Rec'd with letter dtd 2/14/97

ENCLOSURE

MINUTES OF THE DECEMBER 16, 1996 U.S. NUCLEAR REGULATORY COMMISSION/U.S. DEPARTMENT OF ENERGY TECHNICAL MEETING ON THE EXPLORATORY STUDIES FACILITY

On December 16, 1996, U.S. Nuclear Regulatory Commission staff met with staff from the U.S. Department of Energy (DOE) and DOE's contractor to discuss items of mutual interest regarding progress on the excavation of DOE's Exploratory Studies Facility (ESF) at Yucca Mountain, Nevada, and technical issues related to the design of the geologic repository. The items discussed included the status of ESF construction, an update on the status of scientific studies at the ESF — including alcove testing — and some background on the proposed changes to the geologic repository design. In addition, the NRC staff's concerns related to alcove excavation testing methods and thermal tests, identified during an earlier July 24, 1996, Appendix 7 meeting, were discussed.

This meeting was another in a continuing series of periodic ESF technical meetings. The meeting was held via a three-way videoconference at the NRC office in Rockville (Maryland); the DOE office in Las Vegas (Nevada); and Center for Nuclear Waste Regulatory Analyses (CNWRA) office in San Antonio (Texas). Representatives from the State of Nevada; Clark County, Nevada; the U.S. Geological Survey (USGS); and the U.S. Nuclear Waste Technical Review Board also attended. The agenda is in Attachment 1. Attachment 2 contains the list of attendees.

Before the scheduled presentations began, the NRC staff announced that there had recently been a reduction in the engineering staff because of the transfer of high-level waste program personnel to other NRC regulatory programs. In light of the reduction, the staff noted that until the vacated position was filled, it would not be able to track DOE work related to the design control process nor would the staff be able to review other repository-related design products. Consequently, the staff noted that, because of resource limitations, it was reviewing only Seismic Design Topical Report II; this review is expected to be completed in February 1997. There were no other announcements nor opening comments by any other participants.

In the first series of presentations, DOE provided an update on the status of ESF tunnel and alcove construction. The briefing materials reviewed are contained in Attachment 3. The topics covered included: an update on ESF tunneling operations; a discussion of testing alcove excavation sequencing, including schedules and method of excavation; tunnel boring machine (TBM) progress; south portal construction activities; and special topics regarding the construction of electrical systems. DOE reported that excavation of the thermal test alcove will rely on a combination of drill and blast and the Alpine Miner. DOE reported that its analyses suggest that the use of a drill and blast excavation technique will not have an adverse effect on the outcome of the tests. In addition, DOE reviewed its current policy regarding the use of respirators in the ESF and on the TBM, while it is operating. In general, this policy no longer requires the use of respirators in the ESF, while the TBM is in operation, because of improvements in the ventilation system. However, while the TBM is in operation, partial (half-face) respirators will be needed. During the presentations, DOE noted that ground conditions within the ESF had been slowing down TBM progress significantly.

102.2

After these presentations, there was a short discussion of a recent incident within the ESF in which newly applied shotcrete fell from the wall inside the ESF. The NRC staff was curious if this incident was due to loose ground conditions and if it involved a "reportable geologic condition" based on YAP-30.27 criteria. DOE went on to note that the incident did not constitute a reportable geologic condition nor did it concern a safety issue.

In the second series of presentations, DOE provided an update on the status of scientific investigations within the ESF. The briefing materials reviewed are contained in Attachment 4. The first topic covered was a review of the recent re-organization of the Yucca Mountain Site Characterization Office (YMSCO) as well as some key staff changes. Additional presentations included the following topics: ESF mapping progress; surface-based testing; testing and preliminary results based on surface investigations and borehole data of the Ghost Dance fault and related structures; and wet areas reported in various ESF tunnel locations. With regard to this second series of presentations, the following points are noteworthy. First, DOE provided a preliminary description of the Ghost Dance fault, prepared by the USGS, as recently observed from an alcove borehole. Revisions to this description are expected in the future as additional information becomes available. Second, as regards the wet areas along portions of the ESF south ramp, DOE noted that it did not consider these features as "reportable geologic conditions," although DOE intends to continue investigating these particular features. DOE also presented some preliminary results from its chlorine-36 (^{36}Cl) testing within the ESF. In was noted that the existence of both the wet spots and the bomb-pulse ^{36}Cl confirms the expectation that some hydraulic fast pathways would likely occur within the repository block.

Next, DOE presented an update from its thermal testing programs. (This information is considered preliminary.) This presentation included initial measurements and data from both the Single Heater Test and the Drift-Scale Heater Test. DOE reported that the preliminary temperature and saturation data from the Single Heater Test indicate that the measurements are within predicted limits. The materials reviewed are contained in Attachment 5.

After the presentations on the status of scientific investigations within the ESF, there was some brief follow-up discussion of items from the previous ESF Appendix 7 meeting (dated July 24, 1996). The first item discussed was the use of drill and blast mining techniques in the thermal test alcove (which was addressed earlier in the meeting). The second issue concerns the Drift-Scale Heater Test. Both the NRC and the CNWRA staffs believe that the higher wall temperatures being proposed by DOE in this test will inhibit development of the phenomena intended to be observed — condensation and water dripping. The staff recommend that the experiment be conducted at temperatures in the 120-130-degrees-Centigrade (°C) range initially, instead of quickly raising the temperature to the maximum 400 °C proposed by DOE. In response, DOE indicated that the test boreholes are extended to capture the lower range of temperatures of interest to the staff. Moreover, DOE reported that it was using instrumentation to monitor the presence of liquid water, at all temperatures, including those temperatures of interest to the staff. DOE offered to incorporate any NRC-CNWRA-developed instrumentation into the experiment, if the staff believed that it could monitor the phenomena of interest. The last Appendix 7 carry-over item was some discussion of DOE's plans to evaluate techniques for lining the ESF with concrete. DOE reported that it planned to line about one-third of the ESF thermal test alcove to evaluate cast-in-place concrete lining techniques.

The last series of presentations were focused on DOE's engineering design program for the geologic repository. The briefing materials reviewed are contained in Attachment 6. The presentations included a discussion of the YMSCO re-organization on design activities and products; potential changes to the current repository footprint; and the potential impact of concrete lining of drifts on geologic repository performance. In describing the nature of the changes being contemplated to the current repository footprint, DOE noted that there were sufficient site characterization data to proceed with developing the revised design and that the proposed changes would probably result in some net cost savings. The NRC staff was interested in knowing whether any additional site characterization work would be needed to support the extension of the repository design, to the north. DOE responded that the need for additional information of this type has not been determined at this time although the Department still intends to collect additional site characterization data to support its design decisions. On this subject, DOE acknowledged that it had to finalize certain basic design decisions by September 1997 for its forthcoming "Viability Assessment." The design decisions would be formalized in its "Yucca Mountain Project Repository Plan. When completed, this 5-year plan will define the basic reference design for the geologic repository, which is tied to performance and is of sufficient detail to support the major DOE programmatic milestones — the Viability Assessment, the 10 CFR Part 960 site suitability determination, and a potential 10 CFR Part 60 license application. Moreover, the plan includes the identification of additional site characterization needs necessary to support the remaining design decisions. (This topic will be discussed in greater detail in a forthcoming DOE/NRC Appendix 7 meeting on DOE's so-called "one-pass" engineering design in February 1997.) Although this plan is still under development, DOE noted that for calendar year 1997, alone, it planned on preparing about numerous engineering analyses, specifications, and drawings, as part of this overall plan, to support its revised design; planning for the out-years is currently underway. When questioned about whether the plan identified the need for east-west exploratory drifting through the repository block, DOE noted that this issue was being evaluated as part of the development of the plan and a decision should be made by the end of the year as part of its development. The NRC staff was advised that a preliminary version of the plan should be available in the March 1997 timeframe. For its part, the NRC staff noted that the recent staff reductions in both the Division of Waste Management and at the CNWRA would affect the staff's ability to review much of the material evolving from this planning effort.

As part of these discussions, the NRC staff raised a few questions and expressed its concerns regarding the possible effects of concrete lining of the repository drifts on performance. DOE noted that it was undertaking evaluations to understand how materials and placement methods might affect repository performance. No time table nor schedule was presented on when these evaluations would be completed, although DOE did refer to a report dated September 30, 1996, which summarized the status of evaluations of the consequences of cementitious materials on repository performance.

The last item on the agenda concerned the staff's review of DOE's response to the staff's December 14, 1995, letter on the design control process for the repository design. The staff noted that once it had completed its review of Seismic Design Topical Report II, it would be able to review DOE's September 25, 1996, response. However, the staff did note that a preliminary review of DOE's letter suggested that the rationale concerning the use of ESF concrete inverts in the repository was not clear. As part of this dialogue, the respective staffs had a brief discussion on the quality assurance classification of concrete inverts in the ESF. DOE noted that the unqualified inverts were not considered permanent and were only intended to support the functional requirements of the ESF — e.g., providing support for the steel sets and creating a roadbed for the ESF railway system. DOE noted that because the inverts were temporary they could be removed and replaced at any time with a different (and qualified) design. The NRC staff intends to address this issue during the review of DOE's design control process and the September 25, 1996, letter.

After the presentations listed on the agenda were completed, the NRC staff reiterated for the record that resource limitations would severely limit the staff's efforts to follow DOE's progress in developing the reference designs for the geologic repository, in light of the number of submittals contemplated by DOE. In response DOE noted that it would attempt to rely on what NRC design guidance was available for 10 CFR Parts 20, 50, and 72.

At the close of these discussions, the staff representing the State of Nevada and Clark County , Nevada, were invited to make some closing comments. Both participants declined to make comments.

Finally, scheduling for the next meeting in the series was not discussed. However, the schedule for an Appendix 7 meeting concerning the level of design detail in a license application was discussed and tentatively scheduled for February 6, 1997, at NRC Headquarters in Rockville, Maryland.

Michael P. Lee
Division of Waste Management
Office of Nuclear Material
Safety and Safeguards
U.S. Nuclear Regulatory Commission

Christian E. Einberg
Regulatory Coordination Division
Office of Civilian Radioactive
Waste Management
U.S. Department of Energy

AGENDA FOR THE
DOE-NRC VIDEO CONFERENCE
ON THE STATUS OF THE
EXPLORATORY STUDIES FACILITY

December 16, 1996
12:30 — 4:00 p.m. (EST)

NRC:
Two White Flint North, 11555 Rockville Pike, Room T2B5
Rockville, Maryland

DOE:
Summerlin I Facility
1551 Hillshire Drive, Atrium Room
Las Vegas, Nevada

Time	*Subject*	*Lead(s)*
12:30 p.m.	**Opening Remarks**	DOE, NRC, State, AUG
12:40	**ESF Construction Update**	DOE
	- Status of Tunnel and Alcove Construction	
	- South Portal	
	- Thermal Test Alcove Construction Methods (Drill & Blast)	
	- Discussion	All
1:30	**Scientific Studies Update**	DOE
	- Status of Tunnel Mapping	
	- Ghost Dance Fault	
	- Status of Thermal Tests and Preliminary Test Data	
	- Discussion of NRC Concerns from Previous Appendix 7 Meeting	
	- Discussion	All
2:30 — 2:45	**BREAK**	
2:45	**Engineering Design Program**	DOE
	- YMSCO Reorganization and Impact on Design	
	- Potential Change to Repository Footprint	
	- Impact of Concrete Lining on Performance	
	- Feedback on DOE's Response to 12/14/95 Letter	DOE/NRC
	- Discussion	All
3:45	**Closing Remarks and Additional Discussion**	All
4:00	**Adjourn**	

ATTACHMENT 1

LIST OF ATTENDEES FOR THE DOE-NRC VIDEO CONFERENCE ON THE STATUS OF THE EXPLORATORY STUDIES FACILITY

December 16, 1996

DOE
C. Einberg
D. Bryan
B. Burke
T. Hawe
J. Replogle
K. Skipper
M. Tynan

State of Nevada
S. Frishman
J. Treichel

DOE M&O
J. Bailey
J. Beyer
R. Datta
J. Doyle
K. Lobe
A. Haghi
A. Segrest
R. Wagner

Center for Nuclear Waste Regulatory Analyses
R. Green
L. McKague

NRC
M. Bell
J. Bradbury
B. Ibrahim
B. Jagannath
M. Lee
M. Natarja
R. Weller

NRC (Las Vegas)
W. Belke
C. Glenn

Clark County, Nevada
E.V. Tieseshausen

U.S. Geological Survey
R. Wallace

U.S. Nuclear Waste Technical Review Board
R. McFarland

ATTACHMENT 2

ATTACHMENT 3

YUCCA MOUNTAIN PROJECT

Studies

DOE-NRC ESF Technical Meeting

Exploratory Studies Facility Construction Update

Presented by:

Richard L. Craun
Assistant Manager

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

December 16, 1996

STATUS OF ESF TUNNEL AND ALCOVE CONSTRUCTION

2ESF.ppt

ESF Tunneling Operations Update

- **ESF Tunneling is currently at Station 71 + 18.9 as of 12/9/96**
  - Approximately 700m remain to daylight at South Portal
  - Some variability exists in current ground conditions

2ESF.ppt

ESF Tunneling Operations Update (continued)

- **Phase I excavation on North Ghost Dance Fault Alcove access drift completed to Sta. 1 + 34m on 11/23/96**
  - Phase I (single borehole testing) underway scheduled completion 3/12/97
  - Fault was located at Sta. 1 + 54 (fault zone from 1 + 43 to 1 + 55)
- **Excavation of Phase I access drift in South Ghost Dance Fault Alcove underway**
  - Current (12/9/96) Sta. is 0 + 23m

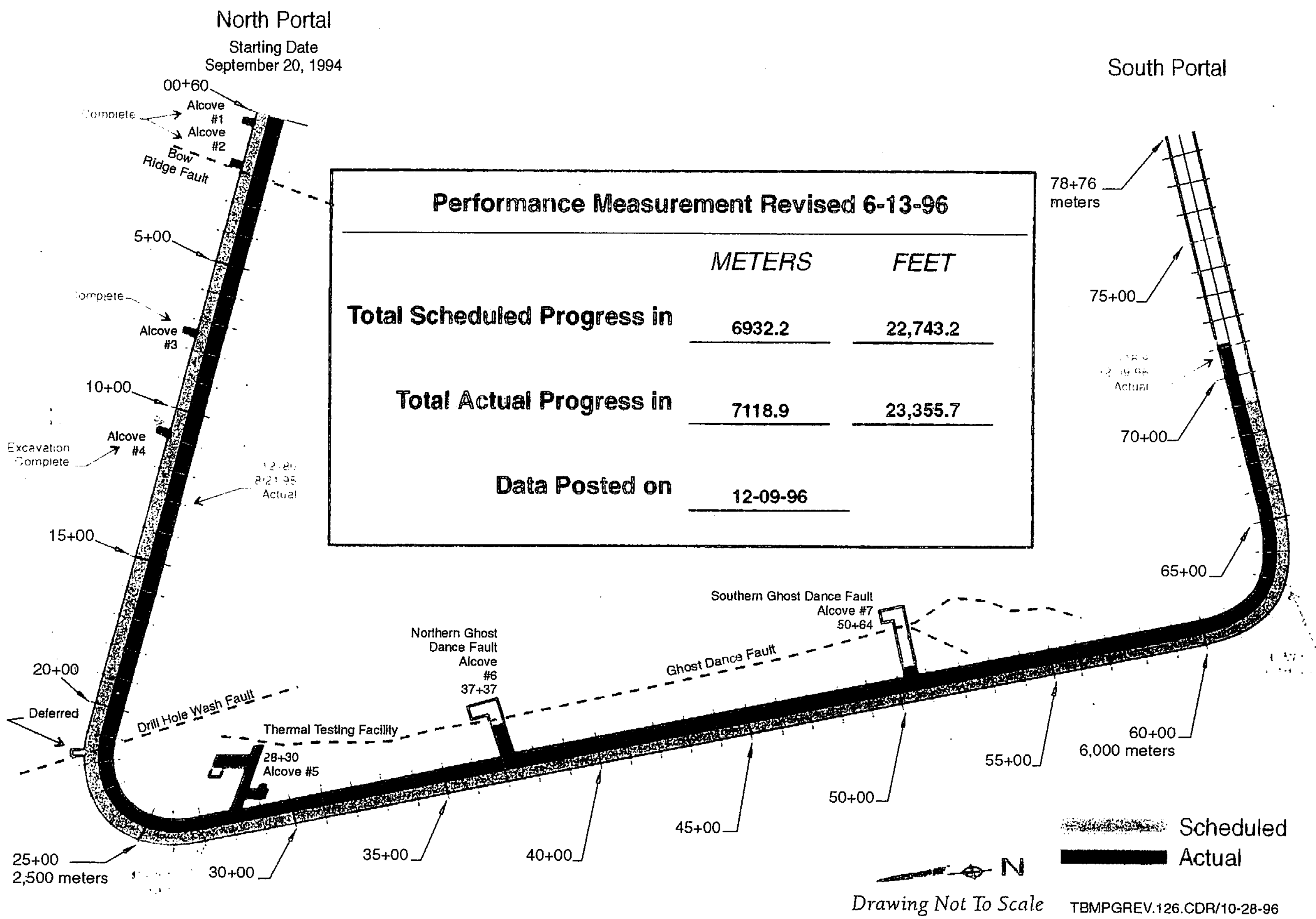
2ESF.ppt

ESF Tunneling Operations Update (continued)

- **Excavation of Thermal Test Facility Crossover Drift completed 11/22/96**
  - Drilling of test boreholes in Crossover Drill Bay began 11/12/96
  - Excavation of Heated Drift with Alpine 75 commenced on 12/2/96
- **Single Element Heater Test (Thermo-mechanical Alcove) is ongoing. Heater energized 8/26/96**

2ESF.ppt

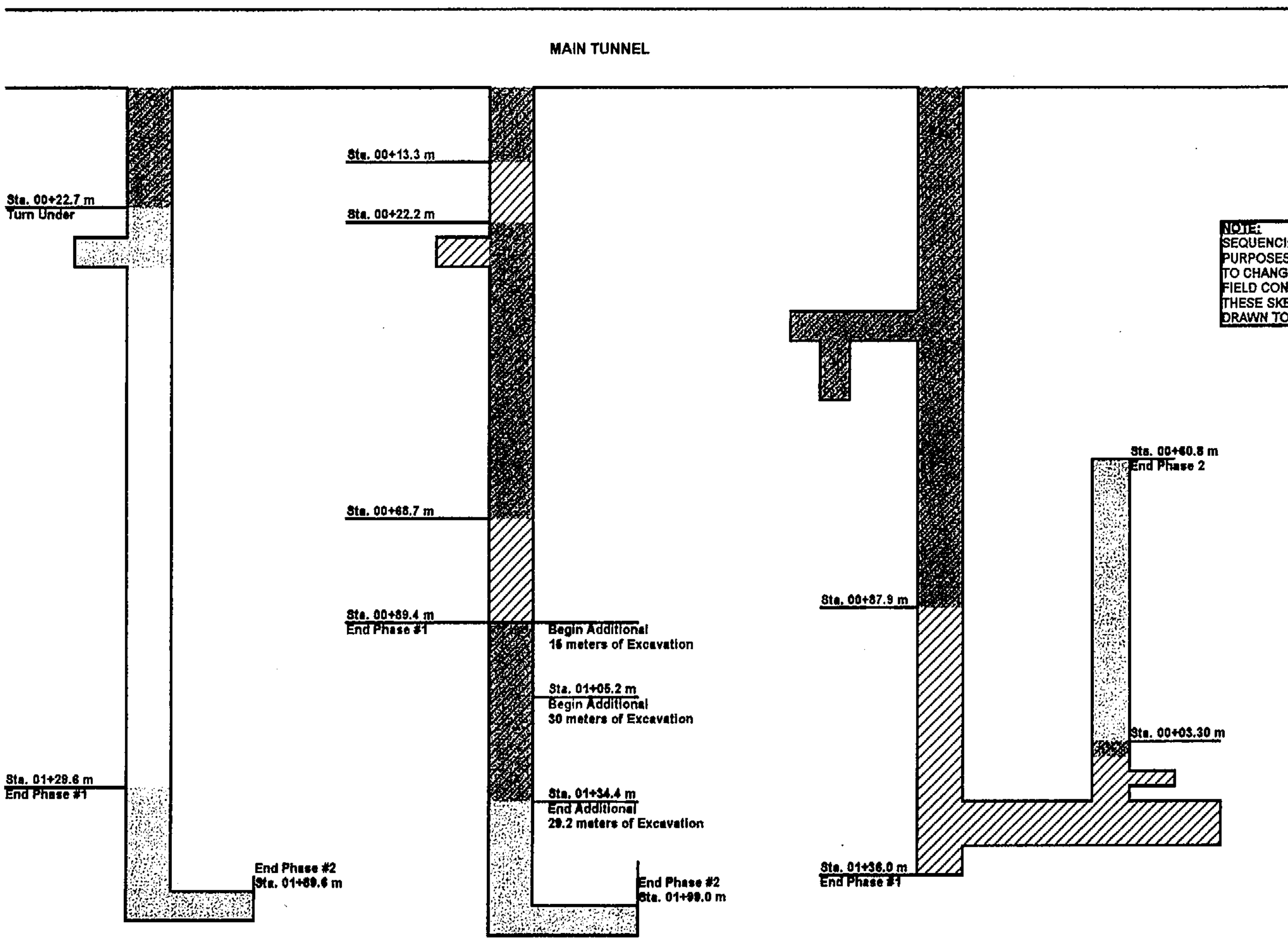
TUNNEL BORING MACHINE PROGRESS



Performance Measurement Revised 6-13-96

	METERS	*FEET*
Total Scheduled Progress in	6932.2	22,743.2
Total Actual Progress in	7118.9	23,355.7
Data Posted on	12-09-96	

ALCOVE EXCAVATION SEQUENCING



NOTE:
SEQUENCING IS FOR PLANNING PURPOSES ONLY AND IS SUBJECT TO CHANGE AS REQUIRED BY FIELD CONDITIONS.
THESE SKETCHES ARE NOT DRAWN TO SCALE.

SOUTH GHOST DANCE FAULT ALCOVE

SCHEDULED COMPLETION - 22 AUG 97
MILESTONE COMPLETION - 28 JUL 97

NORTH GHOST DANCE FAULT ALCOVE

SCHEDULED COMPLETION - 30APR 97
MILESTONE COMPLETION - 25 FEB 97

HEATER TEST ALCOVE #1

SCHEDULED COMPLETION - 12 FEB 97
MILESTONE COMPLETION - 26 MAR 97

ALPINE MINER
DRILL & BLAST
COMPLETED EXCAVATION

UP DATED 12-09-96

South Portal Construction

- Approximately 6,800 yards of the estimated 23,000 yards have been excavated in the previous weeks
- Progress for the current week is an additional 1,400 yards of excavation
- Current estimate for % completion for the boxcut:
  - 35% total excavation
  - 35% highwall presplitting
  - 15% ground support installation
- Access road completed
- Expected completion date: mid-January 1997

2ESF.ppt

Special Topics

- Electrical System (drawings as constructed)
- Evaluation of other systems
- Respiratory Policy

Electrical System

- **Electrical System consists of:**
  - Surface and subsurface power distribution
  - Site grounding including grounding grids
  - Site lighting
- **Provide a 12.47 kV distribution system for power to both surface and subsurface facilities**
- **System to include substations,distribution systems, overhead power lines, secondary power distribution to facility equipment.**

2ESF.ppt

Electrical System (continued)

- **Remaining construction work includes:**
  - electrical niches for tunnel power and ventilation motor starters
  - installation of seismic mounting hardware for electrical equipment and cable support brackets
  - installation of lighting poles and power cables for site lighting
  - installation of grounding of perimeter security fence and rail

2ESF.ppt

Electrical System (continued)

- **Remaining Construction work:**
  - Construction of battery enclosure building
  - heat tracing all exposed surface water and compressed air lines, and the first 1000 ft. in tunnel

Systems Selected for Evaluation

The following 14 systems have been identified as having the highest priorities. Their evaluation will start in FY 97:

- Power System
- Potable Water System
- Communications System
- Fire Water System
- Subsurface Fire System
- Compressed Air System
- Ground Support "Non-Q"
- Ground Support "Q"
- Roads, Topsoil & Rock Storage
- Sanitation System
- Waste Water System
- Subsurface Material Handling
- Non-Potable Water System
- Subsurface Lighting

(starts in FY97, completes in FY98)
(starts in FY97, completed in FY98)

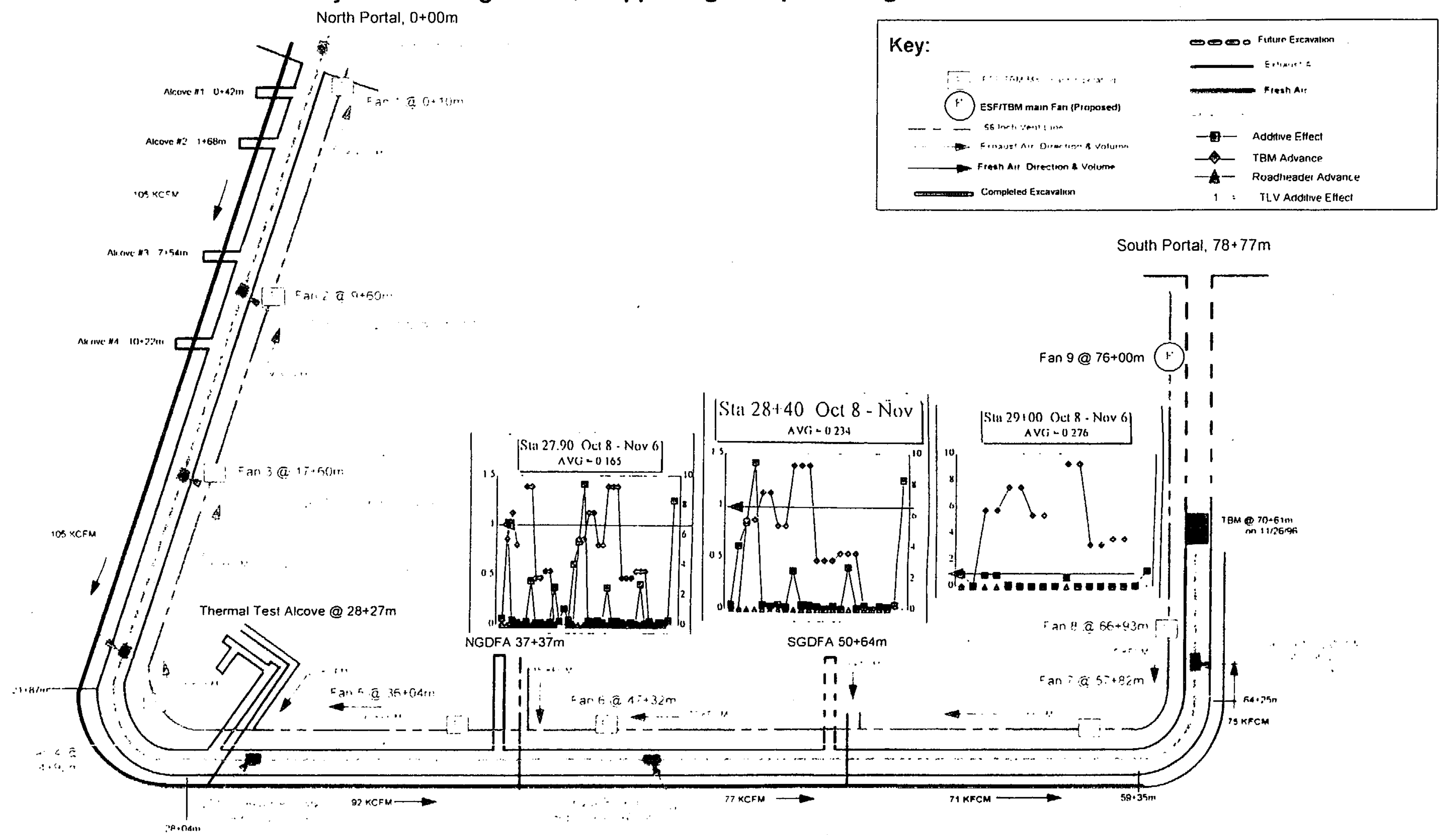
2ESF.ppt

Respiratory Policy

The Respirator program is of paramount importance:

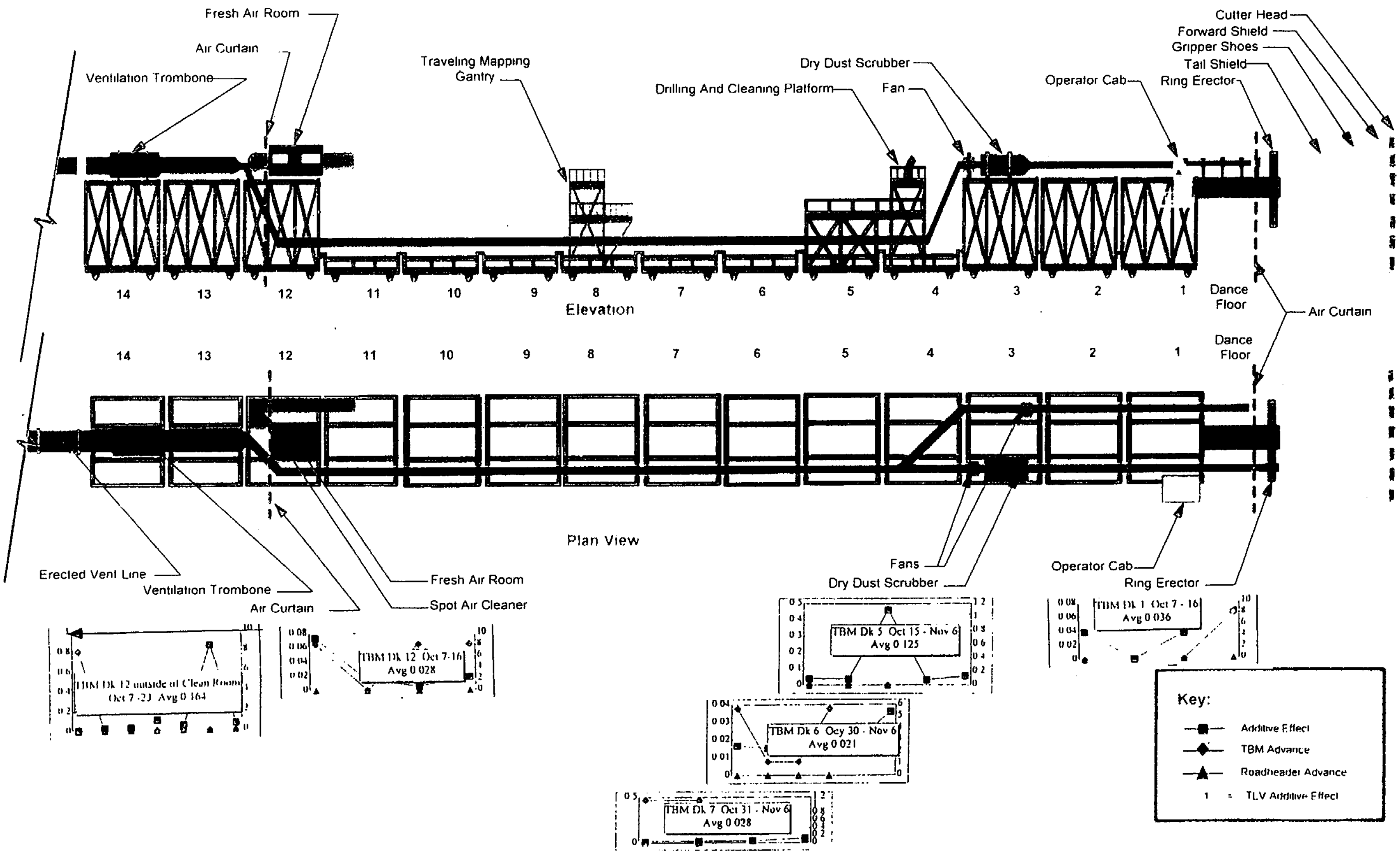
- Personnel to don respirators properly in the posted regulated area and wear them as long as tunnel supervision so indicates
- Respirators shall be worn continuously except:
  - an emergency or immediate health related situation requiring respirator removal
  - respirator removal directed/permitted by tunnel supervision in accordance with tunnel respiratory protection clearance protocol
  - within the clean air room
  - when TBM and Alpine Miner are not operating and exposure levels are below exceedence to TLV

ESF Systems Configuration, Supporting Multiple Mining Faces & TBM Advance



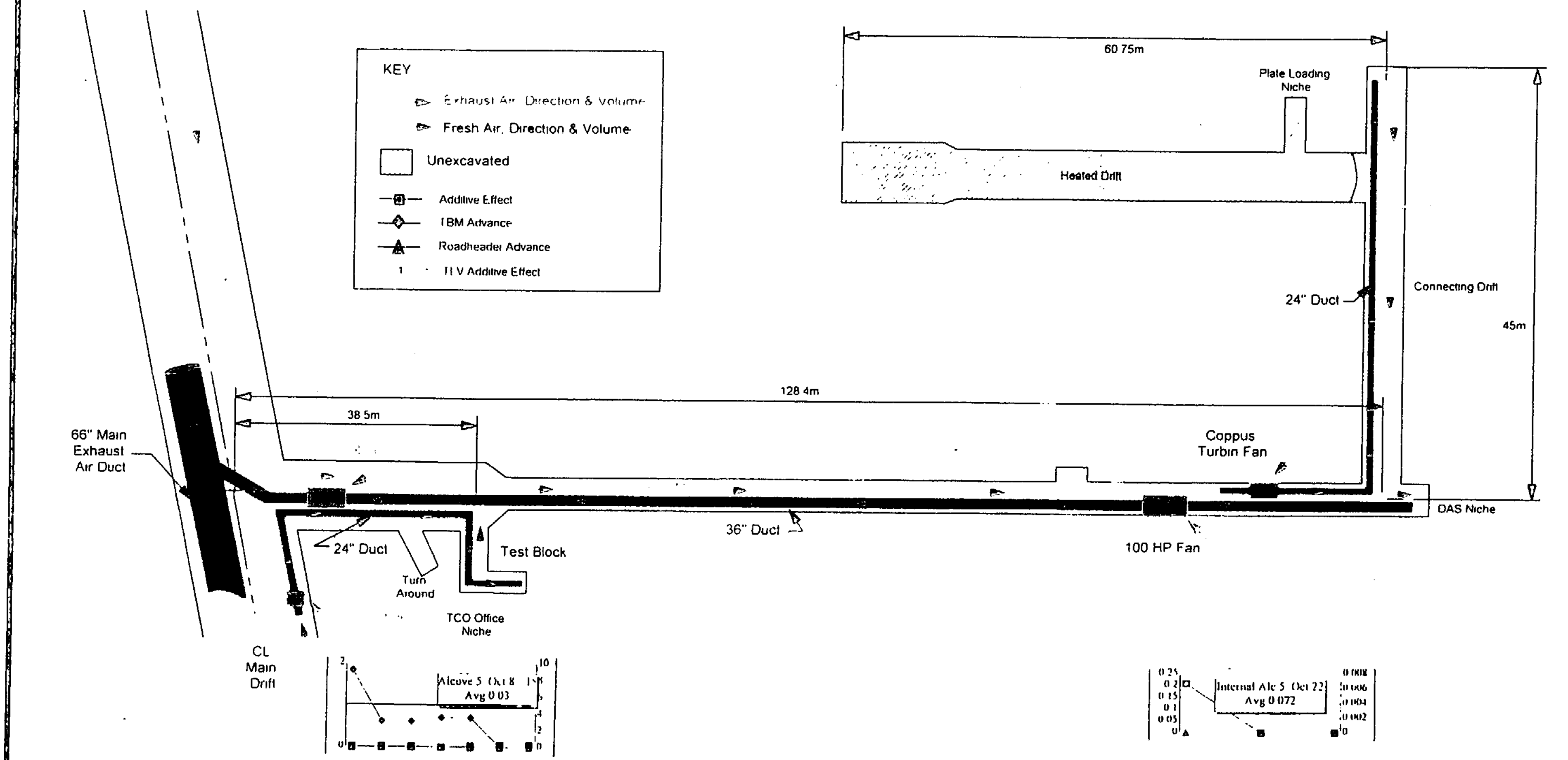
11/26/96

Tunnel Boring Machine (TBM), Yucca Mountain Project



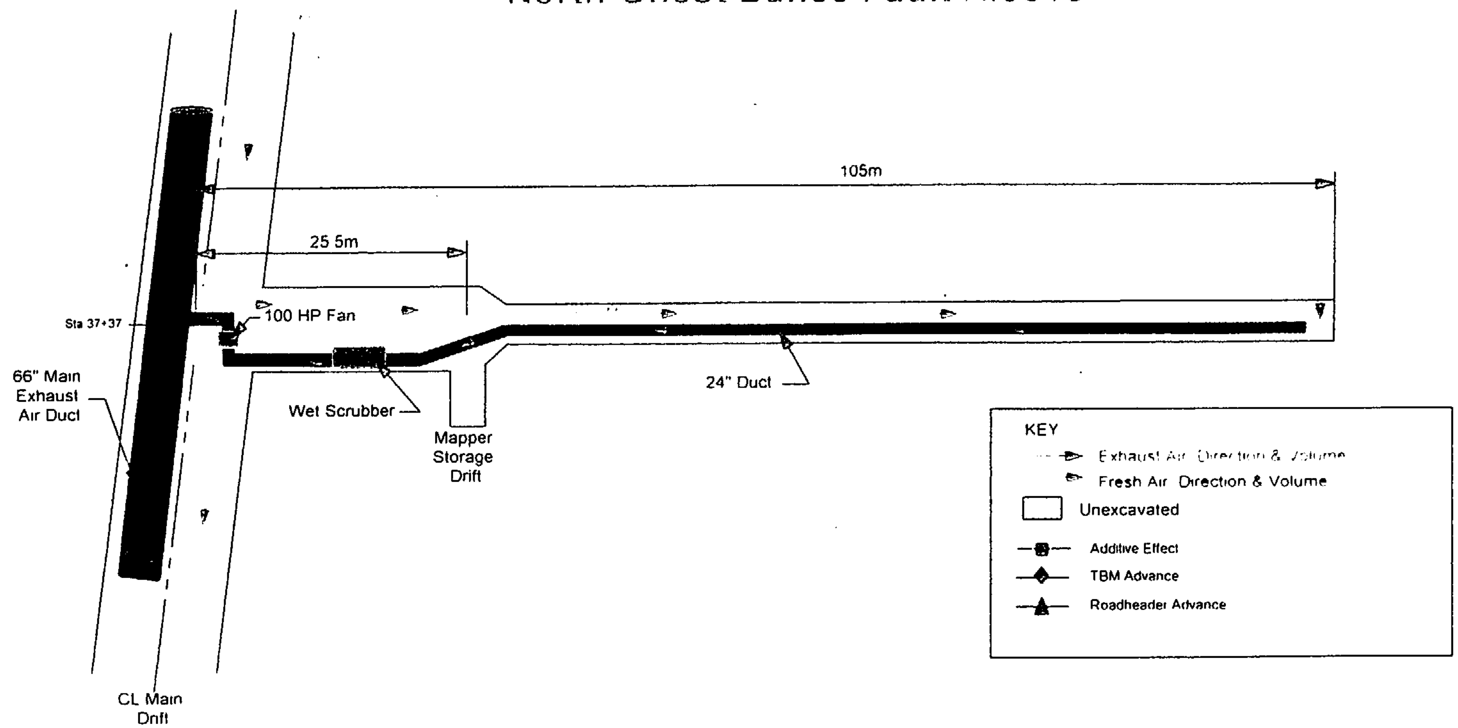
11/26/96

Thermal Testing Facility Alcove



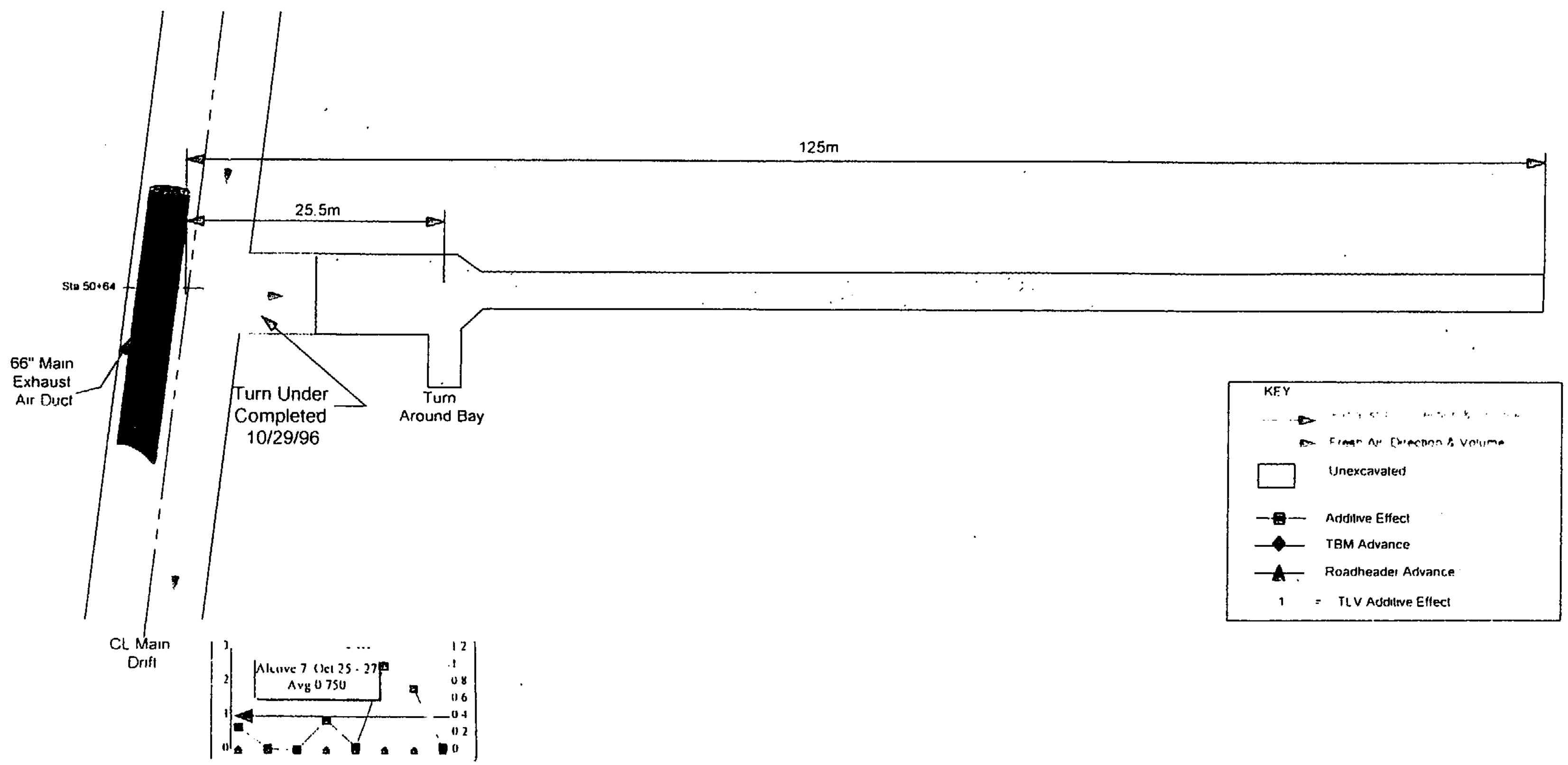
11/26/96

North Ghost Dance Fault Alcove



11/26/96

South Ghost Dance Fault Alcove



11/26/96

Silica Issues Pertinent to Respiratory Policy

- **Silica Assessments Findings**
  - Exposure to crystalline silica, especially cristobalite; exposure of concern past 2100m from portal
  - Exceedence to TLV exposures on Alpine Miner Operations
- **Pertinent Administrative Controls**
  - Training conducted in areas regarding silica
    - Respiratory protection
    - Hazard communication
    - Sanitation

2ESF.ppt

Silica Issues Pertinent to Respiratory Policy (continued)

- Comprehensive respirator program implemented
- Engineering controls implemented
  - Examples: West Spot Scrubbers in Alpine Miner location, fresh air zone on TBM, additional wetting on conveyor, vent duct maintenance, etc.
  - Controls have eliminated respirator usage on TBM from Deck 12 to Deck 6. Respirator zone starting point moved from 21+00 to 29+00 temporarily until Alpine Miner Operation was resumed (re-evaluating that impact now)
- IH sampling strategy to assist evaluation of controls.

