LABQUARK

Containment Data Report

B. Hudson
T. Stubbs
R. Heinle

May 1995

Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

This report has been reproduced
directly from the best available copy.

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information
P.O. Box 62, Oak Ridge, TN 37831
Prices available from (615) 576-8401, FTS 626-8401

Available to the public from the
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LABQUARK Instrumentation Summary

Instrumentation	Fielded	Data Return	Present in this Report
<u>Plug Emplacement</u>	yes	yes	yes
<u>Radiation</u>	yes	yes	yes
<u>Pressure</u>			
Stemming	yes	yes	yes
Challenge	no	-	-
Cavity	no	-	-
Atmospheric	yes	yes	yes
<u>Motion</u>			
Free field	no	-	-
Surface	yes	yes	yes
Plug	no	-	-
Stemming	yes	yes	yes
Surface casing	no	-	-
Emplacement pipe	no	-	-
Recording trailer	yes	yes	yes
<u>Hydroyield (a)</u>	yes	yes	no
<u>Collapse (b)</u>	yes	yes	yes
<u>Stress</u>	no	-	-
<u>Strain (c)</u>	yes	yes	yes
<u>Other Measurements (d)</u>	yes	yes	no

- (a) CORTEX in emplacement hole.
(b) EXCOR in emplacement hole.
(c) On emplacement pipe during stemming.
(d) Motion of the ground near microwave antenna and on antenna tower.

Event Personnel

Containment Physics

B. Hudson	LLNL
C. Sisemore	LLNL
J. Kalinowski	EG&G/AVO
T. Stubbs	EG&G/AVO

Instrumentation

S. Pratuch	LLNL
T. Valk	LLNL
T. Brown	EG&G/AVO
L. Farthing	EG&G/NVO
R. Spilsbury	EG&G/NVO

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
Handwritten signature

Contents

1.	Event Description								
1.1	Containment summary	.	.	.	.	.	.	.	1
1.2	Site	.	.	.	.	.	.	.	1
1.3	Instrumentation	.	.	.	.	.	.	.	1
2.	Emplacement								
2.1	Pipe strain	.	.	.	.	.	.	.	8
2.2	Plug level and temperature	.	.	.	.	.	.	.	8
3.	Stemming Performance								
3.1	Radiation and Pressure	.	.	.	.	.	.	.	15
3.2	Motion	.	.	.	.	.	.	.	15
3.3	Collapse	.	.	.	.	.	.	.	15
4.	Other Measurements								
4.1	Motion at the LLNL trailer park	.	.	.	.	.	.	.	34
References	.	.	.	.	.	.	.	.	40

1. Event Description

1.1 Containment summary

The LABQUARK event was detonated in hole U19an of the Nevada Test Site (figure 1.1). Detonation time was 15:30 PDT on September 30, 1986. A surface collapse occurred at about 3 hour, 51 minutes after detonation. No measurements of the crater dimensions were made, however, visual estimates of the crater depth varied from 1 to 4 feet depending upon the observer.

No radiation arrivals were detected above ground and the LABQUARK event containment was satisfactory.

1.2 Site.

A geologic map showing some of the surface features near the U19an site is shown in Figure 1.2. The device had a burial depth of 613 m in Area 19 rhyolite lava about 30 m above the static water level (SWL), as shown in the corresponding geologic cross section of figure 1.3⁽¹⁾.

Stemming of the 3.05 m diameter emplacement hole followed the plan shown in figure 1.4. A log of the stemming operations was maintained by Holmes & Narver⁽²⁾.

1.3 Instrumentation

Figure 1.5 is a schematic layout of the instrumentation in hole U19an, designed to monitor the stemming emplacement procedures and performance on the LABQUARK event.

Each of the six sanded gypsum concrete (SGC) plugs was monitored during emplacement with arrays of thermistors and conductivity probes. The coarse stemming below each of the upper five SGC plugs was instrumented with pressure and radiation stations. Sensitive radiation & pressure sensors were fielded near the upper four standard pressure & radiation stations and on the ground surface at a range of 15.24 m from Surface Ground Zero (SGZ). Data from each of the transducers (except for the sensitive pressure gauges) were transmitted to the recording trailer by an analog system and recorded on magnetic tape.

Pressures at the sensitive radiation & pressure stations were measured by a Paroscientific system which converts the signals to digital form for recording on "Wavetek 6000" instruments in an auxiliary trailer. This information was intended for a study of the permeability of the plugs and the geologic formation. The data recovered from these transducers are unavailable. Atmospheric pressure was monitored by a sensor mounted inside the recording trailer, ported through the trailer wall.

