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Holes drilled but not loaded or fired.

Seismology location
Feb. 23-24, 1967
Blasts 17-24

Approximate position
of Seismology for ripping tests.
March 1, 1967

Seismology
location
Blasts 12-16

Seismology
location
Blasts 9, 10, 11

Seismology
location
Blast 6, 7, 8

Seismology
location
Blast 3, 4, 5



Seismology
location
Blast 1

Approximate
Seismology
location
Blast 2



BLAST HOLE PLAN
FIGURE 1
BEAL STREET KINGMAN PROJECT F-039-I-503
for
ARIZONA HIGHWAY DEPARTMENT
TAPE AND COMPASS PLAN BY J. N. FAICK
FEB. 15-24, 1967 SCALE 1" = 10 FT.
? HOLE NOT USED, DRILLED, OR IN QUESTION
• SHOT HOLE LOCATION
BLASTS 4* & 10* - SEE FIGURE 2 & TEXT



GEOEXPLORATION COMPANY
 BOX 6871, TUCSON, ARIZONA, 85703
 PHONE: (AREA CODE 602) 823-0876

**BLAST HOLE PLAN
 FIGURE 1
 BEAL STREET KINGMAN PROJECT F-039-I-503
 for
 ARIZONA HIGHWAY DEPARTMENT**

TAPE AND COMPASS PLAN BY J.N. FAICK
 FEB. 15-24, 1967 SCALE 1" = 10 FT.

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 • SHOT HOLE LOCATION
 BLASTS 4* & 10* - SEE FIGURE 2 & TEXT



Seismolog location Blast 1
 Approximate Seismolog location Blast 2
 Power pole

**REPORT OF OBSERVATIONS OF BLASTING
ON BEALE STREET - KINGMAN, ARIZONA**

For

Arizona State Highway Project F-039-1-503

February - March 1967

By

**Heinrichs Geoporation Company
P. O. Box 5671 Tucson, Arizona 85703
Phone: 623-0578 Area Code: 602**

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Copies of logs (28)*	

* With original report only

INTRODUCTION

The Arizona State Highway Department contracted for construction of an extension of Beale Street, Kingman, Arizona to connect with Andy Devine Boulevard, the name assigned to U. S. Highways 66 and 93 within the city. The connection is a short distance east of the Travelodge Motel and much of the right of way is from 25 to 70 feet from its rear wall and parts of one or two other nearby buildings. Blasting of bedrock was required prior to excavation, and Heinrichs Geoexploration Company of Tucson, Arizona was retained by the Arizona Highway Department to observe, record, and report effects.

In order to meet critical time factors and provide maximum technical competence at the site at all times, Dr. John N. Faick was retained by Heinrichs to make the actual observations, take seismic readings and record the results. During the assignment Dr. Faick was continually in close collaboration with employees of the Arizona Highway Department, with the Reel Contracting Company, who did the blasting, and with Vibration Measurement Engineers, a seismological engineering firm located in Evanston, Illinois, whose recorder was used.

On February 13, 1967, Walter E. Heinrichs, Jr., President of Heinrichs, and Dr. John Faick accompanied Mr. Lewis E. Scott, Materials Field Engineer, Arizona State Highway Department, to Kingman and work started on the site the same day.

All personnel and groups represented were completely cooperative and we hereby express our appreciation for this and the material assistance involved.

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Bedrock at the site is composed of a well cemented and indurated fragmental volcanic tuff in a zone about 560 feet long and from 35 to 50 feet wide. This material was drilled with about 990 holes to depths ranging from four to twelve feet and these were loaded with explosives and detonated in 24 separate blasts, the positions of which are shown on the accompanying map (Fig. 1). A total of 4626.35 pounds of

explosives and 2428 caps were used. Each blast was carefully observed and the effects measured with a seismic instrument which permanently recorded on photographic film the resultant vibrations.

Of the 24 separate blasts set off, only No. 1, which was far from the motel, No. 4, and No. 10 which was only 46 feet from where the instrument was placed in the motel, were rated as "danger", or of a possible magnitude which, under some circumstances, might conceivably cause technical damage. No damage was in fact observed or recorded, however.

Blasts 3 through 24 (total 22 excluding 1 and 2) were less than 100 feet from the Travelodge Motel. Of these 22 blasts, 14 were rated "safe", four were rated "caution", and two were rated in the "danger" category and two were unrecorded. Vibrations from drilling and from a passing freight train were slight, as were vibrations caused by ripping with the single tooth ripper pulled with a D-9 bulldozer. See table Fig. 2 and photos attached.

None of the drilling, ripping or blasting caused any apparent damage to the Travelodge Motel or other nearby buildings. The few blasts in the "caution" range seem to have been caused by cumulation effects, or by overlapping detonations from some delays. The first blast rated "danger" because too much explosive was detonated at one time. Blasts No. 4 and No. 10 were rated in the potential danger region due to proximity, overlapping or cumulative reaction of delays adjacent in time or position, too much powder exploded at one or more particular delay instant or times, or combinations of all of these. Cumulation or overlapping is reportedly more frequent with full-second delays than with millisecond delays. Except for these aspects, the blasting procedures followed on this project were entirely satisfactory.

In the future, we suggest more delays and millisecond delays be used rather than full second delays whenever feasible. This will reduce the total and accumulative effects of overlapping explosions of individual charges. More important would be to specify maximum allowable charge and minimum allowable distance that can be detonated at any one shot instant, regardless of kind or amount of delays used, under a given set of conditions.

ORGANIZATION, COMPANIES AND PERSONNEL

All of the planning, designing and preliminary testing was done by personnel of the Arizona Highway Department which also prescribed all specifications and let the contract. Closely associated with this project in positions of responsibility in the Arizona Highway Department are Mr. R. D. Wingfield, Project Supervisor, P. O. Box 990, Kingman, Arizona 86401; Mr. Walter O. Ford, Assistant District Engineer, Phoenix, and Mr. Lewis E. Scott, Materials Engineer, Phoenix, who worked out the design and construction procedures specified for blasting, recording and analysis. An accurate account of all holes loaded and amount of explosives used was recorded for each blast by Mr. Fred Genung, Grade Inspector, Arizona Highway Department.

A memorandum report on Materials Design dated May 4, 1966 and a Special Report on prevention of blasting damage to nearby buildings dated November 30, 1966, both transmitted by Mr. W. G. O'Harra, Engineer of Materials, Phoenix, were placed at our disposal. These reports proved very useful as they provided results of experiments in blasting rock similar to that encountered in the Beale Street Project, and the reports also provided specific recommendations for prevention of damage by blasting. As understood, the recommendations made in these reports were incorporated in the contract drawn for excavation of the roadway but we did not see the actual contract.

THE CONTRACTOR

The contract for blasting and excavation of the roadway was Reel Contracting Inc., Box 2355 Phoenix, Arizona. The project was under the general supervision of Mr. John Williams of Tucson and all blast-hole work, including drilling, loading and detonating was done or directed by Mr. Charles F. Chapman, an experienced, capable, licensed powderman from Phoenix.

HEINRICHS GEOEXPLORATION COMPANY

Drilling and blasting observations were conducted by John N. Faick, P.E., under the supervision of Heinrichs Geoexploration Company, a widely experienced geophysical firm with offices in

Tucson, Arizona. Mr. Walter E. Heinrichs, Jr., P.E., was retained by the Arizona Highway Department, and was in actual charge of the work. Our principal duties were to measure with a recording seismograph the effects of each blast, or other source of disturbance, and to report on the results. Measurements were made with a seismic-type instrument made by Vibration Measurement Engineers and commercially known as Seismolog. This instrument was obtained specifically for this job at the request of the Highway Department because it was used in earlier testing and because legal qualification of its results had been established. However, other equally valid instruments are available and some have the important advantage of immediately providing an interpretable record for use at the site.

VIBRATION MEASUREMENT ENGINEERS INC.

This firm, at P. O. Box 1502, Evanston, Illinois 61530, telephone, DAVIS 80400, has specialized in seismological engineering since 1935, providing instruments, services, and information to users of commercial explosives. Sealed records of observations were sent to them for developing, interpretation, and filing. Contact with them was Mr. Paul C. Hosking, P.E., with whom we were in frequent touch.

The rented instrument was serial no. 155, a three component film recording seismograph, in which the records are acquired on film in a sealed camera. After each blast or other observation, the whole camera was returned immediately by air to Vibration Measurement Engineers. Results of each observation were transmitted back to us within hours on data cards colored pink for danger, yellow for caution and green for safe. Other data were given in terms of energy ratio, frequency in cycles per second and displacement in inches. These cards accompany this report and the information they contain, together with the other relevant factors, are all tabulated on Figure 2 attached herewith.

PROJECT SITUATION

Location of the work was from the east end of Beale Street at survey point 43+00, eastward to the present Highway 66 near survey point 55+00. The most critical zone was immediately behind the Travelodge Motel from about 49+50 to 53+50, a distance

of about 400 feet as shown on Figure 1. Design provided for a road about 40 feet wide trending about N70°W, approximately parallel to the rear wall of the Travelodge Motel. The center line is 40 feet north of the Motel and blasting took place from 24 to 70 feet north of it, with the most intense blasting along a line of holes farthest from the motel. The deepest cut is 10 feet on the north or uphill side of the roadway. The surface slopes toward the motel. Therefore, near the motel the holes were shorter, less powder was required in blasting and the cut shallower than on the north side. The contractor allowed for two feet of overbreak at the bottom of the cut. Only enough powder was used to break and loosen the rock to the extent that it could be dug by regular earth moving equipment. It was not intended that any of the rock should be moved significantly from its normal resting place by use of explosive agents.

GEOLOGY OF THE BEDROCK

The rocks blasted at the Beale Street, Kingman Project consist entirely of volcanic tuff, except in a small area about 50 feet square which is covered with a thin veneer of alluvial material. This tuff is a massive rock composed of an aggregate of small angular rock fragments of diverse igneous characteristics which are compacted and cemented together into a relatively homogeneous mass. Most of the fragments are small, generally being less than an inch in maximum dimensions but a few are as large as about four inches across. The rock is uniform in character and unstratified. Where exposed back of the Travelodge Motel in a cut ranging from about three to 10 feet deep, the rock appears to be broken by a few widely spaced irregular fractures; one of the most prominent is nearly horizontal but others dip steeply west. As the rock is uniform in character, massive, essentially unstratified and only slightly broken by fractures, it probably would react to blasting like a nearly homogeneous mass. Because of its fragmental character and the porous nature of some of the fragments, the rock has a high percentage of pores or voids and has a low specific gravity. It is not especially brittle but probably should be considered resilient or elastic, and free of excessive shattering when blasted.

PRELIMINARY TEST WORK DONE PREVIOUSLY

To determine breaking characteristics and ability of the rock to transmit vibrations induced by blasting, a series of test holes were drilled and blasted in similar rocks of the same formation west of Kingman. These tests were made by the Arizona Highway Department under the direction of Mr. Lewis E. Scott in collaboration with Mr. Thomas J. Ellis, Consulting Geophysicist. The test blasts were made under conditions intended to simulate those on Beale Street and the results were used as a guide in drawing specifications for the contract. It was determined that shock waves or vibrations having a particle displacement of 0.003 inch were safe, i.e., these would not damage nearby buildings, therefore, this was set as a maximum allowable limit of particle displacement specified in the contract. This low limit was selected as a safety precaution although it was not known at that time whether it would be practical or necessary to stay within this limit.

THE CONTRACT

The contract required that a Seismolog or similar recording seismic instrument be used to measure the effects of each blast and that particle displacement resulting from the blast should not exceed 0.003 inch. The contract also defined the critical zone as being within 100 feet of the Travelodge Motel, which places it between survey stations 49+50 and 53+40, a distance of about 400 feet. Within this zone maximum precautions were to be taken against damage to the building by blasting. The area of each blast was to be covered with suitable screen or mats to prevent flying of loose material.

DRILLING AND BLASTING PROCEDURES

The area drilled and blasted (see attached map) was about 560 feet long and from 35 to 50 feet wide. Holes were drilled vertically with a track-mounted wagon drill on a slightly irregular grid-like pattern with an average spacing of either four or five feet, depending on what was necessary in the opinion of the driller or powderman and allowances were made

for slope, grade and direction of the cut. The holes were drilled with two and one half inch bits and depths ranged from four to twelve feet and an allowance of two feet of overbreak at the bottom of the proposed cut.

The entire area was blasted by loading with explosives and firing 990 holes in 24 separate blasts using a total of 4,626.35 pounds of explosives. The holes were loaded with from one to eleven small charges of explosive separated by sand stemming and the charges were detonated with full-second delays ranging from 0 to 10 inclusive. A total of 2428 caps were used.

The explosives were fuel-treated NITRO CARBO NITRATE pellets used with Atlas 40 percent strength gelatin primer and detonated with electric caps. The average hole took 0.309 pounds of powder per inch of hole and the largest single charge filled only 12 inches of hole; most charges were much smaller. The contractor attempted to break one cubic yard of rock with three-fourths of a pound of explosive and this was practically achieved except on the first couple of blasts which seem to have been slightly overloaded.

At the time the contract was drawn it was thought advisable to require placing of a wire screen or mat over the blast area to prevent the flight of loose material dislodged by the blast. At first the screen was laid upon old tires but these were left off after the second blast.

RESULTS OF BLASTING

The first blast to be set off was over 200 feet east of the Travelodge Motel and, therefore, was outside of the critical area, which was designated as being within 100 feet of the motel, (see Figure 1). On the first blast 110 holes were loaded with 668 pounds of explosives (see Figure 1 and 2) which was detonated with 271 caps using full second delays 0 through 7. For this blast the Seismolog was set on a rock and two survey stakes driven in old fill, an available but not the most ideal setup. The distance from the Seismolog to the nearest charge was 40.5 feet. The blast lifted large blocks of rock to the surface (see photo 8), and smaller fragments,

some as much as from 4 to 6 inches across were thrown on the main highway, a distance of about 50 feet. This blast was considered much more powerful than it should have been and this was confirmed by seismic readings which placed it in a dangerous class with a frequency of 41.7 cps, a displacement of 0.0111 inches and an energy ratio of 2.32. Nevertheless, this blast caused no apparent damage and served as a guide for subsequent blasts, the intensity of which were greatly reduced.

On the second blast, about 160 feet from the motel, 91 holes were loaded with 465.75 pounds of explosive and detonated with 234 full second delays ranging from 0 through 10. The recording instrument was placed on a sloping sidewalk 43 feet from the nearest charge and recorded a frequency of 25.0 cps, a displacement of 0.0095 inches with an energy ratio of 0.61. This blast was still somewhat more intense than desired, exceeded the displacement limit set by the contract specification and was given a "Caution" rating by Vibration Measurement Engineers. A little flyrock was produced by this blast as one of the charges apparently blasted out a weak fracture or minor fault (see photos 9 and 10) from which some loose rock was discharged. There was no damage from this blast because it was relatively mild and was a reasonable distance from the motel.

On the third blast, at a distance of 59 feet from the recording instrument, which was set in the northeast corner of the Motel Annex, 141 holes were loaded with 479 pounds of explosive and were detonated with 268 caps using full-second delays 0 through 8. Vibration Measurement Engineers reported this blast as having a frequency of 31.3 cps, displacement of 0.0051 inches, an energy ratio of 0.28 and a safe rating.

It is to be noted that the second and third blasts used approximately the same amount of powder and caps, but that the third blast had the safer rating. Placing of the seismograph and resultant frequency effects, may have been a factor. For the second blast, it was necessary to set the recorder on a sloping concrete sidewalk and level it with one side resting on an iron pin driven in an expansion crack, whereas, during the third blast, the instrument was set securely flat on the concrete floor near a footing of the motel.

After the third blast it was decided that the number of holes and amount of explosives per unit of blasting should be even further reduced because of nearness to the motel. The next shooting, therefore, was divided into two units represented by blasts 4 and 5. In both of these the instrument was set on the concrete floor near or over a footing of the motel at the same place as Blast 3.

In Blast 4, 49 holes were loaded with 252.5 pounds of explosive and detonated with 147 caps at a distance of 62 feet from the instrument. Readings indicated a frequency of 71.4 cps, displacement .0037 and an energy ratio of 0.76 and was classified "Danger".

In Blast 5, 61 holes were loaded with 252.25 pounds of explosive and detonated with 118 caps at a distance of 42 feet from the instrument. Seismolog readings indicated a frequency of 50.0 cps, displacement .0048 inches and an energy ratio of 0.62, and it was classified as "Safe".

After the fifth blast it was decided to make further reductions in the amount of explosive detonated at any one time. Therefore, zones prepared for blasting were subdivided so that each zone would be broken from four to six blasts with each zone being blasted in a short period of time, usually not exceeding 20 minutes. Similar effect would have been achieved in one shot by the contractor, using more delays and millisecond delays. Six blasts were set off February 24. Details concerning the number of holes, amount of explosives and caps used, and the results of each blast as calculated and recorded from the Seismolog observations are given in Figure 2. No damage resulted from the blasting.

