Image Cover Sheet

CLASSIFICATION	SYSTEM NUMBER
UNCLASSIFIED	137672

TITLE

VAPOUR DANGER FROM GROSS MUSTARD CONTAMINATION

System Number:

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Notes:

DSIS Use only:

Deliver to:

This Report is Informal and the Conclusions are only Tentative

Karch

SUFFIELD FIELD REPORT NO. 6
(31 Dec. 1943)

Vapour Danger from Gross Mustard Contamination

Ref: Field Experiment 141 Trial II carried out 4.11.43. D.C.W. & S. Project No. 54.

INTRODUCTION

1. The vapour danger to be expected from ground heavily contaminated with mustard gas, when the surface temperature is between 21° and 42°C (70° - 107°F) has been reported in Suffield Report 92.

2. Trial II of Field Experiment 141 is concerned with the danger likely to be encountered at lower surface temperatures.

MATERIAL

3. 25 light gauge 50 gallon drums each containing 555 pounds U.S. Lewinstein mustard gas of approximately 70 percent purity.

PROCEDURE

4. The 25 drums were emplaced on an area adjacent to that used for trial one. As in the earlier trial, they were placed on three concentric circles, 3 on a circle of radius 34 yards, 7 on a circle of radius 60 yards, and 14 on a circle of radius 94 yards, the remaining drum being at the centre.

5. The drums were burst simultaneously using twelve 4 oz. sticks of 40 percent dynamite under each drum.

6. The ground contamination from one drum was not assessed on a separate layout as in the first trial. Instead, the area contaminated by one of the 25 drums, which had been dyed red for the purpose, was estimated visually.

7. After the drums had been exploded, 57 injector operated bubblers were placed on the area as shown in Appendix I. One unit was placed at the centre of the layout to sample at 8 inches above ground and the remainder were placed on three concentric circles with radii of 34 yards, 115 yards and 165 yards respectively. 4 units, all sampling at 8 inches above ground were placed on the inner circle, 28 were placed in pairs on the middle circle, and 24 in pairs on the outer circle. Of each pair, one unit sampled at 8 inches above ground and one at 5 ft. 6 inches above ground.

8. Samples were taken according to the following schedules, zero being the time at which the drums were burst.

	Sampling Period						
Inner circle & centre sample	a	b	c	d	e	f	g
Commencement of sampling (time after zero)	9'	47'	1h50'	4h13'	6h00'	23h57'	48h22'
Sampling period	15'	14'	14'	15'	15'	30'	30'
Middle circle							
Commencement of sampling (time after zero)	9'	50'	1h52'	4h16'	6h05'	24h30'	48h31'
	15'	16'	15'	15'	16'	28'	27'

	Sampling period						
	a	b	c	d	e	f	g
Outer circle							
Commencement of sampling (time after zero)	12'	50'	1h51'	4h17'	6h04'	24h38'	48h35'
Sampling period	16'	17'	14'	15'	15'	25'	26'

(6h05' = 6 hours 5 minutes.)

9. An area on the inner sampling circle between the contaminatio from two adjacent drums was chosen as the site for the exposure of 30 men.

10. The men were dressed as follows:-

Battle dress Canadian	non-impregnated.
Shirts	non-impregnated.
Undershirts short armed	non-impregnated.
Drawers (panties)	impregnated.
Socks and boots	non-impregnated.
Drill order	
Respirators, light type at the gas position.	

11. In this area three stakes were driven into the ground at intervals of two yards. Inlets from injector operated sampling units were attached to these stakes to sample at 36 inches above ground.

12. The thirty men were divided into groups of six and one group was exposed on the area at each of the following periods:-

Group	
I	Zero plus 2 hours to zero plus 2 hours 42 minutes.
II	Zero plus 6 hours to zero plus 6 hours 34 minutes.
III	Zero plus 8 hours to zero plus 9 hours 5 minutes.
IV	Zero plus 24 hours to zero plus 25 hours 5 minutes.
V	Zero plus 48 hours to zero plus 50 hours 20 minutes.

13. The men in Groups I to III were separated into pairs and during exposure each pair dug a trench around one of the three stakes.

14. For the last two exposures an area approximately five yards by three yards at the site of the earlier exposures was roped off. A sampling point was erected at the centre of each of the four sides to sample at a height 36 inches above ground.

15. During the exposures 6 men chopped or sawed wood in this area.

16. 'On the spot' vapour samples were taken during the early part of the last two exposures and indicated that exposures of eight to ten hours would be required to produce casualty dosages. Such exposures were not considered feasible and the two groups of observers were withdrawn after 65 and 140 minutes respectively.

17. The first three groups of observers were transported in a closed truck to the site of their exposure to minimise the unmeasured dosage to which they would be exposed in passing over the 115 yards of contaminated ground between the central point and the exposure site.

18. To determine the concentration of vapour likely to be encountered in this truck, it was driven one hour after zero, to the site of the exposure where it remained for 10 minutes. The rear flaps were then opened for one minute after which the truck was driven back to the control point. A continuous vapour sample was taken inside the truck during this manoeuvre. No mustard gas was detected.

19. After exposure all men wore their clothes for four hours. During this time, Group I spent about two hours and GroupII one hour in a small unventilated room.

20. Persistence tests were made around two drum craters seven days after the trial.

RESULTS

21. The zero for the trial was 0949 M.D.T.

22. The meteorological conditions covering the periods of sampling are given in detail in Appendix II. A summary for the first six hours of sampling is included here.

Wind speed at 2 metres	7 rising to 23 mi/hr.
Air temperature	-1°C rising to 8.9°C (30°- 48°F)
Surface temperature	-0.5°C rising to 11.7°C (31° - 53°F)
Relative Humidity (percent)	91 falling to 49.
Vertical temperature Gradient (39-4 ft)	varying between 0° and -0.3°C.

Contamination

23. An aerial photograph of the contamination produced in this experiment is shown in Appendix V. The contamination from the earlier trial can be seen to the east.

24. The area contaminated by the drum containing dyed charging was estimated visually as an area 30 yards in the direction of the wind by 19 yards across wind. Of this total of 570 square yards, 380 square yards was heavily contaminated.

