

ECA TECHNICAL REPORT NO. 65-9-G (SUPPLEMENT)

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CB FIELD TEST PREDICTION TRIALS

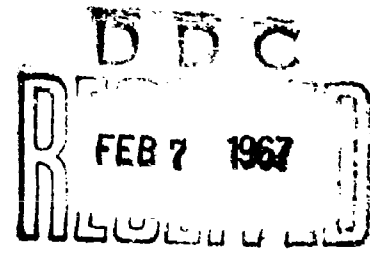
Supplement to Final Report
Contract No. DA 42-007-AMC-36(R)

by

H. E. Cramer
G. M. DeSanto

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CONTRACT NO. DA-42-007-AMC-276(R)
RDT&E PROJECT NO. 113650212D62405

PREPARED FOR
US ARMY DUGWAY PROVING GROUND
DUGWAY, UTAH

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OCTOBER 1966

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GCA CORPORATION
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Bedford, Massachusetts

SUMMARY

This report is a supplement to "CB Field Test Prediction Trials," GCA Technical Report No. 65-9-G, Final Report under Contract No. DA-42-007-AMC-36(R) with Dugway Proving Ground and presents the results obtained from seven additional quasi-instantaneous, line-source releases. A finely divided particulate tracer was used in three of these trials, and a vapor tracer was used in the remaining four trials. Analysis of the measurements made during these new field experiments supports the conclusions stated in the final report. Tabular summaries of the dosage measurements and graphs of the vertical expansion rates are presented in the appendices.

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SECTION 1

INTRODUCTION

The results of 24 quasi-instantaneous ground-level line-source diffusion trials completed prior to 1 May 1965 under Phases A and B of Test Series BC-412 at Dugway Proving Ground have been presented in "CB Field Test Prediction Trials," GCA Technical Report No. 65-9-G, Final Report under Contract No. DA-42-007-AMC-36(R). Subsequent to 1 May 1965, seven more field trials have been completed, three in Phase A (A-19 through A-21) and four in Phase B (B-7 through B-10). This report, presented as a supplement to GCA Technical Report No. 65-9-G, describes the measurements obtained during these latest trials. Descriptions of the tracer generators, test-grid instrumentation, and the data reduction and analysis procedures are given in the earlier report. Appendix A contains the regression analysis of the dosage data for Trials A-19 through A-21 and B-7 through B-10. Comprehensive tabular listings of the dosage measurements are presented in Appendix B.

SECTION 2

DISCUSSION OF RESULTS

All seven field trials were conducted during the hours between sunset and a few minutes past midnight in the presence of light to moderate winds and moderate stability conditions. Since the temperature profile sensors were inoperative during Trials A-19, A-20, and B-7, no stability ratios could be computed for these three trials; the wind data indicate that the thermal stratification during Trials A-19 and B-7 was the most stable of all the trials.

The results of the analysis and reduction of the meteorological and diffusion data are displayed in the accompanying tables. The numbering of the tables and figures in this supplement corresponds to that used in GCA Technical Report No. 65-9-G. The tables are extensions of the original tables and include only data from the seven additional trials. The figures show all of the data accumulated to date; new second order least-square curves have been calculated and are included in the figures.

Table 2-3 identifies the time, date, grid array, source characteristics and sampling period for each trial. Tables 2-4, 3-1, 3-2, and 3-3 list the basic meteorological parameters, measurements of the vertical profiles of wind speed and air temperature, and the standard deviations of azimuth and elevation angle, respectively. The variability of the dosages measured at the crosswind line 1200 feet from the source is given in Table 3-4, which also includes the stability ratio for those trials for which the required meteorological data were available. This ratio is given by the centigrade temperature difference between 4m and 0.5m divided by the square of the wind speed in meters per second at a height of 2m.

Table 3-5 presents the ratios of the mean dosages at various heights along the crosswind sampler line. These ratios reaffirm the tendency noted in the analysis of the earlier trials for invariance with height during the Phase A trials and for a slight elevation of the cloud axis during the Phase B trials.

TABLE 2-3

SUMMARY OF BC-412 SOURCE PARAMETERS

Trial	Date	Sampling Array	Tracer Amount Disseminated	Cloud Generation Time (min)	Function Time (MST)	Sampling Period (MST)	Malfunctions And Comments
A-19	7/1/65	North	6.00	Misg	0011	Misg	Temperature gradient and 30-meter wind speed inoperative.
A-20	10/5/65	South	6.00	3.17	1942	Misg	Temperature gradient inoperative.
A-21	1/11/66	South	6.00	3.08	1840	1832-1900	One nozzle of E2 head froze. Towers 14, 15, 16, 17, and 18 were low on vacuum.
B-7	6/22/65	North	211	4.35	2306	2257-2325	Temperature gradient inoperative.
B-8	7/1/65	South	224	5.17	2400	2345-0015	
B-9	9/15/65	South	277	4.43	2218	2110-2233	
B-10	11/22/65	North	617	5.90	1814	1745-1830	4-meter temperature gradient inoperative. High flow rate due to orifice in disseminator blowing out.

TABLE 2-4

SUMMARY OF BASIC METEOROLOGICAL PARAMETERS FOR BC-412 TRIALS. EXCEPT AS NOTED, WIND, TEMPERATURE, AND RELATIVE HUMIDITY ARE MEASURED AT 2 METERS AND AVERAGED OVER A 30-MINUTE PERIOD.

Trial	Date	Function Time (MST)	Wind		Temperature (°F)	Relative Humidity (per cent)	Cloud Cover (10ths)	Ground Condition
			Direction (deg)	Speed (mi/hr)				
A-19*	7/1/65	0011	142.3	5.0	61.3	31	0	Dry
A-20	10/5/65	1942	351.5	7.8	59.5	52	3	Dry
A-21*	1/11/66	1840	352.1	7.0	33.4	79	0	Moist
B-7*	6/22/65	2306	131.3	7.7	68.8	38	0	Dry
B-8	7/1/65	2400	358.7	6.8	65.4	44	0	Dry
B-9*	9/15/65	2218	339.2	7.2	62.2	40	8	Dry
B-10*	11/22/65	1814	147.5	8.0	45.3	64	10	Dry

*Temperature and relative humidity measured at 1 meter.

TABLE 3-1

SUMMARY OF METEOROLOGICAL PROFILE DATA (30-MINUTE AVERAGES)

Trial	Wind Direction (deg)	Wind Speed (mi/hr)				Temperature Difference (°F)						
		0.5	2	4	8	16	30	2-½	4-½	6-½	16-½	30-½
A-19	142.3	3.0	5.0	7.6	9.0	9.5	Misg	Misg	Misg	Misg	Misg	Misg
A-20	251.5	4.2	7.8	8.4	10.9	12.4	13.1	Misg	Misg	Misg	Misg	Misg
A-21	352.1	6.5	7.0	8.2	10.3	12.7	16.2	0.5	0.7	1.4	2.1	2.9
B-7	133.5	5.5	7.7	8.7	11.7	15.3	19.3	Misg	Misg	Misg	Misg	Misg
B-8	000.4	7.2	6.8	7.6	9.8	12.2	15.0	0.6	0.9	1.6	1.9	2.5
B-9	339.2	5.0	7.2	8.6	9.0	12.0	12.9	0.5	0.9	1.5	1.8	2.3
B-10	147.5	6.8	8.0	9.6	9.8	13.8	17.7	0.2	Misg	1.1	1.9	3.4

TABLE 3-2

STANDARD DEVIATIONS OF AZIMUTH ANGLE σ_A (DEC)
AS A FUNCTION OF HEIGHT AND AVERAGING TIME

Trial	Date	Function Time (MST)	Averaging Time (min)										
			2 m		4 m		8 m		10	2.5	10	2.5	10
A-19	7/1/65	0011	5.73	7.83	5.30	7.64	Misg	Misg	8.94	11.48			
A-20	10/5/65	1942	3.91	5.70	3.11	4.73	2.10	3.09	2.50	4.61			
A-21	1/11/66	1840	2.88	3.45	2.16	2.72	1.58	2.25	1.70	2.32			
B-7	6/22/65	2306	3.25	Misg	3.39	Misg	Misg	1.99	3.37				
B-8	7/1/65	2400	3.73	4.09	3.62	4.05	Misg	Misg	2.38	2.71			
B-9	9/15/65	2218	3.97	4.24	3.29	3.62	Misg	Misg	2.20	2.85			
B-10	11/22/65	1814	3.16	3.82	2.57	3.36	1.71	2.74	1.56	2.28			

TABLE 3-3

STANDARD DEVIATIONS OF ELEVATION ANGLE σ_E (DEG)
AS A FUNCTION OF HEIGHT AND AVERAGING TIME

Trial	Date	Function Time (MST)	Averaging Time (min)							
			2.5	10	2.5	10	2.5	10	2.5	10
			2 m		4 m		8 m		16 m	
A-19	7/1/65	0011	2.18	2.29	2.16	2.38	2.31	2.49	2.95	3.05
A-20	10/5/65	1942	2.17	2.36	2.09	2.20	1.74	1.86	1.71	1.77
A-21	1/11/66	1840	2.12	2.15	1.54	1.58	1.20	1.27	0.98	1.05
B-7	6/22/65	2306	1.98	Miss	1.73	1.77	1.04	1.09	0.68	0.71
B-8	7/1/65	2400	2.92	2.98	3.06	3.14	2.36	2.41	1.73	1.77
B-9	9/15/65	2218	2.26	3.61	2.38	2.44	2.00	2.10	1.72	1.75
B-10	11/22/65	1.84	1.98	2.01	2.01	2.05	1.35	1.38	1.02	1.06

TABLE 3-4

VARIABILITY OF CROSSWIND DOSAGE FOR THREE MEASUREMENT
HEIGHTS AT A TRAVEL DISTANCE OF 1200 FEET

Trial	$\frac{\Delta T_{4-0.5m}}{\bar{U}_{2m}^2}$ ($^{\circ}\text{C m}^{-2} \text{sec}^2$)	σ_D/\bar{D} (5 ft)	σ_D/\bar{D} (3 ft)	σ_D/\bar{D} (1 ft)	Average
A-19	Misg	0.37	0.34	0.36	0.35
A-20	Misg	0.29	0.31	0.27	0.29
A-21	0.043	0.30	0.29	0.31	0.30
B-7	Misg	0.22	0.22	0.22	0.22
B-8	0.042	0.27	0.26	0.32	0.28
B-9	0.056	0.36	0.41	0.48	0.41
B-10	Misg	0.26	0.24	0.24	0.25

TABLE 3-5

DISTRIBUTION OF DOSAGE NEAR THE GROUND AT A TRAVEL DISTANCE OF
1200 FEET. RATIOS ARE BETWEEN MEAN DOSAGES AT TWO HEIGHTS.
SUBSCRIPTS INDICATE HEIGHT ABOVE GROUND IN FEET.

