KRYDOST

Containment Data Report

T. Stubbs
R. Heinle

May 1995

This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the Laboratory.

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

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

This report has been reproduced
directly from the best available copy.

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information
P.O. Box 62, Oak Ridge, TN 37831
Prices available from (615) 576-8401, FTS 626-8401

Available to the public from the
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

KRYDOST 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	yes	yes	yes
Surface	yes	yes	yes
Plug	yes	yes	yes
Stemming	no	-	-
Surface Casing	no	-	-
Emplacement Pipe	no	-	-
<u>Hydroyield</u> (a)	yes	yes	no
<u>Collapse</u> (b)	yes	yes	yes
<u>Stress</u>	no	-	-
<u>Strain</u> (c)	yes	no	-
<u>Other Measurements</u> (d)	yes	yes	yes

- (a) CORTEX or SLIFER in emplacement hole.
(b) EXCOR or CLIPER in emplacement hole.
(c) Emplacement pipe.
(d) Motion across an intersecting fault.

Event Personnel

Containment Physics

B. Hudson	LLNL
C. Olsen	LLNL
J. Kalinowski	EG&G/AVO
T. Stubbs	EG&G/AVO

Instrumentation

C. Cordill	LLNL
R. Salazar	EG&G/AVO
B. W. Bellow	EG&G/NVO
R. Sievert	EG&G/NVO

MASTER

Contents

[illegible]

1. Event Description

1.1 Site

The KRYDOST event was detonated in hole U2co of the Nevada Test Site as indicated in figure 1.1. The device had a depth-of-burial (DOB) of 335 m in the Paintbrush tuff of Area 2, about 200 m above the Paleozoic and about 260 m above the standing water level, as shown in figures 1.2 and 1.3⁽¹⁾. Stemming of the 2.44 m diameter emplacement hole followed the plan shown in figure 1.4. An additional exploratory hole (Ue2co) was drilled 15.24 m to the south-south east of the emplacement hole. This hole was grouted from depth to the surface. A log of the stemming operations was maintained by Holmes & Narver⁽²⁾.

During drilling, a deeply dipping fault was discovered to intersect both the emplacement and the satellite holes and an associated antithetic fault also found to intersect the emplacement hole as seen in figures 1.2 and 1.3.

Detonation time was 13:00 PDT on May 6, 1982 and about 3 hours later a subsurface collapse to about half the DOB occurred.

No radiation arrivals were detected above the ground surface and the KRYDOST 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 KRYDOST event.

The three stemming plugs were composed of two-part epoxy (TPE). A layer of coal tar aggregate (CT/A) was poured on the top of each of the top two TPE plugs to act as a gas seal.

Pressure and radiation was monitored in the coarse stemming about 4 m beneath the bottom surfaces of each of the three stemming plugs. Similar stations were fielded at two locations in the coarse stemming between the device canister and the deepest plug and also about 13m above each of the deepest two plugs.

Vertical motion was monitored in each of the three plugs in the emplacement hole and at two locations in the satellite hole corresponding to bottom two stemming plugs in the emplacement hole.

The geologic feature of a fault transecting both the emplacement and satellite holes afforded an unique opportunity to monitor the motion across a fault during a nuclear detonation. Tri-axial motion was monitored in the satellite hole Ue2co at four stations fielded symmetrically across the fault at vertical distances of 12 and 24 m from it (figure 1.6). The top tri-axial station in the satellite hole was at nearly the same slant range from the working point as the vertical motion station in the bottom plug of the emplacement hole.

The ground surface motion was motored at four tri-axial stations, as shown in figure 1.7. Three of the surface stations were at 167 m (roughly 0.5 DOB) from surface ground zero (SGZ) while the fourth (station 61) was 15.24 m from SGZ. All were buried 0.91 m in the ground surface. Stations 61 and 62 lay on a line roughly normal to the strike (N13°E) of the fault. Stations 63 was placed northeast of SGZ so that it would be approximately the same distance from the fault strike as station 62. Station 64 was fielded southwest of SGZ, symmetrically between stations 62 and 63.