25. In Trial I where accurate assessment of the contamination from one drum was made, the density of 94 percent of the contamination was above 5 g/sq.m. (This contamination covered an area of 1700 sq. yds, the average density of contamination being 170 g/sq.m.) It is considered that contamination in excess of 5 g/sq.m. can be detected visually and it is therefore reasonable to assume that, in the present trial, at least 90 percent of the charging from the drum was included in the area of 570 sq. yds. given in para. 24. On this assumption, the average density of contamination over this area is approximately 500 g/sq.m. (The difference in the density of contamination obtained in the two trials is probably accounted for by the difference in wind speeds at the time of burst - 18 mi/hr. for Trial I and 8 mi/hr. for Trial II.)

Vapour Samples

26. The following is an abstract of the total data available, figures being the recorded mean concentrations in mg/cu.m. over the sampling periods.

Sampling Period	a		b		c		d		e		f		g	
Sampling Position	1[x]	2[x]	1	2	1	2	1	2	1	2	1	2	1	2
1)	22.3	-	3.9	-	3.9	-	6.0	-	3.3	-	0.80	-	0.65	-
2) Inner	11.0	-	7.5	-	8.9	-	11.0	-	lost	-	0.50	-	0.22	-
3) Circle	4.6	-	5.6	-	6.5	-	2.4	-	1.4	-	0.83	-	0.25	-
4)	10.0	-	5.0	-	5.4	-	7.0	-	6.6	-	0.20	-	0.27	-
5) Centre	10.7	-	10.0	-	8.4	-	7.0	-	5.6	-	2.8	-	1.75	-
8)	0.4	nil	nil	nil	0.15	0.07	lost	lost	nil	nil	0.57	0.31	0.42	0.18
9)	0.25	0.15	0.5	lost	0.10	lost	0.11	nil	0.04	nil	0.13	0.28	0.09	lost
10)	6.0	2.5	3.4	2.4	0.07	0.35	0.07	lost	0.13	nil	0.21	0.05	nil	nil
11)	10.7	0.26	10.3	0.3	7.0	1.2	1.00	lost	0.59	0.22	0.13	0.13	nil	nil
12)	8.9	1.9	11.7	1.9	15.0	2.0	4.7	1.1	1.41	0.47	0.10	0.08	nil	0.03
13) Middle	10.7	2.1	7.8	1.4	16.4	3.3	19.4	1.6	11.0	1.7	0.02	0.17	nil	0.03
14) Circle	9.0	3.2	11.2	2.8	10.3	2.1	17.4	0.3	11.0	3.0	lost	0.05	N	N
1)	3.5	0.83	5.0	3.0	4.5	3.5	9.0	5.0	5.5	3.5	nil	0.17	I	I
2)	0.11	nil	0.23	0.28	1.3	0.75	4.5	2.0	3.5	2.0	0.02	0.05	L	L
3)	0.11	nil	0.06	0.09	nil	0.05	2.5	1.5	2.8	1.8	0.12	0.17		
4)											0.95	0.12	0.08	0.14
5)											1.0	0.57	0.39	0.14
6)											1.4	0.83	0.69	nil
7)											1.2	0.52	0.78	0.30
9)	0.83	0.20	nil	0.05	0.06	nil								
10)	5.9	2.3	2.4	3.8	1.4	0.58								
11)	5.0	1.8	3.3	4.7	2.7	1.25	0.05	0.05						
12)	0.67	nil	4.0	nil	2.5	1.8	4.0	2.4	2.2	2.0				
1) Outer	nil		0.05	0.05	0.80	0.75	2.5	1.7	3.5	2.0				
2) Circle	nil		nil	nil	nil	nil	1.7	1.2	2.2	lost				
3)											nil	nil		
4)											1.1	0.60	0.06	0.04
5)											1.5	0.40	0.25	0.25
6)											0.50	0.37	0.26	0.15
7)											nil	nil	nil	nil

[x] Column 1 gives concentrations at 8 inches.
Column 2 gives concentrations at 5 ft. 6 inches.

Physiological Tests

27. The dosages to which the five groups of observers were exposed, based on their special 36 inch sampling points, were 50-70; 40-50; 40-50; 40-70; 160-277 mg min/cu. m. respectively.

28. All the observers from Group I and four from Group II developed conjunctivitis at 4 hours after zero, and some of the observers developed mild effects in the armpits.

29. After exposure both groups had rested in a small unventilated room and it is considered that the above effects were produced by concentrations set up by the mustard vapour on the observer's boots and possibly also by the mustard vapour desorbed from their clothing.

Persistence Tests

30. Seven days after the trial, persistence tests using 'hot water bottles' and S.D. paper were carried out at points 2 and 8 yards from two craters. The tests gave positive results in 2 minutes.

DISCUSSION OF RESULTS

Exposure of Observers

31. The dosages to which the five groups of observers were exposed, based on the results of the special samples at a height of 36 inches, were 50-70, 40-50, 40-70 and 160-280 mg min/cu.m., respectively. For the first three groups, a dose of approximately 700 mg min/cu.m. had been predicted. These predictions were based on:

(i) A distribution of contamination similar to that obtained in the earlier trial (Suffield Report No. 92) which contamination could reasonably be treated as 2 mm. drops on sand.

(ii) Ground temperatures as forecasted, a wind speed of 10 mi/hr. and zero temperature gradient conditions.

(iii) An effective exposure height of 30 inches.

32. Calculations made after the trial and therefore based on actual conditions gave the following predicted dosages for the first two groups.

Group	Predicted Axial Dose at 36 in. (2 mm. drops on sand)	(Bulk contamination on sand)
I	1000	425
II	350	220

33. It will be observed that the predictions made prior to the trial agree, as regards order of magnitude with similar calculations after the trial. However, since the contamination was much more localised than expected, predictions for 2 mm. drops are high and predictions for bulk contamination are found to give the best agreement with observed results. On the inner circle, where the observers were exposed, even the predictions for bulk contamination are 5 to 10 times those reported from the special samples but show fair agreement with some of the results of chemical samples taken at 8 inches.

Occupation of Area

34. It was hoped that confirmation of 700 mg. min/cu.m. as the dosage required to produce casualties under low temperature conditions, would be obtained from the observers exposed in this trial.

