OPERATION CORNERSTONE

**Onsite Radiological Safety Report
For Announced Nuclear Tests**

October 1988 through September 1989

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ABSTRACT

Cornerstone was the name assigned to the series of underground nuclear experiments conducted at the Nevada Test Site (NTS) from October 1, 1988, through September 30, 1989. This report includes those experiments publicly announced.

Remote radiation measurements were taken during and after each nuclear experiment by a telemetry system. Radiation Protection Technicians (RPT) with portable radiation detection instruments surveyed reentry routes into ground zeros (GZ) before other planned entries were made. Continuous surveillance was provided while personnel were in radiation areas and appropriate precautions were taken to protect persons from unnecessary exposure to radiation and toxic gases. Protective clothing and equipment were issued as needed. Complete radiological safety and industrial hygiene coverage were provided during drilling and mineback operations. Telemetered and portable radiation detector measurements are listed. Detection instrumentation used is described and specific operational procedures are defined.

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SECTION 1.0

INTRODUCTION

Cornerstone was the name assigned to the series of underground nuclear experiments conducted at the NTS from October 1, 1988, through September 30, 1989. These tests were conducted by the NTS Users: Los Alamos National Laboratory (LANL); Lawrence Livermore National Laboratory (LLNL); and the Defense Nuclear Agency (DNA). The U.S. Department of Energy (DOE) had the final responsibility for these nuclear experiments.

The Reynolds Electrical & Engineering Co., Inc. (REECo) Health Physics Department (HPD) was accountable to the Manager, DOE, Nevada Operations Office (NV), for all radiological safety and industrial hygiene support services. However, during the time that LANL, LLNL and DNA had control of the test area, the REECo/HPD was accountable to the User Test Group Director for whatever services were required.

Services provided by the REECo/HPD during preevent and postevent operations of the Cornerstone Series are described in Section 2, including information on exposure limits and personnel radiation exposures. Individual nuclear experiments conducted during the Cornerstone Series are described in Section 3. Postevent operations associated with each experiment are summarized as follows: The portable radiation detection instruments used by the initial survey parties included the Eberline E-520 and the Ludlum 14C (Geiger-Müller (GM)). During postevent sample and experiment recovery operations the preceding instruments were used to measure all radiation levels up to 200 mR/h. The Eberline PIC-6 (ion-chamber) was used to measure radiation levels above 200 mR/h. The PIC-6 was used to determine the radiation levels on core samples during the core sampling operations.

SECTION 2

RADIOLOGICAL SAFETY SERVICES

This section describes services provided by the REEC/HPD during preevent and postevent operations of the Cornerstone series. Information on exposure limits and personnel radiation exposures is also included in this section.

2.1 PREEVENT SUPPORT ACTIVITIES

Detailed support plans were prepared jointly by representatives of the REEC/HPD and the user agency conducting the experiment. (Typical safety support plans are presented in Appendices C, D and E.) Radiation telemetry probes usually were placed in concentric circles around the surface ground zero (SGZ array). Forty permanent telemetry stations were operational at various locations on the NTS to monitor any radioactive effluent which might move out of the immediate test area.

REEC/HPD RPTs were stationed at security roadblocks and at the Test Controller's barricade. These RPTs were equipped with the necessary radiation detection instruments and protective clothing required for reentering the test area with entry parties or for determining the extent of any radiation hazard in the SGZ area or tunnel portal area. These personnel were placed in a "standby" status subject to release by the Test Controller.

Facilities were established for the issuance of protective clothing, respiratory equipment, and for the decontamination of personnel and equipment.

2.2 TEST SUPPORT ACTIVITIES

Telemetry data from the SGZ array was the first information recorded by REEC/HPD personnel following detonation of a nuclear device. Each gamma-sensitive ion chamber detector was linked by microwave and hard wire communications to a read-out console in Control Point Building No. 1, 2 (CP-1, CP-2) or Control and Data Acquisition Center (CADAC). A read-out for each of the permanent telemetered remote area monitoring stations (RAMS) was located in CP-2. Readings on each read-out and the time of the readings in minutes after zero time were recorded and displayed.

RAMS utilizing an eight decade chamber record actual preevent background which varies from .02 to 0.1 mR/h, depending on the chamber response and location. A check source is

used in conjunction with the six decade chamber RAMS in order to give an on scale reading of approximately 2 mR/h.

When released by the Test Controller, REEC/HPD RPTs accompanied the Test Group Director's (TGD) inspection party entering the potential radiological exclusion area to perform an initial survey. Radiation measurements (obtained using portable detection instruments as listed in Appendix B) plus measurement time and location were recorded on survey forms and the information reported via the radio net. Locations were determined from roadside numbered reference stakes. Maps showing the locations of these reference stakes in relation to roads and landmarks were provided to participating test groups. Radiation exposure rates (E/R) obtained with portable instruments were made at waist-high level (approximately one meter from the surface). Radioactive core samples were measured at contact with the plastic holder. Exceptions were noted on the radiation survey forms.

2.3 POSTEVENT SUPPORT ACTIVITIES

When the control of the test area was released by the DOE Test Controller for postevent operations, REEC/HPD personnel under the direction of the User established a mobile base station facility in the test area and adjacent to the SGZ access road or near the tunnel portal. All personnel entering the controlled portion of the area were required to pass through the mobile base station facility. REEC/HPD RPTs were assigned radiation monitoring responsibilities for area surveys, cable-cutting operations and other predrilling or reentry requirements. All radiological exclusion areas resulting from the nuclear experiments were posted with radiation signs and barricades. Other exclusion areas were posted as required.

During the postevent drillback and mining activities, REEC/HPD personnel maintained continuous environmental surveillance in the work area. For drillback coverage, radiation detector probes were placed in strategic locations in the work areas and connected to recorders and alarms to warn of increases in radiation levels. Routinely, RPTs using portable instruments, periodically checked radiation levels and gas concentrations in the work area and issued protective equipment or evacuated the area of personnel when necessary.

For drillback containment, the LANL utilized a pressurized recirculation radioactive effluent containment system; whereas a ventline filter system designed to trap radioactive particulates released from the drill casing was used by the LLNL. In the venting system, trapped radioactive material was allowed to decay under controlled conditions.

When requested by the User conducting the experiment, portable air sampling units were placed at predetermined locations. The sampler drew air at a calibrated rate through a prefilter and charcoal cartridge. Gaseous radionuclides present (radioiodine in particular)

were trapped in the cartridges. The filters and cartridges were changed at specific times and analyzed by the REECO/HPD laboratory.

Measurements were made of toxic gas and explosive mixtures during postevent period activities. In the open areas around drill sites, these gases dissipated rapidly and were usually only a nuisance. When gas concentrations did present a health problem, all nonessential personnel were evacuated and the remaining personnel used protective breathing equipment until the gases dissipated.

Radioactive samples to be shipped offsite were packaged and labeled in accordance with U.S. Department of Transportation regulations. Usually, decontamination of vehicles, equipment, instruments and tools was performed at the work site. Radioactive waste disposal was accomplished after each event.

Contamination was primarily isolated to the rig floor and the core sampling shack. Items that could not be decontaminated at the work sites were taken to the permanent Area 6 Decontamination Facility for specialized decontamination. Protective anticontamination clothing (Anti-Cs) were cleaned at the decontamination laundry located in the same area.

Environmental surveillance was maintained through continuous sampling and analysis of air, soil and water at numerous locations on the NTS. The collected samples were analyzed by the REECO/HPD laboratory. Upon completion of each postevent operation, event-related reports were prepared from the information contained in HPD logbooks, surveys and sampling and analysis documents. Copies of these reports were distributed to the NTS User and DOE/NV.

2.4 CORNERSTONE EXPOSURE LIMITS AND PERSONNEL EXPOSURES

The REECO/HPD laboratory was responsible for the personnel dosimetry program at the NTS and provided any dosimetry support upon request. Alphabetical accumulated positive dose reports were used to ensure that an individual approaching an exposure limit would not be assigned work in a radiation exposure area. Radiation exposure limits were established by the manager, DOE/NV, and are listed in DOE Order 5480.11, Chapter XI. Operations were conducted in such a manner to ensure that radiation exposure to individuals and population groups was limited to levels as low as reasonably achievable (ALARA) levels and did not exceed the permissible whole-body exposure guidelines for radiation workers of 3 rem per quarter and 5 rem per year.

For calendar year 1988, 68,512 dosimeters were processed and evaluated by REECO/HPD for 26,923 personnel. No one exceeded the established guides for radiation exposure at the NTS.

SECTION 3.0

CORNERSTONE TEST EVENTS

3.1 DALHART

The DALHART event was an underground nuclear experiment conducted by the LANL at site U4u at 0700 hours on October 13, 1988.

Telemetry

Thirteen remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 15°, 45°, 75°, 105°, 135°, 165°, 195°, and 220° at 256 meters from SGZ.
- 255° at 563 meters from SGZ.
- 285° at 578 meters from SGZ.
- 315° at 545 meters from SGZ.
- 345° at 517 meters from SGZ.

Telemetry measurements began at 0700 hours on October 13, 1988, and ended at 0700 hours on October 14, 1988. The maximum E/R detected was background.

Effluent Release Information

The LANL calculated and reported any effluent release associated with this nuclear experiment.

Initial Survey

The initial radiation survey into the test area began at 0855 hours on October 13, 1988. The Health Physics Department (HPD) survey teams consisted of one REECO/HPD supervisor and five REECO/HPD RPTs. The readings were relayed via Net 3 as they were

obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h. The initial survey was completed at 0946 hours on October 13, 1988.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 1100 hours on October 13, 1988. Postevent drilling commenced at 1735 hours on October 14, 1988; core samples were collected and gamma intensity measured.

Postevent sample information.

PS#IA	Drilled through shoe:	1830 hours on 10-14-88
	Sampling began:	1120 hours on 10-19-88
	Sampling completed:	1240 hours on 10-20-88
	Number of samples:	42
	Maximum gamma intensity on core samples at contact:	15 R/h
PS#IAS	Sampling began:	0928 hours on 10-25-88
	Sampling completed:	1930 hours on 10-25-88
	Number of samples:	40
	Maximum gamma intensity on core samples at contact:	20 R/h

Postevent Support Requirements

In accordance with LANL requirements, the following equipment was used:

- Air from the recirculating containment system was monitored by a scintillation detection unit contained in the LANL HSE-1 radiological laboratory trailer (with recording and alarming locally and with remote alarming in the REEC/HPD Radsafe base station and the LANL health physicist room).
- Air from the drilling platform was monitored by a scintillation detection unit positioned near a charcoal cartridge and paper filter contained in the LANL HSE-1 radiological laboratory trailer with recording and alarming the same as the cellar air monitor.
- One scintillation detector was mounted on the mud return line with recording and alarming capabilities the same as the cellar air monitor.

- A portable air monitoring unit containing a High Efficiency Particulate air (HEPA) cartridge was employed on the rig platform by the "rig monitor" for immediate local detection and differentiation between gases and general increases in background levels in the area.
- Lithium fluoride thermoluminescence dosimeters (TLD) (with minimum gamma radiation dose detection threshold of 0.01 rad total integrated dose and radiation energy detection limits of 100 keV), were installed on the postevent perimeter fence to provide a cumulative record of any airborne gamma-emitting radionuclide that may have been released.
- Five continuous low-volume air samplers containing particulate filter and charcoal cartridges were placed on the drill rig; one on each corner of the rig and one at the cellar entrance of the drill rig.
- One continuous low-volume air sampler containing a particulate filter and charcoal cartridge was operating at the 24-hour personnel living quarters.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating during coring operations in the core shack.
- One low-volume air sample containing a particulate filter and charcoal cartridge was operating in the extractor area during the coring operation.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

The maximum gamma E/R detected in a potential work area during postevent drilling operations was 120 mR/h on PS#1A at 0725 hours on October 20, 1988. This was due to packaging samples.

There were no toxic gases or explosive mixtures detected during the postevent drilling period.

There were no whole-body external or internal exposures which exceeded the radiation protection guides in DOE Order 5480.11, Chapter 9B. No alpha radiation was detected.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

- Four hundred eighty-five personnel entries were processed into the control area.
- Nine hundred eighty sets of Anti-Cs were issued to personnel entering the control area.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-13-88	0700	Zero time.
	0855	Initial reentry started.
	0907	Standby at shrink point.
	0918	GZ cratered.
	0930	Resumed reentry.
	0946	Initial reentry complete. All readings 0.05 mR/h (background).
	0954	Grounding party enters Trailer Park.
	1014	Recovery party enters Trailer Park.
	1100	Area turned over to HPD control per LANL HSE-1 Orcutt.
	1110	Crater lip survey began.
	1129	Crater lip survey completed.
	1130	Began perimeter fence downwind survey. E/R 0.05 mR/h. Uncovered fence signs.
	1135 to 2330	Perimeter fence downwind surveys. All readings 0.05 mR/h.
	1518	Trailer Park recoveries complete.
	1530	Began moving in drilling equipment.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-13-88	1830	Started 24-hour background air sample.
(Cont'd)		
10-14-88	0020	Began drilling for surface casing.
	0030 to 0800	Downwind perimeter fence surveys. All readings 0.05 mR/h.
	0145	Completed drilling surface casing hole to 120 feet (36.6 meters).
	0200	Coming out of the hole.
	0300 to 0500	Running casing into the hole.
	0725	Cementing casing.
	0745	Completed cementing casing.
	0800	Completed perimeter fence downwind surveys. All readings 0.05 mR/h (background).
	0900 to 1430	Rigging up.
	1500 to 1645	Pressure check blowout preventer (BOP).
	1500	Laboratory Trailer operational.
	1700	Making tools.
	1720	Started rig floor air samples.
	1735	Started drilling on cement.
	1830	Drilled through the shoe. E/R 0.05 mR/h on rig floor.
	1845	Lost circulation at 186 feet (56.7 meters).
	1855	Pumping air down the annulus.
	1920	Directional survey at 187 feet (56 meters).
	2100	Drilling at 310 feet (94.4 meters).
	2117	Closed the flow line.
	2120	Directional survey at 342 feet (104 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>	
10-14-88 (Cont'd)	2134	Coming out of the hole.	
	2155	Opened annulus 1-inch test line.	
	2209	Hydrill closed. Stripping out of the hole.	
	2213	Rotating head removed.	
	2215	Out of the hole, ball valve closed. Annulus 1-inch test line closed.	
	2219 to 2223	Cellar entry to secure BOP. E/R 0.05 mR/h (background). Negative carbon monoxide (CO) and lower exposure limit (LEL).	
	2225	Air samples shut down. Cellar integrity sample started.	
	2300	Area secured. Departed.	
	10-16-88	0800	Checked cellar integrity sample 0.05 mR/h (contact).
		0830	Perimeter fence survey. Maximum E/R 0.05 mR/h.
1530		Checked and changed cellar integrity sample. 0.05 mR/h.	
10-17-88	0001	Stopped cellar integrity air sample. Started rig floor, shaker table, and Trailer Park air samples.	
	0028 to 0030	Cellar entry to remove rotating head lock. E/R 0.05 mR/h. Negative CO and LEL, 21% oxygen (O ₂).	
	0031	Ball valve open, flow line open.	
	0035	Rotating head on, going into hole with tools.	
	0100 to 2345	Routine drilling and directional surveys from 342 feet (104 meters) to 1,055 feet (322 meters) with Atlas Wireline steering tool. Rig floor E/R 0.05 mR/h during this time.	
	0900	Flow line closed in at 475 feet (145 meters).	
	1400	Flow line opened at 749 feet (228 meters).	
	1805	Flow line opened.	
	1845	Flow line closed.	
	1900	Annulus 1-inch test line opened.	