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

Two CLIPER/CORRTEX sensors were emplaced in the emplacement hole and one in the satellite hole, as indicated in figures 1.5 and 1.6, to measure the hydrodynamic yield of the device and to monitor cavity collapse and chimney formation. Results of the yield measurements are reported elsewhere⁽³⁾.

A history of the fielding operations of the instrumentation, including the emplacement pipe strain measurements, is outlined in reference 4. Details of the instrumentation are given in reference 5.

1.3. Emplacement

A single strain station (99) was fielded near the top of the emplacement pipe to monitor the load during installation and stemming. This station was monitored randomly during these procedures and was recorded by hand during the device installation only. Emplacement was detailed by Holmes & Narver⁽²⁾. The stemming plugs consisted of three "LAE 59" epoxy plugs. The bottom two were about 4 m thick while the top was 6.4 m thick. Both of the top two plugs were capped with about 1.6 m of soft "LAE 59 MY" epoxy to act as a gas sealant. Stemming between the plugs consisted of layers of fines and coarse gravel, each about 60 m thick. The top of the hole (above the top plug) was filled with ground surface derived backfill. See figure 1.4.

Figure 1.1 Map of the Nevada Test Site indicating the location of hole U2co.

Figure 1.3 Southwest-Northeast geologic cross sections through hole U2co.

Figure 1.4 As-built stemming plan for the event KRYDDOST in Hole U2co.

1877
 1878
 1879
 1880
 1881
 1882
 1883
 1884
 1885
 1886
 1887
 1888
 1889
 1890
 1891
 1892
 1893
 1894
 1895
 1896
 1897
 1898
 1899
 1900
 1901
 1902
 1903
 1904
 1905
 1906
 1907
 1908
 1909
 1910
 1911
 1912
 1913
 1914
 1915
 1916
 1917
 1918
 1919
 1920
 1921
 1922
 1923
 1924
 1925
 1926
 1927
 1928
 1929
 1930
 1931
 1932
 1933
 1934
 1935
 1936
 1937
 1938
 1939
 1940
 1941
 1942
 1943
 1944
 1945
 1946
 1947
 1948
 1949
 1950
 1951
 1952
 1953
 1954
 1955
 1956
 1957
 1958
 1959
 1960
 1961
 1962
 1963
 1964
 1965
 1966
 1967
 1968
 1969
 1970
 1971
 1972
 1973
 1974
 1975
 1976
 1977
 1978
 1979
 1980
 1981
 1982
 1983
 1984
 1985
 1986
 1987
 1988
 1989
 1990
 1991
 1992
 1993
 1994
 1995
 1996
 1997
 1998
 1999
 2000
 2001
 2002
 2003
 2004
 2005
 2006
 2007
 2008
 2009
 2010
 2011
 2012
 2013
 2014
 2015
 2016
 2017
 2018
 2019
 2020
 2021
 2022
 2023
 2024
 2025
 2026
 2027
 2028
 2029
 2030
 2031
 2032
 2033
 2034
 2035
 2036
 2037
 2038
 2039
 2040
 2041
 2042
 2043
 2044
 2045
 2046
 2047
 2048
 2049
 2050
 2051
 2052
 2053
 2054
 2055
 2056
 2057
 2058
 2059
 2060
 2061
 2062
 2063
 2064
 2065
 2066
 2067
 2068
 2069
 2070
 2071
 2072
 2073
 2074
 2075
 2076
 2077
 2078
 2079
 2080
 2081
 2082
 2083
 2084
 2085
 2086
 2087
 2088
 2089
 2090
 2091
 2092
 2093
 2094
 2095
 2096
 2097
 2098
 2099
 2100
 2101
 2102
 2103
 2104
 2105
 2106
 2107
 2108
 2109
 2110
 2111
 2112
 2113
 2114
 2115
 2116
 2117
 2118
 2119
 2120
 2121
 2122
 2123
 2124
 2125
 2126
 2127
 2128
 2129
 2130
 2131
 2132
 2133
 2134
 2135
 2136
 2137
 2138
 2139
 2140
 2141
 2142
 2143
 2144
 2145
 2146
 2147
 2148
 2149
 2150
 2151
 2152
 2153
 2154
 2155
 2156
 2157
 2158
 2159
 2160
 2161
 2162
 2163
 2164
 2165
 2166
 2167
 2168
 2169
 2170
 2171
 2172
 2173
 2174
 2175
 2176
 2177
 2178
 2179
 2180
 2181
 2182
 2183
 2184
 2185
 2186
 2187
 2188
 2189
 2190
 2191
 2192
 2193
 2194
 2195
 2196
 2197
 2198
 2199
 2200
 2201
 2202
 2203
 2204
 2205
 2206
 2207
 2208
 2209
 2210
 2211
 2212
 2213
 2214
 2215
 2216
 2217
 2218
 2219
 2220
 2221
 2222
 2223
 2224
 2225
 2226
 2227
 2228
 2229
 2230
 2231
 2232
 2233
 2234
 2235
 2236
 2237
 2238
 2239
 2240
 2241
 2242
 2243
 2244
 2245
 2246
 2247
 2248
 2249
 2250
 2251
 2252
 2253
 2254
 2255
 2256
 2257
 2258
 2259
 2260
 2261
 2262
 2263
 2264
 2265
 2266
 2267
 2268
 2269
 2270
 2271
 2272
 2273
 2274
 2275
 2276
 2277
 2278
 2279
 2280
 2281
 2282
 2283
 2284
 2285
 2286
 2287
 2288
 2289
 2290
 2291
 2292
 2293
 2294
 2295
 2296
 2297
 2298
 2299
 2300
 2301
 2302
 2303
 2304
 2305
 2306
 2307
 2308
 2309
 2310
 2311
 2312
 2313
 2314
 2315
 2316
 2317
 2318
 2319
 2320
 2321
 2322
 2323
 2324
 2325
 2326
 2327
 2328
 2329
 2330
 2331

