MINUTES OF THE NOVEMBER 8, 1995
U.S. NUCLEAR REGULATORY COMMISSION/U.S. DEPARTMENT OF ENERGY
TECHNICAL MEETING ON THE EXPLORATORY STUDIES FACILITY

On November 8, 1995, staff from the U.S. Nuclear Regulatory Commission met with representatives of the U.S. Department of Energy (DOE) to discuss items of mutual interest regarding progress in constructing DOE's Exploratory Studies Facility (ESF) at Yucca Mountain: tunnel boring status; the drilling, testing and sampling program; design status; health and safety issues; and the flowdown of requirements. The meeting, held by videoconference between DOE facilities in Washington, D.C., and Las Vegas, Nevada, was convened at noon EDT. Attachment 1 is the meeting agenda.

Other organizations represented were the State of Nevada Nuclear Waste Project Office (NV NWPO); Clark County, Nevada; Nye County, Nevada; the Nuclear Waste Technical Review Board (NWTRB); the United States Geological Survey (USGS); the United States Environmental Protection Agency (EPA); DOE's Management and Operating Contractor (M&O); DOE's Quality Assurance Technical Support Services Contractor (QATSS); Weston; and, by telephone, NRC's Center for Nuclear Waste Regulatory Analyses (CNWRA). Attachment 2 is the attendance list for the meeting.

DOE's first presentation was an update on construction of the ESF. Progress continues to be ahead of schedule. The tunnel boring machine (TBM) is progressing around the first bend in good ground. The baseline target for Fiscal Year 1995 was reached on August 22, 1995. No steel sets have been installed since early September. The construction of Alcoves 1-3 is complete as is the excavation of Alcove 4. A refuge chamber for emergency use is planned for Alcove 4. As noted in the report of September 13, 1995, meeting, Alcoves 5 and 7 will not be constructed due to lack of funds. A consulting board of four tunneling experts has been established and is functioning to advise senior DOE and M&O management on cost-effective tunneling safety, and design adequacy. Attachment 3 provides details on progress of the tunnel. The presentation ended with the showing of photographs of ESF activities.

Next, DOE reported on the status of surface-based testing and updated the ESF drilling, sampling, and testing program as of November 8, 1995. Attachment 4 provides an overview of work in boreholes and trenches that has been completed and is planned as well as accomplishments and near-term objectives of ESF geohydrology (permeability) tests, construction monitoring, and other ESF testing activities. It was noted that the planned Large Block Test was being "mothballed" due to funding restrictions. Attachment 4 also includes photographs of drilling, mapping, sampling, and testing. The representative from Nye County, Nevada, requested data from the thermal tests. DOE indicated that this information would be provided. In response to a question, DOE indicated that it knew of no plans to remove the seismic test station from Alcove 1.

The discussion of the status of ESF design was led by Mr. Sandifer due to Mr. Snell's unavailability. The discussion centered around an update of the design progress, the status of the design products for excavating the main drift of the ESF, and an update of the changes to the design control process. Progress on ESF design packages, schedule for design of Alcove #4, drawings for the interface of the ESF with the repository, design analyses for the main

102.8
Rec'd w/LTR DTD 9512140054 951130

drift excavation, and the updated design control process were discussed. Updates of M&O procedures QAP-3-10, "Design Control Process," and QAP-3-12, "Transmittal of Design Input," were described. Attachment 5 provides the "overheads" that were used during the discussion. DOE noted that NRC will receive "observer" copies of documents going through external design review.

Environmental, safety, and health issues associated with ESF construction and worker safety were discussed next, and Attachment 6 provides the "overheads" that were used during this discussion. DOE described its safety and health organization for Yucca Mountain and the directives it works under, noting that there is a documented safety and health plan. DOE's "Concerns Program" and its relationship to the safety and health plan were discussed. Pages 11-13 of Attachment 6 provide data comparing worker safety at Yucca Mountain with worker safety at other similar projects. Regarding the data on Page 11, DOE had not determined why there was a relatively large difference in total reportable cases (TRC) even though the lost workday cases (LWD) are very comparable.

NRC has been concerned for some time with obtaining assurance that the requirements of 10 CFR Part 60 are reflected in the ESF design documents, and the final technical subject on the agenda addressed these concerns. Attachment 7 was used during the discussion. Historical problems and improvements to the design system were discussed. The NRC Senior Site Representative noted that a meeting was scheduled later in the week where the subject would be discussed in more detail and that he would be following-up to ensure that the revised system will provide the information required by the staff.

The meeting concluded at 3:00 p.m. EST after it was generally agreed that the next meeting would probably be more than three months later.

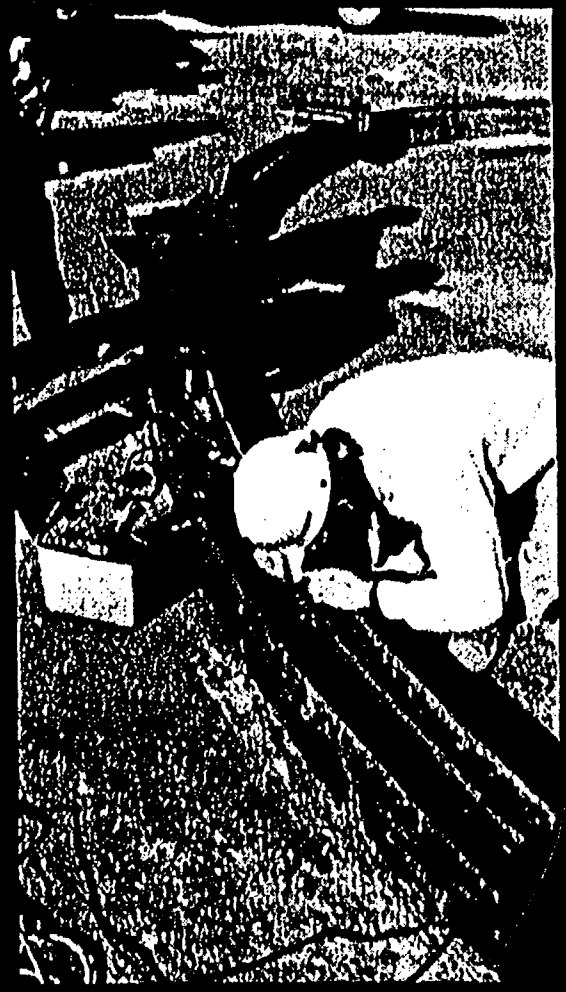
11/30/95

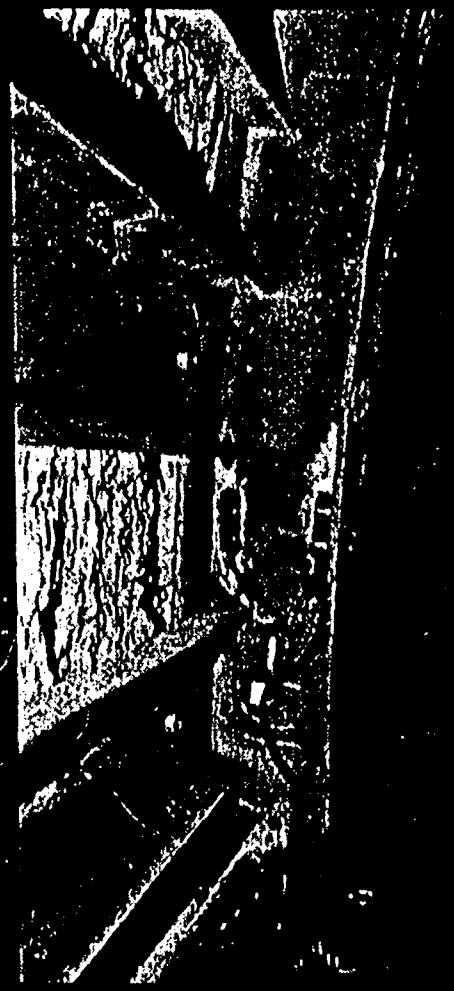
John G. Spraul
Division of Waste Management
Office of Nuclear Material
Safety and Safeguards
U.S. Nuclear Regulatory Commission

11/30/95

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

CONSTRUCTION MONITORING IN THE ESF





AS OF OCTOBER 25, 1995, 30 STEEL SETS HAVE BEEN INSTRUMENTED WITH 6-POINT CONVERGENCE PINS AND A TOTAL OF 360 STRAIN GAUGES. 6 MPBXs AND 5 SPBXs HAVE BEEN INSTALLED IN THE ESF NORTH RAMP, AND 1 MPBX AND 2 SPBXs WERE INSTALLED IN ALCOVE #1 FOR THE MEASUREMENT OF ROCK DEFORMATION. ROCK MASS QUALITY SCAN LINES ARE CONDUCTED ON 5 METER INTERVALS BEHIND THE TBM SHIELD. CONVERGENCE MONITORING ACTIVITIES HAVE ALSO BEEN PERFORMED IN EACH OF THE THREE TEST ALCOVES.

DOE-NRC TECHNICAL MEETING AGENDA
EXPLORATORY STUDIES FACILITY DESIGN AND CONSTRUCTION
VIDEO CONFERENCE
Bank of America Center, Blue Room, Las Vegas, Nevada
Forrestal Building, Room 1E267, Washington, DC
November 8, 1995

9:00 PDT (Noon EDT)	Opening Remarks	DOE, NRC, NV, AUG
9:15 PDT (12:15 EDT)	ESF Construction Update - Consulting Board - Alcove #4 Construction Status - Refuge Chamber Status	DOE
9:45 PDT (12:45 EDT)	Drilling, Testing, and Sampling Program Update - Drift Scale Heater Test Status	DOE
10:15 PDT (1:15 EDT)	ESF Design Status - Design Progress Update - Design Control Process - Design Products for Main Drift Excavation - Ground Support* - Ghost Dance Fault Design Activities*	DOE
10:45 PDT (1:45 EDT)	ES&H Issues Associated With ESF Construction and Workers Safety	DOE
11:15 PDT (2:15 EDT)	Requirements Flowdown	DOE
11:45 PDT (2:45 EDT)	Closing Remarks and Discussion	DOE, NRC, NV, AUG
12:15 (3:15 EDT)	Adjourn	

Note: The topics marked with asterisks will be addressed only if the information is available

10/23/95

ATTACHMENT 1

DOE/NRC ESF TECHNICAL MEETING

NOVEMBER 8, 1995

ATTENDANCE LIST

NAME	ORGANIZATION	PHONE
(Las Vegas, Nevada)		
Heitkamp, Joe B.	M&O	(702) 295-9179
Haghi, Ali	M&O	(702) 295-9394
Verna, Bernard J.	DOE	(702) 294-7410
Dana, Steve	QATSS	(702) 294-7176
Kennedy, William	M&O	(702) 294-7062
McKenzie, Dan	M&O	(702) 294-1863
Frishman, Steve	NV NWPO	(702) 687-3744
Gil, April V.	DOE	(702) 794-7622
Segrest, Alden	M&O	(702) 794-9704
Thom, Barry	M&O	(702) 794-1944
Rindskopf, Milton	M&O	(702) 794-7628
v. Tiesenhausen, E.	Clark County	(702) 455-5175
Blaylock, Jim	DOE	(702) 455-7913
Stellavato, Nick	Nye County	(702) 295-6142
Murphy, M.R.	Nye County	(360) 943-5610
Geer, Tom	M&O	(702) 794-7868
Royer, Dennis	DOE	(702) 794-7501
Belke, Bill	NRC	(702) 388-6125
Petullo, Colleen	EPA	(702) 998-2446
Glenn, Chad	NRC	(702) 388-6125
Fortner, Tom	DOE	(702) 794-7576
Harrington, Paul	DOE	(702) 794-7785
Craun, Richard	DOE	(702) 794-7787
Boyle, William	DOE	(702) 794-7595
Hanlon, Carol	DOE	(702) 794-5118
Sandifer, Robert	M&O	(702) 794-1869
Adkins, Howard	M&O	(702) 794-7417
Parker, Charles	M&O	(702) 794-9177

ATTACHMENT 2

NAME	ORGANIZATION	PHONE
(Las Vegas, Nevada - concluded)		
Snell, Dick	M&O	(702) 794-5360
Brocoum, Steve	DOE	(702) 794-9611
(Washington, D.C.)		
Einberg, Chris	DOE	(202) 586-8869
Delligatti, Mark	NRC	(301) 415-6620
Wallace, Ray	USGS	(202) 586-1244
Rogers, Tom	M&O	(202) 448-2320
Spraul, Jack	NRC	(301) 415-6715
Nataraja, Mysore	NRC	(301) 415-6695
Dresser, Dan	Weston	(202) 646-6781
Minwalla, Homi	M&O	(202) 488-2306
McFarland, R.K.	NWTRB	(703) 235-4473
Jagannath, Banad	NRC	(301) 415-6653
Bell, Michael	NRC	(301) 415-7286
(San Antonio, Texas - by telephone)		
Brient, Bob	CNWRA	(210) 522-5537
Mabrito, Bruce	CNWRA	(210) 522-5149

YUCCA MOUNTAIN PROJECT

Studies

ESF Construction Update

Presented to:
DOE NRC Technical Meeting

Presented by:

Robert M. Sandifer
Manager, Site Construction and Operations
CRWMS Management and Operations Contractor

November 8, 1995

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

ATTACHMENT 3

Construction Update

(1 of 2)

- TBM PROGRESS

- Station 25+38.6 meters on 10/31/95 @ 8:00 a.m.
- Actual Advance Since Last Meeting — 917.5 meters (3,486.6 feet)
- Scheduled Progress Since last Meeting; per Program Plan was — 282.4 meters (926.3 feet)
- Variance (amount Ahead of Schedule) — 635.1 meters (2,083.1 feet)

- Job-to-Date Progress — 2,538.6 meters (8,326.6 feet)
- Baseline Program Plan Scheduled Advancement — 1,440.0 meters (4,723.2 feet)
- Variance (amount Ahead of Schedule) — 1,098.6 meters (3,603.4 feet)

- TUNNEL REFERENCES AND STATIONING

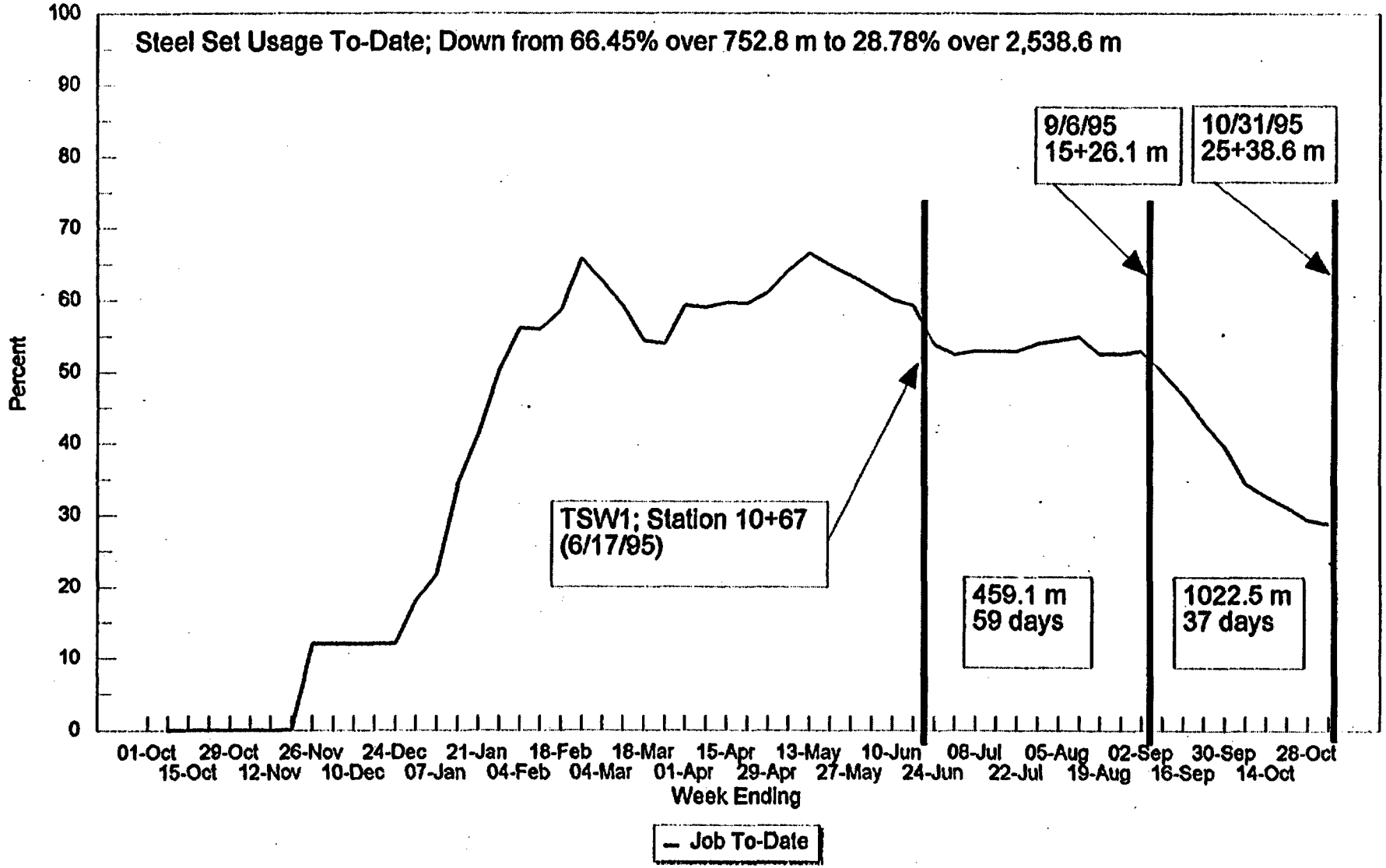
- TSW1 Station 10+67 meters
- Drill Hole Wash Fault Zone Station 19+00 meters and Station 19+38 meters
- TSW2 (approximate location) Station 27+00 meters
- Thermal Test Area, (approximate location) Station 28+30 meters
- 1st Access to Ghost Dance Fault, Alcove 6 (approximate location) Station 38+00 meters
- 2nd Access to Ghost Dance Fault, Alcove 7 (approximate location) Station 47+00 meters
- Second Curve Toward the South Ramp Station 59+35 meters

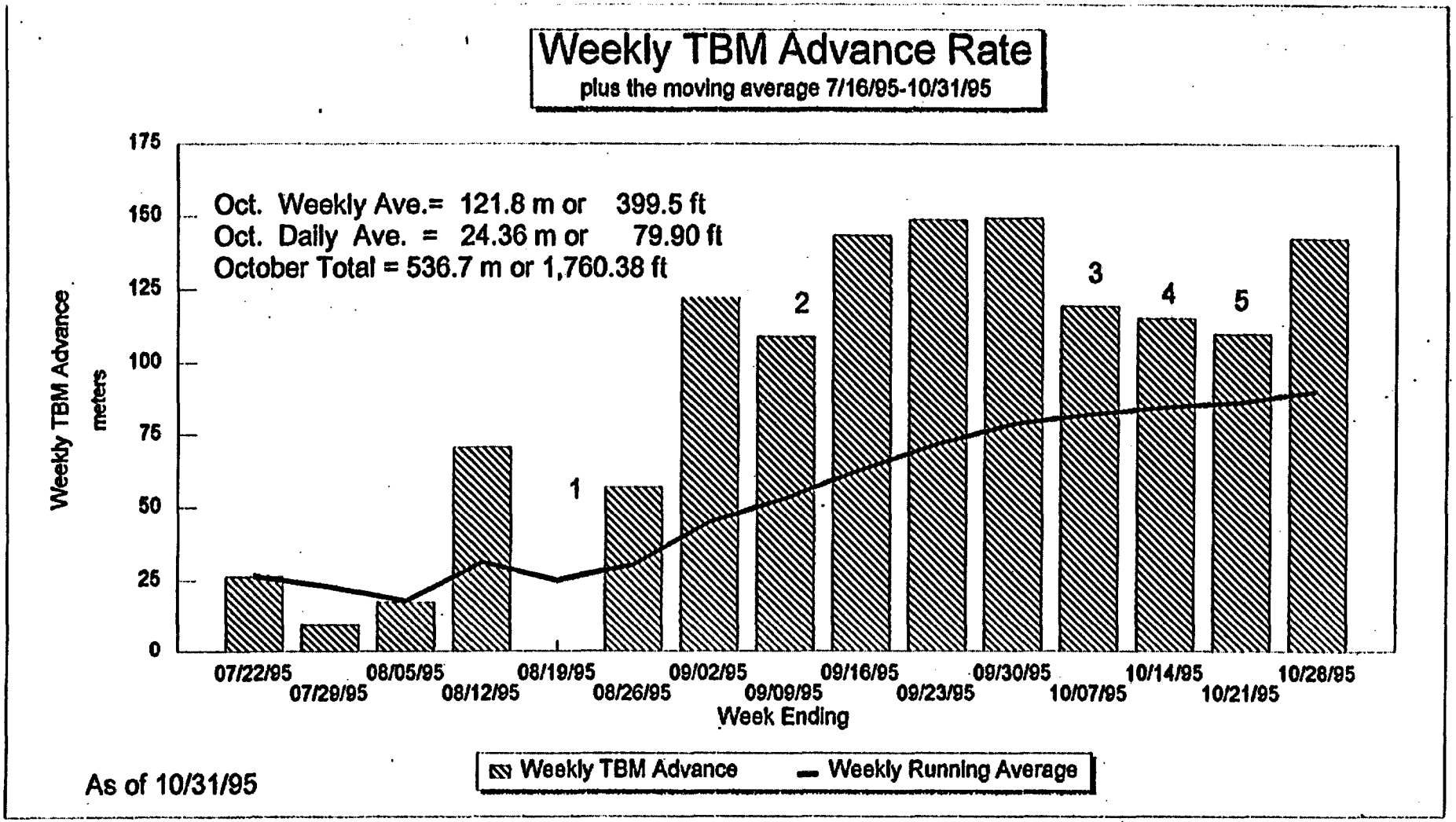
ALCOVE #4 DESIGN AND CONSTRUCTION STATUS

- Design Length 51.7 meters or 160.6 feet, at Station 10+27.76 meters;
- Design Complete and Released for Construction 10/11/95;
- K/PB Completes Work Package and Procedures 10/13/95;
- Mobilization of Equipment 10/14/95;
- Construction Began 10/14/95, Completed the Excavation 10/27/95;
- Program Baseline Schedule for Completion of Excavation 10/11/95 Based on an Original Start Date of 9/29/95.