2ESF.ppt

Silica Issues Pertinent to Respiratory Policy (continued)

- **Planned Action**
  - Continual fixed point real-time silica monitoring for control evaluation
  - Continue on engineering controls to further improve air quality and reduce respirator usage in the ESF
  - Work with engineering on improving dust control for repository construction
  - Increased focus on noise control, diesel exhaust monitoring and heat stress
  - Increased emphasis on OSHA issues: records, data management, respirator surveillance, education and training

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THERMAL TEST ALCOVE CONSTRUCTION METHOD (DRILL AND BLAST)

2ESF.ppt

Principal Drill & Blast Features Related to Thermal Test Alcove Construction Method

- **Performing blast seismic monitoring during construction of thermal test alcoves (TTA) in ESF is of particular importance to help design controlled and smooth blasting to preserve rock integrity**
- **Objectives of the monitoring are:**
  - To gauge compliance with subsurface drilling and blasting by monitoring vibration limits
  - To develop relationship between peak particle velocity (PPV) and scale distance in providing a predictive tool for controlled and smooth blast design

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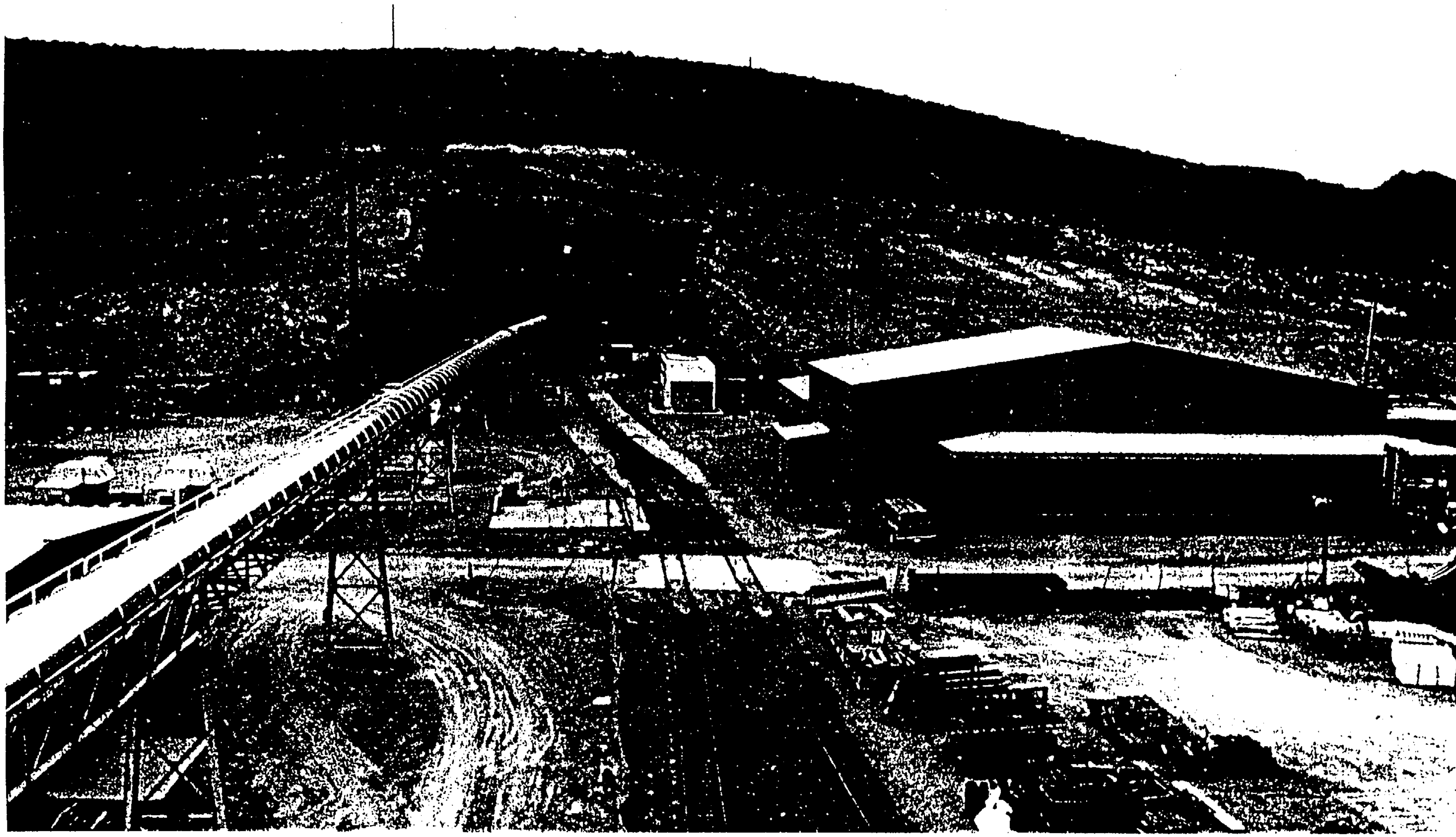
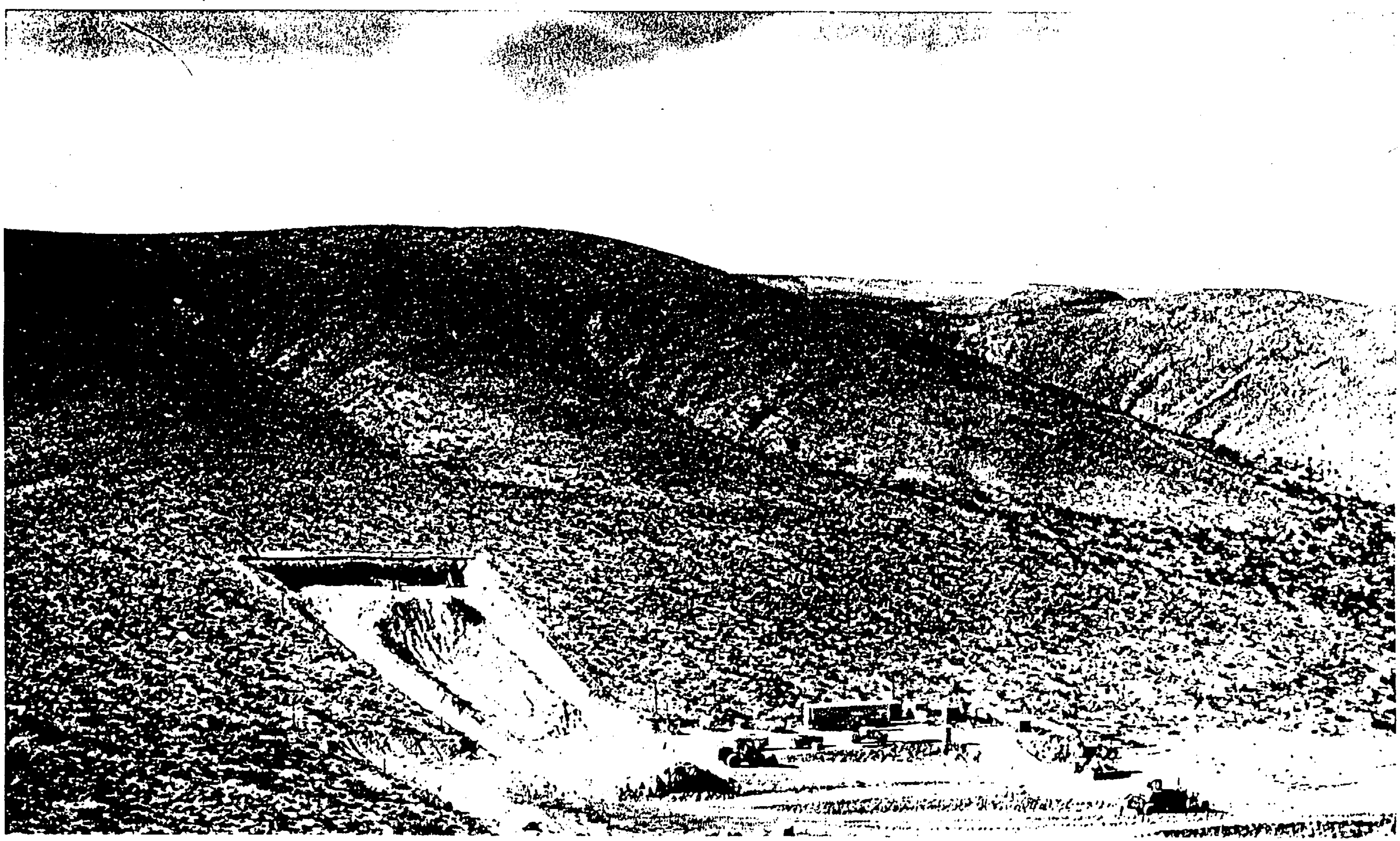
YM13273 11/13/96

EXPLORATORY STUDIES FACILITY - NORTH PORTAL



YM13324 11/20/96

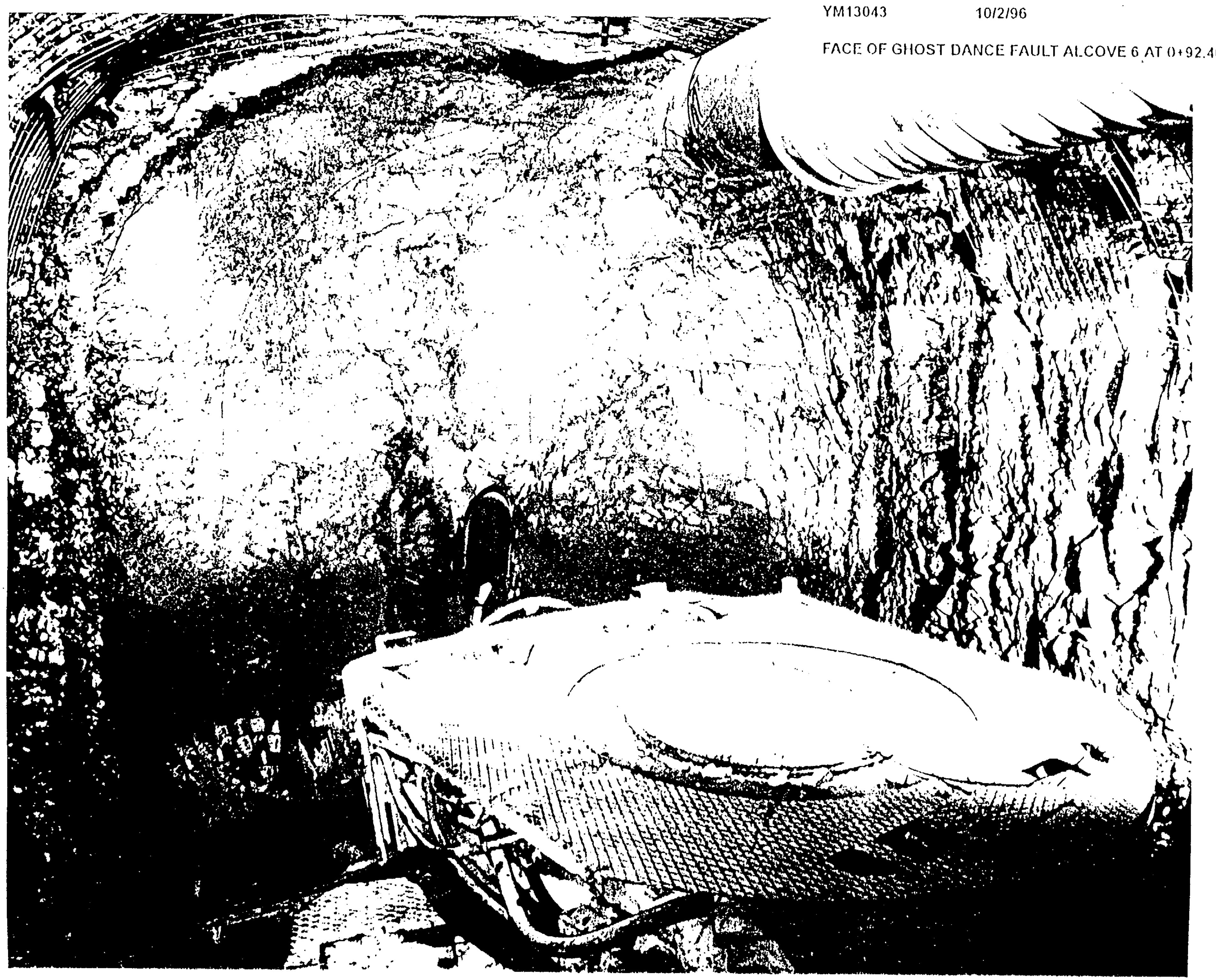
CONSTRUCTION ACTIVITIES AT THE SOUTH PORTAL



YM12728 08/21/96

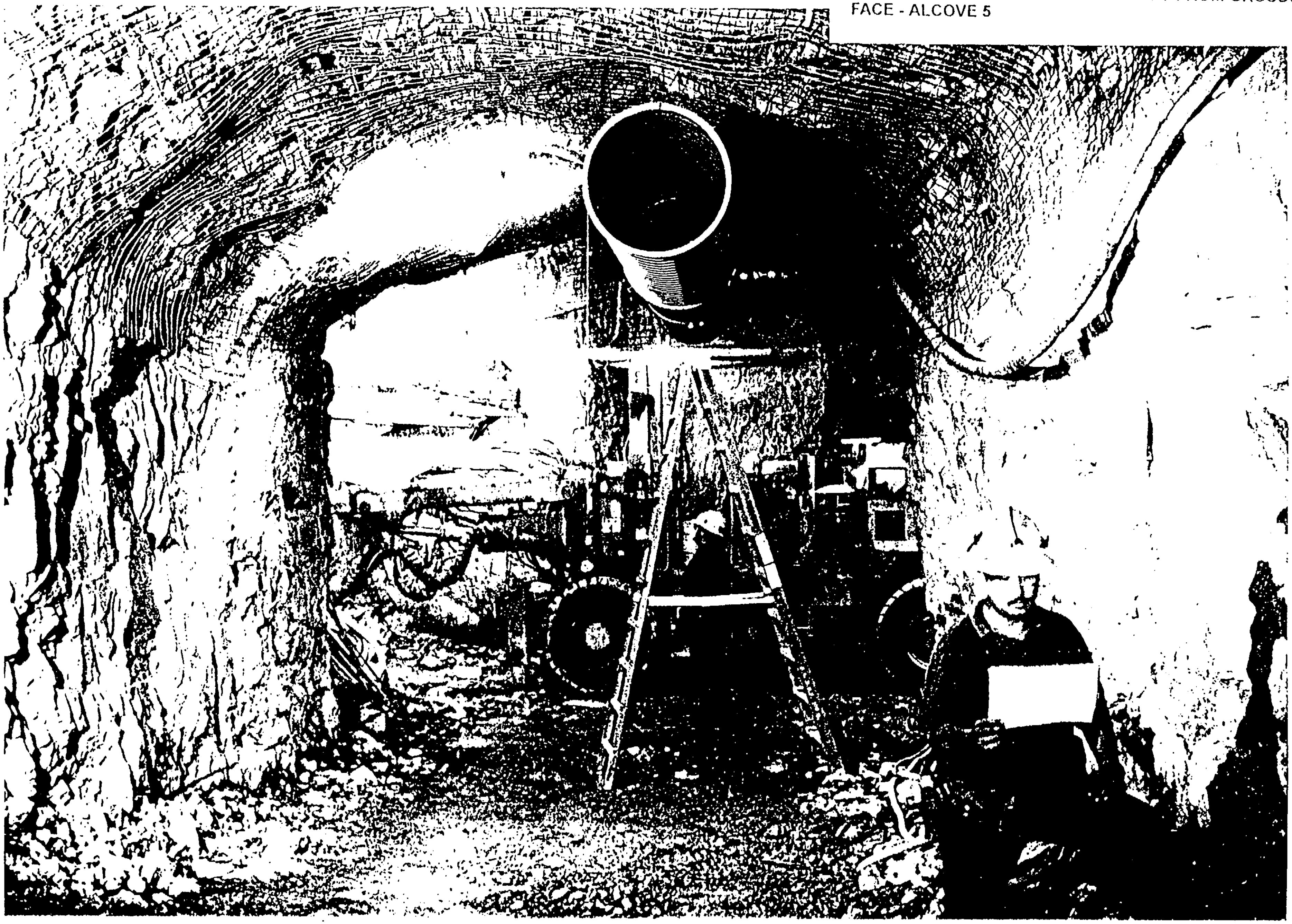
VIEW OF THERMO-MECHANICAL DRIFT FROM THE ACCESS/ OBSERVATION DRIFT, ALCOVE 5, ESF.

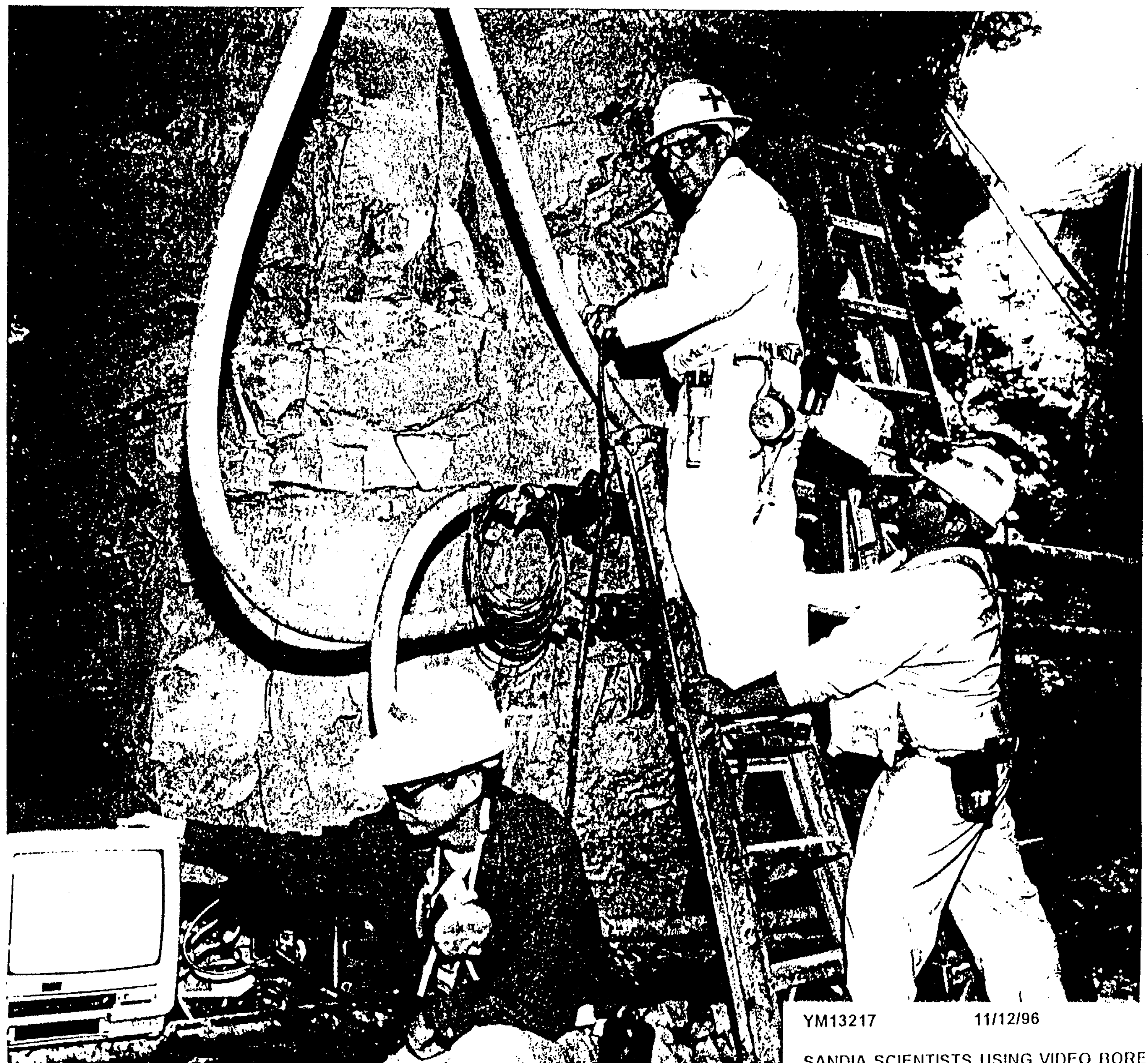
YM 12728


YM13043 10/2/96
FACE OF GHOST DANCE FAULT ALCOVE 6 AT 0+92.40

YM13047 10/2/96

VIEW TO ACCESS OBSERVATION DRIFT FROM CROSSCUT FACE - ALCOVE 5



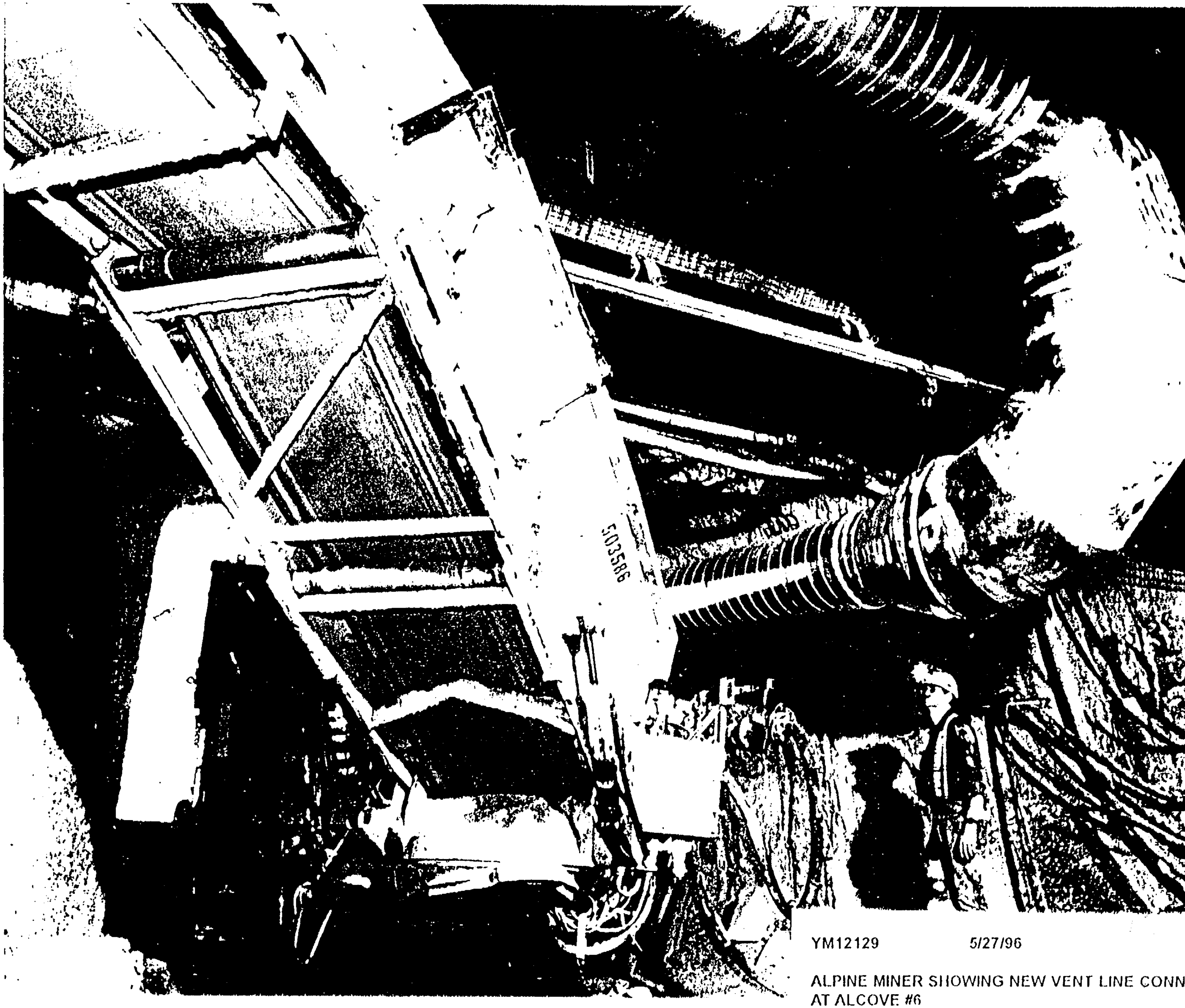


YM13217 11/12/96

SANDIA SCIENTISTS USING VIDEO BOREHOLE CAMERA

YM12900 9/25/96

CROSS-CUT DRILLING ACTIVITIES IN ACCESS/
OBSERVATION DRIFT, ALCOVE 5



YM12129 5/27/96

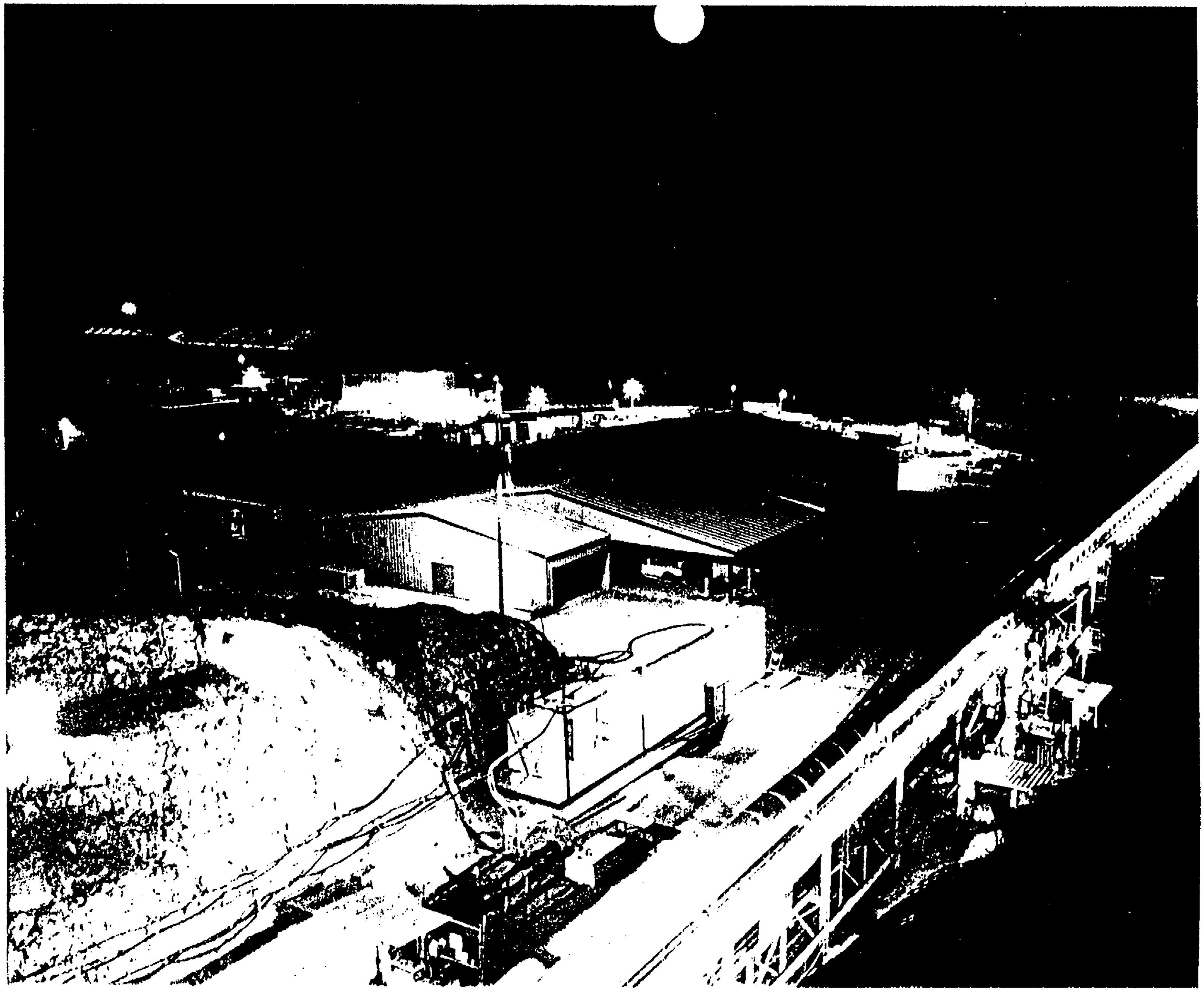
ALPINE MINER SHOWING NEW VENT LINE CONNECTION AT ALCOVE #6

YM12724 08/20/96

EMPLACEMENT OF RADIOACTIVE SOURCE IN THE LLNL NEUTRON HOLE, ACCESS/OBSERVATION DRIFT, ALCOVE 5, ESF.

YM13315 11/13/96

NIGHT SHOT OF ESF PAD TAKEN FROM EXILE HILL



ATTACHMENT 4

YUCCA
MOUNTAIN
PROJECT

Studies

Overview of Testing Activities

Presented to:
DOE-NRC ESF Technical Meeting, Video conference

Presented by:
Mark C. Tynan
DOE Staff, Assisstant Manager for Licensing
Yucca Mountain Site Characterization Office

December 16, 1996

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

DOE / NRC Technical Meeting

December 16, 1996

All technical information presented herein is to be considered preliminary. Project documents and reports will contain final data and interpretations. These data are provided for information purposes.

DOE / NRC Technical Meeting

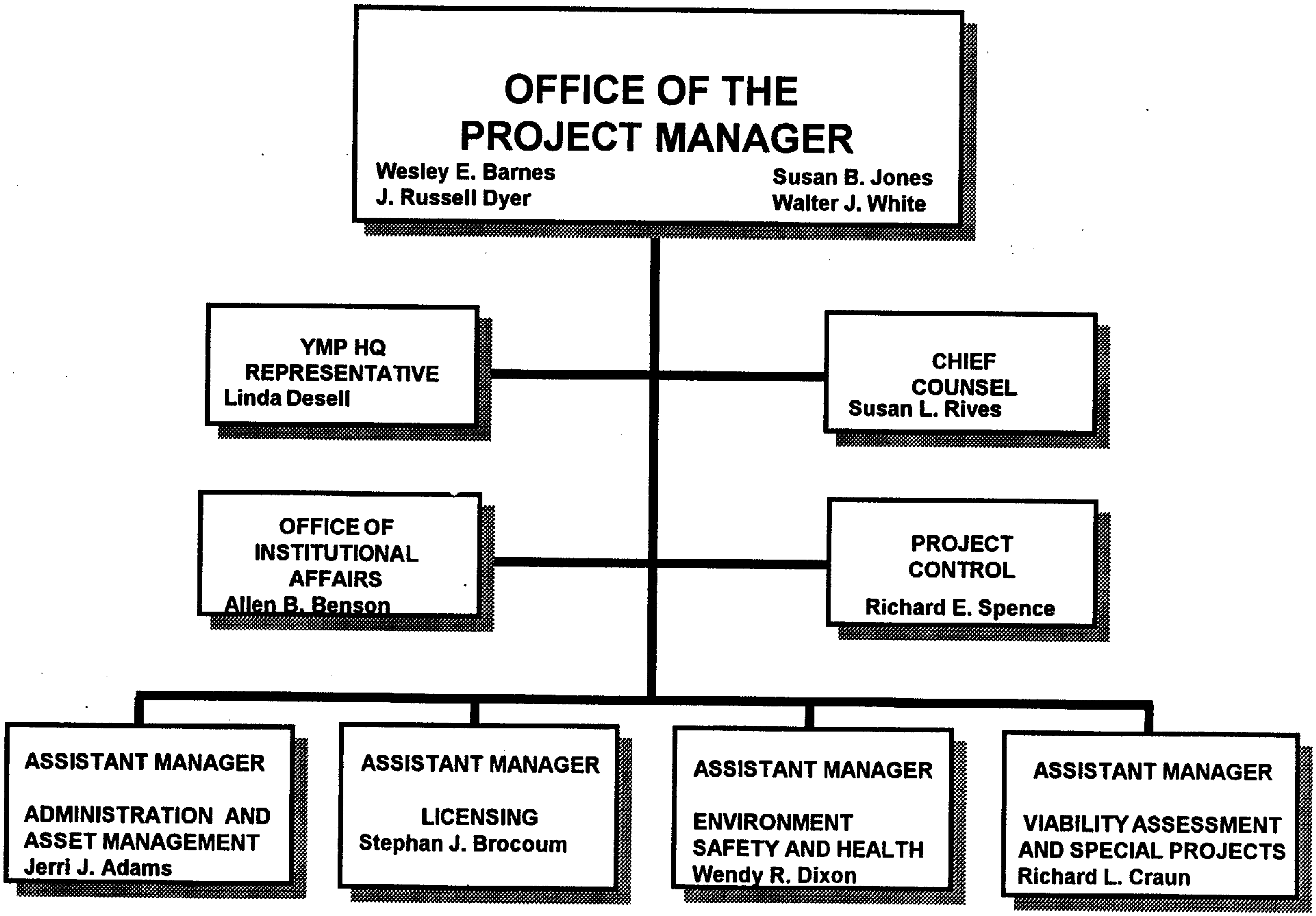
December 16, 1996

"For the great enemy of truth is very often not *the lie* - deliberate, contrived, and dishonest - but *the myth* - persistent, persuasive, and unrealistic...We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought. Mythology distracts us everywhere..."

John F. Kennedy

1962

YUCCA MOUNTAIN SITE CHARACTERIZATION OFFICE



YMORGS.PPT 12/10/96 11:37 AM

YUCCA MOUNTAIN SITE CHARACTERIZATION OFFICE(CONTINUED)

ASSISTANT MANAGER LICENSING
Stephan J. Brocoum

- **VIABILITY ASSESSMENT**
  J. Timothy Sullivan
- **SITE RECOMMENDATION**
  April V. Gil
- **LICENSE APPLICATION**
  Paul G. Harrington
- **PERFORMANCE CONFIRMATION**
  William J. Boyle

DOE / NRC Technical Meeting

December 16, 1996

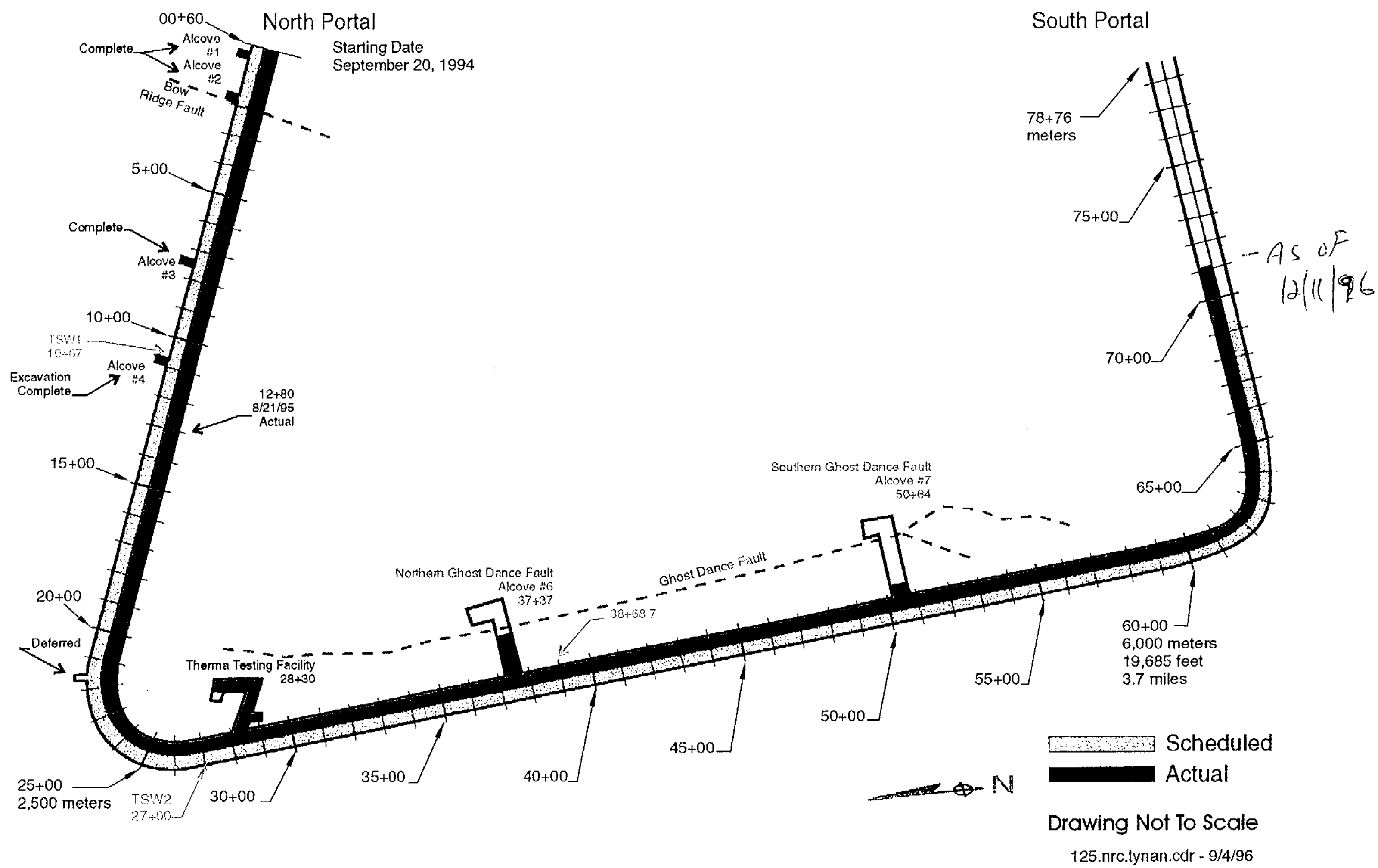
South Portal Activities

- Excavation continues
- Mapping of portal excavation has been initiated (12/96); only down about 20' of 60' depth for excavation
- Will conduct one or two detailed line surveys
- Will photograph and map from photos in addition, thus, providing plan view and photo overlay map
- SNL is conducting bulk rock properties testing on muck samples

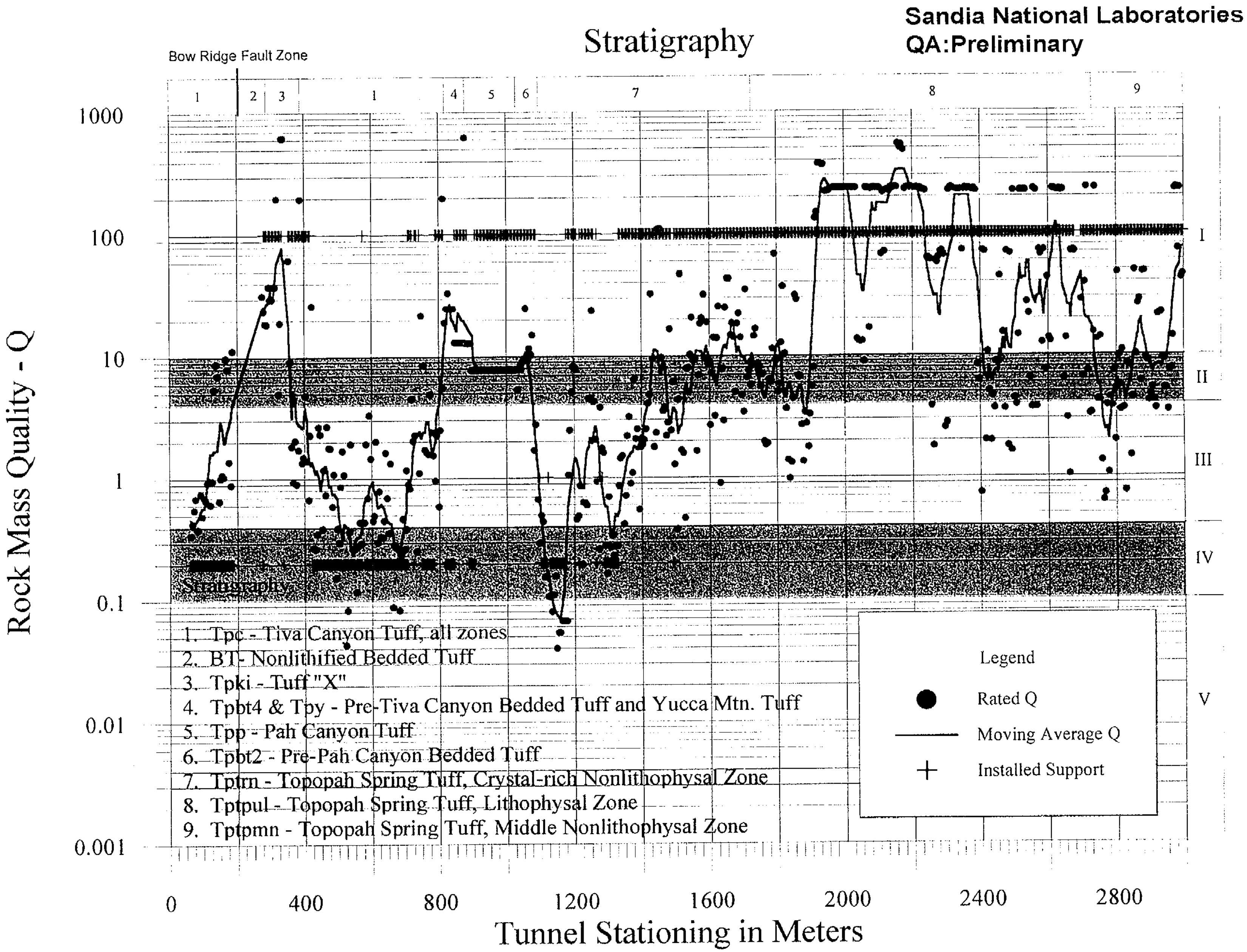
South Portal Excavation 11/96

7

Tunnel Boring Machine Progress

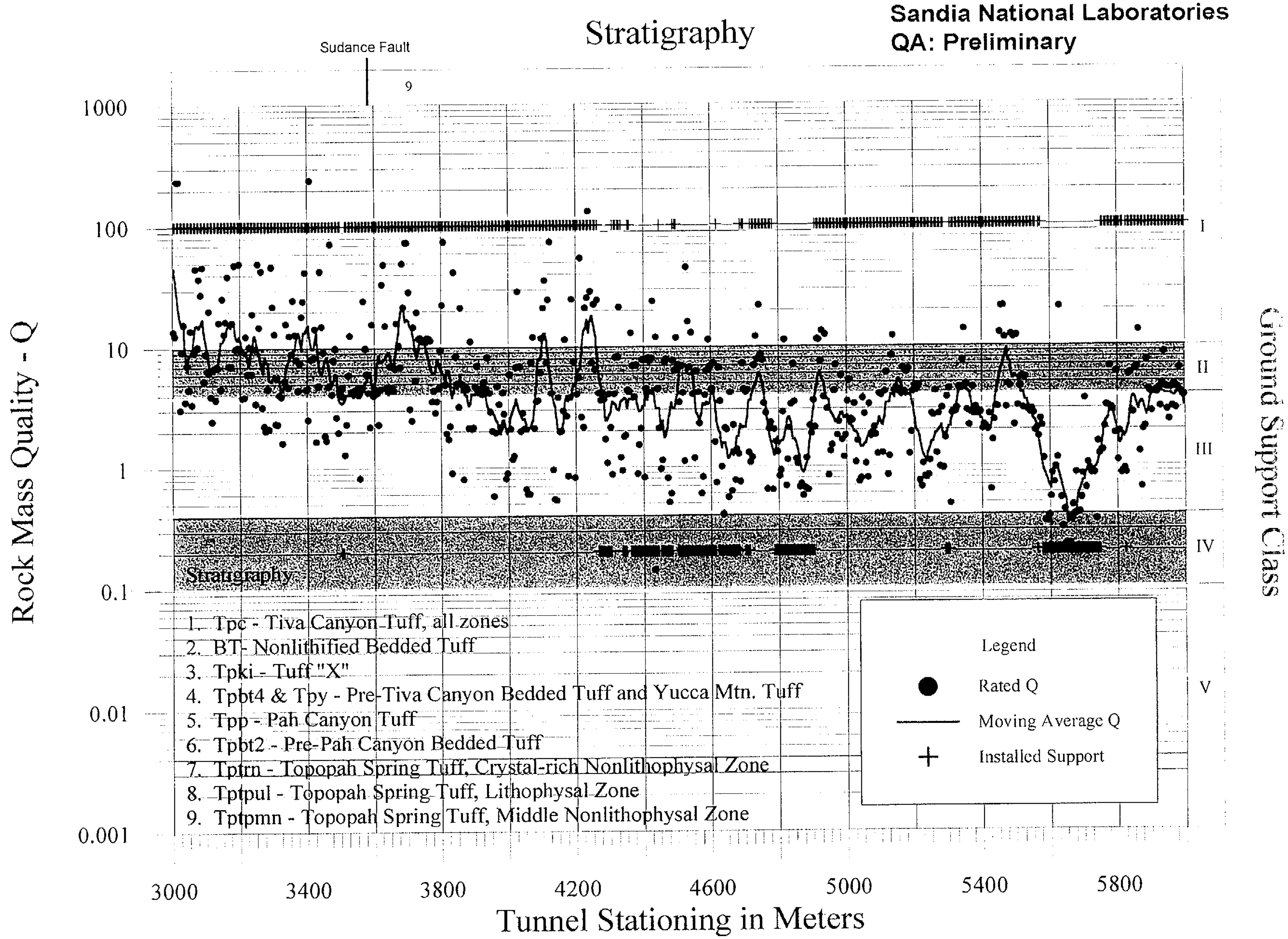


Station (00+60 to 30+00 m) versus Rated Q and Q Moving Average in the Main Drift.



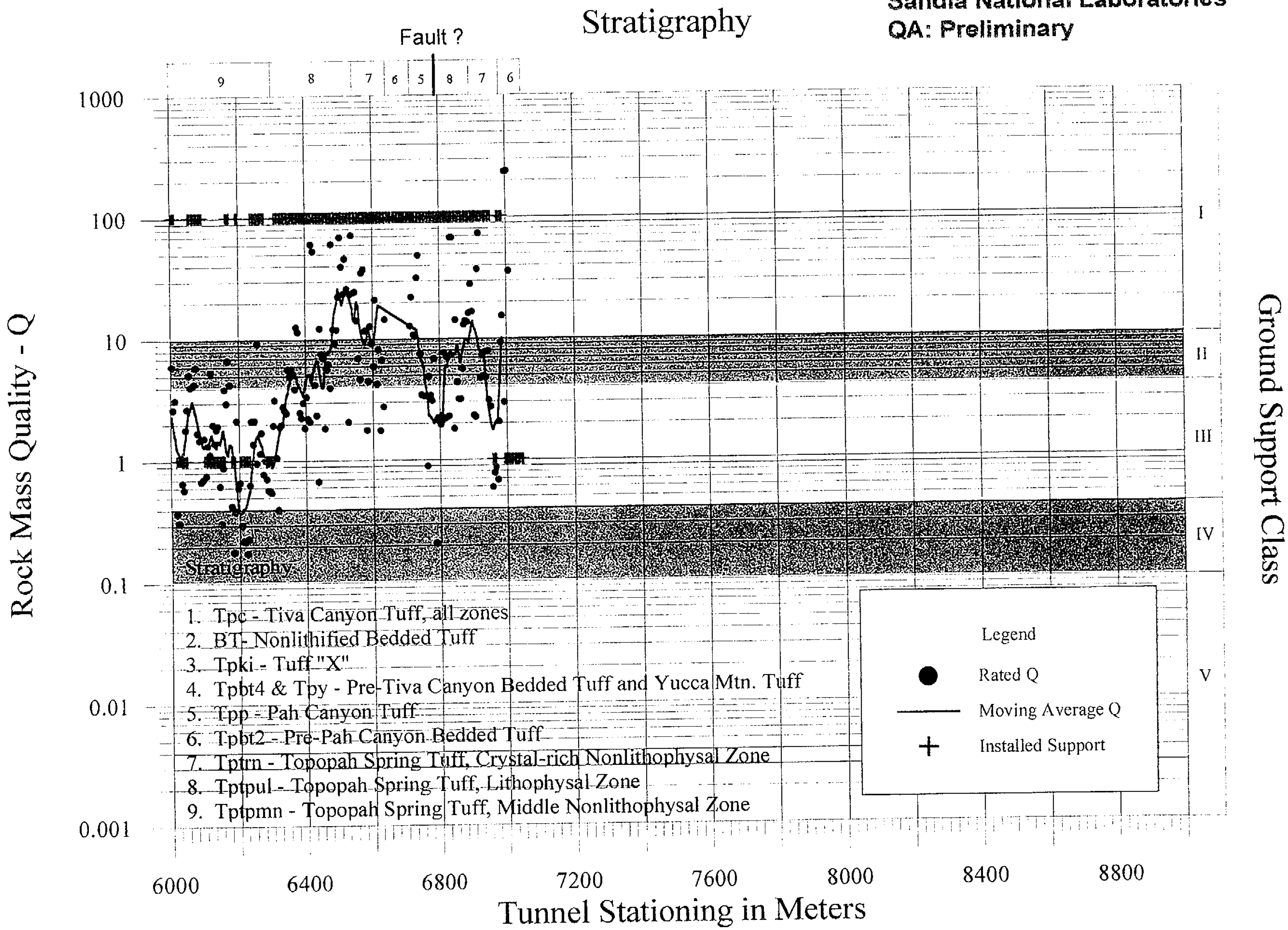
Station (30+00 to 60+00 m) versus Rated Q and Q Moving Average in the Main Drift.

Sandia National Laboratories
QA: Preliminary



Station (60+00 to 70+50 m) versus Rated Q and Q Moving Average in the Main Drift.

Sandia National Laboratories
QA: Preliminary



Note :

- Q values from station <u>6640 to 6710</u> and <u>7010 to 7050</u> were not determined. This is due to the soil-like texture of the rock in the two intervals which makes conducting rock mass quality assessment difficult. Because of the ground conditions the U.S. Bureau of Reclamation (USBR) has also not evaluated the intervals. SNL and USBR are both currently discussing how to evaluate the two intervals. (Unfortunately software used to plot the Moving average Q has incorrectly connected the points over the interval 6640 to 6710 m.)

- There is a "major" fault located approximately near station <u>6785</u> m. There also appears to be a second "major" fault located near <u>7050</u> m which is not displayed. Once the second faults displacement has been determined it will be plotted. These two faults have sufficient displacement to cause a repeat of the stratigraphic section. Numerous small displacement faults are not displayed for clarity.

DOE / NRC Technical Meeting

December 16, 1996

ESF MAPPING STATUS

Status on 12/10/96 with TBM at Station 71+21

Full Periphery Geol Mapping completed to	Station 70+43
See attached Table with horizons, key structural features, other support data	
Detailed Line Survey completed to	Station 70+22
Stereophotography completed to	Station 70+34
RQD Classification completed to	Station 70+33
Q&RMR completed to	Station 69+65

ESF STRATIGRAPHY

STRATIGRAPHY	Top Contact (meters)	Bottom Contact (meters)
North Ramp - Main Drift (tunnel is proceeding down section)		
Tiva Canyon Tuff (Tpc)	**0+00**	**1+99.5**
Tiva Canyon crystal poor upper lithophysal zone (Tpcpul)	0+00	0+99.5
Alcove 1	0+42.5	
Tiva Canyon crystal poor middle nonlithophysal zone (Tpcpmn)	0+99.5	1+99.0
Alcove 2	1+68.2	
Tiva Canyon crystal poor lower lithophysal zone (Tpcpll)	1+90	1+99.5
Bow Ridge Fault Zone	**1+99.5**	**2+02**
Pre-Rainier Mesa bedded tuffs	**2+02**	**2+63.5**
Fault	**2+20**	**~4.3m offset**
Tuff "X"	**2+63.5**	**3+33**
Pre-Tuff "X" bedded tuffs	**3+33**	**3+49.5**
Tiva Canyon Tuff (Tpc)	**3+49.5**	**8+69**
Tiva Canyon crystal rich vitric zone (Tpcrv)	3+49.5	3+59.5
Tiva Canyon crystal rich nonlithophysal zone (Tpcrn)	3+59.5	4+34
Fault	4+30	~10m offset
Tiva Canyon crystal rich lithophysal zone (Tpcrl)	4+34	4+39*
Tiva Canyon crystal poor upper lithophysal zone (Tpcpul)	4+39*	5+53
Fault	5+50	~5m offset
Tiva Canyon crystal poor middle nonlithophysal zone (Tpcpmn)	5+53	5+87

ESF STRATIGRAPHY

STRATIGRAPHY	Top Contact (meters)	Bottom Contact (meters)
Tiva Canyon crystal poor lower lithophysal zone (Tpcpll)	5+87	6+17
Tiva Canyon crystal poor lower nonlithophysal zone (Tpcpln)	6+17	7+77
Fault	7+00	~20m offset
Alcove 3	7+54	
Tiva Canyon crystal poor vitric zone (Tpcpv)	7+77	8+69
Pre-Tiva Canyon bedded tuffs (Tpbt4)	**8+69**	**8+72.5**
Yucca Mountain Tuff (Tpy)	**8+72.5**	**8+73.5**
Pre-Yucca Mountain bedded tuffs (Tpbt5)	**8+73.5**	**9+12**
Pah Canyon Tuff (Tpp)	**9+12**	**10+20**
Pre-Pah Canyon Tuff bedded tuffs (Tpbt2)	**10+20**	**10+51.5**
Alcove 4	**10+27.8**	
Topopah Spring Tuff (Tpt)	**10+51.5**	
Topopah Spring crystal rich vitric zone (Tptrv)	10+51.5	12+00
Topopah Spring crystal rich nonlithophysal zone (Tptrn)	12+00	17+17
Topopah Spring crystal rich lithophysal zone (Tptrl)	17+17	17+97
Topopah Spring crystal poor upper lithophysal zone (Tptpul)	17+97	27+20
Topopah Spring crystal poor middle nonlithophysal zone (Tptpmn)	27+20	63+08* ⓐ
Alcove 5	28+27	
Sundance Fault	35+93	minor offset
Splay of Ghost Dance Fault	57+30	offset ≤2m
Topopah Spring crystal poor upper ~~prelim.~~ lithophsal zone (Tptpll)	63+08	64+55 ⓐ

* Not varified; preliminary to face

ⓐ = see next page

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ESF STRATIGRAPHY

STRATIGRAPHY	*Top Contact (meters)*	*Bottom Contact (meters)*
Main Drift - South Ramp (tunnel is proceeding up-section)		
Topopah Spring crystal-poor middle nonlithophysal zone (Tptpmn)	63+08?	59+40?
Topopah Spring crystal-poor upper lithophysal zone (Tptpul)	64+53?	63+08?
Topopah Spring crystal-rich lithophysal zone (Tptrl)	65+13?	64+53?
Topopah Spring crystal-rich nonlithophysal zone (Tptrn)	65+23*	65+13?
Topopah Spring crystal-rich lithophysal zone (Tptrl)	65+35?	65+25*
Topopah Spring crystal-rich nonlithophysal zone (Tptrn)	66+35?	65+35?
Topopah Spring crystal-rich vitric zone (Tptrv)	66+40?	66+35?
bedded tuffs (Tpbt2)	**66+98?**	**66+40**
Tiva Canyon Tuff (Tpc)	**67+88***	**66+98?**
Tiva Canyon crystal-poor vitric zone (Tpcpv)	67+26?	66+98?
Tiva Canyon crystal-poor lower nonlithophysal zone (Tpcpln)	67+62*	67+26?
Tiva Canyon crystal-poor vitric zone (Tpcpv)	62+70?	67+62*
Tiva Canyon crystal-poor lower nonlithophysal zone (Tpcpln)	67+88*	67+70*
Topopah Spring Tuff (Tpt)	**69+96?**	**67+88***
Topopah Spring crystal-poor upper lithophysal zone (Tptpul)	68+47?	67+91*

ESF STRATIGRAPHY

STRATIGRAPHY	Top Contact (meters)	Bottom Contact (meters)
Topopah Spring crystal-rich lithophysal zone (Tptrl)	68+85?	68+47?
Topopah Spring crystal-rich nonlithophysal zone (Tptrn)	69+84?	68+85?
Topopah Spring crystal-rich vitric zone (Tptrv)	69+96?	69+90?
bedded tuffs (Tpbt)	70+58*?	69+96?
Topopah Spring Tuff (Tpt)		**70+58***
Topopah Spring crystal-poor middle nonlithophysal zone (Tptpmn)		**70+58***

* - Faulted contact
** - Not Encountered by the ESF
(?) - Not confirmed by the USGS

ESF STRATIGRAPHY

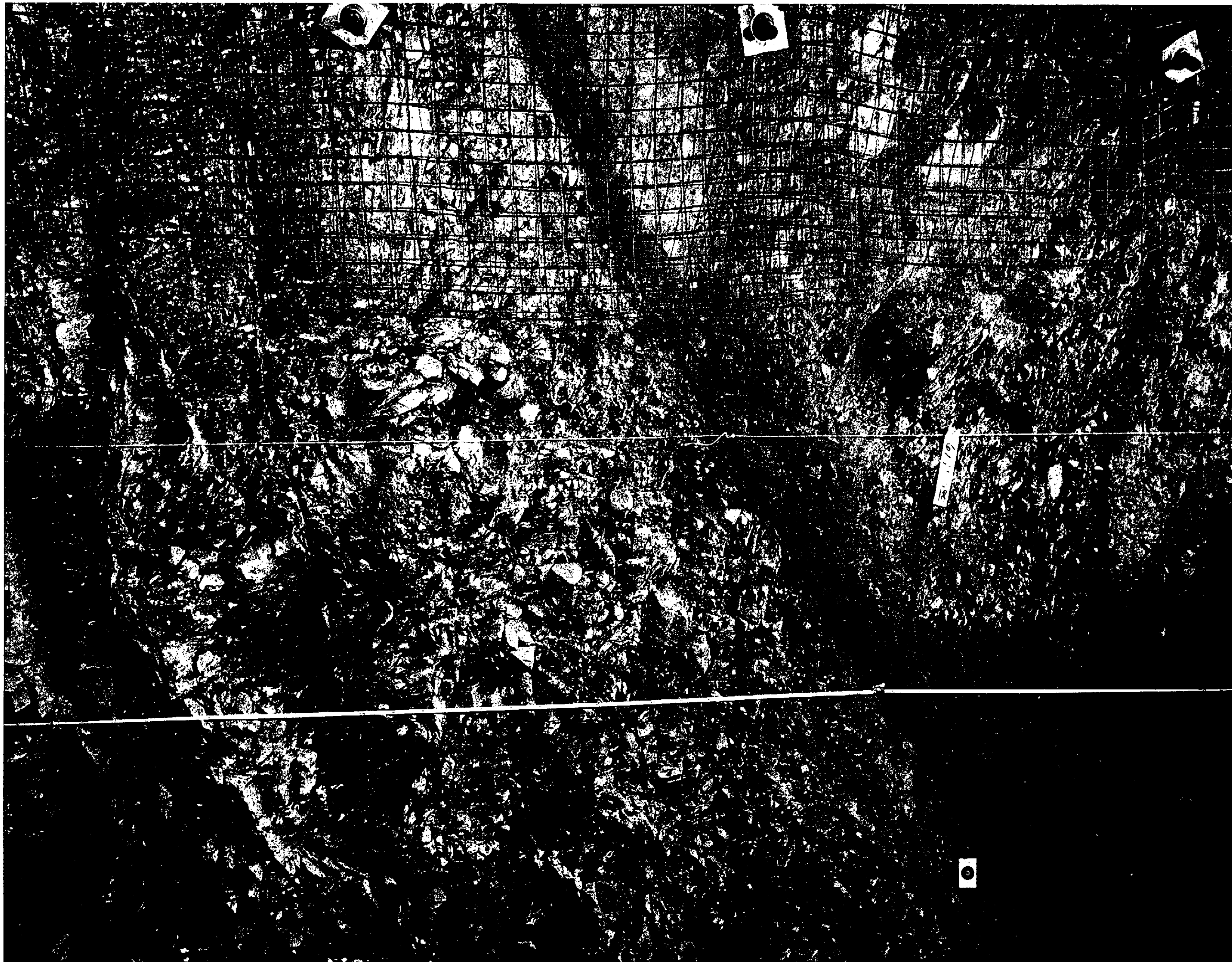
(Preliminary: picks not varified from 63+00 to current location)

