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STATIC TEST of SECTIONAL MUNITIONS

DPGR 107

RW 1-52

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STATIC TEST OF FOUR SEGMENTS OF FULL-DIAMETER SECTIONAL MUNITIONS, E83, ~~RDS-TM 1-52~~

DUGWAY PROVING GROUND REPORT 107

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Project Numbers 4-98-05-004 and 4-98-05-007

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ABSTRACT

OBJECTIVES

The objectives of this test were (1) to determine the effect of shaping the explosive charge of the modified radiological bomb, E83 type, on the dispersion of compressed pellets of radioactive tantalum dust, and (2) to assess the radiation fields produced.

RESULTS

Four sectional RW munitions were functioned on 20 May 1952. Readings were taken of the gamma-radiation intensity produced by the four munitions, and area coverage was tabulated for various radiation-intensity levels.

There were no appreciable disintegrating effects of weather upon the pellets.

CONCLUSION

Variations in structure and shape of the explosive charge of the four modified E83 munitions tested produced no variations in agent dispersion patterns which may be considered significant.

RECOMMENDATION

Future tests should be designed to give an estimate of the variance in the dispersion pattern of any one modification of the type munition being tested.

INTRODUCTION

AUTHORITY

This test was authorized by:

Letter, CMLRE-CR(T), 29 February 1952, subject: Request for Dugway Proving Ground Tests;

Test Directive, CMLRE-G, 10 March 1952, subject: Development Test, Bomb Radiological, 750#, E83;

Project 4-98-05-004: Testing of RW Agents, DPG; and

Project 4-98-05-007: Testing of RW Aerial Munitions, DPG.

OBJECTIVES

The objectives of this test were (1) to determine the effect of shaping the explosive charge of the modified radiological bomb, E83 type, on the dispersion of compressed pellets of radioactive tantalum dust, and (2) to assess the radiation fields produced.

MATERIALS AND METHODS

MATERIALS

Target

This test was conducted on Target H, which has monitoring stations staked at intervals of 50 yards in a rectangular array. Four grids, each approximately 1000 yards on a side, were set aside for the four munitions. The ordinate of each grid was designated with the letter of the munition at its center and sequential odd numbers (i.e., B1, B3, etc.). The abscissa of each of the grids was also lettered and numbered with sequential odd numbers (i.e., Z1, Z3, etc., for the Baker munition grid). For example, the coordinates of one point on the Baker grid would be Z15, B23. The locations of the grids and the labels of the coordinates on each grid are illustrated in Figures 1 and 2. At the center of each grid, the munition was supported at a height of 50 feet by a 60-foot gibbet (Fig. 3).

Figure 4 shows the circuit for firing the munitions.

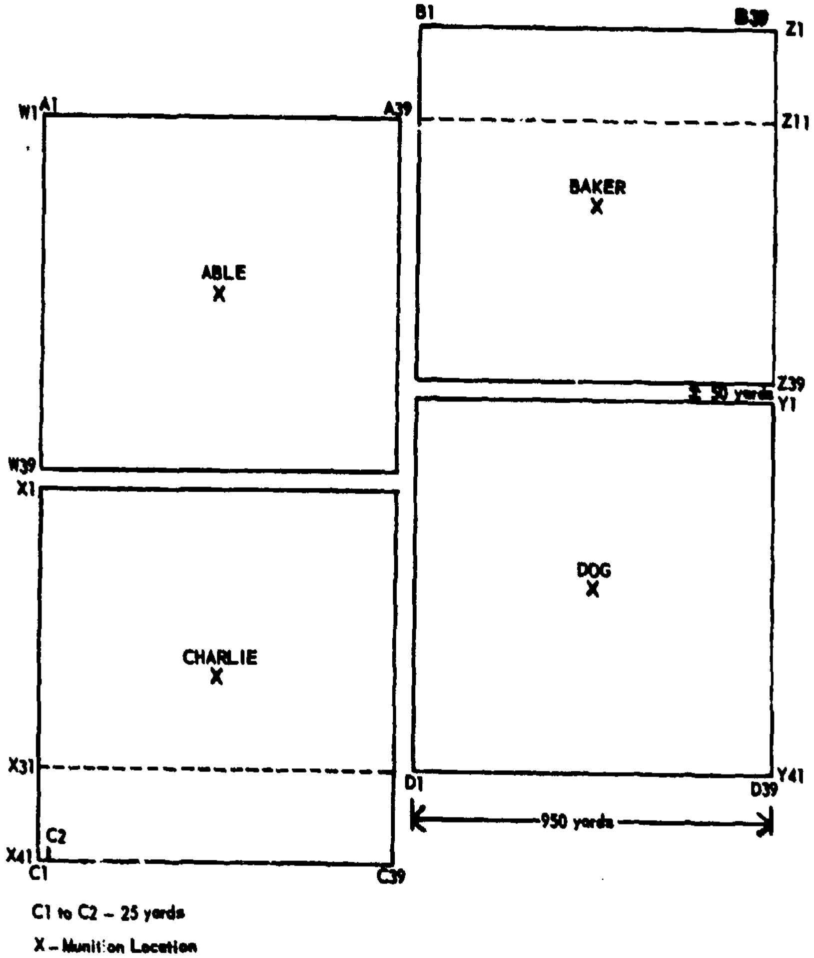

Fig. 1.-Grid Complex

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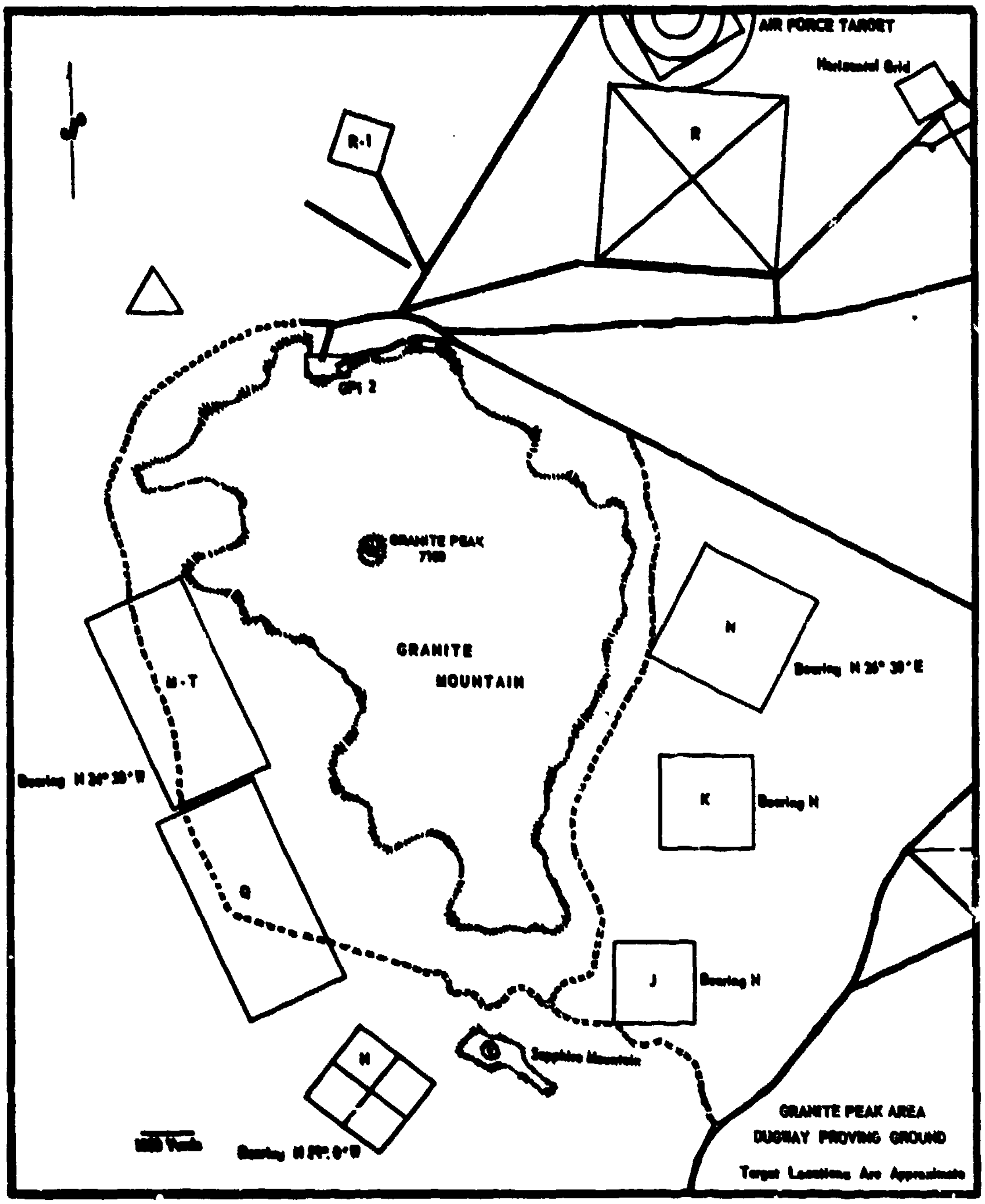

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Fig. 2

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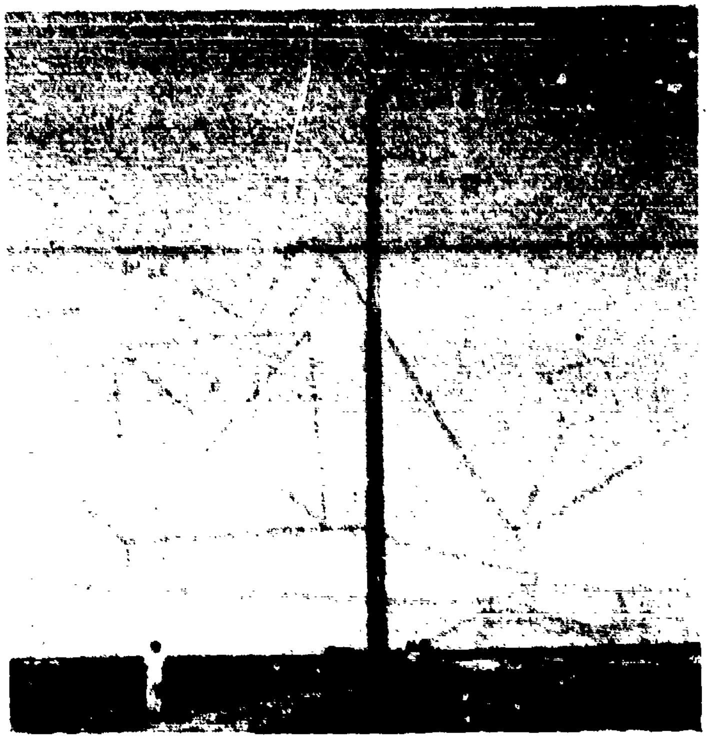

Fig. 3.-The gibbet.

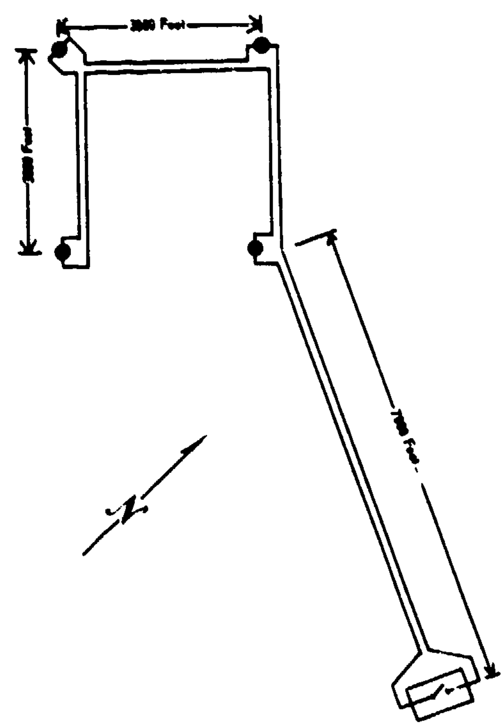

Fig. 4.-Firing circuit.

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Agent

The agent was composed of approximately 75 per cent tantalum dust, 400 mesh, and 25 per cent fine copper wire to provide effective binding. The mixture was compressed with a pressure of 125,000 pounds per square inch into cylindrical pellets. Each pellet had a diameter of 5/16 inch and a height of 5/16 inch.

The pellets were placed in aluminum tubes at the Chemical and Radiological Laboratories and shipped to Oak Ridge, Tennessee, where the material was irradiated for a time calculated to produce an activation level of three to five curies per pound. The tubes were shipped to Dugway Proving Ground in lead-lined iron containers.

Munitions

The four munitions tested were sections of the modified E83 radiological bomb. This RW munition has a container designed to hold a high-explosive charge with 12 compartments arranged around the charge to hold the active agent (Fig. 5). In this munition a shaped-charge effect is obtained by 12 jets, copper-lined wedge-type cavities on the perimeter of the explosive charge. The agent compartments are separated from the burster by steel plates called "pusher plates." The shaped charge is designed to increase the velocity of the shock wave through a predetermined path. Thus the shock wave dislodges the compartment partition member and ruptures the bomb container. This action frees the pusher plates between the charge and the agent and allows the immediately succeeding

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shock wave to disperse the agent without premature disintegration of the pellets. Such disintegration would alter the ballistic properties of the pellets, resulting in a concentration of agent around the burst point. Thus, the shaped-charge design produces a more uniform distribution of agent over the entire target area.

