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SYSTEM NUMBER

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TITLE

HIGH SPRAY FROM S.C.I. TYPE S/L 400 ON OBSERVERS

System Number:

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15 SEPT 1963

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EXPERIMENTAL STATION, SUFFIELD, ALTA.

SUFFIELD REPORT NO. 86

SERIAL NO. 23

X DATE 15 SEPT 63

HIGH SPRAY FROM S.C.I. TYPE S/L 400 ON OBSERVERS

(Field Experiment No. 144).

SUMMARY

1. 67 men were exposed to mustard spray from 20 S.C.I. Type S/L 400 charged HTV alloprene (12 poise) released from aircraft flying crosswind at 225 mi/hr. at a height of 10,000 feet. Perspex (0.37 per cent) was added in error to the charging in six of the S.C.I. At the time of spraying, the air temperature was 25°C (77°F.) and the relative humidity 40 per cent.
2. The men were wearing tropical clothing (long limbed) with short limbed summer underwear, drill order and respirators at the gas position. A small number wore U.S. Field Uniforms with U.S. gas masks but without webbing. They wore their clothing for 4 hours in the open after contamination.
3. The average ground contamination density was 0.2 g./m² for drops larger than 1 mm. diameter.
4. 57 of the 67 men were hit by the spray. 50 were within the Zone of Risk. 30 of these developed lesions. 3 of casualty severity. The remainder of the lesions were trivial in nature.

CONCLUSIONS

Under the conditions of this trial, men contaminated with mustard spray from S.C.I. Type S/L 400 released from 10,000 ft. to the minimum density defining the Zone of Risk, stand a small chance of becoming casualties.

Classification / Designation _____

Changed to / Remplacé par U/D

By Authority of C. Laforce

Sur l'Autorisation de _____

Date 26 Feb 98

Appointment D. Kuseler

Fonction _____

WS / JM

H.M. Barrett

X (H.M. Barrett)
Acting Chief Superintendent,
Experimental Station.

46/1679 41

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X EXPERIMENTAL STATION, SUFFIELD, ALTA. X
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HIGH SPRAY FROM S.C.I. TYPE S/L 400 ON OBSERVERS

(Field Experiment No.144)

REFERENCE

1. V. 1 (b), Suffield Priority Programme No. 5 Item IV. 7 (a) and Item

OBJECT

2. To determine the effect on men within the Zone of Risk from high spray from S.C.I. Type S/L 400.

PROCEDURE

3. Details of spraying are given in Appendix II.
4. 67 observers were positioned on the layout in 4 lines $\frac{1}{2}$ mile apart (see Appendix II, Diagram Lines O, Q, S and U).
5. On each line, the observers, placed 1/10 mile apart, stood alternately facing towards and away from the spray. A change in the surface wind at the time of spraying resulted in the contamination striking the observers obliquely.
6. The dress worn was as follows:-

Twenty of the observers were dressed in:

 - U.S. Field uniforms (trousers and blouse)
 - U.S. Summer underwear (short limbed)
 - Full U.S. personal equipment with U.S. gas masks adjusted on the face, but excluding webbing which was not available.

The remaining 47 were dressed in:

 - Tropical shirts (long-sleeved)
 - K.D. long trousers.
 - Summer underwear (short limbed)
 - Drill order, including respirators at the Gas Position and capes A.G. rolled.
7. The observers wearing U.S. uniforms were distributed at random on the observer layout.
8. During the spray, the men stood to attention.
9. After the spray, they applied personal decontamination to any liquid droplets on the bare skin.
10. The contamination density was assessed from 4 jump cards placed 6 feet from each man, one on either side and one upwind of him. The fourth card was placed about 12 feet away.

11. After the spray, the observers were inspected on the layout and the extent and type of contamination on men and the jump cards noted. Photographs were taken of typical degrees and distribution of contamination on the clothing. (See Appendix VI, Plates III - VII).
12. The observers were driven by M.T. to an area in the station where they continued to wear their clothing under observation for a total period of 4 hours. During this time, they sat and lay in the ground in the open.
13. The observers were examined daily for 4 days and suitable lesions were photographed.