STRATIGRAPHY	Top Contact (meters)	Bottom Contact (meters)
Fault	63+25	3.8M offset
Dune Wash Fault	67+90	>10m? offset ?
Fault	70+55	offset uncertain; 3-4 m gouge zone

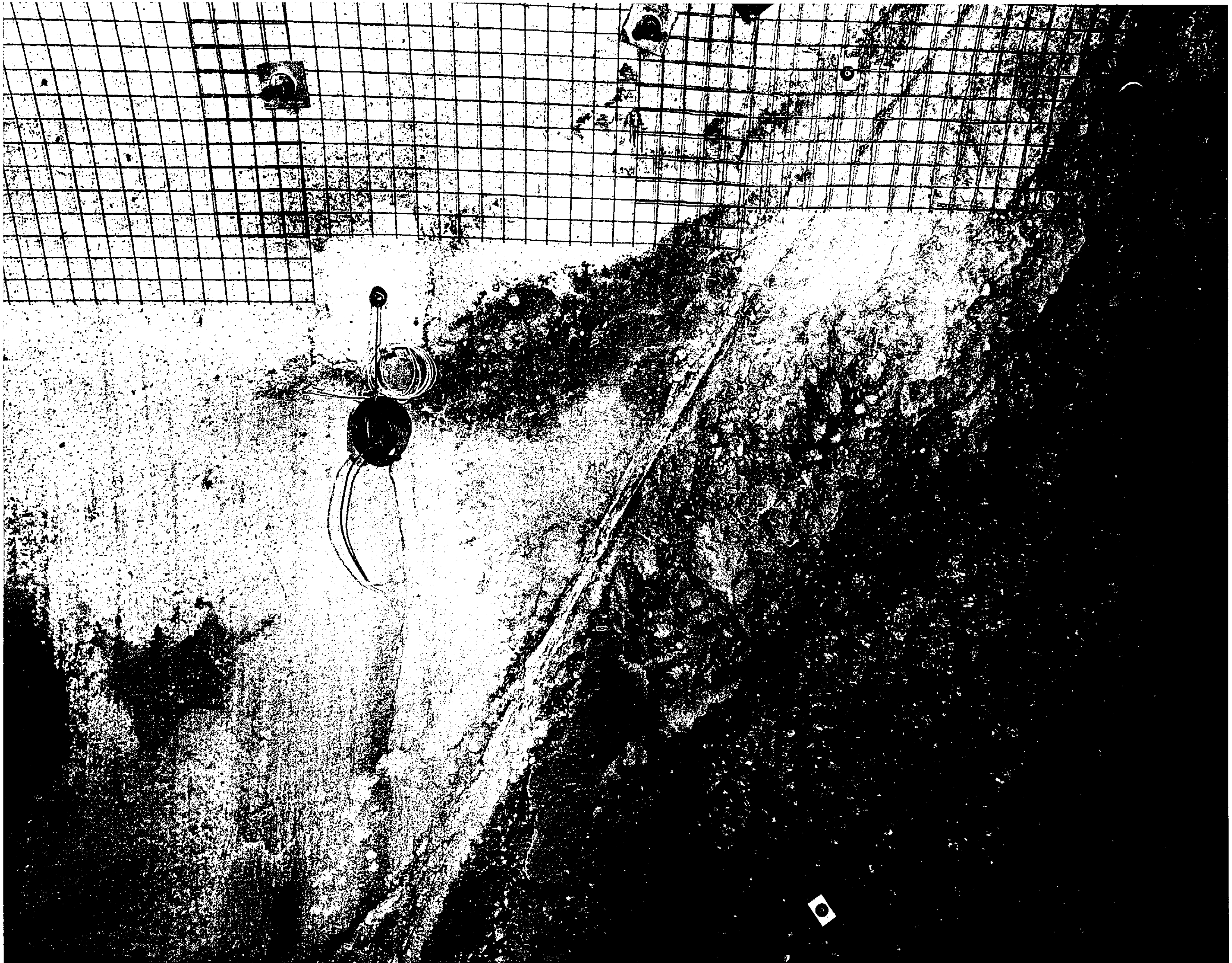
* - Faulted contact
**- Not Encountered by the ESF
(?)- Not confirmed by the USGS

Dune Wash fault zone

- At Station 67+88 to 67+91 (Right wall)
- Consists of two distinct planes oriented 140 / 86 and 175 /60
- Hanging wall is composed of Tiva Canyon, crystal-poor, lower nonlithophysal zone (Tpcpln)
- Foot wall is composed of Topopah Spring, crystal-poor, upper lithophysal zone (Tptpmn)
- NOTE: Fault zone contains blocks of bedded tuff (Tpbt3?), Topopah Spring crystal-rich, vitrophyre (Tptrv), and Topopah Spring, crystal-rich, nonlithophysal (Tptrn)



Dune Wash Fault - Main trace - Right Rib E ⟷ West



Dune Wash Flt Left Rib 67+50 West ⟵⟶ E

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DOE / NRC Technical Meeting

December 16, 1996

ALCOVE CONSTRUCTION AND TESTING UPDATE

DOE / NRC Technical Meeting

December 16, 1996

STATUS OF WORK IN ALCOVES 5,6, & 7*

Alcove 5	**HS**	**FPM**	**DLS**	**Ph**	**RQD**	**Q/RMR**
AOD	1+30	1+30	1+30	1+30	1+30	1+30
con-necting	0+45	NS	NS	NS	NS	NS
heated drift	0+18	NS	NS	NS	NS	NS
Alcove 6	1+34	NS	0+85	NS	0+92.60	0+75
Alcove 7	0+24	NS	NS	NS	NS	NS

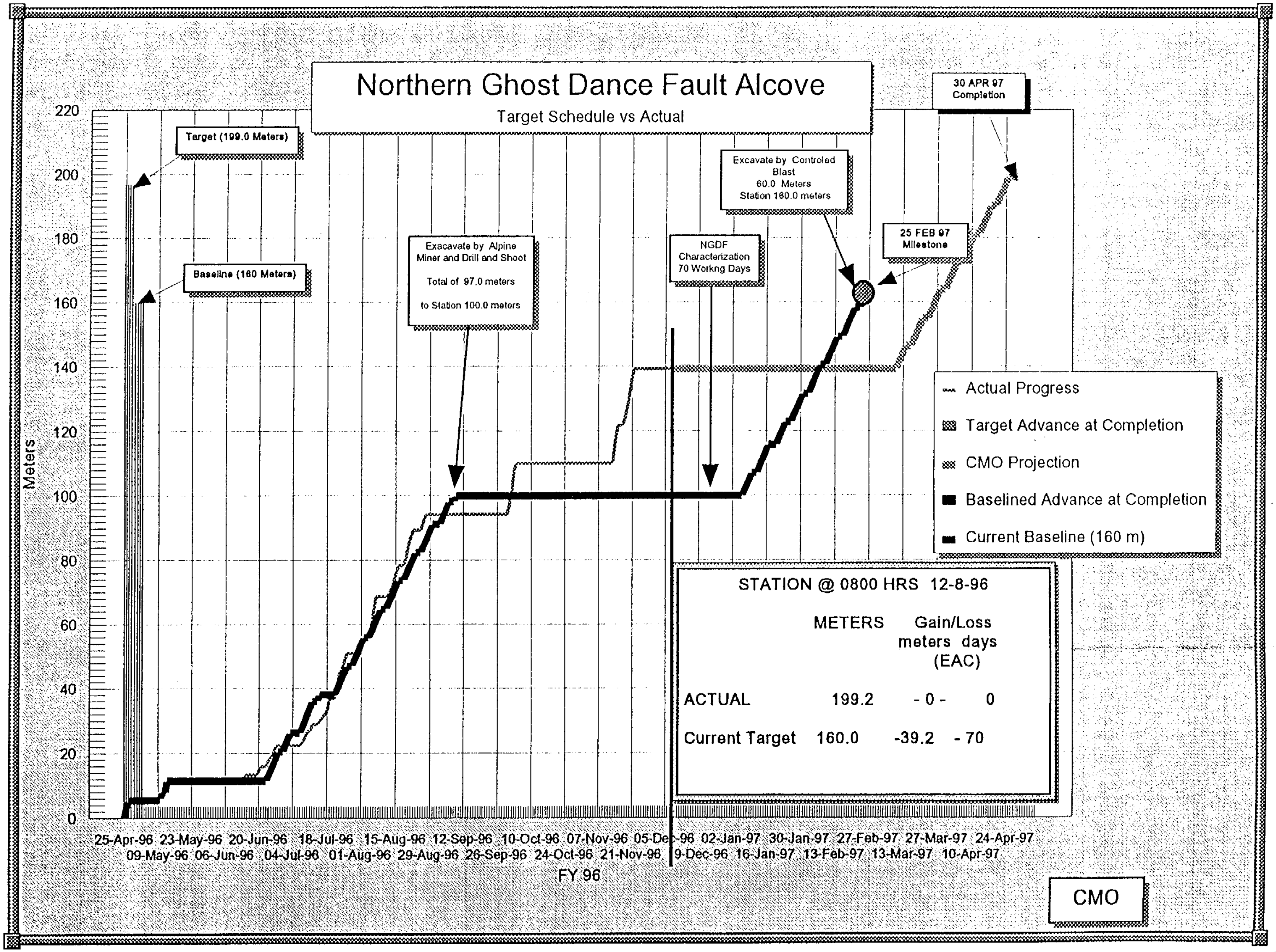
NS= Not Started
Heading/ Station = HS

Detailed Line Survey = DLS
Full- periphery map = FPM

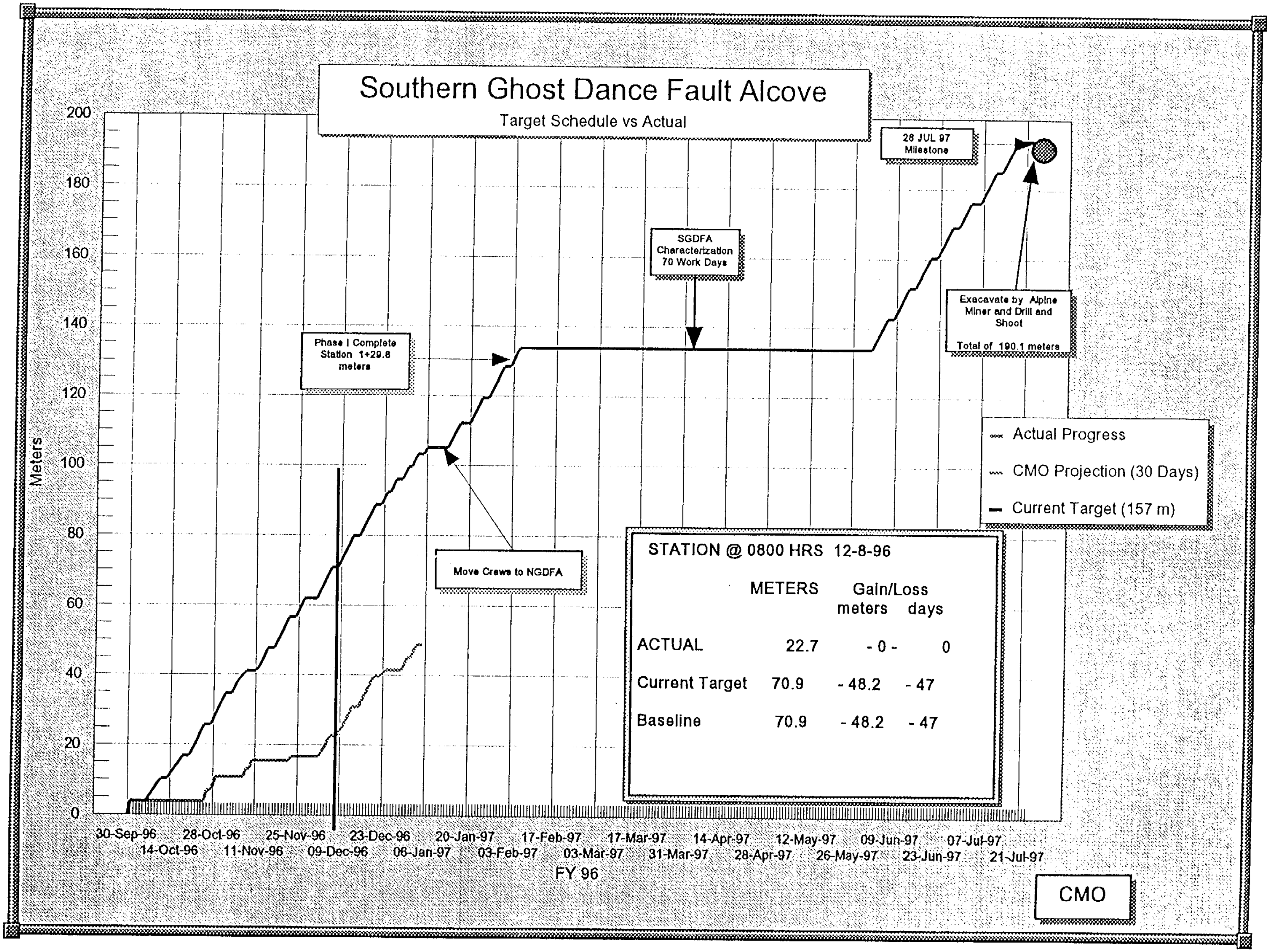
Photography = Ph
RQD Assessment = RQD

AOD = Access Observation Drift
Q & RMR Assessment = Q/RMR

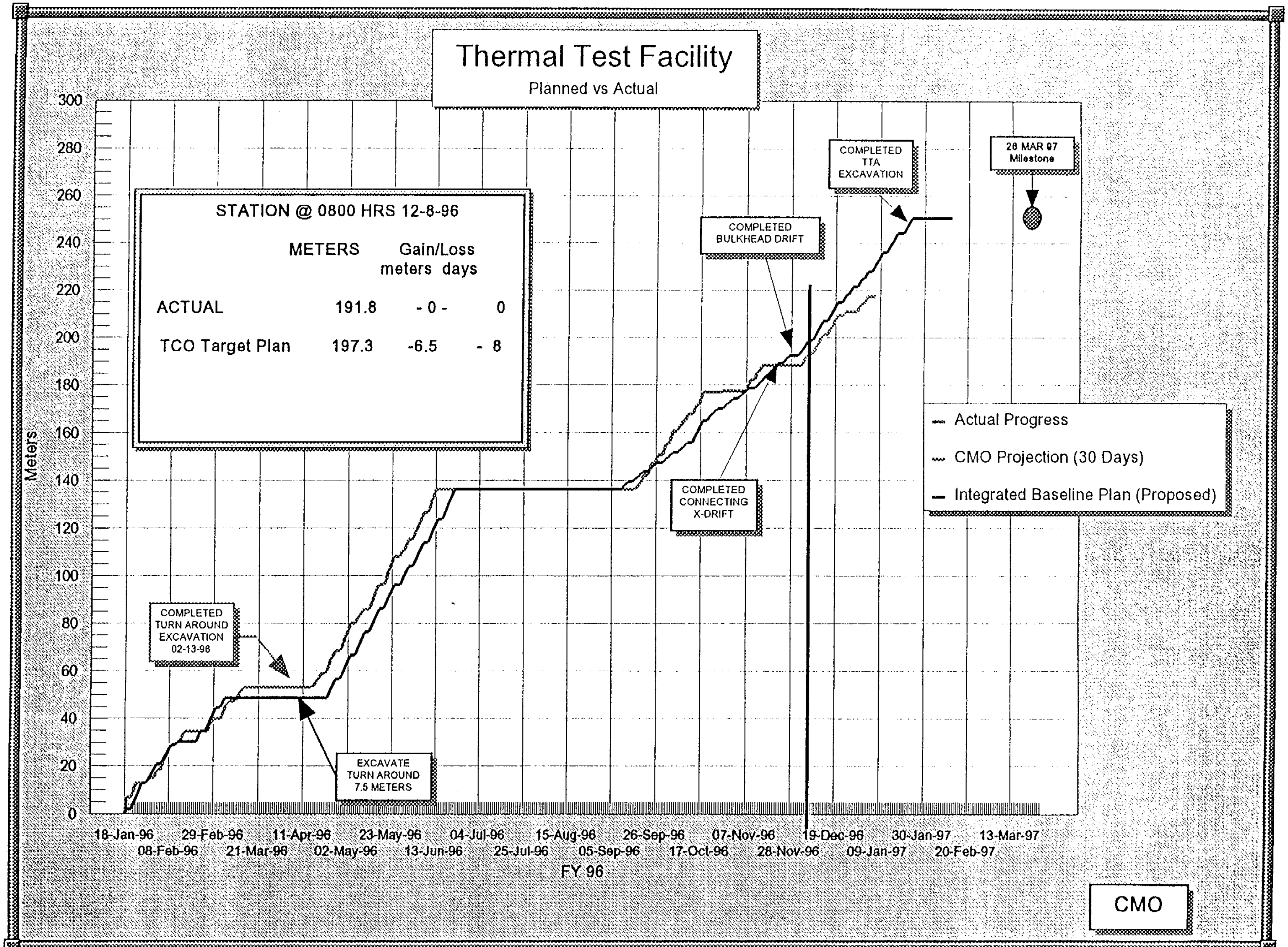
* As of 12-10-96



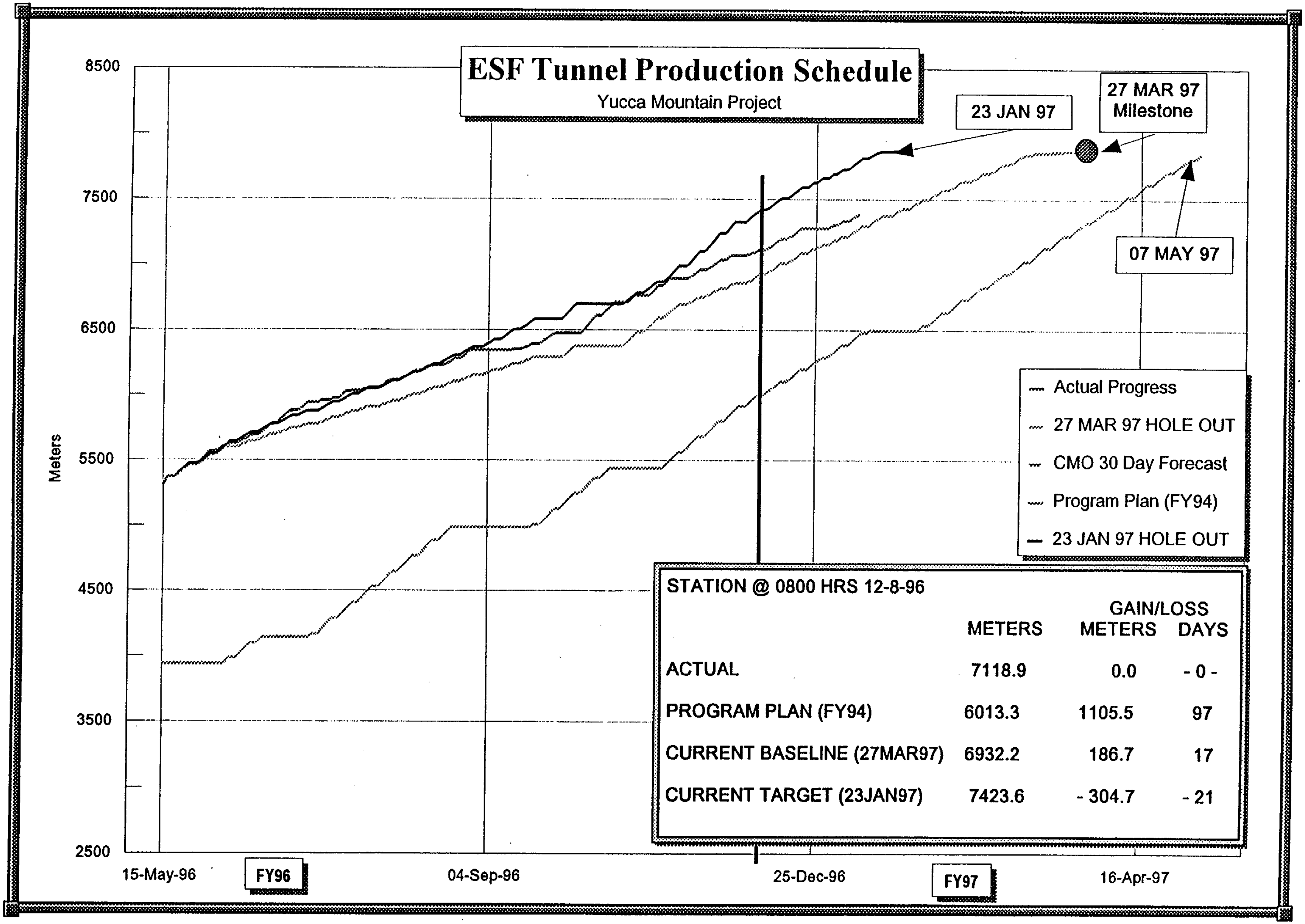
Northern Ghost Dance Fault Alcove
Target Schedule vs Actual
Target (199.0 Meters)
Baseline (160 Meters)
Exacavate by Alpine Miner and Drill and Shoot
Total of 97.0 meters
to Station 100.0 meters
NGDF Characterization 70 Workng Days
Excavate by Controled Blast
60.0 Meters
Station 160.0 meters
25 FEB 97 Milestone
30 APR 97 Completion
Meters
220
200
180
160
140
120
100
80
60
40
20
0
25-Apr-96 23-May-96 20-Jun-96 18-Jul-96 15-Aug-96 12-Sep-96 10-Oct-96 07-Nov-96 05-Dec-96 02-Jan-97 30-Jan-97 27-Feb-97 27-Mar-97 24-Apr-97
09-May-96 06-Jun-96 04-Jul-96 01-Aug-96 29-Aug-96 26-Sep-96 24-Oct-96 21-Nov-96 19-Dec-96 16-Jan-97 13-Feb-97 13-Mar-97 10-Apr-97
FY 96
Actual Progress
Target Advance at Completion
CMO Projection
Baselined Advance at Completion
Current Baseline (160 m)
STATION @ 0800 HRS 12-8-96
METERS
Gain/Loss
meters days
(EAC)
ACTUAL 199.2 - 0 - 0
Current Target 160.0 -39.2 - 70
CMO



Southern Ghost Dance Fault Alcove
Target Schedule vs Actual
Meters
200
180
160
140
120
100
80
60
40
20
0
28 JUL 97 Milestone
SGDFA Characterization 70 Work Days
Phase I Complete Station 1+29.8 meters
Excavate by Alpine Miner and Drill and Shoot
Total of 190.1 meters
Move Crews to NGDFA
Actual Progress
CMO Projection (30 Days)
Current Target (157 m)
STATION @ 0800 HRS 12-8-96
METERS
Gain/Loss
meters days
ACTUAL 22.7 - 0 - 0
Current Target 70.9 - 48.2 - 47
Baseline 70.9 - 48.2 - 47
30-Sep-96
14-Oct-96
28-Oct-96
11-Nov-96
25-Nov-96
09-Dec-96
23-Dec-96
06-Jan-97
20-Jan-97
03-Feb-97
17-Feb-97
03-Mar-97
17-Mar-97
31-Mar-97
14-Apr-97
28-Apr-97
12-May-97
26-May-97
09-Jun-97
23-Jun-97
07-Jul-97
21-Jul-97
FY 96
CMO



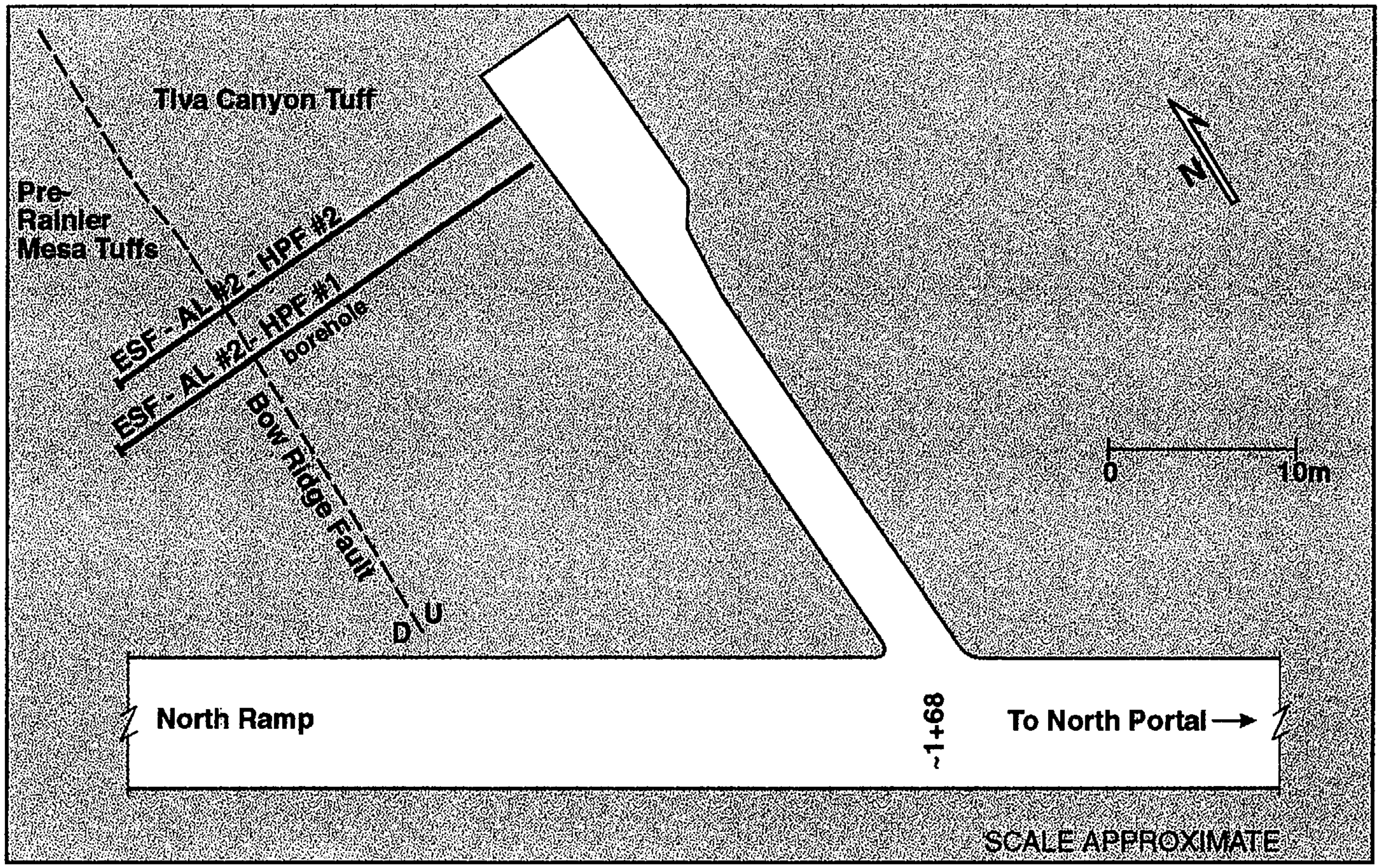
Thermal Test Facility
Planned vs Actual
STATION @ 0800 HRS 12-8-96
METERS
Gain/Loss meters days
ACTUAL 191.8 - 0 - 0
TCO Target Plan 197.3 -6.5 - 8
COMPLETED TTA EXCAVATION
28 MAR 97 Milestone
COMPLETED BULKHEAD DRIFT
COMPLETED CONNECTING X-DRIFT
COMPLETED TURN AROUND EXCAVATION 02-13-96
EXCAVATE TURN AROUND 7.5 METERS
Actual Progress
CMO Projection (30 Days)
Integrated Baseline Plan (Proposed)
Meters
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
18-Jan-96
08-Feb-96
29-Feb-96
21-Mar-96
11-Apr-96
02-May-96
23-May-96
13-Jun-96
04-Jul-96
25-Jul-96
15-Aug-96
05-Sep-96
26-Sep-96
17-Oct-96
07-Nov-96
28-Nov-96
19-Dec-96
09-Jan-97
30-Jan-97
20-Feb-97
13-Mar-97
FY 96
CMO


ESF Tunnel Production Schedule
Yucca Mountain Project
Meters
8500
7500
6500
5500
4500
3500
2500
15-May-96
FY96
04-Sep-96
25-Dec-96
FY97
16-Apr-97
23 JAN 97
27 MAR 97 Milestone
07 MAY 97
Actual Progress
27 MAR 97 HOLE OUT
CMO 30 Day Forecast
Program Plan (FY94)
23 JAN 97 HOLE OUT
STATION @ 0800 HRS 12-8-96
GAIN/LOSS
METERS
METERS DAYS
ACTUAL 7118.9 0.0 - 0 -
PROGRAM PLAN (FY94) 6013.3 1105.5 97
CURRENT BASELINE (27MAR97) 6932.2 186.7 17
CURRENT TARGET (23JAN97) 7423.6 - 304.7 - 21

ALCOVE 1 - Upper Tiva Canyon Alcove

ESF Alcove 2

Bow Ridge Fault Test; two radial boreholes ~30m deep



125.nrc.tynan.cdr - 12/6/96

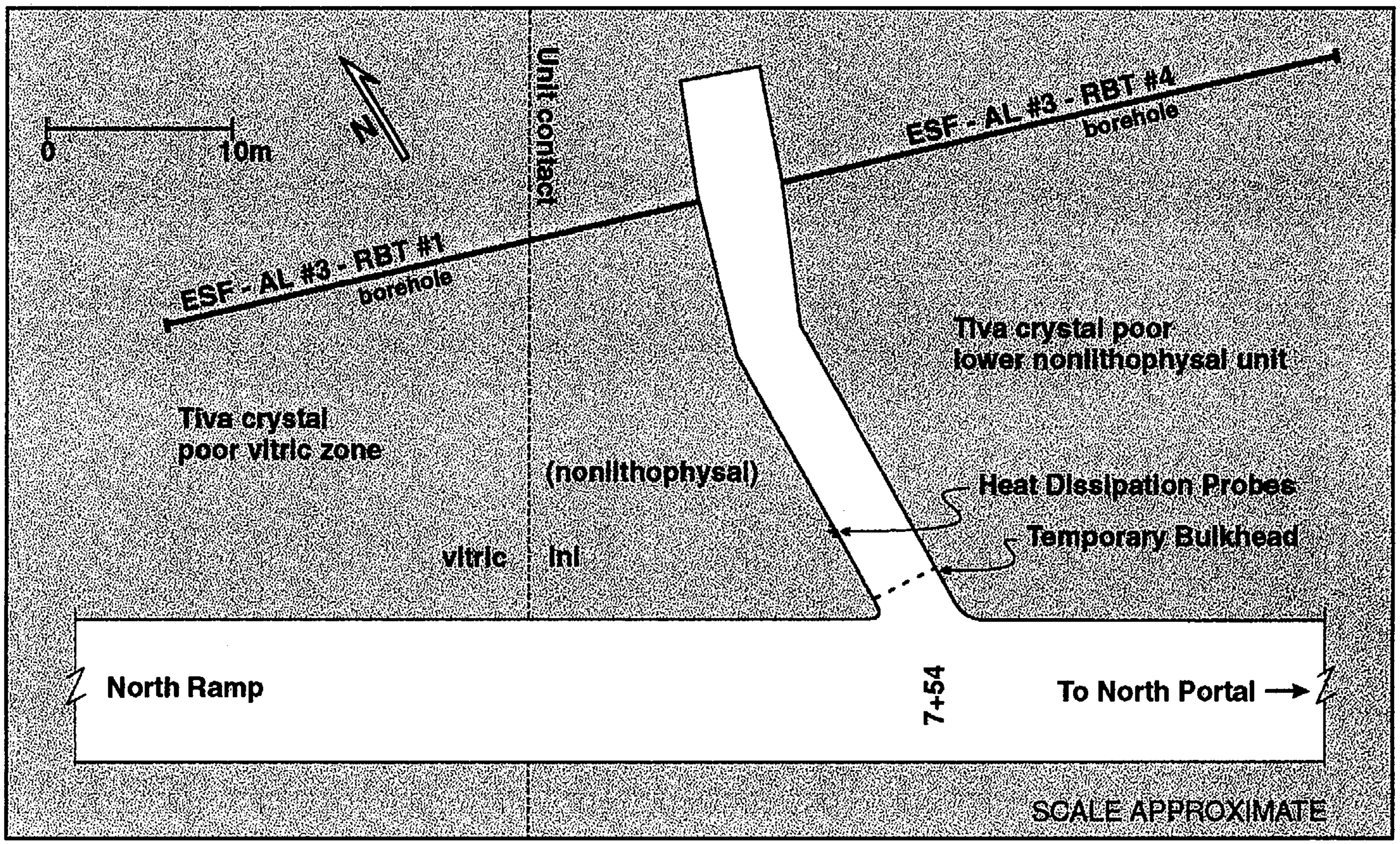
DOE / NRC Technical Meeting

December 16, 1996

Alcove 2

No additional significant testing results to report since last update

ESF Alcove 3:
Upper Paintbrush Tuff Non-Welded Contact
Test of Lower Tiva hydrostratigraphic unit; two radial boreholes ~ 30m deep each



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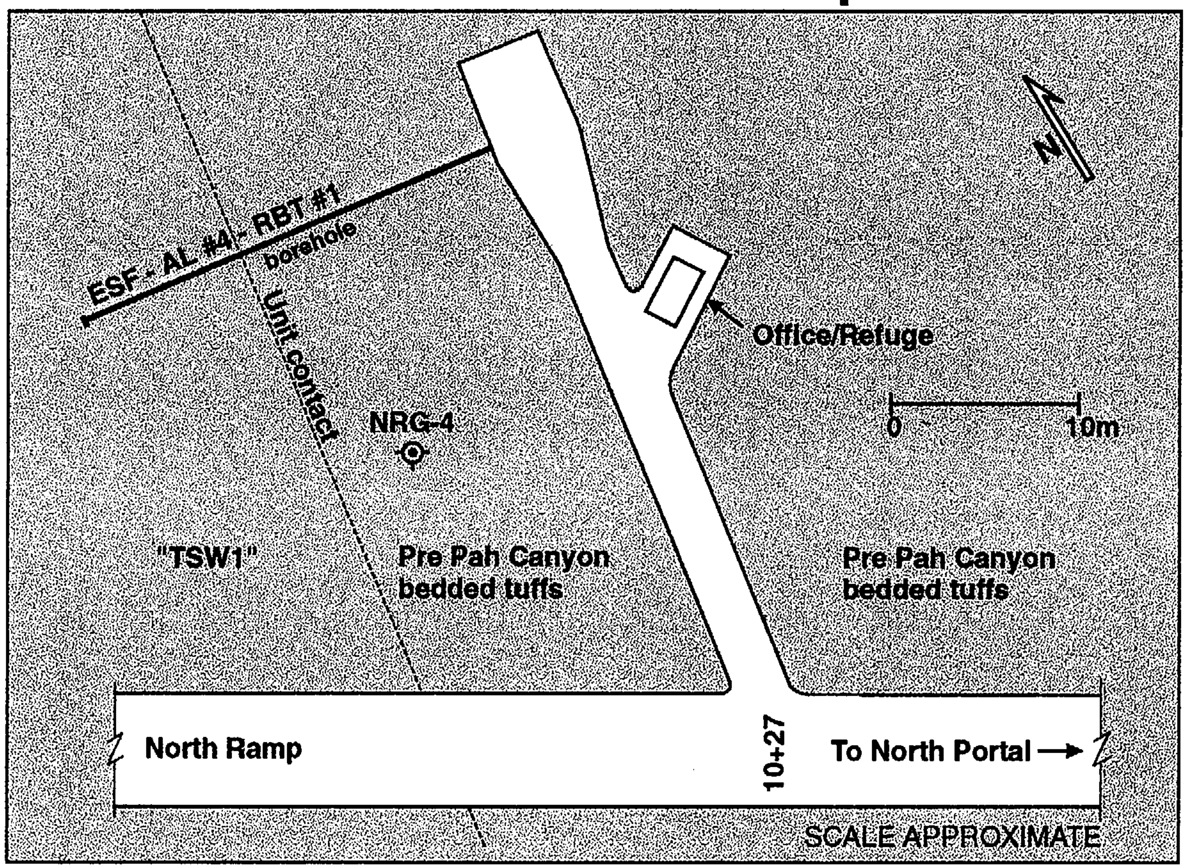
Alcove 3 = Upper PTn Contact Alcove

- During construction, staff noted walls dried out with time
- Temporary bulkhead installed to isolate alcove
- Heat dissipation probes installed
  - Evaporation rates measured at less than 0.5mm/day
  - Rock Saturations measured in excess of 90%
  - Water potentials exceed -0.1 Megapascals

ESF Alcove 4

Lower Paintbrush Non-welded Contact

Test of PTn hydrostratigraphic unit; one radial borehole ~ 30m deep



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DOE / NRC Technical Meeting

December 16, 1996

Alcove 4

No additional significant testing results to report since last update

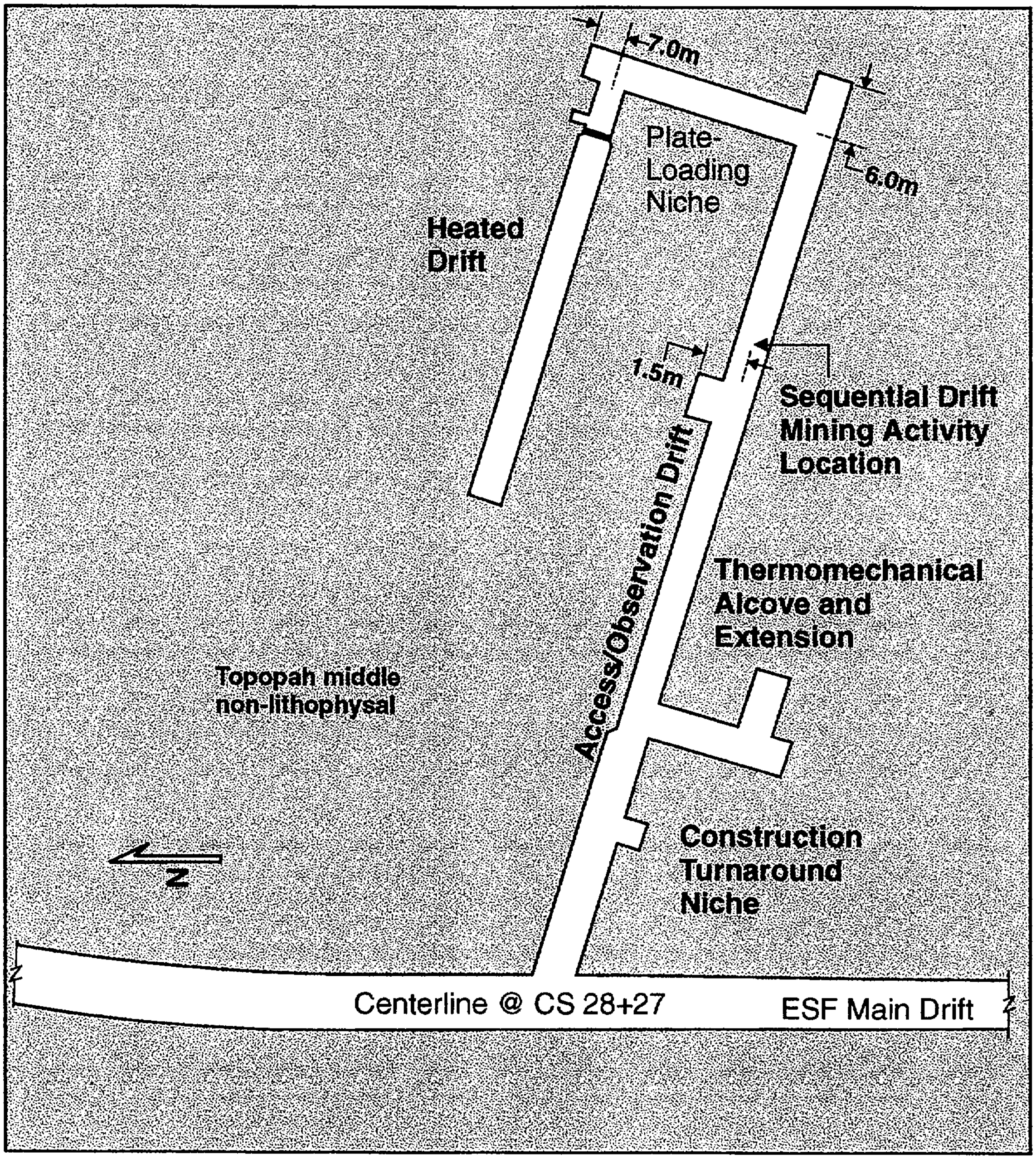
DOE / NRC Technical Meeting

December 16, 1996

Alcove 5

Bill Boyle is presenting status and results testing in thermal alcove

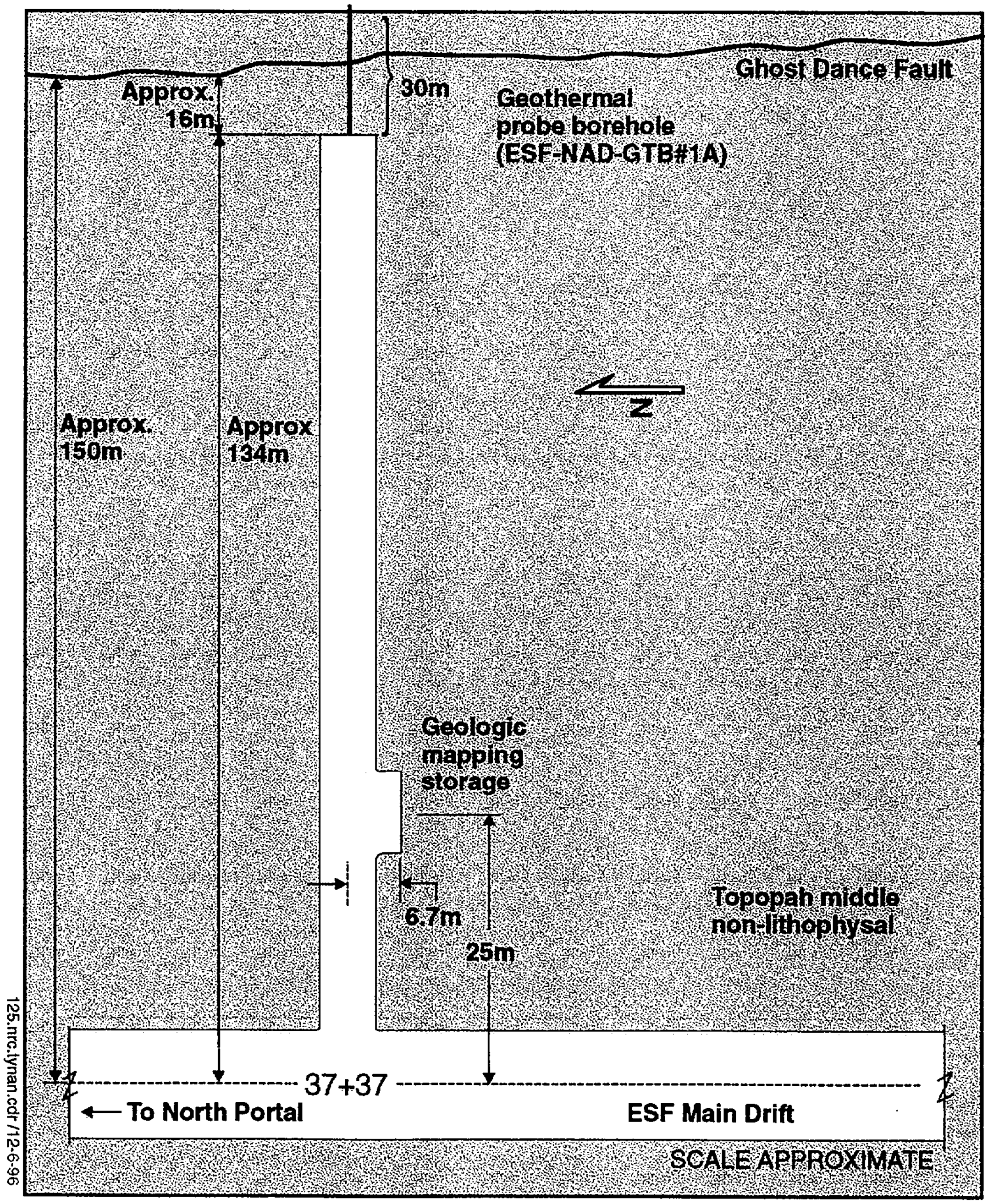
ESF Alcove 5
Thermal Test Facility



125.nrc.tynan.cdr - 12/6/96

ESF Alcove 6

Northern Ghost Dance Fault Alcove: Phase 1 as Constructed



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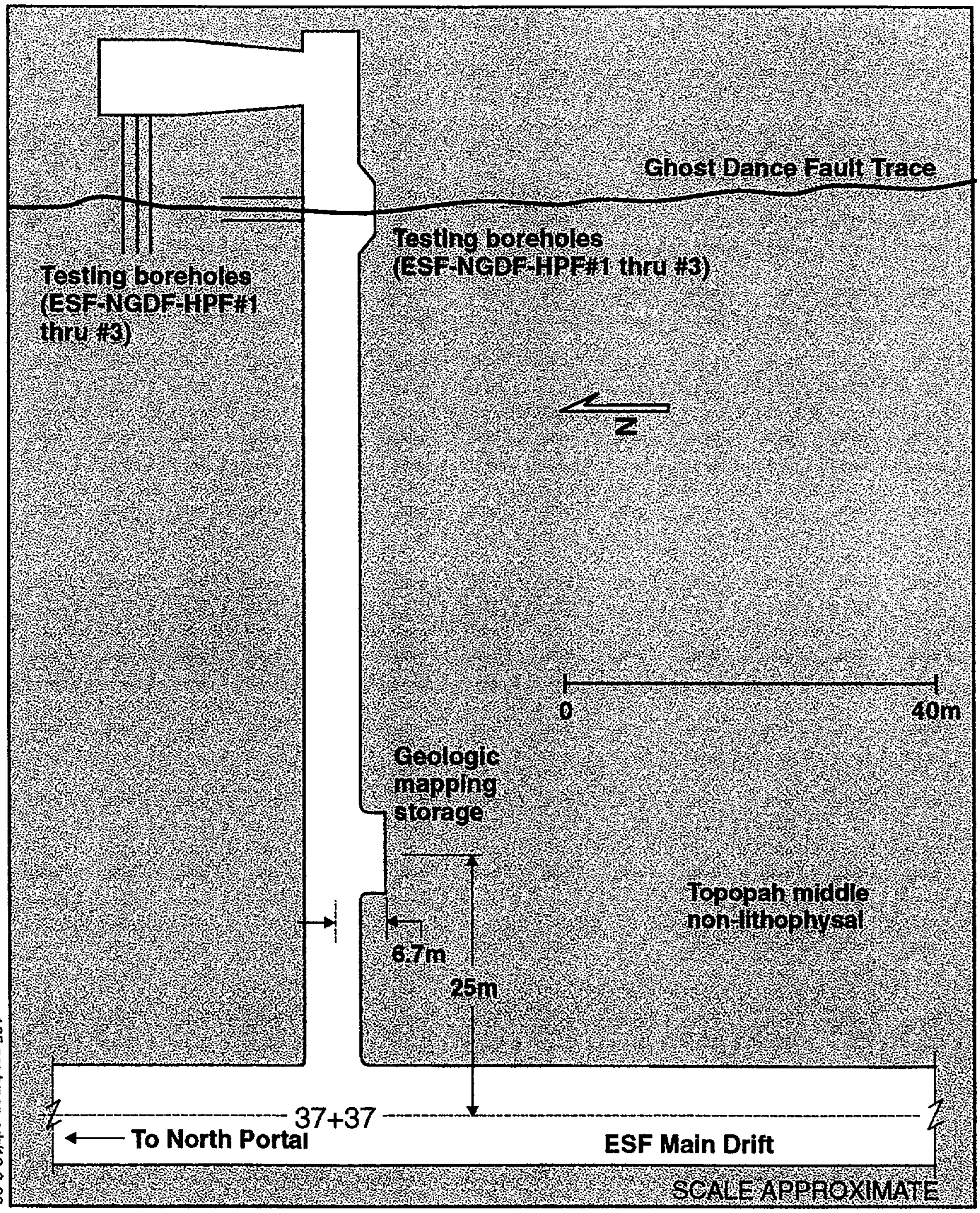
ESF Alcove 6
Northern Ghost Dance Fault Alcove: Phase II



