

## **WARNING / AVERTISSEMENT**

**The documents released are a result of a request under the *Access to Information Act*. Therefore, the pagination on the following pages does not necessarily correspond to the pagination of the original file. In order to publish on our website, the following documents were also subject to a copyright verification and additional content may have been removed to be compliant with the *Copyright Act*.**

**Les documents divulgués sont le résultat d'une demande sous la *Loi sur l'Accès à l'information*. Donc, la pagination des pages suivantes ne correspond pas nécessairement à la pagination du dossier original. Afin d'être conforme à la *Loi sur le droit d'auteur* pour fin de publication à notre site Web, une vérification des droits d'auteur a également pris place et du contenu additionnel pourrait avoir été retiré.**

DEPARTMENT OF NATIONAL DEFENCE

BIOLOGICAL WARFARE -  
GENERAL

FOR CROSS REFERENCES SEE INSIDE COVER

ROUTING				P.A. & B.F. ENTRIES				REGISTRY ONLY	
REFERRED	REMARKS	DATE OF PASS	INITIALS	DATE OF P.A.	INITIALS	DATE OF B.F.	CANCEL B.F.	DATE RECEIVED	IN- SPECTED
CS	With Papers	31/5/63	ES						
Min	comment?	31/5/63	LP						
POD		4-6-63	108						
D/F		13-6-63	LB						
LD		17/6/63	ES						
ES	With Papers	27/8/63	ES						
POD	Commendation	27/8/63	108						
CS		11/9/63	ES						
CS	With Papers	21/9/63	ES						
SIR	for action	21/10/63	ES						
CS		22/10/63	ES						
CS	With Papers	29/1/63	ES						
AT/O		29/1/63	108						
POD		20/6/63	108						
SIR	infection								
Micro									
Micro	Reg								

FEDERAL RECORDS CENTRE  
PRAIRES NORTHWEST REGION  
NATIONAL ARCHIVES OF CANADA  
ARCHIVES NATIONALES DU CANADA  
CENTRE FEDERAL DE DOCUMENTS  
REGION DES PRAIRES ET DU  
NORD-OUEST

A/1750/w

"B.F." — DO NOT HOLD THIS FILE WHEN  
LAPSE IN ACTION MAY EXCEED 48 HOURS.

CR 7  
82M-4-56 (M-8759-560)  
HQ. 2-815-CR 7

—

**FILE  
No.**

[illegible]

**NOT TO BE REMOVED FROM FILING CABINET**

C. R. 109  
300M-9-53 (M-6972-26)  
HQ. 200-115-C.R. 109

FILE  
No.

1800-1

CHARGED OUT					RETURNED		
TO	PER	DATE		BY	DATE		FILED BY
64	P	24	8	62	4		
2F	P	24	8	62	4	21	9
S7	37	4	9	62	B	4	9
C8	m	10	9	62	B		
P.R.S	P	11	9	62	B		
Bact	P	18	9	62	B	20	9
CS	m	28	9	62	B		
Bact	P	28	9	62	B	4	10
P.R.S	R	16	11	62	B	19	11
CS	m	10	12	62	B		
Bact	P	10	12	62	B		
P.R.S	P	11	12	62	B		
ATHO	P	19	12	62	B	21	12
CS	m	21	1	63	B		
P.R.S	P	21	1	63	B	24	1
S7	R	28	2	63	B	1	3
C8	m	31	5	63	B		
Micro	P	31	5	63	B		
P.R.S	P	4	6	63	B		
S7	P	14	6	63	B		
64	P	18	6	63	B	20	6
68	M	27	8	63	B		
P.R.S	P	27	8	63	B	11	9

NOT TO BE REMOVED FROM FILING CABINET

C. R. 109  
300M-5-53 (M-8972-26)  
HQ. 200-115-C.R. 109

FILE  
No.

SES S. 1800-1

CHARGED OUT					RETURNED		
TO	PER	DATE			DATE	FILED BY	
CS	m	23	2	61	B		
SR	P	23	2	61	B		
Library	P	27	2	61	D	27	2 61 B
Phyp	P	13	4	61	B	14	4 61 B
Bact	R	14	4	61	B	17	4 61 B
Bact	R	22	8	61	B	8	9 61 B
Bact	T	28	12	61	B	28	12 61 B
CR(S)	M	30	3	62	B	30	3 62 B
CS	M	13	4	62	B		
PR	TDI	16	4	62	B	16	4 62 B
SR	P	16	4	62	B		
PRS	P	17	4	62	B		
SR	TDI	16	4	62	B	18	4 62 B
SZ	P	17	4	62	B		
PRS	TDI	18	4	62	B	27	4 62 B
CS	P	25	4	62	B		
SZ	P	27	4	62	B		
SZ	P	27	4	62	B		
SR	P	27	4	62	B		
SR	TDI	27	4	62	B	29	8 62 B
Bact	TD2	30	7	62	G	31	7 62 G
SR	TD2	31	7	62	G		
RRS	P	14	8	62	B		
SR	P	22	8	62	B		

NOT TO BE REMOVED FROM FILING CABINET

C. R. 109  
300M-9-53 (M-6972-26)  
HQ. 290-115-C.R. 109

FILE  
No.

SES S. 1800-1

CHARGED OUT						RETURNED		
TO	PER	DATE		BY		DATE	FILED BY	
PRS	P	21	9	60	K	21	9	60
CS	M	17	10	60	D			
Bact	P	18	10	60	D			
Ptm	P	21	10	60	B	21	10	60
SR	BF	24	10	60	K	28	10	60
Chm	BF	3	1	60				
CS	BF	31	10	60	K	1	11	60
CS	M	4	11	60	B	7	11	60
CS	M	14	11	60	B			
SR	P	14	11	60	L			
PRS	P	14	11	60	D			
ATLO	P	16	11	60	R	17	11	60
CS	M	22	12	60	B			
SR	P	22	12	60	L			
PRS	P	27	12	60	B			
ATLO	P	27	12	60	B	29	12	60
CS	M	30	12	60	B			
Bact	P	3	1	61	L	<del>4</del>		
PRS	P	4	1	61	L			
ATLO	P	6	1	61	L			
SR	P	9	1	61	L	12	1	61
PRS	R	17	1	61	B	18	1	61
CS	M	10	2	61	B			
Bact	P	15	2	61	B			

NOT TO BE REMOVED FROM FILING CABINET

SR P 13-2-61B

15-2-61B

C.R. 109  
300M-9-53 (M-6972-26)  
HQ. 200-115-C.R. 109

FILE  
No.

SES S.1800-1

CHARGED OUT					RETURNED		
TO	PER	DATE		BY	DATE	FILED BY	
Bact	P	14	10	59	10		
SR	M	1	12	59	10		
Bact	P	2	12	59	10		
PRS	P	2	12	59	B		
SF	P	3	12	59	10		
PVM	P	4	12	59	10	7	12 59 10
SR	M	11	1	60	10		
Bact	P	11	1	60	B		
PRS	P	12	1	60	B		
S.F.	P	12	1	60	B		
Bact	P	13	1	60	10	14	1 60 B
S.I.							
CS		15	2	60	B		
Phys	P	15	2	60	B		
SR	P	18	2	60	10		
Bact	P	19	2	60	10	19	2 60 B
SR	M	21	8	60	B		
Bact	P	11	8	60	10		
PRS	P	12	8	60	B	15	8 60 10
CS	M	9	9	60	B		
SR	P	9	9	60	10		
ATLD	P	16	9	60	10		
Phys	P	19	9	60	10		
Libins	P	20	9	60	10		

NOT TO BE REMOVED FROM FILING CABINET

C. R. 108  
300M-9-53 (M-6972-26)  
HQ. 200-115-C.R. 100



FILE  
No.

S.1-800-1 VOL.1.

CHARGED OUT					RETURNED		
TO	PER	DATE	BY		DATE	FILED BY	
CS		25 4 58	BJ				
Bact	P	25 4 58	D				
P.R.S	P	25 4 58	BJ				
SR	P	30 4 58	D				
CS	P	2 5 58	D		2 5 58	D	
CS		12 5 58	BJ				
SR	P	12 5 58	D				
P.R.S	P	13 5 58	D				
SF	P	13 5 58	D				
Bact	P	14 5 58	BJ		15 5 58	D	
SF		16 5 58	BJ				
M.T.S.	P	16 5 58			27 5 58	D	
SR		26 5 59	B				
<del>Bact</del> P		26 5 59	B		26 5 59	B	
SR		1 6 59	B				
Bact	P	1 6 59	B		2 6 59	B	
SR	M	6 7 59	Q				
P.R.S	P	6 7 59	Q				
Bact	P	10 7 59	Q		13 7 59	Q	
CS	M	14 9 59	B				
Bact	P	14 9 59	Q				
CS	P	15 9 59	Q		15 9 59	Q	
SR	M	14 10 59	B		15 10 59	B	

NOT TO BE REMOVED FROM FILING CABINET

C. R. 109  
300M-9-53 (M-6972-25)  
HQ. 200-115-C.R. 109

DATE 30 August 1963

DATE 30 August 1963

SECRET ATTACHMENTS

19 June, 1963

Chairman,  
Defence Research Board,  
Ottawa.

Attention DAR B&C

Large Area Coverage by BW Agents

1. Reference is made to your DRBS 1800-1 DAR(B&C) dated 28 May, 1963.

2. Your paper entitled "Large Area Coverage by BW Agents" has been reviewed by several members of the staff at Suffield. Rather than combine their many observations and comments I am attaching them as separate items and trust that you will find them of value in remodelling your presentation.

(A. M. Pennie)  
Chief Superintendent

Encs. Secret

AMP/ad

SECRET

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

COMMENT 1.

Volume 9 of U. S. Army Chemical Corps Operational Research Group Study No. 21 deals with Biological Warfare and Appendix V of this volume, which is the only portion of it which has been made available to SES (Acc. No. 60/5568), has as its object an analysis of the effectiveness of biological weapons for the production of casualties. Such an analysis has to take account of many factors and I honestly believe that the best way to satisfy a DSI request for quantitative information on large area coverage by BW agents would be for DAR to summarise this Appendix. If this is done it should, however, be pointed out to DSI that the factors given in the Appendix for the dependence on meteorological conditions of the loss of viability in aerosols during downwind travel, are based largely on laboratory data and that one of the major problems in BW at the present time is the confirmation of these factors for field conditions.

Specific comments on DAR's paper are:-

para 3(d) Table I - These areas are really meaningless unless the dosage taken to define them is given.

para 3, last sentence - The apparent loss of fluorescence found by the British very probably does not apply to the conditions of the U. S. trials. I suggest this sentence be deleted. The U. S. have been most unsatisfied with several aspects of the sampling and counting techniques used in the U. K., and the U. K. have not so far refuted their criticisms.

para 4 - I do not believe it is correct to imply that generation of aerosols in 1 to 5 micron diameter size presents no great problem.

The best efficiency that can be claimed for aerosol emission from an aircraft spray tank at the present time is probably only 25 per cent. Although the speed of the aircraft has not to my knowledge ever been shown to have any effect on viability, the efficiency will be reduced to a greater or lesser extent, depending on the organism considered, because of kill during the initial rapid evaporation of the wet droplets produced by the spray device.

Agglomeration is not the only problem in dispersing powdered agents. Another major problem is, I believe, the development of a procedure which allows for efficient bulk loading of the powdered agent in the airborne carrier and the efficient break down of the bulk powder into unit particles again at the high rates which will be required for the emissions. This is apart from the problems of producing a dried powdered agent of good viability.

para 5 - Suggest deletion of first sentence of this paragraph.

We do not yet know even how effective the West can be with  
1 live agent with the apparatus it has developed and certainly not what the Russians may be able to do.

It should be mentioned here, along with the reference to the

- 2 -

effect of sunlight, that survival of organisms in aerosol form is also sensitive to relative humidity and temperature.

The meaning of the last sentence is not clear. Is the point that increasing the initial dose will not change the delay time?

para 6 - A much more acceptable procedure for calculating casualty effects from a given source strength and one which does not require the assumption of optimum inversion conditions made in reference (7) of the paper is given in Fort Detrick Technical Memorandum 3-17. The graphs in this paper include estimates for a range of decay rates.

para 7 - What are the justifications for assuming a 50 per cent efficiency for powder dissemination, a ten-fold reduction of viable organisms and an inversion height of 2200 feet?

Table II gives the downwind dimension of the area within which the average casualty rate is predicted to be 50 per cent. This should be carefully distinguished from the downwind distance at which the LD50 is produced.

Why is a decay rate of 2.5 per cent/min chosen as a contrast to no decay? With UL this would still require a relative humidity greater than 87 per cent. I don't know how frequent such conditions are in the Sarnia-Quebec area but the comment on para 9 regarding humidity probably applies.

para 9 - No justification is given in the referenced report for the 80 per cent efficiency assumed in Table III. It seems rather generous.

What are the relative humidity limitations assumed for the agent considered in Table III? If the agent is UL then the requirement would be for a relative humidity above 87 per cent which, as the referenced report says, is rarely if ever likely to be achieved for the several hours of travel over such large areas.

para 10 - I'm not sure that the case made for the vulnerability of the Sarnia-Quebec area will carry much weight unless a detailed study is included of how an enemy might launch an attack against the area and the frequency of weather conditions suitable for a BW attack. I wonder if it is necessary, until more definitive data are available, to provide any more examples of the potential threat from BW than are available in the Operational Research Group Study.

COMMENT 2

Paras 2 and 6 - I should consider that the state of resistance or susceptibility of the target which is governed in part by their past immunological history, and by abnormal states which affect their physiology (e. g. Imbalanced diets, starvation, radiations, etc. ), is frequently as important in assessing BW attack successes or hazards, as the delivery efficiency and agent decay phenomena. Since these factors govern to a large extent resistance to the initiation of infections, as well as the severity of clinical symptoms if infections do occur, their influence in determining the degree of success or failure of BW attack of large or small areas must not be neglected.

Therefore, it would seem an extremely difficult task in some cases to determine realistic 50% casualty figures for a specified target area, unless the dose for the particular susceptible target species is determined, and their immunological history known. Furthermore, post attack factors such as communicability and vector transmission, may have to be considered in determination of casualty figures.

Para 5 - The inherent nature of biological agents makes them best suited in most instances for large scale targets, and therefore a strategic role. This fact would seem to dilute to some extent the possible disadvantages of BW agents, because of the lag between exposure and symptoms in the target population.

Frequently, perhaps too often, the term BW denotes only direct attack against man with biological agents. It may be well to remember that although man is the ultimate target he may also be attacked by successful exposure of his economically important animals and plants.

The following reference may be read to supplement the information contained in this paper:-

"Defence Against Biological Warfare" - A Symposium;  
Military Medicine, 128, 80-146, 1963.

COMMENT 3.

My feeling is that it is still dangerous to extrapolate from FP to living organisms without confirmation of source strength, viability and infectivity from actual field test. Factors of ten can easily be found by slight alteration of conditions, and until we have more data all we can say is that inert particles of size 1 - 5 $\mu$  indicate a possibility of maximum coverage, perhaps up to the figures given in the paper. Trials this Fall at SES, and by the United States and Great Britain in 1964 should do much to provide the data needed to tie the BW picture to that given by FP.

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTASECRET

13 June 1963

MEMORANDUM

To: Chief Superintendent

Fm: H/Planning and Reporting Section

Subject: Comments on paper "Large Area Coverage by BW Agents" by H.R. Richards

Volume 9 of U.S. Army Chemical Corps Operational Research Group Study No. 21 deals with Biological Warfare and Appendix V of this volume, which is the only portion of it which has been made available to SES (Acc. no. 60/5568), has as its object an analysis of the effectiveness of biological weapons for the production of casualties. Such an analysis has to take account of many factors and I honestly believe that the best way to satisfy a DSI request for quantitative information on large area coverage by BW agents would be for DAR to summarise this Appendix. If this is done it should, however, be pointed out to DSI that the factors given in the Appendix for the dependence on meteorological conditions of the loss of viability in aerosols during downwind travel, are based largely on laboratory data and that one of the major problems in BW at the present time is the confirmation of these factors for field conditions.

Specific comments on DAR's paper are:-

para 3(d) Table I - These areas are really meaningless unless the dosage taken to define them is given.

para 3, last sentence - The apparent loss of fluorescence found by the British very probably does not apply to the conditions of the US trials. I suggest this sentence be deleted. The US have been most unsatisfied with several aspects of the sampling and counting techniques used in the UK, and the UK have not so far rebutted their criticisms.

para 4 - I do not believe it is correct to imply that generation of aerosols in 1 to 5 micron diameter size presents no great problem.

The best efficiency that can be claimed for aerosol emission from an aircraft spray tank at the present time is probably only 25 per cent. Although the speed of the aircraft has not to my knowledge ever been shown to have any effect on viability, the efficiency will be reduced to a great or lesser extent, depending on the organism considered, because of kill during the initial rapid evaporation of the wet droplets produced by the spray device.

Agglomeration is not the only problem in dispersing powdered agents. Another major problem is, I believe, the development of a procedure which allows for efficient bulk loading of the powdered agent in the airborne carrier and the efficient break down of the bulk powder into unit particles again at the high rates which will be required for the emissions. This is apart from the problems of producing a dried powdered agent of good viability.

para 5 - Suggest deletion of first sentence of this paragraph.

We do not yet know even how effective the West can be with live agent with the apparatus it has developed and certainly not what the Russians may be able to do.

It should be mentioned here, along with the reference to the effect of sunlight, that survival of organisms in aerosol form is also sensitive to relative humidity and temperature.

The meaning of the last sentence is not clear. Is the point that increasing the initial dose will not change the delay time.

6 - A much more acceptable procedure for calculating casualty effects from a given source strength and one which does not require the assumption of optimum inversion conditions made in reference (7) of the paper is given in Fort Detrick Technical Memorandum 3-17. The graphs in this paper include estimates for a range of decay rates.

para 7 - What are the justifications for assuming a 50 per cent efficiency for powder dissemination, a ten-fold reduction of viable organisms and an inversion height of 2200 feet.

Table II gives the downwind dimension of the area within which the average casualty rate is predicted to be 50 per cent. This should be carefully distinguished from the downwind distance at which the LD50 is produced.

Why is a decay rate of 2.5 per cent/min chosen as a contrast to no decay. With UL this would still require a relative humidity greater than 87 per cent. I don't know how frequent such conditions are in the Sarnia-Quebec area but the comment on para 9 regarding humidity probably applies.

para 9 - No justification is given in the referenced report for the 80 per cent efficiency assumed in Table III. It seems rather generous.

What are the relative humidity limitations assumed for the agent considered in Table III. If the agent is UL then the requirement would be for a relative humidity above 87 per cent which, as the referenced report says, is rarely if ever likely to be achieved for the several hours of travel over such large areas.

para 10 - I'm not sure that the case made for the vulnerability of the Sarnia-Quebec area will carry much weight unless a detailed study is included of how an enemy might launch an attack against the area and the frequency of weather conditions suitable for a BW attack. I wonder if it is necessary, until more definitive data are available, to provide any more examples of the potential threat from BW than are available in the Operational Research Group Study.



(H.J. Fish)

H/Planning and Reporting Section

HJF/md



SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

4 June 1963

## MEMORANDUM:

TO: Chief Superintendent

FROM: H/Microbiology Section

SUBJECT: Observations on paper entitled "Large Area Coverage by BW Agents", by H.R. Richards.

Paragraphs 2 and 6 -

I should consider that the state of resistance or susceptibility of the target which is governed in part by their past immunological history, and by abnormal states which affect their physiology (e.g. Imbalanced diets, starvation, radiations etc.), is frequently as important in assessing BW attack successes or hazards, as the delivery efficiency and agent decay phenomena. Since these factors govern to a large extent resistance to the initiation of infections, as well as the severity of clinical symptoms if infections do occur, their influence in determining the degree of success or failure of BW attack of large or small areas must not be neglected.

Therefore, it would seem an extremely difficult task in some cases to determine realistic 50% casualty figures for a specified target area, unless the dose for the particular susceptible target species is determined, and their immunological history known. Furthermore, post attack factors such as communicability and vector transmission, may have to be considered in determination of casualty figures.

Paragraph 5 -

The inherent nature of biological agents makes them best suited in most instances for large scale targets, and therefore a strategic role. This fact would seem to dilute to some extent the possible disadvantages of BW agents, because of the lag between exposure and symptoms in the target population.

Frequently, perhaps too often, the term BW denotes only direct attack against man with biological agents. It may be well to remember that although man is the ultimate target he may also be attacked by successful exposure of his economically important animals and plants.

The following reference may be read to supplement the information contained in this paper:

Defence Against Biological Warfare - A Symposium; Military Medicine, 128, 81-146, 1963.

*J.R. Maltman*  
(J.R. Maltman)  
H/Microbiology Section

JRM/sp

*Good specific  
comment on  
content of  
H.R.'s paper*

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

17 June, 1963.


MEMORANDUM NO. 47/63

TO: Chief Superintendent

FROM: Superintendent/Field

Comments on Paper "Large Area Coverage by BW Agents" by H.R. Richards

1. The technical details have been covered by H/PRS and H/Micro S.
2. My feeling is that it is still dangerous to extrapolate from FP to living organisms without confirmation of source strength, viability and infectivity from actual field test. Factors of ten can easily be found by slight alteration of conditions, and until we have more data all we can say is that inert particles of size 1 - 5  $\mu$  indicate a possibility of maximum coverage, perhaps up to the figures given in the paper. Trials this Fall at SES, and by the United States and Great Britain in 1964 should do much to provide the data needed to tie the BW picture to that given by FP.

  
(A.P.R. Lambert)  
Superintendent/Field

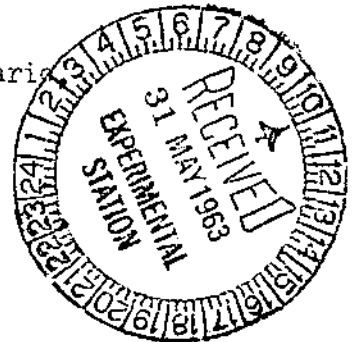


DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD

OUR FILE REF. DRBS 1800-1  
DAR(BAC)

REFERRED TO	CS
C.R.	
1800-1	

Ottawa 4, Ontario  
28 May, 1963.



Chief Superintendent,  
SES.

Large Area Coverage by BW Agents

1. Some time ago a paper entitled "BW Attack Against North America" was prepared by this office in response to a request from the federal civil authorities responsible for public health, who required the information for planning purposes. A copy of the paper was sent to SES.
2. As a sequel, another paper "Large Area Coverage by BW Agents" has been prepared by this office and a copy is attached.
3. Would you please give your comments on this paper together with any suggestions that you think may make the paper more useful to both civil and military authorities.

*Micro S. SP*  
*PRS. attached #B.*  
*SIF*

*Observation*

*H. R. Richards*  
H. R. Richards,  
for Chairman,  
Defence Research Board.

Attach.

## LARGE AREA COVERAGE BY BW AGENTS

### General

1. This paper is a digest of US and British studies and trials carried out on large area coverage (LAC) of terrain by small particles. It has been prepared to meet a request from DSI for quantitative information on large area coverage by BW agents and it supplements a previous review paper from this office on the hazard and threat of BW attack on North America.

2. In dealing quantitatively with LAC by BW agents, the two most important aspects are:

- (a) Long distance travel of particulates.
- (b) Factors affecting disseminating efficiency and the effects of decay of viability and infectivity after aerosolisation.

### Long Distance Travel of Particulates

3. Prior to 1950 little work had been done on area coverage by particles, but during the next decade several trials were carried out, starting with the coverage of relatively small areas and culminating in Operation IAC. These trials include the following:

- a. 1950 (20-27 Sept) Six simulated BW attacks upon the San Francisco Bay area (1) with Bacillus globigii (BG) and Serratia marcescens (SM) released from ships making a course 2 - 6 miles long and 2 - 10 miles offshore. At the same time 10 lb. of fluorescent cadmium zinc sulphide particles, FP (2- $\mu$  diameter,  $6 \times 10^{10}$  particles per g.) were released (2). The best coverage was obtained in the trial when the FP covered 67 sq. miles (including all San Francisco) to at least 200 particle min./l. In general the biological doses were lower than the FP by a factor of ten. It was concluded that it is entirely feasible to attack a seaport city with a BW aerosol generated from a ship or other source located some distance offshore.
- b. 1952 (March-April) Five trials were conducted in which FP were released from a ship travelling a course 100 - 180 miles long, 5 - 10 miles offshore and parallel to the South Carolina - Georgia coastline (3). 200 - 450 lb. of FP were released in each trial and the area covered varied from 13,100 to 34,800 sq. miles with the particles being detected 150 - 435 miles from the source. It was concluded that it is feasible to obtain long range aerosol cloud travel to several hundred miles and large area coverage by aerosol dissemination at ground level if stable layers are present in the lower levels of the atmosphere.
- c. 1957 British trials showed that FP released from aircraft over the North Sea, and 50 miles upwind of the East Coast of Britain, covered most of England (4). It was shown (5) that large area coverage with particles is practicable under most meteorological conditions.

- d. 1957-58. Operation IAC (6). Four trials were carried out over a site consisting of the continental United States east of the Rocky Mountains. F.P. were disseminated from aircraft flying 136 - 156 knots, at 1500 - 3000 ft. With release line lengths of 231 to 1,265 miles the total area coverages were 343,500 to 655,000 sq. miles. Table I shows the quantity of FP used, together with other relevant results for the four trials.

TABLE I  
Results of Operation IAC

Trial	FP (lb.)	Release line (miles)	Release altitude (ft.)	Height of inversion cap (ft. above terrain)	Total Area Covered (square miles)
1	4550	395	1800-2500	2500	343,500*
2	2725	231	2000-2800	2200	655,500
3	3400	880	1500-2000	5000	472,000 (328,000)
4	4200	1265	< 2000	none	524,000 (470,000)

The figures in brackets are for 12-hour coverage, which is the longest time that agents may be expected to travel in the dark. Solar radiation destroys BW agents rapidly.

\* Should be greater, but a large proportion of particles drifted north of the US border.

These trials also showed that FP recoveries in the centre of urban areas were similar to the recoveries at the peripheries and that FP could remain airborne in significantly detectable amount for at least 72 hours after initial release. The FP used in these trials were zinc cadmium sulphide particles, 1 - 5  $\mu$  diameter, with about  $10^{10}$  particles per gram. It may be noted here that the British have recently found an appreciable loss in fluorescence of particles, so that the actual area coverage in Operation IAC may have been greater than the figures quoted.

Factors Affecting Disseminating Efficiency and the Effects of Decay of Viability and Infectivity after Aerosolisation

4. Studies have been carried out for many years on aerosol generation and aerosol cloud travel. The generation of aerosols, from liquids and slurries, in the 1-5  $\mu$  diameter size from airborne spray tanks presents no great problems, although there may be some loss of viability due to dissemination at high speed. The generation of aerosols from dry powdered BW agents, however, presents serious problems, due to agglomeration of particles in the dry state.

5. There are still problems to be overcome before a completely satisfactory BW munition is developed, which is completely satisfactory for large area coverage. Sunlight causes a rapid decrease in viability and infectivity of BW agents and therefore, at present, BW attacks would be envisaged only during the hours of darkness. A further problem concerning the use of BW agents is that the infective dose is known for very few BW agents. Of the agents under study, mention may be made of Bacillus anthracis (N) and Pasteurella tularensis (UL). The former can be readily produced and stored for many years without loss of viability. It can be dispersed in the dry state to give a stable cloud of spores, affected by only a few phenomena including sunlight. However, the infective dose (ID50) of B. anthracis for man is quite high, being of the order of  $10^5$  spores although the exact figure is not known. P. tularensis is normally aerosolised from a slurry and the resulting microorganisms have an appreciable decay rate (as high as 20% per minute at 75% RH, but may be only 1.2% per minute if the relative humidity is above 90%), but with a known human ID50 of 10 organisms, this agent may still produce many casualties. For instance, in the case of limited area targets, P. tularensis may be a more efficient casualty producer than B. anthracis, but for large area targets B. anthracis is more efficient than P. tularensis (8). Other agents with low decay rates include Venezuelan Encephalomyelitis (NU) and Coxiella burnetii (OU), these agents having decay rates of approximately 1% per minute and 0.1% per minute respectively, and the rates are not RH-critical. One of the disadvantages of BW agents is the appreciable time between infection and symptoms, being of the order of 2 - 7 days for most agents but for OU the time is 15 - 18 days. This incubation time would not, however, affect the amount of agent initially required for infection.

#### Calculation of Casualties

6. From the results of the trials, it is obvious that large area coverage by particles is a practicability. By making certain assumptions about such factors as the rate of loss of infectivity of aerosolised agents, the meteorological conditions, the number of particles required for infection in man and other assumptions, an estimate may be made of casualties to be expected under certain conditions (7).

7. If a uniform recovery is assumed it can be readily seen from the "box" model that

$$N = \frac{PR}{VH}$$

where

- N = number of particles recovered
- P = effective source strength (particles per mile)
- = total number of particles x dissemination efficiency
- R = sampling rate (cubic miles per hour)
- V = wind speed (miles per hour)
- H = height of inversion (miles) - where an inversion exists, its height is that height above which there is little vertical diffusion

A reasonable estimate of the concentration of dried BW agent (if the agent aerosol is generated from slurry, a correction must be made) is  $10^{11}$  organisms per ml, with a density of 0.4 g/ml, giving  $2.5 \times 10^{11}$  organisms per gram. A dissemination rate of 11 lb. per mile and a dissemination efficiency of 50% yields a source strength of about  $7 \times 10^{14}$  organisms per mile. Assuming a ten-fold reduction of viable organisms due to a high-speed delivery system and other factors the source strength will be  $7 \times 10^{13}$  organisms per mile. Using this figure for P and a sampling rate of 12.5

litres/minute (breathing rate of man at rest) =  $1.8 \times 10^{-10}$  cubic miles/hour, a windspeed of 20 mph and inversion height of 2,200 ft (0.4167 miles), this gives a theoretical recovery of 1,500 organisms, which is in good agreement with actual downwind recoveries from Operation IAC (1,148 and 1,622 particles).

8. If the biological decay rate is  $k\%$  per minute the number ( $N$ ) of viable organisms remaining after a given time ( $t$  minutes) from  $N_0$  original particles ( $t=0$ ) is obtained from:

$$N = N_0 e^{-kt}$$

The time may be found approximately from the wind speed and distance travelled.

Assuming an ID50 of 100 organisms, Table II shows the number of organisms and the quantity of agent required for 50% casualties at distances to 200 miles from the source for an agent with no decay and for an agent with a decay rate of 2.5% per minute, being disseminated from a plane travelling at 486 knots.

TABLE II  
Total Source Requirements for 50% Casualties

Miles downwind	Total Source Strength			
	<u>Organisms</u>		<u>Weight</u>	
	(Org/mile)	(Org/minute)	(lb/mile)	(lb/minute)
	<u>No decay</u>			
0-50	$4.5 \times 10^{13}$	$4.2 \times 10^{14}$	0.8	7.1
0-100	$6.6 \times 10^{13}$	$6.2 \times 10^{14}$	1.1	10.5
0-150	$1.3 \times 10^{14}$	$1.2 \times 10^{15}$	2.2	20.6
0-200	$2.8 \times 10^{14}$	$2.6 \times 10^{15}$	4.8	44.4
	<u>2.5%/min.decay</u>			
0-50	$2.1 \times 10^{14}$	$2.0 \times 10^{15}$	4	33
0-100	$9.8 \times 10^{14}$	$9.1 \times 10^{15}$	17	155
0-150	$6.6 \times 10^{15}$	$6.2 \times 10^{16}$	112	1045
0-200	$4.2 \times 10^{16}$	$3.9 \times 10^{17}$	714	6660

9. An ID50 of 100 has been used for the above calculations, but the ID50 for different organisms covers a wide range. In Table III (8) the percent casualties over an area of  $1.5 \times 10^6$  square miles are shown as a function of the ID50, for an agent with zero decay and for an agent with 2.5% per minute decay under the following conditions:

- a) Agent released along 10 lines from 50 large aircraft, each carrying 15,000 lb of agent (total agent = 750,000 lb.).
- b) Released over mixed urban and open terrain with average meteorological conditions.
- c) Munition efficiency of 80%.

TABLE III

% Casualties Over  $1.5 \times 10^6$  Square Miles

ID50	Percent casualties for decay rate of	
	0	2.5% per min
1	100	80
10	100	68
$10^2$	100	48
$10^3$	95	27
$10^4$	84	12
$10^5$	25	3
$10^6$	3	0

10. Using the information in this paper a calculation shows that an aircraft flying from Quebec City to Sarnia, Ontario, a distance of about 620 miles, would require to release only 682 lbs of a BW agent to give 50% casualties in the most densely populated area of Canada. This is assuming an ID50 of 100 organisms, a release speed of 486 knots, no decay, and a north west wind. If the decay rate is assumed to be 2.5% per minute, about sixteen times this weight of agent is required, which is well within the capabilities of a large plane. The area covered, which is approximately 60,000 square miles includes cities such as Montreal, Toronto, Hamilton and many others containing a large proportion of the Canadian population. As the prevailing winds are westerly in this part of the country the conditions envisaged above are not uncommon. The annual average wind speed for the area considered is about 10 mph, being slightly higher in winter than summer and higher during the day than at night. Therefore the above area (60,000 sq.miles) would be covered in about 8 hours during the day and 12 hours at night for the source length (620 miles) considered.



1. Chemical Corps Biological Laboratories Special Report No. 142, 22 Jan 1951.
2. Stanford University Quarterly Report No.3, 1950.
3. Chemical Corps Biological Laboratories Special Report No. 162, 1 Aug 1952.
4. Porton, Field Report No. 504, 5 Feb 1957.
5. Porton "Study of the Possible Attack on Large Areas with BW Agents"  
E.K.G. James and J.D. Morton, 1956.
6. Dugway Proving Ground Report 227, Vol. II, April 1959.
7. Fort Detrick, Biological Warfare Laboratories Technical Memo 3 - 6,  
Aug 1959.
8. US Army Operations Research Group Study No. 26, Aug 1962.
9. Dugway Proving Ground Report 225, July 1958.

H.R. Richards,  
BW & CW Research Section,  
Directorate of Atomic Research,  
Defence Research Board.

24 May 1963  
Ottawa.

CONFIDENTIAL  
ENCLOSURES

*file*

2 May 1963

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: G.R. Vavasour

1. We are enclosing two dozen (24) copies of the "Review of Microbiology Programme since January 1963 to April 1963" for circulation to the Advisory Committee Members and D.R.K.L.
2. We are also enclosing three (3) copies of the above for circulation to DSIS for onward transmission to: The War Office - 1 copy for DPR and 1 copy for D/MRE; and DRS, Wash. - 1 copy for Mr. R. Holmes.

(J.R. Maltman)  
for Chief Superintendent

JRM/sp  
Encl's - 27

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTACONFIDENTIALREVIEW OF MICROBIOLOGY PROGRAMME SINCE JANUARY 1963 TO APRIL 1963STUDIES ON AEROSOLS OF BACTERIA

Difficulty in the ability to properly control the conditions in replicate experiments with bacterial aerosols has led to wide variations in the data obtained. Tests have indicated that one of the trouble sources is the air supply, presumably due to oil fumes in the air lines. In addition, one of the temperature controlled units which houses the toroid drum gives off toxic fumes.

Since wide variations in results of replicate experiments do not occur where the Standard Reference Aerosol Testing System is used, it is planned to convert our total aerosol facilities to this system. Consequently, most of the aerosol experiments in the section will be curtailed until these requirements are met.

I. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH:1. Practical Investigations:The Effect of Preconditioning Aerosols on the Survival of Airborne Bacteria:

Previous studies in toroid drums have indicated that secondary air influenced the survival values of *Serratia marcescens* aerosols produced by Collison spray. Similar tests will be carried out in the near future in the bursting chamber with realistic clouds produced by an E4 disseminating device. It is hoped that these aerosols may simulate those produced in the field, and provide a satisfactory means of laboratory-field correlation.

2. Basic Investigations:Mechanisms Involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

The study of metabolic differences between aerosol resistant and aerosol sensitive *S. marcescens* cells has been extended. The ability to utilize various carbohydrates was studied by measuring oxygen consumption manometrically. Preliminary results indicate little quantitative difference in substrate utilization, however a variation in rate was sometimes found. This effect is being more thoroughly investigated.

In continuing the study of the effect of growth media on aerosol resistance of microorganisms, emphasis has been placed on the influence of carbohydrates in the medium. This has been studied as a result of the finding that the presence of glycerin in a chemically defined medium appeared to be an important factor responsible for the increased resistance of resulting bacteria. Of the carbohydrates tested to date, none are as effective as glycerin in enhancing aerosol resistance.

II. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (Confidential)

There has been no standard reference aerosol experiments in this period. Next fall a test, probably the last, using a viral agent will be conducted.

III. TRIALS:

Trials concerned with the assessment of early warning devices will be conducted at S.E.S. this summer as a joint Canada-United States project.

IV. THE EFFECT OF SOLAR RADIATION ON MICROBIAL AEROSOLS:  
(Project - D52-18-20-18) (Confidential)

Until further notice, this project is suspended.

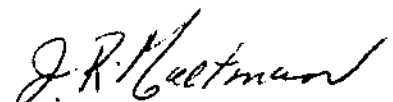
V. INFECTIVITY AND VIRULENCE: (Project - D52-18-20-18) (Confidential)

Tests have been conducted in this period with "wet" chicks as a possible test host for staphylococci. They proved to be much more sensitive than mice to intraperitoneal challenge with different strains of staphylococci. Deaths were produced with virulent strains of staphylococci at challenge doses below one hundred cells. However, variation in the dose mortality relationship was so great that reasonable quantitation was impossible. An in-bred line of chicks might allow this species to serve as an extremely useful experimental host for pathogenic staphylococci, rather than the hybrids tested.

Preliminary tests have also been conducted with a strain of virulent Staphylococcus aureus in S.E.S. and D.R.K.L. Swiss-Webster strain of mice. Intravenous challenge produced considerably higher death rates in D.R.K.L. mice than the same doses in S.E.S. mice.

Protein and Ribonucleic Acid Synthesis:

No further studies on the effects of desiccation on protein and ribonucleic acid synthesis in staphylococci have been conducted in this period. When control facilities are available for high humidity desiccation tests, these experiments will be completed.



(J.R. Maltman)  
for Chief Superintendent

JRM/sp  
2 May 1963

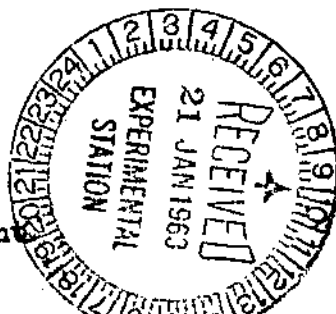


CANADA

SECRET

OUR FILE REF. DRBS 1800-1  
DRBS 1800-20  
DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa 4, Ontario,  
18 January 1963.

Chief Superintendent  
SES.

REFERRED TO	CS
C. R. FILE NUMBER	
	1800-1

Essay on BW Attack Against North America

1. I was pleased to receive your comments in SES 1800-1 (CS) dated 21 December, 1962.
2. It is agreed that a treatment of the hazard to civilians from covert attack should have been fuller. The reason the hazard was treated so briefly was that the threat of clandestine use was so slight (see last paragraph, first page). We do not doubt that it would be technically feasible to conduct simultaneous covert use of BW at many points by a planned "grid" of saboteurs and, although this possibility was not included in the essay, it has been discussed from time to time with DSI. (The use of a planned "grid" of saboteurs is, of course, a technique that could be used with other weapons.) DSI, in conversations over the years, have stated that intelligence authorities believe that the risk of compromise is too high to make it an attractive method, particularly if one considers that prior discovery would serve to alert the nuclear retaliatory course. Hence, while agreeing that the treatment of the hazard from covert attack might have been fuller, we cannot agree that it is a serious threat.
3. The point in paragraph 2 is simply another instance of the thinking which is referred to in the addendum at the end of the essay.
4. The comment in your paragraph 3 has been discussed with Dr. H. Hurtig, the entomological advisor on the BW Advisory Committee. It was his opinion that the only circumstances under which the use of vectors would be effective over areas as large as cities would be those obtaining in a city after an attack with nuclear weapons. If all the facilities and power required to maintain the high standards of urban sewage disposal, sanitation and hygiene were inoperative, the introduction of a vector-borne pathogen into the environment could result in widespread dissemination of disease by the native vectors. He believes that it is very unlikely that either the introduction of a pathogen into the insect vectors of the normal peacetime environment, or the use of an unusual vector-agent combination against an intact North American city would cause widespread disease in that city.
5. Your comments have pointed out one bad flaw in the essay, and that is that it deals only with the use of BW instead of nuclear weapons, but does not say so specifically. Whether it would be possible to write anything better than science fiction on the threat and hazards associated with the use of BW after the use of nuclear weapons is more than I can say at the moment.

cc: DSI  
CS/DRCL  
DRKL - Mr. Currie

*G. L. Vavoson*  
for Chairman  
Defence Research Board.

8 January 1963

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: G.R. Vavasour

1. We are enclosing two dozen copies of the "Review of Bacteriology Programme since September 1962 to December 1962", for circulation to the Advisory Committee Members and D.R.K.L.
2. We are also enclosing three (3) copies of the above for circulation to DSIS for onward transmission to: The War Office - 1 copy for DPR and 1 copy for D/MRE; and DRS, Wash. - 1 copy for Mr. R. Holmes.
3. Twelve (12) copies of the Bacteriology Section Annual Report are enclosed for distribution to the Advisory Committee, as requested by DRBS 170-80/B1 DAR(B&C), dated 27 December 1962.

JRM/sp  
Encl's - SECRET and  
CONFIDENTIAL

(J.R. Maltman)  
for Chief Superintendent

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTACONFIDENTIALREVIEW OF BACTERIOLOGY PROGRAMME SINCE SEPTEMBER 1962 TO DECEMBER 1962STUDIES ON AEROSOLS OF BACTERIAI. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH:1. Practical Investigations:Protection of Aerosolized Cells with Chemical Additives:  
(Project - D52-18-20-18) (Confidential)

The Standard Reference drum has been utilized to study the protective action of additives on the survival of mixed aerosols of *Serratia marcescens* (SM) and *Sarcina lutea* (SL). It has been found that when frozen pellets of these organisms are suspended and sprayed from Peptone Yeast Extract (PYE) containing these additives, aerosol recovery values decreased at intermediate and high relative humidities. Similar suspensions prepared in distilled water containing the additives provided aerosol recovery values at 70°F., and relative humidities of 10, 25, 45, 55 and 80 per cent, equivalent to those obtained with suspensions prepared in PYE-additive combinations at low relative humidity. Both additive combinations appear to be equally effective for SM.

The Effect of Preconditioning Aerosols on the Survival of Airborne Bacteria:

Previous studies had indicated that secondary air decreased survival values of airborne SM appreciably at relative humidities below 50 per cent when sprayed from PYE. When SM is disseminated from distilled water combinations, and held as aerosols in the Standard Reference drum, secondary air does not decrease survival. The effect of secondary air and other spray suspension materials on survival values of airborne SM will be continued, since it is possible that these aerosols may more closely simulate aerosols disseminated in the field. It is hoped that good correlation of laboratory and field data may be obtained in this way.

Protein Detector Studies:

No further tests have been conducted in this period.

2. Basic Investigations:Mechanisms Involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

Although the additive program has been temporarily suspended, evidence was obtained that chemically defined medium No. 2 (S.T.P. 259), offered physical protection to *Serratia marcescens* cells when airborne. Organisms recovered from certain complex growth media and sprayed from the synthetic medium exhibited a considerable increase in survival over similar cells sprayed from distilled water. On investigating the individual components of the medium for their capacity to protect aerosolized cells, it was found that glycerine yielded greatest protection. The degree of protection however, appears to vary with the constitution of the medium in which the cells are grown.