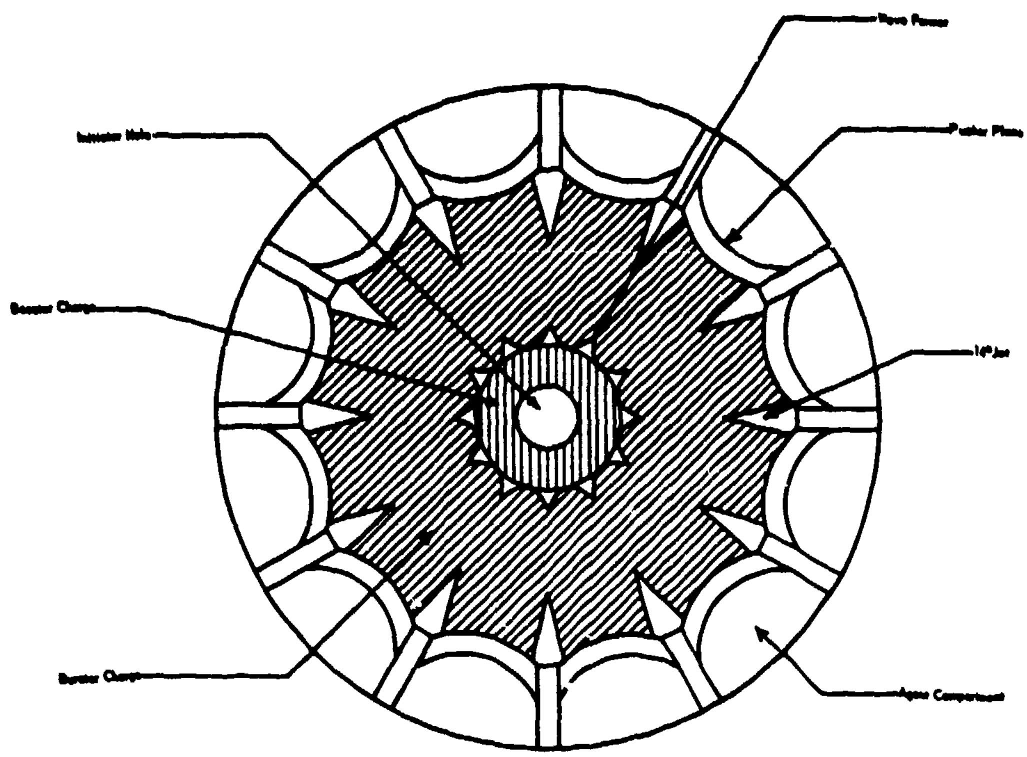

Fig. 5.-Modified E83 Radiological Bomb

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The four sectional munitions, previously filled with explosives at Picatinny Arsenal, Dover, New Jersey, arrived at Dugway Proving Ground by plane on 13 May 1952. Though these munitions were different in internal design, each had the same external diameter of 16 inches and a weight of approximately 300 pounds. For all the sectional munitions, the agent compartments were closed with face plates which were bolted over the end of the munition.

The internal characteristics of the munitions are summarized in Table 1. Photographs of the munitions are shown in Figures 6 through 10.

Fig. 6.-The component parts of the munition. In the foreground is the face plate, behind that is the charge cover, then the munition. The plug and the initiator tube are on the right. The hook on the left is used for hoisting the munition. (In this photograph, and in Figures 7-10, there are no agent pellets in the munition.)

TABLE 1: Munition Characteristics

	ABLE	BAKER	CHARLIE	DOG
Dimensions:				
OD	16 in	16 in	16 in	16 in
Height	7 in	6 in	6 in	6 in
Initiator System:	Tetryl Pellet	Jet Initiator: Detonator fires into a cone-shaped void		
Diameter	1½ in	1½ in	1½ in	1½ in
Booster:	Tetrytol	Tetrytol	Tetrytol	Tetrytol
OD	4 in	3½ in	3½ in	3½ in
ID	2 in	1½ in	1½ in	1½ in
Cross-sectional Area	9.42 in^2	7.85 in^2	7.85 in^2	7.85 in^2
Height	5-5/8 in	4-15/16 in	4-15/16 in	4-15/16 in
Volume	53.0 in^3	38.8 in^3	38.8 in^3	38.8 in^3
Weight	3.10 lbs	2.27 lbs	2.27 lbs	2.27 lbs
Wave Former:	Al	Cu	Cu	Cu
OD	5-15/16 in	4½ in	4½ in	4½ in
ID	4-1/8 in	3-9/16 in	3-9/16 in	3-9/16 in
Burster:	TNT	TNT	TNT	TNT
Cross-sectional Area	75.48 in^2	82.20 in^2	89.36 in^2	82.20 in^2
Height	6 in	5 in	5 in	5 in
Volume	453 in^3	411 in^3	447 in^3	411 in^3
Weight	25.7 lbs	23.3 lbs	25.3 lbs	23.3 lbs
Jets:	28°	14°	None	14°
Pusher Plate:	4130 HT Steel	4130 HT Steel	4130 HT Steel	½:4130 Steel ½:Plastic
Thickness	½ in	½ in	½ in	½ in
Agent:	Ta-182	Ta-182	Ta-182	Ta-182
Cross-sectional Area	72.6 in^2	67.8 in^2	67.8 in^2	67.8 in^2
Height	6-1/4 in	5½ in	5½ in	5½ in
Volume	454 in^3	373 in^3	373 in^3	373 in^3
Weight	96.0 lbs	76.8 lbs	76.8 lbs	76.8 lbs
Ratio of Weights of Agent to Explosive:	3.34	3.00	2.78	3.00

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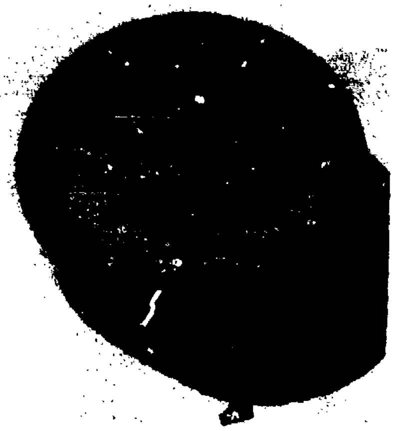

Fig. 7.-Munition Able with the face plate removed.

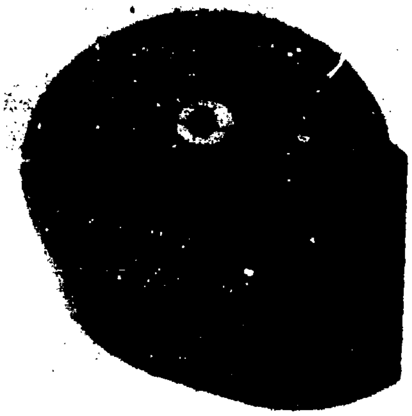

Fig. 8.-Munition Able completely assembled.

Fig. 9.-Munition Baker. Munition Dog looked exactly like Baker.

Fig. 10.-Munition Charlie.

Vehicles

Transporting and fuzing procedures (see below) required the use of the following vehicles: a heavy-duty flatcar-type trailer, or lowboy, equipped with a lead brick shield (Fig. 11); and a $2\frac{1}{2}$-ton truck equipped with a lead shield to protect the driver from excessive radiation, and a square compartment lined with lead bricks to surround the munitions (Figs. 12 and 13).

Monitoring and Laboratory Equipment

The MX-5 and the T1-B radiation meters were used in the field. In the laboratory, the Berkeley-2000 scaler was used in conjunction with the Nuclear geiger tube. A Gram-atic balance was used for weight determination.

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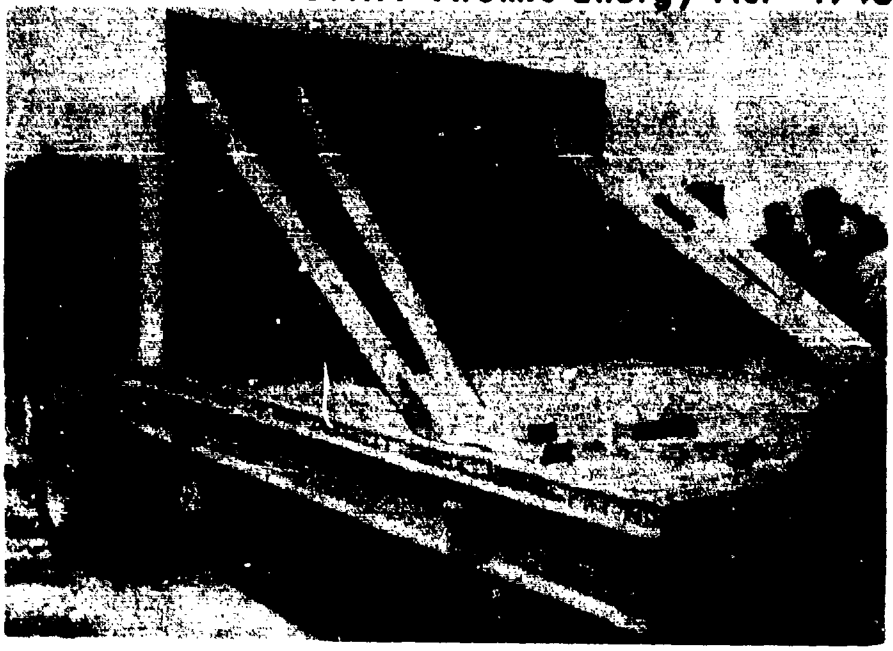

Fig. 11.-The lowboy with lead-lined shield. Note how the truck has backed into position for the fuzing operation.

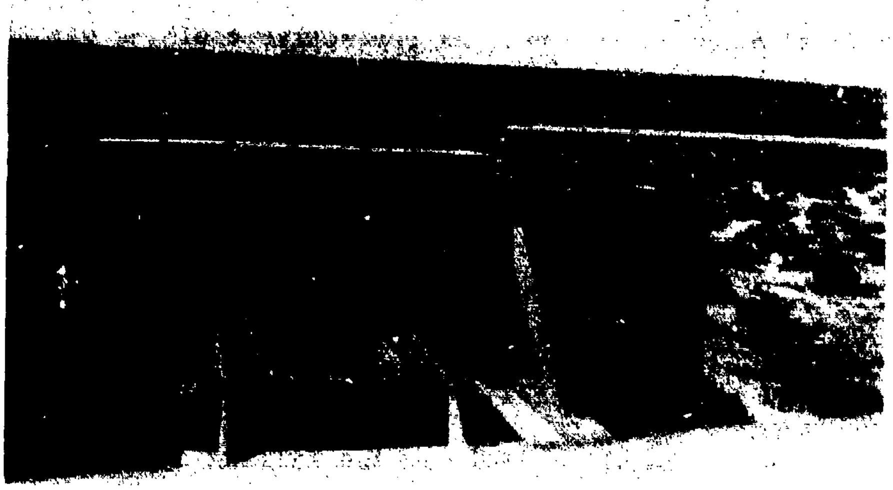

Fig. 12.-Rear of the munition truck. The lead shield is toward the front of the truck, between the cab and the munition. In this picture the initiator tube is being lowered from the lowboy by a long-handled tool. In the extreme foreground the top of the shield on the lowboy may be seen.

Fig. 13.-Munition on the truck bed surrounded by lead bricks.

Protective Equipment

At all times personnel wore film badges, as well as self- and nonself-reading dosimeters. RW protective clothing was worn whenever there was a possibility of direct contact with radioactive materials.

METHODS

Filling Operations

Figures 14 through 17 illustrate the operations accomplished with remote-control handling tools in the filling cell at the RW slab area. Each munition had twelve agent compartments, two of which were filled at a time. Each tube of agent contained about 1.6 pounds of pellets. Five tubes were required to fill each

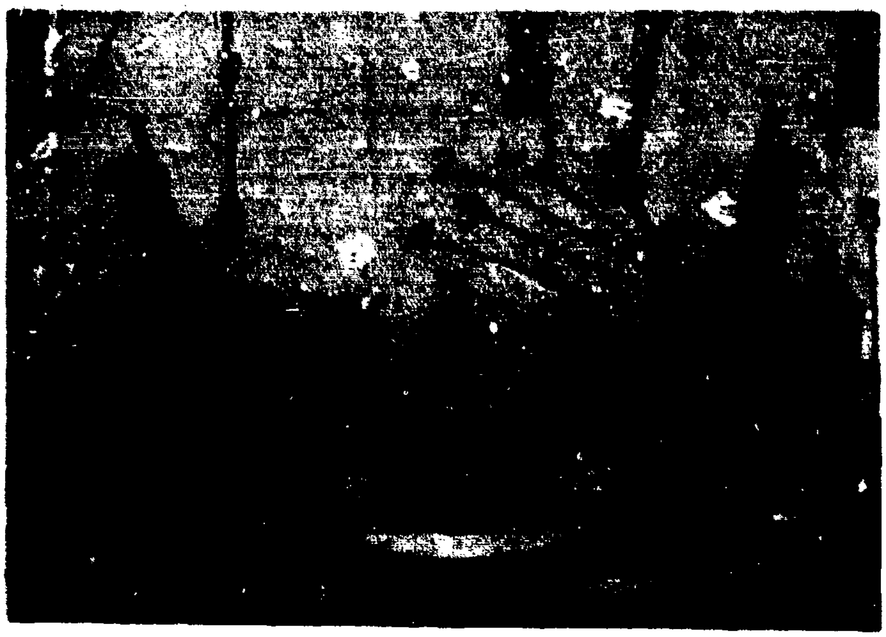

Fig. 14.–Filling operation. The (1) mechanical hand picks (2) a pellet tube from (3) the lead-lined container, and places it between the clamps on (4) the hydraulic cap-puller. (The operation on the left is at a different stage from the one on the right.)

Fig. 15.–The prongs on the cap-puller fit under the cap, and the cap is pulled out as the tube is drawn down into (5) a hot vaseline bath.

Fig. 16.-The hand lifts the tube from the vaseline and pours out the excess liquid, then dumps the pellets from the tube into (6) the munition through (7) the funnel.

Fig. 17.-The emptied tube is discarded into (8) a hot-trash barrel. As each compartment in the munition is filled, the spout of the funnel is lifted and the munition is rotated by (9) a revolving table, bringing the next compartment under the funnel.

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compartment of Munition Able, and four were required for each compartment of the other munitions. After a munition had been filled, its face plate was replaced and the munition put into a shielded enclosure until its transportation to the test site.

Pellet Measurements

During the filling operations, a number of pellets were selected from each sectional munition. The pot into which each group was placed was labeled A, B, C, or D according to the letter of the respective munition from which the pellets were taken.

Activity of these pellets was measured by a Nuclear geiger tube in conjunction with a Berkeley-2000 scaler. The geiger tube, an end-window type (3.5 mg/sq. cm.) shielded from extraneous radiation by a lead sheath, was operated at 900 volts. It was located on a stand 46 1/8 inches above the pellet, which was placed on an aluminum planchet in an enclosure lined with lead bricks. Before the pellet was measured, it was immersed in carbon tetrachloride to remove the dust. The pellet was dried under an infrared lamp while being measured for activity.

The weight of each pellet was determined by a Gram-atic balance placed behind a lead-brick barricade. The pellet was placed directly on the aluminum foil covering the balance pan. Aluminum foil was used also on the floor of the balance.

[redacted]

The measuring and weighing of a pellet required five to eight minutes depending on the number of measurements necessary. If the first two measurements did not agree within 0.4 seconds for 20,000 counts, a third measurement was made and an average of the measurements taken.

Data on activity determination are given in Appendix V. The method used to convert counts per minute to millicuries is given in Appendix VI.[1]

Transporting and Fusing Operations

Each munition was transported separately by truck from the RW slab area to the grid. Initiators for the munitions had been wired previously into the firing circuit and the connections checked. Personnel working behind the lead shield on the lowboy placed the initiators into the munitions. The fused munitions were then placed at the base of the 60-foot gibbet at the center of each grid. Operations began at 1230 hours, on 19 May. Each round trip required approximately three hours.