RESULTS

14. Meteorological conditions will be found in Appendix I.
15.

Number of observers exposed on layout	67
Number of observers hit by spray	57
Number of observers within the Zone of Risk	50
Number of observers who developed lesions (All these were within the Zone of Risk)	30
Number of casualties	3
Number of non-casualties	
Class III	1
Class IV	26

27 (Note)

(For classification of lesions, see Appendix IV)

Note:

One of the men (S.37 Appendix II) included in this group was struck by a piece of contaminated insulation which broke off one of the S/L 400 in flight. He sustained a number of lesions on the left leg and foot for which he was treated in hospital. His lesions, apart from these, were not of casualty severity.

16. Details of assessment of contamination will be found in Appendix II. Details of weapons and a description of their functioning will be found in Appendix III.
17. Description of the lesions sustained by individual observers will be found in Appendix V.

DISCUSSION

18. The average contamination density aimed at -- 0.2 g./m^2 for drops larger than 1 mm. diameter -- was attained on the greater portion of the area occupied by the observers. (See Appendix II).
19. A few unusually large drops, about 6 mm. in diameter were scattered chiefly on the upwind edge of the observers' layout. In 3 cases, observers were hit by these large drops (O 29, O 31 and Q 35 Appendices II, V and VI Plates I and II) and all 3 men became casualties. The presence of these large drops was possibly due either to the addition of Perspex (0.37 per cent) to the charging of six of the S.C.I., or to the S.C.I. which exploded during emission.
20. Two of these men (O 29 and O 31) were dressed in U.S. uniform.
21. Photographs of typical degrees and distribution of droplet contamination on the clothing will be found in Appendix VI, Plates III - VII.

22. Excepting the cases of the three casualties, the lesions produced by the spray were slight and were chiefly scattered patches of erythema. When blisters developed, they were usually annular in outline, shallow and small (less than 1 cm. in diameter), and were not of casualty severity.
23. One observer (S 37) was struck on the left leg by a piece of waterproof covering of the glass wool insulation (about 18 x 12 in.) which separated from S/L400 which exploded shortly after release. The left trouser leg was heavily contaminated and the clothing was removed as soon as possible (about $\frac{3}{4}$ hour). Burns developed on the foot and leg which required hospital treatment. Since this occurrence can be regarded as fortuitous and since this man sustained no other lesions, he has been included amongst the non-casualties.
24. After contamination, the observers remained about $\frac{3}{4}$ hour on the layout while they were inspected "in situ". Subsequently, they returned by motor transport to the camp area (about one hour's drive) where they lay or sat down in the sun for a further period of 2 hours, making a total wearing period of 4 hours. Evidence derived from previous trials with mustard spray indicates that lesions are likely to be accentuated if the men sit or lie down rather than if they march while wearing the contaminated clothing. (Suffield Report No. 70).
25. When the men were sprayed and until they removed their contaminated clothing, the air temperature ranged between 25 - 30°C. (77 - 86°F), and while they were not sweating, they were warm.

26. Added protection was afforded to men facing the spray by the respirator haversack and ammunition pouches on the Canadian uniforms. American webbing was not available, but in any event the American gas mask container does not offer the same degree of shielding of the body, since being worn by the left side, it protects an area ordinarily shielded in part by the left arm. If two of the casualties O 29 and O 31 had been wearing Canadian respirators instead of American gas masks, that portion of the body where they were contaminated (the neck) would have been protected by the respirator sling and they probably would not have become casualties.

