CABRA Containment Data Report

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March 1996

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

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CABRA Instrumentation Summary

Instrumentation	Fielded on this Event	Data Return	Present in this Report
<u>Plug Emplacement</u>	yes	yes	yes
<u>Radiation</u>	no	-	-
<u>Pressure</u>			
Stemming	no	-	-
Challenge	no	-	-
Cavity	no	-	-
Atmospheric	no	-	-
<u>Motion</u>			
Free Field	no	-	-
Surface	yes	yes	yes
Plug	yes	yes	yes
Stemming	no	-	-
Surface Casing	yes	yes	yes
Emplacement Pipe	no	-	-
<u>Hydroyield (a)</u>	yes	yes	no
<u>Collapse (b)</u>	yes	yes	yes
<u>Stress</u>	no	-	-
<u>Strain(c)</u>	yes	yes	no
<u>Other Measurements</u>	no	-	-

- (a) CORTEX and/or SLIFER in emplacement hole.
(b) EXCOR or CLIPER in emplacement hole - Description only.
(c) Strain load on emplacement pipe.

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1. Event Description

1.1 Site

The CABRA event was detonated in hole U20aj of the Nevada Test Site as indicated in figure 1.1. The CABRA device had a depth-of-burial (DOB) of 542 m in the Tuffs and rhyolites of area 20, about 20 m above the standing water level, as shown in figure 1.2⁽¹⁾. Figure 1.3 is a plan map of the immediate vicinity of hole U20aj showing the drill holes used in the construction of the cross section plot of figure 1.2. Stemming of the 2.44 m diameter emplacement hole followed the plan shown in figure 1.4. A log of the stemming operations was maintained by Holmes & Narver⁽²⁾.

Detonation time was 12:20 PST on March 26, 1983, and a sub-surface collapse to a depth of 380 m was observed.

No radiation arrivals were detected above ground and the CABRA containment was considered successful.

1.2 Instrumentation

Figure 1.5 is a schematic layout of the instrumentation designed to monitor the emplacement procedures and stemming performance of the CABRA event.

The two stemming plugs above the CABRA event were composed of coal-tar epoxy (LAE 59, denoted CTE). A soft layer of coal-tar and aggregate (LAE 59MY, denoted CTA) was poured on the top of each of the plugs to act as a gas seal.

Neither pressure nor radiation were monitored as part of the containment measurements.

Vertical motion of both of the stemming plugs as well as the motion of the surface casing was monitored. A reel-type extensometer was mounted between the surface casing and an anchor buried 1.5 m in the backfill within the casing.

Additionally, an array of five vertical motion stations buried 0.9 m in the ground surface was fielded as shown in figure 1.6.

Data from each of the above instruments were transmitted to the recording trailer by an analog system and recorded on magnetic tape.

D-cable information was used for quality assurance during the stemming operations. One CLIPER sensor was mounted in the emplacement hole to monitor cavity collapse and chimney formation.

A history of the fielding operations of the instrumentation is outlined in reference 4. Details of the instrumentation are given in reference 5.

1.3. Emplacement

The stemming plugs consisted of two "LAE 59" coal-tar epoxy (CTE) layers. The bottom plug was about 4 m thick while the top was about 6 m thick. Both plugs were capped with about 2 m of soft coal-tar-aggregate "LAE 59MY" epoxy (CTA) to act as a gas sealant. Stemming between the plugs consisted of layers of fines and coarse gravel. The top of the hole (above the top plug) was filled with ground surface derived backfill and the inside of the emplacement pipe was grouted for its full length. See figure 1.4.

Figure 1.1 Map of the Nevada Test Site indicating the location of hole U20aj.

