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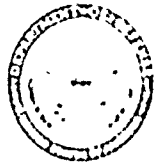
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CWL TECHNICAL MEMORANDUM 33-13

A SERIES OF STATIC AND DYNAMIC TESTS OF SINGLE BIS AND VX-FILLED 155-MM. SHELL,
EQUIPPED WITH AGENT TO BURSTER RATIOS OF 2/1 AND 18/1, AND DETONATED
ON THE GROUND AND AT HEIGHTS OF 25 and 50 FT. (U)

**FC
BAC**

by

Dwight M. Shaw
13 June 1958

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Directorate of Development
U.S. Army Chemical Warfare Laboratories
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CWL Technical Memorandum 33-13
A Series of Static and Dynamic Tests
of a Single Bis and VX-Filled 155-mm.
Shell, Equipped with Agent/Burster
Ratios of 2/1 and 18/1, and Detonated
on the Ground and at Heights of 25
and 50 ft. (U)

Dwight M. Shaw
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Author

Submitted by:

Robert M. Black
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Chief, Planning & Evaluation Br.

Project No.: 4-04-15-032-04

Approval Recommended:

Notebook No.: Test Division Field
Test Folders: 1781 through 1801.
DPC Field Test Folders: 354-B1
and B2, 355-E1, E2, F1 through F5,
G2 and G3.

Charles E. Miller
CHARLES E. MILLER
Chief, Test Division

APPROVED:

R. D. Chapman
R. D. CHAPMAN
Colonel, CMC
Director of Development

Date Started: 20 February 1957
Date Completed: 23 May 1958

Typed: 5 December 1958

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ABSTRACT

(U) Object.

The object of project 4-04-15-032-04 is to conduct developmental studies on shells, rockets, land mines, spray tanks, bombs, and bomblets for the dissemination of V agent.

The object of this series of tests is to determine the density and drop-size distributions of ground contamination and liquid impaction of a V agent filled 155-mm. shell.

(C) Results.

1. The total area coverage with respect to ground deposition at a density level of 0.05 g./sq.m. for this munition statically functioned at ground level and equipped with agent/burster ratios of 2/1 and 18/1 was 1,500 and 1,000 sq.m., respectively. The area coverage with respect to vertical impaction for the 2/1 and 18/1 ratios was 1,400 and 800 sq.m., respectively. The total quantity of agent deposited on the grid as ground deposition was approximately 100% of the agent filling weight for each ratio.

2. The total area coverage with respect to ground deposition at a density level of 0.05 g./sq.m. for this munition dynamically functioned at a height of 25 ft. and equipped with an agent/burster ratio of 2/1 ranged from 3,700 to 5,500 sq.m. The total quantity of ground deposition ranged from approximately 80 to 100% of the agent filling weight.

3. The total area coverage with respect to ground deposition at a density level of 0.05 g./sq.m. for this munition statically or dynamically functioned at a height of 50 ft. and equipped with agent/burster ratios of 2/1 and 18/1 ranged from 3,800 to 7,700 sq.m. and 2,200 to 6,500 sq.m., respectively. The area coverage with respect to vertical impaction for the 2/1 and 18/1 ratios ranged from 12,800 to 13,000 sq.m. and 3,600 to 8,900 sq.m., respectively. The total quantity of ground deposition ranged from 70 to 100% of the agent filling weight for each ratio.

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A SERIES OF STATIC AND DYNAMIC TESTS OF SINGLE BIS AND VX-FILLED 155-MM. SHELL, EQUIPPED WITH AGENT TO BURSTER RATIOS OF 2/1 AND 18/1, AND DETONATED ON THE GROUND AND AT HEIGHTS OF 25 AND 50 FT. (U)

I. INTRODUCTION.

A. (U) Object.

The object of project 4-04-15-032-04 is to conduct developmental studies on shells, rockets, land mines, spray tanks, bombs, and bomblets for the dissemination of V agent.

The object of this series of tests is to determine the density and drop-size distributions of ground contamination and liquid impaction of a V agent filled 155-mm. shell.

B. (U) Authority.

This investigation was authorized under project 4-04-15-032-04, V-agent Munitions, established 12 December 1957 (CCTC Item 3388).

II. (U) HISTORICAL.

Among the test programs established to conduct developmental studies on the dissemination of V-agent from shell, rockets, land mines, spray tanks, bombs, and bomblets is the 155-mm. shell which is outlined in this report. These tests were conducted at Army Chemical Center and Dugway Proving Ground for the purpose of determining the efficiency of agent dissemination from a VX and VX simulant-filled 155-mm. shell when equipped with agent/burster ratios of 2/1 and 18/1 and statically and dynamically functioned at various heights. This test program is continuing since the presently conducted tests have not been completely evaluated at this time. These additional results will be published at a later date as an addendum to this report.

III. EXPERIMENTAL.

A. (U) Munition.

For each test, conducted at the Army Chemical Center M field test installation and at Dugway Proving Grounds, a single 155-mm. shell was filled with VX or VX simulant [bis-compound bis(2-ethyl hexyl) hydrogen phosphite]; containing tetrytol as a burster; agent/burster ratios of 2/1 and 18/1; and statically or dynamically functioned on the ground and at heights of 25 and 50 ft. The exact agent filling weight, burster weight, and agent to burster ratios for each munition are given in table 1.

B. (U) Procedure.

All of the ground and 50 ft. air burst tests, conducted at Army Chemical Center, were statically functioned on a 500-yd. square horizontal grid with the exception of field test 1792-A which was conducted on a 1000-yd. circular grid. The sampling equipment was emplaced on the grid as described in the test directive and amendments for field tests 1781 through 1801, given in appendix A, and also as described in Standard Plan of Test No. 11 for field test 1792A.

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All of the air burst tests, conducted at Dugway Proving Ground, were functioned dynamically from a field piece located approximately 100 yd. upwind from the grid into a plate glass target suspended at heights of 25 and 50 ft. The tests were conducted as specified in DPG Test Plan No. 354, Phase B, and No. 355, Phases E, F and G.

C. (U) Results.

1. General.

A summary of the operational data of each test is given in table 1. The results of each test that had agent flashing are not included since a memorandum will be issued summarizing all data with respect to agent stability on detonation.

Table 1

Summary of Trials

Field test	Place of test	Date & time	Weight of agent g.	Weight of pure agent g.	Weight of burster	Agent/burster ratio	Burst height ft.	Detonation	Agent
1781	ACC	8 Mar 1957, 1225hr.	2,835	2,835	1,234	2/1	gr.	Static	Bis
355	E1 DPG	19 Dec 1957, 0600hr.	2,549	2,192	1,191	2/1	25	Dynamic	Bis
	E1 DPG	19 Dec 1957, 0600hr.	2,549	2,192	1,191	2/1	25	Dynamic	VX
	E2 DPG	14 Jan 1958, 1904hr.	2,549	2,192	1,191	2/1	25	Dynamic	VX
	F1 DPG	21 Jan 1958, 2142hr.	2,549	2,192	1,191	2/1	50	Dynamic	VX
	F2 DPG	3 Feb 1958, 1949hr.	2,549	2,192	1,191	2/1	50	Dynamic	VX
	F3 DPG	19 Mar 1958, 1850hr.	2,549	2,192	1,191	2/1	50	Dynamic	VX
	F4 DPG	27 Mar 1958, 0751hr.	2,549	2,192	1,191	2/1	50	Dynamic	VX
	F5 DPG	15 Apr 1958, 0755hr.	2,549	2,192	1,191	2/1	50	Dynamic	VX
354	B1 DPG	9 Apr 1957, 0615hr.	2,455	2,455	1,191	2/1	50	Dynamic	Bis
	B2 DPG	11 Apr 1957, 0641hr.	2,455	2,455	1,191	2/1	50	Dynamic	Bis
1784	ACC	18 Mar 1957, 1255hr.	2,835	2,835	1,234	2/1	50	Static	Bis
1785	ACC	25 Mar 1957, 1234hr.	2,722	2,722	1,234	2/1	50	Static	Bis
1783	ACC	18 Mar 1957, 1025hr.	3,289	3,289	188	18/1	gr.	Static	Bis
1790	ACC	21 Mar 1957, 1130hr.	3,402	3,402	188	18/1	50	Static	Bis
1791	ACC	27 Mar 1957, 1415hr.	3,289	3,289	188	18/1	50	Static	Bis
1792A	ACC	3 Nov 1957, 1135 hr.	3,400	2,754	140	18/1	50	Static	Bis
355	G2 DPG	18 Mar 1958, 1919hr.	3,473	2,987	186	18/1	50	Dynamic	VX
	G3 DPG	16 Apr 1958, 0929hr.	3,473	2,987	186	18/1	50	Dynamic	VX

2. Meteorological Data.

A summary of the meteorological data that was obtained from burst to cloud passage for each test is given in table 2.

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Table 2

Metecorological Data

Field test	Average wind speed m.p.h.	Average wind direction deg.	Temperature gradient		Temperature	
			2 m.-0.3 m. °F.	4 m.-0.5 m. °F.	Surface °F.	Air °F.
1781	3	192	-2.8	-2.2	54	37
355 E1	6	144	+0.5	+2.5	22	25
E1	6	144	+0.5	+2.5	22	25
E2	8	125	+0.5	+1.0	28	30
F1	7	141	+0.7	+1.7	30	21
F2	14	142	+0.5	+0.8	38	40
F3	7	135	+1.2	+2.7	46	49
F4	9	115	-0.1	-0.7	39	37
F5	5	112	-0.3	-1.3	49	51
354 B1	6	130	+0.9	+1.3	36	37
B2	4	160	-0.6	-1.3	45	43
1784	8	86	-1.2	-1.2	46	44
1785	10	66	-1.4	-1.4	44	42
1783	2	240	-1.0	-0.8	50	52
1790	9	320	-1.6	-2.1	50	45
1791	7	16	-1.5	-1.7	42	45
1792A	13	288	-1.2	-1.8	54	49
355 G2	6	132	+0.6	+1.1	41	42
G3	3	85	0.0	-1.6	59	63

IV. DERIVED RESULTS.

A. (U) Ground Deposition.

1. Area Coverage.

The total areas covered by various contamination densities for ground deposition (measured by sampling pans at ACC and by petri dishes at DPG) are given in table 3.

