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Environmental and Emergency Response Capabilities of Los Alamos Scientific Laboratory's Radiological Air Sampling Program

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ENVIRONMENTAL AND EMERGENCY RESPONSE CAPABILITIES OF LOS ALAMOS SCIENTIFIC LABORATORY'S RADIOLOGICAL AIR SAMPLING PROGRAM

by

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ABSTRACT

This report describes environmental and emergency response radiological air sampling capabilities of the Environmental Surveillance Group at Los Alamos Scientific Laboratory. The air sampling program provides a supplementary check on the adequacy of containment and effluent controls, determines compliance with applicable protection guides and standards, and assesses potential environmental impacts on site environs. It also allows evaluation of potential individual and total population doses from airborne radionuclides that may be inhaled or serve as a source of external radiation. The environmental program is sufficient in scope to detect fluctuations and long-term trends in atmospheric levels of radioactivity originating onsite. The emergency response capabilities are designed to respond to both onsite unplanned releases and atmospheric nuclear tests.

I. INTRODUCTION

This report describes environmental and emergency response radiological air sampling capabilities of the Environmental Surveillance Group (H-8) at the Los Alamos Scientific Laboratory (LASL). The H-8 air sampling program provides a supplementary check on the adequacy of containment and effluent controls, determines compliance* with applicable protection guides[1] and standards,[2] and assesses potential environmental impacts on the environs. Because air is a primary exposure pathway to man from radionuclides released to the atmosphere, environmental and emergency response air sampling programs are conducted to evaluate potential individual and total population doses from airborne radionuclides that may be inhaled or serve as a source of external radiation. Airborne radioncludes from a facility or from resuspension following deposition may be absorbed by the lung and/or gastrointestinal tract. Some airborne radionuclides, notably tritiated water vapor, may also enter the body by absorption through the skin.

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*Because many Department of Energy (DOE) orders, manuals, and directives are still being promulgated and were not considered final when this report was being written, references have been made herein to Energy Research and Development Administration (ERDA) Manual Chapters, which continue to serve as guidelines until superseded by the final DOE orders and manuals.

II. ENVIRONMENTAL AIR SAMPLING PROGRAM

A. Sampling Program Design

1. Rationale. Several federal government documents[1-3] and ICRP Publication No. 7[4] list objectives for an environmental air surveillance program. LASL's sampling program design was developed from these references along with consideration of the following factors:

- Potential hazard of radionuclides released, considering both quantities and relative radiotoxicities.
- Chemical and physical state of the effluents.
- Extent to which facility operations are routine and unchanging.
- Need for supplementing and complementing stack effluent monitoring.
- Size and distribution of the exposed population.
- Cost-effectiveness of additions to the air sampling program.
- Availability of measurement techniques that provide sufficiently sensitive comparisons with applicable standards and background measurements.

LASL's history of stable operations, as evidenced by air sampling results (many routinely less than detection levels), warranted a program sufficient in scope to detect short-term fluctuations and long-term trends in atmospheric levels of radioactivity originating onsite.

2. Sampling Locations. Twenty-five continuously operating air samplers (Figs. 1 and 2 and Table I) were deployed after considering a variety of site meteorological and population distribution parameters. Three regional stations (Española, Pojoaque, and Santa Fe), located 28 to 44 km from the Laboratory, serve as reference points in determining the regional background for atmospheric radioactivity. Three locations were chosen as a precaution against loss of data or anomalous results. Eleven perimeter stations, 0 to 4 km from the Laboratory boundary, are in nearby population centers or along the site boundary. Eleven onsite stations are in locations of predicted maximum concentrations and in other locations needed to help interpret offsite sample results. One air sampler is also located on the roof of the onsite Occupational Health Laboratory.

3. Sampling Frequency. Monthly collection of air particulate filters and silica gel cartridges (used to collect atmospheric water vapor for tritium analysis) at LASL is based on the air pump capability, analytical sensitivities, and problems (manpower, economics, etc.) of retrieving samples from each location on a fixed time frequency. The filters are counted for gross alpha and gross beta activities. Samples are composited on a quarterly basis and analyzed for ^{238}Pu, ^{239}Pu, total U, and ^{241}Am. This quarterly compositing takes advantage of the larger air volume sampled to achieve desired sensitivity with lower analytical costs. This practice implies that the concentration of each nuclide is sufficiently constant to be compatible with the final uses of the data. For annual dose calculations this practice is acceptable. The annual average concentration for a location can be compared against an annual average concentration for a background location as an indication of potential Laboratory impact during the year in question. Averages for successive years can also be compared for detection of general trends.