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-18-88 (Cont'd)	0001 to 1645	Routine drilling and directional surveys from 1,055 feet (322 meters) to 1,749 feet (533 meters). Maximum rig floor E/R 0.05 mR/h.
	1649	Set Otis Plug.
	1705	Tripping out of the hole. Rig floor E/R 0.05 mR/h.
	1810	Out of the hole. Closed ball valve. No gases detected.
	1925	Opened ball valve. Going into the hole. Swipe of bit was nondetectable alpha and beta/gamma.
	2105	Rotating head installed.
	2125	Hit a bridge.
	2235	Past bridge, continued down the hole.
	2300	Back on bottom.
	2310	Otis Plug pulled.
	2320	Resumed drilling.
	2330	Routine drilling at 1,770 feet (539 meters).
10-19-88	0001 to 0910	Routine drilling and directional surveys with Atlas Wireline steering tool from 1,821 feet (555 meters) to 2,535 feet (773 meters). Maximum rig floor E/R 0.05 mR/h.
	0925	Total depth (TD) reached on PS#1A.
	0930	Gamma log started.
	1040	Gamma log completed.
	1100	Area secured as per J. Moroney, LANL HSE-1; fence secured.
	1105	Pulled Hunt Plug. First sign of radiation. Hunt Plug reading 70 mR/h (contact).
	1120	Pulled first sample from PS#1A.
	1130 to 1600	Coring in progress. Average rig floor E/R 0.05 mR/h. Average core shack E/R 0.7 mR/h.
	1615	Hunt Plug set. Conditioning the hole.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-19-88 (Cont'd)	1650	Hunt Plug pulled. No radioactive gases detected. Rig floor reading 0.05 mR/h.
	1705 to 1850	Coring in progress. Average rig floor E/R 0.05 mR/h. Average core shack E/R 1.5 mR/h.
	1926	Hunt Plug set.
	1930 to 2030	Conditioning the hole.
	2051	Hunt Plug pulled. No radioactive gases detected.
	2055 to 2345	Coring in progress. Average rig floor E/R 0.3 mR/h. Average core shack E/R 2.0 mR/h.
10-20-88	0020	Hunt Plug set to condition hole.
	0030 to 0300	Conditioning the hole.
	0320	Hunt Plug pulled.
	0330 to 0550	Coring in progress
	0600	Hunt Plug set to condition hole.
	0625	Reaming hole.
	0637	Coming out of hole ten joints.
	0700 to 0800	Going back into hole while conditioning hole.
	0725	Packaging samples. Maximum E/R 120 mR/h for 30 seconds while packaging samples.
	0815	Back on the bottom; rig floor E/R 0.12 mR/h.
	0830	Core shipping barrels No. 9 and No. 13 departed the area with core samples from PS#1A. Maximum E/R in cab, 0.5 mR/h.
	0840	Pulled Hunt Plug.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-20-88 (Cont'd)	0850	Resumed coring on PS#1A. Core shack E/R 3 mR/h. Average rig floor E/R 0.2 mR/h.
	0900 to 1230	Coring in progress. Maximum rig floor E/R 40 mR/h at one meter for two minutes. Core shack E/R 3 mR/h. Average rig floor E/R 0.2 mR/h.
	1240	Coring completed on PS#1A. Forty-two samples pulled. Maximum intensity 15 R/h. Maximum E/R in work area, 120 mR/h for 30 seconds while packaging samples.
	1245 to 1325	Attempting to set Hunt Plug. Rig floor E/R 0.2 mR/h.
	1330	Fishing for Hunt Plug.
	1345	Retrieved Hunt tool.
	1400	Could not set Hunt Plug. Started coming out of the hole.
	1400 to 1530	Coming out of hole; working a tight hole.
	1530 to 1925	Stuck in hole.
	1930	String free. Resumed coming out of hole. Rig floor E/R 0.05 mR/h.
	2015	Stuck in hole.
	2100 to 2330	Working a tight hole.
	2115	Packed remaining core samples from PS#1A in core shipping barrel INC-10. Maximum reading at one meter 1.0 mR/h.
10-21-88	0001 to 0120	Continue working a tight hole.
	0120 to 0420	Preparing to blow off pipe.
	0452	Charge exploded at depth of 1,874 feet (571 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-21-88 (Con't)	0520	Out of hole with pipe cutter tool. Pipe string free. Rig floor E/R 0.05 mR/h.
	0520 to 0645	Preparing to set bridge plug.
	0700	Bridge plug set at 1,750 feet (533 meters).
	0700 to 0850	Coming out of hole. Rig floor E/R 0.2 mR/h to 7 mR/h due to contaminated drill pipe. Maximum E/R during trip, 100 mR/h around rotary table. Maximum contact reading 200 mR/h on mud on rotating table.
	0914	Out of hole. Ball valve closed.
	0920	Core samples packed in shipping barrel No. 10 depart. Average E/R in cab, 0.05 mR/h.
	0935	Alarm on S-6; 1,000 counts per second (cps); constant AR monitor (CAM) read 100 cps. HSE-1 notified; average rig floor E/R 3 mR/h, average E/R in cellar, 2 mR/h. Crew evacuated.
	1045	S-6 and CAM continued to fluctuate intermittently. Maximum remained the same. Rig crew back on rig floor making tool string. Contaminated mud from drill pipe spread to area in front of laboratory trailer and around J-6 parts trailer; possibly by tires on forklift and water truck this area. Reading between 10 mR/h and 100 mR/h contact. One hot spot of 200 mR/h found between pipe rack and containment sub base. This spread of contamination around laboratory trailer was determined to be the cause of the increased readings on the S-6 and CAM. Sandbags were placed over 200 mR/h spot as shielding.
	1055	Lead bricks were placed in front of S-6 detector in laboratory trailer. This decreased the reading on the S-6 detector.
	1102	Opened the ball valve; making tool string.
	1130	Out of hole with tool string; ball valve closed.
	1142 to 1147	Cellar entry to secure BOP. E/R in cellar, 1.5 mR/h. Negative CO and LEL, 21% O ₂ .
	1150	Stopped rig floor air samples.
	1223	Lost commercial power.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-21-88 (Cont'd)	1230	Regained commercial power; started cellar integrity air sample.
	1430 to 1530	Roped off radiation areas around rig; hung signs. Area E/R 15.0 mR/h.
	1700	Checked cellar integrity air sample 0.05 mR/h (contact). Solidified and bagged coring waste taken to U3fl. Maximum contact reading 195 mR/h; 10 mR/h at one meter.
	1800 to 2220	General cleanup of base station and exclusion area.
	2230	Checked and changed cellar integrity sample. Sample readings 0.05 mR/h (contact).
	2240	Departed area.
10-22-88		No activity. Area secured.
10-23-88		Cellar integrity sample changed. Sample reading 0.05 mR/h contact. Serviced and tested alarm system in laboratory trailer.
10-24-88	0001 to 0600	Checked cellar integrity sample twice. Sample reading 0.05 mR/h (contact). Trailer Park sample change; sample reading 0.05 mR/h (contact).
	0630	Started rig floor and cellar air samples.
	0830	Began pumping air down the hole. Rig floor E/R 2 mR/h, E/R in cellar, 3 mR/h.
	0930	Discontinued pumping air.
	0938	Cellar entry to remove BOP Blind plug. E/R in cellar, 5 mR/h, negative CO and LEL; 21% O ₂ .
	0950	Ball valve open. Going into hole with tool string.
	1005	Scraping pad to remove hot spots.
	1015	Rotating head installed; going into hole. Both Otis and Hunt Plugs set.
	1045	Hit bridge, reaming hole.
	1115	Completed scraping pad. Maximum contact reading 40 mR/h.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-24-88 (Cont'd)	1140 to 1340	Down for rig repairs.
	1225	LANL HSE-1 trailer back on line.
	1352	Otis Plug pulled.
	1400 to 1422	Directional survey at 1,811 feet (552 meters). Attempting to establish shoulder.
	1535	Laid down eight joints.
	1540	Directional survey at 1,340 feet (500 meters).
	1610 to 2000	Attempted to sidetrack.
	2005	Annulus rad detector showed elevated reading. Determined as equipment malfunction as per J. Moroney.
	2009	Sidetrack confirmed at 1,475 feet (450 meters).
	2200 to 2345	Routine drilling and directional surveys from 1,680 feet (512 meters) to 1,782 feet (543 meters). Rig floor E/R 1 mR/h.
	10-25-88	Routine drilling and directional surveys from 1,782 feet (543 meters) to 2,535 feet (773 meters).
		0730 Reached TD.
		0745 Began gamma log. Rig floor E/R 1 mR/h.
		0855 Completed gamma log.
		0907 Hunt Plug pulled. Plug read 2 mR/h.
		0928 Began coring on PS#1AS.
		0930 to 1900
		Coring in progress.
	1930	Coring completed on PS#1AS. Forty samples pulled. Maximum intensity 20 R/h. Maximum E/R 70 mR/h at one meter for two minutes in core shack.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
10-25-88 (Cont'd)	1944	Hunt Plug set.
	1958	Otis Plug set.
	2000 to 2200	Coming out of the hole. Rig floor E/R 1.5 mR/h.
	2150	Packaged core samples from PS#1AS.
	2253	Rotating head removed. No radioactive gases detected.
	2318	Out of the hole. Ball valve closed. No radioactive gases detected.
	2326	Cellar entry to check BOP. E/R in cellar, 5 mR/h. Negative CO and LEL, 21% O ₂ .
	2330	Rig air samples shut down. Started cellar integrity sample.
10-26-88	0030 to 1545	Rigging down and moving out equipment.
	0710	Truck departed area with core samples.
10-26-88 to 11-07-88		Cellar integrity sample checked three times daily and changed once a day.
11-07-88 to 01-24-89		No log entries of cellar integrity.
02-28-89	0810	Checked cellar integrity sample. 0.05 mR/h on Whatman and charcoal.
	0840	Blind plug removed.
	0922	One-inch annulus test line opened.
	0924	3% LEL in the annulus. No radioactive gases detected.
	0935	Began pumping air down the hole, approximately 55 cfm.
	0940	Rig floor air sample started.
	0946	Ball valve opened. Hydrill closed.
	0959	Rotating head installed.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-28-90 (Cont'd)	1009	Cellar integrity sample discontinued.
	1045	Cellar entry (Spooneman and Pena).
	1048	Cellar entry completed. Negative CO and LEL. E/R 20 mR/h.
	1308	Packer set at 1,211 feet (369 meters).
	1310	Hydrill closed. Crew departing rig until 0800 hours.
	1350	Rig floor air sample changed.
03-01-89	0755	Arrived on location. Rig floor E/R 0.05 mR/h.
	0828	Began pumping 75 cfm air down the hole.
	0830	Rig floor air sample changed.
	0840	Hydrill opened. Rig floor E/R 0.05 mR/h.
	1002	Cementback began; first pour 50 ft ³ .
	1035	Atlas Wireline source reading 35 mR/h at one meter.
	1002 to 1700	Made a total of 10 pours; 817 ft ³ of cement. Tenth pour tagged at 10 feet (3.05 meters) from ground level.
	1710	Rig floor air sample stopped. Reading 0.05 mR/h.

3.2. MISTY ECHO

The MISTY ECHO event was an underground nuclear experiment conducted by the DNA at site U12n.23 at 1230 hours on December 10, 1988.

Telemetry

Forty-two (42) remote telemetry radiation monitoring provided event coverage at the following locations.

Surface RAMS

<u>Station</u>	<u>Reference</u>	<u>Bearing</u>	<u>Distance</u>	
			<u>feet</u>	<u>meters</u>
1.	On the tunnel drain line			
2.	On the portal vent line			

Surface RAMS

<u>Station</u>	<u>Reference</u>	<u>Bearing</u>	<u>Distance</u>	
			<u>feet</u>	<u>meters</u>
3.	From the portal	N 16 E	400	(122)
4.	From the portal	N 89 E	275	(84)
5.	From the portal	S 16 E	365	(111)
6.	From the portal	S 12 W	480	(146)
7.	From the portal	S 48 W	560	(171)
8.	From the portal	N 69 W	420	(128)
9.	On the mesa vent line			
10.	On the mesa vent line			
11.	On the mesa vent line			
12.	From SGZ	N 00 E	500	(152)
13.	From SGZ	N 60 E	500	(152)
14.	From SGZ	S 60 W	500	(152)

Underground RAMS

<u>Station</u>	<u>Reference</u>	<u>Distance</u>	
		<u>feet</u>	<u>meters</u>
15.	U12n.23 Main Drift	CS 9+50	(290)
*16ER.	U12n.23 Main Drift	CS 9+50	(290)
17.	U12n.23 Main Drift	CS 8+30	(253)
18.	U12n.23 FAST alcove		
19.	U12n.23 main drift	CS 3+00	(91)
20.	U12n extension vent drift		
21.	U12n extension south drift	CS 70+00	(2,134)
22.	U12n extension south drift	CS 55+50	(1,692)
23.	U12n extension north drift	CS 70+00	(2,134)

<u>Station</u>	<u>Reference</u>	<u>Distance</u>	
		<u>feet</u>	<u>meters</u>
24.	U12n extension north drift	CS 60+00	(1,829)
25.	U12n extension north drift	CS 56+00	(1,707)
26.	U12n extension north drift	CS 48+00	(1,463)
*27ER.	U12n extension north drift	CS 48+00	(1,463)
28.	U12n extension	CS 40+00	(1,219)
29.	U12n extension utilities drift	CS 10+00	(305)
*30ER.	U12n extension utilities drift	CS 10+00	(305)
31.	U12n extension utilities drift	CS 2+00	(61)
32.	U12n.05	CS 6+00	(183)
33.	U12n extension	CS 29+00	(884)
34.	U12n extension	CS 23+00	(701)
35.	U12n extension	CS 12+00	(366)
36.	U12n extension	CS 2+00	(61)
37.	U12n main drift	CS 26+00	(792)
38.	U12n gas seal bypass drift	CS 2+35	(72)
39.	U12n main drift	CS 17+00	(518)
40.	U12n main drift	CS 12+00	(366)
41.	U12n main drift	CS 2+00	(61)
42.	U12b Portal	CS 1+00	(30)

*Extended range 100 mR/h to 100,000 R/h

Telemetry measurements began at 1230 hours on December 10, 1988. At zero time all of the remote area telemetry stations were operational. At H+2 seconds the RAMS read background and remained background throughout the entire period. All RAMS were secured at 1230 hours December 13, 1988.

Initial Survey

The initial surface reentry party, consisting of one supervisor and five HPD RPTs, departed the Test Controller's Barricade at Gate 300 at 1324 hours on December 10, 1988. A mobile check van was provided for area control and equipment supply. By 1401 hours, the initial survey team and damage assessment team had completed the initial survey of U12n Portal Yard. No radiation levels above the normal area background of 0.04 mR/h were detected.

Survey teams stood by at the U12n tunnel portal during gas sampling of the tunnel atmosphere. No toxic or explosive gases were detected and a normal 21% of O₂ was measured in the following locations: work point side (WPS) of the gas seal plug (GSP), portal side (PS) of the utilities drift protection plug (UDPP), WPS of the UDPP, the SLOW alcove, the facilities drift protection plug (FDPP) in the n.23 drift and at the end of stemming (EOS). Gas sampling was completed at 1610 hours and by 1615 hours all personnel had departed the U12n portal.

Tunnel Reentry

Initial reentry into the tunnel began at 0825 hours on December 11, 1988. Additional gas samples were taken of the tunnel atmosphere before the work team entered the tunnel. No radiation levels above the normal area background of 0.04 mR/h and no toxic or explosive gases were detected. The oxygen concentration was at a normal 21% throughout the work team reentry to the gas seal door (GSD). Anti-Cs was not required during this reentry. The work team completed opening the GSD and installing railroad tracks by 1001 hours. The work team returned to the portal at 1014 hours.

Initial reentry team No. 1 and the rescue team, wearing Anti-Cs departed the portal at 1033 hours December 11, 1988.

By 1100 hours team No. 1 had donned self-contained breathing apparatus (SCBA) and departed the GSP. Team No. 1 proceeded down the main drift, to the n.05 drift, and on to the n.05-n.08 wye. Very little structural damage was noted. Team No. 1 went up the n.08 drift to the main ventilation hole, opened the vent hole hatch, and returned to the n.05-n.08 wye. At 1222 hours the mesa ventilation fan was started. Air samplers at the mesa ventilation pad were started at the same time. No toxic or explosive gases were detected and the oxygen content was 21%. All readings were 0.04 mR/h. Team No. 1 proceeded to the utilities drift protection plug (UDPP) and re-established ventilation. Team No. 1 stood by the UDPP until the rescue team arrived at the UDPP at 1322 hours.

At 1326 hours team No. 1 went through the UDPP and proceeded to the north extension drift and on to the alcove protection plug (APP) No. 1. Team No. 1 sampled the

atmosphere at WPS of APP No. 1. No toxic or explosive gases were detected, readings were 0.04 mR/h and 21% O₂. Team No. 1 continued on to the FAST Alcove. At 1353 hours team No. 1 experienced problems with the communication line and returned to the UDPP. By 1420 hours both team No. 1 and the rescue team were at the portal.

Team No. 2 and the rescue team entered the portal at 1500 hours. The rescue team again stood by at the UDPP while team No. 2 donned SCBAs. Team No. 2 proceeded to the south extension drift. At 1529 hours team No. 2 was at the n.23 drift and the south extension drift wye where some structural damage was observed. Team No. 2 proceeded to the APP No. 5, FDPP and APP No. 1 where they took gas samples, opened the turn tubes and ventilated the areas. The readings were 0.04 mR/h, the oxygen level varied from 17% to 21% and a maximum of 20% LEL and 140 parts per million (ppm) CO were seen at the WPS of the FDPP. Very little structural damage was noted and the instrument racks in both the SLOW and FAST Alcoves were standing and in good condition.

At 1712 hours team No. 2 had returned to the UDPP. Team No. 2 and the rescue team departed the UDPP at 1717 hours. All reentry personnel were surveyed and released at the portal by 1740 hours. Air samples, water samples and swipes taken during the reentry were sent to the laboratory for analysis.

At 1825 hours data recovery teams accompanied by HPD RPTs entered the tunnel. This part of the reentry did not require Anti-Cs. The data recovery teams were surveyed and released at the portal by 2000 hours.

On December 11, 1988, at 2200 hours, the Mining Department started mining the U12n extension gas seal plug and the main drift gas seal plug. Mining of the gas seal plugs was completed at 0130 hours on December 13, 1988.

3.3 TEXARKANA

The TEXARKANA event was an underground nuclear experiment conducted by the LANL at site U7ca at 1206 hours on February 10, 1989.

Telemetry

Seventeen remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 0°, 45°, 90°, 128°, 180°, 225°, 270° and 315° at 201 meters from SGZ.

- 22°30', 67°30' and 112°30', 202°30', 247°30', 292°30' and 335°30' at 305 meters from SGZ.
- 151°30' at 398 meters from SGZ.

Telemetry measurements began at 1206 hours on February 10, 1989, and ended at 1206 hours on February 11, 1989. The maximum E/R detected was background.

Effluent Release Information

The LANL calculated and reported any effluent release associated with this nuclear experiment.

Initial Survey

The initial radiation survey into the test area began at 1221 hours on February 10, 1989. The HPD survey teams consisted of one REECo/HPD supervisor and six RPTs. The readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h (background). The initial survey was completed at 1300 hours on February 10, 1989.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 2100 hours on February 11, 1989. Postevent drilling began at 0320 hours on February 12, 1989; core samples were collected and gamma intensity measured.

Postevent sample information:

PS# 1A	Drilled through shoe:	0345	hours on	02-12-89.
	Sampling began:	2010	hours on	02-13-89.
	Sampling completed:	0420	hours on	02-14-89.
	Number of samples:	28		
	Maximum gamma intensity on core samples at contact:	4.5	R/h	
PS# 1AS	Sampling began:	1317	hours on	02-14-89.
	Sampling completed:	1755	hours on	02-14-89.
	Number of samples:	11		
	Maximum gamma intensity on core samples at contact:	3	R/h	

Postevent Support Requirements

In accordance with LANL requirements, the following equipment was used:

- Air from the recirculating containment system was monitored by a scintillation detection unit contained in the LANL HSE-1 radiological laboratory trailer (with recording and alarming locally, and with remote alarming in the REECO/HPD Radsafe base station and the LANL health physicist room).
- Air from the drilling platform was monitored by a scintillation detection unit positioned near a charcoal cartridge and paper filter contained in the LANL HSE-1 radiological laboratory trailer with recording and alarming the same as the cellar air monitor.
- One scintillation detector was mounted on the mud return line with recording and alarming capabilities the same as the cellar air monitor.
- A portable air monitoring unit containing a HEPA cartridge was employed on the rig platform by the "rig monitor" for immediate local detection and differentiation between gases and general increases in background levels in the area.
- Lithium fluoride TLDs with minimum gamma radiation dose detection threshold of 0.01 rad total integrated dose and radiation energy detection limits of 100 keV were installed on the postevent perimeter fence to provide a cumulative record of any airborne gamma-emitting radionuclide which may have been released.
- Five continuous low-volume air samplers containing particulate filter and charcoal cartridges were placed on the drill rig; one on each corner of the rig and one at the cellar entrance of the drill rig.
- One continuous low-volume air sampler containing a particulate filter and charcoal cartridge was operating at the 24-hour personnel living quarters.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating during coring operations in the core shack.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating in the extractor area during the coring operation.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

In accordance with LANL requirements, the postevent drill hole was cemented to the surface and capped at 0945 hours on March 22, 1989.

