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CHEMICAL WARFARE SERVICE
RESEARCH AND DEVELOPMENT PROGRAM
DUGWAY PROVING GROUND
REPORT FOR WEEK ENDING JULY 1, 1943

SERIES 2 - REPORT 10

Copy No. 2

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- No. 1 - Dugway Proving Ground File
- No. 2 - Chief, Technical Division, Edgewood Arsenal
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- No. 5 - Suffield Experimental Station
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- No. 9 - Chief, Technical Division, Edgewood Arsenal
- No. 10 - Deputy Chief, Technical Division, OC-CWS

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Director of Operations

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C O N F I D E N T I A L

CHEMICAL WARFARE SERVICE
RESEARCH AND DEVELOPMENT PROGRAM
DUGWAY PROVING GROUND
REPORT FOR WEEK ENDING JULY 1, 1943

1. General.

a. Eleven (11) tests were run during the current week.

b. The following visitors arrived at Dugway Proving Ground during the current week in connection with operations:

Capt. George McCullough	Edgewood Arsenal, CWS	Rockets
Mr. F. O. Berry	OC-CWS, Industrial	4.2" Chemical Mortar
Mr. John Blazek	Lempco Products	4.2" Chemical Mortar
Dr. J. T. Thurston	Stamford, Conn.	CC
Dr. F. A. Brooks	NDRC.	Gas Cloud Travel

c. Two B-25 airplanes assigned to this post are having the bomb-bay doors modified for mounting of M-33 spray tanks.

d. Materials and equipment report:

The following expendable and nonexpendable supplies have been received during the past week:

<u>QUANTITY</u>	<u>UNIT</u>	<u>ARTICLES</u>
16	Each	4.2" C.M. Shells, M2, H.E., Lot No. C.W.S. D-2-127-15.
9	Each	Cluster, Bomb, Incendiary, 500-lb. M2, 192-2 lb. AN-M52, Live, Lot No. 2 NFC.
7	Each	Cluster, Incendiary Bomb, M52, 500-lb. 192-2 lb., AN-M52, Live, Lot No. 2 NFC.
126	Each	Fuzes, No. 855 Mk I, Detonator, Lot No. 58.
12	Each	Shells, 4.2" chemical Mortar, M2
200	Books	Paper, Liquid, Vesicant, Detector, M6 No Lot # Listed.
840	Cans	Paint, Liquid, Vesicant, Detector, M5 No. Lot # Listed. 4 oz. cans.
144	Each	Cordite Charges with Brass Cages 400 lb. SCI Type SL Mk 1.
27	Each	Shell, 4.2" C.M., M2A, Lot PXIV New Design BTW. From Lempco Products.
23	Each	Shell, 4.2", C.M., M2A, Lot P-574-3-L. New Design Vane. From Lempco Products.

C O N F I D E N T I A L

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2. A 1.8-1. Compound 1149.

Field Experiment 158, forwarded herewith, has been prepared and plans have been made to conduct this test on 3 July, 1943.

3. A 3.3-1. CNCl.

Summary of Results:

Experiments Numbers 34, 35 and 36: Experiments on the effect of brass, water and a combination of both brass and water are summarized. These experiments were conducted on a small scale using citrate pressure bottles at atmospheric temperature; a precaution employed when a doubt existed as to a possible rapid polymerization of CNCl. The effect of 2% H₂O on CC in an M-46 A-2 bomb will be reported in Experiment No. 51.

TABULATION OF RESULTS

Exp. No.	Duration of Test	Description of Test	Pounds Filling	Test Temp.	Lbs. Non-Volatile Residue	% Non-Volatile Residue	Remarks
34	30 days	Effect of 2% water on CNCl in citrate btl.	0.78#CC 0.015# H ₂ O	22°C			No results because of leaky bottle.
35	30 days	Effect of 2% brass on CNCl in citrate btl.	0.78#CC 0.015# brass filings	22°C	0.019	2.44	Blue, green solid formed in bottle.
36	30 days	Effect of brass and water on CNCl in citrate bottle	0.78#CC 0.015# H ₂ O 0.015# brass filings	22°C	0.034	4.37	Crystals of NH ₄ Cl formed in bottle.

