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RADIOACTIVE DEBRIS FROM OPERATIONS BUSTER
AND JANGLE

Observations Beyond 200 Miles from the Test Site

Presented by

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*Appendices A and B were given a limited distribution by the New York Operations Office, and is not included in this copy of NYO-1576

SUMMARY

A program for the monitoring of radioactive debris from Operations BUSTER and JANGLE has been conducted in the area beyond 200 miles from the Test Site.

A network of 50 stations located at Weather Bureau installations collected daily samples of settled and air-borne dust. This network was augmented by mobile teams operating immediately beneath the trajectories of the radioactive clouds and aerial collections made along the 85th and 95th meridians.

The program went into operation during the first week in October in order to permit the collection of background data for some weeks prior to the initial test of the BUSTER series. However, two atomic explosions in a foreign country had occurred just prior to the start of this program and background information was thus not obtained.

Data collected by the Weather Bureau stations were reported daily and cumulatively. For the combined BUSTER and JANGLE tests, the highest activities occurred along the East Coast. As was the case during RANGER and GREENHOUSE, the community in which the highest fallout occurred was Rochester, New York, where the total fallout extrapolated to February 1, 1952 was approximately 12,000 d/m/ft² (equivalent to 100 millicuries per square mile). The next highest community, Norfolk, Va., reported about 1/5 the Rochester value. The highest activities reported on a single day were those from the collections beginning on November 1 when Rochester reported 360,000 d/m/ft.² from its open tray. On this day, air samples collected by the fixed monitoring stations along the 85th meridian reported up to 570 d/m/M³. Mobile ground level and limited aerial observations were conducted along the 95th meridian during Operation Buster.

During Operation JANGLE, the mobile monitoring teams were deployed at approximately 0 - 45° in the annulus of 200-500 miles from the Test Site. For both JANGLE detonations, the highest radioactive dust concentrations were reported from Elko, Nevada. The 24 hour average concentration at Elko was 44,000 d/m/M³ following the initial detonation and 38,000 d/m/M³ following the second detonation. The maximum values were 360,000 d/m/M³ and 180,000 d/m/M³. The external radiation levels associated with the passage of the debris over Elko did not exceed 2 mr/hour. Although these values are relatively high in comparison with other data from these and previous tests, the average concentrations are very much lower than the permissible exposures established by the JANGLE Feasibility Committee.

Particle size determinations by two independent methods revealed that substantially all the activity was contained within the range of respirable particle sizes.

INTRODUCTION

The planning of Operations BUSTER and JANGLE was accompanied by increased interest in the deposition of radioactive bomb debris at localities remote from the test site. To some extent this was due to the experience of the photographic manufacturers during Operations RANGER and GREENHOUSE when it was observed that radioactive fallout was occurring in sufficient amounts to be significant to their highly radio-sensitive processes.

Abandonment of plans for Operation WINDSTORM and the decision to conduct Operation JANGLE at the continental test site was likewise an important factor in stimulating interest in the matter of radioactive fallout.

The New York Operations Office was requested⁽¹⁾ by the Division of Biology and Medicine, U.S. Atomic Energy Commission, Washington, D.C. to coordinate a program of monitoring for radioactive fallout over the entire United States beyond 200 miles from the test site.

The monitoring program, as described in this report, was designed for the following purposes:

1. To permit prompt and accurate replies to requests for information that might originate from public sources. (The Public Information Service, NYOO, was designated to represent the Commission in responding to queries from the public beyond 200 miles from the test site.)
2. To provide the National Association of Photographic Manufacturers with information requested by them for purposes of process control.
3. To provide a monitoring program appropriate to the special requirements of Operation JANGLE and to evaluate the data obtained in relationship to the criteria established by the Jangle Feasibility Committee.
4. To provide basic information concerning the manner in which the deposition of bomb debris is related to meteorologic variables, type of burst and properties of the radioactive cloud.

(1) Memorandum October 8, 1951, J. C. Bugher to W. E. Kelley

GENERAL DESIGN OF THE MONITORING PROGRAM

Less extensive studies conducted by the Health and Safety Division during RANGER⁽²⁾ and GREENHOUSE⁽³⁾ made apparent the difficulties that would be involved in sampling over so vast a geographical area and in counting and evaluating the large number of samples that would be collected. Based on experiences obtained from the earlier studies, the monitoring program was designed in two components.

Phase A was a network of more than 50 collection stations located at Weather Bureau installations and operated for 24 hours each day by Bureau personnel. This network provided daily information concerning the presence of radioactive dust in the communities where the stations were located. Maps giving the consolidated data from these stations were prepared daily.

In order to achieve a better understanding of the basic factors involved in the deposition of bomb debris, the ground level network of Phase A was coordinated with aerial reconnaissance of radioactive clouds crossing the 85th meridian. High level traverses of the cloud were made by specially equipped B-29s operated by the Air Weather Service out of Warner-Robins Air Force Base. For purposes of eventual correlation with the aerial observations, ten Weather Bureau stations along the 85th meridian were equipped for ground level measurements. Analysis of the ground level data in its relationship to the aerial observations will be undertaken by the Weather Bureau and it is to be hoped that out of their analysis will come useful knowledge concerning the manner in which meteorological variables influence the rate at which bomb debris is deposited.

Phase B was a program of data collection by mobile sampling teams operating as nearly as one could best judge beneath the trajectory of the radioactive cloud. During Operation BUSTER, the teams were deployed along the 95th meridian, but for Operation JANGLE Phase B monitoring was confined to the annulus from 200-500 miles from the test site.

Whereas Phase A was designed to measure the general levels of activity that were deposited in various parts of the country, Phase B was intended to provide information about maximum deposition immediately beneath the cloud trajectory in communities which, because of numerical limitations in the extent of the Phase A network, might not be provided with fixed monitoring stations.

Again, for purposes of a better understanding of the mechanics of fallout, the ground level observations were coupled with aerial studies,

- (2) "Survey of Fallout of Radioactive material Following The Las Vegas, Nevada Test Explosions" issued by the Health & Safety Division, NYOO, AEC, February 27, 1951.
- (3) "Dust and Precipitation Sampling Program, April thru June 1951" Issued by Health & Safety Division, NYOO, AEC, undated.

but only during Operation BUSTER. A C-47 which had been made available by the Air Materiel Command primarily for the purpose of transporting the mobile ground observers to various stations along the 95th meridian, was utilized for observations aloft. In this portion of the study, the traverses were made at relatively low altitudes (2000-5000 ft.) over the portion of the 95th meridian straddled by the ground observers.

The detailed methods by which the monitoring operations were conducted will be described in a subsequent portion of this report.

ORGANIZATION OF THE MONITORING PROGRAM

Needless to say, a study of this magnitude could not have been accomplished without the close cooperation of several governmental agencies and AEC Laboratories which undertook responsibilities as follows:

1. Health and Safety Division, New York Operations Office

- a. Developed operating procedures for the overall monitoring program.
- b. Developed and fabricated special equipment as required.
- c. Procured and shipped equipment as listed in Appendices C and D.
- d. Provided direction and staff for mobile monitoring operations.
- e. Processed and counted all air samples, settled dust samples from a portion of the Phase A network and all samples collected in Phase B.
- f. Extrapolated and collated all data.

3. U. S. Weather Bureau

- a. Made available facilities for the collection of samples.
- b. Agreed to undertake meteorologic analysis of the data obtained.

4. Civil Aeronautics Administration

- a. Cooperated in scheduling flights and in easing the use of certain CAA airports.
- b. Facilitated direction of the flights and communication with the aircraft in flight.
- c. Provided certain facilities over and above the call of courtesy, such as space and transportation.

5. Santa Fe Operations Office

- a. Permitted access to the facilities of the Test Site.

6. Division of Radiation Safety (RADSAF) of the Test Director

- a. Facilitated courtesies within the Test Site, such as payment for automotive fuel and telephone service.

7. Cooperating Counting Laboratories

- a. The sample counting was undertaken by the following laboratories, in addition to the Health and Safety Division:

Hanford Works
Argonne National Laboratory
Brookhaven National Laboratory
Oak Ridge National Laboratory
University of Rochester, AEC Project
University of California, AEC Project

METHODS OF FIELD OPERATION

Phase A - The Weather Bureau Network

Fifty Weather Bureau stations as listed in Table 1 were equipped in time to begin continuous sampling by the first week in October and remained in operation until December 15 when the program was terminated. Ten additional stations, also listed in Table 1, were activated for Operation JANGLE and likewise operated continuously until December 15. The equipment used at the various stations in the Weather Bureau network is listed in Appendix C. The principal items of equipment are illustrated in Figure 1 and are described below:

1. A fallout tray with an area of about 8.75 square feet, fabricated from sheet metal and supported on 12" legs. This tray was originally designed with a slope of about 4" across a diagonal to permit precipitation to drain readily into a two quart Mason jar. A 1" rim was turned around the 4 edges so that there would be a minimum of loss. The only break in this rim was at the low corner where a small cutout permitted drainage. After the equipment had been fabricated, it was decided that the trays should be maintained wet in order to prevent settled material from being blown off. For this purpose, the legs supporting the tray were recut to permit the use of the tray in a level position. A small plug and modeling clay were included in the tray kit so that the cutout and seams could be adequately sealed.

It was thereby possible to place the tray on a level and maintain a small amount of water on the tray surface at all times. At the end of the collecting period the block was removed from this corner and the tray surface squeegeed in the direction of the drain to obtain as much of the debris as possible.

Trays were exposed for 24 hour periods. The water layer was then collected in a jar, the surface of the tray cleaned with additional water and the combined liquids filtered through a 3" #40 Whatman disc. Where precipitation occurred, the collected water was processed in a similar manner.

2. A gummed paper with an area of about 1.1 ft² was set in a frame to collect settled dust. The papers were of KumKleen label stock, grade 2, made by the Avery Adhesive Co. These were placed on a horizontal surface in the open for 24 hour periods. The papers were used both to produce radioautographs and for radiometric analyses.
3. Two Hi-Volume samplers, which are a standard filtering device employed by the Health & Safety Div. for sampling airborne particulates. The units are capable of filtering air at the rate of 20 cfm thru a 4" #41 Whatman disc. They were operated continuously with papers being changed every 24 hours.

Instructions (Appendix E) for setting up the apparatus, changing samples and filtering the water from the fallout trays were sent to each station.

Table 1

WEATHER BUREAU STATIONS DESIGNATED AS COLLECTION POINTS

<u>Station No.</u>	<u>Place</u>	<u>Equipment*</u>	<u>Samples Counted at:</u>
1	Seattle, Wash.	A	HW
2	Medford, Oregon	C	HW
3	Sacramento, Cal.	B	UCLA
4	Santa Maria, Cal.	C	" "
5	San Diego, Cal.	A	" "
6	Pendleton, Ore.	B	HW
7	Great Falls, Mont.	C	HW
8	Pocatello, Idaho	A	HW
9	Salt Lake City, Utah	C	HW
10	Emery Park, (Tucson) Arizona	B	UCLA
11	Bismarck, N. Dak.	C	HW
12	Rapid City, S. Dak.	B	HW
13	Colorado Springs, Colo.	C	UCLA
14	Norfolk, Neb.	C	HW
15	Topeka, Kans.	C	HW
16	Oklahoma City, Okla.	C	ORNL
17	Abilene, Texas	A	UCLA
18	Corpus Christi	C	UCLA
19	International Falls, Minn.	C	ANL
20	St. Cloud, Minn.	A	ANL
21	La Crosse, Wisc.	B	ANL
22	Peoria, Ill.	A	ANL
23	Memphis, Tenn.	C	ORNL
24	Texarkana, Ark.	C	ORNL
25	Del Rio, Tex.	A	UCLA
26	Sault Ste. Marie, Mich.	D	ANL
27	Grand Rapids, Mich.	D	ANL
28	Fort Wayne, Ind.	D	UR
29	Cincinnati, Ohio	D	UR
30	Lexington, Ky.	D	UR
31	Nashville, Tenn.	D	ORNL
32	Chattanooga, Tenn.	D	ORNL
33	Atlanta, Ga.	D	ORNL
34	Montgomery, Ala.	D	ORNL
35	New Orleans, La.	C	ORNL

* Code

A - 1 Tray
 B - 2 Trays
 C - 1 Tray and Gummed Paper
 D - 1 Tray & Hi-Volume Sampler

(Table 1 - cont'd)

<u>Station No.</u>	<u>Place</u>	<u>Equipment*</u>	<u>Samples Counted At:</u>
36	Cleveland, Ohio	A	UR
37	Rochester, N.Y.	B	UR
38	Elkins, W. Va.	C	BNL
39	Columbia, S. Car.	C	BNL
40	Tallahassee, Fla.	D	ORNL
41	Tampa, Fla.	B	ORNL
42	Caribou, Me.	B	UR
43	Burlington, Vt.	C	UR
44	Binghamton, N.Y.	C	UR
45	Hartford, Conn.	C	BNL
46	New Cumberland, Pa.	B	BNL
47	Atlantic City, N.J.	A	BNL
48	Anacostia, D.C.	C	BNL
49	Norfolk, Va.	A	BNL
50	Raleigh, N. Car.	B	BNL
51	New York, N.Y. (NYO, AEC)	C	NYOO
52**	Boise, Idaho	A	NYOO
53**	Winnemucca, Nev.	A	NYOO
54**	Reno, Nev.	A	NYOO
55**	Millford, Utah	A	NYOO
56**	Grand Junction, Colo.	A	NYOO
57**	Alamosa, Colo.	A	NYOO
58**	Winslow, Ariz.	A	NYOO
59**	Albuquerque, N. Mex.	A	NYOO
60**	Phoenix, Ariz.	A	NYOO
61**	Yuma, Ariz.	A	NYOO

*Code.