The maximum gamma E/R detected in a work area during postevent drilling operations was 50 mR/h on PS#1AS at 1020 hours on February 14, 1989. This was due to Atlas Wireline calibrating instruments.

There were no toxic gases or explosive mixtures detected during the postevent drilling period.

There were no whole-body external or internal exposures which exceeded the radiation protection guides in DOE Order 5480.1 Chapter XI. No alpha radiation was detected.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

- Four hundred and six personnel entries were processed into the control area.
- Six hundred and nine sets of Anti-Cs were issued to personnel entering the control area.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-10-89	1206	Zero time.
	1221	Departed Gate 300. Began initial reentry. All readings 0.05 mR/h (background).
	1226	Time of crater.
	1249	Grounding party into Trailer Park.
	1255	Grounding party completed.
	1300	Initial survey completed; all readings 0.05 mR/h. Started Trailer Park recoveries.
	1415	Area control released to HPD as per LANL HSE R. Smale. Trailer Park recoveries completed.
	1440	A twenty-five minute crater entry was completed by the following: R. Kelly, B. Papathefins, R. Woerner, D. Tatro, R. Cosimi, C. Gallgas, D. Smale, E. Allred, J. Allen, and J. Pena. All readings 0.05 mR/h.
	1500	Started downwind survey; all readings (background). Perimeter fence signs uncovered.
	1730	Moving in equipment.
	1930	Began drilling surface casing hole.
	2000	Continued hourly downwind surveys; all readings 0.05 mR/h.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-10-89 (Cont'd)	2305	Casing hole drilled to 145 feet (44 meters). Coming out of the hole.
02-11-89	0030	Drillers going into the hole with casing.
	0230	B. J. Titan rigging up to cement casing.
	0450	Completed installing surface casing. Hourly downwind surveys continued; all readings 0.05 mR/h (background).
	0600	Began cementing surface casing.
	0610	Completed cementing; rig down (B. J. Titan).
	0730	Downwind survey; all readings 0.05 mR/h (background).
	0900	Wait on cement to dry. Rigging down CP rig.
	1000	Setting up personnel decontamination unit; moving in equipment.
	1145	Installing BOP stack. Holmes & Narver (H&N) surveying for the Skytop rig.
	1500	Drillers positioning cellar doors and rig tracks over cellar.
	1600	Drill crew rigging up Skytop rig.
	1930	Containment personnel in cellar hooking up BOP stack.
	2100	HPD ready to support postevent drilling.
	2320	Rig floor air samples on line.
02-12-89	0030	Completed BOP pressure check. All O.K.
	0215	Drillers tooling up to start drilling.
	0315	Rotating head installed.
	0320	Began drilling on the shoe.
	0345	Drilled through the shoe.
	0455	Directional survey at 201 feet (61 meters).
	0555	Directional completed; resumed drilling.
	0615	Lost circulation at 230 feet (70 meters). Flow line still open.
	0715	Routine drilling at 294 feet (90 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-12-89 (Cont'd)	0800	Directional survey at 357 feet (109 meters).
	0830	Directional completed; resumed drilling.
	1100	Directional survey at 515 feet (157 meters).
	1120	Directional completed; resumed drilling.
	1400	Directional survey at 670 feet (204 meters).
	1420	Directional completed; resumed drilling.
	1615	Flow line closed at 826 feet (252 meters).
	1630	Directional survey at 826 feet (252 meters).
	1654	Directional completed; resumed drilling.
	1816	Directional survey at 982 feet (299 meters). Rig floor E/R 0.05 mR/h (background).
	1840	Directional completed; resumed drilling.
	1951	Directional survey at 1,138 feet (347 meters).
	2013	Directional completed; resumed drilling.
	2040	Air samples set up at INC-7 Trailer.
	2119	Directional survey at 1,295 feet (395 meters).
	2148	Directional completed; resumed drilling.
	2300	Directional survey at 1,453 feet (443 meters).
	2330	Directional completed; resumed drilling. Rig floor E/R 0.05 mR/h.
02-13-89	0045	INC-7 Trailer air samplers started.
	0055	Hunt Plug pulled; rigging up to gas sample.
	0106	Began trying to pump out of the drill pipe.
	0130	Continued pumping out of the drill pipe; all readings remain 0.05 mR/h.
	0205	Stopped trying to gas sample; stopped INC-7 air samples.
	0243	Hunt Plug set.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-13-89 (Cont'd)	0250	Resumed drilling.
	0340	Directional survey at 1,608 feet (409 meters).
	0410	Directional survey completed; resumed drilling.
	0500	Hunt Plug pulled.
	0515	Began pumping out of drill pipe. Attempting to gas sample.
	0615	Continue to pump out of drill pipe; all readings 0.05 mR/h.
	0715	Gas sampling stopped; purging the lines, no gas sample obtained. Stopped INC-7 air samples.
	0835	Hunt Plug set.
	0850	Laid down two joints drill pipe. Gas sampling depth 1,548 feet (472 meters).
	0855	Hunt plug pulled.
	0900	Began gas sampling.
	0914	Pulled two 1,000 cc gas bottles. Both read 0.05 mR/h contact. Swipes nondetectable.
	0929	Gas sampling completed.
	0948	Stopped and changed INC-7 Trailer Air samples.
	0955	C. Bazan LANL departs area with two (2) 1,000 cc gas bottles. Cab E/R 0.05 mR/h (background).
	1055	Start air samples for INC-7 Trailer.
	1100	Began gas sampling.
	1213	Pulled gas bottle #6.
	1305	Pulled gas bottle #8; reading 0.15 mR/h contact. Total of eight gas samples pulled.
	1320	Gas sampling completed. Purging the system with air.
	1327	Purging the system with nitrogen.
	1343	Set Hunt Plug; resumed drilling. Rig floor E/R 0.05 mR/h (background).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-13-89 (Cont'd)	1350	C. Smith, LLNL departs area in vehicle #82295 with four 1,000 cc bottles, with maximum contact reading of 0.15 mR/h. Vehicle cab E/R 0.05 mR/h.
	1559	Directional survey at 1,859 feet (567 meters).
	1638	Directional completed; resumed drilling.
	1710	Directional survey at 1,959 feet (597 meters).
	1730	Directional completed; resumed drilling.
	1755	TD reached.
	1820	Atlas Wireline began gamma log.
	1905	Gamma log completed.
	1955	Hunt Plug pulled. It read 3 mR/h contact.
	2000	Started coring area air samples.
	2010	Began sampling.
	2215	Nine samples pulled. Maximum intensity 3 R/h. Rig floor E/R 0.05 mR/h (background).
	2320	Thirteen samples pulled. Maximum intensity 4.5 R/h contact.
02-14-89	0001	Sampling in progress. E/R on the rig floor, 0.05 mR/h.
	0300	Twenty-three samples pulled this operation. Maximum intensity remains the same.
	0400	Sampling in progress. E/R on the rig floor, 0.2 mR/h.
	0420	Sampling completed; total of 28 samples pulled this operation. Maximum intensity 4.5 R/h. Maximum E/R this operation was 40 mR/h for 20 seconds in the core shack.
	0436	Hunt Plug set.
	0450	Coming out of the hole to sidetrack point.
	0540	Directional survey at 1,735 feet (529 meters).
	0600	Directional completed; pipe orientation.
	0620	Ran second directional survey at same depth.
	0645	Directional completed; attempting to sidetrack.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-14-89 (Cont'd)	0730	Continue to try to sidetrack.
	0755	Sidetrack established at 1,766 feet (538 meters).
	0827	Directional survey at 1,859 feet (567 meters). Rig floor E/R 0.1 mR/h.
	0849	Directional survey completed; resumed drilling.
	0930	Routine drilling at 1,922 feet (586 meters).
	0950	Directional survey at 1,984 feet (605 meters).
	1012	Directional survey completed; resumed drilling.
	1105	Reached TD.
	1130	Gamma log began.
	1222	Started sampling area air samples.
	1225	Gamma log completed. Rigging up to start sampling.
	1300	Hunt Plug pulled.
	1317	Sampling began.
	1416	Completed a six-minute cellar entry by the following: K. Ziemba, J. Spoeneman, R. Smale, D. Cook, and J. Renella. Cellar E/R 0.05 mR/h (background).
	1605	Coring in progress. Rig floor E/R 0.15 mR/h.
	1700	Eight samples pulled from PS #1AS. Maximum contact intensity 3.0 R/h.
	1755	Sampling completed. A total of eleven samples pulled from PS #1AS. Maximum contact intensity 3.0 R/h. Thirty-nine samples pulled this operation.
	1813	Hunt Plug set.
	1822	Otis Plug set. Began coming out of the hole.
	1938	Rotating head removed.
	1953	Rig floor E/R 0.4 mR/h, due to contaminated pipe.
	2013	Out of the hole with tool string. Ball valve closed.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-14-89 (Cont'd)	2028	Three-minute cellar entry completed after checking BOP stack. Entry made by the following: C. Smith, J. Spoeneman, D. Gibbs, N. Hougen, J. Fullmer. Cellar E/R .6 mR/h; neg CO and LEL.
	2030	Stopped rig floor samples. Started cellar integrity sample.
	2100	R. Stone departs area in truck #81354 with samples bound for LANL Warehouse. Truck cab E/R 0.4 mR/h.
02-15-89	0350	Laundry taken to Decontamination Pad. Base Station surveyed and swiped clean.
	1620	Survey of cellar integrity sample taken twice each shift.
02-16-89 to 03-19-89		Continued cellar integrity checks each shift. Entry to location controlled by HPD as per LANL.
03-20-89	0150	Moving equipment to clean side.
	0400	Drill crew into area to start setting up to run tubing. Rig floor E/R 0.05 mR/h.
	0845	Open the one-inch line to sample from the annulus.
	0846	No radiological or explosive gases detected in the annulus.
	0855	Completed a five-minute cellar entry to remove a blind plug. Cellar entry by Pena, Hopper, Smith and Spoeneman. Cellar E/R 0.07 mR/h.
	0903	Ball valve opened, broke hoses loose on power swivel. Rig floor E/R 0.05 mR/h.
	0909	Out of the hole, ball valve closed.
	0920	Hydrill closed, ball valve open, going into hole with gas tubing and packer.
	1157	Packer plug set at 1,442 feet (440 meters); bottom of the stinger at 1,561 feet (476 meters).
	1252	Completed a two-minute cellar entry to hookup B. J. Titan cement lines. Entry made by Mykines, Pena, Fairweather and Gibson. E/R 0.07 mR/h. Neg CO and LEL.
	1325	Started cementing.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-20-89 (Cont'd)	2300	Completed twelfth pour; poured 800 ft ³ of cement. Last pour tagged at 968 feet (295 meters).
03-21-89	0710	Completed twenty-first pour; poured 1,430 ft ³ of cement. Last pour tagged at 118 feet (36 meters). Final pour will not be tagged.
	0945	Completed cementing. Twenty-two total pours. Rig floor air samples turned off. Started cellar integrity air sample.
	1230	Skytop rig departs for Decontamination Pad. Cardwell on location to pull mini Otis Plug.
	1410	Otis Plug pulled. Gas tubing valved off.
	1630	Cellar Integrity reads 0.05 mR/h (background).
	2030	Moving out equipment.
03-22-89	0850	Containment personnel moving out equipment. Laborers chipping out cement in the cellar.
	1345	Crane removes cellar and cellar steps. Both depart for Decontamination Pad.
	1430	Grader completes filling the cellar hole. Surveyed the ground at cellar, 0.05 mR/h contact.
	1435	Laborers completed roping off the mud pit.
	1445	Started exhaust fan sample at the gas sampling INC-7 Trailer.
	1500	Started well head air sample.
	1640	Pulled three 1,000 cc gas bottles. Maximum contact reading 1.5 mR/h.
	1650	Stopped exhaust fan air sample.
	1657	Stopped well head air sample. Valve set on closed position at the well head.
03-23-89	0835	Opened valve at the well head. Air sample started.
	0837	Started air sample at exhaust fan INC-7 Trailer.
	0915	Pulled three 1,000 cc gas bottles. Maximum contact reading 2 mR/h.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-30-89	0950	Stopped exhaust fan air sample.
	1017	Stopped well head air sample.
	1350	Started well head air sample.
	1415	Started exhaust fan air sample.
	1646	Pulled three 1,000 cc gas bottles. Maximum contact reading, 0.5 mR/h.
	1650	Closed well head valve.
	1711	Stopped exhaust fan air sample.
	2125	Stopped well head air sample.
04-05-89	1020	Two mud samples taken from the cellar.
	1030	One mud sample taken from the mud pit.
	1050	Cellar sample read 0.09 mR/h. Swipes nondetectable. Mud pit sample read 0.05 mR/h. Swipes nondetectable.
04-06-89	0920	Collected two samples from the mud pit; both read 0.05 mR/h. Swipes nondetectable.
	0935	D. Henderson departs for LANL Warehouse with the samples.
04-24-89	0950	Started well head and INC-7 Trailer air samples.
	1055	Pulled three 1,000 cc gas bottles. All bottles read 0.05 mR/h contact.
	1100	Closed well head valve.
	1105	Stopped exhaust fan air sample.
	1340	Stopped well head air sample.

3.4 KAWICH

The KAWICH event was an underground nuclear experiment conducted by LLNL at site U2cu at 0815 hours on February 24, 1989.

Telemetry

Nine remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° at 183 meters from SGZ.

Telemetry measurements began at 0816 hours on February 24, 1989, and ended at 0900 hours on February 25, 1989. The maximum E/R detected was background.

Effluent Release Information

There was no detectable release of fission products within the first 60 minutes after detonation. There was release of radioactivity during postevent operations. During the postevent operations, there was a total of 9.79 curies of xenon released through the ventline.

Initial Survey

The initial radiation survey into the test area began at 0843 hours on February 24, 1989. The HPD survey teams consisted of one (1) REECO/HPD supervisor and six (6) REECO/HPD RPTs. The readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h (background). The initial survey was completed at 0930 hours on February 24, 1989.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 2300 hours on February 24, 1989. Postevent drilling commenced at 1600 hours on February 25, 1989; core samples were collected and gamma intensity measured.

Postevent sample information:

PS#1A	Drilled through shoe:	1615 hours on 02-25-89.
	Sampling began:	2200 hours on 02-26-89.
	Sampling completed:	1049 hours on 02-27-89.
	Number of samples:	19
	Maximum gamma intensity on core samples at contact:	20 R/h
PS#1AA	Sampling began:	2005 hours on 02-27-89.
	Sampling completed:	2315 hours on 02-27-89.
	Number of samples:	7
	Maximum gamma intensity on core samples at contact:	10 R/h.

PS#1AB Drilled for gas sample tubing installation

Postevent Support Requirements

In accordance with LLNL requirements, the following equipment was used:

- One primary radiation monitoring unit was used for monitoring radioactive releases through the ventline system. This unit consisted of a 2x2 NaI [Tl] detector and a strip chart recorder with remote alarm. The recorder and alarm unit read-out was inside the LLNL core trailer.
- One secondary radiation monitoring unit, an eight decade Neher-White ionization chamber and an Esterline-Angus recorder, was used for monitoring radioactive releases through the ventline system. This unit was mounted adjacent to and acted as a backup for the primary unit.
- One RAM unit consisting of an eight decade Neher-White ionization chamber and Esterline-Angus recorder was located at the driller's station on the drilling platform to monitor for gamma radiation. Read-out was recorded on a strip chart recorder in the core sampling trailer.
- Four continuous low-volume air samplers containing prefilters and charcoal cartridges were placed on the drill rig; one on each corner of the drill rig floor.
- One GM detector (an Eberline Model HP 270 probe with a strip chart recorder) was mounted on the bleed line to monitor for radioactive contamination of the drilling mud returning to the mud pit and as an audio alarm system for manual closure of the valve.
- Portable radiation survey instruments for detecting alpha and beta/gamma radiation and toxic and explosive gas indicators were used.
- One Tennelec modular counting system with dual phosphor (alpha/beta) detector was available for preliminary evaluation of swipes and air samples prefilters.
- One remote Radector probe (a six decade Neher-White ionization chamber) was installed next to the BOP and the meter positioned in the core trailer.
- One gas sampling air sampler.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

In accordance with LLNL requirements, the postevent drill hole had gas sampling tubing cemented to the surface at 0825 hours on March 2, 1989.

The maximum gamma E/R detected in a work area during postevent drilling operations was 200 mR/h on PS#1A at 1049 hours on February 27, 1989. This was due to the coring operation and had a duration of 45 seconds.

There was no whole-body external or internal exposure which exceeded the radiation protection guides in DOE Order 5480.11 Chapter 9B. No alpha radiation was detected.