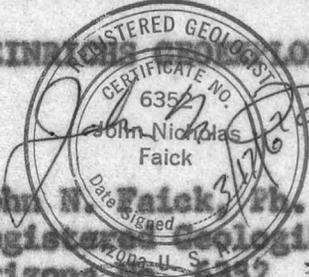
Of the 24 blasts set off only No. 1, No. 4 and No. 10 were sufficiently intense to be rated "Danger". Of the remaining 21 blasts, six were rated "Caution" and 13 rated "Safe". No record was obtained of Blasts 7 and 14 for reasons unknown except that Vibration Measurement Engineers reported the film did not run off the camera. A lesson learned for future use of this type of recorder is that it is possible to reverse the camera in the instrument and also to put the camera in without engaging the driving gears so that the film will not

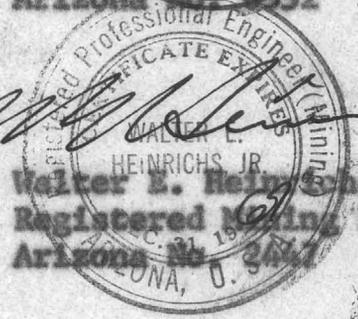
run through although the instrument may be turned on.

Blast 10 was given a "Danger" rating, though Blasts 7 and 9, which rated "Safe" and "Caution" respectively, had considerably more explosive detonated at any instant than was detonated at any instant in Blast 10. The most significant differences in these blasts is the distance factor and cumulative effects from either or both the instantaneous total amount exploded in delays 2 and 3 of Blast 10.

Respectfully submitted,

HEINRICHS GEOEXPLORATION COMPANY

A circular seal for a Registered Geologist in Arizona. The seal contains the text: REGISTERED GEOLOGIST, CERTIFICATE NO. 6357, John N. Faick, Faick, Date Signed, and Arizona, U.S.A. The seal is stamped over a handwritten signature of John N. Faick.
John N. Faick, Ph. D.
Registered Geologist
Arizona No. 6357

A circular seal for a Registered Mining Engineer in Arizona. The seal contains the text: REGISTERED PROFESSIONAL ENGINEER, CERTIFICATE EX-11115, WALTER E. HEINRICHS, JR., Registered Mining Engineer, and ARIZONA, U.S.A. The seal is stamped over a handwritten signature of Walter E. Heinrichs, Jr.
Walter E. Heinrichs, Jr.
Registered Mining Engineer
Arizona No. 2447

March 17, 1967
Tucson, Arizona

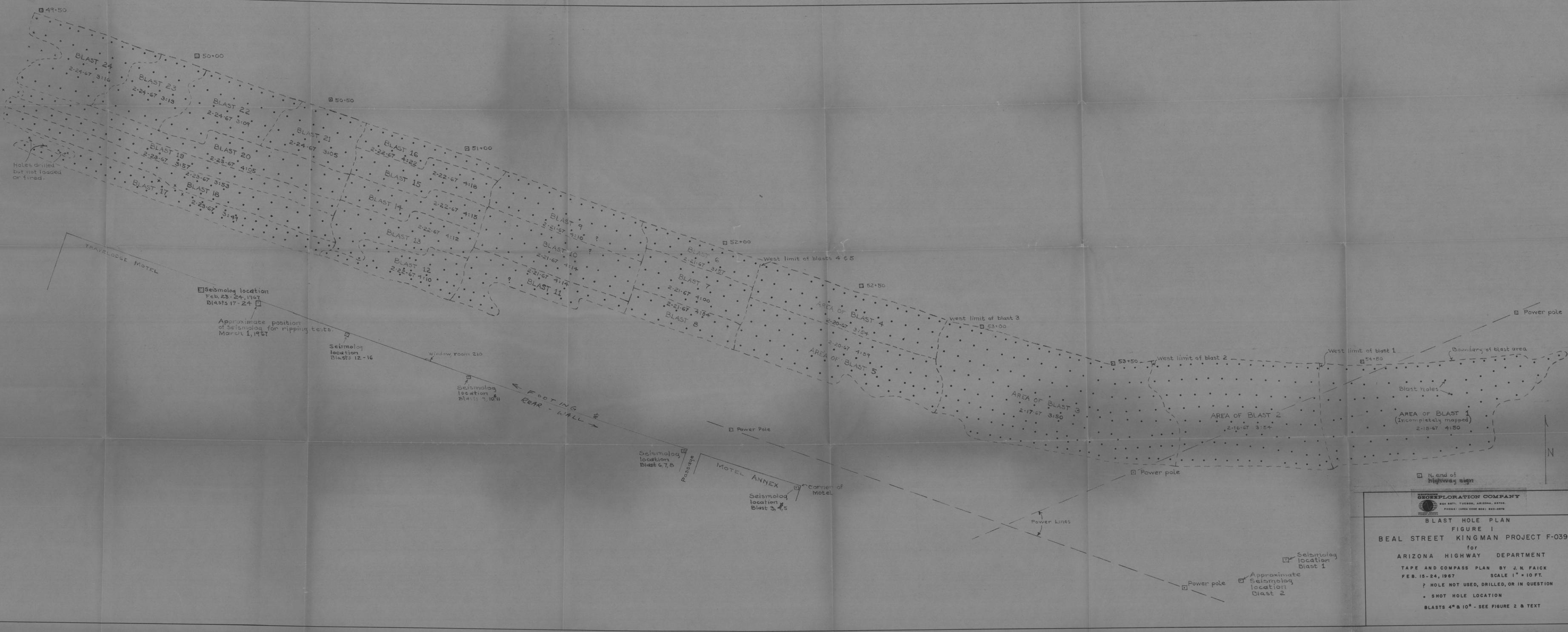
FIG 2, SIGNIFICANT DATA ON BEALE STREET - KINGMAN PROJECT BLASTING

Comment	Blast No.	No. of Recording	Date 1967	Time P.M.	No. of holes	Explosives in pounds	Recorder distance in feet	Seismolog Results				Computations only for more critical shots								
								Frequency in C.P.S.	Displacement in inches	Energy ratio	Class	0	1	2	3	4	5	6	7	8
Initial test	1	1	2-15	4:50	110	668	40.5	41.7	0.0111	2.32	D									
Drill-drilling	2	2	2-16	2:33	—	—	36.01	—	—	-0.0001	S									
	3	3	2-16	3:54	91	465.7	43	25.0	0.0095	0.61	C									
	4	4	2-17	3:50	141	479	59	31.3	0.0051	0.28	S									
Adverse blasting technique and distance	5	5	2-20	3:54	49	252.5	62	71.4	0.0037	0.76	D	4.3	26.2	46.7	64.3	40.8	18.7	30.5	18.5	
	6	6	2-20	3:59	61	252.2	42	50.0	0.0048	0.62	C									
	7	7	2-21	3:57	19	95.6	81 ²	—	—	—	—									
	8	8	2-21	4:00	23	117.7	69	83.3	0.0019	0.27	S	5.14	22.09	42.17	34.25					
	9	9	2-21	4:04	15	25.9	62	35.7	0.0026	0.09	S	5.10	17.63	39.44	33.40	21.84				
	10	10	2-21	4:10	24 ³	129.1	61	55.6	0.0039	0.51	C	7.18	20.83	49.51	38.36	14.05	6.02			
Adverse blasting technique and distance	11	11	2-21	4:14	26 ³	128.3	46	41.7	0.0079	1.17	D	7.29	15.62	24.67	24.50	5.03	13.42	8.88	15.31	11.22
	12	12	2-21	4:18	31 ³	77.6	25	50.0	0.0046	0.57	C					1.62	8.27	16.65	13.98	16.93
	13	13	2-22	4:10	34	103.2	24	50.0	0.0027	0.20	S									
	14	14	2-22	4:12	27	124.5	26 ²	—	—	—	—									
	15	15	2-22	4:15	19	142.7	46	50.0	0.0046	0.57	C									
	16	16	2-22	4:18	21	159.4	56	45.5	0.0031	0.22	S									
	17	17	2-22	4:22	18	105.5	66	50.5	0.0028	0.21	S									
Train (R.R.)	18	18	2-23	12:18	—	—	450 ⁴	90.9	0.0002	0.004	S									
	19	19	2-23	3:49	47	103.7	27	35.7	0.0058	0.046	S									
	20	20	2-23	3:53	35	108.5	32	50.0	0.0050	0.68	C									
	21	21	2-23	3:57	24	97.0	42	50.0	0.0023	0.14	S									
	22	22	2-23	4:05	33	194.1	48	50.0	0.0041	0.45	S									
	23	23	2-24	3:05	24	223	64	41.7	0.0049	0.45	S									
	24	24	2-24	3:09	29	208.9	56	50.0	0.0028	0.21	S									
	25	25	2-24	3:13	22	136.9	63	100.0	0.0010	0.11	S									
	26	26	2-24	3:16	37	227.5	80	100.0	0.0005	0.027	S									
Dozer Ripping	—	R-15	3-1	1:35	—	—	40 ²	50.0	0.0002	0.001	S									
Dozer Ripping	—	R-25	3-1	1:45	—	—	50	55.6	0.0002	0.001	S									

Note: The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %Limit reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.



- Notes:
- 1 Operating drill.
 - 2 Technical failure to record; partial or total.
 - 3 Differs from powder man's verbal report at time of blast, powder man's record, or Fig 1 record by J.N.I.
 - 4 Moving freight train
 - 5 Ripping test



Holes drilled but not loaded or fired.

Seismolog location Feb. 23-24, 1967 Blasts 17-24

Approximate position of Seismolog for ripping tests. March 1, 1967

Seismolog location Blasts 12-16

Window, Room 210

Seismolog location Blasts 9, 10, 11

Seismolog location Blast 6, 7, 8

Seismolog location Blast 3, 4, 5

Seismolog location Blast 1

Approximate Seismolog location Blast 2



BLAST HOLE PLAN
FIGURE 1
BEAL STREET KINGMAN PROJECT F-039-1-503
 for
ARIZONA HIGHWAY DEPARTMENT
 TAPE AND COMPASS PLAN BY J. N. FAICK
 FEB. 15-24, 1967 SCALE 1" = 10 FT.
 ? HOLE NOT USED, DRILLED, OR IN QUESTION
 • SHOT HOLE LOCATION
 BLASTS 4* & 10* - SEE FIGURE 2 & TEXT

FIG 2, SIGNIFICANT DATA ON BEALE STREET - KINGMAN PROJECT BLASTING

Comment	Blast No.	No. of Recording	Date 1967	Time P.M.	No. of holes	Explosives in pounds	Recorder distance in feet	Seismolog Results			Computations only for more critical shots										
								Frequency in C.P.S.	Displacement in inches	Energy ratio Class	Full second delay number and approximate pounds of explosive detonated by each delay										
											0	1	2	3	4	5	6	7	8	9	
Initial test	1	1	2-15	4:50	110	668	40.5	41.7	0.0111	2.32	D										
Drill-drilling	—	2	2-16	2:33	—	—	36.0 ¹	—	—	-0.0001	S										
	2	3	2-16	3:54	91	465.7	43	25.0	0.0095	0.61	C										
Adverse blasting technique and distance	3	4	2-17	3:50	141	479	59	31.3	0.0051	0.28	S										
	4	5	2-20	3:54	49	252.5	62	71.4	0.0037	0.76	D	4.3	26.2	46.7	64.3	40.8	18.7	30.5	18.5		
	5	6	2-20	3:59	61	252.2	42	50.0	0.0048	0.62	C										
	6	7	2-21	3:57	19	95.6	81 ²	—	—	—	-	5.14	22.09	42.17	34.25						
	7	8	2-21	4:00	23	117.7	69	83.3	0.0019	0.27	S	5.10	17.63	39.44	33.40	21.84					
	8	9	2-21	4:04	15	25.9	62	35.7	0.0026	0.09	S					5.13	14.02	6.02			
	9	10	2-21	4:10	24 ³	129.1	61	55.6	0.0039	0.51	C	7.18	20.83	49.51	38.36	14.05					
	10	11	2-21	4:14	26 ³	128.3	46	41.7	0.0079	1.17	D	7.29	15.62	24.67	24.50	5.03	13.42	8.88	15.31	11.22	
Adverse blasting technique and distance	11	12	2-21	4:18	31 ³	77.6	25	50.0	0.0046	0.57	C					1.62	8.27	16.65	13.98	16.93	15.89
	12	13	2-22	4:10	34	103.2	24	50.0	0.0027	0.20	S										
	13	14	2-22	4:12	27	124.5	26 ²	—	—	—	-										
	14	15	2-22	4:15	19	142.7	46	50.0	0.0046	0.57	C										
	15	16	2-22	4:18	21	159.4	56	45.5	0.0031	0.22	S										
	16	17	2-22	4:22	18	105.5	66	50.5	0.0028	0.21	S										
	Train (R.R.)	—	18	2-23	12:18	—	—	450 ⁴	90.9	0.0002	0.004	S									
	17	19	2-23	3:49	47	103.7	27	35.7	0.0058	0.046	S										
18	20	2-23	3:53	35	108.5	32	50.0	0.0050	0.68	C											
19	21	2-23	3:57	24	97.0	42	50.0	0.0023	0.14	S											
20	22	2-23	4:05	33	194.1	48	50.0	0.0041	0.45	S											
21	23	2-24	3:05	24	223	64	41.7	0.0049	0.45	S											
22	24	2-24	3:09	29	208.9	56	50.0	0.0028	0.21	S											
23	25	2-24	3:13	22	136.9	63	100.0	0.0010	0.11	S											
24	26	2-24	3:16	37	227.5	80	100.0	0.0005	0.027	S											
Dozer Ripping	—	R-1 ⁵	3-1	1:35	—	—	40 ²	50.0	0.0002	0.001	S										
Dozer Ripping	—	R-2 ⁵	3-1	1:45	—	—	50	55.6	0.0002	0.001	S										

- Notes:
- 1 Operating drill.
 - 2 Technical failure to record; partial or total.
 - 3 Differs from powder man's verbal report at time of blast, powder man's record, or Fig 1 record by J.N.F.
 - 4 Moving freight train
 - 5 Ripping test

Note: The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %Limit reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

SEISMOLOG RECORD ANALYSIS SERVICE

Date 2-20-67

Gentlemen:

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.	2-16-67	3:54 PM	91	465.75	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88816	On sidewalk at north side of highway	25.0	.0095"	SR = .61	C

Reported by

VIBRATION MEASUREMENT ENGINEERS, INC.



SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-20-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.	2-17-67	3:50 PM	141	479	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88917	N.E. corner	31.3	.0051"	ER = .28	S
	Travelodge Motel				
	Closet in Unit 119				

Reported by

Duplicate
 VIBRATION MEASUREMENT ENGINEERS, INC.



SEISMOLOG RECORD ANALYSIS SERVICE

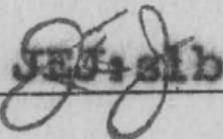
Gentlemen:

Date 2-17-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE — LBS.	
Arizona Highway Depart.		2-15-67	4:50 PM	110	600	
RECORDING	TEST LOCATION	FREQ — CPS	DISPLACEMENT	%LIMIT	CLASS	
88749	Near sidewalk,	41.7	.0111"	152	D	
	528° W, 40.5' from					
	nearest charge					

Reported by



VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Geotemen:

Date

2-17-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.		2-15-67	4:50 PM	110	600	668
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88749	Near sidewalk, 528° W, 40.5' from nearest charge	41.7	.0111"	152	D	

Reported by

VIBRATION MEASUREMENT ENGINEERS, INC.



These are duplicate cards to be sent to:

Mr. R. D. Wingfield
Project Supervisor
Arizona Highway Dept.
P.O. Box 990
Kingman, Ariz. 86401



I have a set of these

~~34~~ two cards and will bring them
to the office. One set should be
sent to Mr. Wingfield as above. All
other cards will be mailed directly
to Heinrichs and there will be 26
of them for this phase of the
project and possibly 3 or 4 more
next week.

Sincerely, John Faick

SEISMOLOG RECORD ANALYSIS SERVICE

Date 2-20-67

Station: _____

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.		2-16-67	3:54 PM	91	465.75	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88816	On sidewalk at	25.0	.0095"	ER = .61	C	
	north side of					
	highway					

*Distance 43 feet*Reported by JEB

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Station:

Date 2-20-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.	2-17-67	3:50 PM	141	479	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88817	N.E. corner	31.3	.0051"	ER = .28	S
	Travelodge Motel				
	Closet in Unit 119				

Distance @ 9 ft ← Should be 59 ft. 9/28

Reported by



VIBRATION MEASUREMENT ENGINEERS, INC.

