mechanical behavior of the host rock**
- **Measure the thermal and mechanical properties of the rock mass**
- **Provide measured data to validate computer models of the rock mass**
- **Investigate stress-induced changes in fracture apertures of the rock mass**

Objectives of Exploratory Studies Facility (ESF) Thermomechanical Experiments

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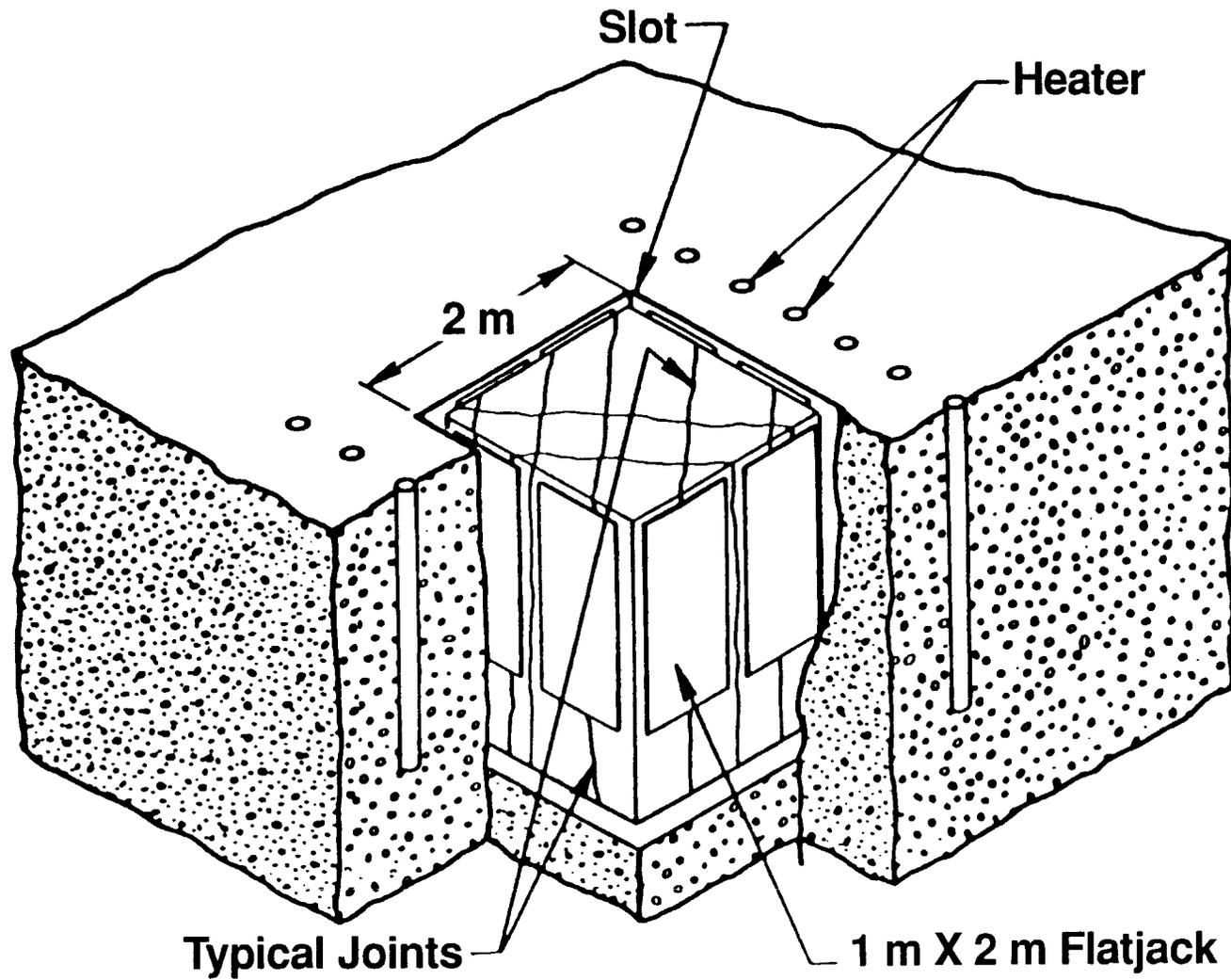
- **Demonstrate the effects of high temperatures on repository-scale volumes of rock**
- **Provide data on stability of emplacement boreholes and drifts**
- **Evaluate the effects of thermal loads on ground-support systems**
- **Confirm design concepts proposed for the potential repository**