DEPTH		STA	MEAS
FEET (METERS)	FEET (METERS)		
U2C0	SC0 (15.24)	98	TH

96° SURFACE CONDUCTOR

SEALING PLUG

BOTTOM OF LINER

117.0 (35.56)

120.0 (36.58)

RIGID PLUG

SEALING PLUG

343.5 (104.70)

338.5 (103.17)

348.9 (105.34)

256.0 (90.22)

134.0 (40.84)

130.5 (39.78)

129.8 (39.56)

110.5 (33.68)

109.3 (33.30)

6.4 (1.55)

3.0 (1.22)

61 — UV,AV

93 — 56

23 — UV,AV

89 — T₁ B,E,W

88 — DY

87 — DY

37 — R_A,P,X,T

36 — R_A,P,X,T

86 — T₁ B

Figure 1.6 As-built instrumentation plan for the satellite hole (Ue2co) on the KRYDOST event.

Figure 1.7 As-built instrumentation plan for the surface motion array on the KRYDOST event.

2. Stemming Performance

2.1 Radiation and Pressure

As seen in figure 1.5, pressure and radiation was monitored in the coarse stemming at a total of seven stations. Three stations were placed about 4 m beneath the bottom surfaces of each of the three stemming plugs. Similar stations were fielded at two locations in the coarse stemming between the device canister and the deepest plug and also about 13 m above plugs 1 and 2.

Pressure and radiation histories from about 100 seconds before detonation until about 1200 s after loss of signal at cavity collapse (about 3 hours later) or until recording was terminated are shown in figures 2.1-2.7. One analog tape holds about 3 hours of data requiring that six tapes be analyzed to produce the data represented in figures 2.5 - 2.7. The gaps in the records of those figures reflect the times required for manually re-mounting the tapes during recording.

No radiation arrivals were seen at any station at any time. Pressure histories at stations 31 and 32 are quite similar: an initial jump of about 0.8 psi decaying to about 0.3 psi above ambient at late time. The primary difference is that the pressure at station 31 decays more slowly than that at station 32. The pressure histories of the remaining stations are unremarkable.