35. In the absence of this confirmation the exposure times, starting at zero plus 24 hours, necessary to obtain dosages of 150, 500 and 700 mg. min/cu.m. have been estimated from the maximum concentrations obtained on the area at 24 and 48 hours after zero. The estimations show that exposures of approximately three, ten and eighteen hours respectively would be required.

Mathematical Analysis of Chemical Results

36. The axial dosage at the three sampling circles have been predicted from P.R. 2515. The data used for these predictions are given in Appendix III.

37. The predicted and measured dosages are compared in the table below. Predictions for grass showed no agreement with the observed results. This confirmed the calculations of trial 1 and the predictions are not included in the table.

Sampling Circle	Height of Sample	Sampling Period	Dosage (m.g. min/cu.m.) Observed Maximum	Observed average	Predicted axial dose for sand 2 mm. drops	Predicted axial dose for sand bulk
Inner	8 inches	a	See para 38	69-334	308	107
		b		55-105	354	123
		c		55-125	448	176
		d		36-165	486	254
		e		22-106	235	146
Middle	8 inches	a	160	152	312	108
		b	187	164	422	146
		c	246	209	482	190
		d	291	239	575	266
		e	176	147	236	146
	66 inches	a	48	36	140	48
		b	48	38	194	67
		c	52	44	221	87
		d	75	42	274	127
		e	56	45	112	70
Outer	8 inches	a	94	63	153	54
		b	68	55	202	70
		c	38	31	218	81
		d	60	41	239	118
		e	53	40	91	60
	66 inches	a	37	23	117	41
		b	80	48	159	51
		c	25	18	171	63
		d	36	26	191	94
		e	30	30	91	48

38. The observed dosages quoted for the inner circle are the complete range of dosages obtained. In the case of the middle and outer circles the maximum dosage and the average dosage of three positions centred about the position of the maximum dosage are given.

39. In Appendix IV the observed total accumulated dosage and that predicted for bulk contamination on sand for the two sampling heights at the middle circle, are plotted.

Inner Circle

40. Prediction is poor for this circle. Dosages predicted for bulk contamination are closest to the observed values. This circle is within the contaminated area and considering the irregular nature of the contamination, the variation in observed results, and the small number of sampling points, satisfactory correlation would not be expected.

Middle Circle

41. On this circle there is a remarkable agreement between the average observed dosages at 8 inches and those predicted for bulk contamination. However, the observed decrease in dosage with height is one and a half times that predicted.

Outer Circle

42. This circle is outside the contaminated area. The agreement between predicted and observed dosages are poor but are again best represented by predictions from bulk contamination.

CONCLUSIONS

43. From the concentrations obtained in this trial it is concluded that, for ground temperatures between 0° and 12°C (32 to 53°F), contamination of a circular area of prairie of radius 100 yards by 13900 lb. Levinstein HS (610 tons/sq.mi) dispersed from 50 gallon drums is not sufficient to produce vapour casualties in under 10 hours amongst men, wearing respirators, who occupy the area 24 hours after contamination.

44. See below.*

45. Calculations, based on P.R. 2515 and assuming that the Levenstein mustard gas is 70 percent pure and that it is dispersed as bulk contamination on sand, have given a good prediction of the dosages to be expected on the downwind edge of such an area. (The assumption of bulk contamination on sand, instead of 2 mm. drops as in S.R. 92, appears natural in view of the more localised contamination in the lighter wind of this trial.)

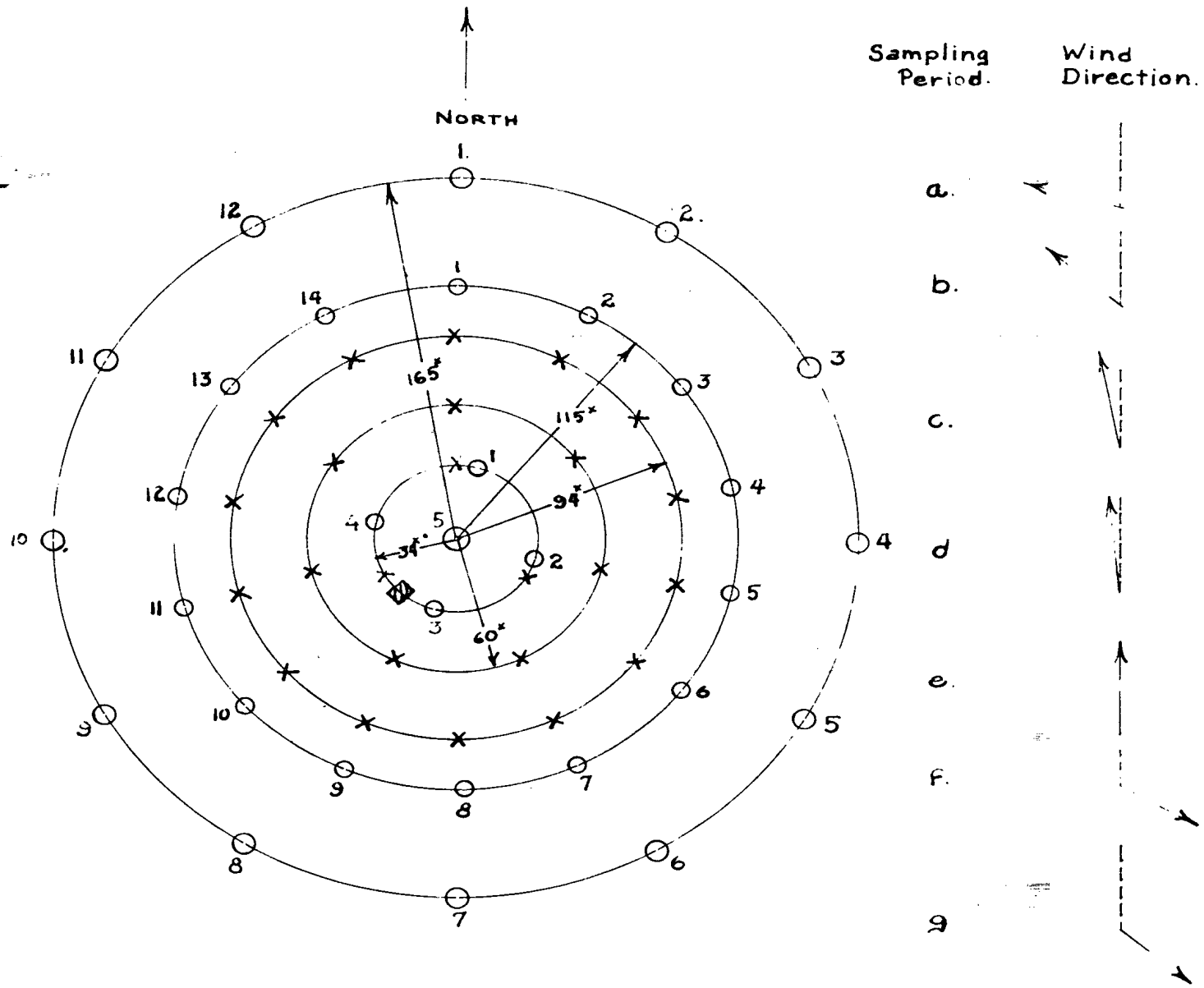
* If men who have worked on the area subsequently occupy a closed space, casualties might be produced by the mustard vapour desorbed from their clothing.