Because relative humidity in northern New Mexico is quite low (5 to 10% during the summer), monthly pickup of silica gel cartridges is adequate. There is no problem with saturating the silica gel, as there often is in more humid climates. The air flow rate chosen for the air filters also produces acceptable dust loading (in Los Alamos typically 30 to 40 $\mu g/m^3$ annual geometric mean) in the relatively clean, northern New Mexico air.

Air filters from the onsite roof sampler are collected and analyzed for gross alpha and gross beta activities daily (Monday through Friday) to provide immediate indication of any unusual activity in the vicinity.

4. Radionuclides Sampled. After analyzing potential hazards of radionuclide stack releases at LASL by considering both quantities and relative radiotoxicities, types of measurements were chosen. Gross alpha and gross beta activities are measured as general indicators of radiological air quality. Levels of ^{238}Pu, ^{239}Pu, ^{241}Am, total U, and tritiated water vapor (HTO) are also determined because these nuclides are routinely released from normal LASL operations.

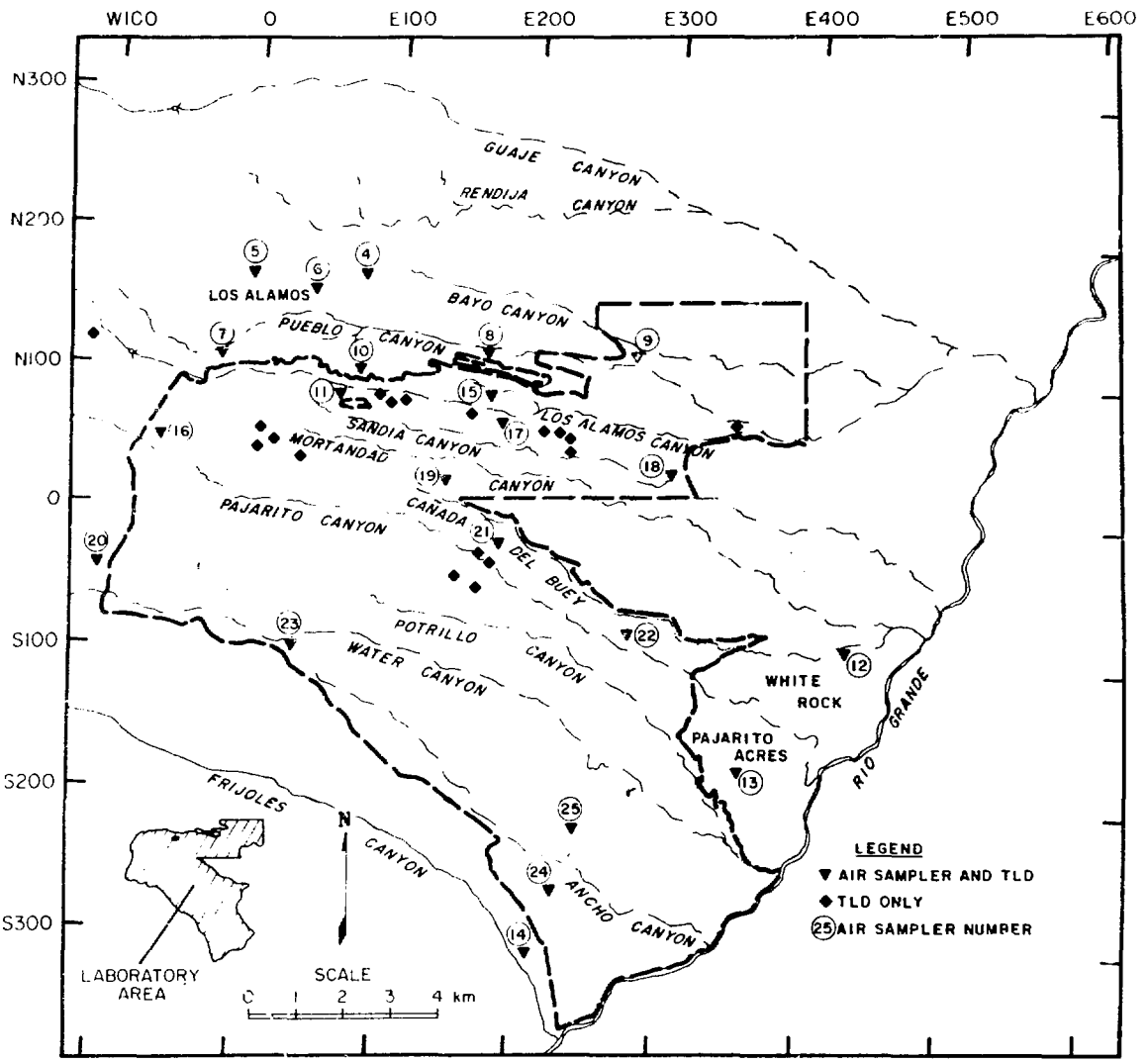

Fig. 1.
TLD and air sampler locations on or near the LASL site.

B. Sampling Hardware

1. **Particulate Sampling Train.** A positive-displacement air pump is used to pull air through a 79 mm diam filter at a flow rate of approximately 3 ℓ/s (Fig. 3). The filter is mounted on a charcoal cartridge, which was originally designed for use on respirators. The cartridges are very convenient because they can be quickly changed and easily transported from field to laboratory. Furthermore, the charcoal can be analyzed for iodine if the need arises. The filter medium is polystyrene and was chosen for its high collection efficiency and capability of sustaining high air flow rates without clogging. It is readily wet ashed with oxidizing agents, but has the disadvantage of low mechanical and tensile strength, so it must be handled carefully.

Measurement of the volume of air sampled is done indirectly with a flow rate meter (located between the filter cartridge and pump) and elapsed-time meter. Initial and final flow rates are read. By assuming a linear decrease in flow rate as filter particulate loading increases, and by correcting for