All pressure and radiation data are consistent with satisfactory containment.

Figure 2.1 Pressure and radiation measured in the coarse stemming at 251 m depth, below the deepest stemming plug 1 (Station 31). Signals were lost at subsurface collapse time (3 hours, 37 s).

Figure 2.2 Pressure and radiation measured in the coarse stemming at 233 m depth, below the deepest stemming plug 1 (Station 32). Signals were lost at subsurface collapse time (3 hours, 37 s).

Figure 2.3 Pressure and radiation measured in the coarse stemming at 205 m depth, below the deepest stemming plug 1 (Station 33). Signals were lost at subsurface collapse time (3 hours, 37 s).

Figure 2.4 Pressure and radiation measured in the coarse stemming at 183 m depth, above the deepest stemming plug 1 (Station 34). Signals were lost at subsurface collapse time (3 hours, 37 s).

Figure 2.5 Pressure and radiation measured in the coarse stemming at 112.5 m depth, below stemming plug 2 (Station 35). Signals were never lost; gaps in the records are due to the requirement for analog tape change.

Figure 2.6 Pressure and radiation measured in the coarse stemming at 90 m depth, above stemming plug 2 (Station 36). Signals were never lost; gaps in the records are due to the requirement for analog tape change.

Figure 2.7 Pressure and radiation measured in the coarse stemming at 112.5 m depth, below the top stemming plug 3 (Station 37). Signals were never lost; gaps in the records are due to the requirement for analog tape change.

2.3 Motion

Explosion-induced histories of the containment related motion measured on the KRYDOST event are shown in figures 2.8-2.13. Characteristics of the associated motion and transducers are given in tables 2.1-2.3. For clarity, station 61 motion histories are also shown in section 4, "Motion of the Ground Surface".

2.4 Collapse phenomena

The CLIPER cables in the emplacement hole (stations 91 and 93) and in the satellite hole (station 51) performed as expected, giving the lower position of the cable end as a function of time during the cavity collapse. The cable of station 91 was attached to the device canister and emplacement pipe while that for station 93 was hung in the hole along with the containment instrumentation. These data are shown in figure 2.14 along with selected pressure wave forms (not to vertical scale). Collapse is seen to progress to about the upper surface of the bottom stemming plug (a depth of about 200 m) while the satellite hole registers collapse to a depth of about 170 m. An additional, final collapse in the satellite hole to a depth of 154 m (not shown) occurred at 3 hours, 11 m, and 43 s.

While the field crew was in the instrumentation trailer, changing the analog tapes, they experienced slight ground tremors indicating that a subsurface collapse had occurred. Unfortunately, the tape machines that were off-line at the time were dedicated to the motion so the collapse motion was not captured.

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) ^(b)
21av	135.9	31(a), 60	7.1	2.2	0.23	0.15
21uv		-	-	2.1	0.23	0.16
22av	228.9	53(a), 116	2.4	0.47	0.040	0.013
22uv		-	-	0.45	0.040	-0.005
23av	301.9	75(a), 161	1.35	0.45	0.057	0.007
23uv		-	-	0.50	0.051	0.002
61av	334.3	191	2.5, 5.3(c)	0.79	0.071	-0.007
61uv		198	-	0.78	0.070	-0.008
61ur		210	-	0.47	0.035	-0.019
61ut		200	-	0.09	0.010	-0.007

(a) Pipe-induced motion.

(b) Estimate.

(c) Slap-down peak.

Table 2.2 Containment-Related Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
21av	620	0.60	24
22av	320	0.75	12
23av	270	0.65	6
61av	264	0.65	24

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	3.64	11.5	74.5	104.8	8
22uv	3.41	9.9	74.4	98.58	4
23uv	3.62	10.4	74.5	103.75	4
61uv	3.50	10.0	73.9	61.68	8
61ur	3.05	10.1	75.3	61.68	4
61ut	3.03	8.9	75.0	61.68	4

Figure 2.8

Explosion-induced vertical motion of the bottom stemming plug at a depth of 199 m (station 21). Traces annotated with "a" are derived from the accelerometer.