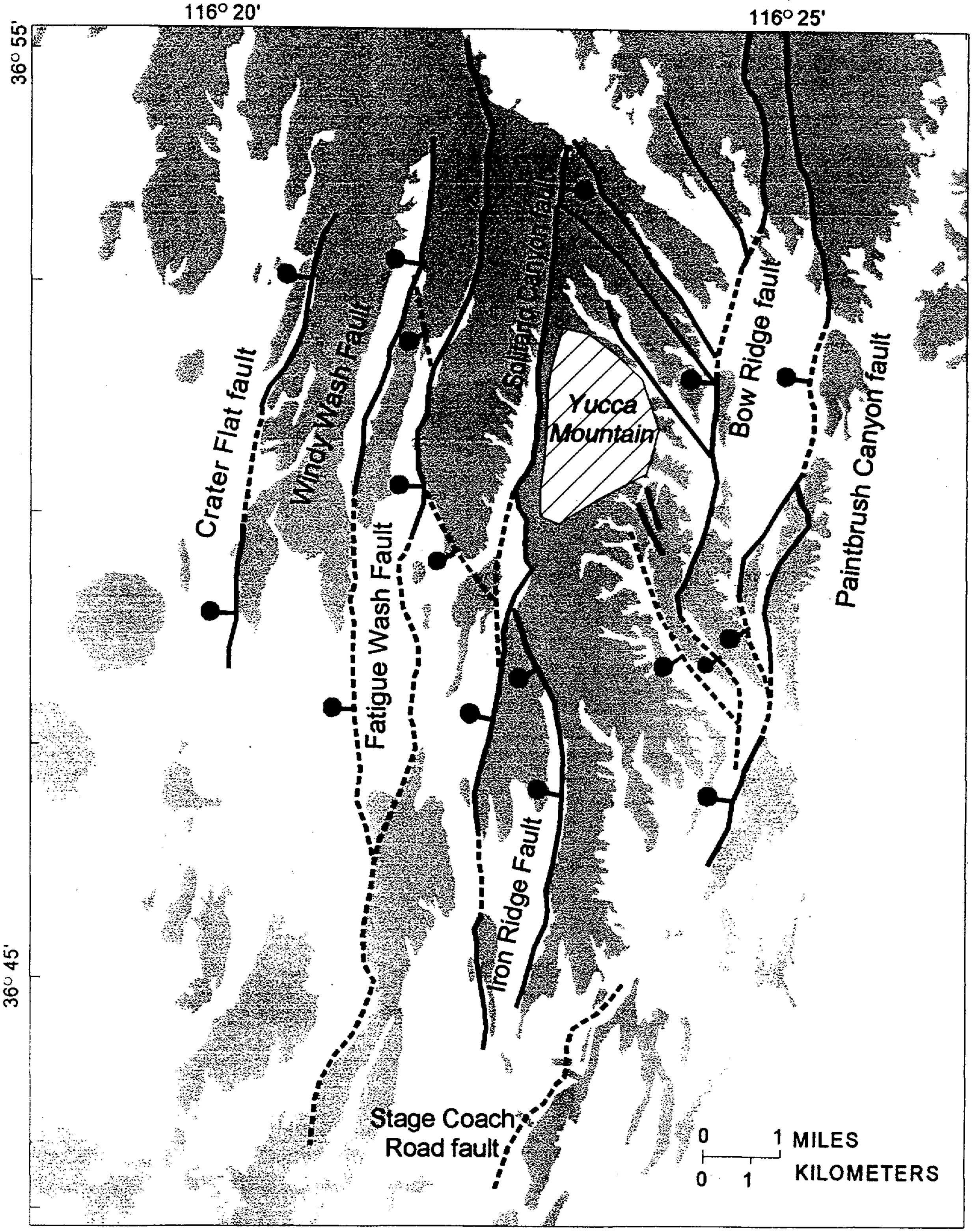
125.nrc.tynan.cdr/12-6-96

DOE / NRC Technical Meeting

December 16, 1996

Phase I

- Alcove Phase I Construction completed
- Thermal probe hole drilled (30m deep) across Ghost Dance Fault; gas pressure and temperature data acquired
- Temperature anomaly reported (see attached graphics)
- Core sampled for saturation and water potential determination
- Additional testing to follow (see schedules)
- Alcove mapping and structural assessment progressing
- **Contaminant gases introduced into borehole during drilling evacuated (SF6 gas); instrumented hole with (seamist) pressure monitoring system**



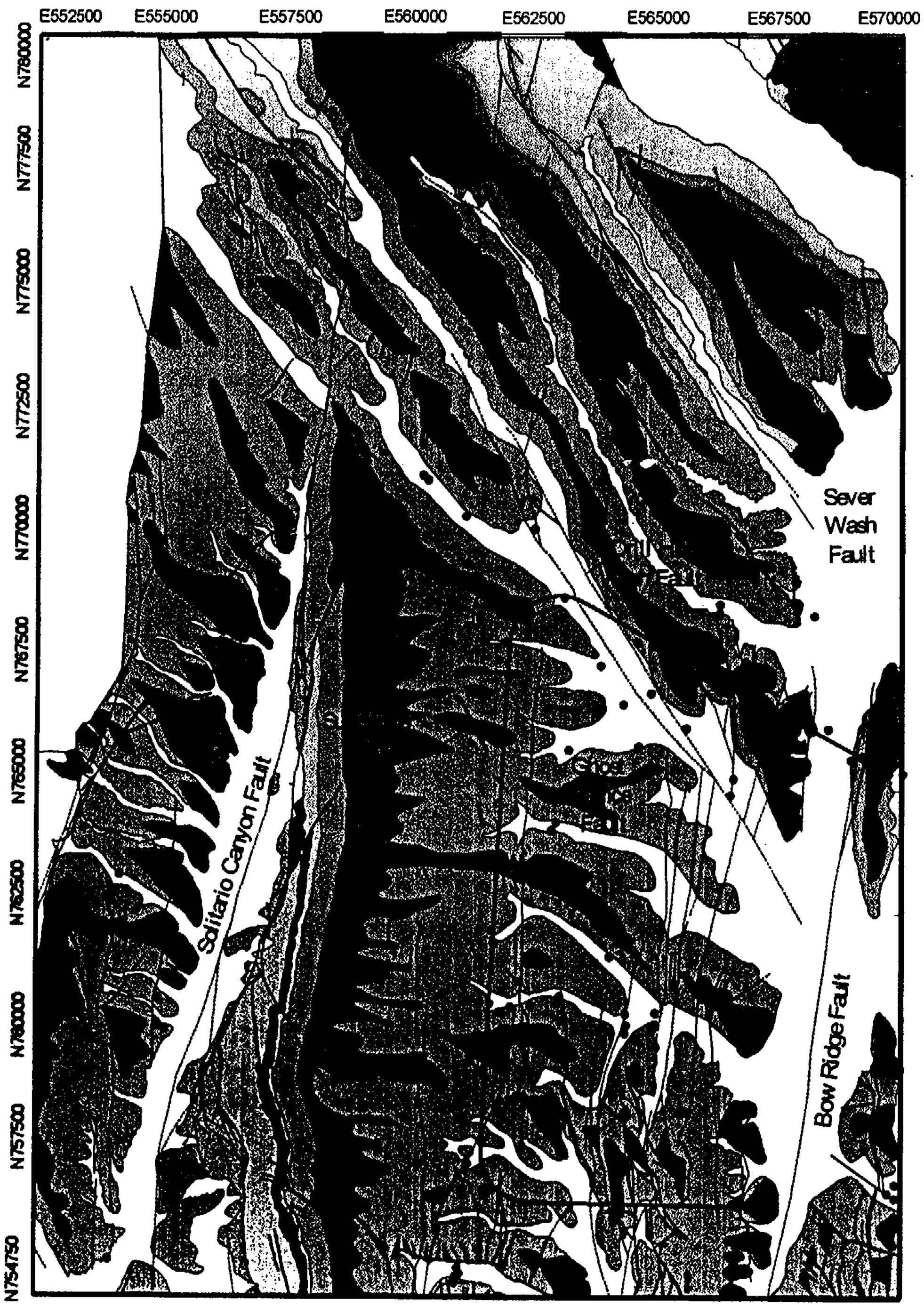
EXPLANATION

Quaternary alluvium

Miocene volcanic bedrock

Block-Bounding Fault, dashed where inferred

Bridging Fault—bleed off displacement along block-bounding faults



Bedrock Geologic Map of the Central Block Area, Yucca Mountain, Nevada

by

W.C. Day, C.J. Potter, D.S. Sweetkind, and R.P. Dickerson

Explanation

Quaternary

- Alluvium & Colluvium

Tertiary

- Rainier Mesa Tuff
- Comb Peak Rhyolite
- Tiva Canyon & Topopah Spring Tuff

Tiva Canyon Tuff

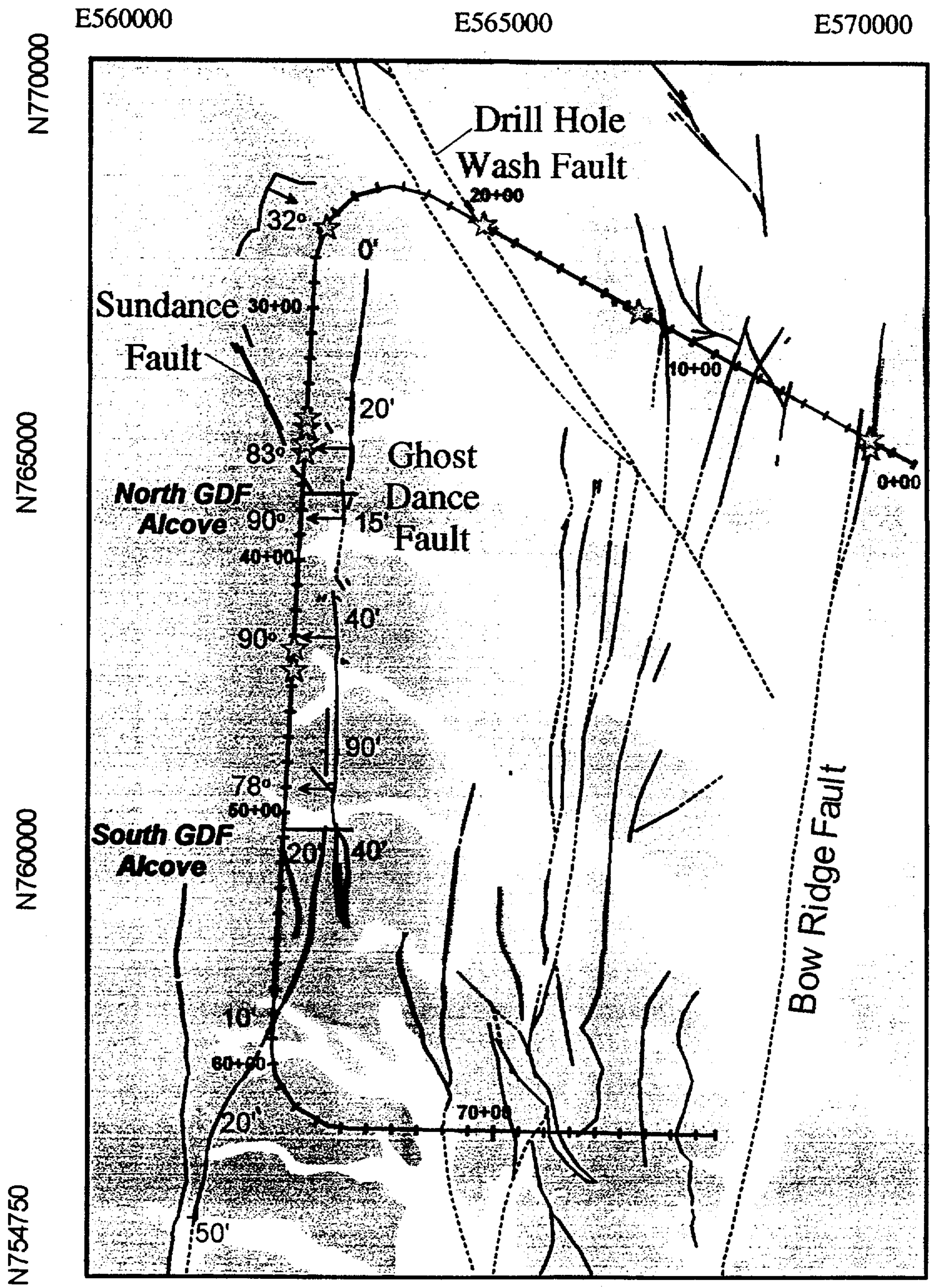
- Crystal - rich member
- Crystal - poor member

Pah Canyon, Yucca Mountain Tuffs - undivided

Topopah Spring Tuff

- Crystal - rich member
- Crystal - poor member

0 2,500 Feet



EXPLANATION

(shaded box)	Volcanic Rock	20'	Amount of Offset on Fault
———	Fault	80° ←——	Dip of Fault
		☆	Bomb Pulse ^{36}Cl Sample Location in ESF

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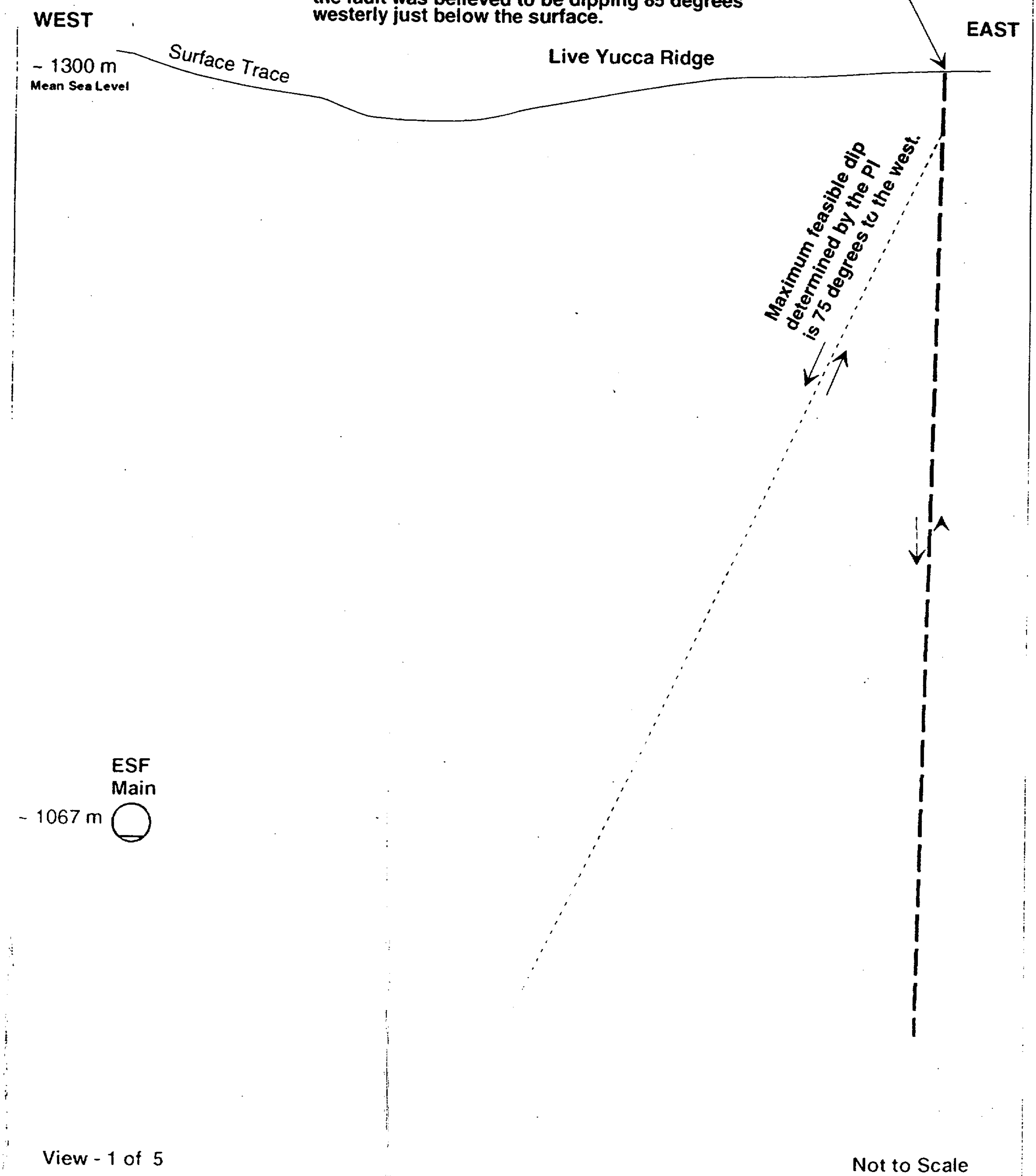
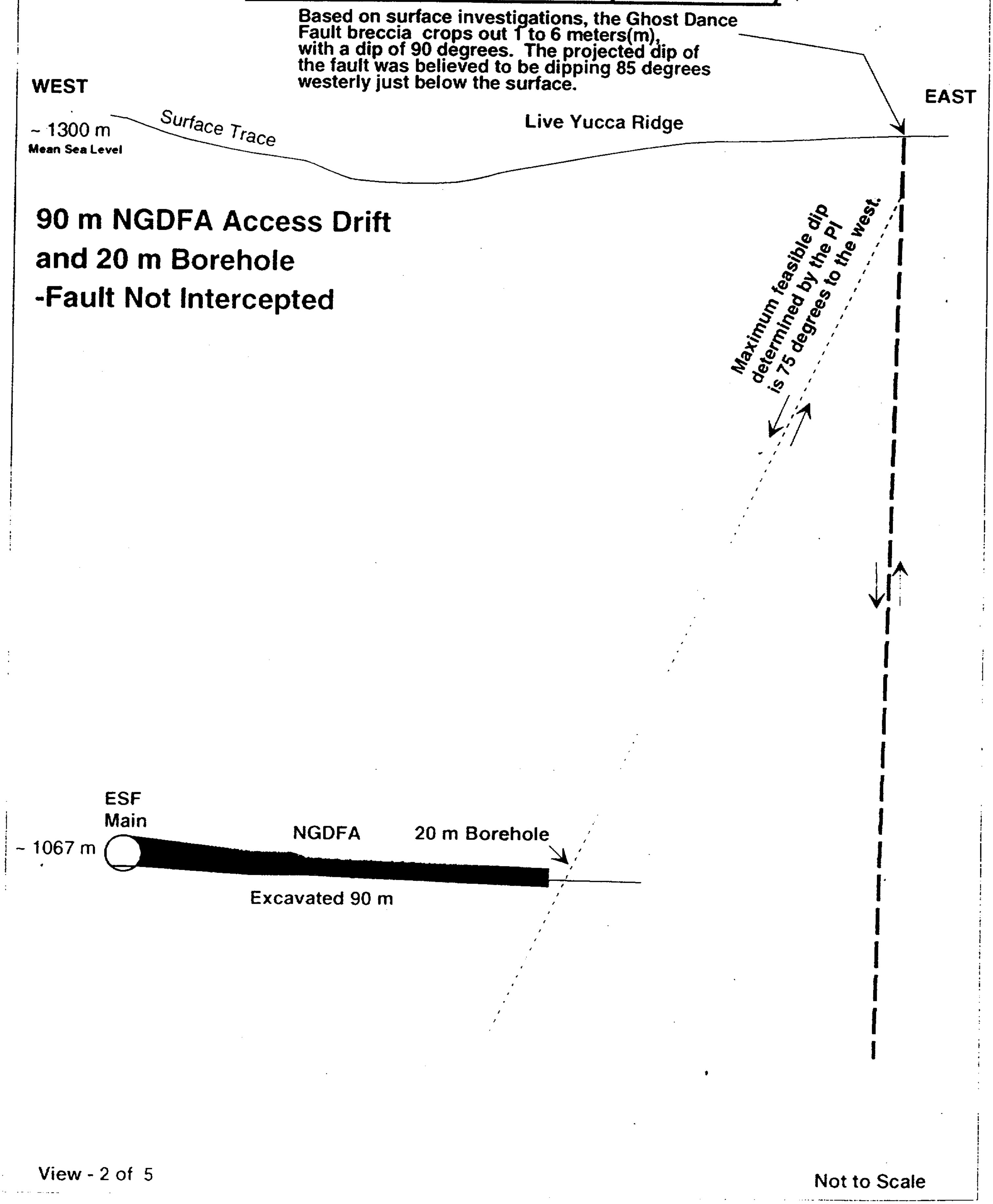
GHOST DANCE FAULT (IN NORTH)

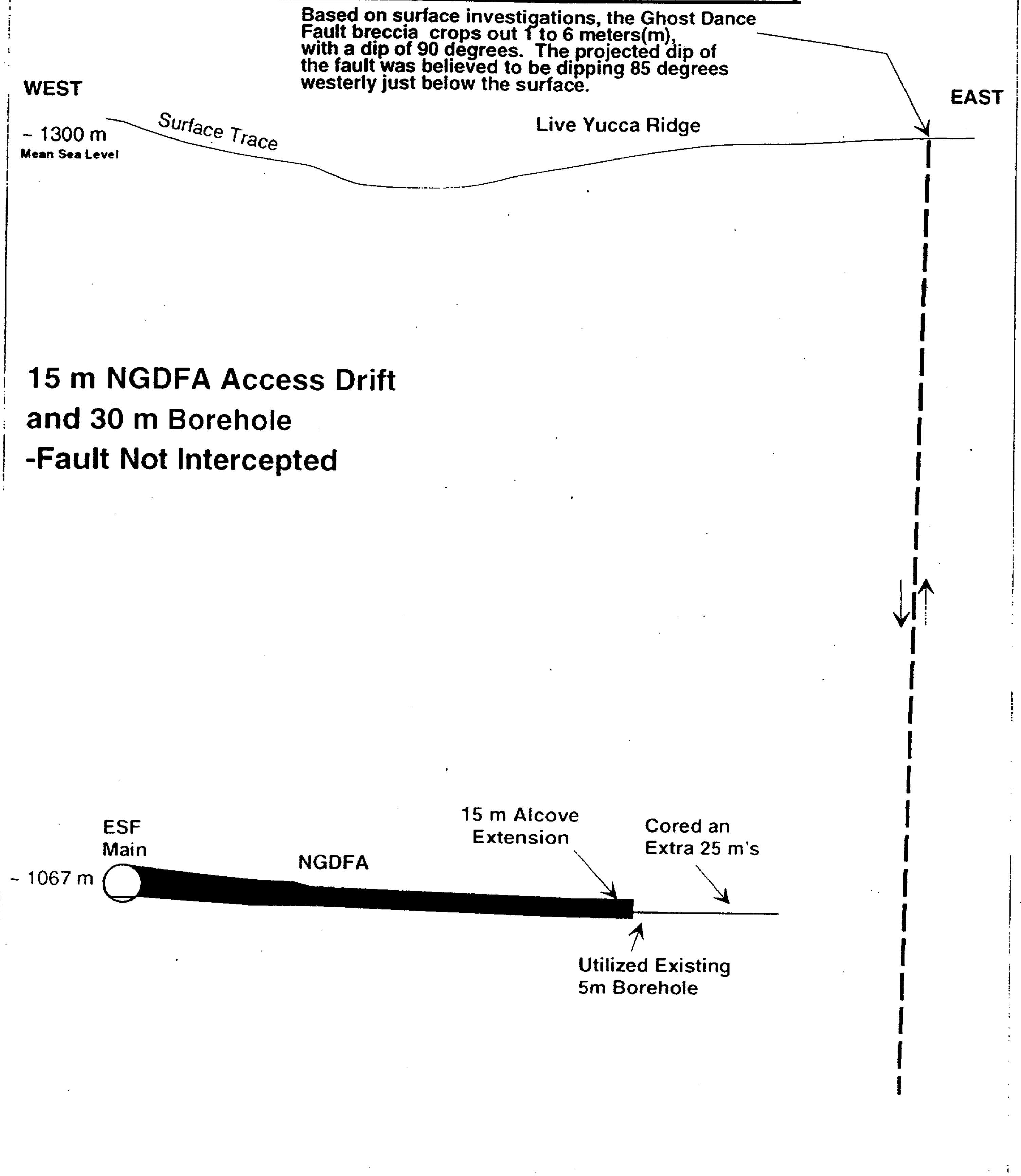
Based on surface investigations, the Ghost Dance Fault breccia crops out 1 to 6 meters(m), with a dip of 90 degrees. The projected dip of the fault was believed to be dipping 85 degrees westerly just below the surface.



GHOST DANCE FAULT (IN NORTH)



GHOST DANCE FAULT (IN NORTH)

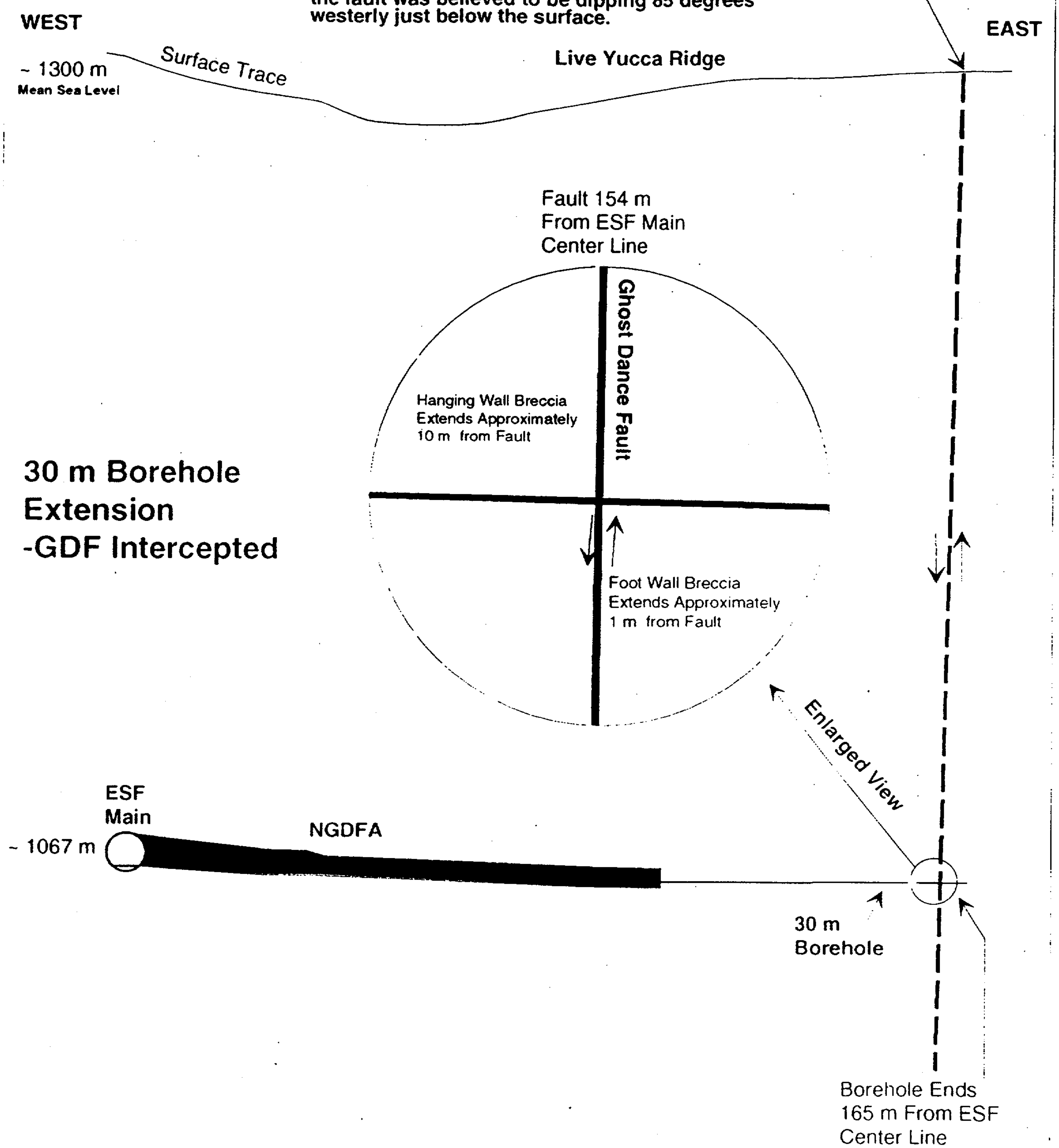


View - 3 of 5

Not to Scale

GHOST DANCE FAULT (IN NORTH)

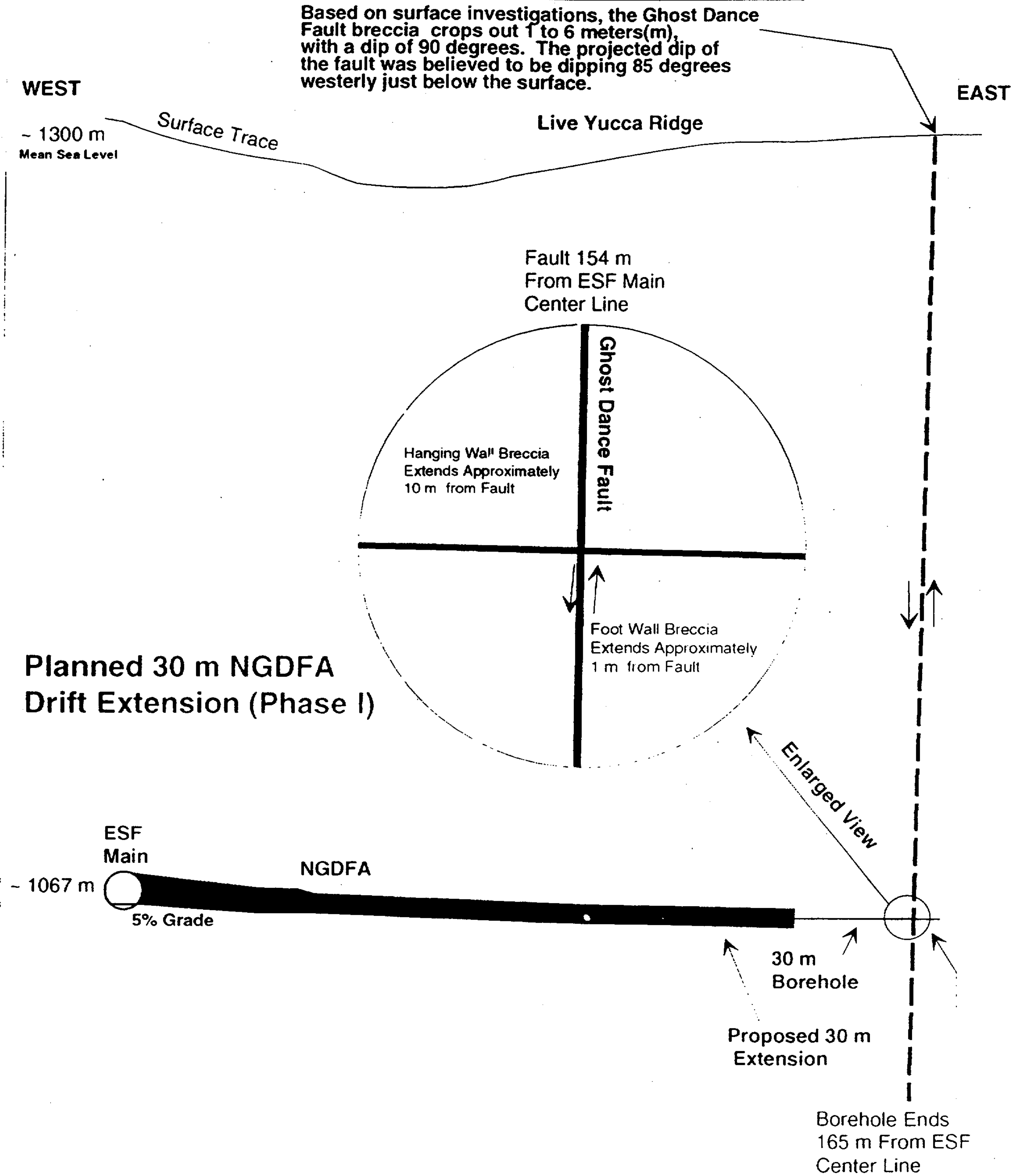
Based on surface investigations, the Ghost Dance Fault breccia crops out 1 to 6 meters(m), with a dip of 90 degrees. The projected dip of the fault was believed to be dipping 85 degrees westerly just below the surface.



View - 4 of 5

Not to Scale

GHOST DANCE FAULT (IN NORTH)



View - 5 of 5

Not to Scale

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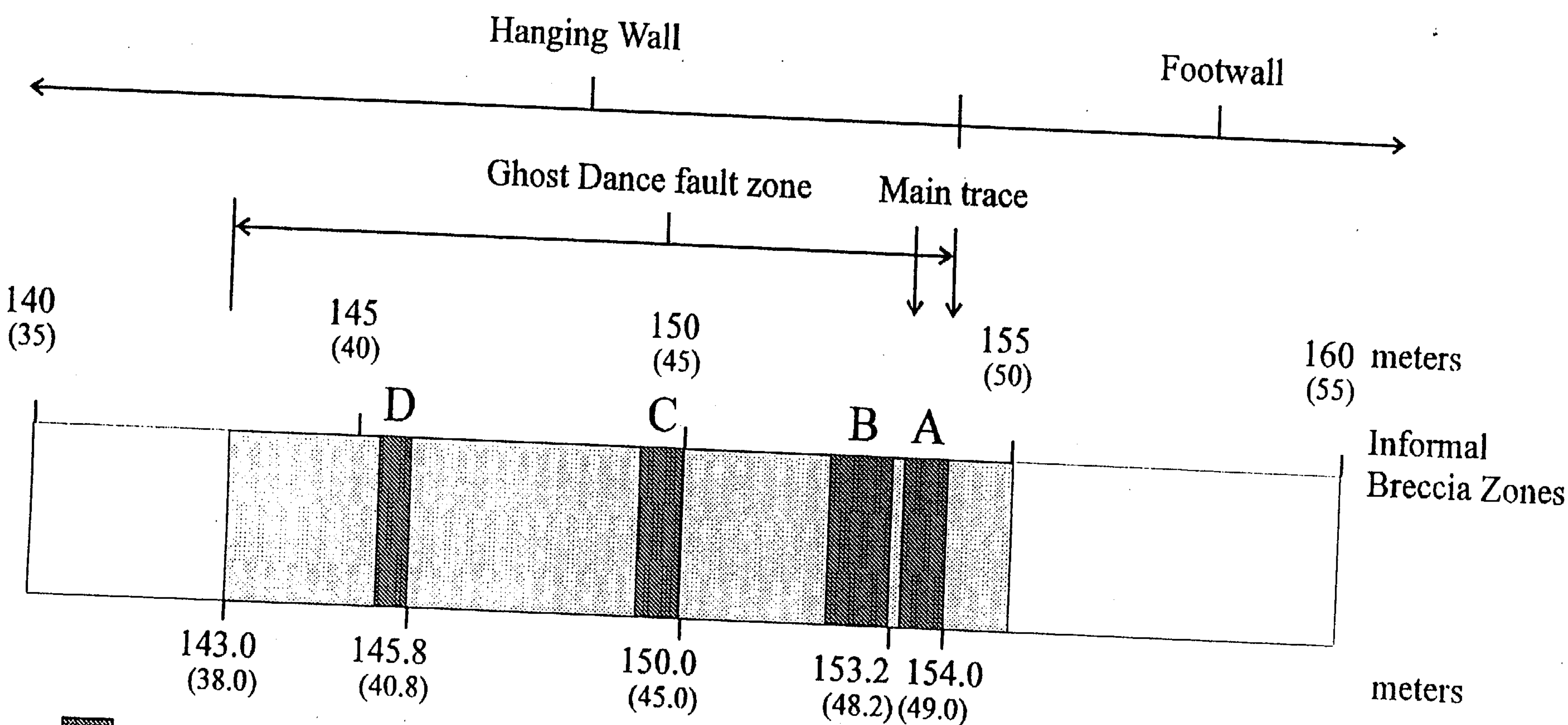
Preliminary Sketch of the Ghost Dance Fault and Related Structures in Borehole ESF-NAD-GTB#1A

Distance from Centerline of the ESF

(Downhole distance in parentheses)



Matrix supported fine-grained breccia

Clast-supported breccia. Contains white to light gray mineral cement (calcite?).

Relatively less fractured rock. Fracturing typical of rocks exposed in ESF and at the surface

United States Department of the Interior

GEOLOGICAL SURVEY / BUREAU OF RECLAMATION
Yucca Mountain Field Operations
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Mercury, Nevada 89023
(702)295-5514
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Ned Z. Elkins
ESF Test Coordinator
Los Alamos National Laboratories
Las Vegas, NV 89109

SUBJECT: Location and Description of Ghost Dance Fault in borehole ESF-NAD-GTB#1A

Borehole video camera logging (using the USBR Rees camera system) was conducted in borehole ESF-NAD-GTB#1A in Alcove #6 (the northern Ghost Dance fault alcove) on November 1, 1996. The initial logging was conducted using a downhole viewing lens. The borehole was logged from collar (station 1+05) to total depth (about station 1+64). A video tape recording with audio stationing locations (depths in meters) was made. The borehole, although fractured, was in gage with only minor wash outs and debris. The frequency of fractures intersecting the borehole increased at approximately station 1+43 (38 meters downhole from the collar). This fracture frequency continued until approximately station 1+55 (50 meters downhole from the collar). A tentative breccia zone was identified during the first logging run.

A second log was run using a side-looking lens. Intervals of interest identified during the initial logging run were viewed and recorded, using the side-looking lens. A breccia zone (approximately 15 cm wide) was identified at station 1+53.80 (48.8 meters downhole from the borehole collar), within the predicted range for the interception of the Ghost Dance Fault in the borehole. The hanging wall of the fault appears more fractured than the footwall, similar to exposures at the surface.

Preliminary inspection of the borehole video reveals that the nature of deformation and geometry of the Ghost Dance fault (GDF) is very consistent with its surface expression. Within the borehole, the fault is a variably brecciated zone approximately 11 meter wide consisting of fractured rock with clast-, matrix-, and fault gouge-supported breccias. Some fractures appear to be cemeted with a white mineral, possibly calcite. The entire borehole is within the repository horizon (middle nonlithophysal zone of the Topopah Spring Tuff), which was one of the original design criteria for Alcove 6. Preliminary correlation with the mapped trace of the fault indicates that the fault is nearly vertical.

The GDF zone intersected in the borehole contains four intense zones of brecciation, which are informally designated A, B, C, and D. All distances are measured in meters from the centerline of the ESF with downhole distances from the collar of ESF-NAD-GTB#1A, assuming the collar is at station 105 meters. Zone A is the eastern most and main trace of the GDF (zone A, fig. 1) and was intersected between approximately 153.5 meters from the center line of the ESF (48.5 meters) and 154 meter (49 meters). Within this interval, the fault is a matrix-supported breccia zone containing subangular rock fragments (<0.5 cm diameter) in a fault gouge matrix. The fragments in this interval are smaller than the rock fragments

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seen in the adjoining clast-supported breccia. Footwall deformation extends about one meter eastward as tectonic fractures, which locally contain calcite (?). Deformation in the hanging wall (west of the main trace) produced an approximately 10 meter wide interval of variably brecciated rock with calcite (?) veinlets. Additionally, there three intervals of intense brecciation were noted (zones B-D, fig. 1), which are interpreted to be fault splays within the Ghost Dance fault zone. Zone B was intersected between approximately 153.2 and 152.3 (48.2 and 47.3 meters, respectively) and is another interval of fault gauge matrix-supported breccia (zone B, fig. 1) similar to that seen in the main trace (zone A, fig. 1). The intervening interval is a clast-supported breccia with calcite (?) in the matrix. Breccia zone C is between 150 meters (45 meters downhole from the collar) and 149.3 meters (44.3 meters). Zone D lies between 145.8 (40.8 meters) and 145.3 (40.3 meters). Both zones C and D appear to be mixtures of both matrix-supported and rock flour matrix-supported breccias.

These preliminary observations are hoped to be a guide to the ensuing hydrologic investigations on the GDF. Final characterization will await its excavation at the completion of Alcove 6. This location information can be used to plan future construction and testing in Alcove 6.

Warren Day, Principal Investigator
Structural Studies Project

David Buesch, Principal Investigator
Stratigraphic Studies Project

cc:

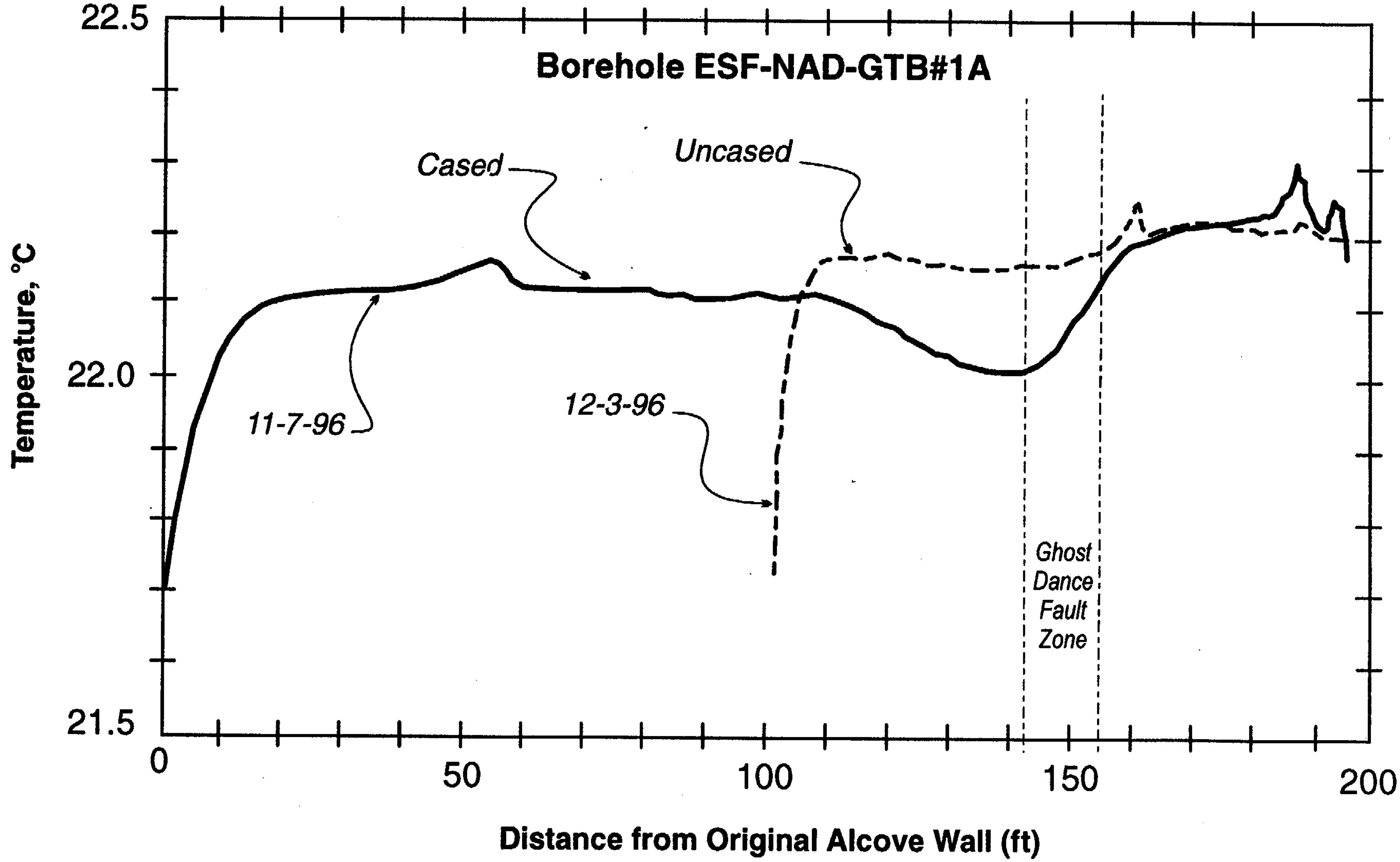
Alan Mitchell
Dick Kovach

25

Ghost Dance Temperature Profile

Preliminary Information

*Provided by John Sass,
U.S. Geological Survey*



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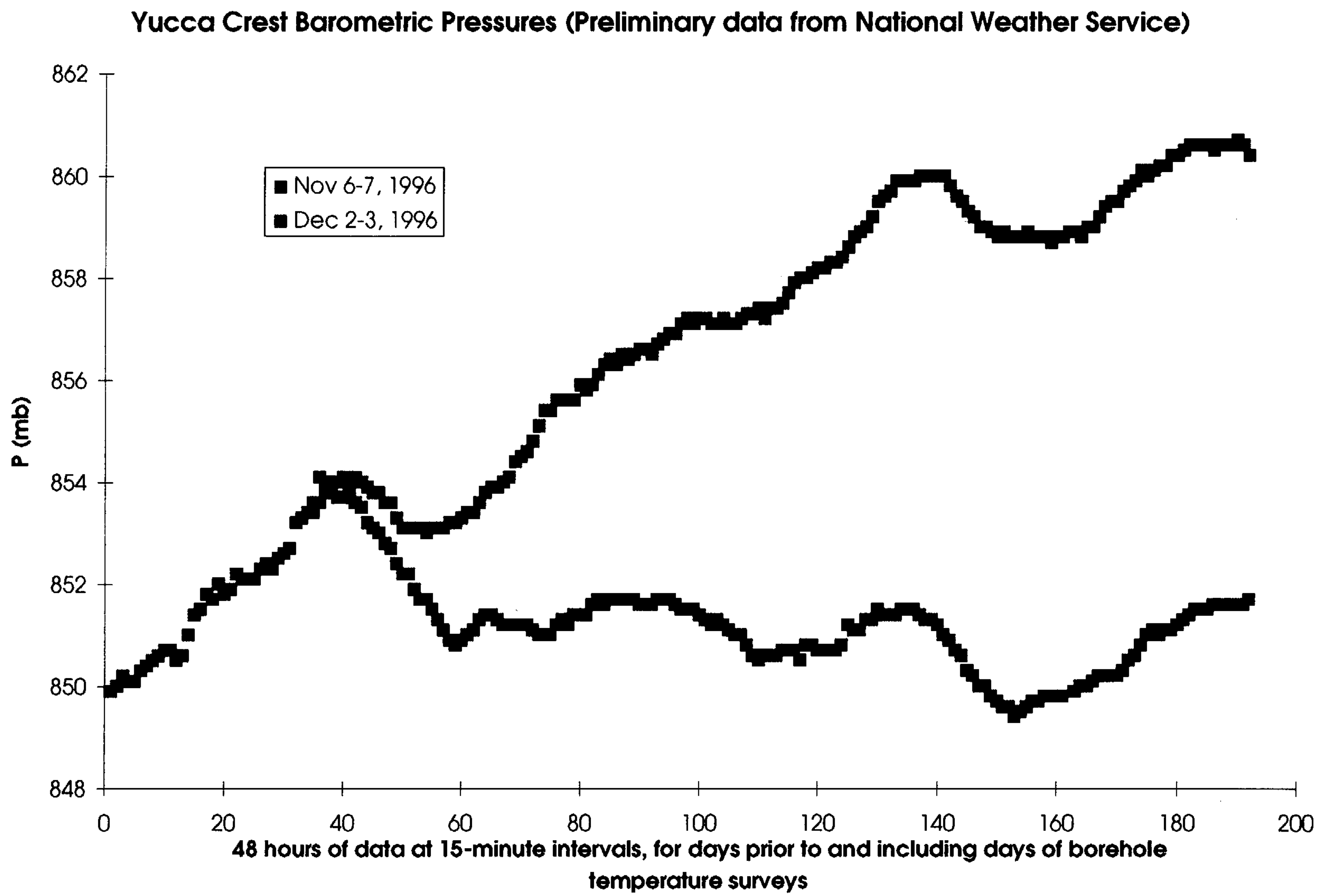
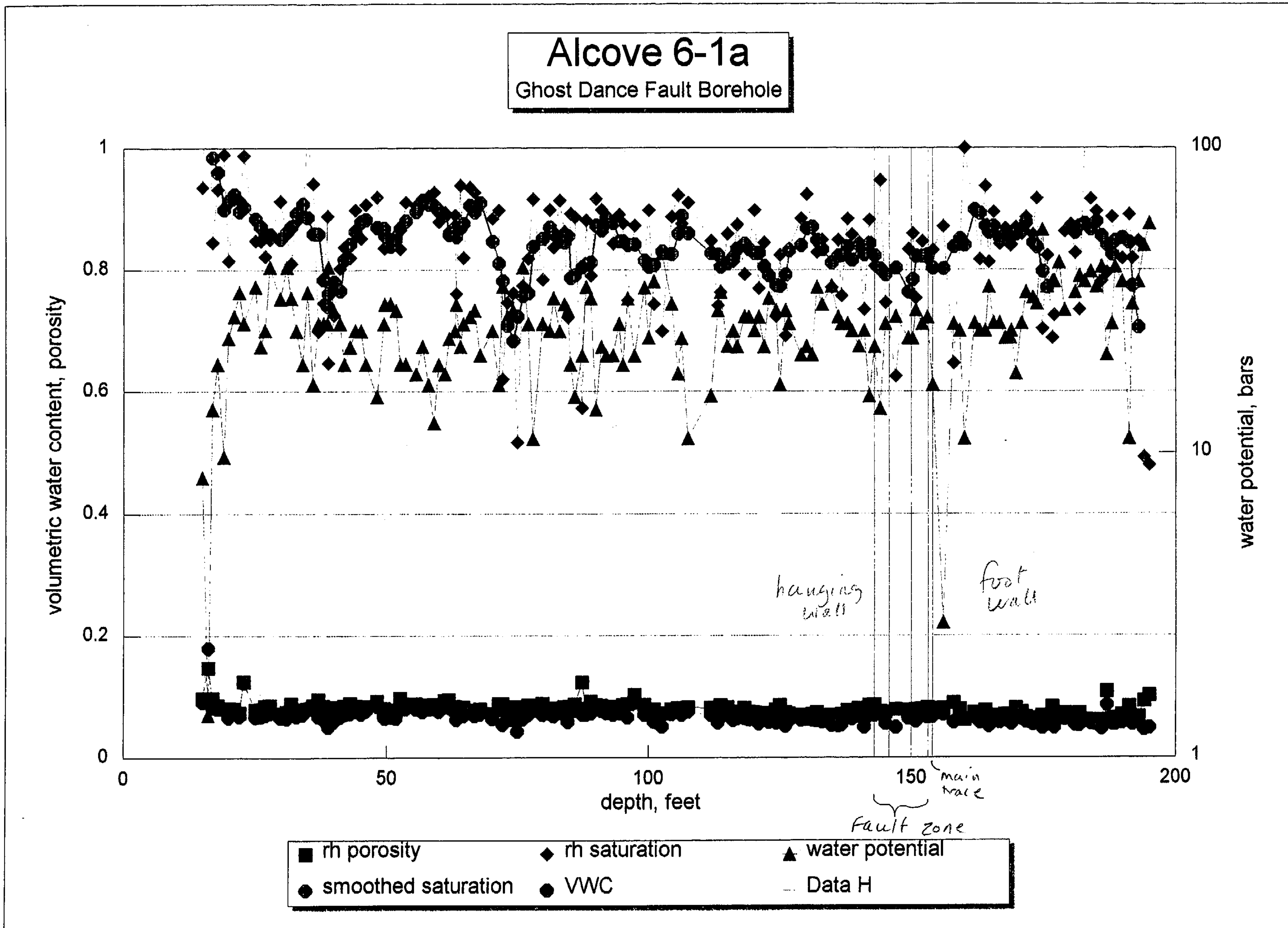
Ghost Dance Fault
Borehole ESF-NAD-GTB#1A

Possible Causes of Observed Temperature Variations

- Residual drilling effects (most likely)
  - (Adiabatic and evaporative cooling, friction heating)
- Cased vs uncased hole
- Ventilation effects near working face
- Advective or fluid (air or water) movement
- Experimental errors related to contact between sensor and borehole wall (least likely)



Yucca Crest Barometric Pressures (Preliminary data from National Weather Service)
Nov 6-7, 1996
Dec 2-3, 1996
P (mb)
862
860
858
856
854
852
850
848
0
20
40
60
80
100
120
140
160
180
200
48 hours of data at 15-minute intervals, for days prior to and including days of borehole temperature surveys