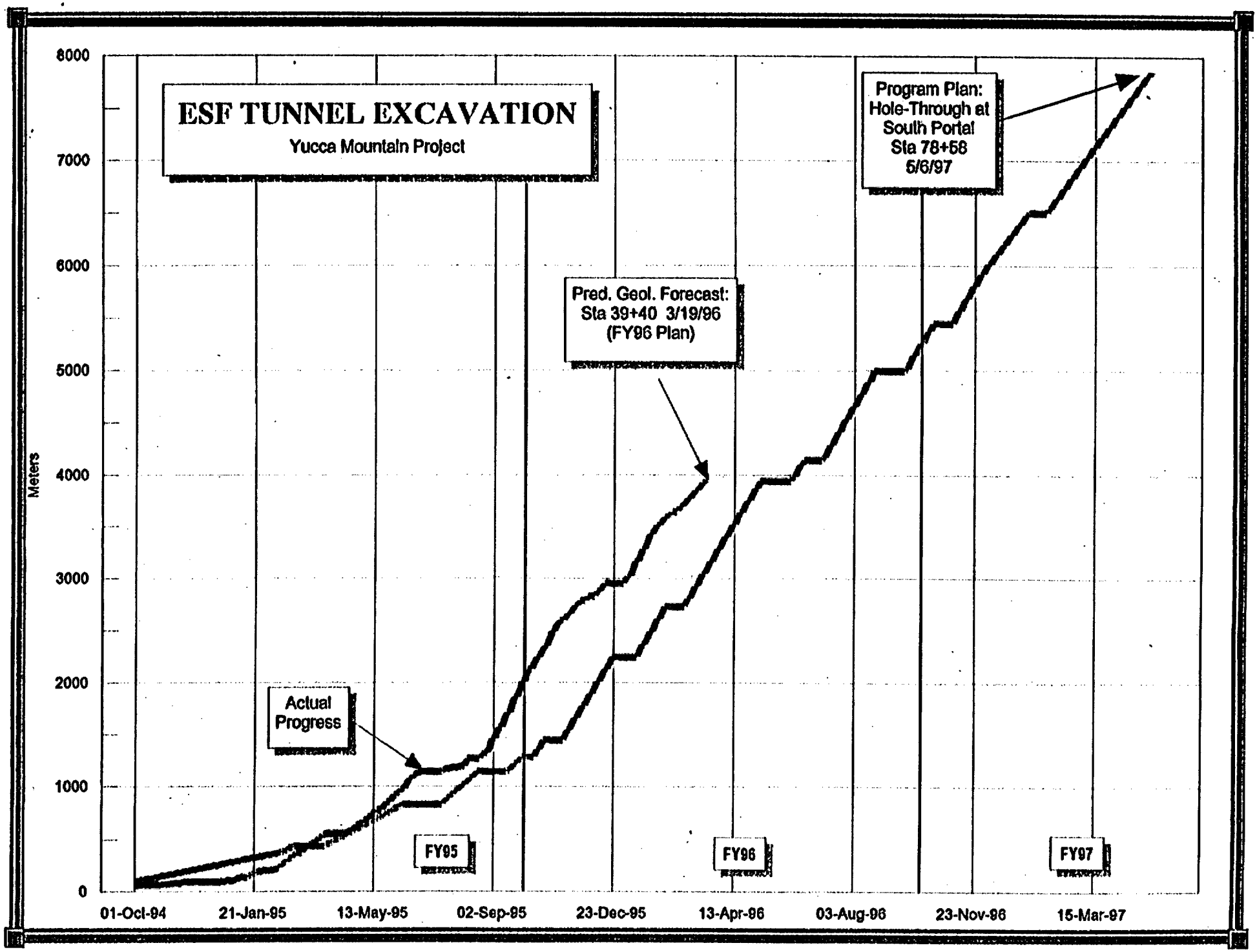
Steel Set Usage Factor

(Percentage of Steel Set Usage over the Length of the Tunnel Excavation)





1. Head Repair, TBM Down 7 days;
2. Labor Day Holiday, 4 Day Work Week;
3. Installed Booster Drive #2, Down 2 days;
4. Moved into the Initial Curve, Reduced Production Time due to set up for Survey Activities;
5. Reduced Production due to Training the TBM Belts, Surveying Activities, and Adjusting the Main Conveyor Belt.


ESF TUNNEL EXCAVATION
Yucca Mountain Project
Program Plan:
Hole-Through at
South Portal
Sta 78+58
5/6/97
Pred. Geol. Forecast:
Sta 39+40 3/19/96
(FY96 Plan)
Actual
Progress
FY95
FY96
FY97
Meters
8000
7000
6000
5000
4000
3000
2000
1000
0
01-Oct-94
21-Jan-95
13-May-95
02-Sep-95
23-Dec-95
13-Apr-96
03-Aug-96
23-Nov-96
15-Mar-97

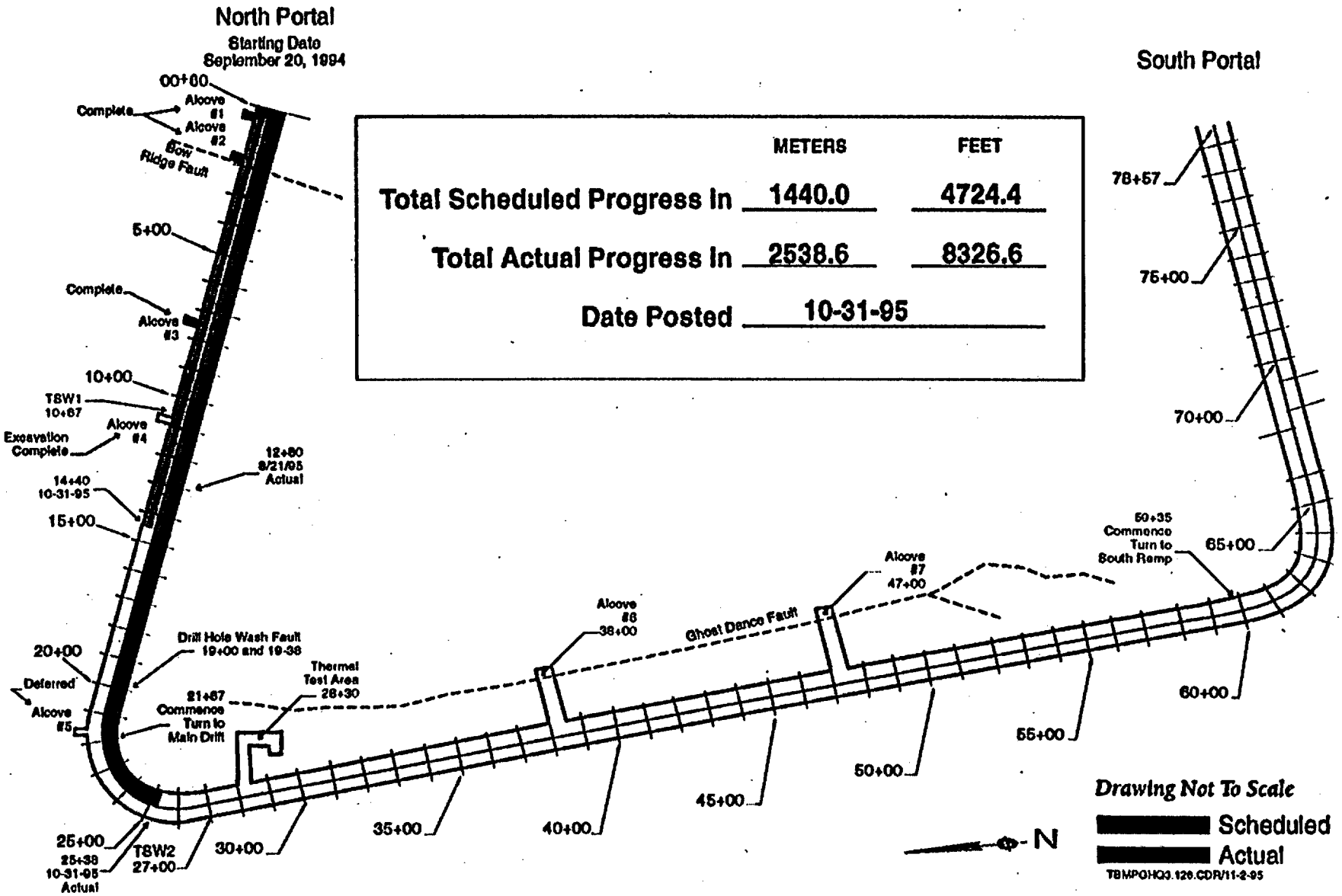
Refuge Chamber

- In accordance with MSHA Standards; but not required by OSHA
- First chamber will be included in test Alcove #4 (Station 10+27.76)
- Requirements:
  - 75 M^2 of floorspace for emergency use
  - Capable of being sealed
  - Fire-resistant
  - Stocked with emergency supplies
  - Separate communication system

Consulting Board

- Yucca Mountain Board of Consultants formed to advise Senior DOE & M&O Management on Cost-Effective Tunneling, Safety, and Design Adequacy
- Board Members:
  - S. H. Bartholomew, Chairman
  - Dr. R. Heuer
  - L. Snyder
  - J. Lemley
- Kick-off meeting October 24-25, 1995
- Initial Report due November 10, 1995

TBM PROGRESS



	METERS	FEET
Total Scheduled Progress In	1440.0	4724.4
Total Actual Progress In	2538.6	8326.6
Date Posted	10-31-95	

YUCCA MOUNTAIN PROJECT

Studies

Drilling, Sampling, and Testing Program Update

Presented to:

DOE NRC Technical Meeting

Presented by:

William J. Boyle
Geoengineering, Team Leader
U.S. Department of Energy

November 8, 1995

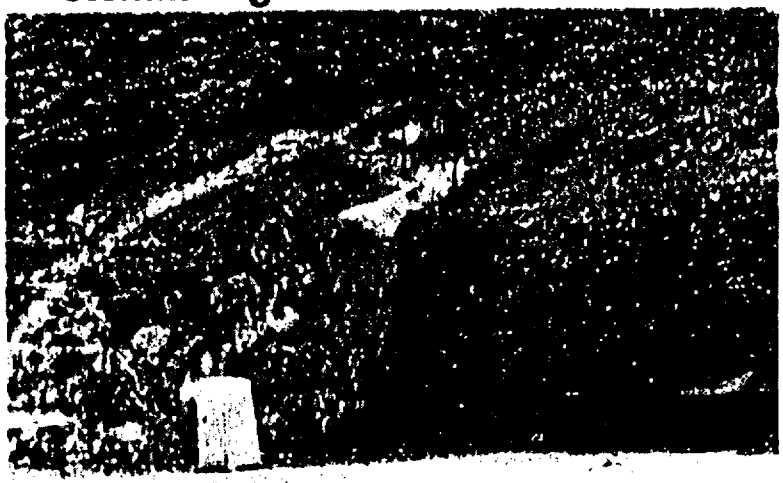
U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

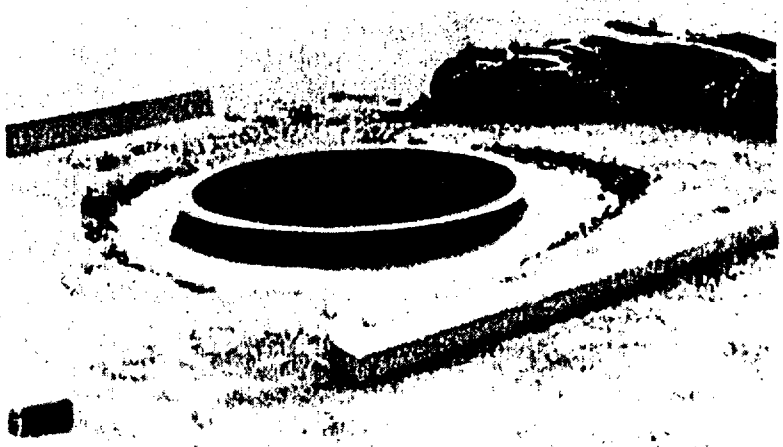
ATTACHMENT 4

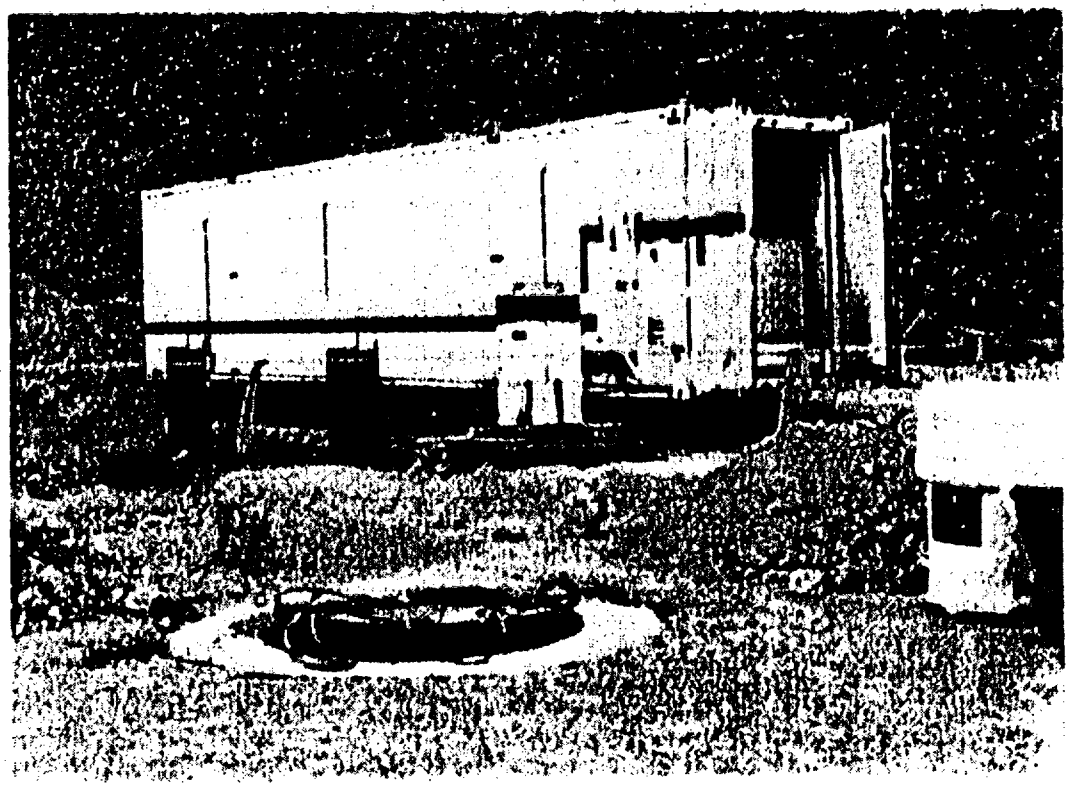
Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995

UZ-7a

Placed pneumatic instrumentation and stemmed/grouted units in borehole.



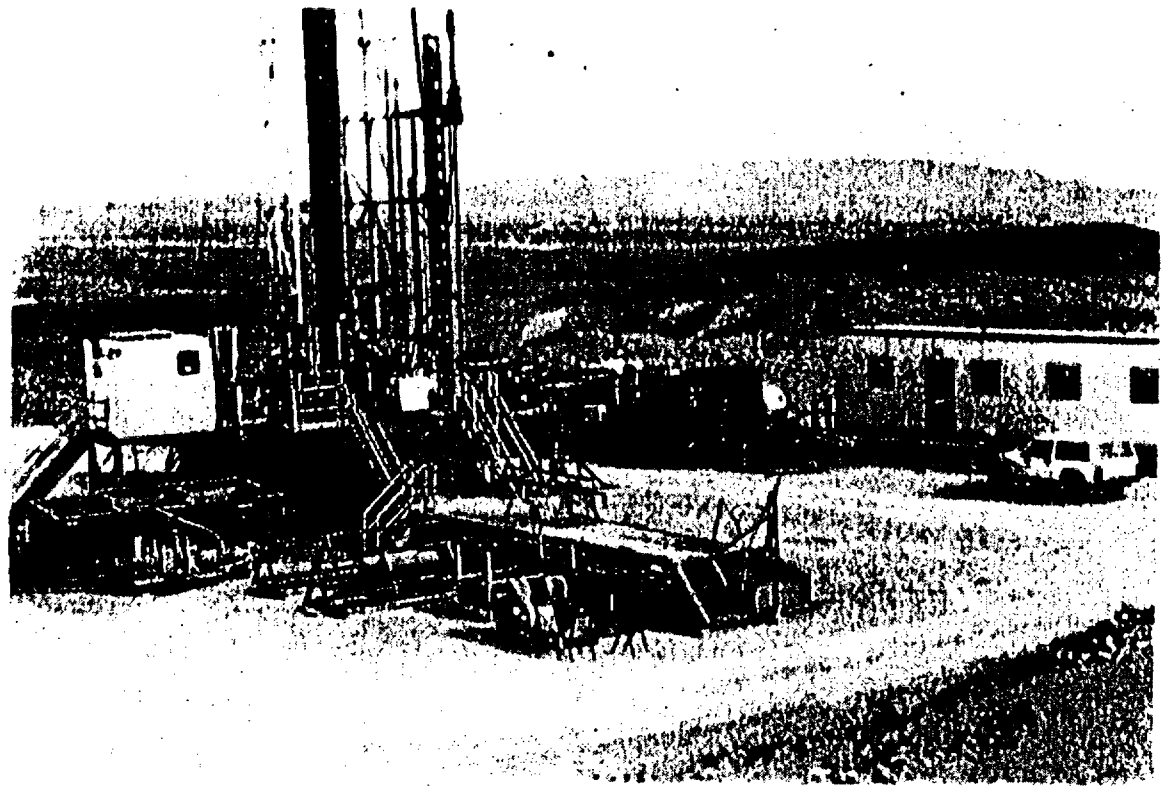




SD-12

Completed wellhead box and instrument shelter installation in preparation for pneumatic instrumentation.

Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995



SD-7

Continued coring to 2492 ft. The ground water table was encountered at a depth of 2084 ft., and hydrochemistry samples were obtained. Planned total depth of 2675 ft.

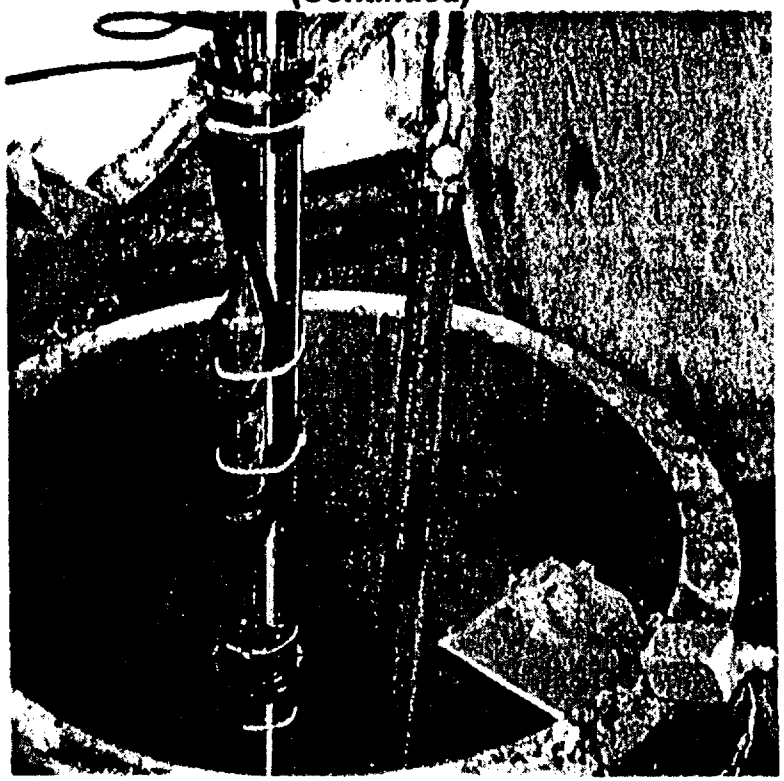
Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995

WT-12

Completed long term pump test of approximately 20 gpm.

Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995

(Continued)



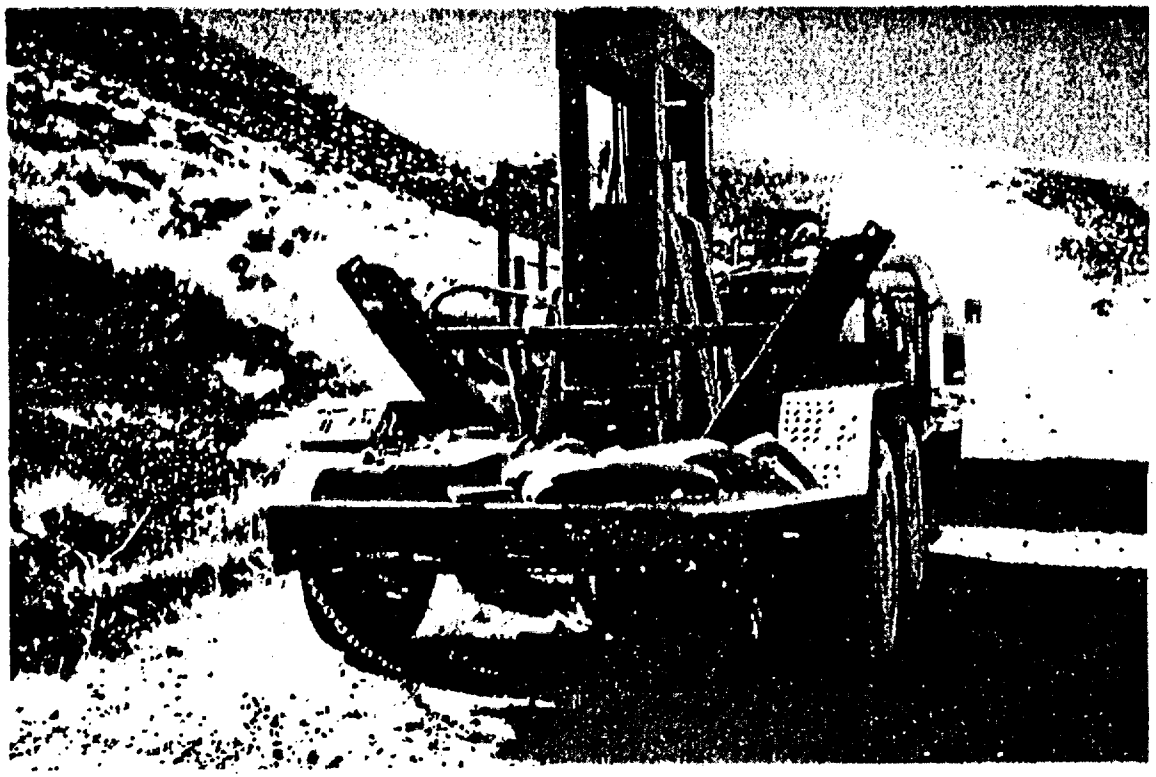
UZ-16

UZ-16 Geophones being installed

Conducted Vertical Seismic Profiling test program. There are 96 3-component geophones grouted into UZ-16. A truck mounted seismic source was used to produce input signals to the geophones.

Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995

(Continued)



LBL Seismic Thumper

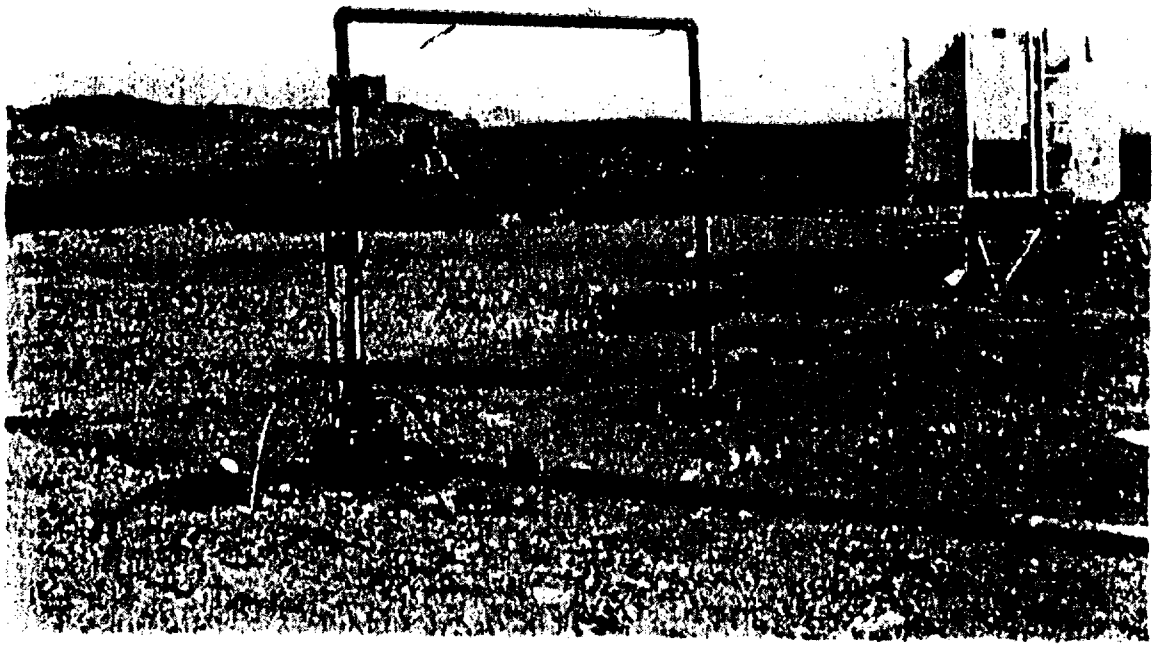
G-2, G-4, RF-4, RF-7a & SD-12

Conducted Vertical Seismic Profiling in open boreholes using moveable geophones and a surface impact source.

Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995

C-Hole

Installed the pump and opened flow ports between isolated zones for hydraulic tests that precede tracer testing of Work Period 2.



Drilling\Sampling\Testing Completed September 1, 1995 - October 31, 1995

- Repository Geophysical Survey
  - Extended seismic reflection survey lines across Yucca Mountain, re-ran one existing line across Yucca Mountain and ran two high resolution seismic lines across the Ghost Dance Fault

Borehole Geophysical Logging Planned November 1, 1995 - December 31, 1995

- UZ-7a Deviation Survey
- SD-7 Logs and Deviation Survey
- G-2 Logs

Drilling\Sampling\Testing Planned November 1, 1995 - December 31, 1995

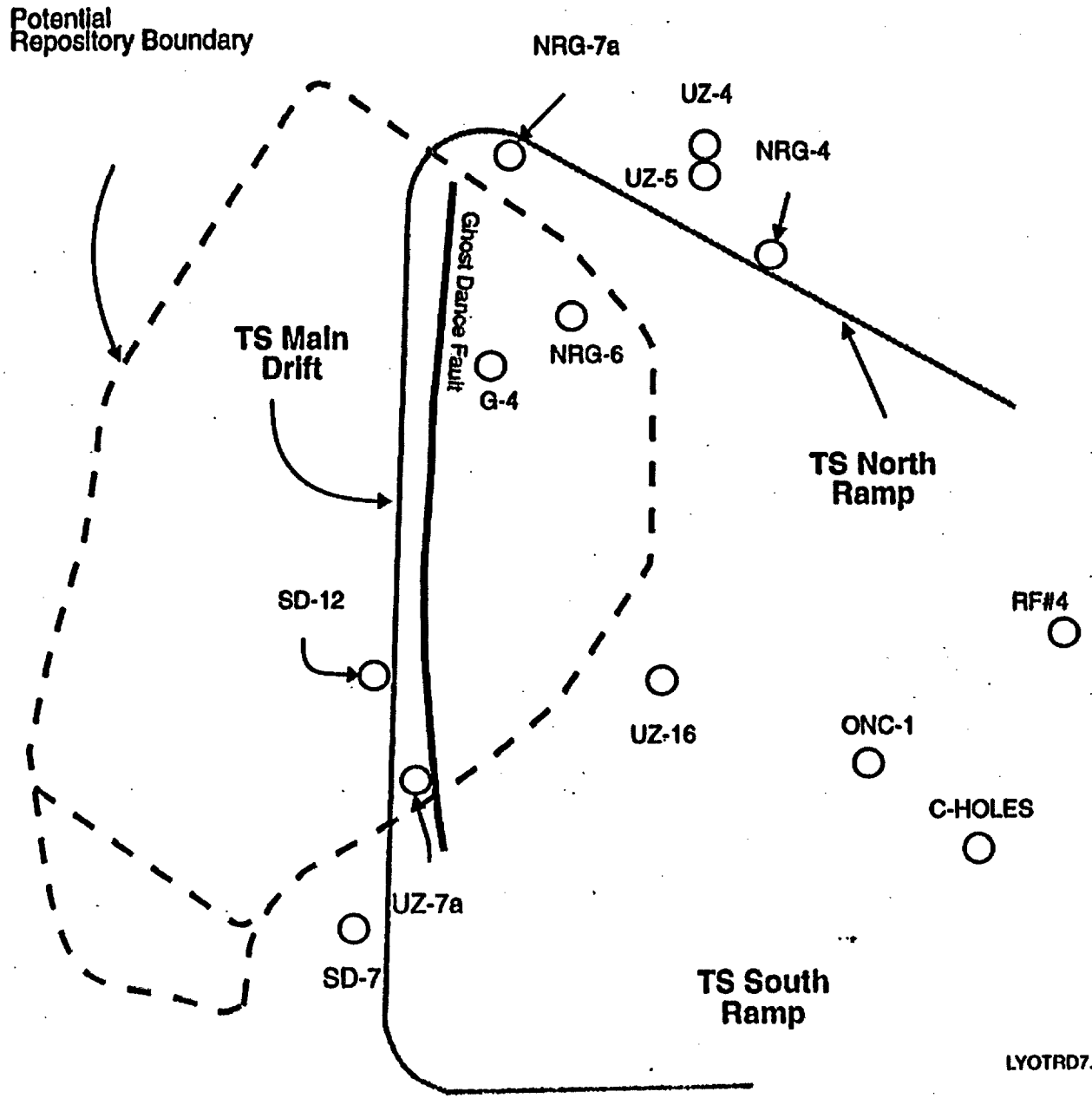
SD-12	Place pneumatic instrumentation in borehole and stem/grout instruments in place.
SD-7	Complete coring to total depth of 2675 ft.
C-Hole	Continue hydraulic testing and set up reactive tracer experiment.
WT-10	Workover existing borehole and run pump test.
G-2	Conduct multiple pump tests.

Drilling\Sampling\Testing Planned November 1, 1995 - December 31, 1995

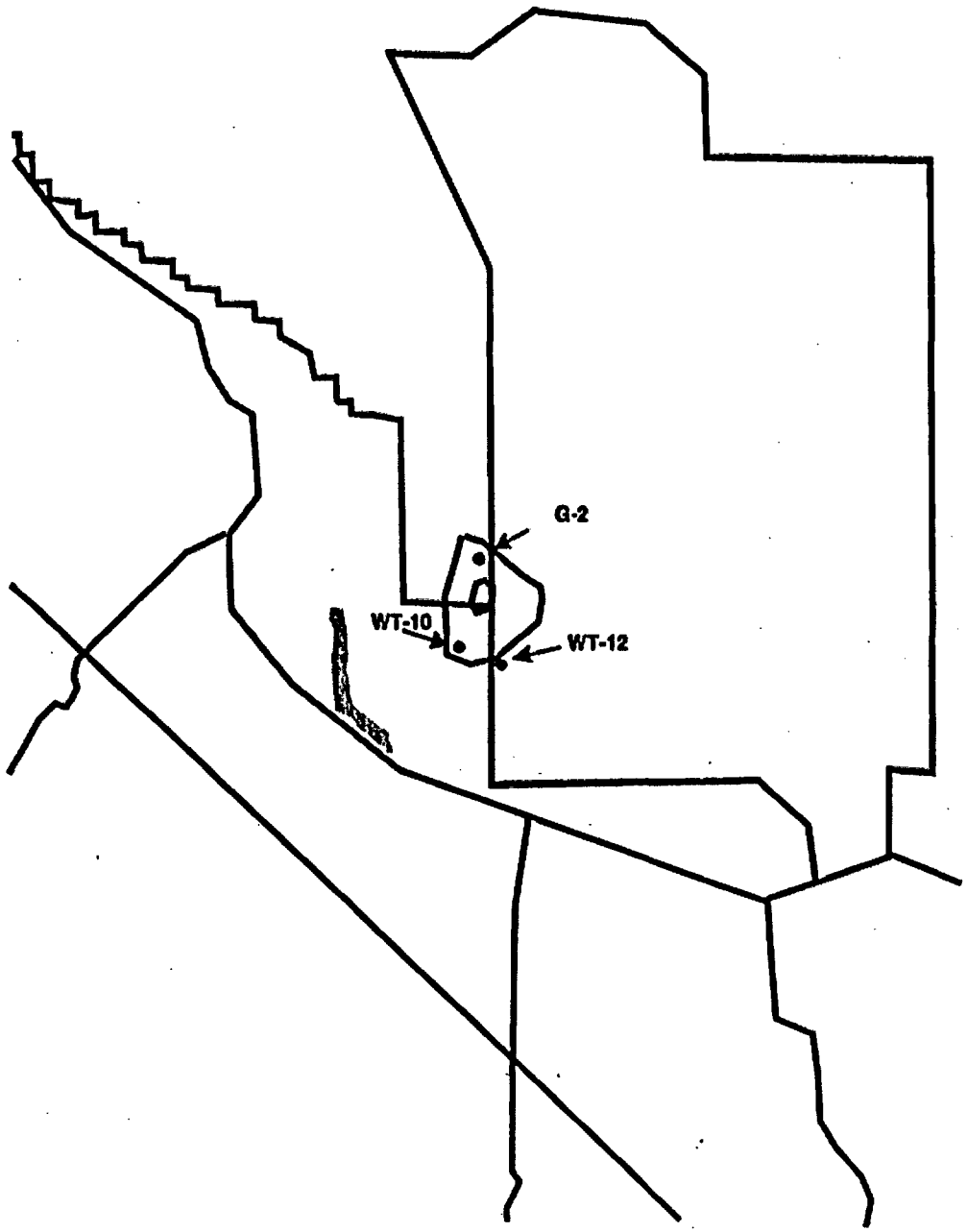
(Continued)

- Monitoring of Pneumatic Instrumentation
  - NRG-4 (Nye County)
  - NRG-6
  - NRG-7a
  - ONC#1 (Nye County)
  - SD-12
  - UZ-4
  - UZ-5
  - UZ-7a

SBT Borehole Activities in the Vicinity of the Repository



SBT Activities in the YM Region



ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

I. GEOHYDROLOGY (PERMEABILITY) TESTS

RECENT ACCOMPLISHMENTS:

ALCOVE #1

- PRIMARY TESTING (CROSS-HOLE) IN ALCOVE #1 WAS COMPLETED BY END-JULY (ANISOTROPIC RADIAL BOREHOLES). ALCOVE #1 HAS ENTERED LONG-TERM MONITORING PHASE.
- LAWRENCE BERKELEY LABORATORY CONDUCTED PACKER EVALUATIONS IN THE 30 METER RADIAL BOREHOLES LOCATED IN ESF ALCOVE #1 THE WEEK OF SEPTEMBER 25.

ALCOVE #2

- DRILLING (DRY CORING) OF THE FIRST BOW RIDGE FAULT PENETRATION BOREHOLE IN ALCOVE #2 BEGAN ON AUGUST 16. FINAL DEPTH IS 26.3 METERS, ACHIEVED ON AUGUST 24.
- BOREHOLE TEMPERATURE MEASUREMENTS WERE CONDUCTED DURING SEPTEMBER.

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

I. GEOHYDROLOGY (PERMEABILITY) TESTS (Cont.)

RECENT ACCOMPLISHMENTS (Cont.):

ALCOVE #3

- EXCAVATION OF ALCOVE #3 BEGAN ON AUGUST 17 USING AN ALPINE MINER-50. EXCAVATION WAS COMPLETED ON AUGUST 25 (FINAL DEPTH 36.5 METERS).
- A BULKHEAD WAS CONSTRUCTED AT THE ENTRANCE OF THE ALCOVE IN SEPTEMBER TO PRESERVE MOISTURE CONCENTRATIONS.

ALCOVE #4

- LOCATION AND DESIGN MODIFICATION CRITERIA FOR ALCOVE #4 WAS COMPLETED IN OCTOBER. EXCAVATION BEGAN USING AN ALPINE MINER-50 ON OCTOBER 16, 1995.

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

I. GEOHYDROLOGY (PERMEABILITY) TESTS (Cont.)

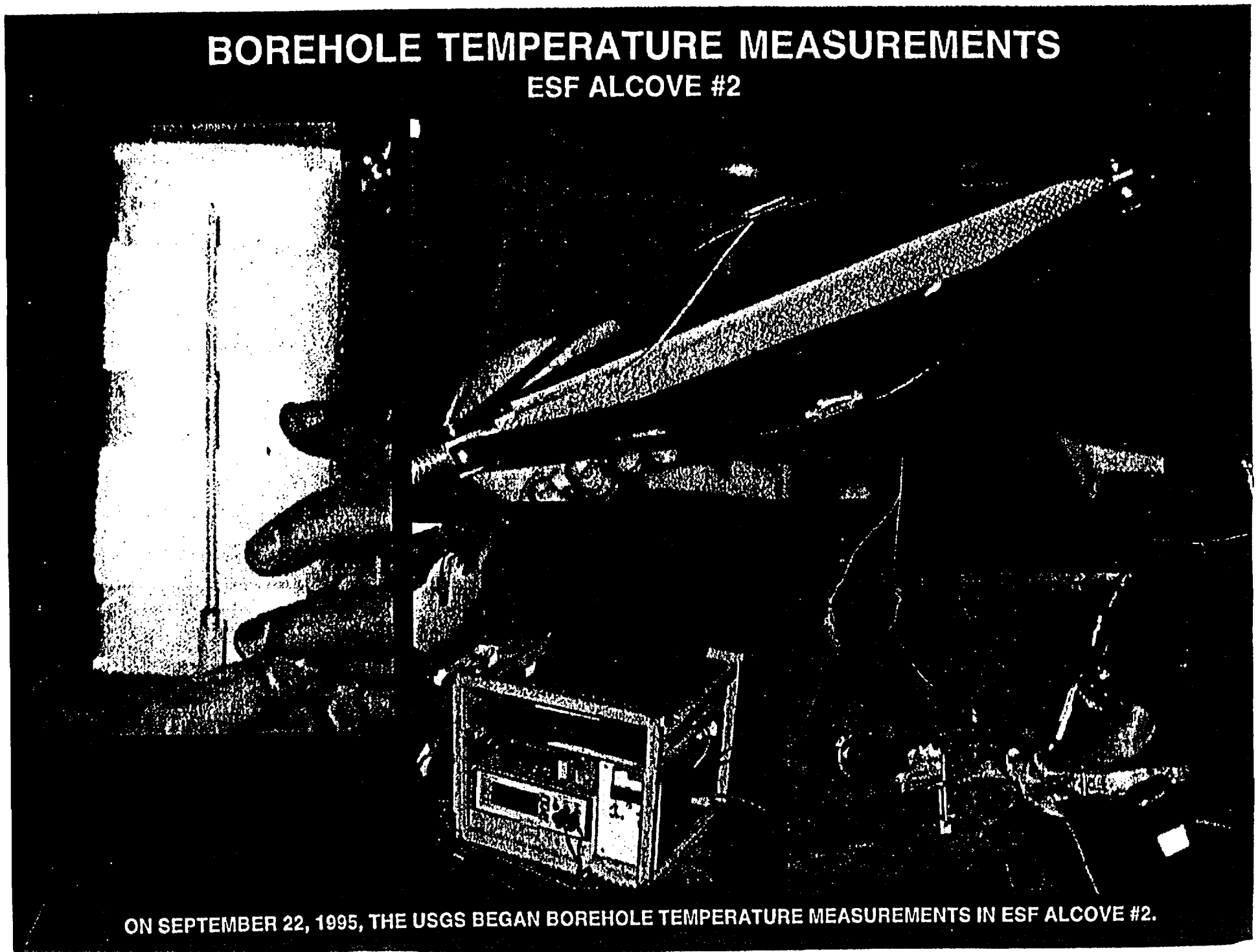
NEAR-TERM OBJECTIVES:

- CORE DRILLING FOR BOW RIDGE FAULT TESTING (ALCOVE #2) IS UNDERWAY; TESTING (SINGLE-HOLE/HYDROCHEMISTRY) WILL BEGIN IN OCTOBER.

- INITIAL CORE DRILLING WILL BE INITIATED IN EARLY NOVEMBER FOR RADIAL BOREHOLE TESTS IN ALCOVE #3.

BOREHOLE TEMPERATURE MEASUREMENTS

ESF ALCOVE #2



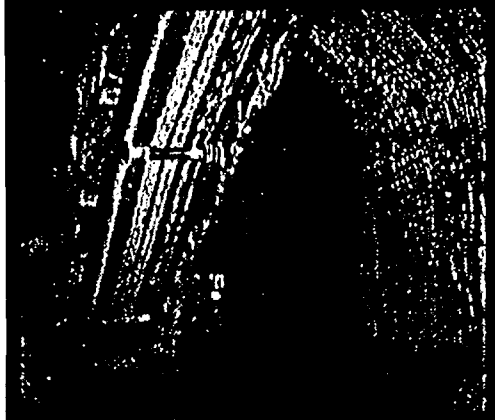
ON SEPTEMBER 22, 1995, THE USGS BEGAN BOREHOLE TEMPERATURE MEASUREMENTS IN ESF ALCOVE #2.

ESF ALCOVE #3

MOISTURE ON THE WALLS OF ALCOVE #3 IS ATTRIBUTED TO ELEVATED SATURATION AT THE UPPER TIVA CANYON/PAINTBRUSH TUFF CONTACT.

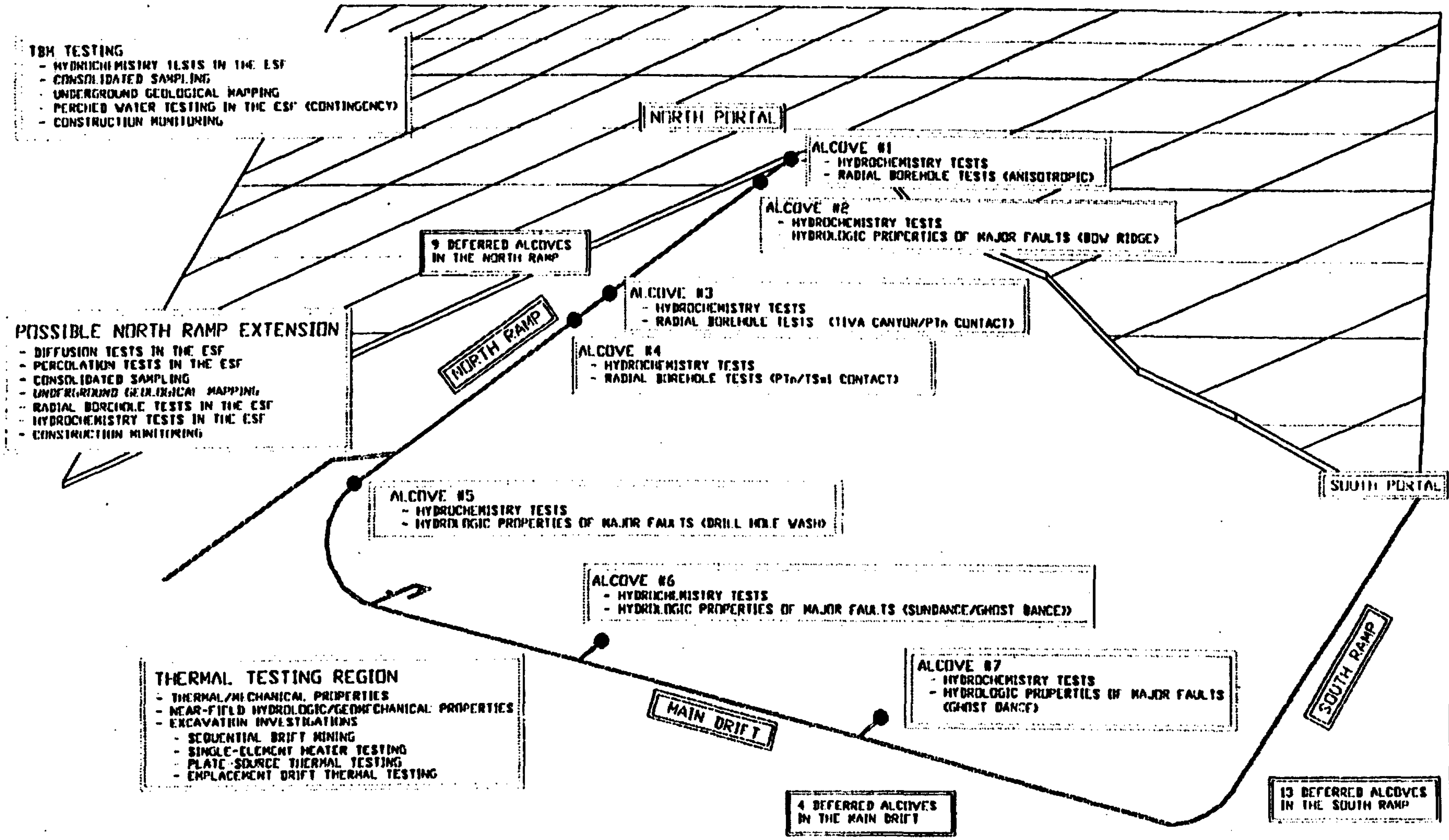
ALCOVE #3 IS LOCATED AT CS 7+56 AND WAS COMPLETED TO A DEPTH OF 36.5 METERS MEASURED FROM THE CENTER LINE OF THE NORTH RAMP ON AUGUST 25, 1995. A BULKHEAD WAS CONSTRUCTED AT THE ENTRANCE OF THE ALCOVE. THE PURPOSE OF ALCOVE #3 IS TO PERFORM HYDROLOGIC PERMEABILITY TESTING OF THE LITHOHYDROLOGIC CONTACT BETWEEN THE TIVA CANYON WELDED UNIT AND THE UPPER PTn UNIT.

ESF ALCOVE 4



EXCAVATION OF ALCOVE #4 BEGAN ON OCTOBER 16, 1995 USING AN ALPINE MINER AND IS LOCATED AT APPROXIMATELY CS 10+28 m MEASURED FROM THE CENTER LINE OF THE NORTH RAMP. THE ALCOVE WAS PLACED PRIMARILY SUCH THAT THE CONTACT OF THE THERMAL/MECHANICAL UNIT OF THE UPPER PAINTBRUSH NONWELDED AND THE TOPOPAH SPRING WELDED CAN BE TESTED. DURING THE CONSTRUCTION, SANDIA NATIONAL LABORATORIES IS MONITORING CONSTRUCTION EFFECTS WITH STRAIN GAGES.

EXPLORATORY STUDIES FACILITY - TEST LOCATIONS



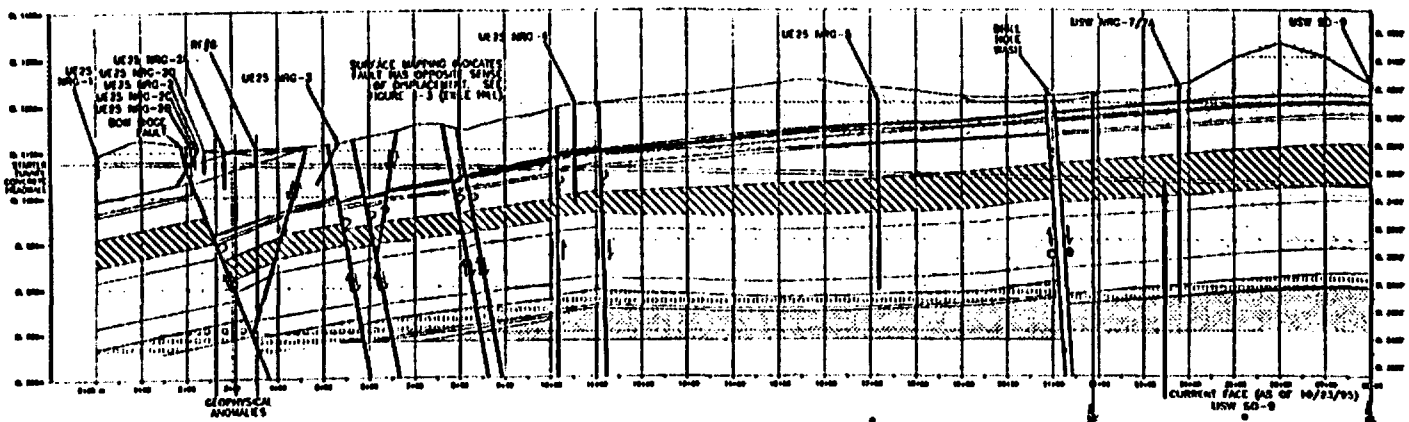
FINAL DECISIONS ON DEFERRAL:

NOTES: TEST/EXCAVATION, AND TESTING IN DEFERRED ALCOVES IS DEPENDENT ON OBSERVATIONS DURING EXCAVATION, EVALUATION OF EARLY TEST RESULTS, AND PROGRAM PRIORITIES.