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Table 3

Total Area Coverage by Ground Deposition

Field test	Agent/ burst ratio	Height of burst	Agent	Contamination density (g./sq. m.)						
				0.01	0.05	0.1	0.5	1	5	10
1781	2/1	ft. gr.	Bis	3,700	1,500	1,150	640	480	170	60
355 E1	2/1	25	Bis	23,000		1,900	600	280	0	
E1	2/1	25	VX	10,000	3,700	2,200	650	380	110	0
E2	2/1	25	VX	11,000	4,700	3,200	1,200	640	10	0
F1	2/1	50	VX	17,300	5,600	3,680	990	270	0	0
F2	2/1	50	VX	20,900	6,500	3,900	910	230	0	0
F3	2/1	50	VX	14,560	5,700	3,700	870	290	0	0
F4	2/1	50	VX	11,670	5,000	3,400	900	400	0	0
F5	2/1	50	VX	10,800	5,700	3,800	1,040	560	0	0
354 B1	2/1	50	Bis	11,000	4,400	2,700	650	330	0	0
B2	2/1	50	Bis	10,300	3,800	1,900	700	400	0	0
1784	2/1	50	Bis	18,500	7,700	5,100	920	215	0	0
1785	2/1	50	Bis	12,600	4,600	3,100	1,180	370	0	0
1783	18/1	gr.	Bis	1,700	990	760	370	270	140	90
1790	18/1	50	Bis	5,750	3,600	2,900	1,450	820	65	0
1791	18/1	50	Bis	4,900	2,250	1,550	820	520	150	20
1792A	18/1	50	Bis	12,640	3,810	2,140	930	500	100	0
355 G2	18/1	50	VX	17,500	6,500	4,200	1,450	700	0	0
G3	18/1	50	VX	8,200	4,300	3,100	1,100	500	80	0

2. Maximum Density.

The maximum recorded contamination density for ground deposition and its location for each field test is given in table 4.

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Table 4

Maximum Recorded Contamination Density

Field test	Density g./sq. m.	Distance from burst yd.
1781	24.5	5
355 E1	1.1	60
E1	5.6	18
E2	8.4	31
F1	1.7	45
F2	1.2	30
F3	2.0	55
F4	2.1	39
F5	4.7	37
354 B1	3.1	24
B2	3.3	24
1784	1.5	50
1785	2.4	80
1783	42.9	5
1790	6.8	50
1791	13.7	30
1792A	6.1	40
355 G2	2.6	79
G3	5.0	37

3. Weight Recovery.

The ground deposition data was converted to a weight of agent deposited on the ground. These values are given in table 5 for the indicated distance downwind of the cloud. Although in one case the agent return is stated as being greater than 100%, it is within the experimental error for the conditions of field testing and the significance of the figure implies that 100% of the agent disseminated was accounted for by ground deposition.

Table 5

Quantity of Agent Deposited on the Grid as Ground Deposition
From Burst to Indicated Distance Downwind

Field test	Agent/burster ratio	Burst height	Agent	Munition's filling weight	Burst to indicated distance downwind(yd.)					
					50	100	200	300	400	600
1781	2/1	ft.	Bis	2,835	94	96*				
355 E1	2/1	25	Bis	2,192	29	47	66	73	76	79*
E1	2/1	25	VX	2,192	46	71	81	83	84	89*
E2	2/1	25	VX	2,192	85	104	109*			
F1	2/1	50	VX	2,192	12	35	68	77	81	86*
F2	2/1	50	VX	2,192	23	42	68	81	88	93*
F3	2/1	50	VX	2,192	32	56	76	81	83	86*
F4	2/1	50	VX	2,192	29	58	80	84	85	86*
F5	2/1	50	VX	2,192	50	76	91	93	94*	
354 B1	2/1	50	Bis	2,455	42	61	73	77	78*	
B2	2/1	50	Bis	2,455	56	63	69	71*		
1784	2/1	50	Bis	2,835	9	32	63	75	78*	
1785	2/1	50	Bis	2,722	4	32	72	82*		
1783	18/1	gr.	Bis	3,289	97	98*				
1790	18/1	50	Bis	3,402	19	68	84	86*		
1791	18/1	50	Bis	3,289	44	63	71*			
1792A	18/1	50	Bis	3,400	52	75	88	92	95	97*
355 G2	18/1	50	VX	2,987	20	39	75	81	84	87*
G3	18/1	50	VX	2,987	50	67	81	85	87*	

*Total agent return for a density of 1.0 mg. and greater.

B. (U) Vertical Impaction.

1. Area Coverage.

The total areas covered by various contamination densities for vertical impaction (measured by sampling plates at ACC and by filter paper attached to cylindrical samplers at DPG) are given in tables 6 and 7.

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Table 6

Total Area Coverage by Vertical Impaction at a Height of 15 in.

Field test*	Agent/burster ratio	Height of burst [†] ft.	Agent	Contamination density (g./sq.m.)						
				0.01	0.05	0.1	0.5	1	5	10
1781	2/1	50	Bis	2,700	1,400	910	310	75	0	0
355 F1	2/1	50	VX	13,000	5,700	4,100	150	0	0	0
F2	2/1	50	VX	21,000	13,000	7,400	920	200	0	0
F4	2/1	50	VX	10,900	8,400	5,600	450	0	0	0
F5	2/1	50	VX	15,300	7,400	4,700	0	0	0	0
1784	2/1	50	Bis	21,000	13,000	9,200	3,400	1,400	0	0
1785	2/1	50	Bis	23,540	12,780	9,670	4,990	2,970	0	0
1783	18/1	gr.	Bis	1,470	800	610	270	165	15	5
1790	18/1	50	Bis	6,160	4,100	3,320	1,900	1,300	320	30
1791	18/1	50	Bis	4,850	3,600	2,780	900	650	170	50
1792A	18/1	50	Bis	11,950	8,850	6,400	2,200	1,900	620	0
355 G2	18/1	50	VX	20,000	8,400	5,800	2,100	1,200	0	0
G3	18/1	50	VX	10,000	3,600	2,800	440	0	0	0

*Field tests that did not have available data are not listed.

Table 7

Area Coverage by Vertical Impaction
at a Height of 60 in.

Field test*	Agent/burster ratio	Height of burst ft.	Agent	Contamination density (g./sq.m.)					
				0.01	0.05	0.1	0.5	1	5
355 F1	2/1	50	VX	21,000	13,500	8,700	1,450	300	0
F2	2/1	50	VX	33,200	17,000	8,800	1,300	450	0
F4	2/1	50	VX	19,500	8,800	5,600	700	0	0
F5	2/1	50	VX	17,500	7,300	4,700	820	0	0
G2	18/1	50	VX	22,000	10,500	7,400	2,500	1,200	30
G3	18/1	50	VX	8,800	4,700	3,000	400	0	0

*Field tests that did not have available data are not listed.

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2. Weight Recovery.

For each test conducted at DPG, the weight of agent transported beyond 500 yd. was measured by vertically positioned cylindrical filter-paper samplers (size 3-3/4 by 8 in.) at each position on the 500-yd. arc at heights of 1.5, 5, 10, 15, 20, 25 and 30 ft. This quantity of agent measured airborne is given in table 8.

Table 8

Quantity of Agent Airborne 500 yd. From Burst

Field test*	Agent/burster ratio	Burst height	Agent	Weight of pure agent filling	Agent recovery	
					Weight	Fraction of filling
		ft.		g.	g.	%
B55 E1	2/1	25	VX	2,192	8	0.4
E2	2/1	25	VX	2,192	22	1.0
F1	2/1	50	VX	2,192	28	1.3
F2	2/1	50	VX	2,192	35	1.6
F3	2/1	50	VX	2,192	8	0.4
F4	2/1	50	VX	2,192	10	0.4
F5	2/1	50	VX	2,192	2	0.1
G2	18/1	50	VX	2,987	16	0.5
G3	18/1	50	VX	2,987	3	0.1

*Field tests that did not have available data are not listed.

C. (U) Particle Size Data.

The particle size data are presently being evaluated for each test conducted at ACC and DPG under this program. The results will be summarized and published in a later report as an addendum to this memorandum.

D. (U) Agent Stability.

Inspection of the motion pictures taken of each test in this Bis and VX-filled 155-mm. shell program, conducted at ACC and DPG, indicate that agent flashing occurred in two out of nine 50 ft. trials with the munition (both statically fired) equipped with a 2/1 agent/burster ratio and two out of seven 50 ft. trials (one static and one dynamic) with the munition equipped with an 18/1 agent/burster ratio. Agent flashing did not occur in the static fired munitions functioned at ground level nor in the dynamic fired munitions functioned at a height of 25 ft. The results of each test that had agent flashing are not included in this report since a memorandum will be issued summarizing all data with respect to agent stability.

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V. (C) DISCUSSION.

Sample area coverage curves are given in appendix B (figures 1 through 8) illustrating the change in area coverage when the munition is fired statically and dynamically, filled with VX and VX simulant, equipped with agent/burster ratios of 2/1 and 18/1, and functioned at various heights. These curves have not been adjusted for standard meteorological conditions; however, the wind speed of each test is given on each figure.

A comparison between the area coverage of ground deposition produced by this munition functioned at a height of 50 ft. when equipped with a 2/1 agent/burster ratio (figure 1), indicates that there is little difference in the results obtained when detonated statically and dynamically; however, there does appear to be an advantage in functioning the munition, equipped with a 18/1 agent/burster ratio, dynamically for density levels below 1 g./sq.m. (figure 2).

Figure 3 indicates that there is little difference in the area coverage of ground deposition when the munition is filled with VX and VX simulant [bis-compound bis(2-ethyl hexyl) hydrogen phosphite].

Inspection of figures 4 and 5 indicates that the optimum height for achieving maximum area coverage for small contamination densities is at some height above 50 ft. for both the 2/1 and 18/1 agent/burster ratios. For high density levels (5 to 10 g./sq.m.) the optimum height appears to be at ground level.

In regard to the 2/1 and 18/1 agent/burster ratios, figures 6 and 7 indicate that there is a slight advantage in equipping the munition with a 2/1 ratio when statically functioned at ground level and at a height of 50 ft. In functioning the munition dynamically, figure 8 indicates that there is essentially no difference in the area coverage of ground deposition.