These recordings are for
Heinrichs files, I will bring
a duplicate set with me



John Faick

Please send total explosive for
shot at 3:54 PM, February 16, 1967

400
65.75

465.75 Total

Keep

Recording No. _____ Date 2/15/67 Seis. No. 155

Seis. Position _____

Location of Shot Point Near sidewalk, 526' W, 40.5' from nearest charge

Distance _____ Time Fired _____ Loaded by _____

Total Explosive Charge _____ Manufacturer Chas. Chapman Strength 40%

No. Holes _____ Hole Diameter _____ Open Face or Buffer _____

Depth of Holes 110 Height of Bank _____ No. of Decks 1-3 Stemming Sand

Hole No.	<u>4-12</u>																			
Spacing	<u>1-110 inclusive</u>																			
Burden	<u>4x9 - 1 3x5</u>																			
Explosive	<u>No</u>																			
Detonator	<u>PELLITE NITRO CARBO NITRATE</u>																			

Seis Operator Atlas electric, & AT1 Camera No. 1260 Seal T. O.K.

Remarks John N. Faick

Diagram: Used 271 caps, Othru 7 delays. One-half stick gellatin primer used in each hole.

Client _____ Job Loc. Beale St. F039-1-92

Reported by Arizona Highway Department Title Geologist

FOR V.M.E. USE ONLY

Recording No. 2 Date Feb 16, 1967 Seis. No. 155
 Site Position Water heater room # 5, Travelodge Motel
 Location of Shot Point Drill hole in line parallel to back wall of motel
 Distance 36 ft Time Fired 2:33 PM Loaded by —
 Total Explosive Charge None Manufacturer — Strength —
 No. Holes one Hole Diameter 2 1/2 in. Open Face or Buffer —
 Depth of Holes 36 ft Height of Bank — No. of Decks — Stemming —

Hole No.													
Spacing													
Burden													
Explosive													
Detonator													

Seis Operator J.M. Faick Camera No. 1067 Seal T. O.K.
FOR V.M.E. USE ONLY

Remarks Measuring vibration caused by

Diagram: Wagon drill and 600 cu ft compressor.

F-039-1-502

Client Arizona Highway Department Job Loc. Beale St, Kingman

Reported by Herman E. Green Title Geophysicist

Recording No. _____ Date Feb 16, 1967 Seis. No. 155

Shot Position On sidewalk at north side of highway

Location of Shot Point Blast area #2

Distance 7.3 Time Fired 7:54 PM Loaded by Chapman

Total Explosive Charge 400# Pellite Manufacturer Atlas Strength 40%

No. Holes 91 Hole Diameter 2 1/2 in Open Face or Buffer -

Depth of Holes 4-10' Height of Bank - No. of Decks - Stemming Sand

Hole No.																			
Spacing	<u>4 x 4</u>	<u>5'0"</u>																	
Burden	<u>None</u>																		
Explosive	<u>Pellite, Cuckoo nitrate, Gelatin primer, Elec caps</u>																		
Detonator	<u>Flac caps</u>																		

Seis Operator John N. Farick Camera No. 1202 Seal T. O.K.

FOR V.M.E. USE ONLY

Remarks Grows of holes, 3' stemming between charges

Diagram: F-039-1-502

Client Arizona Highway Department Job Loc. Route 21, Kingman, Ariz.

Reported by _____ Title _____

Recording No. 4 Date Feb. 17, 1967 Seis. No. 155
 Position NE Corner Travelodge Motel, Closet in unit 119, Annex
 Location of Shot Point 89 ft 3.50 northeast of NE corner of motel
 Distance 89 Time Fired 3:50 PM Loaded by Chapman
 Total Explosive Charge 400 Nitrate 71#6 Manufacturer Atlas Strength 40%
 No. Holes 141 Hole Diameter 2 1/2" Open Face or Buffer -
 Depth of Holes 4-11 Height of Bank - No. of Decks - Stemming Sand

Hole No.																			
Spacing																			
Burden																			
Explosive	<u>Pellite, Nitro Carbo Nitrate 400 lbs</u>																		
Detonator	<u>Atlas dynamite 40%, Atlas elec caps</u>																		

Seis Operator John N. Faick Camera No. 1172 Seal T. O.K.
FOR V.M.E. USE ONLY

Remarks 141 holes, 268 caps, Delays 0 thru 8.

Diagram: Seismology set on concrete floor in corner over footing. F-039-1-503

Client Arizona Highway Dept. Job Loc. Beale St. Kingman AZ.

Reported by Hennrichs Geos exploration Title Geophysics

Recording No. 5 Date Feb 20, 1967 Seis. No. 155
 Seis Position NE Corner Travelodge Motel. Closet in unit 116
 Location of Shot Point 62 ft, N22°E from NE Corner Motel unit 116
 Distance 62 ft Time Fired 3:54 PM Loaded by Chapman
 Total Explosive Charge ~~228 lbs pellets~~ 252 lb Manufacturer Atlas Strength 40%
 No. Holes 49 Hole Diameter 2 1/2" Open Face or Buffer -
 Depth of Holes 7'-9' Height of Bank - No. of Decks - Stemming Sand

Hole No.														
Spacing														
Burden														
Explosive														
Detonator														

Seis Operator John N. Fark Camera No. 1689 Seal T. O.K.

FOR V.M.E. USE ONLY

Remarks Seismology set on concrete floor near table

Diagram: at motel 228 lbs pellets, 24 1/2 lb dynamite, 147 caps.

F-039-1-503

Client Arizona Highway Dept. Job Loc. Dodge St, Kingman

Reported by Heinrich G. Gensel Title Geophysicist

Recording No. 6 Date Feb. 20, 1967 Seis. No. 155

Seis. Position NE Corner Traveler's Motel. Closet in room 116.

Location of Shot Point 92 ft. N 24° E from NE Corner of unit 116

Distance 42 ft Time Fired 3:59 PM Loaded by Chapman, C.F.

Total Explosive Charge ~~48 pellets~~ 252 1/4 Manufacturer Atlas Strength 40%

No. Holes 61 Hole Diameter 2 1/2" Open Face or Buffer -

Depth of Holes 5'-8' Height of Bank - No. of Decks - Stemming Sand

Hole No.																			
Spacing																			
Burden																			
Explosive																			
Detonator																			

Seis Operator John N. Faick Camera No. 1682 Seal T. O.K.

Remarks Used 198 lbs pellets, 54 1/4 gel, 118 caps

Diagram: seismically set over footing on concrete floor
F-039-1-503

Client Arizona Highway Dept. Job Loc. Peak St. Kings, Az

Reported by Heinrichs (General Contractor) Title Geotechnical

FOR V.M.E. USE ONLY

Recording No. 18 Date Feb 23 Seis. No. 155

Seis. Position Closet in Room 102, Travelodge Motel Concrete

Location of Shot Point Mainline tracks Santa Fe Railroad floor

Distance 450 ft Time Fired 12:18 PM Loaded by _____

Total Explosive Charge _____ Manufacturer _____ Strength _____

No. Holes _____ Hole Diameter _____ Open Face or Buffer _____

Depth of Holes _____ Height of Bank _____ No. of Decks _____ Stemming _____

Hole No.	Spacing	Burden	Explosive	Detonator

Seis Operator John N. Faick Camera No. 2243 Seal T. O.K.

Remarks West bound freight train. Eight power units.

Diagram: 02 cars. Entering freight passel after about
1 1/2 minutes. F-039-1-503

Client Arizona Highway Department Job Loc. Keale St, Kingman Az

Reported by Hemrichs Georesoration Title Geophysicist

Recording No. 22 Date Feb 23 '67 Seis. No. 155

Seis. Position Closet, Room 102 Travelodge Motel

Location of Shot Point N 21 E 40° from instrument

Distance ~~48~~ 48' Time Fired 4:05 Loaded by Chapman, C.F.

Total Explosive Charge 194.1 Manufacturer Atlas Strength 40%

No. Holes 33 Hole Diameter 2 1/2 in. Open Face or Buffer -

Depth of Holes 6-12 Height of Bank - No. of Decks - Stemming Sand

Hole No.	Spacing	Burden	Explosive	Detonator															

Seis Operator John M. Farik Camera No. _____ Seal T. O.K.
FOR V.M.S. USE ONLY

Remarks 164.6 pellets, 29.5 gal, 60 caps

Diagram: Seis. loc. on concrete floor
about 3 ft in from wall F-039-1-503

Client Arizona Highway Dept. Job Loc. Peck St. Kingman Az

Reported by John M. Farik Title Geophysicist

Recording No. RIP #1 Date 3/11/67 Seis. No. 155
 Seis. Position Sturkman Travelodge Motel
 Location of Shot Point Sta. 50+50 to 51+00
 Distance 40ft. Time Fired 1:35 PM Loaded by _____
 Total Explosive Charge None Manufacturer _____ Strength _____
 No. Holes None Hole Diameter _____ Open Face or Buffer _____
 Depth of Holes — Height of Bank — No. of Decks _____ Stemming _____

Hole No.	Spacing	Burden	Explosive	Detonator

Seis Operator L.E. Scott Camera No. 2239 Seal T. O.K.
FOR V.M.E. USE ONLY

Remarks Ripping operation in previously shot

Diagram: area with D-9 dozer and single tooth ripper

Client Arizona Highway Dept. Job Loc. Beale Street Kingman, Arizona

Reported by William A. ... Title ...

Recording No. Rip # 2 Date 3/1/67 Seis. No. 155

Seis. Position Storeroom - Travelodge Motel

Location of Shot Point ~~50+40~~ 50+40 to 50+60

Distance 50ft. Time Fired 1:45 PM Loaded by ---

Total Explosive Charge None Manufacturer --- Strength ---

No. Holes None Hole Diameter --- Open Face or Buffer ---

Depth of Holes --- Height of Bank --- No. of Decks --- Stemming ---

Hole No.	Spacing	Burden	Explosive	Detonator

Seis Operator L. E. Scott Camera No. 2358 Seal T. O.K.

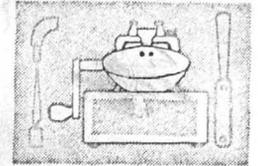
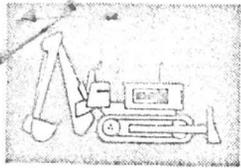
Remarks Ripping operation in previously shot area with

Diagram: B-9 Dozer and single tooth ripper R-039-1-503

Client Arizona Highway Department Job Loc. Beale Street, Kingman, Arizona

Reported by Arnold Geo. Exploration Co Title Geophysicist

FOR V.M.E. USE ONLY



SPECIAL REPORT

November 30, 1966

KINGMAN-HOOVER DAM
(BEALE STREET, KINGMAN)
F 039-1-303 P.E., ITEM #334
F 039-1-503 CONST., ITEM #334
STATION 36+00 to 55+69

PREVENTION OF BLASTING DAMAGE TO NEARBY BUILDINGS

INTRODUCTION

The proposed centerline of the above project lies parallel to the Travelodge Motel and 40 feet from its back wall. Some blasting will be required to excavate up to 10 feet of hard volcanic tuff rock for the 20 foot wide roadway. All excavation on this section will take place on the north (uphill) side of the centerline which is the side away from the two-story, frame and stucco motel building. The possibility of damage to this building by blasting indicated the desirability of a special study of the conditions. This study was made by the Materials Division of the Arizona Highway Department to determine the possible causes of damage and to recommend procedures to eliminate them. These recommendations have been incorporated in the Special Provisions of the project.

TECHNICAL REVIEW

A review of the literature on blasting damage was made to find out what technical information was available and what the legal aspects of the subject were. Of particular interest is a legal book (Ref. 1 see attached sheet) describing in detail what type of testimony can be admitted to evidence and what kind of facts are required by lawyers in preparing a claim. Quoted below are the opening paragraphs which give a brief summary of the problem:

Introductory Comment

"Damage from blasting can occur in only three ways: (1) vibration of movement of earth, (2) flying rocks, earth or debris, and (3) air concussion. While causing rocks or debris to fall upon property constitutes a trespass, for which there is absolute liability, there are two theories concerning damage from concussion or vibration. One theory follows the trespass theory above, while the other theory requires not only that damage be shown, but also that the blasting was done in a negligent manner. (AM Jur Explosions and explosives 53, 54.

In order to prove that earth vibration caused by blasting has resulted in damage to a structure, it is first necessary to show that such vibrations were powerful enough to cause the movement above mentioned. Testimony of witnesses who were on or about the damaged premises at the time of the blast, and who felt peculiar movements of the earth caused by the earth waves at or so near the time of the explosion as to indicate the causal relationship, is relevant, but such evidence may be quite easily shown to be of very little weight. In addition to such evidence the weight of the explosive used, that it was detonated instantaneously rather than in delayed firings, and the proximity of the damaged structure to the point of explosion should be shown. The former two items of evidence are often available from the 'log' required in many instances to be kept by persons using explosives while the matter of distance is merely a matter of measurement. In some cases seismographic tests or tests by an accelerometer have been made before or during blasting operations, as well as preblasting surveys to determine the condition of buildings in the potential area of damage and, if available, are important items of evidence to show the probability of damage. A particularly effective method of proving the probability of damage is the testimony of a vibration expert using displacement and acceleration tables prepared by the United States Bureau of Mines. In this respect, it is important to show the type of ground between the point of explosion and the damaged structure, as well as the type of material under the damaged structure, since earth vibrations differ in intensity according to the type of ground along which they travel."

The technical study followed these guide lines so that the data gathered could be used in the settlement of any claim that might possibly arise.

The first comprehensive study of damage due to blasting was made by the U. S. Bureau of Mines in Bulletin 442 (Reference 2) published in 1942. The most important finding was that the critical factor causing building damage was the amplitude of shock wave and not its velocity.

Several methods of expressing this concept have been advanced by various authors but particle displacement has become the generally accepted method of measurement. This is expressed as thousandths of an inch displacement movement.

Independent studies made in Europe are described in a book by Langefors (Reference 3) which gives similar data based on particle displacement. This year the Bureau of Mines (Reference 4) reviewed their earlier findings and compared them statistically with the newer European and U. S. data which corrolate favorably and are now supported by hundreds of tests.

INVESTIGATION

A thorough geological study has been made of the hillside behind the Travelodge Motel. The rock forming this slope is a well fractured, blocky volcanic tuff. While dense and compact, it is not particularly hard or brittle. The deepest cut to subgrade in the roadway section parallel to the motel structure is 10 feet at the left ditch line. The weathered surface material can be ripped to a 4 foot depth and probably to 6 feet judging from nearby excavations. The remaining 4 to 6 feet of rock will have to be shot only hard enough to loosen it and open the existing joint planes. It will not be necessary to break or shatter the rock since a ripper can easily move the loosened blocks which measure approximately one foot by two feet.

The advice of Mr. Charles R. Sparf, District Representative of the Hercules Powder Company, was sought on blasting techniques. He recommended use of milli-second delay blasting caps to reduce the amplitude of the individual blasts and the use of mats to prevent flying rock. He also recommended that the working or shooting face be parallel to the centerline and away from the motel. His report points out that the ripping operations may actually create more vibrations than the blasting.

To determine the ability of this type of rock to transmit blasting vibrations a series of tests were run on similar rock in the same formation west of Kingman. Mr. Thomas J. Ellis, a consulting geophysicist, was retained to plan and supervise these tests and to record the results on a seismograph. He is a graduate of the Colorado School of Mines with a degree in Geophysics, but is not registered as Arizona does not have or require registration in this specialty. The work followed the standard procedure which has previously been accepted as evidence in court. Its purpose was to determine the amount of vibration transmitted and the level of vibration required to cause structural damage for a given distance. A remote test site was chosen so that the effect of various charges, from light to heavy, could be studied and the results recorded. It was fortunate that this was done as the range of blasts varied from no effect to cratering and flying rock. The test shot pattern was 3 holes in line on 4 foot centers to simulate the roadway ditchline to centerline distance. The test site was located on a sloping hillside to duplicate the expected slope of the rock that cannot be ripped. The seismograph was placed 40 feet from the first hole and in line with the holes to duplicate the actual distance from the motel to centerline of the roadway (40 feet). All tests were made with 60 per cent Gelatin dynamite in

stemmed, 2 inch diameter drill holes fired by electric blasting caps: Instantaneous in the first hole, #1 delay in the second hole and #2 delay in the third hole in each series. The rock breakage noted was:

TEST #1 4 Sticks per hole; holes 4 feet deep. One large crack connecting the holes, smaller radiating cracks not joining. No ground disturbance.

TEST #2 10 Sticks per hole; holes 6 feet deep. Ground surface broken between holes, rock overturned with some bulging. No flying rock.