Conclusion: CNCl produced some chemical action on brass as shown by the presence of a blue-green solid on bottom of bottle indicating a copper compound.

The formation of NH₄Cl is caused by the action of water on CNCl. No evidence of the polymer (CNCl)₃ was observed because of the complete solubility of the non-volatile residue in water.

C O N F I D E N T I A L

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A 3.3-1, CNCl, Continued

Work Started: Certain runs from Lots No 1 and No. 2 per letter OC-CWS, E.A., MI., SPCVB 470.6, contained possible traces of HCl or (CNCl)₃. This sub-standard material was segregated and surveyed in the following two bombs:

1. Experiment #67: Purified cyanogen chloride (Lot No. 1) containing possible trace of HCl or (CNCl)₃ i.e. <0.005% HCl or (CNCl)₃.

Object: To determine the stability of sub-standard CC from Lot No. 1 which analyzes:

- a. Possible trace (< 0.005%) HCl or (CNCl)₃
- b. 0.000% free chlorine
- c. 0.000% HCN
- d. trace (0.005%) H₂O.

Experimental: One M47A1 bomb (as is) was filled to 15% void with 60.4 lbs. CC, fitted with pressure gage and placed at 65°. Lot No. 1 was produced by the standard Warner process, but with excess chlorine (to eliminate HCN), then sent to Stamford for further purification and drying to remove the last traces of HCl, Cl₂ and H₂O. The CC used here was sub-standard material which showed a possible trace (<0.005%) of HCl or (CNCl)₃.

2. Experiment No. 68: Cyanogen chloride from Lot No. 2 containing 0.02% HCN and possible trace (<0.005%) of HCl or (CNCl)₃.

Object: To determine the stability of sub-standard CC from Lot No. 2 which analyzes:

- a. Possible trace (< 0.005%) HCl or (CNCl)₃.
- b. 0.00% free chlorine
- c. Average of 0.02% HCN
- d. Trace (0.005%) H₂O

Experimental: One M47A1 bomb (as is) was filled to 15% void with 60.4 lbs. CC, fitted with pressure gage and placed at 65°C. Lot No. 2 was produced by the standard Warner process, feed kept at neutral point, chlorine removed by iron scrubber, then further purified and dried at Stamford to remove HCl, Cl₂ and H₂O. The CC used here was sub-standard material which showed a possible trace; 0.005%, HCl or (CNCl)₃. This small amount of "possible" acid in Ex. No. 67 and 68 above, should not result in polymerization.

Status of Experiments Under Test:

All bombs show normal pressures at 65°C.

C O N F I D E N T I A L

C O N F I D E N T I A L

C A N C E L L E D

4. A 3.5-1, HCN.

Summary of Results:

Experiment No. 37, on the effect of 2% H₂O on HCN is summarized. This test was conducted in a citrate pressure bottle at a atmospheric temperature: a precaution taken when doubt exists as to possible rapid polymerization.

Exp. No.	Duration of Test	Description of Test	Pounds Filling	Test Temp.	Lbs. Non-Volatile Residue	% Non-Volatile Residue	Remarks
37	30 days	Effect of Water on HCN	0.46# AC 0.01# H ₂ O	22°C	0.001	0.2	Little or no effect on AC.

Water has little or no effect on AC at atmospheric temperatures (22°C).

Work Started:

None

Status of Experiments under Test:

All bombs continued at 65°C for 35 days without change. Sixty-day test period for AC surveillance ends 24, July 1943.

