LONG RANGE FALLOUT FROM SEDAN

AND SMALL BOY

By

Philip W. Krey
Ralph E. Fried

A Report on Work Performed Under Contract No. AT (30-1) 3055

Prepared For

U. S. Atomic Energy Commission
Fallout Studies Branch
Division of Biology and Medicine

October 8, 1964

ISOTOPES, INC.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LONG RANGE FALLOUT FROM SEDAN

AND SMALL BOY

By

Philip W. Krey
Ralph E. Fried

A Report on Work Performed Under Contract No. AT (30-1) 3055

Prepared For

U. S. Atomic Energy Commission
Fallout Studies Branch
Division of Biology and Medicine

October 8, 1964

Isotopes, Inc.

i

DISTRIBUTION

A. Klement 4 copies

Atomic Energy Commission, N. Y. Office 2 copies

ISOTOPES, INCORPORATED

P. Krey 3 copies

H. Feely 1 copy

J. Friend 1 copy

A. Walton 1 copy

J. Hardaway 1 copy

D. Bensen 1 copy

R. Fried 1 copy

F. Bazan 1 copy

R. Lagomarsino 1 copy

R. Schultz 1 copy

TABLE OF CONTENTS

	Page
ABSTRACT	v
I Objectives	1
II Sampling Sites	1
A. Mobile Line Stations	1
B. Fixed Line Stations	1
III Instrumentation	2
A. High-Volume Air Sampler	2
B. Fallout Collector	2
IV Measurements	3
V Results	4
A. Gamma Decay Measurements	4
B. Gross Gamma Analyses	4
C. Gamma Spectrum Analyses	5
D. Sedan Radiochemical Analyses	6
E. Small Boy Radiochemical Analyses	8
VI Conclusions	9
VII List of Tables	10
VIII List of Figures	17

LIST OF TABLES

1. DPM Ratios to MO-99 at Shot Time for Sedan Air Filter Samples Adjusted for Background
2. DPM Ratios to MO-99 at Shot Time for Sedan Fallout Collectors Adjusted for Background
3. MO-99 F Values for Average Sedan Data
4. Sedan MO-99 Ratios of Air Filter Samples/MO-99 Ratios of Fallout Collector Samples
5. DPM Ratios to MO-99 at Shot Time for Small Boy Air Filter Samples Adjusted for Background
6. DPM Ratios to MO-99 at Shot Time for Small Boy Fallout Collector Samples Adjusted for Background
7. MO-99 F Values for Average Small Boy Data

LIST OF FIGURES

1. Location of Sedan and Small Boy Sampling Sites
2. Staplex High-Volume Air Sampler
3. Fallout Collector
4. Meteorological Trajectories - Sedan
5. Meteorological Trajectories - Small Boy
6. Gross Gamma Decay of Sedan and Small Boy Air Filter Samples
7. Sedan Total Gamma Activities, Mobile Line Sites
8. Small Boy Total Gamma Activities, Mobile Line Sites
9. Comparison of Sedan and Small Boy Gamma Spectrum

ABSTRACT

A sampling network was established across the United States to collect debris from the Sedan and Small Boy shots. Gross gamma assays, gamma decay measurements, gamma spectrum analyses and radiochemical analyses were performed on retrieved samples. Sedan which was an underground burst produced a cloud which was fairly homogeneous and highly fractionated. Small Boy, a surface burst, gave a heterogeneous cloud and even greater fractionation effects than Sedan. MO-99 at both shots behaved as a refractory material and did not represent an ideal tracer of fission product debris.

I OBJECTIVES

In the spring of 1962 Isotopes, Inc. undertook to collect, analyze and characterize fallout from sub-surface and surface type bursts at intermediate and long-range downwind distances from ground zero. The nuclear bursts studied were the Sedan and Small Boy shots at Operation Sun Beam. Sedan has been announced as approximately a 100 KT total yield with less than 30 KT fission; Small Boy is referred to as a low yield surface burst⁽¹⁾.