B.A.H. for
(J.M. Sanders)
P & M. S.
Experimental Station

HJF - JMS : rea

H.J. Fish
(H.J. FisH)
P.R.S.
Experimental Station

SUFFIELD FIELD REPORT
NO. 6.
Appendix I.



× Drums.

○ Sampling Points.

▨ Observer Area.

Diagram of Layout.
Scale 1" = 66 yards.

APPENDIX II

METEOROLOGICAL CONDITIONS

1. Meteorological conditions are tabulated below for the following periods.

Period a	Zero plus 10 min. to zero plus 30 min.
Period b	Zero plus 50 min. to zero plus 1 hr. 10 min.
Period c	Zero plus 1 hr. 50 min. to zero plus 2 hr. 10 min.
Period d	Zero plus 4 hr. 15 min. to zero plus 4 hr. 35 min.
Period e	Zero plus 6 hrs. to zero plus 6 hr. 40 min.
Period f	Zero plus 24 hours to zero plus 24 hrs. 40 min.
Period g	Zero plus 48 hrs. 15 min. to zero plus 49 hrs.

2. Fifteen minute samples were taken during the first five sampling periods and thirty minute samples in the last two. However, all samples did not start simultaneously and so the above periods were chosen to bracket the times of practically all samples.

	a	b	c	d	e	f	g
Wind speed at 2 metres (mi/hr)	7.3	8.2	12.3	19.4	23.0	13.9	11.9
Wind direction (T.B.)	105°	130°	170°	175°	180°	300°	310°
Air Temperature °F	30	34	41	48	48	33.5	32
Air Temperature °C	-1.1	+1.1	5	8.9	8.9	0.8	0
Surface Temperature °F	31	35	41	53	49.5	33	30.5
Surface Temperature °C	-0.5	+1.7	5	11.7	9.7	0.5	-0.8
Relative Humidity (%)	91	79	60	49	49	98	62
Vertical Temperature Gradient (39-4 ft)	0°C	-0.2°C	0°C	-0.3°C	0°C	0°C	-0.3°C
Wind Ratio R.	1.18[x]	1.17[x]	1.21[x]	1.18[x]	1.19[x]	1.13[x]	1.10[x]
Lateral Gustiness	0.43	0.47	0.54	-	-	0.56	0.43
Vertical Gustiness	0.22	0.24	0.29	-	-	0.26	0.26
Remarks	6/10 Ac As cloud	8/10 Ac As cloud	9/10 Ac As cloud	5/10 Ac As cloud	1/10 Ac cloud	Cloudy[xx]	4/10 to 6/10 Ac cloud

[x] Conditions for all periods were those usually associated with zero gradient. For the first five periods, R values were measured on a site covered with sparse grass 3 to 6 inches in length with occasional sage bushes about 9 inches high. There would appear to be a roughness correction of -0.06 (approximately) applicable to all values of R measured on this site. However, for the last two periods, the R values were measured on a similar site save there were no sage bushes. These last two R values appear too low even without a roughness correction. It is surprising that such a large range of measured R values should be found under conditions so close to zero gradient. It appears that winds on this area from different directions and on different days may have quite different velocity gradients under similar temperature gradient conditions.

[xx] Light snow fell for a time during this period but melted almost at once.

APPENDIX III

Data Used in Calculations

1. The following table gives the average values of R, wind speed, and surface temperature used in the calculations.

M.D.T. (Zero - 0949 hrs)	Wind Speed (ft./sec.)	Surface Temperature (°F)	R
0949 - 0959	12.8	30	1.17
0959 - 1019	10.7	31	1.15
1019 - 1039	11.9	33	1.14
1039 - 1059	12.0	35	1.14
1059 - 1139	13.2	38	1.14
1139 - 1159	18.0	41	1.14
1159 - 1404	25.8	46	1.13
1404 - 1424	28.5	53	1.13
1424 - 1549	31.5	54	1.12
1549 - 1629	33.7	49.5	1.13

2. The observed values of R appeared questionable in some cases. (See appendix II.) Observed temperature gradients and calculations based on P.R. 2408 both suggest that the values given above are more representative of actual conditions obtaining.

3. The average degree of contamination used for the calculations was 161 g/sq. m. of pure H. A downwind dimension factor of 1.1 was assumed for the area of contamination from individual drums.

4. For the calculations at the middle and outer circles the values of x/x_o assumed were approximately 1.1 and 1.5 respectively.