5. A 10.7, Materials for Thickening Vesicents to Form Large Drops.

A. Surveillance

Final recorded data on settling of Hammermilled paper pulp-EAHS Mixtures for a total time of standing of 530 hours (22 days) in a field of gravitational force of 1 G indicated that a 3% pulp settled to give a volume of clear pulp-free phase of 3.4%. The 2% pulp mix gave a clear phase of 18% and the 5% pulp mix gave a clear phase of 0% under the same conditions as the 3% mix.

A rough comparison of settling rate of assembled, but not agitated, asbestos-EAHS with slightly agitated (shaking) asbestos-EAHS indicated that the non-agitated material gave up a clear pulp phase amounting to about 15% by volume in the first hour of standing. This was about twice as much as that of a corresponding mix which was agitated to about the extent, comparatively, as the M-10 spray tank asbestos-EAHS mix s prepared earlier this week.

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A 10.7 (Continued)

In all the mixes mentioned above, 10% of 10-6 grade asbestos pulp was mixed with EA Levinstein Mustard, R-2926. In comparison with these results, it was found that a similar 10% asbestos mix stirred for 8 hours at high speed with a laboratory stirrer, gave a rigid gel having no apparent tendency to yield its HS on standing in a field of 1 G. This is to be contrasted with the effect of the high speed stirring of a Hammermilled paper pulp-HS mixture, wherein the paper pulp separated from the HS and could not be made to disperse in the HS on further treatment.

Mixtures of asbestos-EAHS in the range of 5% to 10% asbestos have been prepared and are under study for the determination of effect of settling rate vs. degree of mechanical treatment with a view toward determining optimum mechanical treatment for desired asbestos-mustard consistency.

Separate tests run by the Munitions Section yielded the following results:

Degree of settling after 26 days is shown by % of original height of paper pulp.

<u>Experiment</u>	<u>Temperature °C</u>	<u>% of Original Height of Paper Pulp</u>
a.47	Atmospheric (32° C)	90
b.48	Room (25° C)	99
c.49	65° C	62

F.E. No. 125(a) was carried out 26 June at 0855 hours, using two M-10 wing tanks filled with 317 pounds HS thickened with 10% Chrysotile asbestos, 10-6 grade. Specific gravity of agent was 1.36. Period of emission was 9.2 sec. for most of the agent, the discharge being intermittent after the first 3 seconds, and small amounts leaving the tanks for about 20 minutes. There were residues of 116 and 117 pounds respectively in the tanks after discharge. Mean wind was 2.8 mph. Temperature of the agent was 65° F. Some very large drops were formed, but mixture was too viscous for satisfactory spray.

F.E. No. 123(b), Trial 3, with 3% Hammermilled newsprint was conducted at 1045, 26 June 1943. The period of emission was 11 sec. for the greatest portion of one tank, with a residue of 69 pounds after discharge. The outlet detonator did not function in the other tank. Temperature of agent was 73° F. Mean wind was 6.7 mph.

In F.E. No. 126(a), using HS thickened with 1.8% NDR-359 plus 5% monochlorobenzene, run at 0810, 28 June 1943 resulted in a long emission

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A 10.7 (Continued)

period of 14.5 sec. for one tank and 29.5 sec. for other where the inlet detonator did not function. Agent temperature was 68°F., and sp. gr. 1.348 at 10°C. Mean wind was 3 mph.

F.E. No. 126(b), using HS thickened with 5.6% Styron and 5% monochlorobenzene, 1.330 sp.gr., at 68°F., was completed at 0830, 28 June 1943. Mean wind was 2.8 mph. Period of emission was 11 sec.

Further data, including evaluation of drops, will be furnished next week on the above experiments.

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6. B 1.2-2b-2, 4.2" Chemical Mortar Shell.
E16, Technical Assistance with Production Facilities.

Work was started 29, June 1943, on the testing of 4.2" chemical mortar shell, M2, and M2 alternate, submitted by various manufacturers. The purpose of these tests is to evaluate the shell submitted as to flight characteristics, and to determine the significant dimensions accurately.