TEST #3 6 Sticks per hole, holes 4 feet deep. Much flying rock. Each hole cratered, but craters do not join. Large and small cracks joining holes.

TEST #4 2 Sticks per hole, holes 4 feet deep. Some small random surface cracking. Cracks do not connect holes. No surface disturbance. NOTE: The instrument distance was 28 feet instead of 40 feet as on other holes.

TEST #5 Instrument placed on concrete walk in front of east end of motel. Heavy truck traffic on U. S. 66, 80 feet away, recorded.

Test records were not obtained for Tests #2 and #3 due to trouble with the camera drive mechanism. Mr. Ellis' report shows the level of vibration for Test #1 to be .0020 inch and for Test #4 to be .0023 inch. This is particle displacement or the amount of movement of a given point. Both of these figures are well within the SAFE range. The U. S. Bureau of Mines Bulletin #442 and Devine's recent researches (U.S.B.M., 1966) give the limits of these ranges as: SAFE 0 to .0050; CAUTION .0050 to .050; and DANGER .050 and up.

Test #1 shows that adequate loosening of the rock can be accomplished within the lower half of the SAFE range of the recognized scale, therefore a limit of 0.003 inches particle displacement for all blasting in the motel area has been made part of the Special Provisions. The test records and notes for the above tests are on file in the Materials Division and available for inspection by any potential bonding agent or contractor. The bulletins and reports cited are also available in the Materials Division for study.

RESULTS

Based upon the reports and field tests described above the following procedures have been adopted:

A seismograph similar to one used on the above tests will be obtained by the Arizona Highway Department to make permanent records of all blasting during construction. It will be operated by our personnel under the direction of a seismologist. The contractor will be requested to program his work so that all blasting can be finished within a period of a few days to facilitate this operation and to eliminate complaints from local businesses.

Each of the following procedures has been made a part of the Special Provisions of the contract to eliminate a potentially dangerous condition or to provide further records to counter possible claims.

- (1.) *"Immediately prior to beginning construction operations in the area between station 49+00 and station 53+00, an inventory of all existing cracks in the Kingman Travelodge Motel and other nearby buildings shall be made by either an architect or a structural engineer and a builder, both duly licensed to be employed by the Arizona Highway Department. A report of their findings shall be prepared showing the results of this survey and a copy shall be furnished to the engineer."*
- (2.) *"The working face of the excavation and the direction of blasting shall be parallel to the centerline of the roadway and facing in a direction away from the Kingman Travelodge Motel."*
- (3.) *"Explosive charges shall be detonated with millisecond delays between holes in a line and between lines in a pattern. The maximum allowable recorded displacement as a result of blasting or ripping when recorded by a seismograph located on the floor slab of the motel shall not exceed 0.0030 of an inch."*
- (4.) *"Prior to any blasting within 100 feet of the motel, all loose surface rock in the affected area, especially loose rock on the face of the motel site excavation, shall be removed."*
- (5.) *"Suitable mats shall be used during all blasting operations to prevent the flying of rock."*

(6.) *The contractor shall maintain daily, a detailed blasting record consisting of the following:*

1. *Location, number and depth of all drill holes.*
2. *Distance from nearest hole to nearest building.*
3. *Amount and grade of powder per hole.*
4. *Type of caps and delay pattern used.*
5. *Date, time of day, and weather conditions when charge is detonated.*
6. *Powderman's signature.*

A copy of this record shall be furnished to the engineer each day.

This special report has been prepared by Lewis E. Scott, Materials Field Engineer, of this Division. The investigation and field tests described were made under his supervision.

Respectfully submitted,

W. G. O'Harra

W. G. O'Harra *W.G.*
Engineer of Materials

LES:mh

Inc: A/S

Distribution:

File

Mertz

Allen

✓ L. Scott

REFERENCES

- (1.) PROOF OF FACTS, American Jurisprudence; Vol. 2; Blasting, pp. 557-580; Bancroft-Whitney Co. Book No. 92012, State Dept. Library and Archives Capitol Bldg., Phoenix.

- (2.) BULLETIN 442, Seismic Effects of Quarry Blasting, J. R. Thoenen and S. L. Windes, U. S. Bureau of Mines, 1942.

- (3.) THE MODERN TECHNIQUE OF ROCK BLASTING, U. Langefors and B. Kihlstrom, John Wiley & Sons, Inc., 1965. See Chapter 9 Ground Vibrations.

- (4.) AVOIDING DAMAGE TO RESIDENCES FROM BLASTING VIBRATIONS, James F. Devine, U. S. Bureau of Mines, 1966.

between holes in a line and between lines in a pattern.

RECORDS: A "Seismolog" or other type of seismograph giving a permanent record should be used to record all of the blasts. Periodic recording of ripping operations is also recommended as the level of vibrations created may equal or exceed that of the blasting.

Detailed records must be kept by the powderman (to become state property) giving:

1. Location, number and depth of all holes.
2. Distance from nearest hole to structures.
3. Amount and grade of powder per hole.
4. Type of caps and delay pattern used.
5. Date, time of day and weather conditions.
6. Powderman's signature.

CONVENIENCE TO PROPERTY OWNERS: Adjacent property is all business property. All shooting should be done at a definite time each day to create as little inconvenience as possible.

A thorough geological study has been made of the hillside behind the Travelodge Motel. The rock forming this slope is a well factured, blocky volcanic tuff. While dense and compact, it is not particularly hard or brittle. The deepest cut in the roadway section parallel to the motel structure is 10 feet at the left ditch line. The weathered surface material can be ripped to a 4 foot depth and probably to 6 feet judging from nearby excavations. The remaining 4 to 6 feet of rock will have to be shot only hard enough to loosen it and open the existing joint planes. It will not be necessary to break or shatter the rock since a ripper can easily move the loosened blocks.

The motel is constructed on a site benched into this same rock which is continuous to the roadway location. The two-story structure is of stucco and frame construction on a concrete slab and footings set on unweathered rock. The rear of the building is 40 feet from centerline and 60 feet from the left ditch line where the blasting will be concentrated. The light changes required to loosen the rock will have little effect on the motel structure, even at this short distance. The two possible types of damage, flying rock and cracking due to vibration, were investigated in some detail to determine how they could be reduced or eliminated.

Flying Rock damage can be eliminated by the use of mats and by use of the planned small charges. The advice of Mr. Charles R. Sparf,

District Representative of the Hercules Powder Company, was sought on this problem. His suggestions of smaller charges by means of milisecond delays and use of mats follow the thinking of our engineers who have looked at this site. The suggested use of pre-splitting the cut slope and blasting prior to removing the rippable material are not recommended. Until the loosened material is removed, the exact extent of the rock requiring shooting cannot be known. It will depend somewhat on the size and type of ripping equipment used and the jointing of the rock. Once the harder rock is exposed the shooting pattern can be tailored to the topography, the joint spacing and varying degrees of hardness. This more precise method will reduce the amount of powder necessary. Mr. Sparf's report is attached.

Cracking Due to Vibration is a potential danger that can be held to a minimum. To determine the ability of this type of rock to transmit blasting vibrations a series of tests were run on similar rock in the same formation west of Kingman. Mr. Thomas J. Ellis, a consulting geophysicist, was retained to plan and supervise these tests and to record the results on a seismograph. This work followed the standard procedure that can be accepted as evidence in court. Its purpose was to determine the amount of vibration transmitted and the level of vibration required to cause structural damage for a given distance. A remote test site was chosen so that the effect of various charges, from light to heavy, could be studied and the results recorded. It was fortunate that this was done as the range of blasts varied from no effect to cratering and flying rock. The test shot pattern was 3 holes in line on 4 foot centers to simulate the roadway ditchline to centerline distance. The test site was located on a sloping hillside to duplicate the expected slope of the rock that cannot be ripped. The seismograph was placed 40 feet from the first hole and in line with them to duplicate the actual motel to centerline distance. All tests were made with 60% gelatin powder in stemmed 2 inch diameter drill holes using instant, #1 and #2 delay caps in each series. The rock breakage noted was:

TEST #1 4 sticks per hole; holes 4 feet deep. One large crack connecting the holes, smaller radiating cracks not joining. No ground disturbance.

TEST #2 10 sticks per hole; holes 6 feet deep. Ground surface broken between holes, rock overturned with some bulging. No potential flying rock.

TEST #3 6 sticks per hole, holes 4 feet deep. Much flying rock. Each hole cratered, but craters do not join.

TEST #4 2 sticks per hole, holes 4 feet deep. Some small random surface cracking. Cracks do not connect holes. No surface disturbance. NOTE: the instrument distance was 28 feet instead of 40 feet as on other holes.

TEST #5 Instrument placed on concrete walk in front of east end of motel. Heavy truck traffic on U.S. 66, 80 feet away, recorded.

Test records were not obtained for Tests #2 and #3. Mr. Ellis' attached report shows the level of vibration for Test #1 to be .0020 inch and for Test #4 to be .0023 inch. This is particle displacement or the amount of movement of a given point. Both our figures are well within the SAFE range. The percentages given by Mr. Ellis for each show their position within or across this range. The U. S. Bureau of Mines Bulletin #442 and Devine's recent researches (U. S. B. M., 1966) give the limits of these ranges as: SAFE 0 to .0050; CAUTION .0050 to .050; and DANGER .050 and up.

These results have been used to develop a recommended safe loading and hole pattern. A similar instrument should be used to record the actual shooting vibrations during construction. The permanent records from this instrument, located on the floor slab of the motel, can be compared to the hole loading data and this information used to evaluate any future damage claim.

Respectfully submitted,



W. G. O'Harra
Engineer of Materials

LES:rel

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-23-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-16-67	2:33 PM	1	Environmental Chge.	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
68894	Water heater room #5, Travelodge Motel	Less than Energy Ratio		.0001	S

Reported by

S. J. Alb

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-20-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.		2-16-67	3:54 PM	91	465.75	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88816	On sidewalk at	25.0	.0095"	ER = .61	C	
	north side of					
	highway					

Distance = 43 ft

Reported by

J.E. Skib

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-20-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.		
Arizona Highway Depart.	2-17-67	3:50 PM	141	479		
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88817	N.E. corner	31.3	.0051"	ER = .28	S	
	Travelodge Motel					
	Closet in Unit 119					

Distance 59 ft,

Reported by JES VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date **2-23-67**

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-20-67	3:54 PM	49	228	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88895	NE cor. Travelodge Hotel, Closet in Unit 116	71.4	.0037"	ER = .76	D

Reported by

J. J. Field

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Date 2-23-67

Gentlemen:

The results of the seismograph tests of the prima blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-20-67	3:59 PM	61	198	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88896	NE cor. Travelodge Motel, closet in Unit 116	50.0	.0048"	ER = .62	C

Reported by JES/slb VIBRATION MEASUREMENT ENGINEERS, INC.

NOTICE OF NO RECORD

The sealed camera No. 1325 received from your Arizona Highway Dept.
operations of a blast discharged at 3:57 PM on 2-21-67
our recording No. 88966 revealed that no record was obtained.

1. Please check your SEISMOLOG immediately. If all traces are visible in the view slot and camera motor operates after proper set up, please review the operating instructions located on the inside of the instrument cover with your operator, to insure he is following the instructions properly. If SEISMOLOG does not operate according to instructions, please telephone us immediately at Area 312, DAVIS 8-0400.

2. Camera inspection discloses that _____

3. No film run off camera

Reported by J.P. S. B.

~~VIBRATION MEASUREMENT ENGINEERS, INC.~~

NOTICE OF NO RECORD

Arizona Highway
Department

The sealed camera No. 1220 received from your
operations of a blast discharged at 4:12 PM on 2-22-67
our recording No. 88973 revealed that no record was obtained.

1. Please check your SEISMOLOG immediately. If all traces are visible in the view slot and camera motor operates after proper set up, please review the operating instructions located on the inside of the instrument cover with your operator, to insure he is following the instructions properly. If SEISMOLOG does not operate according to instructions, please telephone us immediately at Area 312, DAVIS 8-0400.

2. Camera inspection discloses that _____

3. No film run off camera

Reported by JES
~~VIBRATION MEASUREMENT ENGINEERS, INC.~~

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. IF further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-21-67	4:00 PM	23	117.7	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88967	Travelodge Motel	83.3	.0019"	ER = .27	S
	Room 109, Closet				

Reported by JED:slb VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department		2-21-67	4:04 PM	15	25.9	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88968	Travelodge Motel	35.7	.0026"	ER = .09	S	
	Room 109, Floor					
	In closet					

Shot partially in black - maximum readable reported

Reported by JEFF SL VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department		2-21-67	4:10 PM	24	129.1	
RECORDING	TEST LOCATION		FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88969	Travelodge Motel		55.6	.0039"	ER =	C
	Room 109, Closet					

Reported by JED:slb VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-21-67	4:14 PM	26	128.3	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88970	Travelodge Motel	41.7	.0079"	ER =	D
	Room 109, Closet			1.17	

Reported by

J. E. Sullivan

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-21-67	4:18 PM	31	77.6	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88971	Travelodge Motel	50.0	.0046"	ER =	C
	Room 109, Closet			.57	

Reported by JEJ:sh VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-22-67	4:10 PM	34	103.2	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88972	Travelodge Motel	50.0	.0027"	ER =	S
	Concrete floor			.20	
	Room 105, Closet				

Reported by

J.E. Gilb

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.		
Arizona Highway Department	2-22-67	4:15 PM	19	142.7		
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88974	Clothes closet	50.0	.0046"	ER = .57	C	
	Room 105					
	Travelodge Motel					

Reported by

J. B. K. S. L.

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-22-67	4:18 PM	21	159.4	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88975	Clothes closet	45.5	.0031"	ER = .22	S
	Room 105				
	Travelodge Motel				

Reported by

J.E.J. sfb

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department		2-22-67	4:22 PM	18	105.5	
RECORDING	TEST LOCATION		FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88976	Clothes Closet		50.0	.0028"	ER = .21	S
	Room 105					
	Travelodge Motel					

Reported by

J. B. [Signature]

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-23-67	12:18 PM	FRT -	TRAIN TEST -	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88977	Closet in Room	90.9	.0002"	ER =	S
	102, Travelodge				
	Motel, Conc. floor				

Reported by

J. J. S. 10

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.		
Arizona Highway Department	2-23-67	3:49 PM	47	103.7		
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88978	Closet, Travelodge	35.7	.0058"	ER =	S	
	Motel, Room 102			.46		

Reported by

JEB

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen: Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as 'S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department		2-23-67	3:53 PM	35	108.5	
RECORDING	TEST LOCATION		FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88979	Closet, Room 102		50.0	.0050"	ER =	C
	Travelodge Motel				.68	

Reported by JED:slb VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE	LBS.
Arizona Highway Department	2-23-67	3:57 PM	24	97	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88980	Closet, Room 102	50.0	.0023"	ER = .14	S
	Travelodge Motel				

Reported by

J. J. [Signature]

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date: 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department		2-23-67	4:05 PM	33	194.1	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88981	Closet, Room 102	50.0	.0041"	ER = .45	S	
	Travelodge Motel					

Reported by

J.E.J.

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date **2-27-67**

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB		DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department		2-24-67	3:05 PM	24	223	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88938	Rm. 102 - Travelodge	41.7	.0049"	ER = .45	S	
	Motel - Concrete					
	Floor in closet					

R

ted by

J. E. Smith

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-27-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE -- LBS.		
Arizona Highway Department	2-24-67	3:09 PM	29	208.9		
RECORDING	TEST LOCATION	FREQ -- CPS	DISPLACEMENT	%LIMIT	CLASS	
88939	Room 102-Travel- edge Motel, con- crete floor-closet	50.0	.0028"	ER = .21	S	

Revised by

J. J. [Signature]

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-27-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.		
Arizona Highway Department	2-24-67	3:13 PM	22	136.9		
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS	
88940	Room 102	100.0	.0010"	ER = .11	S	
	Travelodge Motel					
	Concrete fl-closet					

Recorded by JEC:sl VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Date **2-27-67**

Gentlemen:

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - Lbs.	
Arizona Highway Department	2-24-67	3:16 PM	37	227.5	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88941	Rm. 102-Travelodge	100.0	.0005"	ER = .027	S
	Hotel - concrete				
	Floor in closet				

Recorded by *J. J. [Signature]* VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-7-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Ariz. High. Dept. Ripping Operation	3-1-67	1:35 PM	D-9 dozer & Sing. tooth ripper		
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
89167	Storeroom	50.0	.0002"	ER =	S
	Travelodge Motel			.001	

Camera not fully seated in inst. - maximum readable reported

Reported by J. E. Skib VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-7-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Ariz. High. Dept. Ripping Operation	3-1-67	1:45 PM	D-9 tooth	dozer & Sing ripper	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
89168	Storeroom	55.6	.0002"	ER =	S
	Travelodge Motel			.001	

Reported by JFJ

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-23-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-16-67	2:33 PM	1	Environmental Chge.	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88894	Water heater room #5, Travelodge Motel	Less than Energy Ratio		.0001"	S

Reported by

J. J. Sisto

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-17-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Depart.	2-15-67	4:50 PM	110	600	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88749	Near sidewalk, 528° W, 40.5' from nearest charge	41.7	.0111"	152	D

Reported by

JES

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-23-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-20-67	3:59 PM	61	198	
RECORDING#	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88896	NE cor. Travelodge Motel, Closet in Unit 116	50.0	.0048"	ER = .62	C

Reported by J.E. Smith

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 2-23-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-20-67	3:54 PM	49	228	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88895	NE cor. Travelodge Motel, Closet in Unit 116	71.4	.0037"	ER = .76	D.