Emplacement and Detonation

The munitions were raised on the gibbets so that the distance between the munitions and the ground was 50 feet. Emplacement operations began at 0440 hours and were completed at 0510 hours,

[1] This appendix is taken from data in Report No. 1, University of Utah, Dugway Project, Radiological Research, Dugway Proving Ground, Tooele, Utah.

on 20 May. Figure 1 shows the location of the munitions on the grids.

All four munitions were statically fired simultaneously upon command of the test officer at 0605 hours on 20 May, 1952.

Monitoring Procedures

Before the test, each grid was monitored to determine the extent of radioactivity remaining from previous tests. Each time a munition was loaded on the truck, a survey was made of the driver's cab. Gamma-intensity readings at this location ranged between 35 and 40 milliroentgens per hour. After the munitions were detonated, readings of radiation intensity were recorded for all stations on each grid. Readings were taken at the three-foot level.

Determination of Weathering Effects

Studies were made of possible disintegrating effects of weather upon the agent. These effects were determined visually by photographs of pellets located on the grids. On 2 June, 21 days after the test, the pellets were photographed for the first time. On 10 July, 43 days after the test, they were photographed again.

RESULTS

Background measurements were completed before the day of the [redacted] 94 pages

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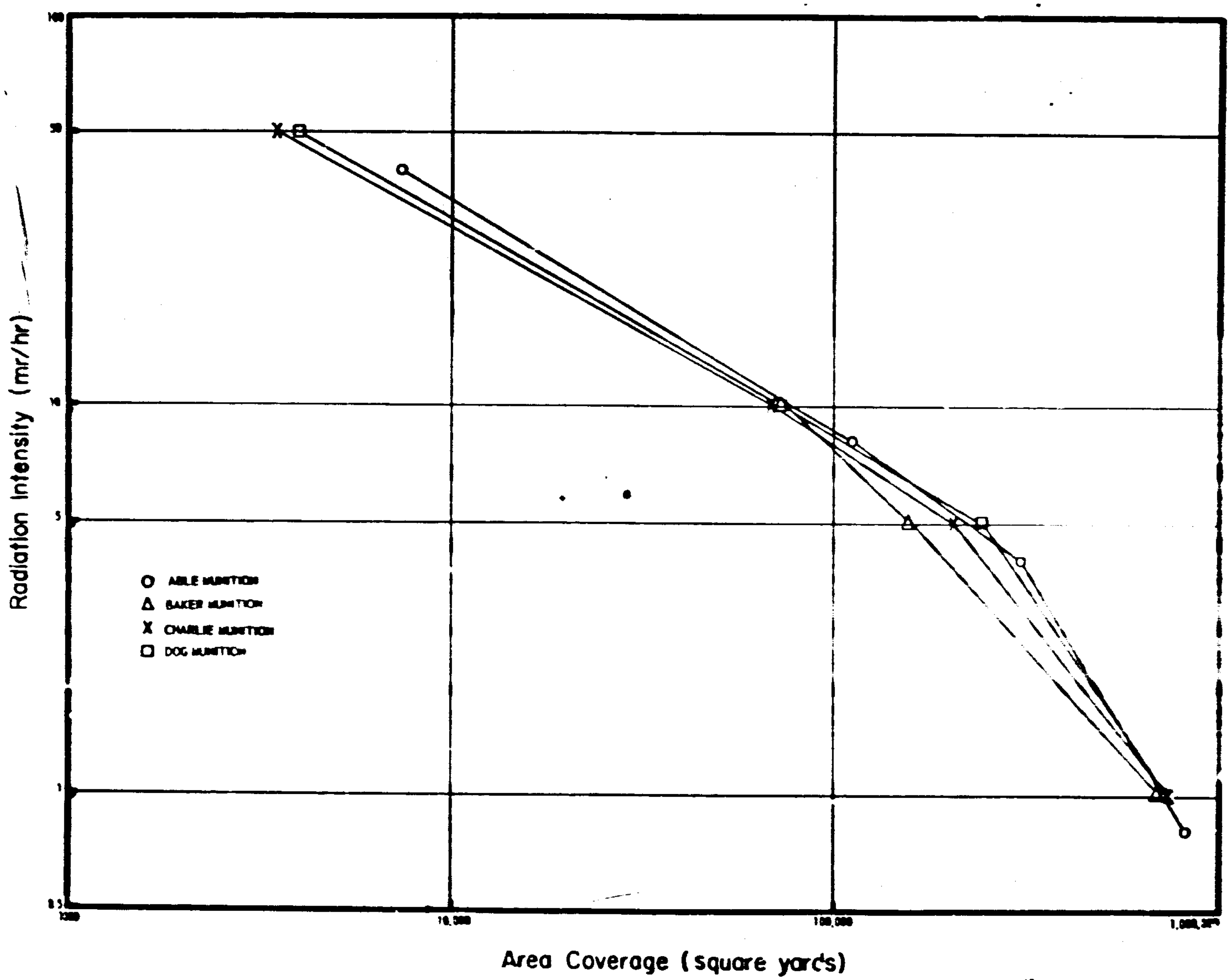

Fig.18a.-Area coverage versus radiation intensity, contour planimetry method.

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test. The four sectional munitions were successfully exploded at 0605 hours on 20 May 1952. Survey of the contaminated targets, at a height of three feet above terrain, was completed the same day. Pellet-activity measurements were completed 20 June.

The apparent activity in curies of the agent contained in each munition was calculated to be as follows:

Able	421 curies	Charlie	337 curies
Baker	337 curies	Dog	337 curies.

These values were based on an average apparent pellet specific activity of 9.66 millicuries per gram (see DISCUSSION) and a total weight of agent equal to 76.8 pounds in Munitions Baker, Charlie, and Dog, and to 96.0 pounds in Munition Able. Data on the specific activity of the pellets sampled are given in Appendix V.

Contour diagrams (Appendix IV) of the radiation field of each munition were prepared from the field survey data tabulated in Appendix III. Area coverage values determined by planimetry of the contour diagrams (Table 2) are plotted as intensity versus area in Figure 18a. Area coverage values calculated by counting the number of monitoring stations having intensities equal to or greater than the given intensity (Table 3) are plotted in Figure 18b.

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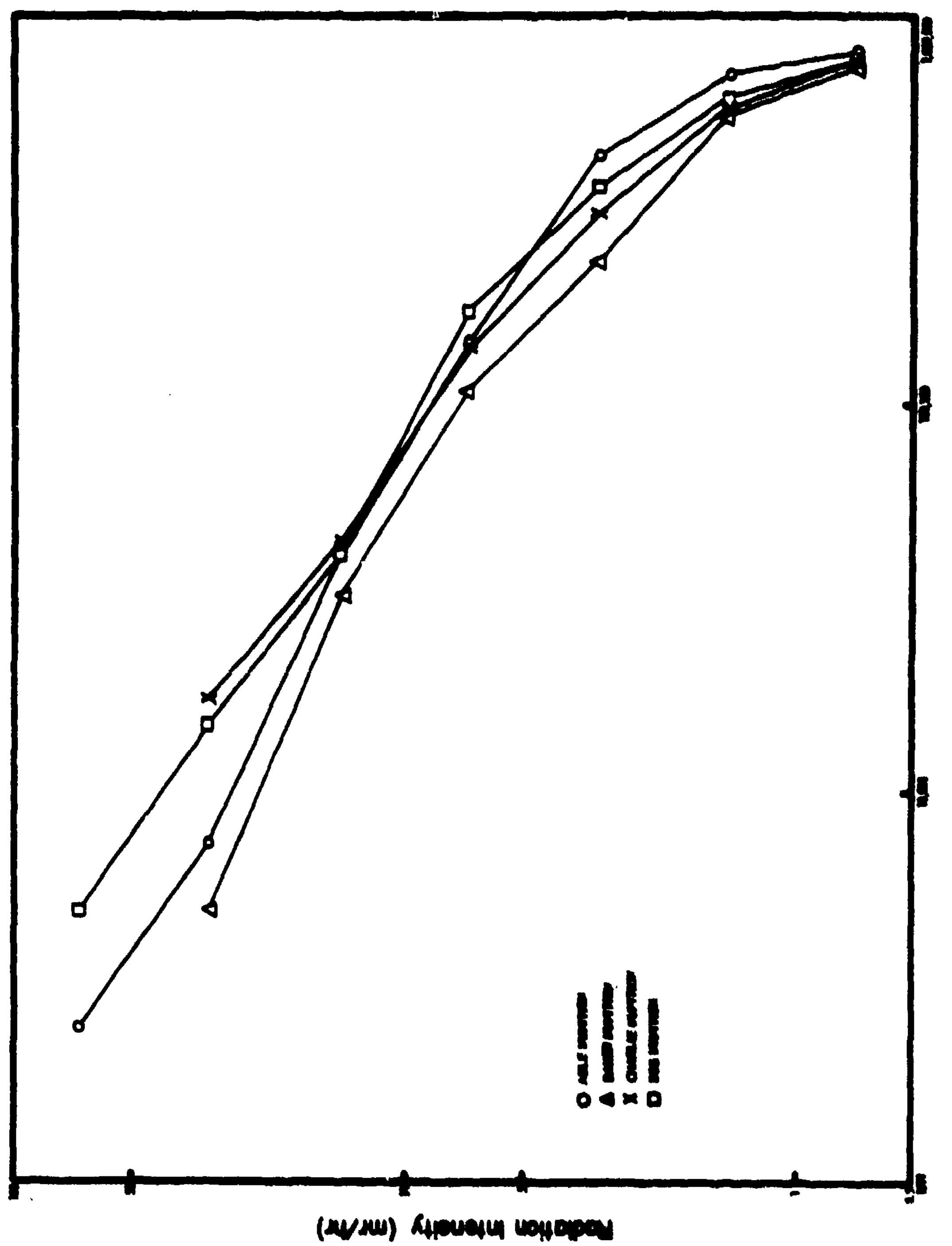

Fig.18b—Area coverage versus radiation intensity, point counting method.

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TABLE 2: Area Coverage in Thousands of Square Yards Determined by Contour Planimetry*

INTENSITY (mr/hr)	AREA COVERAGE IN THOUSANDS OF SQUARE YARDS			
	Munitions			
	Able	Baker	Charlie	Dog
0.8	818.8	-	-	-
1.0	-	711.5	745.8	737.5
4	309.8	-	-	-
5	-	160.0	205.5	244.0
8	110.5	-	-	-
10	-	75.8	68.8	73.2
40	7.5	-	-	-
50	-	0	3.5	4.0

*Tabulated values indicate the area of the target at the listed intensity or greater.

TABLE 3: Number of Stations Reporting Intensities Greater Than or Equal to Given Intensities

MUNITION	NUMBER OF STATIONS						
	Intensity (mr/hr)						
	0.68	1.47	3.2	6.8	14.7	32	68
Able	322	284	177	58	17	3	1
Baker	296	226	95	44	13	2	-
Charlie	317	235	126	56	18	7	-
Dog	311	245	146	70	17	6	2

The data in Table 3 are corrected for unreported stations by interpolation; correction for excess activity of Munition Able was made by counting the stations having readings at levels 25 per cent higher than those shown in the tables. The number of monitoring station converted to an equivalent area by considering the measured intensity at each station to be representative of the

[redacted]

intensity over a surrounding area of 2500 square yards. Profiles, or patterns of agent dispersion produced by each munition, are plotted in Figure 19 from the data tabulated in Table 4. The procedure used in obtaining the profile data is outlined in Appendix VII. Data given in Tables 2 and 4 are also corrected for the excess activity of Munition Able.

TABLE 4: Profile Data Corrected for Munition Fill

CLASS	DISTANCE FROM CENTER (Yards)	AVERAGE INTENSITY (mr/hr)			
		Munition			
		Able*	Baker	Charlie	Dog
1	0	128	16	40	30
2	50	32	34	43	28
3	71	32	19	23	63
4	108	14	16	15	10
5	152	9.6	6.6	6.2	8.0
6	204	5.3	4.2	5.9	5.2
7	260	4.0	2.3	3.6	5.1
8	307	3.5	2.8	2.7	4.5
9	350	3.0	3.0	4.1	3.9
10	382	3.9	2.6	2.9	4.8
11	413	3.4	2.5	2.5	2.9
12	444	2.8	2.0	2.2	1.6
13	467	2.3	1.5	2.2	1.9
14	498	1.7	1.5	2.0	0.94
15	520	1.0	0.72	1.8	1.1

*The tabulated intensities for Munition Able have been reduced by 20 per cent to compensate for agent fill.

Visual estimation of weathering effects on the six pellets examined showed no appreciable changes in the pellets (Figs. 20-23).

Meteorological data are given in Appendix II.