SUMMARY

- 67 men were exposed to mustard spray from 20 S.C.I. Type S/L 400 charged HTV alloprene (12 poise) released from aircraft flying crosswind at 225 mi/hr. at a height of 10,000 feet. Perspex (0.37 per cent) was added to the charging in six of the S.C.I. At the time of spraying, the air temperature was 25°C. (77°F.) and the relative humidity 40 per cent.
- The men were wearing tropical clothing (long limbed) with short limbed summer underwear, drill order and respirators at the gas position. A small number wore U.S. Field Uniforms with U.S. gas masks but without webbing. They wore their clothing for 4 hours in the open after contamination.
- The average ground contamination density was 0.2 g./m² for drops larger than 1 mm. diameter.
- 57 of the 67 men were hit by the spray. 50 were within the Zone of Risk. 30 of these developed lesions, 3 of casualty severity. The remainder of the lesions were trivial in nature.

CONCLUSION

Under the conditions of this trial, men contaminated with mustard spray from S.C.I. Type S/L 400 released from 10,000 feet to the minimum density defining the Zone of Risk, stand a small chance of becoming casualties.

This report was prepared by Major W. Somerville, R.A.M.C.,
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H.M. Barrett
(H.M. Barrett)
A/Chief Superintendent,
Experimental Station.

S.R. 86

APPENDIX I

Meteorological Conditions

Date: 13 Aug 43.
Time: 1130 hours M.D.T.

Meteorological Conditions

Air Temperature	25°C. (77°F.)
Humidity	40 per cent
Wind at 2 metres	180°, 12 to 17ft/sec.
Mean wind to 10,000 ft. above terrain	245° 15 mi/hr.
Sky Condition	Clear

APPENDIX II TO SUFFIELD REPORT NO.

DETAILS OF SPRAYING AND ASSESSMENT OF CONTAMINATION

SPRAYING CONDITIONS

The mean contamination arrived at over the Zone of Risk was 0.22 gm./sq.m. The number of S/L 400 required simultaneously to give this density was 4. They were released in groups of 4 at 5 second intervals in the following distribution:

<u>AIRCRAFT</u>	<u>S/L 400 GROUPING</u>
First B 25	2 - 2 - 1 - 1 - 2
Second B 25	1 - 1 - 2 - 2 - 2
A 20	1 - 1 - 1 - 1

giving a total of five groups of 4 S/L 400's at five second intervals.

AIRCRAFT SPEED

225 miles per hour.

SPRAYING HEIGHT

10000 feet above terrain (elevation of terrain 1500 feet).

EMISSION

The S.C.I.'s appeared to emit normally except the third one on the second aircraft which exploded in flight. Slight instability in flight was noted for several. All aircraft did not appear to follow exactly the same track.

ASSESSMENT OF SPRAY

	<u>EXPERIMENTAL RESULT</u>	<u>PREDICTION FROM P.M. 21</u> (for maximum Zone of Risk)
Recovery in drops above 1 mm.	1265 kg.	1130 kg.
Length of Sprayed Area parallel to A/C Track	3100 yards	2750 yards
Area covered by drops greater than 1 mm. diameter	7.5×10^6 sq. yds.	6.7×10^6 sq. yds.
Mean contamination over total area covered by drops greater than 1 mm.	0.20 gm./sq. m.	0.20 gm./sq. m.
Mean contamination on part of above area occupied by observers.	0.22 gm./sq. m.	0.20 gm./sq. m.

It might be interesting to note that in order to have an overall average density of contamination of 0.2 gm./sq.m. for all drops above 1mm. diameter the following densities of contamination will be found in the separate zones corresponding to various drop sizes.

Drop Diam. (mm.)	1-1.5	1.5-2	2-2.5	2.5-3	3-3.5	3.5-4	>4
Density of Contamination in gms./sq.m.	0.1	0.2	0.3	0.3	0.4	0.4	0.7 (?)