Trial	\bar{D}_3/\bar{D}_5	\bar{D}_1/\bar{D}_5	\bar{D}_1/\bar{D}_3
A-19	0.92	0.94	1.02
A-20	1.08	1.06	0.98
A-21	1.01	1.01	1.00
B-7	0.98	0.92	0.94
B-8	0.99	0.90	0.91
B-9	1.01	0.89	0.88
B-10	1.02	0.98	0.96

TABLE 4-1

SUMMARY OF REGRESSION ANALYSES FOR THE COMBINED TOWER DATA WITHOUT VIRTUAL DISTANCE

Trial	Stability Ratio SR ($^{\circ}\text{C m}^{-2} \text{ sec}^2$)	B	Correlation Coefficient R	Standard Error SE
A-19	Misg	0.547	0.985	1.15
A-20	Misg	0.491	0.993	1.08
A-21	0.053	0.483	0.992	1.09
B-7	Misg	0.313	0.973	1.11
B-8	0.035	0.457	0.994	1.07
B-9	0.049	0.472	0.993	1.08
B-10	0.042	0.415	0.990	1.08

TABLE 4-2
SUMMARY OF REGRESSION ANALYSES FOR THE COMBINED TOWER DATA WITH VIRTUAL DISTANCE

Trial	Stability Ratio SR ($^{\circ}\text{C m}^{-2} \text{ sec}^{-2}$)	B	Virtual Distance X_z (m)	Correlation Coefficient R	Standard Error SE
A-19	Misg	0.653	22.0	0.993	1.10
A-20	Misg	0.655	42.9	0.994	1.08
A-21	0.053	0.718	65.3	0.998	1.04
B-7	Misg	0.589	142.8	0.971	1.11
B-8	0.035	0.768	113.9	0.995	1.06
B-9	0.049	0.712	73.3	0.992	1.08
B-10	0.042	0.619	76.4	0.962	1.18

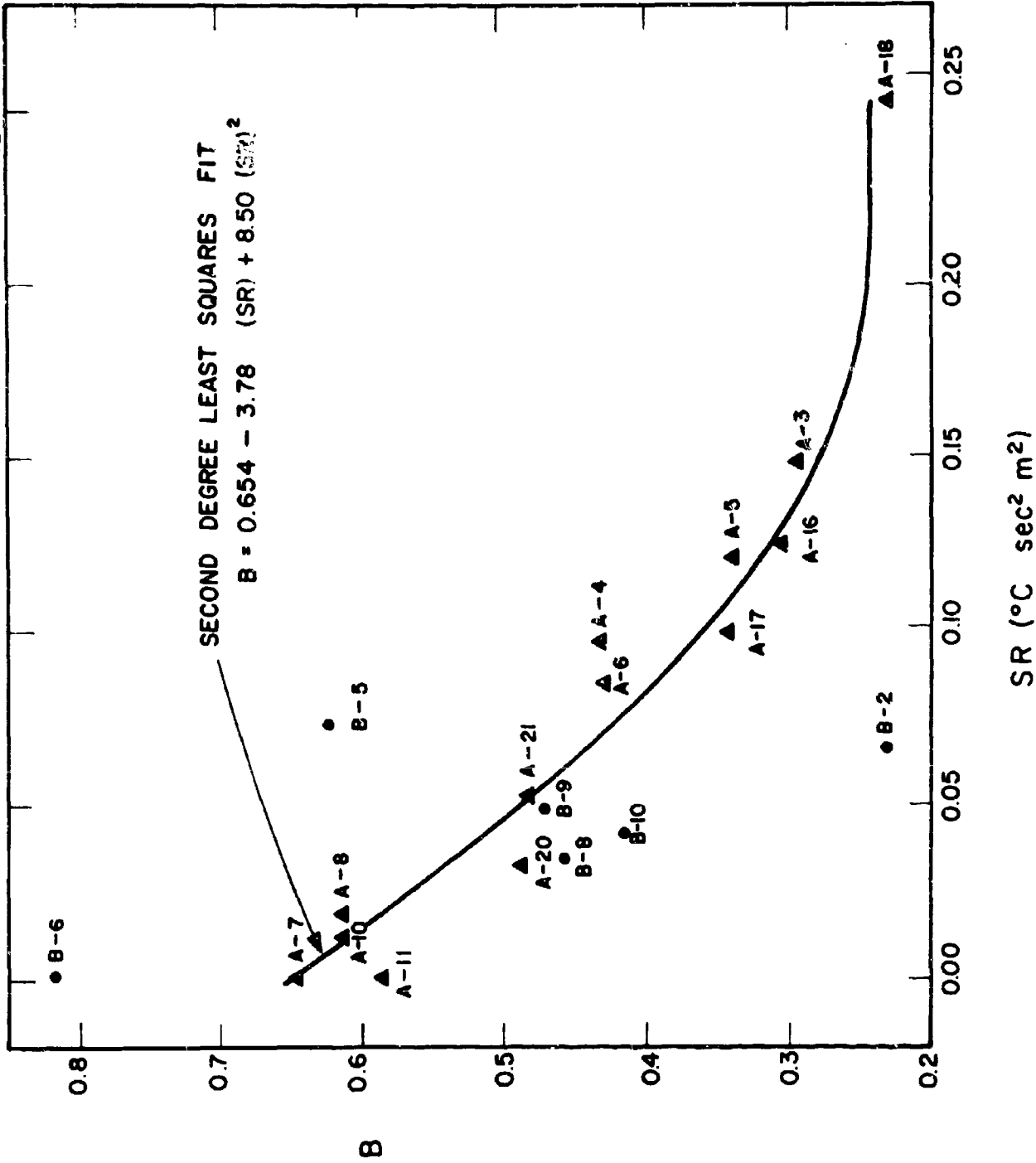


Figure 4-1. Power-law exponent (B) versus stability ratio (SR) of lowest 30-meter layer for non-lapse Phase A and B trials. Virtual distance adjustment not included in derivation of B.

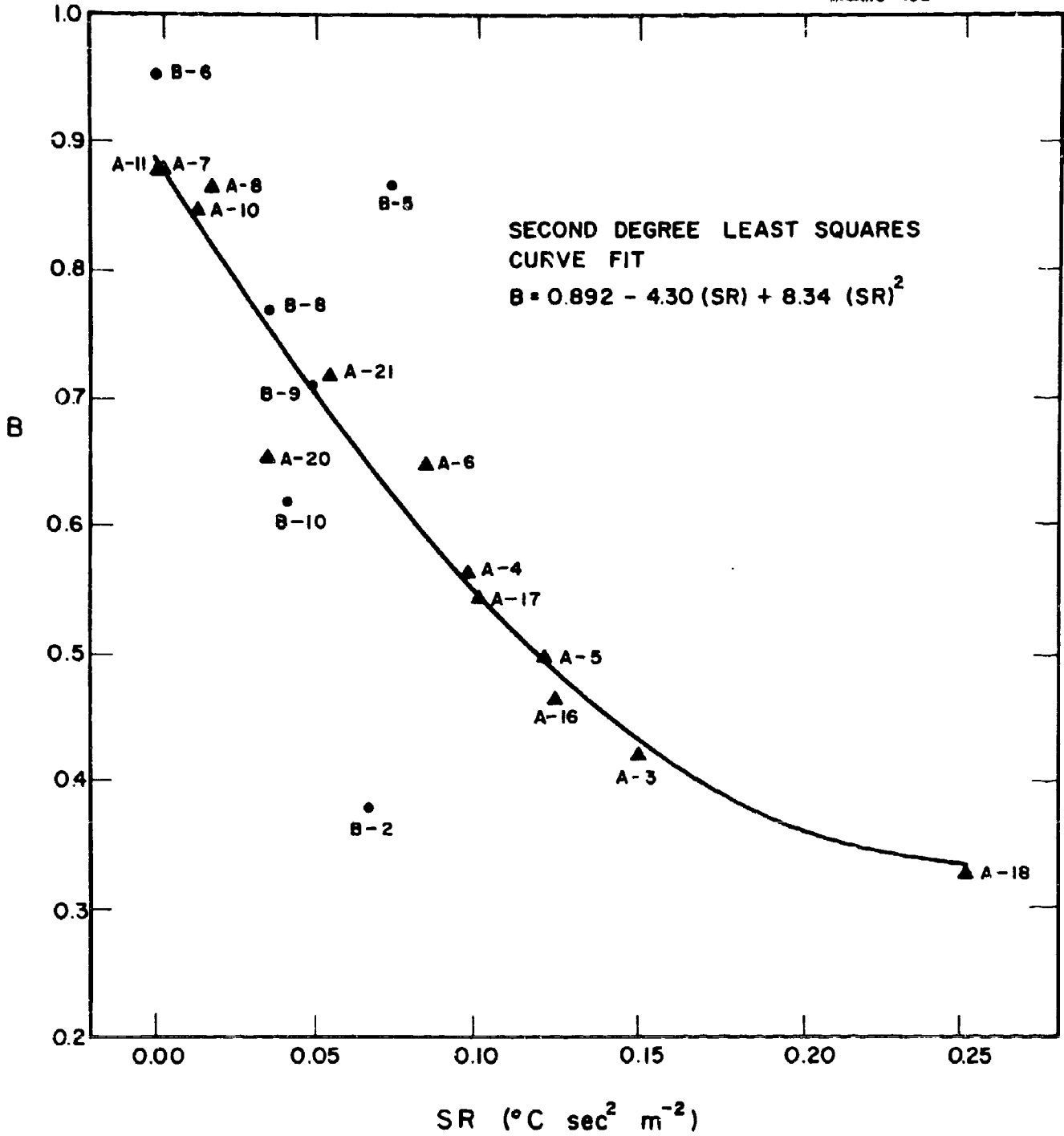


Figure 4-2. Power-law exponent (B) versus stability ratio (SR) of lowest 30-meter layer for non-lapse Phase A and B trials. Virtual distance adjustment included in derivation of B.