Figure 2.9

Explosion-induced vertical motion of the middle stemming plug at a depth of 106 m (station 22). Traces annotated with "a" are derived from the accelerometer.

Figure 2.10 Explosion-induced vertical motion of the top stemming plug at a depth of 33 m (station 23). Traces annotated with "a" are derived from the accelerometer.

Figure 2.11 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). Traces annotated with "a" are derived from the accelerometer.

Figure 2.12 Explosion-induced horizontal-radial motion of the ground surface at a horizontal range of 15.24 m and a depth of 0.9 m (station 61).

Figure 2.13 Explosion-induced horizontal-transverse motion of the ground surface at a horizontal range of 15.24 m and a depth of 0.9 m (station 61).

Figure 2.14 Progression of the collapse as determined from the CLIPER records (stations 51, 91, and 93). The upper limit of the subsurface collapse is indicated to be at a depth of about 150 m (a later, single collapse that registered in the satellite hole occurred at 3h, 11m, 43 s).

4. Motion in the satellite hole

Five stations were fielded in the grout of the satellite hole Ue2co (17.06 m from the emplacement hole at a bearing of S 26:55:21 E). Four of these held tri-axial acceleration and velocity transducers and the fifth contained instrumentation for vertical motion only. The four tri-axial stations were placed symmetrically about a fault that transected the hole at a depth of about 223 m. Since the fault had a dip of 72° , this intersection expressed itself over about 1 m of depth of the .31 m diameter hole. The station elevations were -24, -12, +12 and +24 m with respect to the elevation of the fault transection. The fifth station was fielded 87 m above the top of the four tri-axial stations and at nearly the same slant range from the WP as the middle stemming plug in the emplacement hole.

Explosion-induced histories of the motion measured in the satellite hole on the KRYDOST event are shown in figures 3.1–3.13. Characteristics of the associated motion and motion transducers are given in tables 3.1–3.3.

Figure 3.14 compares the first second of the vertical velocity histories of the emplacement hole with those of the satellite hole. The early character (before 0.4 s) of the vertical velocity wave forms from the two stations immediately above the fault (stations 43 and 44) are quite different from the rest of the wave forms from both the emplacement and satellite holes. This may be due to motion of the fault or the difference in dynamic impedance of the layers displaced by the fault. The latter is the more likely. Figure 3.15 shows a rough geologic cross section (see reference 1) through the two holes indicating the various layers of the medium.

Table 3.1 Summary of Satellite Hole Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (m)	Displacement Residual (m)
41av	89.65	40	12.5	8	(a)	(a)
41uv		-	-	3.4	0.305	0.25
41ar		38	7.0	2.95	0.28	(a)
41ur		-	-	3.9	.335	0.28
41at		45	3	1.10	0.05	(a)
41ut		-	-	1.24	0.06	-0.14
42av	101.6	45	11.0	(a)	(a)	(a)
42uv		-	-	2.76	0.28	0.20
42ar(c)	-	-	-	-	-	-
42ur		-	-	1.74	0.079	0.30
42at		44	± 3.5	-1.56	-0.12	(b)
42ut		-	-	-1.44	-0.12	-0.10
43av(c)	125.4	-	-	-	-	-
43uv		59	-	0.86	0.094	0.06
43ar		60	1.3	1.05	0.13	0.11
43ur		-	-	1.05	0.13	0.10
43at		60	3.1	0.13, -0.58	0.004, -0.030	0.05
43ut(c)		-	-	-	-	-
44av(d)		-	-	-	-	-
44uv	137.3	66	-	0.73	0.075	0.045
44ar(c)		-	-	-	-	-
44ur		62	-	0.84	0.105	0.085
44at		63	1.1, -2.0	-0.74	-0.058	-0.035
44ut		63	-	-0.74	-0.54	-0.20
45av(c)		-	-	-	-	-
45uv	223.8	113	-	0.46	0.042, 0.060	0.015

(a) Noise level too high to estimate.