SECRET

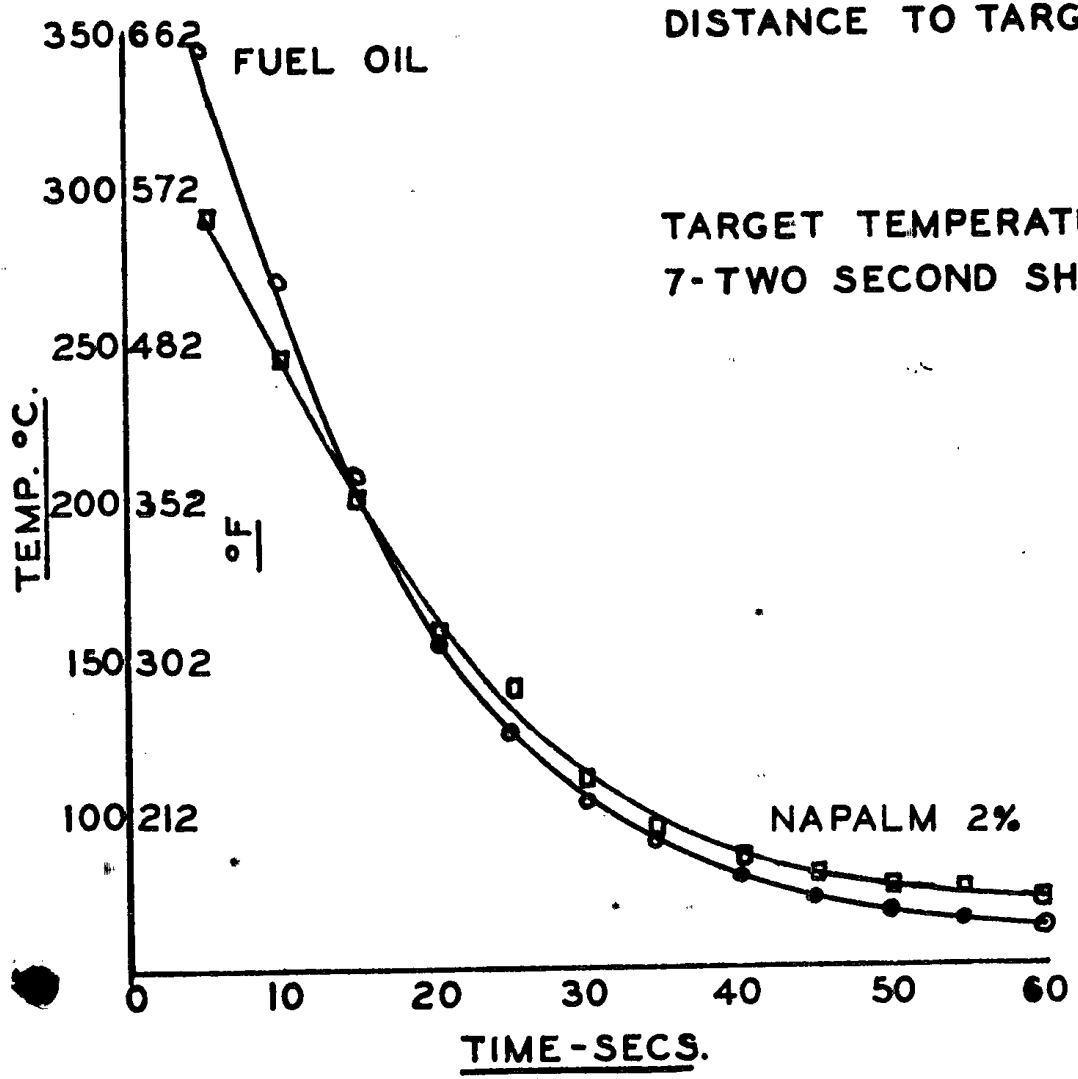
APPENDIX III

SUFFIELD FIELD REPORT (FLAME WARFARE) N°6

FUEL OIL VS. 2% NAPALM FUEL

DISTANCE TO TARGET; USING FUEL OIL:-30 YDS.

DISTANCE TO TARGET; USING NAPALM FUEL:-45 YDS.

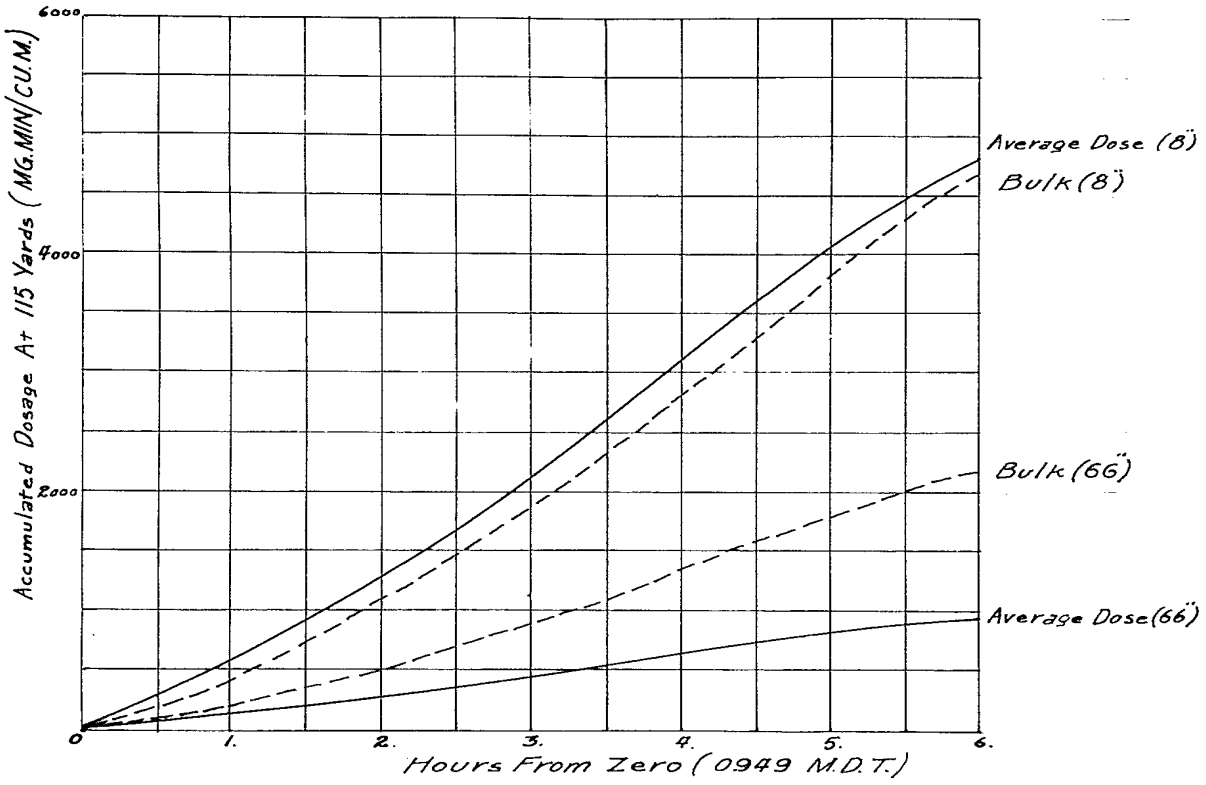


TARGET TEMPERATURES, AVERAGED OVER 7-TWO SECOND SHOTS OF EACH FUEL.