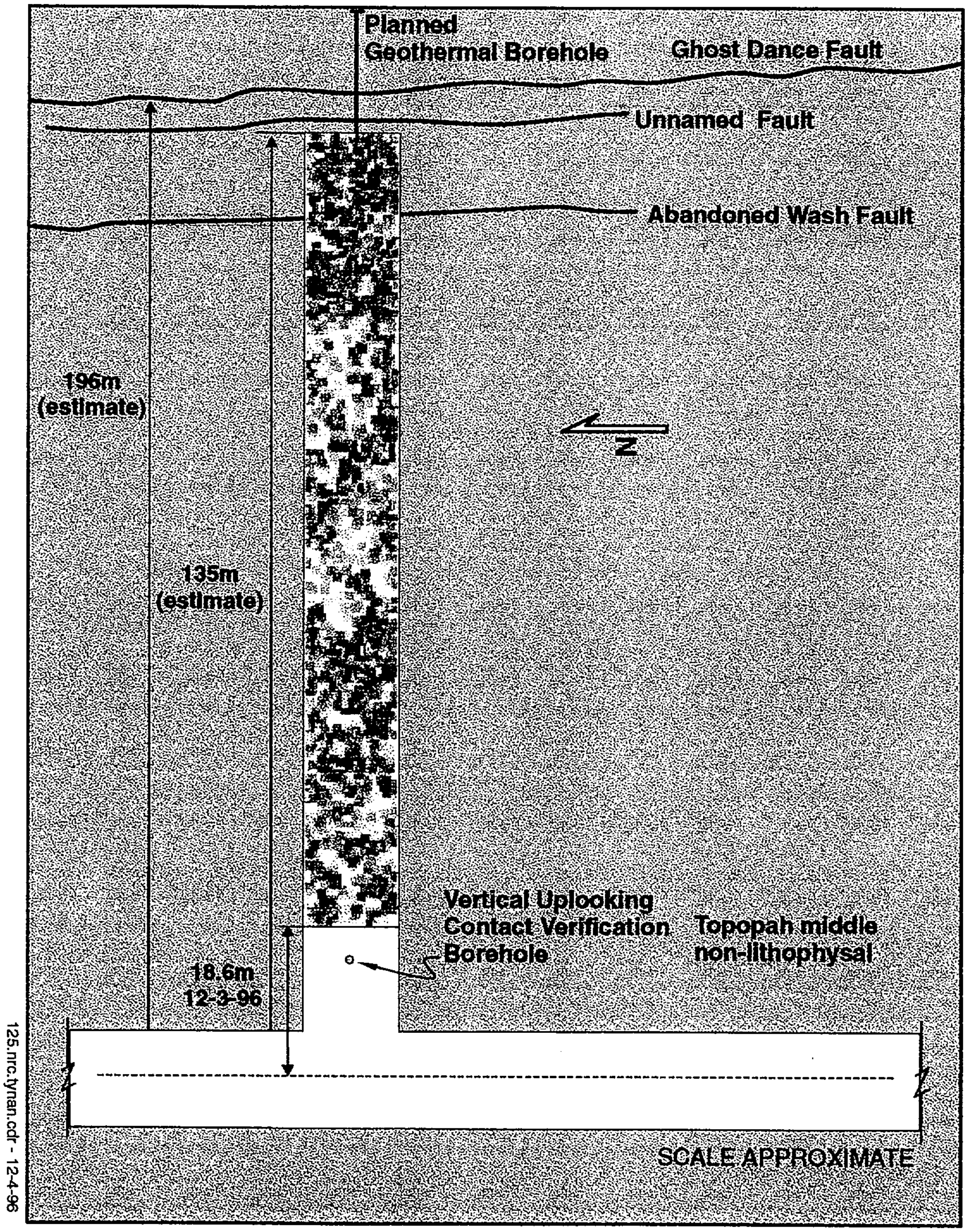

Alcove 6-1a
Ghost Dance Fault Borehole
volumetric water content, porosity
water potential, bars
depth, feet
0
0.2
0.4
0.6
0.8
1
1
10
100
0
50
100
150
200
hanging wall
foot wall
main trace
Fault zone
rh porosity
rh saturation
water potential
smoothed saturation
VWC
Data H

12/07/96

Alcove 7

Construction still underway; see attached support testing plans/schedules

ESF Alcove 7
Southern Ghost Dance Fault test alcove:



NEAR TERM ACTIVITIES TO BE CONDUCTED IN THE ESF

COMPLETE DRILL & SHOOT EXCAVATION OF THE BOTTOM BENCH IN THE TTF CONNECTING DRIFT	11/6/96
COMPLETE NICHE IN TTF ACCESS OBSERVATION DRIFT (CS 00+98)	11/6/96
CONDUCT GEOTHERMAL LOGGING OF BOREHOLE IN ALCOVE #6	11/7/96
INSTALL 3 SEQUENTIAL DRIFT MINING MPBX'S OUT OF AOD IN TTF	11/7/97 - 11/9/96
REMOVE DRILL STEEL FROM ESF-NAD-GTB#1A	11/8/96
EVACUATE BOREHOLES ESF-NAD-GTB#1A	11/8/96
EXCAVATE WITH ALPINE MINER IN ALCOVE #7	11/6/96 - 11/9/96 (THROUGH SATURDAY))
INSTALL DETACHABLE PACKER (S) IN BOREHOLE ESF-NAD-GTB#1A	11/12/96
INSTALL SNL BLAST MONITORING INSTRUMENTATION IN CONNECTING DRIFT (BULKHEAD LOCATION)	11/6/96 - 11/7/96
CONDUCT DRILL & SHOOT APPROX. 11 METERS FROM CON DRIFT TO HEATED DRIFT (BULKHEAD LOCATION)	11/8/96 - 11/15/96
INSTALL & CONDUCT LBNL AMBIENT CHARACTERIZATION TESTING IN AOD	11/12/96 - 11/27/96
DRILL VERTICAL UP-LOOKING CONTACT VERIFICATION BOREHOLE (30 M) IN ALCOVE #7	11/12/96 - 11/22/96
INSTALL SNL BLAST MONITORING INSTRUMENTATION IN ALCOVE #7	11/12/96 - 11/15/96
EXCAVATE WITH ALPINE MINER 30 METERS IN ALCOVE #6 (BEGIN ON SWING SHIFT)	11/27/96 - 11/27/96
DRILL 2 HORIZONTAL BOREHOLES (46 AND 59 METERS) IN TTF CONNECTING DRIFT	11/13/96 - 12/16/96
START DRILL & SHOOT OPERATIONS TO CS 01+25 IN ALCOVE #7	11/25/96
CONDUCT WIRELINE INSTRUMENTATION IN BOREHOLE ESF-NAD-GTB#1A	11/26/96
START USGS TESTING IN BOREHOLE ESF-NAD-GTB#1A	11/26/96
START ALPINE MINER OPERATIONS IN TTF HEATED DRIFT	12/2/96

KEY:
THERMAL TESTING FACILITY
NORTHERN GHOST DANCE FAULT ALCOVE
SOUTHERN GHOST DANCE FAULT ALCOVE

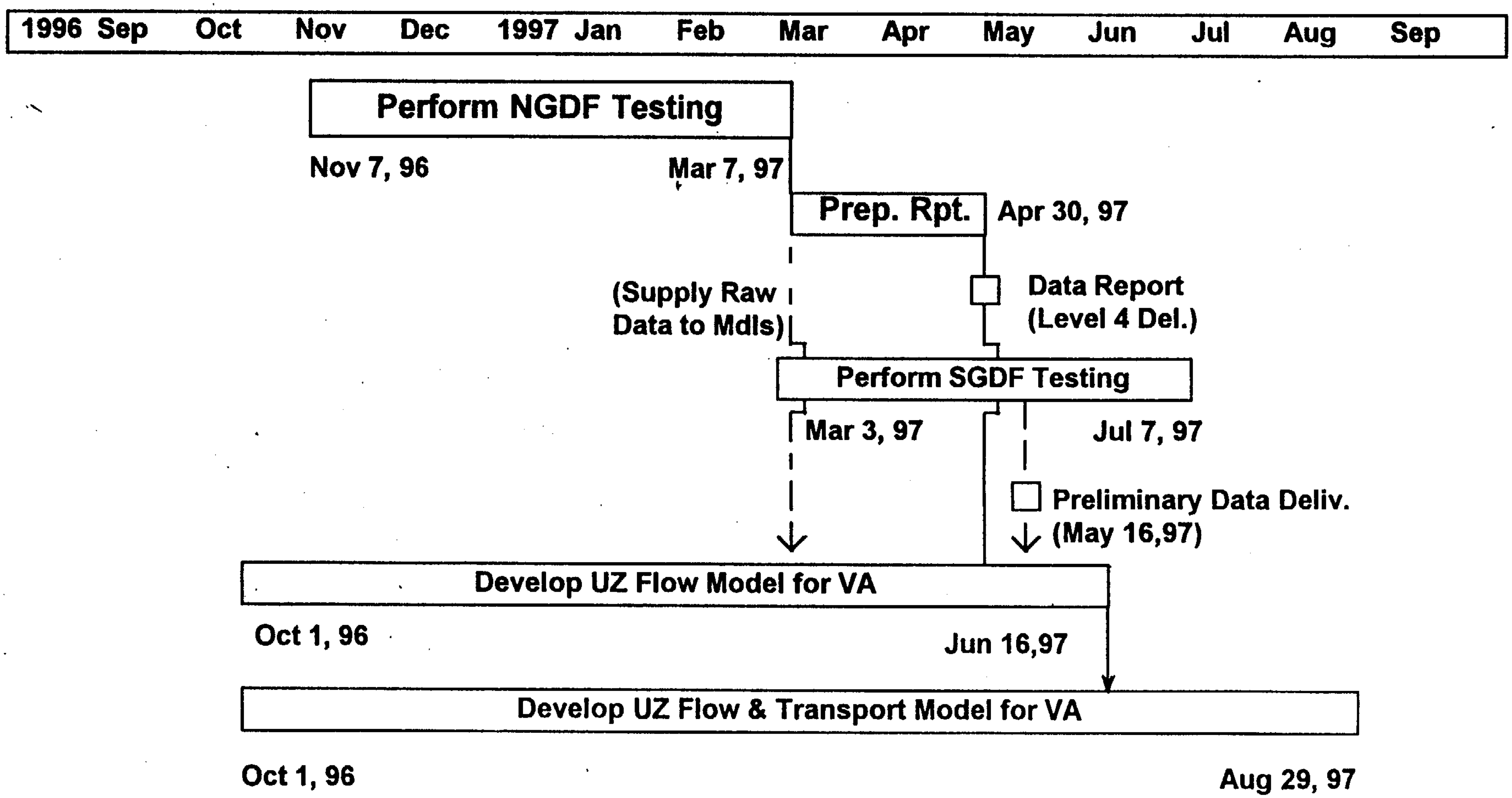
November 6, 1996

Northern Ghost Dance Fault Testing Schedule **(Single Borehole)**

Description	Estimated Duration	Current Estimated Date of Completion
Complete Drilling on ESF-NAD-GTB#1A, 60 meter borehole	N/A	Completed 10-31-96
Conduct Preliminary Borehole Video to Determine Fault Location	1 day	Completed 11-01-96
Conduct Geothermal Logging	1-2 days	11-07-96
Insert Detachable Pneumatic Packers	3 days	11-12-96
Excavate Drift (1.3m/shift)	2 weeks	11-26-96
Conduct Video and Wireline Instrumentation	1 day	11-27-96
Insert Seamist Packer	1 day	12-02-96
Barometric Monitoring W/Seamist	3 weeks	01-03-97 w/holidays
Collect Gas Samples W/Seamist	2 weeks	01-17-97
Remove Seamist	2 days	01-21-97
Set-Up for Air Permeability Tests	4 days	01-24-97
Conduct Air Permeability Tests*	6 weeks	03-07-97
Begin Excavation (Phase II - Alcove)	N/A	

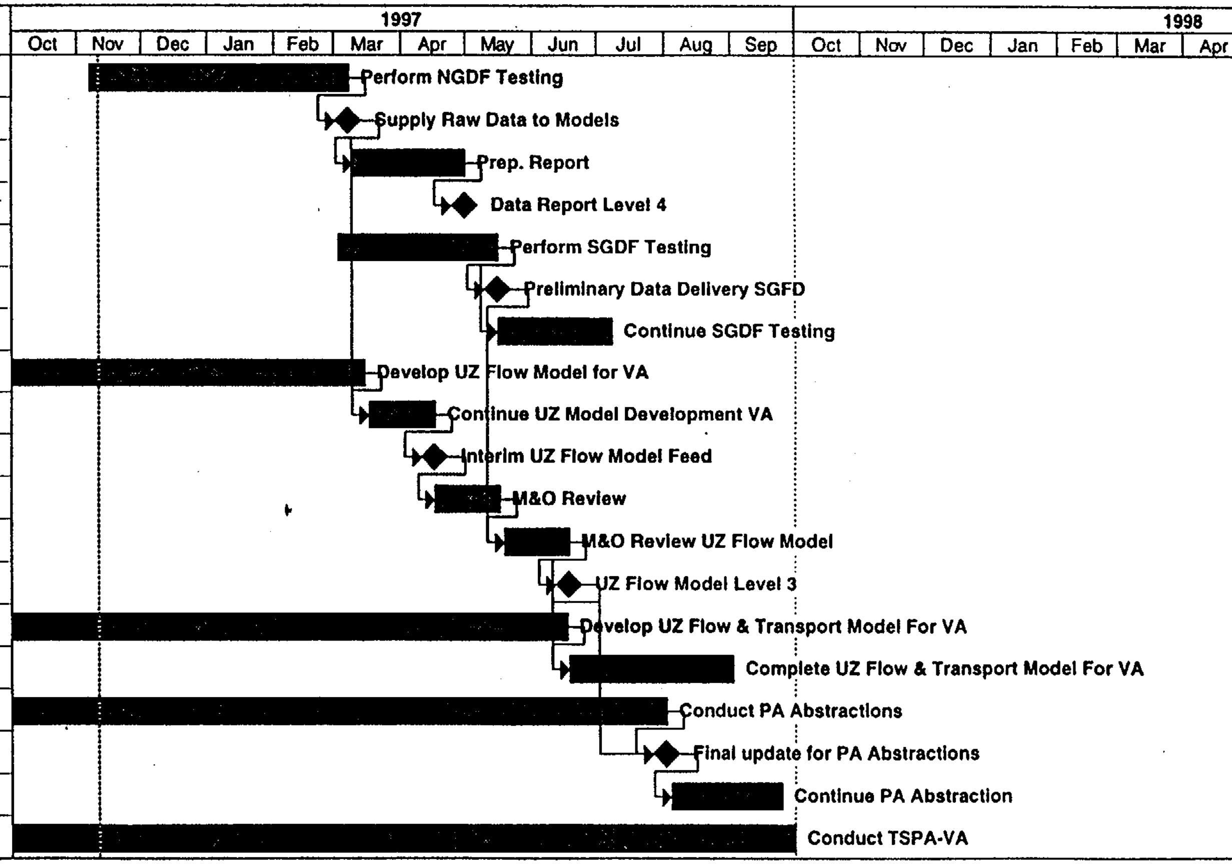
* Dependent upon climatic conditions (fronts). If adequate frontal activity occurs in less than 6 weeks, this activity can be shortened (up to 3 weeks)

Ghost Dance Fault Testing
(Present Plan)



Ghost Dance Fault Testing
(Present Plan)

Activity Description	Start	Finish
Perform NGDF Testing	11/7/96	3/7/97
Supply Raw Data to Models	3/7/97	3/7/97
Prep. Report	3/10/97	4/30/97
Data Report Level 4	4/30/97	4/30/97
Perform SGDF Testing	3/3/97	5/15/97
Preliminary Data Delivery SGFD	5/16/97	5/16/97
Continue SGDF Testing	5/16/97	7/7/97
Develop UZ Flow Model for VA	10/1/96	3/14/97
Continue UZ Model Development VA	3/17/97	4/16/97
Interim UZ Flow Model Feed	4/16/97	4/16/97
M&O Review	4/17/97	5/16/97
M&O Review UZ Flow Model	5/19/97	6/17/97
UZ Flow Model Level 3	6/17/97	6/17/97
Develop UZ Flow & Transport Model For VA	10/1/96	6/16/97
Complete UZ Flow & Transport Model For VA	6/18/97	9/1/97
Conduct PA Abstractions	10/1/96	8/1/97
Final update for PA Abstractions	8/1/97	8/1/97
Continue PA Abstraction	8/4/97	9/24/97
Conduct TSPA-VA	10/1/96	9/30/97



Project:
Date: 11/11/96

Task — Milestone — Baseline Activity
Critical Activity — Critical Milestone — Baseline Milestone
Progress — Completed Milestone

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DOE / NRC Technical Meeting

December 16, 1996

Wet Areas Reported in ESF South Ramp:

Specific wet spot noted at station 67+20 (PTn/Tiva contact area)

Wet areas are present from staion 66+40 to 67+19 (in PTn)

Fault at 70+55 showing some damp areas

Measurements made on zones indicate void space is not 100% saturated

Testing is underway to characterize the zone, including sampling for water content/saturation, water chemistry (and in the near future, possible sampling for isotopic characterization would seem prudent)

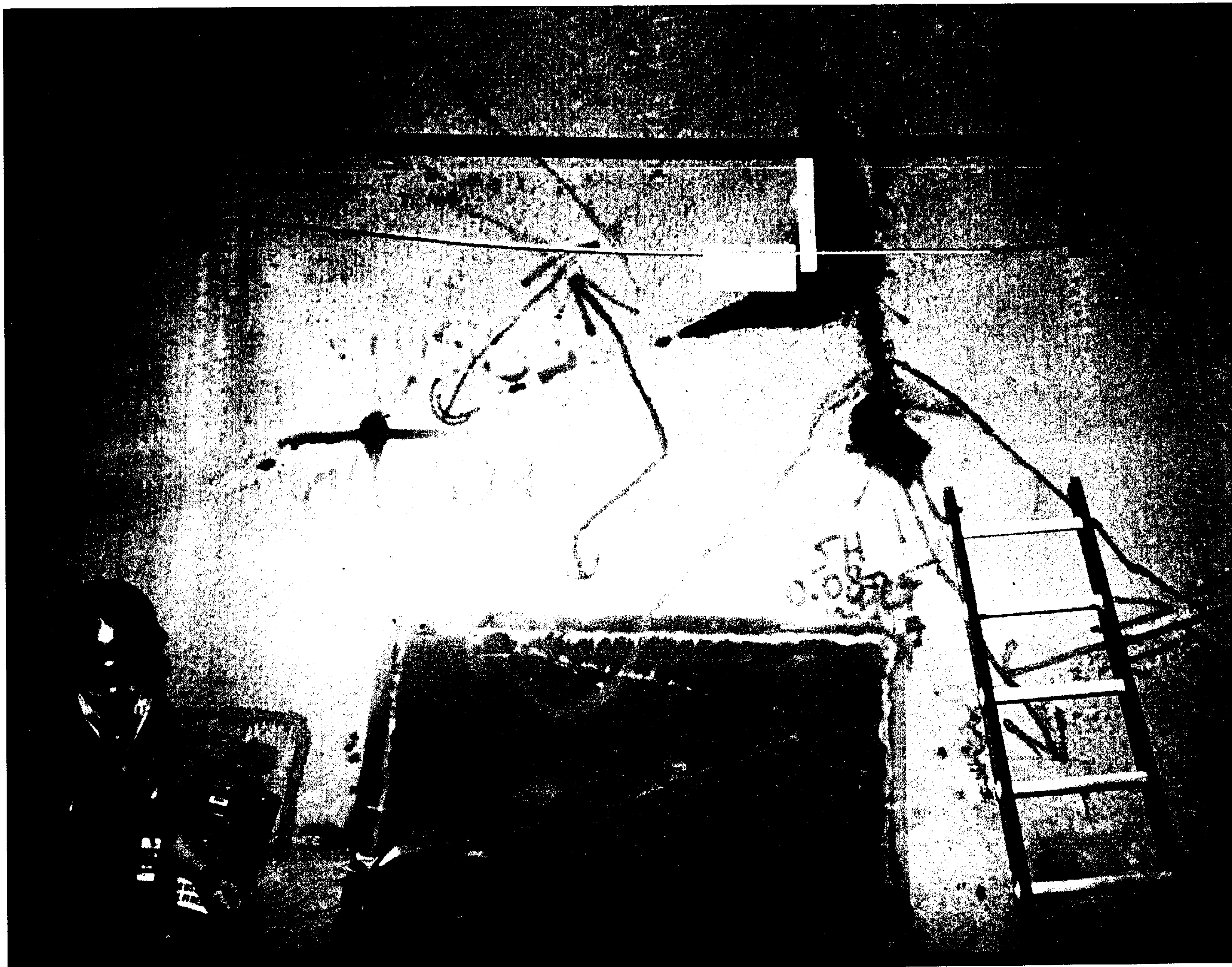
DOE / NRC Technical Meeting

December 16

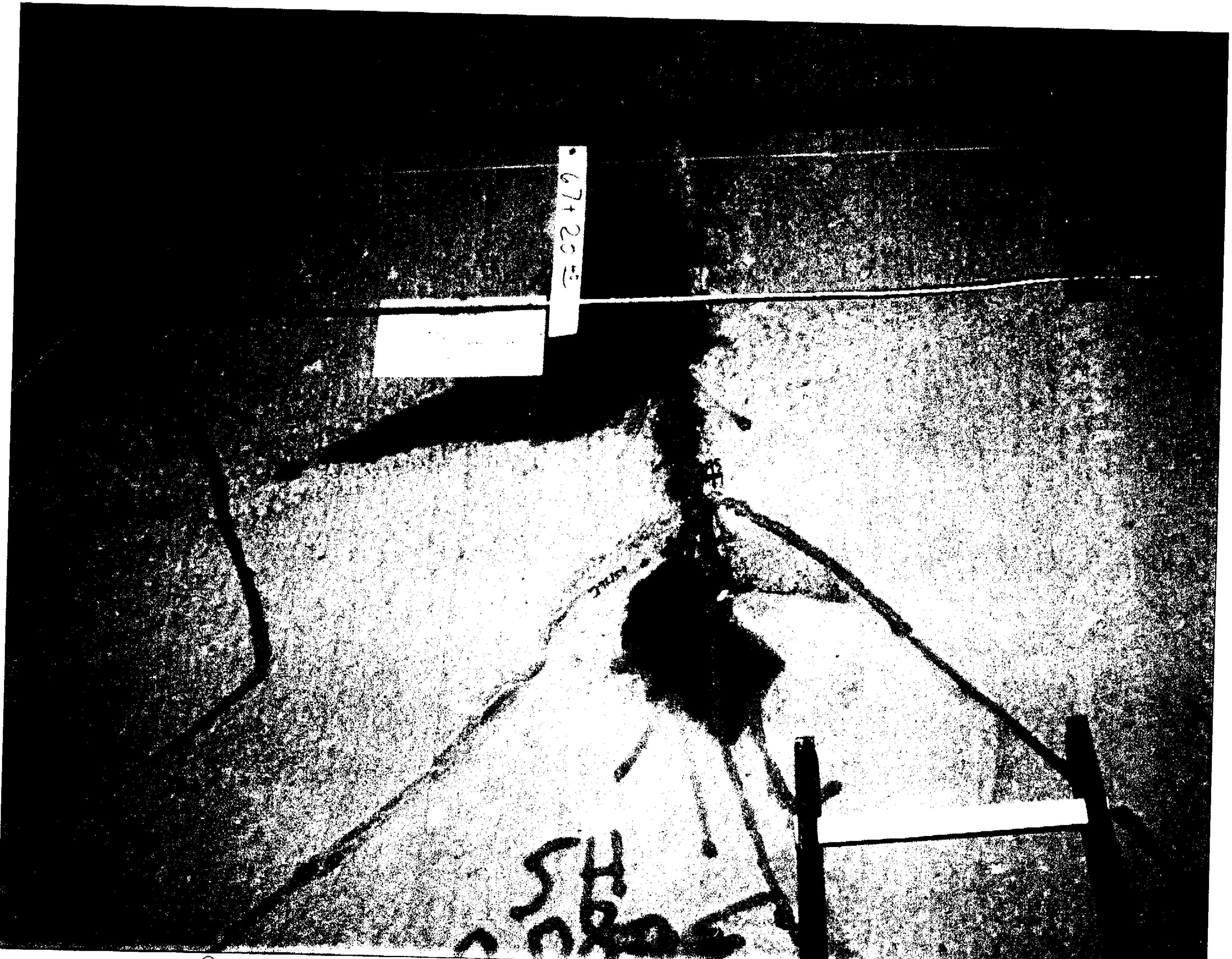
Wet Areas Reported in ESF South Ramp:

Testing program in progress

- Wall rock to be sampled at various locations for saturation and water potential measurements
- Plastic sheeting installed over moist areas to prevent drying out wall rock and to preserve moisture for further testing



- Ramp Wet Spot, 67+20



...t spot South Ramp station 67+20

South Ramp Fault, Wet spots, plastic cover to retain moisture

DOE / NRC Technical Meeting

December 16, 1996

Wet Areas Reported in ESF South Ramp:

Question = Is this is a reportable geologic condition

Myth + Reality

Response = Given the presence of Chlorine 36 within potential repository sequence, and project acceptance of corollary hypothesis that fast pathways likely exist, the reportable geologic condition should be that there are not **more** wet spots noticed in the ESF.

DOE / NRC Technical Meeting

December 16, 1996

Wet Areas Reported in ESF South Ramp:

Reportable geologic conditions for ESF construction should be defined so as to include the encountering a "non-normal" or "out-of-the-ordinary" geologic condition that would suggst that program viability or human safety/health are at risk

Examples of these would include (but not limited to) encountering some geologic condition

- **that suggests the presence of some unanticipated geologic feature**
- **that suggests the site is not suitable for construction of a repository, i.e., that a (10CFR Part 60) disqualifying condition exists, or may exist - a "show-stopper" has been encountered (eg., encountering semi-infinite body of perched water, absence of Ghost Dance in Alcove 7)**
- **that threatens the health and safety of construction workers**

3.1 *Condition* - Any as-found state, whether or not resulting from an event, which may have had adverse safety, health, quality assurance, security, operational, or environmental implications. A condition is more programmatic in nature than an event; for example, an error in analysis or calculation, an anomaly associated with design or performance, and an item indicating a weakness in the management process are all conditions.

3 *Emergency* - An emergency is the most serious occurrence and requires an increased alert status for on-site personnel and, in specific cases, for off-site authorities. The types of occurrences that are to be categorized as emergencies are defined in DOE Order 5000.3B.

3.4 *Event* - A real-time occurrence (e.g., pipe break, valve failure, loss of power, environmental spills, etc.).

3.7 *Nevada Occurrence Reporting System Operations Center* (NORSOC) - The manned operations center to which all DOE/Nevada Operations Office (NV) occurrences are initially reported.

3.8 *Notification Report* - The initial documented report, to the DOE, of an event or condition that meets the reporting criteria defined in this procedure. The Notification Report shall consist of fields 1 through 18 of the Occurrence Report completed according to instructions outlined in Attachment II of DOE Order 5000.3B.

3.9 *Occurrence Report* - A documented evaluation of an event or condition that is prepared in sufficient detail to enable the reader to assess its significance, consequences, or implications and to evaluate the actions being proposed or employed to correct the condition or to avoid recurrence.

3.10 *Off-Normal Occurrence* - An off-normal occurrence is an abnormal or unplanned event or condition that adversely affects, potentially affects, or is indicative of degradation in the safety, security, environmental, or health protection performance or operation of a facility. The types of occurrence that are to be categorized as off-normal occurrences are defined in DOE Order 5000.3B.

3.11 *Reportable Occurrence* - Events or conditions to be reported in accordance with the criteria defined in DOE Order 5000.3B, except as follows:

- if local or state governmental thresholds are lower, the lower threshold shall control;
- if the incident involves a member of the public, it shall be reported as an occurrence regardless of thresholds; and
- if the incident involves an actual or potentially significant impact on the environment, it shall be reported as an occurrence regardless of thresholds.

3.12 *Unusual Occurrence* - An unusual occurrence is a non-emergency occurrence that has significant impact or potential for impact on safety, environment, health, security, or operations. The types of occurrence that are to be categorized as unusual occurrences are defined in DOE Order 5000.3B.

PURPOSE

This procedure provides guidelines for a systematic and documentable process to determine the significance and reportability of a geologic condition and to document notification to the U.S. Nuclear Regulatory Commission (NRC) On-site Representatives (ORs) and other procedural agreement agencies.

3.2 *Delay of Work* - A temporary work stoppage during which a potentially reportable geologic condition may be investigated and evaluated for significance. The length of this work stoppage is dependent on the time required to determine the significance of the geologic condition and, if determined to be significant, the time required to determine the appropriate course of action. A delay of work may occur upon recognition of a potentially reportable geologic condition, during the FTC's evaluation, or during review of the evaluation. The need for a delay of work should be determined on a case-by-case basis and may result from operating necessity, be ordered by the FTC, or be ordered by the Assistant Manager for Scientific Programs (AMSP) or the Assistant Manager for Engineering and Field Operations (AMEFO).

3.3 *Reportable Geologic Condition* - The term "geologic condition" refers to fields in geology such as hydrology, geochemistry, tectonics, and rock mechanics. A "reportable geologic condition" is one determined to be technically significant as defined in Subsection 3.4 a). A reportable geologic condition shall be reported to the NRC ORs and other procedural agreement agencies.

3.4 *Significant Condition* -

a) **Technically Significant Condition** - A specific condition inconsistent with current conceptual models for the site in that it is so different from a predicted or expected range of values or events that the U.S. Department of Energy (DOE) does not have a documented plan of study or correction and meets one or more of the following criteria:

1) adversely impacts the ability to characterize the site or the waste isolation capability of the site;

2) a potential deficiency in the site's characteristics that, if not further examined and evaluated or corrected, could be a potential radiological safety hazard or could result in a substantial deviation from the established design criteria or basis; or

3) sufficiently relevant such that acquisition of additional data in a timely manner would be required to document the condition, prevent loss of the characterization data, and determine impacts to site characterization, design, or construction; and

4) substantially impacts the design and construction of the ESF, waste package, or geologic repository as to cause long-term delay of work.

Examples might include the discovery of petroleum or natural gas in a drill hole; precious metal mineralization in an amount, concentration, and ease of availability attractive for commercial extraction; influx of significant volumes of water (into ESF drifts); an active hydrothermal system; or basaltic intrusion.

b) **Non-technically Significant Condition** - A specific condition that, while not meeting any of the criteria for Technically Significant conditions in Subsection 3.4 a), may be considered

YAP 30.27
Reportable Geol. Cond.

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newsworthy by the media and have political, emotional, or programmatic impacts on the program.

The news media (print and video) report on all manners of site characterization activities, including actual and perceived geologic conditions portrayed as having performance impacts on the site. The DOE may notify, attribute, or discuss media accounts of site characterization activities to inform the NRC and maintain good communications. Non-technically significant geologic conditions are not reportable per this procedure; communications of non-technically significant, newsworthy geologic conditions **do not implement** this procedure. Rather, they represent the normal exercise of the prerogatives of both organizations stemming from procedural and site-specific agreements.

Examples of non-technically significant, but newsworthy, geologic conditions have included the 1992 Little Skull Mountain earthquake, voids in the Bow Ridge Fault zone found in the ESF, perched water, etc.

3.5 ***Unusual Occurrence*** - A non-emergency condition that has significant impact or potential for impact on safety, environment, health, security, or operations (i.e., environmental spills, degradation of personnel safety, etc.), as defined in DOE Order 5000.3B, *Occurrence Reporting and Processing of Operations Information.*

JAP 30.27

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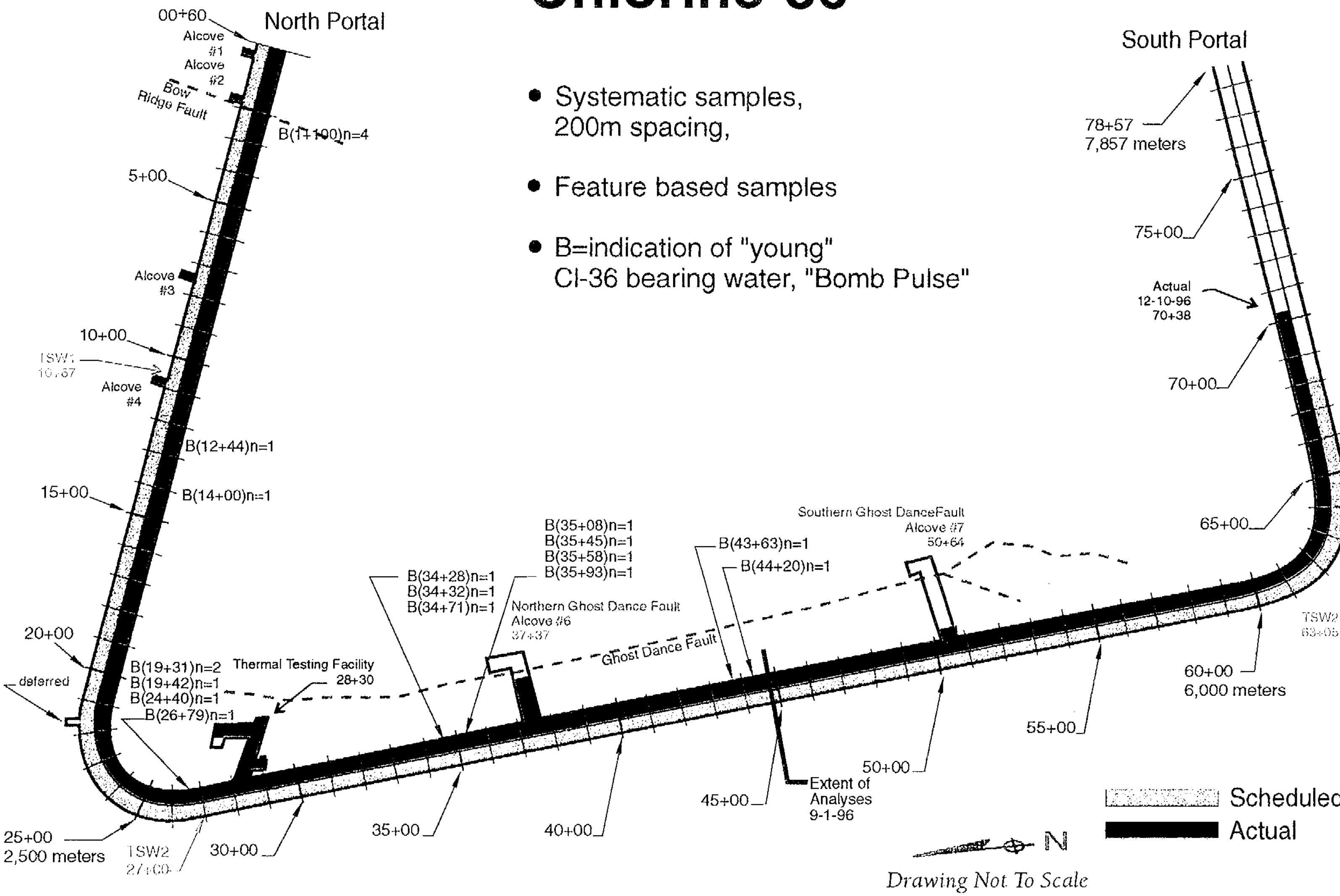
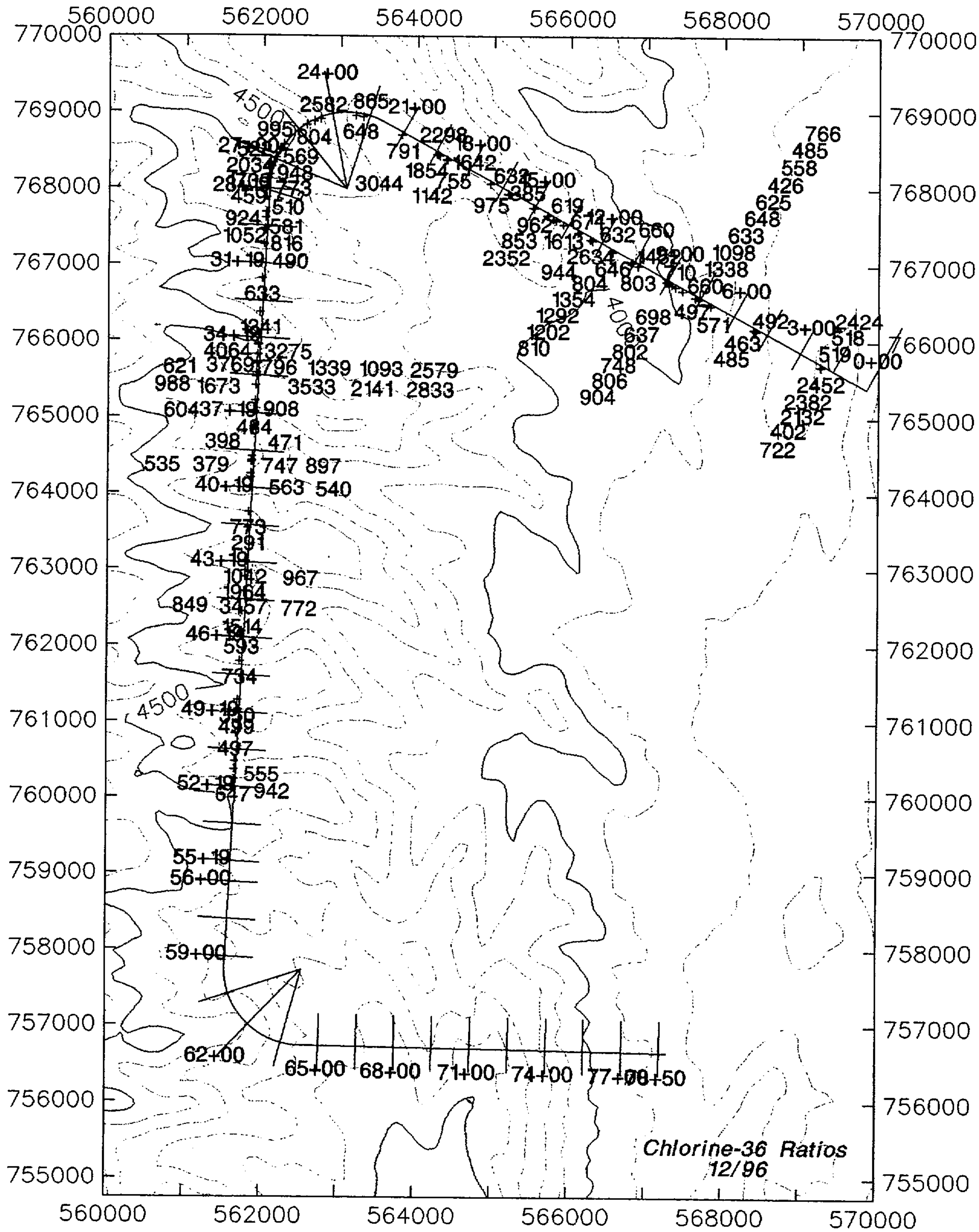
Sampling Locations in ESF: Chlorine-36

- Systematic samples, 200m spacing,
- Feature based samples
- B=indication of "young" Cl-36 bearing water, "Bomb Pulse"





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59+00
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71+00
74+00
77+00
79+50
Chlorine-36 Ratios
12/96

Geochronology of Subsurface Secondary Minerals

Minerals record a long history (millions of years) of deposition under unsaturated conditions

Flow system responsible for calcite/opal deposits appears to be decoupled from flow system producing presence of ^{36}Cl at repository depths

Results of analysis of isotopic data suggest slow and continuous deposition. PTn interpreted to buffer flux at its base

Mass balance calculations suggest minimum flux rates are 2.1 and 0.3 mm/yr based on calcite and opal, respectively

SATURATED ZONE TRACER TESTING
C-HOLE COMPLEX

GOAL-Factors for Groundwater travel times: Determine transport properties and probable pathways	**RESULT-Preliminary factors for transport properties have been determined**
GOAL-Probable chemical and physical retardation of radionuclides	**RESULT-Chemical and physical retardation has been demonstrated in the field**

C-HOLE COMPLEX
SATURATED ZONE TRACER TESTING

- Conservative tracer testing thus far has determined that matrix porosity at 21% is slightly greater than that used for early performance assessment; and that longitudinal dispersivity (ability of the dual-porosity medium to disperse beyond purely advective transport) is reasonable.
- This expands the understanding of the saturated zone transport characteristics required to estimate groundwater travel times.

C-HOLE COMPLEX
SATURATED ZONE TRACER TESTING

- **Reactive tracer testing has determined that the retardation potential for tuffaceous rock is consistent with earlier laboratory results. The second factor resolved is that there is physical retardation of radionuclide-sized particles by the rock fractures.**
- **This confirms the retardation information used in early performance assessment studies.**

Surface Based Testing

(continued)

G-2 Testing

- Initiated initial pump test on 4/8/96, draw down to 4/25/96; monitoring recovery since then
  - Slow recovery to current level at approximately 1 foot below original water elevation; barometric pressure changes evident in curve
  - Preliminary interpretation of the data indicates that drawdown in the well was controlled initially by fracture damage followed by matrix block drainage
  - Drawdown data from about 10,800 minutes until the end of the test suggests a transmissivity of about 25 feet squared per day
  - Boundary conditions do not appear to influence drawdown or recovery

SUPPORT INFORMATION

Table 1. ESF samples collected for ^{36}Cl analysis, February 1995 to November 1996 (DRAFT dated 12-05-96)

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E001	1.98	507923	Report	Fault zone	Bow Ridge Fault, Tiva Canyon tuff wallrock (collected by USBR, Feb 1995)
E002	2.00	507933	NA, Contam	Fault zone	Bow Ridge Fault, Tiva Canyon tuff wallrock (collected by USBR, Feb 1995)
E003	2.00	507932	NA, Contam	Fault zone	Bow Ridge Fault, Tiva Canyon tuff wallrock (collected by USBR, Feb 1995)
E004	2.00	507931	NA, Contam	Fault zone	Bow Ridge Fault, Tiva Canyon tuff wallrock (collected by USBR, Feb 1995)
E005	2.01	507930	NA, Contam	Fault zone	Bow Ridge Fault, Tiva Canyon tuff wallrock (collected by USBR, Feb 1995)
E006	2.02	507925	NA, Contam	Fault zone	Bow Ridge Fault, Tiva Canyon tuff wallrock (collected by USBR, Feb 1995)
E007	2.03	507924	Report	Fault zone	Bow Ridge Fault, pre-Rainier Mesa tuff wall rock, zeolitic (collected by USBR, Feb 1995)
E008	1.99	509016	Report	Fault zone	Bow Ridge Fault, gouge (collected by USBR, Apr 1995)
E009	1.99	509017	Report	Fault zone	Bow Ridge Fault, gouge (collected by USBR, Apr 1995)
E010	1.99	509018	Report	Fault zone	Bow Ridge Fault, gouge (collected by USBR, Apr 1995)
E011	1.99	509019	Report	Fault zone	Bow Ridge Fault, rubble (collected by USBR, Apr 1995)
E012	1.99	509020	Report	Fault zone	Bow Ridge Fault, gouge (collected by USBR, Apr 1995)
E013	7.592	509064	NA	Fracture	Calcite (100 g) (collected by USBR)
E014	7.334	509068	NA	Fracture	Breccia fracture fill (100 g) (collected by USBR)
E015	7.873	509073	NA	Fracture	Calcite and opal (100 g) (collected by USBR)
E016	16.00	509248	NA	Fracture	Bulk rock; calcite and opal in fracture
E017	21.65	509228	NA	Lith cavity	Cavity in otherwise unfractured rock
E018	22.72	509226	NA	Fault breccia	Breccia cement
E019	24.38	509222	NA	Lith cavity	Cavity intercepted by cooling joint
E020	24.68	509220	Report	Fracture	Partly syngenetic rubbly breccia in TSw, fracture surfaces coated with vapor-phase silica

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature (**preliminary**)	Field description (**preliminary**)
E021	26.88	509251	NA	Lith cavity	Silica lining and halo surrounding cavity
E022	26.95	509253	NA	Fracture	Calcite-filled fracture, possibly cooling joint
E023	27.18	509218	NA	Lith cavity	Cavity adjacent to fault
E024	28.80	509215	NA	Lith cavity	Calcite from cavity
E025	28.80	509215	NA	Bedrock	Rock adjacent to above cavity
E027	11.00	503935	NA	Systematic	Systematic sampling of TSw bedrock
E028	12.44	503934	Report	Cooling joints	Vertical cooling joints and intervening horizontal cooling joints
E029	13.00	503932	Report	Systematic	Systematic sampling of TSw bedrock
E030	13.67	503931	Report	Cooling joints	Weakly cemented rubble from shear zone at intersection with another shear zone
E031	14.00	503930	Report	Shear zone	Broken rock from shear zone
E032	14.14	503929	Report	Shear zone	Broken rock from shear zone
E033	14.41	503928	Report	Fault	Calcite-cemented breccia from fault at intersection with fracture
E034	15.00	503926	Report	Systematic	Systematic sampling of TSw bedrock
E035	15.05	503925	Report	Fracture	Calcite lining fracture; calcite-cemented breccia
E036	16.12	509242	Report	Cooling joint	Separated cooling joint with calcite infilling
E037	16.19	509241	Report	Fracture	Clay-rich fracture fill
E038	17.00	503924	Report	Systematic	Systematic sampling of TSw bedrock
E039	17.11	503923	NA	Fracture	Calcite and broken rock from fracture
E040	18.96	503922	Report	Broken rock	Bedrock cut by many short-segment, high-angle cooling cracks
E041	19.00	503921	Report	Systematic	Systematic sampling of TSw bedrock
E042	19.31	503920	Report	Breccia zone	Bulk broken rock and breccia
E043	19.37	503919	Report	Fault zone	Bulk broken rock and breccia
E044	19.42	503918	Report	Breccia zone	3-m wide syngenetic rubbly zone, bounded by vertical fractures, with widespread calcite cement
E045	21.00	503917	Report	Systematic	Systematic sampling of TSw bedrock
E046	22.71	503916	Report	Fracture zone	Near-vertical fracture zone about 6-m wide; 40% of rock is lithophysal cavities

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E047	23.00	509247	Report	Systematic	Systematic sampling of TSw bedrock
E048	23.86	509246	NA	Fracture	Broken rock
E049	24.37	509245	NA	Cooling joint	Broken rock between 2 cooling joints
E050	24.40	509240	Report	Fault zone	Uncemented fault gouge from a near-vertical fault following an old cooling crack
E051	25.00	509259	Report	Systematic	Systematic sampling of TSw bedrock
E052	26.79	509244	Report	Shear zone?	Broken rock from 1-meter wide cooling joint zone
E053	26.88	509239	NA	Cooling joint	Calcite-filled cooling joint in lithophysal zone
E054	27.00	509257	Report	Systematic	Systematic sampling of TSw bedrock
E055	Alcove #1	500788	NA		Representative of drill and blast construction
E056	27.18	509243	Report	Fault	Broken rock from fault separating TSw1 and TSw2
E057	27.50	509238	Report	Fracture	Breccia from fracture, with weak calcite veinlets throughout
E058	27.66	509237	Report	Fault	Fault gouge consisting of clay and breccia with trace of calcite
E059	28.40	509236	Report	Fault	Fault zone with carbonate-cemented breccia
E060	Alcove #2	510542	NA	Fracture	Calcite, 200 g (collected by USBR)
E061	Alcove #2	510536	NA	Shear zone	Calcite-cemented breccia, 200 g (USBR)
E062	1.558	507945	NA	Fracture	Coarse calcite crystals, 100 g (USBR)
E063	1.619	507940	NA	Fracture	Calcite from fractured zone, 200 g (USBR)
E064	2.621	508437	NA		Chert nodules, 200 g (USBR)
E065	3.237	508410	NA		Silt (?), 100 g (USBR)
E066	3.69	508373	NA	Lithophysal	Lithophysal infilling, 200 g (USBR)
E067	3.70	508431	NA	Fracture	Weathered pumice with quartz, 0.5 kg (USBR)
E068	3.752	508367	NA		Calcite + opal + quartz, 200 g (USBR)
E069	4.182	508330	NA		Pumice + vapor phase, 5 g (USBR)
E070	4.368	508304	NA	Fault	Fault breccia, 200 g (USBR)
E071	4.417	508298	NA	Fault	Fault breccia, 200 g (USBR)

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E072	4.636	508273	NA		Vapor phase mineralization, 100 g (USBR)
E073	5.04	504280	Report	Fracture	Breccia (collected by USBR, 1995)
E074	5.05	503866	Report	Fracture	Breccia (collected by USBR, 1995)
E075	8.238	504284	NA	Fracture	Fracture filling (collected by USBR)
E076	8.31	504289	NA	Fracture	Fracture filling (collected by USBR)
E077	8.477	504294	NA	Fracture	Clayey fracture filling (collected by USBR)
E078	9.89	509103	NA	Fault	Quartz (?) From fault (collected by USBR)
E079	9.94	509109	NA		Opal (collected by USBR)
E080	10.08	509114	NA	Fault	Opal and tuff from fault (collected by USBR)
E081	10.28	509132	NA		Opal (collected by USBR)
E082	10.327	509119	NA		Opal (collected by USBR)
E083	10.7915	510515	NA		Quartz/opal (collected by USBR)
E084	10.903	510548	NA		Quartz (collected by USBR)
E085	11.02	510561	NA		Wall rock with opal (collected by USBR)
E086	11.4268	510583	Report	Bedrock	Unaltered TSw (collected by USBR, 1995)
E087	11.4368	510581	NA	Fracture	Tuff/clay infilling of fracture, 300 g (USBR)
E088	0.872	507974	NA	Bedrock	Upper lithophysal unit (collected by USBR)
E089	1.04	507958	NA	Fracture	Fracture (collected by USBR)
E090	1.1167	507959	NA	Fracture	Fracture, 200 g (USBR)
E091	1.23	507960	NA	Fracture	Rubble/fracture zone, Collected by USBR
E092	1.31	507953	NA	Fault	Fault breccia (1bag); intact rock (1 bag); Collected by USBR
E093	1.49	507954	NA	Fault	Fault breccia (1bag); intact rock (1 bag); Collected by USBR
E094	1.49	507951	NA	Shear zone	Shear breccia, Collected by USBR
E095	2.08	507919	NA	Fault	Infilling in fault zone, Collected by USBR
E096	2.08	507920	NA	Fault	Hanging wall at fault zone, Collected by USBR
E097	2.08	507921	NA	Fault	Infilling in fault zone, Collected by USBR
E098	2.08	507922	NA	Fault	Infilling in fault zone, Collected by USBR
E099	2.11	507916	NA		Collected by USBR

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E100	2.12	507918	NA		Collected by USBR
E101	2.13	507917	NA		Collected by USBR
E102	2.18	507910	NA		Collected by USBR
E103	2.62	507906	NA		Collected by USBR
E104	2.62	507907	NA		Collected by USBR
E105	3.26	508415	NA		Chert (?) nodules, Collected by USBR
E106	3.29	508422	NA	Fracture	Fracture filling, 400 g, Collected by USBR
E107	3.64	508378	NA	Fracture	Fracture filling, Collected by USBR
E108	3.99	508314	NA	Fault	Bulk rock, Collected by USBR
E109	4.01	508313	NA	Fault	Bulk rock, Collected by USBR
E110	4.34	508309	NA	Fault	Bulk rock, Collected by USBR
E111	4.38	508302	NA	Fault	Bulk rock, Collected by USBR
E112	4.43	508294	NA	Fault	Bulk rock, Collected by USBR
E113	4.78	509100	NA	Shear	Bulk rock near shear, Collected by USBR
E114	4.79	509003	NA	Shear	Bulk rock near shear, Collected by USBR
E115	4.79	509002	NA	Shear	Material from shear, Collected by USBR
E116	4.98	503893	NA	Shear	Bulk rock near shear, Collected by USBR
E117	5.00	503892	NA	Shear	Shear material, Collected by USBR
E118	4.74	508285	NA	Cooling joint	Tubes on cooling joint, Collected by USBR
E119	5.03	503837	NA		Bulk rock, Collected by USBR
E120	5.04	503836	NA		Bulk rock, Collected by USBR
E121	5.05	503842	NA		Bulk rock, Collected by USBR
E122	5.06	503838	NA		Bulk rock, Collected by USBR
E123	5.02	503891	NA	Shear	Wall rock near shear, Collected by USBR
E124	5.07	503890	NA		Wall rock, Collected by USBR
E125	5.13	503886	NA		Wall rock, Collected by USBR
E126	10.34	509155	NA	Fault	Altered tuff bisected by fault, collected by USBR
E127	10.38	509135	NA	Fault	Tuff within 2 m of fault, collected by USBR
E128	10.4	509147	NA	Fault	Tuff within 2 m of fault, collected by USBR