7. B 3.1d, Technique for High Altitude Spray.

See attached report for work done by Signal Corps Group.

8. B 6a-1a, Determination of Optimum Bomb for Nonpersistent Agents.
B 6a-1b, Determination of Optimum Nonpersistent Agent for Bombs.
B 6a-1c, Determination of Behavior of Nonpersistent Agents when used in Bombs.

Three tests were run this week under these projects. The results are shown in the accompanying charts. Also inclosed is chart of Field Experiment No. 140, Trial 1, which was conducted 22, June 1943, results of which were not available when Weekly Report No. 9, for week ending 24, June, 1943, was written. The effect of strong wind on the dispersion of gas can be especially noted by comparing this trial with Ex. No. 140, Tr. 2, reported this week.

9. B 11, Incendiaries.
B 11.2-1, Incendiary Bomb, Magnesium Type (2-lb.)
B 11.3-3, Incendiary Bomb, Therm-S. Type. (5-10 lbs.)
B 11.3-5, Small Incendiary Bomb, Oil-Type.
E 16, Technical Assistance with Production Facilities.

~~July~~
On 25 ^{JUNE} 1943, eight (8) clusters of M69 bombs were dropped from 10,000 feet. Due to high winds very few hits were scored

On the afternoon of that day one 100-lb. cluster of M52 inert and one 100-lb. cluster of M54 inert bombs were dropped from 100 feet on the target area for penetration data. Damage to the buildings was quite extensive and the test was therefore postponed until the completion of Phase C.

No tests were conducted the remainder of the week in order to permit time for repair to the structures. The tests will be continued on the return of the evaluators to this station.

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10. Miscellaneous.

a. Munitions were filled and preparations made throughout the week for the proposed field trials on Santa Cruz Island.

b. The automatic sampler developed by the N.D.R.C. group in its improved form has been completed by the Dugway Proving Ground Machine Shop in Salt Lake City and is ready for field tests.

c. Measurement of gas cloud dimensions:

Correlation of ground contact with lapse rate was continued. In two cases of a 500-lb. CG bomb dropped from a plane, one series of 16 mm pictures were taken during an "inversion" and the other were taken during a "lapse". The ratios of maximum pillar height to ground width were as follows:

Time after burst (seconds)	Ratio of height to horizontal spread	
	Inversion	Lapse
1 1/2	1.250	4.00
5	.278	1.95
10	.100	.625

Here, as would be expected, when an inversion exists the horizontal spread was accompanied by a decrease in pillar height; under lapse, the pillar height remained approximately constant.