[redacted]

SUFFIELD FIELD REPORT
NO. 6.

Appendix IV



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Appendix V

Contamination from Twenty-five 50 Gallon Drums Charged Levenstein.

H.S.

3-C-147-635

HQ S4354-29-17-8

S4354-29-17-8 12

Pt. 1

EXPERIMENTAL STATION
SUFFIELD ALBERTA

SUFFIELD FIELD REPORT (FLAME WARFARE) No. 6

Reference:- D.C.W.&.S. Project No. S-129

SUMMARY

2 percent Napalm A in gasoline (5¼ lbs. Napalm A in 45 Imperial gallons) when fired in the Ronson FUL Mk. IV Flame thrower, produces a flame with the characteristics of fuel oil, but with 15 yards greater range.

OBJECT

1. To determine whether a low concentration of Napalm in gasoline can be used to reproduce the type of flame resulting from conventional fuel oil.

MATERIALS

2. 27 lbs. Napalm A.
240 gallons Automotive gasoline (leaded)
1 Ronson FUL Mk. IV Flame thrower.
80 gallons Domestic Fuel oil

PROCEDURE

3. Six 40 gallon mixes containing percentages of Napalm from 1 to 2 percent were made and fired under standard test conditions in a Ronson Flame thrower.

4. When it was found that the 2 percent mix appeared the most suitable, it was fired under various conditions, including the temperature recording target (described in Appendix IV) in comparison with fuel oil.

RESULTS

5. The results of the firing trials are shown as Appendix I.

6. Photographs of typical shots of 2 percent Napalm Fuel, and Fuel Oil are shown as Appendix II.

7. Curves showing the temperature vs. time for 2 second shots of 2 percent Napalm fuel in comparison with Fuel Oil are shown as Appendix III.

DISCUSSION

8. It is evident from the data of Appendix I, that the firing performance of Mixes 185 and 182, containing 1 and 1½ percent Napalm respectively, is the same as that of gasoline. This is due largely to the difficulty of hand mixing. It was found that the soap tended to settle out before swelling.

9. Using 2 percent Napalm, however, the fuel can be mixed by the standard method. When fired, the fuel consistently gives an extreme range 15 yards greater than that of fuel oil.

10. At the main range, the burning time on the ground is 15 seconds when the gun elevation is zero degrees. At greater elevations, however, the fuel burns completely in flight.

11. With the carrier driven at 10 mi. per hr. into a 10 mi. per hour wind, an extreme range of 50 yards is obtained with no discomfort to the driver or gunner, although, at the end of every shot a fine spray of fuel blows back.

12. Fuel oil under similar conditions creates a hazard, both to the driver and gunner, who have to be protected from radiant heat and flame.

13. The "target effect" of the two fuels is given by the curves of Appendix III which are the weighted averages of seven 2 second bursts with 2 percent Napalm and fuel oil.

CONCLUSIONS

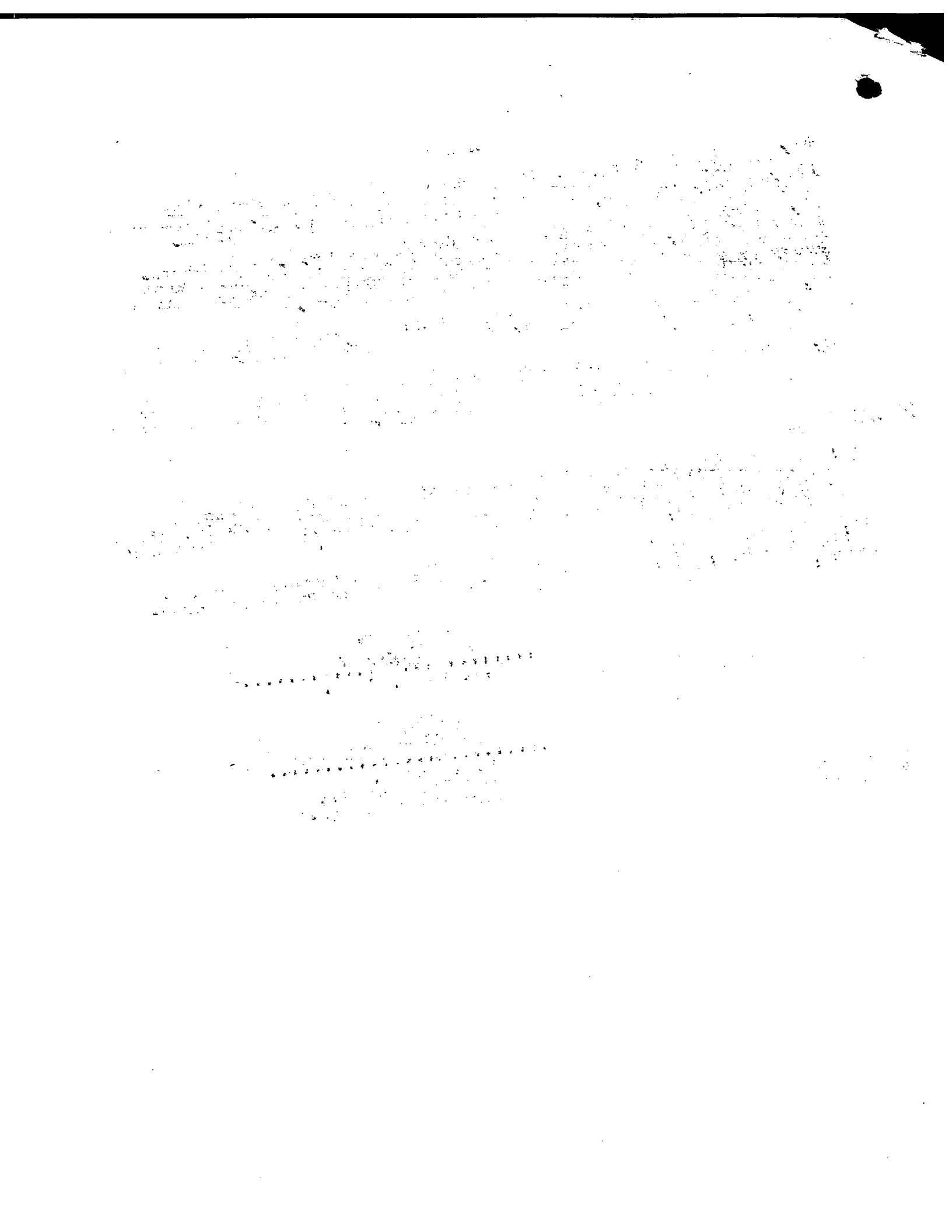
14. One 5¼ lb. can of Napalm A soap mixed with 45 gallons of gasoline by the standard method of hand mixing Napalm fuels, gives a fuel (2 percent) which flash burns completely at gun elevations over zero detrees.

