

Garwin

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Sent again by R.L. Garwin
to M. Meselson (617) 496-2444



UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY
Washington, D.C. 20451

UNCLASSIFIED
FAX COVER SHEET

DATE 7 JULY 1994

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MESSAGE: CRITIQUE OF DR MESSELSON'S PAPER

FOR YOUR CONSIDERATION.

(RETRANSMITTAL - DON'T BELIEVE ALL PAGES
WERE SENT)

THIS IS PAGE 1 OF 9 (7 received)

504 Thomas Avenue
Frederick, MD 21701
July 6, 1994

To: Dr. Richard L. Garwin
c/o JASON

From: Tom Dashiell

Dear Dr. Garwin:

Thank you for the copy of Matt Meselson's paper; it is the same one which I scanned in Washington. Unfortunately, I do not know after reading it what model Matt used. He provides his input parameters but specifies the model only as a Gaussian plume model of which there are several. Nevertheless, I have had a friend from Ft. Detrick who has worked with these models for years review the paper and provide me a critique which is attached. We have generally used models developed by Kenneth Calder and he has provided a series of references which are available from the Defense Technical Information Center. Further, we have generally used animal data from Rhesus monkey exposures to extrapolate to humans; cyno data have not proven to be as reliable.

Thank you also for the copy of the letter from Clyde Raplogle; we have been friends for years. I intend to talk to him later this week since he was not available on Tuesday when I tried. I will let you know if that discussion changes anything.

Perhaps, you could get from Matt more definition on the exact model which he used and we can try again. However, as the last two conclusions indicate, other classified information exists which support the finding that Dr. Meselson's estimate is too low.

Sincerely,

Tom
Thomas R. Dashiell

Attachment

**Critique of Dr. Matthew Meselson Paper re
Sverdlovsk**

A. References:

Kenneth L. Calder is not listed in this paper as a reference. Calder was the first scientist to provide a logical explanation for the behavior of small particle aerosols containing infectious agents. His mathematical equations to define agent aerosols in a wide spectrum of meteorological conditions were pioneering studies and must be included in studies such as this one by Dr. Meselson. To overlook Calder as a key contributor represents a gross oversight.

Calder developed mathematical models to define the downwind travel of infectious aerosols from three different parameters:

- (1) Line source dissemination that occurs perpendicular to the wind
- (2) Multiple point sources
- (3) Single point source

Each method of dissemination reflects a somewhat different mathematical equation. The accident at Sverdlovsk involved what may be termed a "single source release". Single point releases are addressed by Calder in Technical Study No. 3 and represent the most inefficient means of delivering a biological warfare (BW) aerosol. Other studies by Calder which reflect his significant contributions to the BW downwind aerosol relationship are provided here. All are unclassified and have been for seven to eight years.

(1) Kenneth L. Calder: Mathematical models for dosage and casualty coverage resulting from single point and line source releases of aerosol near ground level, Technical Study 3, Defense Technical Information Center (DTIC) Acquisition Number AD 310-361.

(2) Kenneth L. Calder: A mathematical model for casualty effects in the attack of area targets with randomly dispersed anti-personnel BW munitions, Technical Study 1, DTIC Acquisition Number AD 310-359

(3) Kenneth L. Calder: A general method for estimating casualty effects in attacks of area targets with randomly dispersed CW or BW munitions, Technical Study 15, DTIC Acquisition Number AD 226-944

(4) Kenneth L. Calder: Aerosol concentrations produced by an elevated, instantaneous, crosswind line release, Technical Study 41, DTIC Acquisition Number AD 276-559

(5) Kenneth L. Calder: A numerical analysis of the protection afforded by buildings against a BW aerosol attack, Technical Study 2, DTIC Acquisition Number AD 310-360

(6) Kenneth L. Calder: A mathematical model for the penetration of a forest canopy by BW aerosols, Technical Study 37, DTIC Acquisition Number AD 262-228

Although Calder published about 30 BW modeling studies, the above six references illustrate the contributions this scientist made to the behavior of small particle BW aerosols and cover the most common releases of such aerosols.

B. Infectivity and Probit Slope

The Joint CB Technical Source Book: Volume VIII, Part 2, Anthrax, (DTIC Acquisition Number ADC 012-322) addresses the information that Dr. Meselson cites via Jemski. The Source Book remains classified at the SECRET level. Dr. Meselson is correct in that 1236 Cyno monkeys were used in projecting the early aerosol dose for man. A mean of 4130 spores (range of 1980 to 8630) caused an aerosol LD₅₀ with a mean probit slope of 0.669, range of 0.520 to 0.818.

After the early anthrax studies using cyno monkeys, almost all aerosol tests were conducted with the Rhesus monkey. The unclassified results from aerosol test 61-TE-1494 are not unique in that results were quite variable from aerosol test to aerosol test, but these are representative of the Rhesus monkey test. Test 61-TE-1494 results are summarized here:

	<u>Respiratory LD₅₀</u>	<u>Probit Slope</u>
Mean	8,689 spores	2.68
Range	6,524-11,570 spores	1.37-4.0

We generally believe that the Rhesus monkey results are more appropriate for use in determination of aerosol predictions than the Cyno data based on animal response and the much larger volume of data that exists for Rhesus.