II SAMPLING SITES

To accomplish this task three lines of sampling stations extending in a north-south direction were established across the country (Figure 1). The most westerly line for the Sedan shot consisted of 12 stations situated about 15 miles apart at a distance of approximately 630 miles from Ground Zero. The length of this sampling line was 170 miles and extended northward from Antelope to Mayoworth, Wyoming. Since the trajectory of the cloud could not be predicted accurately enough to permit pre-shot installation of the sampling sites, this most westerly line had to have the capability of being rapidly deployed after the shot when better meteorological data were available. This rapid deployment was accomplished with a DC-3 aircraft assigned to the sampling crew and local commercial automobile rentals. For these reasons, this line of stations was called the mobile line. At the Small Boy shot, the mobile line extended from Walsenburg in southern Colorado to Brighton in the northern part of the state.

A second line of 11 stations, about 1,000 miles from Ground Zero and approximately 1,100 miles long, extended from Abilene, Texas, to Williston, North Dakota. A third line of 9 stations, 1,400 miles from Ground Zero and also 1,100 miles long, extended from Jackson, Mississippi, to International Falls, Minnesota.

First order Weather Bureau Stations along these lines were used as sampling sites. Since these sites were not movable in contrast to the mobile line, they were referred to as the first and second line of fixed stations. The fixed stations were utilized as sampling sites for both Sedan and Small Boy shots.

III INSTRUMENTATION

Each site on the mobile and first fixed line was equipped with a Hi-Volume Staplex Air Sampler and a fallout collector. The stations on the second fixed line were provided with only the air sampler. The Hi-Vol is shown in Figure 2 with an 8 inch x 10 inch filter holder. A TFA No. 41 ashless filter paper was employed which is rated at 95 percent collection efficiency for particles as small as one micron in diameter. The units were adjusted to a flow-rate of about 50 cfm at the start of the sampling period. The actual flow rate at subsequent times was read from a small rotameter affixed to the rear of the sampler. After the initial adjustment, the flow rate was recorded every 6 hours for a total of five readings over a 24 hour period. The paper was replaced and the cycle repeated until 3 twenty four hour samples were collected. The total volume sampled by each filter paper was determined by plotting these readings as a function of time and integrating the area under the curve.

The fallout collector consisted of a galvanized tray 42 inches long x 33 inches wide and 3 inches deep (see Figure 3). The surface of the collector was about 18 inches above ground and sloped gently toward the center of the tray where a 3/4 inch hole drained into a 5 gallon polyethylene-lined drum beneath the collector. The capacity of the drum was equivalent to 0.83 inches of rain falling on the collecting surface. The active area of the fallout collector was coated with a thin layer of white petroleum jelly to present a tacky surface. Theoretically, the tacky surface minimized redispersion by the wind of the debris which had already been collected. Each collector was exposed for a 72 hour sampling period.

Upon post-shot notification from the Nevada Test Site as to the expected arrival of the clouds at each of the three sampling lines, sampling was begun about 12 hours before the estimated arrival time. These time estimates were based upon the latest meteorological and survey data available. Figure 4 shows the U. S. Weather Bureau's trajectory of the Sedan cloud. There was a wind sheer of the original cloud at 10,000 and 16,800 feet; the higher level of the cloud traveled slightly north of the lower level and at a slower velocity. Both levels of the cloud were intercepted by the mobile line. At Small Boy, Figure 5, a wind sheer occurred again with the 16,000 foot level travelling at a faster velocity than the 10,000 foot level. The two levels crossed at the northern end of the mobile line although the higher level arrived at the stations about 12 hours before the lower level.

IV MEASUREMENTS

All samples collected from both shots were radioassayed on a 3 inch x 3 inch NaI (Tl) crystal in conjunction with a 400 channel pulse height analyzer. The fallout collectors were scrubbed with chloroform and a rubber "Squeegee" to remove all debris from the collection surfaces. The resultant mixtures were evaporated to dryness in 500 ml. nickel crucibles and ashed over a Meeker burner. Any rain or other contents of the 5 gallon drum associated with each collector was combined with the material in the crucible. The mixture in the crucible was finally evaporated to dryness and assayed on the 3 inch x 3 inch crystal.