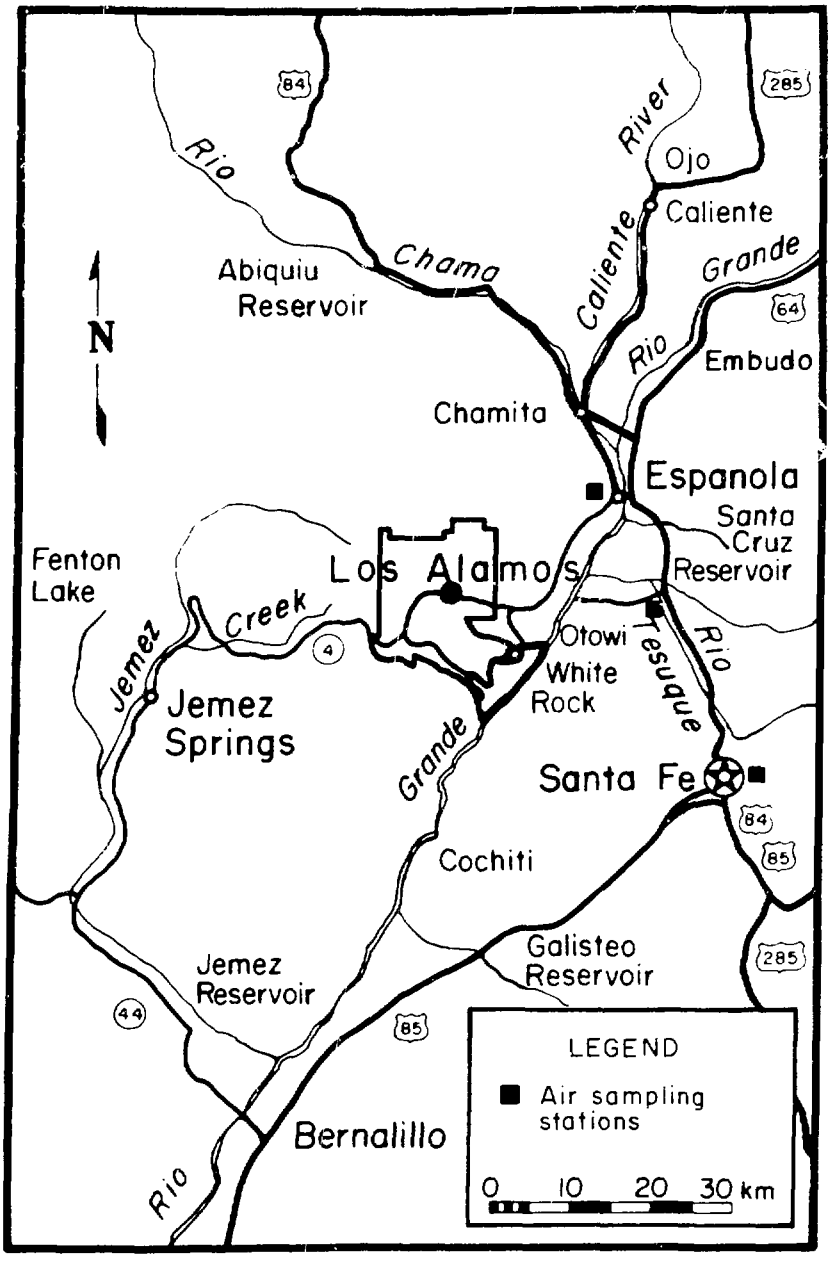

Fig. 2.
Regional air sampler locations.

pressure drop across the flow meter, the total air volume is calculated.

The entire sampling train is housed in an aluminum shelter to protect it from weather (Fig. 4). The shelter is locked to afford a measure of security from accidental or willful damage or tampering, and is approximately 1.5 m above ground level. The entire system is inspected quarterly and recalibrated and maintained when indicated.

TABLE I

LOCATION OF AIR SAMPLING STATIONS

Station	N-S Coordinate[a]	E-W Coordinate[a]
Regional (28-44 km)		
1. Española	---	---
2. Pojoaque	---	---
3. Santa Fe	---	---
Perimeter (0-4 km)		
4. Barranca School	N180	E130
5. Arkansas Avenue	N170	E020
6. Cumbres School	N150	E090
7. 48th Street	N110	E000
8. LA Airport	N110	E160
9. Bayo STP	N110	E260
10. Gulf Station	N100	E100
11. Royal Crest	N080	E080
12. White Rock	S090	E430
13. Pajarito Acres	S210	E370
14. Bandelier	S270	E200
Onsite		
15. TA-21	N090	E170
16. TA-6	N060	W050
17. TA-53 (LAMPF)	N060	E190
18. Well PM-1	N030	E310
19. TA-52	N020	E170
20. TA-16	S030	W080
21. Booster P-2	S030	E190
22. TA-54	S080	E260
23. TA-49	S100	E040
24. TA-33	S250	E230
25. TA-39	S210	E210

[a]All Los Alamos County and vicinity locations references are identified by the LASL cartesian coordinate system, which is based on English units of measurement. This system is standard throughout the Laboratory but is independent of the U.S. Geological Survey and New Mexico State Survey coordinate systems. The major coordinate markers shown on the maps are at 3.048 km (10 000 ft) intervals, but for the purpose of this report are identified to the nearest 0.30 km (1000 ft).

2. Tritium Sampling Train. In air, tritium occurs primarily in two forms: as water vapor (HTO) and as hydrogen gas (HT). Tritiated organic compounds in the vapor phase or attached to particulate matter occur only occasionally. Currently, for dosimetric purposes, the fraction of tritium present as HT is neglected because it is difficult to measure and since the relative dose for a given activity concentration of HTO is 25 000 times that for HT.[5] A