The investigation of metabolic differences between aerosol resistant and aerosol sensitive S. marcescens cells has been continued. The ability of cells to oxidize compounds of the tricarboxylic acid cycle was studied. Resistant cells exhibited a decreased ability to utilize oxalacetic acid and  $\alpha$ -ketoglutaric acid as substrates, but showed a greater oxygen consumption than the sensitive cells in the presence of succinic acid.

The study of the effect of growth media on aerosol resistance of microorganisms has been extended. Results indicate that when glycerine is used as the main energy source in chemically defined media, the bacterial cells are more resistant to storage when airborne. Substitution of glucose for glycerine in the synthetic medium yielded cells exhibiting a decreased resistance.

II. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (Confidential)

Test 4B using Brucella suis, tagged Brucella suis is being conducted at present. This series will be completed by December 19, 1962, and the completed results tabulated by the U.S. Co-ordinator.

III. TRIALS:

Local Trial Number 295 - "Comparison of the Viable Recoveries of Sarcina lutea and Bacillus subtilis var niger when Aerosolized from an Intimate Mixture in the Field at Night."

To date, three trials have been completed, one of which was not satisfactory due to inhibition of growth of B. subtilis on the plating medium. Laboratory tests revealed that the media problem was due to additions of brilliant green inhibitor to the medium after sterilization rather than before. Results of the two completed trials indicate no difference in viable recoveries up to ten miles cloud travel.

IV. THE EFFECT OF SOLAR RADIATION ON MICROBIAL AEROSOLS:  
(Project - D52-18-20-18) (Confidential)

There has been no progress in this quarter, due to other laboratory and trial commitments.

V. INFECTIVITY AND VIRULENCE: (Project - D52-18-20-18) (Confidential)

Permeability Changes in Bacteria After Desiccation and Rehydration:

The object of these studies is to determine the role that permeability changes may play in the reduction of infectivity of bacteria which have been subjected to desiccation. Previous studies on permeability changes of bacteria due to desiccation and rehydration have been extended. Results of permeability change studies indicate that raising the osmotic values of the fluids in which dried staphylococci are reconstituted by use of phosphate buffer containing 0-15 per cent (w/v) sucrose instead of distilled water makes little difference in the magnitude of cellular leakage which occurs. Since it appears that osmotic values can be varied within wide ranges without appreciable effect on leakage, experiments are now in progress to determine if return of the permeability qualities of dried staphylococci toward normal values after reconstitution, affect the infectivity.



Protein and Ribonucleic Acid synthesis:

Effects of desiccation on protein and ribonucleic acid synthesis in staphylococci in growth media have been concerned in this period mainly with replication and standardization of experiments previously reported. When satisfactory standardization of these experiments is obtained, animal tests will be conducted to determine if the rates of desiccation affecting protein and RNA synthesis also have a bearing on infectivity.

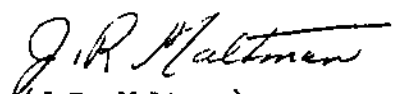
Infectivity of Young and Aged Aerosols:

These studies will not be undertaken until more information concerning cell permeability and reactivation of infectivity is available.

VI. BACTERIOSTASIS BY  $\beta$ -NITROSTYRENES:

The Bacteriology Section has been assisting the Chemistry Section in assaying the bacteriostatic action of  $\beta$ -nitrostyrenes toward Staphylococcus aureus A.T.C.C. Number 6538 and Escherichia coli A.T.C.C. Number 9637. Using a turbidimetric method, over sixty compounds have been tested for bacteriostasis. This study is nearing completion and will be reported as S.T.P. 253 and S.T.P. 264.

JRM/sp  
8 January 1963

  
(J.R. Maltman)  
for Chief Superintendent

BACTERIOLOGY SECTION

ANNUAL REPORT 1962

AIM:

1. To investigate the rate of change of viability and virulence of bacterial aerosols as a function of aerosol age and environmental factors.

METHOD:

1. Bacterial aerosols will be introduced into rotating drums, the rate of rotation being such as to minimize the physical decay of the aerosols. The effects of temperature, relative humidity and solar radiation on the viability of bacteria which remain airborne for periods up to several days will be studied. The relationship between the period of suspension and the rate and extent of the decrease in viability will also be studied. The degree to which the infectivity of airborne bacteria parallels their viability while airborne for periods up to several days will also be investigated.
2. Possible means of preventing the viable decay and decreases in infectivity of airborne organisms will be investigated.

PROGRESS:

1. Factors Affecting the Loss of Viability of Bacterial Aerosols:  
Influence of Chemical Additives -

Suspensions of Serratia marcescens prepared in Peptone Yeast Extract containing certain additive combinations have previously been shown to have advantages in reducing the variability and lowering the decay rate of aerosols stored under conditions of intermediate relative humidity, compared to aerosols generated from inositol, peptone yeast extract. Extension of these experiments has indicated that the fluids to which these chemicals are added also influence the survival response of aerosols of S. marcescens to different degrees under varying conditions of relative humidity. S. marcescens suspended in and sprayed from additive combinations of [REDACTED] produce aerosols which show lower survival values at intermediate and high relative humidity than at low relative humidity.

Similar suspensions prepared in distilled water containing these additives provide aerosol survival values that are similar over relative humidity ranges from 10 to 80 per cent and are equivalent to those obtained with suspensions prepared in peptone yeast extract additive combinations at low relative humidity.

2. Mechanisms Involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

Earlier studies had indicated that S. marcescens and Escherichia coli after growth in simple chemically defined media were appreciably more resistant to aerosolization and storage in the airborne state than when these species were cultured in complex media. Extension of these studies revealed that addition of proteinaceous materials to synthetic media as culture fluid, generally decreased the resistance of S. marcescens to aerosolization.

Individual amino acids added singly to the synthetic media had little effect on survival of S. marcescens in the aerosol state. The possibility of additive effects of amino acids will be investigated.

Results have also shown that when glycerine is used as the main energy source in chemically defined media, the bacterial cells are more resistant to storage as aerosols. Substitution of glucose for glycerine in the synthetic medium yields cells exhibiting a decreased resistance. In addition, the chemically defined medium offers physical protection to airborne S. marcescens. Organisms recovered from complex growth medium and sprayed from synthetic medium exhibit a considerable increase in survival over similar cells sprayed from distilled water.

Investigation of the individual components of the medium for their capacity to protect aerosolized cells has revealed that glycerine offers the greatest protection. The degree of protection however, appears to vary with the constitution of the medium in which the cells are grown.

In addition to experiments with aerosols, studies of the metabolic differences between aerosol resistant and aerosol sensitive cells are being conducted. When compounds of the tri-carboxylic acid cycle are used as substrates, aerosol resistant S. marcescens show a decreased ability to utilize oxalacetic acid and  $\alpha$ -ketoglutaric acid, but show greater oxygen consumption than sensitive cells in the presence of succinic acid.

### 3. The Effect of Preconditioning Aerosols on the Survival of Airborne Bacteria:

Preconditioning entails the mixing of Collison generated aerosols with air which is preconditioned to the same temperature and relative humidity as the air in the drum.

Previous studies indicated that when Serratia marcescens was suspended in peptone yeast extract and the aerosols generated, the secondary air decreased survival values of the airborne organisms appreciably at relative humidities below 50 per cent. Subsequent experiments have shown that the lethal effect of secondary air at these humidities can be eliminated when S. marcescens is suspended in and sprayed from distilled water containing inositol (3%) thiourea (1%), or sucrose (3%) thiourea (1%).

### 4. Standard Reference Aerosol Testing Technique:

This project is a Tripartite Agreement set up to establish baseline information concerning the characteristics of several aerosol testing systems installed in: M.R.E., Fort Detrick, D.P.G., N.B.L., and S.E.S.

Results of Tests 1, 2, and 3 which were discussed at the second meeting of the Working Group of the Tripartite Standardization Project at Fort Detrick, 18-19 September 1961, have been reported previously.

Test 4, Brucella suis, tagged Brucella suis has been conducted this year. Results obtained in Test 4 indicated unexpected wide variations in survival values of the aerosols among the participating laboratories.

Test 4 has been repeated. The results to date have not been tabulated and correlated by the U.S. Co-ordinator for this project.

### 5. Infectivity and Virulence:

Since expressions of maximum virulence would require a complete metabolic system, studies of the possible relationship of synthesis of ribonucleic acid (RNA) and protein to infectivity and virulence have been initiated. Experiments have been conducted with dried and nondried Staphylococcus aureus in which synthesis of RNA and protein have been followed during the growth phases after suspension of the organisms in broth. RNA and protein synthesis in the lag period is considerably slower when the organisms have been previously subjected to desiccation. The cell preparations which were film dried at a relative humidity of 80 per cent showed evidence of slower initial production of both RNA and protein than did preparations film dried at a relative humidity of 20 per cent. After the log phase of growth is reached, rates of synthesis are similar. Earlier observations on the deleterious effect of

Desiccation on the synthesis of coagulase, an important protein material for staphylococcal pathogenicity, can now be explained in part by the evidence of injury to mechanisms involved in the synthesis of RNA.

Previous studies had suggested that the increased permeability displayed by dried bacteria could be associated with decreases in infectivity by allowing easier access on reconstitution of potential antimicrobial substances to vital cell sites. These measurements had indicated that the greatest leakage of cellular material occurred on reconstitution when the organisms had been dried under conditions of high relative humidity. These leakage materials have now been partially characterized and include positive indications of both proteins and RNA. Because greater increases in cellular leakage of 260 mμ materials occur after desiccation at high rather than low relative humidity as well as the characteristic RNA absorption spectra obtained, and because rates of RNA and protein synthesis are slower at high relative humidity, it is suggested that the smaller molecular weight messenger RNA might comprise part of one of the metabolic systems most drastically affected by desiccation. It is suggested that reactivation of infectivity accomplished by reconstitution of dried staphylococci in broth and incubation in the lag period probably reflects return toward normal permeability properties and repair to mechanisms involved in protein and RNA synthesis.

#### 6. Trials:

During the past year the Bacteriology Section took part in field trials held at the Dugway Proving Ground to determine biological decay rates and infectivity of Pasteurella tularensis when it is released in the field from an aerial line source. Although numerous attempts were made to conduct trials, meteorological conditions were not satisfactory. In conjunction with this field effort, some additional data was also obtained on biological decay rates of P. tularensis in toroid drums.

Comparison of the viable recoveries of Sarcina lutea and Bacillus subtilis when aerosolized from an intimate mixture in the field at night (Local Trial 295), have also been undertaken. The laboratory portion of these trials have been completed and indicate that storage from 0 to 15 days at 4°C. in mixed suspension did not affect the viability of either organism. B. subtilis did not become heat sensitive after fluid storage or as three-hour aerosols. When the aerosols were aged for five hours, there was no appreciable difference in viable survival of the two species, but after twenty-two hours, B. subtilis survival values were significantly higher than S. lutea. Aspiration losses of B. subtilis in many collecting fluids were also indicated, while S. lutea losses were not significant. Losses of viability of B. subtilis during aspiration could be prevented by collecting the organisms in modified Gelatin Milk Phosphate.

#### 7. Bacteriostasis by β-nitrostyrenes:

The Bacteriology Section has assisted the Chemistry Section in assaying the bacteriostatic action of β-nitrostyrenes. Using a turbidimetric method, over sixty compounds have been tested for bacteriostasis.

#### FUTURE PLANS:

1. To continue the laboratory and field investigations of the viable decay and the losses of infectivity and virulence of bacterial aerosols.

#### REFERENCES:

Suffield Technical Note Number 90; "Sarcina lutea as a Bacterial Aerosol Tracer"; by A.R. Lejeune and D.E. Davids.

Suffield Technical Note Number 101; "The Relative Stability of Bacillus subtilis var niger and Sarcina lutea in Laboratory Aerosols"; by A.R. Lejeune and D.E. Davids.

J  
Suffield Technical Note Number 102; "Collection and Aspiration of Mixed Aerosols of Bacillus subtilis var niger and Sarcina lutea"; by D.E. Davids and A.R. Lejeune.

Suffield Technical Paper Number 259; "Nutritional Factors Affecting the Aerosol Stability of Microorganisms. I. The Effect of Growth Medium", by D.S. Willoughby, Ph.D. --- Prepared for the BW Basic Research Discussion Group Meetings of the Biennial Tripartite Conference on Toxicological Warfare, June 25-29, 1962.

"The Effect of Secondary Air on Survival of Aerosols of Serratia marcescens"; by D.E. Davids and A.R. Lejeune. --- Prepared for the BW Basic Research Discussion Group Meetings of the Biennial Tripartite Conference on Toxicological Warfare, June 25-29, 1962.

"The Effect of Desiccation and Rehydration on Cell Permeability with Special Reference to Implications Concerning Infectivity"; by J.R. Maltman. --- Prepared for the BW Basic Research Discussion Group Meetings of the Biennial Tripartite Conference on Toxicological Warfare, June 25-29, 1962.

SECRET

21 December, 1962

Chairman,  
Defence Research Board,  
Ottawa.

Attention DAR B&C

Essay from DAR (B&C)  
"BW Attack Against North America"

1. Your essay on "BW Attack Against North America" forwarded to Dr. Pace on 5 December, has been read with considerable interest here at Suffield. There was a general feeling here that your treatment of the hazard to civilians from covert attack was rather casual. We understand that Dr. Milly quite recently gave a talk at Detrick as an opener for the meeting on BW early warning which included reference to U.S. studies of the possibility of simultaneous covert use of BW at many points by a planned "grid" of saboteurs. All studies, and we believe there were three, agreed that such a plan was feasible. Two of them concluded that it was unlikely to be used by Russia because from the military point of view it would be an uncontrollable operation. We would suggest that you obtain these studies and give them some consideration.
2. Dr. Milly also indicated that there is some U. S. thought that the possibility of the use of BW will increase when Russia reaches second flight nuclear capability equal to that of the U. S.
3. We would not agree entirely with the statement that vectors are useful in attacking small areas only. It would seem that the assessment of the problem neglected the factor of communicability. If agents highly communicable in man were used, then even vector attack might be effective over a larger area than anticipated, because of urbanization in North America. Further, airborne delivery might readily produce vector problems over large areas without deliberate dissemination of the vector, i. e. a massive attack may not be necessary if communicability is of major importance.
4. These points are brought to your attention should you wish to develop your essay at some future date.

(A. M. Pennie)  
Chief Superintendent

AMP/ad

COMMENTS ON "BW ATTACKS AGAINST NORTH AMERICA"

1. Unless vast stock piles of plant and animal food products are available to man, I cannot see why the impact on North America should be too slow. In addition, since early warning devices are not suitable at present, how do you prove that BW attacks have been launched?

2. When the statement is made to the effect that vectors are useful in attacking small areas only, one must assume that this means dispersal of vectors.

However, it would seem that this assessment of the problem neglected the factor of communicability. If agents highly communicable in man were used, then even vector attack might be effective over a larger area than anticipated, because of urbanization in North America. Further, airborne delivery might readily produce vector problems over large areas without deliberate dissemination of the vector. (i.e. a massive attack may not be necessary if communicability is of major importance)

*J. H. H. H.*

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

17 December 1962

## MEMORANDUM

TO: Chief Superintendent

Fm: H.J. Fish

Subject: Comments on Vavasour's essay to Pace

Last para on page 1 of Vavasour's essay to Pace.

This appears to be a rather casual elimination of the hazard to civilians from covert use of BW.

A talk given by Dr. Milly at Detrick as an opener for the meeting on BW early warning included reference to US studies of the possibility of simultaneous covert use of BW at many points by a planned "grid" of saboteurs. All studies, and I believe there were three, agreed that such a plan was feasible. Two of them concluded that it was unlikely to be used by Russia because from the military point of view it would be an uncontrollable operation.

Perhaps DAR could get copies of these studies.

Milly also indicated that there is some US thought that the possibility of the use of BW will increase when Russia reaches second flight nuclear capability equal to that of the US. It is not clear who Vavasour is including in his references to "defence community" and "official" opinions.

HJF/md

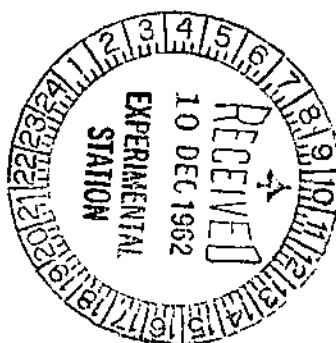
*H.J. Fish*  
(H.J. Fish)  
H/Planning & Reporting Section

*C5.*  
*I have no comment to make on this paper.*

*William May*  
*20 Dec 62.*



DRBS 1800-20  
 DRBS 1800-1  
 DAR(B&C)



REFERRAL TO	CS
C. R. FILE NUMBER	
	1800-1

Ottawa 4, Ontario,  
 5 December 1962.

Dr. F.C. Pace,  
 Medical Consultant,  
 Special Weapons Section,  
 Emergency Health Services Div.,  
 Dept of National Health & Welfare,  
 Ottawa, Ont.

Dear Dr. Pace,

The attached essay is longer than I expected it would be when we discussed the subject of your letter 65-3-13B of 10 October. However, I hope it is not too long. It seemed to me as I drafted a reply to your letter that the answers need the complete background to put them in the right perspective.

I have not met your request for detailed information on specific agents and I think you will see why after reading the attachment. An additional reason was that digging out the information would have delayed this reply even longer. Also I would like to find out more about the amount of detail you want before proceeding to the next step.

The topic mentioned towards the close of your letter has been discussed with the Directorate of Scientific Intelligence. We would be pleased to discuss this with you at your convenience. A phone call is all that's necessary to arrange a meeting.

Yours sincerely,

Original signed by  
 G. R. VAVASOUR  
 for Chairman  
 Defence Research Board.

cc: DSI  
 CS/DECL/KL  
 CS/SES  
 GRV:mo

*B. W. J. H.  
 PPS  
 now*

BW Attack Against North AmericaGeneral

This paper discusses direct anti-personnel BW attack in relation to attacking North America and is written in response to a request from the federal civil authorities responsible for public health for information for planning purposes.

The probability of a BW attack against North America is dependent on two classes of factors, namely, scientific - technical factors and political - military factors. As with any other weapon, that which is not scientifically or technically feasible is not politically or militarily useful, but scientific or technical feasibility of a weapon does not alone determine whether it will be used or not. The use of nuclear energy as a weapon of war was scientifically and technically feasible in the Korean War but the UN forces did not use nuclear weapons. A similar situation existed vis-a-vis the use of chemical weapons in the Pacific Theatre in World War II. It is essential in discussing BW attack against North America to treat the two classes of factors quite separately in order to avoid confusion. Two words, if used carefully, represent the two classes. These are: "hazard" to represent the scientific-technical or tangible factors, and "threat" to represent the political-military or intangible factors.

The Threat

Western defence planning is based on the premise that a Soviet nuclear attack on North America must destroy the US retaliatory capability or else it would be suicidal. It is also generally recognized in the West that destruction of North American cities will, with some possible exceptions, be a secondary rather than the primary purpose of an attack. It is in this context that the threat of BW against North America is considered in this paper. The conclusions would not necessarily be the same if different fundamental assumptions were used.

For reasons which will be apparent after considering the nature of the hazard (below), BW is not a suitable weapon for use by an enemy who wanted to be certain of destroying the retaliatory capability. Whether an enemy would use it in an initial attack designed solely to kill the inhabitants of large cities depends, apart from technical considerations, on whether his attack would provoke nuclear retaliation. Whilst it is not possible to predict with certainty how the US would react to a situation in which millions of people in many large cities become mortally sick at the same time as a result of an undetected, silent, and invisible BW attack, no would-be aggressor could be sure that the retaliation wouldn't be nuclear destruction. Since it is clear that neither the US nor the USSR wishes to precipitate a nuclear war the majority opinion within the defence community is that the USSR would hesitate to use BW for a massive attack on North America.

Nothing has been said so far about clandestine use of BW, i.e. sabotage. It is difficult to see any advantage to be gained by relatively small-scale clandestine use of BW agents against civilians or civil activities. There are of course many attractive and vulnerable military targets (e.g. the Pentagon) but this is primarily a military problem and outside the scope of this paper. The probability of sabotage being a serious problem to the civil authorities is therefore considered to be very small. Anti-animal and anti-crop warfare are not included in this paper because it is generally agreed that their impact on North America would be slow and disrupting over years rather than rapid and catastrophic and hence are very unlikely to be used against us.

It is for reasons such as these that BW attack against North America is officially considered to be unlikely although it is not ruled out completely. It will be seen that all of the above arguments apply even if the USSR is assumed to have a complete and effective BW arsenal.

#### The Hazard

The objective of a BW attack (as considered in this paper) is to infect persons. BW weapons cause infection by introducing infectious microorganisms into the body. There are only three routes into the body, through the respiratory tract, through the gastro-intestinal tract, and by puncture or penetration of the skin. The weapons therefore must contaminate food or water, for entrance by ingestion; the air, for entrance by inhalation; or surfaces, missiles (fragments or moving objects) or insect vectors for entrance through breaks in the skin or by penetration of skin.

Of these three the only significant one with respect to attack on North America is the first, i.e. infection via the respiratory tract. The reasons for classing the other two as insignificant in the North American context are first, that contamination of food and water is a means of sabotage and not a practical means of mounting a massive attack. The threat of sabotage has already been discussed. Secondly, contamination of surfaces (e.g. building walls and floors, terrain) and of bomb fragments, secondary missiles, etc., would only be incidental side-effects of a massive overt BW attack and hence need not be discussed separately. Thirdly, insect vectors are useful only for attacking relatively small areas.

The microbial aerosols required for initiating infection via the respiratory tract may be generated in several ways:

- (a) by exploding bombs or bomblets carrying microorganisms as a liquid slurry or as a dry powder
- (b) by spraying from aircraft or guided missiles
- (c) by devices which generate aerosols by forcing a slurry or through a nozzle. Such devices may be emplaced, air-dropped into position, or functioned while in a moving vehicle.

Which one of these means is chosen depends on the target and the effects desired. For small targets, in cases where the standard of BW personnel protection is low, or where there is no necessity for deception as to the nature of the attack and under certain other circumstances, bombs and bomblets and the more obvious kinds of weapons may be used. For the attack of large areas ( $10^2$  to  $10^5$  sq. mi.), especially if the attack is to be undetected and the aggressor to be unidentified, the choice is restricted to creating a long slim cloud of microorganisms at some distance from the target in such a way that the microorganisms will be carried to the target by natural atmospheric processes. The long slim cloud (a "line source") may be created by a number of means, e.g. an aircraft creating an aerosol as it flies a pre-determined course, a submarine setting up an aerosol as it cruises along the coast, a motor vehicle disseminating an aerosol as it moves along the highway. This off-target, line source type of attack (also called the LAC (large area coverage) method when considering areas of  $10^4$  -  $10^5$  sq. mi.) offers an aggressor the greatest possibility of surprise and the least chance of being caught in the act. For this reason it is generally considered to be the type of attack which would be used against North America. There are additional factors in its favour, for example, it is probably logistically superior as well.

### Microbial Aerosols

The hazard of an area coverage (AC) BW attack depends on a number of technical factors: the properties of microbial aerosols, the properties of the microorganisms in them, the effects of aerosolized microbes on the victim, new agents, and the means of defence against aerosol attack.

It has been experimentally established in large scale field trials by the US and Britain that aerosols of very fine particles when released from a line source under random weather conditions are dispersed by natural atmospheric processes so that the inhabitants of hundreds of thousands of square miles receive dosages which would be infective if the particles were microbial instead of the inert material used in the trials. Similar trials in the US have established that aerosols of non-pathological bacteria released by a ship steaming off-shore will, with on-shore winds, cover hundreds of square miles inland with effective dosages. There is therefore no scientific or technical reason to doubt the feasibility of covering areas ranging from hundreds to hundreds of thousands of square miles with microbial aerosols.

The second factor, the properties of aerosolized microorganisms, has been the subject of research in the tripartite countries for many years. The rate of loss of viability and of infectivity of airborne microorganisms are the two factors of critical importance in assessing the scientific feasibility of the AC concept. The first determines the proportion of the microbes that are still viable at any particular time after their dissemination. The second determines the proportion which are still capable of initiating an infection in the victim. Both these rates are dependent on many variables, many of which are physical or chemical properties of the organism's environment, e.g. relative humidity, temperature, solar radiation intensity, chemical nature of media in which they were grown. The results of this research, which is continuing, are summarized in the next four paragraphs.

Studies of both pathogenic and non-pathogenic bacteria in laboratory facilities have shown that the rate of loss of viability and of infectivity differ greatly among organisms at identical temperatures and relative humidities (RH). In addition, whereas some bacteria are most sensitive to high temperatures and high humidities others are just the reverse, and others still are only sensitive over relatively narrow ranges of RH and temperature. While most of the work has been on bacteria the limited results on viruses show the same differences to exist among viruses.

All three countries have been doing such work in the laboratories but practical difficulties have so far prevented scientific experiments outdoors involving long-distance travel of pathogens. Such trials are too dangerous to carry out at present trial sites and are very difficult and expensive to carry out at safe sites. Comparison of field trial results with results from long-time travel experiments in laboratory equipment for two non-pathogenic bacteria have shown differences as well as similarities so it is not possible yet to extrapolate from the laboratory to the field.

Further complicating the picture is the fact that addition of chemicals to the slurry before aerosolization and changing the nutrient medium in which the organisms are grown can significantly increase the resistance of some organisms to relative humidity and solar radiation effects.

At the present time therefore, it is not possible to calculate for any microorganism, even within an order of magnitude, the area which it could be used to cover effectively or the rate of casualties it would cause at any time after dissemination when used in an AC-type attack. The

scientific evidence to date indicates that although the majority of pathological microorganisms are not hardy enough to use in an AC-type attack there are a number which seem to be suitable and an unknown number which might be suitable. The number of pathogens which would survive the killing effect of solar radiation would be a small fraction of the number which would be effective if the aerosol travelled in the hours of darkness. The uncertainty over the rate of loss of viability and of infectivity will not be removed until either long distance outdoor trials with pathogens are carried out or until some correlation can be found between the results of laboratory trials and of field trials for a range of organisms.

The third factor to be considered when estimating the hazard of an AC BW attack is the effects of aerosolised microbes on the victim. This is a factor because many of the pathogens which are often mentioned as potential BW agents are responsible for diseases for which the natural mode of infection is not inhalation, e.g. plague, rabies, tularemia. For many pathogens therefore little is known of the virulence of the organism or the course of the disease when it is contracted by inhalation of the pathogen. Some pathogens are known however to be much more virulent and overwhelming by the respiratory route than they are by the natural route e.g. anthrax. However, there is another serious deficiency in our knowledge when it comes to estimating the hazard. That is the dearth of knowledge, for the more likely BW agents, of the infective dose for man by the inhalation route. For the more virulent organisms and for those for which therapeutic treatment is not highly effective it is, and may remain, impossible to determine the ID<sub>50</sub> experimentally. This value has been determined for some pathogens, e.g. P. tularensis, Coxiella burnetii, for which effective therapy existed.

New agents, suitable for use in AC attacks by virtue of their hardiness and virulence, may already exist and, if not, seem sure to be 'invented' within the next decade. The extremely rapid advances now being made in our knowledge of microbial genetics, fundamental cellular processes, and the structure of cellular genetic constituents have already permitted investigators to deliberately alter the genetic material of certain microorganisms. This fundamental research is being pursued in most major medical and biological research centres in the world and has no connection with BW or defence programs. However, the knowledge being gained is ambivalent in that it may be used for BW as well as more desirable purposes. New agents can also be 'invented' by adaption of an organism virulent for some animal to a form virulent for humans. New agents may also be discovered through recognition of a naturally-induced mutation. Finally there is also the possibility of an exotic microbe being used against North America. There is no way to assess the hazard from new agents. One can only assume the worst and try to be ready for it.

#### Physical Defence against BW Attack

Scientifically and in practice complete protection against BW attack is simple. Everybody wears respirators (gas masks) all the time, except when in protected shelters or buildings. This, however, is impractical. Similarly, if everybody had his own respirator and carried it with him at all times all that would be necessary to achieve the same results is a reliable, adequate BW warning system.

At the present time North American civilians do not have gas masks because of economic and political reasons, not because of any lack of scientific or engineering knowledge. There is no BW attack warning system either but the reasons are different. Despite 5-10 years of research and development along many different approaches an effective BW detecting and warning device is not yet in sight.

A further difficulty is that even if there is cause for suspecting a BW aerosol attack the only devices for sampling the aerosol now available are complicated and need trained people to operate them. Also, by present methods of laboratory identification, it would take a matter of days to identify the microorganism. This means an undesirable delay in initiating specific therapeutic treatment.

#### Summary

Although BW attack against North America is considered unlikely it is by no means impossible. The scientific information available today does not permit a precise definition of the effectiveness or potential of a BW attack in which large areas are attacked by a slowly dispersing BW aerosol. The information does indicate that a relatively small number of the known pathogens could be used in such an attack and that it would be most effective during the hours of darkness. Finally BW defences in North America are non-existent and North America is consequently very vulnerable to BW attack.

#### Addendum

There are some knowledgeable and qualified scientists within the BW field who consider that the official assessment underestimates the probability of BW. A few of the situations considered by such persons to be suitable for use of BW and advantageous to the USSR as well are (a) to attack cities after the nuclear retaliatory forces were destroyed (b) to create a domestic catastrophe in the US in order to distract the US from and discourage US intervention in Sino-Soviet aggression in another part of the world (c) to create widespread illness in important industrial cities by repeated use of BW to weaken industrial output and create serious economic problems. It is important to note, however, that although these differences of opinion on the threat exist among qualified defence scientists there are no differences among them of significance to defence on the nature of the hazard or our vulnerability to BW.

Original signed by  
G. R. VAVASOUR

30 November 1962  
Ottawa,  
GRV:mo

G.R. Vavasour  
Head, BW & CW Research Section  
Directorate of Atomic Research  
Defence Research Board.

*file*

4 December 1962

U.S. Weather Bureau Research Station,  
Nevada Test Site,  
LAS VEGAS, Nevada.

Attention: H.G. Booth

Dear Sir:

The information regarding constant level balloon is most interesting and much appreciated.

Before attempting to arrange procurement of Mylar tetroons, we intend to play a bit with an ordinary meteorological balloon encased in a fitted plastic bag. This should permit super inflation with some retention similar to the tetroon.

In any event, this appears to be worth trying, and depending on the outcome, we can arrange for tetroons at a later date if necessary.

Thank you again for your valuable assistance.

Yours sincerely,

(D.E. Davids)  
for Chief Superintendent

DED/sp

4 December 1962

Chief, U.S. Weather Bureau,  
WASHINGTON 25, D.C.

Attention: Donald H. Pack

Dear Sir:

The information regarding constant level balloons is most interesting and much appreciated.

Before attempting to arrange procurement of Mylar tetrooms, we intend to play a bit with an ordinary meteorological balloon encased in a fitted plastic bag. This should permit super inflation with some retention similar to the tetroom.

In any event, this appears to be worth trying, and depending on the outcome, we can arrange for tetrooms at a later date if necessary.

Thank you again for your valuable assistance.

Yours sincerely,

DED/sp

(D.E. Davids)  
for Chief Superintendent

P.S. Mr. O. Johnson of our Meteorological Service will be carrying on from here. He may be in touch with you at a later date.



1st October, 1962.

Mr. D.A. Lyon,  
Institute of Computer Science,  
McLennan Laboratory,  
University of Toronto,  
TORONTO 5, Ontario.

Dear Don,

Herewith Part II of your requirements, namely, six charts covering 86 "completed" trials out of 90 for function No. 66M.

The median and range of  $f(o)$  remain the same as I quoted you in my first letter.

The overall  $X^2$  value (7 signs) is now 27.3.

The 22-hour data was disappointing. The predictions were:-

Trial 40	.889 - 8
41	.117 - 8
47	.319 - 5
52	No fit obtained
53	N.F.
54	.604 - 2
55	N.F.
56	N.F.
57	.146 - 1
58	N.F.

The relative standing of the four "M" functions through a sum of squares comparison of 84 mutual trials, is:-

No.	78M	29%
	56M	26
	80M	25
	66M	20.

I can't think of anything else you might need to know in this connection, so I'll wait to receive your further instructions.

Trevor and Neil both asked me to send their regards.

Yours truly,



(A.E. Ames)  
for Chief Superintendent

27 September 1962.

Mr. D.A. Lyon,  
Institute of Computer Science,  
McLennan Laboratory,  
University of Toronto,  
Toronto 5, Ontario.

Dear Don,

Herewith Part I of my "inheritance" - final results of a further 18 trials in function No. 78K. They comprise:-

- (a) Three formerly "unfinished" trials which are now considered complete as they stood (i.e. I saw no need to rework them further);
- (b) The remaining ten of the "unfinished" trials, which have now been carried to completion; and
- (c) Five further trials for which we had no previous valid results (they had never been "reworked" using start values from No. 66 (.03)).

This will raise the total for No. 78K to 34 out of 90, which should satisfy the requirements you left with me. If you wish, there is a small amount of further work I can undertake to resolve another trial or two, but perhaps you do not want any more time spent on 78K now.

Rather than make out new charts, I am also enclosing a sketch of the trial locations, so that you may yourself effect what changes may be necessary on the charts you have and at the same time see how your present mental picture of the distributions may be affected thereby.

In checking Langdon's tables, I noted that you have called for "bc" to be listed in only one function, No. 59. It is available also for No. 78K - will you wish it added to that table, too, or is it sufficient for your purposes simply to present it in chart form for that function?

Now, further to my enquiries on function No. 66K, what tables do you wish made up on it? a, b, c, bc and f(c)? I am proceeding at the moment on that assumption, but have only just begun the computer work to complete the data.

As the tables are completed, may Peg begin to type them, and if so, how do you require them headed? It seems feasible to have one function per page, in two sections of 45 trials each across a horizontal page. For the unresolved trials, I would suggest "NF" (for "no fit obtained"), with appropriate footnote.

Incidentally, the inclusion of the five new trials for No. 78K in a sum of squares comparison with No. 56K and No. 80K does not alter the order of precedence I gave you in my previous letter; nor do I expect final data from No. 66K to affect the order in any way either.

We were very sorry to learn you had been under the weather of late, and trust it is rapidly clearing up.

Yours truly,

(new. 1000)  
For Chief Superintendent

*file*CONFIDENTIAL  
ENCLOSURE

10 September 1962

*(submitted  
from file  
by [unclear])*

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: DAR (B&C)

SUBJECT: Informal Reports on BW Programme

1. Reference is made to DRBS 1800-1 DAR (B&C), dated 17 February 1961, and DRBC 906-300/0 and DRB 904-31/0 (DSIS 3), dated 19 October 1961.
2. We are enclosing two dozen (24) copies of the "Review of Bacteriology Programme since May 1962 to August 1962", for circulation to the Committee Members and D.R.K.L.
3. We are also enclosing three (3) copies of the above for circulation to DSIS for onward transmission to: The War Office - 1 copy for DPR and 1 copy for D/IRE; and DRS, Washington - 1 copy for Mr. R. Holmes.

JRM/sp

(J.R. Maltman)  
for Chief Superintendent

Encl. - 28

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTACONFIDENTIALREVIEW OF BACTERIOLOGY PROGRAMME SINCE MAY 1962 TO AUGUST 1962STUDIES ON AEROSOLS OF BACTERIAI. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH:1. Practical Investigations:Protection of Aerosols Disseminated from Bacterial Slurries:  
(Project - D52-18-20-18) (Confidential)

Due to other commitments, no further studies have been conducted.

The Effect of Preconditioning Aerosols on the Survival of Airborne Bacteria:

This study has been continued using S.E.S. toroid drums modified by the addition of mixing tubes. The results are similar to those previously obtained in the Standard Reference drums. i.e., secondary air decreases survival values appreciably at relative humidity values below 50 per cent.

Protein Detector Studies:

The Mark II Protein Detector set at a five second sampling interval was tested in the laboratory and field. Results indicated that this model has not sufficient sensitivity to be of use in determining cloud parameters in the field.

On the basis of talks with Dr. Leger, it was suggested that consideration be given to the Mark I model, which could be fitted with a controlled sampling interval from thirty seconds to five minutes or more. When this device is available, further tests at S.E.S. will be conducted.

2. Basic Investigations:Mechanisms Involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

The additive programme is still under suspension in order to continue studies on the role of nutrition on survival of airborne bacteria.

The effect of growth medium on subsequent aerosol survival of microorganisms has been extended. The addition of proteins to a chemically defined medium resulted in Serratia marcescens cells having decreased resistance toward the aerosolized state. Individual amino acids when added singly to the synthetic medium had little effect on resistance of the organisms. The possibility of an additive effect of amino acids is being investigated.

A study has been initiated to determine metabolic differences between resistant and sensitive S. marcescens organisms. Of the monosaccharides tested, aerosol sensitive cells exhibited greater oxygen consumption in the presence of glucose and xylose than did more resistant cells of the same strain.

II. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (Confidential)

Aerobiology, Technical Evaluation and the Naval Biological Laboratories are repeating Test 4 with Brucella suis - tagged Brucella suis.

When the results are known it is expected that all participants will repeat Test 4, probably in November 1962.

If the test is satisfactory, infectivity comparisons could be slated for February 1963.

III. TRIALS:

Local Trial No. 288 - "A Test of a Procedure for Comparing the Collison and EA Aerosol Disseminators in the Field at Night."

Superseded by Local Trial No. 295 - "Comparison of the Viable Recoveries of Sarcina lutea and Bacillus subtilis when Aerosolized from an Intimate Mixture in the Field at Night." Two investigations as the laboratory portion of the comparison of Bacillus subtilis var niger (BG) and Sarcina lutea (SL) as biological tracers, have been completed. This information is being prepared as Suffield Technical Notes Numbers 101 and 102 in which various factors governing the choice of a biological tracer are discussed.

Suffield Technical Note No. 101 - "The Stability of Mixed Slurries and Aerosols of Bacillus subtilis and Sarcina lutea."

Storage from 0 to 15 days at 4°C. in mixed suspension did not affect viability of either organism. BG did not become heat sensitive after storage as slurries or as three hour aerosols.

When aerosols were aged five hours there was no significant difference in viable survival of the two species. However, after twenty-two hours in the airborne state, BG survival values were significantly higher than SL.

Suffield Technical Note No. 102 - "Collection and Aspiration of Mixed Aerosols of Bacillus subtilis and Sarcina lutea."

Mixed aerosols of Bacillus subtilis and Sarcina lutea were collected and aspirated for 15, 30 and 60 minutes in gelatin saline and many other collecting fluids.

BG survival was reduced after aspiration in these collecting fluids while SL losses were not significant.

When mixed aerosols were collected and aspirated in modified Gelatin Milk Phosphate, no significant loss of either organism occurred.

Since BG is susceptible to aspiration loss, comparison of BG and SL in the field would necessitate the use of modified Gelatin Milk Phosphate as the collecting fluid. BG has other disadvantages as a biological tracer. For example, it is not compatible with Pasteurella tularensis as mixed slurries or aerosols. In addition this tracer is subject to aspiration losses in fluids that are suitable for collecting P. tularensis. On the other hand, SL is compatible with P. tularensis and shows no appreciable aspiration loss in fluid suitable for collection of P. tularensis.

It is not considered worthwhile at this time to make field comparisons of BG and SL (Local Trial No. 295).

IV. THE EFFECT OF SOLAR RADIATION ON MICROBIAL AEROSOLS:  
(Project - D52-18-20-18) (Confidential)

There has been no progress in this quarter, due to other laboratory and trial commitments.

V. PERMEABILITY CHANGES IN BACTERIA: (Project - D52-18-20-18) (Confidential)

Permeability Changes in Bacteria After Desiccation and Rehydration:

The object of these studies is to determine the role that permeability changes may play in the reduction of infectivity.

There has been no further progress in this quarter. Further studies concerning the influence of osmotic factors on cellular leakage will begin in the near future.

Infectivity of Young and Aged Aerosols:

These studies will not be undertaken until more information concerning cell permeability and reactivation of infectivity is available.

Protein and RNA Synthesis:

Experiments have been conducted with Staphylococcus aureus in which the synthesis of protein and ribonucleic acid have been followed from lag to stationary growth phases in heart infusion broth. RNA and protein synthesis in the lag period is considerably slower when the organisms have been previously subjected to desiccation. When the log growth phase is reached, both dried and fresh staphylococci exhibit approximately the same rate of synthesis. This latter observation agrees with a previously known fact that the minimum generation times in the log phase of staphylococci are the same regardless of their previous drying history. Relative measurements of protein and RNA synthesis in both dried and fresh staphylococci indicate that the peak values occur just about the time of the initial cell divisions. The increased lag period required to double the initial viable population of dried staphylococci, and the slower increases of the optical density of these cells are considered to be a reflection of the slower rates of production of RNA and protein.

The previous observations that protein synthesis of bacteria was adversely affected by desiccation could therefore be due at least in part to sensitivity of the mechanisms involved in RNA synthesis, for proteins cannot be synthesized in the absence of functional RNA. In addition, the slower synthesis of RNA exhibited by the previously dried cells cannot be due to lack of required amino acids for heart infusion broth contains adequate amounts for growth.

Since many of the substances concerned with the virulence of staphylococci are protein, their decreased production in the lag period coupled with the increased cell permeability of dried cells, might well provide reasons for the reduced infectivity and virulence of microorganisms surviving long periods in the environment.

Reactivation of the infectivity and virulence of dried staphylococci which has been accomplished previously at S.E.S. by incubation in broth during the lag period at 37°C., is considered to be associated in part with repair to RNA and protein synthesis mechanisms, as well as a return during this incubation period to normal permeability values.

VI. BACTERIOSTASIS BY  $\beta$ -NITROSTYRENES:

The Bacteriology Section has been assisting the Chemistry Section in assaying the bacteriostatic action of  $\beta$ -nitrostyrenes toward Staphylococcus aureus A.T.C.C. No. 6538 and Escherichia coli A.T.C.C. No. 9637. Using a turbidimetric method, over sixty compounds have been tested for bacteriostasis.

JRM/sp

10 September 1962



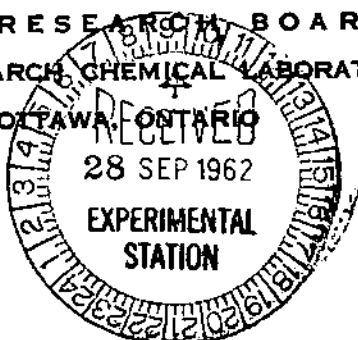
(J.R. Maltman)  
for Chief Superintendent



DEPARTMENT OF NATIONAL DEFENCE

DEFENCE RESEARCH BOARD  
DEFENCE RESEARCH CHEMICAL LABORATORIES  
SHIRLEY BAY, OTTAWA, ONTARIO

CONFIDENTIAL ATTACHMENT



25 September, 1962

Chief Superintendent,  
Suffield Experimental Station,  
Ralston, Alberta

FORWARDED TO	C.S.
C.D. FILE NUMBER	1800-1

Attn: Mr. D. Davids

Field Trials, Dugway Proving Grounds

1. During my visit to SES in August, 1962, trial results obtained at Dugway Proving Grounds in 1961 were mentioned. I promised to obtain data on the time of passage of B.W. clouds.
2. The enclosed report is a portion of the Quarterly Progress Report for April to June, 1961 and beginning at "Field Evaluation of B.W. Detection Devices" gives a resume of data obtained.
3. The Physical Detection Branch Memorandum No. DET-1 has been requested from H.Q. and will be forwarded as soon as it is received.
4. Mr. J. Currie, DRCL, states that the U.S. discussed this matter fully at the last Tripartite meeting (Summer 1962) and still agreed with the above report.

AEL:vmj  
Att:

*A. E. Leger*  
A.E. Leger,  
for Chief Superintendent

P.S. Please show this to Mr. Fish as we received a query from him this morning concerning this matter.  
*A. E. Leger*

*At all  
clear to me*



## QUARTERLY TECHNICAL PROGRESS REPORT

Physical Defense Division

April - June 1961

In an effort to simplify the optics of the Partichrome, tests were conducted using a dry objective as a substitute for the oil immersion lens. It was found unsatisfactory in that stained particles were counted as opaque, presumably due to light scattering.