END

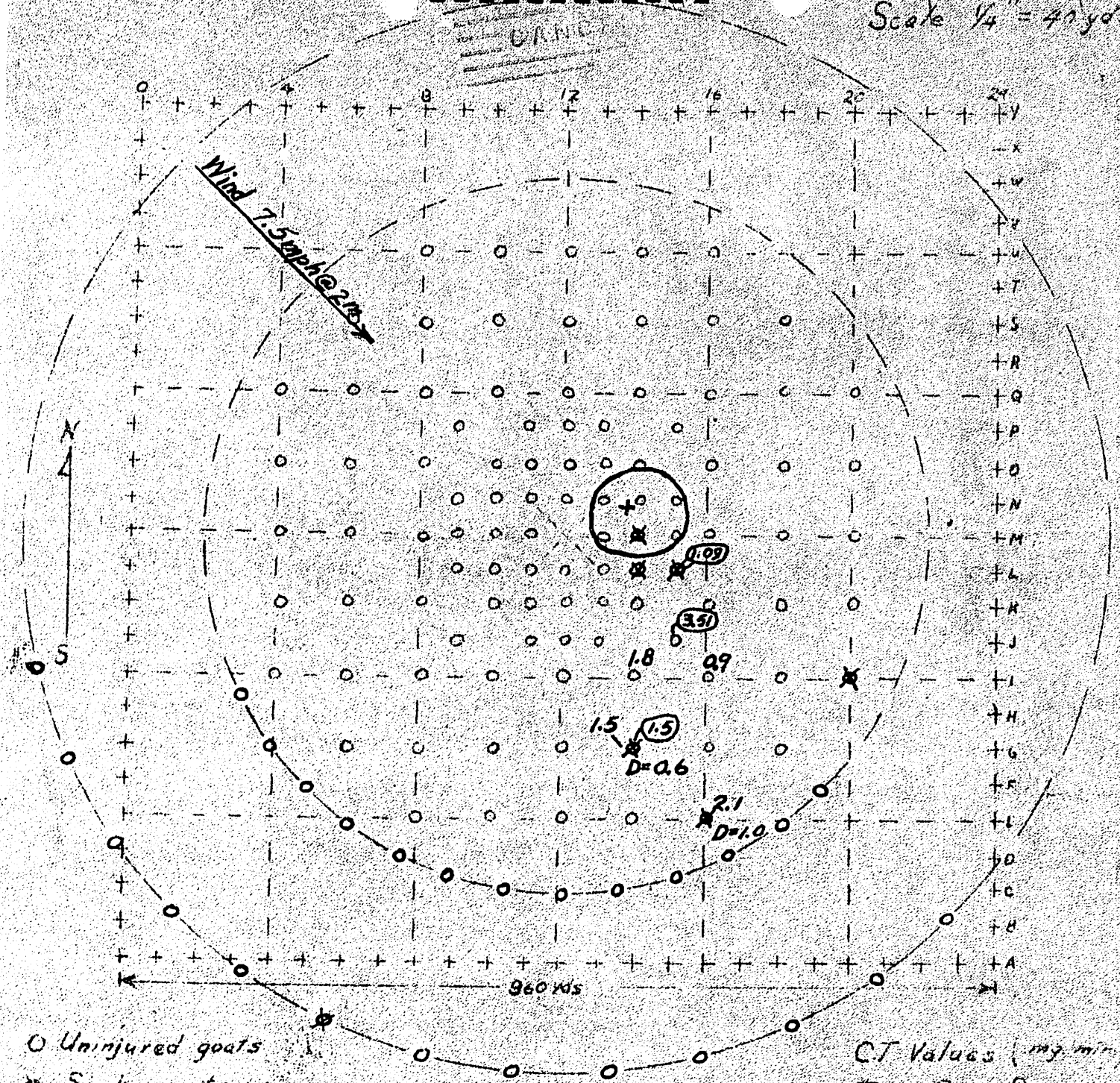
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Target Area

Chem. Sampling and Goat Mortality

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Scale 1/4" = 40 yds.



○ Uninjured goats

⊗ Sick goats

CT Values (mg min/l)

⊗ Snap Samplers

— 10 Sec initial cloud

Point of release

Samplers
D-0.6 - Dickinson
Samplers

F. E. No.: No. 140, 22 June, 1943
Agent: CG (406 lb.) plus NO₂ (22 lb.)
RH: 28% at 68.5°F
R Value: 1.25

Project: B 6a-1a
1000-1B, T2 bomb from 4,500 ft.

Temp. Gradient: { surf. = 70.6
1 m. = 70.3
2 m. = 70.7
3 m. = 70.9

Highest recorded concentration: 6.2 mg/l (Leighton Snap Sampler).

Highest recorded CT value: 3.51 mg. min./l (Leighton Snap Sampler).

<u>Cloud CT profile</u>	1 ft.	M-13 {	0.3	L-12 {	0.4	I-16 {	0.6	E-16 {	2.1
	2 ft.		0.4		0.3		0.9		1.4
	6 ft.		0.4		0.4		0.5		1.3
	12 ft.		1.4		1.8		0.7		1.0

Crater loss was negligible.

Crater size: 10" diameter by 2' deep.