The total gamma spectrum of each sample including pre-shot background samples was obtained by these measurements. The integration of the activity beneath the spectrum after subtraction of detector background represented the total gamma activity of each sample. Selected filter papers were dry ashed at 440° C, refluxed in nitric and hydrofluoric acids and dissolved in nitric acid.

Specific fallout collector residues were fused with sodium carbonate and dissolved.

These solutions were then analyzed radiochemically for a number of radionuclides.

In the interest of brevity only the results from the mobile lines will be discussed in this paper. While debris from these shots was recognizable at the fixed stations, it was much less pronounced and greatly complicated by background levels.

IV RESULTS

A. Gamma Decay Measurement

The gross gamma decay rate of a Sedan air filter sample is plotted as individual points in Figure 6. The decay rate of similar Small Boy debris is normalized to these points and drawn as the solid and dotted lines. It is clear that the gross gamma decay rates of the samples from both events are identical during the period of measurement. Plotted on log paper, the data follow the expression

$$A = A_1 t^{-0.89}$$

Where A = activity at time t after fission

A_1 = activity at unit time after fission

The exponent of the time is greater than the -1.2 usually employed. It is interesting that the debris from two such widely different events decay at exactly the same rate.

B. Gross Gamma Analyses

The plot of the gross gamma activity versus site location for the Sedan mobile line is given in Figure 7. The activity for each post-shot sample was corrected to 1000 hours on D+1 using an extrapolation of the Sedan gross gamma decay curve (Figure 6). The background levels reflected in Figure 7 are the activity of a pre-shot fallout collector assayed on D+10. Since the background samples were

not followed for decay, it is impossible to correct the data to a previous time. The background may constitute a major part of the activity of the first day of air sampling, but it is of little consequence to subsequent days. With this restriction in mind, Figure 7 reveals the collection of fresh activity at all sites on the first day of sampling with higher concentrations in the southern half of the line. The activity on the second day is diffused throughout the arc with concentrations again generally higher in the southern sector. Prominent peaks are observed for the 72 hour fallout collector samples at Douglas and Antelope; significantly, these samples both contained a large rainfall component. Activities on the third day of sampling are lower by a factor of two or three than those on the previous day; the distribution of concentrations approximates those of the first day of sampling.

The total gamma activities of the Small Boy mobile line stations corrected to 1130 hours on D+1 but uncorrected for background contribution are shown in Figure 8. The pre-shot air filter was counted on D+4 while the background fallout collector was assayed on D+9. The background could have amounted to about half the total activities in the post-shot samples particularly in the southerly stations. However, the presence of fresh debris is clear and the relationships between samples should not be seriously hampered. Figure 8 shows a sharply defined peak in total gamma activity at the northern extremity of the line for each of the three days of sampling. It is evident that not only was the mobile line situated too far south to provide for a central interception of the cloud, but that sampling in the southern sector of the line was discontinued too early.

C. Gamma Spectrum Analyses

The gamma spectrum analyses did not uncover any pronounced effects except for the presence of induced tungsten 181 in the Sedan fallout. Particular attention was given to identifying sodium -24 in the Sedan underground burst debris, but

none could be found. The spectra permitted easy identification of fresh debris and they verified the conclusions drawn from the gross gamma considerations. A comparison of the spectra from the two shots is given in Figure 9. The spectra of two air filter samples collected at about the same time after each shot and assayed at about the same elapsed time after each detonation are normalized to the 1.60 Mev photopeak of La -140. The weaker energy emitters possibly associated with Te -132, I -132, I-131, Mo-99, Ru -103 and Ru -106 are in slightly greater abundance relative to La -140 in the Small Boy debris as compared to the Sedan material. However, as was observed, these differences did not bring about any marked variations in the rate of gamma decay of the debris from each shot.