There were no toxic gases or explosive mixtures detected during the postevent drilling period.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

- Three hundred sixty-seven personnel entries were processed into the control area.
- Four hundred seventy-seven sets of Anti-C clothing were issued to personnel entering the control area.
- Two respiratory protection devices were issued to limit internal deposition of radioactive material.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-24-89	0815	Zero time.
	0844	Initial survey begun.
	0925	Subsidence crater.
	0930	Initial survey completed.
	0935	Grounding party into Trailer Park.
	0947	Recovery teams into area.
	0951	Grounding party complete.
	1040	Area released to HPD control by W. Workman (LLNL).
	1100	Drill crews into area, began rigging up.
	1140	Began hourly downwind surveys.
	1230	IRI drill rig moved into postevent pad.
	1240	Hourly downwind survey. E/R 0.05 mR/h (background).
	2130	Completed surface casing hole.
	2305	Began running casing.
	2340	Rigging up IRI.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-25-89	0001 to 0900	Downwind surveys. E/R 0.05 mR/h.
	0300	Surface casing installed.
	0310	Began cementing surface casing.
	0320	Completed cementing.
	1000	Discontinued downwind surveys.
	1220	Began pressure checking BOP.
	1250	Pressure check complete.
	1300	Tools picked up. Ventline blowers started.
	1450	Rig samples begun.
	1600	Started drilling on the shoe.
	1615	Drilled through the shoe.
	1630 to 2330	Drilled and surveyed to 661 feet (201 meters).
02-26-89	0001 to 0510	Drilled and surveyed to 1,132 feet (345 meters).
	0150	Began blooie line swipes.
	0300	Circulation lost at 850 feet (259 meters). Blooie line swipes discontinued.
	0315	Blooie line shut in at 942 feet (287 meters).
	0535	Rigged up for gas sampling.
	0653	Hunt Plug pulled. Swipe and survey nondetectable.
	0725	Began gas sampling.
	0812	Discontinued gas sampling. E/R .05 mR/h.
	0830	Hunt Plug set.
	0848 to 0945	Drilling to 1,256 feet (383 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-26-89 (Cont'd)	0958	Hunt Plug pulled. Swipes nondetectable. Began gas sampling.
	1010	Gas sampling discontinued. Max E/R during sampling, 0.05 mR/h.
	1025	Hunt Plug set.
	1030 to 1115	Drilled and surveyed to 1,288 feet (393 meters).
	1142	Hunt Plug pulled. Swipe and survey nondetectable.
	1145	Began gas sampling from drill pipe.
	1600	Gas sampling discontinued. Maximum rig floor E/R 0.3 mR/h. Maximum E/R on pipe, 60 mR/h at 1 meter.
	1632	Cellar entry to disconnect gas sampling.
	1640	Hunt Plug set.
	1655 to 1905	Drilled and surveyed to TD of PS#1A.
	1925 to 2000	Gamma logged.
	2030	Drill down one joint.
	2043 to 2115	Gamma logged.
	2205	Hunt Plug pulled. First sign of radiation. Coring operations began on PS#1A.
	02-27-89	0001
0120 to 0140		Slight effluent indication, too small to calculate.
0155 to 0220		Slight effluent indication.
0405 to 0413		Effluent indication, less than 3.5×10^{-2} Ci of xenons released through the ventline.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-27-89 (Cont'd)	0420 to 0426	Slight effluent indication.
	0443	Cellar grab sample read 0.06 mR/h gamma on the charcoal and 13 dpm beta and 135 dpm alpha on the Whatman.
	0444 to 0447	Effluent indication too small to calculate.
	0510	Otis Plug set.
	0520	Cellar entry by Orlando McKee, in supplied air, and Jan Fullmer in full-face mask, to check the kill line and change the rotating head rubber.
	0525	Cellar entry completed.
	0535 to 0540	Rotating head removed. Effluent indication less than 3.9 Ci of xenons released through the ventline.
	0545 to 0625	Release through the flex hose over the rotating head due to Hydrill not tight enough around the drill pipe.
	0550	Hydrill snugged up.
	0604	Rotating head with double rubber installed.
	0630	Otis Plug pulled.
	0645	Continue coring.
	1049	Completed coring PS#1A. Total of nineteen samples were pulled. Maximum intensity was 20 R/h. Maximum E/R in core trailer was 200 mR/h. Maximum E/R in cellar was greater than 200 mR/h for 45 seconds. Average rig floor E/R during coring operations was 0.5 mR/h.
	1105	Hunt Plug set.
	1240	Establishing a shoulder for sidetrack.
	1310	Sidetrack confirmed on PS#1AA.
	1330 to 1727	Drilled and surveyed to total depth reached 1,525 feet (465 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-27-89 (Cont'd)	1751 to 1820	Ran gamma log.
	1940	Hunt Plug pulled.
	2005	Began coring on PS#1AA.
	2400	Coring continues.
02-28-89	0001 to 0130	Coring continues.
	0130	Completed coring on PS#1AA. Total of seven samples pulled on PS#1AA. Maximum intensity was 10 R/h. Maximum exposure in core trailer was 60 mR/h at 1 meter from 10 R/h sample. Average rig floor E/R during coring operation was 0.5 mR/h.
	0155	Hunt Plug set.
	0305	Otis Plug set.
	0410	Coming out of the hole.
	0500	Pipe stuck in the hole.
	0629 to 0644	Slight effluent indication, too small to calculate.
	0700 to 1000	Standby for Atlas Wireline to shoot-off pipe.
	0945	Forrest Larve in mask with GMR-I canister to heat and twist-off shock sub.
	1035	Shock sub broke loose.
	1100	Otis Plug pulled.
	1115	Hunt Plug pulled.
	1125	Set positive Otis Plug.
	1234	Pipe shot off at 961 feet (293 meters).
	1330	In-line bridge plug set.
	1350	Coming out of the hole.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
02-28-89 (Cont'd)	1440	Hydrill closed, rotating head off.
	1450	Out of the hole.
	1452	Abandonment valve closed.
	1537	Opened abandonment valve, going into the hole with packer plug. Closed Hydrill.
	1557	Rotating head installed.
	1800	Packer plug set at 895 feet (273 meters).
	1840	Began cementing.
	2400	Cementing in progress.
03-01-89	0001 to 0020	Cementing in progress.
	0020	Cementing complete. Total of five pours made, 400 ft ³ .
	0035	Coming out of the hole.
	0055	Abandonment valve closed, out of the hole.
	0115	Rotating head removed.
	0225	Abandonment valve open, going into the hole with tools.
	0315	Rotating head installed.
	0355 to 0359	Planned release. Less than 2.7×10^{-2} Ci of xenons released through the ventline.
	0445	Establishing a shoulder for sidetrack.
	0800	Sidetrack confirmed on PS#1AB.
	0840 to 1400	Drilled and surveyed to 1,179 feet (359 meters).
	1430	TD reached PS#1AB.
	1505	Otis Plug set.
	1510 to 1630	Coming out of the hole.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-01-89 (Cont'd)	1720	Rotating head removed.
	1727	Hydrill closed.
	1730	Blooie line opened.
	1750	Blooie line closed.
	1757	Out of the hole, abandonment valve closed.
	2000	Abandonment valve open. Going into the hole with gas sample tubing.
	2003	Opened Hydrill.
	2005	Hydrill closed.
	2010	Continued going into the hole with tubing.
	2053	Opened Hydrill.
	2055	Going into the hole with packer plug.
	2103	Closed Hydrill.
	2110	Rotating head installed.
	2112	Hydrill opened. Continued going into the hole with packer and gas sampling tubing.
	2320 to 2400	Rigging up to cement.
03-02-89	0001 to 0815	Cementing in progress. Total of nine pours made, 760 ft ³ .
	0825	Last pour tagged at BOP.
	0900 to 1100	Tearing down drill equipment.
	1135	BOP stack pulled.
	1405	Otis Plug pulled from gas sample tubing.
03-03-89	1710	Gas sampling completed. Future gas sample scheduled.
		Began twice-per-shift check of cellar integrity and change on swing shift.

3.5 INGOT

The INGOT event was an underground nuclear experiment conducted by LLNL at site U2gg at 0605 hours on March 9, 1989.

Telemetry

Nine remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 0°, 43°, 135°, 180°, 270° and 315° at 183 meters from SGZ.
- 90° at 116 meters from SGZ.
- 225° at 206 meters from SGZ.

Telemetry measurements began at 0606 hours on March 9, 1989, and ended at 0800 hours on March 10, 1989. The maximum E/R detected was 0.05 mR/h (background).

Effluent Release Information

There was no detectable release of fission products within the first 60 minutes after detonation. There was no detectable release of radioactivity during postevent operations.

Initial Survey

The initial radiation survey into the test area began at 0630 hours on March 9, 1989. The HPD survey teams consisted of one REECO/HPD supervisor and six REECO/HPD RPTs. The readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h. The initial survey was completed at 0651 hours on March 9, 1989.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 0800 hours on March 10, 1989. Postevent drilling commenced at 0934 hours on March 10, 1989; core samples were collected and gamma intensity measured.

Postevent sample information:

PS#1A	Drilled through shoe:	0950 hours on 03-10-89.
	Sampling began:	0740 hours on 03-12-89.
	Sampling completed:	1330 hours on 03-12-89.
	Number of samples:	14
	Maximum gamma intensity on core samples at contact:	15 R/h
PS#1AA	Sampling began:	0545 hours on 03-13-89.
	Sampling completed:	1004 hours on 03-13-89.
	Number of samples:	10
	Maximum gamma intensity on core samples at contact:	10 R/h

Postevent Support Requirements

In accordance with LLNL requirements, the following equipment was used:

- One primary radiation monitoring unit was used for monitoring radioactive releases through the ventline system. This unit consisted of a 2x2 NaI [TI] detector and a strip chart recorder with remote alarm. The recorder and alarm unit read-out was inside the LLNL core trailer.
- One secondary radiation monitoring unit, an eight decade Neher-White ionization chamber and an Esterline-Angus recorder, was used for monitoring radioactive releases through ventline system. This unit was mounted adjacent to and acted as a backup for the primary unit.
- One RAM unit consisting of an eight decade Neher-White ionization chamber and Esterline-Angus recorder was located at the driller's station on the drilling platform to monitor for gamma radiation. Read-out was recorded on a strip chart recorder in the core sampling trailer.
- Four continuous low-volume air samplers containing prefilters and charcoal cartridges were placed on the drill rig; one on each corner of the drill rig floor.
- One GM detector (an Eberline Model HP 270 probe with a strip chart recorder) was mounted on the bleed line to monitor for radioactive contamination of the drilling mud returning to the mud pit and as an audio alarm system for manual closure of the valve.
- Portable radiation survey instruments for detecting alpha and beta/gamma radiation and toxic and explosive gas indicators were used.
- One Tennelec modular counting system with dual phosphor (alpha/beta) detector was available for preliminary evaluation of swipes and air samples prefilters.
- One remote Radector probe (a six decade Neher-White ionization chamber) was installed next to the BOP and the meter positioned in the core trailer.
- One gas sampling air sampler.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

In accordance with LLNL requirements, the postevent drill hole had gas sampling tubing cemented to the surface at 0504 hours on March 14, 1989.

The maximum gamma E/R detected in a potential work area during postevent drilling operations was 20 mR/h at PS#1A at 1130 hours on March 12, 1989. This was due to coring operations.

There was no whole-body external or internal exposures which exceeded the radiation protection guides in DOE Order 5480.11 Chapter 9B. No alpha radiation was detected.

There were no toxic gases or explosive mixtures detected during the postevent drilling period.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

- Two hundred seventy-nine personnel entries were processed into the control area.
- Three hundred twenty-five sets of Anti-Cs were issued to personnel entering the control area.
- Four respiratory protection devices were issued to limit internal deposition of radioactive material.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-09-89	0605	Zero time.
	0620	Reentry teams arrive at Gate 300.
	0630	Reentry teams depart Gate 300. Initial survey began. E/R .05 mR/h.
	0649	Crater occurs.
	0651	Initial survey completed. All readings, 0.05 mR/h (background).
	0703	Grounding party into Trailer Park.
	0714	Grounding parties completed checks.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>	
03-09-89 (Cont'd)	0716	Recovery parties into Traller Park.	
	0718	Haeberlin, Richards, Ziemba to crater edge. All readings 0.05 mR/h (background).	
	0720	Postevent pad survey, 0.05 mR/h.	
	0725	Haeberlin, Moran, Ziemba to crater edge. All readings 0.05 mR/h.	
	0755	Recoveries complete except for the Special Measurements Group.	
	0757	Area released to HPD by D. Richards (LLNL).	
	0800	Began downwind perimeter fence surveys, 0.05 mR/h (background).	
	0900	IRI 1100 rig arrives on location.	
	1000 to 1200	Rigging up IRI rig and associated equipment. Downwind perimeter fence surveys 0.05 mR/h. Special Measurements Group continues to work in Traller Park.	
	1300	Began drilling surface casing hole.	
	1410	Completed drilling surface casing hole.	
	1500 to 1800	Installing surface casing into hole. Hourly downwind perimeter fence surveys 0.05 mR/h. Special Measurements Group completed. All personnel out of Traller Park.	
	1855	Cementing in surface casing.	
	1900 to 2400	Hourly downwind perimeter fence surveys 0.05 mR/h.	
	03-10-89	0015	Installing BOP.
		0100 to 0500	Hourly downwind perimeter fence surveys 0.05 mR/h and continue installing BOP.
		0555	Pressure check of BOP began.
		0600	Downwind perimeter fence survey 0.05 mR/h (background).
0630		Completed pressure check of BOP. Began making tool string.	

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-10-89 (Cont'd)	0700 to 0800	Hourly and final downwind perimeter fence surveys 0.05 mR/h. Continued making tool string.
	0934	Began drilling on cement.
	0950	Drilled through the shoe at 120 feet (36.6 meters).
	1050 to 1900	Drilled and surveyed to a depth of 845 feet (258 meters).
	1402	At 502 feet (153 meters) began swipe survey of bloole line. Swipes taken during every other joint connection.
	1500 to 2047	Drilled and surveyed to a depth of 1,002 feet (305 meters). Began swipe survey of bloole line during every joint connection. All swipe results of bloole line up to this time are below release limits.
	2100 to 2330	Drilled and surveyed to a depth of 1,189 feet (362 meters). Continued to swipe survey bloole line. All results below release limits.
	2357	Rotating head removed to change out rubber collar. No radioactive gases detected.
03-11-89	0008	Rotating head installed.
	0036	At 1,250 feet (381 meters); hole closed in. All bloole line swipes, including this depth, are below release limits.
	0100 to 0320	Drilled and surveyed to a depth of 1,499 feet (456 meters).
	0355	Cellar entry to connect gas sampling line. Cellar E/R 0.05 mR/h (background).
	0425	Hunt Plug pulled.
	0434	Gas sample line valve opened. Began gas sampling.
	0505	Gas sampling unsuccessful; line closed, sampling discontinued.
	0520	Hunt Plug set. Lost setting. Tool down hole.
	0540	Tripping out of the hole to retrieve.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-11-89 (Cont'd)	0600 to 0800	Tripping out of the hole.
	0807	Rotating head removed. No radiological or toxic gases detected.
	0845	Continue coming out of the hole as tools are broken down.
	0942	Abandonment valve closed. Out of the hole.
	1023	Abandonment valve opened. Going into the hole with a new tool string.
	1058	Rotating head installed, going into the hole.
	1100 to 1230	Going into the hole.
	1255	Conditioning the hole back to bottom.
	1350	Back on bottom. Directional survey at 1,499 feet (457 meters).
	1415	Resumed drilling.
	1500 to 1600	Routine drilling.
	1715	Pulled Hunt Plug, attempted to gas sample, set Hunt Plug, and resumed drilling.
	1925	Pulled Hunt Plug, attempted to gas sample, set Hunt Plug, and resumed drilling.
	2225	Hunt Plug pulled. First sign of radiation; 15 mR/h at contact.
	2240	Air sample started in Trailer 9121, began gas sampling.
	2330	Continued to gas sample.
03-12-89	0030	Gas sampling completed (two samples taken). Began flushing gas sample lines.
	0120	Collected and surveyed gas sample bottles. Bottle #1 130 mR/h at contact; bottle #2 100 mR/h at contact.
	0131	Hunt Plug set.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-12-89 (Cont'd)	0202	Third gas sample collected from pump tank. Bottle #3 40 mR/h at contact.
	0250	Fitters and HPD in full-face respirators into cellar and rig areas to break gas sample lines and cap Reagen head.
	0316	Packaged gas samples. Barrel with gas sample #3, 6 mR/h at contact. Barrel #26 with gas sample #1, 40 mR/h at contact. Barrel #23 with gas sample #2, 40 mR/h at contact.
	0325	Prepared to resume drilling. Directional survey at 1,845 feet (562 meters).
	0355	Completed directional survey. Resumed drilling.
	0516	TD reached on PS#1A.
	0550	Began gamma log.
	0615	Completed gamma log.
	0703	Hunt Plug pulled, preparing to core sample.
	0740	Began coring on PS#1A.
	0800 to 1230	Coring in progress. Rig floor E/R 0.4 mR/h.
	1330	Coring operation completed. Fourteen samples pulled on PS#1A. Maximum intensity of core samples 15 R/h. Maximum E/R 20 mR/h due to coring operations.
	1500	Coming up in the hole to the kickoff point.
	1510	Core samples depart area with Wackenhut Security, Inc. (WSI), enroute to Blue Building. Cab E/R 0.5 mR/h.
	1515	Backup samples departed area to Area-12 Core Library. Cab E/R 6 mR/h.
	1545	At kickoff point. Directional Survey at 1,002 feet (305 meters). Average rig floor E/R 0.2 mR/h.
	1607	Directional survey completed. Began attempt to establish a shoulder.
	1845	Directional survey at 1,157 feet (353 meters).
	1903	Survey completed. Shoulder and sidetrack PS#1AA confirmed. Resumed drilling.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-12-89 (Cont'd)	2000 to 2345	Drilling and surveying to a depth of 1,625 feet (495 meters).
03-13-89	0001 to 0325	Drilled and surveyed to TD. Rig floor E/R 0.1 mR/h.
	0350	Began gamma log.
	0410	Completed gamma log.
	0500	Hunt Plug pulled. Preparing to core sample hole PS#1AA.
	0545	Began coring.
	0630 to 0900	Core sampling in progress. Rig floor E/R 0.3 mR/h.
	1004	Completed core sampling of PS#1AA. Ten samples pulled. Maximum intensity of core samples, 10 R/h. Maximum E/R 15 mR/h for 3) seconds due to coring operation.
	1025	Hunt Plug set.
	1035	Otis Plug set. Core samples depart area with WSI, enroute to Blue Building. Cab E/R 1 mR/h.
	1038	Backup samples depart area for Area-12 Core Library. Cab E/R 12 mR/h. Driver wearing TLD and pocket dosimeter.
	1045	Coming out of the hole.
	1200	Continued to come out of the hole. HPD supported gas sample crew disconnecting gas sample hoses.
	1245	Stopped coming out of the hole. Purging gas sample lines into the hole. Rig floor E/R 0.3 mR/h.
	1338	Cellar entry to disconnect gas sample hoses from BOP stack. E/R in cellar, 0.5 mR/h.
	1346	Resumed coming out of the hole.
	1400	Rotating head removed.
	1430	Abandonment valve closed. Out of the hole. Preparing to run gas sample tubing into the hole.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-13-89 (Cont'd)	1645	Abandonment valve opened. Rig floor E/R 0.3 mR/h.
	1651	Hydrill closed enough to insert the gas sample tubing into the hole.
	1800	Backup packer to install on gas sample tubing to go into the hole.
	1836	Packer in the hole. Rotating head installed,
	1955	In the hole with tubing and packer. Preparing to set later.
	2120	Packer plug set at 820 feet (250 meters); bottom of gas sample tubing at 1,520 feet (463 meters).
	2145 to 2210'	Ran fluid density log.
	2215	Began cementing gas sample tubing in place.
	0001 to 0504	Cemented around gas sample tubing. Rig floor E/R 0.3 mR/h.
	0510	Rigging down IRI and moving out postevent equipment.
03-14-89	0645	Stopped rig floor air samples, began cellar integrity air sample.
	0700 to 0950	Moving out postevent equipment.
	1010	Attempted to pull Otis Plug through the gas sample tubing.
	1030	Unable to pull Otis Plug. Waiting on second overshot.
	1145	Unable to use second overshot. Waiting on Atlas Wireline to arrive to perforate tubing.
	1245	Atlas Wireline on location. Preparing to perforate.
	1350	Perforated tubing between 1,472 feet (449 meters) and 1,482 feet (452 meters).
	1410	Opened gas sample hoses; began gas sampling.
	1500	Completed gas sampling. Closed valves. Two gas samples pulled, 1,000 cc bottles, both 100 mR/h at contact and 5 mR/h at one meter.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-14-89 (Cont'd)	1516	Gas samples depart area in one barrel reading 18 mR/h contact, 2 mR/h at one meter. Cab E/R 1 mR/h.
	1600 to 2330	Continued to move out equipment.
		Gas sampling to follow.