The second degree least-squares regression lines representing the vertical cloud expansion power-law exponent B as a function of the stability ratio have been recomputed. The regression was performed on the results of only those trials during which the temperature difference between 30 meters and 0.5 meters was positive. All Phase A and B trials that met this criterion, and for which complete sets of diffusion data are available, were employed in the calculations. Table 4-1 shows the values of B thus derived without the virtual distance correction for source dimension; the values of B in Table 4-2 include the virtual distance correction. These data are given in graphical form in Figures 4-1 and 4-2.

It is clear from Figure 4-2 that the Phase B trials show a considerably greater scatter about the regression curve than do the Phase A trials. This effect may be partially explained by the relatively large fluctuations in the height of the peak dosage for Phase B trials. For example, the large discrepancy in the values of B obtained for Trials B-2 and B-5, which represent approximately the same stability conditions, may be due to the fact that the peak dosage at the first row is found at a height of 15 feet for B-2 and at a height of one foot for B-5. Because the standard deviation of the vertical dosage distribution σ_z is computed using one foot as the assumed height of the cloud axis, the difference in the observed heights of the cloud axis for these two trials is reflected in the calculated σ_z 's at the first row -- 4.75 meters for B-2 and 2.14 meters for B-5. When in B-2 the cloud expands downward towards the ground from the first sampling row, little growth in σ_z as calculated is shown, and consequently the growth-rate exponent B is depressed. The effect is reversed for Trial B-5 because of the very small σ_z at the first row.

The results of these latest trials confirm the conclusions reached from the analysis of the earlier Phase A and B trials of the BC-412 series. For a summary of these conclusions, reference should be made to GCA Technical Report No. 65-9-G, Final Report under Contract No. DA-42-007-AMC-36(R).

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APPENDIX A

VERTICAL EXPANSION RATES FOR INDIVIDUAL TRIALS

In Figures A-1 through A-7, the standard deviation of the vertical dosage distribution σ^z has been plotted against X , the distance traveled by the cloud from the z release line. In Figures A-8 through A-14, the abscissa is $X+X_z$, where X_z is a virtual distance correction for source dimension. The z lines represent power-law expansions fitted by the method of least squares.

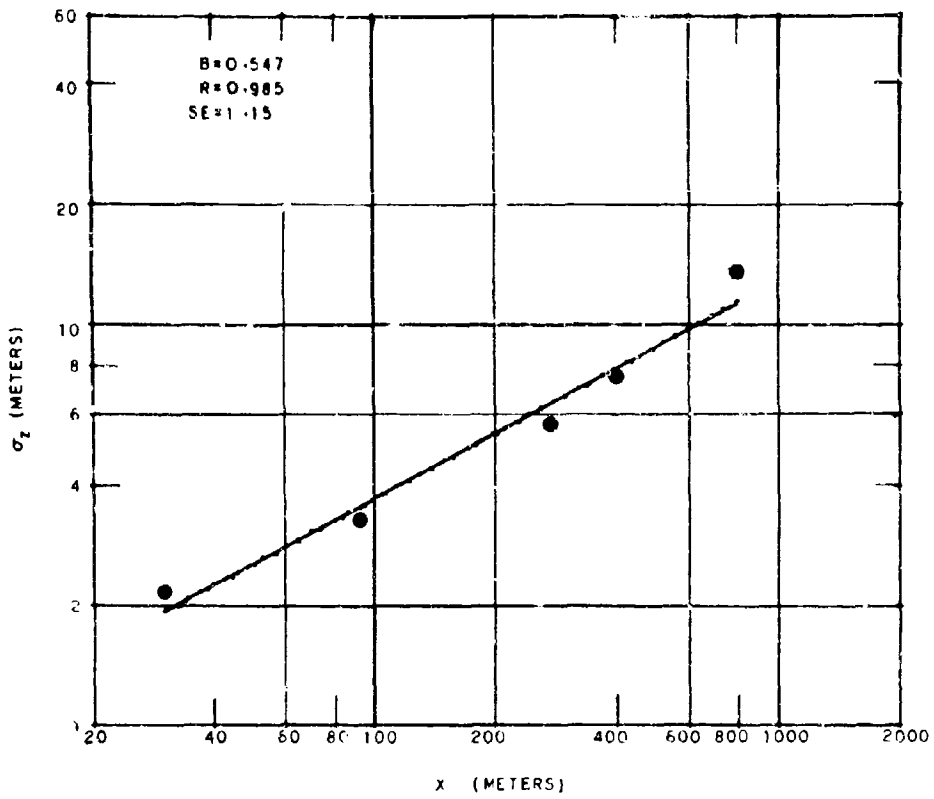


Figure A-1. Sigma Z versus X for BC-412 Trial A-19.

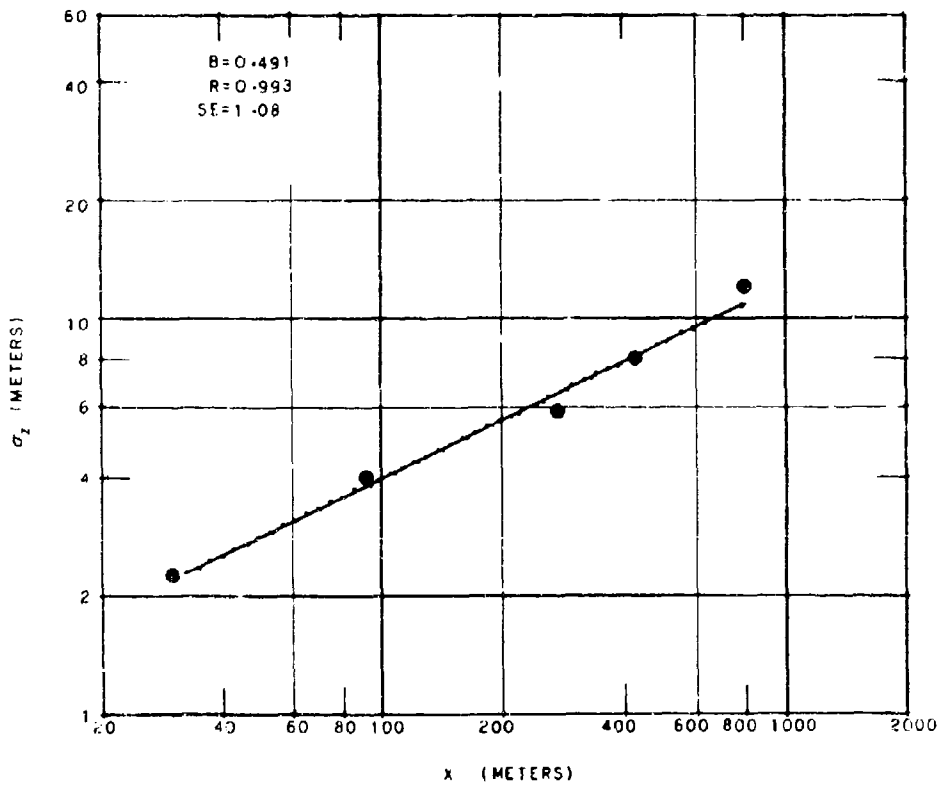


Figure A-2. Sigma Z versus X for BC-412 Trial A-20.

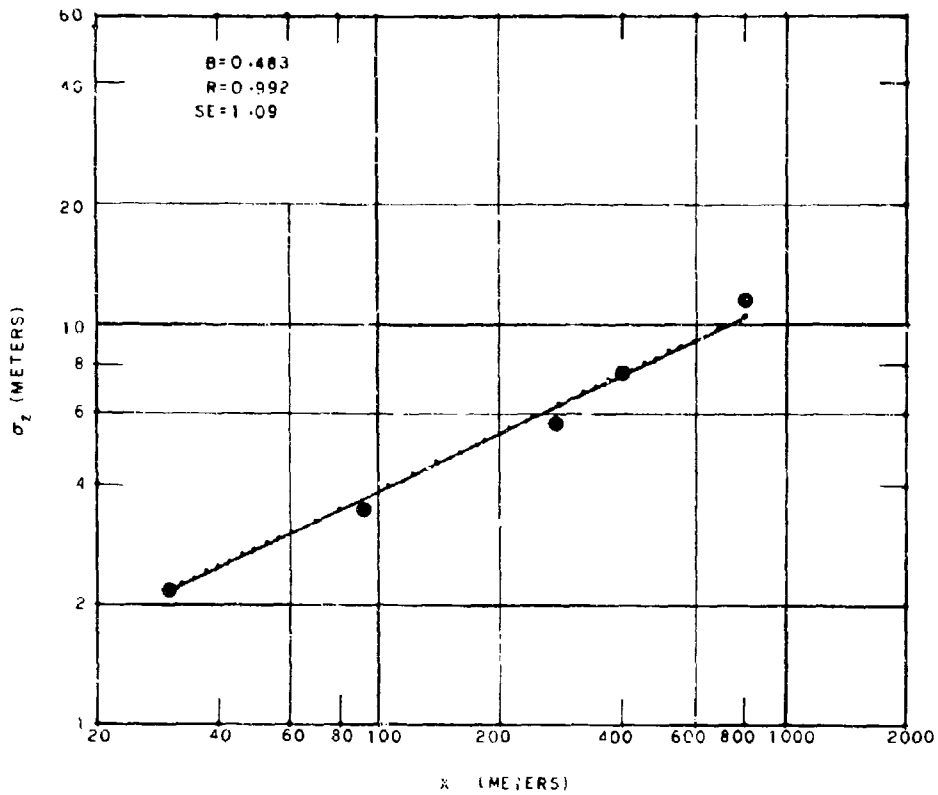


Figure A-3. Sigma Z versus X for BC-412 Trial A-21.