ASSESSMENT OF CONTAMINATION DENSITY IN AREA OCCUPIED BY OBSERVERS

The layout consisted of 17 parallel rows 1/8 mile apart normal to the track of the aircraft and extending for a length of 4 miles each. Cards were placed at 1/20 mile intervals. Observers were placed on the sixth row (O) at the odd numbered cards from 23 to 57 inclusive and on the eighth and twelfth rows (Q and S) at the odd numbered cards from 23 to 53 inclusive. On the tenth row (U) the observers were at the odd cards from 23 to 55 with card 49 missed. There were four cards around each observer and the contaminations and drop size are listed below:

Contamination (Average of 4 cards) gm./sq.m.

Drop Diam. Range (mm.)

Observers developed lesions of casualty severity.

Position	Contamination (Average of 4 cards) gm./sq.m.	Drop Diam. Range (mm.)
O 29 x	Card reported free from drops	
31 x	0.40	2.1-6.0
33	0.67	1.6-4.6
35	0.24	1.5-3.2
37	0.16	1.5-2.5
39	0.26	1.5-2.9
41	0.23	1.5-2.2
43	0.16	1.5-1.9
45	0.14	1.2-1.9
47	0.11	1.3-1.9
49	0.16	1.3-1.5
51	0.05	1.3-1.5
53	0.10	1.3-1.5
55	0.11	1.3-1.5
57	0.01	1.0-1.2

Position	Contamination (Average of 4 cards) gm./sq.m.	Drop Diam. Range (mm.)
Q 25	0.0	2.4
27	---	---
29	0.03	1.5-3.0
31	0.19	1.9-4.4
33	0.49	1.3-6.0
35 x	1.10	1.9-6.0
37	0.24	1.7-2.5
39	0.20	1.3-2.5
41	0.18	1.3-2.2
43	0.09	0.5-1.7
45	0.11	1.3-2.0
47	0.14	1.3-1.7
49	0.12	0.8-1.8
51	0.18	0.8-1.7
53	0.09	0.8-1.3

Position	Contamination (Average of 4 cards) gm./sq.m.	Drop Diam. Range (mm.)
S 29	0.03	2.1-5.4
31	0.00	2.1
33	0.29	0.6-6.0
35	0.51	1.7-3.6
37	0.39	1.7-3.1
39	0.09	1.6-2.3
41	0.11	0.8-2.1
43	0.14	1.0-3.5
45	0.08	1.0-2.1
47	0.15	1.0-2.1
49	No observer at this position.	
51	0.20	0.6-1.9
53	0.19	1.05-1.70
55	0.11	1.0-1.3

