FARM

Containment Data Report

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FARM Instrumentation Summary

Instrumentation	Fielded on this Event	Data Return	Present in this Report
<u>Plug Emplacement</u> ^(a)	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	no	-	-
Stemming	no	-	-
Surface Casing	no	-	-
Emplacement Pipe	yes	yes	yes
<u>Hydroyield</u> ^(b)	yes	yes	no
<u>Collapse</u> ^(c)	yes	yes	yes
<u>Stress</u>	no	-	-
<u>Strain</u> ^(d)	yes	no	-
<u>Other Measurements</u>	no	-	-

- (a) Description only.
(b) SLIFER in emplacement and satellite holes.
(c) CLIPER and D-Cables in emplacement and satellite holes.
(d) Emplacement pipe load.

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1. Event Description 5.8

1.1 Site

The FARM event was detonated in hole U20ab of the Nevada Test Site as indicated in figure 1.1. The device had a depth-of-burial (DOB) of 689 m in the bedded and ashflow tufts of area 20, about 45 m below the standing water level, as shown in figure 1.2⁽¹⁾. Stemming of the 2.44 m diameter emplacement hole followed the plan shown in figure 1.3. A log of the stemming operations was maintained by Holmes & Narver⁽²⁾. Stemming of the satellite hole Ue20ab followed the plan shown in figure 1.4.

Detonation time was 08:07:30 PDT on December 16, 1978. Evidence of subsurface collapse at 41 hours, 35 minutes was inferred by the Nevada Health and Safety personnel from geophone records.

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

1.2 Emplacement

One strain station (85) was fielded on the emplacement pipe to monitor the load during installation and stemming. During these procedures, output of this station was recorded by hand in the stemming log maintained by Holmes & Narver⁽²⁾.

Since the working point (689 m) was below the standing water (SWL) depth of 644 m, a 1.88 m diameter casing was placed in the hole from depth to about 16 m above the SWL to protect the experiment from moisture.

The two stemming plugs were composed of coal-tar epoxy (LAE 59, denoted CTE), each about 4.5 m thick. A gas seal layer of soft coal-tar and aggregate (LAE 59MY, denoted CTA) was poured above a layer of sand and foam cubes resting on the top of the top plug. About 1.1 m of the surface casing extended below the top plug. Stemming between the plugs consisted of layers of fines and coarse gravel. The top 5.8 m of the hole (above the top gas seal layer) was filled with pea gravel. See figure 1.3.

An exploratory hole, Ue20ab, was grouted from its full depth to about 1 m below the surface casing. The remainder of this hole, including the surface casing, was filled with LC 204 plastic. See figure 1.4 The exploratory hole was 31 m south of the emplacement hole, U20ab.

1.3 Instrumentation

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

Motion (acceleration and velocity) of the ground surface was monitored at two stations; one 30.5 m from SGZ (station 61) and the other in the recording trailer park, 311.1 m from SGZ (station 62). Two vertical accelerometers were fielded on the diagnostics canister as part of an electronic PINEX experiment.

D-cable information was used for quality assurance during the stemming operations and one station (station 91) was recorded post-shot to monitor cavity collapse as was the output of a CLIPER gauge (station 92). The exploratory hole (Ue20ab) was used to field another CLIPER (station 51) that also was recorded post-shot. This CLIPER was the only containment related measurement made in the satellite hole.

Data from the motion stations were transmitted to the recording trailer by an analog system and recorded on magnetic tape.

Results of the yield measurements are reported elsewhere⁽³⁾.

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

Figure 1.1 Map of the Nevada Test Site indicating the location of hole U20ab.

Figure 1.2 East- West geologic cross sections through hole U20ab.

Corrections to Stemming Plan

Depth	contents
19' - 0'	Pea gravel
28' - 19'	LAE59
40' - 28'	foam & OV
56.5' - 40'	Pea & OV

Figure 1.3 As-built stemming plan for the event FARM in Hole U20ab.

Figure 1.4 As-built stemming plan for the satellite hole Ue20ab on FARM.

Figure 1.5 As-built containment instrumentation plan for the emplacement hole (U20ab) on the FARM event.

2. Containment Related Measurements

2.1 Explosion Induced Motion

Wave forms of the motion measured on FARM are shown in figures 2.1 - 2.11. Arrivals and peak values of the motion are given in table 2.1 with the transducer characteristics in tables 2.2 and 2.3. A malfunction of the signal conditioner of the vertical velocimeter of station 62 precluded the recording of useful data from that channel.