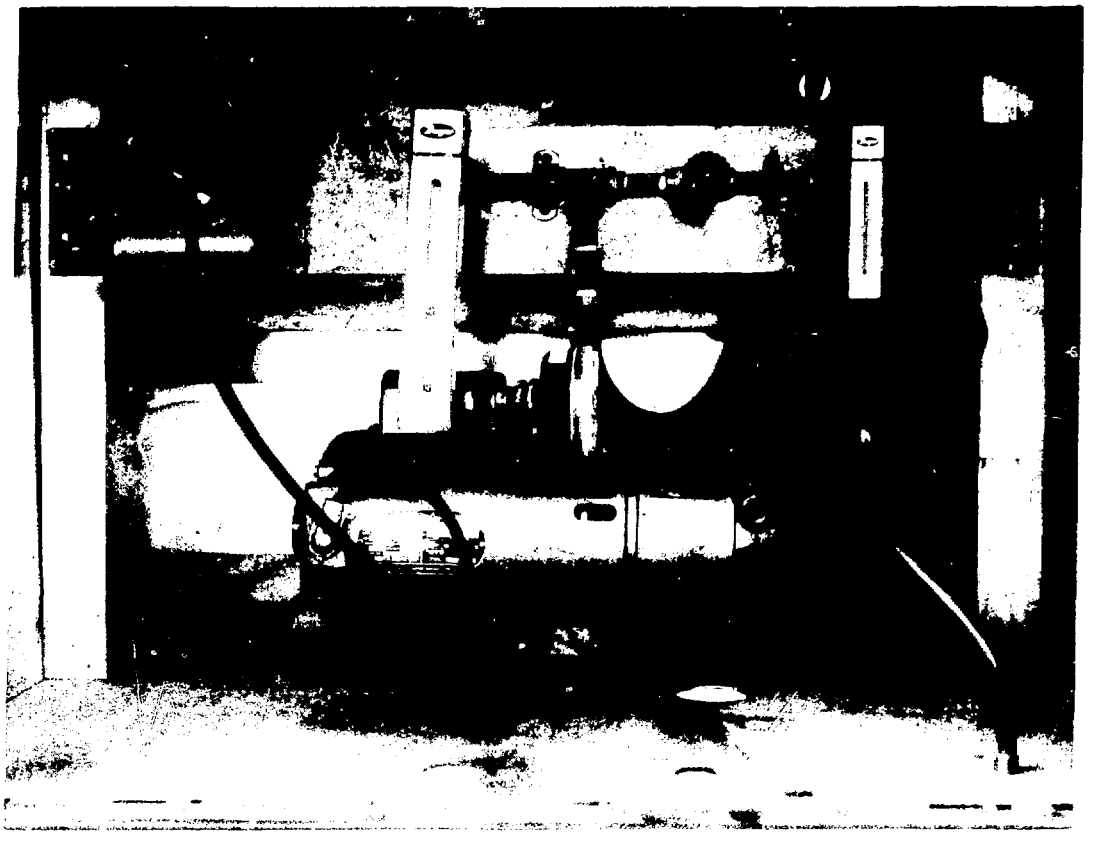

Fig. 3.
Air sampling train in a shelter.

new sampler capable of measuring both HTO and HT is now being developed at LASL and will be used to test the hypothesis that exposure to HTO, not HT, is the limiting factor in dose calculations. Presently, only HTO is routinely sampled by using silica gel as a desiccant to remove moisture (H_2O, HTO) from air.

The silica gel cylinder (Fig. 5) is 25 cm by 4.5 cm, made of polycarbonate, and fitted with a quick disconnect coupling. The same pump that is used for the particulate sampling train is used to pull air through the silica gel column at about 125 cm^3/min. This flow rate is maintained by using the flow adjustment on the flow rate meter as a critical orifice. The weight of the cylinder with gel is determined *before and after sampling to determine* the total amount of water collected. A small amount of blue gel is placed at each end of the cylinder to indicate desiccant over-saturation. Essentially all moisture that enters the column is collected.[6] Following sample collection, the gel is heated (4 h at 120°C) in a distillation flask (Fig. 6) to remove the moisture; the collected moisture is then counted using standard liquid scintillation techniques.[7]

C. Analytical Methods

1. Gross Alpha and Gross Beta. Gross alpha and gross beta activities are measured with a gas-flow proportional counter on collection day and again seven days after collection. Each filter is mounted directly on a counting planchet and covered with 6.35 μm Mylar®. Double-sided adhesive rings slightly larger than the filter are used for securing the Mylar® in place. The first count screens samples for inordinate activity levels, and the second