Reported by JEU:slb

VIBRATION MEASUREMENT ENGINEERS, INC.

SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen:

Date 3-1-67

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Arizona Highway Department	2-15-67	4:50 PM	110	668	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
88749	Nr. sidewalk, S28°	41.7	.0111"	ER =	D
	W. 40.5' from near-est charge				

CORRECTED COPY ← *Note*

Reported by J. J. S. D. VIBRATION MEASUREMENT ENGINEERS, INC.

NOTICE OF NO RECORD

The sealed camera No. 1067 received from your Arizona Highway Department
operations of a blast discharged at 2:33P on 2-16-67
our recording No. 88894 revealed that no record was obtained.

1. Please check your SEISMOLOG immediately. If all traces are visible in the view slot and camera motor operates after proper set up, please review the operating instructions located on the inside of the instrument cover with your operator, to insure he is following the instructions properly. If SEISMOLOG does not operate according to instructions, please telephone us immediately at Area 312, DAVIS 8-0400.

2. Camera inspection discloses that _____

3. Missed shot

Reported by JEJ:slb

~~VIBRATION MEASUREMENT ENGINEERS, INC.~~
CORRECTED COPY



Bldg. 60' #4
 Feb. 21, 1967
 Sta. 51+50
 19 1.2 1.2
 20 0.12 0.12
 21 1.2 1.2
 22 1.2 1.2
 23 1.2 1.2
 24 1.2 1.2
 25 1.2 1.2
 26 1.2 1.2
 27 1.2 1.2
 28 1.2 1.2
 29 1.2 1.2
 30 1.2 1.2
 31 1.2 1.2
 32 1.2 1.2
 33 1.2 1.2
 34 1.2 1.2
 35 1.2 1.2
 36 1.2 1.2
 37 1.2 1.2
 38 1.2 1.2
 39 1.2 1.2
 40 1.2 1.2

Bldg. 50' #2
 Feb. 21, 1967
 Sta. 52+00
 41 1.2 1.2
 42 1.2 1.2
 43 1.2 1.2
 44 1.2 1.2
 45 1.2 1.2
 46 1.2 1.2
 47 1.2 1.2
 48 1.2 1.2
 49 1.2 1.2
 50 1.2 1.2
 51 1.2 1.2
 52 1.2 1.2
 53 1.2 1.2
 54 1.2 1.2
 55 1.2 1.2
 56 1.2 1.2
 57 1.2 1.2
 58 1.2 1.2
 59 1.2 1.2
 60 1.2 1.2

Bldg. 45' #5
 Feb. 21, 1967
 Sta. 52+00
 61 1.2 1.2
 62 1.2 1.2
 63 1.2 1.2
 64 1.2 1.2
 65 1.2 1.2
 66 1.2 1.2
 67 1.2 1.2
 68 1.2 1.2
 69 1.2 1.2
 70 1.2 1.2
 71 1.2 1.2
 72 1.2 1.2
 73 1.2 1.2
 74 1.2 1.2
 75 1.2 1.2
 76 1.2 1.2
 77 1.2 1.2
 78 1.2 1.2
 79 1.2 1.2
 80 1.2 1.2
 81 1.2 1.2
 82 1.2 1.2
 83 1.2 1.2
 84 1.2 1.2
 85 1.2 1.2
 86 1.2 1.2
 87 1.2 1.2
 88 1.2 1.2
 89 1.2 1.2
 90 1.2 1.2

Bldg. 40' #3
 Feb. 21, 1967
 Sta. 52+00
 91 1.2 1.2
 92 1.2 1.2
 93 1.2 1.2
 94 1.2 1.2
 95 1.2 1.2
 96 1.2 1.2
 97 1.2 1.2
 98 1.2 1.2
 99 1.2 1.2
 100 1.2 1.2
 101 1.2 1.2
 102 1.2 1.2
 103 1.2 1.2
 104 1.2 1.2
 105 1.2 1.2
 106 1.2 1.2
 107 1.2 1.2
 108 1.2 1.2
 109 1.2 1.2
 110 1.2 1.2
 111 1.2 1.2
 112 1.2 1.2
 113 1.2 1.2
 114 1.2 1.2
 115 1.2 1.2
 116 1.2 1.2
 117 1.2 1.2
 118 1.2 1.2
 119 1.2 1.2
 120 1.2 1.2
 121 1.2 1.2
 122 1.2 1.2
 123 1.2 1.2
 124 1.2 1.2
 125 1.2 1.2
 126 1.2 1.2
 127 1.2 1.2
 128 1.2 1.2
 129 1.2 1.2
 130 1.2 1.2

Bldg. 24' #6
 Feb. 21, 1967
 Sta. 52+00
 131 1.2 1.2
 132 1.2 1.2
 133 1.2 1.2
 134 1.2 1.2
 135 1.2 1.2
 136 1.2 1.2
 137 1.2 1.2
 138 1.2 1.2
 139 1.2 1.2
 140 1.2 1.2
 141 1.2 1.2
 142 1.2 1.2
 143 1.2 1.2
 144 1.2 1.2
 145 1.2 1.2
 146 1.2 1.2
 147 1.2 1.2
 148 1.2 1.2
 149 1.2 1.2
 150 1.2 1.2
 151 1.2 1.2
 152 1.2 1.2
 153 1.2 1.2
 154 1.2 1.2
 155 1.2 1.2
 156 1.2 1.2
 157 1.2 1.2
 158 1.2 1.2
 159 1.2 1.2
 160 1.2 1.2

Reading #11
 INF-Blast #10
 # @ 45' for
 jobs # 243

L. F. Chapman

* 1 Stick Gel.
 1/2 Stick Gel.

161 holes
 525-1103
 120.5 Gel.
 403. Caps.

Feb. 21, 1967

Feb. 21, 1967

(24) 123 (23) 123 (22) 123 9' (21) 123 (20) 123 8"

(44) 0,1,2 (43) 0,1,2 (42) 0,1,2 9' (41) 0,1,2 8"

(62) 2,3,4 (61) 2,3,4 9' (60) 2,3,4

(82) 0,1,2 (81) 0,1,2 (80) 0,1,2 9' (79) 0,1,2

(102) 5,6,7 (101) 5,6,7 9' (100) 5,6,7 8"

(123) 6,7,8 (122) 6,7,8 (121) 6,7,8 9' (120) 6,7,8 8"

(142) 7,8,9 9' (141) 7,8,9 (140) 7,8,9 (139) 7,8,9 8"

(151) 4,5,6 (150) 4,5,6 8' (149) 4,5,6 8" (148) 4,5,6 8"

(153) 6,7 (152) 6,7 6' 6" 8"

(156) 7,8 (155) 7,8 6' (154) 7,8 9"

(161) 8,9 (160) 8,9 (159) 8,9 (158) 8,9 6' (157) 8,9 3"

241
242

1

2

3

4

5

6

7

8

9

10

Blast # 1

Date Feb. 21, 1967 Time of Blast 4:40 PM. Weather Clear, Cool.
Distance of nearest hole to nearest Bldg. - 65 ft.

Hole #	Depth	Inches Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
1 thru 11	9'	1" - 3' 4" - 6' 9" - 9'	1 2 3 sec.	Electric	11 lb. 40% Gel., 47.6 lb. Carbo Nitrate
25 thru 32	9'	1" - 3' 5" - 6' 9" - 9'	0 1 2 sec.	Electric	8 lb. 40% Gel., 37 lb. Carbo Nitrate

Notes: Carbo-Nitrate wts. in holes are approximate.
Primers consist of cap and 40% gel.
84.6 lbs. Carbo-Nitrate used.
19 lbs. 40% gel. used
58 caps used.

Blast #6 JNF

Hole #	Depth	Inches Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
45 thru 51	10'	1" - 4' 4" - 7' 9" - 10'	2 3 4 sec.	Electric	7 lb. 40% Gel., 30.3 lb. Carbo Nitrate ^{1/3}
63 thru 70	9'	1" - 3' 4" - 6' 8" - 9'	0 1 2 sec.	Electric	8 lb. 40% Gel., 32.2 lb. Carbo Nitrate ^{1/3}
83 thru 90	8'	1" - 3' 4" - 6' 8" - 8'	1 2 3 sec.	Electric	8 lb. 40% Gel., 32.2 lb. Carbo Nitrate ^{1/3}

Blast #2

Notes: Carbo Nitrate wts. in holes are approximate.
Primers consist of cap and 40% gel.
94.7# Carbo-Nitrate used. Nearest hole to Bldg. 50ft
23.0# 40% Gel. used.
69 caps used.

Blast #7 JNF

103 thru 110	6'	1" - 3' 3" - 6'	3 4 sec.	Electric	6 lb. 40% Gel., 9.9 lb. Carbo Nitrate ^{1/3}
124 thru 130	5'	1" - 2' 2" - 5'	4 5 sec.	Electric	3.5 lb. 40% Gel., 6.5 lb. Carbo Nitrate ^{1/4}

Blast No 8 JNF

Blast #3

Notes: Carbo Nitro wts. in holes are approximate.
Primers consist of cap and 40% Gel.
16.4# Carbo-Nitrate used Nearest hole to Bldg. 40ft
9.5# 40% Gel. used
30 Caps used.

x C.F. Chapman
Powder Man

Blasts 1, 2 + 3 on Feb 21, 67 4:50 PM

Date Feb. 21, 1911 Time 4:00 P.M. Weather Clear, Cool

Distance of nearest hole to nearest Bldg. — 60 ft.

Blast #4

Hole #	Depth	In. Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
12 thru 18 ⁷	6'	1" — 3' 8" — 6'	1 2 Sec.	Electric	3.5 lb. ^{1/4} 40% Gel., 19.5 # Carbo-Nitrate
19 thru 24 ⁶	9'	1" — 3' 8" — 9'	1 3 Sec.	Electric	6 lb. ^{1/3} 40% Gel., 24.2 # Carbo-Nitrate
33 thru 39 ⁷	6'	1" — 3' 3" — 6'	0 1 Sec.	Electric	3.5 lb. ^{1/4} 40% Gel., 8.7 # Carbo-Nitrate
40 thru 44 ⁵	9'	1" — 3' 8" — 9'	0 2 Sec.	Electric	5 lb. ^{1/3} 40% Gel., 17 # Carbo-Nitrate
52 thru 57 ⁶	7'	1" — 4' 8" — 7'	2 3 Sec.	Electric	3 lb. ^{1/4} 40% Gel., 16.7 # Carbo-Nitrate
58 thru 62 ⁵	9'	1" — 3' 8" — 9'	2 3 4 Sec.	Electric	5 lb. ^{1/3} 40% Gel., 17 # Carbo-Nitrate

Blast #9
JNF

Notes: Carbo-Nitrate wts. are approximate.
Primers consist of cap and 40% Gel.

103.1 lbs. Carbo-Nitrate used
26 lbs. 40% Gel. Used.
88 Caps. Used.

71 thru 75 ⁵	6'	1" — 3' 3" — 6'	0 1 Sec.	Electric	2.5 lb. ^{1/4} 40% Gel., 6.2 # Carbo-Nitrate
76 thru 82 ⁷	9'	1" — 3' 8" — 9'	0 2 Sec.	Electric	7 lb. ^{1/3} 40% Gel., 28.1 # Carbo-Nitrate
91 thru 99 ⁹	6'	1" — 3' 8" — 6'	2 3 Sec.	Electric	4.5 lb. ^{1/4} 40% Gel., 25 # Carbo-Nitrate
100 thru 102 ³	9'	2" — 3' 6" — 6' 10" — 9'	5 6 7 Sec.	Electric	3 lb. ^{1/3} 40% Gel., 17.6 # Carbo-Nitrate
111 thru 119 ⁹	6'	1" — 3' 3" — 6'	4 5 Sec.	Electric	4.5 lb. ^{1/4} 40% Gel., 11.1 # Carbo-Nitrate
120 thru 123 ⁴	9'	1" — 3' 8" — 6' 8" — 9'	6 7 8 Sec.	Electric	4 lb. ^{1/3} 40% Gel., 14.8 # Carbo-Nitrate

Notes: Carbo-Nitro wts. are approximate. Nearest hole to Bldg. 45 ft.
40% Gel. used in Primers

102.8 # Carbo Nitrate used.
25.5 # 40% Gel. used, 88 caps used.

Blast #5

Blast No 10
JNF

x G. F. Chapman
Powder Man

Blast 485 Feb 21

Blast # 6
 Blast # 11
 JNF

Date Feb. 21, 1917 Time 4:00 P.M. Weather Clear, Cool
 Distance of nearest hole to nearest Bldg. 24 ft.

Hole #	Depth	In. Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
131 thru 138 ⁸	5'	1" — 3' 2" — 5'	5 6 sec.	Electric	4 lb. ^{1/4} 40% Gel., 7.4# Carbo Nitrate
139 thru 142 ⁴	9'	1" — 3' 3" — 6' 8" — 9'	7 8 9 sec.	Electric	4 lb. ^{1/3} 40% Gel., 14.8# Carbo Nitrate
143 thru 147 ⁵	5'	2" — 5'	7 sec.	Electric	1.25 lb. ^{1/4} 40% Gel., 3.1# Carbo Nitrate
148	6'	1" — 3' 8" — 6'	5 6 sec.	Electric	0.5 lb. ^{1/4} 40% Gel., 2.8# Carbo Nitrate
149 thru 151 ²	8'	1" — 3' 2" — 6' 8" — 8'	4 5 6 sec.	Electric	3 lb. ^{1/2} 40% Gel., 10.2# Carbo Nitrate
152 thru 153 ²	6'	1" — 3' 8" — 6'	6 7 sec.	Electric	1 lb. ^{1/4} 40% Gel., 5.5# Carbo Nitrate
154 thru 156 ³	6'	1" — 3' 9" — 6'	7 8 sec.	Electric	1.5 lb. ^{1/4} 40% Gel., 9.3# Carbo Nitrate
157 thru 161 ⁵	6'	1" — 3' 3" — 6'	8 9 sec.	Electric	2.5 lb. ^{1/4} 40% gel., 6.2# Carbo Nitrate

Notes: Carbo Nitrate wts. are approximate.
 40% Gel. used in Primers.
 59.3 lbs. Carbo Nitrate used.
 17.8 lbs. 40% Gel. used.
 65 caps used.

x G. F. Chapman
 Powder Man

Blast 6 on Feb 21.

Time/day 4:40 P.M. Date - Feb 15, 1967
 Weather - Partly Cloudy - Cold.
 dist. Nearest hole - nearest building - 170 ft.

Hole No. #	Depth	Inches Powder	CAP Delay Pattern #	TYPE Caps	Grade + Amount Powder
1	4'	5"	1 Sec.	Electric	1/4 lb. 40% gel, 1 1/2 lb. Carbo Nitrate
2	4'	5"	1 Sec.	"	" "
3	4'	5"	1 Sec.	"	" "
4 thru 9	9'	11"-9' 5"-6'	2 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. Carbo Nitrate
10-21	9'	11"-9' 5"-6' 5"-3'	3 1/2 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
22-29	9'	11"-9' 5"-6'	4 Sec.	"	1/2 lb. 40% gel, 5 lb. "
30-40	12'	11"-12' 5"-9' 5"-6'	6 1/2 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
41-45	8'	11"-8' 5"-4'	2 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. "
46-56	11'	11"-11' 5"-8' 5"-5'	3 1/2 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
57-61	7"	11"-7' 5"-4'	3 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. "
62-71	10'	11"-10' 5"-7' 5"-4'	4 1/2 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
72-74	7'	11"-7' 5"-4'	4 3/4 Sec.	"	1/2 lb. 40% gel, 5 lb. "
75-77	8'	11"-8' 5"-5'	4 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. "
78-84	9'	11"-9' 5"-6' 5"-3'	5 3/4 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
85-97	7'	11"-7' 5"-4'	5 Sec.	"	1/2 lb. 40% gel, 5 lb. "
98-101	4'	11"-4' 5"-2'	5 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. "
102-110	6'	11"-6' 5"-3'	6 1/4 Sec.	"	1/2 lb. 40% gel, 5 lb. "

Notes: Carbo-nitrate wts. per hole are approximate,
 Primer charges consist of Cap and 1/4 lb. 40% gel.
 600 lbs. Carbo nitrate used.
 48 lbs. 40% gel. used.
 271 Caps used.