The inversion was very slight and the wind quite gusty, which probably accounts for the absence of fatalities among the test animals. Fragmentation and dispersion were normal, the initial 10-second cloud was about 100 yards in diameter extending 40 yards upwind and 60 yards downwind. Chemical samplers and lack of goat casualties indicate no lethal area was obtained.

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● Dead goats

to see initial cloud

Lethal cloud

+ Point of release

9.6 - Continuous Samplers

D-8.8 - Dickinson Samplers

F. E. No.: 140 (Trial 2), 29 June, 1943.

Agent: CG plus 5% NO₂

RH and T: 47% at 65.0°F

R Value (Av.): 1.54

Project: B 6a-1a

1000-lb. T2 bomb from 5000 ft.

Temp. Gradient: $\left\{ \begin{array}{l} \text{Surf.} = 59.2 \\ 1 \text{ m.} = 60.6 \\ 2 \text{ m.} = 62.0 \\ 3 \text{ m.} = 62.5 \end{array} \right.$

Highest recorded concentration: 13.9 mg/l (Leighton Snap Sampler.)

Highest recorded C.T. value: 39.0 mg. min./l (Injector Continuous Sampler).

Cloud C.T. Profile: $\left\{ \begin{array}{l} 12 \text{ ft.} \\ 6 \text{ ft.} \\ 2 \text{ ft.} \\ 1 \text{ ft.} \end{array} \right. \begin{array}{l} M-9 \\ \left\{ \begin{array}{l} - \\ 1.25 \\ 7.9 \\ 9.6 \end{array} \right. \\ P-9 \\ \left\{ \begin{array}{l} 2.27 \\ 4.60 \\ 8.52 \\ 15.90 \end{array} \right. \\ Q-10 \\ \left\{ \begin{array}{l} 2.1 \\ 5.4 \\ 23.5 \\ 39.0 \end{array} \right. \\ S-10 \\ \left\{ \begin{array}{l} 0.6 \\ 2.7 \\ 7.3 \\ 8.0 \end{array} \right.$