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APPENDIX A

TEST DIRECTIVE AND AMENDMENTS, FIELD TESTS 1781 THROUGH 1801

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TEST DIVISION
DIRECTORATE OF DEVELOPMENT
CHEMICAL WARFARE LABORATORIES
Army Chemical Center, Maryland

TEST DIRECTIVE

FIELD TESTS 1781 THROUGH 1801

Static Tests of Single Bis-Filled 155-mm Shell
Equipped with Agent to Burster Ratios of 2/1,
10/1, and 30/1 and Detonated on the
Ground and at Heights of 50 and 100 ft.

CMLRD-CW-D(T)

20 February 1957

I. OBJECT.

The object of these tests is:

- A. To establish the effect of the agent to burster ratio on the dissemination of V-agent simulant when the projectile is air and ground burst.
- B. To determine if V-agent projectiles of optimum agent to burster ratio as determined by these tests can be assessed at Carroll Island.

II. AUTHORITY.

Project 4-04-15-028, Gas Artillery Shell, Job Control No. 7-165. These tests were requested in Munitions Division's Work Order dated

III. METEOROLOGICAL REQUIREMENTS.

No precipitation; wind speed at 2 m. height, between 4 and 12 m.p.h.

IV. AGENT.

Bis-compound bis(2-ethyl hexyl) hydrogen phosphite .

V. MUNITION.

A. Munitions Detonated at Ground Level.

Each munition will be a single 155-mm. shell arranged for static firing. The details of each munition's description are given in the following table:

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Field test	Approx. weight of agent	Approx. weight of burster	Type burster	Agent to burster ratio
1781	g. 2800	g. 1400	tetrytol	2/1
1782	3100	310	tetrytol	10/1
1783	4100	140	tetrytol	30/1

B. Munitions Detonated at a 50-ft. Height.

Each munition will be a single 155-mm. shell arranged for static firing at 50 ft. above ground level. The details of each munitions description are given in the following table:

Field test	Approx. weight of agent	Approx. weight of burster	Type burster	Agent to burster ratio
1784-1786	g. 2800	g. 1400	tetrytol	2/1
1787-1789	3100	310	tetrytol	10/1
1790-1791	4100	140	tetrytol	30/1

C. Munitions Detonated at a 100-ft. Height.

Each munition will be a single 155-mm. shell and arranged for functioning at 100 ft. above ground. The details of each munition's description are given in the following table:

Field test	Approx. weight of agent	Approx. weight of burster	Type burster	Agent to burster ratio
1793-1795	g. 2800	g. 1400	tetrytol	2/1
1796-1798	3100	310	tetrytol	10/1
1799-1801	4100	140	tetrytol	30/1

VI. PLAN OF TEST.

A. Procedure.

Each of the tests functioned at ground level and at the 50-ft. height will be conducted at M field on a sampling grid which will be laid out

UNCLASSIFIED

as described in diagram A. The munitions which will be airburst at the 50-ft. height will be suspended between poles on a cable and will be fixed in such a manner that its position simulates the arrival angle of the munition when fired.

The munitions to be functioned at the 100-ft. height will be positioned in the same manner as those detonated at the 50-ft. height. These tests, however, will be conducted at the Aberdeen Proving Grounds. As much of the sampling grid described in diagram A will be used as space will permit at the Aberdeen facility.

If the tests of munitions detonated at the 50-ft. height indicate a decrease in area coverage as compared to the ground detonated munitions, the tests at a higher altitude will be cancelled.

B. Chemical Data.

1. Liquid Sampling.

Sampling pans (393) utilizing hexylene glycol as an absorbent will be positioned on a level surface of the ground at each position, as shown in diagram A. The method of analysis will be the TNB method.

2. Impaction Sampling.

Vertical plates (184) at the 18-in. height will be positioned as shown in diagram A.

3. Particle Spectrum Sampling.

Vertical (184) and horizontal (184) slides will be positioned on the grid as shown in diagram A. The vertical slides will be positioned at the 18-in. height.

4. Analysis of Agent Filling.

A 10-ml. sample of the agent in each munition will be submitted to Chemical Test Branch for agent purity examination. If this is not feasible then a sample of the filling batch will be submitted.

C. Meteorological Data.

1. Macrometeorological Observations.

Observational data (cloud height, type and coverage, air temperature, relative humidity, condition of terrain and precipitation record for previous 24 hr.) will be submitted on standard forms. Observations will be made at the test site 5 min. prior to and immediately after the test.

2. Micrometeorological Data.

The wind tower will be used to obtain wind speeds up to 100 ft. for all airburst trials. In addition the 2-m. wind speed, 2-m. wind direction, surface temperature and temperature gradient (2 m.-0.3 m. and 4 m.-0.5 m.) will be measured. All data should be measured on instruments with continuous recorders and as near the center of the grid as practicable.

D. Photographic Data.

1. Still Photographs.

Still photographs only will be taken of the munitions suspended above the ground and of the cloud of all munitions after detonation.

2. Motion Pictures.

High speed motion pictures (1,700 f./sec.) will be taken of the burst at a position as close to the burst as practicable. Standard motion pictures (64 f./sec.) in color, or black and white, as the lighting permits, will be taken on both upwind and cross-wind positions of the cloud travel at a distance of approximately 150 yd.

E. Operational Data.

The test engineer will submit a written report to include the following:

1. Field test number.
2. Date and time of test.
3. Exact weight of agent and explosive.
4. All changes in test procedure from that called for in the test directive.
5. Description of munition functioning from visual observations, including any irregularities.
6. Careful description of crater where applicable and fragments recovered, including dimensions. This phase requires special attention.
7. A complete description of all equipment malfunctioning or damage.

VII. RESPONSIBILITIES.

A. The requesting agency will supply all munitions or equipment (complete) to be tested.

SECRET

B. Chemical Test Branch, Test Division, will perform all necessary chemical analyses and submit the results with all pertinent information concerning the results to Planning & Evaluation Branch.

C. Field Operations Branch, Test Division, will supply all necessary chemical sampling and meteorological equipment, set up and maintain field, perform all necessary instrumentation, provide test engineers and other necessary personnel, conduct the test, provide auxiliary personnel, equipment and services as necessary and submit the data to Planning & Evaluation Branch.

D. Planning and Evaluation Branch, Test Division, will evaluate the data and results and submit a written report to the requesting agency.

E. Mr. James E. Norton, extension 6119, is the Munitions Division project engineer and the tests will be coordinated through him.

Concurred in:

Submitted by:

H. L. Gotoff
Harold L. Gotoff
Chief, Field Operations Br.

Scott D. Thayer
for Dwight M. Shaw

Concurred in:

Recommending approval:

Abraham Koblin
Abraham Koblin
Chief, Chemical Test Br.

Scott D. Thayer
for Frederick L. Horning
Chief, Data Section
Planning & Evaluation Br.

APPROVED:

Scott D. Thayer
SCOTT D. THAYER
Chief, Planning & Evaluation Branch

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MAG. N
TO CINE CAMERA

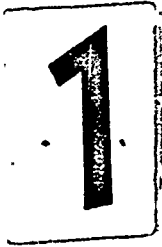


DIAGRAM A

1

2

3

4

5

Square T

6



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1

2

3

4

Square S

5

6

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1

2

3

Square R

4

5

.

1

2

3

4

Square Q

5

6

7

8

.

1

2

3

4

5

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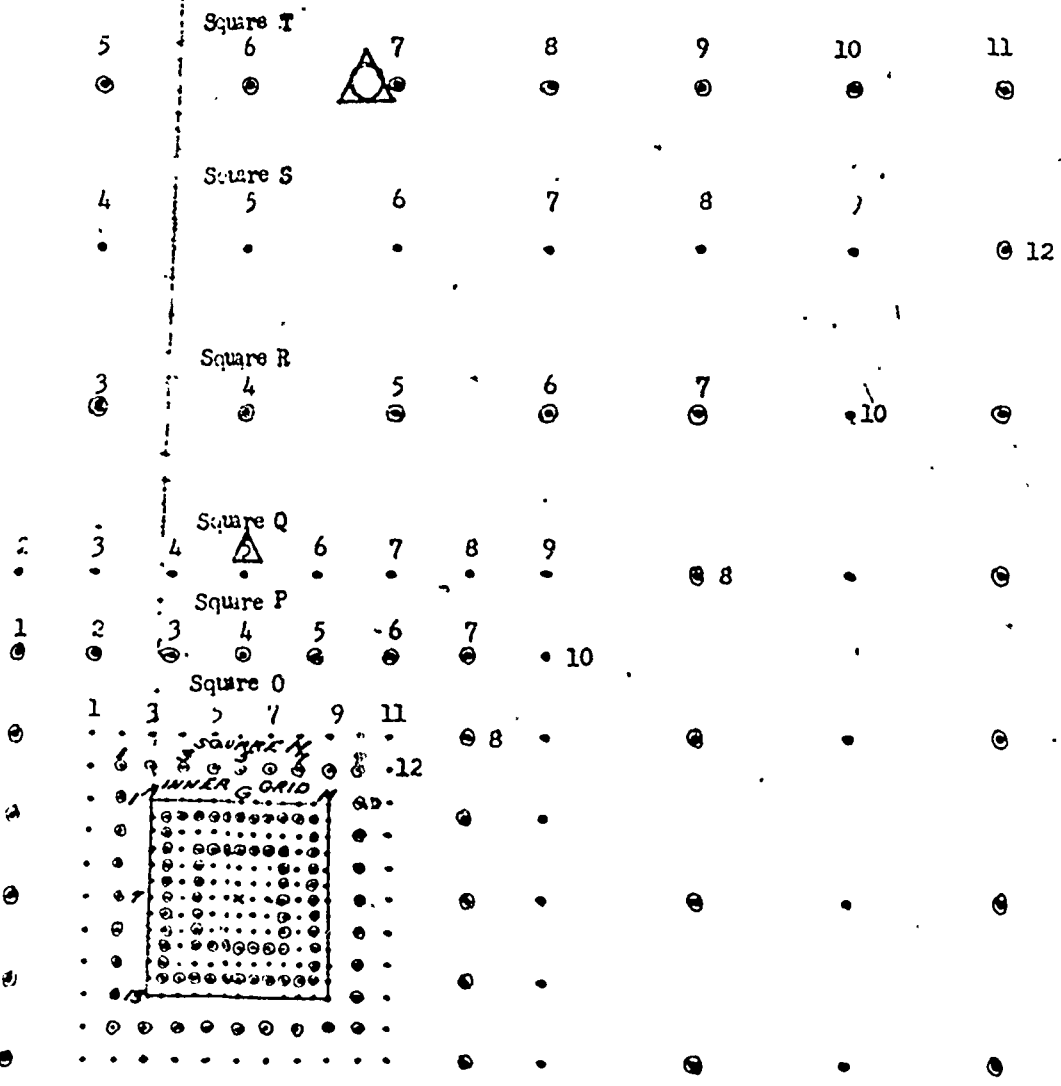
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11