A - 1 Tray

B - 2 Trays

C - 1 Tray and Gunned Paper

D - 1 Tray and hi-Volume Sampler

**For JANGLE only

FIG. 1

FALL-OUT COLLECTION EQUIPMENT USED
IN GROUND SAMPLING OPERATIONS.

The equipment was located at positions convenient to the Weather stations. Trays were placed on the ground outside the buildings or on flat roofs. Hi-Volume samplers were placed on pedestals on the ground with protective enclosures around them or in open windows in balloon sheds or otherwise infrequently used buildings.

In most cases, samples were changed just after midnight when the duties of the man on this shift were fairly light. At this time, Hi-Volume filters were changed and the tray samples were collected and filtered. The entire operation could be completed in from ten minutes to a half hour, depending on the types of equipment at hand.

Samples were mailed each day to the various AEC laboratories as indicated in Table 1.

Aerial Observations Along the 85th Meridian

The six members of the N.Y.O. observation group arrived at Warner-Robins Air Force Base on October 26. The first survey flight following their arrival was dispatched on October 30. In the intervening period, their equipment which had been shipped in advance was arranged in several kits, convenient for carrying aboard the aircraft. Crew technicians modified certain electrical circuits and fabricated brackets on the aircraft to accommodate the apparatus.

| The orders specified the altitudes to be flown and the routes to be followed. Most flights were directed north and south on the 84th meridian. In general, one altitude was flown on the outgoing leg of the round trip and another altitude differing by about 10,000' was flown on the return.

The B-29s were provided by the Air Weather Service and were of a modified type, equipped with radioactive monitoring equipment. These are normally in continual use by the Air Weather Service. The equipment consisted of:

1. Duplicate high capacity dust filters mounted above the fuselage aft of the wing. Each unit consisted of a one square foot filter paper mounted in a metal housing thru which air was forced by the forward motion of the aircraft. The rate of flow has been estimated to be 1000 c.f.m. The frame within the metal housing in which the paper was fastened was replaceable in flight thru an air lock. The filters were changed alternately at 15 minute intervals by a crew member stationed in the aft compartment. A data sheet was made out for each filter paper. Aircraft coordinates at beginning and end of each sampling period, altitude, true air speed and temperature were entered on each sheet. This information was procured from the navigator. The paper was measured in flight by a special instrument described below.

After each flight, the filters and data sheets were submitted to the Air Force radiological specialists. Filters were counted for one minute after a minimum waiting period of five hours from collection.

One paper was returned to NYO for more detailed radiometric analysis.

2. An air conductivity instrument consisting of a vibrating reed electrometer measuring the current passing between two concentric metal cylinders thru which passed air drawn by a scoop on the outside of the aircraft. This instrument measures the concentration of ions in the air and thus is an indicator of radioactivity. It is sensitive, however, to changes in altitude, humidity and atmospheric dust, and therefore, requires careful interpretation. A Brown recorder was incorporated in the circuit so that a continuous record of instrument readings throughout the flight was available. The navigator operated this equipment, adjusting a scale switch when necessary and entering aircraft coordinates and pertinent weather data on the Brown chart periodically.

A representative of the Health and Safety Division was located in the forward compartment next to the navigator. His duties consisted of maintaining a log of instrument readings and of operating the following apparatus:

1. A Cascade Impactor mounted in the bomb bay and operated remotely by an electrical switch in the forward compartment. Since this device was inaccessible at altitudes above 8000', where the compartments were pressurized, one sample was collected on each flight. The impactor was operated briefly below 8000' to adjust the air flow and then turned off until the cruising altitude was reached. The unit was then operated continuously until the altitude was to be altered. Air flow was set at 17.5 liters/minute as indicated on a Brooks Mite Rotameter. These Cascade Impactors were modified by adding a fifth stage consisting of a 1-1/8" diameter #41 Whatman disc in a brass and aluminum holder. Air was drawn thru the impactor by a motor driven, positive displacement, rotary pump. A. C. power was available from the aircraft generators. Slides and papers were removed from the impactors after landing and then packaged for mailing to New York.
2. An RCL GM Tube connected to a modified 2610A battery operated rate meter (Figure 2). This enabled the observer to make direct, approximate measurements of the filters as they were collected by the crew member. The GM Tube was mounted in a brass cylinder which protected

FIG. 2

RCL GM TUBE FITTED WITH SPECIALLY MODIFIED BATTERY OPERATED RATE METER.

the tube and allowed fairly uniform measurements of successive filter papers, rolled up and slipped in between the tube and cylinder.

These instruments were not calibrated for this type of service, but the relative activity collected on the filter papers could be immediately measured and relayed to Washington with a minimum of delay. These data proved an aid in vectoring the survey flights to follow.

3. A Halross Scintillometer, a portable battery operated instrument for the direct measurement of gamma activity. Readings were recorded every fifteen minutes corresponding to the collection of filter paper samples. The instrument was set near the observer's position but as far as possible from navigational instruments, whose radium dials created a high gamma background.

The log maintained by the observer consisted of the following information entered at fifteen minute intervals throughout the flight:

a) time, b) relative filter paper activity, c) conductivity, d) scintillometer reading, e) altitude, f) aircraft position, g) air speed and h) outside temperature.

Phase B - Mobile Monitoring

Operations on the 95th Meridian

The mobile teams, consisting of two representatives from New York Operations and ten airmen, with sampling equipment, arrived at Tinker Air Force Base in a C-47 from Wright-Patterson Air Force Base on October 23. There, the airmen were instructed by the Health and Safety personnel in the operation of equipment and the establishment of ground stations.

From Tinker, the team was deployed

to airfields approximately on the 95th meridian to conduct ground level sampling activities. In each case an effort was made to begin sampling in advance of the cloud arrival.

Airfields were chosen as sampling sites because of speed in getting sampling under way after arrival in the C-47 and because Weather Bureau and Civil Aeronautics Administration personnel at civil fields and military personnel at military fields had been alerted to the program and in most cases were cooperative in providing facilities. The placement of equipment required a relatively flat, clear space for trays, gummed paper and air samplers, a nearby source of 100v. A.C. and running water.

The two Health and Safety members supervised the setting up of ground stations operated by the airmen, set up and operated their own stations, and operated sampling equipment in the C-47 during survey flights. The

equipment was similar to that provided the Weather Bureau stations, but in addition, instruments for particle size differentiation were made available. A coarse separation of airborne particulates into two fractions above and below approximately 5 microns in diameter was achieved by mounting an Aerotec in front of the Hi-Volume sampler. This unit is essentially a small Cyclone dust collector which at its rate of capacity of 45 c.f.m. is efficient in collecting of particles larger than approximately 5 microns. The large diameter fraction separated by the Aerotec was analyzed separately from the small diameter fraction which was collected on the filter paper of the Hi-Volume air sampler.

In addition to the Aerotec, Cascade Impactors were available and semi-quantitative estimates of filter paper activities could be made on the spot using a portable Berkeley Scaler made available for this purpose.

Aerial Observations on the 95th Meridian

When time permitted, the C-47 was utilized for the collection of radioactive dust at altitudes of 2000-5000 feet. Hi-Volume air samplers were mounted in the cabin of the C-47 in such a manner as to sample the heating air emitted at the air duct vents. This air is drawn into the system through scoops mounted on the wings. Cascade Impactors and a Halross Scintillometer were also available.

In general, the plane would traverse the 95th meridian between airfields at which the mobile ground observers were based.

Mobile Monitoring for Operation JANGLE

For each of the two JANGLE tests, temporary ground observation stations were established in the annulus from 200-500 miles from ground zero. A C-47 was used for the transportation of personnel and equipment but aerial survey flights were discontinued.

Seven members of the Health and Safety Division and five airmen, operating in teams of two, set up six ground stations for the first test. For several days prior to the test, this group was based at Indian Springs Air Force Base, Nevada, awaiting orders to sampling locations. Immediately after the detonation, wind data were evaluated and sampling locations were selected by an Air Force meteorologist and a Health and Safety representative at the test site. Within an hour, the teams were airborne, with instructions to establish stations at Delta, Salt Lake City and Wendover, Utah, Elko, Nevada and Burley and Idaho Falls, Idaho. Equipment was set up and sampling started at each site immediately upon arrival. Sampling continued for about 24 hours.

For the second JANGLE test, stations were each manned by one Health and Safety Division member. Since it was expected that south to southwest winds would prevail, personnel were based at Ogden Air Force Base, Utah, prior to the test. A H&S representative at the Test Site telephoned instructions to the team at Ogden when the estimated trajectory became available shortly after the detonation. The C-47 was

dispatched, leaving teams at Ogden, Provo (Utah), Delta, Rock Springs (Wyoming), Wendover (Utah) and Elko (Nevada). The locations of sampling stations are given in Figure 3. Sampling for the second JANGLE test continued for approximately 36 hours.

Each ground observation station was equipped with the following apparatus:

1. One Hi-Volume sampler
2. One Hi-Volume sampler with an Aerotec dust separator
3. Two Cascade Impactors
4. One fallout tray
5. Two gummed paper frames
6. One beta-gamma survey meter (Nuclear Instruments 2610A)
7. One 2610A with a specially designed probe for measuring Hi-Volume air samples.
8. One Zeuto survey meter.

The first five items were utilized as previously described. Tray and gummed paper samples were collected for 24 hour periods. Cascade Impactors were operated simultaneously for 8 hour periods.

The 2610A and Zeuto were used for the direct measurement of ground activity. The two instruments provided a wide range of sensitivity. The areas around the stations were scanned at frequent intervals with the meters held about 3' above the ground. Spots of high activity were measured by the less sensitive Zeuto.

A special probe (Figure 4) was developed for the 2610A to measure activity on filter papers. This device enabled the use of a method of sampling which reduced the total number of Hi-Volume samples collected by cutting down the frequency of collection during periods of low activity. This eased the task of the team members, and more important saved laboratory time later on. Repeated readings were made of the sample on a single Hi-Volume filter paper collected over several hours until an increase in airborne activity was detected. At that time, a 20 minute sampling period would be established. Measurements were then made each 20 minutes as the samples were changed until the activity decreased to its original value. Continuous sampling on one filter was then resumed.

When activity on filters exceeded the high range on the 2610A, the Zeuto was used. An extrapolation determined in the field permitted reliable transition from one instrument to the other.

FIG. 3

DISTRIBUTION OF MOBILE GROUND STATIONS
FOR JANGLE SERIES OF TESTS

FIG. 4

SPECIAL BETA GM PROBE FOR SCREENING
OF FILTER PAPER SAMPLES IN FIELD.

METHODS OF LABORATORY STUDY

In order to correlate the data from the cooperating laboratories, a fixed procedure for handling and counting of samples was used. This procedure was designed to be readily reproducible rather than to be the optimum procedure. The following description covers the methods actually used in the laboratories involved.

Sample Processing

All samples were ashed before counting. Whatman filter paper samples were ashed with the cellophane bag, while the gummed paper and air-dust filter samples were ashed without the bag. The Whatman and air-dust filters were used as received. The gummed papers were sampled by cutting out 1/4 square foot from the center of the paper.

The samples were transferred to a platinum dish, charred at a low temperature and ignited for one-half hour at 700°C in muffle furnace or over a burner. After cooling, the ash was brushed out into a plastic dish for counting.

Counting Procedures

- A. Sample Dish: The containers supplied were 1 $\frac{1}{4}$ " diameter thin plastic dishes with 3/16" retaining walls. It held the ash from all of the fallout samples normally encountered.
- B. Geiger Tube: A thin window (3.5 mg/cm²) halogen-filled GM tube, the Amperex 100N, was furnished by NYO. These tubes are very stable, and in an arrangement as described show a background of 10-12 counts per minute.
- C. Mounting: The tube was mounted on a standard lucite holder (such as AEC #AK-3A) in a vertical lead castle (such as AEC #AL-14A). The dish was placed on a 3 mm thick aluminum shelf, spaced so that the top of the shelf was about 1.2 cm from the tube face.
- D. Scaler: A standard scaler having a scale of 64 was used. No modification was necessary, other than the insertion of a 10 megohm resistor in series with the high voltage lead to the GM tube.

To eliminate the need for plateau runs, a corona discharge regulator was inserted in the high voltage supply. A circuit diagram for this modification as well as the corona voltage regulator was supplied by NYO.

- E. Standardization: The efficiency factor for converting net counts per minute into d/m was obtained by measuring the counting rate of an NBS standard of RaD and RaE plated on a palladium coated silver disc. The disc diameter is 3.8 cm and the active area has a diameter of 2.4 cm. A standard having a disintegration rate of 5000 to 50,000 was supplied to each laboratory. The factor of c/d was obtained by running the standard for 64,000 total counts. The usual factor was about 0.08 c/d.
- F. Counter Background: The background counting rate was measured before and after a day's run of samples. With the arrangement described, more frequent tests were unnecessary, unless a spill occurred.
- G. Sample Counting: In order to maintain a constant precision of counting over most of the range to be covered, the following procedure was used to set the minimum counting time. The maximum counting time for any sample was 30 minutes, as a practical limit, and this was scaled down to 1 minute according to the values in the table below. The data is given for counters having background counting rates of 10, 15 and 20 c/m.