Apart from correcting the operational defects of the processor and scanner, feasibility studies have been initiated on a miniscus-type processor-one in which the tape is moved over the surface of a liquid rather than requiring a staining cup with the problems of introducing and removing the various reagents. Preliminary tests indicate not only is the procedure feasible, but it appears to simplify and shorten the automatic staining process. Studies also were undertaken to evaluate the feasibility of developing a continuous impactor in place of the present item which involves a batch collection. Based on limited tests, this too appears to be feasible.

e. Future Plans: Work will continue in-house and possibly under contract toward correcting the deficiencies of the Mark II processor and the Mark III scanner, and toward exploring further the feasibility of the miniscus processor and the continuous impactor. A request has been submitted for development of a bread-board model of a miniscus-type processor.

## III. FIELD EVALUATION OF BW DETECTION DEVICES

a. Purpose: To obtain basic information on instrumental response when challenged with a realistic microbiological aerosol and to study aerosol characteristics.

b. Approach: Participate in scheduled field trials at various locations with available devices or collect appropriate samples which can be automatically processed to provide information on instrument response.

CONFIDENTIAL

c. Previous Results: Some data were obtained on the response of the ratio alarm to a challenge. This was conducted locally at the Fort Detrick Grid Area B. No challenge had been made using an aerial release at intermediate or long-range from the point of dissemination.

d. Technical Progress:

1. Determination of rate of dispersion of microbiological aerosols and application of particle counting principle.

(a). Dugway Proving Ground

In an attempt to study cloud behavior, personnel at Fort Detrick accompanied by personnel of Southern Research Institute were invited to participate in a scheduled field trial at Dugway Proving Ground during the period of 25 April through 4 May 1961. The test involved dissemination from an aircraft using an Aero 14B tank (later Edo modification). The particle counters consisted of three units which were positioned at selected locations downwind from low level aerial releases; one was a portable particle analyzer recently received from Southern Research Institute, and the other two were particle counters supplied by them.

The particle counters participated in a total of nine tests (Detailed data on tests are included in Physical Detection Branch Memorandum Report No. DET-1 dated 22 May 1961). Data were picked up at distances up to four miles showing that the cloud was approximately 250 to 500 feet wide, passing the instruments in 15 to 30 seconds. Analysis of data obtained on background taken before, during, and after actual test indicated that other types of man-made aerosols differ somewhat from the test aerosol.

The conclusions derived from these tests indicate that under the conditions of the test there was no difficulty in detecting the presence of the aerosol with the particle counting devices. This was accomplished readily principally because of the relatively high concentration of the aerosol particulates and the relative stability of the background.

17th September, 1962.

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: DAR(B&C)

Windsoc II - Canadian Participation

1. Reference is made to DRBS 1800-1 DAR(B&C) dated 6 Sept., 1962.
2. The objective for participation in Windsoc II given in the SES brief was also that suggested in the original Dugway Proving Ground correspondence. The pertinent paragraph states -

"5. (S) During these trials, it would be desirable to conduct agent chamber trials at the site simultaneously with the actual field trials. This could be readily accomplished by on site torrojd chamber experiments utilizing portions of the same slurry and under the same ambient meteorological conditions. Because of the interest expressed in these trials by Canadian and UK representatives, at the Fifteenth Tripartite Conference, and because of the number of years of accumulated experience in this specific area of endeavor, Canadian participation in this series of field trials is invited. It is requested that an appropriate number of personnel (minimum of two professionals and three technicians) from Suffield Experimental Station be assigned to this cooperative effort in order to conduct the torrojd chamber experiments at the site and in addition to assist Dugway Proving Ground personnel with the actual conduct of the Windsoc II field tests."

It also provides a Dugway answer to your query on the interpretation of maximum and minimum number of staff.

3. It would be understood that the SES team would also assist wherever possible in the overall operations. This would be expected to represent an appreciable contribution to the general laboratory work involved in the trials.
4. If the formal invitation is not on the lines suggested in the Dugway correspondence, and if the US could not agree to our including the torrojd drum investigation, which is unlikely to be the case, then the argument for Canadian participation would be our general interest in the performance of B<sub>w</sub> weapons and the possibility of the exchange of B<sub>w</sub> information being restricted if we did not participate.
5. It is suggested that any further detailed treatment of the brief might conveniently be taken up with the SES delegates during the Tripartite Conference.

*CP 9/14*

*H.J. Fish*  
(H.J. Fish)  
for Chief Superintendent

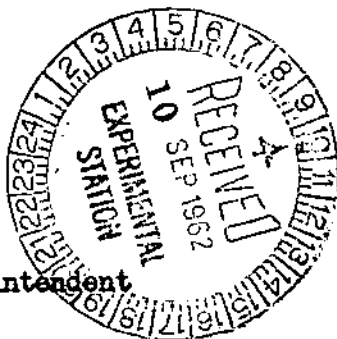


DEPARTMENT OF NATIONAL DEFENCE  
CANADA

# DEFENCE RESEARCH BOARD

IN REPLY PLEASE QUOTE  
DRBS 1800-1  
DAR(B&C)

SECRET



Ottawa, Ontario,  
6 September 62.

Chief Superintendent  
SES

RECEIVED	CS
CAN. FILE NO.	
	1800-1

## Windsoc II - Canadian Participation

1. Reference is made to SES 1800-1 (PRS) dated 22 Aug 62.
2. As you know the U.S. ruled several months ago that U.S. personnel could not discuss Windsoc II with foreign nationals. It is also known that attempts to have this ruling relaxed for Canada were started. The Chief Chemical Officer told Major Doddridge that the State Department would have to concur and, at that time (early June) stated that it should not take more than a month or two. The invitation is therefore overdue, but whether the reason is red tape or a refusal to change the ruling is not known. Because of this and because RPCC only considers "finished" briefs, it has been decided not to proceed now but, in the meantime, to work towards having the brief ready to present if and when the formal invitation is received.
3. There is one aspect which is not at all clear from a study of your brief. That is, what is the exact nature of Suffield's participation? Perhaps this will not be clarified unless and until the formal invitation from the U.S. is received but, in the meantime, what is the SES view? Both DAR staff and Major Doddridge understood from earlier discussions (by the former, with SES staff and Col. De Carlo, and by the latter with US Chemical Corps personnel in Edgewood and DPG) that the U.S. was requesting assistance from SES. This point of view is supported by the statement in the brief that the U.S. has stated a minimum number of staff. However, all other aspects of the brief imply that SES will be taking advantage of a U.S. trial as an opportunity to carry out work chosen and planned by SES but which cannot be done at SES because the organisms are pathogens. In fact, SES states that the work it plans to do is work on which the U.S. puts a low priority. Would not the U.S. have assigned a maximum for the number of SES participants if it viewed SES participation in this latter light?
4. Another aspect not considered in the brief is whether this will be a one-shot or a continuing series of safaris to the South Pacific. We know that you probably do not know for sure but can you estimate the probability of being more or less bound to continue to participate in future years once you start? Also what are the chances of you being able to get all the information you need the first trip as far as Canadian defence requirements are concerned?
5. The answers to the questions in para 4 are not independent of the answers to para 3. Similarly, there are other questions that could be asked on other parts of the brief. However, it seems better to leave a more detailed treatment of the brief until after you reply to this letter.

*B.H. Harasson*  
for Chairman  
Defence Research Board.

*M. PRS. - let's discuss.  
+ reply GP  
Discussed - reply  
written [signature]*

## MESSAGE FORM

FILE SES 1800-1 (BACT)

FOR COMMCEN/SIGNALS USE

NUMBER

PRECEDENCE - ACTION <b>ROUTINE</b>	PRECEDENCE - INFO DEFERRED	DATE - TIME GROUP <b>31-7-62/0900</b>	MESSAGE INSTRUCTIONS
FROM <b>Suffield Experimental Station, RALSTON, Alberta.</b>			PREFIX <b>GR</b>
TO <b>J.F. Currie, D.R.K.L., P.O. Box 123, KINGSTON, Ontario.</b>			SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>
INFO			ORIGINATOR'S NUMBER <b>SES 967</b>

1. Reference is made to your request of 26 July 62 for Brucella suis.
2. None available at present. Possible source of supply E.K. Wolfe at Fort Detrick.

Phoned to J. Gale at 0950 hrs.

*CP* *JW* *J.R. Maltman*

PAGE 1 OF 1 PAGES		REFERS TO MESSAGE		DRAFTER'S NAME <b>J.R. Maltman</b>		OFFICE <b>Bacteriology</b>		TEL. <b>267</b>	
CLASSIFIED YES <input type="checkbox"/> NO <input type="checkbox"/>									
FOR OPR'S USE	R	DATE	SYSTEM	OPERATOR	D	DATE	TIME	SYSTEM	OPERATOR
RELEASING OFFICER'S SIGNATURE									

DAFB 1710 (JDF) (REV 9/58)  
CNS 1320 A (REV 9/58)  
RCAF 843 (REV 9/58)  
7520 - 21 - 562 - 1556

COPY 2

000060

SECRET

22 August 1962.

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: DAR (B&C)

Windsoc II - Canadian Participation

1. Attached is a brief on the participation of SES staff in Windsoc II which has been prepared on the lines indicated in DRBS 1800-1 DAR (B&C) dated 12 April, 1962.
2. It is suggested that the reaction of the Research Projects Control Committee to this brief be determined now in anticipation of a formal U.S. request for Canadian participation.

Secret Attach:

(H.J. Fish)  
H/Planning & Reporting Section  
for Chief Superintendent

*Handwritten initials: "C.P." and "H.J."*

SECRETSUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

22 August 1962.

RECOMMENDATION FOR SES PARTICIPATION  
IN U.S. ARMY FIELD TRIAL WINDSOC IIOBJECTIVE

The objective of the U.S. programme which will be initiated in Windsoc II is to evaluate the long range travel of biological aerosols and to measure the performance of disseminating devices with pathogens.

The programme will, however, also provide an opportunity for the direct comparison of the loss of viability in organisms dispersed as aerosols in the open and in laboratory chambers, an investigation which is of considerable importance since it could justify the use of viable decay rates from the laboratory data in the estimation of the hazard from BW attacks.

Canada accepted in 1958 the primary responsibility for the Tripartite countries for investigating field and laboratory comparisons and has carried out a large number of trials which have been limited, by the range facilities available to her, to the use of a non-pathogen. It appears hopeful from these data that it will be possible to use the rate of loss of viability found in toroid drums in the laboratory as sufficiently reliable estimates of the viable decay in the field.

The SES objective in participating in Windsoc II would be to extend this investigation to other organisms including pathogens.

DETAILS OF PROGRAMME

Present U.S. plans for the first phase of the programme in which SES would participate call for trials with the two organisms NU and UL over distances of approximately 12 miles, and their preferred test site is the Eniwetok Atoll. Details of subsequent phases have not been specified by the U.S.

REASON FOR PROGRAMME

A recommendation that Canada accept primary responsibility for investigating the relative loss of viability of organisms in the laboratory and in the field was made as follows at the 13th Tripartite Conference.

"Conclusion 17

Valuable experience has been gained in field trial procedures required to establish the validity of predictions, from laboratory findings, of the viable decay of bacterial aerosols with downwind travel, and data from these trials are now becoming available. The investigation rests largely with US and Cda since range facilities available in UK are not well suited to this work.

Data on the ability to produce effective dosages of pathogens at considerable distances from the source are urgently required and empirical field trials are justified as well as the more controlled experiments required for the comparison of decay rates in the laboratory and field."

"Recommendation 17

Field trials in US to determine a capability for the production of effective dosages of pathogens at considerable distances downwind (several hours of travel) and trials in UK and Cda to compare the viable decay of bacterial aerosols in the field and in the laboratory, should be continued at high priority.

It is very desirable in trials to determine the viable decay of bacteria in the field, that laboratory tests with the same lot of agent and tracer be made simultaneously and under as similar conditions as possible.

Because of the availability of field facilities side by side with laboratory facilities, Cda should take primary responsibility for establishing the validity of laboratory predictions of viable decay and give consideration to extending the present work to include field trials with pathogens."

A recommendation that Canada participate in trials concerned with the long-range travel of biological aerosols was made as follows at the 15th Tripartite Conference.

"Conclusion 7

Existing field trial sites are inadequate for testing pathogens for two reasons: (a) measurements for application to large area coverage require longer travel distances than the sites will contain, and (b) some agents, for reasons of safety, cannot be tested at all. To conduct such trials will require the modification and development of assay techniques as well as the design and fabrication of suitable disseminating devices.

US outlined a programme of hardware investigations and associated field trials which will extend over several years. The major objective of these trials is the direct measurement of the survival of pathogens during long distance travel downwind. A second and very important objective is the actual demonstration of effective disseminating devices with pathogens under realistic test conditions."

"Recommendation 3

US should select suitable test areas for the evaluation of long range travel of biological aerosols and for measurements of the performance of disseminating devices with pathogens. Since the programme will be protracted, planning of the trials by US, with the assistance of UK and Cda, should proceed as rapidly as possible. The degree of participation of UK and Cda in the actual trials will be decided later."

SCIENTIFIC AND TECHNICAL FACTORS

The amount of data collected from the trials will depend on the success in weather forecasting, the frequency of occurrence of any special conditions required for the trials such as a lower limit for relative humidity, and the stability of the weather conditions during any trial period. The conditions at Eniwatok are likely to be ideal for the purpose. The only uncertainty would be the frequency of those wind directions which would allow full use of the chain of islands as sampling stations.



FACILITIES

A minimum participation of 2 professionals and 3 technicians has been suggested by the US. They would be required to be in Dugway Proving Ground approximately two months prior to date of commencement of trials, for test orientation and travel to the site. Present plans call for conducting a series of 15 trials at the minimum rate of one trial per week.

A safari operation of this type by SES personnel has already been shown to be feasible on a limited scale in two visits to Dugway Proving Ground and no difficulty is foreseen in extending the operation to Eniwetok.

The equipment required by an SES team is already available. If transportation of personnel and equipment has to be with the US team then a commercial carrier will probably be involved and cost of transportation may have to be added to subsistence allowances.

SERVICE CO-OPERATION REQUIRED

It may be necessary to request RCAF transportation for personnel and stores to Dugway Proving Ground and to Eniwetok.

IMPACT ON OTHER PROGRAMMES

Although the minimum number of staff asked for by the US will be a large drain on the BW section at SES, they will during their participation in the US programme, provide data which will contribute directly and importantly to an investigation which is already part of the SES programme. The position will be therefore that this aspect of the SES programme will be temporarily suspended at SES while being continued on the US test site.

It is probably however that SES would only be able to provide 2 professionals and 2 technicians instead of the 2 professionals and 3 technicians suggested by the US.

SECURITY RATING

Data from Windsoc II will presumably be classified SECRET.

RECOMMENDATION

Up to the present the US has emphasized the evaluation of long-range travel of biological aerosols and the assessment of the performance of BW munitions and would from our previous discussions with them put a low priority on including a study of the laboratory/field comparison. We consider specifically that the importance of establishing the relative viable decay in field and laboratory would warrant the amount of Canadian participation in Windsoc II suggested by the US, and generally, that the danger of the exchange of BW information being consequently restricted, would be too great for Canada not to participate in a programme which will presumably become part of the larger Project 112 during the succeeding years.



DEPARTMENT OF NATIONAL DEFENCE  
CANADA

## DEFENCE RESEARCH BOARD

Defence Research Kingston Laboratory  
P.O. Box 123, Kingston  
Ontario.

IN REPLY PLEASE QUOTE  
DRKL/1800-1

26 July, 1962

Chief Superintendent,  
Suffield Experimental Station,  
Ralston, Alta.

REFERRED TO	Bact
C. F. FILE NUMBER	
1800-1	

Attn: Bacteriology Section

TD2

### Brucella suis

1. This laboratory has an urgent requirement for a fresh stock of the highly virulent strain of the m/n organism. If this could be supplied by SES it would be greatly appreciated.



*J.F. Currie*  
J.F. Currie,  
(for) Chief Superintendent, DRCL/KL

M/W

Please  
check & advise  
and send Reply JFC

None available  
E.K. Wolfe at Ft. Detrick  
is having some made for  
a St. Rep. run. He could  
probably supply  
S.D.

1800-1

705 T  
SES +65 L "VIA AIR MAIL"

UNIVERSITY OF CALIFORNIA

NAVAL BIOLOGICAL LABORATORY  
NAVAL SUPPLY CENTER  
OAKLAND 14, CALIFORNIA

2 July 1962

Mr. David Davids  
Suffield Experimental Station  
Suffield, Alberta  
CANADA

Dear Dave:

We have a problem involving the separation of a mixture of Bacillus globigii and Sarcina lutea on plates. Do you have any suggestions for differential media that might be employed? Heat shock could perhaps be used to knock out the S. lutea. We were wondering if you knew of any material which could selectively suppress B. globigii.

I tried to reach you by phone on 2 July. I would appreciate an air mail reply addressed to:

W. R. Leif  
c/o Dr. C. D. Cox  
Office of Naval Research (Code 443)  
Navy Department  
Washington 25, D. C.

Give my and Wolochow's regards to our mutual friends at SES. Thank you for your kind consideration of this problem.

Sincerely,

*Walt*

W. R. Leif  
Research Bacteriologist

WRL:mc

file

4 July 1962

Mr. Walter Leif,  
Naval Biological Laboratories,  
OAKLAND, California, U.S.A.

Dear Walt:

Al told me you had called to ask about BG/SL. Since we have done a fair bit of work I thought I'd note down the highlights and perhaps save you some effort.

Our general approach was to -

- (a) Compare BG/SL mixtures in drums over 22 hour periods.
- (b) Check mixtures of the two organisms for aspiration losses if any, in order to justify making field comparisons of the two "tracer" materials.

I'll just note the pertinent findings:

Assessment of Mixtures -

- BG - always plated on plain Tryptose agar.
- SL - from Gelatin saline - plated on Tryptose agar with 1/50,000,000 Brilliant Green.
- SL - from undiluted G.H.P. or collecting fluid containing  $PO_4$  - plated on Tryptose agar with 1/10,000,000 Brilliant Green.

Apparently undiluted G.H.P. or  $PO_4$  masks the effect of Brilliant Green and BG is not adequately inhibited. We then had to increase the Brilliant Green concentration to properly mask BG.

- 1. BG can be aspirated for 15 minutes in Gelatin saline but no longer. SL can be aspirated in any known collecting fluid for at least 1 hour.
- 2. BG can be aspirated for 1 hour if collecting fluid is G.H.P. (slightly modified from Vic's original formula).

Aerosol Decay -

- BG and SL made up and stored separately in P.Y.E.
- Nominal count  $2 \times 10^{10}$ /ml.
- BG heat shocked before use.
- Before spraying BG/SL mixed 1:1 and sprayed into drums.
- Samples collected for 1 minute in gelatin saline.

- 1. Survival of BG/SL for at least 5 hours aerosol age almost identical.

4 July 1962

2. In some cases, at 22 hours, we recovered slightly more BG than SL. This is not too surprising. In other runs there was no difference in recovery.

Below is the formula for G.H.P. as we used it for aspiration studies:

Skim milk.....	10.0 gm.	
Galatin.....	1.0 gm.	
NaCl.....	8.5 gm.	
Spermidine phosphate.....	0.02 gm.	
Cysteine HCL.....	1.0 gm.	
K <sub>2</sub> HPO <sub>4</sub> .....	3.8 gm.	1.2% } Vic's
KH <sub>2</sub> PO <sub>4</sub> .....	1.19 gm.	0.39 } original
Distilled H <sub>2</sub> O.....	1000 ml.	

Dispense in 500 ml - add 2.5 ml antifonn A and sterilize.

I hope this will help. Best regards.

Sincerely,

D.E. Davids  
for Chief Superintendent

DED/sp

*file*  
CONFIDENTIAL  
ENCLOSURE

24 May 1962

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: J.F. Cockburn

SUBJECT: Informal Reports on BW Programme

1. Reference is made to DRBS 1800-1 DAR(B&C), dated 17 February 1961, and DRBC 906-300/0 and DRB 904-31/0 (DSIS 3), dated 19 October 1961).
2. We are enclosing two dozen copies of the "Review of Bacteriology Programme since January 1962 to April 1962", for circulation to the Committee Members and D.R.K.L.
3. We are also enclosing three (3) copies of the above for circulation to DSIS for onward transmission to: The War Office - 1 copy for DPR and 1 copy for D/MRE; and DRS, Wash. - 1 copy for Mr. R. Holmes.

JRM/sp  
Encl.

J.R. Maltman  
for Chief Superintendent

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

CONFIDENTIAL

REVIEW OF BACTERIOLOGY PROGRAMME SINCE JANUARY 1962 TO APRIL 1962

STUDIES ON AEROSOLS OF BACTERIA

I. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH:

1. Practical Investigations:

Protection of Aerosols Disseminated from Bacterial Slurries:  
(PROJECT - D52-18-20-18) (CONFIDENTIAL)

Due to other commitments, no further studies on additions of chemical substances to bacterial cultures to enhance the survival of airborne cells have been conducted.

The Effect of Preconditioning Aerosols on the Survival of Airborne Bacteria:

This study using the Standard Reference toroid drum and Serratia marcescens as the test organism has been completed. The results are the same as those reported in the September to December 1961, Review of Bacteriology Programme.

A similar study will be initiated shortly in S.E.S. toroid drums.

2. Basic Investigations:

Mechanisms Involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

The additive programme is still under suspension in order to continue studies on the role of nutrition on survival of airborne bacteria.

Previously it had been shown that S. marcescens cells after growth in a simple chemically defined medium were resistant to aerosolization over a five hour period when sprayed from distilled water and maintained at 80°F. and 35% relative humidity. On extending this study it has been found that this resistance to aerosolization held at relative humidities of 30%, 60%, and 80% and a temperature of 80°F.

The addition of proteinaceous material to the synthetic medium before inoculation had a varied effect on the subsequent aerosol stability of S. marcescens. At present, all but one protein tested has caused a decrease in resistance of the organism toward aerosolization.

Work has been initiated to devise a medium for more sensitive organisms such as Pasteurella pestis, which would result in the production of cells resistant to aerosolization.

II. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (CONFIDENTIAL)

This project is a Tripartite Agreement set up to establish baseline information concerning the characteristics of several aerosol testing systems installed in: M.R.E., Fort Detrick, D.P.G., N.B.L., and S.E.S. Results of Tests 1, 2, and 3 have been reported previously.

Test 4 using Brucella suis--tagged Brucella suis--has been completed. Results indicate unexpected wide variations in survival values between the various participating laboratories (Reference SES 375-4-1 (BACT), dated 9 May 1962).

Future Collaborative tests will undoubtedly involve infectivity comparisons.

III. TRIALS:

Local Trial No. 288 - "A Test of a Procedure for Comparing the Collison and E4 Aerosol Disseminators in the Field at Night."  
(CONFIDENTIAL)

These trials have been temporarily suspended to carry out Local Trial No. 295 - "Comparison of the Viable Recoveries of Sarcina lutea (SL) and Bacillus subtilis var niger (BG) when Aerosolized from an Intimate Mixture in the Field at Night."

These latter trials are field tests of biological tracers. The aerosols will be produced by E4 generators. Drum studies carried out to supplement these trials have shown that there is no appreciable difference in the survival of SL or BG, when aerosols up to five hours age, under varying temperature and relative humidity conditions are sampled into impingers containing gelatin saline for one minute.

However, field requirements dictate a one hour sampling period. In laboratory experiments an appreciable death rate has been shown when BG is collected and bubbled for one hour in impingers containing various test fluids. Only gelatin-milk-phosphate shows promise for BG collection in these experiments. SL survives well in all impinger fluids tested under these experimental conditions.

Dugway Proving Ground - Suffield Experimental Station Trials:

The S.E.S. Bacteriology Section was engaged in a joint effort with D.P.G. to determine the biological decay rates of Pasteurella tularensis when it is released in the field from an aerial line source, and to examine the infective capacity of this agent. These trials have been completed, and the results are being tabulated.

IV. THE EFFECT OF SOLAR RADIATION ON MICROBIAL AEROSOLS:  
(PROJECT - D52-18-20-18) (CONFIDENTIAL)

There has been no progress in this quarter, due to other laboratory and trial commitments.



V. MICROBIAL INFECTIONS: (PROJECT - D52-18-20-18) (CONFIDENTIAL)

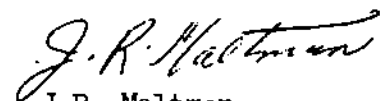
The study of permeability changes in bacteria after desiccation was being conducted in attempts to determine the role that permeability change plays in the reduction in infectivity.

There was no further progress in this quarter as staff was not available for this project.

Plans are now underway to study the magnitude of permeability changes when the cells are dried from various additive materials. In addition, studies will be undertaken to determine the magnitude of leakage of cell materials when various chemical constituents are added to fluids in which the dried organisms are reconstituted. In this way it is hoped that further information can be gathered concerning the importance of permeability changes and leakage in infectivity studies.

Infectivity of Young and Aged Aerosols:

No work has been carried out in this quarter on the decrease in infectivity of aged aerosols. These studies will again be undertaken when more information concerning cell permeability, and reactivation of infectivity is available.

  
J.R. Maltman  
for Chief Superintendent

JRM/sp

24 May 1962

10th May, 1962.

Dr. S.J. Webb,  
Department of Bacteriology,  
University of Saskatchewan,  
SASKATOON, Sask.

Dear Syd,

A peculiar query: you once said in my hearing that you had never seen a vegetative aerosol curve in which survival was assayed to go lower than one viable cell per 10,000 original cells. Do you mind if I quote you to this effect (as a speculative idea on your part) in a paper I am writing on fitting empirical mathematical survival curves to aerosols of Serratia marcescens? i.e. my reference would be "Personal communication, Webb". Have you anything different to say about the subject, now?

I am simply intending to mention two notions: (i) that curves fall to some constant value, below which there is no further death and (ii) given enough time, all such curves will go to zero. I have no evidence one way or another - I just wish to mention the two possibilities.

I expect to leave SIS for Toronto at the end of June.

Yours truly,

*Dal*

(J.A. Lyon)  
for Chief Superintendent



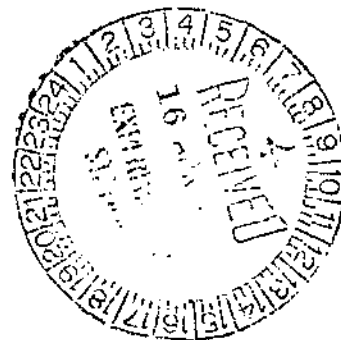
SECRET

OUR FILE REF. DRBS 1800-1  
DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD

CLASSIFICATION	CS
1800-1	70

Ottawa, Ontario,  
12 April, 1962.



Chief Superintendent,  
SES.

Windsoc II - Canadian Participation (U)

1. We have received a copy, from CLO, of the letter of invitation from the CO, DPG to CS/SES.
2. The Chief Scientist has ruled that this proposal must be prepared for presentation and consideration by the Research Projects Control Committee. The RPCC membership terms of reference and operating procedure were described in CDRB Directive 1/62 DRB 170-80/R27 (CDRB) dated 3 January 1962, a copy of which was sent to all establishments.
3. It was the understanding at the recent briefing of the Management Committee that Suffield would make a submission to Headquarters when the Dugway invitation was received. In accordance with the RPCC operating procedure DAR will be responsible for submitting the project appreciation to the RPCC. It would save time later if, in writing to DAR, SES kept in mind, and supplied insofar as possible, the type of information that DAR must include in it's appreciation. (See paragraph 1, sub-paras (a) to (g) of "Procedure for Seeking Approval of Research Projects" dated 4 January 1962, a copy of which was attached to CDRB Directive 1/62, mentioned above.)

*SIR.*  
*Be...*  
*PRB.*  
*SIF*

*to prepare comments pt. 1*

*S.R. Varian*  
for Chairman, Defence Research Board.

*C.S. should have met this and discuss it with the conference at your convenience.*

*Back will supply any information required for the submission.*

*SD*

100M-7/55(50-24)

16 April, 1962.

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: DAR(B and C)

Reference telecon Perry - Vavasour, 16 April, 1962.

1. Enclosed is the Suffield copy of the document discussed. Will you please forward it to USACC.

(B.J. Perry)  
for Chief Superintendent

Encl - SECRET

BJP/gw

Note: Document enclosed - CAS(W)8900-12 (CML) 380 dated 9 Apr 62, re Windsoc II - Canadian Participation (U) enclosing a letter from Colonel D. Armitage, Commanding Officer, Dugway Proving Ground, extending an invitation to Suffield Experimental Station to participate in US Army Field Trial Windsoc II.

---

C O P Y

SECRET

Canadian Liaison Officer  
US Army Chemical Corps  
Building No. 330  
Army Chemical Centre, Maryland

In reply please quote  
No. CAS(W)8900-12 (CML) 380

9 Apr 62

Chief Superintendent,  
Suffield Experimental Station,  
RALSTON, Alberta,  
Canada.

Windsoc II - Canadian Participation (U)

1. Enclosed is a letter from Colonel D. Armitage, Commanding Officer, Dugway Proving Ground, extending an invitation to Suffield Experimental Station to participate in US Army Field Trial Windsoc II.
2. Please note that a copy of this correspondence has been forwarded to DAR (B&C),

(Signed) R.R. Doddridge

(R R DODDRIDGE)  
Major  
CLO to Chemical Corps

Encl.

Cy Furn w/Encl:  
DAR(B&C)

*Back of 523 k take over one  
phase of the work 2.8  
Samples of a particular kind as in  
a given area; or known time only*

COPY

SECRET

HEADQUARTERS  
US Army Chemical Corps Proving Ground  
Dugway Proving Ground  
Dugway, Utah.

Apr 5 1962

In Reply refer to:

CMLRD-DU-ACS

SUBJECT: Windsoc II - Canadian Participation (U)

THRU: Canadian Army Technical Representative  
U.S. Army Chemical Corps  
Building No. 330  
Army Chemical Center, Maryland

TO: Chief Superintendent  
Suffield Experimental Station  
Ralston, Alberta, Canada

1. (U) Reference: Conclusion 7 and Recommendation 3, Final Report of Fifteenth Tripartite Conference on Toxicological Warfare, 12-23 September 1960.
  2. (S) As discussed at the above conference, the U.S. is very much concerned with the changing nature of the requirement for field trials with biological agents and has proceeded with the formulation of plans for this effort. Field trials with simulants and pathogenic agents are scheduled for initiation during the second quarter of FY 1963.
  3. (S) Dugway Proving Ground has been assigned the responsibility for the planning, conduct and evaluation of the first series of trials using biological agents. Windsoc II has been designated as the unclassified title for these trials.
  4. (S) The preferred test site selected for Windsoc II is the Eniwetok Atoll, Marshall Islands. Present plans call for conducting a series of fifteen field trials at the minimum rate of one trial per week starting on or about 15 October 1962. In this initial series, it is planned to release agents NU and UL and simulant agent BG from a modified Aero 14B Spray Tank along a 20 mile elevated line. Aerosol
- 

000077

Sampling will be accomplished out to an approximate 12 mile downwind distance. Assessment of the UL and BG samplers will be performed at the site; NU assessment at Dugway Proving Ground

5. (S) During these trials, it would be desirable to conduct agent chamber trials at the site simultaneously with the actual field trials. This could be readily accomplished by on site torroid chamber experiments utilizing portions of the same slurry and under the same ambient meteorological conditions. Because of the interest expressed in these trials by Canadian and UK representatives, at the Fifteenth Tripartite Conference, and because of the number of years of accumulated experience in this specific area of endeavor, Canadian participation in this series of field trials is invited. It is requested that an appropriate number of personnel (minimum of two professional and three technicians) from Suffield Experimental Station be assigned to this cooperative effort in order to conduct the torroid chamber experiments at the site and in addition to assist Dugway Proving Ground personnel with the actual conduct of the Windsoc II field tests. Additional areas of cooperation and participation will be discussed at the annual Dugway-Suffield meeting which is tentatively scheduled for 6-8 June 1962.

6. (S) If this cooperative effort is considered favorably it would be desirable for Suffield personnel to be at Dugway Proving Ground approximately two months prior to 15 October 1962 for the purpose of test orientation and travel to the site.

(Signed) D. Armitage

DAVID ARMITAGE  
Colonel, CmlC  
Commanding

Copy furnished:  
CG, USA CmlC RDCOM  
ATTN: Test and Eval Div



## DEPARTMENT OF NATIONAL DEFENCE

ARMY

In reply to SES 1800-1 (ATLO)  
Dated 14 Mar 62

Our file ref. JABCS/3480-1

JOINT ATOMIC BIOLOGICAL AND CHEMICAL DEFENSIVE WARFARE SCHOOL

CAMP BORDEN Ont Mar 62

Army Technical Liaison Officer  
Suffield Experimental Station  
RALSTON Alberta

Manual of Biological and Chemical Defence (MOBCD)

1. Receipt is acknowledged, with thanks, of the comments on MOBCD contained in the referenced letter.
2. These comments have drawn attention to some changes which will undoubtedly be included in the next amendment. Other suggested amendments however indicate differences between the source of reference material used for MOBCD and that referred to in the above letter.
3. Discussion of some of these points with an SES staff member would be beneficial should it prove possible to include a visit to JABCS whilst visiting other establishments or HQ's in Ontario, within the next few months. JABCS would welcome advice of such a visit whenever possible.

ATLO.

② CS Env.

a. The comments referred to above  
to were made on biological  
and chemical warfare aspects,  
including mut.

b. Would it be possible for  
SES staff in these fields to  
include JABCS in future  
Eastern itineraries?

(SW Bone) Major  
(HE Staples)  
Lieutenant Colonel  
Commandant

Yes next appropriate  
visit ok? *cr?*

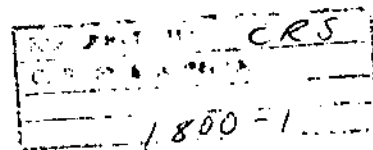
*11 Apr 62*



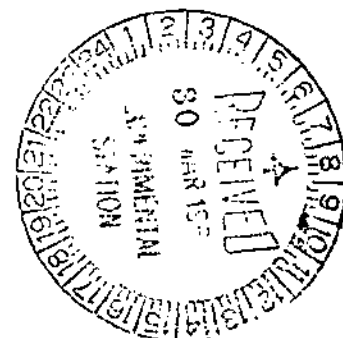


OUR FILE REF. DRBS 1800-1  
DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
26 March 1962.



→ Chief Superintendent,  
SES

Chief Superintendent,  
DRCL/KL

Quarterly Technical Progress Report  
Physical Defense Division Bio-Labs

1. Attached for your information and retention is one copy of the Quarterly Technical Progress Report for the Physical Defense Division at Biological Laboratories, Fort Detrick, Maryland, covering the period January to March, 1962.

*W. F. Cockburn.*

for Chairman,  
Defence Research Board.

Encl.

*Report retained  
in ER(5).  
WFF*

SUFFIELD EXPERIMENTAL STATION

In reply to JABCS/3480-1  
Dated: 19 Dec 61

Ralston, Alberta  
14 Mar 62

Commandant,  
JABCS,  
Camp Borden, Ontario.

Manual of Biological and Chemical Defence

1. The marginally noted document has been reviewed by Sections at Suffield Experimental Station and the following comments are offered for consideration when the Manual is revised:-

- a. Pages 9 and 11 - Nearly all references to percutaneous action are imprecise. It is suggested that a general statement under para 204a or 204e might be made to the following effect:-

"The liquid dosage which will lead to incapacitation or death is generally greater for penetration through the skin than for other routes of entry, and still greater for penetration through clothing and skin. The time of action is also longer for skin penetration than for other routes of entry, and still longer for penetration through clothing and skin. The more volatile the agent, the greater the amount required to exert toxic effects through skin and clothing. However, time of action is shorter for more volatile agents."

or, under para 204i:-

"204 (i) - Penetration of Clothing and Skin.

In general, liquid deposits on skin or clothing will exert their toxic effects much more slowly than agents taken directly into the body through lungs, mouth, or eyes, and the dosages required to produce incapacitation or death will be larger when the skin must be penetrated than when the intake is direct. The volatility of the agent generally affects both the time of action and the dosage required for penetration of skin and clothing. Agents of low volatility will in general be slower-acting, but more effective because of their greater persistence on skin and clothing. Agents of higher volatility will be faster-acting, but generally less effective because of their evaporation from clothing."

- b. Page 15 para 303d. - It is doubtful if this statement is true. What is important is that GA is more hazardous on skin and clothing.
- c. Page 15 para 304b and 304c - The rate of action of VX through skin is much slower than GB or GA. Onset of symptoms may not occur for 4-24 hours.

...../2

- d. Page 15 para 305c - The statement is very true for GB but some distinction should be made for VX.
- e. Page 16 para 308 - Note 1 is very applicable; perhaps this could be brought to the head of this paragraph.
- f. Page 18 para 310b - On the contrary, the body detoxifies nerve gases rapidly. However, the lowering of cholinesterase results in increased susceptibility, even though the agent itself has disappeared. It has generally been assumed that the return to normal resistance after exposure occurs at the same rate, as the recovery of cholinesterase in blood or brain; this assumption is open to question. There is little direct evidence on the rate of recovery of resistance, and what there is would indicate that recovery times may be considerably shorter than the "several weeks" quoted in this paragraph.
- g. Page 18 para 311c - This paragraph gives the impression that atropine affords good protection against nerve gas. This is not the case, certainly unless artificial ventilation can also be given. Protection by 2 mg of atropine in man, injected intramuscularly after exposure, without artificial ventilation, might be very disappointing.
- h. Page 38 para 603c.10(a) - Bryant et al gave 1 ppm as intolerable in 30 secs; this gives.

$$ICt_{50} < 7 \frac{mg}{m^3} \times 1/2 \text{ min}$$

$$< 3.5 \frac{mg}{m^3}$$

- j. Page 43 para 701c(2) - The term "chemical efficiency" is usually applied to the efficiency with which the munition disperses the charging in the desired form. Para 701c(2)(b) implies that the greater the percentage of the total weight of a weapon represented by the charging, the greater the dispersal efficiency - this is not necessarily true.
- k. Page 43 para 701c(3) - Contamination density is usually expressed as g/m<sup>2</sup>.
- l. Page 43 para 701c(4) - It is suggested that the last sentence be replaced by:-  
  
"For contaminating with liquid agent, air-burst munitions are frequently better than ground burst since loss of charging in the crater is avoided."
- m. Page 44 para 702f - Densities would better be written 25 g/m<sup>2</sup> and 10 g/m<sup>2</sup>.
- n. Page 45 para 702h - It would be more realistic to talk of tanks emitting at a rate of 10 US gal/sec at a speed of 350 mi/hr.

Insert. ", contaminated to a particular density," after "path" in the last sentence of this paragraph.


...../3

- o. Page 48 para 802a - Delete "working in some cases through pressure differences" in lines 6 and 7.
- p. Page 49 para 802b(1) - Delete first sentence and substitute "Streamlines lie along the instantaneous wind direction."
- q. Page 51 para 802d(a) - in line 5 - refer to the "surface layer of air" instead of "skin air".
- r. Page 51 para 802d(b) - See comment above re "skin" and also delete "isolated" in line 3, removing parenthesis from "sunlit".
- s. Page 54 - Table 7 - For C.I and H.I field experimental work by Tripartite agreement the vertical temperature gradient is expressed as the temperature at 1/2 metre subtracted from the temperature at 4 metres. However, the heights of one foot and six feet could be used. The figures given in Table 7 are rather high. We would suggest the following temperature differences between six feet and one foot:-

Strong inversion	above + 4° F
Moderate inversion	+ 2 to 4° F
Inversion	+ 1 to + 2° F
Neutral	+ 1 to - 1° F
Lapse	- 1 to - 2° F
Moderate lapse	- 2 to - 4° F
Strong lapse	below - 4° F

- t. Page 121 para 2105c - It is recommended that the last sentence be deleted.
- u. Page 121 para 2105d(2) - Substitute "micro-organisms" for "micrograms" in the last line.
- v. Page 123 para 2106a(2)(c) - Substitute "spirochaeta" for "spirilla".
- w. Page 127 para 2204d - In line 2, delete all after "storage" and substitute:-

" , to withstand dissemination, and to survive airborne suspension as evidenced by growth on a nutrient medium."

  
 (B.G. Cameron) Major  
 Army Technical Liaison Officer,  
 Suffield Experimental Station.

EGC/bas

CR - Tr  
file su  
1800-1

6 March, 1962.

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention : Mr. G.R. Vavasour

Dear

Many thanks for your letter DRBS 1800-1 DAR(B and C) dated 14 February, 1962, with the first draft of your Review on the SES BW Programme. We have gone into this in detail and with great interest and would like to congratulate you on the very good job you have done. We have no quarrels with your conclusions or recommendations except with your definition of the term "simulant", our reasons for which will be given later.

The following comments are offered with regard to your draft:-

Para 4.(b)

We suggest that "particulates" be replaced by "fluorescent particles".

Para 4.(c)

We suggest that "That bacterial ----- but that" be deleted since your statement depends on effective dose as well as hardness. This paragraph could continue "Our knowledge of vegetative bacteria and viruses does not permit one to predict the extent of effective long distance, downwind travel of the more sensitive organisms".

Para 5.

I am afraid we quarrel very strongly with your definition of the term "simulant". The term "simulant" like the term "stability" is one of the more loosely used terms in C and B research and is actually meaningless unless it is carefully specified as to what the simulant is simulating. The original use of the term "simulant" related to the use of relatively harmless materials whose physical properties were close to those of specific chemical agents to facilitate obtaining weapon performance data. Tests show that the behaviour of such non-toxic materials when disseminated from weapons was very similar to that of the agent itself, so that it was true that the non-toxic materials simulated the dissemination characteristics of the particular CW agent. If the term "simulant" is used in any other sense then it is essential that the sense should be carefully defined on each and every occasion. We wonder why you need to define the term "simulant" since you have effectively explained why the term should not be used in your earlier paragraphs.

Para 7.

We suggest that "only" in the first sentence be replaced by "simplest".

Para 7.

A minor point, that SM is spelt Serratia marcescens.

Para 8.(a)(iii)

We would suggest that after "E4 spray aerosol" you insert "(the spray device used in field trials)" and after "for comparison with" insert "the laboratory".

Para 8.(b)(ii)

The second "on" in line 1, should be "and".

Para 12.

The only real quarrel we have is with regard to Para 12(d) and the suggestion that safari teams would be unwelcome visitors and the work an imposition for SES. The point made here was that the Field programme is planned for at least a year ahead and priorities allocated to the various phases of the work. To have a sudden request to accept a safari BW team could raise difficulties, particularly if the Station is not engaged in a BW programme, and could result in serious interference with SES's own Field programme. BW field trials generally require certain meteorological conditions which are not always realized consistently in the practical weather scheme. BW safari teams would, therefore, have to remain at SES for extended periods to complete a programme of trials and SES would feel it incumbent upon them to give priority to the safari team when suitable weather conditions prevailed, even though these meteorological conditions were suitable for SES domestic trials. We would suggest that 12.(a) to 12.(d) should be replaced as follows:-

- (a) BW field trials at SES require certain laboratory facilities. These would have to be kept in shape between safari visits.
- (b) A BW field trial involves far more people than those in the BW section. It would not be practicable to build up an independent safari team in another establishment.
- (c) If SES did not have a BW group their efforts would be concentrated on the other fields studied and those people outside the present BW group who now keep abreast of the BW programme and progress in the tripartite field, could not be expected to keep up this knowledge. The techniques and know-how of the SES staff would, therefore, deteriorate.
- (d) BW trials require<sup>ing</sup> fairly narrow meteorological conditions would require a safari team staying at Suffield for reasonably extended periods of time. Such visits could raise difficulties within the SES domestic programme, particularly when the required meteorological conditions are similar to those required for the SES field programmes. This might be obviated if the safari BW programme is planned sufficiently far ahead to fit in with the SES Field programme, which is normally planned for one or two years ahead.
- (e) *Perry mentioned no factors favouring safaris except where an active facility was already in existence and local aspects of weather, terrain, or agents used, were of specific value to the visiting safari team. None are known to me.*

Para 12. (continued)

- (f) Whatever weight one grants to these points it seems that trial be safari is not the preferred method and a decision to make a programme dependent on safaris should not be taken without further investigation.