C. Mathematical Model:

The most significant aspects of this paper appear on pages 10 and 11. Individual parameters are discussed for atmospheric stability, decay of the spore, downwind travel of the aerosol based on a human aerosol dose of 8,000 spores, a probit slope of 0.7, etc. Notwithstanding, the actual mathematical model used in the calculation is not

described beyond being a Gaussian plume model. Without information on the actual model employed, it is difficult to critique in detail how Dr. Meselson arrives at the conclusion on page 11: "Even if these divergent estimates bracket the actual value, it can only be said that the weight of spores released as aerosol could have been as little as a few milligrams or as much as about a gram."

In the absence of detailed data inserted into a mathematical model to predict downwind coverage of aerosol travel/infectivity relationships, similar calculations were prepared to support information in the "Biological Defense Research Program", Final Environmental Impact Statement, April 1969 (1).

Calder addresses a single point dissemination in several of his studies, but particularly in AD 310-361 (Reference 1 of this critique). Single point dissemination is highly inefficient according to his models when compared to multiple point sources and line sources.

A typical single point release (extracted from Calder's Technical Study 3) for various Q/d doses is provided here as Figure 1. With an assumed starting dose of 4×10^9 cells (Dr. Meselson data) this figure indicates there is no way that a single point dissemination would lead to aerosol infection of humans (8,000 spores) at 7 to 10 kilometers downwind and certainly not infect sheep 50 kilometers downwind (even at reduced doses). Diffusion parameters would kick in during such an extended downwind travel, further diluting the aerosol.

Tables A9-2 and A9-3 are also included in the BDRP Statement based on Calder's models. In the first table, effective hazard of aerosol downwind is provided where:
 Q = total source strength in organisms
 d = dose in retained organisms

In Table A9-3, downwind hazard of the aerosol, in meters, is calculated when source strength is changed and median dose for a respiratory infection is varied. This information also contradicts downwind dosage reported by Dr. Meselson.

Finally, if 4×10^9 spores were actually rendered airborne in an effective aerosol particle size (1 to 5 u, MMD) what was the dissemination efficiency of the release?

Estimated Dissemination Efficiency, %	Meselson Estimated Release of Spores	Actual Number of Spores Available
0.01	4×10^9	$40,000 \times 10^9$
0.1	4×10^9	$4,000 \times 10^9$
1.0	4×10^9	400×10^9

Conclusions:

- (1) Based on the data presented in the above tables which come from Calder's models the quantities proposed by Dr. Meselson in his conclusions are far too low.
 - (2) Based on still classified field tests, we know that Dr. Meselson's calculation is inaccurate, only the magnitude of inaccuracy is the question.
 - (3) Based on still classified intelligence data regarding this accident/incident we also know that Dr. Meselson's calculation is several orders of magnitude low.
- (1) Environmental Impact Statement available from: USAMRDC,
Attn: SGRD-PA, Fort Detrick, Frederick, MD 21701-5012