Approach to Meeting Information Needs

The objectives will be met by four experiments of increasing complexity and scale:

- **Heated-block experiment**
- **Canister-scale heated borehole experiment**
- **Thermal stress test**
- **Heated-room experiment**

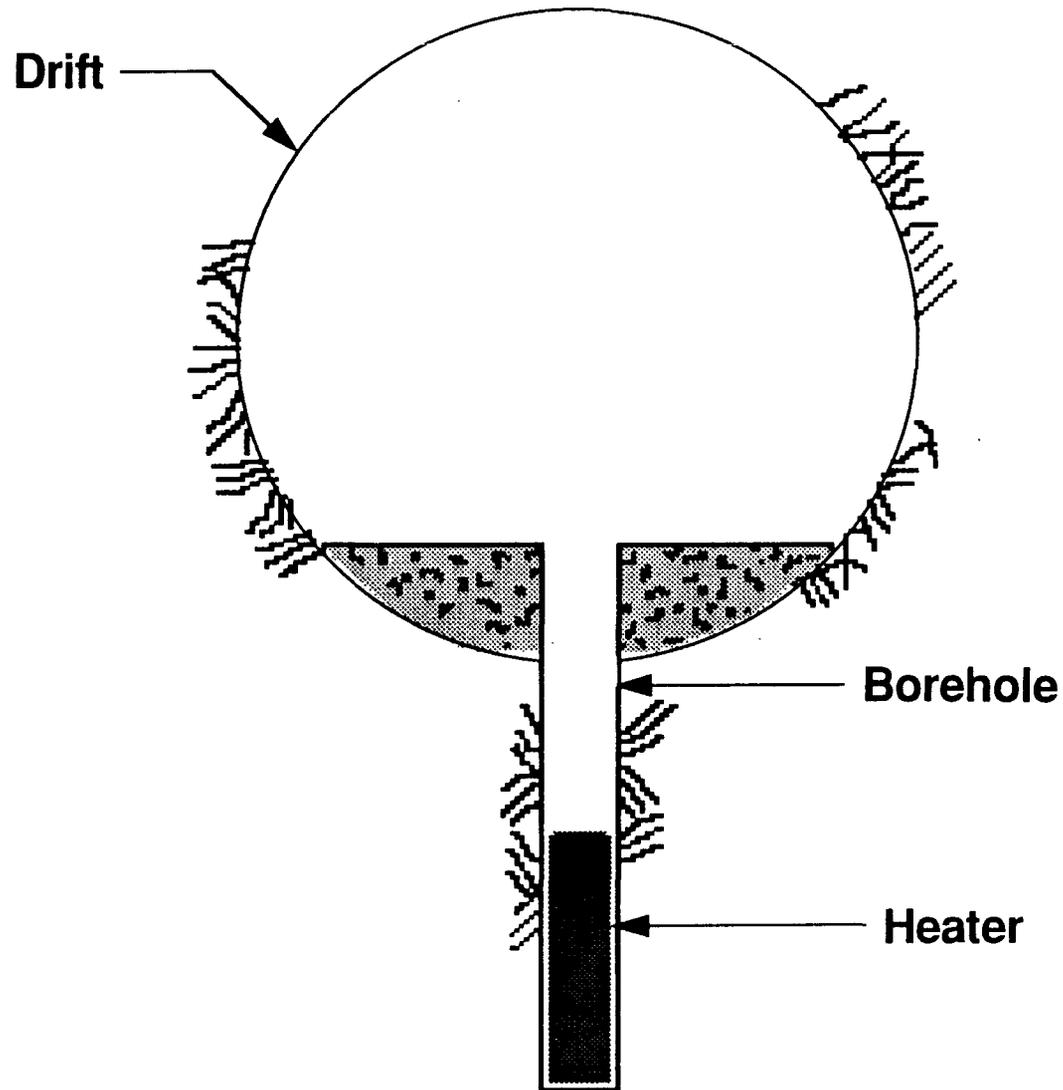
Heated Block Test



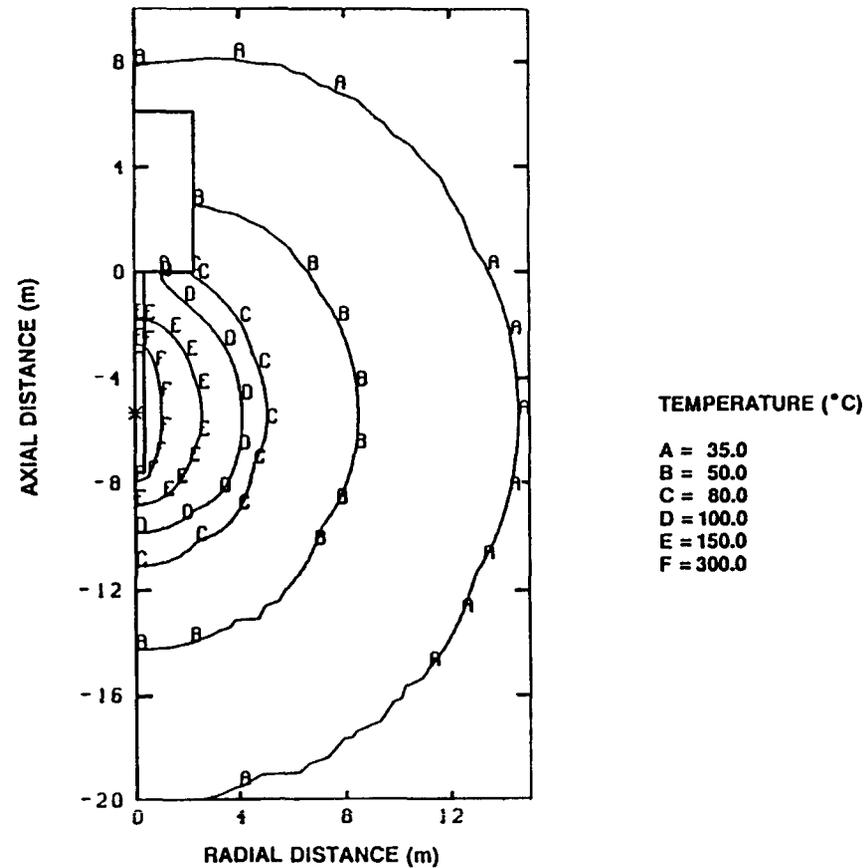
Heated Block Test: Objectives

- **Measure thermal and mechanical properties**
 - **Deformation modulus and Poisson's Ratio**
 - **Coefficient of thermal expansion**
 - **Thermal conductivity and heat capacity**
- **Code validation**
- **Verify physical models**
- **Stress-induced changes in fracture aperture**