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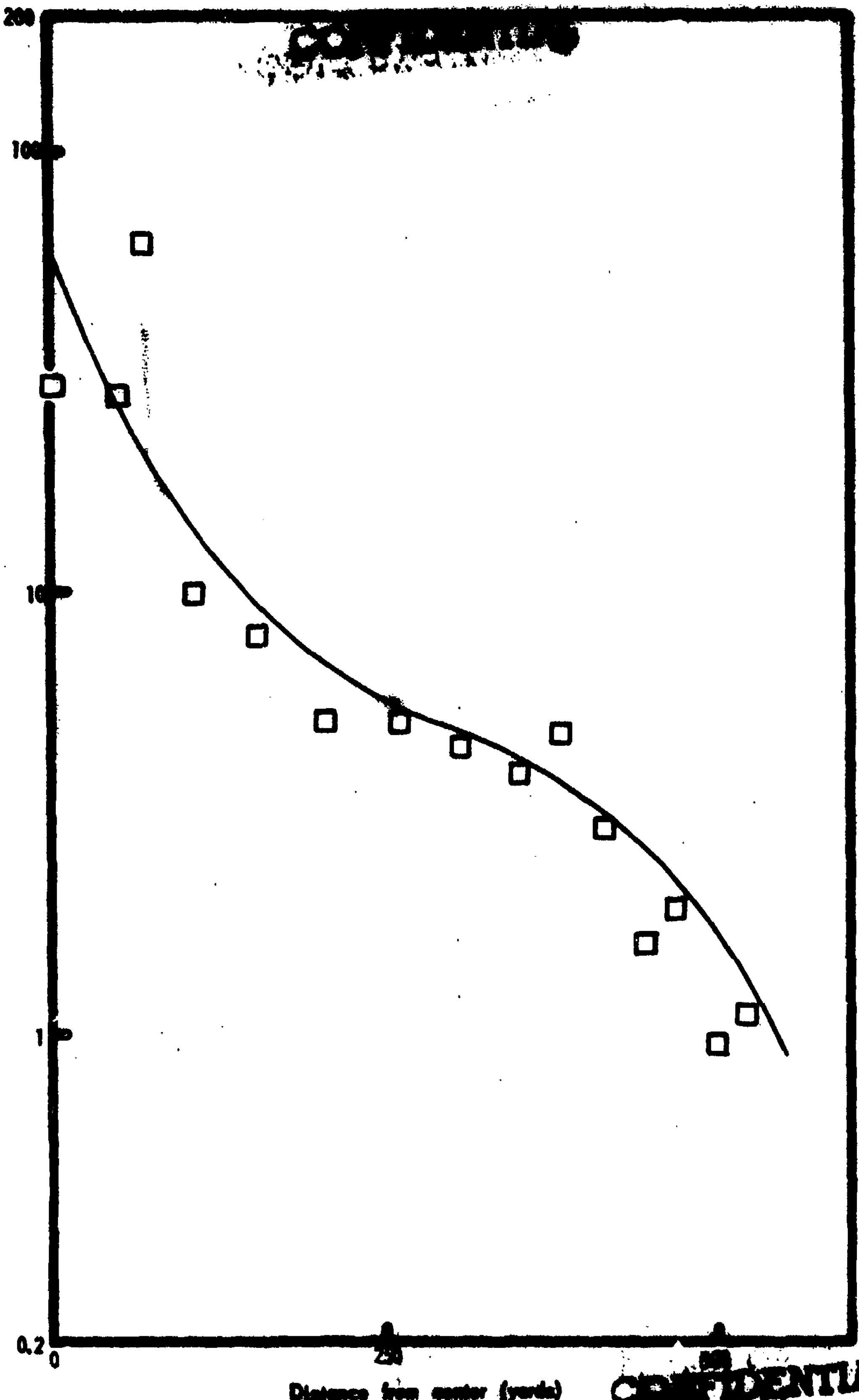

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Fig. 19d-Dog [redacted]

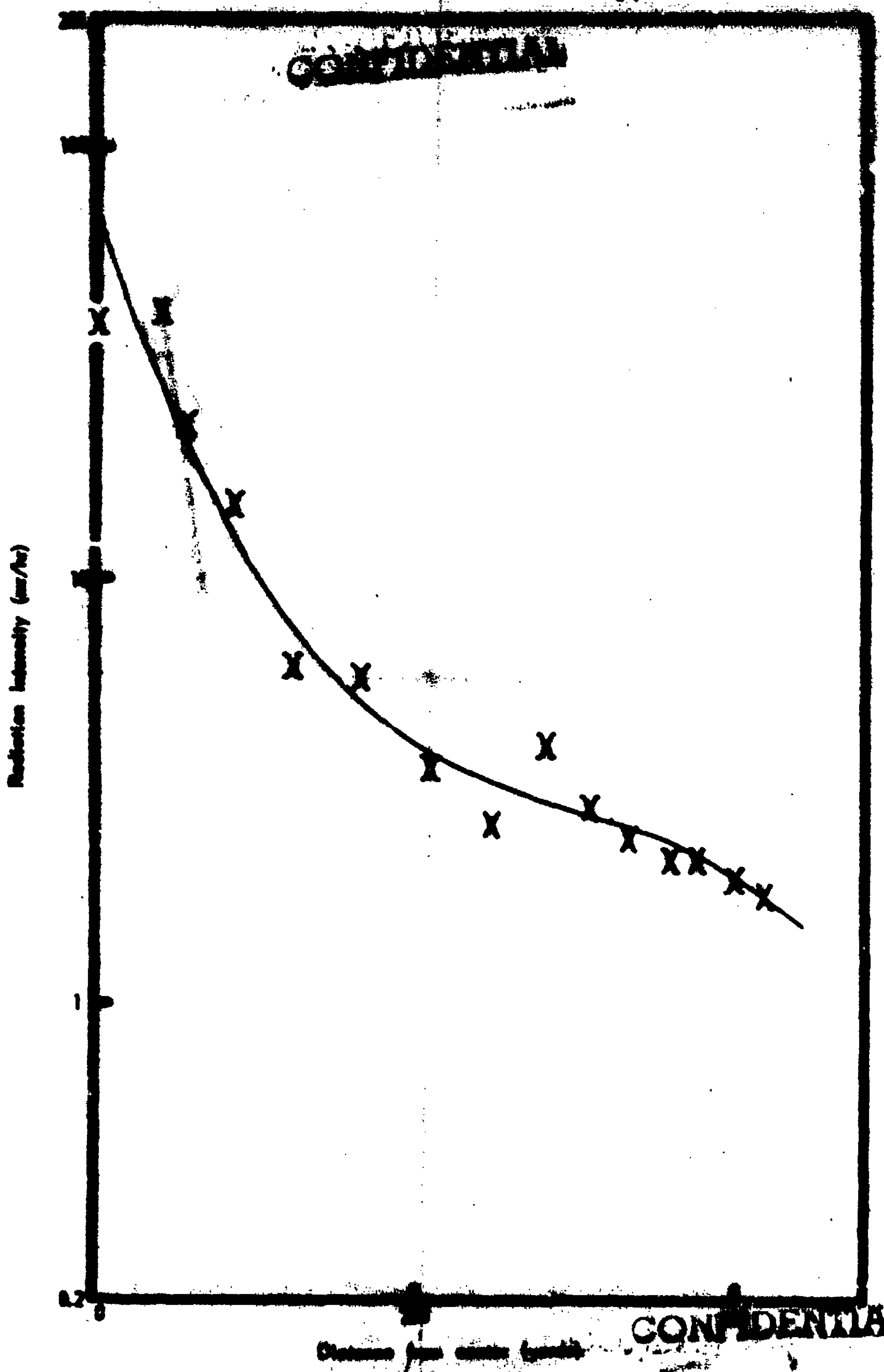

Fig. 19a-[illegible]

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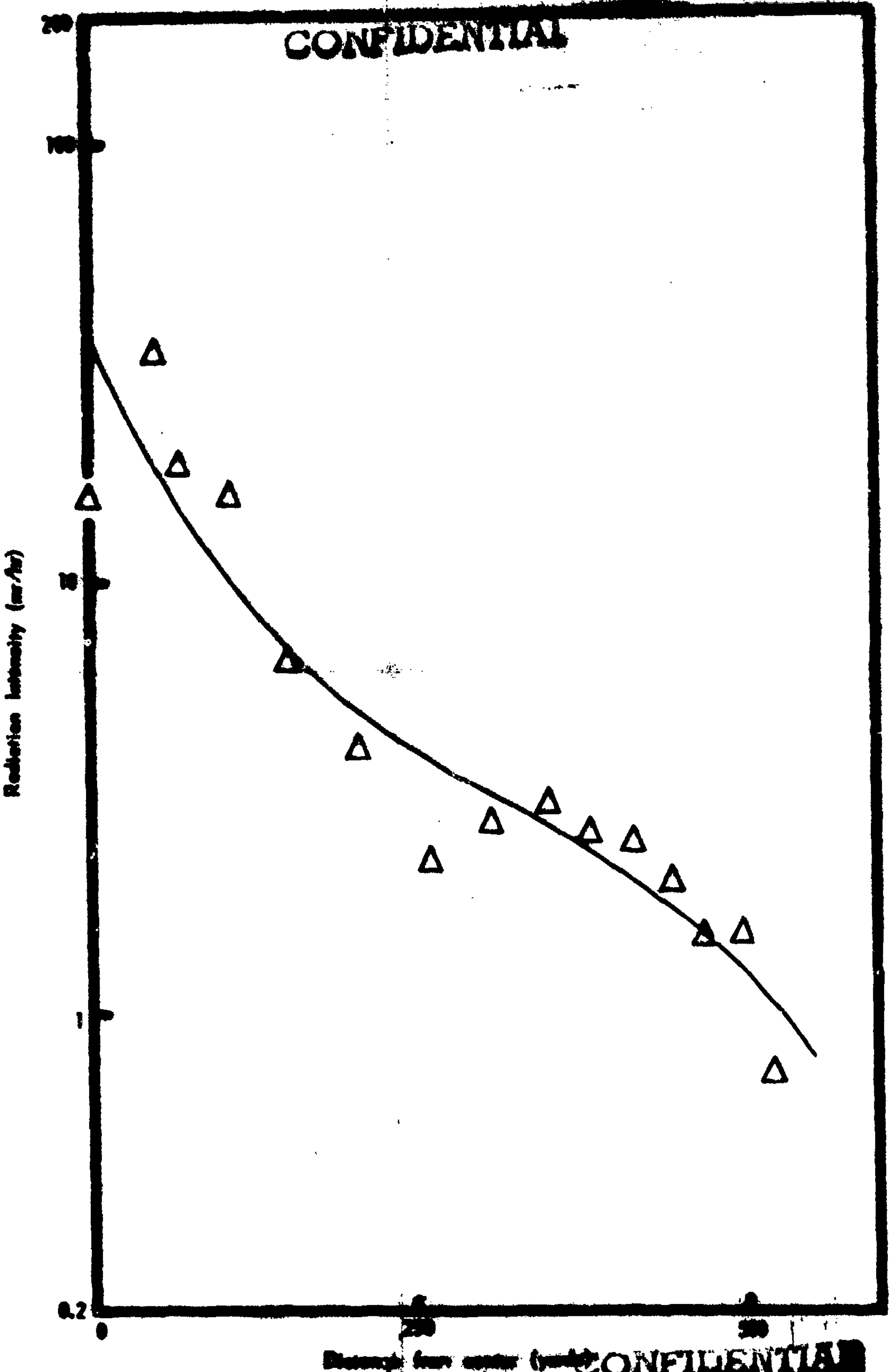

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Fig. 10b—Saber [redacted]

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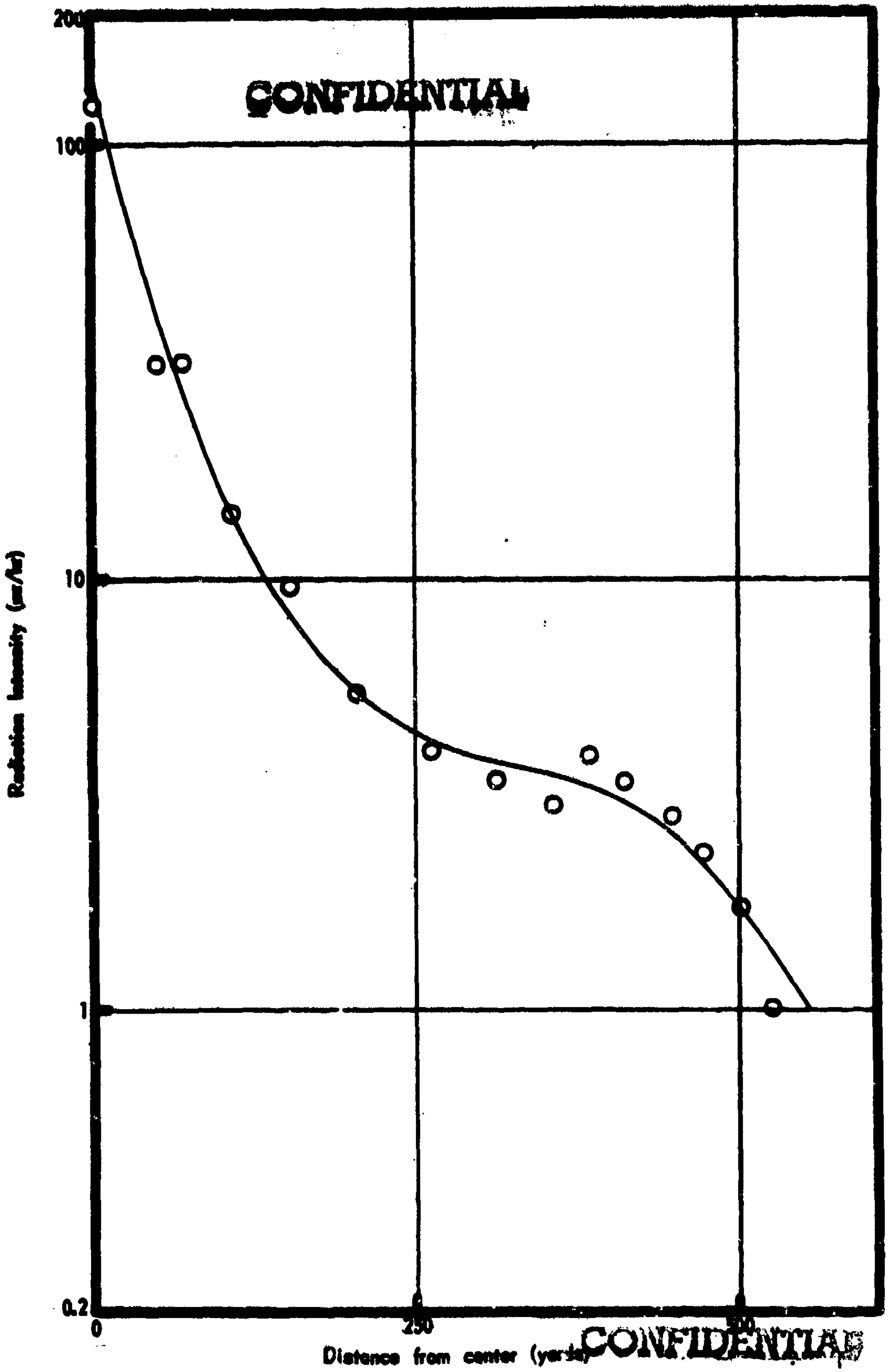

Fig. 19a-Able Munition Profile

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Fig. 20.–Pellet 3, 21 days after test.

Fig. 21.–Pellet 3, 43 days after test.

Fig. 22.–Pellet 5, 21 days after test.

Fig. 23.–Pellet 5, 43 days after test. It is clear that neither pellet was particularly affected by weathering

[redacted]

DISCUSSION

METHODS OF COMPILING DATA

The improbable trend shown by the counting data (Appendix V) suggests that the pellet samples were not representative of the entire population of each munition. Since the method of selection of the pellet samples used for radioactive assay was not known because of manipulatory difficulties encountered during munition filling procedures, an average of all pellet apparent specific activities was used as the best estimate of the apparent specific activity of the pellets in each munition. The term "apparent activity" is used as no corrections were made for self-absorption in the pellet material (Appendix VI).

The field radiation measurements of Able target were corrected for the excess activity of this munition (Tables 2, 3, and 4), as it was desired to compare the area coverage of the munitions on the basis of dispersion of equal amounts of radioactivity by each munition. All other differences in munitions are considered as variables. It is recognized that the adjustment for agent fill does not eliminate the variable of ratio of agent weight to explosive weight (Table 1); however, this ratio was approximately the same for all the munitions except Munition Able.