Figure 1 - Critique

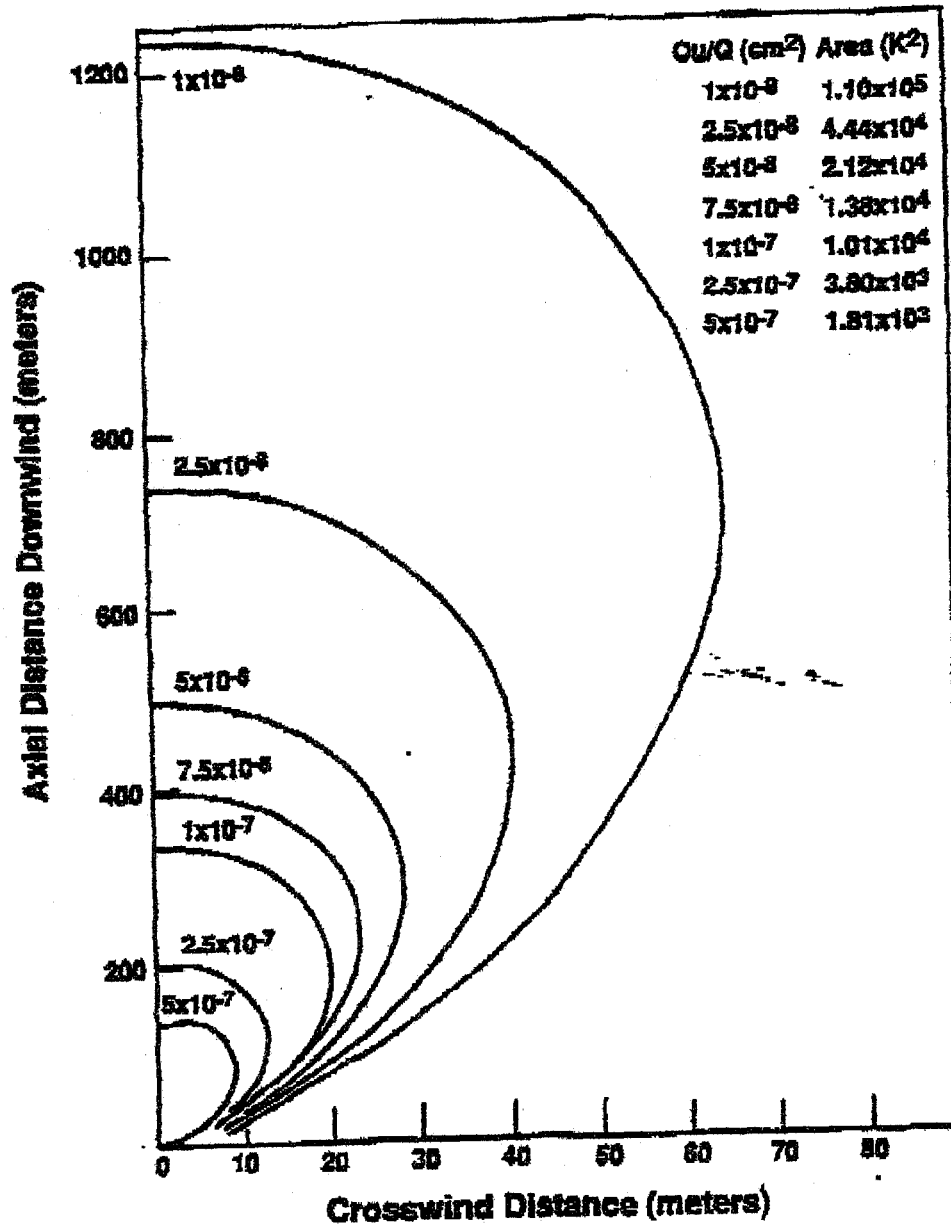


Fig. A9-3 Page 54 of BWL Technical Study No. 3

A9-27

Table A9-2. Downwind Hazard of Aerosol, In Meters, After Point Source Release, and Assuming No Biological Decay

Axis of cloud^b

Meters Downwind	$\frac{d}{Q}$	Dose d in organisms retained when Q^a is						
		$Q=10^8$	$Q=10^7$	$Q=10^6$	$Q=10^5$	$Q=10^4$	$Q=10^3$	$Q=$
1	2.7×10^{-3}	270,000	27,000	2,700	270	27	2.7	.
1.7	1×10^{-3}	100,000	10,000	1,000	100	10	1	.
2.7	5×10^{-4}	50,000	5,000	500	50	5	.5	—
7	1×10^{-4}	10,000	1,000	100	10	1	.1	—
11	5×10^{-5}	5,000	500	50	5	.5	—	—
16	2.5×10^{-5}	2,500	250	25	2.5	0.25	—	—
26	1×10^{-5}	1,000	100	10	1	.1	—	—
38	5×10^{-6}	500	50	5	0.5	0.25	—	—
57	2.5×10^{-6}	250	25	2.5	0.25	—	—	—
92	1×10^{-6}	100	10	1	0.1	—	—	—
135	5×10^{-7}	50	5	0.5	0.25	—	—	—
200	2.5×10^{-7}	25	2.5	0.25	—	—	—	—
335	1×10^{-7}	10	1	0.1	—	—	—	—
390	7.5×10^{-8}	7.5	0.75	—	—	—	—	—
495	5×10^{-8}	5.0	0.5	—	—	—	—	—
735	2.5×10^{-8}	2.5	0.25	—	—	—	—	—
1230	1×10^{-8}	1.0	0.1	—	—	—	—	—

a. Total source strength in organisms.

b. Data from Page 54 of referenced document; for example, if $\frac{d}{Q} = 5 \times 10^{-7}$; then d for $Q=10^{10}$ is $d/10^{10} = 5 \times 10^{-7}$; $d = 5 \times 10^{-7} \times 10^{10} = 5 \times 10^3$ or 5000 at wind speed of about 1 meter per second (2 miles per hour)

Table A9-1. Downwind Hazard of Aerosol, In Meters, When Source Strength is Changed* and Assuming No Biological Decay

Median Dose (ID ₅₀) (Organisms)	Morbidity	
	1%	10%
<u>Source Strength=10³ organisms</u>		
1	7.5	4
10	0.2	0.1
<u>Source Strength=10⁴ organisms</u>		
1	13	7
10	7.5	4
100	0.2	0.1
<u>Source Strength=10⁵ organisms</u>		
1	80	46
10	13	7
100	7.5	4
1,000	0.2	0.1
<u>Source Strength=10⁶ organisms</u>		
10	80	46
100	13	7
1,000	7.5	4
10,000	0.2	0.1
<u>Source Strength=10⁷ organisms</u>		
10	400	205
100	80	46
1,000	13	7
10,000	7.5	4
<u>Source Strength=10⁸ organisms</u>		
10	1500	760
100	400	205
1,000	80	46
10,000	13	7
<u>Source Strength=10⁹ organisms</u>		
10	5600	2800
100	1500	760
1,000	400	205
10,000	80	46

* 1 Morbidity x Source Strength x Median Dose.