(b) Value not determined.

(c) Gauge destroyed at zero time.

(d) Bad gauge: no data.

Table 3.2 Satellite Hole Accelerometer Characteristics

<u>Gauge</u>	<u>Natural Frequency (Hz)</u>	<u>Damping Ratio</u>	<u>System Range (g's)</u>
41av	1740	0.65	1000
41ar	1620	0.65	800
41at	1700	0.85	800
42av	1600	0.65	1000
42ar	1850	0.65	400
42at	1580	0.65	400
43av	1700	0.65	600
43ar	935	0.60	200
43at	975	0.55	200
44av	1300	0.65	300
44ar	945	0.65	120
44at	995	0.65	120
45av	260	0.65	8

Table 3.3 Satellite Hole Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°C)	Operate Temperature (°C)	System Range (m/s)
41uv	4.20	17.75	75.2	73.76	48
41ur	3.12	8.25	74.7	73.76	16
41ut	3.16	8.25	74.7	73.76	16
42uv	3.90	22.8	73.9	73.2	32
42ur	3.04	8.45	74.3	73.2	10
42ut	3.03	8.50	74.3	73.2	10
43uv	3.56	8.5	74.6	71.88	12
43ur	3.03	8.60	75.1	71.88	6
43ut	3.03	9.05	74.9	71.88	6
44uv	3.66	8.18	74.4	70.94	8
44ur	3.03	9.00	75.1	70.94	4
44ut	3.03	9.30	74.8	70.94	4
45uv	3.74	7.40	75.11	66.88	8

Figure 3.1 Explosion-induced vertical motion of the satellite hole at a depth of 247 m (station 41, 24 m below the fault intersection with the hole). Traces annotated with "a" are derived from the accelerometer. Displacement could not be derived from the acceleration.

Figure 3.2

Explosion-induced horizontal-radial motion of the satellite hole at a depth of 247 m (station 41, 24 m below the fault intersection with the hole). Traces annotated with "a" are derived from the accelerometer.

Figure 3.3

Explosion-induced horizontal-transverse motion of the satellite hole at a depth of 247 m (station 41, 24 m below the fault intersection with the hole). Traces annotated with "a" are derived from the accelerometer.

Figure 3.4

Explosion-induced vertical motion of the satellite hole at a depth of 235 m (station 42, 12 m below the fault intersection with the hole). No quadrature of the acceleration was attempted.

Figure 3.5 Explosion-induced horizontal-radial motion of the satellite hole at a depth of 235 m (station 42, 12 m below the fault intersection with the hole).

Figure 3.6

Explosion-induced horizontal-transverse motion of the satellite hole at a depth of 235 m (station 42, 12 m below the fault intersection with the hole). Traces annotated with "a" are derived from the accelerometer.

Acceleration channel lost at zero time.

Figure 3.7 Explosion-induced vertical motion of the satellite hole at a depth of 211 m (station 43, 12 m above the fault intersection with the hole).

Figure 3.8

Explosion-induced horizontal-radial motion of the satellite hole at a depth of 211 m (station 43, 12 m above the fault intersection with the hole). Traces annotated with "a" are derived from the accelerometer.

Figure 3.9

Explosion-induced horizontal-transverse motion of the satellite hole at a depth of 211 m (station 43, 12 m above the fault intersection with the hole). No velocimeter data were reduced: the gauge was destroyed at zero time.

Figure 3.10 Explosion-induced vertical motion of the satellite hole at a depth of 199 m (station 44, 24 m above the fault intersection with the hole).

Acceleration channel lost at zero time.

Figure 3.11 Explosion-induced horizontal-radial motion of the satellite hole at a depth of 199 m (station 44, 24 m above the fault intersection with the hole).

Figure 3.12 Explosion-induced horizontal-transverse motion of the satellite hole at a depth of 199 m (station 44, 24 m above the fault intersection with the hole). Traces annotated with "a" are derived from the accelerometer.

Figure 3.13 Explosion-induced vertical motion of the satellite hole at a depth of 112 m (station 45). No quadrature of the acceleration was attempted.