The first 4 ms of wave form received from the two vertical motion sensors fielded in the diagnostics canister (stations 27 and 28) is shown in figure 2.1. Just prior to 3 ms these were both driven beyond the system limits of 6,000 g and should not be believed at later times. The greatest value in this data is the arrival time. Data were taken at 20,000 samples per second so the apparent discrepancy between the two is only one sample point indicating that both stations registered the data arriving at 0.4 ms within one data sample interval. The motion approached the system limits on the second or third excursion of each transducer (prior to 1 ms).

Figures 2.2 - 2.5 depict the surface ground motion. Station 61 (figure 2.2), 30.5 m horizontally separated from SGZ, shows an initial acceleration pulse, followed by a free-fall period lasting about 0.4 s and a subsequent small slap-down. Station 62 (figure 2.3), 311 m separated from SGZ, exhibits an almost 30% greater, relatively brief, initial acceleration. Horizontal, radial and transverse accelerations both exhibit this initial, sharp acceleration (figures 2.4 and 2.5). This behavior is likely due to the complex, layered geologic structures between the two locations and the working point.

2.2 Collapse Phenomena

Three systems were designated to yield information on the collapse: a CLIPER and a D-cable in the emplacement hole and a CLIPER in the satellite hole. In the emplacement hole, the D-cable (station 91) indicates that it broke at a depth of about 331 m at a time prior to 2 seconds and the CLIPER (station 92) did not respond. The CLIPER in the satellite hole (station 51) registered a break at a depth of 215 m at a time of 0.4 s. This break remained stable at that depth (within 1 m) for two days (as long as the CLIPER was monitored). This is approximately the depth of the base of the Rainier Mesa Member, the uppermost geologic structure⁽¹⁾. These breaks are likely due to the reflection of the explosion-induced stress wave from the surface and not collapse. Nevada Health & Safety personnel reviewed the geophone records and concluded that there was a likely subsurface collapse at 41 hours and 35 minutes with the height of the chimney uncertain.

Figure 2.1 Explosion-induced vertical acceleration at stations 27 and 28 on the PINEX experiment (depth 661.42 m and 653.86, ranges from Reference Depth are 26.54 m and 34.1 m, respectively).

Figure 2.2 Explosion-induced vertical motion at station 61 at a depth of 1.22 m in the ground surface and a horizontal range of 30.5 m. When there is more than one trace on a plot, the lighter was derived from the accelerometer.

Figure 2.3 Explosion-induced vertical motion at station 62 at a depth of 1.22 m in the ground surface and a horizontal range of 311.1 m.

Figure 2.4 Explosion-induced horizontal-radial motion at station 62 at a depth of 1.22 m in the ground surface and a horizontal range of 311.1 m.

Figure 2.5 Explosion-induced horizontal-transverse motion at station 62 at a depth of 1.22 m in the ground surface and a horizontal range of 311.1 m.

Table 2.1 Summary of Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (m)	Displacement Residual (m)
27av	26.54	0.40	(a)	(b)	(b)	(b)
28uv	34.10	0.35	(a)	(b)	(b)	(b)
61av	689.7	275	12.9	3.35	1.24	0.20
61uv	689.7	280	-	3.17	1.18	0.20
62av	756	334	16.6(c)	2.80	0.47	0.22
62ar	756	336	6.1, -4.0(c)	1.38	0.38	0.10
62at	756	335	6.2, -4.2(c)	-1.49	-0.21	0.07

(a) Highly questionable.

(b) Transducer lost before this value attained.

(c) Extremely sharp arrival of blast wave.

Table 2.2 Containment-Related Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
27av	(a)	-	6000
28av	(a)	-	6000
61av	620	0.65	30
62av	310	0.65	20
62ar	310	0.60	12
62at	360	0.65	8

(a) Manufacturer's (Endevco 2264A) specs are linear to 30 KHz

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)
61uv	3.74	7.4	74.8	32.23	9.1

62uv(a)

(a) No information is available on this transducer, the associated signal conditioner failed pre-shot.

References

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3. LLNL contacts for additional information: R. A. Heinle (CORTEX and SLIFER data)
4. William G. Webb, "Special Measurements Final Engineering Report for FARM, U20ab", EG&G, Energy Measurements, Las Vegas, NV, SM:78E-62-26, 9 January, 1979.
5. William G. Webb, "Special Measurements Physics/Instrumentation Package for FARM, U20ab, Final Revision", EG&G, Energy Measurements, Las Vegas, NV, SM:78E-62-27, 19 January,, 1979.

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