CEBRERO

Containment Data Report

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CEBRERO 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	yes	yes	yes
Cavity	no	-	-
Atmospheric	no	-	-
<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	no	-
<u>Stress</u>	no	-	-
<u>Strain</u>	no	-	-
<u>Other Measurements^(c)</u>	yes	yes	no

- (a) EXCOR/CORRTEX in emplacement hole.
 (b) EXCOR measurement in emplacement hole.
 (c) Permeability pressure.

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1. Event Description

1.1 Containment summary

The CEBRERO event was detonated in hole U9cw of the Nevada Test Site (figure 1.1). Detonation time was 1:00 PM PST on August 14, 1985. No subsidence was observed. Radiation arrivals were detected to a depth of 145 m in the emplacement hole; however, no radiation was detected at any elevation above that. The CEBRERO event containment was satisfactory.

1.2 Site.

A magnified geologic map showing some of the surface features near the U9cw site is shown in Figure 1.2. The device had a burial depth of 182 m in Area 9 tuffs about 380 m above the static water level (SWL), as shown in the geologic cross sections of figure 1.3⁽¹⁾.

Stemming of the 1.62 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 U9cw, designed to monitor the stemming emplacement procedures and performance on the CEBRERO event.

For quality assurance during emplacement, each of the three gypsum filled aggregate (GFA) plugs was monitored with arrays of conductivity probes and thermistors.

The coarse stemming below each of the five plugs was instrumented with pressure and radiation stations. A pair of gauges was mounted on a section of gas sample hose to monitor the pressure challenging the bottom plug.

A series of nine sensitive pressure stations was also fielded between each of the plugs, in the stemming above the top plug, and in the ground surface 15.24 from Surface Ground Zero (SGZ) to study the permeability of the GFA plugs and geologic formation. These stations were monitored by Paroscientific data acquisition systems that transmitted the data in digital form for long-term recording on a LSI® computer system. The data from these stations are not available.

Vertical motion was monitored in the stemming at the each of the standard pressure and radiation stations, in the top pressure and radiation station on the section of gas sample hose, on the top of the emplacement pipe, and at 0.61 m depth in the ground surface, 15.24 m from SGZ. Triaxial motion of the recording trailer was also monitored.

Data from each of the transducers above (with the exception of the sensitive pressure stations) were transmitted to the recording trailer by an analog system and recorded on magnetic tape.

Hydrodynamic yield of the device and cavity subsidence was monitored by an EXCOR/CORRTEX cable (labeled "CLIPER/CORRTEX" in figure 1.5) fielded in the emplacement hole. Results of the hydrodynamic yield measurements are reported elsewhere⁽³⁾.

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.

CEBU

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Figure 1.3 Geologic cross section through hole U9cw.

Figure 1.4 As-built stemming plan for hole U9cw.

Figure 1.5 As-built containment instrumentation plan for the CEBRERO event emplacement hole U9cw.

2. Emplacement

2.1 Plug levels and temperature

Emplacement of each of the three GFA plugs was monitored with an array of conductivity probes and thermistors. The locations of the probes are tabulated in figure 1.5. Figure 2.1 shows plots of the GFA emplacement histories. Open circles indicate the upper and lower boundary positions of the plugs as measured with tag lines while solid circles indicate the positions of the probe stations and the times at which the conductivity probes were activated. Those probes which included temperature sensors are noted in the figure caption, however, temperature histories are not available. All plugs were emplaced as planned.

Figure 2.1 Emplacement diagnostics for the GFA plugs. The upper and lower plug boundaries were determined with a tag line. Solid symbols indicate the elevations of the probes while the open symbols indicate the elevation measured by the tag line. Although temperature was measured at probe "B" in plug 1 and at probes "C" in plugs 3 and 5, the data are not available.

3. Stemming Performance

3.1 Radiation and Pressure

All pressure and radiation data are consistent with satisfactory containment.

As indicated in Figure 1.5, the region around each of the five stemming plugs was monitored by pressure and/or radiation stations, as was the ground surface, 15.24 m from SGZ. Signals from these stations were transmitted to the recording trailer in analog form and recorded on magnetic tape.

Pressure and radiation histories, from a few seconds before detonation until 10 minutes and about 50 hours after detonation, are displayed in Figures 3.1–3.14.

Radiation was seen in the coarse stemming between the bottom GFA plug and the bottom gas seal plug, but no further up the hole. Arrival of radiation in the stemming at stations 31 and 33 occurred at less than 10 seconds (figures 3.3, 3.7, and 3.15) with a second surge of radiation arriving at these stations about 0.9 hours later (figures 3.4 and 3.8). The general radiation wave form was also observed at station 32, although at much lower amplitude (figures 3.5 and 3.6). This suggests that the source of the signals observed at all three stations was low level radiation in the stemming. Station 32 directly monitored radiation in the gas sample hose and was shielded from the stemming radiation, partially accounting for the lower levels seen at that station. The long time required for the radiation detector at station 32 to recover from the action of the EMP (greater than 140 s, figure 3.5) further suggests that the detector was defective.