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature (**preliminary**)	Field description (**preliminary**)
E129	10.4	509136	NA	Fault	Tuff within 1 m of fault, collected by USBR
E130	10.41	509150	NA	Fault	Tuff bisected at fault, collected by USBR
E131	10.42	509137	NA	Fault	Tuff within 2 m of fault, collected by USBR
E132	10.42	509149	NA	Fault	Tuff within 2 m of fault, collected by USBR
E133	10.65	509199	NA	Fault	Tuff 0.75 m E of fault, collected by USBR
E134	10.66	510506	NA	Fault	Fault material, collected by USBR
E135	10.66	510507	NA	Fault	Tuff within 0.2 m of fault, collected by USBR
E136	10.67	510505	NA	Fault	Fault material, collected by USBR
E137	10.68	510508	NA	Fault	Tuff within 0.2 m of fault, collected by USBR
E138	10.73	510509	NA	Fault	Tuff within 0.2 m of fault, collected by USBR
E139	10.74	510510	NA	Fault	Fault material, collected by USBR
E140	10.75	510511	NA	Fault	Tuff within 0.35 m of fault, collected by USBR
E141	29.00	503947	Report	Systematic	Systematic sampling of TSw bedrock
E142	29.21	503983	Report	Fracture	Subhorizontal fracture zone with calcite
E143	29.65	503948	Report	Fault	Fault breccia following syngenetic alteration zone
E144	29.73	503949	Report	Cooling joints	Bulk rock above lithophysal cavity at intersection of cooling joints
E145	29.80	503985	R&D	Lith. cavity	Calcite from lithophysal cavity along cooling joint extending below 29+80 sample site
E146	30.18	503987	R&D	Lith. cavity	Calcite from lithophysal cavity
E147	30.27	503976	Report	Cooling joints	Broken rock between two cooling joints
E148	31.61	503975	NA	Cooling joint & lith. cavity	Calcite in incipient lithophysal cavity intersected by two cooling joints
E149	31.64	503973	Report	Cooling joint	Breccia along cooling joint
E150	33.00	503939	Report	Systematic	Systematic sampling of TSw bedrock
E151	33.16	503990	R&D	Lith cavity	Cavity with calcite/opal, intersected by vertical cooling joint
E152	34.28	503993	Report	Fractures	Cooling joints and rubbly rock
E153	34.32	503938	Report	Cooling joints	Broken rock at the intersection of offset cooling joints
E154	34.71	503937	Report	Cooling joints	Breccia in offset cooling joint

LANL ID	Approx. ESF station	SMF barcode	Analytical status for ^{36}Cl (see notes)	Sampled feature (**preliminary**)	Field description (**preliminary**)
E155	35.00	503980	Report	Systematic	Systematic sampling of TSw bedrock
E156	35.00	503969	Report	Cooling joints	Broken rock with throughgoing cooling joints
E157	35.03	503994	Report	Cooling joints	Calcite breccia cement in separated cooling joints
E158	35.08	503995	Report	Cooling joints	Breccia bounded by high-angle cooling joints
E159	35.24	503997	NA	Cooling joint	Calcite from near-vertical cooling joint and adjacent breccia
E160	35.45	503979	Report	Cooling joints	Broken rock from a zone of vertical cooling joints
E161	35.58	503999	Report	Cooling joints	Breccia zone bounded by high-angle cooling joint
E162	28.81	503981	NA	Fracture	Calcite fracture filling
E163	4.94	512551	Report	Systematic	Systematic sampling of TCw bedrock
E164	7.00	512550	Report	Systematic	Systematic sampling of TCw bedrock
E165	7.70	512549	Report	TCw contact	Tpcpln/Tpcpv contact, ~ 1 m above contact
E166	7.70	512548	Report	TCw contact	Tpcpln/Tpcpv contact
E167	7.70	512547	Report	TCw contact	Tpcpln/Tpcpv contact, ~ 1 m below contact
E168	8.59	512546	Report	PTn contact	Tpcpv/Tpbt4 contact, ~ 1 m above contact
E169	8.59	512545	Report	PTn contact	Tpcpv/Tpbt4 contact
E170	8.59	512544	Report	PTn contact	Tpcpv/Tpbt4 contact, ~ 1 m below contact
E171	8.90	512554	Report	PTn contact	Tpbt3/Tpp contact, ~ 1 m above contact
E172	8.90	512553	Report	PTn contact	Tpbt3/Tpp contact
E173	8.90	512552	Report	PTn contact	Tpbt3/Tpp contact, ~ 1 m below contact
E174	9.00	512543	Report	Systematic	Systematic sampling of PTn bedrock
E175	35.93	512511	Report	Fault	Breccia (possibly Sundance Fault)
E176	36.55	512506	Report	Fault	Fault gouge
E177	37.00	512510	Report	Systematic	Systematic sampling of TSw bedrock
E178	37.60	512504	Report	Cooling joint	Fault gouge within modified cooling joint
E179	37.68	512509	Report	Cooling joint	Wallrock and breccia adjacent to cooling joint
E180	38.47	512513	NA	Fracture	Fracture and fracture fill minerals
E181	38.62	512515	NA	Lith cavity	Bulk rock and lithophysal cavity
E182	38.79	512502	Report	Fracture	Fracture material/gouge

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature (**preliminary**)	Field description (**preliminary**)
E183	38.95	512517	Report	Cooling joint	Fracture fill/gouge
E184	39.0	512508	Report	Systematic	Systematic sampling of TSw bedrock (fractured rock)
E185	39.39	503944	Report	Fracture/lith. cavity	Lithophysal cavity with calcite
E186	39.47	503943	Report	Cooling joint	Gouge within offset cooling joint
E187	39.61	503946	Report	Cooling joint	Gouge within offset cooling joint
E188	8.265	515100	NA	PTn contact with fracture	Tpcpv1/Tpbt4 contact, ~1 m above contact, with fracture/fault crossing contact
E189	8.265	515101	NA	PTn contact	Tpcpv1/Tpbt4 contact, just above contact
E190	8.265	515102	NA	PTn contact	Tpcpv1/Tpbt4 contact, ~1 m below contact
E191	8.75	515104	Report	PTn contact	Tpbt3, ~ 1 m above contact between coarse and fine subunits
E192	8.75	515105	Report	PTn contact	Tpbt3, at contact between coarse and fine subunits
E193	8.75	515106	Report	PTn contact	Tpbt3, ~ 1 m below contact between coarse and fine subunits
E194	10.56	512586	Prelim	PTn contact	Tprv2/Tprv1 contact, ~ 2 m above contact, adjacent to NRG-4
E195	10.56	512587	Prelim	PTn contact	Tprv2/Tprv1 contact, ~ 1 m above contact, adjacent to NRG-4
E196	10.56	512588	Prelim	PTn contact	Tprv2/Tprv1 contact, at contact, adjacent to NRG-4
E197	10.625	512585	Report	PTn contact	Tprv2/Tprv1 contact, ~ 1 m below contact, adjacent to NRG-4; vitric tuff
E198	41.65	510700	Report	Cooling joint	Broken rock with cooling joints
E199	43.00	512590	Report	Systematic	Systematic sampling of TSw bedrock
E200	43.39	512589	Report	Fault	Gouge zone with minor offset bounded by cooling joints
E201	43.63	512591	Report	Cooling joint	Hard rock cut by cooling joints
E202	44.20	512592	Report	Cooling joints	Multiple cooling joint sets
E203	44.21	512593	Report	Cooling joints	Multiple cooling joint sets
E204	44.22	512594	Report	Cooling joint	Thin breccia layer along cooling joint

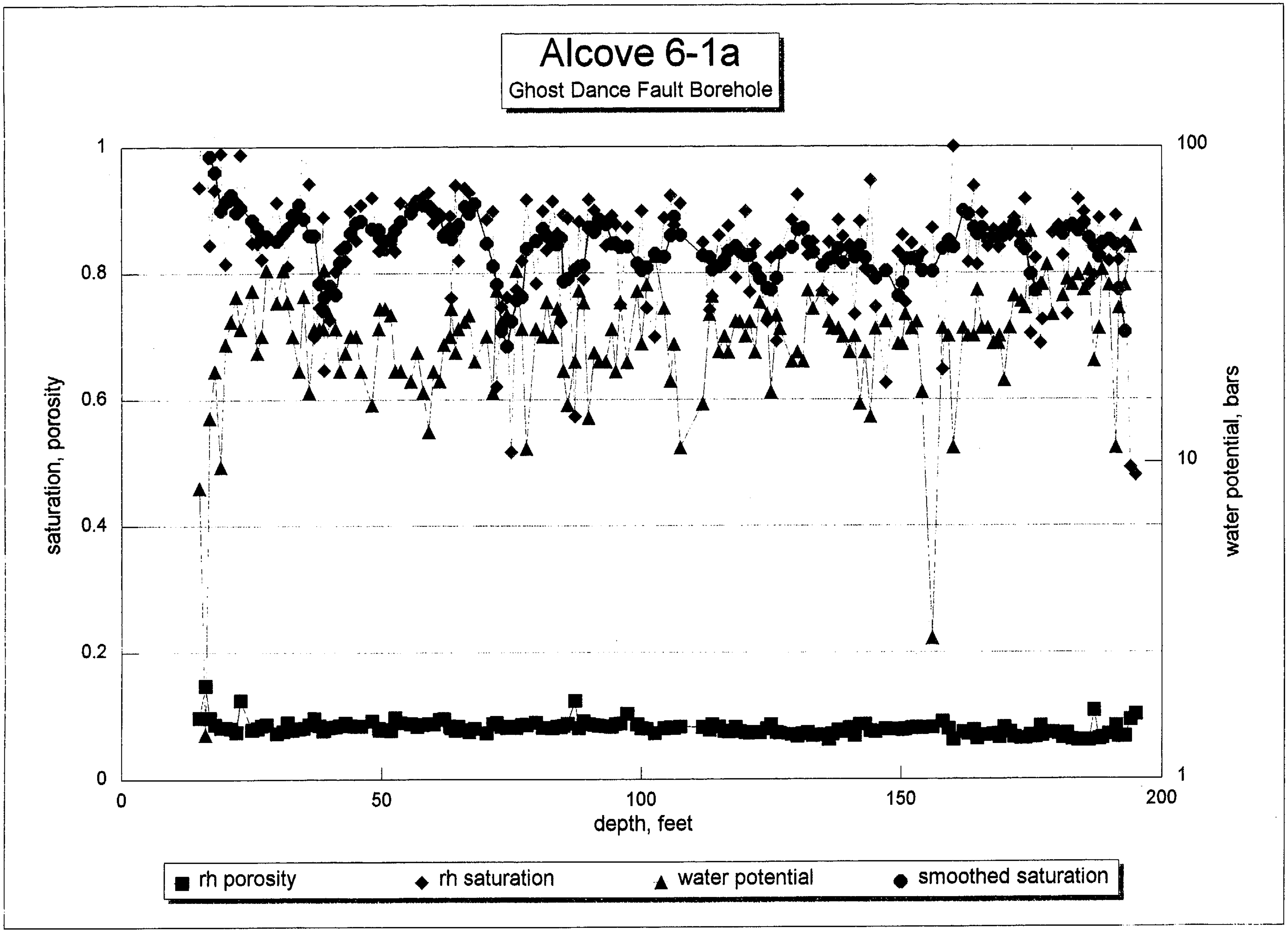
LANL ID	Approx. ESF station	SMF barcode	Analytical status for ^{36}Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E205	45.00	512595	Report	Systematic	Systematic sampling of TSw bedrock
E206	45.78	512596	NA	Cooling joints	Calcite along cooling joints
E207	45.79	512597	Report	Cooling joints	Multiple cooling joint sets
E208	46.18	515103	NA	Fault	Clayey gouge
E209	46.18	512598	NA	Fault	Calcite cement
E210	10.28 Alcove #4	515109	Report	PTn contact	Station 0+51.58, ~2.3 m above red argillic horizon
E211	10.28 Alcove #4	515107	Report	PTn contact	Station 0+51.58, in red argillic horizon
E212	10.28 Alcove #4	515108	Report	PTn contact	Station 0+51.58, below red argillic horizon
E213	12.365	510792	Report	Fracture	0.5 to 1-m wide fracture-breccia zone
E214	12.44	510790	Prelim	Cooling joints	Resampling of above feature
E215	12.49	510791	Report	Cooling joints	Broken rock adjacent to cooling joints
E216	20.71	510788	NA	Fault zone	Broken rock, little secondary mineralization
E217	26.19	510716	Report	Fracture	
E218	26.36	510714	Report	Fracture	Several closely-spaced fractures with secondary mineralization
E219	26.46	510713	Report	Fracture	High-angle fracture with secondary mineralization
E220	26.79	510719	Report	Fracture/fault	Fracture/fault zone in lithophysal tuff
E221	41.00	510710	Report	Systematic	Systematic sampling of TSw bedrock
E222	42.55	510724	Prelim	Shear	Intersecting shear sets: host rock (1 bag); gouge (1 bag)
E223	47.00	510728	Prelim	Systematic	Systematic sampling of TSw bedrock
E224	49.00	510734	Prelim	Systematic	Systematic sampling of TSw bedrock
E225	48.56	510731	Prelim	Cooling joints	Breccia zone bounded by cooling joints
E226	49.56	510737	Prelim	Cooling joint	Breccia along cooling joint
E227	49.89	510705	Prelim	Cooling joints	Breccia zone bounded by cooling joints

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature (**preliminary**)	Field description (**preliminary**)
E228	1.68 Alcove #2	510795	NA	Bulk rock, drill and blast construction	Station 0+25.5 in alcove; objective is to evaluate effects of drill and blast construction on ^{36}Cl and halide signals
E229	7.54 Alcove #3	510702	Prelim	Adjacent to USGS moisture probe site	Station 0+14.5 in alcove; objective is to compare ^{36}Cl signal to flux measurements at this location
E230	51.00	510739	Prelim	Systematic	Bedrock cut by several sets of cooling joints
E231	51.07	510740	Prelim	Cooling joints	Broken rock/breccia at intersection of cooling joints
E232	51.33	510741	Prelim	Cooling joints	Intersection of cooling joints with calcite joint filling
E233	51.73	510742	Prelim	Fracture	Broken rock zone bounded by fracture
E234	52.43	510743	Submit	Cooling joint	Joint surfaces with calcite and fluorite
E235	52.46	510744	Submit	Cooling joint	Joint surfaces and adjacent bedrock
E236	53.00	510745	Submit	Systematic	Bedrock cut by rare vertical cooling joint
E237	53.61	510746	Submit	Cooling joints	Broken rock between cooling joints
E238	54.20	510747	Submit	Cooling joints	Breccia at intersection of cooling joints
E239	55.00	510748	Submit	Systematic	Fractured bedrock
E240	56.63	510756	Submit	Cooling joints	Breccia zone bounded by cooling joints
E241	56.85	510754	Submit	Cooling joints	Breccia/shear zone between cooling joints
E242	56.93	510750	Submit	Cooling joints	Breccia/shear zone between cooling joints
E243	1.99	509751	Report	Fault zone	Bow Ridge Fault, gouge (resampled in vicinity of E012)
E244	8.385	515135	In process	Fault	Fault in TCw with 1 m offset
E245	8.445	515136	In process	Fracture	Fe-stained fracture at base of TCw (only Fe-stained frax in ESF)
E246	8.66	515137	In process	Fault	Fault at top of PTn with 1 m offset
E247	9.32	515138	In process	Fault	Fault in PTn
E248	10.75	515139	In process	Fault	Fault in TSw, dies out about 3 m into PTn; associated calcite
E249	11.00	515142	In process	Systematic	Resample of E027
E250	11.434	515140	In process	Fault	Through-going fault at TSw/PTn contact

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E251	11.775	515141	In process	Fault	TSw/PTn fault with 7-8 m offset
E252	57.00	515143	Submit	Systematic	Systematic sample
E253	57.268	515144	Submit	Fault	Ghost Dance Fault
E254	58.66	515145	Submit	Fault	Fault zone gouge, ~0.5-m wide
E255	58.77	515146	Submit	Unit contact	Nonfractured lower lithophysal zone overlain by fractured middle nonlithophysal zone
E256	59.00	515147	Submit	Systematic	Systematic sample (1 bag); fracture with gouge (1 bag)
E257	61.00	515148	Submit	Systematic	Systematic sample
E258	61.92	515149	Submit	Fracture	Large vertical fracture set
E259	62.00	515150	Submit	Systematic	Systematic sample, ~5 m N of fault trace at E260
E260	62.05	515151	Submit	Fault	Fault ~10 cm wide
E261	62.18	515152	Submit	Fault	Footwall of Ghost Dance Fault, highly fractured, large apertures
E262	62.71	515153	Submit	Shear	Intersecting shear/cooling joint sets
E263	63.00	515154	In process	Systematic	Systematic sample
E264	63.06	515155	In process	Fracture	156/84 fracture, ~ 10 cm wide; calcite-cemented breccia (1 bag); adjacent matrix (1 bag)
E265	63.21	515156	In process	Fracture	Intersecting fractures with breccia
E266	63.26	515157	NA	Fracture	Fracture/breccia zone, ~ 1 m wide, very broken up
E267	63.30	515158	NA	Fault	Intersection of fault (30-cm offset) with vapor-phase parting
E268	56.2	515180	NA	Fracture	Fracture zone
E269	63.73	515188	NA	Fracture	Fracture ~ 1m wide, with calcite filling
E270	63.81	515187	NA	Fracture	Large fracture
E271	64.00	515186	NA	Systematic	Systematic sample with 2 intersecting fractures
E272	64.345	515185	NA	Broken rock	Broken rock, no obvious structure
E273	64.5	515184	NA	Broken zone	Representative sample from broken zone ~ 35 m wide
E274	64.93	515182	NA	Fracture	Calcite in fracture below lithophysal cavity
E275	65.00	515181	NA	Systematic	Systematic sample

LANL ID	Approx. ESF station	SMF barcode	Analytical status for 36Cl (see notes)	Sampled feature **(preliminary)**	Field description **(preliminary)**
E276	65.56	515179	NA	Fracture	Large fracture zone ~ 1.5 m wide
E277	65.80	515178	NA	Fracture	Large 2-m wide fracture zone
E278	66.00	515177	NA	Systematic	Systematic sample with 2 intersecting fractures
E279	66.15	515176	NA	Fault	Calcite-cemented fault breccia
E280	66.40	515175	NA	Fault	Fault zone in TSw with about 2-m offset
E281	67.00	515174	NA	Systematic	Systematic sample in nonfaulted, nonwelded unit
E282	67.20	515183	NA	Damp zone	Large wetted zone in poorly to nonwelded tufff
E283	67.27	515172	NA	Fault	Fault in high-porosity zone of nonwelded tuff, wetted appearance
E284	67.35	515173	NA	Unit contact	Welded/nonwelded contact
E285	67.73	515171	NA	Damp zone	Damp sandy zone (nonhorizontal) in PTn
E286	67.87	515133	NA	Fault	About 3-m wide fault in Tsw: fault gouge (1 bag); calcite-cemented gouge (1 bag)
E287	67.872	515134	NA	Fault	Sandy fault breccia
E288	67.905	515132	NA		

Notes on codes for analytical status:
NA: Sample not yet analyzed (e.g., in queue, low priority, insufficient material for analysis) or results rejected
Report: Sample results contained in milestone report
Prelim: Preliminary results available
R&D: Only RD results are available; testing new procedure for this matrix
Contam: Sample not analyzed for 36Cl because Cl/Br ratio indicates excessive contamination with construction water
Submit: Sample has been submitted to outside laboratory for 36Cl analysis
In process: Sample currently being processed for 36Cl analysis


Alcove 6-1a
Ghost Dance Fault Borehole
saturation, porosity
water potential, bars
depth, feet
0
0.2
0.4
0.6
0.8
1
1
10
100
0
50
100
150
200
rh porosity
rh saturation
water potential
smoothed saturation

12/06/96

ATTACHMENT 5

YUCCA MOUNTAIN PROJECT

Studies

Thermal Testing Update

Presented to:
DOE-NRC ESF Technical Meeting, Video conference

Presented by:
William Boyle
Team Leader
Yucca Mountain Site Characterization Office

December 16, 1996

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

LARGE BLOCK TESTS

- Three dimensional study of the hydrodynamics of thermally driven moisture residing in repository horizon lithology, both during heating (efflux) and cooling (afflux) utilizing Electrical Resistivity Tomography (ERT).

- Study of geochemistry will be carried out by laboratory analyses of water samples during the test and rock samples upon dismantling of the large block at the culmination of the test.

- Determine whether condensate buildup exterior to the boiling isotherm can cross isotherm and contact waste package.

- Validate current conceptual model or identify any missing physics that could improve model precision.

- Measure corrosion rates of waste package materials by placing coupons of materials in boreholes where they will be subjected to the dynamic environment created during the test.

ENGINEERED BARRIER - LARGE BLOCK TESTS

TEST INSTALLATION ACTIVITIES AT THE LARGE BLOCK TEST SITE AT FRAN RIDGE RESUMED IN NOVEMBER, 1996.

ENGINEERED BARRIER - LARGE BLOCK TESTS

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ENGINEERED BARRIER - LARGE BLOCK TESTS

TEST INSTALLATION ACTIVITIES AT THE LARGE BLOCK TEST SITE AT FRAN RIDGE RESUMED IN NOVEMBER, 1996.


#24: ESF-
MOISTURE ME
#23: ESF-TMA-HYD-
CHEMICAL MEASUREMENTS
#22: ESF-TMA-HYD-1

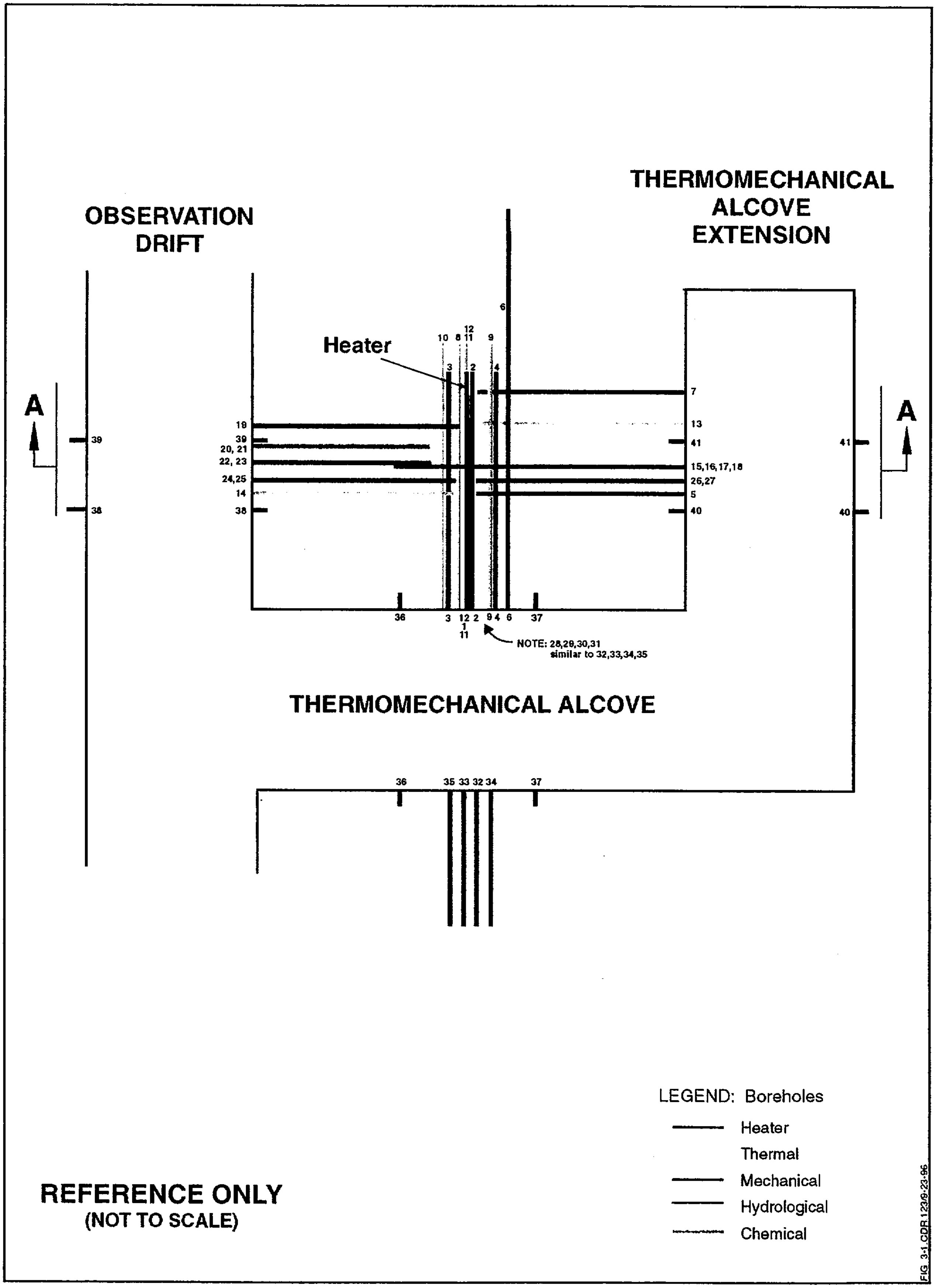


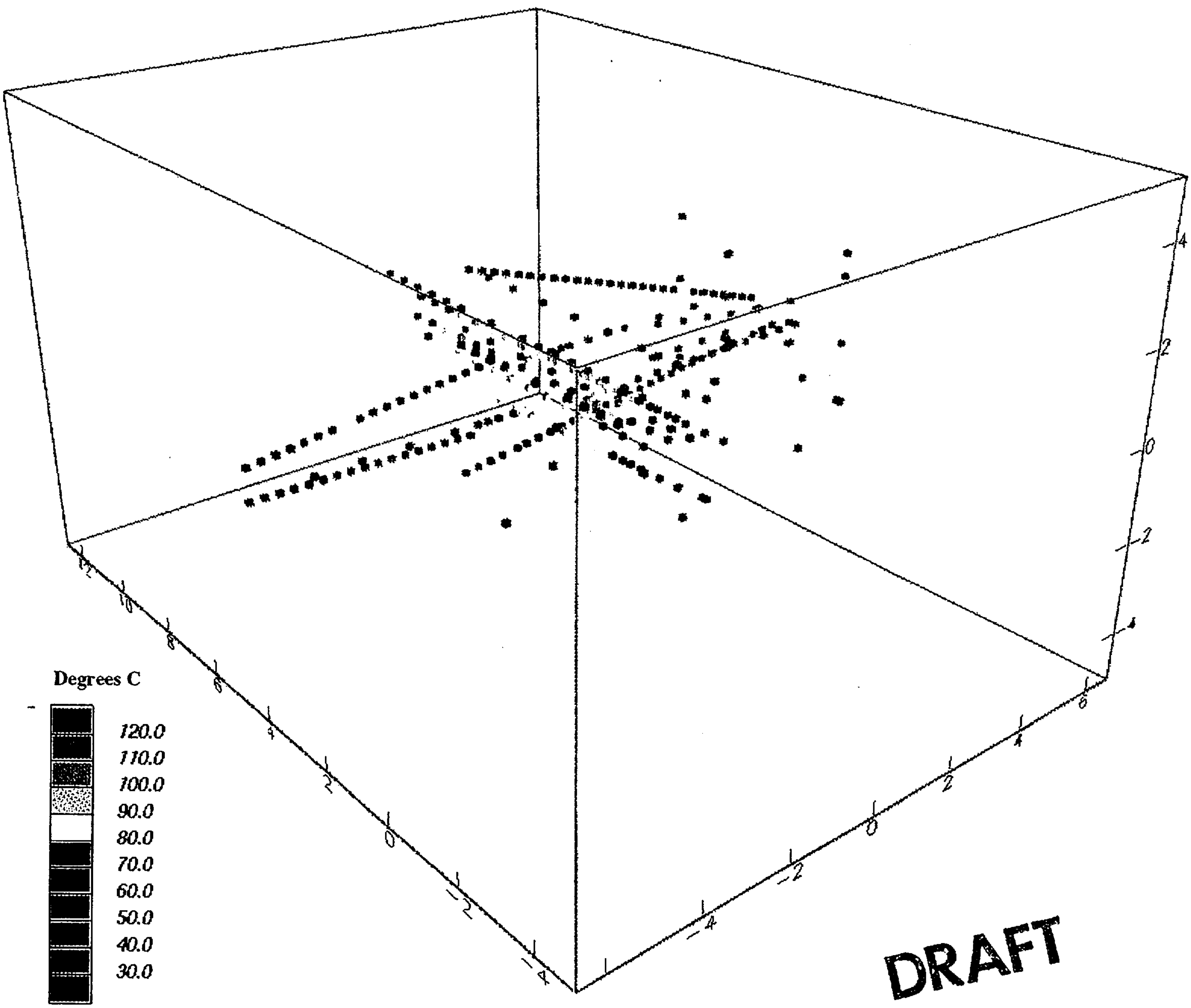
Figure 3-1a. Layout of Single Heater Test

Single Heater Test: Measurements

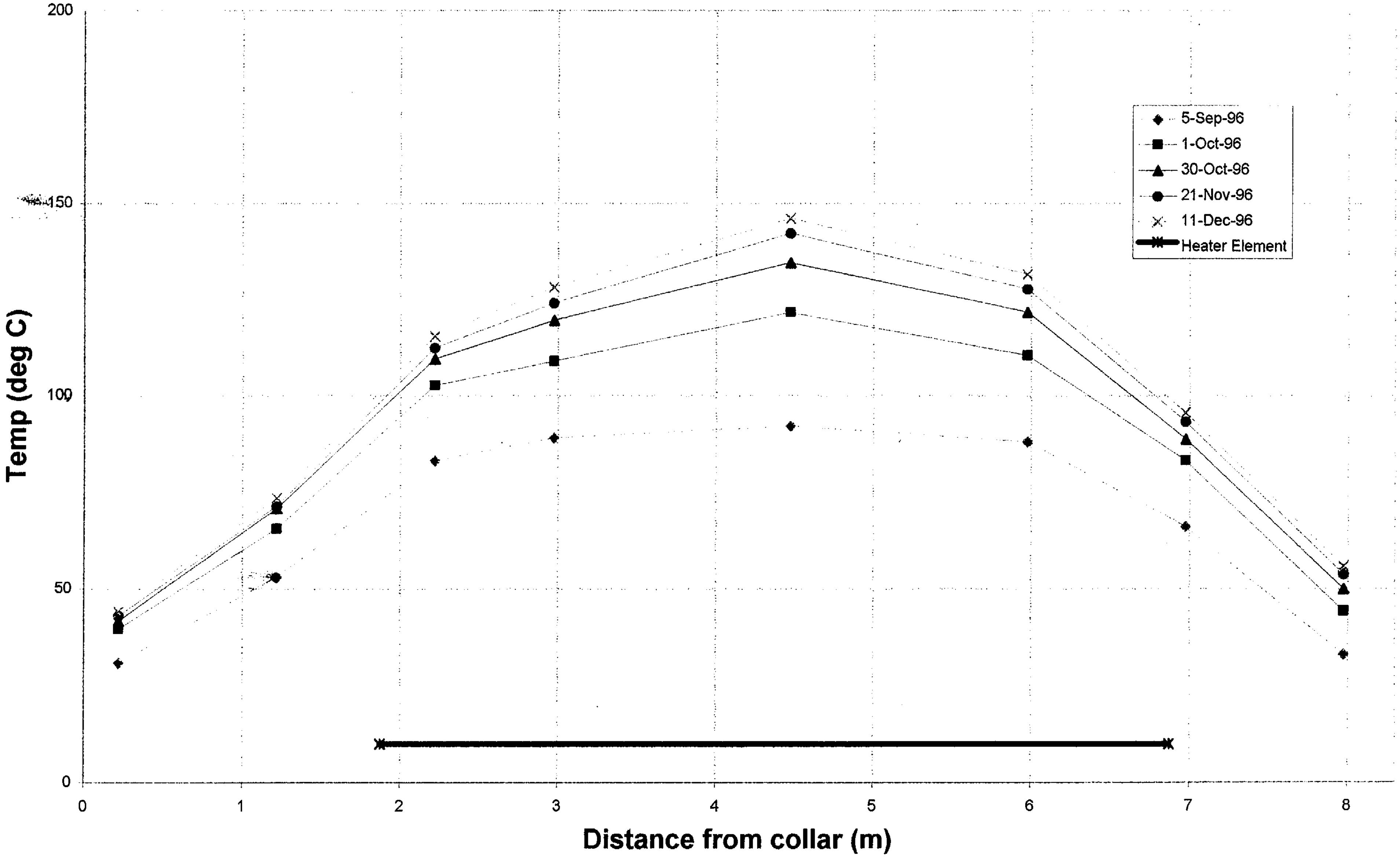
Perspective View

Input Sensor Locations

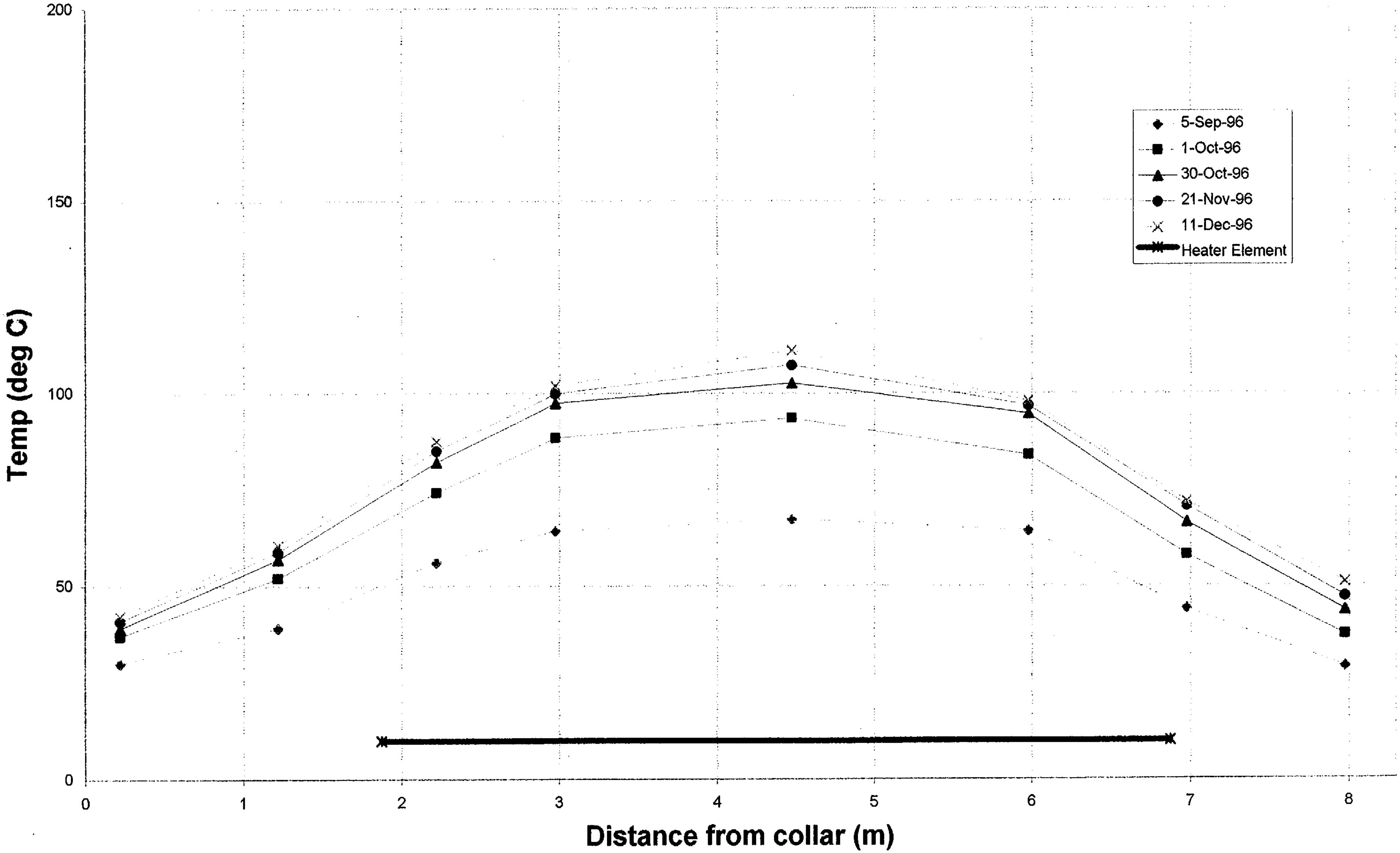
November 30, 1996 (Day 96)



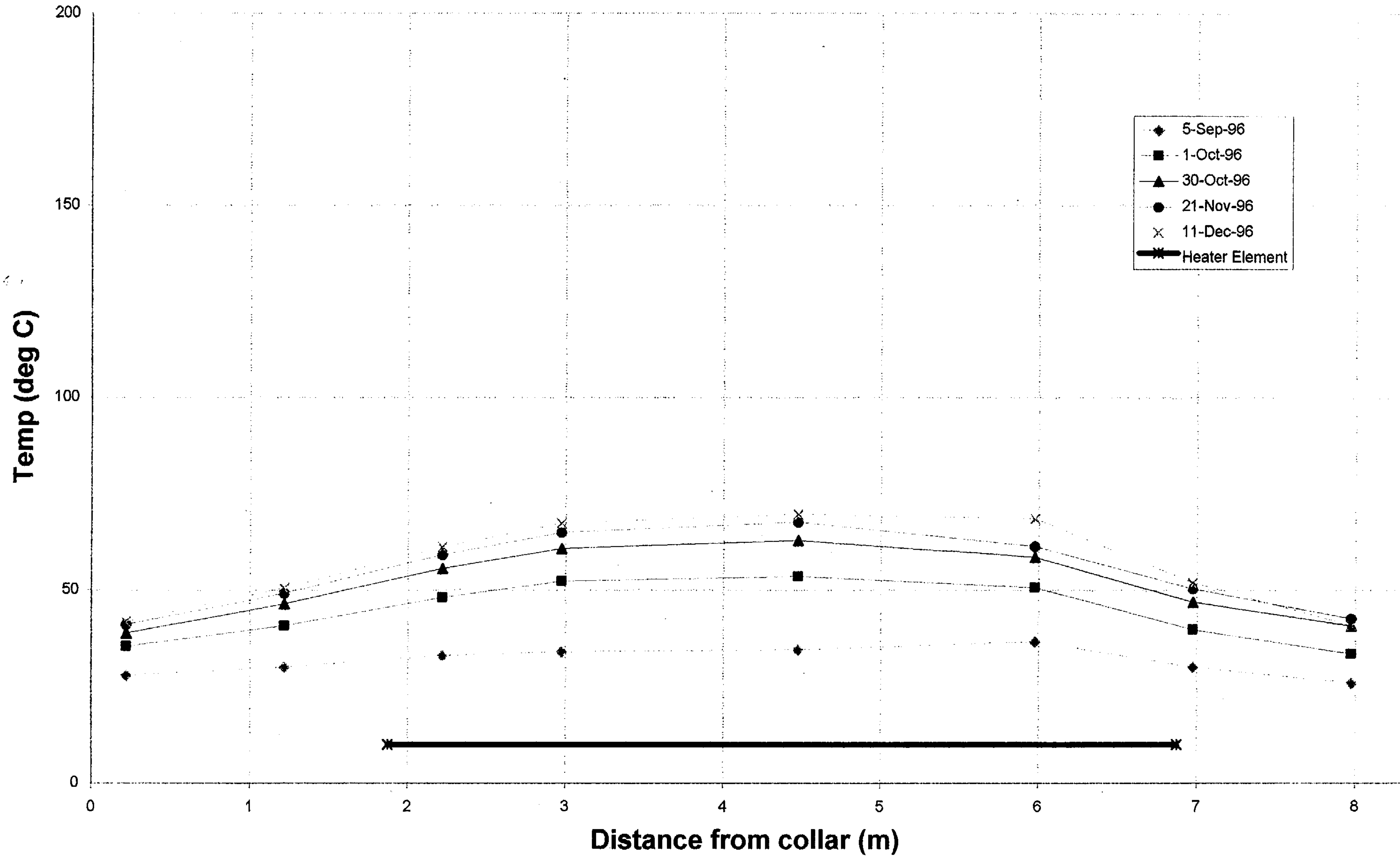
Temperature at Thermocouple TC-1 (0.33 m from heater)



Temperature at Thermocouple TC-2 (0.66 m from heater)



Temperature at Thermocouple TC-3 (1.48 m from heater)

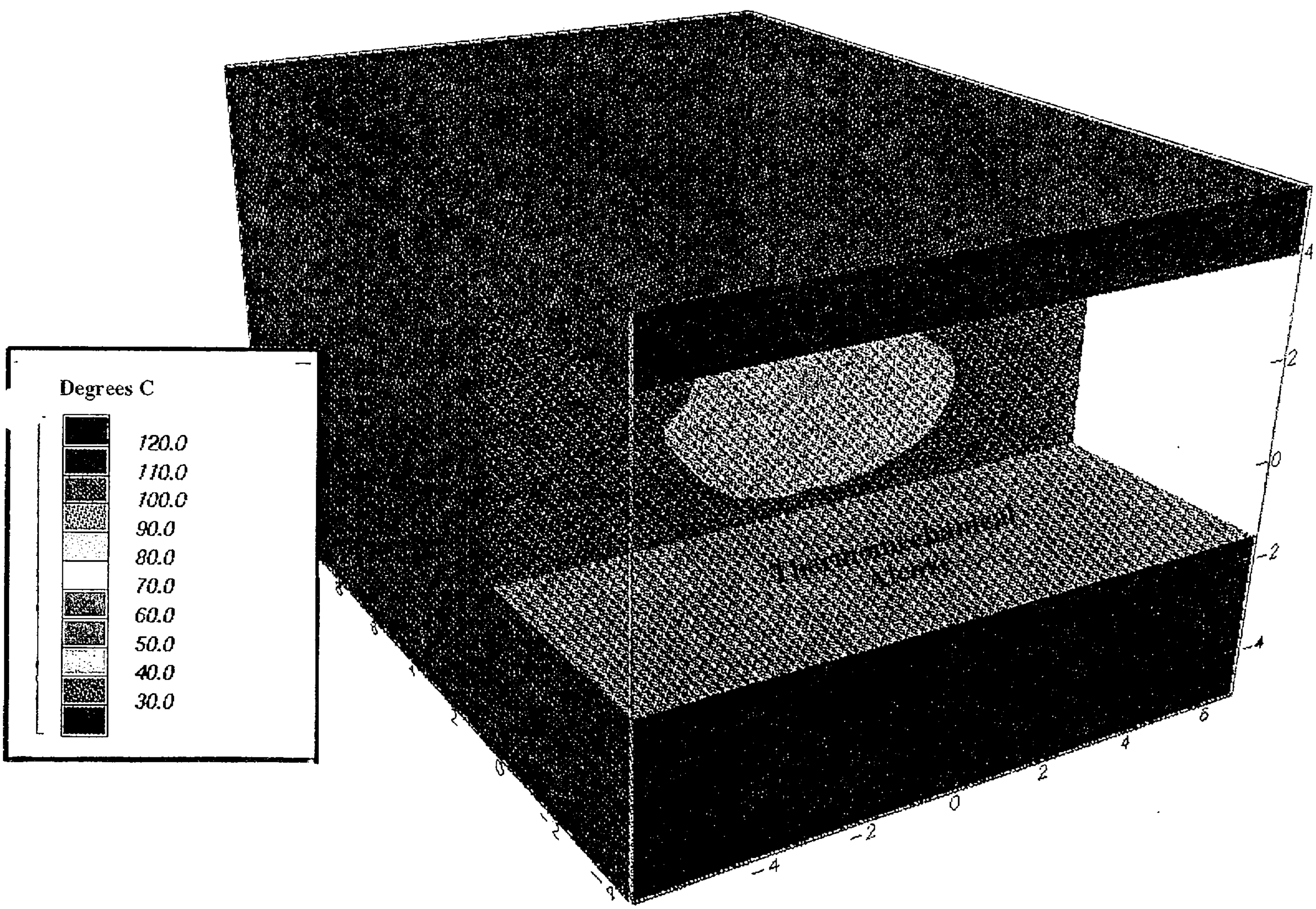


Single Heater Test: Measurements

Perspective Isotherms

View of Modeled Block

November 30, 1996 (Day 96)

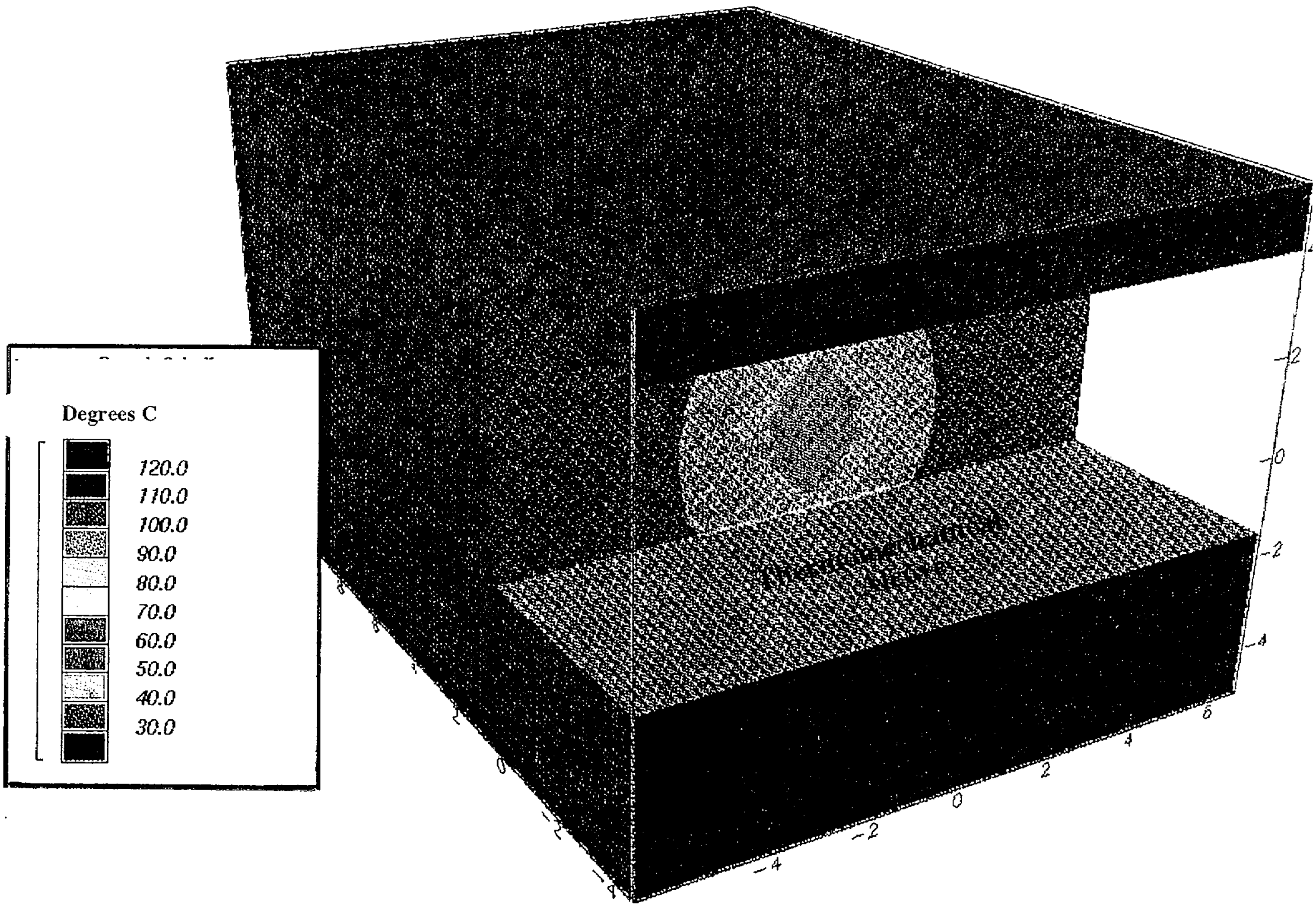


Single Heater Test: Predictions

Perspective Isotherms

View of Modeled Block

November 30, 1996 (Day 96)



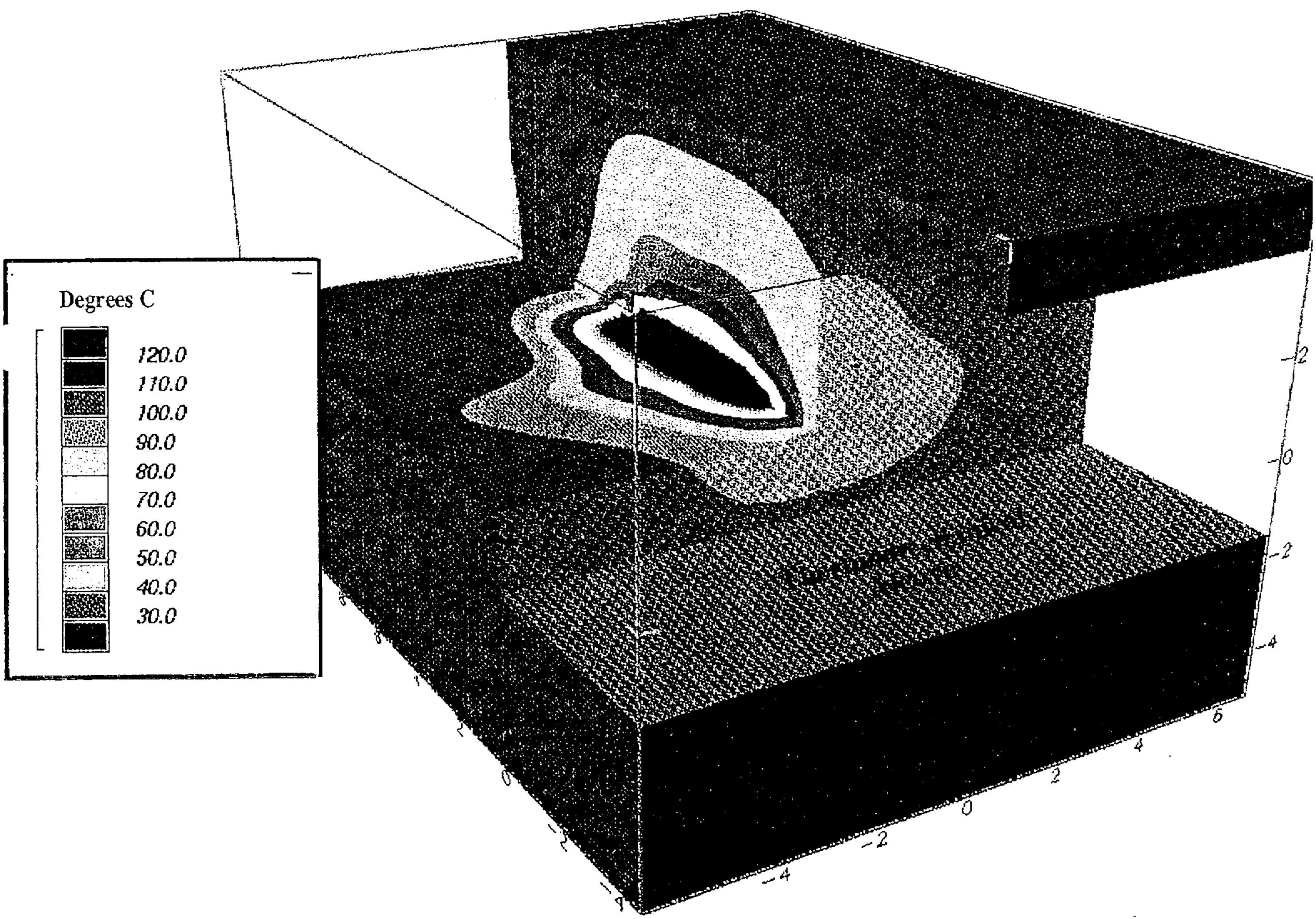
DRAFT

Single Heater Test: Measurements

Perspective Isotherms

Cutaway Along Heater

November 30, 1996 (Day 96)