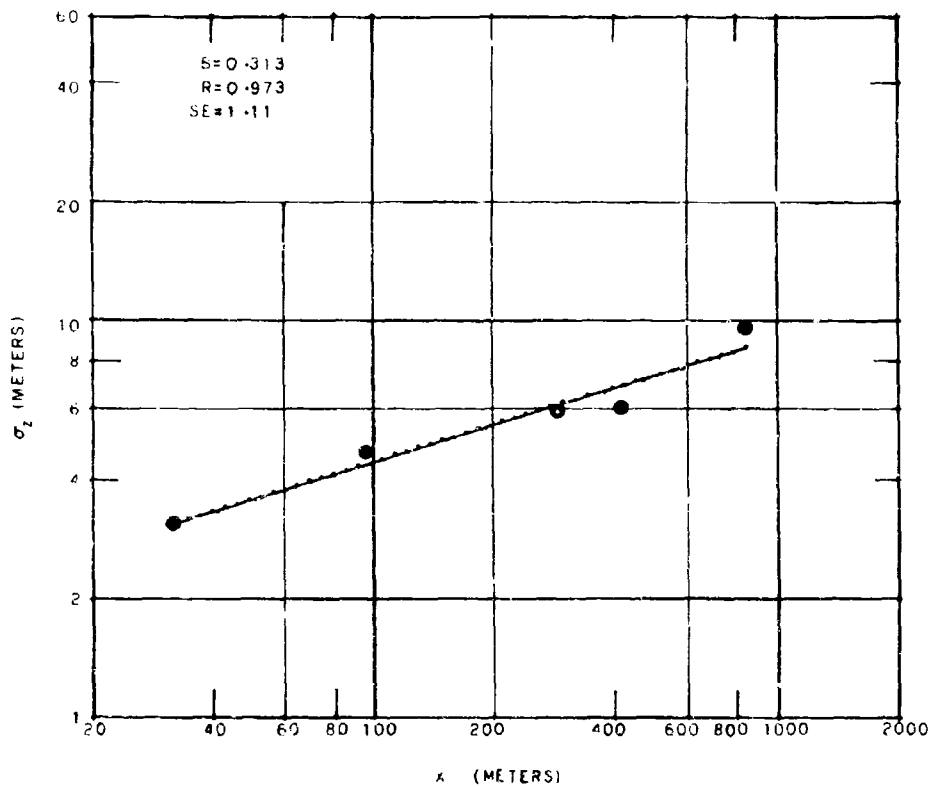


Figure A-4. Sigma Z versus X for BC-412 Trial B-7.

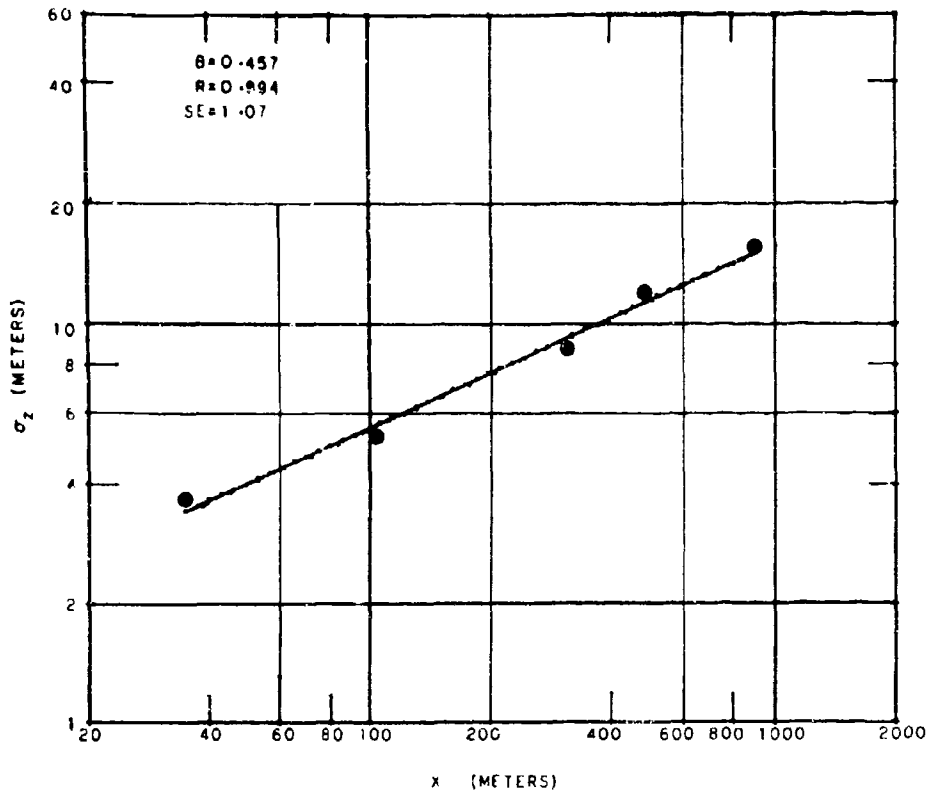


Figure A-5. Sigma Z versus X for BC-412 Trial B-8.

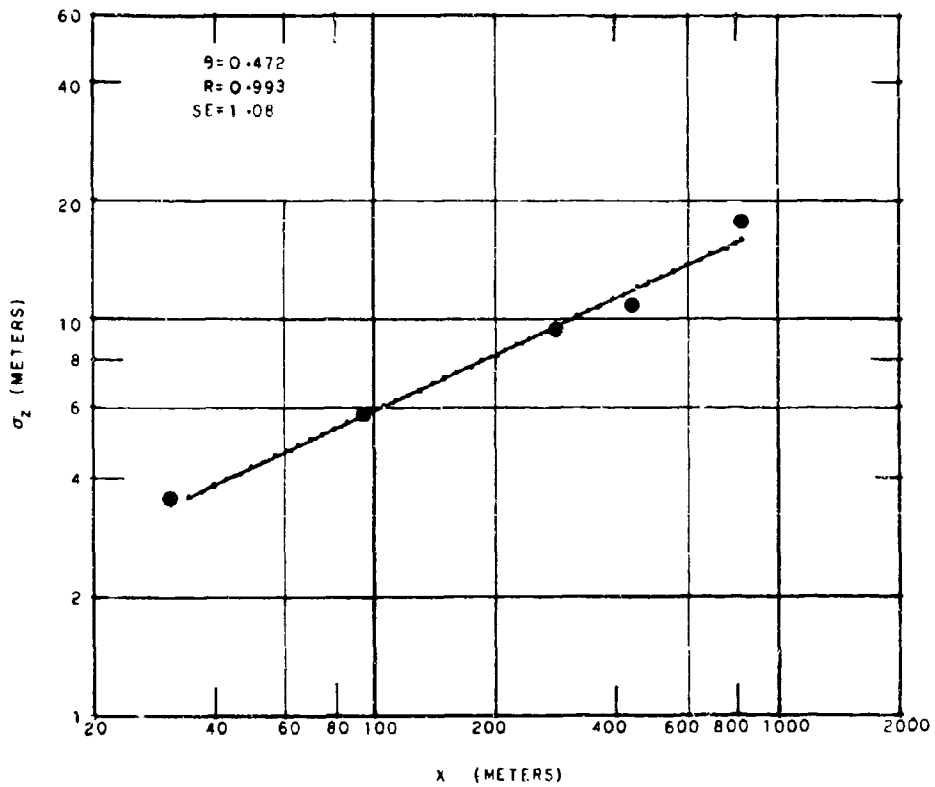


Figure A-6. Sigma Z versus X for BC-412 Trial B-9.

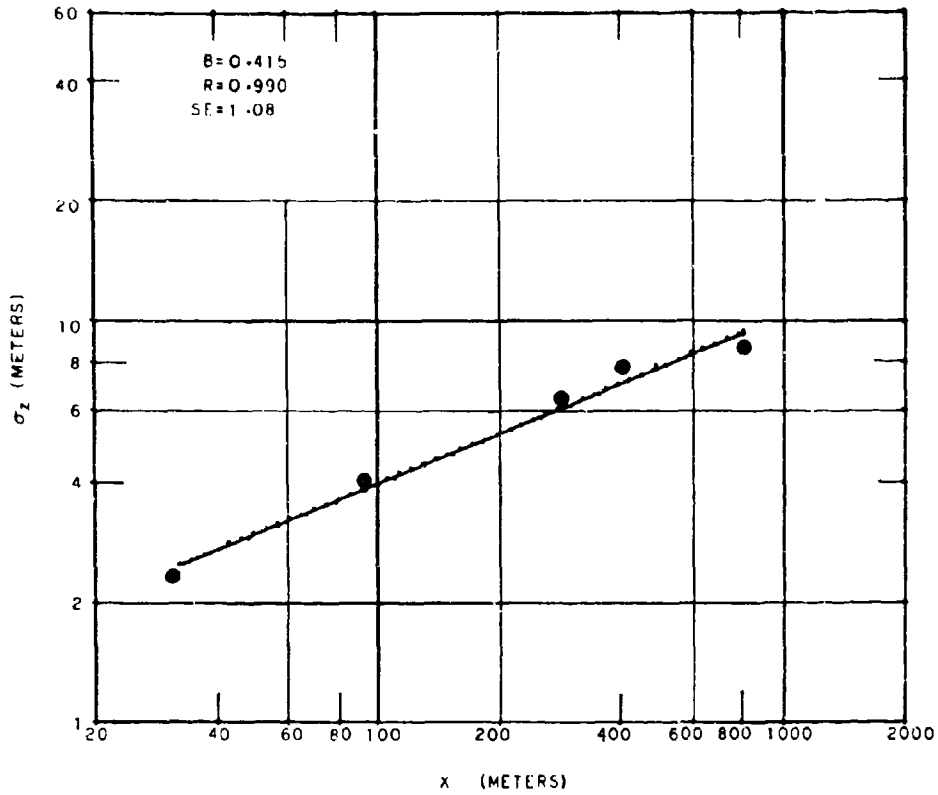


Figure A-7. Sigma Z versus X for BC-412 Trial B-10.