A NORTHWEST

A' EAST

Identification of units used in the geologic map and cross section, U20aj

Tertiary Units

Ttt	Trail Ridge Member, Thirsty Canyon Tuff
Tts	Spearhead Member, Thirsty Canyon Tuff
Ttr	Rocket Wash Member, Thirsty Canyon Tuff
Tat	Ash-fall and reworked tuff
Trb	Lavas of Ribbon Cliff
Tma	Ammonia Tanks Member, Timber Mountain Tuff
Tb	Vitric Bedded Tuff
Tmr	Rainier Mesa Member, Timber Mountain Tuff
Tp(Tb)	Bedded tuff associated with Paintbrush Tuff
Trab	Bedded and ash-flow tuff, Tuffs and rhyolites of Area 20
Trau	Upper rhyolite lavas, Tuffs and rhyolites of Area 20
Tral	Lower rhyolite lavas, Tuffs and rhyolites of Area 20
Tra	Tuffs and rhyolites of Area 20, undifferentiated
Tov	Older volcanics, may include Pre-Silent Canyon lavas and tuffs

Figure 1.2 East-West geologic cross section through hole U20aj.

Figure 1.3 Plan View Map of the region encompassing hole U20aj showing the holes used in the geologic cross section of figure 1.2.

Figure 1.4 As-built stemming plan for the event CABRA in Hole U20aj.

Figure 1.5 Lay out of ground motion surface array. All stations were composed of vertical motion (acceleration and velocity) transducers.

2. Stemming Performance

2.1 Radiation and Pressure

Pressure was not monitored on the CABRA event and the only radiation monitoring was performed by Heath and Safety and not part of the containment program. The radiation data are consistent with satisfactory containment.

2.2 Motion

Explosion-induced histories of the motion measured on the CABRA event are shown in figures 2.1–2.8. Characteristics of the associated motion and transducers are given in tables 2.1–2.3. In station 21 (figure 2.1) the velocity signal was lost at about 0.6 s and the acceleration at about 1 s. Considering the large peak displacement seen at stations 22, 23, and 61, this loss was likely due to differential cable stretch. The high noise level seen in the acceleration signals in stations 21, 22, and 23 renders the second integration (displacement) of the associated signals suspect in figures 2.1–2.3. Signals from several of the accelerometers exceeded the system limits (figures 2.1 and 2.6 - 2.8). For those acceleration signals that lasted for more than 4 s and exceed the band edge during only one short time region, the peak in that region could be augmented to produce an integral (velocity) that returned to the base line of zero at late times. Thus, the accelerations from stations 64 and 65 have been augmented by the amounts shown in figures 2.7 and 2.8.

Relative separation of the surface casing and the top plug may be obtained by subtracting the displacement history of the top plug from that of the surface casing. This history along with those of the two displacements are shown in figure 2.9. This would suggest a 10 cm separation between the two; however, within the quoted 5% of full scale accuracy of the transducers, the separation is zero. We thus can not conclude from these data that there was plug separation from the surface casing due to the explosion.

The output of the Celesco® reel-type displacement transducer (station 20) is shown in figure 2.10. The station housing was mounted to the surface casing and an anchor was buried 1.5 m in the backfill inside the casing. The initial extension was 0.21 m while the final, post-shot extension is seen to be about 80 cm. A shock-induced linear compaction of the soil between the anchor and the top plug of about 5% without any relative motion of the top plug and surface casing would account for this. The wave form of the extension transducer is similar to that of the difference between stations 23 and 22 as seen in figure 2.9, suggesting the validity of those data.

As seen in figures 2.4-2.8 all surface stations underwent a period of free-fall ending in a large acceleration spike, a "slap-down". Ground shock induced spall extended to and probably beyond the most distant station (station 65) at a horizontal distance of 0.9 depths-of-burial.

2.3 Collapse phenomena

The only CLIPER data available indicate an early (1.6 s) cable break at a depth of 404 m and with two TDR measurements taken 4 and 5 days later giving depths of 381 m and 380 m, respectively. D cables 92 and 93 indicate early time (before 1 s after detonation) breakage at depths of 402 m and 176 m, respectively. The collapse information were supplied by E.Woodward⁽⁶⁾.