Figure 3.14 Comparison of all vertical velocity histories obtained at depths greater than 100 m on the KRYDOST event.

Figure 3.15 Expansion of the geologic cross section of figure 1.2⁽¹⁾ detailing the formations around the emplacement and satellite holes.

4. Motion of the ground surface

The position of the tri-axial motion stations of the surface array are given the following table and the characteristics of the associated motion and transducers are given in tables 4.1–4.3. Station 61 is usually considered to be part of the containment diagnostics and, as such, is also included in section 2. "Stemming Performance".

station	horizontal range from SGZ (m)	Surface elevation relative to SGZ (m)	Bearing (deg:min:sec)
61	15.24	-.91	N 72:59:58 W
62	167.0	6.26	N 73:00:00 W
63	167.0	-2.49	N 28:00:00 E
64	167.0	-4.50	S 22:30:00 E

Explosion-induced histories of the surface motion measured on the KRYDOST event are shown in figures 4.1–4.12 and figure 4.13 shows the first one second of horizontal displacement trajectory for all of the stations in their proper locations along with the surface projection of the fault being investigated.

Table 4.1 Summary of Surface Array Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (m)	Displacement Residual (m)
61av	334.4	191	2.5, 5.3(a)	0.79	0.071	-0.007
61uv		198	-	0.78	0.070	-0.008
61ur		210	-	-0.06, 0.47	-0.008, 0.035	-0.019
61ut		200	-	0.10, -0.70	0.010, -0.020	-0.007
62av	379.9	213	1.7, 10.2(a, b)	0.50	0.042	-0.04
62uv		213	-	0.52	0.044	-0.03
62ar		216	0.5, 3.2	0.30	0.045	0.010
62ur		216	-	0.24	0.036	0.010
62at		220	0.37, 1.85	0.33	0.068	0.03
62ut		220	-	0.20	0.040	0.0
63av	372.1	213	1.4, 5.3(a, c)	0.50	0.043	0.01
63uv		213	-	0.52	0.043	-0.04
63ar		215	0.7, ± 1.6	0.36	0.041	0.018
63ur		215	-	0.37	0.041	0.018
63at		223	0.2, -2.65	0.10	0.008	-0.025
63ut		225	-	0.12	0.01	-0.018
64av	370.3	215	1.9, 2.9(a)	0.61	0.057	0.04
64uv		215	-	0.62	0.054	-0.03
64ar		217	0.54, 1.15	0.40	0.118	-0.015
64ur		217	-	0.43	0.115	0.015
64at		216	0.32, 0.42	0.24	0.025	-0.01
64ut		217	-	0.26	0.031	-0.03

(a) Slap-down peak.

(b) Peak probably greater than this value.

(c) Estimate.

Table 4.2 Surface Array Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
61av	264	0.65	24
62av	175	0.65	8
62ar	145	0.65	4
62at	142	0.65	4
63av	233	0.75	8
63ar	143	0.75	4
63at	188	0.75	4
64av	182	0.65	8
64ar	148	0.65	4
64at	153	0.85	4

Table 4.3 Surface Array Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°C)	Operate Temperature (°C)	System Range (m/s)
61uv	3.50	10.0	73.9	61.68	8
61ur	3.05	10.1	75.3	61.68	4
61ut	3.03	8.9	75.0	61.68	4
62uv	3.67	10.45	75.5	63.30	8
62ur	3.03	8.95	74.8	63.30	4
62ut	3.03	9.0	74.5	63.30	4
63uv	3.50	12.85	73.8	62.69	8
63ur	3.03	8.8	74.6	62.69	4
63ut	3.03	8.9	74.6	62.69	4
64uv	3.50	11.72	75.4	63.10	8
64ur	3.05	9.1	74.6	63.10	4
64ut	3.03	9.2	74.7	63.10	4

Figure 4.1

Explosion-induced vertical motion of the ground surface (station 61 at a horizontal range of 15.24 m and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

The acceleration channel was not fielded.