3.6 PALISADE

The PALISADE event was an underground nuclear experiment conducted by LLNL at site U4at at 0610 hours on May 15, 1989.

Telemetry

Nine remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° at 183 meters from SGZ.

Telemetry measurements began at 0611 hours on May 15, 1989, and ended at 0755 hours on May 16, 1989. The maximum E/R detected was 0.05 mR/h (background).

Effluent Release Information

There was no detectable release of fission products within the first 60 minutes after detonation. There was release of radioactivity during postevent operations. During the postevent operations, there was a total of 2.4 curies of xenons released through the ventline.

Initial Survey

The initial radiation survey into the test area began at 0624 hours on May 15, 1989. The HPD survey teams consisted of one REEC/HPD supervisor and seven REEC/HPD RPTs. The readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h. The initial survey was completed at 0711 hours on May 15, 1989.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 1200 hours on May 16, 1989. Postevent drilling commenced at 1630 hours on May 16, 1989; core samples were collected and gamma intensity measured.

Postevent sample information:

PS#1A	Drilled through shoe:	1645 hours on 05-16-89.
	Sampling began:	1955 hours on 05-17-89.
	Sampling completed:	0020 hours on 05-18-89.
	Number of samples:	12
	Maximum gamma intensity on core samples at contact:	20 R/h
PS#1AA	Sampling began:	1105 hours on 05-18-89.
	Sampling completed:	1445 hours on 05-18-89.
	Number of samples:	12
	Maximum gamma intensity on core samples at contact:	5 R/h.

Postevent Support Requirements

In accordance with LLNL requirements, the following equipment was used:

- One primary radiation monitoring unit was used for monitoring radioactive releases through the ventline system. This unit consisted of a 2x2 NaI [TI] detector and a strip chart recorder with remote alarm. The recorder and alarm unit read-out was inside the LLNL core trailer.
- One secondary radiation monitoring unit, an eight decade Neher-White ionization chamber and an Esterline-Angus recorder, was used for monitoring radioactive releases through ventline system. This unit was mounted adjacent to and acted as a backup for the primary unit.
- One RAM unit consisting of an eight decade Neher-White ionization chamber and Esterline-Angus recorder was located at the driller's station on the drilling platform to monitor for gamma radiation. Read-out was recorded on a strip chart recorder in the core sampling trailer.
- Four continuous low-volume air samplers containing prefilters and charcoal cartridges were placed on the drill rig; one on each corner of the drill rig floor.
- One GM detector (an Eberline Model HP 270 probe with a strip chart recorder) was mounted on the bleed line to monitor for radioactive contamination of the drilling mud returning to the mud pit and as an audio alarm system for manual closure of the valve.
- Portable radiation survey instruments for detecting alpha and beta/gamma radiation and toxic and explosive gas indicators were used.

- One Tennelec modular counting system with dual phosphor (alpha/beta) detector was available for preliminary evaluation of swipes and air samples prefilters.
- One remote Radector probe (a six decade Neher-White ionization chamber) was installed next to the BOP and the meter positioned in the core trailer.
- One gas sampling air sampler.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

The maximum gamma E/R detected in a work area during postevent drilling operations was 60 mR/h at PS#1A at 2335 hours on May 17, 1989. This was due to debris in the core trailer.

There were no whole-body external or internal exposures which exceeded the radiation protection guides in DOE Order 5480.11 Chapter 9B. No alpha radiation was detected.

There were no toxic gases or explosive mixtures detected during the postevent drilling period.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

- Two hundred eighteen personnel entries were processed into the control area.
- Three hundred twenty-seven sets of Anti-Cs were issued to personnel entering the control area.
- One respiratory protection device was issued to limit internal deposition of radioactive material.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-15-89	0610	Zero time.
	0624	Started initial survey.
	0700	Cratered.
	0711	Initial survey completed. Maximum E/R 0.05 mR/h (background).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-15-89 (Cont'd)	0714	Grounding party entered Trailer Park.
	0722	Grounding completed.
	0738	Recovery parties entered Trailer Park.
	0955	Recoveries completed. Area released to HPD control by W. Workman (LLNL).
	1000 to 1800	Started hourly downwind perimeter fence surveys, 0.05 mR/h (background).
	1840	Began drilling for surface casing hole.
	1900 to 2100	Downwind perimeter fence surveys, 0.05 mR/h.
	2115	Completed drilling surface casing hole.
	2152	Going into the hole with surface casing.
	2200 to 2359	Downwind perimeter fence surveys 0.05 mR/h.
	0020	Completed installation of surface casing.
	0100	Cementing began.
	0110	Completed cementing.
	0001 to 0500	Downwind perimeter fence survey 0.05 mR/h.
05-16-89	0630	Began installing BOP.
	0700 to 1000	Downwind perimeter fence surveys 0.05 mR/h. Discontinued downwind surveys.
	1236	Began pressure check on BOP.
	1256	Completed pressure checking BOP.
	1330	Began tooling up.
	1524	Abandonment valve open; making tool string.
	1625	Rotating head installed.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-16-89 (Cont'd)	1630	Began drilling on shoe. Rig floor E/R 0.05 mR/h.
	1633	Started rig floor air sample.
	1645	Drilled through the shoe. Ventline operational.
	1646 to 2024	Drilled and surveyed to 441 feet (134 meters).
	2100	Started taking bloole line swipes at 503 feet (153 meters).
	2110 to 2252	Drilled and surveyed to 690 feet (210 meters).
	2322	Lost circulation at 753 feet (230 meters). All bloole line swipes nondetectable. Bloole line swipe survey discontinued.
	2332	Rotating head removed.
	2347	Installed new rubber on rotating head.
	05-17-89	Drilled and surveyed to 1,004 feet (306 meters).
	0001 to 0252	
	0300	Preparing to gas sample at 909 feet (277 meters).
	0303	RAM recorders turned on.
	0330	Hunt Plug pulled. Swipe nondetectable.
	0355	Began gas sampling; gas sample skid air sampler started.
	0447	Completed gas sampling.
	0511	Hunt Plug set.
	0530 to 0600	Drilled to 1,095 feet (334 meters).
	0615	Preparing to gas sample at 972 feet (296 meters).
	0630	Hunt Plug pulled. Swipe nondetectable.
	0640	Began gas sampling.
	0700	Discontinued gas sampling.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-17-89 (Cont'd)	0715	Began gas sampling.
	0820	Gas sampling discontinued.
	0821	Otis Plug set; two joints laid down.
	0845	Otis Plug pulled.
	0850	Began gas sampling at 878 feet (268 meters).
	0945	Discontinued gas sampling.
	1000	Hunt Plug set.
	1010 to 1155	Drilled and surveyed to 1,191 feet (363 meters).
	1200	Coming out of hole nine joints to gas sample at 940 feet (287 meters).
	1225	All personnel in Anti-Cs.
	1229	Hunt Plug pulled. First sign of radiation. Reading 0.05 mR/h (contact). 256 dpm beta and gamma.
	1240	Began gas sampling.
	1245	Gas sampling line 60 mR/h (contact). Rig floor E/R 1 mR/h.
	1255	Indication on LLNL ventline recorder. Hydrill tightened. High-volume air sample started.
	1315	Gas sampling line 80 mR/h (contact). Drill pipe 120 mR/h (contact).
	1327	Several increases on LLNL ventline recorder between 1327 and 1337 hours during gas sampling operations. R. Miller and K. Rashke notified. Maximum reading 1,000 cps. High-volume sample negative with L101.
	1338	LLNL ventline recorder back to 130 cps. Rig floor E/R 0.5 mR/h.
	1358	LLNL ventline recorder reading 800 cps.
	1403	Gas sampling complete.
	1405	LLNL ventline recorder back to 130 cps.
	1410	High-volume air sampler discontinued.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-17-89 (Cont'd)	1423	Purging gas sample lines.
	1500	Four gas samples depart to LLNL Building 600 in vehicle #84348 with Carl Johnson. Cab E/R 0.05 mR/h.
	1512	Hunt Plug set. Going into hole.
	1530	Cellar probe reading 0.19 mR/h.
	1620	Rig floor E/R 3.0 mR/h maximum from annulus due to residual gas from gas sampling operations. Forced air down annulus.
	1645 to 1750	Drilled and surveyed to TD PS#1A.
	1720	Atlas Wireline source exposed. Maximum E/R 35 mR for three minutes at one meter.
	1825 to 1900	Gamma logged.
	1930	Hunt Plug pulled reading 0.1 mR/h (contact).
	1955	Coring began.
	2000 to 2359	Coring in progress.
05-18-89	0020	Coring completed PS#1A. Twelve samples total, maximum intensity, 20 R/h.
	0045	Hunt Plug set. Rig floor E/R 0.3 mR/h.
	0135	Came out of the hole 25 joints to 721 feet (220 meters) to attempt sidetrack.
	0140	Otis Plug set. Rig floor E/R 0.5 mR/h due to pipe on floor.
	0224	Security departs in vehicle #84134 with samples. Cab E/R 0.05 mR/h.
	0230	A. Denning departs area in vehicle #84423 with backup samples 20 mR/h at contact.
	0245	Shoulder established PS#1AA.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-18-89 (Cont'd)	0305 to 0725	Drilled and surveyed to 1,301 feet (397 meters).
	0905	TD PS#1AA.
	0925 to 0950	Gamma logged.
	1040	Hunt Plug pulled reading 0.3 mR/h.
	1105	Began coring PS#1AA.
	1445	Completed coring PS#1AA. Maximum reading 5 R/h (contact). Twelve samples pulled.
	1500	Hunt Plug set.
	1510	Purging gas sample exhaust tanks.
	1515	Began coming out of the hole to gas sample.
	1545	Security departed with core samples in vehicle #84045. Cab E/R 0.3 mR/h.
	1610	A. Denning departed with backup samples in vehicle #82423. Cab E/R 1.5 mR/h.
	1611	Hunt Plug pulled. Rig floor E/R 0.6 mR/h.
	1625	Began gas sampling at 886 feet (270 meters). Contact on gas sample line 30 mR/h. Rig floor E/R 1.5 mR/h.
	1710	Gas sampling completed.
	1737	Hunt Plug set. Rig floor E/R 0.7 mR/h.
	1745	Otis Plug set.
	1747	Cellar entry begun to disconnect gas sampling line by B. Smith, T. Pate, and J. Karasik.
	1752	Cellar entry completed. Cellar E/R 1.5 mR/h, neg CO, neg. LEL, 21% O ₂ . Coming out of the hole.
	1755	Mark Owens departs with two gas cylinders in vehicle #84011. Cab E/R 0.05 mR/h.
	1828	Blowing air down annulus. Cellar E/R 0.4 mR/h.
	1835	Hydrill closed.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-18-89 (Cont'd)	1840	Removed rotating head.
	1859	Abandonment valve closed. Out of the hole. Continued to check cellar integrity once per shift, and change once per day on day shift.

3.7 TULIA

The TULIA event was an underground nuclear experiment conducted by LANL at site U4s at 1107 hours on May 26, 1989.

Telemetry

Seventeen remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 112°30' at 111 meters from SGZ.
- 22°30' at 133 meters from SGZ.
- 67°30', 157°30', 202°30', 247°30', 292°30' and 337°30' at 158 meters from SGZ.
- 0°, 90°, 180°, 225°, 270° and 315° at 304 meters from SGZ.
- 135° at 327 meters from SGZ.
- 45° at 839 meters from SGZ.

Telemetry measurements began at 1107 hours on May 26, 1989, and ended at 1107 hours on May 27, 1989. The maximum E/R detected was background.

Initial Survey

The initial radiation survey into the area began at 1208 hours on May 26, 1989. The HPD survey teams consisted of one REECO/HPD supervisor and seven REECO/HPD RPTs. Readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was .05 mR/h (background). The initial survey was completed at 1238 hours on May 26, 1989.

Effluent Release Information

The LANL calculated and reported any effluent release associated with this nuclear experiment.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 1908 hours on May 31, 1989. Postevent drilling began at 2105 hours on May 31, 1989; core samples were collected and gamma intensity measured.

Postevent sample information:

PS#1A	Drilled through shoe:	0110 hours on	06-01-89.
	Sampling began:	1125 hours on	06-02-89.
	Sampling completed:	1845 hours on	06-02-89.
	Number of samples:	34	
	Maximum gamma intensity on core samples at contact:	800 mR/h.	
PS#1AS	Sampling began:	0800 hours on	06-05-89.
	Sampling completed:	1220 hours on	06-05-89.
	Number of samples:	24	
	Maximum gamma intensity on core samples at contact:	3 R/h	

Postevent Support Requirements

In accordance with LANL requirements, the following equipment was used:

- Air from the recirculating containment system was monitored by a scintillation detection unit contained in the LANL HSE-1 radiological laboratory trailer (with recording and alarming locally, and with remote alarming in the REEC0/HPD Radsafe base station and the LANL health physicist room).
- Air from the drilling platform was monitored by a scintillation detection unit positioned near a charcoal cartridge and paper filter contained in the LANL HSE-1 radiological laboratory trailer with recording and alarming the same as the cellar air monitor.
- One scintillation detector was mounted on the mud return line with recording and alarming capabilities the same as the cellar air monitor.
- A portable air monitoring unit containing a HEPA cartridge was employed on the rig platform by the "rig monitor" for immediate local detection and differentiation between gases and general increases in background levels in the area.
- Lithium fluoride TLDs with minimum gamma radiation dose detection (threshold of 0.01 rad total integrated dose and radiation energy detection limits of 100 keV), were installed on the postevent perimeter fence to provide a cumulative record of any airborne gamma-emitting radionuclide which may have been released.

- Five continuous low-volume air samplers containing particulate filter and charcoal cartridges were placed on the drill rig; one on each corner of the rig and one at the cellar entrance of the drill rig.
- One continuous low-volume air sampler containing a particulate filter and charcoal cartridge was operating at the 24-hour personnel living quarters.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating during coring operations in the core shack.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating in the extractor area during the coring operation.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

In accordance with LANL requirements, the postevent drill hole was cemented to the surface and capped at 1611 hours on September 21, 1989.

The maximum gamma E/R detected in a work area during postevent drilling operations was 25 mR/h on PS#1AS at 1220 hours in the core shack. This was due to sampling operation.

There were no toxic gas or explosive mixture detected during the postevent drilling period.

There was no whole-body external or internal exposure which exceeded the radiation protection guides in DOE Order 5480.11 Chapter 9B. No alpha radiation was detected.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

Four hundred nineteen personnel entries were processed into the control area.

Six hundred twenty-seven sets of Anti-Cs were issued to personnel entering the control area.

One respiratory protection device was issued to limit internal deposition of radioactive material.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-26-89	1107	Zero time.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>	
05-26-89 (Cont'd)	1208	Departed Gate 300. Began initial reentry.	
	1238	Initial survey completed. All readings .05 mR/h(background).	
	1246	Grounding party into Trailer Park.	
	1255	Subsurface subsidence detected. Grounding crew completed operations.	
	1305	Started Trailer Park recoveries.	
	1330	Area control released to HPD as per LANL HSE-1 J. Orcutt. Started downwind survey; all readings 0.05 mR/h (background).	
	1430	Uncovered perimeter fence signs.	
	1530	Continued hourly downwind; all readings, 0.05 mR/h.	
	1634	Trailer Park recoveries completed.	
	2330	All downwind surveys have been 0.05 mR/h.	
	05-27-89	0100	Downwind and cable surveys, 0.05 mR/h.
		0400	Continued hourly downwind and cable surveys. All readings, 0.05 mR/h.
		0800	All downwind survey readings, 0.05 mR/h.
1107		Completed last downwind and cable run survey; all readings, 0.05 mR/h.	
1115		Securing Base Station.	
05-30-89	0005	Base Station operational.	
	0140	Drill rig crew arrives location.	
	0330	Began moving in equipment to the postevent pad.	
	0500	Drillers rigging up the CP rig.	
	0830	Twenty-four hour air sampler started in the Trailer Park.	
	1100	Rigging up to drill the surface casing hole.	
	1330	Began drilling surface casing hole.	
	1645	Surface casing hole drilled to 130 feet (39.6 meters).	
	1730	Running in the hole with casing.	

