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**TITLE**

500-LB.A/C L.C. BOMB CHARGED MUJSTARD GAS \ (HTV\ (MM\)\): REPORT OF AN ACCIDENT AT  
THE EXPERIMENTAL STATION, SUFFIELD, ALBERTA, 15 APRIL 1944

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EXPERIMENTAL STATION  
✓ SUFFIELD, ALBERTA

✓ TECHNICAL MINUTE NO. 61

500-LB. A/C L.C. BOMB CHARGED MUSTARD GAS (HTV(MM))

REPORT OF AN ACCIDENT AT THE EXPERIMENTAL STATION,

SUFFIELD, ALBERTA, ON 15 APR 44

SUMMARY

1. An accident is described in which one 500-lb. A/C L.C. bomb charged HTV(MM) exploded when partly out of the bomb bay of a stationary Boston A/C. Only the tail fuze functioned. The charging threw heavy contamination onto the clothing of a number of personnel, who, having received a very short warning, were attempting to get away from the near vicinity of the bomb.
2. Fragments struck a number of personnel in the vicinity of the A/C, seriously injuring two of them.
3. Even though mustard gas contamination of the clothing was severe in a number of cases, it was possible to prevent serious lesions developing by rapid removal of the contaminated clothing and the quick application of personal decontamination. A number of mustard gas lesions did occur but with two or three exceptions these were trivial and of no consequence.
4. The most severely burned case was a man who sustained, in addition, traumatic injuries. In the first-aid treatment of this case, precedence was given to the treatment of these injuries and a delay in the completion of personal decontamination resulted.
5. One man, whose thigh, covered only by battle dress and underclothing, was penetrated by a metal fragment of less than one inch diameter, showed no signs of systemic poisoning from mustard. It was estimated that such a fragment could have been contaminated with 93 mg of mustard but there was no evidence as to whether or not the fragment which penetrated the man's thigh was contaminated.

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*J. L. Patterson*  
for (E.L. Davies)  
Chief Superintendent,  
Experimental Station.

HLD/EH

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28 JUNE 44

EXPERIMENTAL STATION  
SUFFIELD, ALBERTA

TECHNICAL MINUTE NO. 61

500-LB. A/C L.C. BOMB CHARGED MUSTARD GAS (HTV(MM))

REPORT OF AN ACCIDENT AT THE EXPERIMENTAL STATION,

SUFFIELD, ALBERTA, ON 15 APR 44.

INTRODUCTION

1. This report describes the circumstances and results of the accidental explosion of a bomb A/C L.C. 500-lb. charged mustard gas (HTV(MM)).
2. Injuries to personnel resulting from contamination by mustard gas and from fragments of the bomb casing are described.

THE MUNITION INVOLVED IN THE ACCIDENT

3. Two bombs A/C L.C. 500-lb. Mk.II, No. 42 fuzing and Chorley burster in tail. No. 12 capsule.

TYPE OF MUSTARD GAS CHARGING

4. 172 lbs. HTV(MM) dyed blue.  
Percentage of MM -  $\frac{600,000}{\text{molecular weight}}$   
Temperature of charging  
at time of accident -6°C approx.

CIRCUMSTANCES OF THE ACCIDENT

5. On 15 Apr 44 a Boston A/C (A.20 C.III A) with a crew of two R.C.A.F., one R.A.F., and one Canadian Army personnel was engaged in Field Experiment No. 210 (Flight Cooling Trial of 500-lb. A/C L.C. Bombs Charged HBDV(MM) and HTV(MM)). The A/C was carrying two 500-lb. L.C. bombs charged HTV (MM).
6. The object of the trial was to check the rate of cooling of the 500-lb. A/C L.C. bomb charged HTV(MM) in flight and to assess its performance visually after cooling for three hours at -20°C. This necessitated the A/C flying at an altitude of 17,000 feet, (at which height the temperature of -20°C. was attained), for a period of four hours. After this time an attempt was made to release the bombs as laid down in the trial programme. The bombs, however, failed to fall free of the A/C.