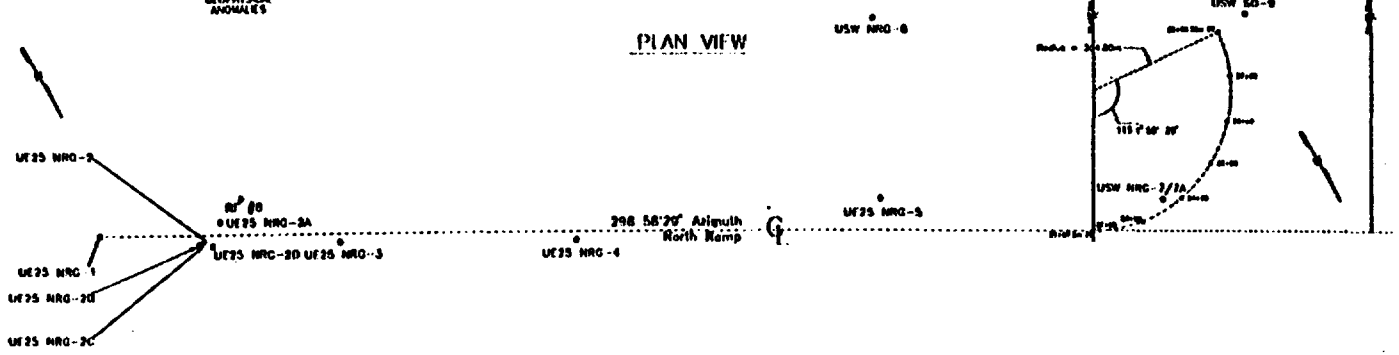
ADMINISTRATIVE RAMP CROSS SECTION: LITHOLOGY AND BOREHOLE PROJECTIONS

Produced by: Sandia National Laboratories

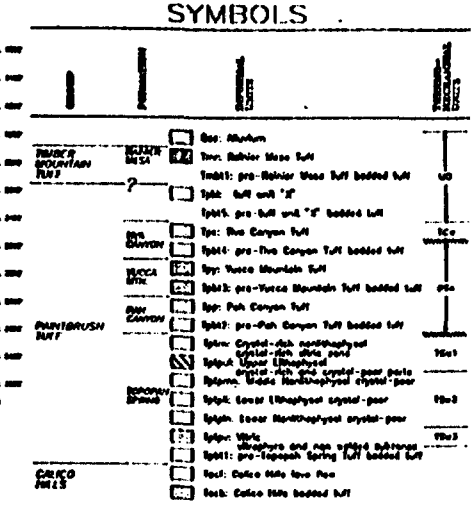
SECTION VIEW



PLAN VIEW



SYMBOLS



STRATIGRAPHIC NOMENCLATURE DEVELOPED BY USGS

DRILL HOLE WASH FAULT ZONE, LOCATION AND ATTITUDE UNCERTAIN

BOW RIDGE FAULT ZONE

MINOR FAULT, ? - ATTITUDE UNCERTAIN

PROPOSED NORTH RAMP ALIGNMENT

APPROXIMATE

STRIKE-SLIP SEPARATION INTO PAGE

STRIKE-SLIP SEPARATION OUT OF PAGE

PRELIMINARY RAMP DATA
ADMINISTRATIVE ONLY

BOREHOLE PROJECTIONS
ADMINISTRATIVE ONLY

FOR INFORMATION ONLY -- NOT CONTROLLED

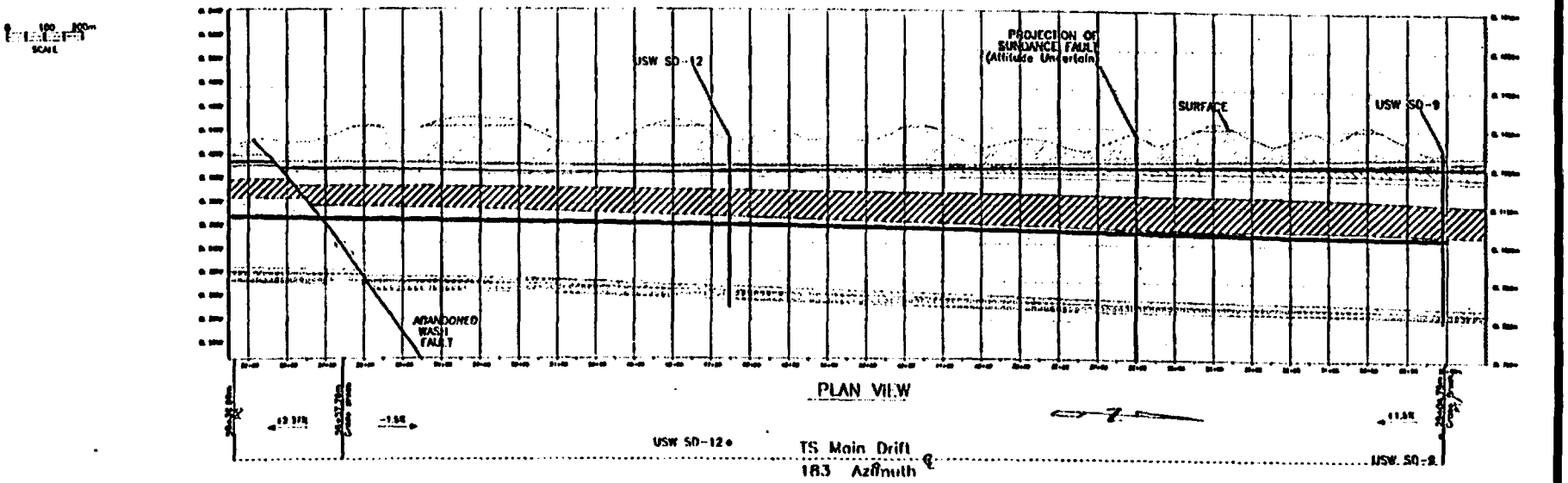
ESF NORTH RAMP
YUCCA MOUNTAIN SITE
CHARACTERIZATION PROJECT
CROSS SECTION ALONG RAMP FROM
0+00 to 28+00.38m (P1)

Sandia National Laboratories

ADMINISTRATIVE MAIN DRIFT CROSS SECTION: LITHOLOGY AND BOREHOLE PROJECTIONS

Produced by: Sandia National Laboratories

SECTION VIEW



PLAN VIEW

STRATIGRAPHY [1]

LITHO-STRATIGRAPHIC UNITS		SYMBOL	THERMAL-MECHANICAL UNITS
Tiva Canyon	Tiva Canyon Tuff, undifferentiated, devitrified	Tpcm	PCw
	Tiva Canyon Tuff, crystal-poor, vitric, nonwelded to moderately welded	Tpcpv1 & 2	
Paintbrush Group	Pre-Tiva Canyon Tuff bedded tuff	Tpbt4	
Yucca Mtn.	Yucca Mountain Tuff	Tpy	PTn
	Pre-Yucca Mountain Tuff bedded tuff	Tpbt3	
Post Canyon	Pah Canyon Tuff	Tpp	
	Pre-Pah Canyon Tuff bedded tuff	Tpbt2	
	Topopah Spring Tuff, crystal-rich, vitric, nonwelded to moderately welded	Tptrv2 & 3	
	Topopah Spring Tuff, crystal-rich, devitrified, nonwelded (includes vitrophyre)	Tptrn	TSw1
	Topopah Spring Tuff, crystal-poor, upper lithophysal (includes crystal-rich lithophysal)	Tptpul	
Topopah Spring	Topopah Spring Tuff, crystal-poor, middle nonlithophysal	Tptpmn	
	Topopah Spring Tuff, crystal-poor, lower lithophysal	Tptpl	TSw2
	Topopah Spring Tuff, crystal-poor, lower nonlithophysal	Tptpln	
	Topopah Spring Tuff, crystal-poor, vitrophyre subzone	Tptpv3	TSw3
	Topopah Spring Tuff, crystal-poor, vitric, nonwelded to moderately welded	Tptrv1&2	CHn

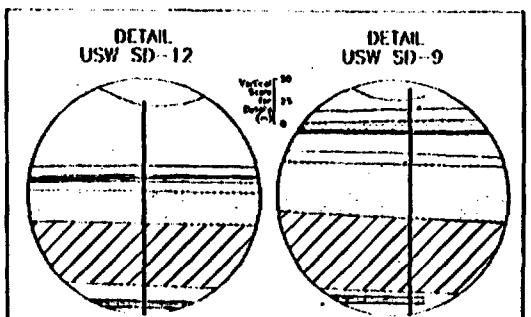
[1] Stratigraphic and thermal-mechanical units as defined by Buesch, et al., USGS Open File Report 96-469, in press. Revised lithostratigraphic nomenclature and more precise identification of stratigraphic units of the Paintbrush Group exposed at Yucca Mountain, Nevada

LEGEND

Note: Stratigraphic contacts based on USGS GFM3 Model Version 3.1; Not applied data. Projections of stratigraphic contacts from USW SD-9 and USW SD-12 Borehole data

PROPOSED TS MAIN DRIFT ALIGNMENT

BOREHOLE CONTACTS BASED ON PROJECTING BOREHOLE ALONG DIP



PRELIMINARY TS MAIN DRIFT DATA ADMINISTRATIVE USE ONLY

BOREHOLE PROJECTIONS ADMINISTRATIVE USE ONLY

BOREHOLE CONTACT PROJECTIONS

FOR INFORMATION ONLY -- NOT CONTROLLED

TS MAIN DRIFT
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CROSS SECTION ALONG DRIFT FROM 28+01.78m (PI) to 59+36.89 (PC)

Sandia National Laboratories

PRELIMINARY

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

II. CONSTRUCTION MONITORING ACTIVITIES

RECENT ACCOMPLISHMENTS:

- INSTRUMENTATION (CONVERGENCE PINS, STRAIN GAGES, AND ROCK BOLT INSTRUMENTATION) BEHIND TBM GROUND SUPPORT INSTALLATION CONTINUES BEYOND CS 23+00; DATA IS BEING SUBMITTED TO A/E.
- MPBX AND SPBX INSTALLATIONS IN TBM MAIN TUNNEL CONTINUE.
- FIRST AUTOMATED DATA ACQUISITION STATION (DAS) IS BEING INSTALLED; DAS WILL SERVICE INSTRUMENTATION IN ESF STARTER TUNNEL AND ALCOVE #1.
- ROCK MASS MOVEMENT AND CONVERGENCE MONITORING WAS CONDUCTED CONTINUOUSLY DURING EXCAVATION OF ESF ALCOVE #3 AND #4.

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

II. CONSTRUCTION MONITORING ACTIVITIES (Cont.)

NEAR-TERM OBJECTIVES:

- CONTINUE GROUND SUPPORT/DRIFT STABILITY INSTRUMENTATION AND MONITORING BEHIND TBM AND IN EXCAVATED ALCOVES.
- INITIATE IDS DATA COLLECTION USING DAS #1.
- CONTINUE SCAN-LINE SURVEYS IN SUPPORT OF ROCK MASS QUALITY DETERMINATIONS IN MAIN TUNNEL.
- CONTINUE MONITORING SUPPORT FOR ALCOVE #4 EXCAVATION.
- PLAN MONITORING SUPPORT FOR THERMAL TESTING REGION.

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

III. OTHER ESF TESTING ACTIVITIES

RECENT ACCOMPLISHMENTS:

- GEOLOGIC MAPPING OF TBM TUNNEL AND ALCOVE #4 IS CONTINUING FROM GANTRY SYSTEM BEHIND TBM SHIELDS AND FROM LIFTS (ALCOVE MAPPING).
- 10" CORE FOR INTACT FRACTURE TESTING WAS TAKEN FROM ALCOVE #2 IN SEPTEMBER.
- A SHUT-DOWN OF THE LARGE BLOCK TEST AT FRAN RIDGE IS COMMENCING WITH THE INSULATION OF THE BLOCK.
- A PRELIMINARY LOCATION AND TEST CONFIGURATION FOR THE IN SITU THERMAL TESTING IN THE TOPOPAH SPRING (TSw2) HAVE BEEN DEVELOPED BY ESF DESIGNERS; INITIAL AND ADDITIONAL DESIGN CRITERIA HAVE BEEN SUBMITTED TO THE A/E.
- SEISMIC INSTRUMENTATION HAS BEEN INSTALLED IN ALCOVE #1.
- NYE COUNTY REPRESENTATIVES CONTINUE TO MONITOR THE HUMIDITY/TEMPERATURE/BAROMETRIC PRESSURE MONITOR ON THE TBM.

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

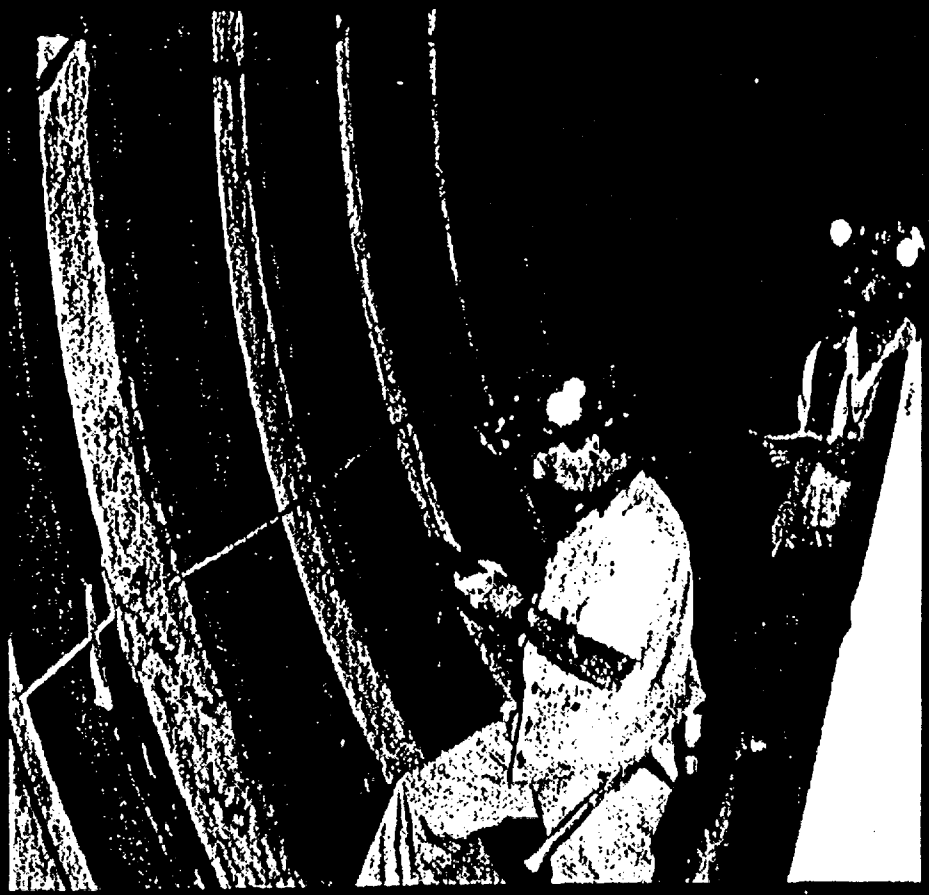
III. OTHER ESF TESTING ACTIVITIES (Cont.)

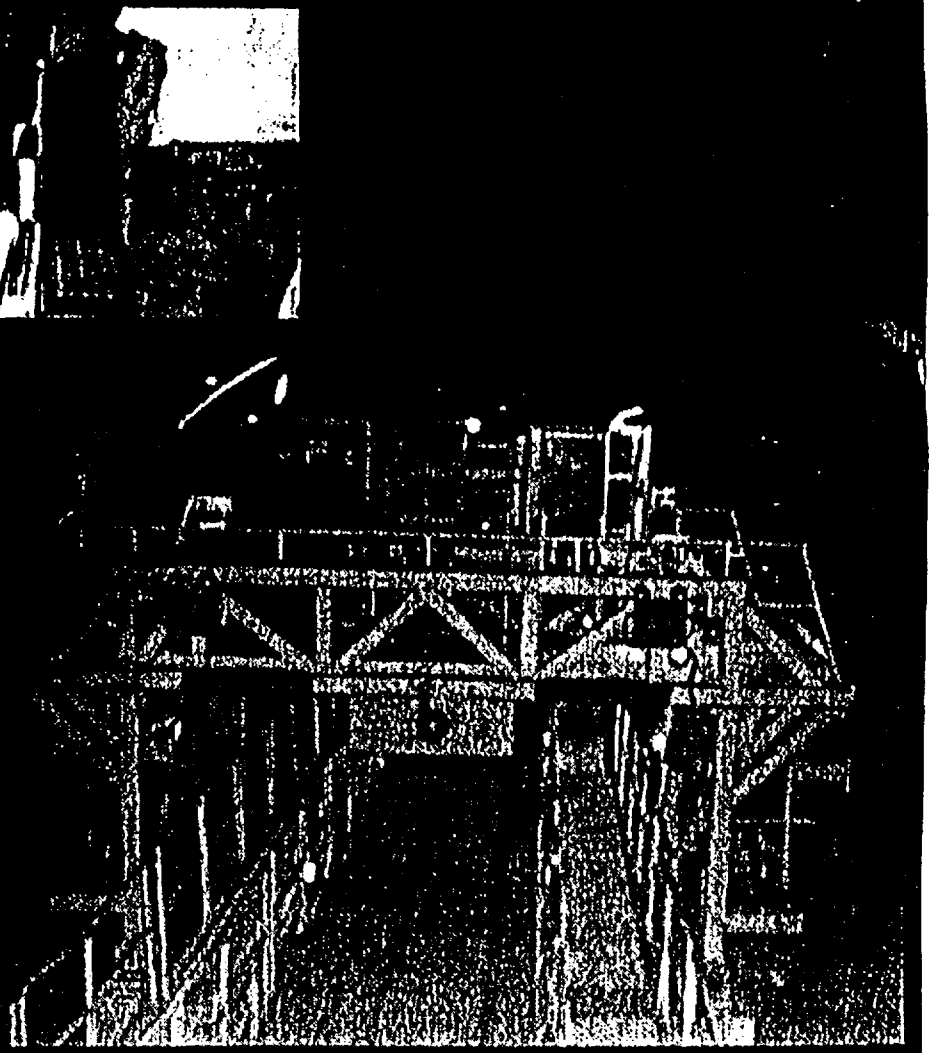
NEAR-TERM OBJECTIVES:

- FULL-SCALE MAPPING AND SAMPLING OF TOPOPAH SPRING WELDED UNIT #1 AND #2 WILL CONTINUE.

- FORMAL DESIGN AND TEST LAYOUT/PLANNING FOR IN SITU THERMAL TESTING WILL CONTINUE THROUGH REMAINDER CALENDAR 1995.

GEOLOGIC MAPPING IN THE ESF

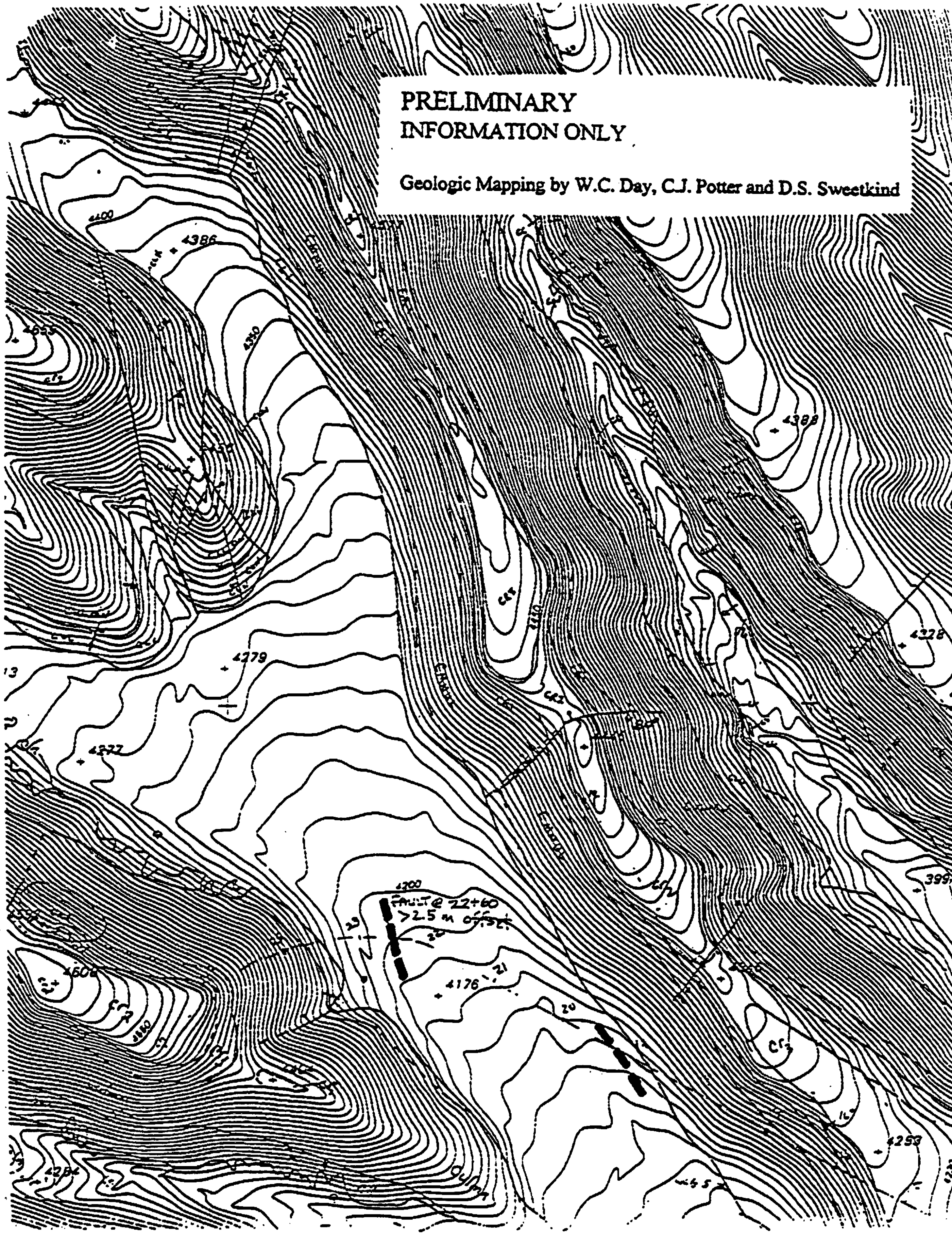




AS OF OCTOBER 23, 1995:	FULL PERIPHERY MAPPING COMPLETED TO	-	CS 22+72 m
	TUNNEL PHOTOGRAMMETRY COMPLETED TO	-	CS 22+76 m
	ROCK MASS QUALITY CLASSIFICATION COMPLETED TO	-	CS 22+56 m
	DETAILED LINE SURVEY COMPLETED TO	-	CS 22+65 m

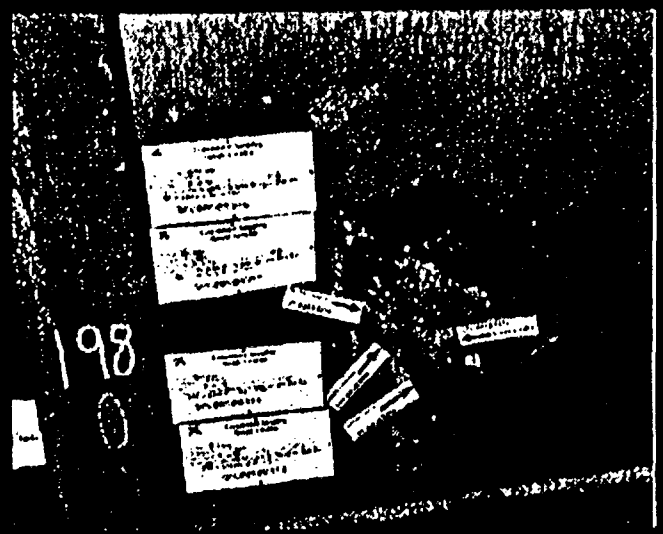
Drill Hole Wash Structure

- Based on mapping, borehole, and geophysical data a fault, probably strike-slip with a wide zone of deformation but small (< 10 m) vertical offset was predicted in North Ramp Report
- Mapped fault zone to the northeast has a vertical displacement of ~10 m
- Two faults encountered in North Ramp below Drill Hole Wash at about 19+00, 22+60
  - Vertical displacement ~2.5 m on each
  - Category 1 ground throughout
- DOE reevaluating basis for prediction



PRELIMINARY
INFORMATION ONLY
Geologic Mapping by W.C. Day, C.J. Potter and D.S. Sweetkind
4386
4388
4279
4277
4228
4176
4253
4608
Fault @ 22+60
>2.5 m offset

CONSOLIDATED SAMPLING IN THE ESF



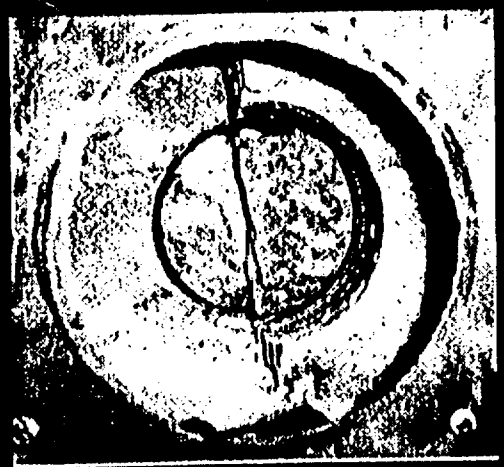
LIST OF STUDIES SUPPORTED BY CONSOLIDATED SAMPLING PROGRAM:

- LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK
- LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES
- IN-SITU DESIGN VERIFICATION
- CHARACTERIZATION OF THE EFFECT OF INTRODUCED MATERIALS ON CHEMICAL AND MINERALOGICAL CHANGES IN THE POST-EMPLACEMENT ENVIRONMENT
- WATER MOVEMENT TESTS, REV. 1
- CHARACTERIZATION OF THE PERCOLATION IN THE UNSATURATED ZONE - SURFACE-BASED STUDY
- CHARACTERIZATION OF THE PERCOLATION IN THE UNSATURATED ZONE - ESF INVESTIGATION
- MINERALOGY, PETROLOGY, AND CHEMISTRY TRANSPORT PATHWAYS
- HISTORY OF MINERALOGIC AND GEOCHEMICAL ALTERATION OF YM
- BIOLOGICAL SORPTION AND TRANSPORT
- CHARACTERIZATION OF STRUCTURAL FEATURES IN THE SITE AREA
- CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY
- UNSATURATED ZONE HYDROCHEMISTRY
- LABORATORY THERMAL PROPERTIES

AS OF OCTOBER 25, 1995, 903 SAMPLES HAVE BEEN COLLECTED IN THE STARTER TUNNEL, ESF NORTH RAMP AND ALCOVES IN SUPPORT OF 14 STUDY PLANS.