Para 14.

Your statement "In fact CS/SES transferred one position to the shock and blast programme not too long ago." is literally true but this decision was in part dependent on the fact that we needed to expand and strengthen our shock and blast group and were proposing methods of doing this in the first instance by a transfer of vacancies from other fields of endeavour. The intent was, that having accomplished the transfers and hiring of appropriate staff, we could then justifiably come, cap in hand, to HQ for extra positions should the need arise for further emphasis on any aspect of our over-all programme.

Para 15.

We suggest you delete definition of a simulant, or re-phrase in the light of our previous comments.

Para 16.(c)

"5(b)" should read "16(b)".

Para 16.(d)

This suggests an exciting possibility for SES. We had dared not suggest it, since it is our impression that U.S. or U.K. would be unlikely to second staff except on an exchange basis. Our present position at SES would preclude an exchange. We would welcome overtures being made to obtain a first-rate man from the other countries.

(B.J. Perry)  
for Chief Superintendent

BJP/gw

21 February 1962

C O M M E N T S

by

D.E. Davids

Para 4

- A (c) Vegetative bacteria and viruses are both classed as "more sensitive organisms". We know that vegetative bacteria generally fit this description, however viruses should not be considered as being "sensitive" in the same sense.

Para 4

- B (d) It's a small point, but I think that 3 years is more correct. Give another year to construction and calibration of drums.

Para 5

- C This definition of a 'simulant' automatically ejects the word from a B.W. glossary. Since the only substitute for a naked vegetative cell is another naked cell necessarily of a closely related strain, and since it is generally known that even closely related strains differ considerably in the properties of viable decay and infectivity, there is no such thing as a true B.W. simulant.

Para 8

- D (iv) Since small scale fluctuations of relative humidity and temperature such as occur in the field can never be accurately reproduced in drums, I take this to mean that given the conditions, the highs and the lows as suggested by D. Lyon be investigated.

A general statement concerning Para 8 might be made. The lab and field programmes combined make for a rather ambitious work load for the present staff at S.E.S. Certainly we agree to the proposed program, the length of time involved before all aspects of it are completed is another matter.

Para 10

Also ref. Para 8 (b), (i) and (ii).

What is a small-scale trial with UL? We have already done limited source, limited travel trials in the mile square and could also do the type of trial referred to in (b) (i). I noted however, at the discussions that S.E.S. is not prepared logistically to carry out trials of even 10 miles travel with UL.

Para 12

Concerning Safari teams:

Agree completely that such a team can only operate at all if grafted onto an existing field facility.

The Conclusion I draw is that:

Other safari teams based elsewhere would not accomplish much by coming to S.E.S. even if permission was obtained for long distance UL trials since there are not enough field staff at S.E.S. to conduct such a trial. An S.E.S. safari team however, if augmented with staff at D.P.G. for example can make a definite contribution.

/sp

D.E. Davids



S/R

I think This is very good. The idea of a US man on loan has exciting possibilities

The programme outlined has been given more prominence than it had in our brief. Will all concerned accept it in this new light. One of Navasari's conclusions is that it should be carried out Y.S.

Some comments in pencil on the draft.

Comments attached Red.



CONFIDENTIAL ENCLOSURE

OUR FILE REF. DRBS 1800-1  
DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD

14 February 1962.

Chief Superintendent,  
SES.

BW Review

1. Enclosed is one copy of my version of our review of the SES Programme during my recent visit. It is the first draft and does not read very smoothly in several places and certainly requires editing.
2. I am sending it to you, not for editing in a non-technical sense, but to give you a chance to comment on the accuracy of the technical information in it and on the soundness of my conclusions and judgments. DAR has seen the draft and has agreed with the suggestion that it be sent to you before going to him officially.
3. I would like to have your comments as soon as possible so that the job can be completed. In cases where you disagree with anything in the report I would appreciate a full explanation so that I will have the information I need in re-writing.

for Chairman, Defence Research Board.

Encl.

A Review of the SES BW Programme

by G.R. Vavasour

1. I visited SES on January 30 - February 1, 1962 to review and discuss the SES BW programme. The visit was arranged well in advance and SES was informed of its purpose. Most of the discussions were held with B.J. Perry, S/R, H.J. Fish, H/PRS and D.E. Davids, Bacteriology Section. Brief discussions were held with CS/SES at the beginning and end of the visit. At the latter I outlined the substance of my conclusions and he agreed with them.
  2. The main question in my mind before the visit was whether further work on 'simulants'\* would be likely to lead to useful results. Almost as important, and not independent of the main question, was the question of the future need for BW field trials at SES. Consolidation of DRB's BW research programme has been proposed both within DRB HQ and at meetings of the Advisory Committee on BW Research. A continuing need for BW field trials would mean that the research group must remain at Suffield unless the trials could be carried out by sending safari groups from another BW research group to SES. However there would be no need for future field work if field trials with 'simulants' were considered to be of little value and if permission could not be obtained to use pathogens in the field. The main topics on which I tried to focus our discussions were, therefore, the value of past, present, and future research on 'simulants', the future requirement for BW field experiments at SES as seen by SES, and the value of some small-scale, carefully-limited field experiments with pathogens. These topics were discussed by Perry, Fish, Davids and myself. Two other important topics, namely, the feasibility of conducting field experiments by safari groups and the possibility of moving the BW group at SES, were discussed with Perry only. A conversation with CS/SES on staff problems associated with such a move is reported elsewhere.
  3. SES had prepared for my visit by writing an explanatory and descriptive account of the past and present BW programme at SES and a forecast of future research and field programmes. It was in the form of a joint memo from Perry and Fish to CS/SES. Davids had been shown a copy and all were in agreement with it. I chose to study the memo alone for a while before beginning discussions with them. It did not, however, cover the whole range of our subsequent discussions.
  4. The discussions began with a consideration of the Canadian defence requirements for BW information in order to ensure that we were all proceeding from the same starting point. The discussions were based on the following premises:
    - (a) That BW is a "large area coverage" rather than a tactical weapon and hence DRB's main concern in hazard evaluation is with respect to Canada itself as opposed to the hazard to overseas forces. (The situation in CW is just the opposite).
    - (b) That it has been shown that areas up to 500,000 square miles can be covered with significant concentrations of/particulates (using the particle size ranges proposed for BW aerosols) from elevated line sources even under meteorological conditions not previously considered suitable for that method. *inert*
- \* The inverted commas mean that the word is being used loosely. It is defined later (para 5) and thereafter has a specific meaning when the inverted commas are omitted.

DRAFT ONLY

- request  
should be  
in effect in force  
as well as  
After 11:00 AM  
& good in daylight*
- (c) (That bacterial and other spores, being hardy, could be used in attacks of large areas but that) our knowledge of vegetative bacteria and viruses does not permit one to predict the extent of the effective down wind travel of these more sensitive organisms. *A*
- (d) Practically nothing is known of the mechanism of death and loss of infectivity of airborne bacteria and viruses despite the research on this subject for the past five years in the Tripartite countries. *B*
- (e) The point was made that the U.S., having as a major objective the development of an offensive BW capability, has a very great need for being able to predict quantitatively the capabilities of their proposed BW weapons systems. On the other hand Canada's defence requirements might be met by just a better qualitative assessment. This point, however, was not discussed fully and the discussions proceeded on the tacit assumption that further basic research in Canada on microbial aerosols was justified by the current lack of knowledge. A closer look at the validity of this assumption was outside the scope of this review but should be part of any future review of DRB's overall BW programme.

5. It became clear early in the discussions that the use of the word "simulant" as synonymous with "non-pathogen" can be and has been, misleading. It's incorrect use can lead to false conclusions because the results are judged, subconsciously, against the wrong criteria. Basic research on the biochemical mechanisms by which microorganisms are injured is equally valid whether done on pathogenic or non-pathogenic bacteria. To class all such work on non-pathogenic bacteria as work on simulants predisposes the mind to judge the results on the basis of their usefulness in extrapolation to candidate agents whereas the results should be judged as contributions to basic bacteriology and for their usefulness as guides or insights into how to attack the specific problems associated with specific BW agents. The definition of a simulant that I like best is as follows: "A BW simulant is a substance which can be used in place of the agent in experiments designed to yield reliable information concerning agent characteristics." *C*

6. A non-pathogenic organism is therefore only a simulant when it is used in place of a BW agent in order to obtain results which are applicable to the agent itself. In this sense practically none of Suffield's work can be classed as work on simulants. In the laboratory the death rate and rate of ~~dissemination~~ infectivity are investigated using both pathogens and non-pathogens in order to elucidate the environmental factors causing these effects and the mechanisms of the organism's reactions to these factors. The results on non-pathogens will not necessarily be applicable to BW agents but SES believes that the results will be of assistance more or less directly as contributions to the basic bacteriology involved in the behaviour of microbial aerosols.

7. The major device used in all three countries in this type of work is the rotating drum for the simple reason that this is the *(only) simplest* means by which organisms can be suspended in air for many hours at a time. The hope of the investigators is that, at the least, the biochemical mechanisms of the changes in organisms suspended in the drums will be the same as when they are suspended in the outdoors and, at the best, that the death and loss of infectivity rates will be of similar orders of magnitude or bear some determinable relationship to each other.

DRAFT ONLY

SES has been the only establishment to carry out drum and outdoor experiments on the same organism to test whether there is a relationship between the two. The work has been done using a non-pathogen (Serratia marcescens). The results have shown differences between decay in the drums and in the field but it is not known yet whether the differences are due to temperature-relative humidity fluctuations in the field or the effect of using different disseminators in the field and the laboratory. SES proposes to do further lab and field work on this problem. Naturally the U.S. which wants to know now how its agents will behave in the field, would be much happier if this work were being done on a standard or candidate agent. SES feels that if a relationship between drum and field behaviour can be established for SM and other non-pathogens the drum work on pathogens would have increased significance and the amount of work necessary to find a relationship between the behaviour of standard and candidate agents in drums and in the outdoors might be considerably reduced. SES also sees the combination of drum work on pathogens and non-pathogens with field work on non-pathogens as a means of screening methods of protecting organisms. Thus any method or additive which has been shown to protect a range of organisms (both pathogenic and non-pathogenic) in the laboratory can be tested for its effectiveness in the field using a non-pathogen.

8. SES provided an outline of its future laboratory and field programme as follows:

(a) Laboratory Programme

- (i) Bring drum studies to stage where decay patterns can be reproduced and the degree of variability is established. This would include cleaning up our commitments in the Standard Drum programme and in particular completing the check of the method of introducing the aerosol into the drum.
- (ii) Establish a firm picture of the decay of SM aerosols under a variety of RH and temperature conditions. This should only require putting together all data now available. Don Lyon has made a study of one large series of SM drum trials. More recent runs should be collated with this earlier series.
- (iii) Carry out decay runs with the <sup>(the spray device used in the field)</sup> EH spray aerosol in new drum over extended periods for comparison with <sup>(the laboratory)</sup> Collison aerosol.
- (iv) In drums determine the effect of small scale fluctuations of RH and temperature such as occur in the field on the loss of viability of organisms. The Meteorology Section is ready to recommend the conditions. D
- (v) Continue work on nutrition and protective additives to determine whether worthwhile increase in the survival of bacteria at night and in sunlight could be expected from use of such procedures.
- (vi) Continue the study of the effect of age on the virulence of airborne bacteria.

DRAFT ONLY

(b) Field Programme

- (i) Examine the degree of loss of bacteria during dispersal and during the first few minutes of aerosol travel when dispersed from a variety of available spray devices to include if possible the spray heads being developed for aircraft and drones. Do this with a variety of organisms including pathogens.
- (ii) Check findings on comparison of drum <sup>and</sup> field behaviour with other organisms including pathogens (e.g. Dugway trials).
- (iii) Check findings on comparison of drum and field behaviour when time of travel is increased to maximum night travel.
- (iv) Complete comparison of the two tracers SL and BG.
- (v) Check in the field any method of increasing survival of bacteria provided it has shown success over a range of organisms in the laboratory.
- (vi) Combine with these field trials the testing of detection devices, such as being developed at DRCL.

9. To me, a non-bacteriologist, the SES approach and programme is a valid one and analogous in many ways to the methods used in chemical warfare to screen toxic agents and methods of therapy and to elucidate the basic biological mechanisms of action of chemicals. In this latter field experimental animals are used not as simulants for humans, but as a means of increasing basic knowledge in order that experimental work on the real object, in this case man, may be reduced to the minimum and based on as firm ground as possible. There are, however, bacteriologists who feel that work on non-pathogens as well as on simulants is of little value and these views are reflected in accounts of recent tripartite meetings. It must be remembered, however, that an intense sense of urgency to get practical results is an important factor in the minds of many and proposals for basic research have often suffered from the pressure of impatient pragmatists. The uselessness of years of testing of small BW munitions is witness to the great need for basic research in this field. However, if a more detailed review of Suffield's programme is needed then a bacteriologist or a group of bacteriologists will be required to do it.

10. There is no doubt that a most valuable contribution<sup>to BW research</sup> would be a field experiment with the standard agent UL (*P. tularensis*) to find out the relationship, if any, between the death rate of UL in the field and in drums. There is a mass of data on UL behaviour in drums in all three countries. SES will attempt to obtain such data by sending a safari team to Dugway to do downwind sampling on the occasion of an engineering test by Dugway of a drone-spray tank weapon system. The results may show that a small-scale trial at SES would be needed to complete the picture. (Ref. 8(b)(i) and (ii)). From our discussions it seemed to me that the possibility of such a trial should not be dismissed out-of-hand but that, if necessary, a detailed proposal for such a trial should be drawn up by SES, including all the safeguards designed into the proposal, and the D of A approached for specific permission for a specific trial. I feel we should take advantage of a member of the Animal Division of the D of A being in our Advisory Committee to explore more fully the

/1

DRAFT ONLY

the past the exact limits within which we can operate with pathogens at SES, not forgetting the special facility known as Area E. SES did not know, for instance, what diseases are endemic in the wildlife of the SES range.

11. SES stated, when asked, that it is impossible to look very far in the future with regard to requirements for field trials. The value of the unique combination of laboratory and field facilities was stressed. It was considered most undesirable to destroy this capability. The need for further field trials at SES in the next year or so leads me to conclude that a BW group is required at SES for 2-3 years. On the other hand the absence of any clear long-term continuing requirement for BW field trials leads me to conclude that this is not the time to consider consolidating all DRB BW work at SES.

12. The feasibility of DRB carrying out BW field trials at SES by safari teams based at another establishment was discussed with Perry. He explained and described what is involved in carrying out field trials and was convinced that safari teams only operate effectively when they are grafted onto an existing field facility that is already active in field work or ~~are~~ completely self-contained. He cited the examples of the SES safari to Dugway and the DRCL safari last year to SES in showing how dependent the safari is on the facilities and organization of the host. He cited the following factors as serious impediments to carrying out trials by safari teams from another establishment to SES.

- (a) BW field trials at SES require certain laboratory facilities. These would have to be kept in shape between safari visits.
- (b) A BW field trial involves far more people than those in the BW section. It would not be practicable to build up an independent safari team in another establishment. He mentioned no factors favoring safaris and none are known to me. Whatever weight one grants to these points it seems that trial by safari is not the preferred method and a decision to make a programme dependent on safaris should not be taken without further investigation.
- (c) The techniques and know-how of both the SES and the other staff would deteriorate.
- (d) If SES did not have a BW group SES would not have the same interest in carrying out BW field trials and it would be only human for SES staff to consider a visiting BW safari team as unwelcome visitors and the work an imposition.

NO

13. Consolidation of DRB's BW programme at one establishment had been discussed at SES before my visit. It was my impression that all but the CS/SES had been considering this as meaning consolidation at SES, although the topic was discussed only with Perry and Pennie; the latter discussion being a very brief one just before my departure. In my discussions I took the position that although consolidation of BW work or removal of the BW group from SES was not my main concern it was bound up with the main questions in my mind, as stated in para 2. The interdependence of the two aspects arise from the fact that if there is no requirement for BW field trials the most compelling reason for siting a BW research programme at SES disappears. While Perry's main reasons for continuing a BW programme at SES were the need for future

DRAFT ONLY

BW field trials and the conviction that the unique capabilities of SES should not be destroyed, he also pointed out that there were other aspects of SES's programme that are or might soon become transferable if they need a field trial connection to justify remaining at SES. This is a valid point and taken together with the rise and fall of the entomology and radiation physics programmes at SES leads me to the conclusion that no major subtraction or addition should be made to SES's programme until after a study is made to decide what Suffield's role will be for the next 10-15 years. i.e. a survey of all defence science fields is made to choose areas in which SES can plan a long-range programme which will be independent of the shifting sands of requirements for field activities. In the past the SES programme has been determined by its field facilities. (Just as AECL's programme at Chalk River is determined by its huge investment in research reactors etc.) The time seems to be coming when this factor will not be of major importance.

14. Although my discussions at SES were almost entirely confined to the technical aspects of the programme and its future one non-technical factor - the lack of a leader for the BW group - has an important bearing on the future. At present leadership is being given to the group by a "troika" consisting of the CS, the S/R and H/PRS, and CS/SES has frozen vacancies for one professional and one technician pending the results of this review. It is difficult to be optimistic about the chances of recruiting a good leader in view of the shortage of qualified persons in Canada and because both DRCL/KL and SES have been unsuccessful in filling vacancies of long standing. In fact CS/SES transferred one position to the shock and blast programme not too long ago. The lack of a firm basis on which to base recommendations regarding the long-term future BW programme at SES leaves an uncertainty that makes the recruitment of a new leader for the BW section at SES even more difficult. The only solution that I have been able to think of to reconcile my conclusion that the BW programme at SES should be continued for 2-3 years with my doubts that recruitment of a leader will succeed is to approach the U.K. and the U.S. to see if they would loan us a suitable scientist for a 2-3 year period. (This possibility was not mentioned during my visit to SES simply because it did not occur to me until after the visit.)

bacteriologist

Recalling  
the visit  
to SES  
in 1961

15. My main conclusions are therefore as follows:

- (a) The use of the term "simulant" as synonymous with "non-pathogen" can be and has been misleading. Its incorrect use can lead to false conclusions because the results are judged, subconsciously, against the wrong criteria. Basic research on the biochemical mechanisms by which microorganisms are injured is equally valid whether done on <sup>or</sup> non-pathogenic bacteria as work on simulants predisposes the mind to judge the results on the basis of their usefulness in extrapolation to candidate agents whereas the results should be judged as contributions to basic bacteriology and for their usefulness as guides or insights into how to attack the specific problems associated with specific BW agents. The definition of a simulant that I like best is as follows:

"A BW simulant is a substance which can be used in place of the agent in experiments designed to yield information concerning agent characteristics."

- (b) Useful results can be obtained from further field trials with non-pathogenic bacteria at SES.

DRAFT ONLY



- (c) The field and laboratory programme proposed by SES should be carried out.
- (d) It is possible, depending on the results obtained by an SES Safari team to Dugway in the next 4-6 weeks, that a requirement will arise for a small-scale field experiment at SES with a BW agent P. tularensis, UL).
- (e) It is difficult to foresee at this time a long-term continuing requirement for BW field experiments at SES but it is not possible to state that there will be no requirement. The facts indicate that it would be premature to proceed at this time with the consolidation of DRB's BW effort either at SES or at DRCL.
- (f) A study of aridecisions regarding DRB's future overall BW programme is needed before any decision on consolidation of BW work is made. It is doubtful whether such a study should be made unless a similar study of the long-term future programme of SES is made at the same time.
- (g) The lack of a firm basis on which to base recommendations regarding the long-term future BW programme at SES leaves an uncertainty that makes the recruitment of a new leader for the BW section at SES even more difficult.

16. My recommendations are as follows:

- (a) That no major change in emphasis, direction or scope of the SES BW programme be made in the next three years.
- (b) That a major study of the future long-term DRB BW programme be initiated with the objective of defining its nature and scope and of forming the basis for deciding whether to consolidate all BW research at one establishment.
- (c) That a study be made, concurrently with 5(b) above, of the long-term (10-15 year) programme of SES.
- (d) That the possibility of obtaining a leader for the SES BW group by means of a 2-3 year loan of a suitable scientist from the U.S. or U.K. be explored.

DRAFT ONLY

13/2/62

# *Intensify War on Animal Diseases*

**Viruses That Hit Us, Too,  
To be Attacked in New Lab**

By AUDREY GILL

This document is still protected by the Copyright Act. Reproduction requires permission from the copyright owner./ Ce document est encore protégé par la Loi sur le droit d'auteur. La reproduction exige une autorisation du titulaire du droit d'auteur.

14 February 1962

American Type Culture Collection,  
2112 "M" Street, N.W.,  
WASHINGTON, D.C.

Gentlemen:

The Bacteriology Section would appreciate  
your help in obtaining the following cultures:

Staphylococcus aureus, ATCC Catalogue 1958,  
No. 6538.

Escherichia coli, ATCC Catalogue 1953,  
No. 9637.

Please address your reply to the Chief  
Superintendent, Suffield Experimental Station, Ralston, Alberta,  
Attention: D.E. Davids.

D.E. Davids  
for Chief Superintendent

DSD/sp



DEPARTMENT OF  
NATIONAL HEALTH AND WELFARE

IN YOUR REPLY REFER TO  
OUR FILE NO.

Laboratory of Hygiene,  
O t t a w a.

February 12, 1962.

Dr. D. E. Davids,  
Defence Research Board,  
Suffield Experimental Station,  
Department of National Defence,  
Ralston, Alberta.

Dear Dr. Davids,

Under separate cover, we are sending a  
dried culture of Staphylococcus aureus, FDA 209,  
which we are using for phenol co-efficients.  
Unfortunately, we do not have the Escherichia coli,  
No. 9637, which you also requested.

Hoping that the culture will prove  
satisfactory, I remain,

Yours sincerely,

*M. A. Mason*

(Miss) M. A. Mason,  
Biologics Control Laboratory.

**LABORATORY OF HYGIENE**

Shipped to Dr. D. E. Davids,  
Defence Research Board, Suffield Experimental Station,  
Department of National Defence, Ralston, Alberta.

QUANTITY	MATERIAL	CHECKED
1 dried culture	<u>Staphylococcus aureus, FDA 209</u>	
	Sent: Feb. 12, 1962.	
	NOTE—Please sign and return one copy of this form to: The Laboratory of Hygiene, Ottawa.	

Shipper

Receipt of Shipment Acknowledged

M. A. Mason

6 February 1962

Laboratory of Hygiene,  
Dept. of National Health & Welfare,  
OTTAWA, Ontario.

Dear Sir:

The Bacteriology Section would appreciate your help in obtaining the following cultures:

Staphylococcus aureus, ATCC Catalogue  
1958, No. 6538.

Escherichia coli, ATCC Catalogue 1958,  
No. 9637.

Please address your reply to the Chief Superintendent, Suffield Experimental Station, Ralston, Alberta, Attention: D.E. Davids.

for Chief Superintendent

DED/sp

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

31 January, 1962.

Bacteriology Programme - SES

One of the first things to be considered in reviewing the productivity or otherwise of any aspects of the Board's operations is to first consider what is the Board's responsibility in the particular field. According to the Board's constitution and mode of operation it has a responsibility to provide information, advice and guidance to the Armed Services, on a wide range of scientific topics. One of these topics is the threat involved in the possible use of bacterial agents.

To the best of our knowledge the Board still has this responsibility. The Services have not turned around and advised the Board that they are no longer interested in the BW threat. Accordingly a capability for assessing this threat must still be maintained. There has been great difficulty in the past years in recruiting bacteriologists for service with the Board, either at Kingston or at Suffield. As a result of separations from the Board, the number of professional bacteriologists is gradually going down but this should not be the automatic signal for saying that the BW programme should be abandoned. If this line of thought were pursued and executed whenever staff in any field began to dwindle, then we would find ourselves continually chopping off programmes just because we were unable to recruit staff. We should, therefore, take great care that we do not abandon the BW field just because we have failed to attract staff. The BW field should only be abandoned if the Services and the Board feel that there is no longer any need for them to be active in this area. Until such time as this radical change in policy has been made, then a BW capability has to be maintained and should be maintained at the maximum strength possible.

The greatest amount of information of value to Canada in the BW and CW fields undoubtedly has its origin within the other members of the tripartite organization but the dissemination of that information

to Canada is only made possible because we are active members of the tripartite organization. The moment that we withdraw completely from active participation in any field we will find that it will be increasingly hard to obtain exchange information and even harder to evaluate it and interpret it for our military colleagues. If only to maintain membership and the opportunity to receive current information from our tripartite partners, we should maintain at least a ~~minimum~~ level of practical operation in the BW field.

*WMP/CLD*



SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

29 January, 1962.

MEMORANDUM S/R 2/62

TO: Chief Superintendent.  
FROM: Supt./Research and H/PRS.

SES BW Programme

1. The main Defence Research Board responsibilities in the field of BW are:
  - (a) Research on early detection and identification of BW clouds, individual and collective protective measures, decontamination and therapy; and
  - (b) Maintain an advisory capability to the Canadian Armed Forces on the BW threat.

To date the problems under (a) above have been the responsibility of DRCL/KL and research to better understand the BW threat has formed the major part of the Suffield BW research programme.

2. From the inception of BW until the early 1950s the main programme in the BW field in both the US and UK was slanted towards the rapid development of small BW munitions. During this period Suffield's major role was to assess the performance of prototype munitions and in 1952 built the Wind Shed specifically to facilitate the rapid assessment and comparison of the performance of various small agent munition combinations. Throughout the whole of this period the analysis of results obtained on weapons performance studies proved most difficult and in many instances seemed meaningless. This position was particularly exemplified in the Wind Shed trials. The reasons were the many problems associated with the sampling and assessment of airborne living organisms and that basic knowledge on the behavior of airborne bacteria was virtually non-existent. The decision was made at SES in 1955 to withdraw from the field assessment work and to concentrate our efforts on a research programme to obtain fundamental data on the behavior of airborne bacteria. Shortly after this the large area concept BW threat was put forward by the UK and US and this concept emphasized even more clearly the need for basic knowledge on the behavior of aerosolized bacteria. Since that time the Suffield programme, although fraught with difficulties, particularly with regard to lack of staff, has nevertheless contributed many important results to the over-all tripartite pool of knowledge on the behavior of airborne bacteria. The programme has been mainly one of basic laboratory research with the use of the field test area to confirm major laboratory findings. Significant contributions have been made in:-

- (a) Mechanism of death studies of airborne bacteria.
- (b) Use of additives to modify the viable death rate of airborne bacteria.
- (c) Determining viable decay rates for several aerosolized organisms under controlled conditions of temperature and relative humidity.
- (d) Although the work is preliminary, we have shown that the infective decay of airborne organisms is at least as important as the viable decay. Everyone realizes, of course, that the infective decay is the ultimate result needed for a true appreciation of the BW threat but it is inherent in the problem that this is the data that is most difficult, laborious and time-consuming to obtain.

- (e) Discovery of a ~~new~~ simulant organism which seems eminently suitable as a "tracer"; tracer substances being essential for decay studies of all kinds.
- (f) Confirmation that the decay of SM under field conditions roughly parallels the decay of SM in laboratory drum experiments under the same ambient conditions of temperature and relative humidity.

3. At the present time the SES BW staff is small, consisting of three professionals, four research type technicians, and the supporting group for preparation and pouring of media, cleaning, sterilization, etc. In the US and the UK increased emphasis is being paid to the virus field. The question of the need for consolidating the DRB effort in the BW field is ever present. These facts give much food for thought and a detailed look at the SES programme has been carried out, as a result of which the following comments are offered:

- (a) It is felt that no one will gainsay the fact that people working in a research field are best able to keep abreast of the over-all developments in that field. Again, that a full appreciation of the BW threat can only be made with a full knowledge of the behavior of airborne bacteria. It should be borne in mind here that such knowledge is also of direct interest in the field of Public Health. It is felt, therefore, that it is essential for DRB to continue its research programme relating to the behavior of airborne bacteria.
- (b) The history of BW in the tripartite countries is one of a series of incompleted investigations. As something new comes to light so problems are dropped and laboratories jump onto the new band wagon. It is feared that the increased emphasis on virus work could well herald a similar phase. Although much work has been done in the field of aerosolized bacteria, the knowledge obtained is very far from complete. One might argue that in such a difficult field it never will be complete, but this is considered retrograde since it is generally used as an excuse to change the programme of work to a new field which might give results more quickly and easily. It is true that in any research programme one must watch closely for the point of diminishing returns. In the BW field, however, it is considered that this point has not nearly been reached and is unlikely to be reached within the next five years. To fulfill its functions DRB should have effort in the virus field. At the same time it is considered essential that DRB should continue its effort in the BW field. This DRB effort is very small and it is considered impossible to graft the virus effort onto the BW programme, that is, if it is considered essential that work in the virus field is carried out by DRB then the extra man-power would have to be supplied from outside the present BW laboratories. In addition, new facilities would have to be provided and it is likely that the provision of a DRB capability in the virus field would be quite costly.
- (c) It is well recognized that a large group is more efficient in producing results than two or three smaller groups. Although DRKL and SES work upon very different aspects of the over-all BW picture, it is felt that consolidation of the DRB effort could produce greater dividends.

4. If consolidation is to take place the main point at issue is the site at which it should occur. It cannot be over emphasized that in the BW field one is carrying out investigations with living organisms and past experience has shown that it is highly desirable, if not essential, to confirm laboratory findings under field conditions. If DRB continues her commitments in the BW field to the other tripartite countries then she should continue to keep her facilities for field research. Throughout the years SES has built up excellent relationships with the UK and, particularly, the US laboratories working in this area, as a result of which the SES

staff are fully abreast of the work being carried out in these laboratories and have developed considerable know-how and experience.

5. An over-all field and laboratory programme such as given later, could be considered, but the present interests would limit field aspects to tests of protected organisms after laboratory testing has been completed. This does not provide an immediate requirement for field support. Some six months will be required to clean up the laboratory and field aspects of F.E. 513 and DRKL could conceivably have a requirement for field testing of detection devices.

6. It must be borne in mind that, in the absence of a routine requirement for the field assessment of disseminating devices, it is difficult to lay down a continuous field research programme. The necessity for the latter can change rapidly as results from laboratory investigations become available. Indeed they can change as a result of field testing since many new factors have come to light when simple field experiments have been carried out. The requirement for field research will always exist and "a priori" requires experienced personnel and know-how. As previously stated this exists at SES and if this is not to be lost then it seems logical that any consolidation of DRB effort that may be required should take place at SES.

7. The BW research facility at SES has been built up to study the behavior of airborne bacteria with a view to developing a capability of making an unbiased appraisal of the BW threat. Even with the small staff available it is considered that SES could still continue to make worthwhile contributions in this area. The laboratories are well equipped for such investigations and the total staff capable of utilizing this equipment to the fullest are seven in number, that is, three professionals and four research type assistants. All aspects worked on in the past few years could not be carried on and efforts would be concentrated on the general problem of factors effecting the survival of airborne bacteria. Details of the programme are attached in Appendix 1.

(B.J. Perry)  
Supt./Research

(H.J. Fish)  
H/Planning and Reporting Section

Attach. - Appendix 1

BJP/gw

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

BW RESEARCH AND FIELD PROGRAMME

PROBLEM

To establish whether it would be possible to produce a BW hazard over large areas with aerosol releases from an upwind source.

Laboratory Programme

Bring drum studies to stage where decay patterns can be reproduced and the degree of variability is established. This would include cleaning up our commitments in the Standard Drum programme and in particular completing the check of the methods of introducing the aerosol into the drum.

Establish a firm picture of the decay of SM aerosols under a variety of RH and temperature conditions. This should only require putting together all data now available. Don Lyon has made a study of one large series of SM drum trials. More recent runs should be collated with this earlier series.

Carry out decay runs with the E4 spray aerosol in new drum over extended periods for comparison with Collison aerosol.

Determine the effect of small scale fluctuations of RH and temperature such as occur in the field on the loss of viability of organisms. Met. Section are ready to recommend conditions.

Continue work on nutrition and protective additives to determine whether worthwhile increase in the survival of bacteria at night and in sunlight could be expected from use of such procedures.

Continue the study of the effect of age on the virulence of airborne bacteria.

An eye should be kept on the development of dried bacteria and the biological stability of these powders.

Field Programme

Examine the degree of loss of bacteria during dispersal and during the first few minutes of aerosol travel (e.g. Local Trial 258) when dispersed from a variety of available spray devices to include if possible the spray heads being developed for aircraft and drones. Do this with a variety of organisms including pathogens.

Check findings of F.E. 513 with other organisms including pathogens (e.g. Dugway trials).

Check findings of F.E. 513 when time of travel is increased to maximum night travel.

Complete comparison of the two tracers SL and EG.

Check in the field any method of increasing survival of bacteria provided it has shown success over a range of organisms in the laboratory.

Field Programme (continued)

Combine with these field trials the testing of detection devices, such as being developed at DRCL.

Keep in mind the possibility of dried bacteria becoming a feasible BW weapon charging.

The objective of such a combined laboratory and field programme would be to determine the likely loss of organisms by death from the slurry to the target. From this can be judged the logistic possibility of attacking large areas with BW aerosols. A paper study of this type has been made by ORG in the U.S. but many of the assumptions were based on very little data.

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

17 January, 1962.

TO: Supt/Research

We spoke some time in November concerning a thorough review of the BW programme here at Suffield. I think this should be done right now and should include many things:-

- (a) The future of the present work, both in the laboratory and in the field;
- (b) The future of the operation of any work here with a limited staff, bearing in mind that Maltman is away for two years, Lejeune is likely to apply for educational leave, etc.
- (c) What is the wisdom of embarking on an entirely new field of virus work? Is it justifiable on Canada's behalf and if so, how should it be carried out? Should it be done as a joint programme with DRKL or should we re-build facilities and staff here at Suffield? If this is contemplated, what sort of programme is envisaged in, let's say, five years?

Would you please go into this in as fine a detail as you can, taking Mr. Fish into your confidence.

I am attaching two notes, one from Maltman which he prepared for me before he left, and a communication from DAR indicating that HQ, themselves, are making a review of their whole programme.

I would like to be able to discuss this with the staff concerned here, well before Vavasour's visit and I would suggest that, if possible, your review should be completed by the 25th of January.

*AM*  
(A. M. Pennie)  
Chief Superintendent

AMP/ad

*Prepared by J. R. M*

(J. R. Maltman)

CONTEMPLATED SHIFT IN EMPHASIS OF BW PROGRAMME TO VIRAL AND RICKETTSIAL AGENTS.

A Tripartite recommendation has urged that more research emphasis in BW should be placed on V & R agents. It is recommended that all ground work required for personnel, laboratory equipment and building facilities for the new research area be studied in the near future. The following is suggested as a guide in determining the requirements involved in V & R research.

Programme and Personnel - *V & R Research must be a team effort.*

A. Professionals:

Virologist are going to be difficult, if not impossible, to obtain in the near future under the present salary schemes. As a result a training programme in modern research techniques in V & R agents must be considered for the professional staff now engaged in BW research at S.E.S. These individuals might then form the nucleus of a V & R section. Further professional staff requirements will also be necessary, since production of the agents and associated testing will increase the research work load. There may be a possibility that V&R agents may be obtained elsewhere. If this is the case some reduction in the production requirements may be made. However, it must be kept in mind that it would be advantageous to have your own production facilities, since this would give the research worker control of agent production and allow more rapid modifications of techniques to ensure better yield and stability of the agent concerned. Further, it provides an opportunity for the scientist to conduct basic studies on factors required to



produce the agents for specific <sup>purposes and</sup> ~~properties~~ to determine the best assessment systems. It would also be of great advantage to have a Bio-chemist as one member of the professional staff, whose main basic research area would be concerned with the chemistry of the agent host relationships.

The following research scientists would then be required:

1. One scientist be required to study the most promising methods of agent production. His group could also engage in associated viral studies and genetics with the main aim to "tailor make" virus agents for specified purposes.
2. Two scientists for research in assessment problems. This group would work in close conjunction with the production group.
3. The Aerosol Group -- two scientists to study factors affecting the stability and infectivity of V&R aerosols.
4. The Bio-chemist previously mentioned will also serve as a consultant for the other research groups when required.

B. Technicians:

The technicians involved in work with V&R agents should consist of individuals who have the mental capacities to learn quickly techniques that will be required in the research programme. These technicians should include not only those routine in virology but also those that could profitably be <sup>used</sup> in fields of Biochemistry and Pathology. The absolute minimum of three technicians per scientist would be required. Since we have technicians in the Bacteriology Section at present, who are not familiar with V&R techniques, it will be necessary to institute a training programme. Those who are not satisfactory in this type of work will not be of much use to the Section.

Besides the scientists and technicians involved in V&R studies, consideration must also be given to increasing staff in wash-up procedures (since this is very critical) and also to provision of animal attendants.

Laboratory Equipment and Building:

Safety dictates that the present section facilities are not adequate for research with pathogenic V&R agents. This is particularly true for aerosol research, since the aerosol equipment at present is known to leak. There is always a danger when working with pathogenic viruses, that an individual may contact the disease and spread it to other members in the building, unless stringent precautions are taken in building design and in handling techniques. In addition, there is always a danger of accidental spills. In the present building such an accident might be very dangerous to all individuals in the building. Therefore, it is recommended that a special building be designed which would take into account the type of research which would be conducted, and which would provide adequate safety for individuals engaged in the programme.



CONFIDENTIAL

DRBS 1800-1 DAR  
OUR FILE REF. ....

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD

Ottawa, Ontario,  
8 January 1962.

Chief Superintendent,  
SES.

To be opened only by Mr. A.M. Pennie

BW Programme at SES

1. The departure of J.R. Maltman for further educational training makes it imperative to review the B.W. work at SES. CSc and C of E agree with this.
2. Could you receive Mr. Vavasour on 31st January and 1st February to conduct a detailed review of the situation in Biological Warfare research at SES, particularly in relation to the value of the field experiments conducted in the last few years, and the requirement for field experiments in the next few years.
3. You and I have discussed this informally before. If the paper Mr. Vavasour writes shows a very low requirement for field experiments, then I will very likely recommend moving the laboratory aspects of B.W. to the East, such field experiments as necessary being conducted by "safari". You may therefore discuss any implications of such a hypothetical move with Mr. Vavasour. On the other hand, you would presumably not wish it to be known at SES that such a possibility is even contemplated - hence the "to be opened only by..."

for Chairman, Defence Research Board.

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

17 January, 1962.

TO: Supt/Research

We spoke some time in November concerning a thorough review of the BW programme here at Suffield. I think this should be done right now and should include many things:-

- (a) The future of the present work, both in the laboratory and in the field;
- (b) The future of the operation of any work here with a limited staff, bearing in mind that Maltman is away for two years, Lejeune is likely to apply for educational leave, etc.
- (c) What is the wisdom of embarking on an entirely new field of virus work? Is it justifiable on Canada's behalf and if so, how should it be carried out? Should it be done as a joint programme with DRKL or should we re-build facilities and staff here at Suffield? If this is contemplated, what sort of programme is envisaged in, let's say, five years?

Would you please go into this in as fine a detail as you can, taking Mr. Fish into your confidence.

I am attaching two notes, one from Maltman which he prepared for me before he left, and a communication from DAR indicating that HQ, themselves, are making a review of their whole programme.

---

I would like to be able to discuss this with the staff concerned here, well before Vavasour's visit and I would suggest that, if possible, your review should be completed by the 25th of January.

(A. M. Pennie)  
Chief Superintendent

AMP/ad

*file*

28 December 1961

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: J.F. Cockburn

SUBJECT: Informal Reports on BW Programme

1. Reference is made to your DRB Teletype No. 1948, received at SES on 28 December 1961.
2. Enclosed please find 12 additional copies of the "Review of Bacteriology Programme since September 1961 to December 1961", and are sorry to have caused you this inconvenience.

JRM/sp

J.R. Maltman  
for Chief Superintendent

Encl. - Confidential

ROUTINE



&3003 AEA020EAA062AHB046

RR RAWEGD

DE RAHC 46/28

R 281550Z

FM DRB HQ OTTAWA

TO SES RALSTON

BT

UNCLAS DRB 1948 REFERENCE SES 1800-1 (BACT) DATED 22 DECEMBER.

YOU SENT ONLY FIFTEEN COPIES STOP PLEASE SEND ADDITIONAL EIGHT

BT

CFN DRB 1948 1800-1 22

28/1604Z DEC RAHC

REF ID: A60
C. R. FILE NUMBER
1800-1

28/0940  
LH

*file*

22 December 1961

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: J.F. Cockburn

SUBJECT: Informal Reports on BW Programme

1. Reference is made to DRBS 1800-1 DAR(B&C), dated 17 February 1961, and DRBC 906-300/0 & DRB 904-31/0 (DSIS 3), dated 19 October 1961.
2. We are enclosing two dozen copies of the "Review Bacteriology Programme since September 1961 to December 1961", for circulation to the Committee Members and D.R.K.L.
3. We are also enclosing three (3) copies of the above for circulation to DSIS for onward transmission to: The War Office - 1 copy for DPR and 1 copy for D/MRE; and DRS, Wash. - 1 copy for Mr. R. Holmes.

*J.R. Maltman*

JRM/sp  
Encl. - Confidential

J.R. Maltman  
for Chief Superintendent



CONFIDENTIALSUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTAREVIEW OF BACTERIOLOGY PROGRAMME SINCE SEPTEMBER 1961 TO DECEMBER 1961STUDIES ON AEROSOLS OF BACTERIAI. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH1. Practical Investigations:Protection of Aerosols Disseminated from Bacterial Slurries:  
(PROJECT - D52-18-50-04) (CONFIDENTIAL)

Studies of the addition of chemical substances to bacterial cultures to enhance the survival values of cells in air suspension has been suspended in order to study the discrepancies in the operation of the Toroid drums. For the same reason the influence of temperature and relative humidity on the survival of the viability of bacterial aerosols has been suspended.

The Effect of Preconditioning Aerosols on the Survival of Airborne Bacteria:

A study is being conducted to determine whether or not the viable recovery values of aerosols of *Serratia marcescens* are affected by preconditioning the aerosols prior to their entry into the drum.

Preconditioning entails the mixing of Collison generated aerosols with air which is preconditioned to the same temperature and relative humidity as the air in the drum. In this way there will be no sharp temperature and relative humidity gradients develop when the preconditioned aerosol enters the drum.

When Collison generated aerosols are sprayed directly into the drum, equilibrium conditions are attained with the temperature and relative humidity which exist in the drum.

Preconditioning the aerosol with 250 litres of air increases subsequent viable decay. Lower decay values are obtained when the aerosols enter the drum without preconditioned air. The deleterious effect is apparent only when the conditions of relative humidity are below approximately 50 per cent.

2. Basic Investigations:Mechanisms Involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

The additive programme in this project area has also been suspended in order to determine the role of nutrition on the survival of airborne bacteria.

Strains of *Escherichia coli* and *S. marcescens* were grown in complex media such as tryptose and peptone yeast extract broth as well as in a chemically defined medium. Cells, after washing and reconstituting in distilled water were aerosolized through a Collison into a rotating steel drum at a temperature of 80°F and 35% relative humidity. Samples of the aerosol were collected in Shipe impingers at intervals over a five hour period, and the number of viable organisms determined in the impinger fluid.