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
05-30-89 (Cont'd)	2000	Casing set at 118 feet (36 meters). B. J. Titan rigging up to cement casing.
	2115	Began cementing surface casing.
	2130	Completed cementing; rig down B. J. Titan.
	2200	Waiting on cement to dry.
05-31-89	0001	Mud trucks filling Baker tanks.
	0445	Rigging down CP rig.
	0530	CP rig departs for Area 2.
	0610	H&N surveyors arrive at location to survey in the Skytop rig.
	0830	Containment in cellar. Installing BOP stack.
	0835	Stopped 24-hour background sample.
	1000	Drillers positioning cellar doors and rig tracks over cellar.
	1030	Drill crew rigging up Skytop rig.
	1500	Continue rigging up.
	1803	HSE-1 Trailer on line.
	1908	Completed BOP pressure check. All O.K. HPD ready to support postevent drilling.
	1912	Rig floor and Trailer Park air samples started.
	2012	Drillers tooling up to start drilling.
	2058	Rotating head installed. Opened ball valve.
	2105	Began drilling on cement.
	2128	Down for rig repairs; plugged tool string.
	2138	Coming out of hole, breaking down tools.
	2140	Remove rotating head, close Hydrill.
	2248	Ball valve closed. Out of the hole.
	2255	Ball valve opened to clean out tools.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-01-89	0001	Making tools; rig floor E/R 0.05 mR/h (background).
	0045	Installed rotating head.
	0050	Drilling on cement.
	0110	Drilled through the shoe; depth 130 feet (39.6 meters).
	0715	Routine drilling and routine directional surveys; depth 359 feet (109 meters).
	1005	Completed a one-minute cellar entry by J. Fullmer, P. Radack, F. Adams for observation as per J. Orcutt.
	1455	Routine drilling and routine directional surveys; depth 797 feet (243 meters).
	1650	Routine drilling at 823 feet (251 meters). Rig floor E/R 0.05 mR/h.
	2256	Routine drilling and routine directional surveys; depth 1,106 feet (337 meters).
06-02-89	0001	Drillers coming out of the hole to check tools.
	0040	Rotating head removed.
	0100	Out of hole; ball valve closed. No radioactive gases or explosive mixtures detected. Drill bit surveyed and swiped clean. Reading 0.05 mR/h at contact.
	0125	Making tools; ball valve open; going into the hole.
	0400	Back on bottom; resumed drilling.
	0530	Routine drilling at 1,169 feet (356 meters).
	0620	Lost circulation at 1,231 feet (375 meters).
	0650	Flow line closed and opened the one-inch annulus line to the explosimeter trailer. Drilling at depth 1,263 feet (385 meters).
	0730	Rig floor E/R 0.05 mR/h.
	0800	Closed gates, put on RAD signs; Anti-C requirements - coveralls, boots, and gloves.
	0915	TD PS#1A.
	1000	Started gamma log.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-02-89 (Cont'd)	1040	Gamma log completed.
	1110	Hunt Plug pulled; 390 dpm (beta and gamma). First sign of radiation.
	1125	Coring begun; hoods added to Anti-C requirements.
	1335	Coring in progress; pulled 12 samples; maximum intensity 450 mR/h (contact).
	1525	Coring in progress; pulled 20 samples; maximum intensity 800 mR/h (contact). Rig floor E/R 0.06 mR/h.
	1845	Coring completed. Thirty-four total samples pulled from PS#1A. Maximum intensity 800 mR/h (contact).
	1856	Hunt Plug set.
	1904	Otis Plug set; coming out of the hole.
	2000	Core barrels depart area in truck #81354 bound for LANL Warehouse. Truck cab E/R 0.05 mR/h.
	2003	Rotating head removed; Hydrill closed.
	2010	Pulling a wet string; rig floor E/R 0.08 mR/h.
	2033	Out of the hole with tool string. Ball valve closed. Rig floor E/R 0.6 mR/h due to a hanging tool string. Stopped rig floor air samples.
	2052	Completed a 12-minute cellar entry by D. Gibbs, N. Haugen, J. Karasik, and K. Hahn to inspect closed valves and to put on a blind plug. E/R in cellar, 0.3 mR/h. No radioactive gases or explosive mixtures detected.
	2100	Started cellar integrity air sample.
	2130	Maximum E/R for this operation was 50 mR/h for one minute due to packaging the samples.
06-04-89	1350	Arrive location. Standing by for LANL technicians.
	1430	LANL technicians into area to setup HSE-1 Trailer.
	1520	Changed cellar integrity air sample.
06-05-89	0001	Started rig floor air samples.
	0024	Completed a four-minute cellar entry by Borrego, Smith, and Spooneman to remove a blind plug from the BOP. E/R in cellar, 0.2 mR/h.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-05-89 (Cont'd)	0035	Closed Hydrill and opened ball valve; started into the hole with the tool string.
	0037	Detected a slight indication of radioactive gas on the annulus radiation detector.
	0038	Pumping air down the hole.
	0040	Annulus gas detector returned to background.
	0100	Continue going into the hole.
	0147	Installed rotating head. Resumed going into the hole.
	0235	Pulled Otis Plug.
	0308	Attempting to sidetrack.
	0430	Sidetrack established at 1,263 feet (385 meters).
	0535	TD (PS#1AS).
	0620	Gamma log begun.
	0650	Gamma log completed. Rigging up to start sampling.
	0750	Hunt Plug pulled.
	0800	Sampling began.
	0905	Nine samples were pulled from PS#1AS. Maximum intensity, 900 mR/h (contact).
	1000	Sixteen samples were pulled. Maximum intensity, 1 R/h.
	1155	Twenty-two samples were pulled. Maximum intensity, 3 R/h. Core shack E/R 2.8 mR/h.
	1220	Sampling completed; total of twenty-four samples were pulled (PS#1AS). Maximum intensity 3 R/h (contact). Maximum E/R (PS#1AS) was 25 mR/h for 30 seconds in the core shack.
	1240	Hunt Plug set.
	1245	Otis Plug set; began coming out of the hole.
	1430	Two barrels depart area bound for LANL Warehouse in truck #81354. Truck cab E/R 0.3 mR/h.
	1440	Rotating head pulled; breaking down tools.
	1530	Out of the hole with tool string. Ball valve closed.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-05-89 (Cont'd)	1545	A five-minute cellar entry was completed after checking closed valves by C. Smith, N. Heugen, K. Hahn, and J. Karasik. Cellar E/R .2 mR/h; neg CO and LEL.
	1600	Stopped rig floor air samples; started cellar integrity air sample. HSE Trailer Instrumentation turned off.
	1700	Solidified waste from samples; radiation signs posted around high-level waste.
	1800	Swipe and survey postevent instruments.
	2200	Continued decontamination procedures and rigging down.
06-06-89	0045	Survey cellar integrity sample. 0.05 mR/h (contact).
	0230	Survey and swipe equipment going to the Decontamination Pad.
	0630	Completed deconning containment parts going to Area 3 Yard.
	0800	Drillers rigging down and moving out equipment.
	1400	Survey cellar integrity sample twice this shift. All readings 0.05 mR/h (contact).
	1540	Equipment from the postevent pad being moved to the Decontamination Pad.
06-07-89		Continue to check and change cellar integrity air sample. All readings 0.05 mR/h (background).
09-20-89	0745	Arrived on location; prepared to support cementing of postevent hole.
	1437	Pumping air down the hole 70 cfm.
	1445	Discontinued cellar integrity air sample. Began rig floor air samples.
	1500	Ball valve opened. Going into hole with packer plug.
	1520	Cellar entry to check cellar lights by Pena, Mykines, and Hornbeck. E/R in cellar, 0.05 mR/h.
	1753	Packer plug would not set; coming out of hole with packer.
	1801	Rotating head removed. Ball valve closed. Out of hole.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
09-20-89 (Cont'd)	1823	Rig floor air sample stopped. Cellar integrity air sample started.
09-21-89	0915	Open one-inch test line. Negative LEL, negative radioactive gases.
	0917	Pumping 75 cfm of air down the hole. Cellar integrity air sample discontinued. Rig air samples started.
	0920	Ball valve opened. Going into hole with packer plug. Hydrill closed. Rotating head installed.
	1225	Packer plug set, bottom at 804 feet (245 meters).
	1306	Started cementing.
	1542	Cellar entry to remove hoses from BOP by J. Spoeneman, E. Mykines, C. Smith, and C. Rhodes. Cellar E/R 0.05 mR/h.
	1611	Cementing completed. Total of four pours, 450 ft ³ .
	1617	Out of the hole.
	1630	Began rigging down Cardwell.
	1715	Rig floor air samples stopped.
09-26-89	0930	Started moving equipment to Decontamination Pad.
	1000	Radioactive waste water tank spilled over while being moved. The mud caused by the spill was collected in a 55-gallon barrel and labeled with contaminated material tape. The mud read less than 100 cpm above background with a L-101.
	1300	Douglas, Gibbs in full-face GMR mask to cut contaminated flange, reading 600 cpm with a Ludlum 101.
	1400	Continued moving postevent equipment to Decontamination Pad.
09-27-89	0930	Survey cellar, maximum reading 0.5 mR/h (contact).
	0935	Collected soil samples from the cellar floor to be sent to Mercury Laboratory.
	1300	Secured area, all personnel surveyed out clean, free from contamination.

3.8 CONTACT

The CONTACT event was an underground nuclear experiment conducted by LLNL at site U20aw at 1415 hours on June 22, 1989.

Telemetry

Nine remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 270° at 134 meters from SGZ.
- 45° at 136 meters from SGZ.
- 0°, 135°, 180°, 225°, and 315° at 152 meters from SGZ.
- 90° at 163 meters from SGZ.

Telemetry measurements began at 1416 hours on June 22, 1989, and ended at 1430 hours on June 23, 1989. The maximum E/R detected was 0.05 mR/h.

Effluent Release Information

There was no detectable release of fission products within the first 60 minutes after detonation. There was no detectable release of radioactivity during postevent operations.

Initial Survey

The initial radiation survey into the test area began at 1438 hours on June 22, 1989. The HPD survey teams consisted of one REECO/HPD supervisor and six REECO/HPD RPTs. The readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h. The initial survey was completed at 1509 hours on June 22, 1989.

Postevent Drilling

There was no postevent drilling operation.

Radiological Control

There was no whole-body external or internal exposure which exceeded the radiation protection guides in DOE Order 5480.11 Chapter 9B. No alpha radiation was detected.

The following services and equipment were provided:

- Ten personnel entries were processed into the control area.

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-22-89	1025	Reentry teams arrive at Gate 400.
	1415	Zero time.
	1438	Reentry teams depart Gate 400. Initial survey begun. E/R 0.05 mR/h (background).
	1509	Initial survey completed. All readings 0.05 mR/h.
	1515	Grounding party into the Trailer Park.
06-22-89	1530	Grounding party completed checks.
	1540	Recovery parties into Trailer Park.
	1655	Sub-surface tremors felt.
	1725	Recoveries completed. Area released to HPD by T. Moran (LLNL).
	1800	Began hourly downwind perimeter fence surveys 0.05 mR/h.
	1857	Sub-surface tremor felt.
	1900 to 2400	Hourly downwind perimeter fence surveys 0.05 mR/h (background).
06-23-89	0100 to 1300	Hourly downwind perimeter fence surveys 0.05 mR/h (background).
	1400	Final downwind perimeter fence survey 0.05 mR/h (background). HPD released from control of area by T. Moran (LLNL).

3.9 AMARILLO

The AMARILLO event was an underground nuclear experiment conducted by LANL at site U19ay at 0830 hours on June 27, 1989.

Telemetry

Thirteen remote telemetry radiation monitoring stations provided event coverage at the following locations.

- SGZ.
- 270° at 176 meters from SGZ.
- 210° at 191 meters from SGZ.
- 300° at 203 meters from SGZ.
- 0°, 30°, 60°, 90°, 120°, 150°, 180°, 240°, and 330° at 255 meters from SGZ.

Telemetry measurements began at 0830 hours on June 27, 1989, and ended at 0835 hours on June 28, 1989. The maximum E/R detected was 0.05 mR/h (background).

Initial Survey

The initial radiation survey into the area began at 0944 hours on June 27, 1989. The HPD survey teams consisted of one REECO/HPD supervisor and four REECO/HPD RPTs. Readings were relayed via Net 3 as they were obtained. A mobile check van was provided for area control and equipment supply. The maximum gamma E/R detected was 0.05 mR/h (background). The initial survey was completed at 1014 hours on June 27, 1989.

Effluent Release Information

The LANL calculated and reported any effluent release associated with this nuclear experiment.

There was one indication of radioactive effluent on the annulus chart on July 2, 1989, at 0400 hours. No indications on the rig floor.

Postevent Drilling

Control of the postevent drill area was established with a base station and appropriate fences and barricades at 1406 hours on June 27, 1989. Postevent drilling commenced at 1002 hours on June 29, 1989; core samples were collected and gamma intensity measured.

Postevent sample information:

PS# 1A	Drilled through shoe:	1030 hours on 06-29-89.
	Sampling began:	1753 hours on 07-01-89.
	Sampling completed:	1423 hours on 07-02-89.
	Number of samples:	40
	Maximum gamma intensity on core samples at contact:	2.2 R/h
PS#1AS	Sampling began:	1956 hours on 07-02-89.
	Sampling completed:	0103 hours on 07-03-89.
	Number of samples:	22
	Maximum gamma intensity on core samples at contact:	2.5 R/h

Postevent Support Requirements

In accordance with LANL requirements, the following equipment was used:

- Air from the recirculating containment system was monitored by a scintillation detection unit contained in the LANL HSE-1 radiological laboratory trailer (with recording and alarming locally, and with remote alarming in the REECO/HPD Radsafe base station and the LANL health physicist's room).
- Air from the drilling platform was monitored by a scintillation detection unit positioned near a charcoal cartridge and paper filter contained in the LANL HSE-1 radiological laboratory trailer with recording and alarming the same as the cellar air monitor.
- One scintillation detector was mounted on the mud return line with recording and alarming capabilities the same as the cellar air monitor.

- A portable air monitoring unit containing a HEPA cartridge was employed on the rig platform by the "rig monitor" for immediate local detection and differentiation between gases and general increases in background levels in the area.
- Lithium fluoride TLDs with minimum gamma radiation dose detection (threshold of 0.01 rad total integrated dose and radiation energy detection threshold of 100 keV) were installed on the postevent perimeter fence to provide a cumulative record of any airborne gamma-emitting radionuclide which may have been released.
- Five continuous low-volume air samplers containing particulate filters and charcoal cartridges were placed on the drill rig; one on each corner of the rig and one at the cellar entrance of the drill rig.
- One continuous low-volume air sampler containing a particulate filter and charcoal cartridge was operating at the 24-hour personnel living quarters.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating during coring operations in the core shack.
- One low-volume air sampler containing a particulate filter and charcoal cartridge was operating in the extractor area during the coring operation.

Radiological Control

Trailers outside the radiological exclusion area were swiped on a routine basis after the first sign of radiation was detected and the area placed under radiological control. All swipes were less than 20 d/m/100 cm² alpha and 200 d/m/100 cm² beta.

All items and equipment departing the radiological exclusion area were surveyed and swiped to determine the levels of contamination. Using the swipe and survey results and the DOE criteria the items and equipment are released or labeled with the appropriate radiation tag.

In accordance with LANL requirements, the postevent drill hole was cemented to the surface and capped at 1642 hours on September 19, 1989.

The maximum gamma E/R detected in a potential work area during postevent drilling operations was 50 mR/h at PS#1A at 1230 hours on July 2, 1989. This was due to sampling operations.

There were no toxic gases or explosive mixtures detected during the postevent drilling period.

There was no whole-body external or internal exposures which exceeded the radiation protection guides in DOE Order 5480.11 Chapter 9B. No alpha radiation was detected.

In addition to the above-mentioned radiological coverage, the following services and equipment were provided:

- Three hundred eighty-five personnel entries were processed into the control area.
- Six hundred sets of Anti-Cs were issued to personnel entering the control area.
- Eight respiratory protection devices were issued to limit internal deposition of radioactive material (cellar entries).