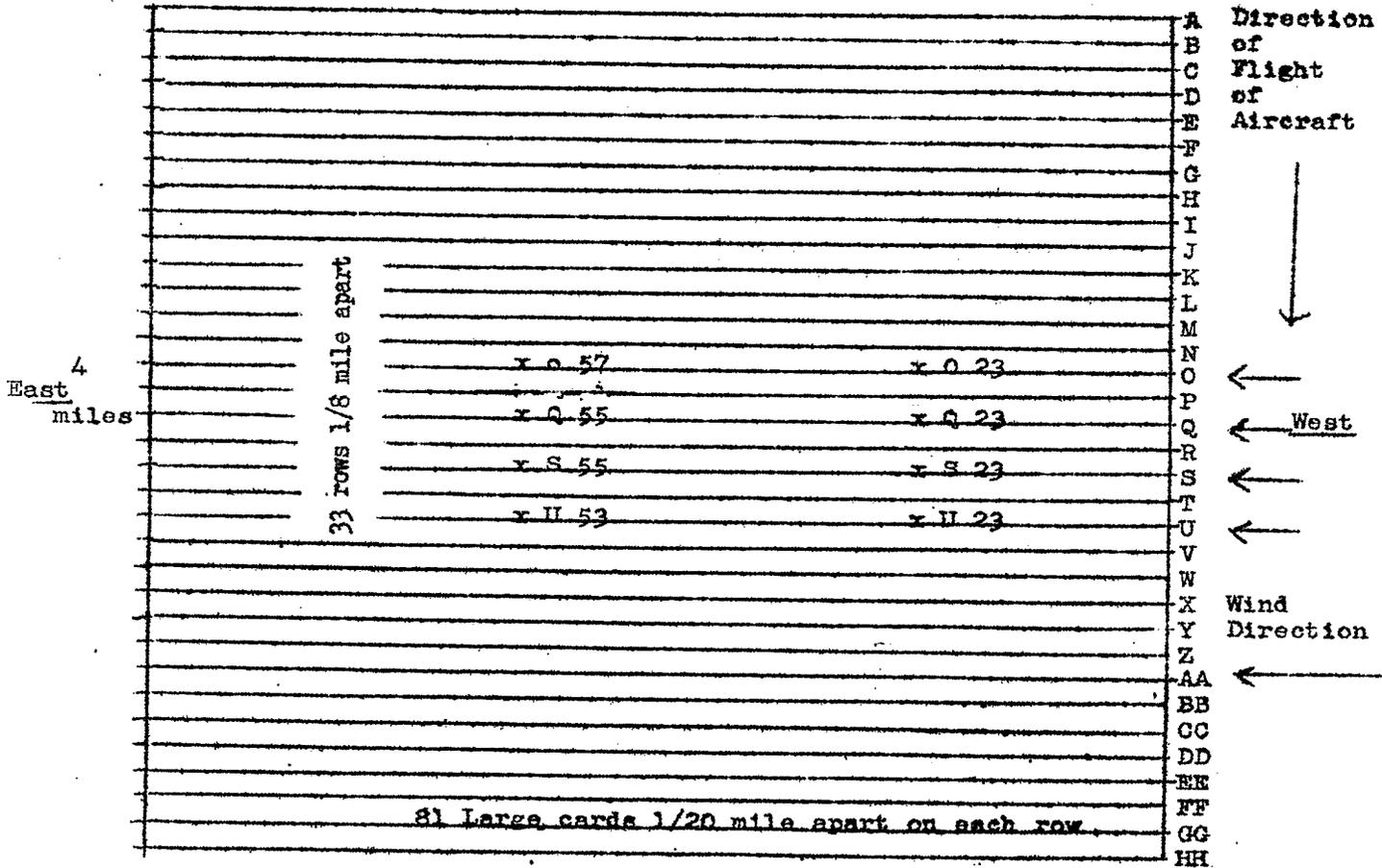
Position	Contamination (Average of 4 cards) gm./sq.m.	Drop Diam. Range (mm.)
U 23	0.00	0.5-1.7
25	0.00	1.3
27	0.00	1.7
29	0.00	2.6
31	0.04	6.0
33	0.17	0.6-6.0
35	0.10	2.8-3.5
37	0.48	2.3-6.0
39	0.27	1.3-2.4
41	0.09	1.3-2.4
43	0.44	1.6-2.3
45	0.11	1.0-2.3
47	0.16	1.3-2.3
49	0.16	1.3-1.7
51	0.09	1.0-2.1
53	0.12	1.0-1.6

x=Casualty

Including all positions from O 29, Q 29, S 33 and U 31 downwind, the mean contamination is found to be 0.2 gm./sq.m., and the observers at these positions can be considered to have been exposed in the Zone of Risk.

DIAGRAM OF LAYOUT FOR SPRAY WITH S/L 400

ATTACHED TO APPENDIX II



81 Large cards 1/20 mile apart on each row.

4 miles x = Observer

APPENDIX V

DESCRIPTIONS OF LESIONS

Note

- (i) Details of Classification of Lesions will be found in Appendix IV.
- (ii) Observers wearing American uniforms who developed lesions are indicated by an x.
- (iii) Observers whose identification numbers are not entered sustained no lesions.