Figure 4.2

Explosion-induced horizontal-radial motion of the ground surface (station 61 at a horizontal range of 15.24 m and a depth of 0.9 m). Solid squares represent the active locations for this figure.

The acceleration channel was not fielded.

Figure 4.3

Explosion-induced horizontal-transverse motion of the ground surface (station 61 at a horizontal range of 15.24 m and a depth of 0.9 m). Solid squares represent the active locations for this figure.

Figure 4.4

Explosion-induced vertical motion of the ground surface (station 62 at a horizontal range of 164.7 m west-northwest of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.5

Explosion-induced horizontal-radial motion of the ground surface (station 62 at a horizontal range of 164.7 m west-northwest of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.6

Explosion-induced horizontal-transverse motion of the ground surface (station 62 at a horizontal range of 164.7 m west-northwest of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.7

Explosion-induced vertical motion of the ground surface (station 63 at a horizontal range of 164.7 m east-northeast of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.8

Explosion-induced horizontal-radial motion of the ground surface (station 63 at a horizontal range of 164.7 m east-northeast of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.9

Explosion-induced horizontal-transverse motion of the ground surface (station 63 at a horizontal range of 164.7 m east-northeast of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.10 Explosion-induced vertical motion of the ground surface (station 64 at a horizontal range of 164.7 m south-southwest of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.11

Explosion-induced horizontal-radial motion of the ground surface (station 64 at a horizontal range of 164.7 m south-southwest of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.12

Explosion-induced horizontal-transverse motion of the ground surface (station 64 at a horizontal range of 164.7 m south-southwest of SGZ and a depth of 0.9 m). Traces annotated with "a" are derived from the accelerometer. Solid squares represent the active locations for this figure.

Figure 4.13 Displacement trajectories of the four surface stations in the horizontal plane. Trajectories consist of only the first 1 s of motion.

References

1. Gayle Pawloski and Jeff Wagoner, "U2co Preliminary Site Characteristics Summary", DM 81-22, Lawrence Livermore National Laboratory, Livermore, CA, March 19, 1981.
2. Alfred E. Burer, "Containment Report for U2co," Holmes & Narver, NTS:A2:82-45, May 4, 1982.
3. LLNL contacts for additional information: H. Goldwire and R. A. Heinle (CORTEX and SLIFER data)
4. B. William Bellow, "Special Measurements Final Engineering Report KRYDOST, U2co, Ue2co", EG&G, Energy Measurements, Las Vegas, NV, SM:82E-96-27, 14 June, 1982.
5. B. William Bellow, "Special Measurements Physics/Instrumentation for KRYDOST, U2co, Ue2co, Revision 'B' ", EG&G, Energy Measurements, Las Vegas, NV, SM:82E-96-29, 23 June, 1982.

Distribution:

LLNL

TID (11)	L-053
Test Program Library	L-045
Containment Vault	L-221
Burkhard, N.	L-221
Cooper, W.	L-049
Denny, M.	L-205
Goldwire, H.	L-221
Heinle, R. (5)	L-221
Mara, G.	L-049
Moran, M. T.	L-777
Moss, W.	L-200
Patton, H.	L-205
Pawloski, G.	L-221
Rambo, J.	L-200
Roth, B.	L-049
Valk, T.	L-154
Yunker, L.	L-203

LANL

App, F.	F-659
Brunish, W.	F-659
Kunkle, T.	F-665
Trent, B.	F-664

Sandia

Chabai, A.	MS-1159
Smith, Carl W.	MS-1159

EG&G/AVO

Brown, T.	A-5
Gilmore, L.	A-1
Hatch, M.	A-5
Still, G.	A-5
Stubbs, T.	A-5

EG&G/NVO

Bellow, B.	N 13-20
Davies, L.	N 13-20
Moeller, A.	N 13-20
Robinson, R.	N 13-20
Webb, W.	N 13-20

DNA

Ristvet, B.

S-Cubed

Peterson, E.

Eastman Cherrington Environment
1640 Old Pecos Trail, Suite H
Santa Fe, NM 87504

Keller, C.