Canister-Scale Heated Borehole Experiment



Canister-Scale Heated Borehole Experiment: Expected Temperatures



Canister-Scale Heated Borehole Experiment: Notes

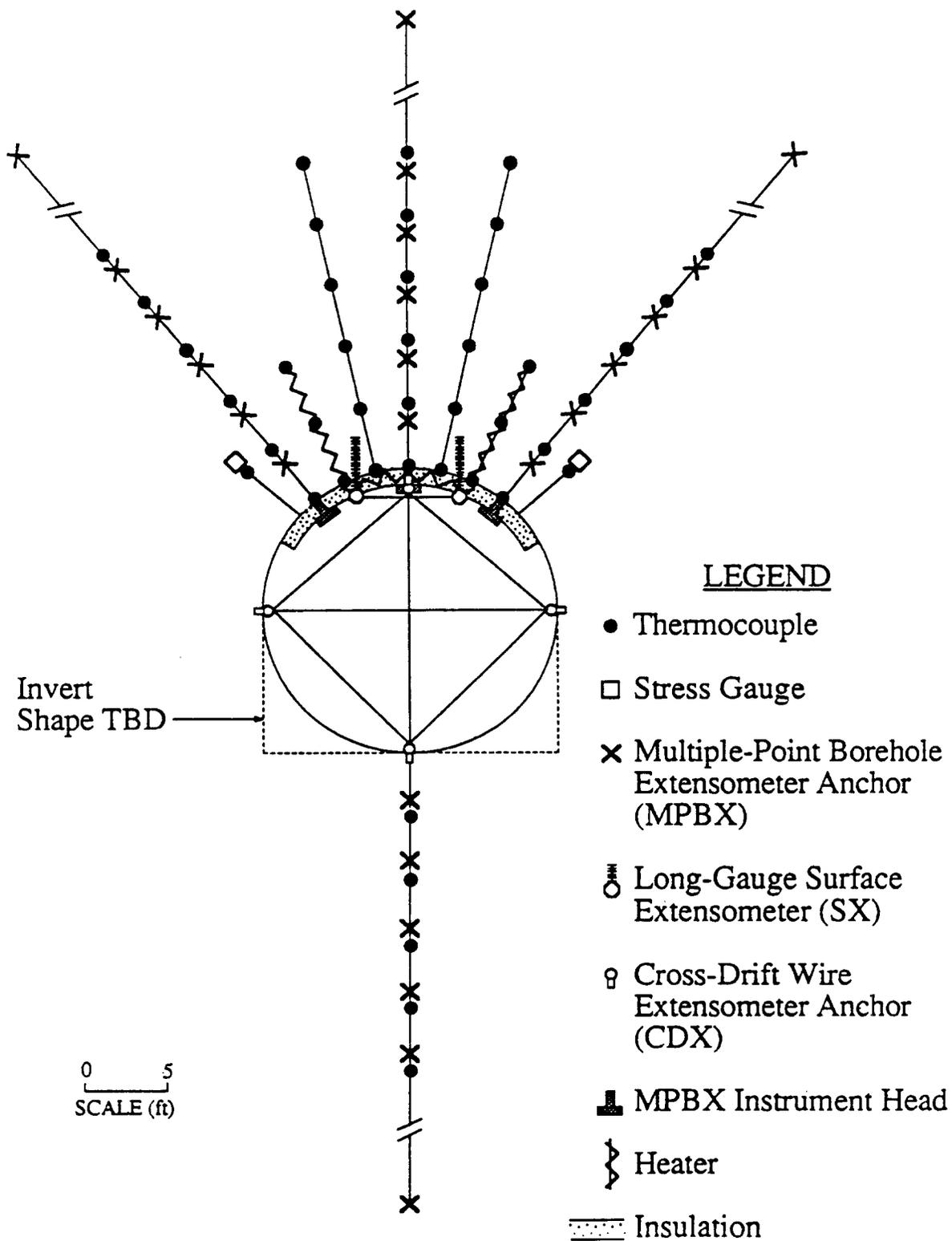
Objectives

