BRANCO

Containment Data Report

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BRANCO Instrumentation Summary

Instrumentation	Fielded on this Event	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	no	-	-
<u>Motion</u>			
Free Field	no	-	-
Surface	yes	yes	yes
Plug	yes	yes	yes
Stemming	no	-	-
Surface Casing	yes	yes	yes
Emplacement Pipe	yes	yes	yes
<u>Hydroyield (a)</u>	yes	yes	no
<u>Collapse (b)</u>	yes	no	-
<u>Stress</u>	no	-	-
<u>Strain (c)</u>	yes	yes	yes
<u>Other Measurements (c)</u>	yes	yes	yes

(a) CORTEX and/or SLIFER in emplacement hole.

(b) EXCOR or CLIPER in emplacement hole.

(c) Plug strain and displacement measurements.

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1. Event Description

1.1 Site

The BRANCO event was detonated in hole U2ew of the Nevada Test Site as indicated in figure 1.1. The event HERKIMER was simultaneously detonated at a greater depth in the same hole. The BRANCO device had a depth-of-burial (DOB) of 293 m in the alluvium of area 2, about 250 m above the standing water level and 670 m above the Paleozoic formation, as shown in figure 1.2⁽¹⁾. Figure 1.3 is a plan map of the immediate vicinity of hole U2ew 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 09:25 PDT on September 21, 1983, and 88.7 minutes later a surface collapse occurred leaving a crater with mean radius of 55.8 m and maximum depth of 9.7 m.

No radiation arrivals were detected above ground and the BRANCO 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 BRANCO event.

The two stemming plugs above the BRANCO 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.

Pressure and radiation were monitored in the loose stemming about 9 m below the top plug.

One of the primary objectives of the containment instrumentation on this experiment was to monitor the behavior of the top stemming plug. Toward this end, vertical motion was monitored in the top plug, on the surface casing and the emplacement pipe. Strain of the top plug was measured by an array of six "dumbbell" type transducers while the relative displacement of the top plug, the surface casing and the emplacement pipe was monitored by an array of reel type extensometers.

Additionally, vertical motion was monitored 0.9 m in the ground surface 15.24 m from surface ground zero (SGZ).

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 5 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 U2ew.

Figure 1.2 East-West geologic cross section through hole U2ew.

Figure 1.3 Plan View Map of the region encompassing hole U2ew showing the holes used in the geologic cross section of figure 1.2.

Figure 1.4 As-built stemming plan for the event BRANCO in Hole U2ew.

Figure 1.5 As-built containment instrumentation plan for the emplacement hole (U2ew) on the BRANCO event.

2. Stemming Performance

2.1 Radiation and Pressure

As seen in figure 1.5, pressure and radiation were monitored in the coarse stemming at only one location (station 31), about 9 m below the top plug. Wave forms of the pressure and radiation measured at this station are shown in figure 2.1 for times beginning about 1 minute before detonation and lasting for about 1.7 hours. No radiation arrivals were detected prior to collapse and signals from this station were lost at collapse time.

The pressure and radiation data are consistent with satisfactory containment.

2.2 Motion

Explosion-induced histories of the containment related motion measured on the BRANCO event are shown in figures 2.2–2.5. Characteristics of the associated motion and transducers are given in tables 2.1–2.3. Signals from station 4 (mounted to the top of the emplacement pipe) were lost shortly after shock arrival and, upon re-entry to ground zero, it was discovered that the station mounting bracket had failed. See figure 2.4.

Figure 2.6 is an over-plot of the first 3 seconds of explosion displacement derived from each of the four motion transducers of stations 21 and 22. Only the displacement derived from the accelerometer at station 22 departs slightly from the wave form of the other three. This is attributed to slight errors in the base-line adjustments of the acceleration wave form which accumulated during the two integrations required to produce the displacement. The velocity-derived wave forms are presented as thick lines while the data derived from station 22 are annotated with a "2". These data strongly suggest that there was no separation of the surface casing and the top plug as a result of the explosion. Direct displacement measurements shown in figure 2.7 suggest, on the other hand, that the stemming and the top plug moved downward almost 50 cm with respect to the surface casing. The anchor in the top of the stemming moved about 10 cm farther than that in the top plug suggesting a possible compaction of the stemming. The discrepancy between the displacement transducers and the motion sensors is unexplained. As noted, the bracket on the top of the emplacement pipe was damaged during or shortly after the detonation. This could have led to the anomalous readings from the displacement transducer of station 2 (figure 2.8).

2.4 Collapse phenomena

No CLIPER data are available and the D-cable information was recorded but not reduced. There was sufficient surface slack in the instrumentation cables to allow all stations (except station 21) in and above the top plug to survive the collapse.

Collapse-induced signals derived from the motion transducers are shown in figures 2.9–2.11. The acceleration signal at collapse from station 61 exceeded the system limit of 40 g's and the peak was augmented to allow the resulting integral (velocity) to return to a mean zero value at late time. The record thus produced was low-pass filtered at 130 Hz, leading to the history presented in figure 2.11. Collapse-induced signals from the displacement transducers are shown in figures 2.8 and 2.9 along with the explosion-induced signals.