Pressure challenging the deepest GFA plug was monitored at stations 30 and 32, mounted at different positions on the same section of gas sample hose which extended through the deepest GFA plug to the coarse stemming below it. Station 30 was located in the plug, 2.9 m above its bottom while station 32 was at the top of the hose, in the coarse stemming 4.5 m above the top of the plug. Comparison of the first 2 minutes of the wave forms from these two stations is shown in figure 3.16. To within experimental error, these two wave forms are identical: the quoted precision is 1 % of full scale which is 10 psi for station 30 and 2.5 psi for station 32. The difference between the two wave forms is less than 0.5 psi for the first 10 minutes (figures 3.1 and 3.6).

3.2 Motion

Characteristics of the motion and of the motion transducers are given in tables 3.1–3.3.

Vertical acceleration of the stemming was measured at each of the pressure and radiation stations (except the deepest, station 30) and on the top of the emplacement pipe. The ground surface, at a depth of 0.91 m and a horizontal range of 15.24 m from SGZ, was instrumented for vertical acceleration and velocity. Explosion-induced data derived from these stations are shown in figures 3.17–3.24. Collapse signals were never observed.

Wave forms of triaxial motion of the recording trailer are shown in figures 3.25–3.27. A geophone and sensitive accelerometer were fielded 0.91 m deep in the ground surface near the recording trailer (station 62). These instruments sensed significant information for about the first 5 seconds after the detonation and the resulting wave forms are shown in figure 3.28. Since the signal exceeded the dynamic range of both transducers, the wave forms have not been converted to engineering units, but only adjusted to baseline.

Table 3.1 Summary of Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (mm)	Displacement Resid. (mm)
31av	29	10	0.3, 1.8	0.015, 0.15	1.8	-4(a)
32av	31	9	0.4, 7.3	0.01, 0.31	2.3	-1(a)
33av	37	12	0.33, 2.6	0.08, 0.14	1.6	-3(a)
34av	49	27	0.1, 1.0	0.004, 0.066	0.8	-2.5(a)
35av	181	74	0.86	0.075	0.75	-0.9(a)
36av	136	97	0.44	0.037	0.41	-0.2(a)
1av	183	120	0.13(b)	0.018	0.33	-3(a)
61av	183	143	0.63, 2.4(c)	0.061	0.85	1
61uv		-	-	0.061	0.85	-3
71ar	204(a)	168	0.21	0.012	0.38	0.3
71ur		-	-	0.018	0.4	0.2
71at	204(a)	171	0.04	0.004	0.06	-0.2
71ut(d)		-	-	-0.004	0.15	-0.2
71av	204(a)	169	0.49	0.053	0.82	-0.2
71uv		-	-	0.45	0.71	0.2

(a) Approximate.

(b) Noisy - peak questionable

(c) Possible slap-down peak.

(d) Possible 90 degree phase shift in data. Possibly out of frequency band of system.

Table 3.2 Accelerometer Characteristics

<u>Gauge</u>	<u>Natural Frequency (Hz)</u>	<u>Damping Ratio</u>	<u>System Range (g's)</u>
31av	(a)	(a)	25.
32av	(a)	(a)	31.25
33av	(a)	(a)	18.75
34av	(a)	(a)	12.5
35av	(a)	(a)	12.5
36av	(a)	(a)	12.5
1av	(a)	(a)	125.
61av	64	0.65	1.6
71ar	240	0.60	5
71at	240	0.75	5
71av	250	0.67	8

(a) Manufacturer's specifications are: natural frequency > 2000 Hz; damping ratio unspecified.

Table 3.3 Velocimeter Characteristics

<u>Gauge</u>	<u>Natural Frequency (Hz)</u>	<u>Time to 0.5 Amplitude (s)</u>	<u>Calibration Temperature (°C)</u>	<u>Operate Temperature (°C)</u>	<u>System Range (m/s)</u>
61uv	3.620	8.72	26.07	26.61	1.6
71ur	3.516	9.10	25.24	23.44	1.5
71ut	3.354	8.71	25.30	23.44	1.5
71uv	3.253	11.17	25.89	23.44	2

Figure 3.1 The first 10 minutes of pressure challenging the deepest GFA plug (station 30 at 168 m depth, within the plug). Measurements originate at a depth of 175 m in the coarse stemming below the plug.