To date, it has been found that organisms grown in a chemically defined medium have the ability to survive after aerosolization to a much greater degree than those grown in more complex media. It has also been noted that the age of the cells when sprayed is an important factor. Cells from 72-hour cultures showed a 4-log increase in recovery over those from fresh 24-hour cultures.

It is proposed to study differences between cells grown in chemically defined media and more complex media. By the use of additives and depletions, an attempt will be made to determine which compounds in complex media render the bacterial cells more sensitive to aerosol survival. In this way it may be possible to determine mechanisms responsible for increased sensitivity of certain bacteria to aerosolization.

## II. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (CONFIDENTIAL)

This project is a Tripartite Agreement set up to establish baseline information concerning the characteristics of several aerosol testing systems installed in: M.R.E., Fort Detrick, D.P.G., N.B.L., and S.E.S.

All phases of Tests 1, 2, and 3 have been completed, and the results were discussed at a Working Party Meeting at Fort Detrick on September 18 and 19, 1961.

The summary results of these Collaborative Tests are as follows:

Results of Test 1 indicated that the equipment, techniques and procedures outlined were satisfactory. Estimates of total, physical and biological decay with mixed aerosols of S. marcescens and Sarcina lutea were sufficiently similar to encourage further testing.

Test 2 compared the physical decay of killed Pasteurella tularensis cells tagged with  $P_{32}$ , up to 22 hours following dissemination at 70°F and 20, 50 and 80% relative humidity. Satisfactory comparisons were obtained.

Test 3 compared physical and biological decay of P. tularensis at relative humidities of 50 and 80%. Physical decay of killed  $P_{32}$  tagged P. tularensis again showed a high degree of consistency for all the participating laboratories. The death rates of P. tularensis in four laboratories were similar, while results in two laboratories were appreciably different.

The death rates obtained by S.E.S. were considerably higher than the average of the other participating agencies. N.B.L. found a much lower death rate. Reasons for these discrepancies were believed to be the method of preconditioning the aerosol at S.E.S., and unsatisfactory assay of radioactivity at N.B.L.

It is planned to conduct Test 4 using Brucella suis, in February 1962. Future Collaborative tests will undoubtedly involve infectivity comparisons.

## III. TRIALS:

Local Trial No. 288 - "A Test of a Procedure for Comparing the Collison and E. Aerosol Disseminators in the Field at Night". (CONFIDENTIAL)

To date, four trials have been carried out. No report will be issued until a sufficient number of trials have been completed.

Dugway Proving Ground - Suffield Experimental Station Trials:

At the present time the S.E.S. Bacteriology Section is engaged in a joint effort with D.P.G. to determine the biological decay rates of P. tularensis when it is released in the field from an aerial line source, and to examine the infective capacity of this agent. Results of these trials are not available at the present time.

IV. THE EFFECT OF SOLAR RADIATION OF MICROBIAL AEROSOLS:  
(PROJECT - D52-18-50-04) (CONFIDENTIAL)

There has been no progress in this quarter, due to other laboratory and trial commitments.

V. MICROBIAL INFECTIONS: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

The study of permeability changes in bacteria after desiccation is being conducted in attempts to determine the role that permeability change plays in the reduction in infectivity. The effects of desiccation produced by aerosolization and airborne storage of Klebsiella pneumoniae has been used in conjunction with lysozyme to study cell wall permeability change. These results were given in the last Progress Report. Preliminary studies indicate that Pasteurella pestis also becomes sensitive to lysozyme after air suspension.

Measurements of increases in permeability of bacterial cell walls and cytoplasmic membranes after desiccation have also been noted using film drying techniques, and measuring phosphatase activity and "leakage" of bacterial material after reconstitution.

K. pneumoniae show increased phosphatase activity particularly during the first 24 hours of drying. Smaller increases in phosphatase activity are noted when the drying times are prolonged. There appears to be little difference in phosphatase measurements obtained when cells are dried at a relative humidity of 20% and 80%. Standard density preparations of dried Staphylococcus aureus show progressive increase in phosphatase activity in drying periods from 0 to 21 days.

Measurements of the "leakage" of 260 mμ absorbing material from K. pneumoniae after the washed cells have been dried in films and reconstituted in distilled water, have been noted. "Leakage" of bacterial substances from the cells is most pronounced when the cells are dried under conditions of high relative humidity, although higher survival values are obtained under these drying conditions.

The "leakage" of substances from P. pestis after desiccation and reconstitution in distilled water are approximately ten times the values obtained with K. pneumoniae. The appreciable permeability changes noted in P. pestis are of interest because of the known decrease in infectivity when the cells are dried in the aerosol state.

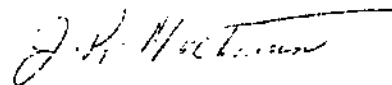
Infectivity of Young and Aged Aerosols:

The effect of aerosol age (0.25 to 12 hour) on the respiratory infectivity of Klebsiella aerosols in mice has not been appreciable. The great variation in sensitivity and resistance of the mice to this pathogen make measurements of infectivity difficult. Part of the host variation appears to be the result of non-specific resistance due to opsonizing activity which can be readily induced in animals whose past history shows considerable lung contamination with microorganisms derived from dusts dispersed from soil and faecal material. Evidence

of this non-specific resistance is seen in the decrease in viable numbers of *Klebsiella* from the lungs of mice compared to little or no reduction in numbers in mice without increased non-specific resistance. Specific immunization of mice leads to rapid decreases in number of *Klebsiella* in the lungs of the test animals. The decrease in viable counts in the lungs of mice is due mainly to kill in the lung sites since  $P_{32}$  tagged cells are cleared very slowly from the lungs. Reduction of 50% of the original  $P_{32}$  count values takes 17-18 hours in mouse lungs whereas a 50 to 60% reduction in viability of the bacteria occurs in one hour in immunized mice!

It is proposed to continue this program with other bacterial pathogenes. *P. pestis* is considered to be the pathogen of choice since it is unlikely to be as dependent on opsonizing materials in the host as *Klebsiella*. In addition, reports in the literature indicate infectivity of *P. pestis* aerosols may decrease within 45 minutes of aerosol age.

JRM/sp  
22 December 1961

  
J.R. Maltman  
for Chief Superintendent

*file*

8 September 1961

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: J.F. Cockburn

SUBJECT: Informal Reports on BW Programme

1. Reference your DRBS 1800-1 DAR(B&C), dated 17 February 1961.

2. We are enclosing two dozen copies of the "Review Bacteriology Programme since May 1961 to August 1961", for distribution to the Committee Members and D.R.K.L.

JRM/sp

CONFIDENTIAL ATTACHMENT

J.R. Maltman  
for Chief Superintendent.



DEPARTMENT OF NATIONAL DEFENCE  
CANADA

## DEFENCE RESEARCH BOARD

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

IN REPLY PLEASE QUOTE

SES 1800-1 (BACT)

CONFIDENTIAL

### REVIEW OF BACTERIOLOGY PROGRAMME SINCE MAY 1961 TO AUGUST 1961

#### STUDIES ON AEROSOLS OF BACTERIA

##### I. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH:

###### 1. Practical Investigations:

Protection of Aerosols Disseminated from Bacterial Slurries:  
(PROJECT - D52-18-50-04) (CONFIDENTIAL)

[redacted] were compared for protective effect with [redacted] were found to provide comparable protection. Both combinations were superior to [redacted]

This work was interrupted by the Halifax trials and will be continued in the next quarter.

###### 2. Basic Investigations:

Mechanisms involved in the Death of Aerosolized Bacteria and Mechanisms of the Protective Effects of Spray Additives:

These studies will begin again on a small scale in the next quarter as some staff is now available for this project.

##### II. INFLUENCE OF TEMPERATURE AND RELATIVE HUMIDITY ON THE VIABILITY OF BACTERIAL AEROSOLS: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

Laboratory experiments with mixtures of *Serratia marcescens* (SM) and the tracer organism *Sarcina lutea* (SL) aerosolized from the Collison spray without protective additives, are being carried out to screen the effects of temperature and relative humidity over wide ranges, and to relate these results to those obtained in Field Experiment 513.

A single Field Trial FE 513-19 was carried out on 26, April, 1961.

The Planning and Reporting Section are now analyzing the data of FE 513, together with the accumulated laboratory data. It is hoped that this analysis will provide information which will indicate whether or not to continue the present series of laboratory-field comparisons.

##### III. COMPARISON OF THE TOTAL DECAY (BIOLOGICAL AND PHYSICAL) OF AEROSOLS OF SARCINA LUTEA WITH PHYSICAL DECAY OF TAGGED KILLED SARCINA LUTEA: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

This study has been completed. The total (biological plus physical) decay of living SL was not measurably greater than the physical decay of dead P<sub>32</sub> tagged SL.

In a number of experiments dead P<sub>32</sub> tagged *Pasteurella tularensis* showed physical decay values that were similar to those obtained with SL.

s.15(1)

IV. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (CONFIDENTIAL)

This project is a Tripartite Agreement set up to establish baseline information concerning the characteristics of several aerosol testing systems installed in: M.R.E., Fort Detrick, D.P.G., N.B.L., and S.E.S.

Tests No. 2 and No. 3 have been completed in this quarter. The objective of Test No. 2 is:

To compare Tripartite reference standard aerosol testing systems on the basis of recovery and physical decay of  $P_{32}$  labelled cells (dead *P. tularensis*) at each of three levels of relative humidity (70°F, relative humidity 20, 50, and 80 per cent).

The objective of Test No. 3 is:

To compare Tripartite reference standard aerosol testing systems on the basis of recovery and decay (viable and physical) of aerosols of viable *P. tularensis* at each of 2 levels of relative humidity (70°F and 50, and 80 per cent relative humidity).

The results of all Reference Standard Aerosol Tests will be discussed at a Working Party Meeting at Fort Detrick, on September 18 and 19, 1961.

V. TRIALS:

Local Trial No. 288 - "A Test of a Procedure for Comparing the Collison and E<sub>a</sub> Aerosol Disseminators in the Field at Night". (CONFIDENTIAL)

To date, three trials have been carried out. No report will be issued until a sufficient number of trials have been completed.

Local Trial No. 289 - "To Determine the Effects of a Simultaneously Released Smoke Cloud on the Survival and Assessment of a BG Aerosol". (CONFIDENTIAL)

Visual aid of smoke was required in the Navy Trials conducted at Halifax. The trials completed in this quarter indicated no interfering effects on viability, sampling and assessment of BG spores.

Field Trial No. 539 - "To Determine the Protection against BW Aerosols Provided to a Destroyer Escort by a Combined Positive Pressure NBCW Filter System fitted to the Citadel". (PROJECT - A12-82-20-21) (UNCLASSIFIED)

Seven trials were successfully completed between the 19th and 29th June, 1961. A formal report is now being prepared by the Planning and Reporting Section, S.E.S.

VI. THE EFFECT OF SOLAR RADIATION OF MICROBIAL AEROSOLS:  
(PROJECT - D52-18-50-04) (CONFIDENTIAL)

There has been no progress in this quarter. Work will start again in this research area in conjunction with studies on the mechanisms involved in death of airborne bacteria, and the role of protective spray additives.

VII. MICROBIAL INFECTIONS: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

1. Reactivation of Infectivity:

The results of previous experiments suggested that metabolic repair of dried Staphylococci after reconstitution in broth was required for a return to more normal infectivity values.

Further work with dried Staphylococci has revealed that this reactivation does not occur if the cells are washed with distilled water or phosphate buffer prior to film drying. In view of this latest information it would appear that some substance(s) on the surface of the unwashed cells before drying could possibly increase the cell permeability so that host substances normally excluded from vital cell areas can gain entry after a history of desiccation. The metabolic requirement previously noted could then be the time necessary to allow a return to normal permeability.

2. Lysozyme Effect:

Preliminary studies had indicated that lysozyme resistant Klebsiella pneumoniae became sensitive to the bactericidal effects of this enzyme after aerosolization and storage in the airborne state. It was also shown that reconstitution of these cells in buffer before addition of lysozyme reduced the lethal effect.

Further study has revealed that aerosols generated from culture show a progressive increase in sensitivity to lysozyme when stored at increasing humidity (20-80%). The same lethal effect of collecting the aerosols in lysozyme solution is noted when the cells are washed and disseminated from sterile broth, but this effect is greatly reduced if distilled water is used to wash the cells prior to aerosolization in distilled water.

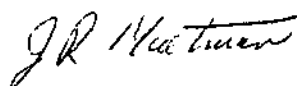
When 6% W/V inositol is added to the culture prior to generation of the aerosols, the highest recovery values on collection of the cells in lysozyme solution occurs in aerosols previously stored at intermediate relative humidity. However, the ratio of the recovery values of inositol protected/unprotected cells reveals that as the humidity increases, the protective effect also increases.

The mechanisms involved in sensitizing the airborne cells to lysozyme apparently is related to permeability changes in the outer wall layer, the role of the spray additive providing some protection to this layer at intermediate and high humidity, but not at low relative humidity.

3. Infectivity of Young and Aged Aerosols:

No progress in this quarter on the effects of aerosol age on the respiratory infectivity of Klebsiella aerosols. Construction of temperature and humidity controlled facilities to house this aerosol equipment has been completed. Studies in this project area will start again in the near future.

JRM/sp  
6 Sept. 61

  
(J.R. Maltman)  
for Chief Superintendent



*CR file*

19 April 1961

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: J.F. Cockburn

Subject: Informal Reports on B<sub>1</sub> Programme

1. Reference your DRBS 1800-1 DAR(B&C), dated 17 February 1961.
2. We are enclosing two dozen copies of the "Review of Bacteriology Programme since January 1961 to April 1961", for distribution to the Committee members and D.R.K.L.

JRM/sp

(J.R. Maltman)  
for Chief Superintendent



DEPARTMENT OF NATIONAL DEFENCE  
CANADA

## DEFENCE RESEARCH BOARD

SUFFIELD EXPERIMENTAL STATION  
RALSTON, ALBERTA

IN REPLY PLEASE QUOTE

SES 1800-1 (BACT)

CONFIDENTIAL

### REVIEW OF BACTERIOLOGY PROGRAMME SINCE JANUARY 1961 TO APRIL 1961

#### STUDIES ON AEROSOLS OF BACTERIA

#### I. THE EFFECT OF ADDITIVES AND MECHANISM OF DEATH:

##### 1. Practical Investigations:

##### Protection of Aerosols Disseminated From Bacterial Slurries: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

In the absence of light the most effective additives to date are [REDACTED] (w/v). At high temperature and low relative humidity the highest mortality occurs when cells of *Serratia marcescens* are aerosolized from slurries without additives. The above additives provide excellent protection under these meteorological conditions.

Protection, although appreciable, is somewhat less between 60-70% RH. Combinations of other additives are being tested for greater protective effect in this range of humidity.

##### 2. Basic Investigations:

There has been no further progress in this quarter on basic studies concerning the mechanisms of the protective effects of spray additives on airborne bacteria and the mechanism of death of aerosolized bacteria. These studies will start again when staff is available.

#### II. INFLUENCE OF TEMPERATURE AND RELATIVE HUMIDITY ON THE VIABILITY OF BACTERIAL AEROSOLS: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

Mixtures of *Serratia marcescens* (SM) and the tracer organism *Sarcina lutea* (SL) aerosolized from Collision spray without protective additives in the absence of light serve as a screening method to determine the effects on viability over a wide range of temperature (20-90°F) and relative humidity (20-95%). The data obtained will form a basis for comparison with results obtained in F.E. 513 (A Field Investigation of the Downwind Survival of Bacteria at Night).

Weather conditions have not permitted any field trials (F.E. 513) to date in this quarter.

#### III. COMPARISON OF THE TOTAL DECAY (BIOLOGICAL AND PHYSICAL) OF AEROSOLS OF SARCINA LUTEA WITH PHYSICAL DECAY OF TAGGED KILLED SARCINA LUTEA: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

Aerosols of SL disseminated into toroid drum by Collision spray show no appreciable decay over a twenty-two hour period. These results are based on the ratio: viable SL/tagged SL of aerosol samples collected in AGI-6/15 impingers charged with gelatin saline.

IV. STANDARD REFERENCE AEROSOL TESTING TECHNIQUE: (CONFIDENTIAL)

\* This project is a Tripartite Agreement set up to establish baseline information concerning the characteristics of several aerosol testing systems installed in: M.R.E., Fort Detrick, D.P.G., N.B.L., and S.E.S.

The work at S.E.S. on this project started in December 1960 after completion of a temperature-relative humidity controlled room in which the aerosol testing equipment is housed.

The three phases of Test No. 1 have been completed in this quarter. The objectives of the three phases of Test No. 1 are as follows:

1. To determine the time required to achieve various conditions of temperature and relative humidity within the test system and to determine the reliability of the equipment in maintaining these conditions.
2. a) To obtain estimates of level of recovery at several early cloud ages employing mixed aerosols of Serratia marcescens and Sarcina lutea.  
b) To obtain estimates of trial-to-trial reproducibility of level of recovery at each of the early cloud ages.  
c) To estimate the effect of jet number on recovery level.
3. To obtain estimates of trial-to-trial and within-trial reproducibility of viable level of recovery, total decay, physical decay, and biological decay with mixtures of two simulants, S. marcescens and S. lutea, over a five-hour period.

V. LOCAL TRIALS:

Number 288 - "A Test of a Procedure for Comparing the Collison and and E<sub>1</sub> Aerosol Disseminators in the Field at Night  
(CONFIDENTIAL)

Differences in SM/SL ratios have been observed in the field experiments using an E<sub>1</sub> disseminating device and in the laboratory experiments using the Collison spray.

The contributions of these spray devices as possible determinants of the differing SM/SL ratios are under test in the field.

To date one trial has been carried out. A report will be prepared by the Planning and Reporting Section when these trials are completed.

Number 289 - "To Determine the Effects of a Simultaneously Released Smoke Cloud on the Survival and Assessment of a BG Aerosol" (CONFIDENTIAL)

Visual aid of smoke clouds may be necessary in the Navy Trials to be carried out off the coast of Halifax.

The present trials were designed to determine if the smoke concentrations required will interfere in any way with the viability, sampling and assessment of Bacillus globigii (BG) spores.

Two trials have been completed in this quarter. Cloud widths at 500 yards were 200 to 280 yards. Bacterial concentrations of 1000 to over 100,000 viable cells per litre of cloud were obtained with or without smoke.

VI. THE EFFECT OF SOLAR RADIATION ON MICROBIAL AEROSOLS:  
(PROJECT - D52-18-50-04) (CONFIDENTIAL)

Further screening studies have been conducted concerning additives that provide protection to aerosols of S. marcescens subjected to solar radiation. The best additives for this purpose are still:

- a) DNA in conjunction with inositol and Alizarin Red.
- b) DNA in conjunction with thiourea and Orange G.

VII. MICROBIAL INFECTIONS: (PROJECT - D52-18-50-04) (CONFIDENTIAL)

1. Reactivation of Infectivity:

Reactivation of infectivity of film dried staphylococci has been accomplished when the cells are reconstituted in broth and held at 37°C without multiplication before intravenous injection into mice.

Dried staphylococci reconstituted in broth and held at 7°C show little if any reactivation of infectivity.

The results suggest that metabolic repair of the organisms which suffer sublethal injury due to desiccation and rehydration procedures can be considered to be one of the controlling factors in infectivity studies with dried staphylococci.

2. The Effect of Host Tissue Constituents on the Survival of Aerosolized Bacteria:

Lysozyme Effects:

Initial experiments show that the high tolerance of Klebsiella to lysozyme decreases appreciably when aerosolized cells are sampled into impingers containing 1-50 µg/ml lysozyme in phosphate buffer pH 6.2.

Return of tolerance to the bactericidal effect of lysozyme occurs when the lysozyme is added to the buffer within 10 seconds after sampling the aerosol. The results suggest the tentative conclusion that permeability and rehydration are factors of concern in these studies.

3. Infectivity of Young and Aged Aerosols

There has been no progress in this quarter on the effects of aerosol age on the respiratory infectivity of Klebsiella aerosols due to construction of temperature and humidity controlled facilities to house this equipment.

18 April, 1961

*J. R. Maltman*  
(J.R. Maltman)  
for Chief Superintendent

24 February, 1961.

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Informal Reports on BW Programme at SES

Reference DRBS 1800-1 DAR(B and C) dated 17 February,  
1961.

1. We appreciate the points raised in your letter of the above mentioned reference. We will undertake to produce informal progress notices on our BW research programme at four monthly intervals. The first of these will be prepared at the end of April 1961 since Mr. Davids, during his recent visit to the East, briefed the Advisory Committee on the present position of the programme.

(B.J. Perry)  
for Chief Superintendent

*Ad*

BJP/gw



DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD

OUR FILE REF. DRBS 1800-1 DAR(B&)

Ottawa, Ontario,  
17 February 1961.

Chief Superintendent,  
SES.

Informal Reports on BW Programme at SES

1. At the recent meeting of the Advisory Committee on BW Research at DRKL, many of the members stated that it would be extremely useful to have some type of informal progress report on the BW programme at SES since at present, they have no satisfactory way of keeping up-to-date with the work at that station. Mr. Currie of DRKL informed the Committee that such reports would be very useful for the DRKL staff also and that he had actually discussed this matter informally with Mr. Lamb before the last Tripartite Conference. Mr. Lamb had agreed to supply a brief quarterly summary of the Suffield BW programme to DRKL and DRB Headquarters.
2. It is obvious that a report of this kind, which could be quite informal in nature and need contain a minimum of experimental detail, would be very useful to many people. Would you therefore please consider whether you could undertake to write such an informal report on a quarterly basis. If so, it is suggested that about two dozen copies could be sent to this office for distribution to Committee members and to DRKL. Alternatively, you could send a few copies direct to DRKL and the balance to this office.

S/R. [Signature]  
Back [Signature]  
[Signature]  
[Signature]  
[Signature]

Jack  
Please see me  
[Signature]

W. F. Cockburn.

for Chairman, Defence Research Board.

OK?

Can please do?

100M-6/59-06-0257

4 months for  
Bact. Section SES.  
will same service  
be supplied to SES  
from DRKL?



DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
7 February 1961.

RECEIVED	CS
C. R. 1800-1	
1800-1	

→ CS/SES  
CS/DRCL/KL

Insect Pests in Shipments to China

1. Attached is a list of insects and plant diseases which was submitted by China to the Plant Protection Division of D of A. Canada is required to certify the absence of all these pests and diseases in wheat and barley shipped to China. D of A sent us this list as being of possible interest from the point of view of susceptibility to various kinds of anti-crop warfare.

*W. F. Cockburn*

for Chairman, Defence Research Board.

encl.

*Back  
SIR.  
PRS. MP*

CHINA REQUIRES THE ABSENCE OF THE FOLLOWING INSECTS IN WHEAT AND BARLEY  
TO THAT COUNTRY:

Cotton Boll Weevil	<u>Anthonomus grandis</u> (Boheman)
San Jose Scale	<u>Aspidiotus perniciosus</u> (Comstock)
Mediterranean Fruit Fly	<u>Ceratitis capitata</u> (Wiedeman)
Sorghum Midge	<u>Contarinia sorghicola</u> (Coquillett)
Pink Bollworm	<u>Pectinophora gossypiella</u> (Saunders)
Melon Fruit Fly	<u>Dacus dorsalis</u> (Hendel)
Spotted Cotton Bollworm	<u>Earias insulana</u> (Boisd)
Fall Webworm	<u>Hyphantria cunea</u> (Drury)
Colorado Potato Beetle	<u>Leptinotarsa decemlineata</u> (Say)
Potato Tuber Moth	<u>Phthorimaen operculelia</u> (Zell)
Vine phylloxera	<u>Phylloxera vastatrix</u> (Planchon)
Hessian Fly	<u>Phytophaga destructor</u> (Say)
Apple Maggot	<u>Rhagoletis pomonella</u> (Walsh)
Beet Moth	<u>Phthorimaea ocelatella</u>
Golden Nematode	<u>Heterodera rostochiensis</u> (Woll.)
Head Nematode	<u>Anguillulina angusta</u>
Potato Wart	<u>Synchytrium endobioticum</u> (Schilb)
Pasmo	<u>Mycosphaerella linorum</u> (Wr.) Garcia reda
Cotton Root Rot	<u>Phymatotrichum omnivorum</u>
Bacterial Ring Rot	<u>Corynebacterium sepeidonicum</u>
Barley Yellow Dwarf	<u>Deuterothoma tracheiphila</u> (Petri)
Rice Dwarf	<u>Spongospora subterranea</u>
Bacterial Wilt of Corn	<u>Bacterium stewartii</u>
Club Root	<u>Plasmodiophora brassicae</u>
Beet Rust	<u>Uromyces betae</u>
Dutch Elm Disease	<u>Ceratostomella ulmi</u>
White Pine Blister Rust	<u>Cronartium ribicola</u> (Fisher)
Walnut Canker	<u>Melanconis juglandis</u> (Graves)

Plant Protection Division,  
OTTAWA

Feb.2/61





DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
28 December 1960.

→ CS/SES  
CS/DRCL/KL

BW Programme at Fort Detrick

REFERRED TO	CS
C. R. FILE NUMBER	1800-1

1. Attached for your information is a brief summary of some of the work in progress at the U.S. Army Medical Unit at Fort Detrick and at the Biological Laboratories.

*W. F. Cockburn.*

for Chairman, Defence Research Board.

c.c. DEP

*BW. dep.*  
*S/R. dep.*  
*PRS. dep.*  
*RTLO dep.*

SECRET

In Reply Please Quote  
No. CAS(W)8934-2 (CML) 961

21 Dec 60

Defence Research Board  
Department of National Defence  
Building "A"  
OTTAWA 4, Ontario  
Canada

ATTENTION: DAR(D&C)

BW Programme

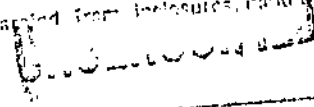
US Army Chemical Corps Biological Laboratories (BL)

1. Attached is a brief summary of some of the work in progress at The US Army Medical Unit, Fort Detrick, and at the Biological Laboratories.

  
(R. R. DODDRIDGE)  
Major

Canadian Army Technical Representative

Encl.

When separated from Enclosures, handle this document  
  
AS \_\_\_\_\_  
(Insert proper classification)

SECRET

**CONFIDENTIAL**

US Army Medical Unit, Fort Detrick (C)

1. Colonel MB Tigarst, Commanding Officer, US Army Medical Unit, Fort Detrick, reviewed the programme. The following changes are planned:

- a. Rift Valley Fever is being phased out of the programme. A useable vaccine resulted from this work. It has been used successfully in some one hundred volunteers.
- b. Work will start on Chicken Gunga Fever.
- c. Work will shift from VEE to the viruses of the Russian Spring - Summer group. It is felt that the answers to all the problems of VEE have been obtained and it could be used as a lab model.
- d. Serious consideration is being given to closing down the animal laboratory for typhus. One more area, respiratory infection, is being investigated. If it appears promising, work will continue.

2. Anthrax (C)

Explanatory work is in progress to turn this agent into a useable experimental model. The monkey is used as the susceptible animal and the rat as the resistant animal. Some of the factors in each case will be determined.

a. Work with Monkeys

*Septicaemia*  
If monkeys are exposed to a fairly large respiratory dose, they die rapidly of septicaemia. However, if penicillin is given 24 hours after exposure, most of the animals can be saved. The animals develop Weil's Disease which can be treated with penicillin. This treatment however, does not rid the monkeys of the spores. There are further indications that there are some problems with the use of penicillin in this field.

b. Work on Rats

The animals used have been age and type standardized. First attempts have involved modification of the rat by dietary deficiency. When rats were placed on a flutrin diet, after one month they were several logs more susceptible to interperitoneal challenge. If the animal was placed back on a full diet for a

..../2

**CONFIDENTIAL**

week before challenge, they returned to their original level of susceptibility. Eighty per cent of egg yolk plus spores drops the LD50 from  $10^9$  to 100 spores. The alcohol insoluble fraction of egg yolk is just as effective. Time to death was shortened from 48 hours to 12 or 18 hours. This does not work subcutaneously in rats. The work will be repeated with dried egg yolk.

3. Vaccine for Tularemia (C)

- a. Immunization of man by small doses by the respiratory route is being investigated. Men have been exposed to the vaccine strain and a very modest dose 1000 cells in a month produces an immune response. At 15,000 cells the response stays good. There is no systemic response. At low inhaled doses (1000 cells) one or two have had non-specific responses but, at 15,000 to 18,000 cells, approach immunological virgins. It appears that you can immunize. This may also be a simulant which can be used for field tests and masking efficiency if a cross relationship with the agent can be made. Men have not been challenged by the virulent strain.
- b. Tularemia vaccine is fairly well along in commercial pilot plant production.

4. Vaccine for VEE (C)

An attenuated strain has been developed which does not kill rats, guinea pigs and monkeys. These animals are resistant when challenged. The vaccine has been in 30 individuals who are inexperienced in this virus. If there is a reaction, it appears within 36 hours but has not been alarming in any instance. About 50% of the volunteers have shown some sort of clinical reaction. Individuals who have had previous experience with the virus or who have had the killed vaccine strain show no reaction.

Current Agent Programs (S)

5. Doctor A. J. Goodlow, Director of Biological Research, US Army Chemical Corps Biological Laboratories (BL) reviewed certain aspects of the current agent programs, emphasizing the problems of certain agents which downgrade their effectiveness.

a. Plague.

BL has been directed to recommend by 1 Jul 61, the suitability of this agent as a lethal agent. The following factors which suggest it is unsuitable must be considered:

SECRET

- (1) The disease is epidemic.
- (2) The dose for man is high.
- (3) Genetic stability is a problem since it mutates to the avirulent form.
- (4) There are problems in storage and aerosol stability.
- (5) The name is politically unsuitable.

b. Tularaemia.

Aerosol stability, the effectiveness of antibiotic treatment and the availability of a vaccine suggest that this is not a good agent. However, only a low dose is required and there are strains which in combination are antibiotic resistant. It may be possible to prepare a strain resistant to all antibiotics.

c. Coccidioides Miosis.

There is no vaccine or treatment for this disease but it is not known if it constitutes a BM threat to man. There is a variance of reaction by race and in monkeys the severity of the disease is dose dependent.

d. Staphylococcus Enterotoxin

Research continues to develop assay and process techniques.

e. Anthrax

Work is in process in the following areas:

- (1) Toxin production in refined medium.
- (2) Genetics
- (3) Spore Germination

f. YEE

This agent will be recommended for type classification.

g. Rickettsia Rickettsii

Process research and pilot plant work is in progress. Consideration is being given to the use of human volunteers.

SECRET

..../4

~~SECRET~~

Annex 1 to  
CAS(W)8934-2 (CHL) 961  
Dated 21 Dec 60

h. Bacterial and Fungal Agents

These agents are coming into the screening programs.

i. Combination of Agents

A grant has been made to Ohio State University to study the clinical aspects of combined agents (BW and BW) in monkeys.

6. (S) Work will be cut back on VEE and Yellow Fever. Agents tentatively selected to enter the screening programs are

- a. Chicken Gungo Fever.
- b. Russian Spring and Summer Encephalomyelitis.
- c. Dengue Fever
- d. Aibo Viruses.

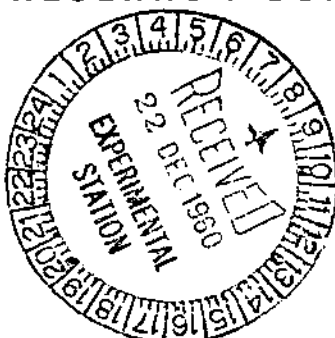
SECRET



SECRET ENCLOSURE

OUR FILE REF. DRBS 1800-20.....  
DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
19 December 1960

RECEIVED	CS
C. R. FILE NUMBER	
1800-	

CS/SES  
CS/DRCL/KL

BW Agent Symbols  
U.S. Army Chemical Corps

Attached for your information and retention is a current list of the symbols used by the U.S. Army Chemical Corps to designate microorganisms of potential BW interest.

W. F. Cockburn.

for Chairman, Defence Research Board.

SIR, *[Signature]*  
Bait *[initials]*  
P121. *[initials]* DL  
ATCO. *[initials]*

**SECRET**BACTERIA:

1. Bacillus anthracis-----	N	
2. Bacillus subtilis var. niger (Simulant)-----	BG	1
3. Brucella abortus-----	AA	
4. Brucella melitensis-----	AM	
5. Brucella suis-----	AB	
6. Corynebacterium diphtheriae (gravis)-----	DX	
7. Actinobacillus mallei-----	LA	2
8. Pseudomonas pseudomallei-----	HI	3
9. Mycobacterium tuberculosis-----	ZP	
10. Pasteurella pestis-----	LE	
11. Pasteurella tularensis-----	UL	
12. Salmonella paratyphi-----	ZE	
13. Salmonella typhosa-----	ZO	
14. Serratia marcescens (Simulant)-----	SM	
15. Shigella dysenteriae-----	Y	
16. Vibrio comma-----	HO	
17. Listeria monocytogenes-----	TQ	
18. Salmonella typhimurium-----	QPL	

B. FUNGI:

1. Actinomyces bovis-----	SK	
2. Blastomyces brasiliensis-----	LB	
3. Blastomyces dermatitidis-----	LL	
4. Coccidioides immitis-----	OC	
5. Cryptococcus neoformans-----	PY	
6. Histoplasma capsulatum-----	OL	
7. Sporotrichum schenkii-----	OY	5

C. RICKETTSIA:

1. Coxiella burnetii-----	OU	
2. Rickettsia prowazekii-----	YE	
3. Rickettsia rickettsii-----	UY	
4. Rickettsia tsutsugamushi-----	MH	
5. Rickettsia typhi-----	AV	

D. VIRUS:

1. African swine fever-----	FW	
2. Bovine diarrhea-----	BV	
3. Eastern equine encephalitis-----	ZX	
4. Foot and mouth disease-----	OO	
5. Fowl plague-----	OE	
6. Hog cholera-----	OH	

**SECRET**



# SECRET

7.	Influenza-----	DE
8.	Japanese B encephalitis-----	AN
9.	Newcastle disease-----	NI
10.	Polioomyelitis-----	RO
11.	Psittacosis-----	SI
12.	Rabies-----	KB
13.	Rift Valley fever-----	FA
14.	Rinderpest-----	R
15.	Smallpox-----	ZL
16.	Venezuelan equine encephalitis-----	NU
17.	Vesicular exanthema-----	EK
18.	Vesicular stomatitis-----	ET
19.	Western equine encephalitis-----	EV
20.	Yellow Fever-----	OJ
21.	Chikungunya-----	RR <sup>h</sup>
22.	Mayaro-----	UJ <sup>h</sup>
23.	Uruma-----	UM <sup>h</sup>
24.	Dengue-----	QA <sup>h</sup>
25.	Russian spring-summer encephalitis-----	PF <sup>h</sup>
26.	Powassan-----	SA <sup>h</sup>
27.	Kyasanur Forest disease-----	IM <sup>h</sup>
28.	Louping-ill-----	HY <sup>h</sup>
29.	Wesselsbron-----	BB <sup>h</sup>
30.	Nairobi sheep disease-----	UF <sup>h</sup>
31.	Apeu-----	HB <sup>h</sup>
32.	Colorado tick fever-----	UA <sup>h</sup>
33.	Monkey B-----	NJ <sup>h</sup>
34.	California bat-----	OJ <sup>h</sup>
35.	Modoc-----	JJ <sup>h</sup>
36.	Coxsackie B (pleurodynia)-----	XO <sup>h</sup>

## E. TOXINS:

1.	Botulinus toxin-----	X
2.	Staphylococcus aureus enterotoxin-----	UC <sup>6</sup>
3.	Shellfish poison-----	SS

## F. OTHER ANTIPERSONNEL AGENTS:

1.	Leptospira pomona-----	OB <sup>h,7</sup>
2.	Bartonella bacilliformis-----	EH <sup>h,8</sup>
3.	Entamoeba histolytica-----	PE <sup>h</sup>

- 2 -

# SECRET

SECRET

1. PLANT PATHOGENS:

1. <i>Gibberella zeae</i> -----	IE
2. <i>Helminthosporium oryzae</i> -----	E
3. <i>Piricularia oryzae</i> -----	IR
4. <i>Phytophthora infestans</i> -----	LO
5. <i>Puccinia graminis secalis</i> -----	SX
6. <i>Puccinia graminis tritici</i> -----	TX
7. <i>Sclerotium rolfsii</i> -----	C
8. <i>Puccinia glumarum</i> -----	MF 4

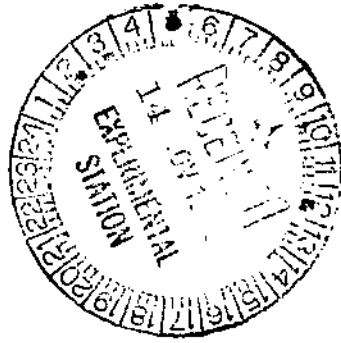
0. PLANT GROWTH REGULATORS:

1. 4-fluorophenoxyacetic acid-----	KF 9
2. Butyl 2,4-dichlorophenoxyacetate-----	LNA
3. Butyl 2,4,5-trichlorophenoxyacetate-----	LNB
4. Isopropyl 3-chlorophenylcarbamate-----	LNC
5. Butyl 2-chloro-4-fluorophenoxyacetate-----	LS 4
6. Cacodylic acid-----	MC 4
7. 3-amino-1,2,4-triazole-----	SR 4

Footnotes

1. Commonly referred to as *Bacillus globigii*
2. Previously listed as *Malleomyces mallei*
3. Previously listed as *Malleomyces pseudomallei*
4. New symbol assigned by this action
5. Corrected spelling
6. Previously listed as *Micrococcus pyogenes* var. *aureus* enterotoxin
7. Classified in the order Spirochetes in the 7th edition of Bergey's Manual of Determinative Bacteriology
8. Classified in the order Rickettsiales in the 7th edition of Bergey's Manual of Determinative Bacteriology
9. Butyl 2-chloro-4-fluorophenoxyacetate, the butyl ester of KF, has been type classified as LNF

SECRET



1800-1
CS
1800-1

Ottawa, Ontario,  
9 November 1960.

Chief Superintendent,  
DRCL/KL.

U.S. Developments in BW Early Warning

1. Attached is a copy of a letter from CATR giving further details on the Chemical Corps' contract with Douglas Aircraft Corporation and DRB's role in assisting with the equipment of the two mobile trailers.

Original Signed by  
W. F. Cockburn

for Chairman, Defence Research Board.

c.c. → SES  
DGS

WFC:pdm

*12/12. 1 Back. End*  
*PRS 12 DL*  
*ATLO.*

C  
O  
P  
Y

CANADIAN ARMY TECHNICAL REPRESENTATIVE  
U.S. Army Chemical Corps  
Building No 330  
Army Chemical Center, Maryland

In Reply Please Quote  
No. CAS(W)8934-2 (CML) 811

26 Oct 60

Army Headquarters  
Department of National Defence  
OTTAWA 4, Ontario  
Canada

ATTENTION: DEP

US Developments in BW Early Warning

1. The US Army Chemical Corps Biological Laboratories (BL) have undertaken a background study as a basis for the development of a biological rapid warning system for the continental USA. This study, to be carried out by Douglas Aircraft Co., California under contract to the Chemical Corps is designed to establish standard patterns for biological particle contamination in the atmosphere. This information is necessary before the threshold at which an alarm system will operate can be determined.
2. a. Under the current contract, Douglas Aircraft will equip each of two mobile trailers with one prototype model of each of the following equipments:
  - (1) Partichrome
  - (2) Particle Size Analyzer
  - (3) US Pyrolyzer
  - (4) Canadian Pyrolyzer
  - (5) Anderson Sampling Device
- b. These trailers, to be ready by 8 Nov 60, will travel WEST-EAST routes from Santa Monica, California to Fort Detrick, Maryland, one through the Southern United States, the other through the Northern States. Each will stop at five sampling locations for periods of up to three weeks. The partichrome, particle size analyzer and pyrolyzers will operate continuously during sampling periods. Three particle size ranges will be studied, below one micron, up to ten microns and above ten microns. All data will be recorded. During sampling periods, six samples per day will be taken by the Anderson Sampler and used for protein-nucleic acid studies.
- c. All data will be analyzed by the Computer Section of Douglas Aircraft. The data relating to the pyrolyzers will also allow a comparison to be made of the US and Canadian equipments.
3. Once the background study is complete, the BL propose to procure ten of each of the partichrome alarm and particle size analyzer to test concepts of a biological rapid warning system for the continental USA. This proposal has not yet been approved by higher authority and the number of alarms to be procured may be revised.

4. Scientific personnel of DRB are collaborating with BL in the Douglas Aircraft study. Doctor Leger, DRCL, or one of his staff, will assist personnel of Douglas Aircraft in the installation and testing of the Canadian pyrolyzer, and will be available, during the five sampling periods, to assist in any way possible.

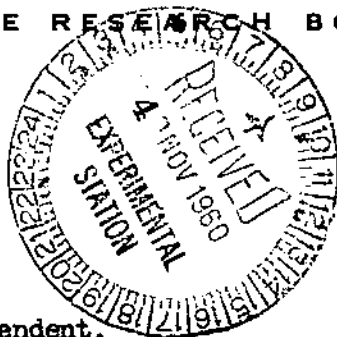
(TG GIBSON)  
Brigadier  
Commander  
Canadian Army Staff (W)



S E C R E T ENCLOSURE

OUR FILE REF. DRBS 1800-1 DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



CS
1800-1

Ottawa, Ontario,  
1 November 1960.

Chief Superintendent,  
SES.

BW Agent Research Program

1. The CLO to US Army Chemical Corps recently attended a review of BW Agent Research Program. Attached is a brief summary of some of the points covered by this review. This is not complete but if this raises any specific questions, answers will be obtained from the individuals concerned if you so desire.

*W. F. Cockburn.*

for Chairman, Defence Research Board.

c.c. DEP

*SIR. [Signature]  
Bail [Signature]*

SUMMARY

OF

REVIEW MEETING OF BW AGENT RESEARCH PROGRAM

1. Pulmonary Anthrax (S)

It had previously been recommended that the possibility of pulmonary anthrax as a BW agent be considered. This decision will be made when the results of deliberations between the Medical Committee of the US Army Chemical Corps Surgeon General Advisory Councils are known.

2. Agent X (S)

Attempts to evaluate the potential of Agent X have been frustrated by the lack of adequate data. The Chief Chemical Officer believes that this evaluation must be done and the Chemical Corps R & D Command have been instructed to obtain the necessary data. The Biological Laboratories have outlined a three year program to obtain this information but cannot carry it out with current funds, unless the program on Dried N is cut back. This R & D Command would not approve. The Biological Laboratories will obtain some of the answers required but it will not be able to implement a satisfactory program unless some additional funds are allotted.

3. Coordination of Effort between Services (U)

The Surgeon General and the Chief Chemical Officer have agreed that greater coordination of effort in the agents field is desirable and possible. The first step in this direction has been a joint meeting of the medical advisory committees of the Chemical Corps and The Surgeon General.

4. Viral and Rickettsial Agent Research (C)

a. Screening of Agents.

The screening of Rift Valley Fever is progressing nicely. Screening of Typhus and Colorado Fish Fever has just started. The aerosol stability of Monkey B Virus is under study.

b. Agent Research.

Agents are studied from the points of view of genetics, tissue culture, concentration, purification, drying pathogenesis and immunology. The laboratory work on smallpox will be completed by 1 Jan 61 and the decision to consider it as a candidate agent will be made at that time. Testing of Psittacosis with aerosol stabilizers is in progress and results

PAGE 1 OF 2 PAGES

PAGE 3 OF 4 PAGES

SECRET

are promising. Comparison of the Columbian and Trinidad Strains of Venezuelan Equine Encephalomyelitis is under way. The Columbian strain appears to have a higher degree of pathogenicity. Work continues on Rocky Mountain Spotted Fever. Jap B Encephalitis has been eliminated from the program.

c. Contracts and Grants.