Hydrodynamic yield of the device and cavity collapse and chimney formation were monitored by two CORRTX/EXCOR cables fielded in the emplacement hole (figure 1.5). Results of the hydrodynamic yield measurements are reported elsewhere⁽³⁾.

Vertical motion was monitored at each of the standard pressure & radiation stations in the emplacement hole and 0.76 m in the ground surface, 15.24 m from SGZ. A sensitive accelerometer and a geophone were placed in the ground surface near the recording trailer (about 322 m from SGZ). Triaxial motion of the recording trailer was also recorded.

A brief history of the fielding operations of the instrumentation, including the emplacement pipe strain measurements, is given in reference 4. Further details of the instrumentation are given in reference 5.

Figure 1.1 Map of the Nevada Test Site indicating the location of hole U19an.

Figure 1.2 Geologic Map of the region near hole U19an.

A-A' GEOLOGIC CROSS SECTION THROUGH U19an

Figure 1.3 Geologic cross section through hole U19an.

LABQUARK U19an

Figure 1.4 As-built stemming plan for hole U19an.

Figure 1.5 As-built containment instrumentation plan for the LABQUARK event emplacement hole U19an.

2. Emplacement

2.1 Pipe strain

The emplacement pipe was instrumented with strain gages on the final pipe section below the load collar (station 88) and just above the diagnostics canister (station 81). The load history measured at station 88 is shown in figure 2.1. The load history at station 81 is unavailable.

2.2 Plug levels and temperature

The emplacement of each of the six SGC plugs was monitored with an array of conductivity probes and thermistors. The locations of the probes are tabulated in figure 1.5. Figures 2.2–2.6 show plots of the SGC emplacement and temperature histories. Open circles indicate the upper and lower boundary positions of the plugs as measured using tag lines while solid circles indicate the positions of the probe stations and the times at which the conductivity probes were activated. Probes including temperature sensors are tabulated in figure 1.5. The cable to multiplex canister #83 (above the second SGC plug) was lost during station emplacement, before the plugs were poured. All plugs appear to have been emplaced as planned.

Figure 2.1 History of the load (strain) on the emplacement pipe during stemming as measured at a position near the top (station 88). Station 81 data are not available.

Figure 2.2 Sanded gypsum emplacement for the first SGC plug. The upper and lower plug boundaries were determined with a tag line (open circles). Solid symbols indicate the probe elevations and shaded symbols indicate elevations of probes that did not report. Probes labeled B, E, and H included temperature sensors.

Figure 2.3 Sanded gypsum emplacement for the third SGC plug. The upper and lower plug boundaries were determined with a tag line (open circles). Solid symbols indicate the probe elevations and shaded symbols indicate elevations of probes that did not report. Probes labeled B, C, D, and E included temperature sensors.

Figure 2.4 Sanded gypsum emplacement for the fourth SGC plug. The upper and lower plug boundaries were determined with a tag line (open circles). Solid symbols indicate the probe elevations and shaded symbols indicate elevations of probes that did not report. Probes labeled B, C, D, and E included temperature sensors.

Figure 2.5 Sanded gypsum emplacement for the fifth SGC plug. The upper and lower plug boundaries were determined with a tag line (open circles). Solid symbols indicate the probe elevations and shaded symbols indicate elevations of probes that did not report. Probes labeled C, E, and G included temperature sensors.

Figure 2.6 Sanded gypsum emplacement for the sixth SGC plug. The upper and lower plug boundaries were determined with a tag line (open circles). Solid symbols indicate the probe elevations and shaded symbols indicate elevations of probes that did not report. Probes labeled C, E, and G included temperature sensors. A composite plot of all the temperature histories is not available: only channel E is shown, as a representative.

3. Stemming Performance

3.1 Radiation and Pressure

As indicated in Figure 1.5, the region near below each of the five upper SGC plugs was monitored by pressure and radiation stations. Station 31 of figure 1.5 was lost during emplacement. Stations 32 through 35 and 10 through 13 continued to provide data until surface collapse at plus about 3 hours, 52 minutes, at which time they were lost. Data from these stations are shown in Figures 3.1–3.4. The radiation history from the sensitive station near the ground surface (station 14) is shown in figure 3.5.

Figure 3.6 shows the atmospheric pressure measured at the recording trailer by a transducer within the trailer (station 72) ported through the trailer wall to the outside environment. Also shown is the pressure history measured 91 m deep in the emplacement hole (station 35). The apparent wide excursions in the pressure history of station 35 tend to cast doubt on its validity.