SAVANA
GRID

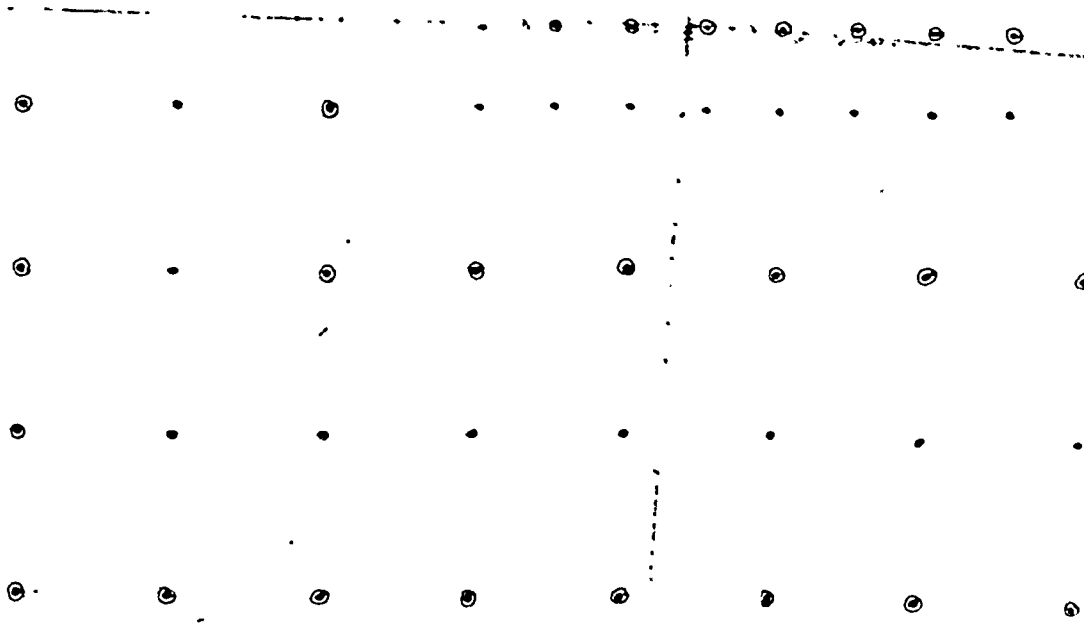


DIAGRAM A



2

3



SCALE

1 in. = 50 yd.

LEGEND

- x - Grid center (5-level Wind recorder)
- . - Sampling pans
- o - Horizontal and vertical slides
vertical plates
- △ Pi-Speed Camera
- ⊙ T.G.Mast
- ⬡ Cine-Camera (64 fr/sec)
- ▲ 100 ft. Wind Mast

(2)

SCALE

1 in. = 50 yd.

POSITION SPACING

Burst to 30 yd. - 5 yd.

30 yd. to 50 yd. - 10 yd.

50 yd. to 100 yd. - 25 yd.

100 yd. to 250 yd. - 50 yd.

4

(2)

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TEST DIVISION
DIRECTORATE OF DEVELOPMENT
CHEMICAL WARFARE LABORATORIES
Army Chemical Center, Maryland

CMLRD-CW-D(T)

5 March 1957

AMENDMENT I

Test Directives for

Field Tests 1781 through 1801
Field Tests 1802 through 1822
Field Tests 1823 through 1846 1873

The directive is amended as follows:

VI. PLAN OF TEST.

A. Procedure.

Each of the tests functioned at ground level will be conducted at M field on a sampling grid which will be laid out as described in diagram A. The tests functioned at the 50 ft. height will be conducted at H field on a sampling grid which will be laid out as shown in diagram B. (Note: The change in grid sampling from A is as follows: Only the sampling pan positions are changed, the slide and plate positions will remain the same. The inner grid will have sampling pans only at those positions which have plates and slides with the addition of 4 positions spaced 10 yd. apart at the corners of a square centered immediately below the munition, square O will have 5 yd. spacing between pans (not 10 yd.), square P will have 5 yd. spacing between pans (not 25 yd.), and square Q will have 12.5 yd. spacing between pans (not 25 yd.)).

B. Chemical Data.

After the words "diagram A" add "or diagram B, as appropriate".

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Amendment I to test directives, P. T. 1761 through 1846.
(continued)

Concurred in:

Harold L. Getoff
Harold L. Getoff
Chief, Field Operations Branch

Submitted by:

Frederick L. Horning
Frederick L. Horning

Concurred in:

Abraham Koblin
Abraham Koblin
Chief, Chemical Test Branch

Recommending approval:

Scott D. Thayer
Scott D. Thayer
Chief, Planning & Evaluation Branch

APPROVED:

Charles E. Miller
CHARLES E. MILLER
Chief, Test Division

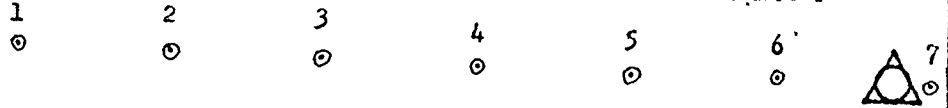
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MAG. N
TO CINE
CAMERA

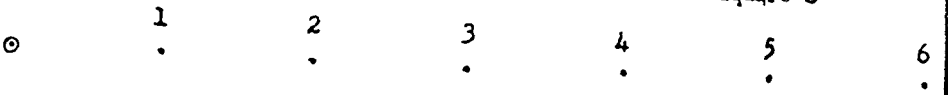
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DIAGRAM B

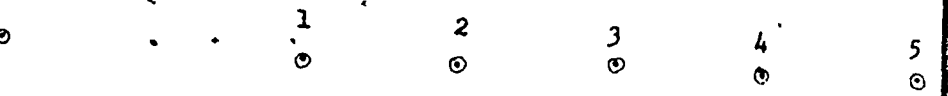
Square T



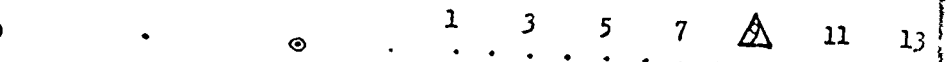
Square S



Square R



Square Q



Square P



Square O

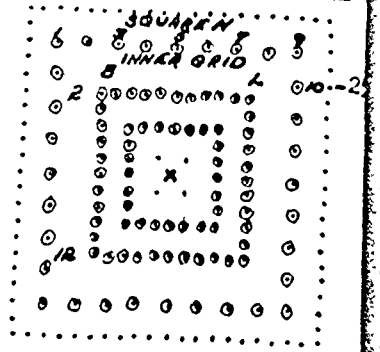
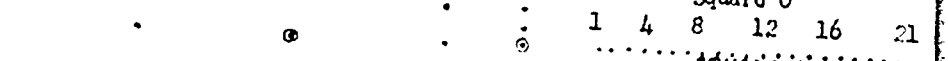
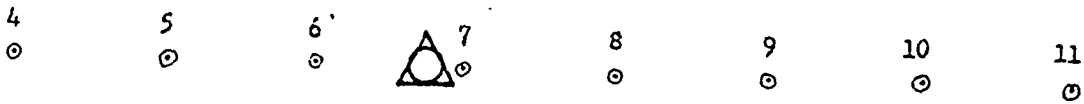


DIAGRAM B

Square T



Square S



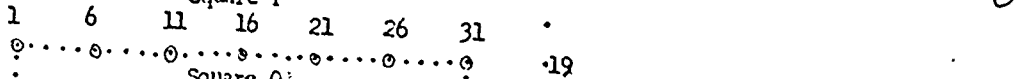
Square R



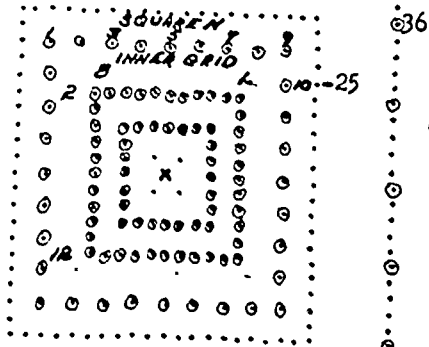
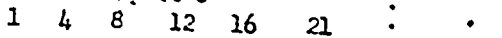
Square Q



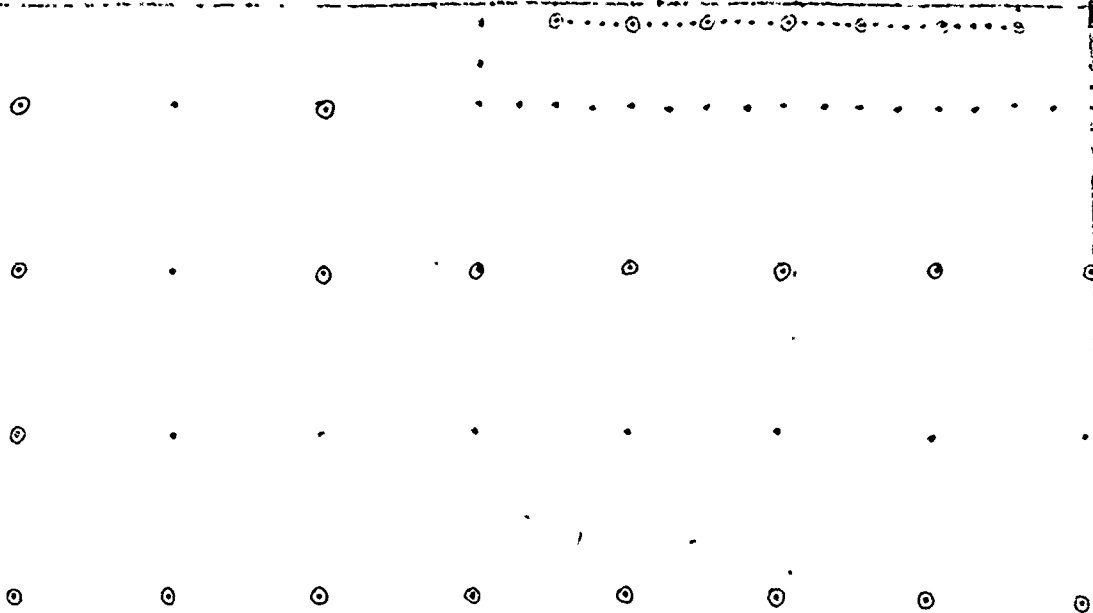
Square P



Square O



2



SCALE

1 in. = 50 yd.