These values were calculated to give an error of ± 20 at the 90% confidence level.

Gross Counting Rate Required for Various Counting Times

Minimum Counting Time	Background		
	10 c/m	15 c/m	20 c/m
30 min.	15 or less	21 or less	27 or less
20	17	23	30
10	22	30	35
5	30	35	45
2	50	60	65
1	85 or more	95 or more	100 or more

These values were meant to act as guides to minimum counting times, and not as rigid rules for counting.

For the purposes of this work, no sample was counted less than 48 hours after the end of the collecting period. This allowed time for at least partial decay of thoron daughter products.

Before any atomic tests occurred, each laboratory was to have several days' samples to determine the background activity level at the collecting sites. The level of significant activity was arbitrarily set at five times this background level. (The background and sample activity levels are compared after subtraction of counter background). Of course,

the fallout from other tests effectively nullified this system, and arbitrary levels had to be taken to judge significance.

- H. General: It was realized that the procedure described was crude, but refinement was impossible if a large number of samples were to be handled economically. Therefore, it was important that the techniques were standardized.

The factors of self-absorption by the ash and the variation in beta energies were ignored. All results, however, were corrected at NYO for radioactive decay of the fission products. Analysis of decay curves showed that the effect of thoron daughters was negligible if the time between sampling and counting was greater than 48 hours.

Calculations and Reports

The preliminary calculations followed the form recorded on the data sheets. Precipitation and settled dust samples were reported as d/m/ft² per 24 hours. Airborne dust samples were reported as d/m per cubic meter, using the average of the initial and final sampling rates.

Summary sheets were provided for tabulating the data from each site. One sheet was used for each type of sample at a single site counted during a week.

Samples of the data sheets and summary sheets used are included as Appendix F.

Extrapolating

The individual values obtained at each collecting station for each day of the survey period were all extrapolated to the day of sampling. This extrapolation allowed for the radioactive decay between sampling and counting and brought all samples to a common basis.

The preferable method would be to measure the decay rate of each sample and extrapolate on the basis of the individual curve. This would be extremely laborious, and it was decided to accept an approximation for the rate of decay of mixed fission products and apply it to all samples. In addition, the calculation was simplified by tabulating the extrapolation factors for the possible combinations of days from burst to sampling and burst to counting. The rounding off to the nearest day does not introduce an error greater than the experimental counting error. The extrapolation factors are given in Table 2.

TABLE 2

EXTRAPOLATION FACTOR
FROM COUNTING DATE TO SAMPLING DATE

Days-Burst to Count	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.00																			
2	.44	1.00																		
3	.27	.62	1.00																	
4	.19	.44	.71	1.00																
5	.14	.34	.54	.76	1.00															
6	.12	.26	.44	.61	.80	1.00														
7	.10	.22	.36	.50	.66	.83	1.00													
8	.08	.19	.30	.43	.56	.71	.86	1.00												
9	.07	.16	.27	.38	.50	.62	.75	.88	1.00											
10	.06	.14	.24	.34	.44	.54	.66	.77	.88	1.00										
11	.06	.13	.21	.30	.39	.48	.58	.68	.78	.89	1.00									
12	.05	.12	.19	.26	.35	.44	.53	.62	.70	.80	.90	1.00								
13	.05	.10	.17	.24	.32	.40	.48	.56	.64	.73	.82	.91	1.00							
14	.04	.10	.16	.22	.29	.36	.44	.52	.58	.66	.75	.83	.92	1.00						
15	.04	.09	.14	.20	.27	.34	.40	.48	.54	.61	.69	.76	.84	.92	1.00					
16	.04	.08	.14	.19	.25	.31	.38	.44	.50	.57	.64	.71	.78	.85	.93	1.00				
17	.03	.08	.12	.18	.23	.29	.34	.40	.46	.53	.60	.66	.72	.79	.86	.93	1.00			
18	.03	.07	.12	.16	.22	.27	.32	.38	.44	.50	.56	.62	.68	.74	.80	.86	.94	1.00		
19	.03	.07	.11	.16	.20	.25	.30	.36	.40	.46	.52	.58	.64	.70	.76	.82	.88	.94	1.00	
20	.03	.06	.10	.14	.19	.24	.28	.34	.38	.44	.49	.54	.60	.66	.71	.76	.82	.88	.94	1.00
21	.03	.06	.10	.14	.18	.22	.27	.32	.36	.41	.46	.51	.56	.62	.67	.72	.78	.84	.89	.94
22	.02	.06	.09	.13	.17	.21	.26	.30	.34	.39	.44	.48	.53	.58	.64	.68	.74	.79	.84	.89
23	.02	.05	.09	.12	.16	.20	.24	.28	.32	.37	.42	.46	.50	.55	.60	.64	.70	.74	.80	.84
24	.02	.05	.08	.12	.16	.19	.23	.27	.31	.35	.40	.44	.48	.52	.57	.62	.66	.71	.76	.80
25	.02	.05	.08	.11	.14	.18	.22	.26	.30	.34	.38	.42	.46	.50	.54	.58	.63	.68	.72	.76

The burst date corresponding to fallout at a given sampling station on a given day was selected by consideration of the unextrapolated results for the tray samples collected at each station. These results were tabulated by day and by station on daily maps. Significant increases in activity were marked on the map, and by consideration of results in different areas, the course of the fallout for a given burst was charted. Gummed paper and air-dust samples were used only for confirmation.

The decay curves on samples were of little value in burst selection. They were used only to consider an unexpected rise of activity about the 11th and 12th of November.

The extrapolated values were recorded on daily maps and the assumed burst noted for each sample.

A second extrapolation was performed to determine the total activity that should exist at any sampling station on February 1, 1952. This calculation was simplified by working from the maps of the first extrapolated values. Thus, for any day, one factor would be needed for each burst represented on the map. The extrapolations to February 1 were tabulated by station and day and the total calculated activity plotted on a map for ease in visualizing the complete picture.

The factors for this second extrapolation are recorded in Table 3.

If it is desired to determine the activity of a given station at any date after February 1, 1952, the totalized value for the station may be used, as the difference in blast date is negligible. The factors for such an extrapolation are given in Table 4.

TABLE 3

FACTORS FOR EXTRAPOLATION FROM SAMPLING DATE TO FEBRUARY 1st

<u>Days-Burst to Sampling</u>	<u>Burst 10/18</u>	<u>Burst 10/28</u>	<u>Burst 10/30</u>	<u>Burst 11/1</u>	<u>Burst 11/5</u>	<u>Burst 11/19</u>	<u>Burst 11/29</u>
1	.004	.004	.004	.004	.004	.006	.007
2	.008	.010	.010	.010	.011	.013	.016
3	.014	.016	.016	.016	.017	.021	.026
4	.020	.022	.022	.023	.024	.030	.036
5	.026	.029	.030	.031	.032	.040	.048
6	.032	.036	.036	.038	.040	.049	.058
7	.038	.043	.044	.045	.048	.059	.070
8	.045	.050	.052	.053	.056	.070	.083
9	.052	.058	.059	.061	.064	.080	.095
10	.058	.064	.066	.068	.072	.089	.105
11	.065	.073	.075	.078	.081	.101	.120
12	.073	.082	.084	.086	.090	.112	.134
13	.080	.090	.092	.095	.100	.123	.147
14	.088	.099	.102	.105	.110	.136	.163
15	.096	.107	.109	.113	.118	.147	.175
16	.106	.116	.118	.122	.128	.159	.190
17	.113	.126	.129	.134	.140	.174	.207
18	.118	.132	.135	.140	.147	.182	.217
19	.126	.142	.145	.150	.157	.195	.233
20	.135	.151	.154	.160	.167	.208	.248
21	.144	.162	.165	.171	.179	.222	.265
22	.155	.170	.173	.179	.188	.233	.278
23	.159	.178	.182	.188	.198	.245	.292
24	.165	.185	.189	.196	.206	.254	.304
25	.175	.196	.200	.208	.216	.269	.320
26	.185	.208	.212	.220	.230	.284	.340

Table 4

FACTORS FOR EXTRAPOLATION OF DATA BEYOND
FEBRUARY 1, 1952

<u>Extrapolation Date</u>	<u>Factor*</u>
March 1, 1952	0.70
April 1, 1952	0.53
May 1, 1952	0.44
June 1, 1952	0.36
July 1, 1952	0.31
Aug. 1, 1952	0.21

*
To multiply total activity on February 1, 1952

FINDINGS

Natural Radioactive Background

It was hoped that the Weather Bureau stations could be activated sufficiently in advance of the first explosion to permit background measurements. The first complete sets of samples were collected by the end of the first week in October. Unfortunately, two atomic explosions in a foreign country had occurred just prior to the start of this program. Our intention to secure background information prior to the start of Operation BUSTER was thus defeated by the circumstances. It is, however, quite in order to point out that consideration of the occurrence of naturally radioactive isotopes in airborne particulate material leads one to the conclusion that except for the possibility of absorbed radon and thoron daughter products, the radioactivity which could settle to a surface in a day would, by the counting procedure described previously, be reported as nil (less than one disintegration per minute per square foot per day). If due precautions are taken to prevent the counting of short-lived radon and thoron daughters, one may conclude that for the counting procedure used in this program, all positive indications of activities are artificial in origin.

It is of some interest to inquire into the existence of residual radioactivity from previous tests at the start of Operation BUSTER. The only data available to the NYO Health and Safety Division are those collected as part of our study of Operation GREENHOUSE, at which time daily observations of fallout were made at ten locations in the eastern half of the United States. The cumulative residual at the conclusion of Operation GREENHOUSE were reported earlier by NYO⁽³⁾. These data have now been extrapolated to February 1, 1952 and the data are listed in Table 5. Although the activities are relatively low in magnitude, it will be noted that they are a finite contribution of intermediate half life activity to the pre-existing radiation background. Later in this report it will be noted that the cumulative data from Operations BUSTER and JANGLE have similarly been extrapolated to February 1 for comparison with the fallout from earlier tests.

Fallout During the Pre-test Period

Daily observations obtained from the Weather Bureau network are given in Appendix A. As noted earlier, it was to have been a period during which background measurements would be recorded, but the occurrence of atomic explosions in a foreign country conspired to vitiate this portion of the study. Positive indications of activity were reported from the very first of our collections. Beginning on October 7 and continuing until October 21 we find positive but low level indications of radioactivity. The values are low in comparison with the data to be reported when Operations BUSTER and JANGLE were in progress.

Table 5

CUMULATIVE RADIOACTIVITY OF DUST COLLECTED ON TRAYS
DURING OPERATION GREENHOUSE

<u>Location</u>	<u>d/min/ft², extrapolated to Feb. 1, 1952</u>
New York	9.6
Washington	16
Binghamton, N.Y.	4.1
St. Louis, Mo.	52
Parlin, N.J.	0.57
Cleveland, Ohio	28
Rochester, N.Y. (U.of Rochester)	22
Rochester, N.Y. (Eastman)	89
Boston, Mass.	29
Upton, N.Y.	15

One sample of dust collected from the high volume sampler at Fort Wayne, Indiana, on October 11-12 was studied for decay characteristics. If the decay is assumed to be the usual fission product form, with a slope of -1.2, then the estimated date of the burst from which this sample originated would be September 24.

The relatively low values continued throughout this period until October 21. The cumulative fallout from the observations during this period, extrapolated for purposes of subsequent comparison to February 1, 1952, are given in Figure 5.

Observations from the Weather Bureau Network During Operations BUSTER-JANGLE

The BUSTER-ABLE detonation occurred on October 22. During the 24 hour period ending on the 22nd there was a marked increase in radioactivity collected from the fallout tray at the Seattle Weather Bureau Station. On this day, with the second highest observed value being 200 d/m/ft²/24 hours, the Seattle Station reported 26,000. This was the first of a great many observations made during the several days subsequent to October 22 which gave indications of the second foreign explosion announced during this period. Twenty-three of these samples were studied for decay characteristics and, again assuming the usual expression for fission product decay, the estimated date of burst is October 18. These data are discussed more fully in a subsequent section of this report.

The occurrence of radioactive debris from other than the Nevada Test site served to confuse our monitoring program from the start. It proved to be an additional complication in a study which from the outset was beset by innumerable difficulties.

The daily maps giving all data reported from the Phase A Weather Bureau network are given in Appendix A. In coordinating the collection and counting of samples and in putting the data into useful form, the purpose for which this survey was undertaken has been largely served. There remains a requirement for extensive meteorological analysis of the information. It is to be hoped that when this is accomplished cooperatively by the U. S. Weather Bureau and the U. S. Air Force, there will accrue a better understanding of the fundamental phenomena involved in fallout.

However, of immediate interest, for the purpose of this report, are the highlights of these data which may be summarized as follows:

1. Figure 6 gives the cumulative fallout expressed in disintegrations per minute per square foot for the period October 22 through December 15; all data being extrapolated to February 1, 1952. It will be observed that the highest activities are along the east coast, and the highest report in the country is from Rochester where the contribution to Rochester from the test program will be 12,000 d/m/ft² on February 1. Expressed in other units, this is approximately 100 millicuries per square mile at a time (February 1, 1952) when the activity

will have a half life of approximately three months. The community which is next highest is Norfolk, Virginia with 2200 d/m/ft²; about one-fifth of the Rochester value. A large number of communities along the east coast report cumulative values of 1000 d/m/ft².