The profiles shown in Figure 23 may be represented by equations of the form

$$\text{Log}_{10} I = a + br + cr^2 + dr^3 \qquad (1)$$

[redacted]

where I is the radiation intensity, r the distance from the firing point, and a, b, c, and d are constants. The constants estimated for the various munitions are given in Table 5. These constants are applicable only in the region containing the data and should not be used to extrapolate beyond this region.

TABLE 5: Parameters of Equation (1) Determined by the Least-Squares Method

Munition	a*	b*	c*	d*
Able	2.208	-0.6915	0.1014	-0.005223
Baker	1.572	-0.3395	0.03957	-0.002054
Charlie	1.860	-0.4759	0.05556	-0.002465
Dog	1.775	-0.4089	0.05716	-0.003318

*Estimated value

Comparison of Figures 18a and 18b shows that calculation of area coverage by the method used to compile the data in Figure 18b gives results comparable to those obtained by planimetry of the contour diagrams (Fig. 18a).

ANALYSIS OF FIELD DATA

The different methods of presenting the field data were used in an attempt to picture the effect of variations in the shapes of the explosive charges of the munitions (Table 1) on the patterns of agent dispersion.

Since only one munition of each design was functioned in this

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test, the variance in area coverage or dispersion pattern of any one munition is not known and the differences illustrated by the curves plotted in Figures 18 and 19 cannot be considered significant. An additional functioning of any one munition might have indicated a variance in field charactertistics which, if considered common to all of the munitions, could have accounted for the differences shown in dispersion patterns.

The effects of variations in the shapes of the explosive charges, for the single trials of each munition functioned, are shown in the profiles plotted in Figure 19. The slopes of these curves are independent of the total activity content of each munition. Comparison of the profiles shows that the greatest intensity near the firing point is produced by Munition Able and the greatest at a distance of about 250 yards by Munition Dog. The profile of Munition Charlie, the only munition tested which had no jets, flattened out at a point approximately 350 yards from the firing point and showed the highest intensities of the four munitions tested beyond 450 yards from the point of explosion. Although repeated tests of munitions of identical design might prove otherwise, these facts suggest that the absence of jets in Munition Charlie did not cause loss of uniformity in agent dispersion.

CONCLUSION

Variations in structure and shape of the explosive charge of the four modified M83 munitions tested produced no variations in

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agent dispersion patterns which may be considered significant.

RECOMMENDATION

Future tests should be designed to give an estimate of the variance in the dispersion pattern of any one modification of the type munition being tested.

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APPENDIX I

TEST DIRECTIVE

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RESTRICTED DATA Atomic Energy Act - 1946

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HEADQUARTERS
CHEMICAL CORPS RESEARCH AND ENGINEERING COMMAND
ARMY CHEMICAL CENTER, MARYLAND

CMLRE-G 10 March 1952

SUBJECT: Test Directive, Development Test, Bomb Radiological, 750#, E83

TO: Commanding Officer
Dugway Proving Ground
Tooele, Utah

1. Reference is made to CMLRE-CR(T), 29 February 1952, subject: "Request for Dugway Proving Ground Tests" with two inclosures, copy attached.

2. Requirement for subject test has been established by above referenced letter.

3. Background Information: Original investigations on a munition for use in disseminating RW agents consisted of attaching an annular collar of radioactive material around a general purpose bomb. This munition resulted in a doughnut shaped dispersion pattern of contamination on the ground. In order to provide better distribution and more ground coverage, an explosive munition employing the principles of wave shaping was developed. This became the E83 radiological bomb. Further modification of the agent and explosive has been accomplished to improve the contamination pattern in regard to uniformity and area coverage.

4. Test Agency, Site and Dates: Dugway Proving Ground is designated the test agency responsible for subject test to be conducted at Dugway Proving Ground, Tooele, Utah, during the period 15 May to 30 May 1952.

5. Objectives:

a. To determine the effect of shaping the explosive charge of the modified bomb, radiological 750#, E83, on the dispersion of compressed pellets of radioactive tantalum dust.

b. To assess the radiation field produced.

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6. Procedure: A [redacted] for conduct of this test is contained in the above referenced letter.

7. Responsibilities: Dugway Proving Ground is responsible for conduct of subject test as a joint operation with Cml C Chemical and Radiological Laboratories.

8. Funding: Expenditures in connection with this test are chargeable to Research and Development Projects 4-12-30-001, 4-98-05-011, and 4-98-05-007, as applicable.

9. Plan of Test and Test Report: The policy established in Circular No. 8, Headquarters, Research and Engineering Command, 27 February 1952, is applicable. The plan of test will be prepared and submitted to this office prior to 15 April 1952. Deadline for draft report will be 15 July 1952.

10. Coordination: Direct coordination between appropriate personnel Dugway Proving Ground and Cml C Chemical and Radiological Laboratories is authorized as required to implement this test.

BY COMMAND OF BRIGADIER GENERAL CREASY:

/s/ Zim E Lawhon

ZIM E. LAWHON
Lt Col, Cml C
Chief, Prov Gr Div

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APPENDIX II

METEOROLOGICAL DATA

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TABLE 1: Wiresonde Data - Target H, 20 May 1952

TIME (MST)	HEIGHT (Feet)	TEMPERATURE (oF)
0546	0	55.4
0547	5	56.8
0548	10	57.2
0549	19.2	58.3
0550	44.5	58.3
0551	66.2	58.6
0553	106.3	59.2
0605	108.7	60.4
0606	88.2	60.1
0607	65.8	59.4
0607	42.5	59.4
0608	22.0	60.4
0609	10.0	59.0
0609	5	59.0
0610	0	58.1

TABLE 2: Hygro-Thermograph Data - Target H, 20 May 1952

TIME (MST)	TEMPERATURE (oF)	RELATIVE HUMIDITY (%)
0445	54	50
0500	59	49
0530	65	40
0600	72	38
0630	73	36
0700	64	44
0730	59	44
0800	56	45
0830	53	50
0900	50	49
0930	60	44
1000	77	36
1030	86	27
1100	71	30
1130	58	42
1200	52	48
1300	48	47

Continued

TABLE 2: Hygro-Thermograph Data - Target H, 20 May 1952 (Continued)

TIME (MST)	TEMPERATURE (°F)	RELATIVE * HUMIDITY (%)
1400	55	—
1500	63	—
1600	60	—
1700	57	—
1800	72	—
1900	83	—
2000	73	—
2100	64	—
2200	79	—
2300	90	—
2400	79	—

21 May 1952		22 May 1952	
TIME (MST)	TEMPERATURE (°F)	TIME (MST)	TEMPERATURE (°F)
0100	69	0100	72
0200	82	0200	83
0300	86		
0400	77		
0500	68		
0600	81		
0700	83		
0800	70		
0900	64		
1000	81		
1100	91		
1200	76		
1300	68		
1400	87		
1500	88		
1600	80		
1700	74		
1800	85		
1900	84		
2000	74		
2100	71		
2200	83		
2300	83		
2400	72		

* Necessary measurements for determination of relative humidity were not taken after 1300 20 May 1952

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TABLE 3: Surface Weather Observations, Target H

Date	Time (MST)	Temperature (°F)	Wind Speed (mph)	Wind Direction	Relative Humidity (%)
20 May 52	0430	56	calm	calm	57
	0500	55	3.5	N W	60
	0530	54	7	N W	54
	0600	57	10.5	N W	44

Surface Weather Observations, Dog Area

Date	Time (MST)	Temperature (°F)	Wind Speed (mph)	Wind Direction	Relative Humidity (%)
20 May 52	0520	56	5.8	N W	65
	1121	78	2.3	SS W	62
	1158	—	2.3	S	—
	1350	—	23	N W	—
	1400	—	23	N W	—
	1407	—	24	N W	—
	1435	—	11.5	N W	—
	1631	—	23	N W	—
	1643	—	16	NN E	—
	1723	50	16	N	92
	1732	—	15	N	—
	1736	—	calm	calm	—
	1923	50	3.5	W	88
	2223	50	calm	calm	94
	2323	50	calm	calm	94
21 May 52	0435	—	calm	calm	—
	0520	46	3.5	WN W	88
	1122	57	7	W	49
	1721	56	16	NN W	53
	1759	—	11.5	NN W	—
	2320	44	4.6	N W	67
22 May 52	0001	—	10.5	N W	—
	0224	43	2.3	S E	93
	0523	40	2.3	E	96
	0624	42	calm	calm	93
	1120	54	10.5	NN W	56
	1720	61	3.5	NN W	61
	2320	54	2.3	S E	72
23 May 52	0523	46	3.5	S W	90
	1120	69	2.3	NN W	42
	1720	73	8.1	N	33
	2320	56	3.5	S	55

Continued

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TABLE 3: Surface Weather Observations, Dog Area (Continued)

Date	Time (MST)	Temperature (°F)	Wind Speed (mph)	Wind Direction	Relative Humidity (%)
24 May 52	0520	45	1.2	S	43
	1120	77	3.5	W SW	39
	1720	80	2.3	S W	24
	2320	62	2.3	E NE	58
25 May 52	0522	53	calm	calm	66
	1123	79	calm	calm	31
	1323	85	8.1	N W	22
	1437	—	16	S W	—
	1507	—	16	S	—
	1623	78	21	N	25
	1722	78	8.1	W	27
	2020	70	8.1	N E	24
	2320	67	16	N E	45
26 May 52	0521	50	calm	calm	69
	1120	72	3.5	W NW	45
	1723	74	20	N E	28
	2323	60	2.3	S	49
27 May 52	0520	45	2.3	S E	70
	1120	73	calm	calm	27
	1720	81	3.5	W NW	32
	2320	60	2.3	SE	65
28 May 52	0520	46	calm	calm	66
	1120	80	5.8	S	20
	1520	85	10.5	S SE	19
	1720	79	calm	calm	27
	2320	69	15	N NE	39
29 May 52	0520	58	calm	calm	62
	0920	71	3.5	N W	47
	1120	79	3.5	N W	36
	1720	80	11.5	N NE	25
	2320	66	25	N NE	33
30 May 52	0520	50	calm	calm	53
	1120	73	2.3	S W	21
	1720	81	calm	calm	32
	2320	63	3.3	E SE	42

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Continued

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TABLE 3: Surface Weather Observations, Dog Area (Continued)

Date	Time (MST)	Temperature (°F)	Wind Speed (mph)	Wind Direction	Relative Humidity (%)
31 May 52	0523	50	calm	calm	54
	1123	81	15	S	17
	1223	82	16	S	19
	1548	—	40	S	—
	1720	70	20	S	40
	2320	63	8.1	S E	42

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APPENDIX III

GAMMA-INTENSITY READINGS

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GAMMA-INTENSITY READINGS

Each of the 50 MX-5 field meters used in this test was calibrated on its 2 mr/hr and 20 mr/hr scales. The 0.2 scale could not be calibrated because of background interference.

With its scale selector switch turned to the 2 mr/hr scale, each meter was placed successively at points calculated to receive intensities of 0.2, 0.5, 1.0, 1.5 and 2.0 mr/hr from a 24.65 millicurie radium source. At each point the meter reading was recorded and a plot of five points on a graph of true intensity versus meter reading was obtained. A straight line was fitted to these points by minimizing the sum of the squared deviations from the line to the points. These deviations were measured parallel to the meter reading axis. A similar operation, using points of 2, 5, 10, 15, and 20 mr/hr, obtained a least-squares line for the 20 mr/hr scale of each meter. These lines were used to correct the field data taken on the 2 mr/hr and 20 mr/hr scales; those data obtained on the 0.2 scales were used uncorrected.

The number of decimal points used in a reading depended on the scale of the MX-5 on which the reading was made. On the 0.2 mr/hr scale (maximum reading 0.2 mr/hr), two decimal places were recorded; on the 2 mr/hr scale, one decimal place; and on the 20 mr/hr scale, only integers were recorded.

In performing the background calculations described in Table

[redacted]

1 readings were rounded to the fewest number of decimal points available in the numbers being subtracted; thus 0.3 - 0.09 = 0.3 - 0.1 = 0.2; 0.3 - 0.03 = 0.3 - 0.0 = 0.3; etc.

The target was monitored for background prior to the day of test. Table 1 lists the stations which showed background readings of 0.10 mr/hr or greater. If a station reported a background less than 0.10 mr/hr, the only correction applied to the field reading at that station was the calibration correction. If the background reported at a station was 0.10 mr/hr or greater, an "excess background" value was obtained by subtracting 0.03 mr/hr (the average background in the uncontaminated target) from the quoted background value. The net field reading, given in Tables 3 - 6, is the difference between the calibrated field reading and the "excess background". Therefore, no corrections for normal background were made on the data in these tables.

TABLE 1: Background Readings (mr/hr) 3-foot Level

STATION		CALIBRATED FIELD READING	CALIBRATED BACKGROUND	"EXCESS BACKGROUND"	NET FIELD READING
B11	Z25	2.	0.3	0.3	2.
B21	Z29	4.	0.13	0.10	4.
B33	Z29	5.	0.10	0.07	5.
	Z31	2.	0.11	0.08	2.
B35	Z29	3.	0.15	0.12	3.
	Z33	0.3	0.12	0.09	0.2
	Z35	0.6	0.5	0.5	0.1
B37	Z27	1.1	0.13	0.10	1.0
	Z29	0.6	0.2	0.2	0.4

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TABLE 1: Background Readings (mr/hr) 3-Foot Level (Continued)

STATION	CALIBRATED FIELD READING	CALIBRATED BACKGROUND	"EXCESS BACKGROUND"	NET FIELD READING
Z31	0.5	0.3	0.3	0.2
Z33	0.2	0.2	0.2	0.0
Z35	0.2	0.10	0.07	0.1
Z37	0.1	0.12	0.09	0.0
B39 Z11	0.2	0.2	0.2	0.0
Z23	2.	2.	2.	0.
Z25	0.3	0.2	0.2	0.1
Z27	0.4	0.2	0.2	0.2
Z29	0.5	0.3	0.3	0.2
Z31	1.0	0.4	0.4	0.6
Z33	0.5	0.3	0.3	0.2
Z35	0.3	0.2	0.2	0.1
Z37	0.2	0.2	0.2	0.0
Z39	0.3	0.10	0.07	0.2
D11 Y15	4.	0.10	0.07	4.0
D19 Y21	40	0.4	0.4	40
D23 Y17	9	0.12	0.09	9.
D35 Y3	2.	1.5	1.5	0
Y11	4	0.2	0.2	4.
D37 Y9	0.3	0.15	0.12	0.2
D39 Y1	0.2	0.2	0.2	0.0
Y5	0.3	0.3	0.3	0.0

The targets were extended during the field survey to include all stations reporting greater than 1 mr/hr. The off-target numbering corresponded to that on the target. For areas west and north of the target, new row and column numbers were introduced, starting with 99 and decreasing in number away from the target. Thus station A99-W21 was 50 yards west of A1-W21, A97-W21 was 50 yards west of A99-W21, etc. Similarly, station A9-W99 was 50 yards north of A9-W1, etc. Table 2 lists all off-target readings.