Figure 3.2 The first 50 hours of pressure challenging the deepest GFA plug (station 30 at 168 m depth, within the plug). Measurements originate at a depth of 175 m in the coarse stemming below the plug.

Figure 3.3 The first 10 minutes of pressure and radiation measured in the coarse stemming above the deepest GFA plug (station 31 at 153 m depth).

Figure 3.4 The first 50 hours of pressure and radiation measured in the coarse stemming above the deepest GFA plug (station 31 at 153 m depth).

Figure 3.5 The first 10 minutes of pressure and radiation challenging the deepest GFA plug (station 32 at 151 m depth). Measurements were taken through a hose that penetrated the plug and extended below it to a depth of 175 m.

Figure 3.6 The first 50 hours of pressure and radiation challenging the deepest GFA plug (station 32 at 151 m depth). Measurements were taken through a hose that penetrated the plug and extended below it to a depth of 175 m.

Figure 3.7 The first 10 minutes of pressure and radiation measured in the coarse stemming below the second plug (station 33 at 145 m depth).

Figure 3.8 The first 50 hours of pressure and radiation measured in the coarse stemming below the second plug (station 33 at 145 m depth). Pressure data are available for only the first 27 hours.

Figure 3.9 The first 10 minutes of pressure and radiation measured in the coarse stemming below the third GFA plug (station 34 at 128 m).

Figure 3.10 The first 50 hours of pressure and radiation measured in the coarse stemming below the third GFA plug (station 34 at 128 m).

Figure 3.11 The first 10 minutes of pressure and radiation measured in the coarse stemming below the fourth plug (station 35 at 81 m depth).

Figure 3.12 The first 50 hours of pressure and radiation measured in the coarse stemming below the fourth plug (station 35 at 81 m depth).

Figure 3.13 The first 10 minutes of pressure and radiation measured in the coarse stemming below the top plug (station 36 at 46 m depth).

Figure 3.14 The first 50 hours of pressure and radiation measured in the coarse stemming below the top plug (station 36 at 46 m depth).

Figure 3.15 Comparison of the first 30 seconds of radiation measured at stations 30 and 32. The system is shut off just before the EMP to protect the rams and then is allowed to recover. This recovery takes from one to 180 seconds, depending on the electronics and the background source strength.

Figure 3.16 Comparison of the first 2 minutes of challenge pressure measured at stations 30 and 32. The two sensors show identical wave forms with station 30 being 0.45 psi greater in amplitude than station 32. This is within the quoted error of 1% of full scale (full scale = 1000 psi for station 30 and 250 psi for station 32).

Figure 3.17 Explosion-induced vertical motion in the coarse stemming of the emplacement hole at a depth of 153 m (station 31, above the deepest GFA plug).

Figure 3.18 Explosion-induced vertical motion of the top of the section of gas sample hose used to measure challenge pressure (station 32 at a depth of 151 m). Motion station was about 8 m above the bottom GFA plug.

Figure 3.19 Explosion-induced vertical motion in the coarse stemming of the emplacement hole at a depth of 145 m (station 33, below plug 2, the deepest CT/A gas seal plug).

Figure 3.20 Explosion-induced vertical motion in the coarse stemming of the emplacement hole at a depth of 133 m (station 34, above plug 2, the deepest CT/A gas seal plug).

Figure 3.21 Explosion-induced vertical motion in the coarse stemming of the emplacement hole at a depth of 81 m (station 35, below plug 4, the shallow CT/A gas seal plug).

Figure 3.22 Explosion-induced vertical motion in the coarse stemming of the emplacement hole at a depth of 46 m (station 36, below the top GFA plug).

Figure 3.23 Explosion-induced vertical motion of the top of the emplacement pipe (station 1).

Figure 3.24 Explosion-induced vertical motion of the ground surface near the emplacement hole (station 61 at a depth of 0.91 m and a horizontal range of 15.2 m). Traces annotated with "a" are derived, by quadrature, from the accelerometer data.

Figure 3.25 Explosion-induced horizontal-radial motion of the recording trailer (station 71). Traces annotated with "a" are derived, by quadrature, from the accelerometer data.

Figure 3.26 Explosion-induced horizontal-transverse motion of the recording trailer (station 71). Traces annotated with "a" are derived, by quadrature, from the accelerometer data.

Figure 3.27 Explosion-induced vertical motion of the recording trailer (station 71). Traces annotated with "a" are derived, by quadrature, from the accelerometer data.

Figure 3.28 The first five seconds of vertical data from a geophone and sensitive accelerometer placed in the ground surface near the recording trailer (station 62). Amplitude is given in digitizer units since both sensors went beyond their dynamic ranges.

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