D. Sedan Radiochemical Analyses

It was found that the measured pre-Sedan shot levels of Sr -90, Y -91, Zr -95, Ru -106 and Ce -144 at the mobile line which resulted mainly from stratospheric fallout represented a large fraction of the total activities of these nuclides collected in post-Sedan samples. It is likely that the background levels vary significantly from day to day depending upon local meteorological conditions. Therefore, the background levels determined for a period of time at one location on the sampling line may not be directly applicable to another location on the same line at another time. Consequently, interpretations involving these radionuclides must be made with this reservation in mind.

The disintegrations per minute (DPM) ratios of the various fission products to Mo -99 corrected to shot time are given in Table 1 for the air filter samples collected from D+2 to D+3. These values are adjusted for the pre-shot background levels. The theoretical ratios for the thermal fission of U -235 by Katcoff⁽²⁾ and the 14 Mev neutron fission of U -238 by Dolan⁽³⁾ are listed in Table 1 for reference. Presumably the production ratios for the Sedan shot would be closer to Dolan's figures. There are no obvious trends in the data with collection site which suggests

that the two levels in the cloud were not fractionated with respect to each other. The zeros in Table 1 represent the situation where no measurable activity was found or where the measured activity was less than the background activity. Comparing the average ratios with Dolan's values shows a deficiency of Zr -95, Ce -141 and Ce -144 with respect to Mo -99 in the airborne particulate matter of the Sedan debris. Sr -89, Sr -90, Y -91, Cs -137 and Ba -140 are nuclides with rare gaseous or volatile precursors. Because of their volatile precursors, all of these nuclides show a surplus to Mo -99 compared to Dolan's production values. Ruthenium has volatile oxides, and both Ru -103 and Ru -106 reflect an overabundance with respect to Mo -99. However, it is likely that the 103 and 106 mass chains would be present as their respective Nb or Mo precursors during the time of radioactive particle formation.

The DPM ratios to Mo -99 at shot time adjusted for background levels are given in Table 2 for the fallout collector samples. As for the air filter samples, there is no observable trend with collection site. The Zr -95 behaves as a refractory exhibiting a deficiency in the fallout while the Sr -89, Sr -90, Y -91, Ru -103, Ru -106, Cs -137 and Ba -140 show a surplus. Contrary to the air filter samples, Ce -141 and Ce -144 also show a surplus with respect to Mo -99 although there are several zeros for these nuclides in Table 2. These zeros may be the result of the uncertainty in the background values subtracted. A plausible explanation for all the measured fission products except Zr -95 showing a surplus to Mo -99 is that Mo -99 is not a good reference nuclide and is itself deficient in the fallout collector debris. This is not unreasonable because Mo -99 would most probably be present as refractory Y -99 or Zr -99 at the time of radioactive particle formation in the Sedan cloud.

If we define an F value, a fractionation index, as the observed DPM ratio to Mo -99 divided by Dolan's production ratio to Mo -99, the F value will indicate the intensity of the fractionation which occurred at the Sedan event. A value of unity would indicate no fractionation. Table 3 gives the F values for the average of the air filter and fallout collector samples. F values in excess of 100 for Sr -89 and Cs -137 reflect extreme departure from ideal behavior.

The relationship of the air filter samples to the fallout collector samples can be described by dividing the ratios to Mo -99 in the one type of sample by the same ratio in the other (see Table 4). This calculation assumes that Mo -99 behaves as an ideal tracer of the fission products and does not fractionate with respect to particle size. The values greater than unity in Table 4 reflect a preferential association of the volatile nuclides with the smaller particles collected in the air filter samples as compared to the larger particles of the fallout collector samples. The opposite is true for Ce -141 and Ce -144 which exhibit a preference for the larger particles of the fallout collector samples.