INTACT FRACTURE TESTS IN THE ESF

ESF ALCOVE #2



INTACT FRACTURE TESTING IN THE ESF BEGAN SEPTEMBER 20, 1995 WITH THE CORING OF 10" CORE FROM THE LEFT RIB OF ESF ALCOVE #2. INTACT FRACTURE TESTING IS DESCRIBED IN SCP SECTION 8.3.1.2.2.4.1 AND WILL SUPPORT HYDROLOGIC TRANSPORT MODELING.

ESF TEST ACTIVITIES SUMMARY

ACCOMPLISHMENTS AND NEAR-TERM OBJECTIVES

IV. IN-SITU THERMAL TESTING

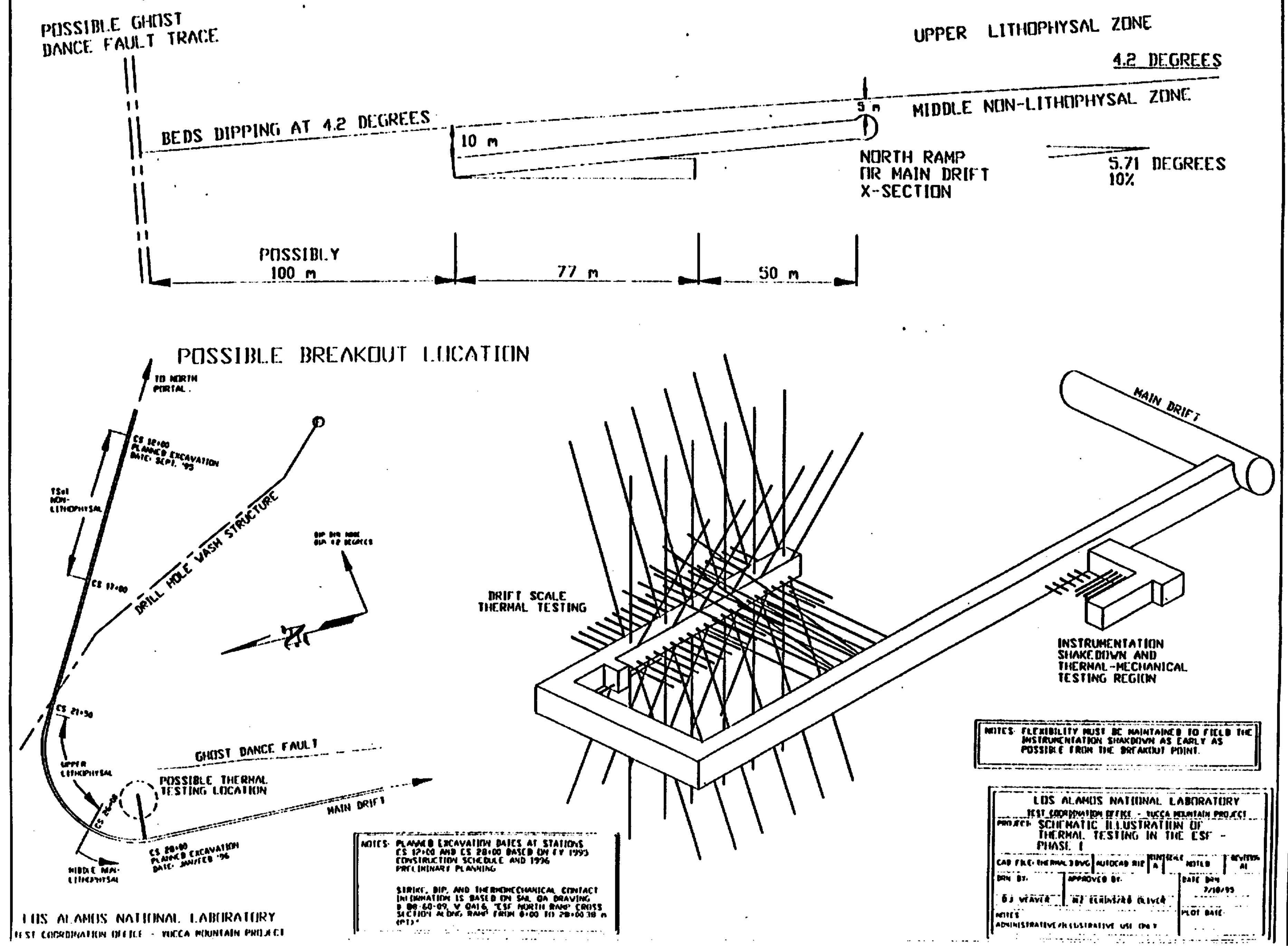
OVERVIEW:

- ADDITIONAL DESIGN CRITERIA/TEST REQUIREMENTS WERE SUBMITTED TO THE ESF DESIGN A/E DURING OCTOBER. A SCIENTIFIC TEST CRITERIA AND PLANNING DOCUMENT IS BEING DEVELOPED BY THE THERMAL TESTING TEAM AND IS SCHEDULED FOR SUBMITTAL TO THE ESF TCO IN DECEMBER OF 1995.

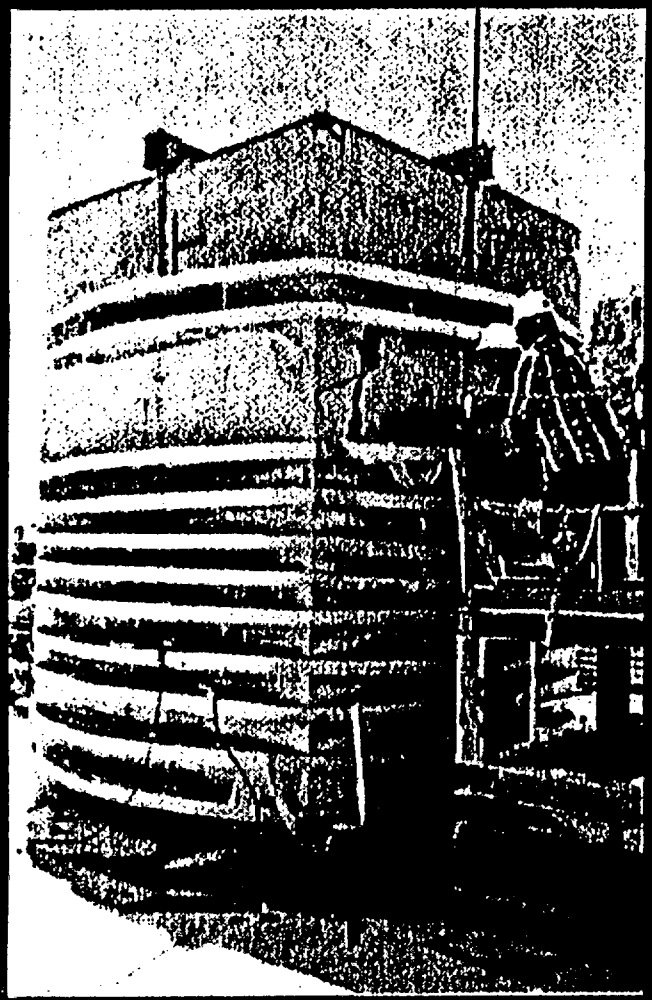
- EARLY SMALL-SCALE THERMAL-MECHANICAL-HYDROLOGICAL TESTING AND INSTRUMENTATION SHAKEDOWN IS SCHEDULED TO BEGIN IN THE FALL OF 1996. THE TEST WILL BOLSTER CONFIDENCE IN THE ABILITY TO CONSTRUCT AND INSTRUMENT THE REMAINDER OF THE TEST AND GAIN SOME THERMAL-MECHANICAL DATA NOT DERIVABLE FROM OTHER PLANNED ACTIVITIES.

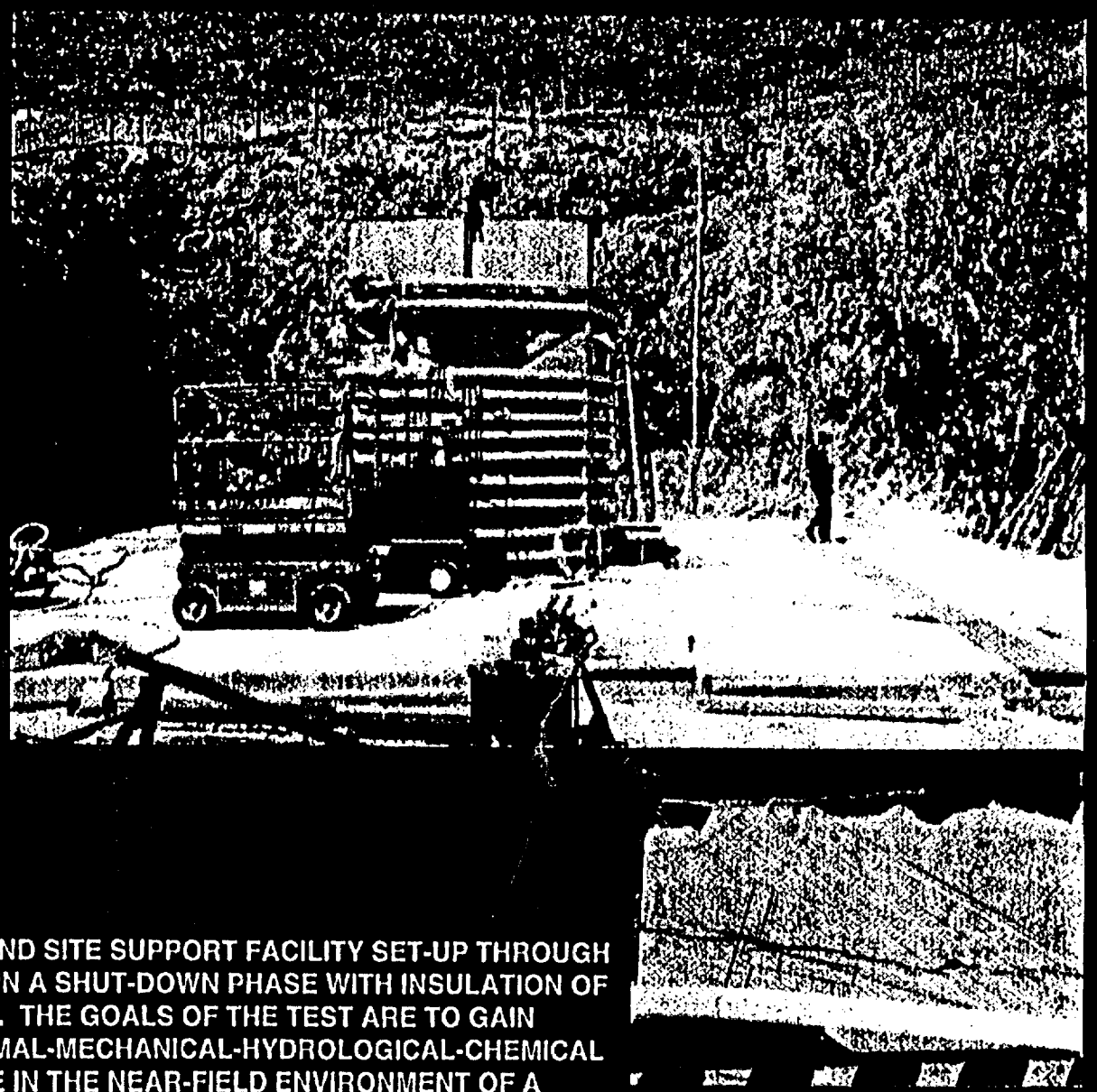
- AS THE SHAKEDOWN/THERMAL-MECHANICAL AREA IS BEING CONSTRUCTED AND INSTRUMENTED, CONSTRUCTION WILL CONTINUE ON THE REMAINDER OF THE THERMAL TEST FACILITY. THIS WILL INCLUDE A REPOSITORY EMPLACEMENT-SCALE, HEATED DRIFT WITH SIGNIFICANT THERMAL-MECHANICAL-CHEMICAL-HYDROLOGICAL INSTRUMENTATION, WING HEATERS AND A PLATE-LOADING COMPONENT. TESTING IS SCHEDULED TO BEGIN IN EARLY 1998.

SCHEMATIC ILLUSTRATION OF THE THERMAL TESTING REGION LAYOUT



LARGE BLOCK TESTS AT FRAN RIDGE





WORK CONTINUED WITH TRAILER, POWER AND SITE SUPPORT FACILITY SET-UP THROUGH SEPTEMBER. THE SITE IS CURRENTLY IN A SHUT-DOWN PHASE WITH INSULATION OF THE LARGE BLOCK COMMENCING. THE GOALS OF THE TEST ARE TO GAIN INFORMATION ON THE COUPLED THERMAL-MECHANICAL-HYDROLOGICAL-CHEMICAL PROCESSES THAT WILL BE ACTIVE IN THE NEAR-FIELD ENVIRONMENT OF A REPOSITORY; TO PROVIDE FIELD DATA FOR TESTING AND CALIBRATION MODELS; AND TO HELP IN THE DEVELOPMENT OF MEASUREMENT SYSTEMS AND TECHNIQUES.

YUCCA MOUNTAIN PROJECT

Studies

Exploratory Studies Facility Design Status

Presented to:
DOE NRC Technical Meeting

Presented by:
R. D. Snell
Manager, Engineering and Integration Operations
CRWMS Management and Operations Contractor

November 8, 1995

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

ATTACHMENT 5

Scope

- Design progress update
- Design products for main drift excavation
- Design control process update

Design Progress Update

- GROA/ESF interface drawings
  - 7 drawings, 2 analyses
  - Submit for baselining by November 30, 1995
  - Developing technical report to define changes
    - » Currently in final checking
  - Develop coordinate geometry analysis to define layout
    - » Currently in final checking
  - Revise/develop drawings in accordance with results of analysis and conclusions of technical report
    - » Drafts complete and will enter review cycle upon approval of the analyses

Design Progress Update

(Continued)

- GROA/ESF interface drawing changes
  - Removed slight curve in main drift
  - Removed two slight breaks in grade of main drift
  - Remove potential waste main
  - Remove South Ramp extension
  - Remove Imbricate Fault drift
  - Remove ESF main test area
  - Change alignment of North Ramp extension
  - Make minor adjustments to North Ramp alignment
  - Adjust shape of GROA layout (decrease width at south end)

Design Progress Update

(Continued)

- Ghost Dance Fault design
  - Preliminary layout and location included in *Layout and Sizing of ESF Alcoves and Refuge Chambers* analysis (approved 8/25/95)
  - Existing blasting and ground support analyses, drawings and specifications will apply
  - Plan & Grade drawings expected to be issued 4/96

Design Products for Main Drift Excavation

Design Products for Main Drift Excavation

Main Drift (8A) Analysis Estimated Schedule

Analysis Title	Ext Review	Approval
Geology - ESF TS Loop	5/23/95(A)	6/19/95(A)
ESF layout calculation	6/12/95(A)	7/07/95(A)
Shotcrete & rockbolt material dedication	7/19/95(A)	9/20/95(A)
General construction methods	7/24/95(A)	8/18/95(A)
Layout and sizing of ESF alcoves & refuge chambers	8/07/95(A)	8/25/95(A)

Design Products for Main Drift Excavation

Main Drift (8A) Analysis Estimated Schedule

Analysis Title	Ext Review	Approval
ESF ground support design	8/14/95(A)	9/06/95(A)
Ground support - structural steel	9/20/95(A)	10/24/95(A)
Ground support - structural steel material dedication	11/10/95	11/23/95
Invert segment	11/30/95	12/26/95

Design Products for Main Drift Excavation

Main Drift Design Output Estimated Schedule

Outputs	Ext Review	Issue
Main drift plan & profile drawings	8/17/95(A)	9/08/95(A)
Revised subsurface general construction specification	10/02/95(A)	11/10/95
Revised rockbolt/shotcrete specification	11/09/95	12/11/95
Revised ESF ground support specifications and drawings	11/13/95	12/11/95
Revised steel set drawings	12/14/95	1/11/96
Revised steel set & accessories specification	12/15/95	1/12/96

Design Control Process Update

Design Control Process

- QAP-3-12, Transmittal of design input
  - Revision 6 effective 10/30/95
  - Require transmittals to be tracked or logged
  - Require all requests for data to be in writing (oral requests no longer allowed)
  - Require requests for information gathered through ESF testing activities to be submitted to the TCO

Design Control Process

- QAP-3-0, Design control process
  - Expand interdiscipline review to include organizations external to Engineering (e.g. DOE, TCO, constructor)
  - Retain external review as optional
  - Allow M&O approval and baselining of design products without DOE acceptance (DOE will accept design products through surveillances)
  - Remove references to Basis for Design document
  - Incorporate editorial changes and clarifications
  - Reflect QARD, Revision 5

YUCCA MOUNTAIN PROJECT

Studies

YMP Safety & Health

Presented to:
DOE NRC Technical Meeting

Presented by:
Wendy R. Dixon
Assistant Manager for Environment, Safety and Health

November 8, 1995

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

ATTACHMENT 6

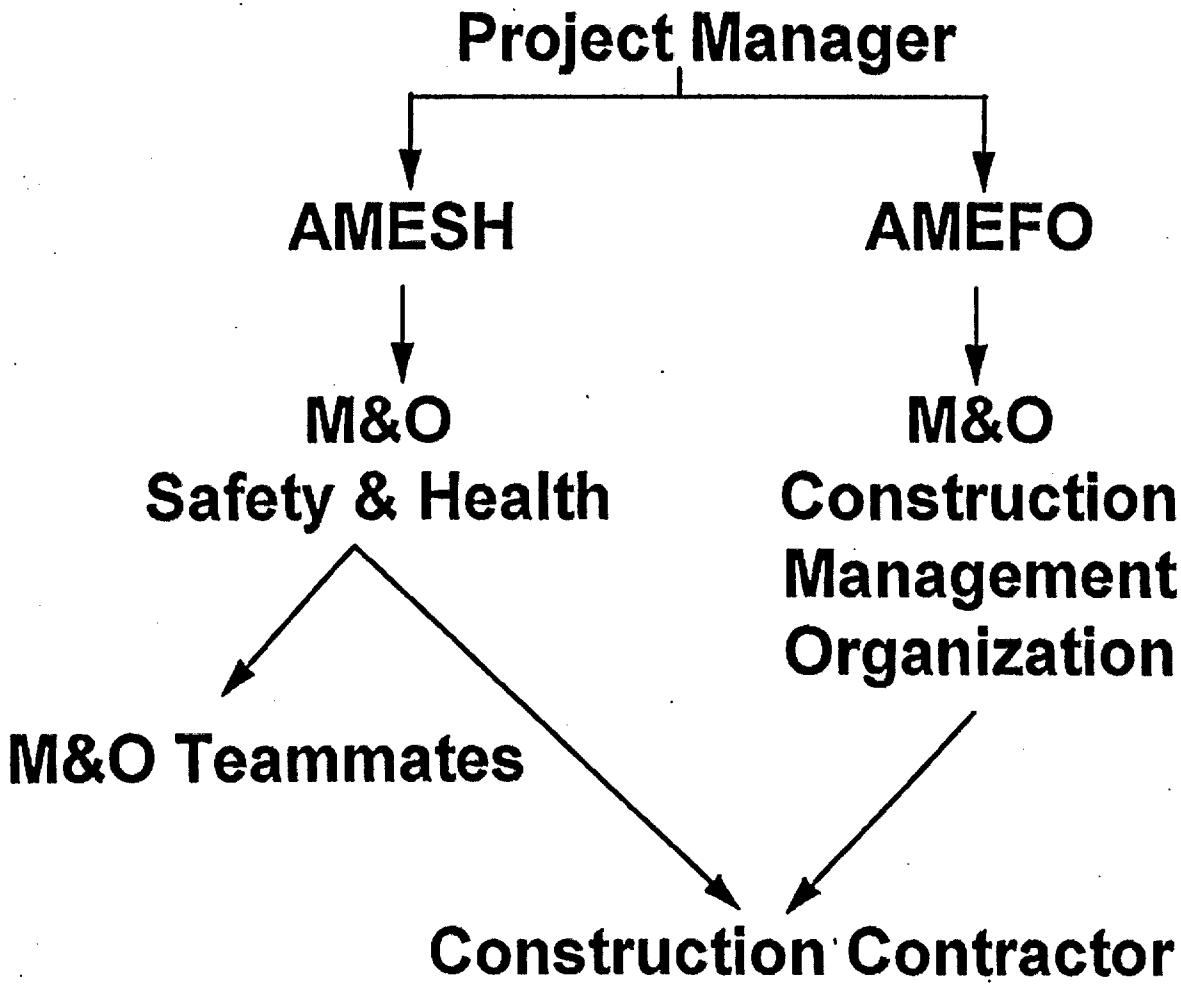
YMP S&H Organization

- Project Manager (EH-1, RW-1)
- AMESH
- M&O Safety and Health
- Constructor (K/PB)
- Teammates (Consortium, Laboratories)
- Management and Supervision
- Employees

YMP S&H Directives

- Federal Laws and Regulations (OSHA)
- State Laws and Regulations
- DOE Orders
- DOE and Industry Standards (OSHA, NFPA)
- OCRWM Requirements - Document Hierarchy
- YMP Requirements - Plans, Procedures
- M&O Requirements - Plans, Procedures
- Best Management Practices

YMP S&H Flowdown



YMP S&H Communications

- YMSCO S&H Policy
- M&O S&H Policy
- M&O Safety Steering Committee
- M&O Employee Safety & Health Committee
- M&O CMO Safety Meetings
- Teammate Safety Meetings
- Supervisor's Safety Meetings
- OCRWM AP 32.1 (Employee Concerns)

OCRWM Concerns Program

- **Purpose:**
  - Provide a 'Confidential' Avenue For Reporting Concerns Without Fear of Retaliation
  - Promote Management's Availability & Visibility

- **Responds To:**
  - DOE Order 5480.29 Employee Concerns Management System
  - 29 CRF 1903 Inspections, Citations and Proposed Penalties

- **Implemented By:**
  - OCRWM Administrative Procedure -(AP) 32.1 "OCRWM Concerns Program"

    (This AP Consolidated Project and Program Procedures for QA and ES&H concerns into one procedure).