LEGEND

- x - Grid center (5-level Wind Recorder)
- - Sampling pans
- o - Horizontal and vertical slides
vertical plates

Pans only at: F6, H6, F8, H8

Pans, plates and slides at:
 B2, C2, D2, B2, F2, G2, H2, I2, J2, K2, L2
 B3, L3, B4, D4, E4, F4, G4, H4, I4, J4, L4,
 B5, D5, J5, L5, E6, D6, J6, L6, H7, D7, J7,
 L7, B8, D8, J8, L8, E9, D9, J9, L9, H10,
 D10, E10, F10, G10, H10, I10, J10, L10, H11,
 L11, F12, D12, E12, F12, G12, H12, I12, J12,
 L12.

- △ Hi-Speed Camera
- △ T.G.Mast
- ◻ Cine-Camera (64 fr/sec)
- ▲ 100 ft. Wind Mast

3

Square	Perpe- dista- edge ce
X*	
Y*	
Z*	
N	
O	
P	
Q	1
R	1
S	2
T	2

* Inner Grid

①

SCALE
1 in. = 50 yd.

POSITION SPACING

Square	Perpendicular distance from edge to grid center	Pan spacing	Flate and slide spacing
	<u>yd.</u>	<u>yd.</u>	<u>yd.</u>
X*	5	10	—
Y*	15	5	5
Z*	25	5	5
N	40	10	10
O	50	5	—
P	75	5	25
Q	100	12.5	—
R	150	50	50
S	200	50	—
T	250	50	50

* Inner Grid

4

①

border)

es

J2, K2, L2
I4, J4, L4,
E7, D7, J7,
L9, B10,
O, L10, B11,
I2, I12, J12,

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TEST DIVISION
DIRECTORATE OF DEVELOPMENT
CHEMICAL WARFARE LABORATORIES
Army Chemical Center, Maryland

CMIRD-CW-D(T)

3 April 1957

AMENDMENT II

Test Directives for
Field Tests 1781 through 1801
Field Tests 1802 through 1822

AMENDMENT III

Test Directives for
Field Tests 1823 through 1843

The directives are amended as follows:

III. METEOROLOGICAL REQUIREMENTS.

No precipitation; wind speed at 2 m. height, between 4 and 12 m.p.h.; wind direction for each munition functioned at the 100-ft. height, between 165° and 207°.

VI. PLAN OF TEST.

A. Procedure.

Each of the tests functioned at ground level and at the 50-ft. height will be conducted at H field on a sampling grid which will be laid out as described in diagram A and B. The tests functioned at the 100-ft. height will be conducted at the Aberdeen Proving Grounds on a sampling grid which will be laid out as shown in diagram C, attached hereto.

B. Chemical Data.

The chemical data for each test functioned at the 100-ft. height is amended as follows:

1. Liquid Sampling.

Sampling pans (400) utilizing hexylene glycol as an absorbent will be positioned on a level surface of the ground at each position, as shown in diagram C. The method of analysis will be the THB method.

2. Impaction Sampling.

Vertical plates (19) at the 18-in. height

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will be positioned as shown in diagram C.

3. Particle Spectrum Sampling.

Vertical (192) and horizontal (192) slides will be positioned on the grid as shown in diagram C. The vertical slides will be positioned at the 18-in. height.

4. Analysis of Agent Filling.

A 10-ml. sample of the agent in each munition will be submitted to Chemical Test Branch for agent purity examination. If this is not feasible then a sample of the filling batch will be submitted.

Concurred in:

H. L. Gotoff
Harold L. Gotoff
Chief, Field Operations Branch

Submitted by:

Dwight H. Shaw
Dwight H. Shaw

Concurred in:

Alexander Koblin
Alexander Koblin
Chief, Chemical Test Branch

Recommending approval:

Scott D. Thayer
Scott D. Thayer
Chief, Planning & Evaluation Branch

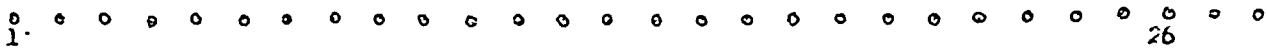
APPROVED:

Charles E. Miller
CHARLES E. MILLER
Chief, Test Division

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DIAGRAM C

1000 yd.



26

1

800 yd.



K

1

21

56

47

2

J 1 600 yd. 21

I 1 400 yd. 21

H 1 300 yd. 17

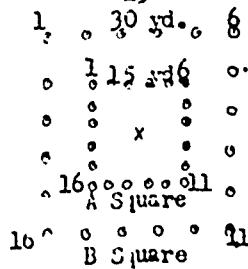
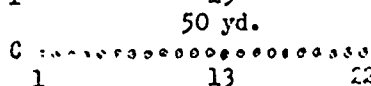
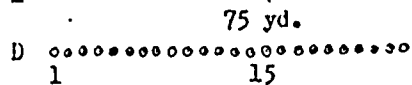
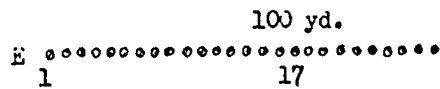
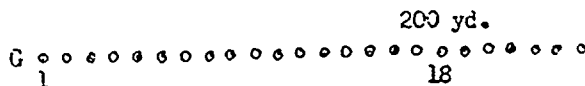
3

..... 45

..... 41

..... 33

4



LEGEND:

x - Ground Zero

⊙ - Meteorological Mast

⊙ - Sampling Station

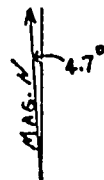
Plans on all positions

Horizontal slides

Vertical slides

Vertical plates

} Positions 1 through 6 on B Square
and at all positions on line
L, F, H, J and L



5

33

26

31

26

SCALE:

1 in. = 50 yd.

SPACING:

- A - 6 yd.
- R - 12 yd.
- C - 5 yd.
- D - 5 yd.
- E - 5 yd.
- F - 7.5 yd.
- G - 7.5 yd.
- H - 10 yd.
- I - 10 yd.
- J - 12.5 yd.
- K - 15 yd.
- L - 15 yd.

6

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APPENDIX B

SAMPLE AREA COVERAGE CURVES MEASURED BY GROUND DEPOSITION

- Fig. 1, Dynamic Firing Vs Static for the 2/1 Ratio Trials
- Fig. 2, Dynamic Firing Vs Static for the 18/1 Ratio Trials
- Fig. 3, Bis Filled Vs VI
- Fig. 4, Ground Burst Vs Airburst for the 2/1 Ratio Trials
- Fig. 5, Ground Burst Vs 50-ft. Burst for the 18/1 Ratio Trials
- Fig. 6, Ratios of 2/1 Vs 18/1 for Ground Burst Trials
- Fig. 7, Ratios of 2/1 Vs 18/1 for Static Fired Trials
- Fig. 8, Ratios of 2/1 Vs 18/1 for Dynamic Fired Trials

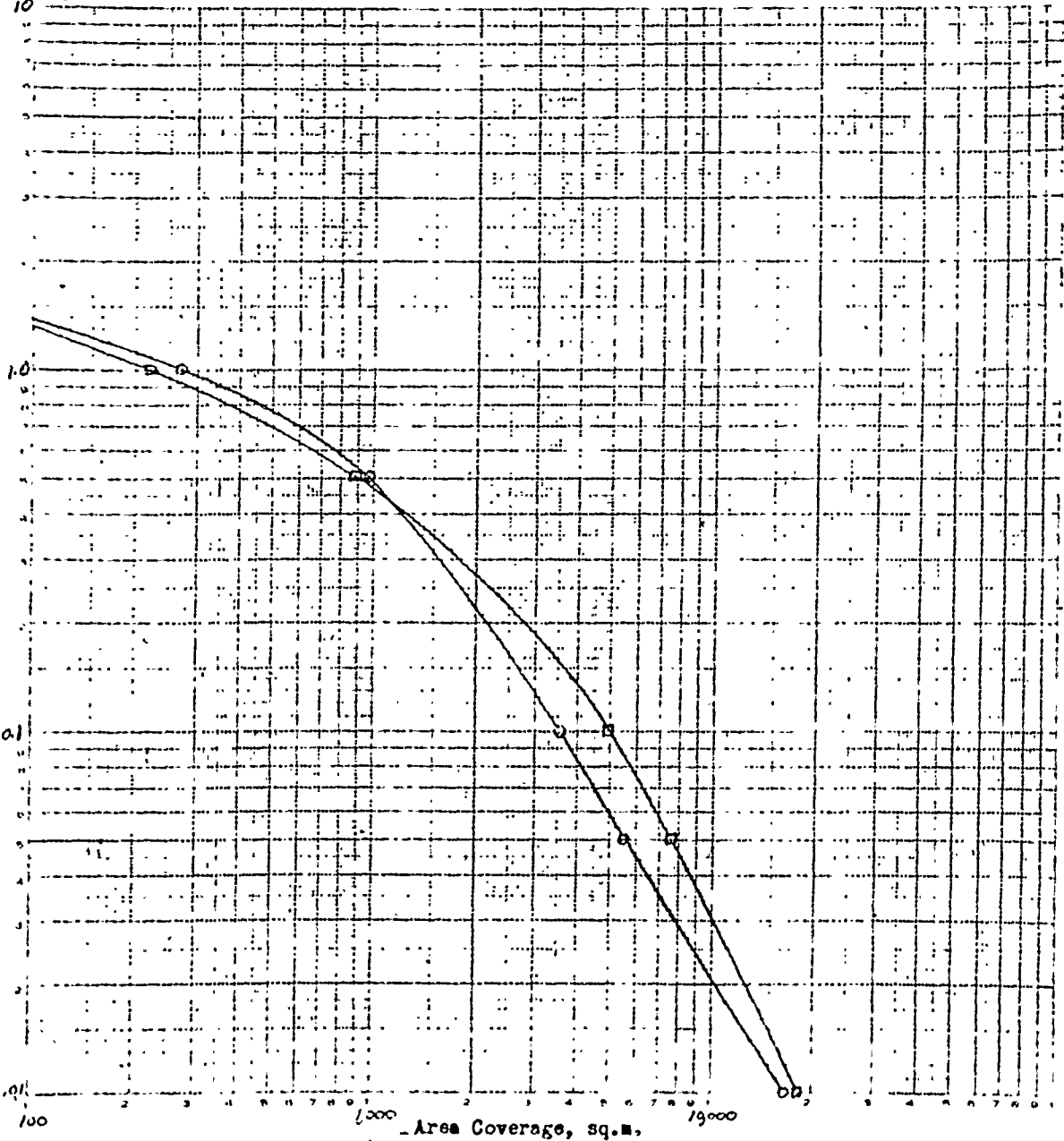
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FIGURE 1

Area Coverage by Ground Deposition
Dynamic Fired Vs Static for the 155-mm. Shell
Equipped with a 2/1 Ratio

Contamination
Density
g./sq.m.