E. Small Boy Radiochemical Analyses

The DPM ratios to Mo -99 for the Small Boy air filters adjusted for background levels are reported in Table 5. All samples were collected from D+2 to D+3 except for the last two in the table which were collected from D+3 to D+4. Some of the nuclides exhibit trends with geographical location. Sr -90, Zr -95 and Cs -137 increase with southerly direction while Ba -140 appears to decrease slightly in that direction. All of the nuclides except Ce -141 show a surplus compared to either of the reference production ratios. This behavior is particularly surprising for refractory nuclides like Zr -95 and Ce -144. As in the case of the Sedan fallout collector samples, the pattern suggests that Mo -99 is behaving as a refractory material.

Table 6 gives the DPM ratios to Mo -99 of the fallout collector samples

from Small Boy adjusted for background contribution. Severe fractionation among samples is clearly evident from these data. All of the ratios either peak around Monument, Colorado, or increase with southerly collection. Once again, Mo -99 is best described as being a refractory material. A possible explanation of the wide variations displayed in Table 6 is derived from the cloud sheer. Because of its more southerly swing near the sampling line, the lower 10,000 foot level might have contributed more debris to the southern stations than to the northern ones. As far as the cloud at the sampling location is concerned, the one from the underground Sedan burst was much more homogeneous than the cloud from the surface Small Boy shot.

F values to Mo -99 for the average ratios given in Tables 5 and 6 are presented in Table 7. Average ratios for the fallout collector samples are not very meaningful because of the large range in the data, but the F values give some indication of the magnitude of the fractionation at Small Boy. A comparison of Tables 3 and 7 shows that the air filter samples are less fractionated at Small Boy than they are at Sedan. The opposite is true for the fallout collector samples; that is, they are more fractionated at Small Boy than they are at Sedan which is a surprising observation.

VI CONCLUSIONS

This program has proven the feasibility of collecting off site samples at long downwind distances from nuclear detonations. Debris from Sedan depicts the cloud from an underground burst to be fairly homogeneous and highly fractionated. Small Boy, a surface burst, gave a heterogeneous cloud and even greater fractionation effects than Sedan. Mo -99 at both shots behaved as a refractory material and does not represent an ideal tracer of fission product debris.

VII LIST OF TABLES

Table 1

DPM Ratios to Mo -99 at Shot Time for Sedan Air Filter Samples Adjusted for Background

Sample	Sr -89	Sr -90 (10 ⁻³)	Zr -95 (10 ⁻²)	Y -91 (10 ⁻¹)	Ru -103 (10 ⁻¹)	Ru -106 (10 ⁻²)	Cs -137 (10 ⁻²)	Ba -140	Ce -141 (10 ⁻²)	Ce -144 (10 ⁻²)
Kaycee #107	2.54	7.25	0	2.16	5.50	14.0	4.58	2.39	0	1.9
Midwest #167	2.24	4.31	0	1.52	2.60	4.08	2.48	1.92	11.0	0
Casper ATT #142	2.99	7.00	0	2.10	2.28	4.05	3.97	3.98	0	0
Casper ATT #157	3.39	9.59	0	3.12	2.77	4.7	5.26	4.06	0	0
Casper #117	3.60	6.06	0	2.60	2.81	2.92	4.66	3.45	0	15.7
Orin #112	2.19	8.93	0	2.30	2.38	6.74	4.92	2.15	0	0
Pepperville #173	4.32	8.49	2.60	2.57	2.81	0.67	6.06	3.94	0	0
Average	3.04	7.38	~0	2.34	3.01	5.31	4.56	3.13	~0	~0
Katcoff Th U -235	0.0434	0.258	4.4	~0.43	0.34	0.047	0.0257	0.227	~8.3	~0.98
Dolan 14 Mev U -238	0.0248	0.144	3.49	0.287	0.545	0.356	0.0268	0.170	6.27	0.559

Isotopes, Inc.