All pressure and radiation data are consistent with satisfactory containment.

3.2 Motion

Figures 3.7–3.10 show the explosion–induced vertical motion measured in the coarse stemming of the emplacement hole. Station 61 monitored the vertical motion of the ground surface at a depth of 0.76 m and a horizontal range of 15.24 m from SGZ. Explosion–induced vertical motion histories derived from this station are shown in Figure 3.11. Characteristics of the motion and of the motion transducers are given in tables 3.1–3.3.

3.3 Collapse

Only one of the two EXCOR cables (station 91) was active post–shot. Position of the lower end of this cable as a function of time is shown in Figure 3.12.

Pressure records characteristically show a significant drop as a result of stemming loss deeper in the hole. Just such a drop was noted on the four standard stations in the stemming; the last few seconds of pressure data from each station are superimposed on the EXCOR record in figure 3.12.

The motion sensed in the stemming and at station 61 during the collapse phase (around 3 hours, 51 minutes) is shown in figures 3.13–3.17.

Table 3.1 Summary of Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (m)	Displacement Residual (m)
32av	244.1	118	-10.1, 64.0	35.5	11.0	(a)
33av	320.3	147	12.3	5.1	1.67	1.6
34av	396.5	132 ^(b) , 180	6.6	2.6	1.34	0.8
35av	524.6	165 ^(b) , 240	8.5	2.9	1.14	0.2
61av	615.3	274	7.2, 1.2 ^(c)	3.75	1.19	0.3
61uv	-	-	-	3.76	1.10	-0.08

(a) The data become questionable before a permanent displacement is reached.

(b) Emplacement pipe-stemming interaction.

(c) Slap-down.

Table 3.2 Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
32av	>30,000	0.002	675
33av	?	?	250
34av	2209	0.70	62.5
35av	2082	0.70	25.0
61av	650	0.75	40.0

Table 3.3 Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°C)	Operate Temperature (°C)	System Range (m/s)
61uv	3.319	12.78	24.25	12.79	12

Figure 3.1 Pressure and radiation measured in the coarse stemming below the third SGC plug (stations 10 and 32 at 374 m depth). Station signals were lost at about 3 hr, 51 min (13,860 s, the time of collapse).

Figure 3.2 Pressure and radiation measured in the course stemming below the forth SGC plug (station 11 and 33 at 296 m depth). Station signals were lost at about 3 hr, 51 min (13,860 s, the time of collapse).

Figure 3.3 Pressure and radiation measured in the coarse stemming below the fifth SGC plug (station 12 and 34 at 219 m depth). Station signals were lost at about 3 hr, 51 min (13,860 s, the time of collapse).

Figure 3.4 Pressure and radiation measured in the coarse stemming below the sixth SGC plug (station 13 and 35 at 91 m depth). Station signals were lost at about 3 hr, 51 min (13,860 s, the time of collapse).

Figure 3.5 Radiation measured 0.76 m in the ground surface 15.24 m from SGZ (station 14). Recording was terminated at about 4 hours (14,4000 s).

Figure 3.6 Pressure measured in the recording trailer (station72) and at station 35 (91 m deep in the emplacement hole). The pressure wave form at station 35, when compared to that of station 72, casts doubt on the validity of station 35.

Figure 3.7 Explosion-induced vertical motion measured in the coarse stemming at a depth of 374 m (station 32). Data at times later than 2 s are questionable.

Figure 3.8 Explosion-induced vertical motion measured in the coarse stemming at a depth of 296 m (station 33).

Figure 3.9 Explosion-induced vertical motion measured in the coarse stemming at a depth of 219 m (station 34).

Figure 3.10 Explosion-induced vertical motion measured in the coarse stemming at a depth of 91 m (station 35).

Figure 3.11 Explosion-induced vertical motion of the ground surface, measured at a horizontal range of 15.24 m from SGZ and at a depth of 0.76 m (station 61). Traces annotated with "a" are derived from the accelerometer.

Figure 3.12 Progression of the cavity collapse as shown by breakage history of the EXCOR cable (station 91) and the pressure wave forms measured at stations 32-35.

Figure 3.13 Collapse-induced vertical motion measured in the coarse stemming at a depth of 374 m (station 32).

Figure 3.14 Collapse-induced vertical motion measured in the coarse stemming at a depth of 296 m (station 33)

Figure 3.15 Collapse-induced vertical motion measured in the coarse stemming at a depth of 219 m (station 34)

Figure 3.16 Collapse-induced vertical motion measured in the coarse stemming at a depth of 91 m (station 35).