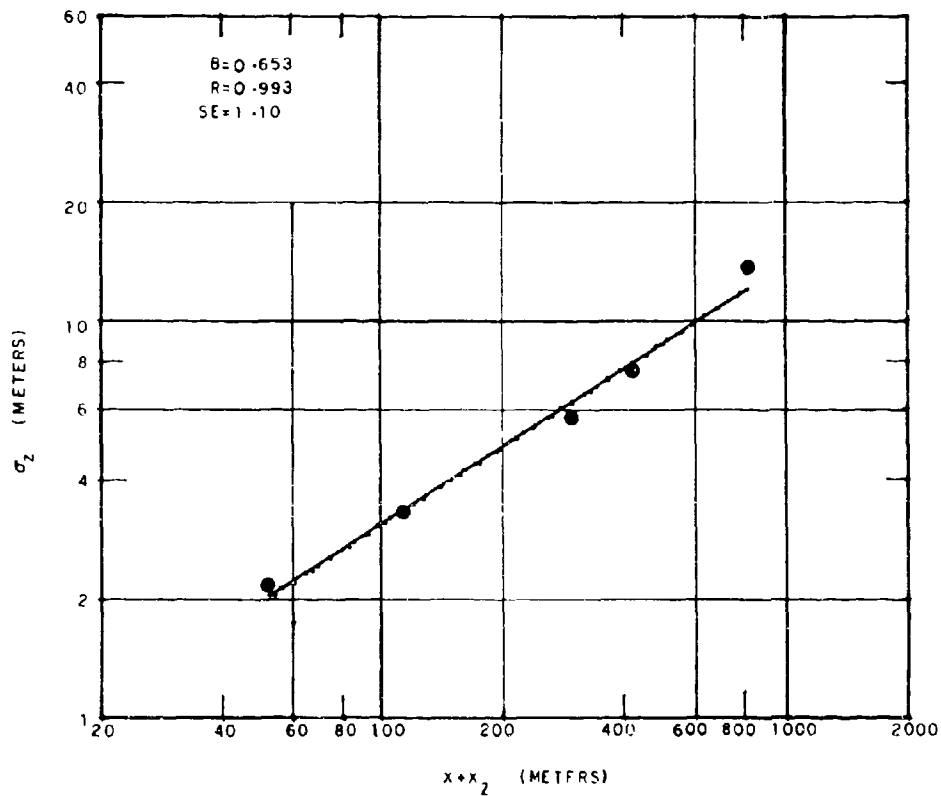


Figure A-8. Sigma Z versus $X + X_z$ for BC-412 Trial A-19.

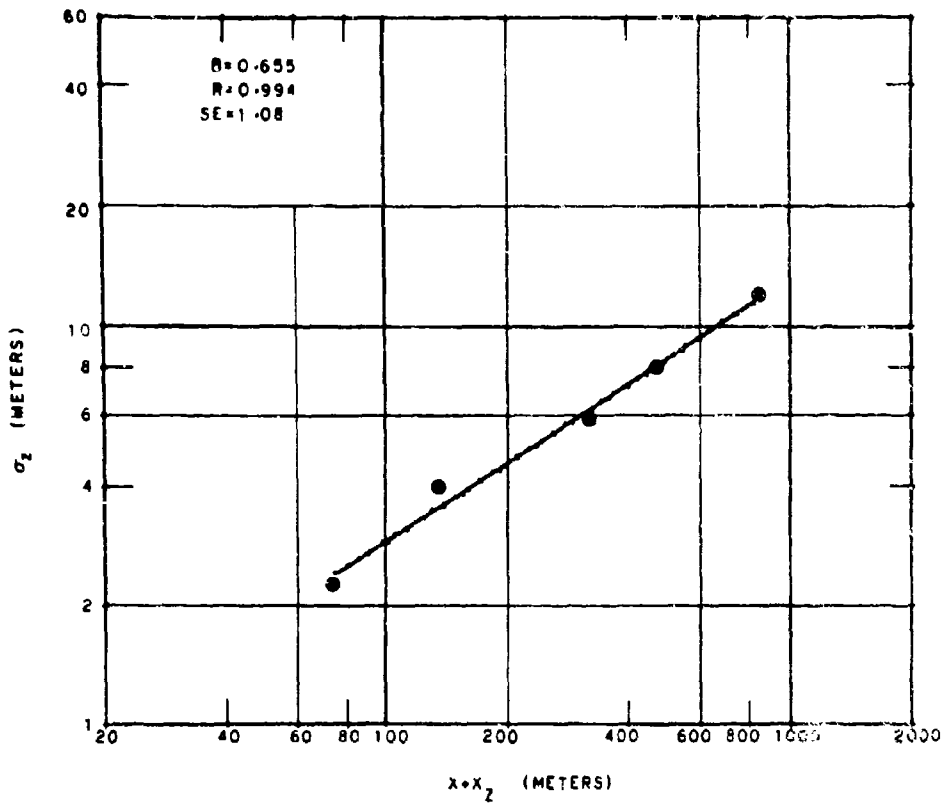


Figure A-9. Sigma Z versus $X + X_Z$ for BC-412 Trial A-20.

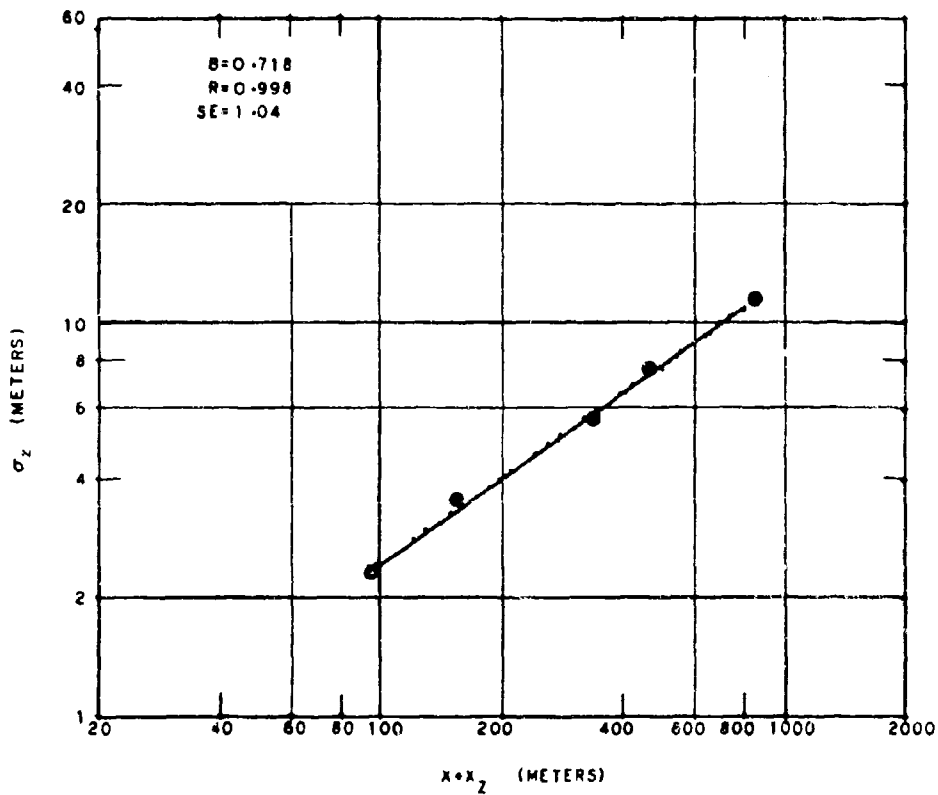


Figure A-10. Sigma Z versus $X + X_Z$ for BC-412 Trial A-21.

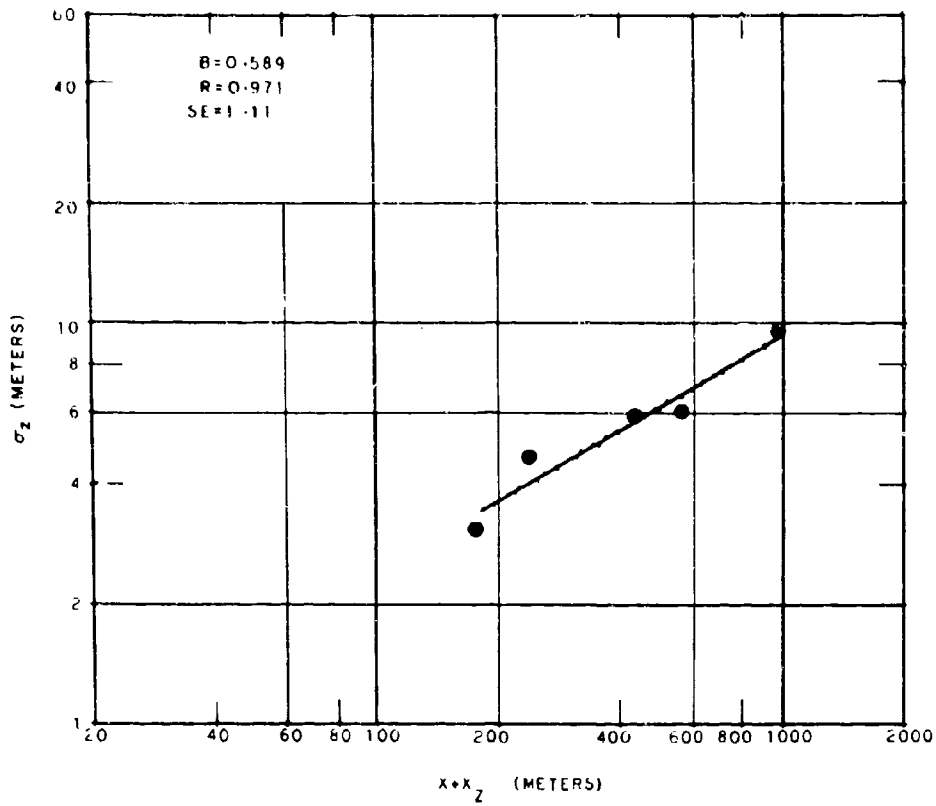


Figure A-11. Sigma Z versus $X + X_Z$ for BC-412 Trial B-7.