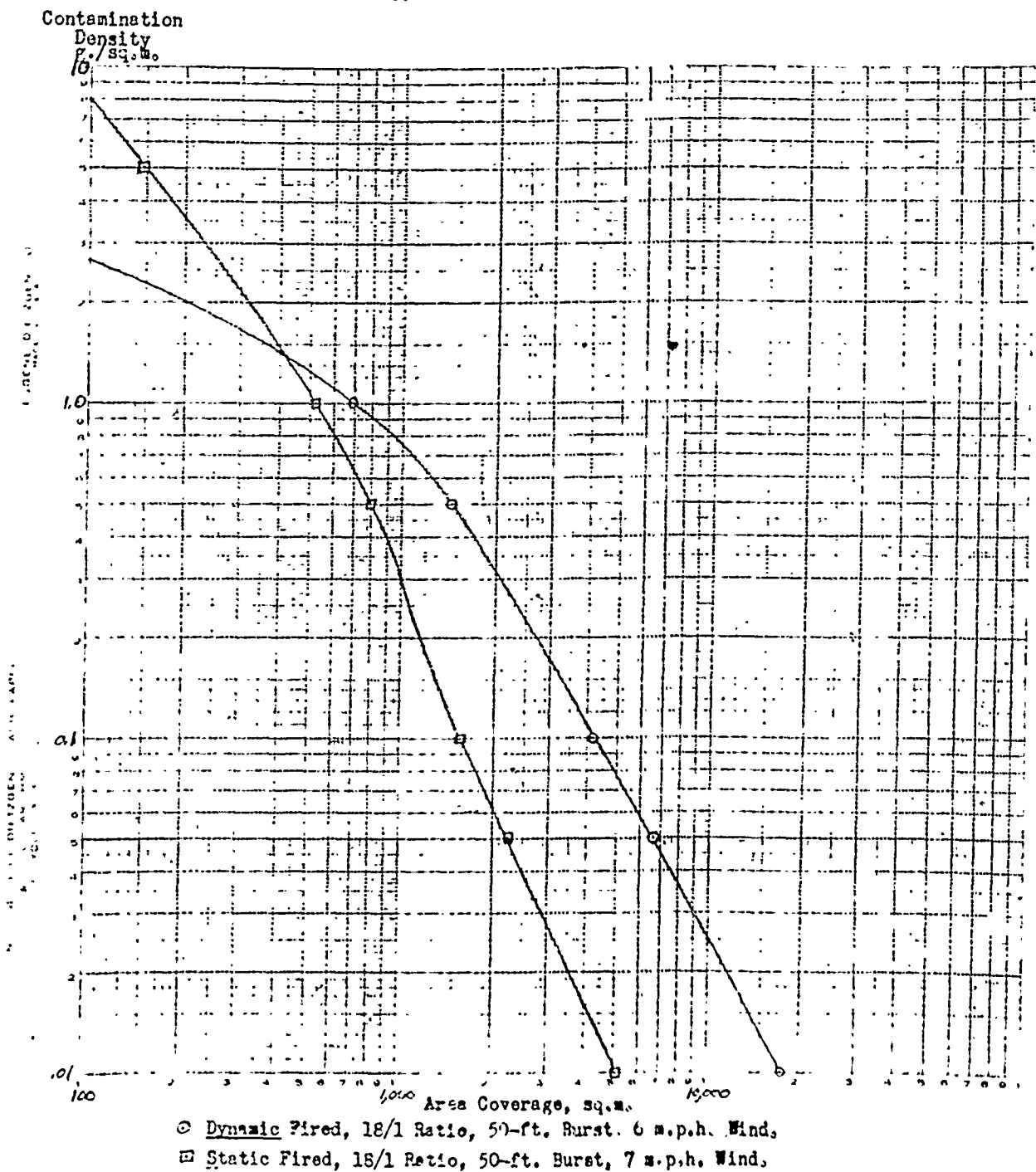
- Dynamic Fired, 2/1 Ratio, 50-ft. Burst, 7 m.p.h. Wind.
□ Static Fired, 2/1 Ratio, 50-ft. Burst, 8 m.p.h. Wind.

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FIGURE 2

Area Coverage by Ground Deposition
Dynamic Fired Vs Static for the 155-mm. Shell
Equipped with an 18/1 Ratio



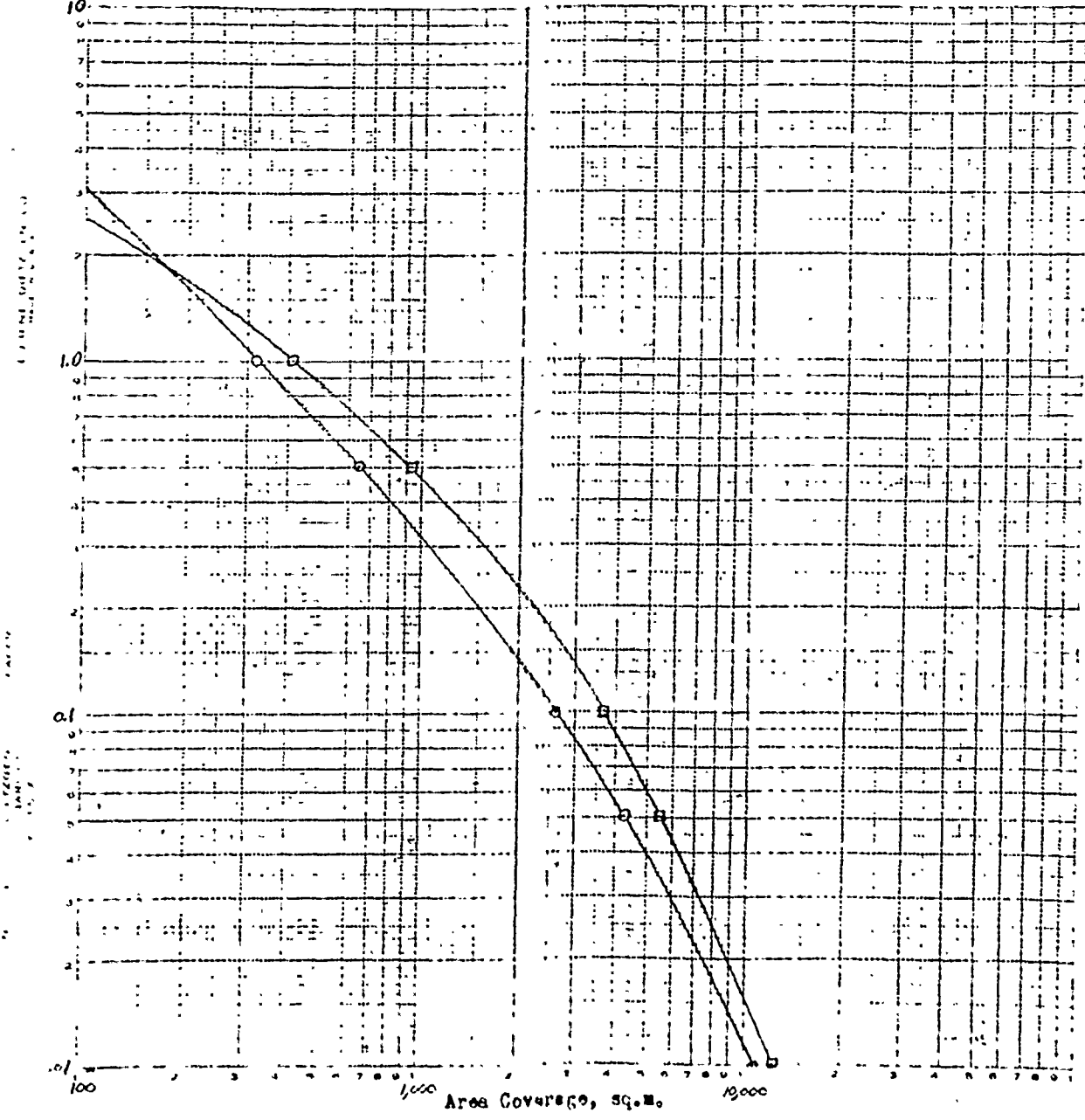
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FIGURE 3

Area Coverage by Ground Deposition
Rie-Filled Vs VX for the 155-mm. Shell

Contamination
Density
g./sq.m.