OCRWM Concerns Program (cont'd)

ES&H Process:

- OCRWM Concerns Program Manager (DOE) Receives, Logs and Tracks all Concerns
- ES&H Concerns Transferred to AMESH for Resolution
- AMESH Conducts Investigation
- AMESH Report Sent to OCRWM Concerns Program Manager for Disposition
- Final Results are Reported to RW-1/RW-2

OCRWM Concerns Program (cont'd)

- ES&H Concerns:
  - Fifteen issues received in Fiscal Year '95
  - Six closed
  - Four awaiting closure
  - Five being investigated
- Categorization:
  - No imminent danger or serious S&H situations
  - Concerns from disgruntled employees
  - Concerns resulting from termination of employees
  - Concerns with Management Responsiveness

S&H Oversight

- DOE EH-1 Site Representative Program
  - DOE Headquarters
  - Individually Assigned Site Rep
  - Frequent Visitation
- YMSCO AMESH
  - Overall YMP S&H Responsibility
  - Oversight of all Participants
  - Surveillances, Audits, Assessments

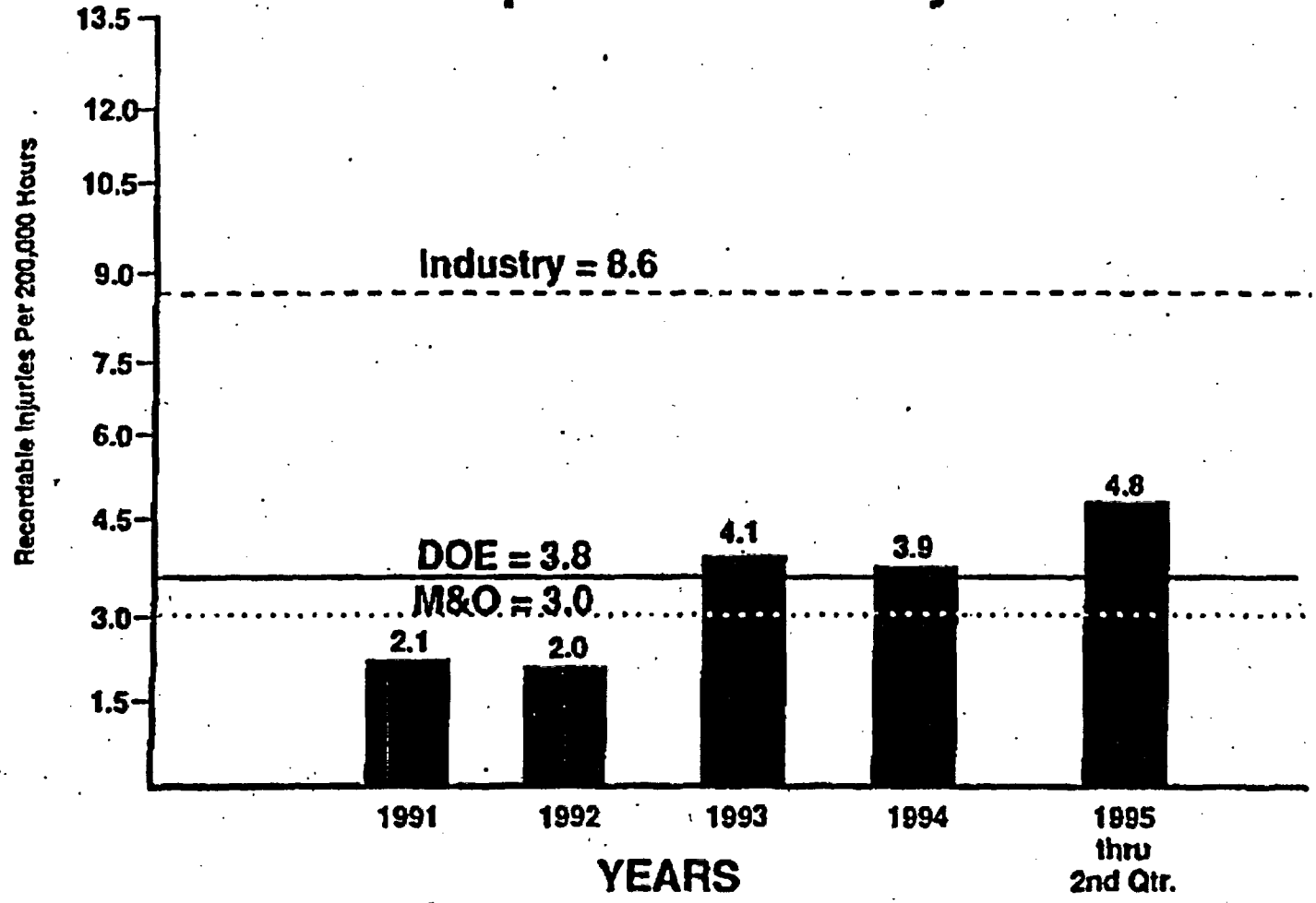
S&H Oversight (cont'd)

- AMESH Participation In Readiness Reviews
  - TBM Start-Up
  - Phase IV TBM Operations
- M&O Surveillance Program
  - Occupational Safety Compliance Reports
- Reporting and Recordkeeping
  - Incidents/Illnesses
  - Lost Workdays

Tunnel Project Statistics

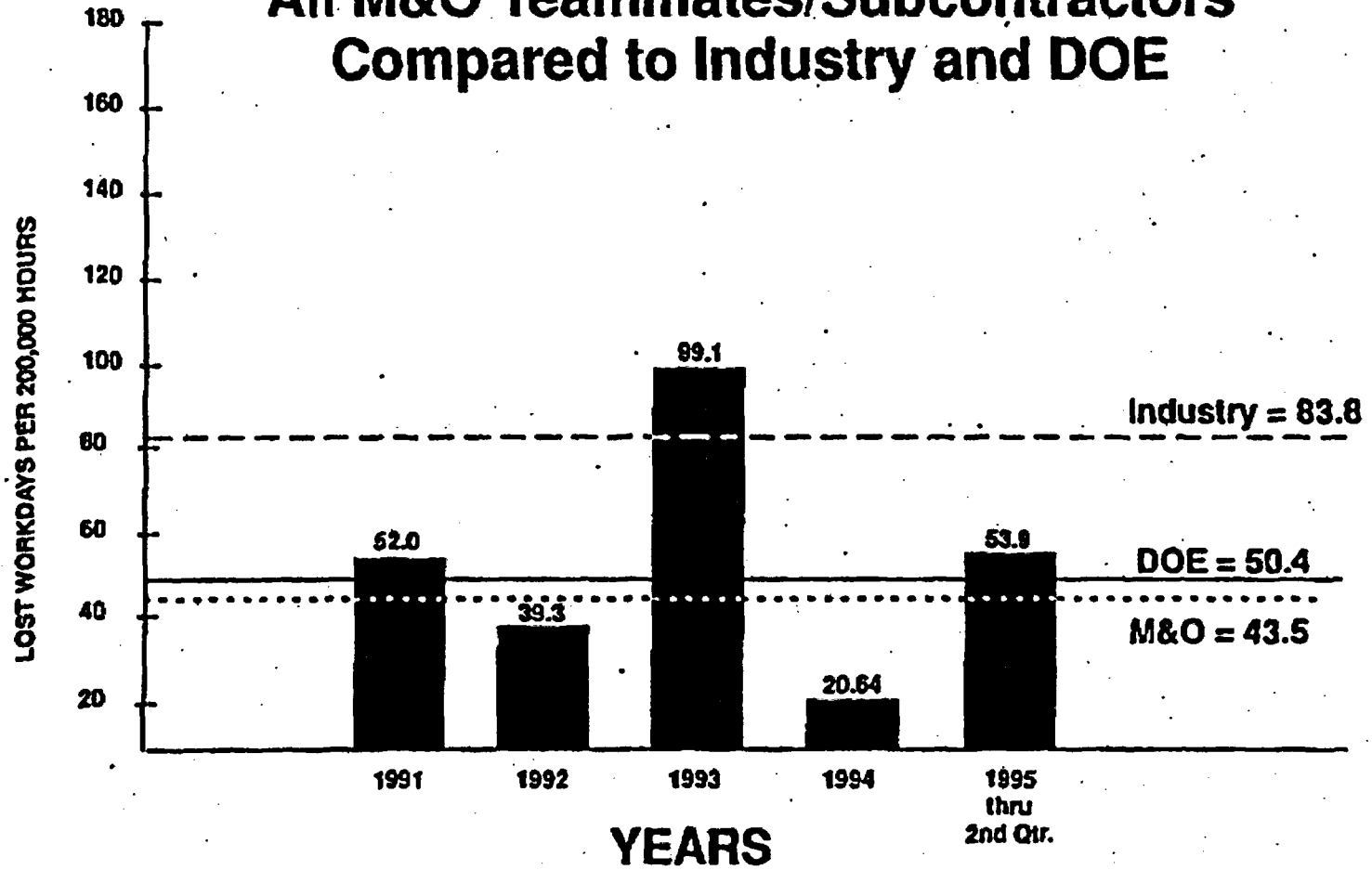
	TRC	LWC
Project A	25.1	6.2
Project B	35.3	5.4
Project C	43.8	13.8
8 Project Avg. - CY94 (>2.6M Labor Hours)	28.3	6.4
M&O Construction Rate (from 1994-1995/2) (1.2M Labor Hours)	9.1	6.4

Recordable Injury/Illness Incidence Rates
All M&O Teammates/Subcontractors
Compared to Industry & DOE



BARCHART.CDR.1213/8-25-95

Lost Workday Incidence Rate
All M&O Teammates/Subcontractors
Compared to Industry and DOE



BARCHART.CDR.1213/8-25-95

YMP S&H Implementation Summary

- Documented Program
- Input/Oversight Required at all Levels
- Employee Concerns Addressed
- Program Dynamics Result in Change/ Improvement
- Program Results Compare Favorably With Industry Standards

YUCCA MOUNTAIN PROJECT

Studies

Requirements Flowdown

Presented to:
DOE/NRC Technical Meeting

Presented by:
Thomas C. Geer
Manager, Systems Engineering
CRWMS Management and Operations Contractor

November 8, 1995

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

ATTACHMENT 7

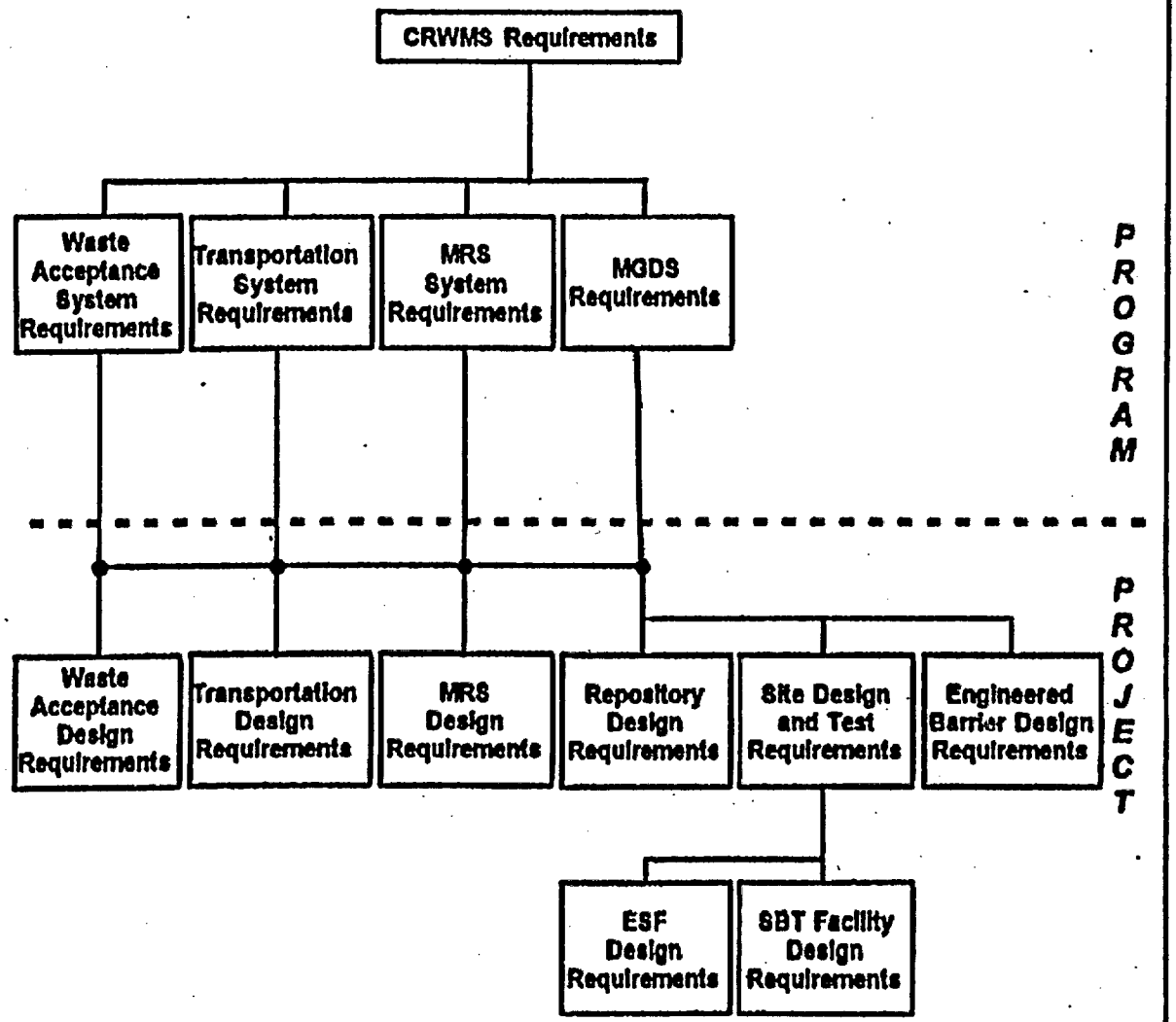
Purpose of the Technical side of the OCRWM Hierarchy

- To identify applicable technical and regulatory requirements and consistently allocate them to the system elements (e.g., Storage System Requirements, MGDS Requirements)
- To refine the allocated requirements to more specifically address the item being designed
- To be able to maintain the connection between the original technical and regulatory requirement and the requirement interpretation used for design (i.e., provide traceability)

What is NOT the Purpose of the Technical side of the OCRWM Hierarchy?

- The Hierarchy is not intended to:
  - Systematically disposition every Part 60 Citation
  - Identify management requirements
  - Dictate design solutions

OCRWM Document Hierarchy



How are the MGDS Hierarchy Documents Used?

- Upper level documents such as the MGDS SRD, SD&TRD etc., are used by the lower level document developers and are not used by the designer
- The following documents are used by the designer:
  - Repository Design Requirements (RDR)
  - Engineered Barrier Design Requirements Document (EBDRD)
  - Exploratory Study Facility Design Requirements (ESFDR)
- The designers use the requirements in Section 3
- The document developers use trace tables as a document development tool and as a summary for the reviewers to use during the technical reviews
- The trace tables are not used by the designers

Flowdown

- **Flowdown of requirements is the process that occurs when requirements are:**
  1) **Allocated to System Elements (e.g., as documented in the CRD)**
  2) **Refined and allocated to System Segments (e.g., as documented in the MGDS SRD)**
  3) **Refined and allocated to Configuration Items (e.g., as documented in the SD&TRD, ESFDR)**

Flowdown of 10 CFR 60

- CRD allocated 10 CFR 60 to the MGDS Element
- MGDS SRD allocates 10 CFR 60 to the Site, Repository, and Waste Package Segments
- SD&TRD generally allocates the 10 CFR 60 requirements only to the ESF CIs which may become part of the Repository
- ESFDR allocates applicable 10 CFR 60 requirements to lower level CIs

Traceability

- Traceability is the ability to determine the path a particular requirement takes through the CRWMS System from the point of origin (e.g., CRD) to the actual input into the design
- Traceability is represented within the requirements sections (i.e., Section 3) of each of the requirements documents in the following manner
  1) There is a reference to the parent requirement in brackets (e.g., [MGDS SRD 3.7.B.1])
  2) If the requirement originates from 10CFR60, then it is also identified with brackets (e.g., [10 CFR 60.122(a)]
- Trace tables found in the back on the requirements documents represent a summary of traceability, but do not by themselves constitute traceability
- Traceability from the Requirements Documents to the design is established through design analyses as documented in accordance with QAP-3-9

Historical Problems

Design Requirements Documents (DRDs)

- Organization of the DRDs required a requirement allocation for every CI design
- Redundant and unnecessary requirements existed
- 10 CFR 60 requirements were not clearly identified to designers

Engineering Analyses (QAP-3-9)

- DRD requirements addressed by a given analysis were not clearly indicated
- Difficult to determine the design criteria developed in response to the requirements

Improvements

Design Requirements Documents (DRDs)

- Documents have been reorganized by CIs
- All 10 CFR 60 requirements are labeled at the end of the requirements for visibility to the designer
- Requirements that are not applicable or redundant have been removed
- Each of the 10 CFR 60 requirements which were identified by NUREG 1439 have been addressed in Appendix F of the ESFDR

Engineering Analysis (QAP-3-9)

- Design analysis identifies applicable DRD requirements
- Design analysis specifically identifies criteria developed to meet the requirements

Example 1

60.131(b)(3)

Protection against fires and explosions

an underground facility located in the unsaturated zone to the accessible environment.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

[48 FR 28222, June 21, 1983, as amended at 50 FR 29647, July 22, 1985]

DESIGN CRITERIA FOR THE GEOLOGIC REPOSITORY OPERATIONS AREA

§ 60.130 Scope of design criteria for the geologic repository operations area.

Sections 60.131 through 60.134 specify minimum criteria for the design of the geologic repository operations area. These design criteria are not intended to be exhaustive, however. Omissions in §§ 60.131 through 60.134 do not relieve DOE from any obligation to provide such safety features in a specific facility needed to achieve the performance objectives. All design bases must be consistent with the results of site characterization activities.

§ 60.131 General design criteria for the geologic repository operations area.

(a) *Radiological protection.* The geologic repository operations area shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in restricted areas within the limits specified in part 20 of this chapter. Design shall include:

(1) Means to limit concentrations of radioactive material in air;

(2) Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation;

(3) Suitable shielding;

(4) Means to monitor and control the dispersal of radioactive contamination;

(5) Means to control access to high radiation areas or airborne radioactivity areas; and

(6) A radiation alarm system to warn of significant increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluents. The alarm system shall be designed with provisions for calibration and for testing its operability.

(b) *Structures, systems, and components important to safety*—(1) *Protection against natural phenomena and environmental conditions.* The structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the geologic repository operations area will not interfere with necessary safety functions.

(2) *Protection against dynamic effects of equipment failure and similar events.* The structures, systems, and components important to safety shall be designed to withstand dynamic effects such as missile impacts, that could result from equipment failure, and similar events and conditions that could lead to loss of their safety functions.

(3) *Protection against fires and explosions.* (i) The structures, systems, and components important to safety shall be designed to perform their safety functions during and after credible fires or explosions in the geologic repository operations area.

(ii) To the extent practicable, the geologic repository operations area shall be designed to incorporate the use of noncombustible and heat resistant materials.

(iii) The geologic repository operations area shall be designed to include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on structures, systems, and components important to safety.

(iv) The geologic repository operations area shall be designed to include means to protect systems, structures, and components important to safety against the adverse effects of either the operation or failure of the fire suppression systems.

(4) *Emergency capability.* (i) The structures, systems, and components important to safety shall be designed to maintain control of radioactive waste and radioactive effluents, and permit prompt termination of operations and evacuation of personnel during an emergency.

EXAMPLE 1

F.2.45 10 CFR 60.131(a)(6), The GROA design to include a radiation alarm system

DISCUSSION

This requirement pertains to radiation levels in the air in restricted areas. Since no radioactive materials will be brought into the ESF, this requirement does not apply to the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.46 10 CFR 60.131(b)(1), SSCs that are ITS to withstand anticipated natural phenomena and environmental conditions so as not to interfere with safety functions

DISCUSSION

The ground support system is the only ITS item in the ESF. Being underground, the only natural phenomena will be seismic motion. The naturally occurring and man induced environmental conditions underground will be considered in the ground support design.

APPLICABILITY

Permanent ground support system will be designed for Repository seismic loads and all naturally occurring and man induced underground environmental conditions.

F.2.47 10 CFR 60.131(b)(2), SSCs that are ITS to withstand impacts from equipment failures that could lead to loss of safety functions

DISCUSSION

This requirement has been interpreted as impacts to ITS items from machinery (runaway train) or rotating equipment failures (flywheel, cutter disc, etc.). The application of this interpretation is for Repository only and not during ESF construction and/or operations; therefore, there are no ESF design requirements associated with this requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.48 10 CFR 60.131(b)(3)(i), SSC ITS to perform safety functions during and after fires and explosion

DISCUSSION

The definition of credible fires and explosions in the GROA will be defined by the Repository and any permanent structures, systems, and components (SSCs) provided by the ESF will be evaluated by Repository design before relying on it to perform ITS function(s). Ground support is the only ITS item being designed and installed in the ESF. The level of ground support, installed by ESF design, will meet ESF operational requirements but not necessarily

Repository requirements. The ESF ground support design and installation will be installed compliant with all Q-controls and will allow supplemental ground support to be added by Repository, if needed.

APPLICABILITY

No specific ESF design requirements.

F.2.49 10 CFR 60.131(b)(3)(ii), Repository to incorporate noncombustible and heat resistant materials

DISCUSSION

To the extent practical rather than practicable, this requirement is applicable to the ESF and will be complied with. Practical is being specified rather than practicable because risk and cost analysis will need to be performed before committing to applying this requirement everywhere possible, regardless of whether the risk warrants the expense.

APPLICABILITY

Incorporate noncombustible and/or heat resistant materials, to the extent practical.

F.2.50 10 CFR 60.131(b)(3)(iii), Explosion and fire detection alarm system; suppression system to reduce adverse effects on SSC ITS

DISCUSSION

The Repository will install alarm and suppression systems when the ITS items are installed. The ESF will install a portion of the permanent ground support and if there were to be a fire the integrity of the ESF installed ground support will be evaluated before using it for Repository operations.

APPLICABILITY

No specific ESF design requirements.

F.2.51 10 CFR 60.131(b)(3)(iv), The repository to include protection against the adverse effects of the operation or failure of the fire suppression systems

DISCUSSION

The only ITS item in the ESF is the ground support system. If there were to be a fire the integrity of the ground support will be evaluated before using it for Repository operations. The ground support system is upgradeable and/or replaceable.