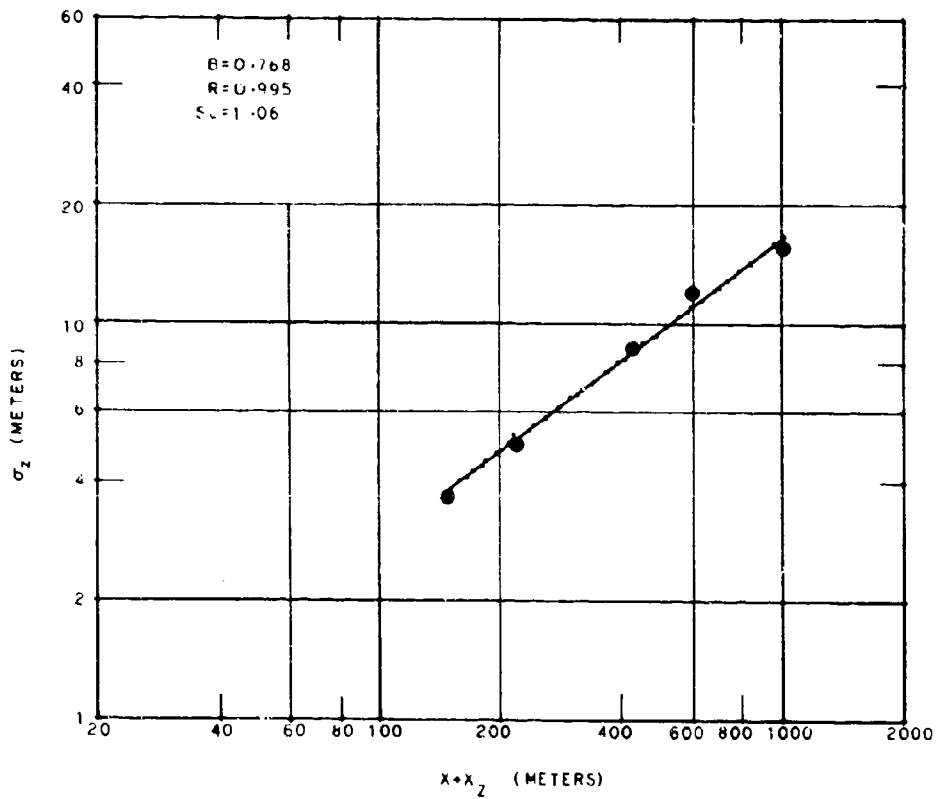


Figure A-12. Sigma Z versus $X + X_Z$ for BC-412 Trial B-8.

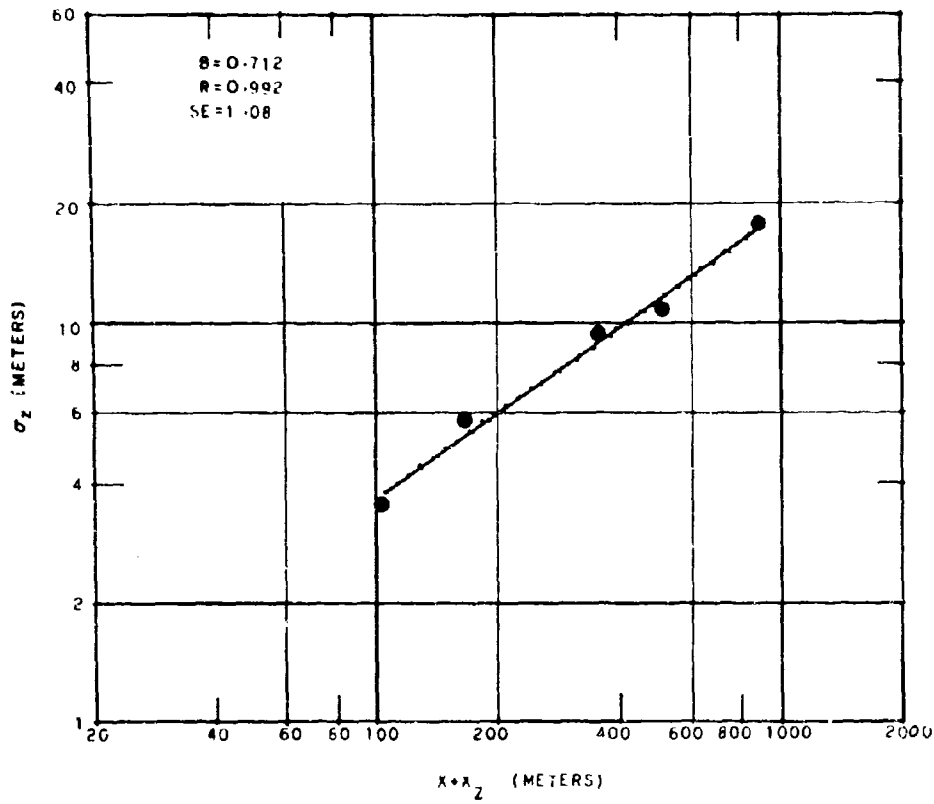


Figure A-13. Sigma Z versus $X + X_Z$ for BC-412 Trial B-9.

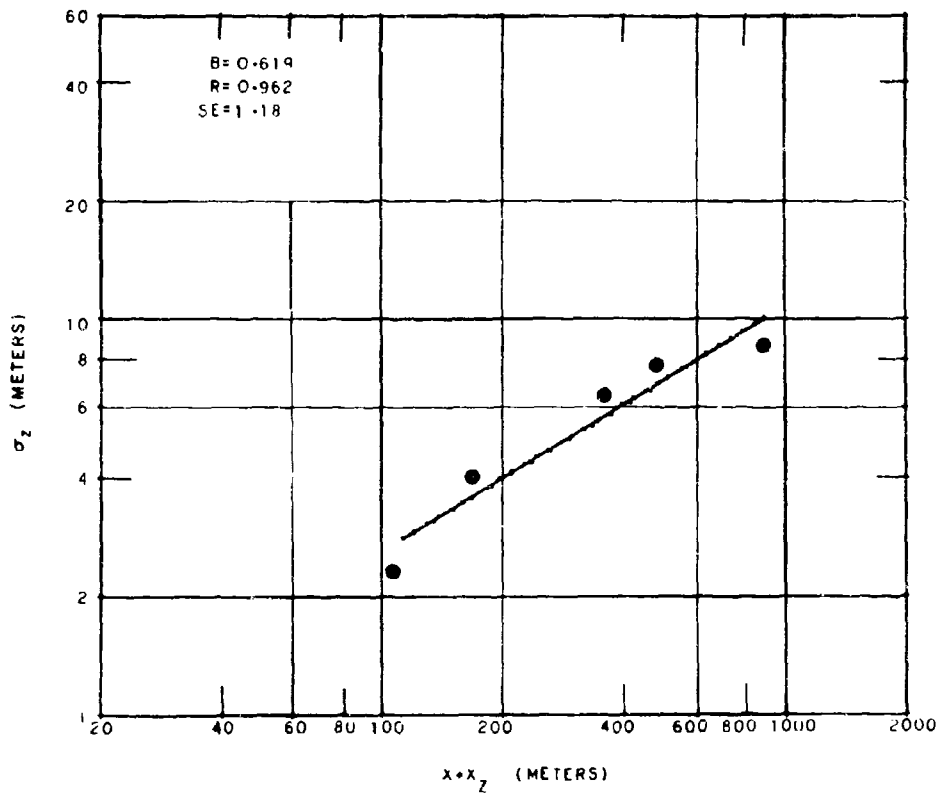


Figure A-14. Sigma Z versus $X + X_Z$ for BC-412 Trial B-10.

APPENDIX B

DOSAGE MEASUREMENTS

The tabulations in this appendix present a detailed listing of dosage measurements made during the BC-412 trials of Phases A and B reported in this supplement. All the measurements have been subjected to the checking and screening procedures described in Section 3 of the final report. The dosage units for the Phase A trials are counts min^{-1} per 6 liters; the dosage units for the Phase B trials are mg min m^{-3} . All heights are given in feet.

TRIAL A-19 HEIGHT	TOWER 1 DOSAGE	TOWER 2 DOSAGE	TOWER 3 DOSAGE
25		312	
20	36075	11250	
15	146575	109687	
10	213500	175625	16140
5	543750	357000	118537
3	271250	319000	156975
1	251250	431250	333750

TRIAL A-19 HEIGHT	TOWER 4 DOSAGE	TOWER 5 DOSAGE	TOWER 6 DOSAGE
35	810	2396	4517
30	4151	2632	5568
25	30712	17111	8876
20	68000	85050	7312
15	110600	146650	22750
10	213500	145600	50287
5	325500	209475	130500
3	395250	25962	183675
1	460000	147600	207312

TRIAL A-19 HEIGHT	TOWER 7 DOSAGE	TOWER 8 DOSAGE	TOWER 9 DOSAGE
100	446		
95	212		
90	382		
85	356		
80	658		
75	1035	337	
70	2066	517	
65	1947	427	675
60	4725	697	1187
55	4125	1353	1350
50	3525	2280	1500
45	5000	2066	2600
40	2731	4655	4162
35	4525	6103	8000
30	5602	9761	12810
25	10395	18500	14662
20	17587	30637	21000
15	38100	47775	35200
10	87550	75000	40000
5	72450	103125	58500
3	71250	101775	55800
1	56062	110825	73862

TRIAL A-19 HEIGHT	TOWER 10 DOSAGE	TOWER 11 DOSAGE	TOWER 12 DOSAGE
100	780		460
95	390	390	776
90	1187	656	1190
85	877	625	1155
80	1755	1031	1700
75	1560	682	2240
70	4680	1562	3577
65	5297	1072	4615
60	5655	2343	8302
55	6565	2502	10766
50	6662	3282	11947
45	5980	5362	14040
40	6142	6500	19845
35	9100	13357	24500
30	9847	20150	36400
25	21465	28687	45150
20	30037	63050	58800
15	53187	72900	74200
10	60950	91800	93162
5	55275	88450	87375
3	60087	93000	99375
1	73587	85125	84000