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TABLE 8 : Off-target Intensity Readings (mr/hr) 3-foot Level

STATION	INTENSITY	STATION	INTENSITY
A97 W21	1.0	C97 X1	1.5
A97 W25	0.9	C97 X21	1.5
A99 W21	4.0	C97 X25	1.5
A99 W25	1.5	C99 X1	1.2
A9 W99	0.8	C99 X21	1.5
A21 W99	0.5	C99 X25	1.8
A25 W99	0.3	C13 X43	0.2
C93 X21	0.8	C17 X43	0.15
C95 X1	0.9	C21 X43	0.15
C95 X21	1.3	C21 X45	0.1
C95 X25	0.7	C21 X47	0.08

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TABLE 3 : Intensity Readings in mr/hr, Munition Able (taken at 3 feet) 50 yard Station Interval

	STATION NUMBERS									
	W1	W3	W5	W7	W9	W11	W13	W15	W17	W19
A1	0.9	1.3	0.2	0.2	0.8	0.7	0.7	2.	1.	6.
A3	0.9	1.7	0.5	0.5	0.9	1.2	0.8	5.	1.5	4.
A5	0.7	2.	1.3	9.	1.1	4.	3.	6.	3.	5.
A7	0.4	3.	2.	1.0	2.	Hot	7.	3.	2.	9.
A9	2.	3.	2.	11.	5.	4.	4.	3.	7.	5.
A11	1.	3.	2.	2.	2.	3.	2.	6.	2.	4.
A13	0.6	4.	4.	2.	2.	2.	12.	4.	4.	9.
A15	0.6	4.	3.	2.	4.	4.	6.	10.	12.	10.
A17	0.0	2.	4.	2.	1.	3.	7.	7.	10.	15.
A19	0.0	3.	7.	1.	2.	4.	4.	13.	32.	32.
A21	2.	3.	7.	2.	5.	5.	6.	10.	26.	38.
A23	1.	2.	6.	3.	4.	3.	6.	6.	13.	34.
A25	0.7	1.6	5.	10.	1.6	3.	4.	12.	14.	18.
A27	0.3	0.8	1.9	3.	2.	14.	7.	6.	7.	13.
A29	0.1	0.9	12.	5.	9.	4.	5.	4.	6.	5.
A31	0.2	0.3	1.6	6.	7.	4.	4.	13.	9.	6.
A33	0.2	0.2	0.6	5.	3.	2.	4.	9.	4.	5.
A35	0.2	0.2	0.4	6.	2.	2.	2.	18.	4.	2.
A37	0.2	0.2	3.	5.	0.8	0.9	3.	9.	4.	6.
A39	0.4	0.3	0.4	3.	1.0	1.2	0.9	1.2	1.1	0.8

	STATION NUMBERS									
	W21	W23	W25	W27	W29	W31	W33	W35	W37	W39
A1	2.	28.	2.	1.2	0.5	0.4	0.2	0.2	0.2	0.5
A3	4.	2.	6.	5.	0.9	0.5	0.7	0.6	0.4	0.5
A5	5.	3.	4.	2.	1.6	2.	1.0	2.	1.4	0.5
A7	4.	2.	6.	2.	3.	5.	8.	2.	2.	0.7
A9	4.	2.	2.	2.	2.	5.	4.	6.	3.	0.4
A11	6.	12.	4.	4.	2.	4.	2.	2.	3.	0.6
A13	14.	6.	7.	3.	5.	4.	4.	1.7	1.7	0.8
A15	19.	6.	5.	12.	5.	3.	2.	2.	2.	0.8
A17	32.	18.	38.	8.	2.	9.	7.	3.	3.	2.
A19	68.	60.	9.	11.	4.	2.	7.	3.	1.	2.
A21	160.	28.	11.	6.	8.	4.	9.	4.	3.	3.
A23	24.	32.	14.	10.	13.	7.	5.	6.	4.	2.
A25	9.	6.	7.	4.	3.	4.	3.	20.	5.	0.9
A27	8.	4.	4.	3.	5.	3.	6.	5.	2.	3.
A29	8.	4.	2.	3.	3.	2.	3.	6.	1.6	0.4
A31	5.	4.	2.	2.	1.4	1.2	5.	1.3	0.6	0.2
A33	2.	12.	3.	3.	3.	1.4	2.	0.6	0.5	0.2
A35	4.	3.	6.	3.	8.	0.6	0.4	0.3	0.2	0.2
A37	3.	9.	5.	2.	1.0	0.4	0.3	0.2	0.2	0.2

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TABLE 4 : Intensity Readings in mr/hr, Munition Baker (taken at 3 feet) 50 yard Station Interval

	STATION NUMBERS									
	Z1	Z3	Z5	Z7	Z9	Z11	Z13	Z15	Z17	Z19
B1	0.10	0.1	0.1	0.2	0.4	7.	2.	1.2	2.	2.0
B3	0.1	0.1	0.1	1.5	1.	1.	6.	2.	2.	2.
B5	0.05	0.10	0.4	1.	2.	6.	2.	6.	1.2	4.
B7	0.2	0.6	0.6	1.2	10.	2.	5.	3.	4.	7.
B9	0.1	0.2	0.9	1.5	6.	5.	1.	2.	3.	11.
B11	0.3	0.8	4.	2.	2.	2.	2.	2.	4.	6.
B13	0.2	0.4	1.0	1.0	2.	4.	3.	3.	7.	7.
B15	0.5	0.5	1.1	2.	9.	3.	3.	4.	11.	10.
B17	1.7	0.6	0.6	0.8	0.8	1.9	1.6	5.	5.	15.
B19	0.03	0.09	2.0	0.6	3.	3.	1.6	4.	12.	15.
B21	0.3	0.9	0.9	4.	0.8	1.3	4.	5.	15.	20.
B23	0.4	11.	1.4	0.7	0.7	1.4	1.2	5.	7.	10.
B25	0.4	0.7	14.	13.	2.	2.	3.	3.	3.	11.
B27	0.3	3.	1.1	2.	1.1	5.	0.8	1.6	3.	2.
B29	0.2	2.	2.	1.	11.	3.	1.	2.	5.	2.
B31	0.2	0.3	0.5	0.3	0.8	1.6	1.5	0.8	1.3	2.
B33	0.2	0.15	0.2	2.	4.	0.5	0.9	1.1	0.5	1.6
B35	0.05	0.09	0.10	0.10	0.3	2.	2.	0.1	1.2	1.5
B37	0.04	0.07	0.07	0.0	0.1	0.2	0.5	0.6	0.	1.
B39	0.07	0.03	0.07	0.08	0.09	0.0	0.2	0.2	0.2	0.5

	STATION NUMBERS									
	Z21	Z23	Z25	Z27	Z29	Z31	Z33	Z35	Z37	Z39
B1	3.	1.0	0.6	1.5	0.6	1.0	0.6	0.2	0.3	0.1
B3	1.	1.	2.	0.	9.	0.	6.	0.2	0.2	0.1
B5	3.	2.	7.	1.	3.	2.	1.8	0.4	0.5	0.5
B7	2.	3.	2.	2.	2.	6.	2.	1.	0.5	0.9
B9	3.	2.	3.	2.	1.1	1.1	0.5	0.8	4.	0.4
B11	4.	2.	2.	2.	1.2	1.5	0.8	2.	1.	1.8
B13	12.	4.	4.	3.	1.2	3.	5.	2.	3.	1.1
B15	20.	4.	5.	2.	3.	8.	4.	3.	1.2	1.1
B17	40.	13.	5.	10.	6.	2.1	1.0	1.9	4.	0.9
B19	60.	40.	19.	5.	3.	1.6	1.6	1.9	3.	1.0
B21	16.	40.	19.	7.	4.	4.	13.	6.	1.8	4.
B23	14.	10.	15.	14.	4.	3.	1.2	2.1	1.6	1.2
B25	12.	8.	7.	4.	2.	2.	2.	3.	4.	2.
B27	6.	3.	2.	4.	1.5	1.1	2.	1.5	1.4	0.4
B29	2.	2.	3.	2.	2.	2.	3.	3.	3.	0.6
B31	2.	1.	2.	4.	3.	1.	3.	2.	1.	1.
B33	0.6	3.	2.	3.	5.	2.	0.6	0.4	0.9	0.2
B35	3.	4.	1.4	2.	3.	1.6	0.2	0.1	0.3	0.2
B37	8.	1.5	0.5	1.0	0.4	0.2	0.0	0.1	0.0	0.1
B39	[redacted]								0.0	0.2

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TABLE 8: Intensity Readings in mr/hr, Munition Dog (taken at 3 feet) 50 yard Station Interval

	STATION NUMBERS										
	Y1	Y3	Y5	Y7	Y9	Y11	Y13	Y15	Y17	Y19	Y21
D1	0.1	0.1	0.1	0.2	0.3	0.3	0.6	1.5	6.	1.5	0.7
D3	0.2	0.1	0.3	0.3	0.4	0.5	2.	1.	2.	2.	0.3
D5	0.2	0.2	2.	7.	0.8	0.6	0.9	2.	2.	5.	1.5
D7	0.4	0.4	0.7	5.	2.	1.	5.	2.	2.	7.	2.
D9	0.2	0.5	0.8	3.	1.	5.	1.	4.	2.	28.	2.
D11	0.4	1.	1.	1.3	5.	7.	1.	4.	2.	10.	3.
D13	0.9	1.0	4.	3.	2.	2.	3.	3.	3.	9.	7.
D15	3.	17.	4.	3.	2.	4.	5.	6.	4.	7.	12.
D17	1.0	2.	2.	5.	3.	3.	14.	7.	11.	18.	7.
D19	0.06	0.8	1.7	2.	4.	3.	5.	5.	15.	80.	40.
D21	0.4	1.2	1.3	3.	1.6	4.	4.	5.	9.	32.	30.
D23	1.3	1.4	8.	5.	11.	6.	4.	6.	9.	40.	19.
D25	0.5	1.6	3.	2.	3.	2.	2.	4.	12.	7.	9.
D27	1.6	0.5	8.	3.	13.	5.	4.	5.	12.	8.	5.
D29	0.3	0.5	1.	3.	2.	4.	4.	2.	3.	4.	4.
D31	0.3	0.6	6.	4.	6.	4.	2.	4.	14.	5.	6.
D33	0.2	0.3	0.4	4.	4.	11.	3.	3.	9.	2.	5.
D35	0.2	0.0	0.3	0.6	7.	4.	8.	2.	4.	5.	3.
D37	0.1	0.1	0.2	0.2	0.2	0.	0.	1.	1.	1.	4.
D39	0.0	0.2	0.0	0.1	0.1	0.1	0.2	0.5	0.5	0.4	0.7

	STATION NUMBERS									
	Y23	Y25	Y27	Y29	Y31	Y33	Y35	Y37	Y39	Y41
D1	0.7	4.	0.8	0.8	0.3	0.3	0.2	0.1	0.1	0.0
D3	1.	1.	1.	1.	0.4	0.3	0.2	0.1	0.0	0.10
D5	1.	4.	1.4	1.2	1.1	1.2	0.5	0.4	0.15	0.10
D7	1.	9.	2.	2.	4.	1.	2.	0.4	0.2	0.2
D9	2.	2.	2.	2.	7.	7.	0.9	0.8	0.2	0.0
D11	2.	2.	3.	2.	4.	4.	3.	0.5	0.4	0.10
D13	3.	3.	9.	3.	1.8	3.	1.6	0.7	3.	0.7
D15	6.	8.	5.	6.	1.4	4.	3.	1.5	0.6	0.4
D17	9.	5.	5.	4.	2.	4.	1.2	1.0	0.3	ND
D19	32.	9.	12.	6.	4.	8.	1.2	1.2	1.6	0.3
D21	19.	13.	9.	3.	19.	2.	4.	1.4	1.8	0.2
D23	100.	8.	7.	4.	3.	5.	7.	5.	1.2	0.9
D25	8.	10.	8.	1.9	1.2	2.1	2.1	0.8	0.5	1.0
D27	8.	3.	4.	8.	1.5	1.5	4.	1.1	0.8	0.2
D29	6.	5.	13.	4.	2.	2.	3.	1.7	0.3	0.2
D31	4.	4.	2.	11.	4.	12.	3.	1.	0.2	0.2
D33	11.	5.	2.	3.	16.	1.4	1.0	0.6	1.3	1.4
D35	16.	3.	14.	1.	1.2	1.1	0.3	0.2	0.09	0.06
D37	4.	3.	2.	1.1	0.2	0.1	0.1	0.1	0.0	0.0
D39	1.1	[redacted]	[redacted]	0.2	0.1	0.1	0.1	0.1	0.0	0.0

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TABLE 6 : Intensity Readings in mr/hr, Munition Charlie (taken at 3 feet) 50 yard Station Interval

	STATION NUMBERS										
	X1	X3	X5	X7	X9	X11	X13	X15	X17	X19	X21
C1	2.	1.8	0.6	0.5	0.5	1.3	1.1	0.6	0.5	2.	2.
C3	1.9	2.	0.4	0.5	2.	1.4	16.	1.5	1.1	1.2	2.
C5	1.7	4.	1.2	8.	5.	0.7	0.9	1.4	3.	1.3	6.
C7	1.8	6.	3.	2.	2.	2.	2.	2.	2.	2.	6.
C9	2.	4.	2.	4.	3.	2.	4.	5.	6.	2.	8.
C11	1.	4.	2.	2.	3.	11.	1.	2.	35.	1.	9.
C13	1.3	0.5	1.9	1.	2.	3.	3.	4.	10.	6.	10.
C15	4.	5.	7.	2.	1.	2.	4.	4.	4.	9.	11.
C17	1.	4.	3.	5.	1.	2.	18.	7.	8.	12.	37.
C19	1.	3.	8.	9.	4.	2.	4.	3.	9.	38.	60.
C21	3.	4.	5.	3.	2.	3.	3.	3.	8.	20.	40.
C23	1.	5.	6.	2.	4.	4.	4.	8.	10.	22.	40.
C25	0.6	2.0	8.	1.3	13.	1.9	3.	4.	6.	6.	35.
C27	0.6	5.	9.	4.	3.	3.	2.	5.	5.	8.	8.
C29	0.4	1.2	5.	1.4	15.	0.9	3.	3.	3.	5.	4.
C31	0.3	0.7	4.	3.	2.	1.3	5.	1.0	1.6	4.	4.
C33	0.2	0.6	1.0	3.	3.	3.	28.	6.	5.	3.	1.3
C35	0.2	0.3	0.6	6.	3.	3.	3.	12.	3.	3.	3.
C37	0.3	0.3	0.5	10.	0.7	0.5	0.6	1.4	0.9	1.4	0.9
C39	0.3	0.3	0.7	16.	0.8	0.5	4.	5.	0.9	3.	0.6

