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HAVARTI Containment Data Report

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HAVARTI Instrumentation Summary

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

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

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Contents

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1. Event Description

1.1 Site

The HAVARTI event was detonated in hole U10bg of the Nevada Test Site as indicated in figure 1.1. The HAVARTI device had a depth-of-burial (DOB) of 200 m in the Tunnel Bed tufts of area 10, about 280 m above the Paleozoic formation and 330 m above the standing water level, as shown in the geologic cross-sections of figures 1.2 and 1.3⁽¹⁾. 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 06:41 PDT on August 5, 1981. At a depth of 149 m there was an indication of subsurface collapse occurring 1780 s after detonation.

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

1.2. Emplacement

The four stemming plugs above the HAVARTI event were composed of rigid two-part-epoxy (TPE). These plugs were about 3 m thick except for the top which was about 5 m thick. A soft (about 1.8 m thick) layer of coal-tar and aggregate (LAE 59MY, denoted CTA) was poured on the top of each of the rigid plugs to act as a gas seal. Drag rings were welded to the emplacement at the location of the bottom rigid plug (the formation coupling plug) to insure that the pipe was coupled to the formation at that region. Stemming between the plugs consisted of layers of fines and coarse gravel. The top of the hole (above the top plug) was filled with surface-derived backfill and the emplacement pipe was grouted from about 10 m above the diagnostics canister to the surface. See figure 1.4.

1.3 Instrumentation

Figure 1.5 is a schematic layout of the instrumentation designed to monitor the stemming performance of the HAVARTI event.

Seven stations were fielded in the stemming to monitor pressure and radiation. Two of these spanned the deep fines layer between 172 and 157 m depth, two stations were placed in the coarse stemming on either side of the deepest rigid plug and there was one station fielded in the coarse stemming 6 or 10 m below each of the remaining three rigid stemming plugs.

Standard LLNL vertical motion canisters, containing variable reluctance velocity and acceleration transducers, were emplaced in the deepest rigid stemming plug, the ground surface, 15.24 m from SGZ, and in the recording trailer.

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

Two CLIPER sensors, one attached to the emplacement pipe and one to the instrumentation pendant, were fielded to estimate device yield and to monitor cavity collapse and chimney formation. Results of the yield measurement are reported elsewhere⁽³⁾. A "D-cable" was fielded on the instrumentation pendant to monitor the stemming emplacement and was recorded post-shot to sense collapse.

After emplacement, but before stemming, it was found that station 21 (in the deepest rigid plug) was compromising the trailer electronics and it was decided to disconnect this station.

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 U10bg.

Figure 1.2 Surface map of the local region around hole U10bg showing some of the surface faulting and other drill holes.

Figure 1.3 East-West geologic cross section through hole U10bg.

Figure 1.4 As-built stemming plan for the event HAVARTI in Hole U10bg.

Figure 1.5 As-built containment instrumentation plan for the emplacement hole (U10bg) on the HAVARTI event.

2. Stemming Performance

2.1 Radiation and Pressure

Pressure and radiation stations were fielded on the HAVARTI at seven locations as indicated in figure 1.5. Wave forms of the data recorded at these locations between about 15 minutes before detonation to 24 hours after detonation of HAVARTI are shown in figures 2.1-2.7. All pressure records can be explained by ground motion with the exception of that from station 34 (figure 2.4) which was noisy for the first 10,000 s. Only the three stations below the formation coupling plug (deepest rigid plug) detected significant radiation as shown in figures 2.1 - 2.3. However only the deepest location (station 31, figure 2.1, below the fines layer) showed radiation before a subsurface collapse. There, the first radiation arrival was about 60 s. First arrivals of the radiation at subsequent stations was at about 2000 s, after subsurface collapse at about 1780 s.

Early time structure (the first 2400 seconds) of the pressure and radiation wave forms measured at and below the deepest rigid plug are shown in figures 2.8 - 2.11. These show the details of the records through subsurface collapse.

No radiation arrival was detected above the deepest rigid plug and the radiation data are consistent with satisfactory containment.

2.2 Motion

Explosion-induced histories of the motion measured in the stemming column and on the ground surface during the HAVARTI event are shown in figures 2.12-2.14. Characteristics of the associated motion and transducers are given in tables 2.1-2.3. Early motion arrival seen in figure 2.12 was likely due to pipe motion coupled through the drag rings in the plug.

2.3 Collapse phenomena

No collapse-induced motion was detected at any station. CLIPER data are not available and the D-cable data, although recorded on analog tape, are not in a form that is amenable to interpretation. The only indication of collapse was seen in the pressure and radiation records at stations below the deepest rigid plug. See figures 2.8 - 2.11.

Figure 2.15, a composite of the pressure histories measured at stations 31, 32, and 33 during the time interval including the subsurface collapse and the late radiation arrivals, indicates that the collapse progressed in two major stages at 1780 s and 1790 s. The earlier was the predominant of the two at the stations surrounding the fines layer (stations 31 and 32) while the second pressure drop was the major feature seen at station 33, just below the fines layer under the bottom rigid plug. The pressure recovery of station 33 was slow, suggesting that the station was nearly uncovered and gas diffused into the resulting vacuum from a relatively low permeability formation. This further suggests that the emplacement hole in the region of the bottom plug was still intact and the top of the chimney was below that elevation.