- **Measure thermal and mechanical properties**
- **Validate computer models**
- **Evaluate borehole stability**
- **Design confirmation**

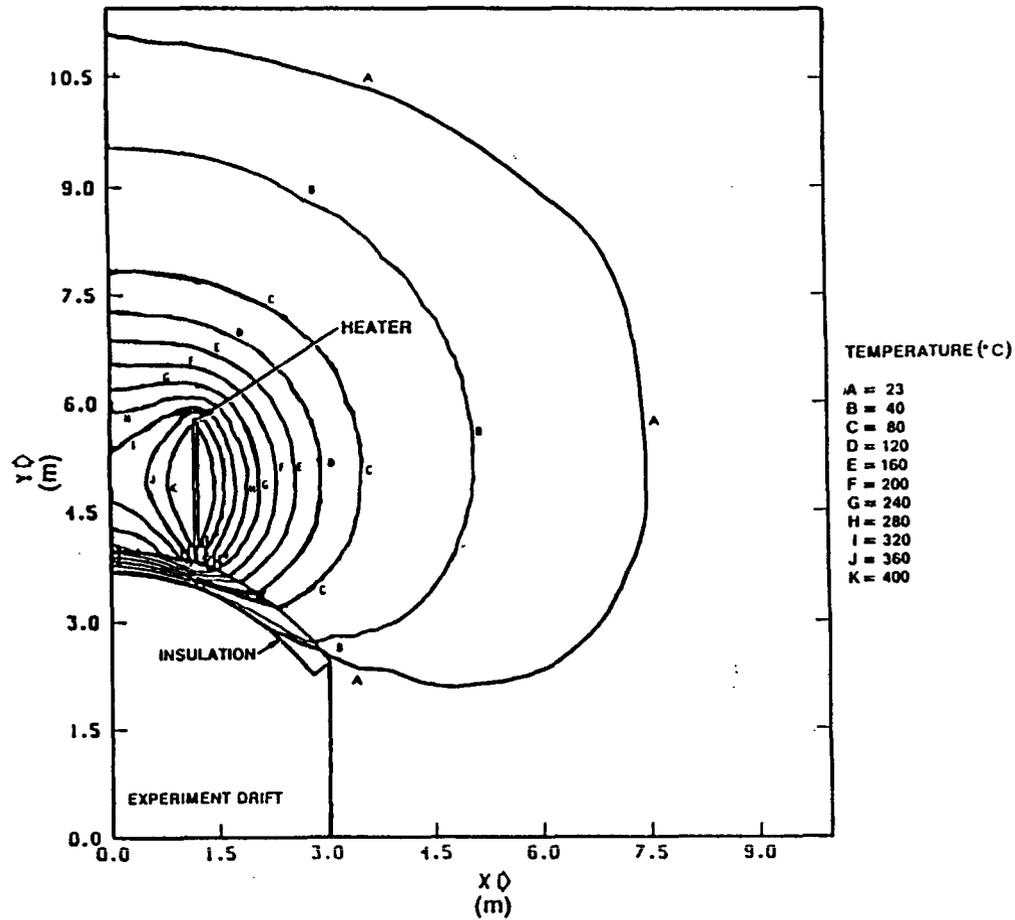
May be dropped if drift emplacement is used