<u>POSITION</u>	<u>LESIONS</u>	<u>CLASSIFICATION</u>
O 29 ^x	On the left wrist 3 vesicles developed (i) 1.8 x 1.5 cm. (ii) 0.5 x 0.5 cm. (iii) 0.5 x 1.0 cm. At 24 hours an area of intense erythema 8 x 5 cm. was present on the nape of the neck which progressed to vesication within 48 hours.	<u>CASUALTY</u> <u>(Class II)</u>
O 31 ^x	At 24 hours a band of vesication, 22 cm. in length and 4 - 6 cm. wide, stretched around the left side of the neck. Several large vesicles were situated within this area (i) 4.5 x 2 cm. (ii) 2.5 x 4 cm. (iii) 2.0 x 2 cm. The intervening space was occupied by pin point vesication. By 48 hours the lesions had reached their maximum size. On the outer aspect of the left thigh a diffuse area of erythema developed, but no vesication occurred.	<u>CASUALTY</u> <u>(Class II)</u>
O 33	2 minute vesicles appeared on the right knee. There were scattered areas of erythema on right thigh with a diffuse area of mild erythema on the left thigh.	NON-CASUALTY (Class IV)
O 35	A vesicle, 1 cm. in diameter, appeared below the nape of the neck. There were scattered small areas of erythema over the left hip.	NON-CASUALTY (Class IV)
O 37	Below the nape of the neck, a diffuse area of erythema, 3 cm. in diameter appeared. A similar area developed below the right shoulder blade. There were 2 vesicles, 1 cm. in diameter, on the right loin and an area of erythema, 3 cm. in diameter, on the right buttock.	NON-CASUALTY (Class IV)
O 39 ^x	A small area of erythema developed on the left shoulder.	NON-CASUALTY (Class IV)
O 41	2 small blisters, 1 cm. in diameter, developed on the left shoulder. A vesicle, 0.5 cm. in diameter, and 2 small areas of erythema appeared on the right shoulder. There was a vesicle, 1 cm. in diameter, on the right buttock.	NON-CASUALTY (Class IV)
O 45	A minute vesicle appeared on the right shoulder, a cluster of small vesicles on the right buttock, and a minute vesicle above the bend of the right knee.	NON-CASUALTY (Class IV)
O 47	On the left foot there was one small area of erythema.	NON-CASUALTY (Class IV)
O 49 ^x	On the right wrist and thigh there were a few scattered areas of erythema.	NON-CASUALTY (Class IV)

<u>POSITION</u>	<u>LESIONS</u>	<u>CLASSIFICATION</u>
Q	<p>Within 24 hours the outer aspect of the left elbow was involved by a vesicated area 11 x 6 cm., consisting of a number of small annular vesicles and one vesicle 2 x 3 cm. This area was surrounded by a larger area of intense erythema with swelling of the tissues. Mobility of the elbow was markedly impaired.</p> <p>An annular vesicle, 2 x 2 cm., developed on the dorsal aspect of the forearm. Minute pinpoint vesicles appeared over the right eye. On the left shoulder there was an annular vesicle 3 x 3.5 cm. After 48 hours the lesion on the left shoulder had increased further in size.</p>	CASUALTY (Class I)
Q 39 ^x	There was a vesicle 1 cm. in diameter over the left shoulder, with several small areas of erythema.	NON-CASUALTY (Class IV)
Q 41	On the right buttock there were vesicles 0.5 and 0.7 cm. in diameter, and scattered small vesicles on the left buttock involving an area 10 x 4 cm., with another annular vesicle 1 cm. in diameter close by. There were scattered minute vesicles on the left thigh and left leg. These lesions had reached maturity by 36 hours.	NON-CASUALTY (Class III)
Q 45 ^x	Small scattered areas of mild erythema on the abdomen.	NON-CASUALTY (Class IV)
Q 49	On the left jaw, a vesicle 1.5 cm. in diameter appeared together with a smaller vesicle on the side of the neck.	NON-CASUALTY (Class IV)
Q 53	The only lesion was a minute vesicle over the left wrist.	NON-CASUALTY (Class IV)
Q 55 ^x	2 minute vesicles over the left shoulder blade were the only lesions.	NON-CASUALTY (Class IV)
S 33 ^x	There was an area of erythema about 4 cm. in diameter over the right shoulder with a few pin point vesicles at the centre. A similar small area appeared on the right upper arm.	NON-CASUALTY (Class IV)
S 35	There was a small vesicle on the left shoulder and two vesicles 1 cm. in diameter on the inner aspect of the right calf.	NON-CASUALTY (Class IV)
S 37	<p>This man was struck on the left leg by a piece of contaminated waterproof covering which separated from a S/L 400 which exploded during flight. The left trouser leg was deeply stained with liquid mustard. The trousers, but not the boots, were changed after $\frac{5}{4}$ hour. He developed an area of vesication 2 x 2 cm. on the left knee and a diffuse area of erythema down the leg to the ankle. A few vesicles, 0.5 to 1 cm. in diameter appeared on the left foot.</p> <p>Apart from these lesions, this man had a few trivial areas of erythema on his back. He was treated in hospital for the more serious injuries, but for purposes of assessment was classed as a non-casualty.</p>	NON-CASUALTY (Class III)
S 39	There was a patch of erythema on the left shoulder.	NON-CASUALTY (Class IV)
S 43	The only lesion was a vesicle 2.5 x 1 cm. on the left side of the neck.	NON-CASUALTY (Class IV)
S 45	The only lesion was a small area of erythema on the right side of the neck.	NON-CASUALTY (Class IV)
S 47	The only lesion was a small area of erythema on the right side of the neck.	NON-CASUALTY (Class IV)
S 51	Examination at 24 hours showed nothing. At 48 hours, an area of erythema 4 cm. in diameter appeared over the left side of the abdomen.	NON-CASUALTY (Class IV)