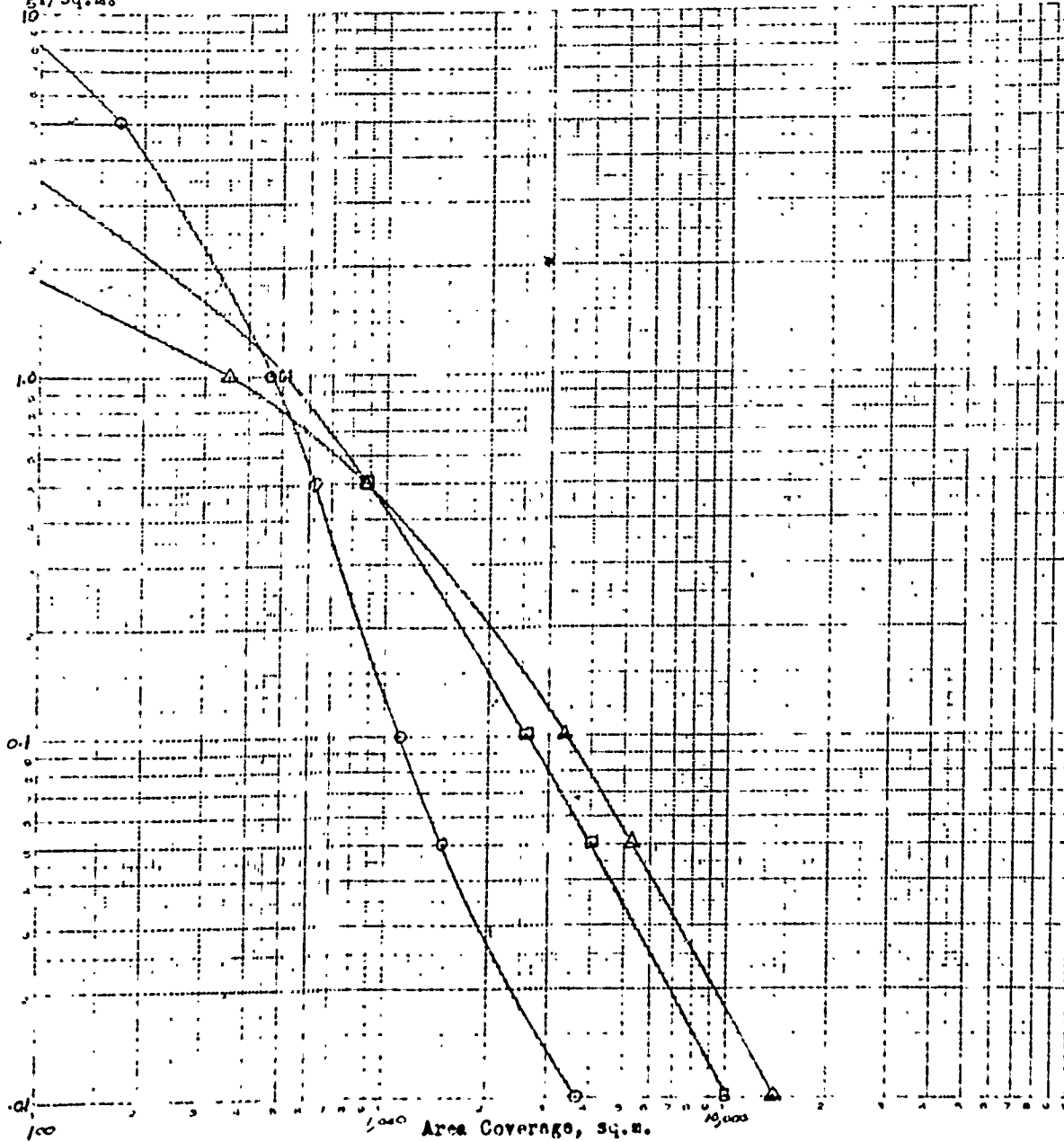
- Rie-Filled, Dynamic Fired, 50-ft. Burst, 2/1 Ratio, 6 m.p.h. Wind.
- VX-Filled, Dynamic Fired, 50-ft. Burst, 2/1 Ratio, 6 m.p.h. Wind.

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FIGURE 4

Area Coverage by Ground Deposition
Ground Burst Vs Airburst for the 155-mm. Shell
Equipped with a 2/1 Ratio

Contamination
Density
g./sq.m.



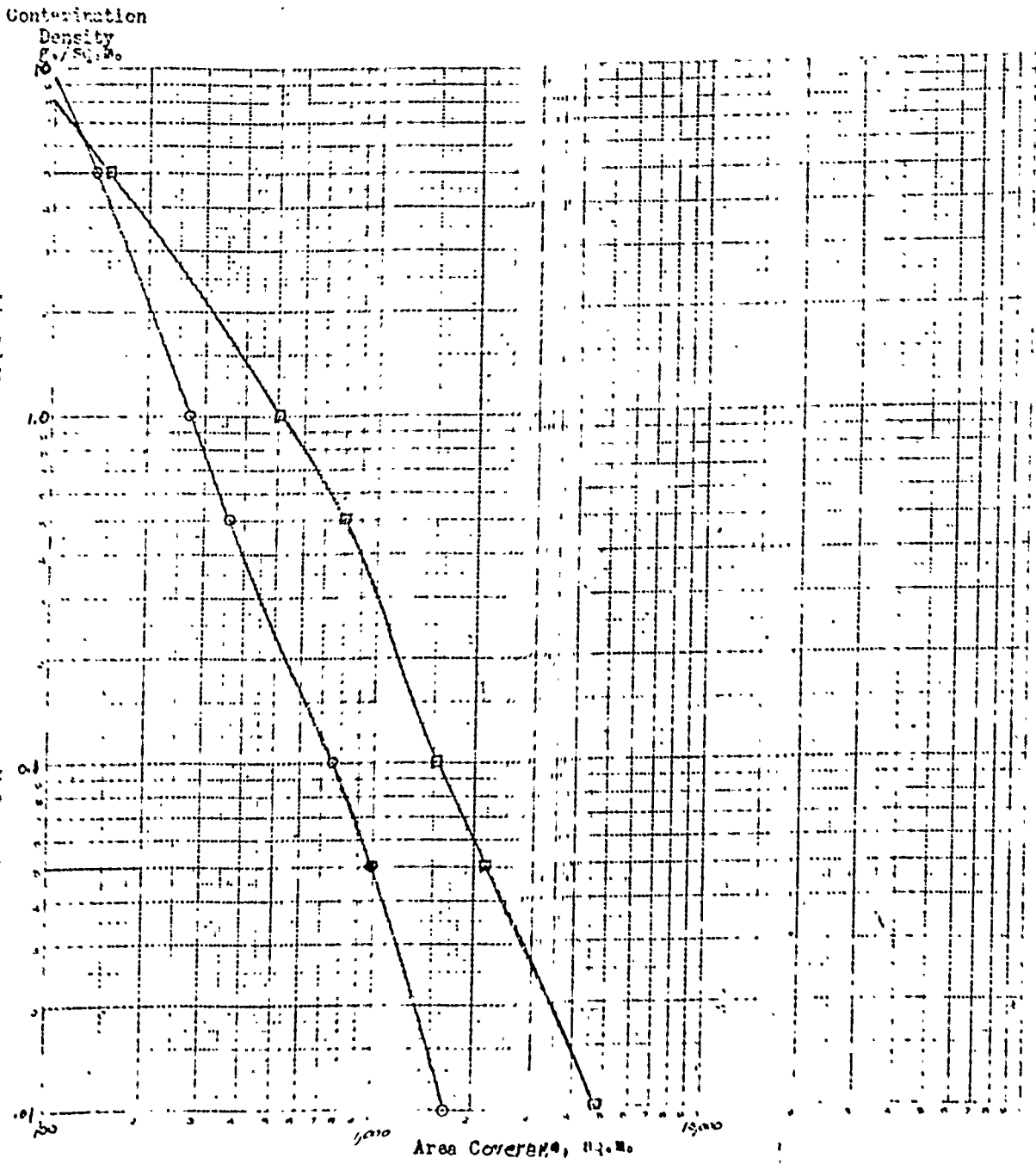
- Ground Burst, 2/1 Ratio, 3 m.p.h. Wind.
- 25 ft. Burst, 2/1 Ratio, 7 m.p.h. Wind.
- △ 50 ft. Burst, 2/1 Ratio, 8 m.p.h. Wind.

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FIGURE 5

Area Coverage by Ground Deposition
Ground Burst Vs 50 ft. Burst for the 155-mm. Shell
Equipped with an 1 $\frac{1}{2}$ Ratio



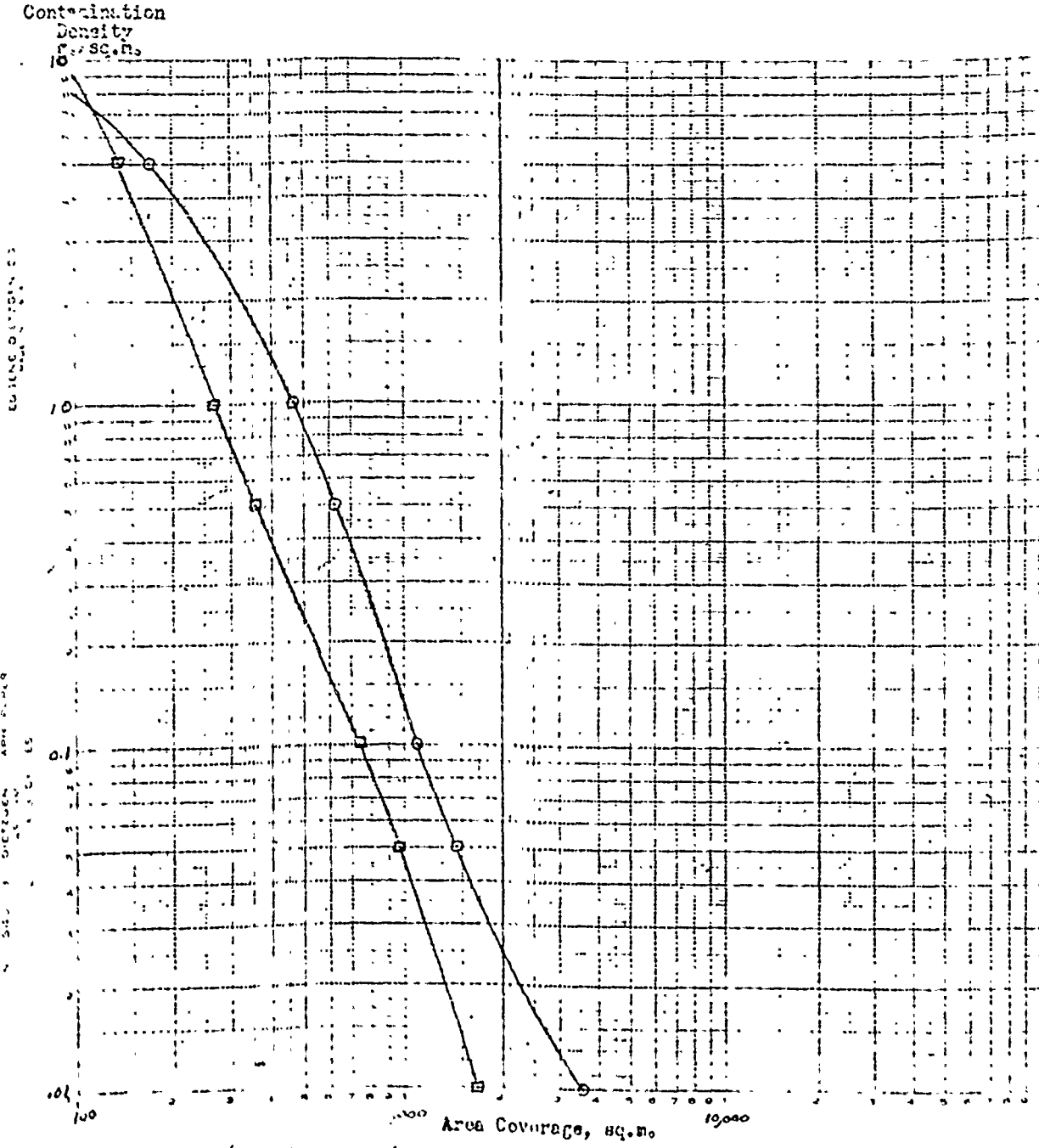
○ Ground Burst, 1 $\frac{1}{2}$ Ratio, Static Fired, 2 m.p.h. Wind;
□ 50 ft. Burst, 1 $\frac{1}{2}$ Ratio, Static Fired, 7 m.p.h. Wind;