	STATION NUMBERS									
	X23	X25	X27	X29	X31	X33	X35	X37	X39	X41
C1	7.	4.	9.	0.4	0.2	0.2	0.6	0.06	0.04	0.04
C3	2.	4.	0.5	1.2	8.	0.4	0.2	0.7	1.2	0.6
C5	3.	2.	4.	10.	6.	0.3	0.1	0.12	0.15	0.07
C7	5.	4.	1.0	0.8	1.8	1.0	0.3	0.2	0.1	0.0
C9	2.	2.	0.8	0.5	2.	1.0	0.2	6.	0.1	0.07
C11	3.	1.	0.6	1.5	0.4	0.4	0.4	0.9	0.8	0.3
C13	5.	20.	4.	1.4	1.1	0.6	3.	4.	0.4	0.2
C15	4.	5.	3.	3.	2.	1.1	0.6	1.5	0.4	0.4
C17	8.	5.	3.	4.	1.	0.	3.	1.	1.5	0.0
C19	19.	11.	8.	8.	1.	0.	1.	0.	0.	1.
C21	50.	11.	7.	18.	2.	0.8	0.7	0.9	0.8	1.0
C23	12.	7.	4.	3.	2.	2.	1.	1.	0.6	0.1
C25	23.	4.	3.	4.	1.0	0.7	0.5	0.5	0.3	0.5
C27	4.	2.	6.	1.8	8.	2.	8.	0.5	0.4	0.1
C29	2.	3.	2.	3.	2.	3.	0.9	0.7	0.2	0.06
C31	0.8	3.	4.	0.7	1.4	3.	0.9	0.9	0.1	0.05
C33	0.7	2.	5.	2.	0.7	0.4	0.5	0.2	0.18	0.08
C35	0.8	2.	3.	2.	3.	0.3	0.2	0.10	0.08	0.11
C37	0.9	1.4	4.	2.	2.	0.3	0.15	0.10	0.05	0.05
C39	0.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.09	0.09

APPENDIX IV

CONTOURS FOR VARIOUS ISOINTENSITY LEVELS

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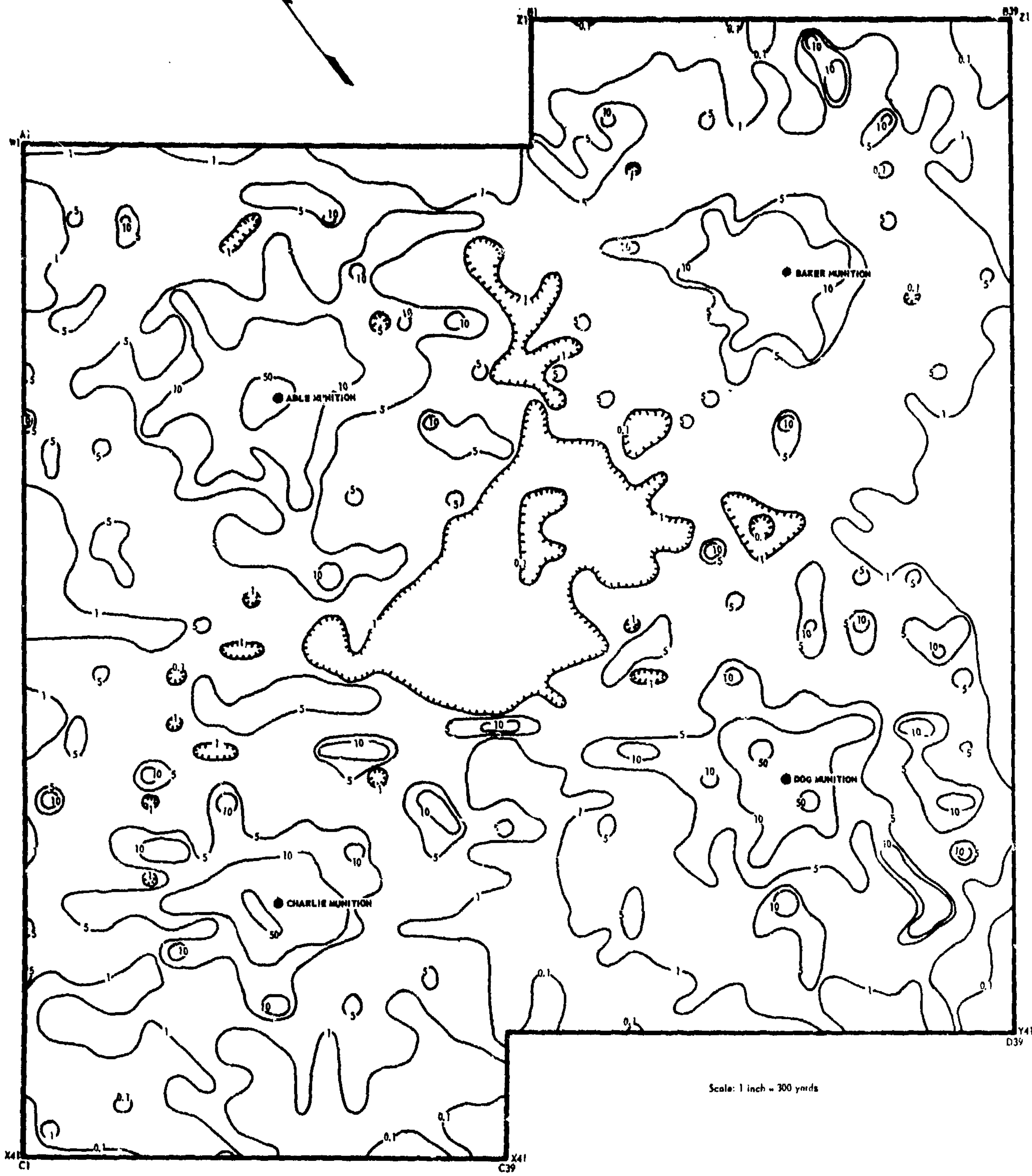

Fig. 1.-Isointensity contours in milliroentgens per hour at various levels

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APPENDIX V

ACTIVITY OF PELLETS

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ACTIVITY OF PELLETS

As described in Pellet Measurements (page 21), a number of pellets were selected from each munition and were placed in appropriately labeled pots. These pellets were placed individually under a geiger-mueller tube connected to a Berkeley-2000 scaler, and the time required for each pellet to record 20,000 counts was determined. Then the times for two separate countings were averaged. If these differed by more than 0.4 seconds, a third count was taken and the three values were averaged. The counts per minute were calculated from these averages and corrected for coincidence loss and background.

Two more corrections were then made to obtain the activity in millicuries of each pellet. The linear calibration factor (1cpm = 0.001194mc) obtained in Appendix VI was used for converting cpm to mc. The second factor was used to estimate the apparent intensity of the pellet on the date of the trial, 20 May. The dates of the pellet activity measurements and the decay correction factors used are given in Table 1.

TABLE 1: Decay Correction Factors

POT	PELLET NUMBERS	DATE OF MEASUREMENT	CORRECTION FACTOR*
A	1- 7	16 June 1952	1.1688
A	8-24	17 June 1952	1.1755
B	1-12	17 June 1952	1.1755
B	13-24	18 June 1952	1.1823
C	1-12	18 June 1952	1.1823
C	13-24	19 June 1952	1.1891
D	1-11	19 June 1952	1.1891
D	12-30	20 June 1952	1.1962

* Based on a half-life of 120 days for Tantalum 182.

The coincidence correction factor and the linear calibration factor used to adjust these pellet counting data were obtained from measurements made four to five months after these data were taken (Appendix VI). The factors are considered usable in correcting the data of this test because (1) the same counting geometry and the same model GM tube were used in both instances, and (2) the count of the radium standard used to check counter operation remained constant. The pellets had the same dimensions and varied in density by less than three per cent.

TABLE 2: Activity of Pellet Samples

MUNITION ABLE							
PELLET NUMBER	ACTIVITY IN MC	PELLET WEIGHT (gm)	SPECIFIC ACTIVITY (mc/gm)	PELLET NUMBER	ACTIVITY IN MC	PELLET WEIGHT (gm)	SPECIFIC ACTIVITY (mc/gm)
1	42.3	3.5904	11.77	13	45.1	4.1253	10.92
2	22.2	3.9986	5.55	14	45.6	4.0000	11.40
3	34.9	3.9781	8.75	15	26.5	4.0136	6.61
4	33.6	3.8009	8.85	16	37.1	4.0031	9.26
5	35.0	4.1973	8.35	17	40.6	3.7269	10.88
6	35.2	3.9223	8.97	18	38.6	3.9370	9.80
7	38.4	3.9926	9.61	19	28.2	4.0422	6.98
8	31.4	3.6161	8.69	20	35.9	4.0104	8.96
9	21.3	4.0179	5.31	21	23.4	4.1265	5.68
10	40.1	3.9820	10.08	22	33.4	4.0419	8.26
11	39.9	3.8171	10.44	23	36.1	3.6921	9.77
12	34.9	3.7532	9.31	24	32.4	3.8393	8.44
Average							8.86
MUNITION BAKER							
1	20.5	2.9129	7.03	13	18.4	3.9214	4.68
2	33.0	3.8564	8.56	14	34.3	3.9057	8.78
3	29.3	3.9927	7.35	15	23.0	3.9512	5.82
4	28.2	3.9779	7.09	16	25.4	3.8648	6.57
5	29.5	3.8945	7.57	17	36.1	3.8894	9.29
6	22.7	3.7137	6.12	18	29.2	4.0307	7.25
7	31.2	3.6002	8.65	19	28.1	3.7306	7.53
8	33.4	3.5022	9.54	20	31.9	3.9190	8.14
9	51.2	4.0386	12.69	21	19.6	4.0819	4.81
10	27.8	3.4216	8.12	22	47.9	4.0340	11.86
11	29.1	3.6940	7.87	23	32.2	4.0309	7.98
12	24.7	3.3669	7.34	24	35.4	3.8046	9.31
Average							7.91

Continued

TABLE 2: Activity of Pellet Samples (Continued)

PELLET NUMBER	ACTIVITY IN MC	PELLET WEIGHT (gm)	SPECIFIC ACTIVITY (mc/gm)	PELLET NUMBER	ACTIVITY IN MC	PELLET WEIGHT (gm)	SPECIFIC ACTIVITY (mc/gm)
[redacted] CHARLIE							
1	42.5	3.7341	11.38	13	29.8	3.8888	7.67
2	46.9	4.2968	10.91	14	40.6	3.8712	10.49
3	30.1	3.9842	7.55	15	44.3	4.0057	11.06
4	56.9	3.9510	14.40	16	38.8	3.7733	10.27
5	56.7	3.8931	14.56	17	39.3	4.0841	9.63
6	22.7	3.7152	6.12	18	24.1	3.9395	6.13
7	56.0	3.7438	14.97	19	28.5	3.8374	7.44
8	43.2	3.9400	10.96	20	30.8	3.9618	7.78
9	40.9	3.9517	10.36	21	24.8	3.8971	6.38
10	27.5	3.2590	8.46	22	21.0	3.7695	5.57
11	57.5	3.9901	14.40	23	43.2	3.9579	10.91
12	24.6	3.4156	7.19	24	30.1	3.9923	7.54
Average							9.67
[illegible] DOG							
1	34.5	3.7735	9.14	16	45.6	4.0642	11.21
2	38.9	4.0805	9.53	17	46.0	3.8276	12.02
3	31.4	4.0890	7.67	18	45.2	3.8922	11.61
4	37.1	3.7283	9.94	19	33.6	3.8924	8.62
5	69.7	3.9292	17.74	20	50.8	4.0233	12.63
6	55.2	3.7030	14.91	21	43.7	3.9651	11.02
7	71.7	4.4742	16.03	22	55.6	4.0373	13.76
8	43.3	3.6771	11.78	23	44.3	4.0267	11.00
9	50.0	3.8398	13.02	24	46.1	4.1069	11.23
10	54.5	3.8452	14.18	25	38.5	3.6090	10.71
11	42.6	4.0496	10.52	26	39.3	4.0737	9.64
12	34.6	4.3286	7.99	27	56.7	3.8661	14.66
13	65.8	3.8873	16.94	28	34.6	3.8936	8.88
14	47.7	4.0357	11.82	29	33.6	4.6222	7.26
15	54.8	4.1514	13.21	30	46.7	4.1005	11.39
Average							11.67

APPENDIX VI

A METHOD FOR THE DETERMINATION OF THE APPARENT ACTIVITY OF RW AGENTS

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ABSTRACT[1]

A technique is presented by the authors for the measurement of the apparent curie value of the agent pellets which does not include a direct comparison of the Ta 182 activity with a standard source. A GM tube is calibrated to measure activity in curies by obtaining a plot of activity in curies versus counts per minute for pellets identical to those sampled from the munitions used in DPG FT RW 1-53.[2]

The apparent activity in curies is found by measurement of the radiation intensity of a number of pellets with an ionization chamber previously calibrated with a standard radium source. These pellets are then counted and a plot of counts per minute versus apparent curie values gives the calibration curve of the GM tube. The term "apparent curie" is used as no correction is made for self-absorption in the pellet material.

The roentgen per hour measurements were made using Kelley-Koett, 200 mr, self-reading, chamber type pencils. Each pencil was calibrated against a National Bureau of Standards calibrated radium source (Fig. 1).

---

[1] Alder, Marilyn G., Campagna, Edward R., and Anderson, Keith P., "A Method for the Determination of the Apparent Activity of RW Agents," RRD-1, University of Utah, Radiological Research, Dugway Proving Ground, Tooele, Utah.

[2] The pellets used in RW 1-53 were 5/16 inch in diameter and 5/16 inch in height. They were composed of tantalum dust, 400 mesh, 83 per cent; fine copper wire for binding, 15 per cent; and molybdenum sulfide, two per cent.