A composite of the radiation histories measured at stations 31, 32, and 33 during the time interval including the subsurface collapse and the late radiation arrivals is shown in figure 2.16. It postulated that, as the stemming fell at station 31, it reduced the radiation mean-free-path (increased shielding) from the source (radioactive gas percolating through the stemming after collapse) to the detector thus reducing the radiation signal. Radiation was seen to arrive at stations 32 and 33 at about 2000 s, more than 200 s after the stemming fall. The peak of the radiation at station 33 was more than two orders of magnitude greater than that at station 32, (figures 2.2 and 2.3) suggesting that the shielding afforded by the stemming was much reduced at station 33 in agreement with the stemming falling away from station 33 as postulated from the pressure records.

Figure 2.1 Pressure and radiation measured in the coarse stemming below the deep fines layer (station 31 at a depth of 171.9 m). Total time span is about 24 hours.

Figure 2.2 Pressure and radiation measured in the coarse stemming above the deep fines layer (station 32 at a depth of 156.7 m). Total time span is about 24 hours.

Figure 2.3 Pressure and radiation measured in the coarse stemming below the deep rigid plug (station 33 at a depth of 149.0 m). Total time span is about 24 hours.

Figure 2.4 Pressure and radiation measured in the coarse stemming above the deep rigid plug (station 34 at a depth of 135.3m). Total time span is about 24 hours.

Figure 2.5 Pressure and radiation measured in the coarse stemming below the second rigid plug (station 35 at a depth of 86.9 m). Total time span is about 24 hours.

Figure 2.6 Pressure and radiation measured in the coarse stemming below the third rigid plug (station 36 at a depth of 67.1 m). Total time span is about 24 hours.

Figure 2.7 Pressure and radiation measured in the coarse stemming below the top rigid plug (station 37 at a depth of 44.5 m). Total time span is about 24 hours.

Figure 2.8 Pressure and radiation measured in the coarse stemming below the deep fines layer (station 31 at a depth of 171.9 m). Time span is from 50 s before detonation until 2400 s after and includes signals from the subsurface collapse.

Figure 2.9 Pressure and radiation measured in the coarse stemming above the deep fines layer (station 32 at a depth of 156.7 m). Time span is from 50 s before detonation until 2400 s after and includes signals from the subsurface collapse.

Figure 2.10 Pressure and radiation measured in the coarse stemming below the deep rigid plug (station 33 at a depth of 149.0 m). Time span is from 50 s before detonation until 2400 s after and includes signals from the subsurface collapse.

Figure 2.11 Pressure and radiation measured in the coarse stemming above the deep rigid plug (station 34 at a depth of 135.3m). Time span is from 50 s before detonation until 2400 s after. No indication of subsurface collapse is observed at this station or at any shallower depth.

Figure 2.12 Explosion-induced vertical motion of the deep rigid plug (station 21 at a depth of 141.2 m). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.13 Explosion-induced vertical motion of the ground surface (station 261 at a depth of 1.22 m and horizontal range of 15.24 m). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.14 Explosion-induced vertical motion of the recording trailer (station 71). The traces annotated with "a" are derived from the acceleration while the velocimeter-derived signals are shown as heavy traces.

Figure 2.15 Pressure histories during subsurface collapse at stations below the formation coupling plug (bottom rigid plug). Each of the stations was fielded in coarse stemming near a layer of fines material.

Figure 2.16 Radiation histories during subsurface collapse at stations below the formation coupling plug (bottom rigid plug). Each of the stations was fielded in coarse stemming near a layer of fines material.

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)
21av	63.6	15(a), 41	7.9, 115(b)	0.6	1.2	-0.5
21uv		42	-	0.62	1.2	-0.7
61av	205	157	1.8, 10.4(c)	0.29	0.9	-0.5
61uv		165	-	0.30	0.9	-0.5
71av	229(d)	185	0.9	0.28	1.2	-0.5
71uv		195	-	0.28	1.2	-0.2

(a) Pipe response.

(b) Re-compaction wave.

(c) Slap-down.

(d) Approximate; Station was in recording trailer.

Table 2.2 Containment-Related Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
21av	610	0.65	40
61av	192	0.75	10
71av	185	0.75	10

(a) Not available.

Table 2.3 Containment-Related Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°F)	Operate Temperature (°F)	System Range (m/s)
21uv	3.42	12.00	74.8	107.6	2
61uv	3.63	9.95	74.0	81.1	2
71uv	3.00	11.06	74.2	70.9	4

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4. Troy L. Williams, "Special Measurements Final Engineering Report HAVARTI, U10bg", EG&G, Energy Measurements, Las Vegas, NV, SM:81E-88-29, 27 August, 1981.
5. Troy L. Williams, "Special Measurements Physics?Instrumentation Package for HAVARTI, U10bg, (Final) ", EG&G, Energy Measurements, Las Vegas, NV, SM:81E-88-26, 27 August, 1981.

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