2. The total activities, both from the Nevada test and from fallout of foreign origin, are given in Figure 7. In the area of maximum deposition, the eastern half of the United States, the foreign contribution is only slightly significant, but it will be observed that in northwestern U. S. the foreign contribution to the total is more prominent.
3. The highest activities reported on a single day were those from the collections beginning on November 1. Rochester, N.Y., reported 360,000 d/m/ft²/24 hrs. from its open tray. Washington, D. C. reported 260,000 d/m/ft²/24 hrs. from the gummed paper collector and Raleigh, N.C. 100,000 from its open tray.

Of some interest are the relatively high air samples reported along the 85th meridian on the same day. Cincinnati reported 570 d/m/cubic meter and Lexington, Ky. 220 d/m/cubic meter.

Because of their bulk Appendices A and B will not be distributed to all readers of this report. A copy of the map for November 1 is therefore included in the body of this report (Figure 8).

4. Referring again to Figure 6, there is a band of higher fallout which is almost on a direct line from Los Angeles, Calif., through the Great Lakes area up to the northwest corner of the United States. In this area, the lowest normal sample appears to be about 300 d/m/ft². Except for a single sample of 750 d/m/ft² obtained at Los Angeles during an unusual condition of wind, the samples obtained west of the Rockies are below 200 d/m/ft². Two samples, one at Topeka, Kansas and the other at Oklahoma City showed 720 d/m/ft² and 450 d/m/ft², being the only other samples west of the 85th meridian to show more than 400 d/m/ft². As the east coast is closer approached, however, the magnitude of the samples rises and several samples above 500 d/m/ft² appear. In the area between Tallahassee, Fla. and Cleveland, Ohio, there are a number of points all showing relatively high radiation, with Cleveland being the maximum at 1380 d/m/ft².
5. As we approach the coastal area, maximum readings have been obtained. Almost without exception, the samples which were obtained on the coastal plain from Columbus, So. Car. north to Caribou, Maine, are 1000 d/m/ft² or higher with the single maximum value at Rochester, N.Y. at 12,000 d/m/ft².

Of considerable interest in visualizing the day to day variation in the mean radioactive yield of the fallout trays in the Weather Bureau network is Figure 9.

Mobile Monitoring for Operation BUSTER

The locations at which mobile monitoring operations were undertaken during Operation BUSTER are shown on the maps of Appendix B. The tray collections are reported on these maps for each 12 hour period as are the mean of the two hour serial air samples for the period. The tabulated compilation of two hour air samples each of the mobile stations is given in Appendix G in which all data have been extrapolated to the date of collection. Appendix G also gives the estimated percentage of the radioactive particulates that were less than 5 microns in diameter. It will be noted that although the data are erratic, the high and low values tend to group together.

It will be recalled that the mobile ground operations along the 95th meridian were designed to obtain data during and after the clouds transit. These data were collected for two purposes, to provide information about radioactive deposition immediately beneath the cloud trajectory and to provide by means of two hour serial samples a picture of the manner in which the ground level fallout is related to cloud trajectory.

It appears clear from examination of Appendices B and G and comparison of these data with Appendix A, that the data collected along the 95th meridian were lower in magnitude than would be expected, considering the levels of activity reported by the fixed stations.

A complete understanding of these data must await meteorological analyses by the U. S. Weather Bureau.

Aerial Observations Along the 95th Meridian (low level)

Table 6 gives the data collected aloft by the C-47 traversing the 95th meridian between communities at which mobile stations were located. As in the case of the ground level samples, the values are surprisingly low considering that these traverses were presumably made beneath the main cloud body. On the other hand, as noted elsewhere in this report, the data are suspect because of difficulties in obtaining representative air samples on the C-47 flights.

The dust samples collected on these flights consisted almost entirely of material smaller than 5 microns.

Aerial Observations Along the 85th Meridian (High level)

The data collected from B-29's operating out of Warner-Robins Air Force Base are compiled on the maps of Appendix B. These data will be analyzed by the U. S. Weather Bureau

TABLE 6

RADIOACTIVE DUST COLLECTED AT 2500 TO 5000 FEET ALTITUDE (95TH MERIDIAN)

Beta Gamma Activity in d/min/m ³ (Extrapolated to Date of Collection)						
<u>Flight</u>	<u>Sampling Date</u>	<u>Mean Sampling Time</u>	<u>High Volume Samplers</u>			<u>Cyclone Sampler less than 5 Microns</u>
Oklahoma City,	10-29	1900	8.0			100
Oklahoma to Watertown, South Dakota	10-29	1900	15	16	9.1	97
Watertown, South Dakota to Oklahoma City, Oklahoma	10-30	1600	11	0.6		50
Oklahoma City,	10-31	1100	6.3	6.1	6.1	100
Oklahoma to Dallas, Texas	10-31	1100	4.6			100
Dallas, Texas to Oklahoma City,	10-31	1300	180	160	91	99
Oklahoma	10-31	1300	90			100
	10-31	1300	41	0		
	10-31	1300	48	0		
Oklahoma City,	11-1	1000	28	29		
Oklahoma to Houston, Texas	11-1	1800	23			97
	11-1	1800	181			100
Omaha, Nebraska to Oklahoma City, Oklahoma	11-1	2230	6.3	3.0		
Houston, Texas to Omaha, Nebraska	11-1	1600	37	140		
Corpus Christi, Texas to Oklahoma City, Oklahoma	11-2	1900	6.3	8.4	9.1	62
	11-2	1900	13			72
Oklahoma City,	11-2	1400	12	8.4	8.4	100
Oklahoma to Corpus Christi, Texas	11-2	1400	7.0			90
	11-3	1300	16	450		
Corpus Christi, Texas to Oklahoma City, Oklahoma	11-4	1100	32	14	28	99
San Antonio, Texas to Brownsville, Texas	11-8	0900	5.2	4.3	0.5	100

Mobile Monitoring During Operation JANGLE

During Operation JANGLE the NYO mobile monitoring teams were deployed at approximately 0° to 45° in the annulus 200-500 miles from the Test Site.

Initial JANGLE Detonation

The findings of the mobile teams for JANGLE-ABLE are given in Table 7. Of interest, are the relatively high activities at Elko, Nevada and Burley, Idaho in contrast to the other sampling locations.

The area west of Elko should have been included in the survey, as shown by the sharp increase in activity between Wendover and Elko. Our data do not define the most western extent of fallout zone. The best available estimate of the trajectory indicated that in the positions shown our teams would be astride the fallout zone on the line from Salt Lake City to Elko. That this was not the case is clear from the data.

The records of the atmospheric dust concentrations during the entire period of sampling are given in Figures 10 through 12 which give data for Elko, Burley and Idaho Falls. Observations from Wendover, Delta and Salt Lake City are not plotted because the data were essentially negative.

The maximum dust concentration had probably passed by the time Elko collections were started. The first sample collected for 20 minutes beginning at 1630 MST was the highest value reported, 360,000 d/min/M³. Thereafter, the airborne activity rapidly declined to well under 100 d/min/M³ at 0200 the following morning. For the 24 hour period the average concentration was 44,000 d/min/M³ taking the means of all samples with the result of each sample extrapolated to the midpoint of its individual time of collection. The mean age of this dust may be taken as approximately 10 hours.

Burley, Idaho, about 135 miles northeast of Elko shows a peak at 2300 at which time the dust was 14 hours old. The maximum recorded concentration was 1,000 d/min/M³ and the 24 hour mean was 2150 d/min/M³.

Idaho Falls shows markedly less activity with a sustained rise to 3000 d/min/M³ occurring for about $2\frac{1}{2}$ hours starting 2245.

Radioactive dust occurred in Wendover, there being a sustained rise to 3000 d/min/M³ starting at 2000 and continuing until 0600 on 20 November.

As will be noted from Table 7, the bulk of the activity was contained in particles less than 5 microns in diameter. The one exception was the Aerotec sample at Burley where the bulk of the activity was included in particles larger than 5 microns in diameter. This is in contrast, not only to the data from other stations, but to the results of Cascade Impactor samples of Burley air collected at the same time as the Aerotec sample.

TABLE 7
FINDINGS OF MOBILE TEAM - TEST OF 19 NOVEMBER 1951

Place	Monitoring Period	AIRBORNE DUST					SETTLED DUST	
		Highest Sample	Ave.	% < 5 μ		Type	Total Fallout d/m/ft. ²	
		Time Conc** (d/m/M ³)	Conc** (d/m/M ³)	Cascade Impactor	Aerotec	Collector		
Elko, Nev.	19 Nov. 1630 - 20 Nov. 1100	19 Nov. 1640 to 1700	380,000	44,000	90	82	Tray Gummed Paper	110,000 59,000
Salt Lake City, Utah	19 Nov. 1435 - 20 Nov. 0905	-	-	4	-	95	Tray Gummed Paper	180 3,200
Wendover, Utah	19 Nov. 1630 - 20 Nov. 1100	19-20 Nov. 2000 to 0600	3,000	1,000	-	-	Tray Gummed Paper	220,000 105,000
Delta, Utah	19 Nov. 1415 - 19 Nov. 2230	-	-	52	-	97	Tray	540 0
Burley, Idaho	19 Nov. 1920 - 20 Nov. 0810	19 Nov. 2250 to 2315	11,000	2,150	99+	9.7	Tray Gummed Paper	22,000 110,000
Idaho Falls, Idaho	19 Nov. 2045 - 20 Nov. 0800	20 Nov. 0000 to 0100	3,000	400	-	-	Tray Gummed Paper	4,100 120,00

* Extrapolated to time of collection

** Ave. of individual samples extrapolated to time of collection

The tray activities are lower than would be expected, considering the high concentrations of airborne dust. During Operation JANGLE, as during BUSTER, the relationship between air-borne and settled dust was not as would be expected.

The highest external radiation level observed by the mobile teams was 2 mr/hour at Elko. This level had been reached when the mobile team arrived at 1350 on 19 November.

The Second JANGLE Detonation

The second detonation of Operation JANGLE produced somewhat similar conditions. The principal findings are given in Table 8 where it will be noted that Elko was again the location at which the highest activities were observed.

Aerial dust measurements are given in Figures 13 through 17. The maximum concentration was 180,000 d/m/M³ and occurred at 0600 MST. The average concentration for the 24 hour period was 38,000 d/m/M³, and again the particulates were almost entirely in the range below 5 microns. The mean age of the Elko activity was approximately 20 hours.

With respect to the deposition of radioactive dust on the ground, the activities were again lower than would be expected, considering the high concentrations of air-borne radioactivity.

Relationship of Findings To Criteria of JANGLE Feasibility Committee

The external radiation and radioactive dust measurements gave no indication that the exposure criteria of the Jangle Feasibility Committee were exceeded in the area beyond 200 miles from the Test Site.

The maximum external radiation dose was 2 mr/hr measured at 1650 19 November at Elko, Nevada, at which time the activity was only 7½ hours old, and thus decaying rapidly.

With essentially all of the particles in the respirable range, the radioactive dust concentration at Elko, Nevada, when averaged over a 24 hour period, was 44,000 d/m/M³ and 38,000 d/m/M³ for the two Jangle tests. The cumulative exposures were thus well below the 2.2×10^6 d/m/M³ permitted by the report of the Feasibility Committee.

TABLE 8

FINDINGS OF MOBILE TEAM - TEST OF 29 NOVEMBER 1951

Place	Monitoring Period	AIRBORNE DUST					SETTLED DUST	
		Highest Sample Time	Sample Conc* (d/m/M ³)	Ave. Conc** (d/m/M ³)	% (5 μ)		Type Collector	Total Fallout d/m/ft ²
					Cascade Impactor	Aerotec		
Elko, Nev.	29 Nov. 1720 - 30 Nov. 2230	30 Nov. 0600	190,000	38,000	>95	--	Tray Gummed Paper	Lost 210,000
Ogden, Utah	29 Nov. 1900 - 30 Nov. 1900	30 Nov. 0100	710	205	--	84	Tray Gummed Paper	1,300 9,700
Wendover, Utah	29 Nov. 1640 - 1 Dec. 0045	1 Dec. 0045	4,300	2,200	77	65	Tray Gummed Paper	60,000 7,000
Delta, Utah	29 Nov. 1100 - 30 Nov. 1110	29 Nov. 1100	550	185	--	92	Tray Gummed Paper	840 30,000
Rock Springs Wyoming	29 Nov. 1245 - 30 Nov. 2250	30 Nov. 1450	2,800		85	94	Tray Gummed Paper	1,300 50,000
Provo, Utah	29 Nov. 1915 - 30 Nov. 2020	30 Nov. 0420	5,400	190	--	83	Tray Gummed Paper	1,000 11,000

* Extrapolated to time of collection

** Ave. of individual samples extrapolated to time of collection

THE PROPERTIES OF FALLOUT SAMPLES

Limited studies were made of the physical properties of bomb debris collected in the air samplers and fallout trays.

Particle Size

Measurements of particle size were undertaken because of its relationship to the pulmonary retention and distribution of an aerosol. The methods by which the samples were fractionated into various portions of the particle size spectrum have been described in an earlier section of this report, and in Tables 7 and 8 are given data pertinent to the evaluation of the JANGLE monitoring observations.

The satisfactory agreement between replicate and consecutive samples collected by Cascade Impactor at Elko (19 November and 29 November) and Wendover (29 November) are given in Figures 18 and 19.

In Figure 18, are plotted 5 samples collected following the two explosions from Operation JANGLE. The mass median of these various samples ranges from 1.4 to 2.2 μ . The mean of the 5 estimates of the mass median is 1.8 μ .