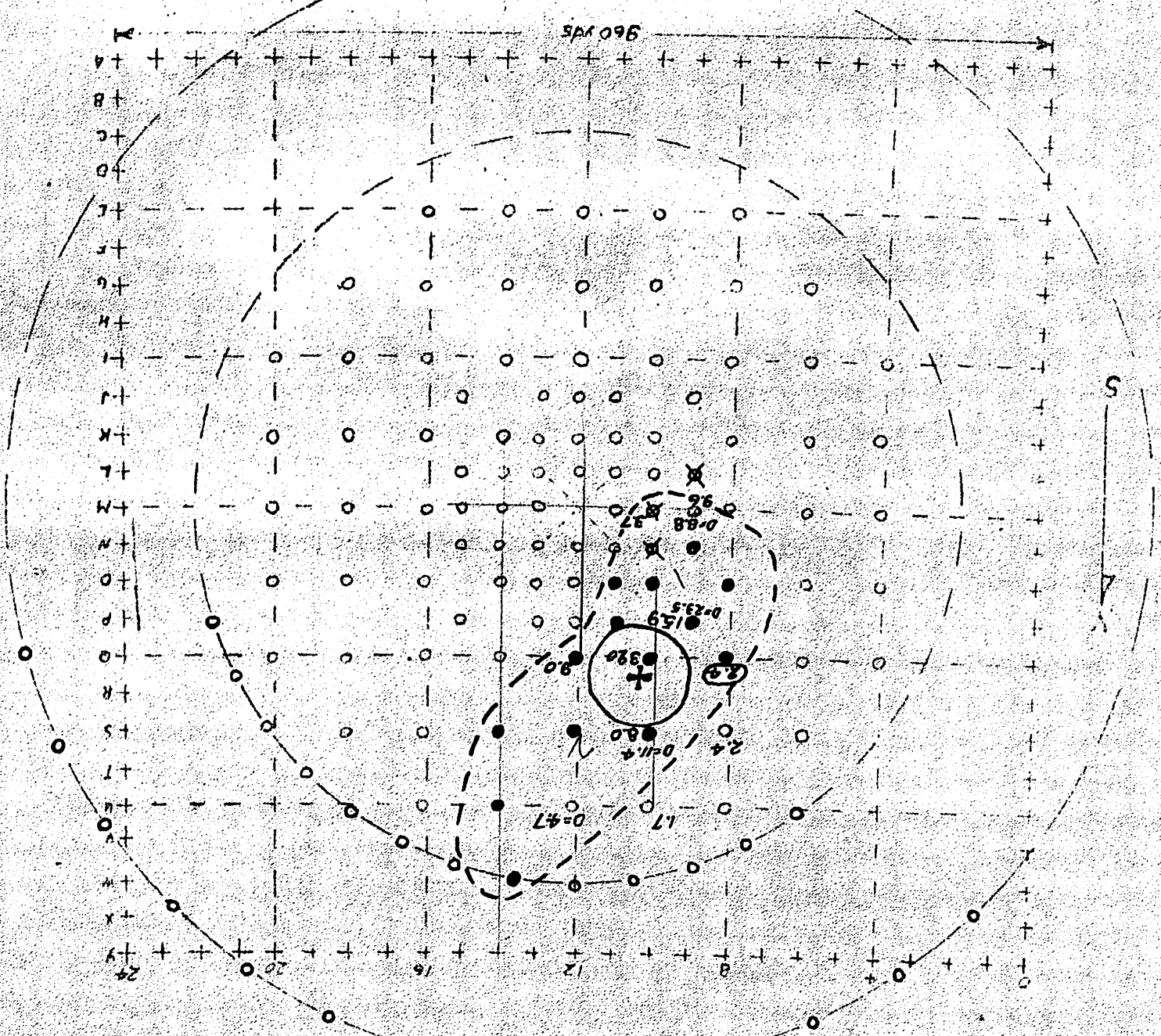
Crater loss was negligible, and fragmentation and dispersion were normal. The peculiar shape of the lethal area is due to shifting winds. A portion of the Meteorology Section report is reproduced below:

Time	Wind Velocities		R	W.D.
	1 m	2 m		
0620	0.48	0.74	1.54	SE
0624	Shoot			
0625	1.02	1.84	1.80	NE
0630	Calm			
0635	1.43	2.36	1.64	WSW

C O N F I D E N T I A L

○ Uninjured goats

CT Values (mg/min)



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Scale 1/4" = 40 yds

0.39

⑨

0.25

⑩

0.05

0.0

0.1

⑪

⑫

⑬

⑭

⑮

⑯

⑰

Temp. Grad. $\left\{ \begin{array}{l} 1m = 76.7^{\circ}F \\ 2m = 76.7^{\circ}F \\ 3m = 76.8^{\circ}F \end{array} \right.$

R value = 1.13

Cloud profile shown at each sampler.

$\left. \begin{array}{l} 6' \\ 2' \\ 1' \end{array} \right\}$ on all but Dickinson, only 1/2 ft level for them.

Sampler Positions

Canadian + Fe = 1, 2, 3, 4, & 8

Fe (Motor Driven - 110 v) 5, 6, & 7

Stang + Fe (Battery Driven) 11, 13, & 15

Dickinson 9, 10, 12, 14, 16, & 17


This bomb was dropped from an indicated altitude of 5,000 feet above ground level onto soft ground at Target "I". Crater dimensions were approximately fifteen (15) feet in diameter by five (5) feet deep. Fragmentation and dispersion were normal and ground loss was negligible. The initial cloud appeared to be approximately 100 yds. in diameter as is usual for this munition and filling.

Since the impact point was approximately 285 yards from the aiming point, samplers were not within sufficient distance of the bomb to record any lethal area which may have existed. Samplers showed a fairly uniform cloud downwind, although the entire area of the cloud did not pass through the sampling positions.