C. F. Chapman
 Powder Man

Feb 15, 4:40 P.M.

Time/day — 4:00 P.M. Date — Feb. 16, 1967

Weather Cond. — Clear + Cool

Distance to Nearest Bldg. — 120'

Hole#	Depth	Inches Powder	Cap Delay Pattern	Type Caps	Grade and Amount of Powder
1 thru 7					
1 thru 10	10'	9"-10" 5"-7" 5"-4"			
1 thru 13	10'	9"-10" 5"-7" 5"-4"	23 22 Sec. 31	Electric	1 lb. 40% Gel. + 5.9 lb. Carbo Nitrate
14	10'	9"-10" 5"-7" 5"-4"	810 89 Sec. 88	"	1 lb. 40% Gel. + 5.9 lb. Carbo Nitrate
15 thru 25	12'	9"-12" 5"-9" 5"-6"	82 81 Sec. 80	"	" "
26	12'	9"-12" 5"-9" 5"-6"	810 89 Sec. 88	"	" "
27 thru 37	11'	9"-11" 5"-8" 5"-5"	23 22 Sec. 31	"	" "
38 thru 47	9.5'	9"-9.5" 5"-6.5" 5"-3.5"	24 23 Sec. 42	"	" "
48 thru 57	8.5'	8"-8.5" 5"-5.5"	54 45 Sec.	"	1/2 lb. 40% Gel. + 3.9 lb. Carbo Nitrate
58 thru 67	7'	8"-7" 5"-4"	56 65 Sec.	"	" "
68 thru 78	6'	8"-6" 5"-3"	67 76 Sec.	"	" "
79 thru 91	4'	None	8 sec.	"	1/4 lb. 40% Gel. No Carbo Nitrate

Notes: Carbo-nitrate wts. per hole are approximate.
 Primer charges consist of Cap. and 40% gel.
 400 lbs. Carbo Nitrate Used.
 65.75 lbs. 40% Gel. used.
 234 Caps. Used.

x C. F. Chapman
 Powder Man

Time/day — 4:00 P.M. Date — Feb. 16, 1967

Weather Cond. — Clear + Cool

Distance to Nearest Bldg. — 120'

Hole#	Depth	Inches Powder	Cap Delay Pattern	Type Caps	Grade and Amount of Powder
1 thru 7		9"-10"			
1 thru 10	10'	5"-7" 5"-4"			
1 thru 13	10'	9"-10" 5"-7" 5"-4"	1/2 sec. 2 3	Electric	1 lb. 40% Gel. + 5.9 lb. Carbo Nitrate
14	10'	9"-10" 5"-7" 5"-4"	8/9 sec. 9 10	"	1 lb. 40% Gel. + 5.9 lb. Carbo Nitrate
15 thru 25	12'	9"-12" 5"-9" 5"-6"	0/1/2 sec. 1 2	"	" "
26	12'	9"-12" 5"-9" 5"-6"	8/9/10 sec. 8 9 10	"	" "
27 thru 37	11'	9"-11" 5"-8" 5"-5"	1/2/3 sec. 1 2 3	"	" "
38 thru 47	9.5'	9"-9.5" 5"-6.5" 5"-3.5"	2/3/4 sec. 2 3 4	"	" "
48 thru 57	8.5'	8"-8.5" 5"-5.5"	4/5 sec. 4 5	"	1/2 lb. 40% Gel. + 3.9 lb. Carbo Nitrate
58 thru 67	7'	8"-7" 5"-4"	5/6 sec. 5 6	"	" "
68 thru 78	6'	8"-6" 5"-3"	6/7 sec. 6 7	"	" "
79 thru 91	4'	None	8 sec.	"	1/4 lb. 40% Gel. No Carbo Nitrate

Notes: Carbo-nitrate wts. per hole are approximate.
 Primer charges consist of Cap. and 40% gel.
 400 lbs. Carbo Nitrate Used.
 65.75 lbs. 40% Gel. used.
 234 Caps. Used.

x C. F. Chapman
 Powder Man

See revised sheet.

Feb 16, 4:00 PM Dist to Bldg 120'

53+20

Feb. 17, 1967

9

53+50

18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3
30	31	30	31	30	31	30	31	30	31	30	31	30	31	30	31	30	31
0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2	0.1.2
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31
1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3	1.2.3
65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
124	123	122	121	120	119	118	117	116	115	114	113	112	111	110	109	108	107
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
144	143	142	141	140	139	138	137	136	135	134	133	132	131	130	129	128	127
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8

400# Carbo-Nitrate
 268 caps.
 79# 40% Gel.

X to F. Chapman
 Powder Man

Date 2/17/67 - Time of Day 3:45 P.M. Weather Clear - Cool
 Distance from Nearest Hole to nearest Bldg. - 89 ft.

Hole #	Depth	Inches Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
1 thru 18	9'	8" - 9' 5" - 6' 5" - 3'	3 2 1 sec.	Electric	1 lb. 40% gel., 100 lb. Carbo Nitrate
19 thru 32	11'	8" - 11' 5" - 8' 5" - 5'	2 1 0 sec.	"	1 lb. 40% gel., 78 lb. Carbo Nitrate
33 thru 48	10'	8" - 10' 5" - 7' 5" - 4'	3 2 1 Sec.	"	1 lb. 40% gel., 89 lb. Carbo Nitrate
49 thru 65	8'	7" - 8' 4" - 5'	4 3 sec.	"	1/2 lb. 40% gel., 58 lb. Carbo Nitrate
66 thru 82	7'	7" - 7' 4" - 4'	5 4 sec.	"	1/2 lb. 40% gel., 58 lb. Carbo Nitrate
83 thru 103	6'	1" - 6'	6 sec.	"	1/4 lb. 40% gel., 6 1/2 lb. Carbo Nitrate
104 thru 124	5'	1" - 6'	7 sec.	"	1/4 lb. 40% gel., 6 1/2 lb. Carbo Nitrate
124 thru 141	4'	0" - 4'	8 sec	"	1/4 lb. 40% gel., - 0 - "

Notes:

Carbo Nitrate wts. are approximate.

Primers consist of caps and 40% gel.

400# Nitrate used
 79# 40% gel. used.
 268 Caps used

x C. F. Chapman
 Powder Man

2/17/67 3:45 PM, Dist 89 ft to bldg.

Blast #1

Date Feb. 20, 1967 Time of Blast 4:00 P.M. Weather clear, Cold
 Distance of Nearest hole to Nearest Bldg. 53 ft.

Hole #	Depth	In. Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
1 thru 7	8'	1" - 3'	1	Electric	7 lb. 40% Gel., 32.5 lb. Carbo Nitrate
		5" - 6'	2 sec.		
		9" - 8'	3		
8 thru 14	8'	1" - 3'	4	Electric	7 lb. 40% Gel., 32.5 lb. "
		5" - 6'	5 sec.		
		9" - 8'	6		
15 thru 18	8'	1" - 3'	1	Electric	4 lb. 40% Gel., 18.5 lb. "
		5" - 6'	2 sec.		
		9" - 8'	3		
19 thru 23	8'	1" - 3'	0	Electric	5 lb. 40% Gel., 26.3 lb. "
		7" - 6'	1/2 sec.		
		9" - 8'	2		
24 thru 30	8'	1" - 3'	3	Electric	7 lb. 40% Gel., 36.8 lb. "
		5" - 6'	4 sec.		
		9" - 8'	5		
31 thru 34	8'	1" - 3'	0	Electric	4 lb. 40% Gel., 21.0 lb. "
		4" - 6'	1 sec.		
		9" - 8'	2		
35 thru 39	7'	1" - 3'	2	Electric	5 lb. 40% Gel., 20.0 lb. "
		4" - 5 1/2'	3 sec.		
		8" - 7'	4		
40 thru 46	9'	1" - 3'	5	Electric	7 lb. 40% Gel., 28 lb. "
		4" - 6'	6 sec.		
		8" - 9'	7		
47 thru 49	9'	1" - 3'	2	Electric	3 lb. 40% Gel., 12 lb. "
		4" - 6'	3 sec.		
		8" - 9'	4		

Notes:

This is blast #1.
 Carbo-Nitrate wts. are Approximate.
 227.4 lbs. Carbo-Nitrate Used
 49 lbs 40% Gel. used for primers.
 147 Caps. used.

X C. F. Chapman
 Powder Man

Date - Feb 20 1967 Time of Day - 4:00 P.M. Weather - clear, cold

Blast # 2 Distance of Nearest hole to Nearest Bldg. - 42' - - -

Hole #	Depth	Inches Powder	Cap Delay	Type Caps	Amt + Grade of Powder
50 thru 54	8'	6" - 5' 9" - 8'	0 1 Sec.	Electric	2 1/2 lb. 40% Gel., 23 lb. Carbo Nitrate
55 thru 61	8'	1" - 3' 6" - 6' 9" - 8'	0 1 2 Sec.	Electric	7 lb. 40% Gel., 35 lb. "
62 thru 64	8'	1" - 3' 4" - 6' 8" - 8'	0 1 2 Sec.	Electric	3 lb. 40% Gel., 12 lb. "
65 thru 69	6'	1" - 3' 9" - 6'	3 4 Sec.	Electric	2 1/2 lb. 40% Gel., 15.4 lb. "
70 thru 76	6'	1" - 3' 9" - 6'	1 2 Sec.	Electric	3 1/2 lb. 40% Gel., 21.6 lb. "
77 thru 79	8'	1" - 3' 4" - 6' 8" - 8'	1 2 3 Sec.	Electric	3 lb. 40% Gel., 12 lb. "
80 thru 86	6'	2" - 6'	5 Sec.	Electric	1 3/4 lb. 40% Gel., 4.3 lb. "
87 thru 93	6'	4" - 3' 8" - 6'	3 4 Sec.	Electric	3 1/2 lb. 40% Gel., 26 lb. "
94 thru 96	8'	2" - 3' 4" - 6' 7" - 8'	2 3 4 Sec.	Electric	3 lb. 40% Gel., 12 lb. "
97 thru 102	5'	1" - 5'	6 Sec.	Electric	1 1/2 lb. 40% Gel., 1.9 lb. "
103 thru 110	6'	3" - 3' 7" - 6'	4 5 Sec.	Electric	4 lb. 40% Gel., 24.7 lb. "

Notes: Blast # 2
 Carbo-Nitrate wts. are approximate.
 187.9 lbs. Carbo-Nitrate Used
 35 1/4 lb. 40% Gel. used
 125 caps Used.

x G. F. Chapman
 Powder Man

Blast 2; 2-20-67, 4:00 PM?

Date 2/11/41 - Time of Day 3:45 P.M. Weather Clear - Cool
 Distance from Nearest Hole to Nearest Bldg. - 89 ft.

Hole #	Depth	Inches Powder	Cap Delay	Type Caps	Amt. + Grade of Powder
1 thru 18	9'	8"-9' 5"-6' 5"-3'	3 2 1 sec.	Electric	1 lb. 40% gel., 100 lb. Carbo Nitrate
19 thru 32	11'	8"-11' 5"-8' 5"-5'	2 1 0 sec.	"	1 lb. 40% gel., 78 lb. Carbo Nitrate
33 thru 48	10'	8"-10' 5"-7' 5"-4'	3 2 1 sec.	"	1 lb. 40% gel., 89 lb. Carbo Nitrate
49 thru 65	8'	7"-8' 4"-5'	4 3 sec.	"	1/2 lb. 40% gel., 58 lb. Carbo Nitrate
66 thru 82	7'	7"-7' 4"-4'	5 4 sec.	"	1/2 lb. 40% gel., 58 lb. Carbo Nitrate
83 thru 103	6'	1"-6'	6 sec.	"	1/4 lb. 40% gel., 6 1/2 lb. Carbo Nitrate
104 thru 124	5'	1"-6'	7 sec.	"	1/4 lb. 40% gel., 6 1/2 lb. Carbo Nitrate
24 thru 141	4'	0"-4'	8 sec.	"	1/4 lb. 40% gel., - 0 -

Notes:

Carbo Nitrate wts. are approximate.
 Primers consist of caps and 40% gel.

400# Nitrate used
 79# 40% gel. used.
 268 Caps used

12" Am No₃ =
 2.4 lbs

x G. F. Chapman
 Powder Man

Feb 17
 3:45 PM,
 89 ft.

Time/day — 4:00 P.M. Date — Feb. 16, 1967
 Weather Cond. — Clear + Cool
 Distance to Nearest Bldg. — 120'

Hole#	Depth	Inches Powder	Cap Delay Pattern	Type Caps	Grade and Amount of Powder
1 thru 7	10'	9"-10"	33		
1 thru 10	10'	5"-7"	32		
1 thru 10	10'	5"-4"	31		
1 thru 13	10'	9"-10"	33	Electric	1 lb. 40% Gel. + 5.9 lb. Carbo Nitrate
		5"-7"	32		
		5"-4"	31		
14	10'	9"-10"	310	"	1 lb. 40% Gel. + 5.9 lb. Carbo Nitrate
		5"-7"	309		
		5"-4"	308		
15 thru 25	12'	9"-12"	302	"	"
		5"-9"	301		
		5"-6"	300		
26	12'	9"-12"	310	"	"
		5"-9"	309		
		5"-6"	308		
27 thru 37	11'	9"-11"	33	"	"
		5"-8"	32		
		5"-5"	31		
38 thru 47	9.5'	9"-9.5"	34	"	"
		5"-6.5"	33		
		5"-3.5"	32		
48 thru 57	8.5'	8"-8.5"	34	"	1/2 lb. 40% Gel. + 3.9 lb. Carbo Nitrate
		5"-5.5"	33		
58 thru 67	7'	8"-7"	56	"	"
		5"-4"	65		
68 thru 78	6'	8"-6"	67	"	"
		5"-3"	76		
79 thru 91	4'	None	8	"	1/4 lb. 40% Gel. No Carbo Nitrate

Notes: Carbo-nitrate wts. per hole are approximate.
 Primer charges consist of Cap. and 40% gel.
 400 lbs. Carbo Nitrate Used.
 65.75 lbs. 40% Gel. used.
 234 Caps. Used.

x C. F. Chapman
 Powder Man

2/16/67, 4:00 PM

19	18	17	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	#
1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	113.5
54+50																		19
39	38	37	36	35/2	34	33	32	31	30	29	28	27	26	25	24	23	22	15
2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	2.1, 2	13
55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	13
1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2, 3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	10
70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	90
2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	2.3, 4	E
93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	33
3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	3.4, 5	75.5
92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	26
5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	60
100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	
6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	

L. J. Chapman

1
Feb 15, 1967

68#
60#
Caps
61#

S

-N-

54+00

(21) 1,2,3
(20) 1,2,3

(19) 0,1,2

(52) 1,2,3

(7) 2,3,4

(84) 3,4,5
E

(97) 5,6

(110) 6,7

#2

P. F. Chapman

Feb 15, 1967

W

S

Time/day 4:40 P.M. Date - Feb 15, 1967
 Weather - Partly Cloudy - Cold
 dist. Nearest hole - nearest building - 170 ft.

Hole No.	Depth	Inches Powder	CAP Delay Pattern	TYPE Caps	Grade + Amount Powder
1	4'	5"	1 Sec.	Electric	1/4 lb. 40% gel, 1 1/2 lb. Carbo Nitrate
2	4'	5"	1 Sec.	"	" "
3	4'	5"	1 Sec.	"	" "
4 thru 9	9'	11" - 9' 5" - 6'	2 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. Carbo Nitrate
10-21	9'	11" - 9' 5" - 3'	2 1/2 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
22-29	9'	11" - 9' 5" - 6'	2 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. "
30-40	12'	11" - 12' 5" - 7' 5" - 6'	2 1/2 Sec.	"	3/4 lb. 40% gel, 6 1/2 lb. "
41-45	8'	11" - 8' 5" - 4'	2 1/2 Sec.	"	1/2 lb. 40% gel, 5 lb. "
46-56	11'	11" - 11' 5" - 8" 5" - 5"	3 1/2 Sec.	"	3/4 lb. 40% gel. 6 1/2 lb. "
57-61	7"	11" - 7' 5" - 4'	3 2/3 Sec.	"	1/2 lb. 40% gel. 5 lb. "
62-71	10'	11" - 10' 5" - 7' 5" - 4'	4 2/3 Sec.	"	3/4 lb. 40% gel. 6 1/2 lb. "
72-74	7'	11" - 7' 5" - 4'	4 3/4 Sec.	"	1/2 lb. 40% gel. 5 lb. "
75-77	8'	11" - 8' 5" - 5"	4 4/5 Sec.	"	1/2 lb. 40% gel. 5 lb. "
78-84	9'	11" - 9' 5" - 6' 5" - 3'	5 3/4 Sec.	"	3/4 lb. 40% gel. 6 1/2 lb. "
85-97	7'	11" - 7' 5" - 4'	6 5/6 Sec.	"	1/2 lb. 40% gel. 5 lb. "
98-101	4'	11" - 4' 5" - 2'	6 5/6 Sec.	"	1/2 lb. 40% gel. 5 lb. "
102-110	6'	11" - 6' 5" - 3'	7 6/7 Sec.	"	1/2 lb. 40% gel. 5 lb. "

Notes: Carbo-nitrate wts. per hole are approximate,
 Primer charges consist of Cap and 1/4 lb. 40% gel.
 600 lbs. Carbo nitrate used.
 48 lbs. 40% gel. used.
 271 Caps used.