In Figure 19 are shown the six samples collected at Wendover, Utah, following the second of the JANGLE bursts. The estimates of the mass medians vary from 1.9 μ to 3.5 μ with a mean of 2.5 μ .

As noted earlier, both the Aerotec Collector and Cascade Impactor indicate that the bulk of the radioactive dust was smaller than 5 microns in diameter.

Radioactive Decay

The beta decay of mixed fission products is complex, but may be represented approximately by a linear plot on log-log paper. Way and Wigner⁽⁴⁾ estimated the beta activity and summarized the available data in the form of the equation:

$$A_2 = A_1 \left(\frac{t_2}{t_1} \right)^{-1.2}$$

where A_2 and A_1 are the activities at times t_2 and t_1 after fission.

(4) K. Way and E. P. Wigner Phys. Rev. 73, 1318 (1948)

Hunter and Ballou⁽⁵⁾ have calculated the individual and total beta activities produced in a U^{235} atomic explosion. In the time range of 1 to 100 days, the Way and Wigner expression is shown to be valid as far as decay rate is concerned.

The experimental data taken during this series of tests included about 150 decay curves run for periods of 10 to 50 days. Because none of the runs were begun less than three days after sampling, there was no interference from thoron or radon decay products. The results of the determinations are given in Table 9. The values given for the slope were obtained by visually fitting a line to the data plotted as $\log d/m$ against $\log$ time in days since burst. It must be remembered that not all samples contain debris that is predominantly from one burst or another. In Table 9 where there was doubt as to the burst from which a sample originated, more than one slope may be indicated.

Figure 20 shows how a decay following the -1.2 exponent would behave if the burst were misjudged by two days in either direction. If the burst was assumed to be two days earlier than the true time, a straight line through the later points would have a slope of -1.37 , while the opposite error would give a slope of -1.06 .

If the sample is counted within three or four days after the burst and the decay follows the -1.2 exponent, it should be a simple process to place the burst time to the nearest day. However, it is apparent from Table 9 that the decay rates vary widely. The general use of decay rate for selection of burst date is subject to great error, particularly if the normal counting error is taken into consideration.

While the overall variation in decay rates is large, there is excellent agreement within the groups assigned to a specific burst, as shown by the standard deviations in Table 10.

Some of the samples whose decay rates were measured had been subjected to particle size separation with a Cascade Impactor or Aerotec unit. The results on these samples are tabulated in Table 11.

All indications from these scattered results are that the larger particles decay at a greater rate than the smaller particles. This factor may be slightly complicated by the presence of induced activities, but this effect should not be large after a few days, unless the fraction of induced activity in the sample is very large.

(5) H. F. Hunter and N. E. Ballou *Nucleonics* 9, C-2 (1951)

Table 9

Tabulation of Observed Decay Rates

Location	Time of Collection	Burst Date	Type Sample	Decay Slope
Fort Wayne, Indiana	10/11 - 10/12	9/24	Airborne Dust	1.20
B-29	10/24 1930	10/18	" "	1.20
B-29	10/24 1230	"	" "	1.86
New York	10/24 - 10/25	"	Tray	1.20
" "	10/24 - 10/25	"	"	1.25
Montgomery, Alabama	10/24 - 10/25	"	Airborne Dust	1.21
Bismarck, N. Dakota	10/25 - 10/26	"	Tray	1.27
Oklahoma City	10/26 - 10/27	"	Tray	1.21
Atlanta	10/26 - 10/27	"	Airborne Dust	1.20
Grand Rapids	10/26 - 10/27	"	" "	1.18
Nashville	10/27 - 10/28	"	" "	1.20
Lexington, Ky.	10/27 - 10/28	"	" "	1.28
New York	10/27 - 10/28	"	Tray	1.24
Cincinnati	10/28 - 10/29	"	Airborne Dust	1.11
Lexington, Ky.	10/28 - 10/29	"	" "	1.13
Tallahassee	10/28 - 10/29	"	" "	1.23
"	10/29 - 10/30	"	" "	1.24
Cincinnati	10/30 - 10/31	"	" "	1.24
Pendleton, Oregon	10/21 - 10/22	"	Tray	1.20
Seattle	10/21 - 10/22	"	"	1.62
Great Falls, Montana	10/22 - 10/23	"	"	1.05
Medford, Oregon	10/22 - 10/23	"	"	1.20
Seattle	10/22 - 10/23	"	"	1.17
Pocatello, Idaho	10/23 - 10/24	10/18	"	1.22
Forbes AFB	10/30 2100	10/28	Tray	1.16
B-29	10/31 1545	10/28	Airborne Dust	1.87
		10/30	---	1.82
Topeka, Kansas	10/31	10/28	Tray	1.17
		10/30	---	1.04
Fort Wayne	10/31 - 11/1	10/30	Airborne Dust	1.22
New York	10/31 - 11/1	10/28	Tray	1.35
		10/30	---	1.29
" "	11/1 - 11/2	10/28	Tray	1.22
" "	11/1 - 11/2	10/28	Tray	1.34
Cincinnati	11/1 - 11/2	10/30	Airborne Dust	1.51
Oklahoma City	11/1 - 11/2	10/30	Tray	1.26
Houston, Texas	11/1 - 11/2	10/30	Tray	1.49
		11/1	---	1.28
"	11/2 - 11/3	11/1	Tray	1.26
Tucson, Arizona	11/2 - 11/3	11/1	"	1.29
Cincinnati	11/3 - 11/4	10/28	"	1.12
		10/30	---	1.05
Atlanta	11/3 - 11/4	10/30	Airborne	1.02
Chattanooga	11/3 - 11/4	10/18	"	1.44
		10/30	---	0.78
New York	11/4 - 11/5	10/30	Tray	1.30
		11/1	---	1.20

Table 9 (Cont'd.)

Location	Time of Collection	Burst Date	Type Sample	Decay Slope
Corpus Christi	11/5	10/30	Airborne Dust	1.63)
		11/1	-----	1.43)
	11/5	10/30	Airborne Dust	1.43)
		11/1	-----	1.24)
New York	11/6 - 11/7	11/1	Gummed Paper	1.32)
		11/5	-----	0.98)
B-29	11/9 - 0145	11/5	Airborne Dust	1.12
Lexington, Kentucky	11/10 - 11/11	11/1	" "	1.01)
		10/30	-----	1.16)
Cincinnati	11/10 - 11/11	10/30	Airborne Dust	.97)
		11/5	-----	.75)
Tallahassee	11/12 - 11/13	10/30	Airborne Dust	.80)
		10/18	-----	1.22)
Medford, Oregon	11/14 - 11/15	11/5	Tray	0.94
Pendleton, "	11/19 - 11/20	11/5	Tray	1.00
Wendover	11/19 - 11/20	11/19	Tray	1.80
B-29	11/21 0500	"	Airborne Dust	1.47
B-29	11/21 2230	"	" "	1.65
B-29	11/22 0330	"	" "	1.60
B-29	11/21 2035	"	" "	1.67
Boise, Idaho	11/19 - 11/20	"	Tray	1.43
"	11/20 - 11/21	"	"	1.63
"	11/21 - 11/22	"	"	1.48
"	11/22 - 11/23	"	"	1.58
Burley, Idaho	11/19 - 11/20	"	"	1.52
"	11/20 - 0255-0810	"	Airborne	1.28
Pocatello, Idaho	11/18 - 11/19	"	Tray	1.82
Elko	11/19 - 11/20	"	Tray	.67
	11/19 - 1640-1700	"	Airborne Dust	1.24
	11/19 - 1700-1720	"	Airborne Dust	1.69
Wendover	11/30 - 0000	11/29	Tray	1.69
"	11/30 0810	"	Airborne Dust	0.92
"	" 1440	"	" "	1.20
"	" 1540	"	" "	1.22
"	" 1640	"	" "	1.27
"	" 1740	"	" "	1.20
"	" 1840	"	" "	1.12
"	" 2040	"	" "	1.08
"	" 1930	"	" "	1.43
"	" 2300	"	" "	1.00
Pocatello	11/29 2330 -	"	Tray)	2.20)
	11/30 2330	"	)	)
Elko	11/30 0200	"	Airborne Dust	1.10
	" 0200	"	" "	.84

Table 9 (Cont'd.)

Location	Time of Collection		Burst Date	Type Sample		Decay Slope
Elko	11/30	0400	11/29	Airborne Dust		.94
"	"	0400	"	"	"	.99
"	"	0500	"	"	"	.99
"	"	0500	"	"	"	.95
"	"	0530	"	"	"	.98
"	"	0530	"	"	"	1.04
"	"	0600	"	"	"	1.05
"	"	0600	"	"	"	1.01
"	"	0630	"	"	"	1.02
"	"	0630	"	"	"	1.01
"	"	0700	"	"	"	0.96
"	"	0700	"	"	"	0.98
"	"	0730	"	"	"	.95
"	"	0730	"	"	"	1.04
"	"	0800	"	"	"	0.92
"	"	0800	"	"	"	0.97
"	"	0830	"	"	"	0.89
"	"	0830	"	"	"	0.90
"	"	0900	"	"	"	0.83
"	"	0900	"	"	"	0.94
"	"	1130	"	"	"	0.91
"	"	1130	"	"	"	1.00
"	"	1300	"	"	"	1.12
"	"	1300	"	"	"	0.85
"	"	1500	"	"	"	0.88
"	"	1500	"	"	"	0.85
"	"	1700	"	"	"	1.01
"	"	1700	"	"	"	0.96
"	"	1900	"	"	"	0.90
"	"	1900	"	"	"	0.97
"	"	2100	"	"	"	1.03
"	"	2100	"	"	"	0.89
Rock Springs	"	1430	"	"	"	1.01
"	"	1500	"	"	"	1.14
"	"	1520	"	"	"	1.08
"	"	1540	"	"	"	1.13

FIG. 20 POSSIBLE ERROR IN ASSIGNMENT OF BURST DATE.

Table 10

AVERAGE DECAY RATES BY BURSTS

<u>Burst</u>	<u># Samples</u>	<u>Average Slope</u>	<u>Standard Deviation</u>
10/18	24	1.25	0.16
10/28 - 11/5*	24	1.22	0.15
11/19	15	1.59	0.14
11/29(Elko)	34	0.96	0.07
11/29(others)	15	1.25	0.32
<hr/>			
TOTAL	112	1.20	0.26

* Burst date selected to give slope closest to -1.2

Table 11

DECAY SLOPES OF AIR SAMPLES FRACTIONATED BY AEROTEC

<u>Location</u>	<u>Date of Sample</u>	<u>Burst Date</u>		<u>Decay Slope</u>
Elko	11/19 - 11/20	11/19	Aerotec-large	1.59
			Aerotec-small	1.32
Wendover	11/19-11/20	11/19	Aerotec-large	1.88
	11/30	11/29	Aerotec-small	1.03
Rock Springs	11/30	11/29	Aerotec-large	1.89
			Aerotec-small	0.97

Absorption Measurements

Like the radioactive decay of mixed fission products, their absorption characteristics should be complex, as many energies are represented. However, analysis of absorption curves for several fallout samples showed that all of them could be broken down into four major components, one gamma and three beta. The latter were characterized by energies of about 0.3, 1.0 and 1.6 mev. respectively.

Five active fallout samples were studied to determine whether the characteristic breakdown varied with time and with the particular burst represented by the sample. For this purpose, the fraction of the sample activity due to each component was determined from each absorption curve. From this data, the decay of each component could be followed.

The general conclusions for the absorption measurements are:

1. Four components are obtained consistently.
2. The gamma component remains constant at about 1% of the activity as counted. We do not know the gamma efficiency of our counters.
3. The 0.3 mev component is complex, decaying at a more rapid rate than the total activity.
4. The 1.0 mev component maintains a relatively constant fraction of the total activity for about 30 days and is the major component during this period.
5. The 1.6 mev component is complex, decaying at a slower rate than the total activity and becoming the major component after about 30 days.
6. The apparent range and decay rate of the 0.3 mev component are very constant, regardless of the source of the sample.
7. The sample from the burst of November 29 shows a second component of higher apparent range than the other samples.

The results on the decay rates of the components are given in Table 12.

Absorption data on other samples were obtained but decays were not run. All showed similar components.

Absorption curves are of value in characterizing fallout samples, but their preparation and analysis are tedious and time consuming. No conclusions as to elemental components, particularly as to induced activities could be drawn.

Table 12

SLOPES OF PRINCIPAL COMPONENTS

<u>Sample</u>	<u>Source</u>	<u>Total</u>	<u>I</u>	<u>II</u>	<u>III</u>
237	10/18	1.82	2.45	2.12	1.11
222	10/30	1.52	2.22	2.12	0.64
3	11/19	1.72	2.39	1.79	1.00
162	11/19	1.72	2.51	1.39	0.88
567	11/29	0.95	2.52	0.60	1.39

Radioautographs of Settled Dust

Duplicate gummed papers were exposed on the roof of NYO during the survey period. One of these samples was processed and counted, while the other was radioautographed to determine the distribution of radioactive particles.

The gummed paper was covered with a film of rubber hydrochloride and exposed to Eastman Type M X-ray film for about seven days. Ordinarily two films were used together to prevent chemical staining or alpha radiation being mistaken for fallout particles.

A sample radioautograph exposed from 1500 on 10/31 to 1500 on 11/1 is reproduced full size in Figure 21. The numbered spots were cut out of the gummed paper and counted individually. The results extrapolated to the sampling date are given in Table 13.