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FIGURE 6

Area Coverage by Ground Deposition
Ratios of $2/1$ Vs $13/1$ for the Ground Burst 155-mm. Shell



○ $2/1$ Ratio, ground burst, Static Fired, 3 m.p.h. Wind.
□ $13/1$ Ratio, ground burst, Static Fired, 2 m.p.h. Wind.

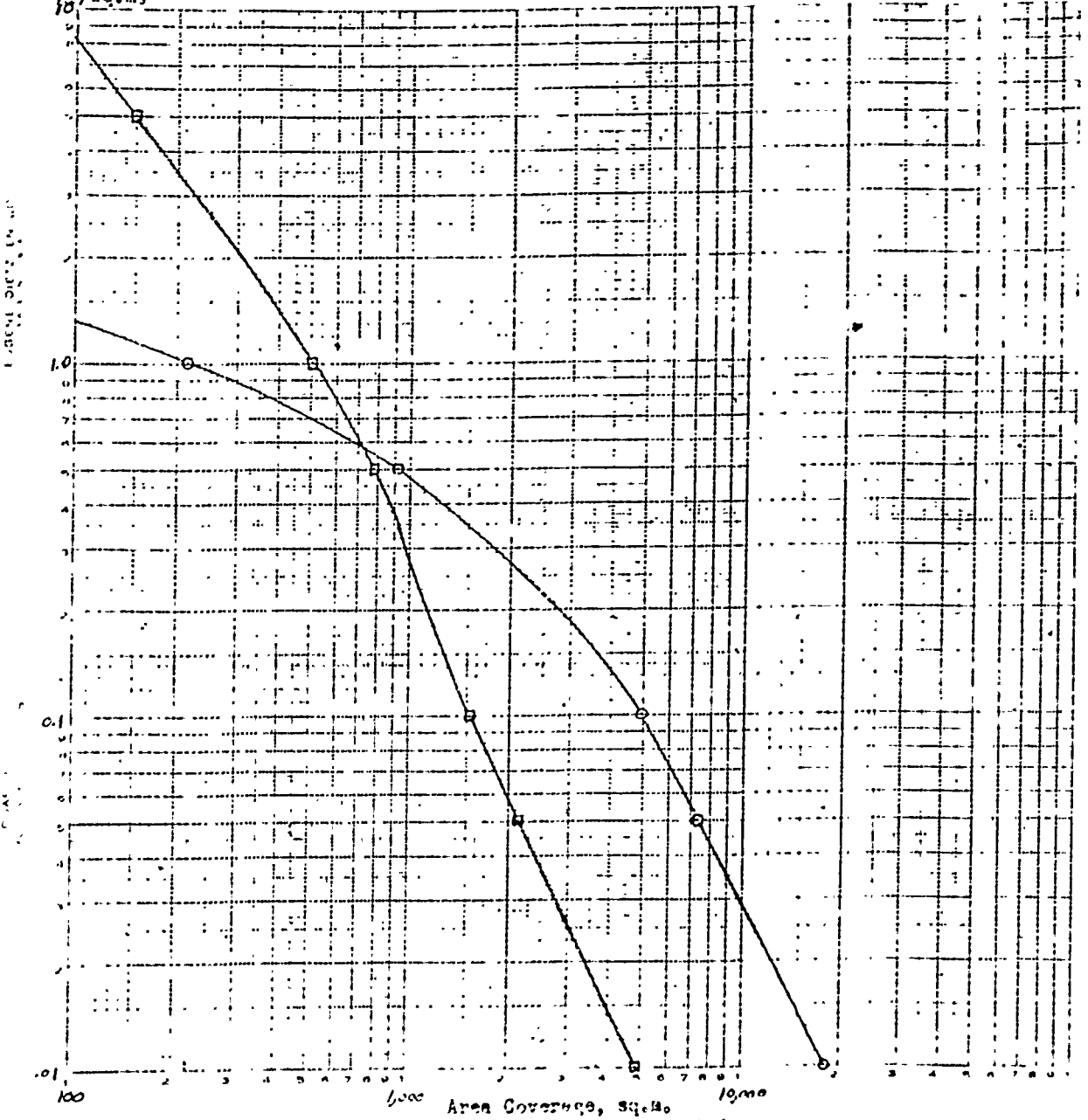
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FIGURE 7

Area Coverage by Ground Deposition
Ratios of 2/1 Vs 18/1 for the Static Fired 155-mm. Shell

Contamination
Density
 ρ_0 / Sq. M.



○ 2/1 Ratio, Static Fired, 50-ft. Burst, 8 m.p.h. Wind.
□ 18/1 Ratio, Static Fired, 50-ft. Burst, 7 m.p.h. Wind.

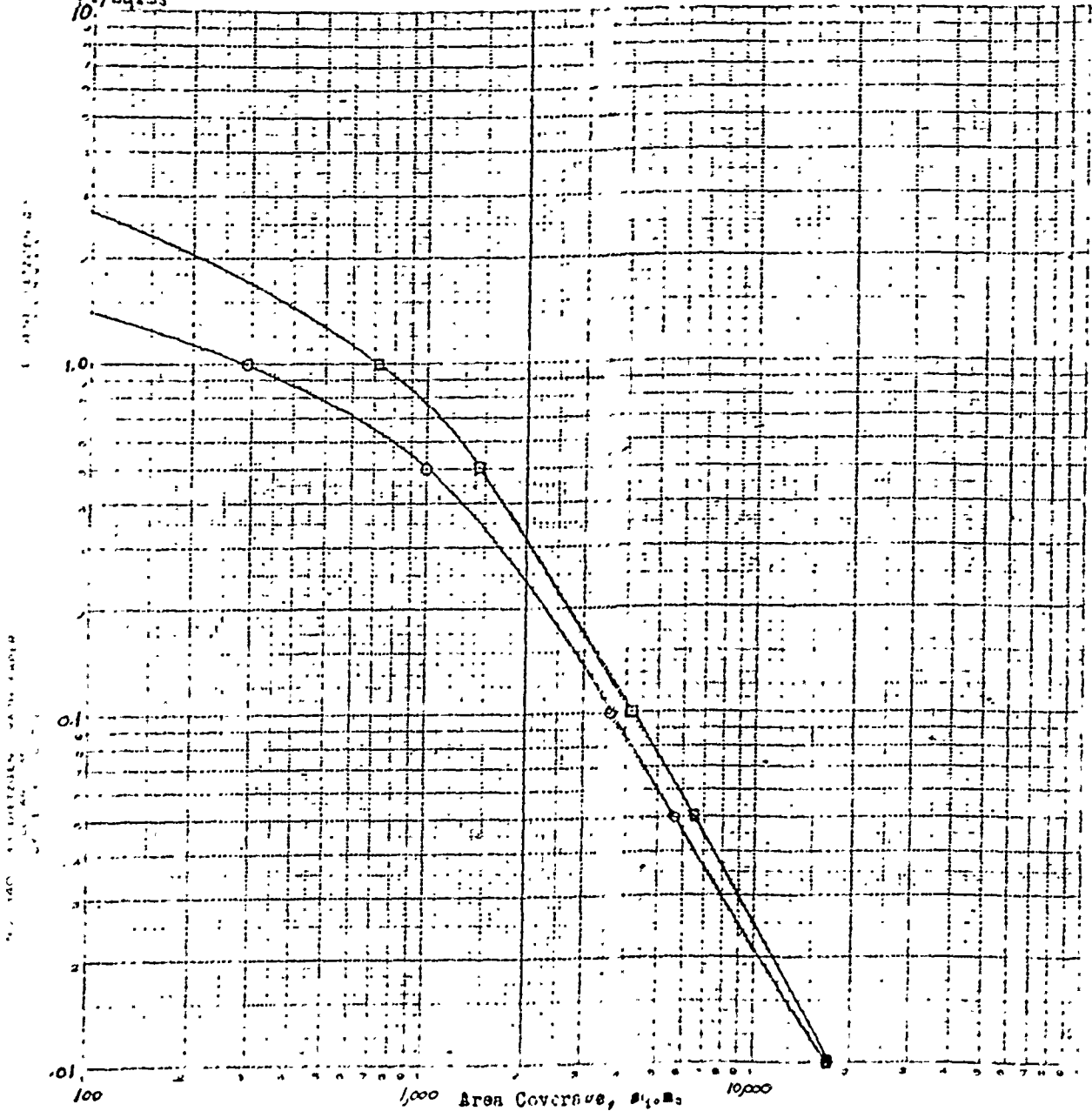
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FIGURE 2

Area Coverage by Ground Deposition
Ratios of 2/1 Vs 18/1 for the Dynamic Fired 155-mm. Shell

Contamination
Density
r./sq. ft.



○ 2/1 Ratio, Dynamic Fired, 50-ft. Burst, 7 m.p.h. Wind.
□ 18/1 Ratio, Dynamic Fired, 50-ft. Burst, 6 m.p.h. Wind.

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