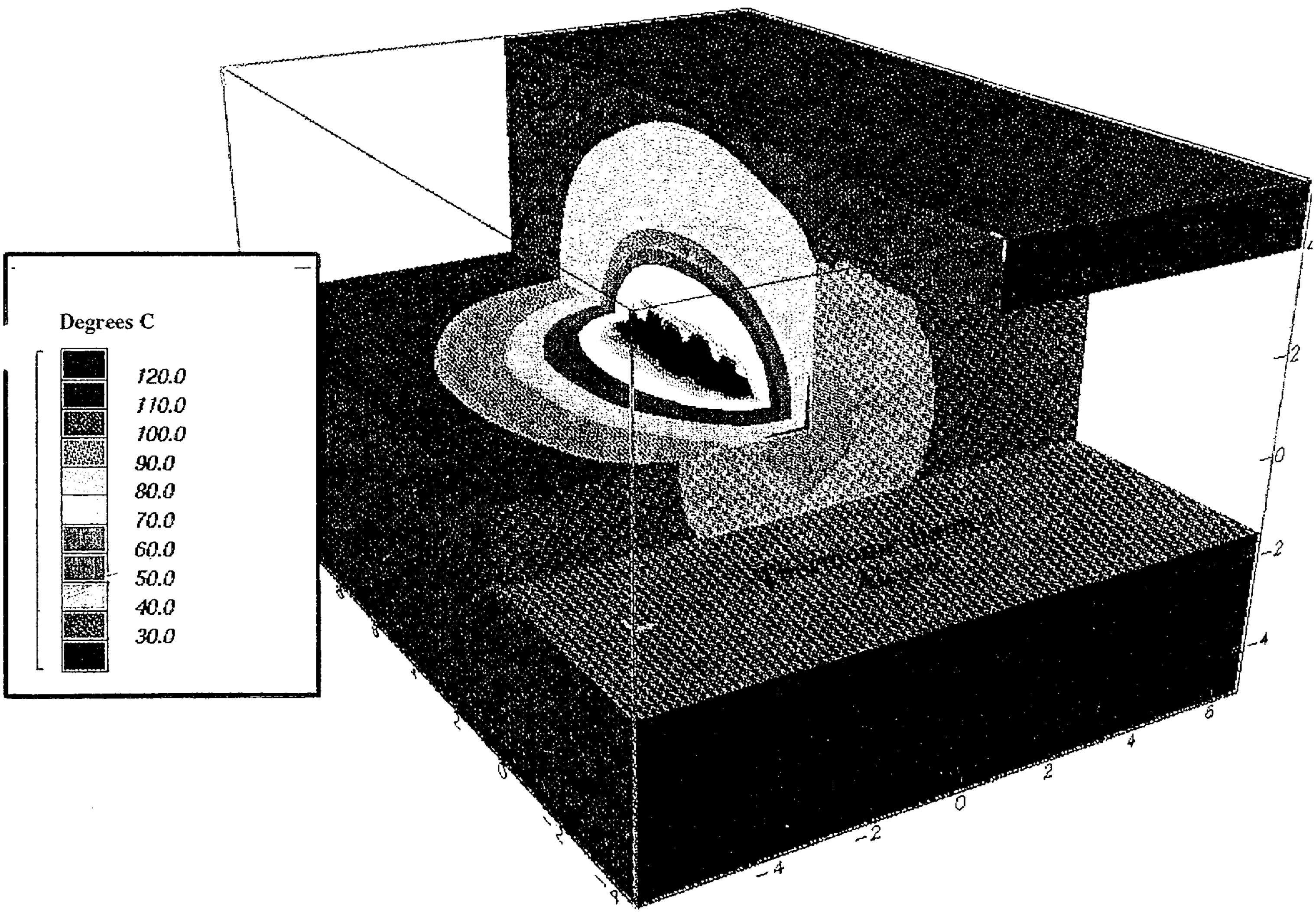


Single Heater Test: Predictions

Perspective Isotherms

Cutaway Along Heater

November 30, 1996 (Day 96)

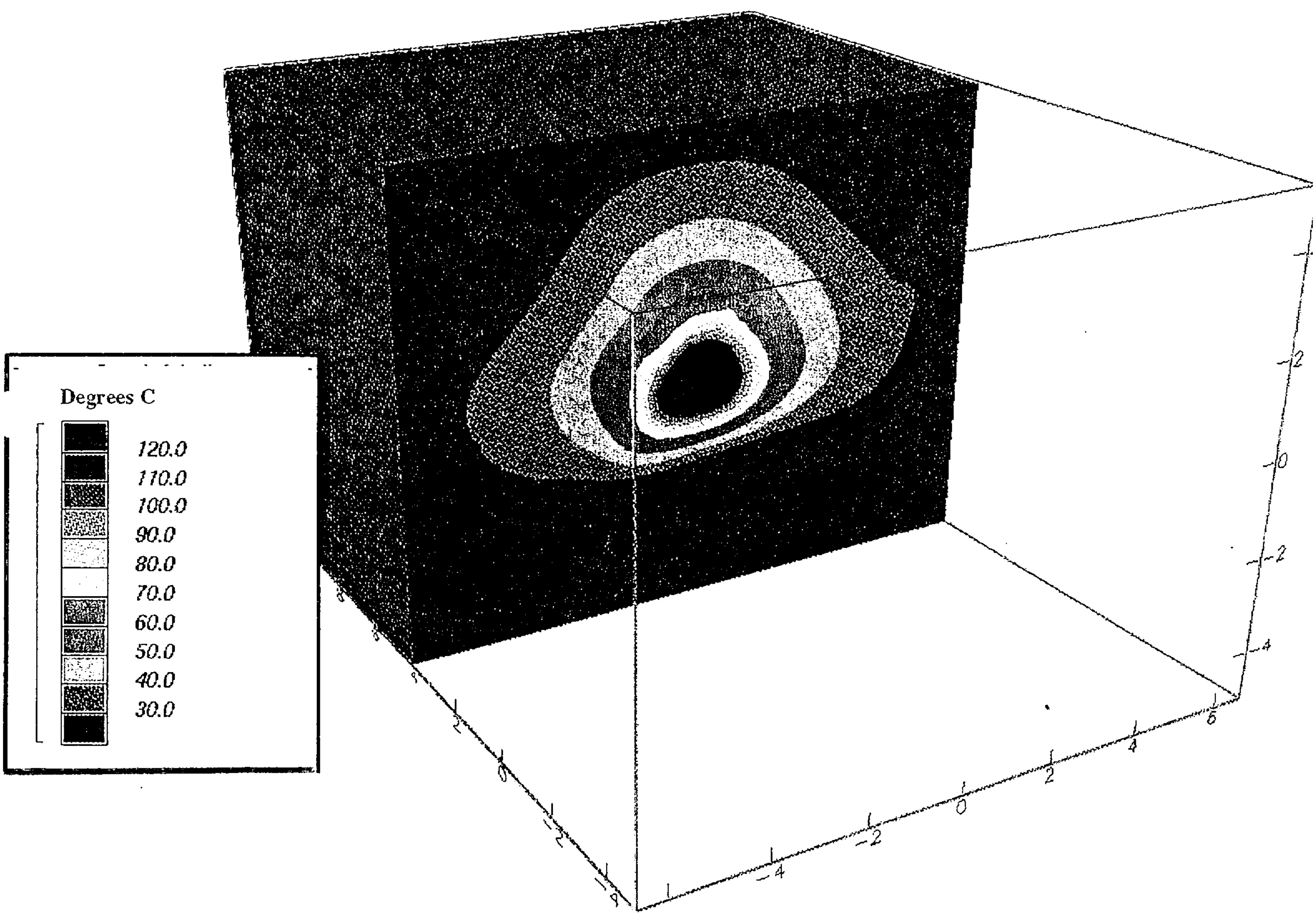


Single Heater Test: Measurements

Perspective Isotherms

Vertical Slice at Heater Midlength

November 30, 1996 (Day 96)

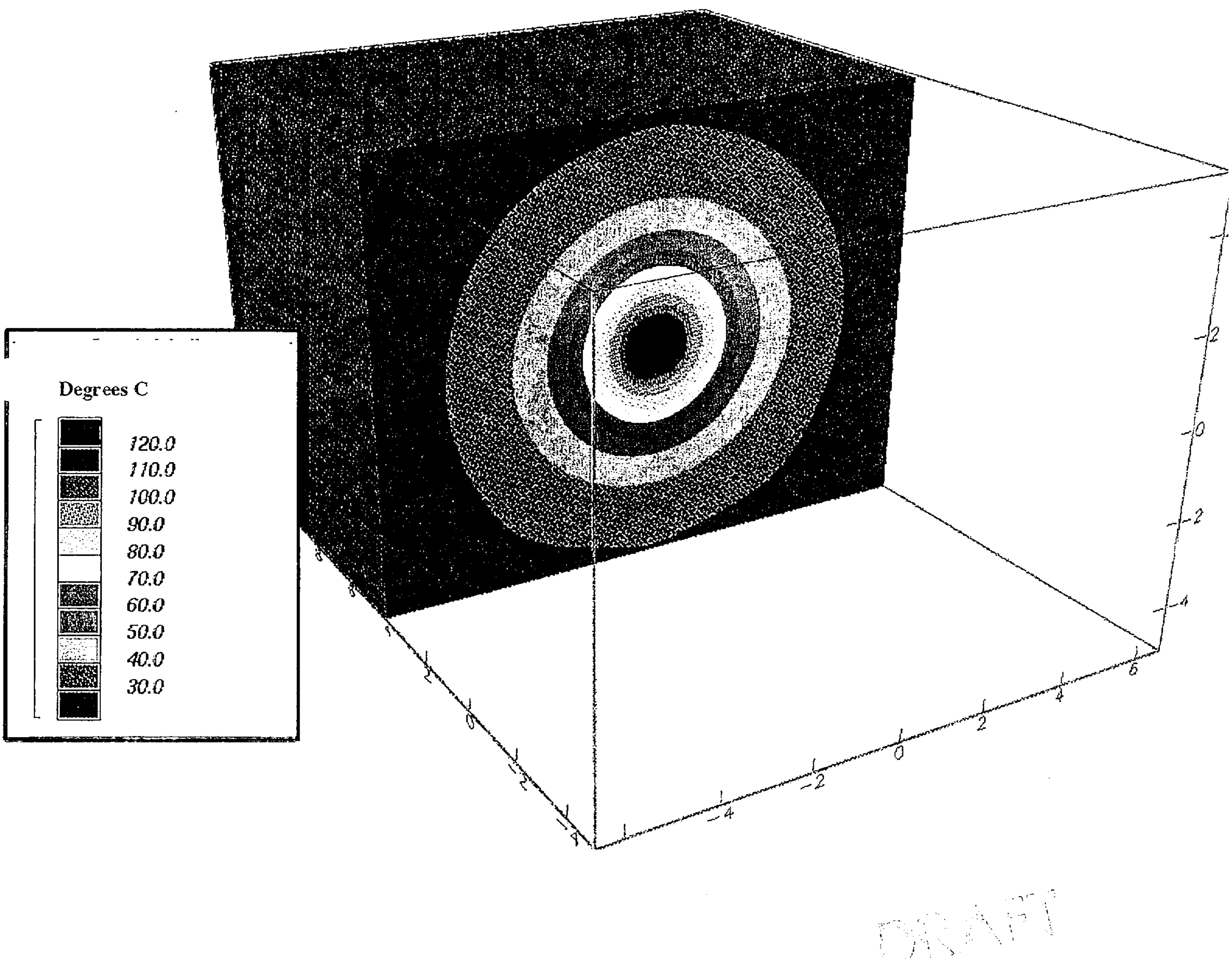


Single Heater Test: Predictions

Perspective Isotherms

Vertical Slice at Heater Midlength

November 30, 1996 (Day 96)

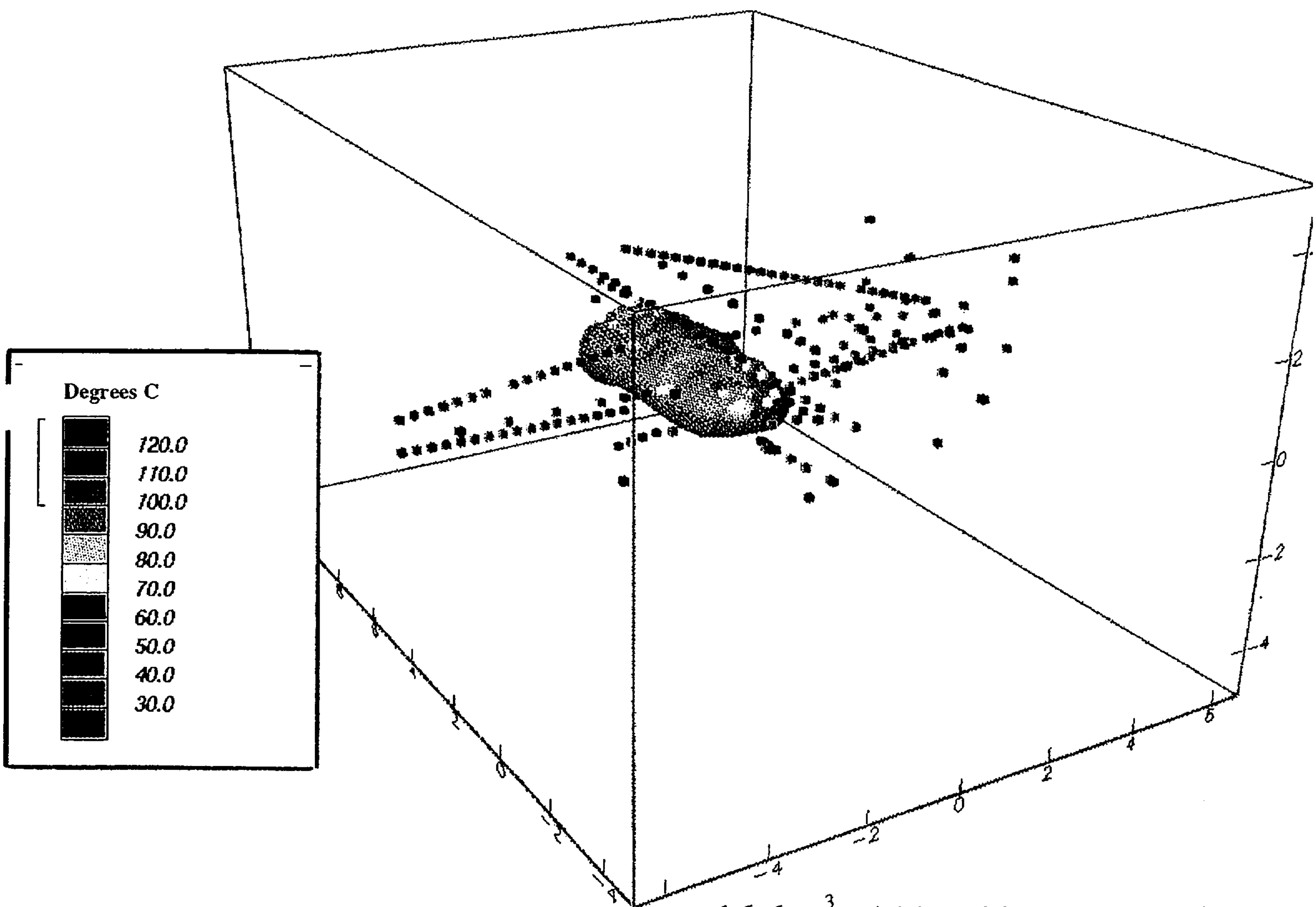


Single Heater Test: Measurements

Perspective Isotherms

100 Degree C Isotherm and Data Points

November 30, 1996 (Day 96)



16.6 m^3 within 100 degree isotherm

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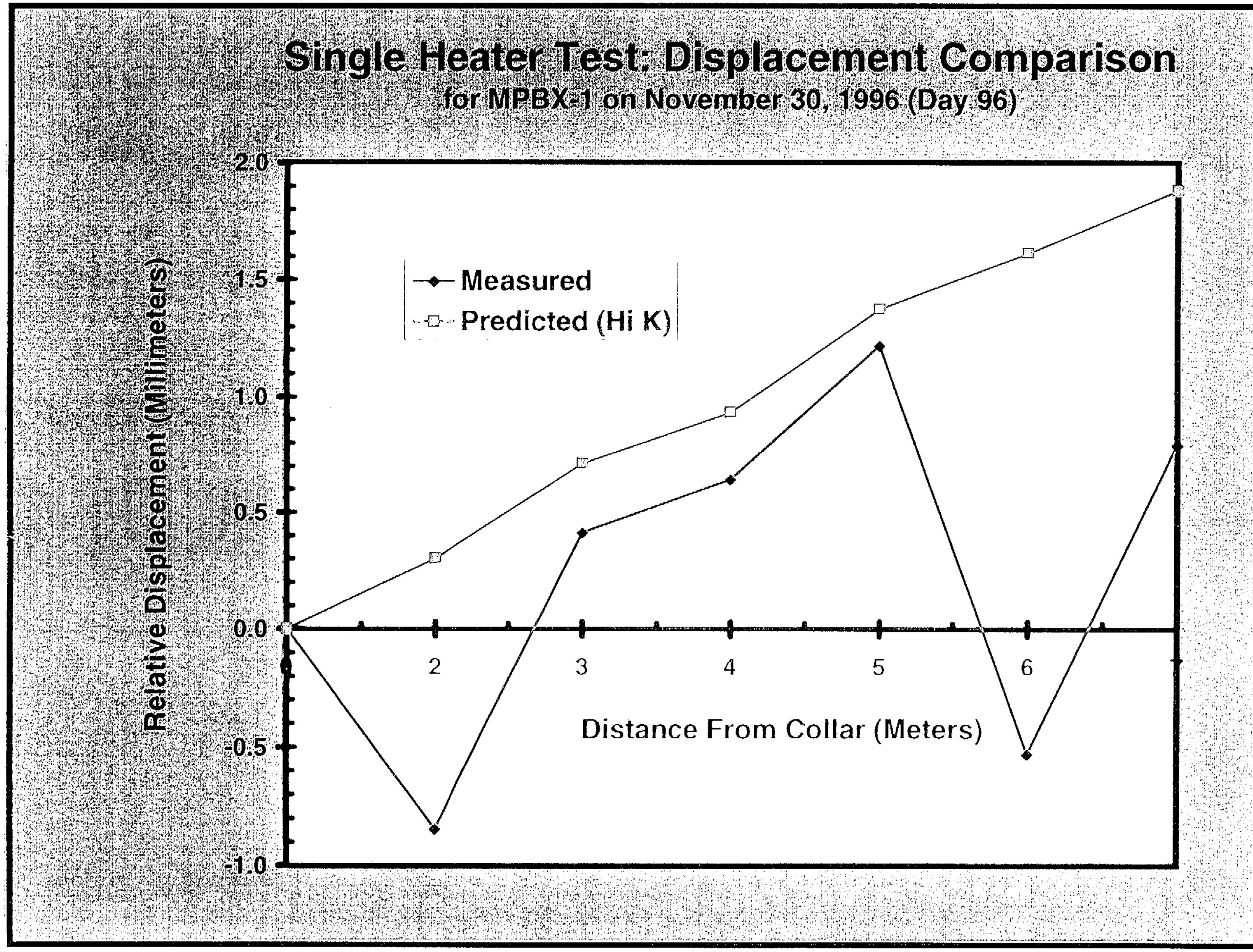
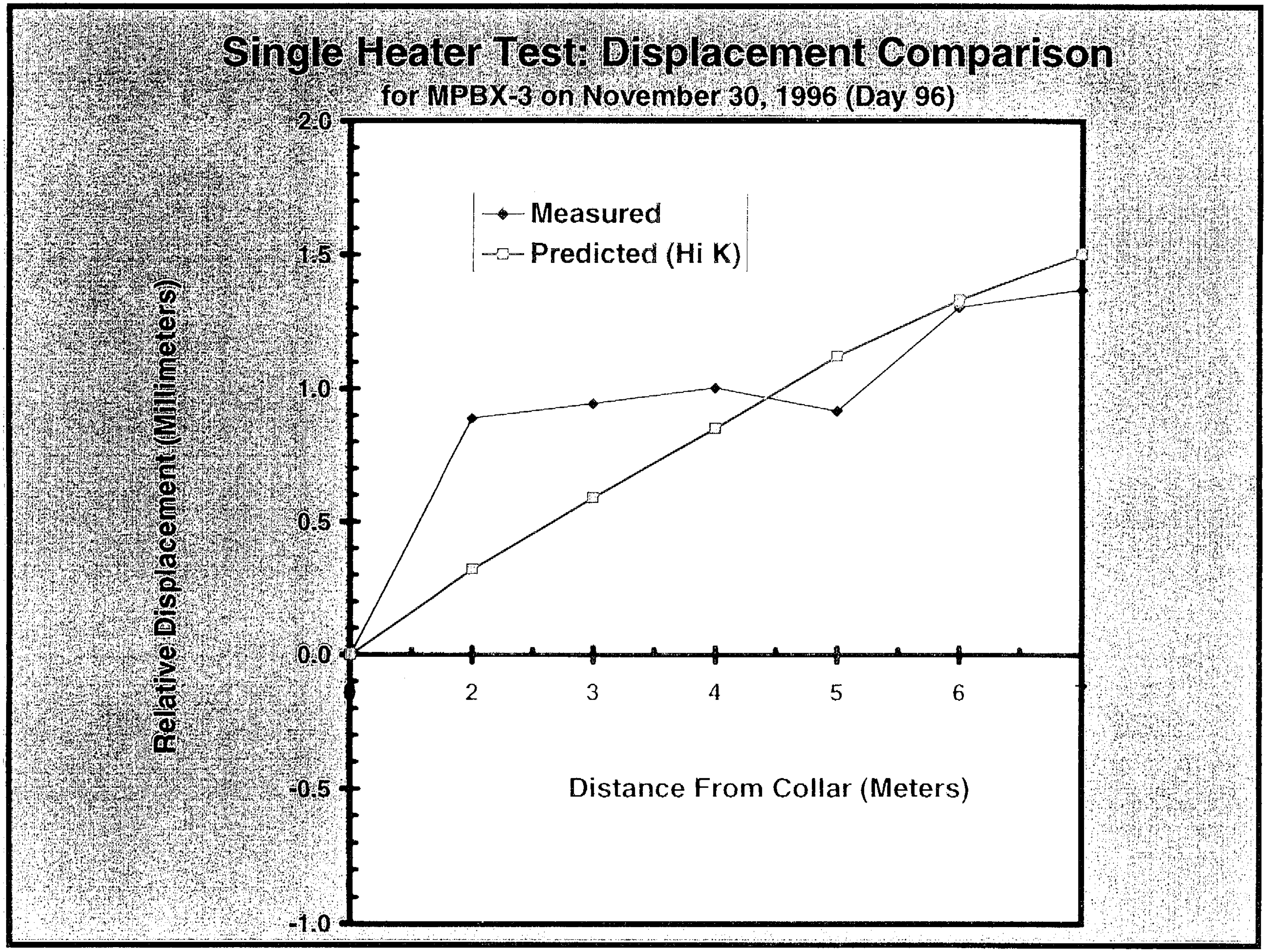
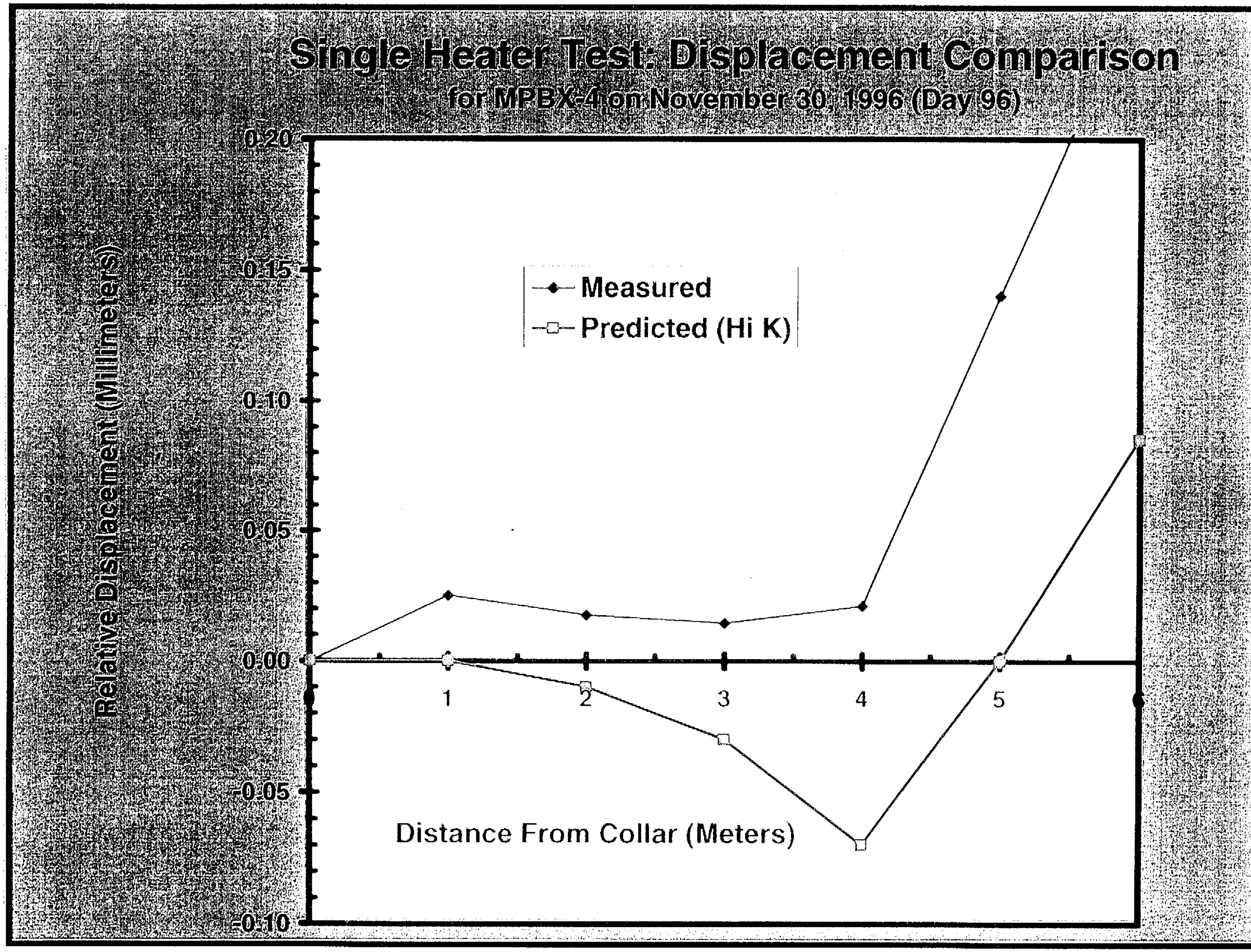
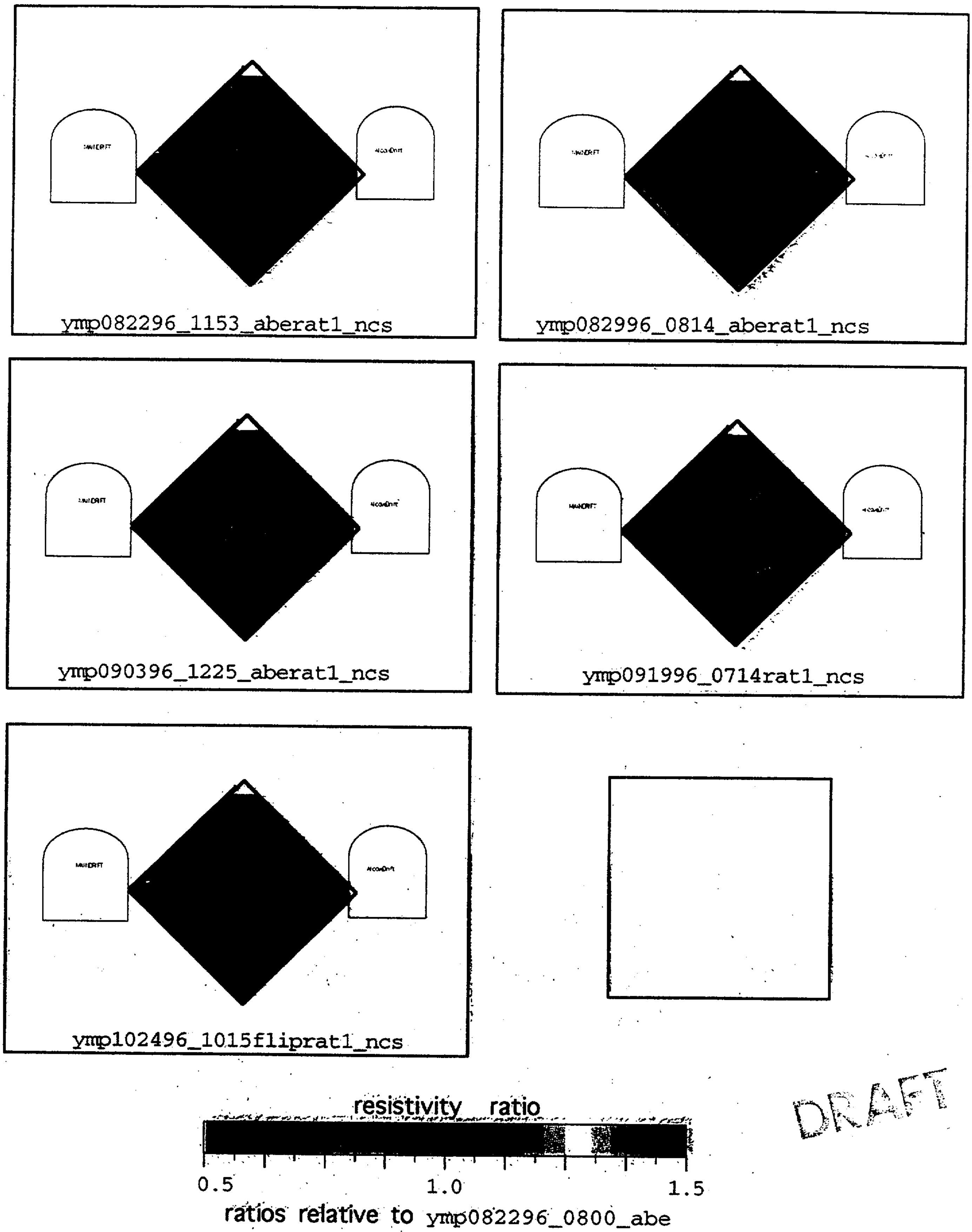

Single Heater Test: Displacement Comparison
for MPBX-1 on November 30, 1996 (Day 96)
Measured
Predicted (Hi K)
Relative Displacement (Millimeters)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
2
3
4
5
6
Distance From Collar (Meters)


Single Heater Test: Displacement Comparison
for MPBX-3 on November 30, 1996 (Day 96)
Measured
Predicted (Hi K)
Relative Displacement (Millimeters)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
2
3
4
5
6
Distance From Collar (Meters)


Single Heater Test: Displacement Comparison
for MPBX-4 on November 30, 1996 (Day 96)
Relative Displacement (Millimeters)
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
Measured
Predicted (Hi K)
1
2
3
4
5
Distance From Collar (Meters)


ymp082296_1153_aberat1_ncs
ymp082996_0814_aberat1_ncs
ymp090396_1225_aberat1_ncs
ymp091996_0714rat1_ncs
ymp102496_1015fliprat1_ncs
resistivity ratio
0.5
1.0
1.5
ratios relative to ymp082296_0800_abe

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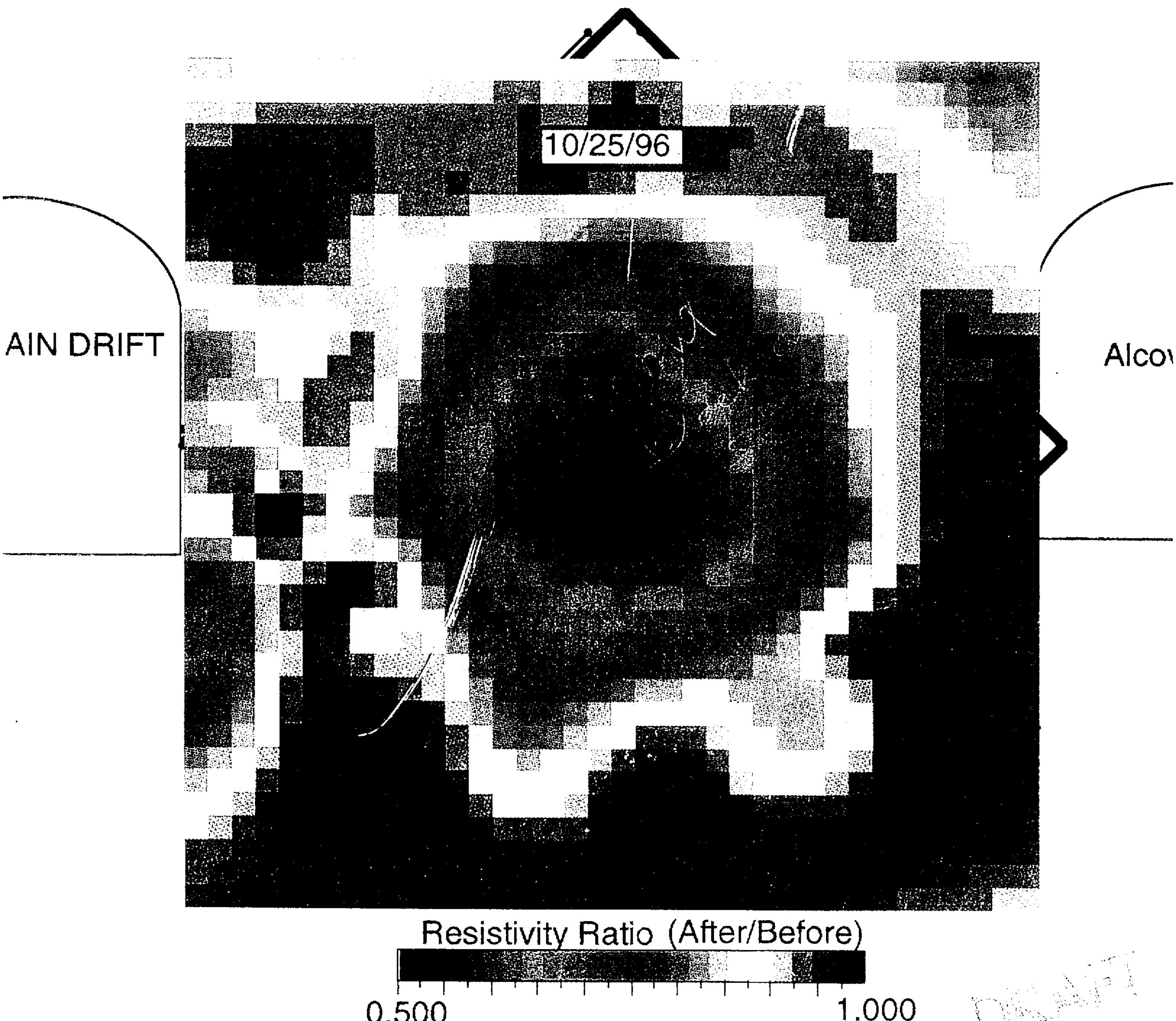
Single Heater Test: Measurements

Liquid Saturation Contours

Vertical Slice Along ERT Boreholes

October 25, 1996 (Day 60)

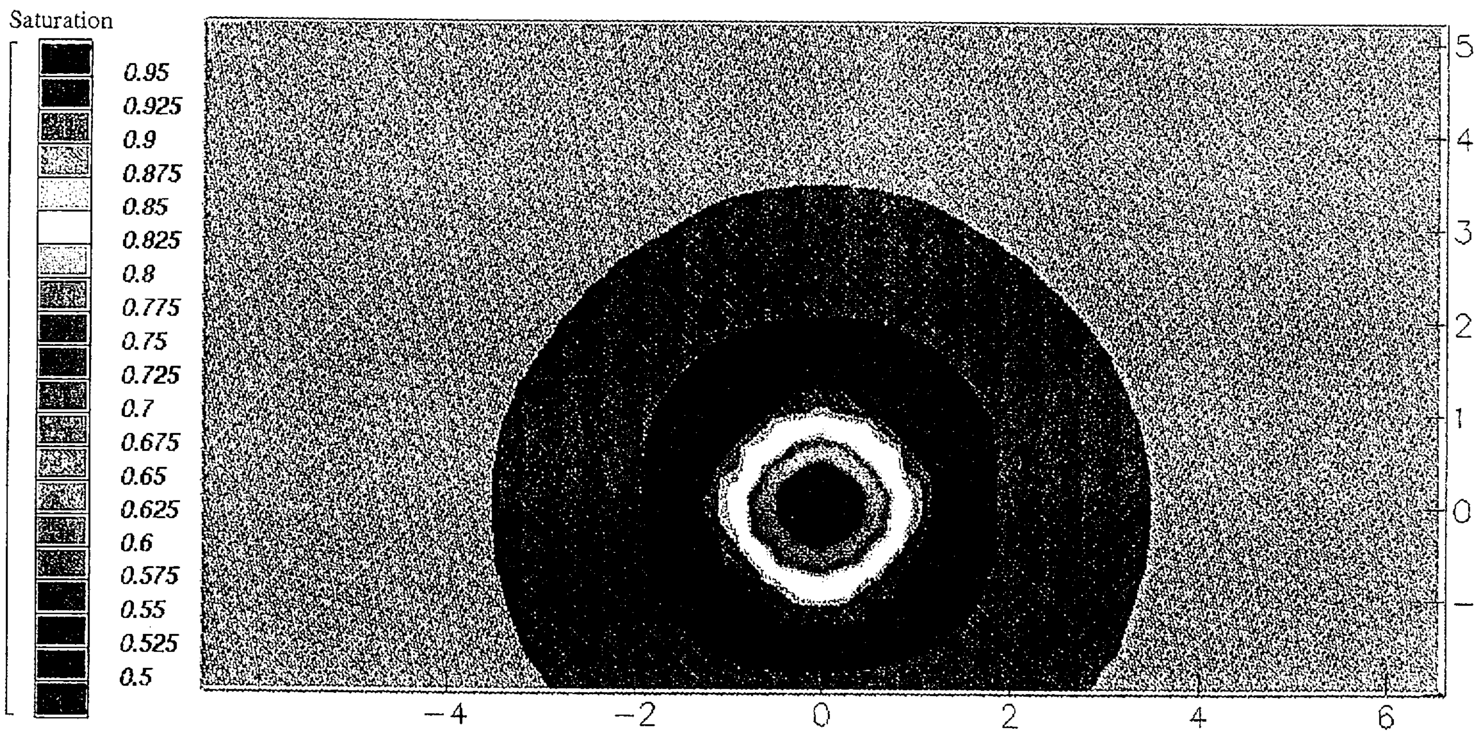


Single Heater Test: Predictions

Liquid Saturation Contours

Vertical Slice Along ERT Boreholes

October 25, 1996 (Day 60)



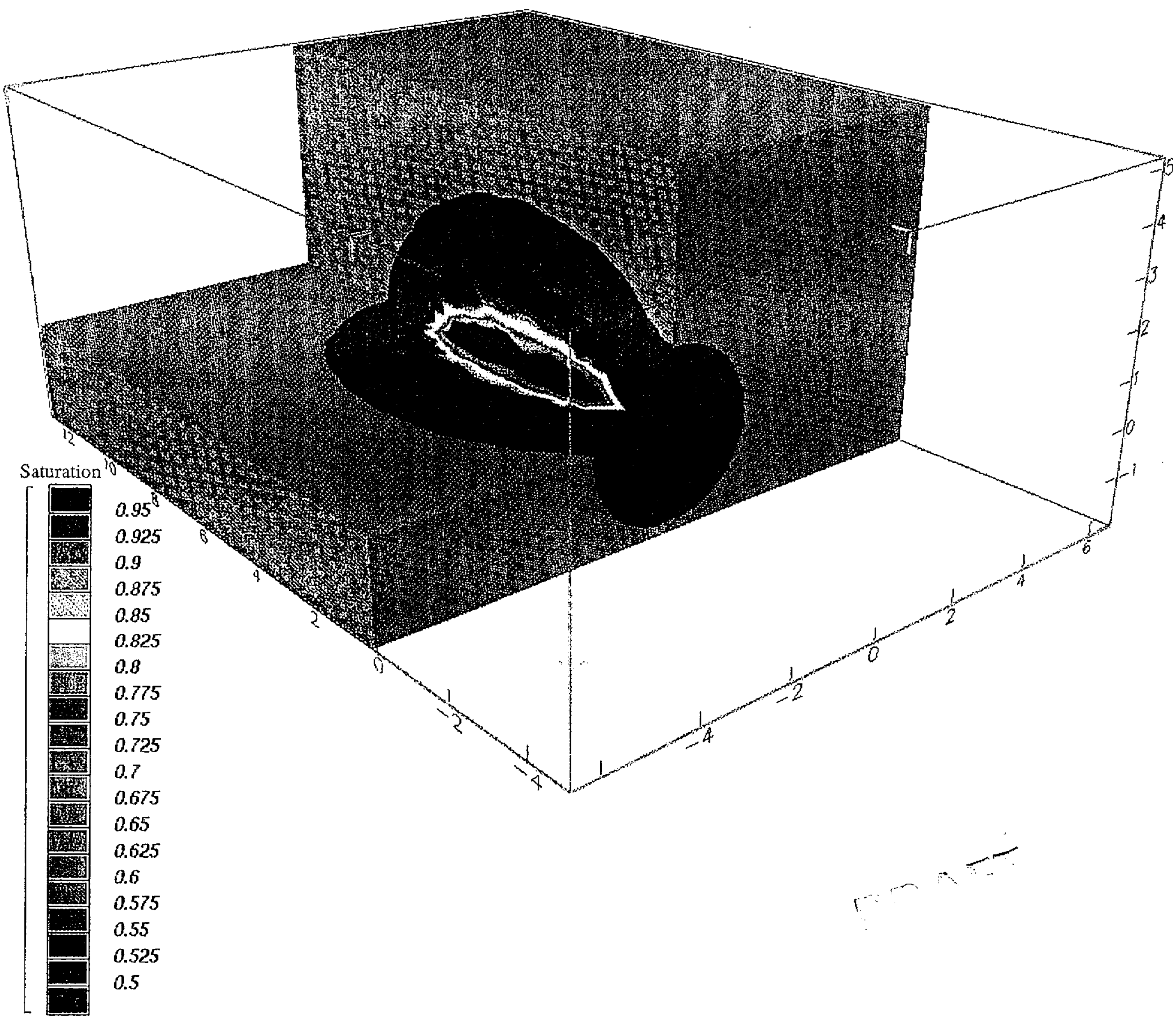
DRAFT

Single Heater Test: Predictions

Liquid Saturation Contours

Cutaway Along the Heater

October 25, 1996 (Day 60)



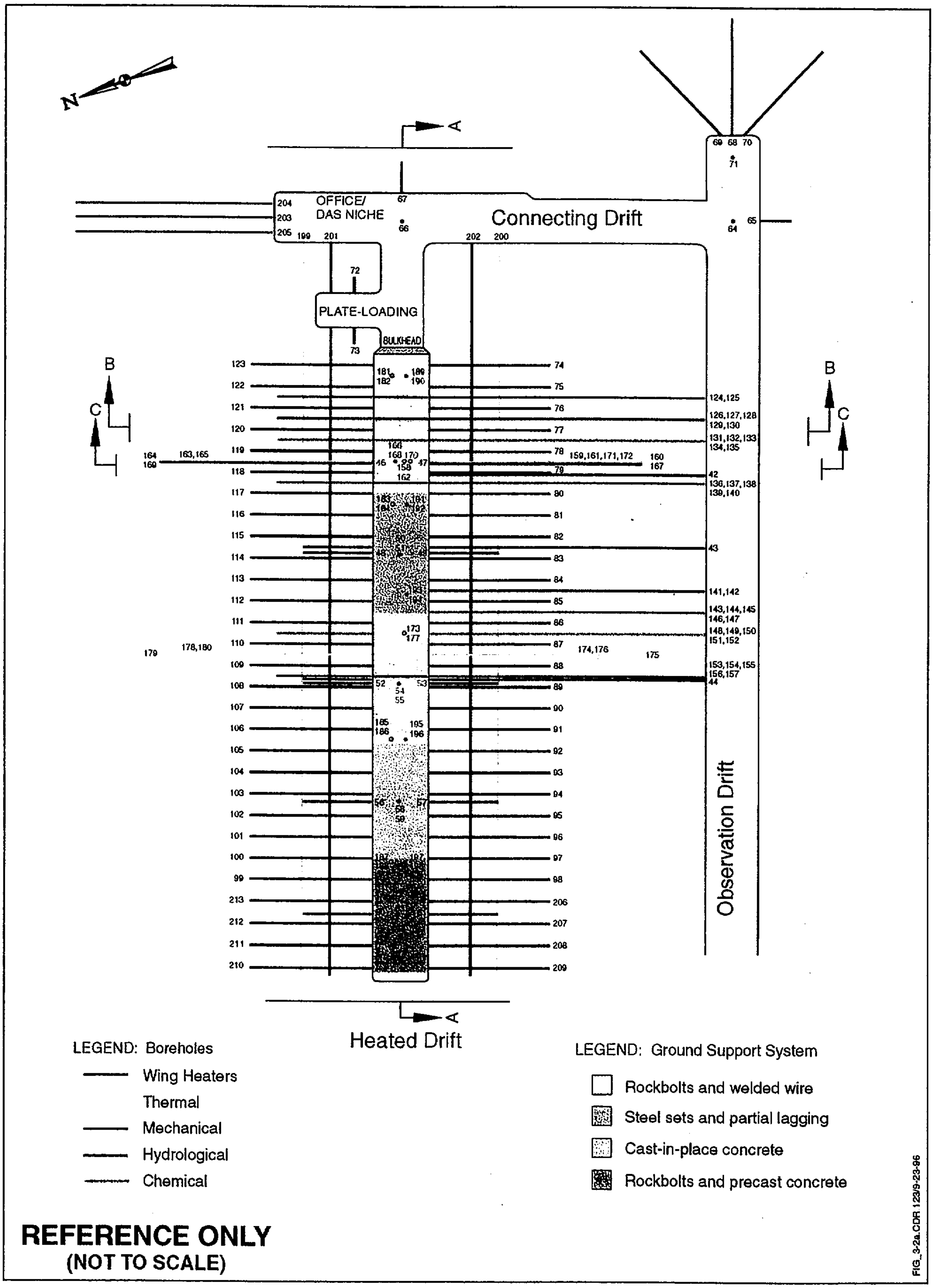
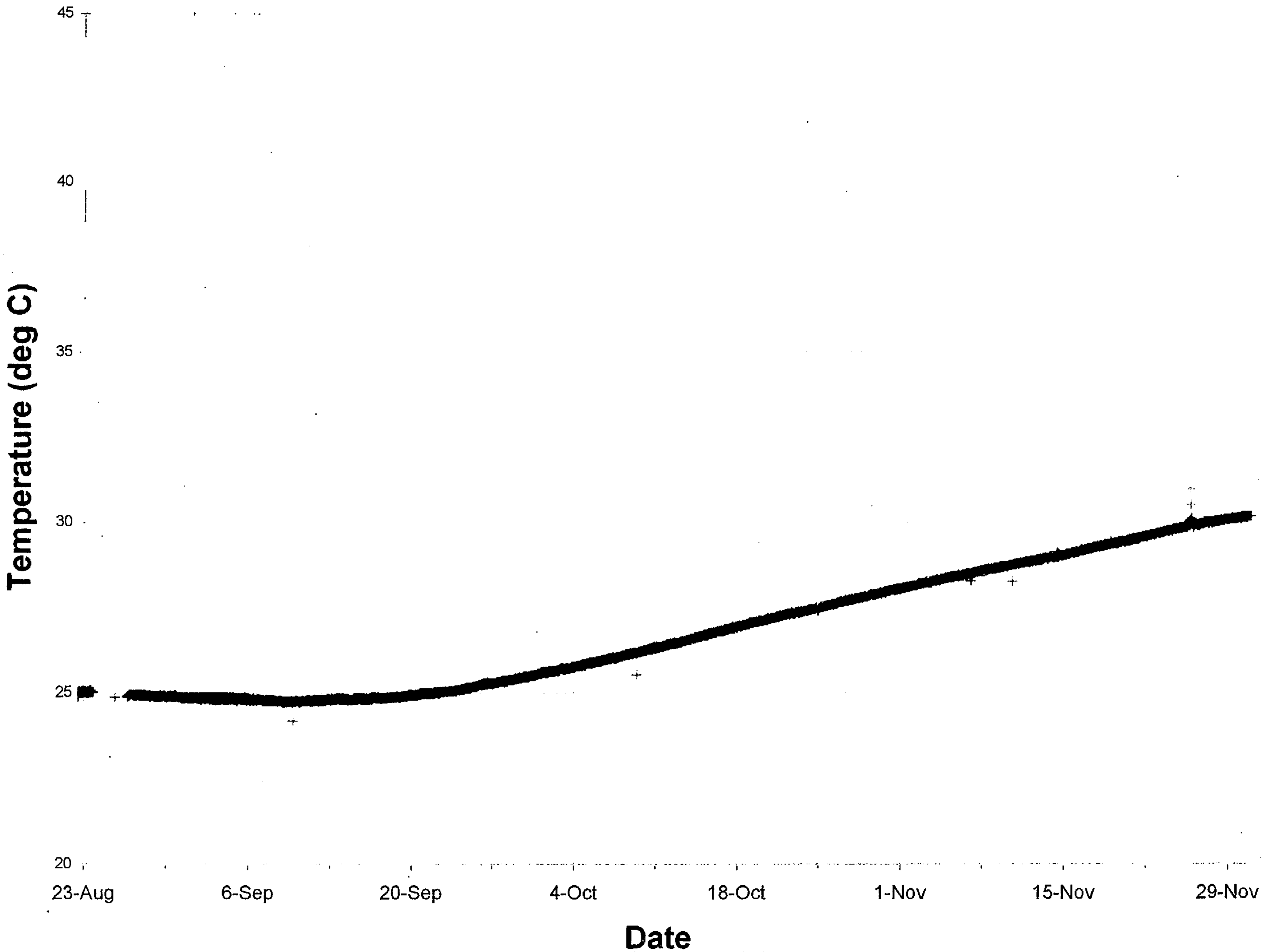
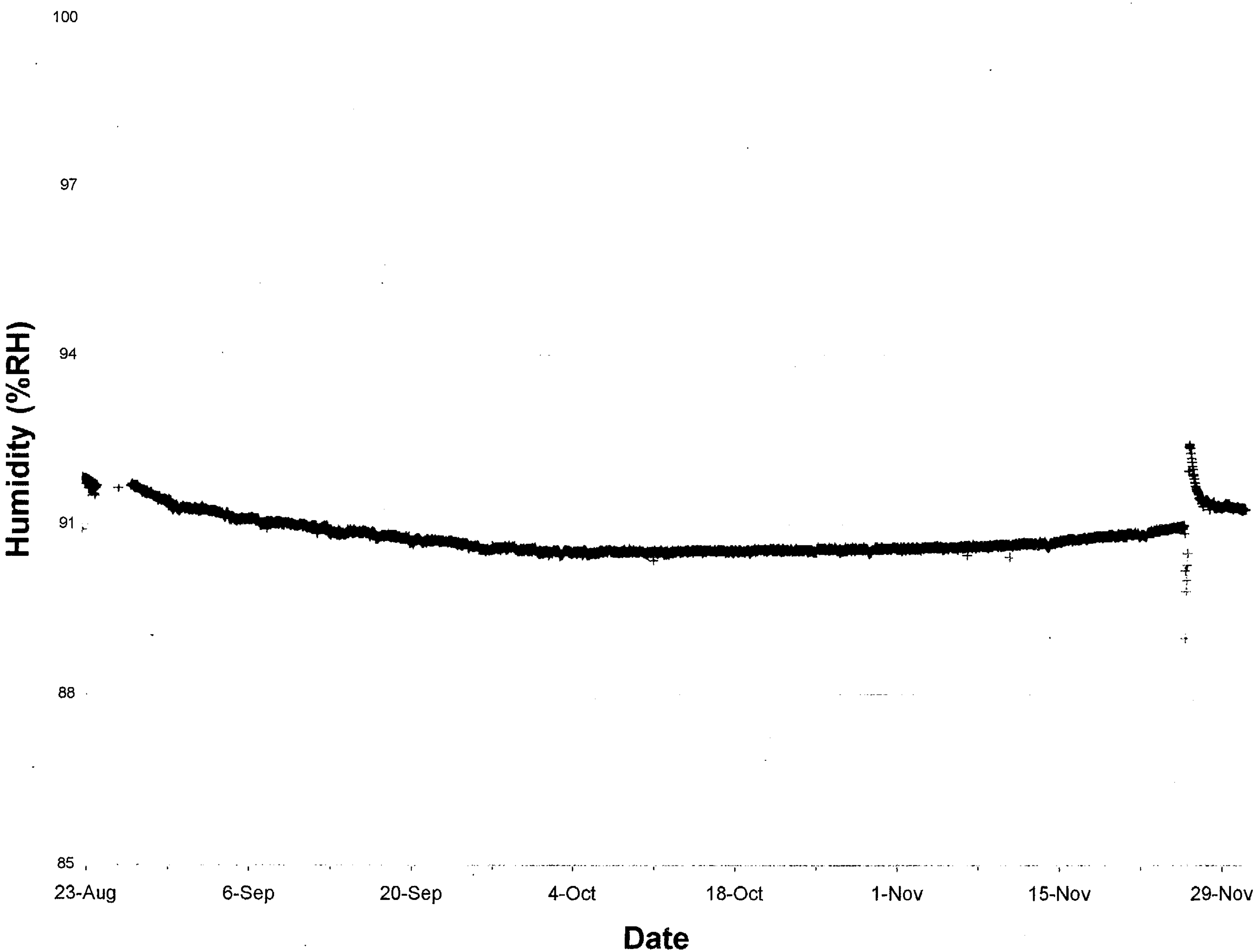