■ above sea level.

7. When the A/C parked on return to the hangar, the bomb doors were opened part way allowing one bomb to fall partially out of the bomb bay. In falling the tail fuze of this bomb was actuated so that the bomb exploded after a delay, presumably, of 12 seconds. The other bomb did not function. Heavy liquid mustard gas contamination was thrown into the bomb bay, on the fuselage, wings, nacelles, and propellers of the A/C, onto the ground and onto personnel close by. Fragments struck a number of persons in the vicinity, injuring two of them severely and causing damage to the body of the A/C.

#### METEOROLOGICAL CONDITIONS AT THE TIME OF THE ACCIDENT

8. Time: 1220 hrs., MDT., 15 Apr 44.  
 Weather: High overcast.  
 Wind: S.W. 14 mi/hr. at 6 ft.  
 Air Temp.: 11°C. (52°F.)  
 Visibility: Unlimited.

#### INJURIES TO PERSONNEL BY MUSTARD GAS

9. Injuries to personnel resulted from contamination with liquid mustard gas and from fragments. Eighteen persons in all were contaminated by liquid mustard gas. At the instant of the explosion, seven of these were in the vicinity of the A/C, that is to say, they were either emerging from the A/C or were within 15 yards of it. These seven men were heavily contaminated on their clothing and in some cases on the bare skin of the neck, face, and hands. The other eleven men who were contaminated had run to the scene of the accident after the explosion, or had assisted in the decontamination of the men or of the area involved.

10. Decontamination by means of A.G. ointment No. 2 was carried out within 2 to 15 minutes (in most cases within 10 minutes), either by the persons themselves or by helpers. Facilities for washing out the eyes were available at the site of the accident but they were not utilized until at least 30 minutes had elapsed. Each of the 18 men developed mustard gas burns but in only 2 of them were the burns of any significance. No liquid burns of the eyes developed.

#### INJURIES CAUSED BY METAL FRAGMENTS

11. Four of the seven persons in the vicinity of the A/C at the time of the accident were struck by fragments. Two men sustained serious injuries:-

- (a) A compound fracture of three bones of the right foot from a glancing blow from a bomb fragment. (Sgt. Morrison)
- (b) A penetrating wound of the right thigh with rupture of the main blood vessels and nerve of the limb, (L.A.C. Fallis). These injuries eventually necessitated amputation of the leg.

12. In the case of the last named individual it was soon apparent that a metal fragment, possibly coated with mustard, had traversed battle dress and the soft tissues of the thigh. The size of the entrance and exit wounds suggested that this fragment could not have been larger than one inch in diameter. As it was feared that any mustard on the fragment might have been absorbed directly through the damaged tissues, investigations were carried out to determine the amount of mustard that might have been adherent to the material and a close watch on the patient was kept for signs of systemic poisoning. The results of these investigations were as follows:

1. Examination of the skin adjacent to the skin wound either at the time of undressing the man or at the time of operation, did not reveal any visible sign of dye.
  - ii. Segments of skin removed from the wound of entry several hours after the accident were analysed chemically. While the test for mustard in tissues is not extremely fine, it can be said that there was less than 0.5 mg. of thiodiglycol present from the hydrolysis of mustard.
  - iii. Three fragments of the bomb were recovered from the ground at the site of the accident and their mustard contamination (from the amount of dye present) was 0.6 mg/sq cm, 2.1mg/sq cm, and 14.5 mg/sq cm respectively. The fragments from the A/C were found (by dye content) to be contaminated to an extent of 0.3 and 1.1 mg/sq cms respectively.
  - iv. Daily blood examinations were carried out for one week on the injured man. The results are given in detail in Appendix "A". No evidence of systemic poisoning by mustard was found; immature cells of the granulocyte series were noted but these were interpreted as a reaction to severe acute haemorrhage, not to mustard gas.
13. More details on the clinical course of the two casualties from fragments are given in Appendix "B" together with a brief report on two men who were heavily contaminated with mustard.