Total collapse fall was 8 and 10 m occurring at about 5320 s after detonation, as shown by figures 2.9–2.11. A survey of the crater on 9/23/83 confirms these data. The motion transducers indicate that the surface casing was displaced downward farther than the top plug by nearly 1 m while the inverse is suggested by the displacement transducers (figure 2.7). Loss of station 21 (near the bottom of the surface casing) suggests that either the plug or the plug-casing bond was compromised by the collapse.

Figure 2.1 Pressure and radiation measured in the loose stemming at 38.1 m depth (Station 31, below the top stemming plug 1).

Figure 2.2 Explosion-induced vertical motion of the top plug at a depth of 34.6 m (station 21).

Figure 2.3 Explosion-induced vertical motion of the surface casing (station 22).

Figure 2.4 Explosion-induced vertical motion of the top of the emplacement pipe (station 4). Station was lost shortly after shock arrival.

Figure 2.5 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).

Figure 2.6 Over-plot of the displacement records derived from the acceleration and velocimeter transducers of stations 21 and 22. Velocity-derived wave forms are shown as thick lines and the data from station 22 are annotated with "2".

Figure 2.7 Relative displacement between the surface casing and both the backfill and the top CTE plug (stations 1 and 3).

Figure 2.8 Relative displacement between the emplacement pipe and the backfill (station 2).

Figure 2.9 Collapse-induced vertical motion of the top plug at a depth of 34.6 m (station 21).

Figure 2.10 Collapse-induced vertical motion of the surface casing (station 22).

Figure 2.11 Collapse-induced vertical motion of the ground surface at a horizontal range of 15.24 m and a depth of 0.9 m (station 61).

Table 2.1 Summary of Containment-Related Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (cm)	Displacement Residual (cm)
4 av	294	71	80(a)	(a)	(a)	-
4uv	294	71	-	15(a)	(a)	-
21av	258.4	60(b), 160	0.9, 8.6(c)	0.76	11.0	-11
21uv	258.4	168	-	0.67	9.8	-12
22av	293	69(b), 180	0.9, 11.0(c)	0.78	11	-7
22uv	293	183	-	0.74	10.4	-12
61av	293.4	200	1.2, 22(c)	0.80	11.8	-17
61uv	293.4	202	-	0.76	11.8	-15
1dv	293	180	-	-	9(d)	43
2dv	293	80	-	-	40(d)	-18
3dv	293	200	-	-	7(d)	51

(a) System limit or gauge lost before the peak was reached.

(b) Emplacement pipe induced motion.

(c) Slap-down.

(d) First transient in displacement record.

Table 2.2 Containment-Related Accelerometer Characteristics

<u>Gauge</u>	<u>Natural Frequency (Hz)</u>	<u>Damping Ratio</u>	<u>System Range (g's)</u>
4av	700	0.60	80
21av	395	0.65	20
22av	380	0.65	20
61av	640	0.72	40

Table 2.3 Containment-Related 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>
4uv	3.515	8.55	24.64	22.86	15
21uv	3.431	8.63	23.69	39.24	12
22uv	3.438	10.39	24.00	19.93	12
61uv	3.552	8.67	23.77	23.26	14

3. Strain measurements in the top plug

Internal strain of the top CTE plug was monitored by an array of six earth strain transducers of varying lengths, mounted both horizontally and vertically within the plug. Stations 33 and 37 formed a vertical-horizontal pair at a depth of 35.6 m while stations 35 and 38 formed another pair at an average depth of 33.8 m. Station 34, a vertically mounted transducer was at a depth of 35.2 while station 36 was a vertical transducer covering most of the plug depth. The mounting brackets required were quite massive and lead to uncertainties in the quantities measured. The resulting histories obtained are presented in figures 3.1 - 3.6. In each figure, both the early time (at detonation) and the late time (at collapse) are presented above the full history.

Stations 33 and 37 were emplaced at a depth about 1 m greater than was the motion station 21 which was lost at collapse time. It was suggested in section 2 that the loss could be due to a break-up of the plug upon collapse slap-down. None of the strain transducers were lost due to collapse. The large mounting brackets for the strain transducers could have protected them.

Figure 3.1 Vertical strain of the top CTE plug at a depth of 35.59 m (station 33). This gauge was initially 0.61 m long.

Figure 3.2 Vertical strain of the top CTE plug at a depth of 35.21 m (station 34). This gauge was initially 1.22 m long.

Figure 3.3 Vertical strain of the top CTE plug at a depth of 33.96 m (station 35). This gauge was initially 1.72 m long.

Figure 3.4 Vertical strain of the top CTE plug at a depth of 34.14 m (station 36). This gauge was initially 3.05 m long.

Figure 3.5 Horizontal strain of the top CTE plug at a depth of 35.63 m (station 37). This gauge was initially 0.305 m long.

Figure 3.6 Horizontal strain of the top CTE plug at a depth of 33.62 m (station 38). This gauge was initially 0.305 m long.

References

1. S. R. Clark and N. W. Howard, "U2ew Preliminary Site Characteristics Summary", DM 83-5 5, Lawrence Livermore National Laboratory, Livermore, CA, June 10, 1983.
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