Table 2

DPM Ratios to Mo -99 at Shot Time for Sedan Fallout Collectors Adjusted for Background

Sample	Sr -89 (10^{-1})	Sr -90 (10^{-3})	Zr -95 (10^{-2})	Y -91 (10^{-2})	Ru -103 (10^{-2})	Ru -106 (10^{-2})	Cs -137 (10^{-3})	Ba -140 (10^{-1})	Ce -141 (10^{-2})	Ce -144 (10^{-2})
Mayworth #62	4.08	1.34	0	8.05	18.7	5.01	3.83	4.80	9.76	2.34
Ranch 13 #74	4.70	1.62	Lost	3.64	17.0	3.69	7.29	7.78	12.3	0
Midwest #100	5.80	1.97	0	8.14	5.49	0	12.8	6.76	61.4	9.38
Casper ATT #64	6.46	2.57	Lost	8.93	1.94	0.87	16.1	10.0	4.42	0.701
Casper ATT #75	7.05	2.54	Lost	9.45	3.30	1.8	16.4	10.9	6.09	0.35
Casper #66	5.89	2.37	0	7.34	14.6	2.20	9.89	7.85	19.8	0.542
Orin #72	4.98	1.51	16.6	6.74	8.38	2.20	8.89	7.24	0	0
Pepperville #68	7.22	3.70	0	12.4	9.18	1.0	13.9	10.5	22.3	3.92
Antelope #71	3.54	1.16	Lost	4.21	0.875	0	6.52	4.84	3.47	0
Average	5.22	2.09	~0	7.66	8.83	1.86	10.6	7.85	15.5	1.91
Katcoff Th U -235	0.434	0.258	4.4	~4.3	3.4	0.047	0.257	2.27	~8.3	0.98
Dolan 14 Mev U -238	0.248	0.144	3.49	2.87	5.45	0.356	0.268	1.70	6.27	0.559

Isotopes, Inc.

Table 3

Mo -99 F Values for Average Sedan Data

<u>Nuclide</u>	<u>Air Filter Sample</u>	<u>Fallout Collector Sample</u>
Sr -89	122	21
Sr -90	51	14
Y -91	8.2	2.7
Ru -103	5.5	1.6
Ru -106	15	5.2
Cs -137	178	40
Ba -140	18	4.6
Ce -141	-	2.5
Ce -144	-	3.4

Table 4

Sedan Mo -99 Ratios of Air Filter Samples/Mo -99 Ratios of Fallout Collector Samples

<u>Sr -89</u>	<u>Sr -90</u>	<u>Y -91</u>	<u>Ru -103</u>	<u>Ru -106</u>	<u>Cs -137</u>	<u>Ba -140</u>	<u>Ce -141</u>	<u>Ce -144</u>
5.8	3.5	3.0	3.4	2.8	4.3	4.0	0	0

Table 5

DPM Ratios to Mo -99 at Shot Time for Small Boy Air Filter Samples Adjusted for Background

Sample	Sr -89 (10^{-1})	Sr -90 (10^{-3})	Zr -95 (10^{-2})	Y -91 (10^{-2})	Ru -103 (10^{-1})	Ru -106 (10^{-2})	Cs -137 (10^{-3})	Ba -140 (10^{-1})	Ce -141 (10^{-2})	Ce -144 (10^{-2})
Brighton #545	1.33	2.14	4.95	7.02	0.921	2.27	3.91	6.91	0	3.93
Denver #518	1.15	2.26	5.17	6.53	2.49	3.22	3.61	6.35	10.4	2.90
Denver #562	1.16	1.96	4.80	7.27	Lost	Lost	3.34	6.20	8.42	2.91
Parker #547	1.40	3.06	7.46	8.63	1.72	3.01	6.28	4.96	0	1.2
Castle Rock #553	0.936	4.28	8.74	6.52	0	1.3	6.49	4.60	0	5.55
Monument #554 *	1.60	6.12	17.3	0.2	0.44	0	7.14	4.62	0	11.1
Colorado Springs #753 *	1.75	5.1	15.2	9.48	3.47	6.96	10.4	3.98	0	5.1
Average	1.33	3.56	9.09	6.52	1.51	2.79	5.88	5.37	~0	4.67
Katcoff Th U -235	0.434	0.258	4.4	~4.3	0.34	0.047	0.257	2.27	~8.3	~0.98
Dolan 14 Mev U -238	0.248	0.144	3.49	2.87	0.545	0.356	0.268	1.70	6.27	0.559

* These samples collected from D+3 to D+4. All others were collected from D+2 to D+3.