Figure 3-2a Layout of Drift Scale Test

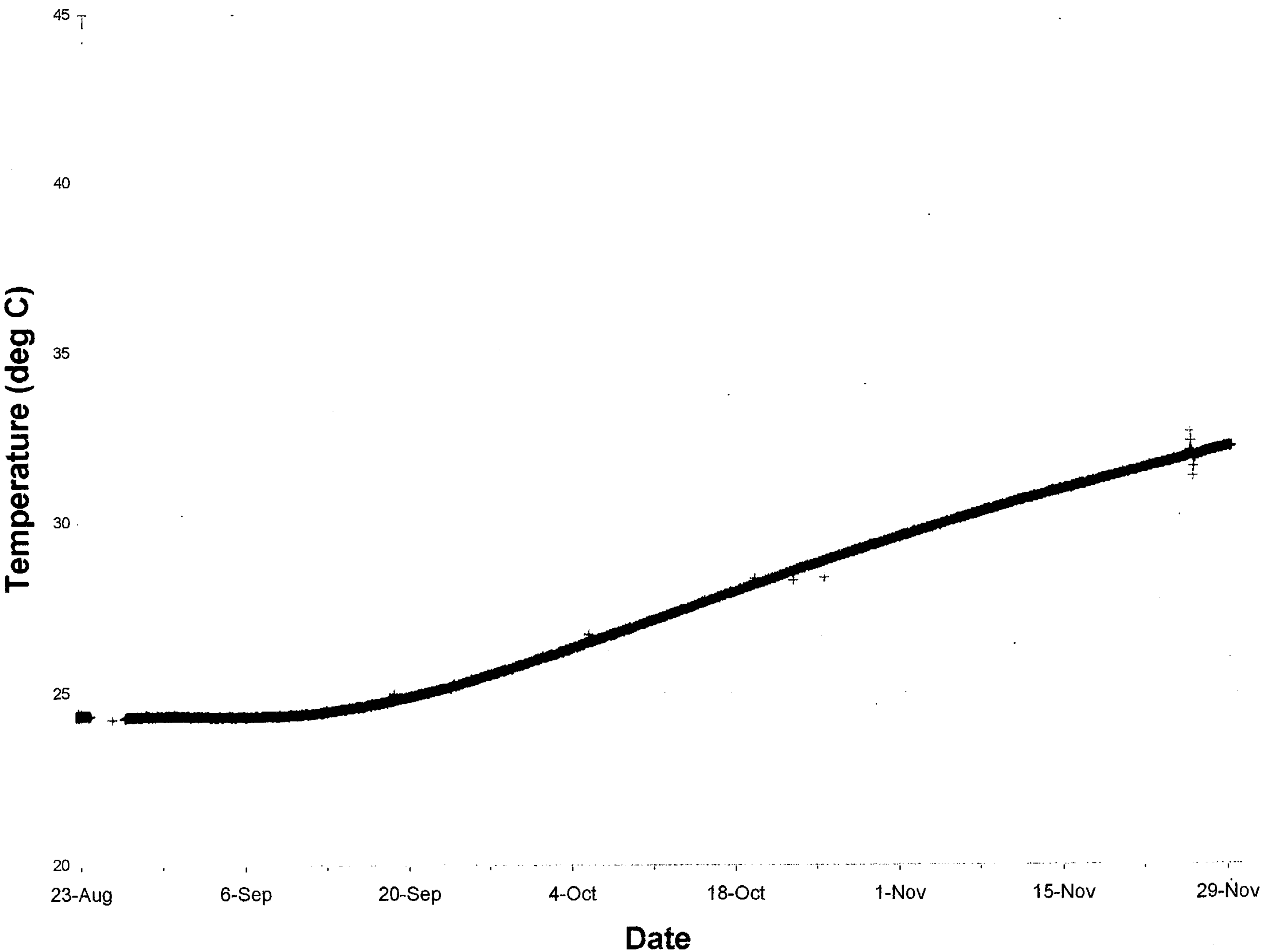
Temperature at TMA-TEMP-16-1



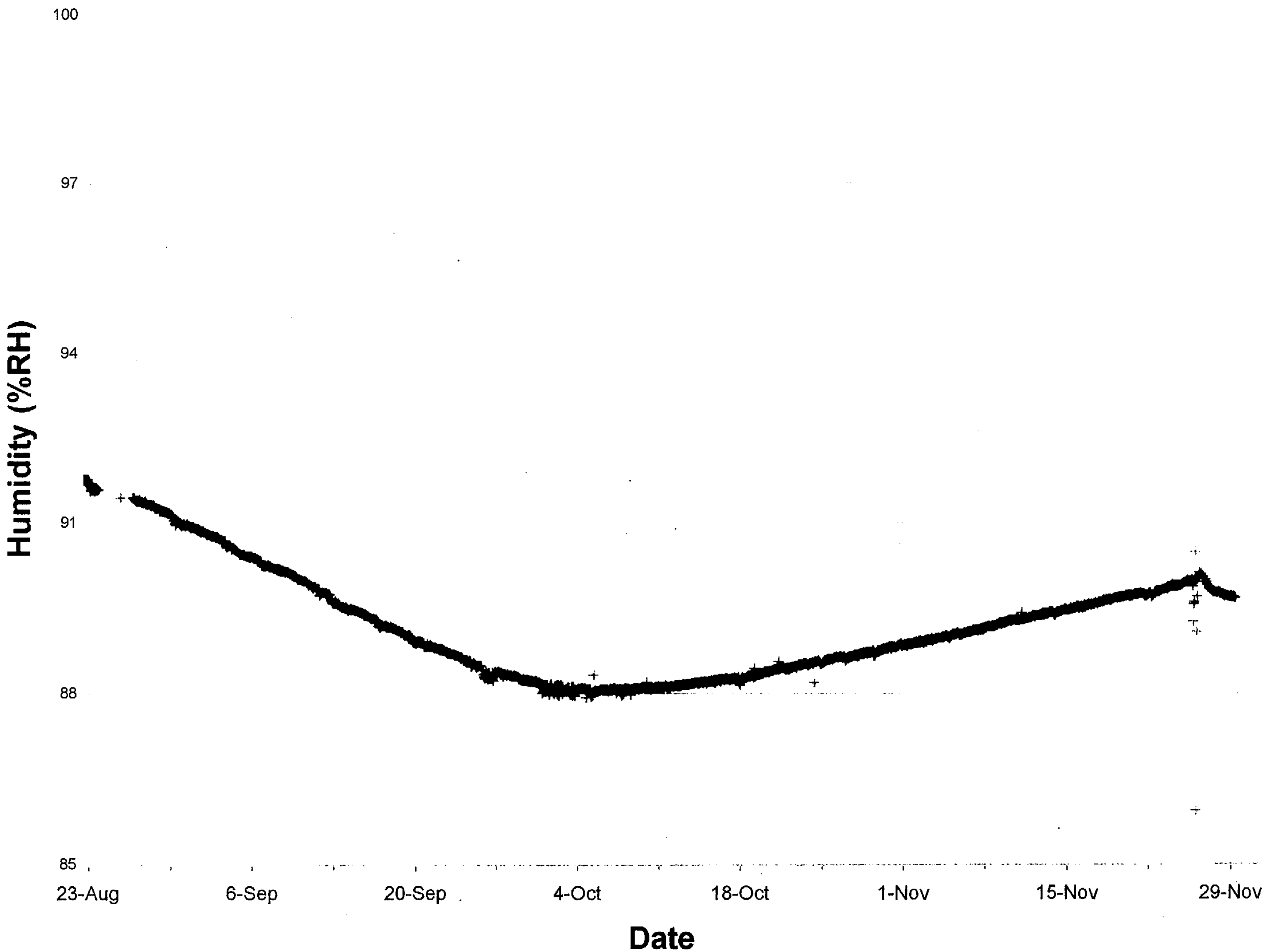
Humidity TMA-HUM-16-1



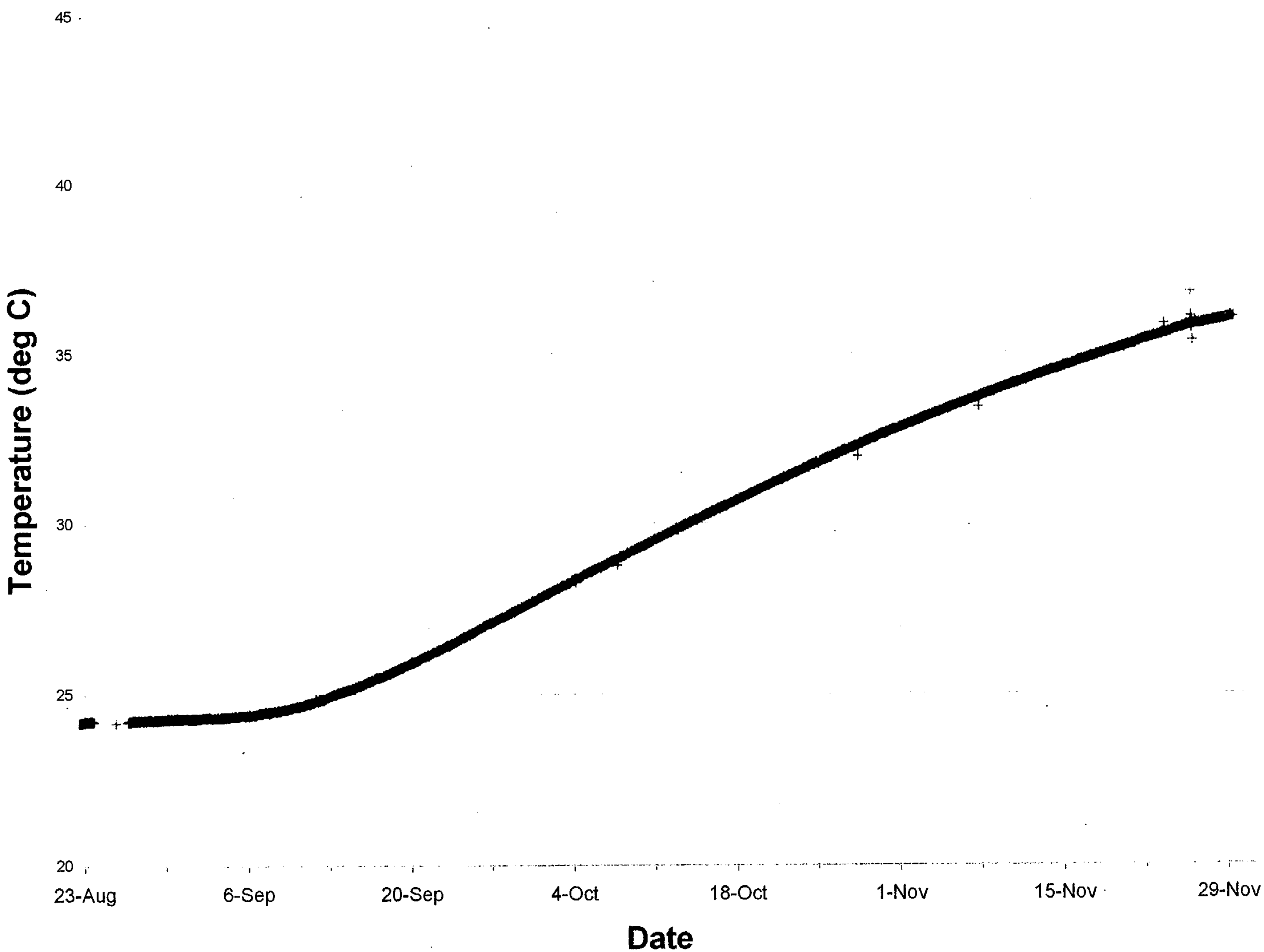
Temperature at TMA-TEMP-16-2



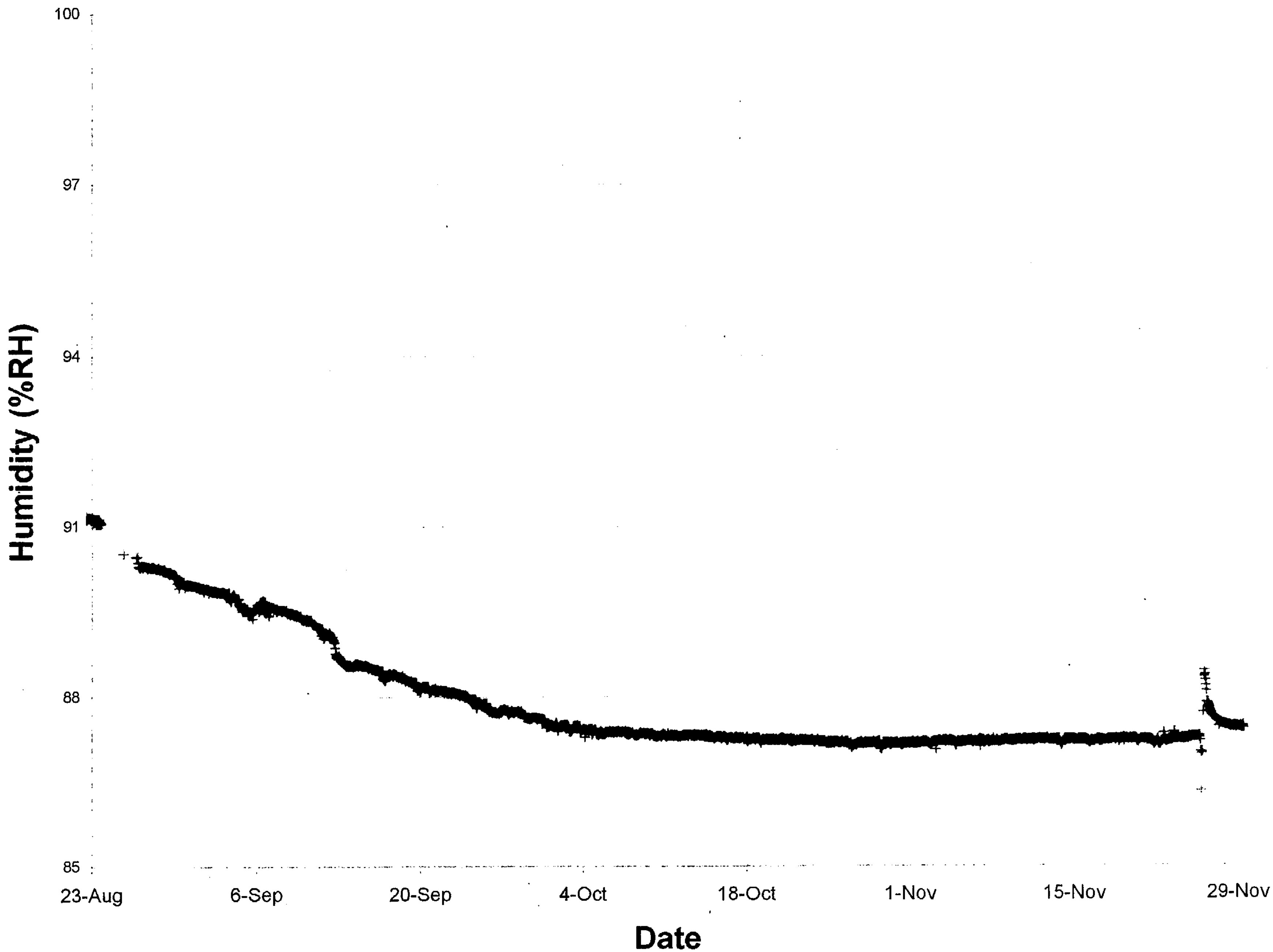
Humidity TMA-HUM-16-2

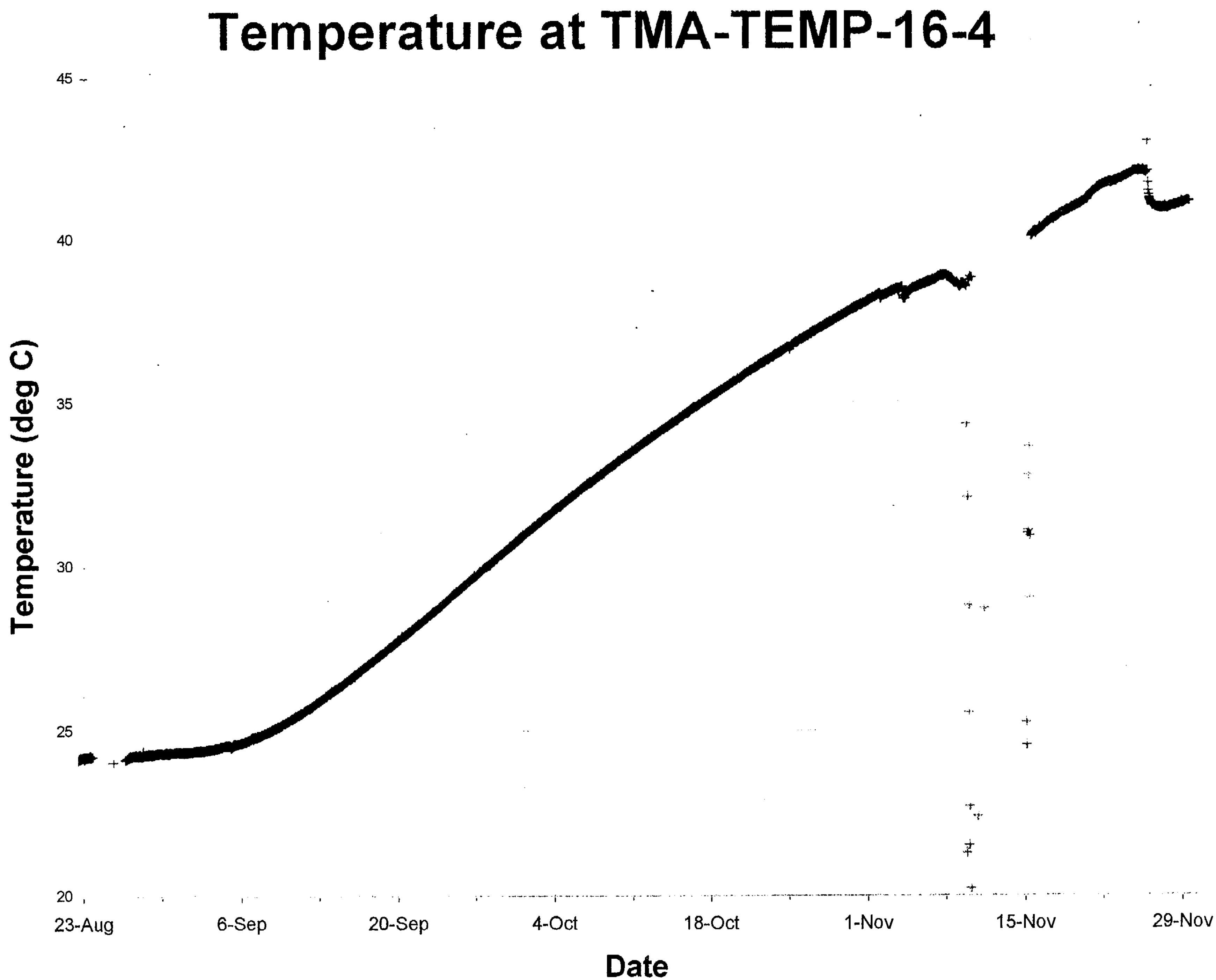


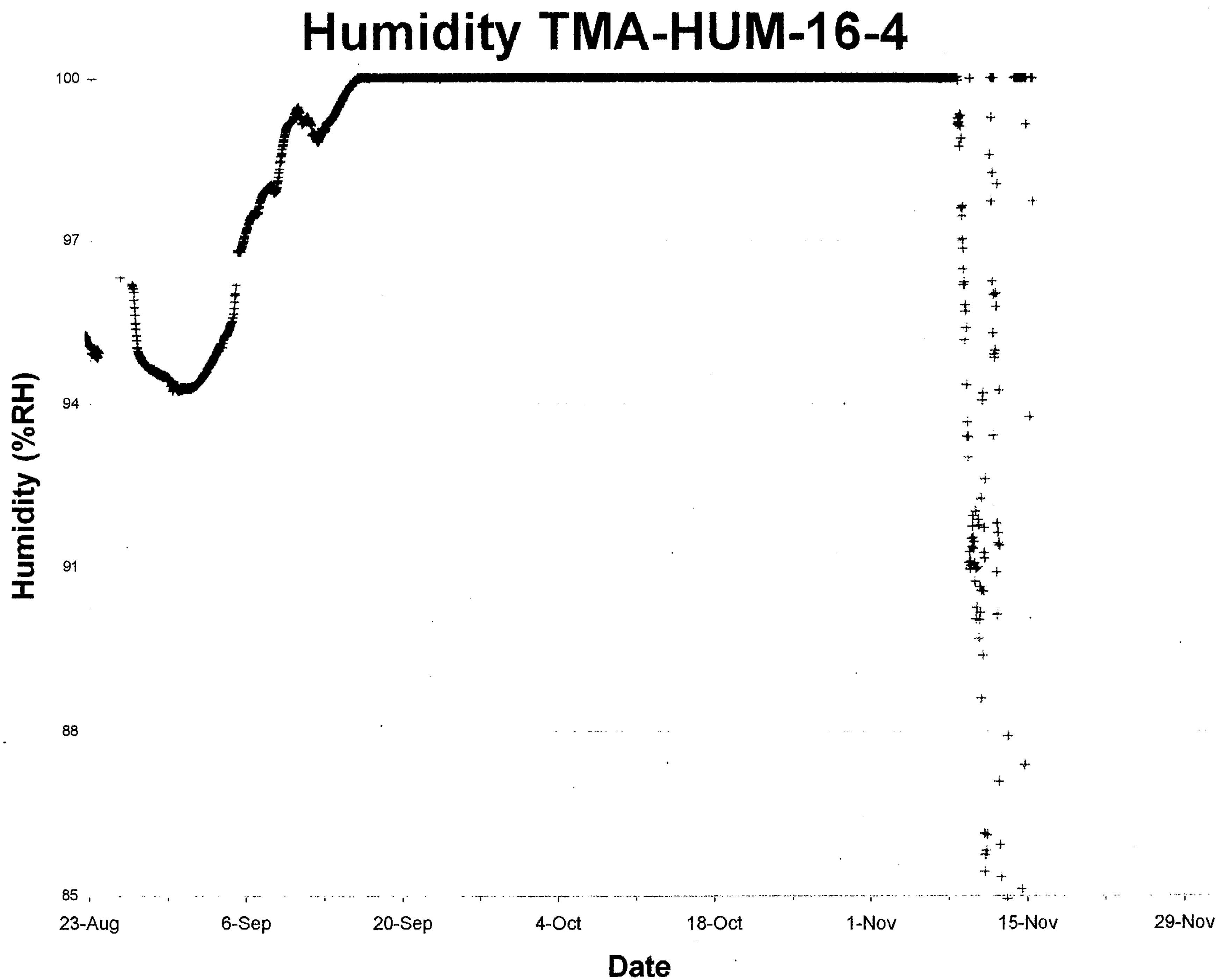
Temperature at TMA-TEMP-16-3



Humidity TMA-HUM-16-3




Temperature at TMA-TEMP-16-4
Temperature (deg C)
45
40
35
30
25
20
23-Aug
6-Sep
20-Sep
4-Oct
18-Oct
1-Nov
15-Nov
29-Nov
Date



Humidity TMA-HUM-16-4
Humidity (%RH)
100
97
94
91
88
85
23-Aug
6-Sep
20-Sep
4-Oct
18-Oct
1-Nov
15-Nov
29-Nov
Date

ATTACHMENT 6

Civilian Radioactive Waste Management System

Management & Operating Contractor

TRW Environmental Safety Systems Inc.

DOE/NRC ESF Technical Meeting

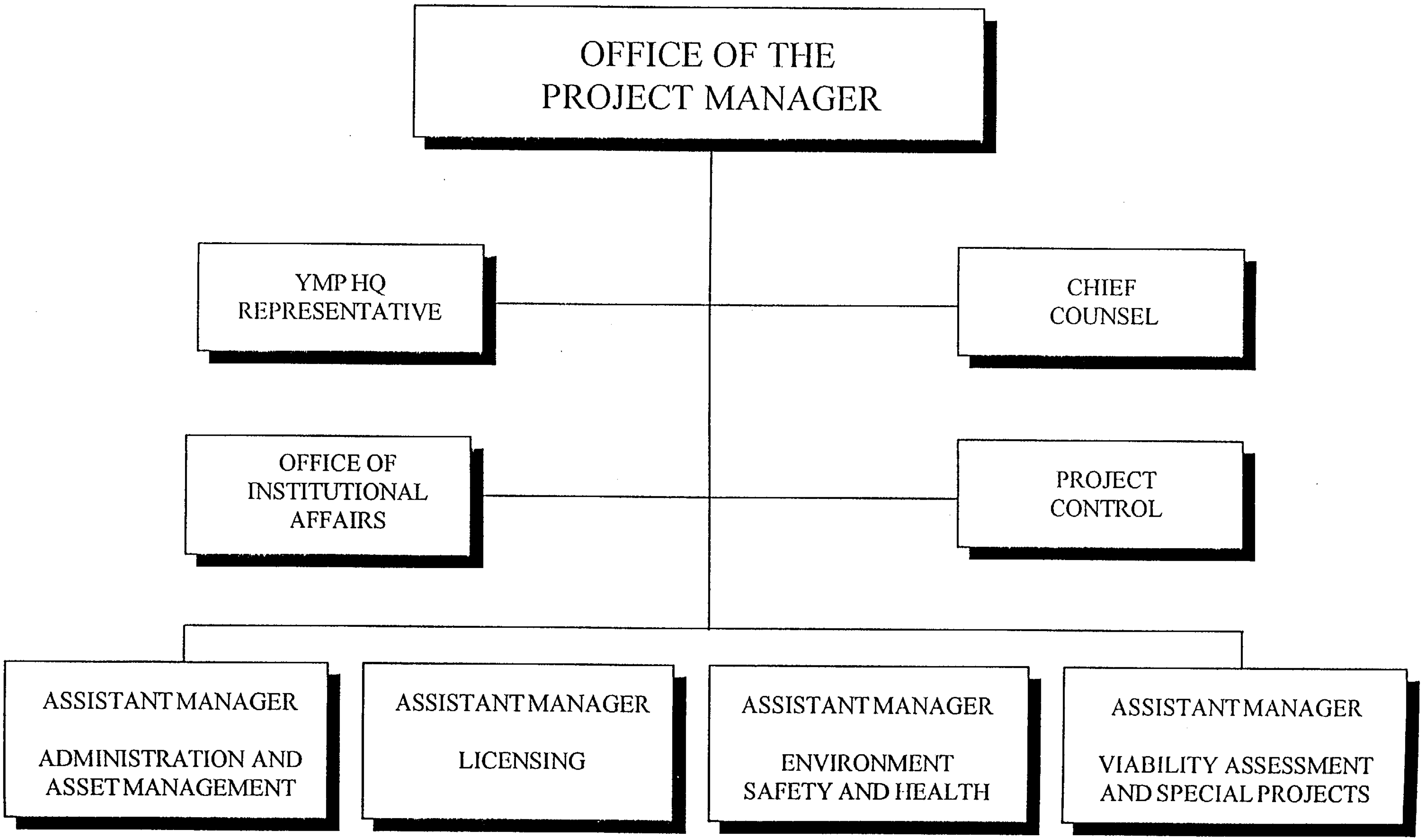
Engineering Design Program

Jack N. Bailey

YMSCO Reorganization/Design Impact

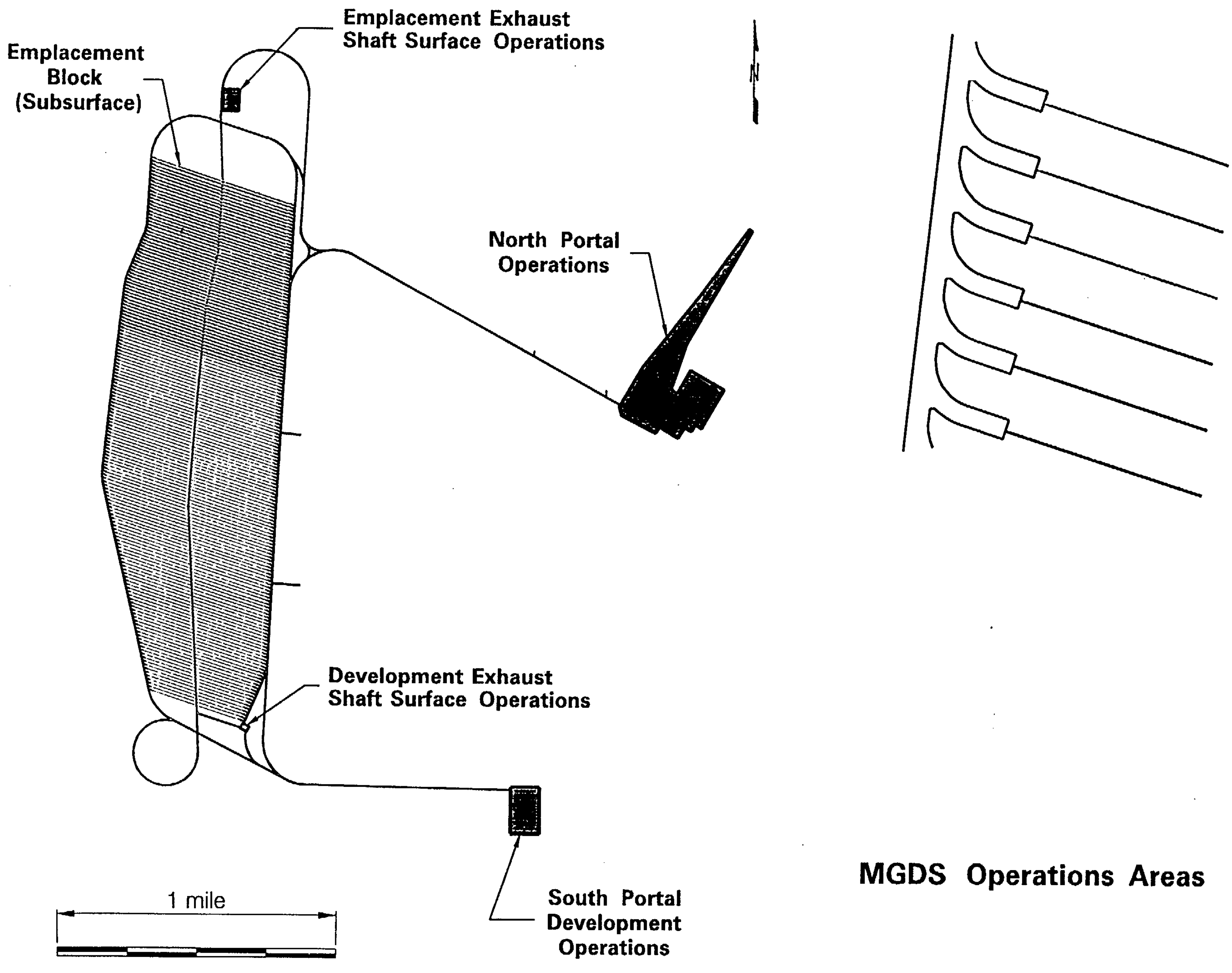
- **Organization Chart**

YUCCA MOUNTAIN SITE CHARACTERIZATION OFFICE

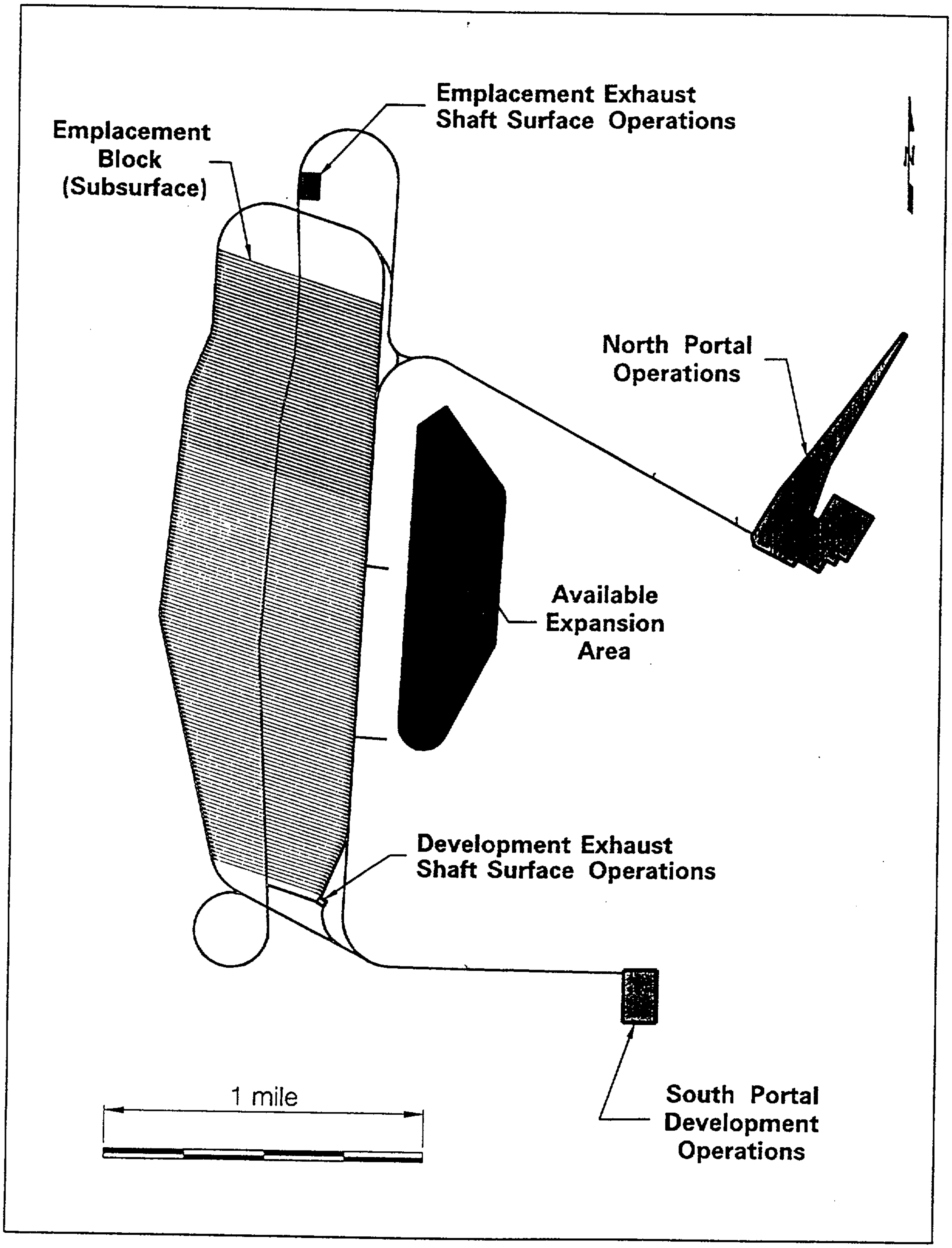


Repository Footprint

- Repository Footprint (Proposed)
  - Planned extension Upper Block 300m North
  - Eliminate Lower Block (East of Ghost Dance Fault)
  - Reduction from 240 to about 190 km excavated drifts
- Advantages
  - Nearly the same storage capacity
  - Simpler construction/ less cost
  - Easier operation

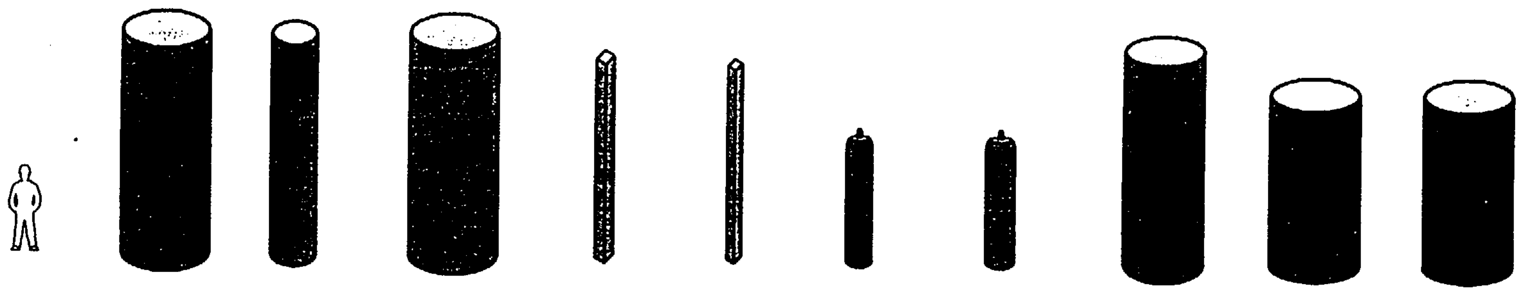


MGDS Operations Areas



MGDS Operations Areas

Representative Waste Form Data



	Received		Transferred					Emplaced		
	Rail Cask	Truck Cask	SNF Canister	PWR Assy	BWR Assy	DOE SNF	DHLW Canister	SNF DC	DHLW DC 5	DHLW DC 4
Loaded Weight (tonnes)	105	25	31	0.9	0.4	2.0	2.4	53	39	34
Peak Units per Year	420	140	460	4,900	8,300	103	800	370	160	200

Key

BWR	Boiling Water Reactor
DC	Disposal Container
DC 4	4 Pack
DC 5	5 Pack DOE Center
DHLW	Defense High Level Waste
PWR	Pressure Water Reactor
SNF	Spent Nuclear Fuel

Repository Physical Characteristics

- Disposal of 70,000 MTU
  - In 11, 000 1.7 to 1.8 meter diameter containers
- Horizontal emplacement in underground drifts
  - 160 km miles of 4.6- to 6 meter diameter tunnel
  - 360 Hectacres of emplaced area
  - 200 to 400 meters below the surface in welded tuff

Repository Physical Characteristics (cont'd)

- Surface facilities
  - 29 buildings for emplacement, excavation, and support
  - 800,000 ft^2 of floor space (~ 18 football fields)
- Staffing: 600 for surface and subsurface operations; 300 for underground drift excavation

Engineering Design Description

One Pass Program

Ongoing development of a Single Design to support:

- Viability Assessment
- Environmental Impact Statement and
- License Application

Developed over 5 year period

Engineering Design Description (cont'd)

Near Term Goal of Design

- Develop reference design for viability assessment
  - A design tied directly to Total System Performance Assessment for viability assessment (TSPA)
  - Identify tentative/likely resolution to engineering drivers
- VA Reference Design
  - A design that balances the overall facility
  - Adds additional confidence to the TSPA- VA design
  - Develops potential solutions to resolve unprecedented regulatory designs
  - Define requirements for the systems, structures & components

Engineering Design Description (con't)

- Continuing Activity - Develop the LA Design
  - Develop designs to appropriate detail for LA
  - Identify changes to design as a result of ongoing scientific results, potential reallocation of performance and design development

Repository Progress

- Yucca Mountain Project Repository Plan

- FY'97 Design Development Includes:
  - Analyses 28
  - Specifications 25
  - Drawings 121

NOTE: Detailed planning for FY'98 currently in process

ESF Concrete Inverts

- **Emplaced Inverts**
  - Original planning was to use a small number of inverts supporting steel sets
  - Temporary
  - Non-qualified
  - Removable
    - Repository design will
      - a) Qualify (use as installed)
      - b) Modify (i.e. grout, overlay)
      - c) Replace (New design to specific requirements)
- **Change Not Warranted (at this time)**
  - Inverts satisfy ESF Function
  - Invert can be modified

ESF Concrete Inverts (Explanation)

- **Non-Q Rationale**
  - Number of steel sets resting on inverts assumed small during ESF planning & design
  - It is possible to remove unqualified inverts when repository design requirements set

Issue: Repository Ground Support

- **Description**
  - Compatibility of ground support system with the Engineered Barrier System performance of the repository and performance confirmation requirement
- **Impacts**
  - Emplacement drift ground control system
  - Repository layout
  - Retrievability

Issue: Repository Ground Support (cont'd)

- Resolution process
  - Issue of materials of construction being worked with Performance Assessment (PA) for compatibility with waste isolation
  - Design focused on the most promising support system(s) to meet long life, performance confirmation needs, and drift environment

Ground Support Alternatives for Emplacement Drifts

- Expanded precast segmental lining
- Cast-in-place concrete lining
- Steel sets

Note: This presentation will only deal with concrete alternatives

Concrete

- Ground Support Concept Issues
  - Materials compatible with post-closure performance
  - Methods compatible with performance confirmation (Mapping/Sampling Program)
  - Materials & methods compatible with constructability
  - Drifts must remain stable for a long period
  - Heat & radiation make maintenance difficult
  - Have an established mapping strategy

Concrete

- Interfaces
  - PA needs suitable materials for post closure (TSPA)
  - Solution must fit cost constraints and be incorporated into MGDS Cost Estimate
  - Issue must be resolved for License Application

Concrete

- **Current Design work for construction**
  - <u>"Heated Drift Cast-In-Place Concrete Lining Test Configuration Requirements Analysis"</u> (BABEAF000-01717-0200-0002)

Concrete

- Heated Drift Design

  Objectives

  - Develop higher confidence in Thermomechanical Modeling
  - Advance understanding of interaction of support system & rock mass
  - Qualitative performance of concrete lining subjected to high temperatures
  - Evaluate test specimens
  - Estimate concrete mechanical properties after high temperature exposure

Concrete

- **Heated Drift Design**

  Features

  - Nominal 5.6m O.D. 5.2.m I.D. x 12.4m long
  - 4.12m steel fiber reinforced concrete (SFRC)
  - ACI 117 Tolerances
  - Crown grouted
  - Cast-In-Place (CIP) both unreinforced & SFRC
  - Test at 200-300°C for about 2 years
  - Convergence, video observation, pretest properties, temperature history

Concrete

Sep. 30, 1996 Report

Status/summary report for fiscal year 1996 Activities within the Performance Assessment Overview Study on the Consequences of Cementitious Materials

Highlights - Preliminary P.A. Recommendations

IF Concrete is the desirable lining material:

- Use precast concrete
- Design mix with lower calcium/silica ratio

Concrete

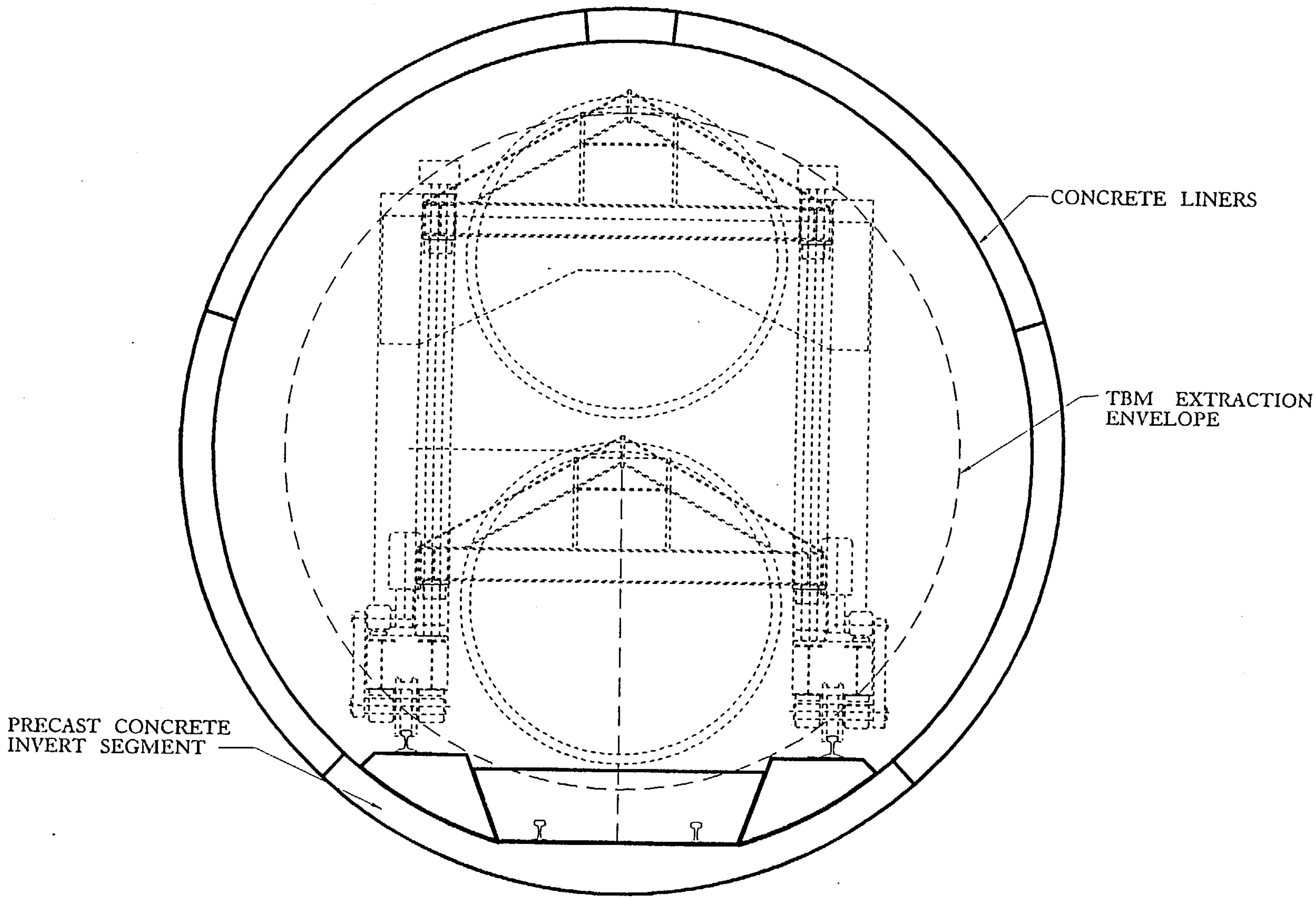
Highlights (cont'd)

- Reduce concrete permeability by
  - particle size engineering
  - steam or pressure curing
  - reduce water content for high Si cements
- Use tuff aggregate
- Consider alternative cements

Concrete

PA Work going forward

- Constrain pH levels perturbation
- Refine solubility - limited concentration distributions/functions for Np & Pu
- Constrain alkaline sorption coefficients for Np & Pu
- Refine alkaline plume migration through unsaturated zones



Preliminary

Precast Invert W/Cast–In–Place Pier And Haunch

Concrete

- Two main cementitious tunnel lining alternatives are being considered--precast & cast-in-place

Preliminary Advantages

Precast

- Better control over chemistry (cacium/silica)
  - Permits easier use of silica fume
- Permits easier use of steel fibers

Cast-In-Place

- Less joint permeability
- Uniform/smooth lining I.D.
- Mapping is possible

Concrete

Preliminary Advantages (cont'd)

- Manufacture of segment out of tunnel
- Single pass operation
- Handling rebar cages easier outside tunnel
- Thermal expansion less of a problem - joints
- Erection takes place immediately
- Suitable for deformation of tunnels due to loads
- Preliminary support required (rockbolts or shot crete)
- Fits profile perfectly

Concrete

- Cementitious Tunnel Lining (cont'd)

Preliminary Disadvantages

Precast

- Grout required for invert
- Handling segment more difficult
- Mapping is difficult

Cast-In-Place

- Pumping is required
  - Reduced quality
  - High slump-more water
  - Organic plasticizers req'd
  - Steel fibers hard to pump

Concrete

- Cementitious Tunnel Lining (cont'd)

Preliminary Disadvantages

Precast

- Handling may produce tensile loading

Cast-In-Place

- Transportation of mix underground
  - Segregation
  - Mixed Life
- Rockbolts or shotcrete required
- Rebar assembly in tunnel
- A longitudinal expansion joint is required