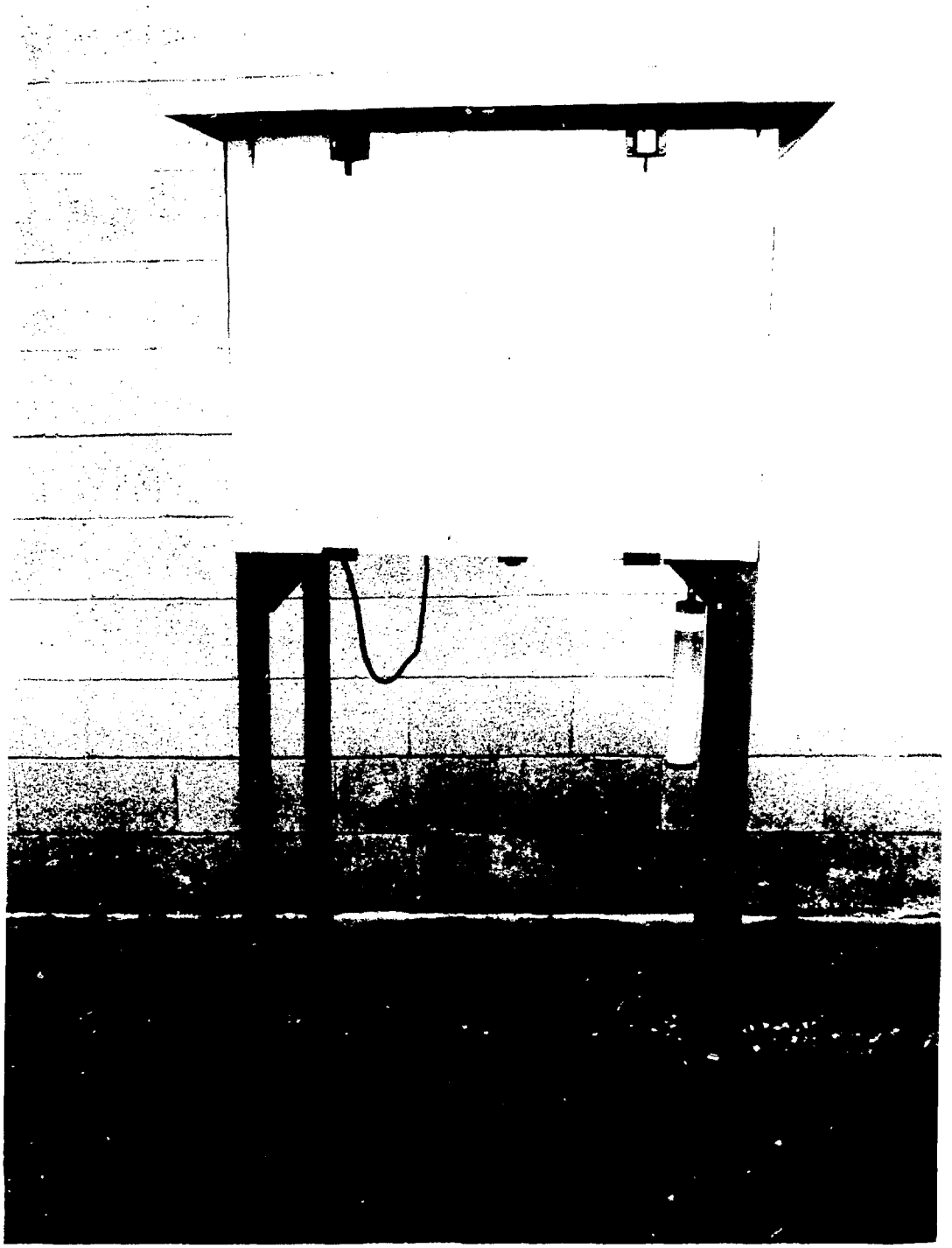

Fig. 4.
Shelter for air sampling hardware.