POSITION

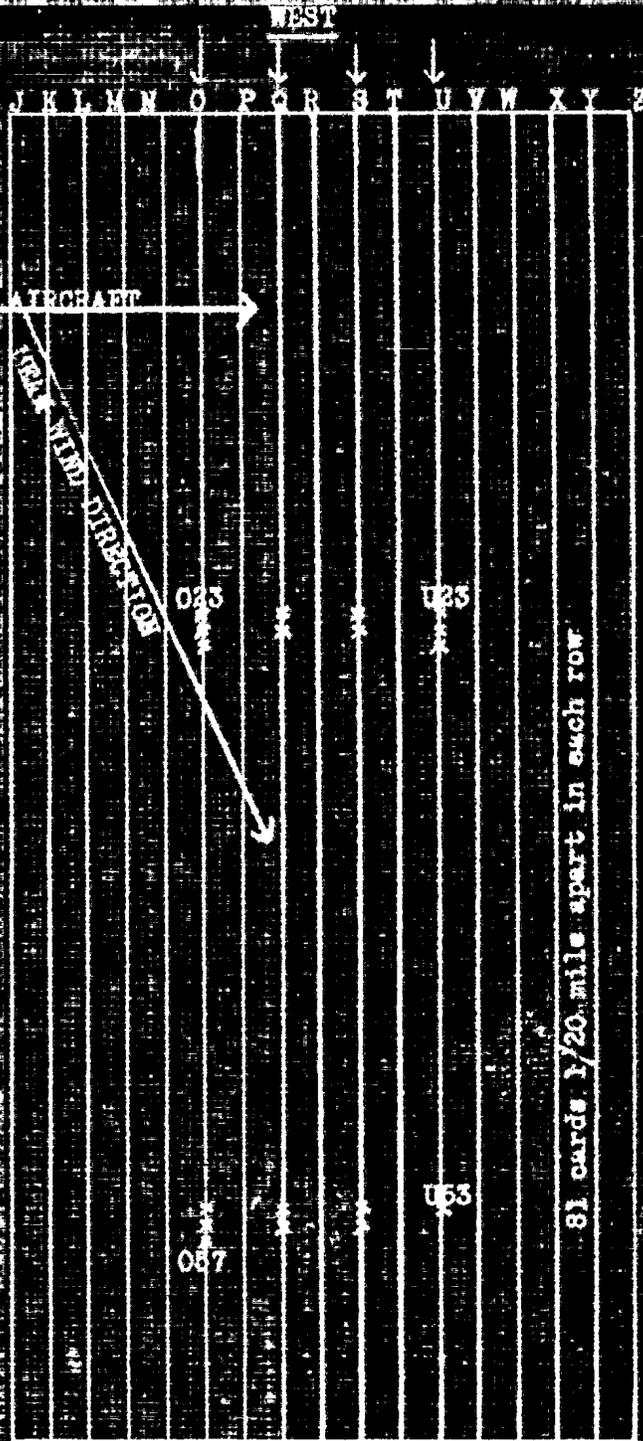
LESIONS

CLASSIFICATION

U 33 ^x	There were 2 medium areas of erythema on the right side of the chest, and an annular vesicle 2.5 x 1.5 cm. on the scalp. The space between the lobe of the right ear and the scalp was occupied by a cluster of small blisters.	NON-CASUALTY (Class IV)
U 37	There was an area of erythema 4 cm. in diameter on the left arm.	NON-CASUALTY (Class IV)
U 39 ^x	On the right shoulder a small area of erythema, and on the right forearm a small area of erythema with central pin point vesication appeared. The bend of the left elbow was crossed by 3 linear areas of erythema, which did not interfere with the mobility of the joint in any way.	NON-CASUALTY (Class IV)
U 45 ^x	Over the left shoulder blade there were scattered small areas of erythema. The depression between the shoulder blades was occupied by an area of erythema 10 x 2 cm. There were a few scattered vesicles on both wrists, and on the left knee.	NON-CASUALTY (Class IV)
U 47	Small areas of erythema developed on the left shoulder, left side of neck and left upper arm.	NON-CASUALTY (Class IV)

DIAGRAM OF LAYOUT FOR SPRAY WITH S/L 400

ATTACHED TO SUPFIELD REPORT NO. (APPENDIX II



OBSERVER

2 MILES

17 ROWS 1/8 Mile apart



Plate I

5-P-64-495-5

Observer 0 31

Average contamination density on adjacent cards: 0.4 gm/sq.m.

Drop range 2.1 to 6.0 mm.

This man became a casualty from the lesion produced by the large drop on the left side of neck.