Table 13

ACTIVITY AND DIAMETER OF SPOTS ON FIGURE 21

<u>Spot</u>	<u>Activity</u>	<u>Spot Diameter (mm.)</u>
1	1000 d/m	2.6
2	2500	4.0
3	870	2.8
4	5800	6.7
5	640	4.0
6	2500	4.0
7	3000	6.0
8	540	3.0
9	6900	6.0
10	2200	5.0
11	520	2.8
12	470	2.9
13	570	2.0
14	2000	4.0
15	870	2.7
16	660	3.5

NOTES ON FIELD TECHNIQUES

Comparison of Tray And Gunned Paper Techniques

The two methods were tested in parallel at 20 Weather stations. Definitely higher results (significantly so at the 99% confidence level) were obtained with the gummed paper than with the trays. The unextrapolated data for days when no precipitation was reported are plotted in Figure 22. A regression line of the form $\log y = a + b \log x$, where x and y are the tray and gummed paper data respectively, was fitted. (Only pairs counted on the same day, and not including zeros, were plotted.)

The regression coefficient, b , is highly significant (at the 99% confidence level) showing that the results to be expected from trays can be estimated on the basis of tests with gummed paper and vice versa.

A similar comparison was made of data for days when more than a trace of rain was reported. Figure 23 is the logarithmic plot. In this case, also, the gummed paper collected the more activity and the regression coefficient was highly significant. The relationship between tray and gummed paper data is essentially the same in rain and fair weather. That is, the differences between corresponding coefficients in the equations are not significant statistically.

The precisions of the two methods have not been compared. Such a comparison would entail replication of both at the same locations. Both methods may be subject to inaccuracies which the data cannot reveal. It appears possible, for instance, that the gummed paper may overestimate the fallout by collecting dust blown from nearby surfaces. This source of inaccuracy might be investigated by comparing gummed papers located at different heights.

Variation Between Duplicate Trays

The trays were duplicated at 10 stations. In 26 pairs out of 36 having activity greater than 100 d/m/ft^2 the difference between duplicate results was greater than 20% and in each of 11 pairs the difference exceeded the lower of the two values. Since the procedure was controlled to keep the counting error below 20%, it is clear that the variation between duplicates is large. More replication is indicated to bring the precision closer to that of the counting.

At levels below 100 d/m/ft^2 a larger part of the variation can be ascribed to counting error.

The paired data are listed in Appendix H.

TRAY d/min ft²

Comparison of High Altitude Measurements

Dust filtered out of air at high altitudes was tested with an RCL GM tube as described previously. These measurements were made on the plane but after its return to the base the activity of filter paper was determined with a laboratory beta counter. The results by the two methods are plotted on logarithmic Scales in Figures 24 and 25. The points of Figure 24, representing activities below 1000 counts per minute, give the impression of random scatter rather than correlation. Above 1000 counts per minute the results of the two measurement methods are clearly correlated. These data and the regression line are plotted in Figure 25. (The regression coefficient is highly significant.)

For the comparison it was necessary to reject zeros, negative values and activities above the maximum of the instrument used on the plane, introducing uncertainty into the statistical analysis. However, it is obvious that the two methods of measurement agree well at high activities. In the case of low values error in measurement of background must have a relatively large effect on the result.

The relation between the filter paper activity and the readings of a scintillometer and a conductivity meter was investigated. An inspection of the time graphs (Figures 26 - 33) indicates that there is a rough correlation among the three sets of data. There are peaks in the curves which appear to correspond, but they do not coincide in time. Rather, there are irregular lags which prevent the pairing of the data and make the use of statistical methods of comparison difficult. Some of the peaks in the instrument readings are accompanied, usually with a time difference, by rises in filter paper activity, but there are other conductivity and scintillometer peaks with no corresponding change in the filter paper.

COUNT AT BASE C/M

100

- 712 -

FIG. 26
HIGH ALTITUDE DATA

Flight No. 1
Oct. 30 - 31, 1951

FIG. 27

HIGH ALTITUDE DATA

Flight No. 2
October 31, 1951

FIG. 28

FIG. 29

HIGH ALTITUDE DATA

Flight No. 4
Oct. 31 - Nov. 1, 1951

FIG. 30

HIGH ALTITUDE DATA

Flight No. 5
November 1 - 2, 1951

FIG. 31

FIG. 32
HIGH ALTITUDE DATA

Flight No. 7
November 2 - 3, 1951

FIG. 33

HIGH ALTITUDE DATA

Flight No. 9
November 3, 1951

APPENDIX A*

(Bound Separately)

*Appendix A was given a limited distribution by the New York Operations Office, and is not included in this copy of NYO-1576.

APPENDIX B*

(Bound Separately)

*Appendix B was given a limited distribution by the New York Operations Office, and is not included in this copy of NYO-1576.

APPENDIX C

Equipment Provided for Weather Bureau Network (Phase A)

GROUP A - 10 Stations (1 sample per day)

- 1 Tray
- 1 Squeegee
- 1 Kit of equipment for filter samples
- 70 Data Sheets
- 1 Set of Instructions
- 70 Addressed franked envelopes
(addressed to the local analytical lab)
- 70 Plastic sample envelopes

GROUP B - 10 Stations (2 samples per day)

- 2 Trays
- 1 Squeegee
- 2 Kits
- 140 Data Sheets
- 1 Set of Instructions
- 70 Addressed franked envelopes
- 140 Plastic sample envelopes

GROUP C - 20 Stations (2 samples per day)

- 1 Tray
- 1 Squeegee
- 1 Kit
- 140 Data Sheets
- 1 Set of Instructions
- 70 Addressed franked envelopes
- 140 Plastic sample envelopes
- 1 Frame for gummed papers
- 70 Sheets of gummed paper

GROUP D - 10 Stations (2 samples per day)

- 1 Tray
- 1 Squeegee
- 1 Kit
- 140 Data Sheets
- 1 Set of Instructions
- 70 Addressed franked envelopes
- 140 Plastic sample envelopes
- 1 Hi Volume Sampler
- 70 4" diameter dust filters
- 70 Addressed envelopes (addressed to NY00)

Groups A, B and C are evenly distributed geographically and intermixed but not on the 85th meridian.

Group D stations are along the 85th meridian.

APPENDIX D

Equipment Provided For Mobile Monitoring Teams (Phase B)

Schedule I - Airborne Team

<u>No. of Items</u>	<u>Designation</u>
2	H - Cascade Impactor Kit
3	K - Scintillometer
1	M - Survey Instruments
2	N - 6 Volt Air Sampler
1	P - Dosimeter Kit
8	Q - Film Badges

Schedule II - Ground Teams (2)

<u>No. of Items per Team</u>	
Team 1 - 5)	E - Hi Volume Sampler Kit
" 2 - 4)	
4	G - Fall out tray with Kit
1	H - Cascade Impactor Kit
1	I - Berkley Portable Scaler with End Window Tube ($3\frac{1}{2}$ mg/cm ²)
Team 1 only - 1	F - Aerotec Unit
" " 1	K - Scintillometer
" " 1	L - Sleeping Gear
1	O - Gummed Paper Kit
12	Q - Film Badges

APPENDIX D (Con't)

E - Hi Volume Sampling Kit

- 1 Carrying Case
- 1 Extension Cord 50'
- 1 Cube Tap
- 2 Boxes 4" Whatman #41 Filter Paper
- 2 Boxes Comfo All Dust Filters (100)
- 300 Cellophane Sample Envelopes
- 1 Pair Forceps
- 1 Glass Marking Pencil
- 300 Data Sheets
- 25 Large, Addressed, Franked Manila Envelopes
- 2 Hi Volume Samplers
- 4 Hi Volume Sampler Heads
- 4 3-Wire Filter Supports
- 1 Stapling Machine

F - Aerotec Units (5)

G - Fall out Tray with Kit

- 1 Tray
- 1 Squeegee
- 1 Kit
- 50 Data Sheets
- 1 Set of Instructions
- 50 Plastic Sample Envelopes

H - Cascade Impactor Kit

- 1 Carrying Case
- 1 Cascade Impactor
- 50 Coated Aluminum Slides in File Box
- 1 Box 1-1/8" Whatman #41 Filter papers
- 15 Glassene Sample Envelopes
- 15 Data Sheets
- 1 Hudson Pump with Rotameter
- 1 Tripod

APPENDIX D (Con't)

I - Berkley Portable Scaler - Model 8 with End Window
Tube ($3\frac{1}{2}$ mg/cm²)

K - Scintillometer

L - Sleeping Gear

2 Cots, Folding
6 Blankets

M - Survey Instruments

2 2G10A Survey Meter with AFOAT Probe
1 2G10A Survey Meter

N - 6 Volt Air Sampler

O - Gummed Paper Kit

1 Pkg. 11" x 17" X-ray Film
3 Frames
3 Pkgs. Gummed Paper (50 sheets each)
1 X-ray Exposure Holder
150 Data Sheets

P - Dosimeter Kit

4 Direct Reading Dosimeters
2 Battery Chargers

Q - Film Badges - NYO Design

APPENDIX E

PROCEDURE FOR COLLECTION OF PRECIPITATION AND DUST SAMPLES FOR RADIOACTIVE FALL-OUT STUDIES

The radioactivity associated with the fall-out being studied decays very rapidly so that speed in the handling of samples is essential. For all shipments, air mail is recommended where one day's transit time will be saved.

In order to correlate the radioactivity measurements with the fall-out, the date and hour of sampling and of measurement must be known for each sample. For uniformity, the use of the 24 hour time scale, rather than A.M. and P.M. notations is recommended. The time zone must be included for both collecting stations and laboratories.

The data sheets, of which a sample is attached, should be filled out completely with the pertinent information, using a separate sheet for each sample. Collecting stations will record the data on the upper half of the sheet, while the laboratories will fill in the counting data. This will aid in the collation of data from the large number of samples to be handled.

Four types of samples are to be used in the study of radioactive fall-out in this program, but not every station will collect each type.

1. Precipitation samples taken by collecting the rain or snow fall during 24 hours on the specific area of a collecting tray. The insoluble particulate matter is filtered off for measurement.
2. Settled dust samples taken by washing down the surface of the collecting tray used for precipitation samples when no rain or snow fall occurs. The insoluble particulate matter is filtered off from the washings for measurement.
3. Settled dust samples collected on gummed paper mounted on a metal frame. The paper is destroyed by ashing and the ash used for measurement.
4. Airborne dust samples collected by drawing known volumes of air through a filter with a high volume air sampler. The filter is destroyed by ashing and the ash used for measurement.

The procedure for taking and handling each of these samples will be given in detail so that comparable results may be obtained at all collecting stations and laboratories.

I. Precipitation Samples

- A. Collection: The sampling trays furnished by NYO have an area of 9 square feet and are mounted on legs for ease in setting up. The tray should be erected and a two quart Mason jar placed under the outlet. In case of heavy rain, the jar should be replaced when full, and all jars treated as one sample.

Light snowfalls may be transferred to the jar with the rubber squeegee furnished. After allowing it to melt, it is treated the same way as collected rain. It is not possible to furnish large containers, so for heavier snowfalls, two jars may be filled with snow from a smaller area than the whole tray, and the area cleared noted on the data sheet.

- B. Filtration: The filtration kit furnished by NYO contains a filter funnel, rubber tubing, a water aspirator to supply suction and two couplings for fitting the aspirator to various types of faucets. The filter funnel may be connected directly to the aspirator with the rubber tubing, the filtered water being pulled into the aspirator.

To filter a sample, a filter paper is placed on the perforated plate of the funnel and, with the suction on, a little water is poured over the paper to moisten it and hold it in place. The sample is then poured through the filter. Any residual solid matter in the jar should be washed onto the paper with water.

After all the water has been sucked through the paper, some drying may be obtained by allowing the aspirator to pull air through the paper for one or two minutes. The rubber tubing should then be disconnected at the filter funnel before turning off the aspirator.

The filter paper should be placed in a cellophane bag and the bag stapled to a data form containing the pertinent information.

Collecting stations should send the filter, bag and data sheet to the specified laboratory (in envelopes furnished) by mail, and if an appreciable saving in time would result, by air mail.

II. Settled Dust on Trays

- A. Collection: If no precipitation occurs in a 24 hour period or if the tray has dried out after a rain, the dust settling on the tray in that period is collected. This is done by wetting down the tray with water and washing the dust into the Mason jar with the rubber squeegee furnished and more water. This may be readily accomplished with less than two quarts of water. (If it has rained, the tray washings are filtered with the collected rain as one sample).

- B. Filtration: This is done exactly as for precipitation samples.

III. Settled Dust on Gummed Paper

- A. Collection: Sheets of "Kum-Kleen" gummed paper are supplied with a metal frame which will hold the paper by its own adhesive. This frame is placed on a box or suitable support next to the collecting tray and at about the same height with the gummed side up.

The papers are changed every 24 hours whether precipitation occurs or not. The gummed face of the paper is then folded together and refolded to fit into a cellophane bag. The bag should be stapled to a data form containing the pertinent information.

Collecting stations should send the paper, bag and data sheet to the specified laboratory, by mail, and if an appreciable saving of time would result, by air mail.

IV. Airborne Dust Samples

- A. Collection: Airborne dust samples are collected by drawing known volumes of air through a paper filter. The pump furnished consists of a head for holding the filter, an AC-DC 115 volt motor-blower, and a gage for determining the air flow in cubic feet per minute. The pump should be protected from rain, and may be set up at an open window, or under a suitable shelter.