In this field, \$225,000 contract has been awarded to the Naval Biological Laboratories. Grants in the amount of \$225,000 for basic research have been made to various researchers.

d. Future Plans.

Effort will be reduced on small pox, Yellow Fever and VEE. Twenty-five viral agents will be selected for further screening as aerosol agents. These include some recently isolated agents. One or two exotic agents which produce uncommon diseases will eventually enter the program.

5. Vaccines (U)

A separate report on Vaccine work of Doctor Ziegelsbach has been forwarded to Mr. Currie, DRKL. Additional information will be available in the near future. Our letter CAS(W)8934-2 (CML) 804 dated 25 Oct 60 refers.

6. Coccidioides Immitis (C)

This is an incapacitating BW Fungal agent. It is the causative agent of the disease known as Desert Rheumatism and Valley Fever. It is highly infectious, non-contagious and its portal of entry is the respiratory track. There is no known prophylaxis, effective therapy or immunization. Research on this agent continues.

SECRET

7. 2 2 18  
COPY 3 4 7 18



SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

November 1, 1960

Chief Superintendent,  
Defence Research Kingston Laboratories,  
P.O. Box 123,  
KINGSTON, Ontario.

Attention: J.F. Currie

Two slopes of Klebsiella pneumoniae type 1, will be mailed to you tomorrow.

METHOD OF CULTURE:

1. Fluid Medium - Tryptose phosphate broth
2. Solid Medium - Heart Infusion Agar (no inhibitor is used at SES)
3. 24 Hour, 37°C. broth culture - generation by Shaker used as Collison spray fluid.

Since the organism is mucoid, better spraying properties are obtained if the culture is heated to 37°C before spraying (Collison spray)

4. 6% inositol (W/V) provides good protection to aerosolized cells.

ANIMALS:

1. Mice (Swiss-Webster strain) - weights 34-40 grams are those generally used at SES.
2. Regardless of the challenge route used (I.P.IV or respiratory) the mice must be housed individually since cross infection occurs readily.
3. Immunization:
  - (A) Whole cells - Heat killed culture diluted in saline to O.D. of 0.45 (Spectronic 20 Reading)  
Route - I.P.  
Volume - 0.1 ml. - 3 inoculations, 3 days apart.
  - (B) Capsules - purified by method of TOENNIESSEN 1921  
Zbl. Bakt., 85, 225  
  
Concentration of Capsule - 10 $\mu$ g per 0.1 ml  
3 - IP inoculations 3 days apart

Mice have been used as soon as 7 days after the 3rd inoculation, and show a higher level of resistance to challenge by Aerosol.

Based on median counts in lungs of non-immune mice obtained by homogenate technique. A 50% mortality represents a respiratory dose of approximately 850 cells.

I hope this information may be of some value to you in your studies of radiation and infection.

Sincerely,

for Chief Superintendent

JRM/SP

## TRANSMITTAL SLIP

DATE

28-10-60

TO:

S. R.

FROM:

C. R.

- |   |  |
|---|--|
| <input type="checkbox"/> Note and File                  | <input type="checkbox"/> Take Appropriate Action |
| <input type="checkbox"/> Note and Return                | <input type="checkbox"/> As Requested            |
| <input type="checkbox"/> Please Speak                   | <input type="checkbox"/> For Information         |
| <input type="checkbox"/> Please Answer                  | <input type="checkbox"/> For Your Comments       |
| <input type="checkbox"/> For Your Approval              | <input type="checkbox"/> For Signature           |
| <input type="checkbox"/> Prepare Reply for My Signature |  |

## COMMENTS:

File signed out to

S. R. 24-10-60

C.A.P.A. 1237

SM-PAD'S OF 100-7-81 (445)

N.S. 4864-A-1237

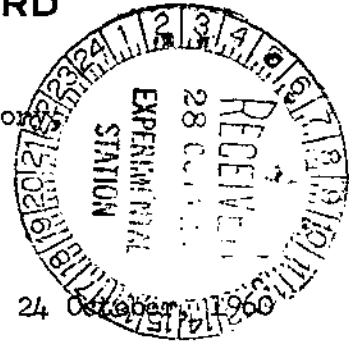


DEPARTMENT OF NATIONAL DEFENCE  
CANADA

## DEFENCE RESEARCH BOARD

Defence Research Kingston Laboratory  
P.O. Box 123,  
Kingston, Ontario.

IN REPLY PLEASE QUOTE  
DRKL/1801-05



Chief Superintendent,  
S.E.S.,  
Ralston, Alta.

REFERRED TO	<i>SR</i>
C. R. FILE NUMBER	
<i>1800-1</i>	

### Klebsiella pneumonia culture

1. In discussing the work of Maltman using the marginally noted organism, it appeared that this might be a suitable agent to use in our studies of radiation and infection.
2. It would be appreciated if this establishment (DRKL) could obtain a culture of this organism together with information on methods of culture, LD<sub>50</sub> and other relevant data.

*SR*

*Box + Can do? then go ahead*

J.F. Currie,  
(for) Chief Superintendent,  
DRCL/KL



DRBS 1800-1 DAR(B&C)

FORWARDED TO	CS
C. R. FILE NUMBER	
1800-1	

Ottawa, Ontario,  
12 October 1960.

Chief Superintendent,  
DRCL/KL.

U.S. Developments in BW Early Warning.

1. Reference is made to the extract from "Aviation Week and Space Technology" of September 12, 1960, which was sent to Dr. Leger from this office a short time ago, and which was sent to Major Doddridge for comment.
2. A copy of Major Doddridge's reply is attached. If you agree to the proposal in Para 4 of CATR's letter, would you please take the necessary steps to request six-month clearances for the personnel involved. Would you also please inform this office of the names of those Canadian personnel in your Establishment who will be making the visit.

Original Signed by  
W. F. Cockburn

for Chairman, Defence Research Board.

c.c. D Plans  
→ SES - for info only.

WFC:pdn

*Handwritten notes:*  
BW noted  
RM inford  
Cup  
[Signature]

In Reply Please Quote  
No. CAS(W)8934-2 (CML) 757

In Reply to DRBS 1800-1 DAR(B&C)  
Dated 19 Sep 60

6 Oct 60

Defence Research Board  
Department of National Defence  
Building "A"  
OTTAWA 4, Ontario  
Canada

ATTENTION: DAR(B&C)

US Developments in BW Early Warning

1. The contents of the extract enclosed in your letter were discussed with Mr. Nelson of the Biological Research Laboratories (BRL). The following information was provided:
  - a. Under the current contract with Douglas Aircraft, BRL will procure two (2) prototype models of each of the partichrome and particle size analyzer. These will be housed in mobile trailers along with the US and Canadian pyrolyzers and an Anderson Sampling Device.
  - b. These trailers to be ready by 1 Nov 60 will be used for background studies by Douglas Aircraft, one travelling a WEST-EAST route from Los Angeles to Fort Detrick through the Southern United States, the other through the Northern States. Each will stop at five sampling points for periods of up to three weeks. The partichrome, analyzer and pyrolyzer will operate continuously during sampling periods. Three particle size ranges, below one micron, one to ten micron and above will be taken with the Anderson sampler. These samples will be used for Protein-Nucleic Acid Studies. All data will be analyzed by the Computer Section of Douglas Aircraft.

.... /2

2. BRL has proposed to US Army Chemical Corps R and D Command that ten of each of the partichrome and particle size analyzer alarms be procured to test concepts of a biological rapid warning system for Continental USA. The proposal or funding has not yet been approved and the total number of alarms to be procured may be altered.

3. Please note that the current project is a study of the background and not the study of an alarm system.

4. During the discussion with Mr. Nelson, he emphasized that BRL wished to have Canadian BW workers visit these trailers during various phases of the test. As it is difficult to forecast when a visit would be beneficial, it is proposed that a six month clearance 15 Nov - 1 May 61 be requested for those personnel whom you consider interested in these developments. The purpose of the visit would be to visit Mr. S. Nelson, BRL, to discuss background studies and observe field tests being undertaken by Douglas Aircraft Company for Biological Research Laboratories.

5. May I have your comments on the proposal in par 4 and if you concur, please submit Requests for Visits and advise the undersigned of the names of those BW workers involved. Ensure that the Request for Clearance includes an explanation along the following lines:

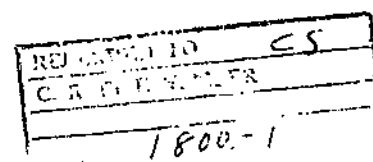
"This request for six-month clearance is submitted for the following reasons:

- a. The exact time of visit cannot be determined in advance and a visit may be required at short notice.
- b. Canadian equipment will be under test along with US equipments and may necessitate a visit at short notice."

(sgd) R.R. Doddridge

(R R DODDRIDGE)  
Major

Canadian Army Technical Representative



Ottawa, Ontario,  
6 September, 1960.

Chief Superintendent,  
DRCL/KL

Attention: Mr. Currie

Soviet Experiments on Effect of Radiation on BW

1. The following extract from the "Weekly Intelligence Review" dated 8 January, 1960 issued by the North American Defence Command should be of interest.

Original Signed by  
W. F. Cockburn

WFC:mas  
Encl. 1

for Chairman, Defence Research Board.

cc: Meds  
CS/SFS ←  
Dr. C.A. Mitchell

Bact ~~180~~  
Physiol ~~180~~  
Chem ~~180~~  
S/F ~~180~~  
ATL ~~180~~  
PRS ~~180~~  
SIA.

to Mr.



CONFIDENTIAL

Extract from

WEEKLY INTELLIGENCE REVIEW

8 January, 1960

SOVIET SCIENTIST STATES BW AGENTS  
MORE EFFECTIVE AFTER IRRADIATION

Agents of biological warfare (BW), chemical warfare (CW), and radiological warfare (RW) can be combined so that they will complement each other, producing a much more highly complicated effect than if they are used alone, according to Professor I.N. Morgunov, a leading Soviet microbiologist. Military operations would be hindered by the complicated decontamination and protective measures required, Morgunov stated in an article included in the book, "Medical Service in Mass Attack," which was published in Kiev in 1957.

These statements support previous information indicating Soviet interest in the feasibility of using BW and CW agents either following a nuclear attack or after the employment of RW agents.

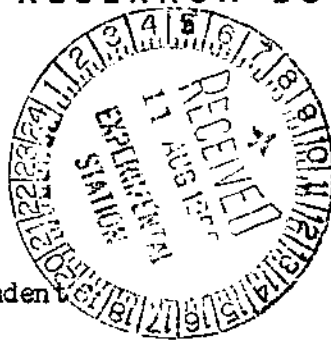
Soviet research on radiation sickness and its after-effects amply supports Morgunov's observations that animals subjected to sublethal doses of radiation are more susceptible to disease-producing organisms than animals that have not been irradiated. In this connection, Soviet microbiologists are known to have investigated the course of paratyphoid, dysentery, pneumonia, leptospirosis, and anthrax in animals following exposure of the animals to various dose levels of radiation. They have also studied the influence of sublethal radiation on the immunity of animals to diphtheria and tularemia.

Another method of combining radiation with infectious diseases is irradiation of the disease-producing organisms prior to introducing them into the human body. Soviet experiments have shown that micro-organisms grow very well on nutrient media containing radioactive isotopes. For instance, Soviet scientists reported in January 1959 on the successful cultivation of anthrax bacteria on a growth medium containing radioactive sulfur. The isotopes are absorbed by the organism and enter the molecular composition of the microbial cell. Morgunov states that such irradiated organisms will not only introduce harmful radiation into the body but will produce disease more rapidly.

1. Admit combination effective because of more complicated decontam procedures.
2. However, doubt if ~~greater~~ lethality or other such effects sufficiently enhanced by combining to be worth logistic awkwardness. D.L.

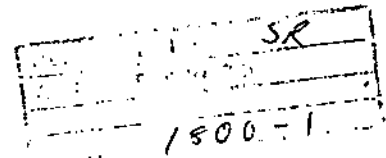


DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
8 August 1960.

Chief Superintendent  
SES



USSR Work on Aerogenic Immunization

1. It is understood from a letter just received from Major R.R. Doddridge that the m/n subject has aroused considerable interest and is considered quite good at Fort Detrick.
2. During the past six to eight months, Fort Detrick has exposed animals to aerosols of living tularemia vaccine and plan to carry out tests on volunteers. The live vaccine has been used parenterally in volunteers and has performed well.
3. Future work at Fort Detrick depends on the results of the present work, which will be made available when completed.

*H.R. Richards.*

for Chairman, Defence Research Board.

*HRR/IMH*

c.c. DBR(MED)  
DEP 3

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

28 July 1960.

Dr. E.T. Bynoe,  
Laboratory of Hygiene,  
Tunney's Pasture,  
Ottawa, Ontario.

Dear Ted:

Last December you were kind enough to send us  
a culture of Klebsiella pneumoniae P.C. 1 602 (Your No.  
CRX-8).

We have reached the stage where we would like  
to know whether it is Type I, II, etc. However, we are  
not in a position to type it. Should you know which  
type it is would you be good enough to let me know.  
Failing that, do you know where it could be sent to be  
typed?

Please address your reply to the Chief  
Superintendent, Suffield Experimental Station, Ralston,  
Alberta, attention A.B. Lamb.

Sincerely,

ABL/dg

for Chief Superintendent

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

30 June 1960.

Chief Superintendent,  
D.R.K.L.,  
KINGSTON, Ontario.

Attention: Mr. J. Currie

A drawing of the Animal Exposure Chamber which is used in the Bacteriology section at S.E.S. is being forwarded under separate cover.

Please do not hesitate to write if there are any points you wish to clear up concerning the operation of this chamber.

We thoroughly enjoyed your recent visit and hope the Vancouver meeting went off well.

Many thanks for attending to our numerous requests for the information which will be used in compiling the Tripartite Progress report.

Kindest regards,

ABL/dg

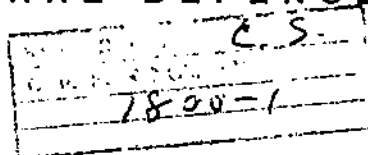
for Chief Superintendent



CONFIDENTIAL

OUR FILE REF. DRBS 1800-1  
DRBS 2000-1  
DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
11 February 1960.

→ CS/SES  
CS/DRCL/KL

Resume of the Research Programme of  
the Pathology Branch at ACC

1. Attached is a brief outline of seven papers presented on 22 January during the discussions of the research programme of the Pathology Branch, Directorate of Medical Research, U.S. Army Chemical Warfare Laboratories.
2. In addition to the work outlined the Pathology Branch is involved in cooperative studies with other branches of these laboratories in the field of CW agents and CW chemicals.

W. F. Cockburn.

for Chairman, Defence Research Board.

Encl.

cc: Meds.

*S/R. [signature]  
Phys WCA  
Abstracts [signature]*

COPY

Annex 1 to  
CAS(W)8934-1 (CML) 193  
2 Feb 60Research Staff Meeting22 Jan 60Synopsis of Papers

1. Benign Focal Pulmonary Lymphomatosis by Captain H.W. O'Neil, MC

(U) This paper described a peculiar spotty infiltration of lymphocytes in the lungs of guinea pigs. Infection or malignancy is not apparent. The infiltration lymphocytes is complete by the time the animals reach five to six months old.

2. Selective Fluorescein Labeling in the Non-specific Regions of the Specifically Purified Antibody Molecule by Miss Catherine E. Wilson

(U) The author described a fluorescent antibody technique in which the antibody is labelled with fluorescein isothiocyanate. It is not very specific for bacteriologic diagnosis. Specificity can be attained with a new method in which a specifically purified antibody is used instead of antiserum globulin. The antibody is labelled with fluorescein isothiocyanate while its combining sites are under protection by antigen. The antigen is then separated from the antibody in the final stage of preparation.

3. Potentiation and Protection among Four Mitotic Poisons by Lt. Beryl D. Mell, VC

(C) The author showed by the use of charts that, upon simultaneous application, the effects of ionizing radiation and mustard are potentiating or at least additive. Radiation, however, will protect against mustard given three days later.

4. Homologous Disease; Prophylaxis by Pfc George Mackay and Pfc John Petrali

(U) It is known that the life of lethally irradiated mice can be prolonged from approximately 11 days to about 30 days by transplantation of homologous bone marrow. However, delayed fatal illness, homologous disease, occurs apparently because of an immune reaction of the accepted transplant against the host.

CONFIDENTIAL

The authors described attempts, so far only partially successful, to prevent this reaction by the use of homologous donor marrow, made specifically immune-unresponsive to host tissues. Survivals from lethal radiation up from 180 to 250 days have been obtained. The only pathologic changes in sacrificed animals were mite infestation of the skin.

5. Homologous Disease, Pathology by Mr. Edward J. Donati

(U) The author added certain new observations to existing knowledge of the pathology of homologous disease and lethal radiation damage. He discusses a peculiar inclusion body in the liver and pancreas.

6. Antibody Precursors and Desoxyribonucleic Acid by Mr. John J. Cuculis

(U) The author showed that a factor in the intermediates of antibody formation is sensitive to desoxyribonuclease. He explained the changes of this sensitivity as a function of depletion of precipitating antibody by antigen in terms of equilibrium alterations and subsequent availability of antigen-like substance.

7. A Theory of Antibody Formation by Dr. Ludwig Sternberger

(U) A new theory of antibody formation was proposed. The author believes this may explain such phenomena as separation of formed antibody from antigen, bivalence of antibody, immune tolerance and booster response.

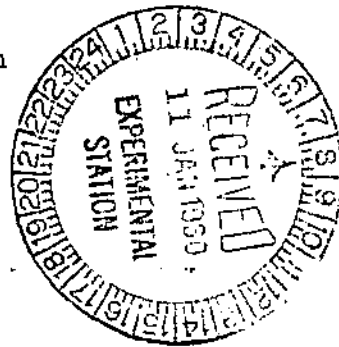
CONFIDENTIAL

---

SR  
1800-1

SUBJECT: TECHNICAL EVALUATION DIVISION TEST NO. 59-TE-1207  
Effect of Inositol on Animal Infectivity and Aerosol  
Recovery of Pasteurella tularensis Slurry After 60  
Days Storage

TO: Chief, Technical Evaluation Division  
Fort Detrick  
Frederick, Maryland



I. PLAN OF TEST

1. OBJECTIVES:

a. To compare source strengths and decay rates of P. tularensis aerosols from untreated slurry, slurry containing inositol (each stored approximately 60 days), and freshly prepared untreated slurry at test conditions of 35% relative humidity and 75°F.

b. To compare animal infectivity of P. tularensis aerosols from untreated slurry, slurry containing inositol (each stored 60 days) and freshly prepared untreated slurry at test conditions of 35% relative humidity and 75°F.

2. LOCATION OF TEST:

Test Tank 96, Building 567; 25, 29 and 30 June 1959, 1 July 1959

3. STARTING DATE AND EXPENDITURE ORDER:

25 June and to end 11 July 1959 and to be charged to Facility Nos. 3600 and 3700; Expenditure Order No. 9100100.

4. REFERENCES:

a. Related Test: 59-TE-1180

b. Data will be recorded in Laboratory Notebook No. CD-3765 and Animal Pathology Laboratory Notebook No. CD-3656.

5. BACKGROUND:

This test is part of a general project in the Biological Research Directorate and Allied Science Directorate to improve the biological stability of agents and to fulfill a Tripartite commitment to test the effect of inositol as an additive for P. tularensis.

*H. Baer S. A. B. Information*  
*H. P. R. S. W. B.*  
*S. F.*



Plan of Test. 59-TE-1207 (continued)

Results from the previous test (59-TE-1180, unreported as yet) show that although an improved decay rate was effected by each of the additives (inositol; raffinose - thiourea) the source strengths obtained were similar to the untreated control slurry. Moreover, the untreated control slurry responded to the effect of a deleterious relative humidity in an atypical manner, its source strength being ten or more fold higher than anticipated. Source strengths of the treated slurries were approximately twice as high as expected. The unusually high source strengths caused the predicted dose response curves to be in error, with the result that the minimum dosage obtained caused 100% mortality of the exposed animals. Animal exposures were limited to the untreated slurry and the slurry containing inositol.

The slurries used in this previous study have been in storage for approximately 60 days at 4°C. A recent check on the counts of these slurries showed that the slurry containing the raffinose - thiourea additive had dropped more than a thousand fold, while the other two slurries had decreased but 1/3 of their original count. Therefore, this present study will test the effect of the storage period only on the untreated and inositol containing slurries. A fresh, untreated slurry, duplicating insofar as possible the original untreated slurry will also be included. An attempt to span the animal dose response curve will be made for each of these three slurries.

6. METHOD OF TEST:

a. Design: The design will be a randomized block; each slurry treatment will be tested once each day to yield four replicates of each treatment for the four test days.

TRIAL SCHEDULE				
Day				
Trial	1	2	3	4
1	B*	A*	C*	B*
2	A*	B*	B*	C*
3	C*	C*	A*	A*

\* Animal Exposure Trials

b. Treatments

- A = untreated slurry, stored 60 days  
B = slurry containing six per cent inositol, stored 60 days  
C = untreated slurry, freshly made

c. Fill: Slurry treatments A and B were originally prepared by MB Division and have been in storage at 4°C for approximately 60 days in this Division. Slurry treatment C will be prepared by MB Division also and tested

## Plan of Test 59-TE-1207 (continued)

without storage. Additional information on the slurries will be presented in the Record of Test.

d. Test Item: The PT-12 fixture, operated at 1100 psig N<sub>2</sub>, and containing 10 ml fill, will be used.

e. Aerosol Sampling:

(1) The ABP-30 sampler containing 20 ml of gelatin saline and three drops of Dow-Corning Antifoam "A" will be used for sampling the aerosols. The inner surface of the pre-impinger will be coated with glycerin and will not be assayed.

(2) Two sampler combinations will be operated at each of the two sampling cabinets for each time period and for the pre-shoot sampling.

(3) Aerosol samples of one minute duration will be obtained at 4, 18 and 32 minute midpoints for all trials and at 38 and 46 minutes for slurry treatment C and 60 minutes for slurry treatment B.

f. Animal Exposure and Holding:

(1) Guinea pig exposures will be based on the following schedule.

Treatment A (Untreated Stored Slurry)

<u>Exposure Time</u> <u>(minutes)</u>	<u>Time Period</u> <u>(midpoint)</u>	<u>Duration</u> <u>(minutes)</u>
3.5 - 5.5	4.5	2
3.5 - 4.5	4	1
13.5 - 14.5	14	1
24.5 - 25.5	25	1

**Treatment B. (Slurry Containing Inositol)**

<u>Exposure Time</u> <u>(minutes)</u>	<u>Time Period</u> <u>(midpoint)</u>	<u>Duration</u> <u>(minutes)</u>
6.5 - 7.5	7	1
17.5 - 18.5	18	1
31.5 - 32.5	32	1
59.5 - 60.5	60	1

Treatment C (Untreated Fresh Slurry)

<u>Exposure Time</u> <u>(minutes)</u>	<u>Time Period</u> <u>(midpoint)</u>	<u>Duration</u> <u>(minutes)</u>
21.5 - 22.5	22	1
29.5 - 30.5	30	1
37.5 - 38.5	38	1
45.5 - 46.5	46	1

(2) Four Hartley strain guinea pigs, each weighing approximately 250-375 grams, will be exposed at each time period. Sixty-four guinea pigs will be exposed for each of the three slurry treatments during the test.

(3) Exposed guinea pigs will be held for ten days in individual ventilated cages. Diagnosis of infection will be based on the SOP for this agent.

g. Laboratory Assessment:

(1) The four ABP-30 samplers for each time period will be pooled for assay. All assays will be SOP for this agent.

(2) A control assay of each slurry treatment will be processed each day.

h. Physical Property Measurements: Viscosity, specific gravity, surface tension, pH, and total solids of each slurry treatment will be obtained on first and last test day by personnel of MR and AE Branch, Technical Evaluation Division.

i. Test Tank Operating Conditions:

(1) Temperature: 75°F

(2) Relative Humidity: 35%

(3) Fanning: the fan will be operated at 40 rpm, 30° blade pitch, upward thrust, continuous.

(4) Purging: the tank will be purged at 600 cfm for 30 minutes at the end of each trial.

7. DATA TO BE OBTAINED:

a. Before Test

(1) MB Division production data on fills

Plan of Test 59-TE-1207 (continued)

- (2) Physical property measurement of fills
- (3) Viable cell concentration of fills

b. During Test

- (1) Assay of control and aerosol samples
- (2) Physical property measurement of fills
- (3) Dissemination time and residual fills

c. After Test

Appropriate analysis of data

8. SUGGESTED METHOD OF DATA ANALYSIS:

a. Source strengths and decay rates based on the 4 through the 32 minute time period of the three slurry treatments will be contrasted using the analysis of variance shown below.

<u>Source</u>	<u>d.f.</u>
Days	3
Treatments	2
Error	6
Total	<u>11</u>

b. Appropriate analysis will be conducted on the guinea pig infectivity data.

Submitted by:

*Gary H. Boyer*  
GARY H. BOYER  
Test Sponsor

Concurred in:

*J. H. Morrison*  
J. H. MORRISON  
Chief, SC Section

Approved by:

*L. S. Idoine*  
L. S. IDOINE  
Chief, MR&AE Branch

*H. T. Euelsbach*  
H. T. EUELSBACH  
MB Division

*F. M. Wadley*  
F. M. WADLEY  
Statistical Advisor

*E. K. Wolfe*  
E. K. WOLFE  
Chief, Technical  
Evaluation Division

SUBJECT: TECHNICAL EVALUATION DIVISION TEST NO. 59-TE-1207  
Effect of Inositol on Animal Infectivity and Aerosol Recovery of  
Pasteurella tularensis Slurry After 60 Days Storage

TO: Chief, Technical Evaluation Division  
Fort Detrick  
Frederick, Maryland

## II. RECORD OF TEST

1. a. SUMMARY: This experiment was performed as part of a general project in the Directorates of Biological Research and Allied Sciences to improve the biological stability of agents and to fulfill a Tripartite commitment to test the effect of inositol as an additive for Pasteurella tularensis with respect to stability and animal infectivity.

Slurries of freshly prepared P. tularensis (a) untreated, (b) containing 6 per cent inositol, and (c) containing 5 per cent raffinose plus 0.1 per cent thiourea were aerosolized at 35 per cent relative humidity and 75°F with the PT-12 fixture in Technical Evaluation Division Test No. 59-TE-1180. In this study the aerosol test was repeated after 60 days storage of the slurries at 4°C with the exception of the raffinose-thiourea treatment which had a decrease of three logs in viable cell count.

In both studies, fresh untreated slurries of P. tularensis were used as controls. The reaction of the control slurries to the stress of relative humidity differed considerably between the two studies, both with respect to source strength and subsequent decay rate. These results precluded establishing a baseline against which to contrast the effect of storage of P. tularensis, untreated, or in the presence of inositol, and hence, few conclusions were drawn.

Extrapolation of the animal data obtained with the fresh materials (59-TE-1180) indicated that there was no evident difference between the infectivity of the untreated slurry and the slurry with inositol. The animal data in this study show that this relationship was maintained after storage of the slurries for 60 days at 4°C.

b. RECOMMENDATIONS: It is recommended that the batch-to-batch variability of P. tularensis (from MB Division) when aerosolized at 35 per cent relative humidity and 75°F be investigated.

2. DISCUSSION AND CONCLUSIONS: The LD<sub>50</sub>s and probit slopes, presented in the following table were consistent with previous experience.

Record of Test 59-TE-1207 (continued)

Slurry Treatment	LD <sub>50</sub> Organisms		Slope, Probits/Log Dose	
	Mean	95% C. L.	Mean	95% C. L.
Untreated, fresh	98 <sup>a</sup>	40 - 238	2.16 <sup>a</sup>	0.593 - 3.72
Untreated, stored	322 <sup>a</sup>	105 - 485	1.05 <sup>a</sup>	0.277 - 1.82
6% Inositol, stored	44 <sup>a</sup>	16 - 123	1.19 <sup>a</sup>	0.640 - 1.74

Values in each column having the same superscript are not significantly different at  $P \leq 5\%$ .

The beneficial effect which inositol had on the decay rate of fresh *P. tularensis* was not observed after the slurries had been stored 60 days, as evidenced in the following table.

	Decay Rate, %/Min (4-32 Min)	
	Fresh Material (Test No. 1180)	Stored 60 Days (Test 1207)
Untreated <i>P. tularensis</i>	9.25 <sup>a</sup>	13.8 <sup>a</sup>
<i>P. tularensis</i> + Inositol	4.32 <sup>b</sup>	11.5 <sup>a</sup>

Values in each column having the same superscript are not significantly different at  $P \leq 5\%$ .

After storage for 60 days at 4°C the viable cell count of the *P. tularensis* slurry containing 5 per cent raffinose and 0.1 per cent thiourea was less than 0.1 per cent of the original concentration. In contrast, slurries of *P. tularensis*, with and without inositol, were approximately 60 per cent of the original concentration.

<i>P. tularensis</i> , treatment	Viable Cell Concentration ( $\times 10^9$ org/ml)	
	Fresh	Stored
Untreated (1)	31.4 (1180)	20.3 (1207)
Inositol	31.4 (1180)	19.7 (1207)
Raffinose-Thiourea	27.6 (1180)	<0.3 (1207)
Untreated (2)	34.6 (1207)	-----

For comparison, the aerosol data from Test 1180 and 1207 are listed below:

Record of Test 59-TE-1207 (continued)

P. tularensis	1180		1208	
	S. S. (%)	DR, %/Min	S. S. (%)	DR, %/Min
Untreated, fresh (1)	5.33 <sup>a</sup>	9.25 <sup>a</sup>	—	—
Untreated, stored (1)	—	—	*0.293 <sup>a</sup>	*13.8 <sup>a</sup>
Untreated, fresh (2)	—	—	0.320 <sup>a</sup>	21.3 <sup>a</sup>
Inositol treated	4.97 <sup>a</sup>	4.32 <sup>b</sup>	*0.484 <sup>a</sup>	*11.5 <sup>a</sup>
Raffinose-Thiourea treated	5.27 <sup>a</sup>	2.24 <sup>b</sup>	—	—

\*Stored 60 days at 4°C.

Values in each column with the same superscript are not significantly different at  $P \leq 5\%$ .

The slurries used in this test were produced by MB Division. The slurries used in Test 1180, and the fresh slurry used in this test were five days old on Day 1 of the test and nine days old on the last day of the test.

The mean physical property measurements obtained at 30°C for each treatment are presented below.

Mean Physical Property Measurements

Slurry Treatment	Viscosity (cstks)	Spec. Gravity	Surface Tension (dynes/cm)	pH	Dry Wt. (%)
Untreated, fresh	1.104	1.020	49.4	6.8	3.6
Untreated, stored	1.114	1.022	50.1	6.9	3.7
Treated with Inositol, stored	1.202	1.046	50.3	6.8	9.2

The higher dry weight of the treated slurry was attributed to the addition of the inositol. The physical property values for each comparable treatment in test 1180 were similar, with the exception of an increase in dry weight with the stored slurry containing inositol (6.8% dry weight for un-stored slurry).

3. INCLOSURES:

- Table I - Table of Means
- Table II - Analysis of Variance
- Table III - Organisms/Liter and Per Cent Recoveries
- Table IV - Animal Data
- Figure I - Decay Curves
- Figure II - Dose Response Curves

TABLE I  
TABLE OF MEANS

Linear Source Strength, Linear Decay Rate - 95% Confidence Limits

Treatment	Linear Source Strength - %			Linear Decay Rate %/Min <sup>2.1</sup>		
	Mean	95% C. L.		Mean	95% C. L.	
		Lower	Upper		Lower	Upper
Untreated Stored	0.293	0.126	0.682	13.8	6.99	20.1
Inositol Stored	0.484	0.208	1.13	11.5	4.52	18.0
Untreated Fresh	0.320	0.137	0.745	21.3	15.1	27.1

Linear Source Strength, Linear Decay Rate Day x Treatment

Treatment	Linear Source Strength %			Linear Decay Rate %/Min <sup>2.1</sup>		
	Untreated Stored	Inositol Stored	Untreated Fresh	Untreated Stored	Inositol Stored	Untreated Fresh
Day						
I	0.322	0.151	0.372	15.5	9.72	30.6
II	0.140	0.542	0.0972	15.7	13.1	21.0
III	0.351	1.10	0.292	12.3	12.5	10.4
IV	0.467	0.609	0.993	11.7	10.8	22.1



TABLE I (continued)

Per Cent Recovery - Treatment x Period

<u>Period</u> <u>Treatment</u>	<u>4 Min</u>	<u>18 Min</u>	<u>32 Min</u>
Untreated			
Stored	0.221	0.0107	0.00341
Inositol			
Stored	0.342	0.0401	0.0110
Untreated			
Fresh	0.152	0.00277	0.000706

Recovery Organisms/L<sup>-1</sup> - Treatment x Period

<u>Period</u> <u>Treatment</u>	<u>4 Min.</u>	<u>18 Min.</u>	<u>32 Min.</u>
Untreated			
Stored	10,430	508	161
Inositol			
Stored	17,960	2,106	579
Untreated			
Fresh	14,140	259	95

TABLE I (continued)

## Daily Control Averages, 95% C. L. x Treatment

<u>Day</u>	<u>Untreated Stored</u>	<u>Inositol Stored</u>	<u>Untreated Fresh</u>
I	111.8	198.1	390.9
II	230.7	150.3	409.1
III	249.7	220.0	281.8
IV	219.6	218.4	304.3
Mean	203.0	196.7	346.5
95% C.L. (Lower	104.4	145.0	246.6
Upper	301.6	248.4	446.4

Probit LD<sub>50</sub>, Probit Slope, 95% C. L. per Treatment\*

<u>Treatment</u>	<u>Probit LD<sub>50</sub>--Organisms</u>			<u>Probit Slope</u>		
	<u>LD<sub>50</sub></u>	<u>95% C. L.</u>		<u>Slope</u>	<u>95% C. L.</u>	
		<u>Lower</u>	<u>Upper</u>		<u>Lower</u>	<u>Upper</u>
Untreated, stored	322	105	985	1.05	0.277	1.82
Inositol, stored	44	16	123	1.19	0.640	1.74
Untreated, fresh	98	40	238	2.16	0.593	3.72

\* Day 4 omitted from Treatment C.

TABLE I (continued)

## Physical Properties

<u>Treatment</u>	<u>Test Day</u>	<u>Viable Cell Count</u>	<u>Viscosity C. Stokes T = 30°C</u>	<u>Specific Gravity T = 30°C</u>	<u>Surface Tension T = 30°C</u>	<u>pH T=30°C</u>	<u>% Dry Wt.</u>
Untreated							
Stored	1	35*	1.100	1.022	47.5	6.9	3.6
Inositol							
Stored	1	--	1.205	1.046	47.9	6.8	9.0
Untreated							
Fresh	1	36*	1.107	1.021	45.2	6.8	3.6
Untreated							
Stored	5	--	1.129	1.022	52.7	6.9	3.8
Inositol							
Stored	5	--	1.199	1.046	52.7	6.9	9.3
Untreated							
Fresh	5	--	1.101	1.018	53.6	6.8	3.7

\* x 10<sup>9</sup>

TABLE II  
ANALYSIS OF VARIANCE  
OF  
LINEAR SOURCE STRENGTH

Log Per Cent Recovery

<u>Effect</u>	<u>D.F.</u>	<u>Sum of Squares</u>	<u>Mean Square</u>	<u>Error Line</u>	<u>F 0</u>	<u>Approx. Prob.</u>
Days (D)	3	0.523	0.174	3	1.93	N.S.
Treatments (T)	2	0.108	0.0542	3	<1	N.S.
D x T	<u>6</u>	<u>0.540</u>	0.0900	-	--	--
Total	11	1.17				

Coeff. of Variation = 99.5%

## LINEAR DECAY RATE

Slope

<u>Effect</u>	<u>D.F.</u>	<u>Sum of Squares</u>	<u>Mean Square</u>	<u>Error Line</u>	<u>F 0</u>	<u>Approx. Prob.</u>
Days (D)	3	0.00225	0.000752	3	1.02	N.S.
Treatment (T)	2	0.00573	0.00286	3	3.89	N.S.
D x T	<u>6</u>	<u>0.00441</u>	0.000735	-	--	--
Total	11	0.0124				

Coeff. of Variation = 36.6%

TABLE III  
ORGANISMS/LITER AND PER CENT RECOVERIES

Per Cent Recoveries

Day	I			II		
Treatment	A	B	C	A	B	C
Period						
4	0.244	0.0970	0.0863	0.115	0.334	0.0616
18	0.00711	0.0255	0.000519	0.00239	0.0367	0.000525
32	0.00221	0.05551		0.000949	0.00648	0.0000835
38						
46			0.0000649			
60		0.00243				

Day	III			IV		
Treatment	A	B	C	A	B	C
Period						
4	0.274	0.859	0.206	0.308	0.489	0.481
18	0.0187	0.0564	0.0336	0.0418	0.0489	0.00643
32	0.00688	0.0205	0.00947	0.00934	0.0202	0.000445

\*Organisms/Liter

Day	I			II		
Treatment	A	B	C	A	B	C
Period						
4	1,988	1,514	2,660	10,650	19,780	10,324
18	58	398	16	222	2,172	88
32	18	86	0	88	384	14
38			0			
46			2			
60		38				

Day	III			IV		
Treatment	A	B	C	A	B	C
Period						
4	21,060	78,200	24,000	26,620	44,400	60,600
18	1,432	5,130	3,918	3,620	4,440	810
32	528	1,864	1,104	808	1,832	56

\*Net Fill Volume Day I = 5 ml; Net Fill Volume Days II-IV = 20 ml.

A = Untreated slurry, stored 60 days  
B = 6% Inositol treated, stored 60 days  
C = Untreated slurry, freshly made

TABLE IV  
ANIMAL DATA

Day	Trial	Treatment	Period	No. Exposed	No. Response	% Response	Wt.	Org/L.	Dose
I	2	A	3.5--5.5	4	3	75.0	320	3,976	466
			4	4	4	100.0	320	1,988	233
			14	4	0	0	320	250	29
			25	4	0	0	320	39	5
	1	B	7	4	3	75.0	310	1,151	132
			18	4	4	100.0	310	398	46
			32	4	1	25.0	310	86	10
			60	4	0	0	320	38	4
	3	C	22	4	0	0	340	4	0
			30	4	0	0	340	0	0
			38	4	0	0	340	0	0
			46	4	0	0	340	2	0
II	1	A	3.5--5.0	4	4	100.0	350	15,975	2,003
			11	4	1	25.0	350	1,975	248
			10.5--12.5	4	2	50.0	350	3,640	456
			18	4	1	25.0	350	222	28
	2	B	6.0--8.0	4	4	100.0	370	21,769	2,846
			10	4	4	100.0	380	7,863	1,049
			16	4	2	50.0	370	3,379	442
			25	4	2	50.0	370	952	124
	3	C	4	4	4	100.0	370	10,324	1,350
			8	4	3	75.0	370	2,475	324
			11	4	3	75.0	370	1,220	160
			19.5--22.5	4	1	25.0	370	352	46

A = Untreated slurry, stored 60 days  
 B = 6% Inositol treated, stored 60 days  
 C = Untreated slurry, freshly made

TABLE IV (continued)

Day	Trial	Treatment	Period	No. Exposed	No. Response	% Response	Wt.	Org/L	Dose
III	3	A	3.5-5.0	4	4	100.0	320	31,590	3,704
			11	4	3	75.0	320	6,337	743
			10.5-12.5	4	4	100.0	320	11,892	1,395
			18	4	1	25.0	320	1,432	168
	2	B	6.0-8.0	4	4	100.0	300	78,927	8,817
			10	4	4	100.0	300	26,388	2,948
			16	4	4	100.0	300	11,850	1,324
			25	3	2	66.7	300	3,565	398
	1	C	4	4	4	100.0	310	24,000	2,748
			8	4	4	100.0	310	14,135	1,618
			11	4	4	100.0	360	10,164	1,302
			19.5-22.5	4	4	100.0	310	10,197	1,168
IV	3	A	3.5-5.0	4	4	100.0	320	39,930	4,683
			10	4	1	25.0	300	10,244	1,144
			10.5-12.5	4	1	25.0	320	19,288	2,262
			18	4	2	50.0	320	3,620	425
	1	B	6.0-8.0	4	4	100.0	340	49,962	6,131
			10	4	4	100.0	340	17,721	2,175
			16	4	4	100.0	340	8,952	1,099
			25	4	4	100.0	340	3,212	394
	2	C	4	4	4	100.0	320	60,600	7,108
			8	4	4	100.0	320	17,033	1,998
			11	4	4	100.0	320	8,057	945
			19.5-22.5	4	4	100.0	320	2,033	238

Note: Day four omitted in obtaining LD<sub>50</sub> for Treatment C

A = Untreated slurry, stored 60 days  
 B = 6% Inositol treated, stored 60 days  
 C = Untreated slurry, freshly made

FIGURE I TE-1207

LINEAR DECAY BASED ON LOG PER CENT RECOVERY

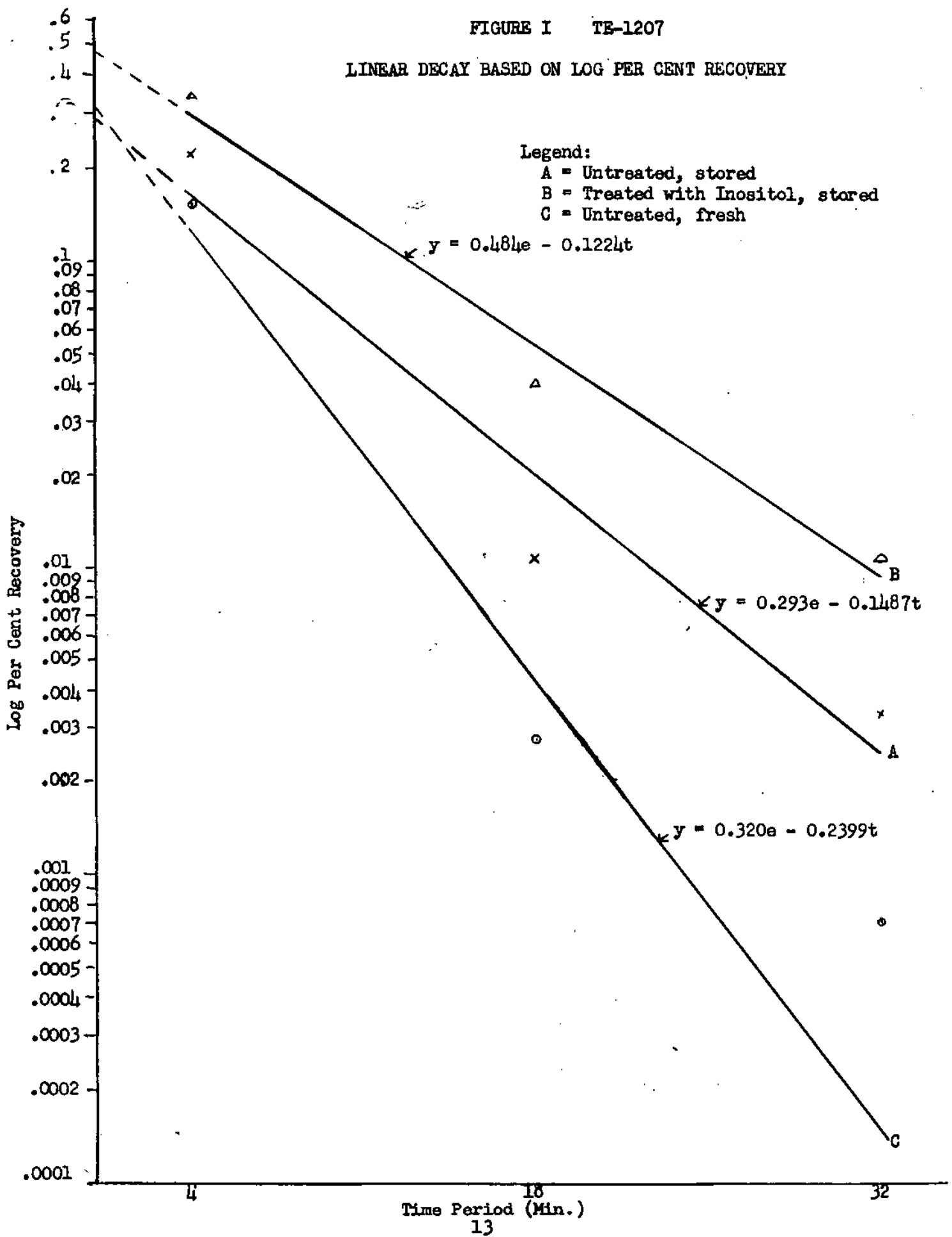
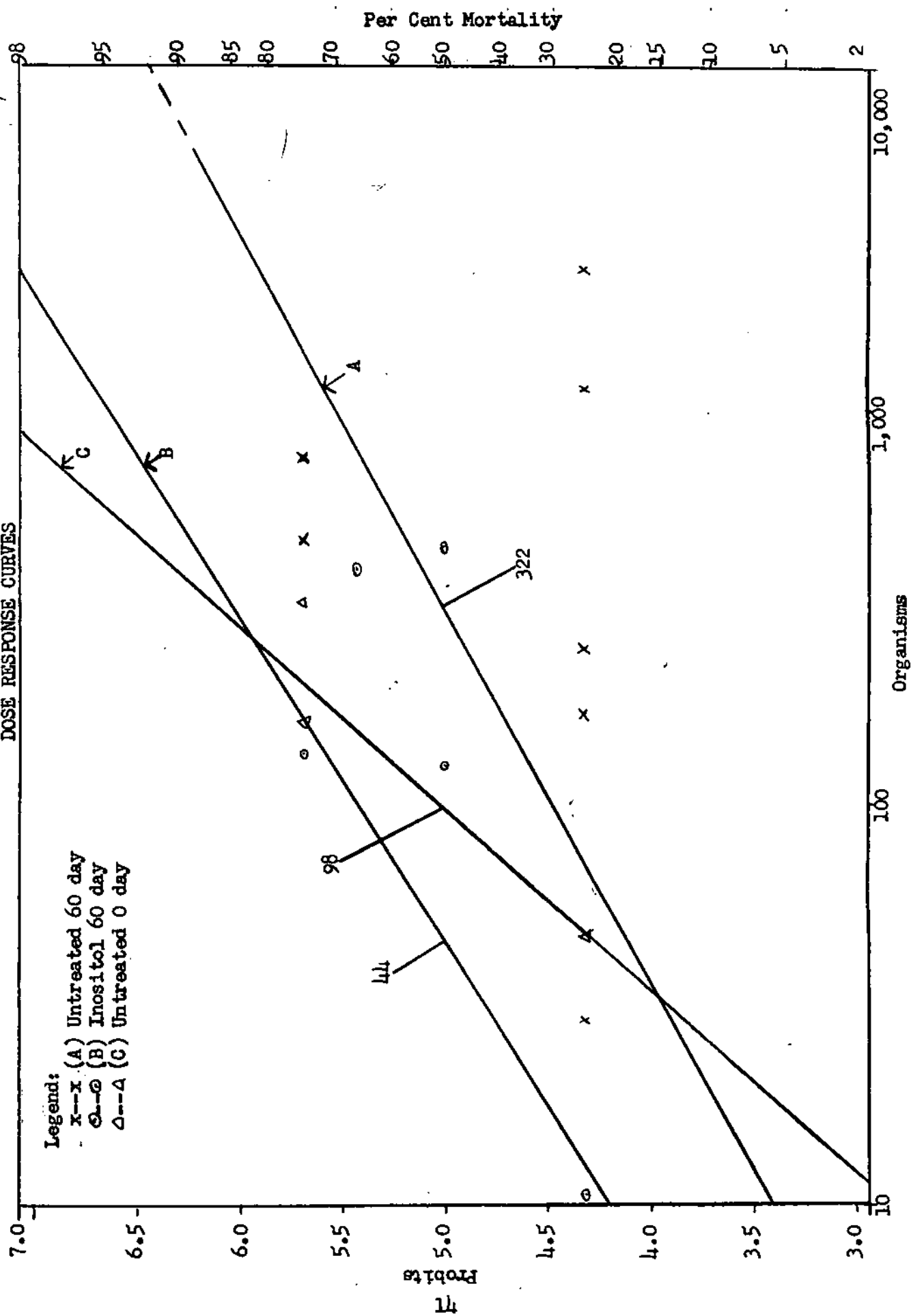




FIGURE II TE-1207  
DOSE RESPONSE CURVES



*Subject 5  
at 10:00 PM  
S.E.*

*It looks like a  
damned poor  
experiment*

SUBJECT: TECHNICAL EVALUATION DIVISION TEST NO. 59-TE-1182  
Protection of Pathogenic Bacterial Aerosols Against  
Ultraviolet Energy.  
II. Determination of Protection Against UV radiation  
(2900-3800A°) afforded to wet Pasteurella tularensis  
by three optical bleaches, using a modified aerosol  
transport system.