Summary of Activities and Operations

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-27-89	0600	Arrived at Gate 400.
	0830	Zero time.
	0944	Departed Gate 400. Initial reentry survey started; 0.05 mR/h (background).
	1014	Initial reentry survey completed. All readings, 0.05 mR/h.
	1016	All reentry personnel standing by at shrink point.
	1041	Grounding party and HPD RPTs enter trailer park.
	1106	Grounding party completed. All personnel standing by at Trailer Park perimeter fence.
	1113	Two Centel personnel and one HPD RPT enter Trailer Park to check communication systems.
	1127	Firemen enter Trailer Park to check fire safety equipment.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-27-89 (Cont'd)	1140	Centel and firemen exit the Trailer Park. HPD RPT standing by in the Trailer Park.
	1230	Started recoveries in two buildings.
	1406	Opened up recovery site, control to HPD as per D. Tatro.
	1450	Hourly downwind perimeter fence and cable way check. Surveys began. No one allowed inside perimeter fence. Check on postevent pad periodically (RAM #4225).
	1500	Perimeter fence, signs uncovered.
	1530	Downwind surveys all 0.05 mR/h.
	1630	Postevent pad, 0.05 mR/h.
	1647	All personnel out of the Trailer Park. Recoveries are complete at this time.
	1700 to 2330	Moving in postevent equipment and downwind surveys. All readings, 0.05 mR/h.
06-28-89	0001 to 0800	Moving in postevent equipment, downwind survey.
	0440	Subsurface collapse. Felt severe ground movement.
	0445	Contacted telemetry. All RAMS still on the line and reading 0.05 mR/h (background).
	0830	Downwind surveys discontinued as per J. Orcutt. All readings, background (0.05 mR/h). Drill crew rigging up.
	0840	Started 24-hour background sample.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-28-89 (Cont'd)	1000 to 1515	Continue to rig up. Work areas 0.05 mR/h.
	1625	Began drilling the surface casing hole.
	1856	Surface casing hole drilled to 131 feet (39.9 meters).
	1945	Coming out of the hole. Breaking down tool string.
	2020	Going into the hole with surface casing.
	2100	Rad lab trailer on the line.
	2305	Bottom of shoe set at 118 feet (36.0 meters).
	2317	Pumping mud out of the cellar.
06-29-89	0005	Completed cementing surface casing.
	0400	Began installing BOP.
	0700	Completed installing BOP. Preparing to pressure check.
	0710	Began BOP pressure check.
	0800	Completed pressure check. Started rig floor air samples. Opened ball valve. E/R 0.05 mR/h (background).
	0813	Stopped Trailer Park 24-hour air sample.
	0830	Making tool string.
	0957	Rotating head in place. E/R 0.05 mR/h.
	1002	Began drilling on cement 85 feet (25.9 meters).
	1030	Drilled through the shoe at 118 feet (36.0 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-29-89 (Cont'd)	1112	Directional survey at 167 feet (50.9 meters).
	1210	Completed assembling tool string at 193 feet (58.8 meters).
	1310	Directional survey at 287 feet (87.5 meters).
	1400	Mud sample taken from Baker tanks and sump. Samples taken to Mousehouse for gamma scan.
	1430	Routine drilling at 379 feet (116 meters). Checking shaker table every half-hour.
	1530	Routine drilling at 461 feet (141 meters). Rig floor E/R 0.05 mR/h. No Anti-Cs required.
	1730	Routine drilling at 548 feet (167 meters).
	2030	Routine drilling at 617 feet (188 meters). Shaker table, cellar, and rig floor; all readings, 0.05 mR/h.
	2220	Directional survey at 721 feet (220 meters).
	2300	Changed rig floor air sample. Drilling at 730 feet (223 meters).
06-30-89	0001	No Anti-Cs required. Drilling at 751 feet (229 meters).
	0015	Lost circulation at 760 feet (232 meters).
	0100	Lost power to postevent pad and Traller Park. Drilling at 800 feet (244 meters).
	0105	Regained power. Reset laboratory trailer.
	0120	Orcutt and Boyd source-checked laboratory trailer.
	0210	Mud truck surveyed. Exiting with load of mud going to U19ab. Sample taken from the sump.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-30-89 (Cont'd)	0300	Directional survey at 875 feet (267 meters).
	0500	Flow line closed in. Still pressure on the hole. Drilling 938 feet (286 meters). Rig floor E/R 0.05 mR/h.
	0645	Routine drilling at 1,000 feet (305 meters).
	0740	Directional survey at 1,030 feet (314 meters). Anti-Cs not required.
	0920	Exit survey of mud truck #325; 0.05 mR/h (contact).
	1000	Routine drilling at 1,124 feet (343 meters).
	1025	Technicians source-checked laboratory trailer. All instruments responded.
	1220	Began tripping out of the hole at 1,210 feet (369 meters) to change bits, Dynadrill, and sampling tools.
	1303	Removed rotating head. Rig floor E/R 0.05 mR/h.
	1340	Out of the hole. Ball valve closed. No radioactive gases detected.
	1345	Drill bits surveyed. Below release limits.
	1400	Ball valve opened. Making tool string.
	1420	Hunt tool attached.
	1452	Tripping into the hole.
	1510	Rotating head installed. Rig floor E/R 0.05 mR/h.
	1550	Going back into the hole. Source-check laboratory trailer O.K.
	1630	Back on bottom. Working the hole at 1,210 feet (369 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
06-30-89 (Cont'd)	1700	Resumed drilling at 1,210 feet (369 meters).
	2005	Directional survey at 1,347 feet (411 meters). Rig floor E/R 0.05 mR/h.
	2008	Completed one minute cellar entry by K. Hahn and J. Karasik to photograph BOP. E/R 0.05 mR/h. 21% O ₂ , negative CO and LEL.
	2030	Resumed drilling. All readings 0.05 mR/h.
	21	Routine drilling at 1,415 feet (431 meters).
07-01-89	0150	Routine drilling at 1,566 feet (477 meters).
	0400	Directional survey at 1,659 feet (506 meters). Rig floor E/R 0.05 mR/h.
	0610	Drilling at 1,721 feet (525 meters).
	0630	Rig floor air sample changed.
	0820	Directional survey at 1,814 feet (553 meters). Rig floor E/R 0.05 mR/h. No Anti-Cs required.
	0900	Radiological laboratory trailer source checked.
	0915 to 1343	Routine drilling and directional surveys to depth of 2,375 feet (724 meters).
	1400	Directional survey completed. Resumed drilling.
	1500	Rig floor air sample changed.
	1516	Full Anti-Cs required. Reached TD. Began directional survey. Rig floor E/R 0.05 mR/h.
	1545	Directional survey completed. Rigging up for gamma log.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
07-01-39	1552	Atlas Wireline source out of the pig. E/R on rig floor 4.0 mR/h for 2.0 minutes at 1 meter.
(Cont'd)	1615	Began gamma log.
	1650	Gamma log completed.
	1710	Hunt Plug pulled, reading 0.4 mR/h. First sign of radiation.
	1748	Started air sample in the coring area.
	1753	Sampling began - first core pulled.
	1830	Pulled four samples. Maximum reading 275 mR/h.
	1900	Rig floor E/R 0.07 mR/h.
	1913	Eight samples pulled. Maximum reading 1.7 R/h.
	2022	Rig floor E/R 0.1 mR/h.
	2056	Sixteen samples pulled. Maximum reading 1.7 R/h. Maximum E/R in the core shack, 2.0 mR/h due to Europium source and contamination.
	2134	Seventeen samples pulled. Maximum intensity 2.06 R/h (contact).
	2157	Lost part of the core tool. E/R 0.15 mR/h.
	2200	Fishing for tools.
	2242	Rig floor E/R 0.4 mR/h.
	2250	Coring ceased for this shift.
	2305	Stopped coring-area air samples.
	2310	Rig floor E/R 0.1 mR/h.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
07-01-89 (Cont'd)	2315	Maximum E/R for this shift, 20 mR/h for 30 seconds at one meter.
07-02-89	0045	Rig floor E/R 0.1 mR/h. Full Anti-Cs required.
	0110	Otis Plug set. Began tripping out of the hole.
	0230	Pulling "wet string." HPD RPT hosing down tools as they come out of the hole to keep contamination at a minimum.
	0244	Rotating head off. Rig floor E/R 0.1 mR/h.
	0330	Ball valve closed. Out of the hole. Maximum reading on drill bit 50 mR/h.
	0350	Ball valve opened. Going into the hole with new Dynadrill and bit.
	0400	Slight radioactive effluent buildup indication on annulus chart; pumping air down the hole.
	0505	Rotating head on. Going in the hole.
	0600	Drilled through the bridge that was encountered at 1,077 feet (328 meters). Rig floor E/R 0.25 mR/h.
	0650	Back on the bottom.
	0711	Otis Plug pulled. Maximum E/R 5.0 mR/h for approximately three minutes.
	0730	Hunt Plug pulled.
	0740	Full Anti-Cs required with extremity TLD. Rig floor E/R 0.40 mR/h.
	0750	Sampling resumed on PS#1A.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
07-02-89 (Cont'd)	0805	First sample this shift. Total of 18 samples pulled. Maximum intensity remains 2.06 R/h.
	0830	Rig floor E/R 0.10 mR/h after washdown.
	1030	Ten samples were pulled this shift for a total of twenty-seven.
	1230	Thirteen samples were pulled this shift for a total of thirty. Maximum contact intensity 2.2 R/h. Rig floor E/R 0.30 mR/h.
	1423	Twenty-three samples were pulled this shift for a total of forty samples from PS#1A. Sampling ended. Maximum reading core 2.2 R/h.
	1450	Hunt Plug set.
	1520	Changed rig floor air sample. Began coming out of the hole.
	1525	Maximum E/R this shift was 50 mR/h for approximately 15 seconds due to core samples.
	1530	Directional survey at 2,283 feet (696 meters). Rig floor E/R 0.2 mR/h.
	1545	Directional survey completed.
	1605	Attempting to establish shoulder. Rig floor E/R 0.7 mR/h after washdown.
	1718	Shoulder established at 2,220 feet (677 meters). Kickoff on PS#1AS.
	1800	Routine drilling at 2,467 feet (752 meters). Rig floor E/R 0.05 mR/h.
	1818	TD on PS#1AS.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
07-02-89 (Cont'd)	1820	Atlas Wireline source out for 5 minutes. 10 mR/h at one meter.
	1850	Rigging up for a gamma log. Rig floor E/R 0.05 mR/h.
	1925	Gamma log completed.
	1945	Pulled Hunt Plug. Reading 1.5 mR/h. Core-area air samples started.
	1956	Coring began on PS#1AS.
	2002	Truck #81354 departed area with three barrels of core samples (Inc-4, Inc-10, and Inc-12). Cab E/R 1.0 mR/h (ROC 3 #551).
	2030	Three samples were pulled this shift. Maximum intensity, 1.5 R/h. Rig floor E/R 0.1 mR/h.
	2230	Twelve samples were pulled. Maximum intensity, 2.5 R/h.
	2300	Changed air samples.
	2325	Sampling in progress. Rig floor E/R 0.2 mR/h. Maximum E/R this shift was 50 mR/h at one meter for 20 seconds. Pulled sixteen samples on PS#1AS.
03-03-89	0024	Sampling continues. Rig floor E/R 0.1 mR/h. Cellar E/R 0.08 mR/h.
	0103	Sampling completed. A total of sixty-two samples were pulled; forty from PS#1A and twenty-two from PS#1AS. Maximum intensity 2.5 R/h. Core shack E/R 2.0 mR/h.
	0115	Hunt Plug set.
	0130	Rig floor E/R 0.12 mR/h. Set the Otis Plug. Began coming out of the hole.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
03-03-89 (cont'd)	0230	Packaging core samples.
	0300	Rotating head off.
	0305	Coming out of the hole with tools, 0.07 mR/h E/R.
	0310	Pulling a "wet string."
	0321	Hydrill closed. (Stripping out tools.)
	0339	Ball valve closed. Out of the hole.
	0356	Completed a six minute cellar entry: D. Gibbs, N. Haugen, K. Hahn, and J. Karasik to secure BOP. E/R 0.20 mR/h. Negative LEL and CO 21% O ₂ . Rig floor air samples stopped.
	0400	Began cellar integrity sample.
	0440	Truck #81354 took core samples out of the area. E/R in truck cab, 0.3 mR/h.
07-03-89 to 09-18-89		Checked and changed cellar integrity sample once each 24 hours (except for weekends and holidays).
09-19-89	0800	Radiological laboratory trailer on line.
	0835	Rig floor E/R 0.05 mR/h.
	0850	Cellar integrity stopped.
	0900	Rig floor air sample started.
	0905	Began cellar entry.
	0914	Cellar entry completed. Mykines, Hahn, Parr, and Spoeneman entered to remove blind plug.
		E/R in the cellar, 0.05 mR/h 21% O ₂ , negative CO and LEL. Rig floor E/R 0.05 mR/h.

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
09-19-89 (Cont'd)	0920	One-inch test line open. Radiation in the annulus 60 C/S maximum; 6% LEL in annulus. Spooneman (J-6) informed.
	0925	Began pumping air down the hole at 50 cfm. Radioactive and explosive mixture; indications dropping off rapidly. Source checked sniffer; operational.
	0950	Hydrill open.
	0954	Ball valve open.
	1000	Rotating head installed. Going into the hole with the packer plug.
	1100	Rig floor E/R 0.05 mR/h.
	1130	Bottom of packer set at 1,241 feet (378 meters).
	1150	Rigging up to cement.
	1210	First pour tagged at 1,162 feet (354 meters), 50 ft ³ poured.
	1330	Second pour 100 ft ³ tagged at 1,025 feet (312 meters).
	1356	Third pour 100 ft ³ tagged at 830 feet (253 meters).
	1415 to 1445	Rig repairs.
	1440	Carl L. Morgan cut the back of his left hand while on rig repairs. Radiological Occurrence Report written by Charles Parr.
	1500	Fourth pour 100 ft ³ tagged at 676 feet (206 meters).
	1530	Fifth pour 100 ft ³ tagged at 434 feet (132 meters).

<u>DATE</u>	<u>TIME</u>	<u>ACTIVITY/OPERATION</u>
09-19-89 (Cont'd)	1550	Sixth pour 100 ft ³ tagged at 294 feet (89.6 meters).
	1620	Seventh pour 150 ft ³ tagged at 117 feet (35.7 meters).
	1625	Cellar entry began.
	1635	Cellar entry completed. Mykines, Spoeneman, Smith and O'Brien entered to disconnect lines from BOP. E/R 0.05 mR/h. 21% O ₂ , negative CO and LEL. Maximum E/R this shift, 30 mR/h at 1 meter for 30 seconds (Atlas Wireline source).
	1642	Eighth pour of 75 ft ³ tagged at 10 feet (3.05 meters).
	1655	Rig floor air sample stopped. Cementing completed.
	1700	Rigging down Skytop.
	1800	Mud samples taken from four Baker tanks and sent to Area 23 Mousehouse.
	2030	Mud from four Baker tanks dumped in U19ba sump.

3.10 DISKO ELM

The DISKO ELM event was an underground nuclear experiment conducted by DNA at site U12P.03 at 0800 hours on September 14, 1989.

Telemetry

Forty-six remote telemetry radiation monitoring stations (RAMS) provided event coverage at the following locations.

SURFACE RAMS

<u>Station</u>	<u>Reference</u>	<u>Bearing</u>	<u>Distance</u>	
			<u>feet</u>	<u>meters</u>
1.	At the Portal			
2.	On the Portal Ventline	N 38 E	46	(14)
3.	From the Portal	N 42 E	310	(94.5)
4.	From the Portal	N 84 E	328	(99.9)
5.	From the Portal	S 39 E	265	(80.7)
6.	From the Portal	S 02 W	238	(72.5)
7.	From the Portal	S 63 W	309	(94.2)
8.	From the Portal	N 72 W	296	(90.2)
9.	From the Portal	N 27 W	300	(91.4)
10.	On the Tunnel Drain Line	S 05 E	236	(71.9)
11.	From the Portal	N 74 E	1017	(310)
12.	From the Portal	S 50 E	1950	(594)
13.	From Surface Ground Zero	N 00 E	400	(122)
14.	From Surface Ground Zero	S 60 E	400	(122)
15.	From Surface Ground Zero	S 60 W	400	(122)

UNDERGROUND RAMS

16.	U12p.03 LOS Drift	CS 6+00	600	(183)
17.	U12p.03 LOS Drift	CS 4+50	450	(137)
18.	U12p.03 LOS Drift	CS 2+75	275	(83.8)
19.	U12p.03 LOS Drift	CS 2+30	230	(70.1)
20.	U12p.03 LOS Drift	CS 1+60	160	(48.8)
21.	U12p.03 LOS Drift	CS 1+20	120	(36.6)
22.	U12p.03 LOS Drift	CS 0+85	85	(25.9)
23.	U12p.03 LOS Drift	CS 0+60	60	(18.3)
24.	U12p.03 By-Pass Drift	CS 5+00	500	(152)
* 25ER	U12p.03 By-Pass Drift	CS 5+00	500	(152)
26.	U12p.03 By-Pass Drift	CS 3+20	320	(97.5)
27.	U12p.03 By-Pass Drift	CS 2+10	210	(64)
28.	U12p.03 LLNL Alcove			
29.	U12p.02 By-Pass Drift	CS 6+60	660	(201)
30.	U12p.02 By-Pass Drift	CS 5+50	550	(168)
31.	U12p.02 By-Pass Drift	CS 0+90	90	(27.4)
32.	U12p.02 LOS Drift	CS 2+90	290	(88.4)
33.	U12p.02 Alcove 2-11			
34.	U12p.02 Fast Alcove			

35.	U12p.01 Drift	CS 4+00	400	(122)
36.	U12p.01 Drift	CS 1+50	150	(45.7)
37.	U12p Main Drift	CS 28+80	2880	(878)
38.	U12p Main Drift	CS 23+50	2350	(716)
39.	U12p Main Drift	CS 21+80	2180	(665)
* 40ER	U12p Main Drift	CS 21+80	2180	(665)
41.	U12p Main Drift	CS 18+70	1870	(570)
42.	U12p Main Drift By-Pass	CS 4+00	400	(122)
43.	U12p Main Drift	CS 14+50	1450	(442)
44.	U12p Main Drift	CS 13+00	1300	(396)
45.	U12p Main Drift	CS 8+00	800	(244)
46.	U12p Main Drift	CS 2+00	200	(60.9)

*Extended Range 100 mR/h to 100,000 R/h.

Telemetry measurements began at 0800 hours on September 14, 1989. All RAMS were secured at 0900 hours on September 21, 1989. RAMS #1 through #12 were background at zero time and remained background. RAMS #13, #14, and #15 were inoperable at zero time and remained inoperable.

At H + 10 seconds:

RAM #16 was 79.9 R/h
RAM #17 was 37.3 R/h
RAM #18 was 246.0 R/h (maximum reading)
RAM #19 was 81.1 R/h
RAM #20 was 189.0 R/h
RAM #21 was 25.7 R/h
RAM #22 was 11.6 R/h
RAM #23 was 2.52 R/h

At H + 30 minutes:

RAM #16 was 628 mR/h
RAM #17 was 257 mR/h
RAM #18 was 2070 mR/h
RAM #19 was 710 mR/h
RAM #20 was 1350 mR/h
RAM #21 was 145 mR/h
RAM #22 was 151 mR/h
RAM #23 was 20.3 mR/h

At H + 24 hours, all the above RAMS indicated less than 100 mR/h.

RAMS #24, #25, and #26 were background (RAMS #25 and #26 are preset at <.1 mR/h, #24 contains a check source and starts out reading ~ 2.0 mR/h) until H + 5 hours 20 minutes, when RAM #26 began showing an increase. At H + 5 hours 34 minutes, RAM #24 indicated 2.58 mR/h.