Plate II

5-P-64-495-13

Observer Q 35

Average contamination density on adjacent cards: 1.1 gm/sq. m.

Drop range: 1.9 to 6.0 mm.

This man became a casualty from an extensive lesion involving the bend of the ~~last~~ elbow



Plate III

5-P-64-495-4

Observer U 39

Average contamination density on adjacent cards: 0.3 gm/m^2 .

Drop range: 1.3 to 2.4 mm.

This man developed a small area of erythema on the right shoulder and three small linear areas of erythema involving the bend of the left elbow.



Plate IV

5-P-64-495-12

Observer sS 53

Average contamination density on adjacent cards: 0.2 gm/m^2 .

Drop range: 1.0 to 1.7 mm.

This man developed no lesions.



Plate V

5-P-64-495-9

Observer U 47

Drop stains can be seen on sleeve, trousers and equipment. Range of drops on jump cards was 1.3 - 2.3 mm. Average contamination 0.2 gm/m².

This man developed small areas of erythema on the left side of neck, shoulder and upper arm.



Plate VI

5-P-64-495-4

Observer O 41

Average contamination density on adjacent cards was 0.2 gm/m^2 .
Drop range was 1.5 to 2.2 mm.

2 vesicles, 1.6cm. and 1.1 cm. in diameter developed on left shoulder. One vesicle 0.7 cm. in diameter appeared on the right shoulder with two small areas of erythema. On the upper part of the right buttock, there was a vesicle 1.0 cm. in diameter and 2 small areas of erythema. This man was a non-casualty.

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