APPLICABILITY

No specific ESF design requirements.

3.7.3.1.C The ground support system shall be designed to provide a safe and stable opening during operational and retrieval periods to meet personnel, equipment, and ventilation requirements.

[DERIVED][SD&TRD L3.7.2.5.D.2.18][10CFR60.133(e)(1)]

3.7.3.1.D The ground support system shall be compatible with the excavation methods and equipment.

[DERIVED]

3.7.3.1.E The ground support system shall incorporate the use of noncombustible and heat resistant materials in the design.

[DERIVED][SD&TRD L3.7.2.5.D.2.9][10CFR60.131(b)(3)(ii)]

3.7.3.1.F The ground support system shall be designed to permit periodic inspection, monitoring, testing, and maintenance, as necessary, to ensure their continued function and readiness.

[DERIVED][SD&TRD L3.7.2.5.D.2.11, L3.7.2.5.D.2.19][10CFR60.131(b)(6), 10CFR60.133(e)(2)]

3.7.3.1.G The ground support system shall be designed and installed throughout the main access openings and all alcove transition regions to reduce the potential for deleterious rock movement or fracturing.

[DERIVED][SD&TRD L3.7.2.5.D.2.19][10CFR60.133(e)(2)]

3.7.3.1.H The ground support system shall be designed to meet ESF design basis events including those natural, credible disruptive events likely to occur during ESF construction and operation.

[DERIVED]

3.7.3.1.I The ground support system shall be designed to accommodate the anticipated ground conditions at the depth the main access opening, operations support areas and test support areas will be constructed, by utilizing the available site characterization data at that time.

[SD&TRD L3.7.2.5.D.2.5][10CFR60.130]

3.7.3.1.J The ground support system design shall have the capability to be supplemented as required when identified through additional site characterization data and analyses.

[SD&TRD L3.7.2.5.D.1.8, L3.7.2.5.D.3.6, L3.7.2.5.D.3.8][10CFR60.141(a), 10CFR60.141(b), 10CFR60.141(d)]

3.7.3.1.K The ground support system shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

[DERIVED][SD&TRD L3.7.2.5.D.2.15][10CFR60.133(b)]

3.7.3.1.L The ground support system shall be designed to meet the predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system for the site characterization heater tests.

[DERIVED]

I.3.7.2.5.D.2.3 The Subsurface Excavations CI interface with the geologic repository shall be designed so that any or all of the emplaced waste can be retrieved on a reasonable schedule starting at any time up to 100 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the Commission. Paragraph I.3.7.2.5.D.2.4 gives guidance for developing the schedule.

[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.111(b)(1)]

I.3.7.2.5.D.2.4 The Subsurface Excavations CI interface with the geologic repository shall be designed for the option to retrieve waste within a period of time equal to the approximate time taken for construction of the geologic repository operations area and the emplacement of wastes.

[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.111(b)(3)]

I.3.7.2.5.D.2.5 The Subsurface Excavations CI design bases shall be consistent with available results of site characterization test activities.

[DERIVED][MGDS RD 3.3.1.E][10 CFR 60.130]

I.3.7.2.5.D.2.6 The Subsurface Excavations CI SSC ITS planned for incorporation into the GROA shall be designed so that the effects of anticipated natural phenomena and environmental conditions will not interfere with necessary safety functions.

[DERIVED][MGDS RD 3.2.6.1][10 CFR 60.131(b)(1)]

I.3.7.2.5.D.2.7 The Subsurface Excavations CI SSC ITS shall be designed to withstand dynamic effects, such as missile impacts, that could result from equipment failure and similar events and conditions that could lead to loss of their safety functions.

[DERIVED][MGDS RD 3.2.6.2.1.C][10 CFR 60.131(b)(2)]

I.3.7.2.5.D.2.8 The Subsurface Excavations CI SSC ITS shall be designed to perform their safety functions during and after credible fires or explosions in the GROA.

[DERIVED][MGDS RD 3.2.1.8.C, 3.2.5.1.3][10 CFR 60.131(b)(3)(i)]

I.3.7.2.5.D.2.9 The Subsurface Excavations CI SSC ITS design and construction shall incorporate the use of noncombustible and heat-resistant materials.

[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.131(b)(3)(ii)]

I.3.7.2.5.D.2.10 The Subsurface Excavations CI SSC ITS shall be designed with the means to be protected against the adverse effects of either the operation or the failure of the fire-suppression systems.

[DERIVED][MGDS RD 3.2.5.1.3][10 CFR 60.131(b)(3)(iv)]

I.3.7.2.5.D.2.11 The Subsurface Excavations CI SSC ITS shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.

[DERIVED][MGDS RD 3.2.5.2.1][10 CFR 60.131(b)(6)]

I.3.7.2.5.D.2.12 The Subsurface Excavations CI SSC ITS design and construction shall consider the Federal Mine Safety and Health Act of 1977. The ESF design shall include provisions for worker protection regarding the construction and operation of the

decommissioning do not adversely affect the waste isolation capabilities of the Repository or the geologic setting.

3.7.1.3 Site Characterization Requirements

Execution of the site characterization and site suitability activities requires facilities to support the subsurface- and surface-based studies and to collect the data specified in Appendix A. These facilities have been designated as the ESF and the SBTF respectively.

Conceptually, the ESF is envisioned to include: a subsurface facility; site civil improvements; surface support facilities on two main sites that contain entrances to the underground and on various auxiliary sites for storage and other uses; test support subsystems; and subsystems to supply, distribute, and control various utilities such as electrical power, water, and communications.

The SBTF is envisioned to include small, distributed test sites designated for a variety of activities including, but not limited to, drilling and trenching; roads and trails; and a pool of transportable support equipment such as generators, fuel and water tanks, chemical latrines; and the like.

A. Limitations. Site characterization activities (including but not limited to design, development, ESF construction, and site investigations) at Yucca Mountain shall be limited to those necessary to provide the data required for evaluation of the suitability of the site for an application for construction authorization[17]. [NWPA, 113(c)(1), as amended]

B. Requirements. DRDs shall apply the requirements listed below in the design of site characterization systems and facilities, as appropriate (some are not applicable to the SBTF). [Derived]

1. Mandatory Design Requirements. The Site characterization facilities and systems shall be designed and constructed in accordance with the applicable[18] design requirements derived from the regulations, included in, but not limited to, those listed in Table 3-7 such that they do not preclude the ability of the Repository and EBS Segments to meet the requirements in this MGDS-RD.
[DOE Letter 2/27/90]

---

[17] Section 113(c)(1) of the NWPA also allows activities necessary to provide data required for compliance with the National Environmental Policy Act of 1969 (42USC4321 et seq) (activities that are not considered part of site characterization).

[18] This recognizes that not all of the regulations are applicable to the facility design.

Table 3-7. Mandatory 10CFR60 Requirements for Site Characterization Facilities

	10CFR60 REQUIREMENT	SUBJECT
a	10CFR60.4(b)	Communications and records
b	10CFR60.15(b)	In situ exploration
c	10CFR60.15(c)(1)	Limit adverse effects on repository
d	10CFR60.15(c)(2)	Limit borings
e	10CFR60.15(c)(3)	Boring locations
f	10CFR60.15(c)(4)	Coordinate with repository design
g	10CFR60.16	SCP required
h	10CFR60.21(c)(1)(ii)(D)	SAR: effectiveness of barriers
i	10CFR60.21(c)(1)(ii)(E)	SAR: analysis of SSC important to safety
j	10CFR60.21(c)(11)	SAR: Close and Decommission
k	10CFR60.72(a)	Construction records
l	10CFR60.72(b)	Construction records
m	10CFR60.74	Tests
n	10CFR60.111(a)	Protection against rad exposures
o	10CFR60.111(b)(1)	Retrievability
p	10CFR60.111(b)(3)	Retrievability: schedule
q	10CFR60.112	Overall system performance
r	10CFR60.113(a)(1)(i)	Engineered Barrier System (EBS)
s	10CFR60.113(a)(1)(ii)(A)	Waste package
t	10CFR60.113(a)(1)(ii)(B)	EBS
u	10CFR60.130	Scope of design criteria
v	10CFR60.131(b)(1)	Natural phenomena/environmental conditions
w	10CFR60.131(b)(2)	Equipment failure
x	10CFR60.131(b)(3)	Fire and explosions
y	10CFR60.131(b)(4)(i)	Control of radioactive materials
z	10CFR60.131(b)(6)	Maintainability
aa	10CFR60.131(b)(9)	MSHA regulations
ab	10CFR60.133(a)(1)	Configuration of underground facility
ac	10CFR60.133(a)(2)	Disruptive events
ad	10CFR60.133(b)	Flexibility
ae	10CFR60.133(c)	Retrievability
af	10CFR60.133(d)	Control of water/gas
ag	10CFR60.133(e)(1)	Underground openings: safe operations
ah	10CFR60.133(e)(2)	Underground openings: stability
ai	10CFR60.133(f)	Rock excavation
aj	10CFR60.133(g)	Ventilation
ak	10CFR60.133(h)	EBS

Example 2

60.131(b)(5)(iii)
Emergency Power

EXAMPLE 2 PAGE 1 OF 1

(ii) The geologic repository operations area shall be designed to include onsite facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of available offsite services (such as fire, police, medical and ambulance service) that may aid in recovery from emergencies.

(5) *Utility services.* (i) Each utility service system that is important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions.

(ii) The utility services important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform their safety functions.

(iii) Provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and timely emergency power can be provided to instruments, utility service systems, and operating systems, including alarm systems, important to safety.

(6) *Inspection, testing, and maintenance.* The structures, systems, and components important to safety shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.

(7) *Criticality control.* All systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor (k_{eff}) must be sufficiently below unity to show at least a 5% margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

(8) *Instrumentation and control systems.* The design shall include provisions for instrumentation and control systems to monitor and control the behavior of systems important to safety over anticipated ranges for normal operation and for accident conditions.

(9) *Compliance with mining regulations.* To the extent that DOE is not subject to the Federal Mine Safety and Health Act of 1977, as to the construction and operation of the geologic repository operations area, the design of the geologic repository operations area shall nevertheless include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions. Any deviation from relevant design requirements in 30 CFR, chapter I, subchapters D, E, and N will give rise to a rebuttable presumption that this requirement has not been met.

(10) *Shaft conveyances used in radioactive waste handling.* (i) Hoists important to safety shall be designed to preclude cage free fall.

(ii) Hoists important to safety shall be designed with a reliable cage location system.

(iii) Loading and unloading systems for hoists important to safety shall be designed with a reliable system of interlocks that will fail safely upon malfunction.

(iv) Hoists important to safety shall be designed to include two independent indicators to indicate when waste packages are in place and ready for transfer.

§60.132 Additional design criteria for surface facilities in the geologic repository operations area.

(a) *Facilities for receipt and retrieval of waste.* Surface facilities in the geologic repository operations area shall be designed to allow safe handling and storage of wastes at the geologic repository operations area, whether these wastes are on the surface before emplacement or as a result of retrieval from the underground facility.

(b) *Surface facility ventilation.* Surface facility ventilation systems supporting waste transfer, inspection, decontamination, processing, or packaging shall be designed to provide protection against radiation exposures and offsite releases as provided in §60.111(a).

(c) *Radiation control and monitoring—*
(1) *Effluent control.* The surface facili-

157-030 O—95——5

Example 3

60.133(f)
Excavating methods that will limit preferential pathways

EXAMPLE 3

ties shall be designed to control the release of radioactive materials in effluents during normal operations so as to meet the performance objectives of §60.111(a).

(2) *Effluent monitoring.* The effluent monitoring systems shall be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirement for effluent control. The monitoring systems shall be designed to include alarms that can be periodically tested.

(d) *Waste treatment.* Radioactive waste treatment facilities shall be designed to process any radioactive wastes generated at the geologic repository operations area into a form suitable to permit safe disposal at the geologic repository operations area or to permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any regulations that are applicable.

(e) *Consideration of decommissioning.* The surface facility shall be designed to facilitate decontamination or dismantlement to the same extent as would be required, under other parts of this chapter, with respect to equivalent activities licensed thereunder.

§60.133 Additional design criteria for the underground facility.

(a) *General criteria for the underground facility.* (1) The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides.

(2) The underground facility shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding, fires and explosions, will not spread through the facility.

(b) *Flexibility of design.* The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

(c) *Retrieval of waste.* The underground facility shall be designed to permit retrieval of waste in accordance with the performance objectives of §60.111.

(d) *Control of water and gas.* The design of the underground facility shall provide for control of water or gas intrusion.

(e) *Underground openings.* (1) Openings in the underground facility shall be designed so that operations can be carried out safely and the retrievability option maintained.

(2) Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

(f) *Rock excavation.* The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment.

(g) *Underground facility ventilation.* The ventilation system shall be designed to:

(1) Control the transport of radioactive particulates and gases within and releases from the underground facility in accordance with the performance objectives of §60.111(a),

(2) Assure continued function during normal operations and under accident conditions; and

(3) Separate the ventilation of excavation and waste emplacement areas.

(h) *Engineered barriers.* Engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure.

(i) *Thermal loads.* The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

[48 FR 28222, June 21, 1983, as amended at 50 FR 29648, July 22, 1985]

§60.134 Design of seals for shafts and boreholes.

(a) *General design criterion.* Seals for shafts and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's

EXAMPLE 3

F.2.65 10 CFR 60.133(f), The underground facility to incorporate excavation methods that limit the potential for creating preferential pathway for groundwater

DISCUSSION

Use excavation methods that limit the damage to the rock beyond the intended opening.

APPLICABILITY

Use mechanical excavation equipment and/or controlled drill and blast methods of excavation.

F.2.66 10 CFR 60.133(g)(1), Ventilation system to control the transport of radioactive particulates and gases from the underground in accordance with 60.111(a)

DISCUSSION

This is a Repository requirement. The ESF ventilation system is not permanent and [10 CFR 60.111(a)] has been determined as not applicable to the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.67 10 CFR 60.133(g)(2), The underground facility ventilation system is designed to assure continued function during normal operations and under accident conditions

DISCUSSION

This is a Repository requirement that does not apply to the ESF. The ESF ventilation is temporary and will not be used by the Repository and therefore will not be designed to meet this requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.68 10 CFR 60.133(g)(3), Separate the excavation and waste emplacement ventilation systems

DISCUSSION

This is a Repository requirement. There are no waste emplacement areas in the ESF and by being consistent with the Repository design, the ESF will not preclude the Repository from meeting this requirement.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

3.7.2.1.2.B The ESF underground openings CIs design, construction, and in situ testing shall be planned and coordinated with the repository.
[DERIVED][SD&TRD I.3.7.2.5.B.2.2.B][10CFR60.15(c)(4)]

3.7.2.1.2.C The chemical content of the blasting agents and explosives shall be evaluated during their selection process to limit to the extent practical adverse effects on in situ site characterization.
[DERIVED][SD&TRD I.3.7.2.5.C.1.A][10CFR60.15(c)(1)]

3.7.2.1.2.D Appropriate gravity drainage and/or pumping systems shall be incorporated for draining water away from testing and other work areas to suitable collection points for further treatment and/or disposal.
[DERIVED][SD&TRD I.3.7.2.5.C.1.D][10CFR60.15(c)(1)]

3.7.2.1.2.E Methods for dust control and cleaning of walls in the underground portion of the ESF shall be designed to limit adverse effects on the accuracy and reliability of information from site characterization.
[DERIVED][SD&TRD I.3.7.2.5.C.1.D][10CFR60.15(c)(1)]

3.7.2.1.2.F The construction of the underground facility shall incorporate use of mechanical excavation and drill and blast methods.
[DERIVED][SD&TRD I.3.7.2.5.D.2.20][10CFR60.133(f)]

3.7.2.1.2.G The ESF shall be designed so that the thermal effects of ESF testing do not result in temperatures in excess of 115 C in either the Topopah Spring Welded Unit 3 (TSw3) or Calico Hills non-welded (CHn) units, compatible with the performance measure for the potential repository listed in the SD&TRD.
[DERIVED]

3.7.2.1.2.H Capabilities for plugging or grouting temporary water inflow areas during construction shall be available.
[DERIVED]

3.7.2.1.2.I To the extent practicable, drilling with water into known large-aperture fractures shall be avoided.
[DERIVED][SD&TRD N/A]

3.7.2.2 PORTALS (BABEAA000)

The complete set of Portals CI requirements are obtained by combining the requirements from the following Sections: 3.2.1.2, 3.7.1.2, 3.7.2.1.2, and 3.7.2.2.1.

3.7.2.2.1 DESCRIPTION

The portal of a ramp is defined as the rock face and retaining structure at the surface entrance of the ramp. The North Portal extends from the surface to, approximately, station 00+60. The structure provides ground and utility support and overhead protection for ingress and egress into the ramp during construction and operation.

area as may be necessary to provide reasonable assurance that all SSC ITS can perform their intended functions.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.131(b)(9)]

I.3.7.2.5.D.2.13 The Subsurface Excavations CI design shall contribute to the containment and isolation of radionuclides by considering the orientation, geometry, layout, and depth of the underground facility.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(a)(1)]

I.3.7.2.5.D.2.14 The Subsurface Excavations CI shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding, fires and explosions, will not spread through the facility.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(a)(2)]

I.3.7.2.5.D.2.15 The Subsurface Excavations CI shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(b)]

I.3.7.2.5.D.2.16 The Subsurface Excavations CI shall be designed to permit retrieval of waste in accordance with the performance objectives of paragraphs I.3.7.2.5.D.2.2, I.3.7.2.5.D.2.3, and I.3.7.2.5.D.2.4.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(c)]

I.3.7.2.5.D.2.17 The Subsurface Excavations CI shall be designed to provide for control of water or gas intrusion.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(d)]

I.3.7.2.5.D.2.18 The Subsurface Excavations CI SSC ITS shall be designed so that operations can be carried out safely and the retrievability option maintained.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(e)(1)]

I.3.7.2.5.D.2.19 The Subsurface Excavations CI shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(e)(2)]

I.3.7.2.5.D.2.20 The Subsurface Excavations CI shall be designed to incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment.
[DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(f)]

I.3.7.2.5.D.2.21 The Test Alcove Excavations and Layouts shall provide a minimum stand-off between drifts of twice the drift diameter to preclude interference between tests.
[DERIVED]

I.3.7.2.5.D.2.22 The Subsurface Excavations CI shall be designed and constructed to provide suitable ground control in compliance with 30 CFR 57, Subpart B.
[DERIVED][MGDS RD 3.2.6.2.5]

decommissioning do not adversely affect the waste isolation capabilities of the Repository or the geologic setting.

3.7.1.3 Site Characterization Requirements

Execution of the site characterization and site suitability activities requires facilities to support the subsurface- and surface-based studies and to collect the data specified in Appendix A. These facilities have been designated as the ESF and the SBTF respectively.

Conceptually, the ESF is envisioned to include: a subsurface facility; site civil improvements; surface support facilities on two main sites that contain entrances to the underground and on various auxiliary sites for storage and other uses; test support subsystems; and subsystems to supply, distribute, and control various utilities such as electrical power, water, and communications.

The SBTF is envisioned to include small, disributed test sites designated for a variety of activities including, but not limited to, drilling and trenching; roads and trails; and a pool of transportable support equipment such as generators, fuel and water tanks, chemical latrines; and the like.

A. Limitations. Site characterization activities (including but not limited to design, development, ESF construction, and site investigations) at Yucca Mountain shall be limited to those necessary to provide the data required for evaluation of the suitability of the site for an application for construction authorization[17]. [NWPA, 113(c)(1), as amended]

B. Requirements. DRDs shall apply the requirements listed below in the design of site characterization systems and facilities, as appropriate (some are not applicable to the SBTF). [Derived]

1. Mandatory Design Requirements. The Site characterization facilities and systems shall be designed and constructed in accordance with the applicable[18] design requirements derived from the regulations, included in, but not limited to, those listed in Table 3-7 such that they do not preclude the ability of the Repository and EBS Segments to meet the requirements in this MGDS-RD.
[DOE Letter 2/27/90]

---

[17] Section 113(c)(1) of the NWPA also allows activities necessary to provide data required for compliance with the National Environmental Policy Act of 1969 (42USC4321 et seq) (activities that are not considered part of site characterization).

[18] This recognizes that not all of the regulations are applicable to the facility design.

Table 3-7. Mandatory 10CFR60 Requirements for Site Characterization Facilities

	10CFR60 REQUIREMENT	SUBJECT
a	10CFR60.4(b)	Communications and records
b	10CFR60.15(b)	In situ exploration
c	10CFR60.15(c)(1)	Limit adverse effects on repository
d	10CFR60.15(c)(2)	Limit borings
e	10CFR60.15(c)(3)	Boring locations
f	10CFR60.15(c)(4)	Coordinate with repository design
g	10CFR60.16	SCP required
h	10CFR60.21(c)(1)(ii)(D)	SAR: effectiveness of barriers
i	10CFR60.21(c)(1)(ii)(E)	SAR: analysis of SSC important to safety
j	10CFR60.21(c)(11)	SAR: Close and Decommission
k	10CFR60.72(a)	Construction records
l	10CFR60.72(b)	Construction records
m	10CFR60.74	Tests
n	10CFR60.111(a)	Protection against rad exposures
o	10CFR60.111(b)(1)	Retrievability
p	10CFR60.111(b)(3)	Retrievability: schedule
q	10CFR60.112	Overall system performance
r	10CFR60.113(a)(1)(i)	Engineered Barrier System (EBS)
s	10CFR60.113(a)(1)(ii)(A)	Waste package
t	10CFR60.113(a)(1)(ii)(B)	EBS
u	10CFR60.130	Scope of design criteria
v	10CFR60.131(b)(1)	Natural phenomena/environmental conditions
w	10CFR60.131(b)(2)	Equipment failure
x	10CFR60.131(b)(3)	Fire and explosions
y	10CFR60.131(b)(4)(i)	Control of radioactive materials
z	10CFR60.131(b)(6)	Maintainability
aa	10CFR60.131(b)(9)	MSHA regulations
ab	10CFR60.133(a)(1)	Configuration of underground facility
ac	10CFR60.133(a)(2)	Disruptive events
ad	10CFR60.133(b)	Flexibility
ae	10CFR60.133(c)	Retrievability
af	10CFR60.133(d)	Control of water/gas
ag	10CFR60.133(e)(1)	Underground openings: safe operations
ah	10CFR60.133(e)(2)	Underground openings: stability
ai	10CFR60.133(f)	Rock excavation
aj	10CFR60.133(g)	Ventilation
ak	10CFR60.133(h)	EBS

Example 4

60.133(g)
Underground facility ventilation

ties shall be designed to control the release of radioactive materials in effluents during normal operations so as to meet the performance objectives of §60.111(a).

(2) *Effluent monitoring.* The effluent monitoring systems shall be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirement for effluent control. The monitoring systems shall be designed to include alarms that can be periodically tested.

(d) *Waste treatment.* Radioactive waste treatment facilities shall be designed to process any radioactive wastes generated at the geologic repository operations area into a form suitable to permit safe disposal at the geologic repository operations area or to permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any regulations that are applicable.

(e) *Consideration of decommissioning.* The surface facility shall be designed to facilitate decontamination or dismantlement to the same extent as would be required, under other parts of this chapter, with respect to equivalent activities licensed thereunder.

§60.133 Additional design criteria for the underground facility.

(a) *General criteria for the underground facility.* (1) The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall contribute to the containment and isolation of radionuclides.

(2) The underground facility shall be designed so that the effects of credible disruptive events during the period of operations, such as flooding, fires and explosions, will not spread through the facility.

(b) *Flexibility of design.* The underground facility shall be designed with sufficient flexibility to allow adjustments where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

(c) *Retrieval of waste.* The underground facility shall be designed to permit retrieval of waste in accordance with the performance objectives of §60.111.

(d) *Control of water and gas.* The design of the underground facility shall provide for control of water or gas intrusion.