RAM #24 and #26 gradually increased to 3.86 and 0.47 mR/h respectively by H + 8 hours 42 minutes. The maximum on RAM #24 was 4.19 mR/h at H + 11 hours. The maximum reading on RAM #26 was 0.80 mR/h at H + 11 hours 42 minutes. By H + 24 hours, RAM #24 was background and RAM #26 was 0.2 mR/h. RAMS #27, 28, and 29 were background at zero time and remained that way.

At H + 10 seconds:

RAM #30 was 28.7 mR/h

RAM #31 was 0.86 mR/h

RAM #32 was 27.8 mR/h

RAM #30 started increasing at H+22 minutes, rising to 0.6 mR/h. At H + 4 hours 30 minutes, RAM #30 was at a low of 0.17 mR/h, and RAM #32 was background. RAM #30 began increasing again around H + 7 hours and at H + 24 hours indicated 1.61 mR/h. RAMS #33 through 46 were background at zero time and remained background.

Initial Survey

The initial surface reentry party consisting of one REEC/HPD Supervisor and five Radiation Protection Technicians (RPTs) departed the Test Controller's barricade at Gate 300 at 0946 hours on September 14, 1989. A mobile check van was provided for area control and equipment supply. By 1056 hours, the initial survey team and damage assessment team had completed the initial survey of the U12p portal yard. No radiation levels above the normal area background of 0.04 mR/h were detected.

Survey teams stood by the U12p tunnel portal during the initial gas sampling of the tunnel atmosphere. No toxic or explosive gases were detected and a normal concentration of 21% oxygen was measured in the following locations: Work Point Side (WPS) of the Gas Seal Plug (GSP), WPS of the Drift Protection Plug (DPP), Portal Side (PS) of the DPP, End of Stemming (EOS), and inside the Line of Sight (LOS) pipe. The initial gas sample taken at 1251 hours from the LOS Drift was 1 mR/h, 5 mrad/h contact, 20% oxygen, negative LEL, and 10 ppm CO. Gas sampling was completed at 1350 hours and the samples were sent to the HPD counting lab by the Industrial Hygiene technicians. The HPD Base Station was set up and all personnel departed the portal area by 1500 hours.

Tunnel Reentry

Initial reentry into the tunnel began at 0905 hours on September 15, 1989. Additional gas samples were taken of the tunnel atmosphere before the work team entered the tunnel. Ventilation was established through the GSP by the work team at 0952 hours by opening the 48" turn-tube door. Maximum radiation levels detected at the GSP were 0.04 mR/h. No toxic or explosive gases were detected and 21% oxygen was detected. Anti-Cs or respiratory protection was not required during this part of the reentry.

At 1345 hours, the Work Team began to walk out (inspect) the tunnel to the DPP. Maximum radiation levels detected PS of the DPP were 0.04 mR/h, no toxic or explosive

gases were detected, and the oxygen was a normal 21%. By 1408 hours the Work Team had exited the tunnel.

Four M-102 air samplers and four noble gas samplers were placed between 300 feet (91.4 meters) and 1,000 feet (305 meters) North, South, East, and West from the portal. The M-102's were operational by 1440 hours and the noble gas samplers were operational by 1733 hours. These samplers were emplaced at the request of the DOE Event Radiation Safety Advisor, JoAnne Burrows.

Miners began dismantling the Gas Seal Doors at 1600 hours. At 2200 hours the miners began building a ramp for the Alpine Miner at the Gas Seal Plug. RPTs continued radiation and toxic gas surveys.

On September 16, 1989, (D + 2) a limited reentry was performed to allow a minimum recovery in the LLNL Alcove. The Initial Reentry Team #1 and the Rescue Team wore full Anti-Cs and self-contained breathing apparatus (SCBA) and, at 0905 hours were at the PS of the By-Pass Drift Protection Plug (BPDPP), (Designated Fresh Air Station). The Rescue Team stood at the BPDPP while Team #1 proceeded to walk out the Main Drift Alcove Protection Plug (APP) #1, the Fast Alcove, the 02 LOS Drift, and the LPARL Alcove. Gas samples at the LPARL Alcove were 0.06 mR/h, negative toxic and explosive gases, and 21% oxygen. Team #1 continued the walkout to the Facilities Drift Protection Plug (FDPP) #2, the 2-12 KSC Alcove, Plug #1, Plug #6, and Plug #2. Gas samples were taken at WPS of plug #2 at 0953 hours were 0.05 mR/h, 0.12 mrad/h, negative LEL, 10 ppm CO, and 20% oxygen. Team #1 returned to the Main Drift, passing by the APP #5 and proceeded to the LLNL Alcove APP #7. The gas sample taken at APP #7 was 0.05 mR/h, negative toxic and explosive gases, and 20% oxygen.

At 1002 hours the LLNL party, wearing Anti-Cs only, departed the portal. By 1028 hours Reentry Team #1 had entered the LLNL Alcove and the survey readings were 0.05 mR/h, negative toxic and explosive gases, and 20% oxygen. The LLNL recovery party entered the Alcove at 1035 hours and had completed their recovery and exited the Alcove by 1055 hours.

Reentry Team #1, at 1034 hours proceeded to the FDPP #3 and then to plug #4. The gas sample taken WPS of plug #4 was 0.4 mR/h, 1.4 mrad/h, 100 ppm CO, a trace of LEL, and 20% oxygen.

The Reentry Team secured the LLNL Alcove, and returned to the DPP. At 1125 hours the BPDPP doors were sealed and by 1140 hours all Reentry personnel were out of the tunnel. Bioassay samples were collected from the Recovery Party and Reentry Team.

On September 16, 1989, at 0430 hours, the Mining Department began alpine mining on the Gas Seal Plug. At 1800 hours mining broke through the Gas Seal Plug. By September 17, 1989, at 0540 hours, the alpine miner was removed from the tunnel and miners were spading away the earthen ramp.

On September 18, 1989, at 0605 hours, the Mining Department began alpine mining on the Main Drift Protection Plug.

On September 18, 1989, at 0855 hours, the Initial Reentry and Rescue Teams, wearing Anti-Cs the SCBA gear, departed the portal. Additional gas samples were taken before the teams entered the tunnel. The Rescue Team again stood by at the PS side of the DPP while the Reentry Team proceeded to plug #4, a gas sample was taken and the crawl way door opened. The E/R at the door was 0.3 mR/h and 0.6 mrad/h. The team continued on to the FDPP #3, up the 03 By-Pass Drift to the EOS and to plug #5. By 1029 hours the crawl way door at Plug #5 was opened and at 1033 hours the team was inside the p.03 LOS Drift. The E/R just outside the Test Chamber #2 (TC) door was 0.4 mR/h and 0.9 mrad/h. The TC #2 ventline valve was opened at 1042 hours and the gas sample read 0.4 mR/h, 0.7 mrad/h, 100 ppm CO, a trace of LEL, and 20% oxygen. At 1051 hours the TC #2 door was opened and the E/R inside the door was 0.2 mR/h and 0.3 mrad/h. The TC #2 door was closed and secured and the team proceeded to and through Plug #4. The ventline valve at TC #1 was opened and the sample read 1.3 mR/h, 1.5 mrad/h, 50 ppm CO, negative LEL, and 20% oxygen. The TC #1 door was opened at 1111 hours and the E/R inside was 5.5 mR/h and 6.0 mrad/h. The TC #1 door was left open approximately 2" and secured.

Team #1 returned to the p.03 By-Pass Drift and proceeded to FDPP #1. The FDPP #1 crawl-way door was opened at 1134 hours and the E/R inside was 0.15 mR/h and 0.2 mrad/h. The team continued on to Shield Wall #2 and #3, opening both crawl-way doors. The maximum reading in these areas was at the WPS of shield wall #3 and those readings were E/R 0.75 mR/h, 0.9 mrad/h, 10 ppm CO, negative LEL, and 20% oxygen.

The Team returned through the shield walls and proceeded to plug #2. By 1216 hours the Team had reentered the Vacuum Scatter Alcove and the readings in the Alcove were 0.05 mR/h, 0.6 mrad/h, negative toxic and explosive gases, and 20% oxygen. At 1221 hours Team #1 was returning to the DPP. By 1240 hours all reentry personnel were surveyed and released at the portal.

On September 19, 1989, at 0833 hours, the Reentry Team entered the tunnel to complete the initial reentry. Anti-Cs and SCBA gear was not required as per the DNA HP consultant.

The Team proceeded to the Alcove Protection Plug #1 (APP) and opened the crawl-way door. At 0842 hours the Team was inside the Slow Alcove; the E/R inside was 0.05 mR/h,

21% oxygen, and negative toxic and explosive gases. By 0851 hours the Team had exited the Slow Alcove and was at the APP #4. The Team proceeded to the APP #3, APP #7, and Plug #4. By 0911 hours the Team was at the APP #5. The gas sample taken at APP #5 was 0.05 mR/h, negative toxic and explosive gases, and 20% oxygen. At 0919 hours the Team entered the Fast Alcove and walked it out. At 0927 hours they had returned to the DPP and were exiting the tunnel. Air samples, gas samples, water samples, bioassay samples, and some swipe samples taken during the reentry were sent to the HPD Laboratory for analysis.

On September 20, 1989, the Scientific Assessment Team entered the tunnel at 0910 hours. Anti-Cs was not required except in the LOS pipe, where coveralls, totes, hoods, gloves and full face respirators with HEPA filters were required. At 1030 hours the Vacuum Scatterer tank was opened; the E/R inside was 0.7 mR/h. By 1300 hours the Scientific Assessment was completed and all experiment areas were secured.

The major part of experiment recovery was completed by October 2, 1989.

APPENDIX A

TELEMETRY AND DRILLBACK READINGS

Event	Maximum Telemetry Reading	Location	Maximum Drillback Reading (mR/h)	Location
DALHART	Background	---	120 mR/h	On PS#1A due to packaging samples
MISTY ECHO	Background	---	---	---
TEXARKANA	Background	---	50 mR/h	PS#1AS due to Atlas Wireline calibrating instruments
KAWICH	Background	---	200 mR/h	PS#1A due to coring operation (lasted 45 seconds)
INGOT	Background	---	20 mR/h	PS#1A due to coring operations
PALISADE	Background	---	60 mR/h	On PS#1A due to debris in the core trailer
TULIA	Background	---	25 mR/h	On PS#1AS due to sampling operation
CONTACT	Background	---	---	No postevent drilling

AMARILLO	Background	---	50 mR/h	PS#1A due to sampling operations
DISKO ELM	246.0 R/h	At CS2+75 in the U12p.03 LOS drift (Station 18)	---	---

APPENDIX B
RADIATION, TOXIC GAS and EXPLOSIVE
MIXTURE DETECTION INSTRUMENTS

<u>Instrument</u>	<u>Meter Range and Scales</u>	<u>Radiation Measured</u>
Eberline E-520	0 to 200 mR/h	gamma beta
Ludlum 14C (Geiger-Müller)	Five linear scales: 0 to 0.2 mR/h 0 to 2 mR/h 0 to 20 mR/h 0 to 200 mR/h 0 to 2000 mR/h (gamma only)	
EIC RO-3C (Ion Chamber)	0 to 5,000 mR/h Three linear scales: 0 to 5 mR/h 0 to 500 mR/h 0 to 5,000 mR/h	gamma beta
Eberline PIC-6A-B (Ion Chamber)	1 mR/h to 1000 R/h Two logarithmic scales: 1 to 1000 mR/h 1 to 1000 R/h	gamma beta
Eberline PAC-4G (Gas Proportional) Linlog Scale	0 to 500,000 c/m/50 cm ² Two linlog scales, 4 decades 0 to 500 c/m/50 cm ² 500 to 5,000 c/m/50 cm ² 0 to 50,000 c/m/50 cm ² 50,000 to 500,000 c/m/50 cm ² No range switching	alpha
PAC-4S Scintillation Linlog Scale	0 to 2,000,000 c/m/59 cm ² Two linlog scales, 4 decades 0 to 2000 c/m/59 cm ² 2000 to 20,000 c/m/59 cm ² 0 to 200,000 c/m/59 cm ² 200,000 to 2,000,000 c/m/59 cm ² No range switching.	alpha
Ludlum Model 19 Micro-R-Meter	Range: 0 to 5,000 µR/h Scale: Dual 0 to 25 (Red) 0 to 50 (Black) Selector Switch Ranges: 0 to 25 µR/h 0 to 50 µR/h 0 to 250 µR/h 0 to 500 µR/h 0 to 5,000 µR/h	gamma

<u>Instrument</u>	<u>Meter Range and Scales</u>	<u>Radiation Measured</u>
Eberline E-140	Range: 0 to 50,000 cpm	beta
Ludlum Model 101 (Pancake) GM 15 cm ² Count Rate Meter	Three Linear Scales: 0 to 500 cpm 0 to 5000 cpm 0 to 50,000 cpm Switch: XI, XIO, XIOO	gamma

<u>INSTRUMENT</u>	<u>DESCRIPTION</u>
Remote Area Monitoring Station (RAMS)	This unit utilizes a Neher-White ion chamber to detect gamma radiation. The instrument has two ranges, mR/h and R/h, with a maximum full scale reading capability to 1000 mR/h and 1000 R/h over six or eight logarithmic decades.
Gamma Intensity Time Recorder	This unit utilizes an Esterline-Angus recorder with Radector electronics and Neher-White ion chamber.
Draeger Multi-Gas Detector, Model 31	This instrument utilizes a hand-operated bellows pump to pass air through glass tubes containing chemical indicators. The chemicals change color in the presence of toxic gases.
M.S.A. Explosimeter	This battery-operated detector is calibrated to indicate the concentration of flammable gases and vapors in the ambient atmosphere. This instrument has a meter scale which indicates from 0 to 100 percent of the lower explosive limit.
J & W Combustible Gas and Oxygen Indicators	This is a battery-operated instrument which detects and measures the concentrations of explosive gases and oxygen in the atmosphere. The instrument has a meter scale which indicates from 0 to 100 percent of the LEL.
Model RM-19 Radiation Detector	This Eberline instrument is a small versatile alarming rate meter with a single channel pulse height analyzer capability. It provides audible and visual alarm functions which are adjustable over the entire range of the instrument. The meter scale is from 0 to 0.2 mR/h in conjunction with a multiplier switch marked X1, X10, X100 and X1K (range is 0 to 200 mR/h). The unit can operate with several different detectors and is primarily used during LLNL postevent drilling on the ventline and mud return lines.

INSTRUMENT	DESCRIPTION
TRITON Model 111	The TRITON Model 111, a product of the Johnston Laboratories, Inc., detects, monitors and measures tritium in air. Other radioactive gases may also be monitored and measured; however, a calibration scale factor must be used for each new gas since the instrument is only calibrated for tritium. The Model 111 operates on an internal battery or on 115 VAC line power and its range is 0 to $10^6 \mu\text{Ci}/\text{m}^3$.

APPENDIX C

REYNOLDS ELECTRICAL & ENGINEERING CO., INC. ENVIRONMENTAL SCIENCES DEPARTMENT FIELD OPERATIONS SECTION

LLNL EVENTS

Reynolds Electrical & Engineering Co., Inc., Environmental Sciences Department is responsible to the Test Group Director or his representative for radiological safety within his area of control.

An adequate number of monitors and equipment will be available to ensure compliance with the DOE Test Controller's Operations and Security Plan and the Test Controller's requirements.

Telemetry locations for this event are included herewith. These locations, plus the reentry survey routes, will be plotted on area maps which will be posted at CP-1 and the reentry Muster Station.

The read-out information for telemetry detectors will be logged at CP-2 and transmitted simultaneously to the DOE Operations Office at CP-1 and to the LLNL Control and Data Acquisition Center (CADAC) Facility Telemetry, Room 105.

All initial survey data will be reported to the reentry muster station.

REECO Environmental Sciences personnel will be on duty at the DOE Operations Office, CP-1, to perform liaison functions.

The Personnel Assignment List included herewith indicates the functions of ESD personnel supporting this event.

APPENDIX D

REYNOLDS ELECTRICAL & ENGINEERING CO., INC. ENVIRONMENTAL SCIENCES DEPARTMENT FIELD OPERATIONS SECTION

LANL EVENTS

Reynolds Electrical & Engineering Co., Inc., Environmental Sciences Department is responsible to the Test Group Director or his representative for radiological safety within his area of control.

A Duty Officer's station will be manned at CP-2 on D-day no later than 0001 hours. This station will monitor Net 3 radio (station identification will be the radio call number of the assigned Duty Officer) and will be available at telephone number 3552.

A sufficient number of RPTs and adequate equipment will be available to ensure compliance with the DOE Schedule of Events.

Telemetry station locations for this event are included herewith. These locations, plus the reentry survey routes, will be plotted on area maps which will be posted at CP-1 and the reentry station.

The read-out information for telemetry detectors will be transmitted simultaneously to and logged in the LANL Telemetry Room and the DOE Operations Office (both at CP-1).

All initial survey data will be reported to the reentry master station.

REEC/HPD personnel will be on duty at the DOE Operations Office and in the LANL Telemetry Room (CP-1) to perform liaison functions.

The Personnel Assignment List included herewith indicates the function of ESD personnel supporting this event.

APPENDIX E

REYNOLDS ELECTRICAL AND ENGINEERING CO., INC. ENVIRONMENTAL SCIENCES DEPARTMENT FIELD OPERATIONS SECTION

DNA EVENTS

The Defense Nuclear Agency (DNA) Test Group Director is responsible for the health and safety of all participants in the test area under his/her control.

Reynolds Electrical & Engineering Co., Inc., Environmental Sciences Department (ESD) will supply supervision, personnel, services and equipment as requested to assist the Test Group in exercising radiation safety controls.

Procedures for radiation exposure and contamination control in this area will be in accordance with the request of responsible DNA and Sandia National Laboratories representatives. These procedures will include telemetered radiation measurements, air samplers, film badges and qualified monitors.

In keeping with DOE Order 5480.1A, Chapter XI, all radiation exposure levels will be maintained as low as reasonably achievable.

A Personnel Assignment Sheet will be provided to test participants indicating the function of the REEC/HPD personnel supporting this event.

Telemetry station (RAMS) locations for this event are included herewith. Telemetry read-out data will be plotted simultaneously in the Sandia RAMS Room and the DOE Operations Center both in Building CP-1.

Initial survey data will be reported via Net 3 radio.

END

DATE FILMED

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