The paper filter is mounted in the head with the rough, dark side out toward the entering air. The flow rate and date and hour of starting should be noted on the data sheet. Since the flow rate may decrease as dust collects, the same data must be noted at the end of the run.

The filter should be changed after every 24 hours. After removal, the filter is placed in a cellophane bag and the bag stapled to a data form containing the pertinent information.

Collecting stations should send the filter, bag and data sheet to the specified laboratory, by mail, and if an appreciable saving of time would result, by air mail.

DATA SHEET

STATION _____
CITY _____ STATE _____
TAKEN BY _____

Start Sample - Date _____ Hour _____ Time Zone _____
End Sample - Date _____ Hour _____ Time Zone _____
Wind Direction _____ Velocity _____
Weather Conditions _____

☐ Precipitation
Estimated Volume Collected _____ pints
Estimated Rainfall _____ inches
Duration, from _____ to _____

☐ Settled Dust on Tray
☐ Settled Dust on Gummed Paper
☐ Airborne Dust

Sampling Rate, start _____ finish _____ $\text{ft}^3/\text{min.}$

General Remarks _____

Counting Data:

Time of Counting - Date _____ Hour _____ Time Zone _____
Total Count _____ Counting Period _____ min.
Gross Rate _____ c/m
Background _____ c/m
Net Rate _____ c/m Efficiency Factor _____ c/d
Results _____ d/m/sample
_____ d/m _____
(unit)
Final Extrapolated Value _____ d/m/ _____
(unit)
Extrapolated to - Date _____ Hour _____ Time Zone _____

(Use separate sheet for each sample)

NY-98

SUMMARY SHEET

COLLECTING STATION.....
City.....State.....Time Zone.....

Dust on Tray ☐
Gummed Paper ☐

Laboratory.....
City.....State.....Time Zone.....

Sample Number	Start Sample		End Sample		Rainfall	Rain-fall	Wind Di- rection	Wind Velocity	Airborne Dust		First Count at			Second Count at			Extrap- olated Value
	Date	Hour	Date	Hour	Snowfall				From	To	Starting Rate(cf/m)	Final Rate(cf/m)	Date	Hour	d/m	Date	
Remarks																	
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APPENDIX G

Air Samples from 95th Meridian Mobile Monitoring

High Volume Samplers
(Extrapolated to Date of Collection)

October 28

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity in d/min/m³</u>					<u>Cyclone Sampler % less than 5 microns</u>
Oklahoma City, Oklahoma	2400-0200	1.4	3.4	21	21	39	100
	2400-0200	1.1					100
	0200-0400	0.7	0.9				
	0400-1000	2.7					
	0400-0600	0.5	0.5	1.2			100
	0600-0800	0.9	0.7	0.6			83
	0800-1000	0.7	1.1	1.1	0.1		91
	0800-1000						100
	1000-1200	9.8					8
	1200-1400	3.1	3.3	0.8			38
	1400-1600	3.2	6.4	1.7			76
	1600-1800	2.2					
	1800-2000	0.1	4.1	1.3			92
	2000-2200	3.8	2.9				
Omaha, Nebraska	1200-1400	0.6	1.5				93
	1400-1600	1.1					
	1600-1800	4.4					
	1800-2000	5.9					
	2000-2200	3.9					

October 29

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>					<u>Cyclone Sampler</u> <u>% less than</u> <u>5 microns</u>
Oklahoma City, Oklahoma	2400-0200	110	4.1	4.5	3.8	120	89
	2400-0200						100
	0200-0400	120	1.9	3.0	3		63
	0400-0600	5.6	3.4	7.5	4.2		98
	0400-0800	110	94	104			90
	0600-0800	7.5	5.3	5.6			93
	0800-1000	12	110	75			90
	1000-1200	41	35	26			100
	1200-1400	100	86	38			97
	1400-1600	140	98	88			98
	1600-1800	71	130	2.6			
	1800-2000	140	0.0	110	84		98
	2000-2200	83	75				
Omaha, Nebraska	1000-1200	0.0	0.2				
	1200-1400	8.3					
	1400-1600	2.3					
	1600-1800	0.1	0.0				
	1800-2000	3.6	0.1				
	2000-2200	3.9	0.1				
Watertown, South Dakota	0200-0400	0.0	8.4				
	0400-0600	11	11				
	0600-0800	4.4	7.4				
	0800-1000	5.9	3.2				
	1000-1400	0.6	1.6				
	1000-1200	0.7					100
	1400-1600	1.1	1.5				
	1600-1800	2.1	1.2	1.0			90
	1800-2000	2.5	1.3	0.4	1.1	1.9	100
	2200-2400	0.9	0.7				

October 30

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity in d/min/m³</u>			<u>Cyclone Sampler % less than 5 microns</u>
Oklahoma City, Oklahoma	2400-0400	0.8	1.8	17	11
	0800-1000	53	49	50	98
	1000-1200	45	57	67	96
	1200-1400	81	57	63	100
	1400-1600	48	51		82
	1600-1800	30	22	22	100
	1800-2000	4.6	51		
	2000-2200	1.4	2.6		
Omaha, Nebraska	2400-0200	1.9	1.5	2.7	
	0200-0400	3.0	0		
	0400-0600	0			
	0600-0800	0			
	0800-1000	0			
	1000-1200	0.4	7.7	4.8	
	1200-1400	1.2	0.1	1.2	
	1400-1600	0.8	3.2		
	1600-1800	3.5	0	7.9	
	1800-2000	1.8			
	1800-2200	4.7	3.1		
	2000-2400	3.5	2.4		
Topeka, Kansas	2400-0200	5.0	6.3	2.0	75
	2000-2200	6.6	8.6	3.6	58
Watertown, South Dakota	2400-0200	1.9	1.5	0.6	83
	0200-0400	4.6	3.9		
	0400-0600	0.4			100
	0400-0800	22	0.8		
	1000-1200	26	1.0		60
	1600-1800	3.5			

October 31

Station	Sampling Time	Beta Gamma Activity in d/min/m ³					Cyclone Sampler % less than 5 microns
Oklahoma City, Oklahoma	2400-0200	2.2	1.9	4.3	1.9		100
	0200-0400	1.8	1.6	1.6			
	0400-0600	5.0	1.2	0.4			
	0600-0800	4.5	4.9				
	0800-1000	7.0	8.0	13			100
	1000-1200	3.0	1.9				
	1200-1400	5.0	4.5				
	1400-1600	3.0	4.9	51	16	26	14
	1400-1600						12
	1600-1800	6.0	4.1	1.9			100
	1800-2000	16	8.6				
	2000-2200	5.6	2.1	3.4			76
Omaha, Nebraska	2400-0200	3.0					
	0200-0400	4.4	180	89	7.2	0.2	100
	0600-0800	2.3	7.1	8.0			
	0800-1000	1.8					
Topeka, Kansas	2400-0200	160	78	32			5
	0200-0400	16	5.2				79
	0400-0800	3.5					86
	0600-0800	7.1	8.0				
	0800-1000	6.2	4.4				
	0800-1200	4.5	7.5	2.1			67
	1200-1600	4.1	7.1	3.7	3.7		41
	1200-1600						100
	1600-1800	290	33	27			7
	1800-2000	3.7	230	31			9
	2000-2200	63					4
	2200-2400	220	930				

November 1

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>					<u>Cyclone Sampler</u> <u>% less than</u> <u>5 microns</u>
Dallas, Texas	2400-0200	31	74	2	0.2		
	0200-0400	0.8	1.5				
	0400-0600	1.8	2.2				
	0600-0800	5.2	5.7				
	0800-1000	7.8	5.2				
	1000-1200	1.3	7.0				
	1200-1400	3.5	8.7				
	1400-1600	9.6	9.6	2.2			
	1800-2000	52	40				
	1800-2200	60	46				
	2000-2400	6.9	22				
Houston, Texas	2400-0200	32					
	1600-1800	9					
	1800-2000	18					
	2000-2200	44					
	2200-2400	18					
Oklahoma City, Oklahoma	2400-0200	7.8	7.4	2.2	22	8.7	45
	2400-0200	13.5					74
	0400-0800	39	24				
	0800-1200	100	52	52	31	11	64
	0800-1200	23					
	1000-1400	16	11				8
	1400-1600	4.8	6.1	37			35
	1600-1800	190	4.8	13			35
	1800-2000	270	2.6	18			24
	2000-2400	530	770	5.7	14		100
	2000-2400						37

November 1
(Continued)

Station	Sampling Time	Beta Gamma Activity in d/min/m ³				Cyclone Sampler % less than 5 microns
Omaha, Nebraska	2400-0200	1600	5.7	2.7		88
	0200-0400	2.5	4.9			100
	0400-0600	5.7	8			100
	0600-0800	7.6	5.1			100
	0800-1000	4.6	93			0
	1000-1200	7.0	2.6	3.0	3.7	62
	1200-1400	6.4	6.8			
	1400-1800	7.2	6.8			
	1800-2200	5.7	9.8			
	2000-2200	4.6	3.7			
Topeka, Kansas	2400-0200	3.0	4.2	6.9	2.4	
	2400-0600	14.4				17
	0200-0600	1.5	7.8			4
	0600-0800	5.1	3.6	6.6		23
	0800-1000	2.4	3.3	5.1		59
	1000-1400	7.7	2.7	3.9		33
	1400-1600	6.9	4.2	98		2
	1600-1800	9.0	9.6	9.2		24
	1800-2000	4.8	3.0	5.4		37
	2000-2200	8.4	9.0	2700	11	16
	2200-2400	1.5				100

November 2

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u>				<u>Cyclone</u>
		<u>in d/min/m³</u>				<u>Sampler</u>
					<u>% less than</u>	
					<u>5 microns</u>	
Corpus Christi, Texas	1800-2000	8.6	4.8	8.6	80	
	2000-2200	12	6.9	6.9	62	
	2200-2400	7.5	8.6			
Dallas, Texas	0200-0400	15	7.6			
	0400-0600	3.2	3.9			
	0600-0800	4.4				
	0600-1000	2.3				
	0800-1000	3.0				
	1000-1200	4.7				
	1200-1400	4.7	10	7.4	6.8	
	1400-1600	15	10	5.5		
	1800-2000	13	16			
	2000-2200	8.4	17			
	2200-2400	11	15			
Houston, Texas	2220-0020	8.6				
	0200-0400	17				
	0400-0600	7.9				
	0600-0800	4.6				
	0800-1000	26				
	1000-1200	14				
	1200-1400	3.2				
	1400-1600	2.3				
	1600-1800	130				
	1800-2000	26				
2000-2200	9.5					

November 2
(Continued)

Station	Sampler Time	Beta Gamma Activity in d/min/m ³			Cyclone Sampler % less than 5 microns
Oklahoma City, Oklahoma	2400-0200	2.6	0.4	5.2	42
	0200-0400	16	6.5	7.3	41
	0400-0600	6.1	9.1	3.0	87
	0600-0800	10	9.6	3.0	100
	0800-1000	15	22	9.1	77
	1000-1400	32	4.9		
	1400-1800	24			
	1800-2200	22			
	2200-2400	25			
Omaha, Nebraska	0800-1000	0.7	2.7		
	2200-0800	7.2			
	2200-0800	5.8			
Topeka, Kansas	0200-0400	4.9	11	7.8	89
	0400-0600	7.7	8.4	4.2	67
	0600-0800	17	11	5.6	100
	0800-1000	9.1	7.0		
	1000-1200	23	14	8.4	58
	1200-1400	27	20	25	69
	1600-1800	13	24	14	78
	1800-2000	16	32	9.8	64
	2000-2200	12	11	8.4	100
	2200-2400	7.7	1.3	4.2	83

November 3

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>			<u>Cyclone Sampler</u> <u>% less than</u> <u>5 microns</u>
Corpus Christi, Texas	2400-0200	18	8.0	16	81
	0200-0400	2.3	1.5		
	0400-0600	4.5	4.2		
	0600-0800	2.6	4.9		
	0800-1000	3.4	3.0		100
	1000-1200	4.2	3.4		
	1200-1400	7.2	3.4	6.1	
	1400-1600	7.6	4.9	12	97
	1600-1800	9.0	3.9		
	1800-2000	7.8	8.1		
	2000-2200	7.5	1.9	6.9	82
	2200-2400	10	5.3	6.8	100
Dallas, Texas	2400-0200	6.1	4.8		
	0200-0800	4.8	6.0		
	0800-1000	4.4	5.3		
	1000-1200	1.8	4.4		
	1400-1600	2.3	3.5		
	1600-1800	4.2	6.3		
	1800-2000	2.7	3.0		
	2000-2200	5.6	4.7		
	2200-2400	3.7	3.3		
Houston, Texas	2400-0200	9.0	3.4		
	0200-0400	1.1			
	0400-0600	1.1			
	0600-0800	5.6			
	0800-1000	17			
	1000-1200	10			
	1200-1400	11			
	1400-1600	12			
	1600-1800	14			
	1800-2000	9.5			
	2000-2200	15			

November 3
(Continued)