TRIAL A-19 HEIGHT	TOWER 20 DOSAGE	TOWER 21 DOSAGE	TOWER 22 DOSAGE
100	1017	3363	4620
95	1495	5261	4675
90	1897	5032	5362
85	2616	6037	6698
80	4020	7562	10470
75	5220	8280	10680
70	4916	8222	12190
65	7560	9817	13950
60	2625	9405	12908
55	13500	10005	14940
50	21850	18112	12155
45	24300	23700	19837
40	30900	20987	22913
35	27600	30900	23287
30	51000	29150	21600
25	63050	38400	20370
20	76875	47400	16905
15	89050	48750	16620
10	100100	56100	10080
5	86100	44587	10698
3	71412	85550	8400
1	69962	58875	7357

TRIAL A-20 HEIGHT	TOWER 22 DOSAGE	TOWER 21 DOSAGE	TOWER 20 DOSAGE
25			1650
20		712	35262
15	1162	39750	72850
10	129375	100362	87200
5	248840	189200	171200
3	260360	183200	195525
1	278160	224800	180262

TRIAL A-20 HEIGHT	TOWER 19 DOSAGE	TOWER 18 DOSAGE	TOWER 17 DOSAGE
45			1400
40	435		7141
35	1190	797	16131
30	3516	1595	23272
25	10010	6380	26100
20	24255	13666	20175
15	63075	25375	32987
10	119250	28500	55125
5	161250	88350	87200
3	211187	87575	89100
1	168175	123600	92800

TRIAL A-20 HEIGHT	TOWER 16 DOSAGE	TOWER 15 DOSAGE	TOWER 14 DOSAGE
70		450	
65		215	465
60		525	930
55		1237	2363
50	1387	2512	2325
45	1631	3565	3100
40	4162	8370	4882
35	7575	14453	7982
30	15900	22746	15190
25	23325	30612	11392
20	28875	36037	16546
15	40125	53087	26427
10	35625	48437	39200
5	49087	63600	35475
3	48262	64350	45787
1	52800	58162	41662

TRIAL A-20 HEIGHT	TOWER 12 DOSAGE	TOWER 11 DOSAGE	TOWER 10 DOSAGE
90	465		
85	1162	600	
80	620	232	
75	2053	697	
70	1588	1350	
65	3061	4200	542
60	2092	3797	1875
55	3840	5076	3371
50	6006	7943	6122
45	7711	9648	6600
40	12880	12206	10720
35	15840	19220	12942
30	23880	17088	17640
25	27600	21700	24160
20	34100	24296	29837
15	35600	26737	28815
10	51600	36425	27200
5	73012	29287	28131
3	38775	25575	24675
1	48675	45787	21207

TRIAL A-20 HEIGHT	TOWER 3 DOSAGE	TOWER 2 DOSAGE	TOWER 1 DOSAGE
100	487	1312	1012
95	450	1837	1425
90	862	862	4185
85	825	3675	2247
80	1087	4237	2227
75	1500	5287	4417
70	2700	7687	5287
65	3037	5850	11508
60	3150	5100	12975
55	3712	11250	10837
50	5812	14066	11625
45	6862	15035	17476
40	7788	12375	17243
35	12562	24375	21971
30	11850	18638	17863
25	12600	14737	17515
20	14221	16650	31000
15	13756	17100	21467
10	22862	12710	27512
5	17747	28558	18080
3	19440	26000	25200
1	21880	25520	22000

TRIAL A-21 HEIGHT	TOWER 22 DOSAGE	TOWER 21 DOSAGE	TOWER 20 DOSAGE
20		9932	23925
15	9787	13195	39550
10	48212	58725	61500
5	96875	130975	100125
3	110825	126325	100500
1	139500	178125	103850

TRIAL A-21 HEIGHT	TOWER 19 DOSAGE	TOWER 18 DOSAGE	TOWER 17 DOSAGE
35	387	760	1898
30	2712	3840	16507
25	9300	14337	31775
20	15887	27512	51925
15	32167	35262	52800
10	55025	82537	117200
5	49600	104625	141200
3	47662	126325	256000
1	46800	130950	99500

TRIAL A-21 HEIGHT	TOWER 16 DOSAGE	TOWER 15 DOSAGE	TOWER 14 DOSAGE
60	542		
55	637	620	562
50	1317	2208	1356
45	2363	3836	2287
40	5657	6432	4837
35	10152	9842	11512
30	16042	24800	25962
25	28287	22320	30612
20	30225	27125	34500
15	47275	43012	33600
10	49600	38750	42800
5	55412	53600	50400
3	43012	62800	61500
1	49987	38362	59287

TRIAL A-21 HEIGHT	TOWER 12 DOSAGE	TOWER 11 DOSAGE	TOWER 10 DOSAGE
75			487
70	906		426
65	761	787	1705
60	2287	1462	2363
55	3187	2962	6525
50	6000	4012	5925
45	8120	5115	6487
40	10762	8587	10312
35	13012	10275	11625
30	22537	12375	26250
25	19312	15383	18173
20	23100	17205	23887
15	20537	20072	29625
10	30000	31775	28675
5	26350	27512	35262
3	34487	32800	39912
1	28000	20498	25875

TRIAL A-21 HEIGHT	TOWER 3 DOSAGE	TOWER 2 DOSAGE	TOWER 1 DOSAGE
100	637	580	
95	712	1156	412
90	1051	1087	580
85	1462	1703	1012
80	2102	2320	1312
75	2791	3842	1612
70	4462	3588	2362
65	11625	4950	3412
60	12862	6488	4462
55	14101	8808	8025
50	9412	7032	7425
45	9600	12375	7162
40	10657	10537	12283
35	11382	13612	13097
30	14400	12637	11780
25	14391	15337	15616
20	16612	19462	17825
15	15712	23562	17437
10	18632	20305	17512
5	24000	18057	22475
3	18450	18677	27125
1	21450	18483	26040

TRIAL B -7 HFIGHT	TOWER 1 DOSAGE	TOWER 2 DOSAGE	TOWER 3 DOSAGE
25	8		
20	22		40
15	19	17	29
10	28	86	54
5	35	85	63
3	59	85	78
1	58	74	65

TRIAL B -7 HFIGHT	TOWER 4 DOSAGE	TOWER 5 DOSAGE	TOWER 6 DOSAGE
35			5
30	3	3	21
25	10	12	36
20	12	12	44
15	16	20	43
10	17	35	31
5	23	28	33
3	27	30	26
1	26	26	26

TRIAL B -7 HEIGHT	TOWER 7 DOSAGE	TOWER 8 DOSAGE	TOWER 9 DOSAGE
65	1		
60	1		
55	1		
50	1		
45	2	2	1
40	4	1	4
35	6	4	8
30	9	12	16
25	14	17	20
20	17	22	17
15	20	26	24
10	21	25	27
5	24	26	25
3	23	23	26
1	18	19	27

TRIAL B -7 HEIGHT	TOWER 10 DOSAGE	TOWER 11 DOSAGE	TOWER 12 DOSAGE
60		1	
55		1	
50		1	1
45	2	2	2
40	4	3	3
35	9	6	5
30	13	12	12
25	16	17	14
20	18	19	19
15	24	20	23
10	21	20	22
5	22	21	25
3	22	20	24
1	21	18	21

TRIAL B -7 HEIGHT	TOWER 20 DOSAGE	TOWER 21 DOSAGE	TOWER 22 DOSAGE
80		1	1
75	1	2	2
70	1	3	2
65	1	3	4
60	2	3	6
55	2	4	7
50	5	6	9
45	5	8	9
40	7	11	11
35	1	12	13
30	11	13	15
25	13	15	16
20	18	15	15
15	15	19	13
10	15	16	13
5	14	16	14
3	13	15	13
1	13	13	12

TRIAL B -8 HEIGHT	TOWER 22 DOSAGE	TOWER 21 DOSAGE	TOWER 20 DOSAGE
30	1		
25	16	3	
20	49	42	35
15	45	42	49
10	74	50	67
5	56	67	70
3	43	63	75
1	31	49	53

TRIAL B -8 HEIGHT	TOWER 19 DOSAGE	TOWER 18 DOSAGE	TOWER 17 DOSAGE
45		1	
40	5	2	
35	9	5	1
30	10	3	6
25	8	17	18
20	9	22	31
15	12	35	36
10	17	28	41
5	18	30	31
3	19	26	23
1	18	26	20

TRIAL B -8 HEIGHT	TOWER 16 DOSAGE	TOWER 15 DOSAGE	TOWER 14 DOSAGE
70	1	1	
65	1	2	1
60	3	2	1
55	5	4	2
50	8	4	2
45	15	6	3
40	12	7	4
35	15	9	6
30	13	11	16
25	4	13	13
20	15	16	13
15	17	15	12
10	14	15	13
5	13	15	12
3	5	14	13
1	15	15	11

TRIAL B -8 HEIGHT	TOWER 12 DOSAGE	TOWER 11 DOSAGE	TOWER 10 DOSAGE
100		1	1
95		1	1
90		1	1
85		2	1
80	1	2	2
75	2	3	3
70	3	4	3
65	4	4	4
60	4	6	6
55	4	6	8
50	5	6	10
45	5	7	12
40	6	9	14
35	4	10	12
30	7	12	15
25	7	13	19
20	8	15	14
15	8	15	19
10	9	15	22
5	8	15	19
3	8	14	19
1	8	14	19

TRIAL B -8 HEIGHT	TOWER 3 DOSAGE	TOWER 2 DOSAGE	TOWER 1 DOSAGE
100	2	1	1
95	3	3	1
90	2	2	2
85	3	2	2
80	3	3	2
75	4	2	2
70	4	4	4
65	5	4	5
60	5	5	5
55	6	6	6
50	7	6	6
45	6	7	7
40	6	8	8
35	7	7	9
30	7	8	9
25	8	8	10
20	7	10	10
15	9	10	12
10	8	11	12
5	8	10	12
3	7	11	12
1	8	12	11

TRIAL R -9 HFIGHT	TOWER 22 DOSAGE	TOWER 21 DOSAGE	TOWER 20 DOSAGE
40		1	
35		2	
30	3	2	3
25	7	3	20
20	20	8	44
15	81	30	63
10	76	83	69
5	78	75	67
3	71	70	62
1	70	65	67