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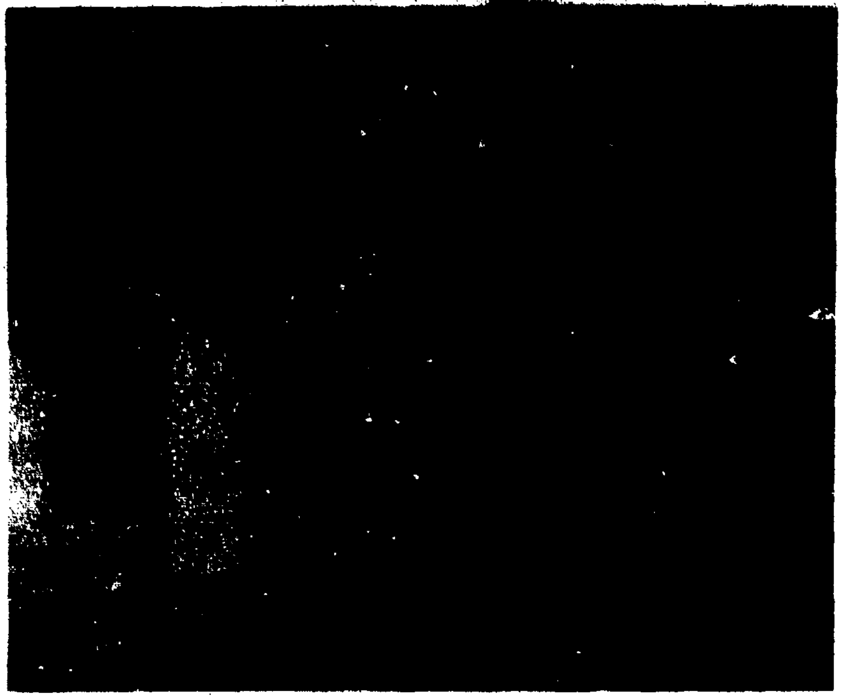

Fig. 1-Calibration of the Kelley-Koett dosimeters. The pencils are positioned as shown at B. The midpoint of the radium source at A is exactly one foot from the midpoint of each pencil.

The pellets were then placed at a distance of one foot from the calibrated pencils (Fig. 2). A series of readings over precisely measured time intervals were taken on each pellet. The apparent activity in curies is calculated from the equation $C = R/6.77$ where R is the intensity in roentgens per hour at one foot and C is the apparent number of curies of Ta 182. The conversion constant, 6.77, is calculated for the energies of the gamma rays of Ta 182 whose most recently determined values are 1.22 mev, 38.0 per cent, 1.12 mev, 21.4 per cent, and 1.11 mev, 41.6 per cent.[3]

[3] Ferguson, H. K., Co., HKF-114, Atomic Energy Division, New York, Sept 1951 (SECRET); Engelkemeir, M. S., Freedman, M. S. and May, J., ANL-4473, June 1950.

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Fig. 2-Measurement of pellet radiation intensity. The pellets were placed as shown at A with the pellet center on a line with the midpoint of each pencil.

The counting rate, in counts per minute, of each calibrated pellet was found using the equipment shown in Fig. 3. A plot of the counting rate versus apparent curie value (Fig. 4) gives a calibration curve from which the apparent curie value of subsequently counted pellets of the same size and density may be determined. The counting rates are corrected for coincidence loss and background. The tube efficiency calculated from these data is 1.19×10^{-6} apparent curies of Ta 182 per count per minute for the pellet samples used.

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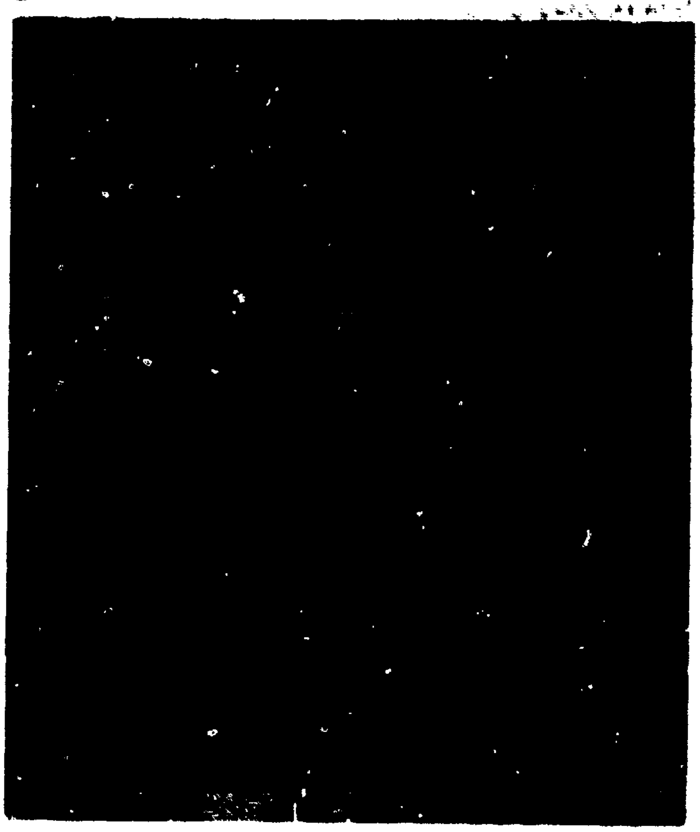

Fig. 3-GM tube and scaling circuit. An end-window type GM tube is in the lead shield shown at the top center. The tube is 1 1/8 inches in diameter and has a window thickness of 3.5 mg/cm^2. Pellets are placed through the opening in the lead brick shield shown at the bottom of the photograph, in a holder which is 3.79 feet from the tube window.

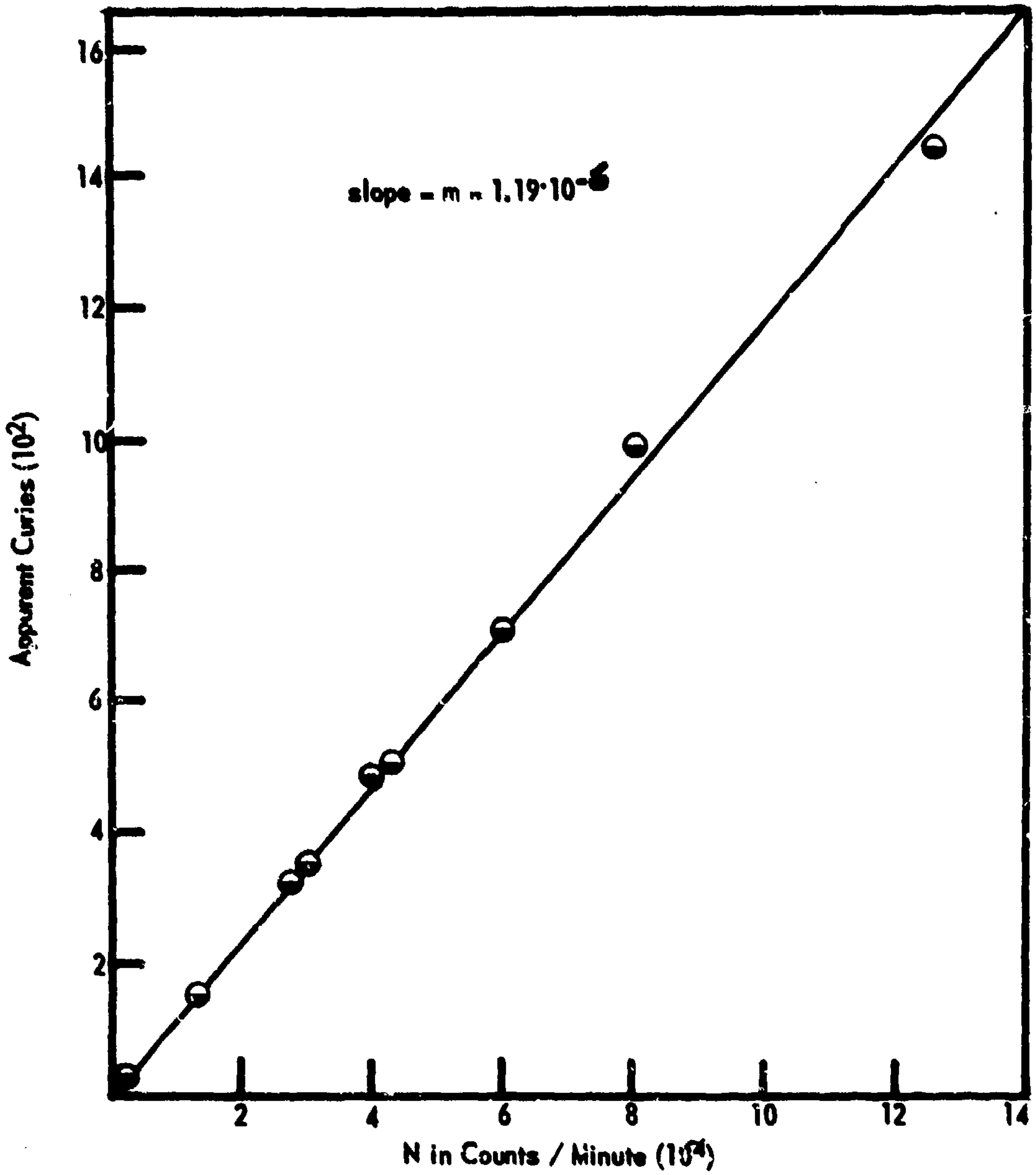

Fig. 4.-Apparent curies versus coincidence corrected counting rates for RW 1-53 sample pellets containing ${}_{73}Ta^{182}$

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APPENDIX VII

PROFILE DETERMINATION

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PROFILE DETERMINATION

The "profile" method of analysis used in this report is a procedure for estimating the average intensities in mr/hr of radiation recorded at varying distances from ground zero of the munition. Ground zero was taken as the stake directly below the functioned munition.

As a preliminary calculation, the distance from the ground zero of each grid to every stake on that grid was determined. Near ground zero all stakes the same distance from the center were grouped into one class, the stake at ground zero being considered a class by itself. Farther from the center, stakes at nearly equal distances from ground zero were grouped together, the number of stakes in any one class numbering about 32. The distance of each class from ground zero was computed as the average of the distances of all the stakes comprising the class. Table 1 gives the average distance, the number of stakes, and the coordinates of the first octant of stakes of each class. The coordinates of this table assume the ground zero stake as station (0,0).

TABLE 1: Characteristics of Classes used for Profile Determination

CLASS	RADIUS IN YARDS	NUMBER OF STAKES	STAKE COORDINATES
1	0	1	(0,0)
2	50	4	(1,0)
3	71	4	(1,1)
4	108	12	(2,0),(2,1)
5	152	16	(2,2),(3,0),(3,1)
6	204	32	(3,2),(3,3),(4,0),(4,1),(4,2)
7	260	32	(4,3),(4,4),(5,0),(5,1),(5,2)
8	307	36	(5,3),(5,4),(6,0),(6,1),(6,2)
9	350	32	(5,5),(6,3),(6,4),(7,0),(7,1)
10	382	28	(6,5),(7,2),(7,3),(8,0)
11	413	36	(6,6),(7,4),(8,1),(8,2),(8,3)
12	444	28	(7,5),(8,4),(9,0),(9,1)
13	467	32	(7,6),(8,5),(9,2),(9,3)
14	498	32	(7,7),(8,6),(9,4),(10,0),(10,1)
15	520	32	(8,7),(9,5),(10,2),(10,3)

The intensity readings for each munition were separated into classes according to the system represented in Table 1. The intensity assigned to each class was the average of all values falling in that class (Table 4, page 29). If values were missing, the average was calculated by interpolation. This intensity average is plotted versus the distance of the class from ground zero (Fig. 19). A third-degree curve was fitted to the logarithms of the intensities by the least squares method. The method of obtaining the parameters of this curve is described below.

Let the desired curve be represented by the function

$$\log I = a + br + cr^2 + dr^3,$$

where I is the intensity, r is the distance from ground zero, and the $\underline{a}$, $\underline{b}$, $\underline{c}$ and $\underline{d}$ are the constants to be estimated. The function to be minimized is

$$F = \sum_{i=1}^{15} (\log I_i - a - br_i - cr_i^2 - dr_i^3)^2.$$

$$\partial F/\partial a = -2\sum(\log I_i - a - br_i - cr_i^2 - dr_i^3),$$

$$\partial F/\partial b = -2\sum r_i\,(\log I_i - a - br_i - cr_i^2 - dr_i^3),$$

$$\partial F/\partial c = -2\sum r_i^2(\log I_i - a - br_i - cr_i^2 - dr_i^3),$$

$$\partial F/\partial d = -2\sum r_i^3(\log I_i - a - br_i - cr_i^2 - dr_i^3).$$

Setting each of these partial derivatives equal to zero in order to minimize $\underline{F}$, the following normal equations are obtained, $\underline{a}^*$, $\underline{b}^*$, $\underline{c}^*$ and $\underline{d}^*$ indicating the estimates for the appropriate parameters:

$$a^*n + b^*\sum r + c^*\sum r^2 + d^*\sum r^3 = \sum \log I$$

$$a^*\sum r + b^*\sum r^2 + c^*\sum r^3 + d^*\sum r^4 = \sum r \log I$$

$$a^*\sum r^2 + b^*\sum r^3 + c^*\sum r^4 + d^*\sum r^5 = \sum r^2 \log I$$

$$a^*\sum r^3 + b^*\sum r^4 + c^*\sum r^5 + d^*\sum r^6 = \sum r^3 \log I$$

The simultaneous solution of these four equations gave the parameter values found in Table 5, page 42.

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Dear Sir:

The Department of Defense (DoD) Radiation Experiments Command Center (RECC) was established in response to the direction of the 7 January 1994 Secretary of Defense memorandum to compile, review, catalog, and retain documents and information pertaining human subject experiments involving ionizing radiation. DoD RECC made documents and information available to the public after proper reviews for classifications, personal privacy, or other release restrictions. The RECC is the approving authority for the release of documents and information once the redacted material has been extracted.

The documents in the following list have been reviewed and are now approved for release to the public, i.e. DoD Distribution Statement A:

AD 161955: A Study of the Effects of Total and Partial Body Radiation on Iron Metabolism and Hematopoiesis

AD 202550: Study of the Post-Irradiation Syndrome in Humans

AD 332449: Preparation of O-Alkyl Alkylphosphonoazidothioates of the Type MEP (S) or N3

AD B969511: Preparation of 4-Benzylpyridine

AD 114826: Preparation of V Agents in Aqueous Medium

AD 521703: RW Decontamination and Land Reclamation Studies

AD 596085: Static Test of Full-Diameter Sectional Munitions, E83, DPG RW 1-53

AD 521702: Dynamic Test of Spherical Radiological Munitions

AD 521701: Static Test of Four Segments of Full-Diameter Sectional Munitions, E83

This information is provided to you so that you can update your records. If you have any questions, please call me at (703) 325-2407.

Sincerely,

D. M. Schaeffer
Program Manager
Radiation Experiments Command Center