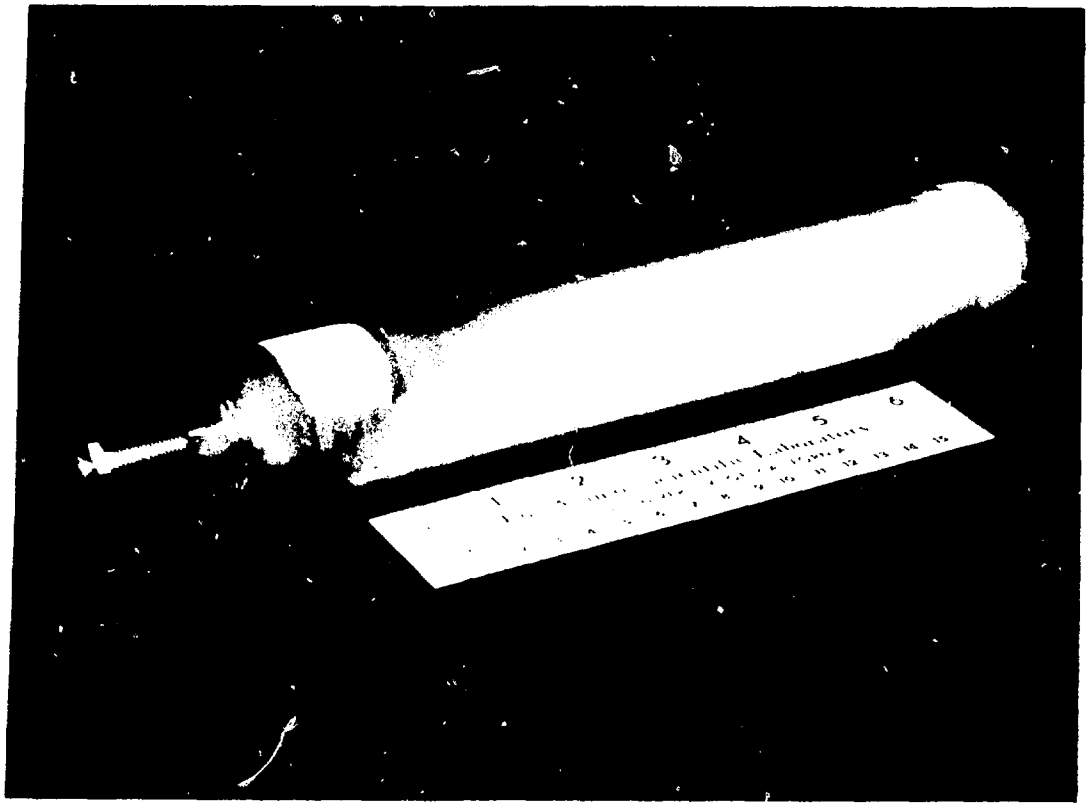

Fig. 5.
Silica gel cartridge used for atmospheric tritiated water vapor sampling.

provides a record of long-lived atmospheric radioactivity.

The seven day count is made after adsorbed, naturally-occurring radon-thoron daughters have reached equilibrium with their long-lived parents (Fig. 7). Radon (^{222}Rn) occurs in typical surface air at concentrations of 10^{-3} to 10^{-5} $\mu Ci/m^3$. Thoron (^{220}Rn) and its daughters also provide an unwanted background count, but usually at concentrations one to three orders of magnitude less than radon.[8] These radon and thoron daughters are found on air particulate filters because they adhere to particulate matter and thus are efficiently trapped by the air filter. After collection, the filter is retained seven days[9] before counting to allow decay of the short-lived radon ($T_{1/2} \simeq 0.5$ h) and thoron ($T_{1/2} \simeq 10$ h) daughters.

Two blank filters are prepared and accompany the air sampling filters into the field. The blanks are stored in the laboratory during the sampling period, and then accompany the air sampling filters on their return trip to the laboratory. These blanks are then counted in conjunction with the air sampling filters. This procedure allows detection of any contamination of the filters while they are in transit to and from the field.

2. Tritium. Water (H_2O, HTO) is distilled (4 h at 120°C) from each silica gel sample and collected. A 5 mℓ aliquot of the collected water is then taken for scintillation counting. Fifteen mℓ of scintillation liquid is added and the solution vigorously shaken. The sample is counted in a liquid scintillation counter for 50 min or 10 000 counts, whichever comes first. Standards and blanks are counted in conjunction with each set of samples.