Table 6

Sample	DPM Ratios to Mo -99 at Shot Time for Small Boy Fallout Collector Samples Adjusted for Background									
	Sr -89 (10^{-2})	Sr -90 (10^{-2})	Zr -95 (10^{-1})	Y -91 (10^{-1})	Ru -103 (10^{-2})	Ru -106 (10^{-2})	Cs -137 (10^{-2})	Ba -140 (10^{-1})	Ce -141 (10^{-1})	Ce -144 (10^{-1})
Brighton #344	4.22	0.512	1.00	0.664	9.26	4.13	0.758	3.02	1.78	2.18
Denver #343	4.62	0.153	2.51	0.742	0	0.511	0.460	1.57	1.22	0.791
Denver #345	6.09	0.258	3.51	0.865	0	0.23	0.436	1.95	1.54	0.626
Parker #342	7.97	0.877	1.80	1.63	6.99	12.9	1.57	6.52	4.53	1.87
Castle Rock #341	22.5	3.02	5.48	3.98	4.36	0.13	2.14	8.48	3.91	5.20
Monument #340	99.8	18.4	24.5	18.3	90.8	67.1	18.4	5.66	4.94	5.30
Colorado Springs #339	30.1	4.33	2.8	6.10	57.8	5.38	6.13	5.78	0	9.22
Pinon #338	14.5	1.85	15.8	5.76	18.1	2.7	1.82	5.50	7.94	8.19
Average	24.0	3.7	7.2	4.8	23.0	12.0	4.0	4.8	3.2	4.2
Katcoff Th U -235	4.34	0.0258	0.44	~0.43	3.4	0.047	0.0257	2.27	~0.83	~0.098
Dolan 14 Mev U -238	2.48	0.0144	0.349	0.287	5.45	0.356	0.0268	1.70	0.627	0.0559

Table 7

Mo -99 F Values for Average Small Boy Data

<u>Nuclide</u>	<u>Air Filter Sample</u>	<u>Fallout Collector Sample</u>
Sr -89	5.4	9.7
Sr -90	25	260
Zr -95	2.6	21
Y -91	2.3	17
Ru -103	2.8	4.2
Ru -106	7.8	34
Cs -137	22	150
Ba -140	3.2	2.8
Ce -141	0	5.1
Ce -144	8.4	750

VIII LIST OF FIGURES

FIGURE 1 · LOCATION OF SEDAN AND SMALL BOY SAMPLING SITES

FIGURE 2. STAPLEX HI-VOLUME AIR SAMPLER

FIGURE 3 · FALLOUT COLLECTOR

FIGURE 4 · METEOROLOGICAL TRAJECTORIES — *SEDAN* — DETONATED
JULY 6, 1962 AT 1700Z, DAY/TIME (GCT)

FIGURE 5 · METEOROLOGICAL TRAJECTORIES — *SMALL BOY* — DETONATED JULY 14, 1962 AT 1830 Z, DAY / TIME (GCT)

FIGURE 6 · GROSS GAMMA DECAY OF SEDAN AND
SMALL BOY AIR FILTER SAMPLES

FIGURE 9 · COMPARISON OF SEDAN AND
SMALL BOY GAMMA SPECTRA

BIBLIOGRAPHY

1. Announced Nuclear Detonations 1945-1962, Compiled by the Atmospheric Radioactivity Research Project, Meteorological Research Projects, U. S. Weather Bureau, Washington D. C., Nov. 1963
2. Katcoff, S., Fission-Product Yields from Neutron-Induced Fission, Nucleonics, 18, No. 11, 200-208 (Nov. 1960)
3. Dolan, P. J., Calculated Abundances and Activities of the Products of High Energy Fission of Uranium -238, D. O. D. Report DASA 525 (May 1959)