15. The flame has the characteristics of that produced by domestic fuel oil, with greater range, and less hazard to the operators.

W.L. Gray, Capt.

S.G. Mason,
For Chief Supt.,
Experimental Stn.

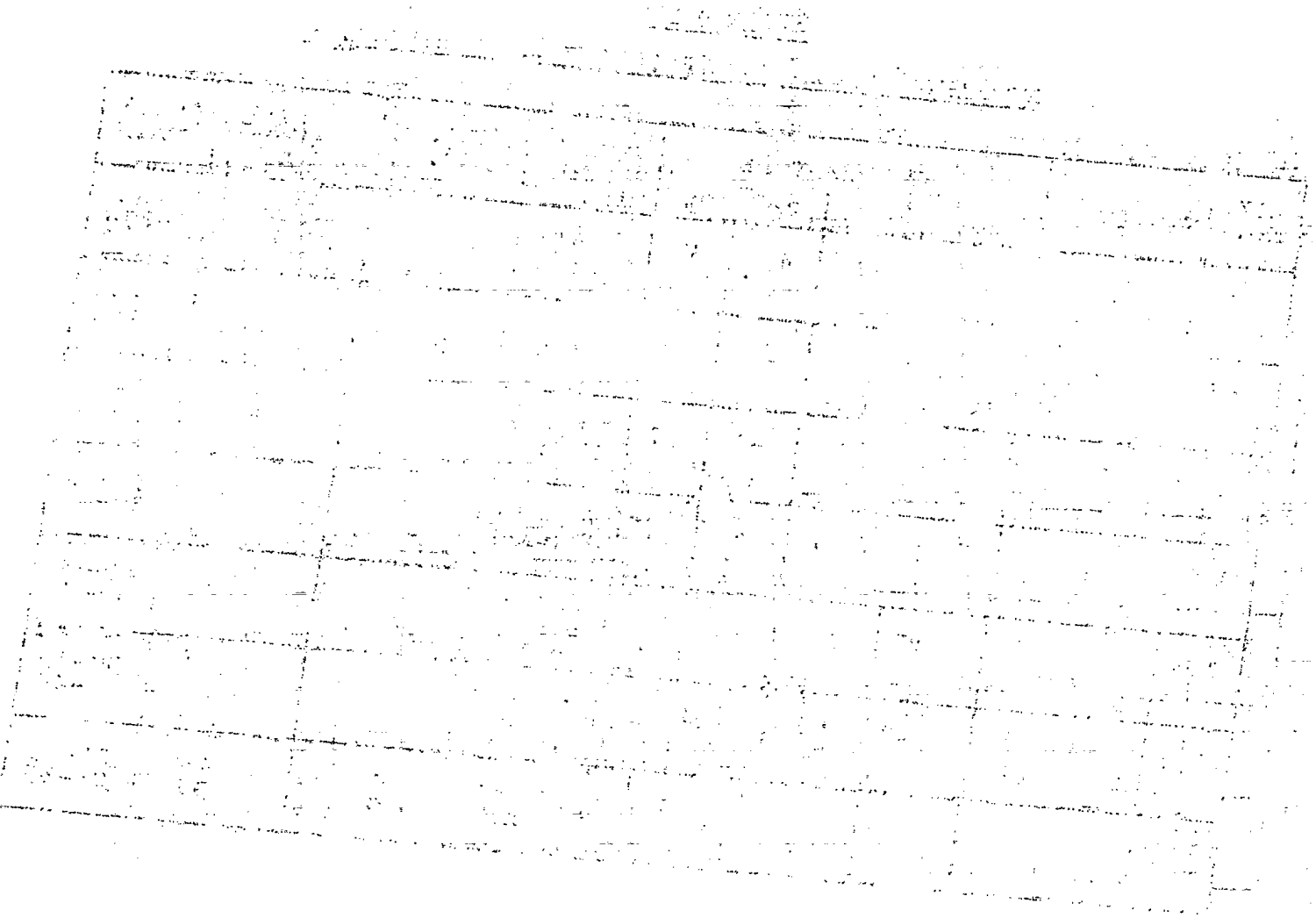
WLG:SGM:MMV
3 May 44



APPENDIX I

SUFFIELD FIELD REPORT (FLAME WARFARE) NO. 6

MIX NO.	% NAPALM	TEMPERATURE CHARGE °C	CHARGE °F	AIR °C	AIR °F	WIND SPEED MPH.	ELEV. DEG.	RANGE EXTREME	(YDS) MAIN
185	1	19	66	4	38	8 tail 8 head	0 0	50 35	30-40 20-27
182	1½	17	63	5	41	6 tail 6 head	0 0	50 30	30-40 20-25
137	2	18	64	-1	30	11 tail 11 head	0 0	70 50	55-65 48-50
191	2	5	41	3	37	8 tail 8 head	0 0	65 50	35-45 30-45
194	2	17	63	5	41	9 tail 9 head	0 0	62 50	49-62 30-55
179	2	19	66	-12	10	9 tail 9 head	0 0	65 52	30-45 30-40
Fuel Oil						9 tail 9 head	0 0	45 35	25-45 25-35