Figure 3.17 Collapse-induced vertical motion of the ground surface, measured at a horizontal range of 15.24 m from SGZ and at a depth of 0.76 m. Records annotated with an 'a' are derived from the accelerometer.

4. Other Measurements

4.1 Motion at the LLNL trailer park

Figures 4.1–4.3 show the explosion–induced triaxial motions of the recording trailer. Motion sensed during the collapse at about 3 hours, 51 minutes is of too low an amplitude for meaningful reduction and is not shown.

Figure 4.4 shows data as recorded on a high sensitivity accelerometer and a geophone mounted in the ground surface of the trailer park (station 63). Except for the expected disturbance due to the detonation, these records are remarkably quiet for the entire time of recording.

Table 4.1 Summary of Motion

Gauge	Slant Range (m) ^(a)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (m)	Displacement Residual (cm)
71av	693	330	2.8	1.8	0.37	-80 ^(b)
71uv	693	330	-	2.28	0.64	-3
71ar	693	327	4	0.9	0.9	--22
71ur	693	340	-	1.3	0.94	-34
71at	693	314	~2.5	-0.75	-0.59	-30
71ut	693	325	-	-0.9	-0.72	-58

(a) Range is approximate: stations are in trailer park.

Table 4.2 Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
71av	330	0.70	20
71ar	340	0.70	15
71at	310	.75	15

Table 4.3 Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°C)	Operate Temperature (°C)	System Range (m/s)
71uv	3.253	12.03	24.71	17.78	7.0
71ur	3.516	9.59	25.39	17.78	5.0
71ut	3.354	8.87	25.41	17.78	5.0

Figure 4.1 Explosion-induced vertical motion of the recording trailer (station 71). Records annotated with an 'a' are derived from the accelerometer.

Figure 4.2 Explosion-induced horizontal-radial motion of the recording trailer (station 71). Records annotated with an 'a' are derived from the accelerometer.

Figure 4.3 Explosion-induced horizontal-transverse motion of the recording trailer (station 71). Records annotated with an 'a' are derived from the accelerometer.

Figure 4.4 Data from the vertical geophone and sensitive accelerometer mounted in the ground surface at the recording trailer (station 62). Surface collapse occurred at about 3 hours, 51 minutes (13860 s).

References

1. Stephen Clark and Jeff Wagoner, "U19an Site Characteristics Report", CP 8613, Lawrence Livermore National Laboratory, Livermore, CA, April 15, 1986.
2. Harold E. Begley, "Emplacement and Containment Report for LABQUARK U19an", Holmes & Narver, NTS:A2-86-76, September 29, 1986.
3. LLNL contact for additional information: R. Heinle (CORRTEX data).
4. B. William Bellow, "Special Measurements Final Engineering Report for LABQUARK, U19an," EG&G, Energy Measurements, Las Vegas, NV, SM:86E-136-35.
5. B. William Bellow, "Special Measurements Physics/Instrumentation LABQUARK, U19an, Revision 'A', Final", EG&G, Energy Measurements, Las Vegas, NV, SM:86E-136-34, 21 October, 1986.

Distribution:

LLNL

TID (11)	L-053
Test Program Library	L-045
Containment Vault	L-221
Burkhard, N.	L-221
Cooper, W.	L-049
Denny, M.	L-205
Goldwire, H.	L-221
Heinle, R. (5)	L-221
Mara, G.	L-049
Moran, M. T.	L-777
Moss, W.	L-200
Patton, H.	L-205
Pawloski, G.	L-221
Rambo, J.	L-200
Roth, B.	L-049
Valk, T.	L-154
Yunker, L.	L-203

LANL

App, F.	F-659
Brunish, W.	F-659
Kunkle, T.	F-665
Trent, B.	F-664

Sandia

Chabai, A.	MS-1159
Smith, Carl W.	MS-1159

EG&G/AVO

Brown, T.	A-5
Gilmore, L.	A-1
Hatch, M.	A-5
Still, G.	A-5
Stubbs, T.	A-5

EG&G/NVO

Bellow, B.	N 13-20
Davies, L.	N 13-20
Moeller, A.	N 13-20
Robinson, R.	N 13-20
Webb, W.	N 13-20

DNA

Ristvet, B.

S-Cubed

Peterson, E.

Eastman Cherrington Environment
1640 Old Pecos Trail, Suite H
Santa Fe, NM 87504

Keller, C.