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Project B6a-1a
Field Experiment 138
Target I (Salt Flats)
2114 hours, June 27, 1943.
1-1000 lb T-2 Bomb-CG + 5% NO₂

Impact Point. 

Wind 8.57 mph at 2m.

265 yd

N


Aiming Point. 

Out of	0.7	0.6	0.7	0.25	-	-	-
Order.	1.2	0.8	1.2	0.30	-	-	-
	1.2	0.7	1.1	0.35	-	-	0.05
①	②	③	④	⑤	⑥	⑦	⑧

150 yd.

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+ Impact Point

PROJECT: B 6a-1a
 TEST NO: 18, F. E. No. 139
 AGENT: HCN plus dye
 DATE: 30 June, 1943
 TARGET: Salt Flats, near I and I¹
 MUNITION: One 1000-lb. T2 aerial bomb

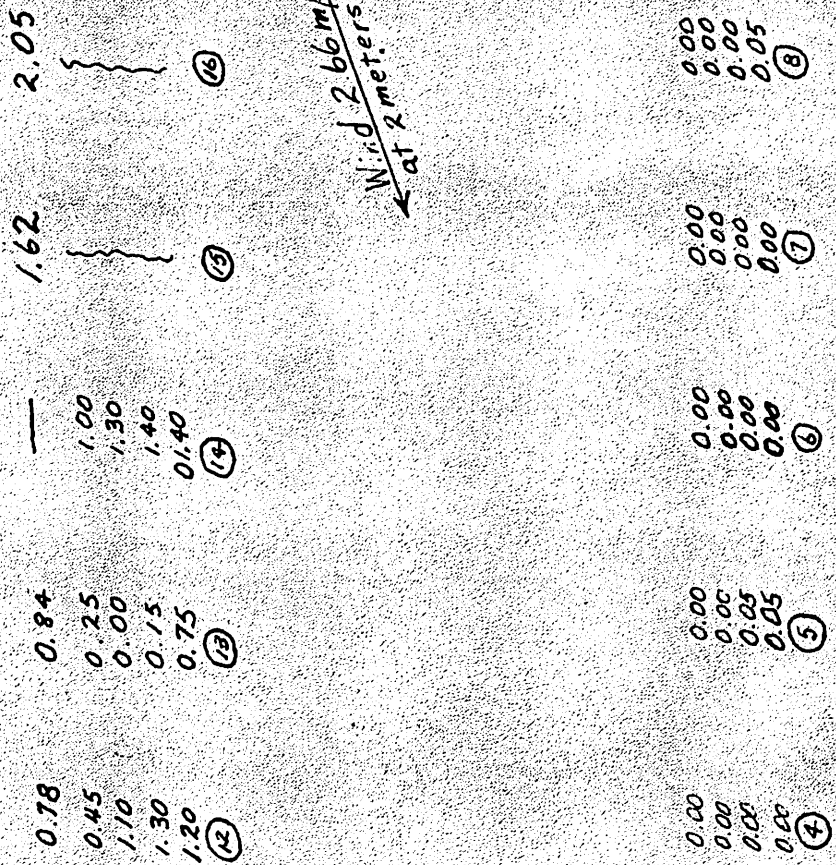
+ Aiming Point

N

Wind 266 mph
 at 2 meters

LEGEND: Position and Type of Sampler.

- 3, 4, 5, 6, 7, and 8.
AC Motor Pumps.
- 1, 2, 10, 11, 12, 13, and 14
Canadian Injectors
- 9, 10, 12, 13, 15, and 16
Dickinson Samplers



0.00
0.00
0.05 (8)

0.00
0.00
0.00 (7)

0.00
0.00
0.00 (6)

0.00
0.00
0.05 (5)

0.00
0.00
0.00 (4)

0.00
0.00
0.00