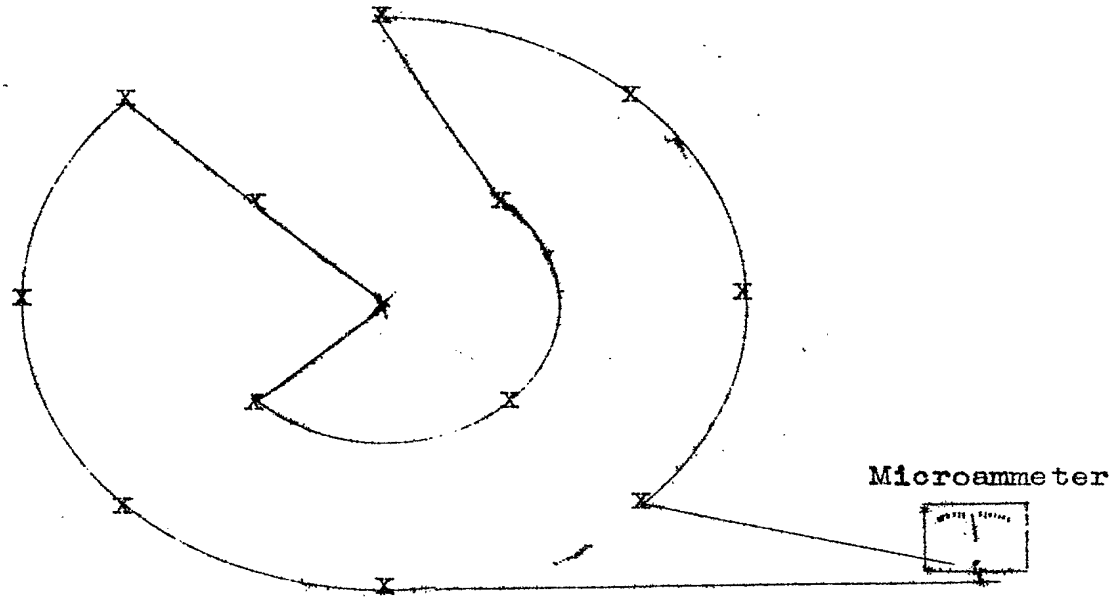


APPENDIX IV

SUFFIELD FIELD REPORT (FLAME WARFARE) NO. 6

TEMPERATURE RECORDING TARGET

Reference:- H.Q.S. 4354-24-3 (D.C.W.&.S.) dated 11 Feb. 44



PLAN AND WIRING DIAGRAM

The temperature recording target, consists of 13 thermocouples arranged in concentric circles, as shown in the diagram. The outer circle is 12 feet in diameter, and the inner one 6 feet.

The cold junctions are 6 inches below the ground surface and the hot junctions 12 inches above the ground.

The thermocouples are wired in series, and connected to a microammeter calibrated for this system. The average temperature on the target is recorded every 5 seconds from the start of firing.

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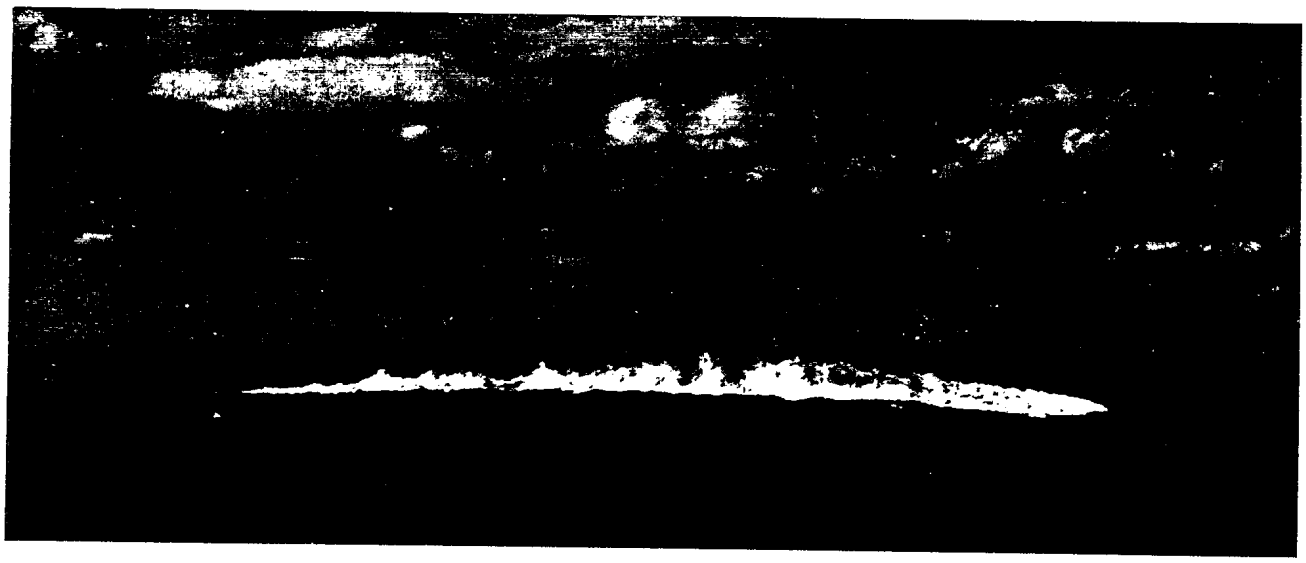
APPENDIX II

SUFFIELD FIELD REPORT (FLAME WARFARE) No.6



2-F-22-736-1

2% of Napalm Fuel. Range:- 65 yds. Tail Wind 8 mi./hr.

2-F-22-736-2

Fuel Oil. Range:- 45 yds. Tail Wind 8 mi./hr.

2-F-22-736-3.

2% of Napalm Fuel. Range:-50 yds. Head Wind 8 mi./hr.
Elevation:- 0°.

2-F-22-736-4.

Fuel Oil. Range:- 35 yds. Head Wind 8 mi./hr.
Elevation:- 0°.

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53-1755