#### DISCUSSION

14. When the explosion occurred, the bomb was partly out of the bomb bay. Only the tail fuze was actuated.
15. The dispersion of the charging and of the fragments of bomb casing was restricted by the body of the A/C. Heavy mustard contamination was thrown up into the bomb bay, down to the ground, and onto the fuselage and nacelles of the A/C. (See Plate I.)
16. At the instant of the explosion there were 7 men in close proximity to the A/C, i.e. either within or just outside of the A/C or within 15 yards of it. Four of these men had been flying for four hours at a temperature of  $-20^{\circ}\text{C}$  and were suitably clad in heavy flying suits, battle dress, shirts and underwear. Even though these men were grossly contaminated with liquid mustard gas their thick clothing gave them adequate protection and three of them sustained no significant burns. The fourth man, (Sgt. Morrison) was left lying on top of his partially removed, contaminated flying clothes for approximately 45 minutes after the accident. He was restless during the interval and it is possible that his legs became contaminated at this stage. He developed areas of vesication on both thighs.
17. Decontamination measures were promptly instituted and consisted of the application of A.G. ointment No. 2 and in the removal of grossly contaminated clothing. In the majority of cases these measures were carried out within 10 minutes of the accident. In the case of the two severe casualties from fragments decontamination was delayed until haemorrhage was stopped, i.e. for about twenty minutes.
18. No eye effects attributable to droplets of liquid mustard gas occurred, even though some of the men were contaminated on the face with droplets of the agent. In at least one case (Cpl. Oates) contamination of the eyes was almost certainly prevented by spectacles, the lenses of which showed a number of small drops of mustard on them.

19. Another man, L.A.G. Caron, was heavily contaminated over the lower part of the face and mouth with liquid mustard gas. He maintains that he tasted the agent within his mouth and spat out blue coloured saliva. On his own initiative he put A.G. ointment No. 2 into his mouth, rubbed it around with his finger, and then spat it out. After these measures had been applied, inspection showed blue dye on the gums below the dental margin. This man developed considerable vesication of the lower portion of his face and neck. There were no lesions or any discomfort inside his mouth. Complete blood counts were done on alternate days for 10 days. No change was noted.

#### SUMMARY AND CONCLUSIONS

20. An accident is described in which one 500-lb. A/C L.C. bomb charged HTV(MM) exploded when partly out of the bomb bay of a stationary Boston A/C. Only the tail fuze functioned. The charging contaminated the bomb bay, fuselage, engine nacelles and propellers and threw heavy contamination onto the clothing of a number of personnel nearby.

21. Fragments struck a number of personnel in the vicinity of the A/C, severely injuring two of them.

22. Even though mustard gas contamination of the clothing was severe in a number of cases, it was possible to prevent serious lesions developing by rapid removal of the contaminated clothing and the quick application of personal decontamination. A number of mustard gas lesions did occur but with two or three exceptions these were trivial and of no consequence.

23. The most severely burned case was a man who sustained in addition, traumatic injuries. In the first-aid treatment of this case, precedence was given to the treatment of these injuries and a delay in the completion of personal decontamination resulted.

24. One man whose thigh, covered only by battle dress and under-clothing, was penetrated by a metal fragment of less than one inch diameter, showed no signs of systemic poisoning from mustard. It was estimated that such a fragment could have been contaminated with 93 mg of mustard but there was no evidence as to whether or not the fragment which penetrated the man's thigh was contaminated.

This report was prepared by E/L<sup>X</sup> H.L. Dobson, of the Physiology Section, Experimental Station.

*J. E. Paterson*  
for (E.L. Davies)  
Chief Superintendent,  
Experimental Station.