Figure 2.1 Explosion-induced vertical motion of the bottom plug at a depth of 164 m (station 21). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.2 Explosion-induced vertical motion of the top plug at a depth of 16.7 m (station 22). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.3 Explosion-induced vertical motion of the surface casing (station 23). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.4 Explosion-induced vertical motion of the ground surface at a horizontal range of 15.24 m and a depth of 0.9 m (station 61). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.5 Explosion-induced vertical motion of the ground surface at a horizontal range of 245.8 m and a depth of 0.9 m located South, Southwest of SGZ (station 62). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.6 Explosion-induced vertical motion of the ground surface at a horizontal range of 121.9 m and a depth of 0.9 m located Southwest of SGZ (station 63). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.7 Explosion-induced vertical motion of the ground surface at a horizontal range of 365.8 m and a depth of 0.9 m Southwest of SGZ (station 64). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.8 Explosion-induced vertical motion of the ground surface at a horizontal range of 487.7 m and a depth of 0.9 m Southwest of SGZ (station 65). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.9 Displacement histories of station 22 (top plug) and 23 (surface casing) and the difference (station 23 – station 22). To within the accuracy of the transducers and the processing, the difference is zero.

Figure 2.10 Separation between the surface casing and an anchor buried 1.5 m in the backfill within the casing (station 20).

Table 2.1 Summary of Containment-Related Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (m)	Displacement Residual (m)
21av	378	83(a), 146	14(b)	4.8	1.45	(c)
21uv		143	-	5.0	(c)	(c)
22av	525.4	125(a), 281	4.9, 8.0(d)	4.7(e)	1.92(e)	7(e)
22uv		295	-	5.0	1.81	-2.5
23av	542	129(a), 290	5.4, 17.2(d)	4.7(e)	1.73(e)	4(e)
23uv		124(a), 293	-	4.8	1.75	-2
61av	541	300	7.2, 24(d)	5.0	1.83	0
61uv		300	-	5.0	1.81	0
62av	593.4	330	4.8, 13.7(d)	2.5	0.59	0
62uv		345	-	2.1	0.47	0.02
63av	554.6	300	(b)	3.7(f)	1.1(f)	-0.17(f)
63uv		300	-	4.6	1.43	0.30
64av	653.0	370	3.5, 13.2(d)	2.1	0.39	0.17
64uv		370	-	2.45	0.45	0.10
65av	728.4	428	3.4, 11.8(d)	1.6	0.225	0.05
65uv		460	-	1.9	0.255	0.03

(a) Pipe-induced motion.

(b) Peak not seen; signal out band.

(c) Signal terminated before this value attained.

(d) Slap-down.

(e) These values questionable due to noise bursts and slight offsets in the acceleration signal.

(f) Value questionable: acceleration signal is out of band at several points.

Table 2.2 Containment-Related Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
21av	420	0.60	12
22av	360	0.65	20
23av	327	0.65	20
61av	590	0.65	30
62av	313	0.75	18
63av	255	0.75	8
64av	NR	NR	6
65av	260	0.65	4

NR : not recorded.

Table 2.3 Containment-Related Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°C)	Operate Temperature (°C)	System Range (m/s)
21uv	3.523	9.26	24.17	33.89	8
22uv	3.824	7.76	24.03	36.39	6
23uv	3.601	8.78	24.12	1.67	6
61uv	3.578	9.43	23.69	5.00	6
62uv	3.742	7.75	23.01	10.83	4
63uv	NR	9.73	24.34	3.00	4
64uv	3.700	7.96	24.04	3.00	3.2
65uv	3.540	8.87	23.94	3.00	2.4

NR : not recorded.

References

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2. George Kronsbein, "Containment Report for U20aj," Holmes & Narver, NTS:A2:83-22, March 23, 1983.
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