C. F. Chapman
 Powder Man

Feb. 24, 1967

(4)

(3)

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50+50

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 29 1 2 3
 28 1 2 3
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 11 1 2 3
 10 1 2 3
 9 1 2 3
 8 1 2 3
 7 1 2 3
 6 1 2 3
 5 1 2 3
 4 1 2 3
 3 1 2 3
 2 1 2 3
 1 1 2 3

Blast # 4
Blast # 3
Blast # 2
Blast # 1

675# Nitrate used from bags.

x G. F. Chapman
Powder Man

M

E

Date: 2-2-67 Time: 3:40 P.M. Weather: clear, mild
 Distance of nearest hole to nearest Bldg. 55 ft.

Blast #1

Hole #	Depth	In Powder	Cap Delay	Type Caps	Amt. + Grade of Powder	
					40% Gel. lb	Carbo Nitrate, lb.
1 thru 5	11'	1" — 3' 4" — 6' 6" — 9' 11" — 11'	6 7 8 9 sec.	Electric	7.5 #	34.0 #
6	9'	1" — 3' 6" — 6' 10" — 9'	6 7 8 sec.	"	1.0 #	5.3 #
31 thru 36	12'	1" — 3' 5" — 6' 5" — 9' 11" — 12'	5 6 7 8 sec.	"	9.0 #	40.8 #
56 thru 61	14'	1" — 5' 6" — 8' 10" — 11' 12" — 14'	4 5 6 7 sec.	"	9.0 #	53.7 #
78 thru 83	14'	1" — 5' 6" — 8' 10" — 11' 12" — 14'	3 4 5 6 sec.	"	9.0 #	53.7 #
					35.5	187.5 # Total

Notes: Carbo-Nitrate wts. are approximate.
 Primers consist of caps and 40% gel.
 95 caps.

Blast #2	50 ft.	Distance of nearest hole to nearest bldg..				
7 thru 11	9'	1" — 3' 6" — 6' 10" — 9'	6 7 8 sec.	"	5.0 #	26.2 #
12 thru 15	9'	1" — 3' 5" — 6' 10" — 9'	7 8 9 sec.	"	4.0	19.8 #
37 thru 39	9'	1" — 3' 5" — 6' 5" — 8' 11" — 9'	5 6 7 8 sec.	"	4.5	20.3 #
40 thru 43	9'	1" — 3' 6" — 6' 9" — 9'	6 7 8 sec.	"	4.0	19.8 #
62 thru 63	14'	1" — 5' 6" — 8' 10" — 11' 12" — 14'	4 5 6 7 sec.	"	3.0	17.9 #
64 thru 67	9'	1" — 3' 7" — 6' 8" — 9'	4 5 6 sec.	"	4.0	19.8 #
84 thru 87	14'	1" — 5' 6" — 8' 10" — 11' 12" — 14'	3 4 5 6 sec.	"	6.0	35.8 #
88 thru 89	9'	1" — 3' 7" — 6' 10" — 9'	5 6 7 sec.	"	2.0	11.1 #
101 thru 103	12'	1" — 5' 7" — 8' 10" — 12'	1 2 3 sec.	"	3.0	16.7 #
					35.5 Total	187.4 # Total

Notes: Carbo-Nitrate wts. are approximate.
 Primers consist of caps and 40% gel.
 96 caps.

E. F. Chapman
 Powder Man

Date: 2-24-67 Time: 3:40 P.M. Weather: clear, mild
 Distance of nearest hole to nearest Bldg. 50 ft.

Blast # 3

Hole #	Depth	In-Powder	Cap Delay	Type Caps	Amt. + Grade of Powder	
					40% Gel. 16.	Carbo-Nitrate
16 thru 18	9'	1" — 3' 5" — 6' 10" — 9'	7 8 9 Sec.	Electric	3.0#	14.8#
44 thru 47	9'	1" — 3' 6" — 6' 9" — 9'	6 7 8 Sec.	"	4.0#	19.8#
68 thru 72	9'	1" — 3' 7" — 6' 8" — 9'	4 5 6 Sec.	"	5	24.7#
90 thru 94	9'	1" — 3' 7" — 6' 10" — 9'	5 6 8 Sec.	"	5	27.8#
104 thru 108	9'	1" — 3' 7" — 6' 10" — 9'	1 2 3 Sec.	"	5	27.8#
					22	114.9#

Notes: 66 caps.
 Carbo-nitrate wts. are approximate.
 Primers consist of caps and 40% gel.

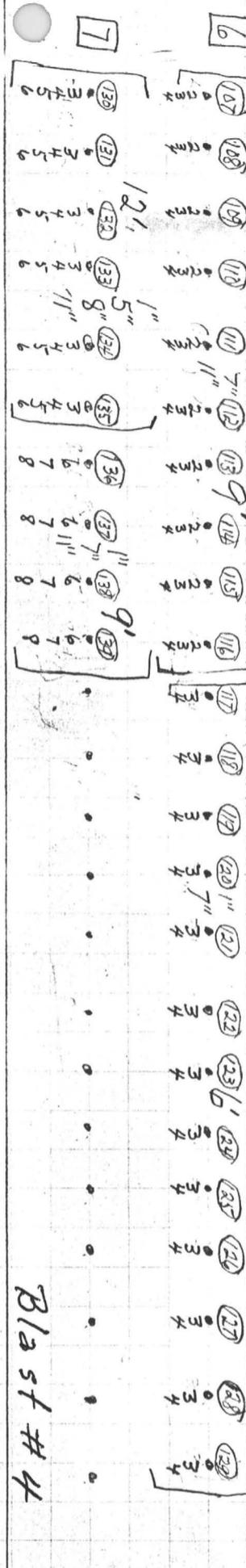
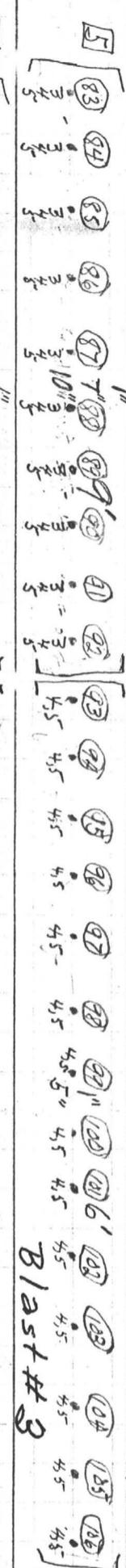
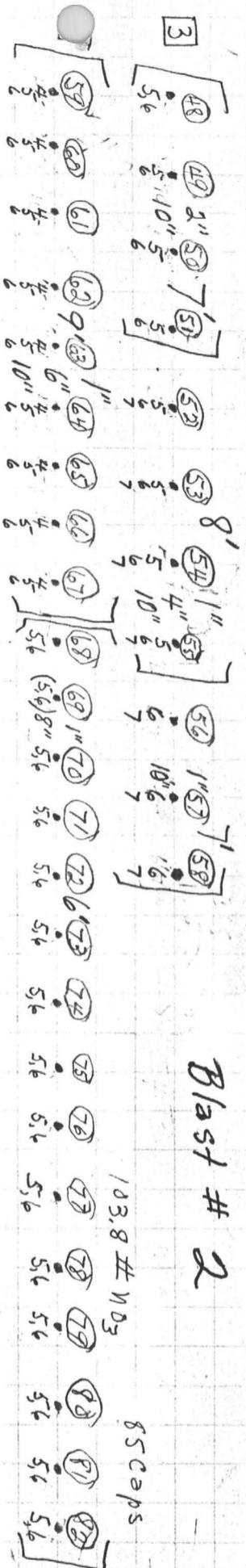
Blast # 4 51 ft. Distance of nearest hole to nearest bldg.

19 thru 30	9'	1" — 3' 5" — 6' 10" — 9'	7 8 9 Sec.	"	12.0#	59.4#
48 thru 55	9'	1" — 3' 6" — 6' 9" — 9'	6 7 8 Sec.	"	8.0#	39.6#
73 thru 77	9'	1" — 3' 7" — 6' 8" — 9'	4 5 6 Sec.	"	5.0#	24.7#
95 thru 100	9'	1" — 3' 7" — 6' 10" — 9'	5 6 8 Sec.	"	6.0#	33.4#
109 thru 114	9'	1" — 3' 7" — 6' 10" — 9'	1 2 3 Sec.	"	6.0#	33.4
					37.0#	190.5

Notes: 111 caps.
 Carbo-Nitrate wts. are approximate.
 Primers consist of caps and 40% gel.

Ed Chapman
 Powder Man

Blast 2-24-67
 3 3:40 PM 50 ft



400# Nitrate
90.5# 40% Gel.
277 Caps
139 Holes

Feb. 23, 1967

-N-
5/8, 49+50

X
F. J. Chapman
Powder Man

Date: Feb 23, 1967 Time: 4:00 P.M. Weather: clear, mild
 Distance of nearest hole to nearest Bldg. 24 ft.

Blast # 1

Hole #	Depth	In-Powder	Cap Delay	Type Caps	Amt. + Grade of Powder	
					40% Gel. (lb.)	Carbo Nitrate (lb.)
1 thru 18	6'	1" — 3' 7" — 6'	6 8 sec.	Electric	9.0	16. 47#
19 thru 24	4'	3" — 4'	6 sec.	"	1.5	" 5.6#
25 thru 43	6'	1" — 3' 7" — 6'	7 8 sec.	"	9.5	" 47.0#
					20# Total	99.6# Total

Notes: Carbo-Nitrate wts. are approximate.
 Primers consist of caps and 40% Gel.

29 ft. — Distance of nearest hole to nearest bldg.

Blast # 2						
48 thru 51	7'	2" — 4' 10" — 7'	5 6 sec.	"	2.0	" 14.8#
52 thru 55	8'	1" — 3' 4" — 6' 10" — 8'	5 6 7 sec.	"	4.0	" 18.5#
56 thru 58	7'	1" — 4' 10" — 7'	6 7 sec.	"	1.5	" 10.2#
59 thru 67	9'	1" — 3' 6" — 6' 10" — 9'	4 5 6 sec.	"	9.0	" 47.3#
68 thru 82	6'	1" — 3' 8" — 6'	5 6 sec.	"	7.5	" 37.1#
					24# Total	127.9# Total

29 ft.

Notes: Carbo-Nitrate wts. are approximate.
 Primers consist of Caps and 40% Gel.

x C. F. Chapman
 Powder Man

Date: Feb 22 1967 Time: 4:00 P.M. Weather: clear - mild
 Distance of nearest hole from nearest Bldg. 38 ft.

Blast # 3

Hole #	Depth	In. Powder	Cap Delay	Type Caps	Amt. + Grade of Powder		Carbo Nitrate	
					40% Gel.	lb.		
83 thru 92	9'	1" — 3' 7" — 6' 10" — 9'	3 3 6 4 9 5	Sec.	Electric	10.0	16.	56.6 #
93 thru 106	6'	1" — 3' 8" — 6'	3 4 6 5	Sec.	"	7.0	16.	39.0 #
38ft.						17.0 #	Total	95.6 # Total

Notes: Carbo-Nitrate wts. are approximate.
 Primers consist of caps and 40% Gel.

44 ft. Distance of nearest hole to nearest bldg.

Blast # 4

107 thru 116	9'	1" — 3' 7" — 6' 10" — 9'	3 2 6 3 9 4	Sec.	"	10.0	16.	55.6 #
117 thru 129	6'	1" — 3' 7" — 6'	3 3 6 4	Sec.	"	6.5	16.	32.2 #
130 thru 135	12'	1" — 3' 5" — 6' 8" — 9' 11" — 12'	3 3 6 4 9 5 12 6	Sec.	"	9.0	16.	46.4 #
136 thru 139	9'	1" — 3' 11" — 6' 7" — 9'	3 6 6 7 9 8	Sec.	"	4.0	16.	23.4 #
						29.5 #	Total	157.6 # Total

44 ft.

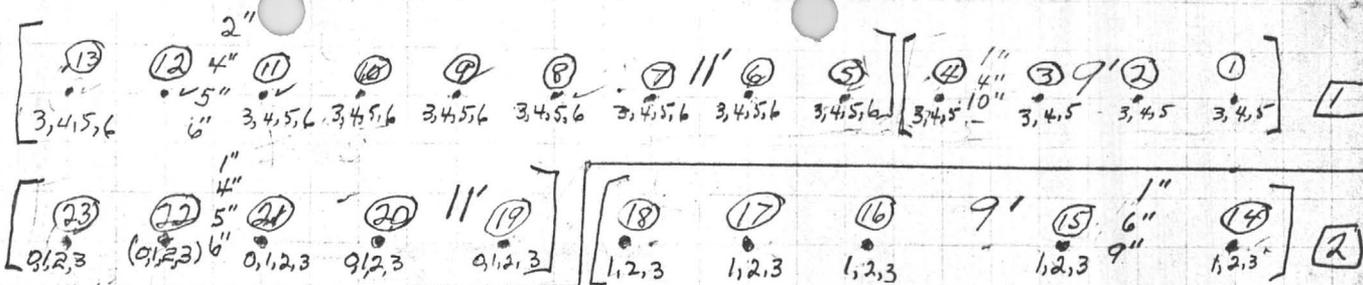
Notes: Carbo-Nitrate wts. are approximate.
 Primers consist of caps and 40% Gel.