*The results  
experiment are  
not conclusive  
insofar as the  
question would  
indicate RAN*

TO: Chief, Technical Evaluation Division  
Fort Detrick  
Frederick, Maryland

PLAN OF TEST

OBJECTIVES:

- a. To determine if a modification of the aerosol transport system used with the stainless steel exposure duct provides sufficient exposure to UV light to elicit a response from P. tularensis aerosols.
- b. To compare the relative effectiveness of three optical bleaches in protecting P. tularensis from UV exposure.

2. LOCATION OF TEST: Tank 96, Building P-567.

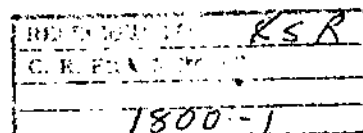
3. ESTIMATED TO BEGIN: 11 May 1959 and to end 20 May 1959, and to be charged to Ex. O. No. 9100100.

4. REFERENCES: Technical Evaluation Division Test No. 59-TE-1153.

5. BACKGROUND: No effect of UV was noted on aerosol recovery of P. tularensis in test 59-TE-1153 when exposure to sunlamps was through a "plexiglass" filter. When uncoated callophane was substituted as the filter medium, however, 99.9% kills were obtained for the same exposure time. This could be due to either (a) the increased energy levels attained, (b) the inclusion of that part of the spectrum (2750-2900A°) excluded by the "plexiglass" filter, or (c) a combination of the two.

A modification of the exposure duct which utilizes critical orifices to control the speed of the aerosol through the duct has replaced the rheostat controlled fan used in the previous test. The slowest speed obtainable with the fan system provided a 4.5 second exposure to the UV. Theoretically the critical orifice controlled system can provide exposures of 56.5, 78.9 and 168.8 seconds.

In test 59-TE-1153, the theoretical energy level at wavelengths of 2900 to 3800A° was approximately 31,000  $\mu$  watt seconds/cm<sup>2</sup> and as previously



Plan of Test No. 59-TE-1182 (continued)

mentioned had no effect on aerosol recovery. At wavelengths of 2750 to 3800Å using the uncoated cellophane filter, the theoretical energy level was approximately 52,000  $\mu$  watt seconds/cm<sup>2</sup> and a 99.9% reduction in viable recovery was noted. Using the modified UV exposure duct with "plexiglass" filters theoretically will provide 7.5 to 22 times the energy obtained with the cellophane filter and will eliminate the undesired wavelengths below 2900Å.

Three optical bleaches (3-Amino-1, 5 Naphthalene disulfonic acid; 8-Amino-1, 3, 6 Naphthalene trisulfonic acid; 2-Naphthol-6, 8 disulfonic acid) will be tested for protective effect against UV light approximating that of sunlight. The compounds will be added to P. tularensis slurry at a concentration of 0.5%.

For a more extensive treatment of the principles and theories concerned in this work, as well as the basic design of the aerosol exposure device, it is suggested that Test 59-TE-1153 be consulted.

6. METHOD OF TEST:

Fixture & Fill Volume: PT-12, 15 ml wet P. tularensis

Treatments:

a. P. tularensis slurry containing 0.5% distilled water as a non-exposed control (lamps off).

b. P. tularensis slurry containing 0.5% distilled water as an exposed control (lamps on).

c. P. tularensis slurring containing 0.5% 3-Amino-1, 5 Naphthalene disulfonic acid (lamps on).

d. P. tularensis slurry containing 0.5% 8-Amino-1, 3, 6 Naphthalene trisulfonic acid (lamps on).

e. P. tularensis slurry containing 0.5% 2-Naphthol-6, 8 disulfonic acid (lamps on).

Tank Conditions: 30% R. H., 75°F, continuous fanning only during first 3 minutes following dissemination.

Aerosol Flow Rate: Aerosol will be pulled through the duct at 37.5 liters/min. for 2 minutes after the tank fan is turned off.

Samples: A single AGI-30 on each side of the duct.

Assay: SOP streak plates for viable counts.

Sampling: Irradiation will commence 2 minutes after dissemination. Samples will be of one minute duration at the 5½ minute time period.

Plan of Test No. 59-TE-1182 (continued)

Design: Randomized block with one trial per treatment per day for 8 days.

7. DATA TO BE OBTAINED:

Prior to Test: Physical properties and control counts of slurries.

During Test: R. H. and temperature.

After Test: Analysis of data.

8. SUGGESTED METHOD OF DATA ANALYSIS:

Analysis of Variance

Days	7
Treatments	4
D x T	28

Special comparisons may be made from the general analysis.

Submitted by:

*R. L. Walker*  
R. L. WALKER  
Test Sponsor

Concurred in:

*J. E. Malligo*  
J. E. MALLIGO  
Chief, MR Section

*F. M. Wadley*  
F. M. WADLEY  
Statistical Advisor

Approved by:

*L. S. Idoine*  
L. S. IDOINE  
Chief, MR&AE Br.

*E. R. Wolfe*  
E. R. WOLFE  
Chief, Technical  
Evaluation Division

SUBJECT: TECHNICAL EVALUATION DIVISION TEST NO. 59-TE-1182  
Protection of Pathogenic Bacterial Aerosols Against Ultraviolet  
Energy. II Determination of Protection Against UV Radiation  
(2900-3800A°) Afforded to Wet Pasteurella tularensis by Three  
Optical Bleaches, Using a Modified Aerosol Transport System.

TO: Chief, Technical Evaluation Division  
Fort Detrick  
Frederick, Maryland

## II. RECORD OF TEST

1. SUMMARY: In a continuation of the effort to develop an aerosol exposure device to investigate the protective effects of various chemical compounds against ultraviolet light, a system using critical orifices to obtain slower aerosol movement through the duct was tested. Although the total exposure to UV was greatly increased by decreasing the rate of aerosol movement through the duct, no lethal effect of Plexiglas-filtered UV light (2900-3800A°) from fluorescent sunlamps could be shown. Viable recovery data indicated a lack of equality between the duct halves at the lower flow rates. There was an indication that the three optical bleaches imparted a protective effect against the adverse effects of aerosolization at the low relative humidity used in the test.

2. RECOMMENDATIONS: It is recommended that the test be repeated using a thinner "Plexiglas", or other filter material which will give higher UV energy levels.

3. RESULTS AND CONCLUSIONS: At the 37.5 l/min flow rate, no pronounced effect of Plexiglas-filtered UV light (2900-3800A°) was evident during the first four days of testing. The flow rate was lowered to 12.5 l/min for the four remaining test days to increase the length of exposure to UV. There appeared to be no difference between recoveries of exposed and non-exposed aerosols of P. tularensis to which no optical bleach protectant had been added regardless of the flow rate used. As shown in the following table, there did appear to be a tendency toward lower aerosol recoveries from the exposure half of the duct indicating some non-uniformity of aerosol movement through the duct halves at lower flow rates.

Record of Test 59-TE-1182 (continued)

Mean Recovery - Organisms/ml x 10<sup>3</sup>

37.5 L/min Flow Rate

Non-Exposed Control		Exposed Control		Optical Bleach Protected					
				C*		D*		E*	
1**	2**	1	2	1	2	1	2	1	2
45.64	53.31	40.93	54.69	110.25	191.04	135.63	167.50	82.55	117.63
Ratio									
1**/2**	.8561		.7484		.5771		.8097		.7018

12.5 L/min Flow Rate

9.75	16.06	10.15	11.85	24.87	40.03	24.16	43.52	23.49	41.90
Ratio									
1**/2**	.6070		.8565		.6212		.5551		.5606

- \*C = 3-Amino-1, 5 naphthalene disulfonic acid  
 D = 8-Amino-1, 3, 6 naphthalene trisulfonic acid  
 E = 2-Naphthol-6, 8 disulfonic acid

- \*\*1 = Irradiation half of duct  
 2 = Control half of duct

A possible explanation for the inequality of unexposed aerosol recoveries from the duct halves may simply be that the duct halves are not truly equal in volume or geometry due to the necessary protrusion of the lamp housing-filter holder units into the duct. This inequality may be most apparent at the low flow rates because the low levels of recovery tend to magnify any differences that exist between duct halves.

It was interesting to note that recoveries from non-exposed optical bleach protected aerosols were about 3 times higher than nonprotected aerosols at either flow rate. This suggests the existence of a more general protective effect of the optical bleaches against the adverse effects of aerosolization at a low relative humidity in addition to protection afforded against UV light.

4. INCLOSURES:

Table I - Table of Means

*the above would make it difficult to find the inhibiting effect of UV, if anything, in the test*

*Artificial.*

Submitted by:

*R. L. Walker*  
R. L. WALKER  
Test Sponsor

Concurred in:

*J. S. Mallory*  
J. S. MALLORY  
Chief, MR Section

*F. M. Wadley*  
F. M. WADLEY  
Statistical Advisor

Approved by:

*L. S. Idoine*  
L. S. IDOINE  
Chief, MR&AE Branch

*E. K. Wolfe*  
E. K. WOLFE  
Chief, Technical  
Evaluation Division

TABLE I

## TABLE OF MEANS

Viable Recovery x Days x Flow Rate

P. tularensis - Organisms/ml x 10<sup>3</sup>

Day	Non-Exposed Control		Exposed Control		Flow Rate - 37.5 L/Min					
					Optical Bleach Protected					
					C*		D*		E*	
	1**	2**	1	2	1	2	1	2	1	2
I	57.25	22.25	69.50	82.50	117.25	115.20	157.00	158.75	90.50	118.25
II	42.00	63.00	29.10	47.00	115.00	342.00	145.25	180.25	48.50	83.00
III	58.75	74.50	37.83	47.50	142.25	223.67	124.50	179.50	123.00	154.00
IV	24.55	53.50	27.30	41.75	66.50	83.00	115.75	151.50	68.25	115.25
$\bar{X}$	45.64	53.31	40.93	54.69	110.25	191.04	135.63	167.50	82.55	117.63
Flow Rate - 12.5 L/Min										
V	3.51	5.83	8.75	8.05	33.00	48.50	37.50	44.75	49.75	59.50
VI	7.75	16.83	11.13	13.70	21.83	72.75	19.95	68.25	24.98	76.25
VII	11.13	13.28	13.48	13.53	12.58	13.60	28.15	49.50	4.63	11.55
VIII	16.60	28.30	7.25	12.13	32.08	25.25	11.05	11.60	14.60	20.30
$\bar{X}$	9.75	16.06	10.15	11.85	24.87	40.03	24.16	43.52	23.49	41.90

\*C = 3-Amino-1, 5 naphthalene disulfonic acid

D = 8-Amino-1, 3, 6 naphthalene trisulfonic acid

E = 2-Naphthol-6, 8 disulfonic acid

\*\*1 = Irradiation half of duct

2 = Control half of duct



SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

15 October 1959.

Mr. George J. Mitchell,  
Dept. of Lands and Forests,  
Natural Resources Bldg.,  
Edmonton, Alberta.

Dear Mr. Mitchell:

We have received your letter of 9 October in which you have estimated the density figures for game animals and birds.

May I thank you for making such a comprehensive report. Your efforts are greatly appreciated and I am sure that the information which you have presented will be of great assistance to us.

Should we require further information I will not hesitate to call upon you, however, I feel certain that your letter covers the problem which we are considering.

ABL/dg

for Chief Superintendent.

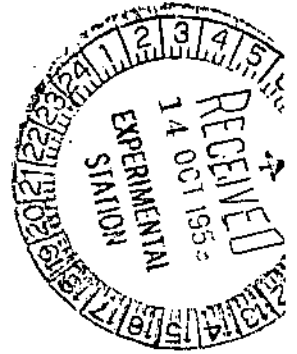


GOVERNMENT OF THE PROVINCE OF ALBERTA  
DEPARTMENT OF LANDS AND FORESTS

Brooks, Alberta,  
October 9, 1959.

Chief Superintendent,  
Suffield Experimental Station,  
Ralston, Alberta.

RECEIVED TO	S.P.
C. & F. FILE NUMBER	1800-1



Dear Sir:

Your letter of August 24 in which you request information on wild animal abundance and density has been passed on to me. As I do not have all my game animal reports with me in the field at present, I cannot give detailed data on mule deer, whitetailed deer and sharptailed grouse abundance. I am assuming that you are interested mainly in game animals and birds and do not wish density figures for the many small mammals indigenous in the region in question nor for the multitude of small and large non-game birds which frequent the area.

Density figures are always difficult to obtain because this assumes that you know the size of the range in question. For example, I run an aerial deer and antelope count each year in the Medicine Hat region, but, not knowing the precise limits of mule deer, whitetailed deer and antelope range, I cannot with any high degree of accuracy, translate my survey figures into density because of the as yet unknown game range size. In winter, most deer are concentrated along the South Saskatchewan, Bow and Red Deer Rivers. For those river valleys I determine density during winter. However I do not know the size of the summer range of deer in this region, nor how far deer wintering along the watersheds will travel from the winter range in spring.

A Big Game

1. Antelope - A few found along Ross Creek, Bullshead Creek, and Seven Persons Creek. To the south, pronghorns more abundant near Wildhorse, Manyberries, Pakowki Lake, Milk River. In the Hilda - Schuler triangle antelope not abundant and restricted mostly to the south and west sides of triangle.

*As far as our own range is concerned I think we can give a better estimate than this one*

*Agree - have replied with thanks ASD*

Large population found in the Eastern Irrigation District, Ronalane area and that region south of Red Deer River to north Boundry of Experimental Block.

August 1957 aerial survey gave the approximate summer density figures:-

<u>Zone</u>	<u>No. Antelope per square mile.</u>
E.I.D. west	1.0
E.ID. middle	4.1
E.I.D. northeast	2.9
Ronalane	Unknown - probably about 0.5
Hilda - Schuler	Unknown - probably about 0.1
South of Irvine	1.5
North of British Block	Unknown - probably about 0.5
British Block	Unknown No access.

Total antelope population in province estimated at 15,000 in 1957. Now approximately 10,000.

2. Mule Deer - Density low on large summer range. In winter animals concentrated in the following areas: (1) Red Deer River valley; (2) South Saskatchewan River valley; (3) Bow River valley near its confluence with the Oldman River; and (4) Cypress Hills.

As mentioned earlier I do not have my survey figures with me at this time. However, I do remember that deer density along the Red Deer River in March 1958 was 7 deer per square mile. Considering the difficulties encountered while censusing, the true density at that time was probably 10 - 15 deer per square mile. Deer are also abundant along the South Saskatchewan River from just north east of Medicine Hat to where the top of township 16 crosses the river. North of that point to Empress are fewer deer. The Sandhills along the eastern portion of the British Block support some deer, but numbers unknown. The Cypress Hills support large numbers of deer but no density figures are available.

3. Whitetailed Deer - No density figures available. Most abundant along Red Deer River from Steveville ferry to Empress, and in the Cypress Hills.

4. Elk - A few (possibly 100) found along Alberta - Saskatchewan boundary within Cypress Hills Provincial Park.

5. Moose - About 8 or 10 moose now inhabiting Cypress Hills Provincial Park since two pair were introduced several years ago.

B. Upland Game

1. Pheasant - Locally found where suitable cover exists i.e. Red Deer River, coulees near Medicine Hat. Density low.

2. Hungarian Partridge - Found throughout dryland farming area. No density figures available.

3. Sharptailed grouse - Distributed throughout region, but most abundant on Cypress Hills foothills, major watersheds, and sandhills in township 19, Range 3 and 4.

4. Sage Grouse - This native grouse is limited in distribution. Found in extreme southeast corner of province and several other small areas. Density over entire range very low.

5. Chukar Partridge - Introduced into the South Saskatchewan valley in 1953 but surveys since has led me to believe that this planting failed. Some birds also planted along Milk River. Density very low.

6. Ruffed Grouse - A few birds are known to inhabit the Cypress Hills. Density low.

C. Waterfowl

Figures are available for breeding pair density on the prairie region, but unfortunately I do not have reports on same with me. If you desire these figures they could be given when I return to headquarters later.

The above treatment is somewhat sketchy owing to the paucity of data that have as yet been accumulated on prairie game species. I do hope however, that what has been presented is of some value to you.

Yours truly,

*George J. Mitchell*  
George J. Mitchell,  
Game Biologist.

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA


9 October, 1959

MEMORANDUM NO. 42/59

TO: File No. 1800 - 1  
FROM: Superintendent/Field  
SUBJECT: Use of Pathogens on SES Range

Late in August we had some discussions with respect to the use of pathogens on the SES range area. The two attached memoranda from H/Bact. and H/PRS discuss the technical aspects and some of the safety aspects of such a proposition. These two memoranda were considered and discussed with the Chief Superintendent and it was finally agreed that we would not consider seriously, at this time, the dispersion of pathogens on the open range area at Suffield. This decision was also influenced by the fact that trials covering travel of pathogens up to distances of perhaps 10 miles are being planned at Dugway Proving Ground. In addition to this we agreed to discuss, at the Tripartite, the question of carrying out joint trials with US and UK for longer times of travel.

This note and attached memoranda are being placed on this file as a matter of record.

  
A.P.R. Lambert  
Superintendent/Field

Attach 2

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

9 September, 1959

MEMORANDUM

TO: Superintendent/Field  
FROM: H/PRS  
SUBJECT: Use of Pathogens on SES Range

1. Over downwind distances of up to 30 miles, a 1 mile long crosswind source must be regarded essentially as an infinite line source. For bacterial aerosols in which there is no loss of viability this will mean that the dosage will decrease almost in inverse proportion to distance of travel.
2. If the dosage at 30 miles was permitted to equal the determined LCt50 of UL to man, i.e. 1 cell min/l, then the downwind distance at which the dosage would have fallen to the minimum necessary for satisfactory assay (say 50 cells min/l) would be 0.6 miles.
3. If a point source were used, the rate of decrease of dosage with distance would be greater. With the conditions in para 2 the distance for a dosage of 50 cells m/l would be 1.6 miles.
4. If a dosage higher than 1 cell m/l could be permitted on the downwind edge of the area, either by using sunrise to destroy cloud or on the basis that the infectivity of bacteria decreases markedly with length of time airborne, then distances further than 1/2 to 1 1/2 miles could be used in the study of viable decay. A ten fold increase in the dosage permitted at 30 miles would allow a dosage of 50 cells min/l to be provided at a distance of 6 to 9 miles.
5. While trials done so far with S.marcescens indicate that it is necessary to study in some detail the viable decay which occurs during the first 30 minutes or so of travel, which on the average requires sampling to about 3 to 4 miles, it seems doubtful whether this alone would justify provision of facilities for trials with pathogens at SES.

*I have considered only diffusion conditions at night. If we come to trials in daytime the increased diffusion will help the situation.*

*H.J. Fish*  
H.J. Fish  
(H/PRS)

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

3 September 1959.

## MEMORANDUM:

TO: Supt/Field

FM: H/Bacteriology Section

Animals found on SES range known to be naturally infected with tularemia, here or in other places, are as follows. An estimate of the numbers of each species to be found at present on SES range is also given. Average intake of air per minute given in brackets.

gophers	less than 1/sq mi
rabbits (700 ml/min)	1-5/sq mi
mice (10-25 ml/min)	comparatively scarce
muskrat	occasional
grouse and <del>Guillemots</del> <sup>Guillemots</sup> flies	} unknown
and ticks	

Other species found on the range or that ~~are~~ <sup>may</sup> get on range but not listed as being naturally infected:

sheep	
cows (70 l/min)	
snakes	comparatively scarce
coyote	12 all told
hawks	scarce
badger	extremely scarce
horses (60 l/min)	20 total
deer	20 total
antelope	{ 10 to 100/sq mi in herd average 1/sq mi

Number of UL cells required to infect in laboratory:

Aerosol Age

20 minutes	1,000
5 hours	10,000

Unprotected UL will not live beyond 1/2 to 1 hour in daylight.

Travel time to area border is about 1 1/2 hours. Under ideal conditions the number of cells likely to be found after 1 1/2 hours of travel (14 miles at 10 mph wind):

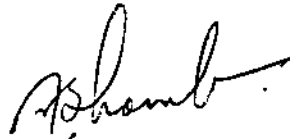
High RH	concentrated SM (unprotected)	$5 \times 10^3 / 1$
Low RH	concentrated SM (unprotected)	$0.5 \times 10^3$ to $0.3 \times 10^3 / 1$

It is likely that the number of cells which we could put up would be below the number we could adequately assess at 10 miles and still be reasonably certain that minimal numbers would go off the area. Emission just prior to sunrise would afford a safety factor.

It would appear that for safety reasons we would likely have to emit only sufficient to sample at 5 miles or at the most 1 hour travel. This is probably an insufficient time to demonstrate protective action of inositol and would therefore limit efforts to checking decay of unprotected UL over a period of 1 hour travel.

Emission would necessarily take place no longer than 1 hour before sunrise.

In my view we could use UL in the field, however, I wonder whether the effort we could make would contribute greatly since the time of travel we could examine would be about 1 hour.



(A.B. Lamb)

H/Bacteriology Section

ABL/dg



~~SECRET~~

REPORT "C"  
Copy No. 4/  
(4 pages)

DEPARTMENT OF THE ARMY  
OFFICE OF THE CHIEF CHEMICAL OFFICER  
Chemical Corps Technical Committee  
Army Chemical Center, Maryland

4-92-02-035-05  
TSE/25110/ras  
26 May 1959

CHLWVH

SUBJECT: Establishment of Subproject 4-92-02-035-05, Wet Suspension of  
ZL (U)

TO: Chairman, Chemical Corps Technical Committee

This document contains information affecting the national defense of the United States within the meaning of Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

1. (C) References:

- a. Project 4-92-02-035, BW Agent Process Development, established by CCTC Item 3402, 27 Mar 1958 (S).
- b. Ltr (S), GMRD-PD Cml C R&D Comd, 25 May 1959, Establishment of Subproject Development of Wet Suspension of ZL (U), to Chm, CCTC, w/Incl (Ltr, BW Labs, 8 May 1959, w/Incl (Data Sheet)).

2. (S) Discussion:

Reference a. identifies the currently approved project in the Chemical Corps R&D program concerned with BW agent development. Under this general project four (4) subprojects concerned with detailed development and assessment of BW agents are also approved. As noted in the inclosure to reference b., work on agent ZL (variola virus) has now reached the stage where detailed development of a satisfactory large-scale production process for a liquid fill for munitions is required. Consequently, establishment of the subject subproject was recommended as described in the project data sheet transmitted therewith. The latter is appended hereto as an inclosure. In consonance with current directives this subproject would be assigned to Technical Objective BW-1a, accorded a 1-B priority, and be classified Secret. The basic letter of reference b. requested necessary action by this Committee to establish this subproject in the current Chemical Corps R&D project program. This will be accomplished by approval of the recommendations below.

3. (C) Recommendations:

It is recommended that:

~~SECRET~~  
SECRET

WH10749  
CI

CATR 474

S E C R E T

4-92-02-035-05

- a. Subproject 4-92-02-035-05, Wet Suspension of ZL (U), be established in the FY 1960 Chemical Corps R&D program.
- b. The requirement, objectives, and subtasks of subproject 4-92-02-035-05, as indicated in the attached project data sheet, be approved.
- c. Subproject 4-92-02-035-05 be assigned to Technical Objective BW-1a, be accorded a 1-B priority, and be classified Secret.
- d. The Chemical Corps FY 1960 R&D project program and all other documents affected by this action be revised accordingly.

Incl  
Project Data Sheet

S E C R E T

C2

S E C R E T

New Subproject  
4-92-02-035-05

PROJECT DATA SHEET

1. PROJECT TITLE: Wet Suspension of ZL (U)
2. SECURITY OF PROJECT: Secret
3. PROJECT NUMBER: 4-92-02-035-05
5. REPORT DATE: 8 May 1959
6. BASIC FIELD OR SUBJECT: Processing and Manufacturing Methods and Techniques and Equipment
7. SUBFIELD OR SUBJECT: Agents, Biological
- 7a. TECHNICAL OBJECTIVE: BW-1a
8. COGNIZANT AGENCY: USA Chemical Corps
9. DIRECTING AGENCY: USA CmlC RDCOM
10. REQUESTING AGENCY: USA CmlC
12. CONTRACTOR AND/OR LABORATORY: BW Laboratories
15. PRIORITY: 1-B
16. MAJOR CATEGORY: 5.17
17. ESTIMATED COMPLETION DATES: Dev - June 1963
18. FISCAL ESTIMATES:

<u>FY</u>	<u>Fiscal Cost</u>
60	110 M
61	600 M
19. REPLACED PROJECT CARD AND PROJECT STATUS: No project card is superseded.  
This is a new subproject.
20. REQUIREMENT AND/OR JUSTIFICATION: (S) This subproject is directed toward increasing the offensive potential of BW as reflected in pars. 1212m and 1212n CDOG 31 Dec 1958. Current guidance recommends the development of a practical method for manufacturing wet suspensions of variola virus, the causative agent of smallpox. This is the first development program of a lethal viral agent, hence necessitates re-evaluation of equipment design, and development of techniques not heretofore required.
21. BRIEF OF PROJECT AND OBJECTIVE:
  - a. (S) Brief: (End Item) Results of a screening and research program on variola virus indicate that it has potential as a BW agent.

S E C R E T

Incl

WH10744

03

SECRET

21.a. (Cont).

4-92-02-035-05

PROJECT DATA SHEET

This subproject is intended to result in the development of a liquid munition fill containing the agent, and in the development of a process which is adaptable to large scale production of the munition fill.

- b. (S) Approach: The preparation of a wet suspension of variola virus possessing desirable characteristics as a munition fill will be undertaken on a laboratory scale. Procedures will be developed for measuring essential physical and biological characteristics of the product. When an acceptable product has been prepared and defined, efforts will be made to develop and demonstrate a process capable of producing such a product on a large scale. This will be accomplished by simple translation of many of the laboratory procedures and by the development, when necessary, of alternate processes and operations for those laboratory procedures which cannot be translated to a larger scale. Since this is the first development of a lethal viral agent, many of the criteria established for the design of equipment for producing and handling incapacitating agents must be re-evaluated and new criteria and equipment developed.
- c. (U) Subtasks:
- (1) Definition of an acceptable product.
  - (2) Development of a process for large scale production of the product
  - (3) Development and design of pilot plant equipment.
  - (4) Demonstration of uniform mass producibility.
  - (5) Evaluation of the mass produced product.

SECRET

C4

GUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

9 September, 1959

MEMORANDUM

TO: Superintendent/Field

FROM: H/PRS

SUBJECT: Use of Pathogens on SES Range

1. Over downwind distances of up to 30 miles, a 1 mile long crosswind source must be regarded essentially as an infinite line source. For bacterial aerosols in which there is no loss of viability this will mean that the dosage will decrease almost in inverse proportion to distance of travel.
2. If the dosage at 30 miles was permitted to equal the determined LCt50 of UL to man, i.e. 1 cell min/l, then the downwind distance at which the dosage would have fallen to the minimum necessary for satisfactory assay (say 50 cells min/l) would be 0.6 miles.
3. If a point source were used, the rate of decrease of dosage with distance would be greater. With the conditions in para 2 the distance for a dosage of 50 cells m/l would be 1.6 miles.
4. If a dosage higher than 1 cell m/l could be permitted on the downwind edge of the area, either by using sunrise to destroy cloud or on the basis that the infectivity of bacteria decreases markedly with length of time airborne, then distances further than 1/2 to 1 1/2 miles could be used in the study of viable decay. A ten fold increase in the dosage permitted at 30 miles would allow a dosage of 50 cells min/l to be provided at a distance of 6 to 9 miles.
5. While trials done so far with S.marcescens indicate that it is necessary to study in some detail the viable decay which occurs during the first 30 minutes or so of travel, which on the average requires sampling to about 3 to 4 miles, it seems doubtful whether this alone would justify provision of facilities for trials with pathogens at SES.

H.J. Fish  
(H/PRS)

→ JES 1800-1(Bact)

SUFFIELD EXPERIMENTAL STATION  
WILSTON ALBERTA

3 September 1959.

MEMORANDUM:

TO: Supt/Field  
FM: H/Bacteriology Section

Animals found on JES range known to be naturally infected with tularemia, here or in other places, are as follows. An estimate of the numbers of each species to be found at present on JES range is also given. Average intake of air per minute given in brackets.

gophers	less than 1/sq mi
rabbits (700 ml/min)	1-5/sq mi
mice (10-25 ml/min)	comparatively scarce
muskrat	occasional
grouse and <del>quail</del> <sup>gull</sup> flies	unknown
and ticks	

Other species found on the range or that <sup>may</sup> get on range but not listed as being naturally infected:

sheep	
cows (70 l/min)	
snakes	comparatively scarce
coyote	12 all told
hawks	scarce
badger	extremely scarce
horses (60 l/min)	20 total
deer	20 total
antelope	10 to 100/sq mi in herd average 1/sq mi

Number of UL cells required to infect in laboratory:

Aerosol Age

20 minutes	1,000
5 hours	10,000

Unprotected UL will not live beyond 1/2 to 1 hour in daylight.

Travel time to area border is about 1 1/2 hours. Under ideal conditions the number of cells likely to be found after 1 1/2 hours of travel (14 miles at 10 mph wind):

High RH	concentrated SM (unprotected)	$5 \times 10^3 / l$
Low RH	concentrated SM (unprotected)	$0.5 \times 10^3$ to $0.3 \times 10^3 / l$

It is likely that the number of cells which we could put up would be below the number we could adequately assess at 10 miles and still be reasonably certain that minimal numbers would go off the area. Emission just prior to sunrise would afford a safety factor.

It would appear that for safety reasons we would likely have to emit only sufficient to sample at 5 miles or at the most 1 hour travel. This is probably an insufficient time to demonstrate protective action of inositol and would therefore limit efforts to checking decay of unprotected UL over a period of 1 hour travel.

Emission would necessarily take place no longer than 1 hour before sunrise.

In my view we could use UL in the field, however, I wonder whether the effort we could make would contribute greatly since the time of travel we could examine would be about 1 hour.

ABL/dg

(A.B. Lamb)  
H/Bacteriology Section

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

24 August 1959.

Mr. Curt P. Smith,  
Director,  
Fish and Wild Life,  
Natural Resources Building,  
Edmonton, Alberta.

Dear Mr. Smith:

Would it be possible for you to give us an estimate of the number of various wild animals and birds to be found per square mile of prairie in the general region of Medicine Hat.

I have contacted the Fish and Wild Life Inspector in Medicine Hat and he has suggested that you may be able to assist in this matter.

Please address your reply to the Chief Superintendent, Suffield Experimental Station, Ralston, Alberta, attention of Mr. A.B. Lamb.

Yours truly,

ABL/dg

for Chief Superintendent





SECRET ENCLOSURE

DRBS 1800-1  
OUR FILE REF. DAR(B&C)

DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
2 July, 1959.

Chief Superintendent,  
SES

FILED TO	SR
FILED BY	
FILED DATE	1800-1

MCs for BW Warheads for Sergeant Missile

1. The attached report is for your information only.  
When you have read it, please return to DAR(B&C).

*W. F. Cockburn*

for Chairman, Defence Research Board

*Noted*

*PRS*  
*Asst. AD*

*Returned to DAR(B&C)*  
*on 15/9/59*

SECRET

SECRET

REPORT "A"  
Copy No. 41  
(7 pages)

DEPARTMENT OF THE ARMY  
OFFICE OF THE CHIEF CHEMICAL OFFICER  
Chemical Corps Technical Committee  
Army Chemical Center, Maryland

4-16-16-021-01  
TSE/25110/ras  
2 June 1958

CMLWH

SUBJECT: Military Characteristics for BW Warheads for SERGEANT Missile (C)

TO:

Chairman, Chemical Corps Technical Committee

This document contains information affecting the national defense of the United States within the meaning of Espionage Laws, Title 18 U.S.C., section 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

1. (C) References:

- a. Subproject 4-16-16-021-01 (S), BW Warhead for SERGEANT Missile (C), Established by CCTC Item 3402, 27 Mar 1958.
- b. Combat Development Objectives Guide (S-RD) (CDOG), par 434a.(4) & 438k., 17 Apr 1959.
- c. Ltr (S), CMLPD-CE OCCm10, 5 Aug 1958, Proposed MC's for BW Warheads for SERGEANT Missile (C), to USCONARC, w/Incls & 1st Ind, ATDEV-4, 13 Oct 1958; 2d Ind, CMLPD-CE, 27 Oct 1958; & 3d Ind, ATDEV-4, 11 Mar 1959, to CCm10.
- d. D/P (S), CMLPD-CE OCCm10, 18 Mar 1959, Proposed MC's for BW Warheads for SERGEANT Missile (C), to this office, w/Incl (ref c.).

2. (S) Discussion:

a. Reference a. identifies the currently approved subproject in the Chemical Corps R&D program that will provide a BW warhead for the SERGEANT Missile now being developed by the Ordnance Corps to meet USCONARC requirements. Subproject 4-16-16-021-01 is assigned to Technical Objective BW-5, accorded a 1-B priority, and classified Secret as an overall category for the work. The annual progress report for this subproject, dated 31 Dec 1958, indicates detailed accomplishments, consolidated from contractor, user, and development agency concepts, to meet the requirement for a BW missile capability at the earliest practicable date. Special emphasis is given to a contractor's effort which was directed toward the essential design criteria, compatibility with the missile's purpose, efficiency of BW component munition packaging, temperature controls required, and fabrication of four (4) warheads for static and flight test vehicles. Results of one successful flight test loaded with live E134 BW Bomblets, conducted at the White Sands Missile Range, was considered to verify basic design. Future

SECRET  
SECRET

WH10783  
A1

CATR 474

S E C R E T

plans anticipate further development and test coordinated with the Ordnance Corps program. Current plans call for the completion of the development by December 1960.

b. The basic requirement for the subject warhead is indicated in Combat Development Objectives Guide (reference b.) which includes the applicable paragraphs reproduced herewith as a matter of information and record:

"434.a.(4) Field Artillery Guided Missile System, Short Range (75-Mile) (SERGEANT) (S).  
(SECRET) A 75-nautical mile solid propellant ballistic guided missile for delivery of atomic and non-atomic warheads with a CEP of 150 meters up to maximum range. The SERGEANT will be employed as mobile army or corps very heavy artillery against area targets to augment and extend other artillery support and to supplement tactical air support. This item will replace the CORPORAL Missile. (LR)"

"438.k. Biological Warfare Warheads (U). (UNCLASSIFIED) A warhead for effective dissemination of biological warfare agents adaptable to the following weapons.  
(1) HONEST JOHN. (MR)  
(2) CORPORAL. (MR)  
(3) SERGEANT. (LR)"

c. When subproject 4-16-16-021-01 was established as indicated in reference a., a detailed statement of military characteristics was not available for approval. To meet this deficiency, the Chemical Corps prepared a list of characteristics which were forwarded to the using agency as indicated in reference c. The 1st Indorsement to reference c. indicates detailed USCONARC comments on the proposed characteristics with reference to applicable operational and organizational concepts for this item. Probabilities of BW accident are noted and the use of the Arming Decision Device seemed desirable for troop safety. The 2d Indorsement to reference c. indicated that although UL is indicated as the warhead filling, it is also planned to use other BW agent fillings. The probabilities of BW accident are not considered sufficiently high to warrant inclusion of the ADD used in atomic heads. Because individual bomblets are used, destruction of a missile on the ground rather than in flight is suggested in case of malfunction, which is a different concept than the aerial destruction provided by ADD system. The 3d Indorsement to reference c. indicated USCONARC concurrence with the characteristics as changed based upon recommendations of the USA Artillery School. This indorsement also noted the possibility of using a newly designed ADD system for nonatomic warheads which, it was felt, should eventually be incorporated into all warhead designs as a matter of safety. Reference d. forwarded the proposed characteristics revised as indicated for appropriate action by this Committee. These

S E C R E T

A2'

SECRET

characteristics are reproduced and enclosed herewith.

3. (C) Recommendations:

It is recommended that:

- a. The military characteristics for BW Warheads for SERGEANT Missile, which are listed in the inclosure herewith, be approved.
- b. These characteristics serve as a guide for the work of subproject 4-16-16-021-01 now approved in the Chemical Corps BW R&D program.
- c. The records of subproject 4-16-16-021-01 and other documents affected by this action be revised accordingly.

Incl

List of MCs (S)

SECRET

A3

S E C R E T

MILITARY CHARACTERISTICS FOR BW WARHEADS  
FOR SERGEANT MISSILE (C)

1. (S) Performance: The warhead shall be capable of:

a. Effectively disseminating agent UL over large areas to produce casualties to unprotected personnel (not wearing mask), whether in an inclosure or in the open. Casualty rates will depend on the area covered and will be approximately:

<u>Area Covered</u>	<u>Casualty Rates</u>	
	<u>Desired</u>	<u>Acceptable</u>
9 sq. mi.	100%	80%
100 sq. mi.	30%	20%

Area covered of approximately 175 sq. mi. is desired.

b. Effectively disseminating other alternate BW agents without change in the basic design.

c. Causing minimum awareness of attack through the human senses of hearing and seeing, i.e., the noise level of functioning and the density of dissemination sources.

d. Control over the casualty level and area attacked by adjustment of the altitude of functioning.

e. All-weather employment within the limitations of the agent filling.

2. (U) Weight, Bulk and Configuration: A fully assembled warhead shall weight 1611±20 pounds. The location of the center of gravity shall conform to the specifications set down for nuclear warheads by the missile system development agency. The warhead shall have the same external configuration as other warhead installations specified for the SERGEANT missile.

3. (U) Durability: The fully assembled warhead, including bomblets and fuze, shall withstand the same ground and in-flight environmental conditions as the SERGEANT guided missile. The bomblet shall not function or show evidence of leakage when dropped in any position onto concrete from a height of 4 to 6 feet. The bomblet shall have safety features incorporated in its design as are required to preclude accidental functioning during handling, storage, and transportation.

4. (U) Simplicity of Operation: The warhead shall be designed to provide the simplest mechanical, electrical, chemical and other functioning in ground operations and during flight.

5. (U) Portability: The warhead shall be designed for ease of handling and to facilitate ease of check-out and maintenance.

Incl

S E C R E T

AL

SECRET

6. (U) Transportability: The warhead shall be capable of being packaged to withstand transport by rail, ship, or aircraft, by motor vehicle over rough roads and cross-country, landings through surf and across beaches; and the normal hazards of loading, unloading, and handling incident to transport and storage compatible with similar requirements for the parent missile.

7. (U) Compatibility with Related Equipment: The warhead shall be interchangeable with other warheads designed for this missile. The warhead shall be designed so that it is compatible with the warhead handling and mating equipment developed for the nuclear warhead.

8. (U) Reliability: The warhead shall be provided with a reliable fuzing system capable of functioning the warhead at any desired altitude over the target within the operational limits of the SERGEANT missile. The design and fabrication shall be such that each warhead manufactured has the following reliability and premature probability:

a. A probability of providing its design lethality of not less than 0.995.

b. A probability of providing safe functioning in prelaunch operations of 0.999.

c. A probability of fuze and warhead functioning of 0.99.