(e) *Underground openings.* (1) Openings in the underground facility shall be designed so that operations can be carried out safely and the retrievability option maintained.

(2) Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

(f) *Rock excavation.* The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater to contact the waste packages or radionuclide migration to the accessible environment.

(g) *Underground facility ventilation.* The ventilation system shall be designed to:

(1) Control the transport of radioactive particulates and gases within and releases from the underground facility in accordance with the performance objectives of §60.111(a),

(2) Assure continued function during normal operations and under accident conditions; and

(3) Separate the ventilation of excavation and waste emplacement areas.

(h) *Engineered barriers.* Engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure.

(i) *Thermal loads.* The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

[48 FR 28222, June 21, 1983, as amended at 50 FR 29648, July 22, 1985]

§60.134 Design of seals for shafts and boreholes.

(a) *General design criterion.* Seals for shafts and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's

F.2.65 10 CFR 60.133(f), The underground facility to incorporate excavation methods that limit the potential for creating preferential pathway for groundwater

DISCUSSION

Use excavation methods that limit the damage to the rock beyond the intended opening.

APPLICABILITY

Use mechanical excavation equipment and/or controlled drill and blast methods of excavation.

F.2.66 10 CFR 60.133(g)(1), Ventilation system to control the transport of radioactive particulates and gases from the underground in accordance with 60.111(a)

DISCUSSION

This is a Repository requirement. The ESF ventilation system is not permanent and [10 CFR 60.111(a)] has been determined as not applicable to the ESF.

APPLICABILITY

No specific ESF design requirements.

F.2.67 10 CFR 60.133(g)(2), The underground facility ventilation system is designed to assure continued function during normal operations and under accident conditions

DISCUSSION

This is a Repository requirement that does not apply to the ESF. The ESF ventilation is temporary and will not be used by the Repository and therefore will not be designed to meet this requirement.

APPLICABILITY

No specific ESF design requirements.

F.2.68 10 CFR 60.133(g)(3), Separate the excavation and waste emplacement ventilation systems

DISCUSSION

This is a Repository requirement. There are no waste emplacement areas in the ESF and by being consistent with the Repository design, the ESF will not preclude the Repository from meeting this requirement.

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth.

EXAMPLE 4

3.7.2.2.1.A The portal shall provide access and protection for safe ingress and egress of personnel, material and equipment to and from the subsurface.
[DERIVED][SD&TRD I.3.3.12, I.3.7.2.5.D.2.22]

3.7.2.2.1.B The surface elevation at the ramp portals shall be above the high-water mark of the probable maximum flood
[DERIVED][SD&TRD I.3.2.3.1.G]

3.7.2.3 MAIN ACCESS OPENINGS (BABEAD000)

The complete set of Main Access Openings CI requirements are obtained by combining the requirements from the following Sections: 3.2.1.2, 3.7.1.2, 3.7.2.1.2, and 3.7.2.3.1.

3.7.2.3.1 DESCRIPTION

The Main Access Openings consist of the North and South Ramps and the Main Drift Connection. The Main Access Openings are mechanically excavated to a 7.62 meter diameter opening. The Main Access Openings have been defined as a permanent item and are maintained on the Q list.

3.7.2.3.1.A A minimum of two accesses shall be incorporated into the underground ESF to ensure adequate alternative routes of egress. A method of refuge shall be provided while a second opening to the surface is being developed.
[DERIVED][SD&TRD I.3.3.6.1.B, I.3.3.6.2.E.2, I.3.3.12]

3.7.2.3.1.B A ramp shall provide safe access between the ground surface and the underground to meet the needs of site characterization testing, emergency egress, ventilation intake and exhaust, major muck handling, fuel transfer, and primary transport of heavy equipment.
[DERIVED][SD&TRD I.3.3.6.1.A, I.3.3.12]

3.7.2.3.1.C A ramp shall serve as emergency egress from the underground during ESF construction and underground testing and shall be capable of evacuating all underground personnel to safety within one hour.
[DERIVED][SD&TRD I.3.3.6.1.A, I.3.3.12]

3.7.2.3.1.D The main access opening shall be designed for a 7.62 meter (25 foot) diameter opening constructed by mechanical excavation..
[DERIVED]

3.7.2.3.1.E The main access opening CI shall be designed and constructed consistent with the orientation, depth and layout of the repository design.
[DERIVED][SD&TRD I.3.7.2.5.B.2.2.A, I.3.7.2.5.B.2.2.E, I.3.7.2.5.B.2.3.A, I.3.7.2.5.B.2.3.B, I.3.7.2.5.B.2.3.D, I.3.7.2.5.C.2, I.3.7.2.5.C.3, I.3.7.2.5.C.7, I.3.7.2.5.D.1.8, I.3.7.2.5.D.2.1, I.3.7.2.5.D.2.3, I.3.7.2.5.D.2.5, I.3.7.2.5.D.2.13, I.3.7.2.5.D.2.14, I.3.7.2.5.D.2.15, I.3.7.2.5.D.2.16, I.3.7.2.5.D.2.17, I.3.7.2.5.D.2.18, I.3.7.2.5.D.2.23, I.3.7.2.5.D.3.2, I.3.7.2.5.D.3.6, I.3.7.2.5.D.3.7, I.3.7.2.5.D.3.8][10CFR60.111(b)(1), 10CFR60.112, 10CFR60.113(a)(1)(i)(A), 10CFR60.113(a)(1)(i)(B), 10CFR60.113(a)(1)(ii)(B), 10CFR60.130, 10CFR60.133(a)(1), 10CFR60.133(a)(2), 10CFR60.133(b), 10CFR60.133(c), 10CFR60.133(d), 10CFR60.133(e)(1),

FOR 10 CFR 60 REF. SEE NEXT PAGE.

10CFR60.133(g)(3), 10CFR60.133(i), 10CFR60.137, 10CFR60.141(a), 10CFR60.141(b), 10CFR60.141(c), 10CFR60.141(d), 10CFR60.15(b), 10CFR60.15(c)(2), 10CFR60.15(c)(3), 10CFR60.74(b)]

3.7.2.4 OPERATIONS SUPPORT AREAS (BABEAE000)

The complete set of Operations Support Areas CI requirements are obtained by combining the requirements from the following Sections: 3.2.1.2, 3.7.1.2, 3.7.2.1.2, and 3.7.2.4.1.

3.7.2.4.1 DESCRIPTION

Operations support areas consist of facilities to support the ESF operations, including refuge stations, sumps, and stationary equipment alcoves. Refuge chambers and test alcoves may be combined in some cases. Subsurface utilities such as electric power, compressed air, water, and waste water, are installed as required to support site characterization and construction.

3.7.2.4.1.A The operations support areas required for rock handling and for miscellaneous support functions shall be located away from in situ site characterization testing to minimize interruptions.
[DERIVED][SD&TRD L3.7.2.5.C.1.D][10CFR60.15(c)(1)]

3.7.2.4.1.B Underground maintenance support areas shall be designed and sized to maintain subsurface equipment, instrumentation, and systems.
[DERIVED][SD&TRD L3.7.2.5.D.2.22]

3.7.2.4.1.C The maintenance support areas shall be separated into a construction maintenance area and an underground test maintenance area.
[DERIVED][SD&TRD L3.7.2.5.D.2.22]

3.7.2.4.1.D Twice the drift diameter shall be the minimum stand-off between drifts to preclude interference between tests, except where required otherwise by specific test requirements.
[SD&TRD L3.3.12, L3.7.2.5.C.1.D, L3.7.2.5.D.2.21][10CFR60.15(c)(1)]

3.7.2.4.1.E The underground facilities in support of site characterization testing shall provide accommodations for a minimum of ten visitors at any one time.
[DERIVED][SD&TRD L3.7.2.5.D.2.22]

3.7.2.4.1.F The ESF shall be designed so that ESF support areas are separated from possible ESF testing areas or future waste emplacement areas, to limit adverse effects.
[DERIVED][SD&TRD L3.7.2.5.C.1.D][10CFR60.15(c)(1)]

3.7.2.4.1.G The maintenance, refueling, and equipment storage areas shall be designed and located to minimize fire and safety risks.
[DERIVED][SD&TRD L3.3.6.1.A, L3.3.12]

Table I.3-8 Categories of Effects Considered in Evaluating the Zone of Influence for Each Site Characterization Test (continued)

I.3.7.2.5.C.4	The Subsurface Excavations CI SSC ITS design shall not preclude the GROA SSC ITS from maintaining control of radioactive waste and radioactive effluent and permitting prompt termination of operations and excavations of personnel during an emergency. [DERIVED][MGDS RD 3.2.1.8.B][10 CFR 60.131(b)(4)(i)]
I.3.7.2.5.C.5	The Subsurface Excavations CI shall be designed not to preclude the repository ventilation system from controlling the transport of radioactive particulates and gases within and releases from the underground facility in accordance with the performance objectives of paragraph I.3.7.2.5.B.2.2.C. [DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(g)(1)]
I.3.7.2.5.C.6	The Subsurface Excavations CI shall be designed not to preclude the repository ventilation system from continuing its function during normal operations and under accident conditions [DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(g)(2)]
I.3.7.2.5.C.7	The Subsurface Excavations CI shall be designed not to preclude the repository ventilation system from separating the ventilation of excavation and waste emplacement areas. [DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(g)(3)]
I.3.7.2.5.C.8	The Subsurface Excavations CI shall be designed not to preclude the engineered barriers from assisting the geologic setting in meeting the performance objectives for the period following permanent closure. [DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.133(h)]
I.3.7.2.5.D	**SUBSURFACE EXCAVATION REQUIREMENTS**
I.3.7.2.5.D.1	**GENERAL**
I.3.7.2.5.D.1.1	Communications and reports concerning the NRC's 10 CFR Part 60 regulation shall be recorded in accordance with 10 CFR Part 60.4, by the Department of Energy's Licensing representative. [DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.4(b)]
I.3.7.2.5.D.1.2	The Subsurface Excavations CI construction shall not start prior to the development, review, and approval of a SCP. [DERIVED][MGDS RD 3.7.1.3.B.1][10 CFR 60.16]

decommissioning do not adversely affect the waste isolation capabilities of the Repository or the geologic setting.

3.7.1.3 Site Characterization Requirements

Execution of the site characterization and site suitability activities requires facilities to support the subsurface- and surface-based studies and to collect the data specified in Appendix A. These facilities have been designated as the ESF and the SBTF respectively.

Conceptually, the ESF is envisioned to include: a subsurface facility; site civil improvements; surface support facilities on two main sites that contain entrances to the underground and on various auxiliary sites for storage and other uses; test support subsystems; and subsystems to supply, distribute, and control various utilities such as electrical power, water, and communications.

The SBTF is envisioned to include small, distributed test sites designated for a variety of activities including, but not limited to, drilling and trenching; roads and trails; and a pool of transportable support equipment such as generators, fuel and water tanks, chemical latrines; and the like.

A. Limitations. Site characterization activities (including but not limited to design, development, ESF construction, and site investigations) at Yucca Mountain shall be limited to those necessary to provide the data required for evaluation of the suitability of the site for an application for construction authorization[17]. [NWPA, 113(c)(1), as amended]

B. Requirements. DRDs shall apply the requirements listed below in the design of site characterization systems and facilities, as appropriate (some are not applicable to the SBTF). [Derived]

1. Mandatory Design Requirements. The Site characterization facilities and systems shall be designed and constructed in accordance with the applicable[18] design requirements derived from the regulations, included in, but not limited to, those listed in Table 3-7 such that they do not preclude the ability of the Repository and EBS Segments to meet the requirements in this MGDS-RD.
[DOE Letter 2/27/90]

---

[17] Section 113(c)(1) of the NWPA also allows activities necessary to provide data required for compliance with the National Environmental Policy Act of 1969 (42USC4321 et seq) (activities that are not considered part of site characterization).

[18] This recognizes that not all of the regulations are applicable to the facility design.

Table 3-7. Mandatory 10CFR60 Requirements for Site Characterization Facilities

	10CFR60 REQUIREMENT	SUBJECT
a	10CFR60.4(b)	Communications and records
b	10CFR60.15(b)	In situ exploration
c	10CFR60.15(c)(1)	Limit adverse effects on repository
d	10CFR60.15(c)(2)	Limit borings
e	10CFR60.15(c)(3)	Boring locations
f	10CFR60.15(c)(4)	Coordinate with repository design
g	10CFR60.16	SCP required
h	10CFR60.21(c)(1)(ii)(D)	SAR: effectiveness of barriers
i	10CFR60.21(c)(1)(ii)(E)	SAR: analysis of SSC important to safety
j	10CFR60.21(c)(11)	SAR: Close and Decommission
k	10CFR60.72(a)	Construction records
l	10CFR60.72(b)	Construction records
m	10CFR60.74	Tests
n	10CFR60.111(a)	Protection against rad exposures
o	10CFR60.111(b)(1)	Retrievability
p	10CFR60.111(b)(3)	Retrievability: schedule
q	10CFR60.112	Overall system performance
r	10CFR60.113(a)(1)(i)	Engineered Barrier System (EBS)
s	10CFR60.113(a)(1)(ii)(A)	Waste package
t	10CFR60.113(a)(1)(ii)(B)	EBS
u	10CFR60.130	Scope of design criteria
v	10CFR60.131(b)(1)	Natural phenomena/environmental conditions
w	10CFR60.131(b)(2)	Equipment failure
x	10CFR60.131(b)(3)	Fire and explosions
y	10CFR60.131(b)(4)(i)	Control of radioactive materials
z	10CFR60.131(b)(6)	Maintainability
aa	10CFR60.131(b)(9)	MSHA regulations
ab	10CFR60.133(a)(1)	Configuration of underground facility
ac	10CFR60.133(a)(2)	Disruptive events
ad	10CFR60.133(b)	Flexibility
ae	10CFR60.133(c)	Retrievability
af	10CFR60.133(d)	Control of water/gas
ag	10CFR60.133(e)(1)	Underground openings: safe operations
ah	10CFR60.133(e)(2)	Underground openings: stability
ai	10CFR60.133(f)	Rock excavation
aj	10CFR60.133(g)	Ventilation
ak	10CFR60.133(h)	EBS

Example 5

60.122(c)(1)
Potentially Adverse Condition for flooding of the underground

EXAMPLE 5 PAGE 1 OF 2

(c) *Potentially adverse conditions.* The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(1) Potential for flooding of the underground facility, whether resulting from the occupancy and modification of floodplains or from the failure of existing or planned man-made surface water impoundments.

(2) Potential for foreseeable human activity to adversely affect the groundwater flow system, such as groundwater withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage, military activity or construction of large scale surface water impoundments.

(3) Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such a magnitude that large-scale surface water impoundments could be created that could change the regional groundwater flow system and thereby adversely affect the performance of the geologic repository.

(4) Structural deformation, such as uplift, subsidence, folding, or faulting that may adversely affect the regional groundwater flow system.

(5) Potential for changes in hydrologic conditions that would affect the migration of radionuclides to the accessible environment, such as changes in hydraulic gradient, average interstitial velocity, storage coefficient, hydraulic conductivity, natural recharge, potentiometric levels, and discharge points.

(6) Potential for changes in hydrologic conditions resulting from reasonably foreseeable climatic changes.

(7) Groundwater conditions in the host rock, including chemical composition, high ionic strength or ranges of Eh-pH, that could increase the solubility or chemical reactivity of the engineered barrier system.

(8) Geochemical processes that would reduce sorption of radionuclides, result in degradation of the rock strength, or adversely affect the performance of the engineered barrier system.

(9) Groundwater conditions in the host rock that are not reducing.

(10) Evidence of dissolutioning such as breccia pipes, dissolution cavities, or brine pockets.

(11) Structural deformation such as uplift, subsidence, folding, and faulting during the Quaternary Period.

(12) Earthquakes which have occurred historically that if they were to be repeated could affect the site significantly.

(13) Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or magnitude of earthquakes may increase.

(14) More frequent occurrence of earthquakes or earthquakes of higher magnitude than is typical of the area in which the geologic setting is located.

(15) Evidence of igneous activity since the start of the Quaternary Period.

(16) Evidence of extreme erosion during the Quaternary Period.

(17) The presence of naturally occurring materials, whether identified or undiscovered, within the site, in such form that:

(i) Economic extraction is currently feasible or potentially feasible during the foreseeable future; or

(ii) Such materials have greater gross value or net value than the average for other areas of similar size that are representative of and located within the geologic setting.

(18) Evidence of subsurface mining for resources within the site.

(19) Evidence of drilling for any purpose within the site.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

(22) Potential for the water table to rise sufficiently so as to cause saturation of an underground facility located in the unsaturated zone.

(23) Potential for existing or future perched water bodies that may saturate portions of the underground facility or provide a faster flow path from

EXAMPLE 5

APPLICABILITY

No specific ESF design requirements.

F.2.42 10 CFR 60.122(c)(1)*, Potentially adverse conditions for site suitability - potential for flooding

DISCUSSION

As indicated in the remarks for [10 CFR 60.122(c)], the identification of adverse conditions is applicable to the Repository design. This requirement identifies flooding as a potential adverse condition to consider for Repository design. The potential for flooding requirement for ESF design is covered under [10 CFR 60.133(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.43 10 CFR 60.130, All design bases to be consistent with the site characterization results

DISCUSSION

All design bases of permanent items in the ESF will be consistent with site characterization data. The main access openings will be consistent with Repository design, and permanent ground support will be selected based upon the local ground conditions. The ESF design will include all site characterization results by using the site data known at the time of design and by following the appropriate implementing procedure developed in compliance with the QARD to evaluate impacts from additional data that is obtained after design. (Currently this is NLP-3-26, *Impact Reviews for Revisions of the Documents That Affect the MGDS Development Organization*).

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Ground support selected based upon local ground conditions.

F.2.44 10 CFR 60.131(a)*, Radiological protection

DISCUSSION

Compliance with this requirement is primarily a function of equipment design and operating procedures for radiation protection which will be provided by the Repository.

APPLICABILITY

No specific ESF design requirements.

Example 6

60.122(c)(22)
Potentially Adverse Condition for rise of the water in the unsaturated zone

EXAMPLE 6 PAGE 1 OF 3

(c) *Potentially adverse conditions.* The following conditions are potentially adverse conditions if they are characteristic of the controlled area or may affect isolation within the controlled area.

(1) Potential for flooding of the underground facility, whether resulting from the occupancy and modification of floodplains or from the failure of existing or planned man-made surface water impoundments.

(2) Potential for foreseeable human activity to adversely affect the groundwater flow system, such as groundwater withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage, military activity or construction of large scale surface water impoundments.

(3) Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such a magnitude that large-scale surface water impoundments could be created that could change the regional groundwater flow system and thereby adversely affect the performance of the geologic repository.

(4) Structural deformation, such as uplift, subsidence, folding, or faulting that may adversely affect the regional groundwater flow system.

(5) Potential for changes in hydrologic conditions that would affect the migration of radionuclides to the accessible environment, such as changes in hydraulic gradient, average interstitial velocity, storage coefficient, hydraulic conductivity, natural recharge, potentiometric levels, and discharge points.

(6) Potential for changes in hydrologic conditions resulting from reasonably foreseeable climatic changes.

(7) Groundwater conditions in the host rock, including chemical composition, high ionic strength or ranges of Eh-pH, that could increase the solubility or chemical reactivity of the engineered barrier system.

(8) Geochemical processes that would reduce sorption of radionuclides, result in degradation of the rock strength, or adversely affect the performance of the engineered barrier system.

(9) Groundwater conditions in the host rock that are not reducing.

(10) Evidence of dissolutioning such as breccia pipes, dissolution cavities, or brine pockets.

(11) Structural deformation such as uplift, subsidence, folding, and faulting during the Quaternary Period.

(12) Earthquakes which have occurred historically that if they were to be repeated could affect the site significantly.

(13) Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or magnitude of earthquakes may increase.

(14) More frequent occurrence of earthquakes or earthquakes of higher magnitude than is typical of the area in which the geologic setting is located.

(15) Evidence of igneous activity since the start of the Quaternary Period.

(16) Evidence of extreme erosion during the Quaternary Period.

(17) The presence of naturally occurring materials, whether identified or undiscovered, within the site, in such form that:

(i) Economic extraction is currently feasible or potentially feasible during the foreseeable future; or

(ii) Such materials have greater gross value or net value than the average for other areas of similar size that are representative of and located within the geologic setting.

(18) Evidence of subsurface mining for resources within the site.

(19) Evidence of drilling for any purpose within the site.

(20) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

(21) Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure.

(22) Potential for the water table to rise sufficiently so as to cause saturation of an underground facility located in the unsaturated zone.

(23) Potential for existing or future perched water bodies that may saturate portions of the underground facility or provide a faster flow path from

EXAMPLE 6 PAGE 2 OF 3.

F.2.38 10 CFR 60.122(a)(1)*, Siting criteria to meet 10 CFR 60.122(b)

DISCUSSION

The *Nuclear Waste Policy Amendments Act of 1987*, 42 USC 10101, Section 160(a), selected Yucca Mountain for investigation as a potential Repository. The testing objectives which control the site characterization tests being performed and the data collected are controlled in the SCP and SD&TRD. This siting criteria is applicable to the final Repository as it will influence the design of the EBS so that together they meet the waste isolation requirements. There are no applicable design requirements for the ESF. Potentially adverse and/or favorable conditions may be discovered at the site because of the ESF activities but these will not affect the ESF design.

APPLICABILITY

No specific ESF design requirements.

F.2.49 10 CFR 60.122(a)(2)*, Repository action if an adverse condition is found during site characterization

DISCUSSION

This requirement applies to the Repository if site characterization discovers an adverse condition. The investigation for adverse conditions is controlled by the tests being performed (SCP and SD&TRD).

APPLICABILITY

No specific ESF design requirements.

F.2.40 10 CFR 60.122(b)*, Favorable conditions for site suitability

DISCUSSION

These identifications of favorable conditions are applicable to the Repository design. The ESF will only investigate those test objectives specified in the SCP and the SD&TRD.

APPLICABILITY

No specific ESF design requirements.

F.2.41 10 CFR 60.122(c)*, Potentially adverse conditions for site suitability

DISCUSSION

These identifications of adverse conditions are applicable to the Repository design. The ESF will only investigate those test objectives specified in the SCP and the SD&TRD. The potential for flooding during ESF construction and operation is covered in [10 CFR 60.133(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.42 10 CFR 60.122(c)(1)*, Potentially adverse conditions for site suitability - potential for flooding

DISCUSSION

As indicated in the remarks for [10 CFR 60.122(c)], the identification of adverse conditions is applicable to the Repository design. This requirement identifies flooding as a potential adverse condition to consider for Repository design. The potential for flooding requirement for ESF design is covered under [10 CFR 60.133(a)(2)].

APPLICABILITY

No specific ESF design requirements.

F.2.43 10 CFR 60.130, All design bases to be consistent with the site characterization results

DISCUSSION

All design bases of permanent items in the ESF will be consistent with site characterization data. The main access openings will be consistent with Repository design, and permanent ground support will be selected based upon the local ground conditions. The ESF design will include all site characterization results by using the site data known at the time of design and by following the appropriate implementing procedure developed in compliance with the QARD to evaluate impacts from additional data that is obtained after design. (Currently this is NLP-3-26, *Impact Reviews for Revisions of the Documents That Affect the MGDS Development Organization*).

APPLICABILITY

Main access openings to be consistent with Repository design with respect to orientation, geometry, layout, and depth. Ground support selected based upon local ground conditions.

F.2.44 10 CFR 60.131(a)*, Radiological protection

DISCUSSION

Compliance with this requirement is primarily a function of equipment design and operating procedures for radiation protection which will be provided by the Repository.

APPLICABILITY

No specific ESF design requirements.

Conclusion

- Implementation of applicable 10 CFR Part 60 requirements into the Design Basis Documentation is demonstrable

- The improvements to the Requirements Documents and to the Design Analysis Documentation make it easier to determine where and how the design satisfies 10 CFR 60 requirements