APPENDIX "A" /

HAEMATOLOGICAL REPORT ON L.A.C. FALLIS FOR ONE WEEK  
FOLLOWING INJURY TO THIGH BY BOMB FRAGMENT

Time after Injury	3 hours	2 days	3 days	4 days	5 days	6 days	7 days
RBC	Lost	3,695,000	3,990,000	3,800,000	2,990,000	4,190,000	3,880,000
WBC	Lost	8,000	6,700	8,200	7,100	10,700	11,200
Hb per cent	Lost	56	62 (Transfusion)	62	59 (Transfusion)	77	74

DIFFERENTIAL LEUCOCYTE COUNT

	200	300	200	200	200	300	200
Number of Cells Counted	200	300	200	200	200	300	200
Non-segmented Neutrophils	12	14	12	15	9	11	19
Mature Neutrophils	77	74	55	60	55	68	58
Eosinophiles	0	0	5	2	5	1	2
Basophiles	0	0	1	0	1	2	0
Lymphocytes	8	11	24	18	28	16	20
Monocytes	3	1	3	5	2	2	1
Number of promyelocytes or myelocytes for every 100 Leucocytes	0	4	3	4	5	3	3



APPENDIX "B"

SGT. MORRISON A.G.

1. This N.C.O. was one of the four members of the crew who were dressed in heavy flying kit. He was within a few feet of the A/C when the bomb exploded and was struck on the right foot a glancing blow by a fragment. He ran a few steps and fell on the contaminated ground. His clothing, face and hands were contaminated heavily with liquid mustard. He had splashes of liquid agent on the chin, angle of the mouth, forehead and around the eyes and ears.
2. Decontamination of his face was begun within a few minutes of the explosion but was not completed adequately until his arrival in hospital some fifteen minutes later, nor were his eyes irrigated with water until his admission to hospital. After irrigation, an albucid solution (2½ per cent) was instilled into each eye. He lay on top of his partially removed flying clothes for approximately forty-five minutes after the accident.
3. No eye effects developed. Vesication appeared on the chin and a number of small discrete areas of erythema were noted on the hands and wrists. An area of vesication about three inches square developed on the front of the right thigh and a similar but less severe lesion on the left thigh.
4. In addition to his mustard gas burns, this N.C.O. sustained compound fractures of the second and third metatarsal bones and the cuneiform bone of the right foot.

L.A.C. FALLIS C.S.

5. This man was about 30 feet from the A/C when the explosion occurred. He was dressed in battle dress. A metal fragment entered the back of his right thigh and emerged through the front. Profuse haemorrhage from the wound occurred. A tourniquet was applied within three minutes but it was estimated that by this time he had lost at least one quart of blood. There were large splashes of mustard gas on his trousers and tunic and drops on his face. No decontamination was carried out, nor were his trousers removed (because of the tourniquet) until his arrival in hospital approximately 15 minutes after the explosion, when his trousers were removed and his face decontaminated. No mustard burns resulted.
6. An exploratory operation revealed that the femoral artery and vein were completely severed and the accompanying nerve partially severed. The leg was amputated below the knee eleven days after the accident. Transfusions of 500 cc. of citrated blood were performed on the third and fifth days respectively. Details of daily blood examinations, carried out for one week, are given in Appendix "A".

CPL. OATES F.T.

7. This N.C.O. was about 20 feet from the site of the explosion. He was dressed in flying kit which was heavily contaminated by liquid mustard gas. He had numerous small drops of liquid agent on the scalp, the forehead, right cheek and right ear. Within three minutes of the explosion Cpl. Oates removed his clothing and applied personal decontamination. The only lesions which developed were a number of small patches of erythema and tiny vesicles on the right side of the face.

SGT. BOISMER J.T.O.

8. This sergeant was in charge of the ground crew at the time of the explosion. He was about 15 feet from the aircraft and had his back to the blast. He was hit on the back of the left hand by a fragment and received a laceration of the index finger and knuckle.

2.

9. He was unable to apply personal decontamination until about half an hour after the accident as he was engaged on duties arising from the emergency.
10. He developed erythema and vesication over the backs of both hands and large areas of vesication on both buttocks. There was a string of small vesicles over the right ear and down the neck. One vesicle formed on the right heel 80 hours after the accident.

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EXPERIMENTAL STATION PHOTOGRAPH

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