**Could be used to evaluate different
waste-emplacement modes**

Thermal Stress Test



Thermal Stress Test Projected Temperatures



Temperature Contours at 90 Days of Heating

Thermal Stress Test: Notes

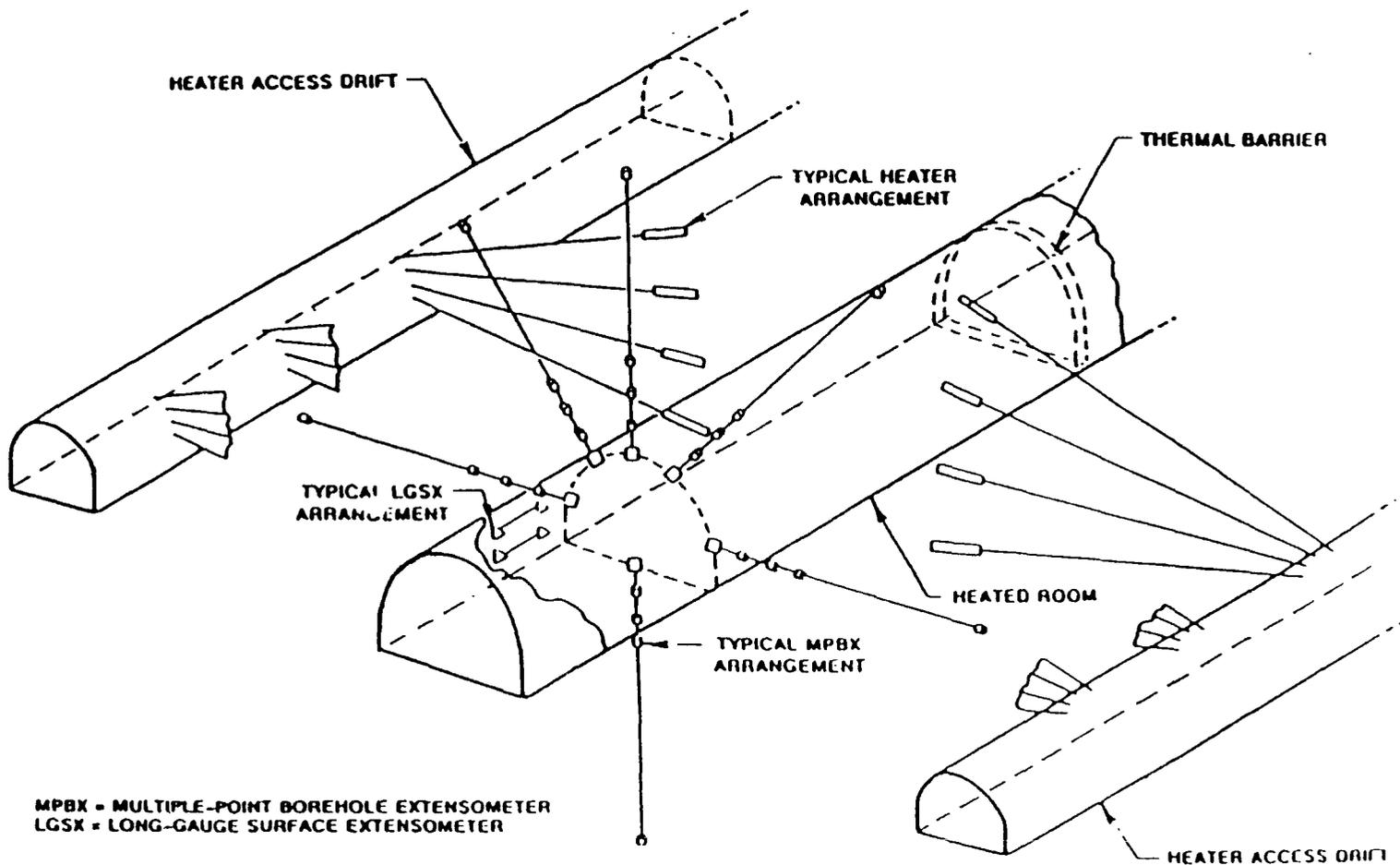
Objectives

- **Measure thermal and mechanical properties**
- **Validate computer models**
- **Evaluate drift stability**
- **Evaluate effect of heat on ground support**