9. (U) Water Proofness: The warhead shall be capable of resisting any exposure to water without deterioration or affecting the mating and functioning sequences.

10. (U) Mildew Proofness: Materials selected for insulation shall be mildew proof.

11. (U) Insect or Mite Proofness: Materials selected for insulation shall be insect proof.

12. (U) Camouflagability: NA

13. (U) Hazards in Handling: The warhead and component munitions must be uncontaminated and leakproof to prevent the BW agent from contaminating the warhead and bomblets creating a hazard to munition handlers. Provisions shall be made for monitoring the functional and safety condition of the warhead from a remote control point prior to launching. It shall be possible to render the warhead safe in case of accidental arming.

14. (U) Simplicity of Instruction: NA

15. (U) Performance Temperature Limitations: (For interim design only) The warhead with ancillary temperature control equipment shall give an acceptable performance for operational usage within an air temperature range extending from 125°F (minimum exposure of 4 hours with full impact of solar radiation, 360 BTU/ft sq 1 hr) down to -25° (minimum exposure of 3 days without benefit of solar radiation). The warhead shall be so designed and constructed as to perform its intended function at all relative humidities up to 100% at all temperatures below 90°F and in those temperatures

SECRET

A5

S E C R E T

above 90°F, at all relative humidities up to a maximum obtainable.

16. (C) Storageability and Transportability Temperature Limitations: (For interim design only) The warhead with ancillary temperature control equipment shall be capable of safe storage and transportation without permanent impairment of its capabilities from the effects of temperature from -80°F (for periods of at least 3 days duration) to 160°F (for periods as long as 4 hours per day). The warhead with bomblets shall be capable of storage under ambient and humidity conditions without deterioration, as follows:

a. In shipping containers in temperature-controlled warehouses with a minimum amount of care for a period equivalent to 75 percent decay of the most hardy agent.

b. In its shipping container with ancillary temperature control equipment under field conditions for a period equivalent to 75 percent decay of the most hardy agent.

c. Under field conditions after removal from shipping container for at least 24 hours with not more than 75 percent decay of the least hardy agent.

d. Shall be designed to permit storage of components, exclusive of the agent filling, under service conditions for at least five years and remain serviceable.

17. (U) Simplicity of Field Maintenance:

a. Testing. Only go-no-go type tests of the complete warhead section are desirable in the field.

b. Maintenance. Disassembly of the warhead section shall not be permitted in the field, except for components of the fuzing system. Maintenance of the fuzing system shall be safe, and shall require a minimum of time, specialized personnel, and specialized tools, equipment and facilities.

18. (U) Consumption Rate of Fuel, Propellants, Lubricants, or other Expendables: NA

19. (C) Fuzing: A suitable fuze shall be provided for the BW type warhead. Available fuzing will be employed if it does not compromise warhead performance. The fuze shall be designed to activate the warhead between 0 and 50,000 feet. Fuze settings will be provided in 5,000 foot increments; the fuze height of burst probable error will not exceed 1,000 feet.

20. (S) Operational Concept: The warhead shall be interchangeable with other warheads devised for this missile and will be employed over those targets that can be more profitably attacked by BW agents. The warhead shall be capable of controlling casualty levels by adjustment of the altitude of functioning. The warhead will be designed to accommodate agent UL, but will also be so designed as to accept other BW agents without requiring any basic engineering changes.

S E C R E T

A6

SECRET

21. (U) Organizational Concept: The organizational concept will be the same as for other warheads for the SERGEANT Missile.

SECRET

A7



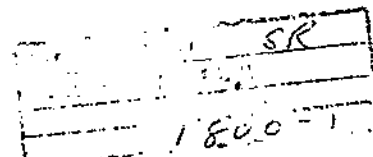


In Reply Please Quote  
No. CAS(W)8934-2 (CML) 413

In Reply to DRBS 1800-1  
Dated 17 April 1959

28 May 1959

Defence Research Board  
Department of National Defence  
Building "A"  
Ottawa, Ontario, Canada



ATTENTION: DAR (B&C)

Nylon Impingers

1. Nylon impingers have been developed by the U.S. Army Biological Warfare Laboratories (BWL) mainly in the interest of safety and economy. These have been developed under contract and production items have now been received for evaluation. Tests are in progress to determine and resolve operational problems involved in the use of these impingers.
2. These impingers were produced by the Danielson Manufacturing Company, Danielson, Connecticut, and cost approximately \$1.80 each. They have a flow rate of 12.5 liters per minute. There are 2 types available. One with a jet to bottom of bottle distance of 15 mm, the other with 30 mm. Some of these could be provided to SES if required.
3. Mr. Fred Ray of BWL will be attending the Suffield-Dugway Conference, 3-5 June, and will be prepared to discuss this further at that time.

*1734  
will discuss with Ray.*

*E W Henselwood*  
(E W HENSELWOOD)  
Lieutenant Colonel  
Canadian Army Technical Representative

Distribution  
SES Attn: Dr. Lamb

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

26 May 1959.

Dr. H.E. Robertson,  
Director of Provincial Public Health Labs.,  
Regina, Saskatchewan.

Dear Dr. Robertson:

Your laboratory is listed as being a source of  
stock cultures of Staphylococcus citreus.

Would it be possible for this laboratory to obtain  
subcultures of such strains of Staphylococcus citreus as you now  
have on hand.

Please address your reply to the Chief Superintendent,  
Suffield Experimental Station, Ralston, Alberta, attention of  
Mr. A.B. Lamb.

Yours sincerely,

ABL/dg

(for) Chief Superintendent

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

26 May 1959.

Dr. P.M. Payne,  
Department of Microbiology,  
University of Manitoba,  
Winnipeg, Manitoba.

Dear Dr. Payne:

Your laboratory is listed as being a source of  
stock cultures of Staphylococcus citreus.

Would it be possible for this laboratory to obtain  
subcultures of such strains of Staphylococcus citreus as you  
now have on hand.

Please address your reply to the Chief Superintendent,  
Suffield Experimental Station, Ralston, Alberta, attention of  
Mr. A.B. Lamb.

Yours sincerely,

ABL/dg

for Chief Superintendent



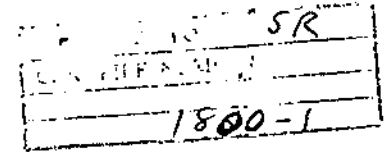
DEPARTMENT OF NATIONAL DEFENCE  
DEFENCE RESEARCH BOARD



Ottawa, Ontario,  
21 May 1959

Chief Superintendent,  
S.E.S.

Att: Mr. A. B. Lamb



Request for Staphylococcus Citreus

1. Reference is made to SES 1800-1(Bact) dated 13th May 1959.
2. We have determined that this organism is not available from NRC, the Laboratory of Hygiene or the Division of Bacteriology, Science Services of the Department of Agriculture. However, Dr. Gibbon, NRC, consulted the latest issue of the species list and advises that the only sources for this organism are:  
  
Dr. P.M. Payne, Department of Microbiology,  
University of Manitoba, Winnipeg, and  
  
Dr. H.E. Robertson, Director of Provincial  
Public Health Laboratories, Regina, Sask.
3. We have not contacted these people as we felt it would probably be better in the long run for you to deal with them directly.

*Robert S. Ash*

*G. L. Vasson*  
for Chairman, Defence Research Board

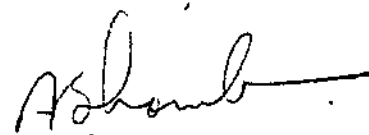
SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

13 May 1959.

Chairman,  
Defence Research Board,  
OTTAWA, Ontario.

Attention: DAR (B&C)

Suffield Experimental Station requires subcultures of four or five strains of Staphylococcus citreus. Would you ask NRC (Ottawa) and The Laboratory of Hygiene, Department of National Health and Welfare (Ottawa) whether they have strains available, if so, would you request that subcultures be forwarded to S.E.S.



ABL/dg

for Chief Superintendent

ROUTINE

TELETYPE

15 MAY 58

TO. SES RALSTON  
FM. DRM WASHINGTON



DRCS 408

REF SES 185. ITEM REQUIRED IS KNOWN AS BEET PT-12  
NOZZLE PROCURED UNDER CONTRACT DA-18-064-CML-496.  
MANUFACTURER IS BEET FOG NOZZLE COMPANY 309 WILLS  
STREET GREENFIELD MASSACHUSETTS. ITEM CAN BE  
OBTAINED BY BEET DRAWING NO 2S-302D ENTITLED BEET  
ASSEMBLY AND DETAIL. ITEM IS SUPPLIED WITH 1/4 INCH  
PIPE ADAPTOR TO BEET DRAWING F243. ITEM COSTS  
APPROXIMATELY 5 DOLLARS.

T.R. 1670840...G

SF

RECEIVED J.M. AND TS
S-1800-1

*Handwritten notes:* H/M TS, Nod and, 20/5/58

# DEPARTMENT OF NATIONAL DEFENCE MESSAGE FORM

FOR UNCLASSIFIED MESSAGES ONLY

INDICATE DEGREE OF PRECEDENCE		FOR MESSAGE CENTRE USE ONLY	
		<div style="font-size: 2em; transform: rotate(-15deg); display: inline-block;">07/17/02</div> <div style="font-size: 1.5em; transform: rotate(-15deg); display: inline-block;">G</div>	
OPERATIONAL IMMEDIATE			
PRIORITY			
ROUTINE	X		
IF NOT MARKED WILL BE TRANSMITTED DEFERRED		OR	UNCLAS
		FROM Chief Supt. S.E.S. Ralston, Alberta	
		TO Lt. Col. H.E. Staples, CATR, Army Chemical Center, Edgewood, Maryland.	

INFO

ORIGINATOR'S NO.  
*SES 185 7/5/58*

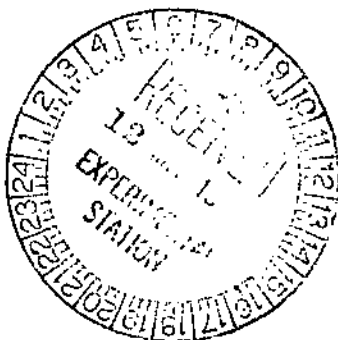
1. SEEK INFORMATION ON A COMMERCIAL SUPPLY OF SPRAY NOZZLES  
TYPE PT. - 12 FOR AEROSOLS.
2. THESE NOZZLES KNOWN AT DETRICK. SUGGEST THEY MIGHT SUPPLY  
INFORMATION WHETHER ITEMS ARE AVAILABLE AND SOURCE OF SUPPLY.

ORIGINATOR	TELEPHONE	DATE-TIME GROUP	FILE NO.
<i>W.J. Ditto</i>	281	Z	S-1800-1

FILE COPY

CNE 1320J  
 CAFE 1618 HQ 4004-S-1416, 1,000M-7-53 (4922)  
 RCAP 8 43

LS/SES



SECRET ENCLOSURE

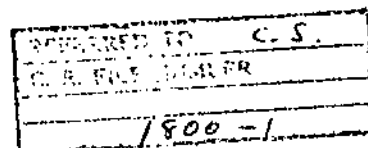
DRBS 1800-1 DAR(B&C)

DEFENCE RESEARCH BOARD

Ottawa, Ontario,  
2 May 1958

To: Addressees listed below

Report on Meeting with WSEG  
EW/CW Weapons Systems



1. Attached is a copy of a report on the m/n subject for your information and retention or circulation as indicated below.

*BK Varasov*

for Chairman, Defence Research Board

DISTRIBUTION

On Retention

DRM(W)  
DRM(Loc.)  
CATR  
ACSc(B)  
DAR  
CS/SES  
CS/DRCL/KL  
Sec/JSWPC (6) (for Service Members  
of JSWPC and JSWC)  
S/ORG  
SA/CGS

On Circulation

CDRB  
VC/DRB  
CSc  
C of E  
SA/CNS  
SA/CAS

*S/R.*  
*H/PRS*  
*S/F*  
*M/BWA*  
*AD*  
*To NW*



S E C R E TREPORT ON MEETING WITH THE WEAPONS SYSTEMSEVALUATION GROUPBW/CW WEAPONS SYSTEMS

1. On April 23rd and 24th personnel of WSEG, a U.S. Defense Department Group, met with DRB and members of the Services in DRB HQ, to discuss a wide variety of topics. On the afternoon of the 24th the topic of discussion was BW/CW weapons systems. The following is a personal report based on brief notes taken during the meeting. The meeting was chaired by Vice-Admiral J.H. Sides and the discussion was initiated by a statement by Maj. Gen. (Ret.) Barriger, on BW.

2. WSEG undertook evaluations of BW in 1951 and in 1955 and it is currently concluding a new evaluation, the report of which is to be submitted in October 1958. In the current evaluation the first step was to survey the progress made in the field since the last evaluation in 1955 to highlight the significant advances. These were summarized by General Barriger as follows:

- (a) The determination of the infective dose for humans, by inhalation, of both Q fever and UL. For the former the infective dose was 10 viable organisms per individual and for the second it was 10 to 20 organisms.
- (b) Considerable progress has been made in the development of a dry fill for munitions.
- (c) Strains of various agents have been developed with improved viability.
- (d) Large area coverage trials with fluorescent particles have shown the feasibility of disseminating solid particulates over large areas.
- (e) The development of a ribbed sphere as a bomblet has increased the area coverage of a single cluster-type bomb to 100 square miles.
- (f) Considerable progress has been made in the design of disseminators for pre-sized dry fill.
- (g) Considerable advances have been made in methods of rearing, infecting, and disseminating insect vectors.

3. In the anti-crop field, although effort had been severely curtailed, the significant point was that the concept of establishing foci of infection had been replaced by the concept of using a line source for massive infection.

4. On the basis of this progress WSEG considered that the field did not warrant another full technical evaluation. WSEG decided, instead, on a qualitative approach for their evaluation. It considered the possible advantages and features of employment of BW weapons system as now known, or as can be predicted from present knowledge, against the following considerations:

- (a) BW weapons systems must compete with other weapons systems in existence in the same time frame.

.... 2

- (b) The basic characteristics of BW weapons systems: their dependence on meteorological conditions; the ease of taking effective, passive counter measures, e.g. masking; the inherent delay in effects; the fact that if destruction is required as well as casualties, they are not useful; the fragility of the agents.
- (c) It is doubtful that anti-crop warfare would ever reduce the diet of any nation to the point of surrender. There is also the fact that in anti-crop warfare specific and detailed intelligence is needed on the target in order that the right anti-crop agent can be used in the right place.

It was therefore concluded that both anti-crop and anti-personnel BW weapons developed from presently known scientific and technical data would be of low potential in a general war in which nuclear weapons would be used.

5. WSEG next considered the case of limited wars. The same technical restrictions on the reliability of the weapons system held in the case of limited wars as in the general wars but it was concluded that BW might be useful in limited situations, such as siege or in areas where public health standards were low. In examining the role of anti-crop warfare in limited wars a survey of the economics of the Middle East, the Far East and the satellites was undertaken. It was concluded that it was doubtful if any advantage would be gained in using anti-crop warfare in such situations, primarily because unless Russia itself were attacked, it would be in its interest to replace the food losses of these smaller countries from its own granaries. It was concluded that BW was of low potential in limited wars.

6. These two primary conclusions led to the further conclusion that there was no reason for the U.S. to maintain an operational capability in BW.

7. These conclusions were also examined in the light of certain arguments put forward by BW enthusiasts. One such argument is that if AW is banned by either formal or tacit agreement between the major powers BW might assume major importance. For advice on this situation political authorities were consulted. Their opinion was that any agreement to restrict or ban AW would be accompanied by a similar agreement for BW. Another argument is that a BW operational capability should be maintained as a deterrent against the use of BW by an enemy was also examined. The opinion here was that the major deterrent to the use of BW is also the major deterrent to the use of AW, that is, the force of world-wide public opinion. Even if this were not so, the possession of an AW capability is considered to be a greater deterrent to the use of BW than is the possession of a BW operational capability.

8. The next question was the recommendations that should be made based on these conclusions. Obviously, the one that comes first to mind is, of course, cancellation of all work on BW. However, there are two factors which make this recommendation untenable. The first is the fact that the progress in the BW field over the past three years has tended to show that the limiting technical factors are more likely to be overcome with further research than to show that they will be limiting factors forever. Secondly, a consideration of the threat shows that the Soviet Union does have a program in this field, although of unknown magnitude, and that BW does lend itself to covert use. These two factors lead to the conclusion that we must know how to defend against it in

case it is used. The major conclusion of the evaluation is therefore that the findings warrant continued research in the BW field on both defensive and offensive aspects. The latter is necessary for intelligent work on the former.

9. The recommendations to be made by WSEG to the Joint Chiefs of Staff are as follows:

- (a) That the BW program be continued and that the policy be that emphasis will be placed on the research area and that manufacture of agents etc. and the development of munitions or devices be limited to that necessary to support the research and not aimed at developing an operational capability.
- (b) That a small effort should be continued in both the anti-crop and anti-animal fields.
- (c) That the major objectives of the program should be an increased defensive capability and the search for a lead towards a "break-through" that might warrant reconsideration of the conclusion that a BW operational capability is not required.

10. Finally, General Barriger stated that although the report was not yet final it was not likely that any work remaining to be done would alter these preliminary conclusions and recommendations.

11. There was some discussion following General Barriger's presentation and although certain persons would weight differently some of the factors on which an estimate of the probability of a break-through is based, it was apparent that there was no real disagreement with the conclusions and recommendations, i.e. that work should be continued in this field and that the emphasis should be on the research side aimed at a greater understanding of the principles involved.

12. No presentation was made on CW. It was stated that it was not considered a strategic weapon. It was also stated that, at present, there were no plans for an evaluation of CW.

*G. R. Vavasour*  
G. R. Vavasour,  
DAR(B&C)

2 May 1958

SECRET

2 May, 1958

Chairman,  
Defence Research Board,  
Ottawa.

Attention DAR B&CFuture BW Programme

1. Reference is made to your DRBS 1800-1 (DAR B&C) over DRBS 1850-04 (DAR B&C) dated 22 April, 1958, concerning the Future BW Programme.

2. The following are the comments on your letter:

A. Protection of Bacteria against Light

(1) In addition to the investigation of the effect of ambient conditions, particularly at low temperatures, on the viability of bacterial aerosols air suspended for long periods of time, we are carrying out the following basic studies:

(a) Determination of the effect of UV on suspended bacteria

To date we have shown that UV of wave length between 2850 A° and 3600 A° (the limited wave length of the sun's UV at the earth's surface is 2920 A°) effects the greatest kill. At the present time we are trying to determine more specifically the effective wave length.

(b) In connection with (a) above, we are determining the protective effect of various added chemicals. Included in these additives are certain fluorescent compounds. We have achieved certain limited success to date.

(c) Since 50% to 90% of the kill of airborne bacteria occurs in the first one to two seconds after dispersal, we are endeavouring to elucidate the mechanism of this kill and also determine the beneficial effects of additives to the spray slurries. We have achieved quite good success in the case of SM and this appears to be paralleled by X19 and also UL. These additives do not protect against light.

(2) Promising laboratory results on the protection of airborne bacteria will certainly be investigated and confirmed under field conditions. In this respect you will note that our BW Programme this summer will consist of proving the effect of additives against the initial kill and subsequent travel in the dark. We have no results sufficiently promising to test under daylight conditions at present.

(g) It would be appreciated if the 23rd Technical Progress Report from the Naval Biological Laboratories in San Francisco, is forwarded to us as soon as possible. From the visit of Mr. D.E. Davids to these Laboratories some little time ago, we obtained some preliminary data and results. At that time, however, the workers were somewhat skeptical themselves. However, we have tested similar compounds with some little success.

B. Viral Studies

(4) We fully recognize the importance of viral studies and consider that Canada could well undertake research in this field. At the present time this is not possible at SES, since the staff we have are fully occupied as given in A above.

(5) We have no virologists, nor have we the special equipment and rooms, etc., required for work with these agents. I understand, however, that the UK are pursuing some studies on these lines and that Dr. Mitchell was interested in utilizing the drums at Grosse Ile. Certainly, however, a study should be made even though it might be on a small scale. The results of such work could well indicate that a future expansion would be necessary, in which case we could consider converting our programme at SES from investigations of bacteria to that of viruses.

(A.M. Pennie)  
Chief Superintendent

AMP/ad

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

1 May, 1958.

MEMORANDUM S/R 15/58.

TO: Chief Superintendent

FROM: Supt./Research

SUBJECT: Future BW Program

Reference DRBS 1800-1 and DRBS 1850 (DAR B+C) dated 22 April, 1958.

I would suggest that Mr. Vavasour's letter be answered somewhat as follows:-

A. Protection of Bacteria Against Light.

1. In addition to the investigation of the affect of ambient conditions, particularly at low temperatures, on the viability of bacterial aerosols air suspended for long periods of time, we are carrying out the following basic studies:-

(a) Determination of the effect of UV on suspended bacteria.

To date we have shown that UV of wave length between 2850 A° and 3600 A° (the limited wave length of the sun's UV at the earth's surface is 2920 A°) effects the greatest kill. At the present time we are trying to determine more specifically the effective wave length.

(b) In connection with (a) above, we are determining the protective effect of various added chemicals. Included in these additives are certain fluorescent compounds. We have achieved certain limited success to date.

50% to

(c) Since/90% of the kill of air-borne bacteria occurs in the first one to two seconds after dispersal, we are endeavouring to elucidate the mechanism of this kill and also determine the beneficial effects of additives to the spray slurries. We have achieved quite good success in the case of SM and this appears to be paralleled by XI9 and also UL. These additives do not protect against light.

2. Promising laboratory results on the protection of air-borne bacteria will certainly be investigated and confirmed under field conditions. In this respect you will note that our BW Program this summer will consist of proving the effect of additives against the initial kill and subsequent travel in the dark. We have no results sufficiently promising to test under daylight conditions at present.

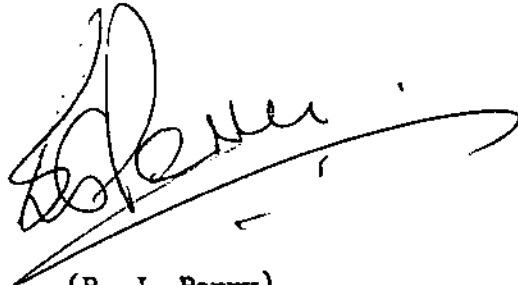
3. It would be appreciated if the 23rd. Technical Progress Report from the Naval Biological Laboratories in San Francisco, is forwarded to us as soon as possible. From the visit of Mr. D.E. Davids to these Laboratories some little time ago, we obtained some preliminary data and results. At that time, however, the workers were somewhat skeptical themselves. However, we have tested similar compounds with some little success.

B. Viral Studies.

4. We fully recognize the importance of viral studies and consider that Canada could well undertake research in this field. At the present time this is not possible at SES, since the staff we have are fully occupied as given in A. above.

B. Viral Studies (contd)

5. We have no virologists, nor have we the special equipment and rooms, etc., required for work with these agents. I understand, however, that the UK are pursuing some studies on these lines and that Dr. Mitchell was interested in utilizing the drums at Grosse Ile. Certainly, however, a study should be made even though it might be on a small scale. The results of such work could well indicate that a future expansion would be necessary, in which case we could consider converting our program at SES from investigations of bacteria to that of viruses.

A handwritten signature in dark ink, appearing to read 'B. J. Perry', with a long horizontal flourish extending to the right.

(B. J. Perry)  
Supt./Research

BJP/gw

SECRET

SUFFIELD EXPERIMENTAL STATION  
RALSTON, ALBERTA

29 April 1958


TO: Chief Superintendent

RE: Future BW Program

If the encouraging results Bacteriology Section are having against the effects of light on bacteria work out, the night-time field trials presently being planned, could be extended to daytime.

Some abstracts, from Tripartite papers on the present status of work on viral aerosols, are attached.

HJF:imw  
Encl.

  
H.J. Fish,  
H/PRS



Tenth Tripartite Report - Sept. 55

UK outlined the work done on vaccinia, emphasizing that this was very much an interim report. Because vaccinia was relatively safe, easy to produce and easy to assess, it was used as a simulant in both laboratory and field trials in order to gain information on the use of smallpox virus (Variola) as a BW agent. The vaccinia material was stable at -60°C, stood up well under freezing and thawing and could be freeze-dried without reduction in titer. In the spray work it was found that the virus was as stable as Bg spores, although the spray factor varied with different batches.

Conclusion 3.

The Ninth Tripartite Conference concluded that "Viral and Rickettsial diseases appear to be of increasing relative importance". This is again emphasized.

Recommendation 3.

Research on viral and rickettsial agents should be given additional support by all Tripartite agencies.

UK Annual Report - Sept. 56

Test Sphere - Nearly 100 experiments have been conducted, sometimes lasting over 2-3 days and on other occasions, more than one per day. The first object was correlation with the last field tests using the same four agents, Br. suis, Bact. tularensis, Venezuelan equine encephalomyelitis virus, and vaccinia virus. The selected temperatures and humidities included those of the Bahamas "night" trials done in the absence of ultraviolet light and the same spray device was used. Correlation was qualitatively good but in general the sphere survivals are better than the field results. Time of survival to half the initial viability at 70°F and 80% RH are Br. suis 5 hrs., Bact. tularensis 1 - 2 hrs., VEE 1 hour and vaccinia, more than 5 hours. The decay appears to be non-exponential and slows up. Br. suis and vaccinia are still around 30% at 24 hours. At lower humidities, the bacteria decay more rapidly but there is some evidence that viruses are relatively indifferent to humidity.

Eleventh Tripartite Report - Nov. 56Recommendation 3 - *review of action on.*

It had been recommended that research on viral and rickettsial agents should be given additional support by all Tripartite agencies. While significant progress was made in virus and rickettsial research during the past year, budgetary limitations, personnel restrictions and delay in completion of new research facilities prevented implementation of this research effort to the extent recommended.

Recommendation 6

All three countries should intensify genetic studies on viral and rickettsial agents and the present effort on bacterial agents should be continued.

UK Progress Report - Twelfth Tripartite - June 57

The employment of the various techniques has taken the following course. Sea trials, especially in the 1954-55 season in the Bahamas (Operation "Negation"), established the general behaviour of suspensions sprayed in a limited range of humidity and fairly constant temperature: viability was measured after travel not exceeding 13 min., and a difference was established between midday sunlight and sunset conditions. The agents tested were Br. suis, Past. tularensis, vaccinia virus and Venezuelan equine encephalomyelitis virus. When trials were made of

these four agents in the test sphere, at similar temperatures and humidities but all in darkness, qualitative agreement was obtained but survivals were better in the sphere. These better survivals were confirmed in laboratory work.

Twelfth Tripartite Report - Sept. 57

Recommendation 1

The following studies on aerosol stability are proposed:

- (a) UK will submit in the near future detailed reports on studies with Br. suis and Bact. tularense. They will undertake similar work with the virus of Venezuelan Equine Encephalomyelitis, altered forms of Br. suis, and production batches of Br. suis and Bact. tularense. These materials will be supplied by U.S.

Recommendation 2

The following studies should be continued:

- (a) Alterations of host specificity of viruses by in vivo and in vitro methods (US, Cda, UK).
- (b) Development of specific prophylactic measures against human and animal virus diseases (US, Cda, and UK).

Recommendation 4

Concentration of effort should now be given to rapid warning devices for BW agents (US) and to methods for early identification of viruses (US, Cda, UK).

SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

28 April 1958.

## MEMORANDUM:

TO: Chief Superintendent

FM: H/Bacteriology Section

SUBJECT: Future BW Program  
DRBS 1800-1(DAR B&C)  
DRBS 1850-04(DAR B&C)

Para 3 - Question 1

SES has conducted experiments with some of the fluorescent chemicals that have been used at NBL and we are in the process of examining the protective effect of other similar chemicals. Some success has been achieved and although we do not feel that the degree of success is sufficient as yet for field application we believe that this approach is worth pursuing.

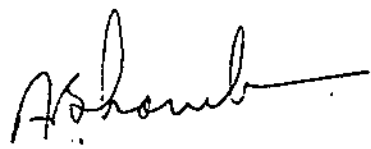
Para 3 - Question 2

The study of viral aerosols in rotating drums is very worthwhile. It has been my understanding that Porton was doing some work along these lines.

Dr. C.A. Mitchell received plans of our rotating drums some time ago and in conversation with him he has expressed his hope that Grossle would investigate viruses with this apparatus.

I would be very interested in seeing viruses investigated in rotating drums at Suffield. Before such work could be conducted here a number of problems would have to be met. A separate and independent laboratory set-up would be required, personnel would have to undergo training and additional workers would be required unless some of the work with bacterial cells was curtailed. Considerable thought would be required before reaching a decision on where and to what extent such an investigation should be made. It has been the BW section's belief for some considerable time that the best BW agents may well be viruses or fungi. It would no doubt be to our advantage to be in on the ground floor of the virus work should this prove feasible.

ABL/dg

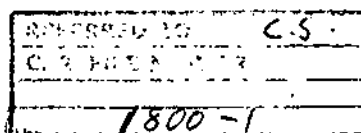
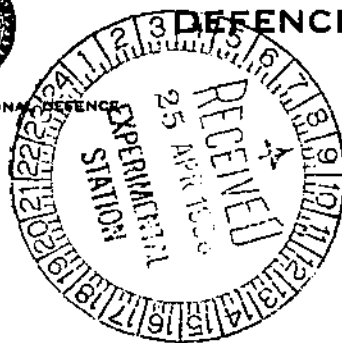
  
(A.B. Lamb)  
H/Bacteriology Section

**SECRET**

IN REPLY PLEASE QUOTE

DRBS 1800-1 (DAR B&amp;CO)

DRBS 1850-04 (DAR B&amp;C)

Ottawa, Ontario,  
22 April 1958.Chief Superintendent, SES ✓  
Chief Superintendent, DRCL/KLFuture BW Program  
Questions

1. The 23rd Technical Progress Report from the Naval Biological Laboratories in San Francisco (DSIS 58/2935 contains very interesting information on the behaviour of bacterial aerosols. From the point of view of one assessing the potential of BW the results show that air-borne bacteria can be protected against ultra violet light by certain chemicals, and, therefore that it might be possible for an enemy to increase the daytime effectiveness of BW weapons. On the other hand, other results show that the rates of change of viability and virulence with the age of the aerosol are not necessarily parallel. In fact, in one instance the virulence decreases more rapidly than the viability. From the same point of view these results point out how greatly the reliability of a BW weapons system is dependant on meteorological and biological factors, as yet only partially understood.
2. Two questions came to mind while reading these reports. The first is the question of the significance of the protective effect of fluorescent chemicals against 2537 A° radiation in view of the SES results which show the killing effect of daylight, even through heavy cloud cover where one would expect the intensity of the 2537 A° radiation to be very low. The second question is this. Do not these results emphasize the increasing importance of studying the behaviour of viral aerosols about which we know so little but which, from the history of the spread of viral diseases, we would expect to be more robust air travellers and hence to pose a greater threat than bacteria?
3. Two practical questions arise from the two basic questions. The first applies to SES, namely, is SES planning to assess the protective effect of any fluorescent chemical under natural daylight conditions? The second applies to DRCL/KL and SES, but chiefly to the former because there are no virologists at SES. Should not DRB undertake studies of viral aerosols in rotating drums at either DRCL or SES, a project which would be uniquely Canadian (for a while at least)?

S/R.  
H/PPS - attached NPT  
H/BLC - Attached ASL

Comments

A handwritten signature, likely of E. R. Varasse.

for Chairman, Defence Research Board

201850-04  
SUFFIELD EXPERIMENTAL STATION  
RALSTON ALBERTA

File **SECRET**  
SES 1850-1 (S/R)

28 February, 1958.

MEMORANDUM S/R 6/58.

To: Chief Superintendent

From: Supt./Research

Subject: B.W. Field Trials at SES, Summer 1958.

1. In the past two years the Tripartite interest in B.W. has been centered on the problem of large area coverage with virulent organisms. In support of this interest a laboratory research programme is being carried out at SES to determine the effects of various factors on the viability and virulence of certain B.W. agents suspended as airborne aerosols for long periods of time. In this programme the so called "Toroid" drums are used to artificially maintain the aerosols in an airborne state. We are also investigating the causes of the very rapid death of organisms which occurs during dispersal and in the first few seconds of travel as an aerosol. In conjunction with both aspects of the research, the protective effect of substances added to the spray suspension of bacteria is being determined.

2. The most important result obtained to date is that [redacted] added to the spray suspension 24 hours before spraying exerts a very marked protective action on the survival of SM disseminated as an aerosol in the dark. Whilst the degree of protective action varies with relative humidity, the number of viable cells in the airborne cloud at any time after dispersion are one to two orders of magnitude greater than in similar control clouds of untreated cells. These results have been confirmed for X19 (avirulent strain of Brucella Suis) and, as far as the experiments have proceeded, for UL. The importance of this discovery in relationship to the large area coverage concept will be obvious. To date we have not succeeded in protecting aerosols of agents disseminated in normal daylight.

3. The above research continues and for many months to come, will form the full-time programme of the entire Bacteriology Section. Even so, we should consider at the present time other ways in which we can contribute to the large area coverage concept of B.W., particularly with regard to our extensive field trials facilities and experience. We could carry out two types of trial:-

- A. Investigate the travel of particulate clouds over prairie terrain for intermediate distances of up to 150 to 200 miles using fluorescent particles as a simulant.

The objects of such a trial would be:-

- (a) To obtain further data on the travel of particulates over distances of the order of 100 to 200 miles.
- (b) To obtain data which will lead to a better understanding of the long distance travel of particulates, in particular, the vertical distribution of the particles.
- (c) To obtain data which will contribute to the confirmation of an empirical theory of particulate travel which has been developed at Dugway Proving Ground since the last Tripartite Conference.

and

s.15(1)

B. Determine what dosages of bacteria can be produced over large areas from a line source.

Trials in support of this long term project would be carried out within the confines of the SES test area and the objects would be:-

- (a) To confirm, under field conditions, the laboratory results of the protective effects of substances added to the spray suspension. *of SM and X19.*
- (b) Obtain information which would enable a decision to be reached on the possibility of carrying out a Type A trial using organisms themselves instead of the fluorescent particle simulant.
- (c) As for the objects of Type A trial above, but with a more limited distance of travel, i.e. up to 30 miles.

4. Both type trials result from recommendations of the 12th. Tripartite Conference and would be significant contributions to the understanding of the large area concept. It is unlikely, however, that SES could bring both type trials to a successful conclusion in the Summer of 1958, when we consider our commitments in other fields, our staff position, etc. The question is, therefore, which of the two type trials should we investigate. In reaching a decision on this question the following points have been considered:-

A. Type A Trials

- (a) Both UK and US are carrying out trials of this type. The trials envisaged at SES would supplement the information obtained by the other countries, though in somewhat greater detail, in the "intermediate" distance of travel range.
- (b) The scale of such a trial would tax the SES facilities and only a comparatively limited sampling array would be possible.
- (c) The value of the results obtained from a limited sampling array would have to be assessed to determine whether objects 3 A (b) 3 A (c) would be achieved. In this respect the Dugway representatives at the recent SES-Dugway Conference stated that they would assess the value of the results with regard to the confirmation of their empirical theory of travel.

B. Type B Trials

- (a) No other country is contemplating trials of this nature at the present time.
- (b) Such trials are a logical extension of our laboratory investigations.
- (c) Although only limited sampling arrays will be possible, the density of sampling units will be greater than that possible for Type A Trials and will give data, which will, in part at least, satisfy the objects of Type A Trials for limited distances up to 20 miles.
- (d) Data would be obtained which would indicate the feasibility of carrying out large scale trials in the future using organisms in the disseminated cloud instead of particulate tracers (should such trials be required).

5. From the above it is concluded:-

- (a) The SES field facilities should be used in the Summer of 1958 to carry out B.W. field investigations in support of the large area coverage concept.

5. (b) The trials carried out should be an extension of the laboratory research programme and designed to confirm that vegetative organisms can be protected during airborne travel by adding various substances to the spray suspension.
- (c) The trials under 5 (b) above to be restricted to the SES experimental area.
6. May permission please be obtained from Headquarters to carry out such projects?

(B. J. Perry)  
Supt./Research



DEPARTMENT OF NATIONAL DEFENCE  
CANADA

DEFENCE RESEARCH BOARD



18007

IN REPLY PLEASE QUOTE

DRBS 1800-1

Ottawa, Ontario,  
6 January 1956.

Chief Superintendent,  
S.E.S.

RECEIVED	<i>Boist</i>
C. R. FILE NUMBER	
	7-1800

Request for Information

1. Reference is made to SES T/1000 (N.9075) dated 14 November 1955 signed by A. B. Lamb with a copy to DRB (SW).

2. The best available information can be found in Camp Detrick Report BLIR Special Report No. 206, dated April 1954. The Report No. 204 covers a laboratory process for the production of UL. This laboratory process is now being converted into a pilot plant process and to date the production has not been finalized. The D.S.I.S. number for this report is 54/9139.

*G. R. Vawson*

for Chairman, Defence Research Board.

*11/Boist.*

*Report enclosed herewith.*

*WJP.*  
*9/1/56.*

*K. 28/12/57.*



## ROUTING

## P.A. &amp; B.F. ENTRIES

## REGISTRY ONLY

REFERRED	REMARKS	DATE OF PAGE	INITIALS	DATE OF P.A.	INITIALS	DATE OF B.F.	CANCEL B.F.	DATE RECEIVED	IN- SPECTED
C. E.	With papers	25-4-58	AS						
H/Bart	for comment	25/4/58	AS						
H/OKS	✓	25/4/58	AS						
SR	✓	30-4-58	AS						
C/S		27/4/58	AS						
CS	With papers	12-5-58	AS						
B/R	for info	12/5/58	AS						
PRS	-	13/5/58	AS						
B/F	✓	13/5/58	AS						
H/Bart	✓	14/5/58	AS						
SF	✓	16-5-58	AS						
WATS	✓	16-5-58	AS						
SR	✓	26/5/58	AS						
H/Bart	for info	26/5/58	AS						
SR	With papers	1/6/59	AS						
H/Bart		2/6/59	AS						
SR	✓	6/7/59	AS						
PRS	✓	6/7/59	AS						
Bart	✓	10/7/59	AS						
C.S.	With papers	14-9-59	AS						
Bart	✓	14/9/59	AS						
C/S	✓	15/9/59	AS						
SR	✓	14-10-59	AS						
CS			AS						
H/Bart		14/10/59	AS						
SR	With Papers	11/12/59	AS						

**"B.F." — DO NOT HOLD — THIS FILE WHEN  
LAPSE IN ACTION MAY EXCEED 48 HOURS.**

## ROUTING

## P.A. &amp; B.F. ENTRIES

## REGISTRY ONLY

REFERRED	REMARKS	DATE OF PASS	INITIALS	DATE OF P.A.	INITIALS	DATE OF B.F.	CANCEL B.F.	DATE RECEIVED	IN. SPECTED
LA	B 4.	3/10/60	AD						
CS	with Papers	4-11-60	CS						
DIR	for info	4-11-60	BS						
H (B) 5	✓	4-11-60	SP						
CS	with Papers	14-11-60	CS						
DIR	for info	14-11-60	BS						
Grant	✓	14-11-60	SP						
PRD	—	16-11-60	PRD						
ATRO	✓	17-Nov-60	ATRO						
CS	with Papers	22-12-60	CS						
DIR	for info	22-12-60	BS						
Grant	✓	22-12-60	SP						
PRD	✓		PRD						
ATRO	✓		ATRO						
CS	with Papers	3-1-61	CS						
Grant	for info	3-1-61	SP						
PRD	—	6-1-61	PRD						
ATRO	—	9-Jan-61	ATRO						
DIR	✓		BS						
CS	with Papers	18-2-61	CS						
Grant	for info	18-2-61	SP						
DIR	—		BS						
PRD	—		PRD						
CS	with Papers	23-2-61	CS						
DIR	for comm. action	23-2-61	BS						
Grant	—	23-2-61	SP						
Library	—	27-2-61	Library						

**"B.F." — DO NOT HOLD THIS FILE WHEN LAPSE IN ACTION MAY EXCEED 48 HOURS.**

CR 7  
82M-436 (M-8759-560)  
HQ. 2-815-CR 7

ROUTING				P.A. & B.F. ENTRIES				REGISTRY ONLY	
REFERENCE	REMARKS	DATE OF PASS	INITIALS	DATE OF P.A.	INITIALS	DATE OF B.F.	CANCEL D.F.	DATE RECEIVED	INSPECTED
21 Bant	With Papers	2/12/57	[Signature]						
W/CCS	✓	2-12-59	[Signature]						
W/F	✓	5/12/59	[Signature]						
P.M.		4/12/59	[Signature]						
W/F	With Papers	11/1/59	[Signature]						
W/CCS	✓	11-1-60	[Signature]						
W/CCS	✓	12-1-60	[Signature]						
W/F	✓	12-1-60	[Signature]						
C.S.	✓	15-2-60	[Signature]						
	✓	15-2-60	[Signature]						
		18/2/60	[Signature]						
W/CCS		19/2/60	[Signature]						
S.R.	With Papers	11-5-60	[Signature]						
C.S.	✓	3	[Signature]						
W/CCS	✓	11-8-60	[Signature]						
W/CCS	✓	12-8-60	[Signature]						
C.S.	✓	9-9-60	[Signature]						
		9-1-60	[Signature]						
		10/9/60	[Signature]						
		10/9/60	[Signature]						
		19/9/60	[Signature]						
		20/9/60	[Signature]						
		21/9/60	[Signature]						
			[Signature]						
C.S.	With Papers	17/10/60	[Signature]						
		18/10/60	[Signature]						

**"B.F." — DO NOT HOLD THIS FILE WHEN**  
**LAPSE IN ACTION MAY EXCEED 48 HOURS.**

ROUTING				P.A. & B.F. ENTRIES				REGISTRY ONLY	
REFERRER	REMARKS	DATE OF PASS	INITIALS	DATE OF P.A.	INITIALS	DATE OF B.F.	CANCEL B.F.	DATE RECEIVED	IN. SPECTED
Bact--	With Papers	12-12-61	J/P						
IRS		13/1/62	J/P						
CS	With Papers	13/4/62	J/P						
S/R		13-4-62	J/P						
S/F		16-4-62	J/P						
Bact									
HKS		16-4-62	J/P						
CS		24/4/62							
S/F		26-4-62							
S/R									
CS			J/P						
S/F	B 7	4-9-62	J/P						
CS	With Papers	10-9-62	J/P						
Bact		11-9-62	J/P						
CS		18-9-62	J/P						
Bact		18-9-62	J/P						
CS	With Papers	28/9/62	J/P						
Bact		28/9/62	J/P						
PRS		1/10/62	J/P						
CS		10/14/62	J/P						
Bact		10/12/62	J/P						
PRS			J/P						
AIR		17/12/62	J/P						
CS		20/12/62	J/P						
CS		21/1/63	J/P						
PRS	To note	2/1/63	J/P						
Bact			J/P						

**"B.F." — DO NOT HOLD THIS FILE WHEN LAPSE IN ACTION MAY EXCEED 48 HOURS.**

CR 7  
82M-4-56 (M-8759-560)  
HQ. 2-815-CR 7

LIBRARY AND ARCHIVES  
CANADA

BIBLIOTHÈQUE ET  
ARCHIVES CANADA

This copy is provided for research purposes only.  
Responsibility regarding questions of copyright that may  
arise in the use of this print is assumed by the recipient.

Cette copie a été préparé pour fins de recherche  
seulement. Le récipiendaire sera tenu responsable de  
toute infraction du droit de propriété de ce document.

FILE/DOSSIER SES.S 1800-1, Biological Warfare--  
General, v. 1, 1956/01/01 - 1963/06/30

RG 024 - National VOL/BOX # 10  
Defence

ACCESSION 1996-97/299

DATE October 22, 2010