TRIAL R -9 HFIGHT	TOWER 19 DOSAGE	TOWER 18 DOSAGE	TOWER 17 DOSAGE
50	1		
45		1	
40	4	4	4
35	11	4	13
30	30	10	23
25	42	16	28
20	40	23	46
15	24	24	45
10	35	30	44
5	20	24	37
3	42	31	8
1	42	33	

TRIAL R -9 HFIGHT	TOWER 16 DOSAGE	TOWER 15 DOSAGE	TOWER 14 DOSAGE
100			
95			
90	1		
85		1	
80	10	2	
75	11	3	
70	1	3	1
65	2	4	1
60	3	4	1
55	6	5	2
50	7	6	4
45	9	8	6
40	14	9	6
35	15	8	9
30	19	8	12
25	21	18	14
20	21	21	19
15	24	27	24
10	24	25	24
5	17	26	8
3	24	25	22
1	26	24	24

TRIAL B -9 HFIGHT	TOWER 12 DOSAGE	TOWER 11 DOSAGE	TOWER 10 DOSAGE
100			
95		1	
90	1	1	1
85	1	2	2
80	1	3	1
75	1	3	1
70	4	4	1
65	6	4	2
60	8	8	4
55	10	8	5
50	11	9	6
45	12	11	9
40	12	14	9
35	13	12	12
30	14	17	14
25	15	15	21
20	12	17	20
15	13	18	21
10	13	21	22
5	12	18	22
3	13	18	20
1	13	19	5

TRIAL B -9 HFIGHT	TOWER 3 DOSAGE	TOWER 2 DOSAGE	TOWER 1 DOSAGE
100	3	2	1
95	3	2	1
90	3	2	1
85	3	3	2
80	3	3	2
75	3	3	2
70	4	4	3
65	5	5	3
60	5	6	4
55	5	7	5
50	6	8	5
45	8	9	6
40	8	10	6
35	7	12	6
30	7	12	8
25	6	13	8
20	7	12	9
15	7	14	9
10	8	13	9
5	6	16	10
3	7	16	9
1	6	13	8

TRIAL B-10 HEIGHT	TOWER 1 DOSAGE	TOWER 2 DOSAGE	TOWER 3 DOSAGE
20		9	41
15	3	70	188
10	126	374	309
5	355	427	87
3	486	359	576
1	459	400	99

TRIAL B-10 HEIGHT	TOWER 4 DOSAGE	TOWER 5 DOSAGE	TOWER 6 DOSAGE
40	4		
35	2	1	
30	59	4	5
25	116	25	13
20	83	29	32
15	128	69	103
10	155	110	49
5	152	138	161
3	146	133	163
1	153	120	61

TRIAL B-10 HEIGHT	TOWER 7 DOSAGE	TOWER 8 DOSAGE	TOWER 9 DOSAGE
60	2		
55			
50	6		1
45	4	5	3
40	23	9	9
35	26	12	20
30	39	18	4
25	39	26	9
20	41	38	51
15	47	2	36
10	55	15	70
5	40	27	88
3	62	12	77
1	17	63	62

TRIAL B-10 HEIGHT	TOWER 10 DOSAGE	TOWER 11 DOSAGE	TOWER 12 DOSAGE
85		1	
80			
75			
70	1	1	1
65	2	2	1
60	4		2
55	6	6	2
50	10	10	3
45	11	17	11
40	19	29	17
35	28	31	26
30	34	41	39
25	34	33	44
20	7	62	47
15	54	49	55
10	28	56	69
5	51	64	23
3	59	23	5
1	59	9	83

TRIAL B-10 HEIGHT	TOWER 20 DOSAGE	TOWER 21 DOSAGE	TOWER 22 DOSAGE
80	1		
75	1		1
70	2	1	2
65	4	2	4
60	7	5	6
55	10	9	9
50	14	13	13
45	19	18	17
40	23	24	23
35	28	28	27
30	32	30	34
25	36	35	38
20	38	38	42
15	42	38	48
10	39	38	58
5	40	42	50
3	37	39	46
1	38	32	43

CROSSWIND DOSAGE

TRIAL A-19

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
M-144	138837	160587	142100
M-148	125062	135375	155825
M-152	128887	114900	128700
M-156	99750	113750	145925
M-160	147550	131962	148925
M-164	147537	154200	184150
M-168	131962	152887	145462
M-172	139725	112512	135675
M-176	136150	155587	170800
M-180	105125	90450	80400
M-184	70500	40425	67850
M-188	80850	68850	86450
M-192	67837	95175	87750
M-196	116775	87750	83025
M-200	57750	62425	61750
M-204	43462	53662	49750
M-208	22550	64600	45150
M-212	87000	87525	89375
M-216			
M-220	145750	103250	119625
M-224	141750	139062	158887
M-228	178500	162150	174000
M-232	114500	100600	
M-236			
M-240			
M-244			
M-248			
M-252			

CROSSWIND DOSAGE

TRIAL A-20

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
P-144	34000	42000	47600
P-148	51200	48675	32587
P-152	38775	38362	45200
P-156	35200	31775	31775
P-160	36400	33200	29600
P-164	25600	27200	29600
P-168	26812	29287	28462
P-172	48800	36400	48000
P-176	48800	73600	53087
P-180	34650	33200	27225
P-184	37950	38400	38000
P-188	44400	34400	36400
P-192	36300	40012	49087
P-196			
P-200			
P-204	34800	45600	36000
P-208	42400	35600	39600
P-212	75175	68400	50400
P-216	28800	39600	41250
P-220	38062	30187	32812
P-224	46500	41850	36037
P-228			
P-232	36425	43400	31387
P-236	29062	29450	6680
P-240	25600	29062	24040
P-244	31000	24412	32550
P-248	29625	26001	31125
P-252	31000	44175	28400

CROSSWIND DOSAGE

TRIAL A-21

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
P-144	44950	24412	49600
P-148	48437	48400	37200
P-152	56575	52700	51527
P-156	48000	46112	39137
P-160	64712	57350	55412
P-164	52700	59287	65875
P-168	30612	30612	31600
P-172	50325	45725	57600
P-176	54375	51150	42750
P-180	37587	54250	48300
P-184	41850	48825	35500
P-188	46500	47275	40687
P-192	32800	34800	37600
P-196	37587	40687	35625
P-200	27512	35262	30612
P-204	45725	43500	38362
P-208	36000	37125	44250
P-212	37875	24800	38250
P-216	32250	22125	27000
P-220	25187	27375	27750
P-224	23250	28875	29625
P-228	39375	50250	42375
P-232	33000	28125	33000
P-236	25962	34487	37587
P-240	46887	35262	33750
P-244	27125	32000	27900
P-248	29250	34125	15750
P-252	15375	24000	25737

CROSSWIND DOSAGE

TRIAL B- 7

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
M-144			
M-148	21	20	22
M-152	25	29	30
M-156	25	23	28
M-160	31	32	35
M-164	24	31	23
M-168	15	18	19
M-172	23	24	26
M-176	15	16	19
M-180	18	18	18
M-184	17	20	17
M-188	26	26	26
M-192	19	21	20
M-196	20	22	21
M-200	22	22	21
M-204	20	22	23
M-208	32	31	29
M-212	21	23	24
M-216	21	22	24
M-220	18	20	21
M-224	27	28	25
M-228	20	19	20
M-232			
M-236	22	29	34
M-240			
M-244	26	28	28
M-248	21	17	21
M-252	11	14	13

CROSSWIND DOSAGE

TRIAL B- 8

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
P-144	7	9	26
P-148	23	16	18
P-152	14	15	16
P-156	21	19	15
P-160	8	10	9
P-164	9	12	11
P-168	13	13	16
P-172	16	18	16
P-176	16	18	15
P-180	10		13
P-184	12	15	15
P-188	8	9	9
P-192	14	14	17
P-196	15	14	16
P-200	10	10	11
P-204	14	11	11
P-208	15	15	15
P-212	5	12	6
P-216	17	17	16
P-220	16	18	17
P-224	9	11	12
P-228	11	15	13
P-232	15	19	18
P-236	12	10	12
P-240	9	9	11
P-244	14	14	14
P-248	12	13	13
P-252	18	21	20

CROSSWIND DOSAGE

TRIAL B- 9

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
P-144	23	20	27
P-148	2	20	26
P-152	1	1	19
P-156	27	29	31
P-160	20	25	22
P-164	26	27	32
P-168	19	20	19
P-172	11	13	14
P-176	41	46	27
P-180	23	26	27
P-184	15	17	20
P-188	12	8	7
P-192	13	16	17
P-196	18	21	22
P-200	15	14	16
P-204	14	17	14
P-208	15	17	18
P-212	12	14	15
P-216	11	12	12
P-220	4	18	18
P-224	15	18	8
P-228	17	17	15
P-232	18	19	17
P-236	16	16	9
P-240	22	22	25
P-244	24	19	19
P-248	19	19	23
P-252	20	21	8

CROSSWIND DOSAGE

TRIAL B-10

GRID POSITION	DOSAGE (1-FT)	DOSAGE (3-FT)	DOSAGE (5-FT)
M-144	50	50	44
M-148	63	72	64
M-152	54	53	52
M-156	49	53	20
M-160	48	54	59
M-164	45	45	23
M-168	50	53	55
M-172	34	43	43
M-176	52	73	67
M-180	78	75	71
M-184	57	59	56
M-188	55	49	54
M-192	75	68	61
M-196	63	56	68
M-200	61	63	51
M-204	55	55	58
M-208	73	76	59
M-212	66	69	35
M-216		61	82
M-220	24	11	58
M-224	60		62
M-228	73	86	76
M-232	57	59	64
M-236	56	49	63
M-240	30	69	60
M-244	66	76	80
M-248	66	71	73
M-252	84	62	75

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
VERTICAL DOSAGE DISTRIBUTION INSTANTANEOUS GROUND-LEVEL LINE-SOURCE VERTICAL EXPANSION RATES OF AEROSOL CLOUDS FIELD MEASUREMENTS DUGWAY PROVING GROUND - SITE OF EXPERIMENTS						

INSTRUCTIONS

1. **ORIGINATING ACTIVITY:** Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.
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12. **SPONSORING MILITARY ACTIVITY:** Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.
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