Used to investigate rock-mass strength

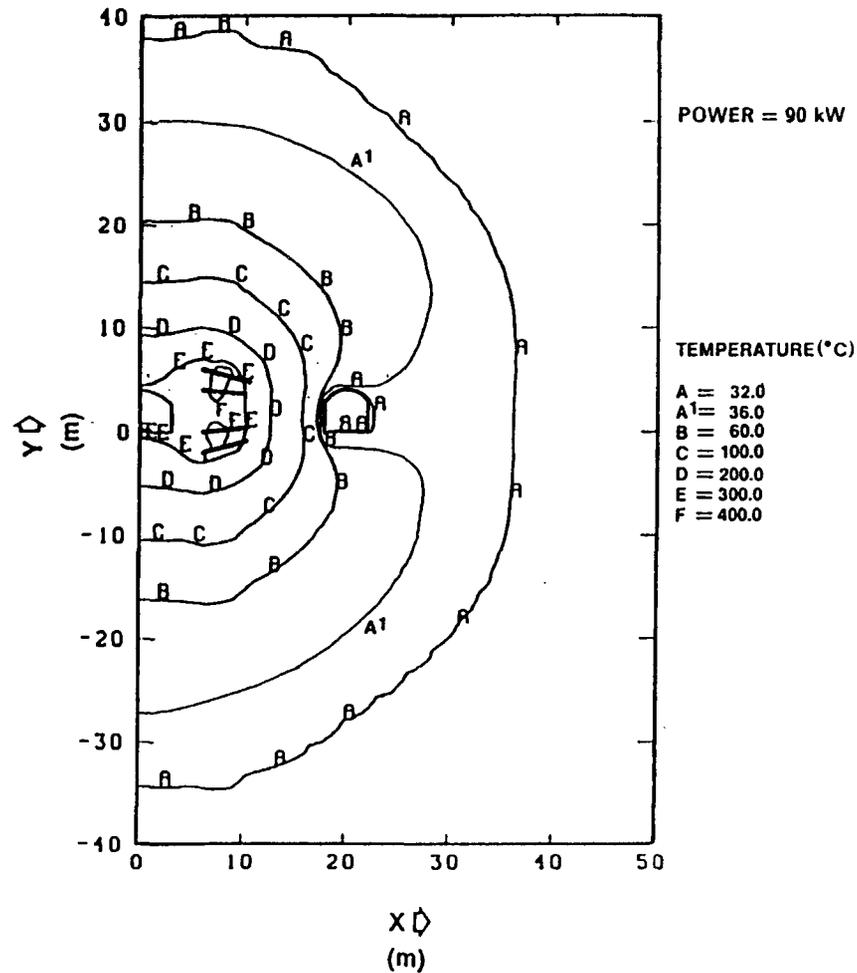
Temperatures and stresses will exceed expected repository conditions

Heated-Room Experiment



(BEST AVAILABLE COPY)

Heated-Room Experiment Projected Temperatures



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Heated-Room Experiment: Notes

Objectives

- **Evaluate repository-scale drift stability under elevated temperatures and stresses**
- **Measure rock-mass thermomechanical properties**
- **Code validation**
- **Ground support under elevated temperatures**

Will be integrated with LLNL hydro-thermal experiment

Proposed ESF Tests and Their Objectives

	Heated Block	Canister-Scale Heated Borehole	Thermal Stress	Heated Room
Measure thermal and mechanical properties	Yes	Yes	Yes	Yes
Evaluate effect of heat on large rock volumes	No	No	Yes	Yes
Verify physical models	Yes	Yes	Yes	Yes
Validate computer models	Yes	Yes	Yes	Yes
Evaluate borehole stability	No	Yes	No	No
Evaluate drift stability	No	No	Yes	Yes
Evaluate effect of heat on ground support	No	No	Yes	Yes
Design confirmation	No	Yes	No	Yes
Stress-induced changes in fracture aperture	Yes	Yes	Yes	Yes

Conclusions

ESF thermomechanical tests

- **Support evaluations of retrievability by**
 - **Evaluating drift and borehole stability**
 - **Validating computer codes**
- **Will obtain information for all potential thermal-loading scenarios**
- **Will support any waste-package emplacement scheme**