x G. F. Chapman
 Powder Man

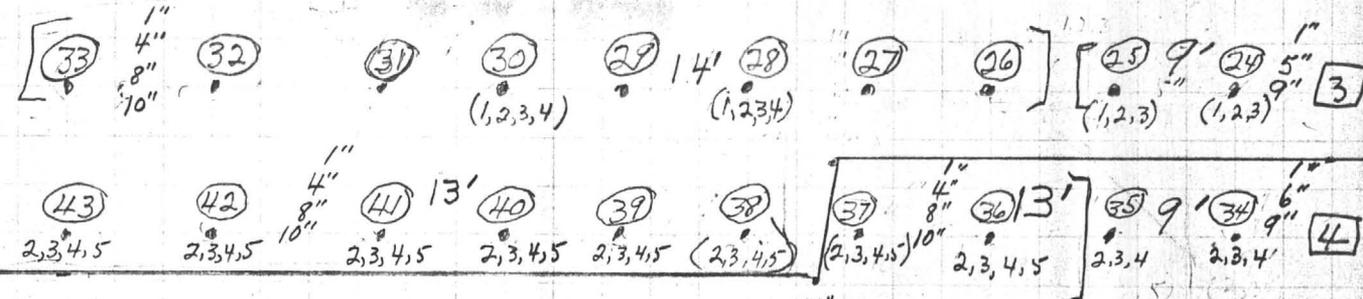
Blast 3 & 4 on Feb 23 '67 4:00 PM

Feb. 22, 1967

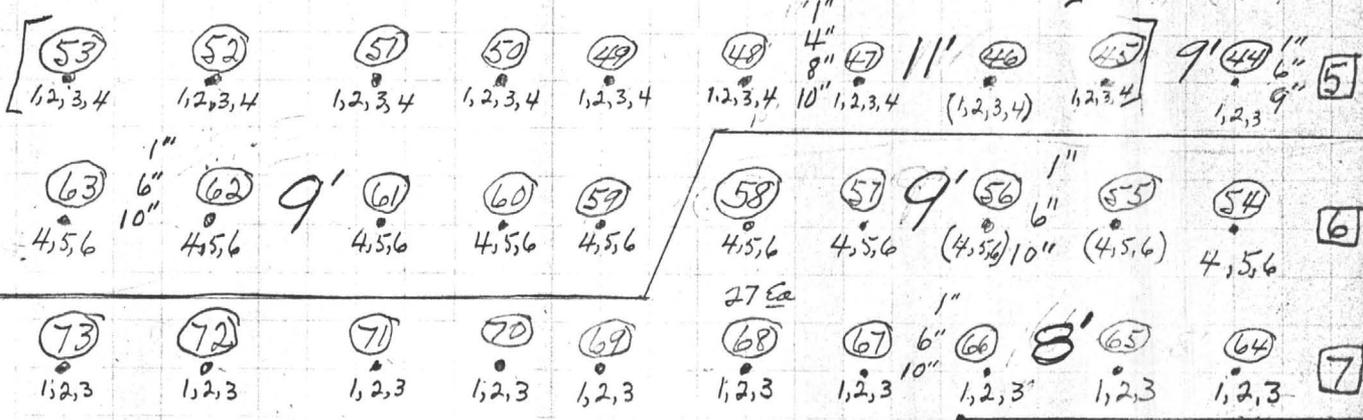
Blast # 5



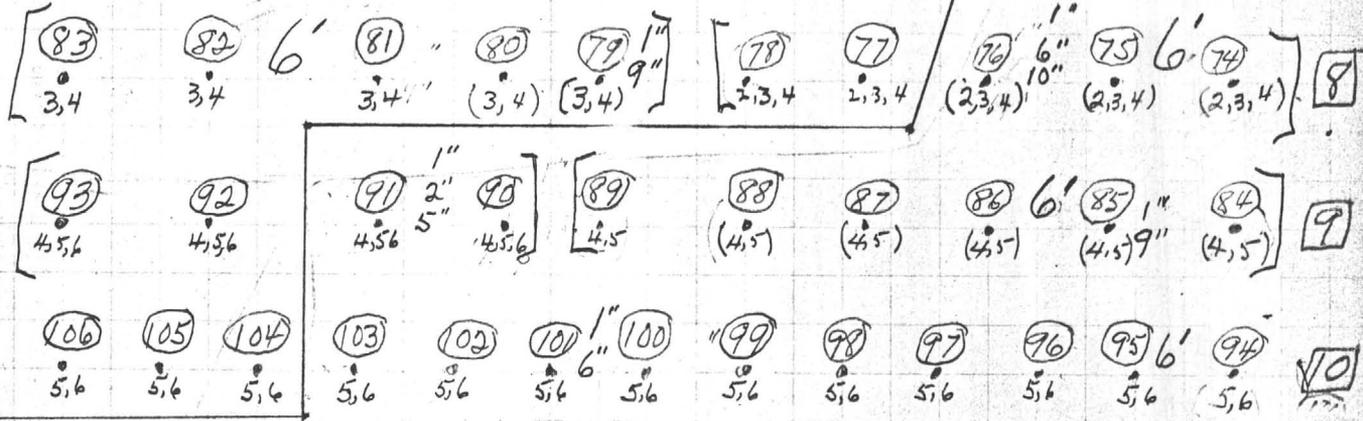
Blast # 4



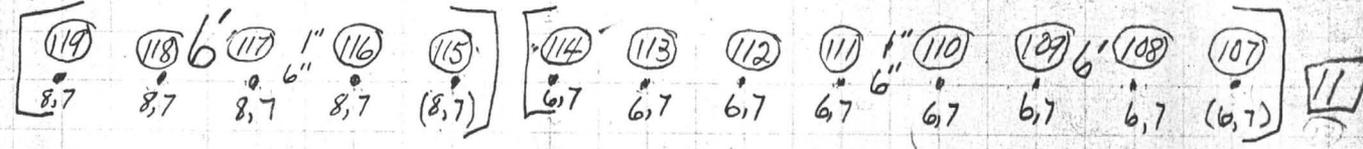
Blast # 3



Blast # 2



Blast # 1



119 holes
550# Nitrate

X L. F. Chapman
Powder Man

Feb 22, 1967

Date 2-22-67 Time 4:00 P.M. Weather Clear, Mild

Distance of nearest hole to nearest Bldg. 26 ft.

Blast # 2

Hole #	Depth	In. Powder	Cap Delay	Type Caps	Amount + Grade of Powder	Carbo-Nitrate
					Gel.	
54 thru 58	9'	1" — 3' 6" — 6' 10" — 9'	4 5 6 Sec.	Electric	5 lb. 40% Gel.,	26.3#
64 thru 73	8'	1" — 3' 6" — 6' 10" — 8'	1 2 3 Sec.	"	10 lb. 48% Gel.,	49.5#
77 thru 78	6'	1" — 3' 6" — 5' 10" — 6'	2 3 4 Sec.	"	2 lb. 40% Gel.,	9.9#
79 thru 83	6'	1" — 3' 9" — 6'	3 4 Sec.	"	2.5 lb. 40% Gel.,	15.5#
92 thru 93	6'	1" — 3' 2" — 5' 5" — 6'	4 5 6 Sec.	"	2 lb. 40% Gel.,	4.9#
104 thru 106	6'	1" — 4' 6" — 6'	5 6 Sec.	"	1.5 lb. 40% Gel.,	6.5#
Notes: Carbo-Nitrate wts. are approximate. Primers consist of caps and 40% gel.					23.0# Total	112.6# Total

24 ft. Distance of nearest hole to nearest bldg.

74 thru 76	6'	1" — 3' 6" — 5' 10" — 6'	2 3 4 Sec.	"	3 lb. 40% Gel.,	15.5#
84 thru 89	6'	1" — 3" 9" — 6"	4 5 Sec.	"	3 lb. 40% Gel.,	18.5#
90 thru 91	6'	1" — 3' 2" — 5' 5" — 6'	4 5 6 Sec.	"	2 lb. 40% Gel.,	4.9#
94 thru 103	6'	1" — 3' 6" — 6'	5 6 Sec.	"	5 lb. 40% Gel.,	21.6#
107 thru 114	6'	1" — 3' 6" — 6'	6 7 Sec.	"	4 lb. 40% Gel.,	17.3#
115 thru 119	6'	1" — 3' 6" — 6'	7 8 Sec.	"	2.5 lb. 40% Gel.,	10.8#
Notes: Carbo-Nitrate wts. are approximate. Primers consist of caps and 40% gel.					19.5# Total	88.6# Total

Blast # 1
24 ft.

x C. F. Chapman
Powder Man

Date Feb. 22, 1967 Time 4:00 P.M. Weather Clear, mild
 Distance of nearest hole to nearest Bldg. 66 ft.

Blast # 5

Hole #	Depth	In. Powder	Cap Delay	Type Caps	Amt. + Grade of Powder	Carbo-Nitrate
1 thru 4	9'	1" — 3' 4" — 6' 10" — 9'	3 4 5	Sec.	Electric	4 lb. 40% Gel., 18.5 #
5 thru 13	11'	2" — 3' 4" — 6' 5" — 9' 6" — 11'	3 4 5 6	Sec.	"	13.5 lb. 40% Gel., 47.3 #
19 thru 23	11'	1" — 3' 4" — 6' 5" — 9' 6" — 11'	0 1 2 3	Sec.	"	7.5 lb. 40% Gel., 24.7 #
					<u>2.5.0 Total</u>	<u>90.5 # Total</u>

Notes: Carbo Nitrate wts. are approximate.
 Primers consist of caps and 40% gel.

Blast # 4

56 ft. Distance of nearest Hole to nearest bldg.

14 thru 18	9'	1" — 3' 6" — 6' 9" — 9'	3 4 5	Sec.	Electric	5 lb. 40% Gel., 24.7 #
24 thru 25	9'	1" — 3' 5" — 6' 9" — 9'	1 2 3	Sec.	Electric	2 lb. 40% Gel., 6.2 #
26 thru 33	14'	1" — 5' 4" — 8' 8" — 11' 10" — 14'	1 2 3 4	Sec.	"	12 lb. 40% Gel., 56.9 #
38 thru 43	13'	1" — 5' 4" — 8' 8" — 11' 10" — 13'	2 3 4 5	Sec.	"	9 lb. 40% Gel., 42.6 #
					<u>28.0 Total</u>	<u>130.4 Total</u>

Notes: Carbo-Nitrate wts. are approximate
 Primers consist of caps and 40% gel.

Blast # 3

46 ft. Distance from nearest hole to nearest bldg.

34 thru 35	9'	1" — 3' 5" — 6' 9" — 9'	2 3 4	Sec.	Electric	2 lb. 40% Gel., 9.3 #
36 thru 37	13'	1" — 6' 4" — 9' 8" — 12' 10" — 13'	2 3 4 5	Sec.	"	3 lb. 40% Gel., 14.2 #
44	9'	1" — 3' 6" — 6' 9" — 9'	1 2 3	Sec.	"	1.5 lb. 40% Gel., 5.0 #
45 thru 53	11'	1" — 3" 4" — 6" 8" — 9" 10" — 11"	1 2 3 4	Sec.	"	13.5 lb. 40% Gel., 64.0 #
59 thru 63	9'	1" — 3' 6" — 6' 10" — 9'	4 5 6	Sec.	"	7.5 lb. 40% Gel., 26.3 #
					<u>27.5 Total</u>	<u>118.8 Total</u>

Notes: Carbo-Nitrate wts. are approximate
 Primers consist of caps and 40% gel. X

G. S. Chapman
 Powder Man

Blasts 3, 4 & 5 on Feb 22, '67 4:00 PM

IF NOT CALLED FOR IN DAYS, NOTIFY

ARIZONA HIGHWAY DEPARTMENT

1739 WEST JACKSON STREET
PHOENIX, ARIZONA 85007

RETURN POSTAGE GUARANTEED

Mr. Walter Heinrich
Heinrich Geoexploration Company
Post Office Box 5671
Tucson, Arizona 85703

from A. H. D

Recording No. 1 Date 2/25/66 Seis. No. 186
 Seis. Position in line with 3 drill holes - 4' centers
 Location of Shot Point 40' to nearest hole
 Distance 40' Time Fired 9:30 AM Loaded by Coupeff
 Total Explosive Charge 12 sticks Manufacturer Atlas Strength 40% Gel.
 No. Holes 3 Hole Diameter 2" Open Face or Buffer —
 Depth of Holes 4' Height of Bench — No. of Decks — Stemming rock dust

Hole No.	1	2	3							
Spacing	4'	4'	4'							
Burden	0	0	0							
Explosive	4	4	4	sticks	1 1/2"	2.8"				
Detonator	inst #2	"A"		delay caps	(200ms. - 200ms)					

Seis Operator Ellis Camera No. 1456 Seal T. O.K.
 Remarks Test shot on N.B. roadway - McCannico -
 Diagram: Kingman section I-40 Note: white centers
 Client Arizona Highway Dept. Job Loc. Kingman
 Reported by Scott Title Mat'ls



SEISMOLOG RECORD ANALYSIS SERVICE

Gentlemen: _____ Date 3/4/66

The results of the seismograph tests of the prime blast discharged on the date and time shown, as recorded from the locations given, are tabulated below. The %LIMIT reported has been referred to an index in which the threshold of DAMAGE equals 100%. This value is further classified as S = SAFE, C = CAUTION, D = DANGER. If further information is desired please refer to the Recording Numbers indicated.

JOB	DATE	TIME	HOLES	EXPLOSIVE - LBS.	
Ariz. H'way Dept.	2/25/66	9:30 AM	3	12 sticks	
RECORDING	TEST LOCATION	FREQ - CPS	DISPLACEMENT	%LIMIT	CLASS
68436	40' to nearest hole	50.0	.0020"	33	S

Reported by [Signature] VIBRATION MEASUREMENT ENGINEERS, INC.

December 14, 1965

Mr. Lewis E. Scott
Arizona Highway Department
Materials Division
1745 W. Madison St.
Phoenix, Arizona

Dear Mr. Scott:

I looked over the material behind the Travelodge Motel in Kingman, Arizona. The proposed road cut through here offers some problems, but I feel that the blasting can be done without adverse results. It will call for close control over both the drilling and the loading by a good powderman.

Two major recommendations that I would like to make would be to pre-split along both the upper and lower limits of the shot area and to drill and shoot the area before removing the material you stated could be ripped. Both of these measures would give you a larger margin of safety. Where the rock is on the surface or within several feet of the surface blasting mats should be used. Millesecond electric blasting caps should be used to keep the vibrations to a minimum.

One point that I would like to make is that the ripping operation; the drilling operation; and the movement of heavy equipment upon this job will undoubtedly produce more vibrations than the actual blasting. As I mentioned to you there are a number of firms who specialize in vibration engineering, making seismic tests before and during the blasting. These firms do a very fine job when they are called in before the start of work. I am attaching the names of several with good reputations in this field.

We discussed whether the Hercules Powder Co.'s Rock Mechanics Research Dept. could test this rock and I am pleased to be able to inform you that it will be able to. If you will send a sample of rock large enough so that it can be cut into a four inch cube. If there are definite physical changes in the appearance of the rock in the vertical section of the face, then send a piece from each area where this change occurs. Rock samples are to be sent to Dr. Joseph B. Arots, c/o Hercules Research Center, Wilmington, Delaware. They should be identified as follows:

1. Name of project
2. Owner (Arizona State Highway Dept. in this case)
3. Exact location, so that it can be located on a U.S.G.S. quadrant map
4. Position from face from which sample or samples came.
5. Your nomenclature of rock.

I am enclosing a sample data sheet on which I have checked the information I would like to be filled in and returned to me. This will serve to identify the sample that you send in.

Charles R. Sparf

Hercules Powder Co.

Thomas J. Ellis

Geophysicist

Phoenix, Arizona

Blasting Investigation for Arizona Highway Department in Kingman, Arizona

Scope

On February 25, 1966, an investigation was conducted in Kingman, Arizona, to determine effects of blasting in rock formations near buildings. Planned highway excavations in the city limits of Kingman -- notably fifty feet north of the Travel Lodge Motel -- necessitated instrumental recording of seismic waves generated by blasting under conditions as near as possible to those expected in future operations.

Procedure

Careful examination of the rock formation next to the Travel Lodge Motel led to the selection of a test site near Kingman on the same formation. Test holes were drilled using a rock bit and dynamite charges of varying weights were detonated and vibrations recorded. Depths of holes were varied as well as distances to the recording equipment. Intensity of flying debris and surface effects (breakage) were noted for each test.

The seismic waves from the detonations were recorded with a "Seismolog" manufactured by Vibration Measurement Engineers, Evanston, Illinois. This instrument records amplitude and frequency of ground waves in the longitudinal, vertical, and transverse directions. A camera is used for each test and the photographic record is returned to Vibration Measurement Engineers for developing and analysis.

In each test three holes were spaced four feet apart, each hole having the same charge of dynamite. The recording instrument was in line with the holes, its distance being measured from the nearest hole. The charges were detonated electrically, the nearest hole having an instantaneous cap, the next having a 1000 msec

delay and the farthest having a 2000 msec delay cap.

Five tests were conducted: recordings were obtained from two of the blasting tests and one of vibration tests of traffic at the Travel Lodge Motel. Two records did not come out due to improper operation of the camera by the operator.

Results

At a distance of 40 feet a charge of 4 sticks per hole, total of 12 sticks -- about 6 pounds -- maximum displacement was .0020 inches and frequency was 50 cycles per second. At a damage level of 100%, this gives a limit of 33%. Breakage occurred between holes which would allow ripping to be done at the site.

At a distance of 28 feet a charge of 2 sticks per hole, total of 6 sticks -- about 3 pounds -- maximum displacement was .0023 inches and frequency was 50 cycles per second. This gives a limit of 38% of amount required for damage. Breakage was slight.

Testing on the walkway at the Travel Lodge Motel showed less than .0001 inches displacement from heavy foot and vehicle traffic.

Conclusions and Recommendations

The testing indicates that up to 4 sticks per hole can be used at a minimum distance of 40 feet. With holes 4 feet deep, breakage will occur with a minimum of flying rock. At 28 feet 2 sticks per 4 foot hole will give minimum breakage and practically no flying rock.

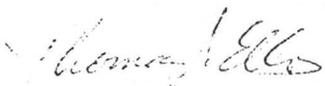
Ten sticks in 6 foot holes placed 4 feet apart and 6 sticks in 4 foot holes placed 4 feet apart cratered the surface and generated extensive flying debris of up to 10 pounds. It is recommended that these size charges at these depths not be used near structures.

It is recommended that delay caps be used with times between caps increasing away from the building structures in the vicinity. It is further recommended that a seismolog be used at the structure site during blasting operations at distances of less than 100 feet from the nearest point to the structure. Non-technical operators can use this equipment at a nominal weekly rental. A permanent record is made that can be used to monitor blasting operations as they progress, as well as serve as a history of the work.

In addition a careful log of each detonation should be kept, listing such information as:

1. number of holes and depth of each
2. distance between holes and location
3. distance of nearest hole to structures
4. amount of dynamite to each hole and array of delay caps
5. date, time of day and weather conditions
6. powder man's signature

It is useful to relate powder requisitions to powder usage for verification of blasting logs.


Thomas J. Ellis
Geophysicist
March 24, 1966