Station	Sampling Time	Beta Gamma Activity in d/min/m ³			Cyclone Sampler % less than 5 microns
Omaha, Nebraska	2400-0200	1.6	1.6		
	0600-0800	6.2	6.0		
	0800-1000	7.6	7.6		
	1000-1200	5.0	5.6		
	1200-1400	2.0	2.0		
	1400-1600	3.0	3.8		
	1600-1800	2.5	4.6		
	1800-2000	2.2	3.5		
Topeka, Kansas	2400-0200	9.3	12	2.6	100
	0200-0400	19	14	4.2	81
	0600-0800	10	8.4	5.3	81
	0800-1000	16	26	6.8	84
	1000-1200	9.0	19	7.2	42
	1200-1400	9.3	14		52
	1400-1600	16	14	20	56
	1800-2000	5.1	5.4	11	97
	2000-2200	9.5	1.8		66
	2200-2400	1.9	4.8	11	17

November 4

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>				<u>Cyclone Sampler</u> <u>% less than</u> <u>5 microns</u>
Corpus Christi, Texas	0200-0600	4.6	4.2	5.0	39	
	0200-0400	6.4				86
	0400-0600	11				100
	0400-0800	5.6	35			
	0800-1200	8.2	4.4	5.8	4.2	
	1200-1400	10	72			
	1400-1600	9.6	6.1	7.7		100
	1600-1800	9.6	8.6	9.5		83
	1800-2000	70	65	48		77
	2000-2200	120	82	94		99
	2200-2400	330	200			
Dallas, Texas	2400-0200	3.2	2.2			
	0200-0400	1.3	3.3			
	0400-0600	1.1	2.5			
	0600-0800	2.4	5.4			
	0800-1000	5.7				
	1000-1200	5.5	8.4			
	1200-1400	3.0	5.5			
	1400-1600	6.3	9.3			
	1600-1800	6.3	8.9			
	1800-2000	5.3	11			
	2000-2200	13	22			
	2200-2400	50	66			
Houston, Texas	2400-0200	5.7	53			
	0200-0400	9.6				
	0400-0600	5.3				
	0600-0800	5.0				
	0800-1000	8.7				
	1000-1200	14				
	1200-1400	14				
	1400-1600	23				
	1600-1800	36				
	1800-2000	70				
	2000-2200	30				

November 4
(Continued)

Station	Sampling Time	Beta Gamma Activity in d/min/m ³			Cyclone Sampler % less than 5 microns
Omaha, Nebraska	2400-0200	2.8	3.2	.	
	0600-1000	1.4	1.2		
	0800-1200	1.6	2.3		
	1200-1600	5.1	3.6		
	1400-1800	3.6	3.2		
	1600-2000	3.8	3.6		
	1800-2200	2.4	3.2		
Topeka, Kansas	2400-0200	4.4	4.0		
	0200-0400	5.1	7.2	2.5	84
	0400-0600	3.5	3.3	1.9	79
	0600-0800	4.4	1.9	1.4	86
	1000-1200	2.5	2.8	1.7	24
	1200-1400	3.8	2.8	1.4	100
	1400-1600	4.7	2.8	3.6	31
	1600-1800	2.7	5.3	16	1

November 5

Station	Sampling Time	Beta Gamma Activity in d/min/m ³				Cyclone Sampler % less than 5 microns
Corpus Christi, Texas	2400-0200	370	300 -	300		100
	0200-0400	130	110	130		99
	0400-0600	230	200	180		100
	0600-0800	200	130	260		99
	0800-1000	360	360	560		100
	1000-1200	400	260	550		91
	1200-1400	380	240	380		94
	1400-1600	240	160	290		97
	1600-1800	340	190	320		99
	1800-2000	400	280	420		100
	2000-2200	360	240			
Dallas, Texas	2400-0200	17	31			
	0200-0400	48	7			
	0400-0600	27	3.4			
	0800-1000	51	93			
	0800-1200	100				
	1000-1600	87	110	51	180	
	1200-1800	5.4	31			
	1600-2000	1.1	1.6			
	1800-2200	0.7	0.8			
Houston, Texas	2400-0200	5.1				
	0200-0400	100	82			
	0400-0600	280				
	0800-1000	54	180			
	1000-1200	182	300			
	1200-1400	106				
	1400-1600	88				
	1800-2000	37				
	2000-2200	44				
	2200-2400	12				

November 5
(Continued)

Station	Sampling Time	Beta Gamma Activity in d/min/m ³			Cyclone Sampler % less than 5 microns
Topeka, Kansas	2400-0200	3.2	2.2		
	0200-0400	3.5	1.2		100
	0400-0600	4.7	2.6	1.8	50
	0800-1000	3.5	3.7	5.8	16
	1000-1200	4.0	4.9	0.9	100
	1200-1400	7.2	3.7	5.4	25
	1400-1600	170	4.7	3.3	57
	1600-1800	4.4	4.4	1.9	73
	1800-2000	4.0	3.7		
	2000-2200	3.2	2.9		

November 6

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>				<u>Cyclone Sampler</u> <u>% less than</u> <u>5 microns</u>
Brownsville, Texas	2400-0200	4.8	3.0	49		99
Corpus Christi, Texas	2400-0600	10	5.1			
	0200-0600	6.6	5.4			
	0400-1000	4.5	1.2	1.8		
	1000-1400	2.0				
	1400-1800	3.0	1.4			
	1800-2200	11	1.4			
Dallas, Texas	2400-0200	2.0	1.5	1.5	1.2	
	0200-0400	1.4	4.2			
	0400-0600	2.1	4.1			
	0600-0800	2.1	5.0			
	0800-1000	3.0	2.1			
	1000-1200	2.0	5.4			
	1200-1400	2.1	0.2			
	1400-1600	1.5	0.6			
	1600-1800	270	2.7			
	1800-2000	6.0	1.5			
	2000-2200	3.2	1.2			
	2200-2400	1.4	0.9			
Houston, Texas	2400-0200	1.8				
	2400-0400	2.1				
	0600-1000	1.4				
	0800-1200	3.0				
	1000-1400	1.4				
	1200-1600	1.2				
	1400-1800	1.6				
	1800-2000	1.8				
	1800-2200	3.4	2.0			
	2000-2400	1.6				

November 6
(Continued)

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity in d/min/m³</u>			<u>Cyclone Sampler % less than 5 microns</u>
Topeka, Kansas	2400-0400	4.6	2.2		
	0400-1000	4.6	4.2	3.6	
	0800-1400	1.8	1.2		
Waco, Texas	2400-0200	0.9	0.0		
	2000-2400	0.4	0.9		

November 7

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>			<u>Cyclone</u> <u>Sampler</u> <u>% less than</u> <u>5 microns</u>
Corpus Christi, Texas	2400-0200	1.8	2.8		
	0600-1000	1.3	1.6		
	1000-1400	1.1	1.4		
	1400-1800	1.8	1.8		
	1800-2200	2.0	1.0		
Brownsville, Texas	2400-0800	9.0	10	5.4	100
	0200-0400	5.5	3.9	1.3	100
	0400-0600	5.7	7.0		
	0600-0800	3.0	2.6	0.9	100
	0800-1200	0			0
	1000-1200	4.0	1.6		
	1000-1400	1.6	2.8	2.1	100
	1400-1600	3.0	3.7	2.1	100
	1600-1800	1.9	1.6	1.6	65
	1800-2000	0.6	1.1		
	2000-2200	1.4	3.4	0.8	100
Dallas, Texas	0200-0800	2.3			
	0400-0600	0.8	1.0		
	0600-0800	0.8	0.6		
	0800-1000	1.0	1.3		
	1000-1400	0.8	1.3		
	1400-1600	0.6	0.7		
	1400-1800	0.6	1.7		
Houston, Texas	2400-0200	2.0			
	0200-0400	0.3			
	0600-0800	3.2			
	1000-1200	1.6			
	1200-1400	1.4			
	1600-1800	1.4			
	1800-2000	2.3			
	2000-2200	1.6			
	2200-2400	1.9			

November 7
(Continued)

Station	Sampling Time	Beta Gamma Activity in d/min/m ³				Cyclone Sampler % less than 5 microns
Waco, Texas	2400-0400	1.4	0.4	0.7	2.0	
	0600-0800	0.6	0.7			
	0800-1200	0.8	0.3			
	1000-1400	0.4	0.8			
	1400-1600	1.7	0.8			
	1600-1800	1.4	1.1			
	1800-2000	0.4	2.0			
	2000-2200	3.1	1.4			

November 8

<u>Station</u>	<u>Sampling Time</u>	<u>Beta Gamma Activity</u> <u>in d/min/m³</u>				<u>Cyclone Sampler</u> <u>% less than</u> <u>5 microns</u>
Brownsville, Texas	0600-1000	4.8	4.8	2.7		100
	1000-1200	6.6	5.5	3.8		89
	1400-2200	5.7	8.5			
Corpus Christi, Texas	0200-0600	3.1	1.5			
	0600-1000	2.4	1.1			
	1000-1400	2.5	0.9			
	1400-1800	3.5	2.3			
	1800-2200	6.4				
Dallas, Texas	0200-0800	2.3				
	0800-1800	1.1				
	0200-1000	2.8				
	1000-1800	2.1				
Houston, Texas	2400-0400	0.8				
	0200-0600	2.0				
	0400-0800	3.5				
	0800-1000	1.6	2.3			
	1000-1400	1.7				
	1200-1600	1.3	2.8			
	1400-1800	2.9				
	1600-2000	2.9				
Waco, Texas	2400-0200	2.4	2.3	1.6	0.6	
	0200-0400	3.7	1.9			
	0400-0800	2.9	1.7			
	0800-1000	5.5	2.3			
	1000-1200	3.6	1.3			
	1200-1400	2.3	1.5			
	1400-1600	3.3	1.3			
	1600-1800	3.1	1.9			
	1800-2200	9.5	2.4			
	2200-2400	2.3	2.1			

APPENDIX H

DUPLICATE TRAY DATA

d/min./ft.²

(Not Extrapolated)

<u>Station #9</u> <u>Pendleton, Ore.</u>		<u>Station #10</u> <u>Tucson, Ariz.</u>	
<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>
6.0	6.6	16.78	22.51
2.9	5.7	10.92	12.62
2.6	1.9	3.51	12.84
32.3	25.4	2.84	2.75
24.2	28.4	4.60	4.76
4.6	2.3	3.74	2.86
1.3	1.4	3.24	7.83
2.8	5.2	0.00	3.18
0.8	0.8	4.13	2.30
2.4	2.1	1.06	3.13
417.3	646.0	1.58	0.00
125.4	133.8	0.98	0.82
45.6	7.7	2.72	2.24
2.3	2.9	4.51	5.95
4.2	6.1	10.45	7.42
1.2	0.2	1.44	1.33
1.6	2.1	1.30	0.66
149.9	83.8	0.40	3.33
50.7	44.9	11	4.5
		5.2	5.2
		110	120
		3000	1200
		270	620
		96	3600
		9.6	61.6
		71	150
		21	25
		25	26
		13	5.8
		5.9	7.8
		70	84
		16	28
		3.3	12

APPENDIX H (Cont'd.)

Station #12
Rapid City, S. Dakota

Station #37
Rochester, New York

<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>
4.9	8.9	24.5	13.1
0.1	0.8	9.2	9.3
0.4	1.9	2.7	1.7
23.1	28.2	3.9	4.0
1.6	3.0	3.4	2.2
0.2	0.6	4.0	3.3
3.5	2.4	0.0	1.8
0.4	0.0	2.9	1.3
1.2	1.3	2.1	0.0
0.8	1.0	4.4	2.5
3.0	1.8	0.6	5.9
31.4	23.1	0.7	0.0
1.8	1.3	0.3	3.4
1.2	0.8	232.0	854.0
0.3	1.1	70.3	33.5
2.0	3.3	42.05	35.2
1.2	0.0	58.0	41.4
1.5	2.2	71.9	65.5
1.2	0.0	9.2	11.2
2.4	2.2	8.2	36.9
1.4	0.0	21.9	45.5
5.8	3.9	87562.0	73494.0
0.7	1.1	54777.0	63330.8
0.5	0.6	34558.9	36951.1
0.07	3.7	5368.5	3530.7
0.0	0.5	2085.1	2432.5
0.8	0.3	430.4	1110.7
1.9	1.5		
3.5	4.3		

APPENDIX H (Cont'd.)

<u>Station #42</u> <u>Caribou, Maine</u>		<u>Station #21</u> <u>LaCrosse, Wisconsin</u>	
<u>A</u>	<u>B</u>	<u>A</u>	<u>B</u>
31.8	16	44	72
3.3	3.8	24	24
22.3	16.9	236	176
0.4	5.3	88	156
4.4	1.0	164	88
3.9	0.3	100	96
3.3	5.3	116	176
4.2	3.6	188	140
3.4	4.8	188	164
1.7	0.6	988	1176
2.6	0.9	48	64
0	0	20	20
0	0	12	16
2.6	2.1	32	20
0	3.5	64	80
4.6	3.8	16	20
186.8	450.7	12	24
0.8	5.6	12	8
262.8	157.2	68	32
82.8	52.1	36	52
21.7	44.1	56	100
63.4	35.9	16	20
33959	27201	16	16
2502.9	3485.8	52	52
1353.8	863.7	12	20
78.8	161.1	24	36
218.6	156.2	24	68
185.7	57.5	80	24
105.2	11.3	24	24
3.7	9.5	16	8
80.5	38.4	12	12
		12	12
		8	16
		12	8
		24	16
		128	28

APPENDIX H (Cont'd.)

Station #46
New Cumberland, Pennsylvania

<u>A</u>	<u>B</u>
22.6	34.8
24.3	28.9
23.2	5.6
19.5	3.3
4.9	18.2
3.7	3.7
0.0	4.3
103.0	86.3
223.4	158.1
485.8	107.9
220.4	288.2