3. Plutonium, Americium, and Total Uranium. After being measured for gross alpha and gross beta activities, the monthly filters for each station are cut

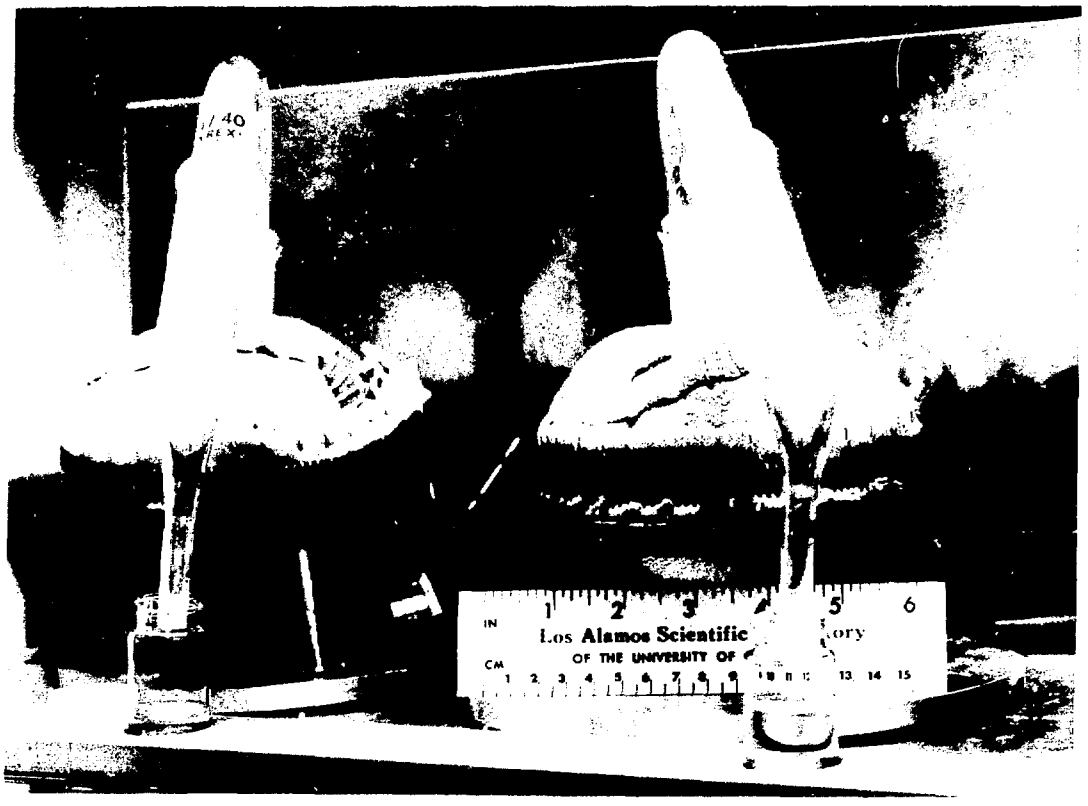

Fig. 6.
Distillation flasks used to drive off water from silica gel.

in half. The first group of filter halves is combined to produce quarterly composite samples for each station. This group is analyzed for total U by delayed neutron activation. The samples are irradiated in a thermal neutron port at LASL's Omega West Reactor and pneumatically transferred to a neutron counter where the delayed neutrons produced by the fission of ^{235}U are measured.[10] The technique is thus very manpower efficient. Total U is calculated assuming the natural $^{235}U/^{238}U$ ratio of 0.0072.

The second group of filter halves is ignited in platinum dishes and treated by wet chemical techniques to get the plutonium and americium into solution.[11] Plutonium is separated from the solution by anion exchange. For 11 selected stations (selection based on population distribution and meteorological parameters), americium is separated by cation exchange from the eluent solutions from the plutonium separation process. Purified plutonium and americium samples are separately electrodeposited and measured for alpha-particle emission with a solid-state alpha spectrometer system. Alpha-particle energy groups associated with the decay of ^{238}Pu, ^{239}Pu, and ^{241}Am are integrated, and the concentration of each radionuclide calculated.

D. Data Analysis

1. Statistical Treatment of Data. Individual station and statio : group means are weighted for the length of each sampling period and for the air volume sampled. Means are calculated using the following equation.[12]

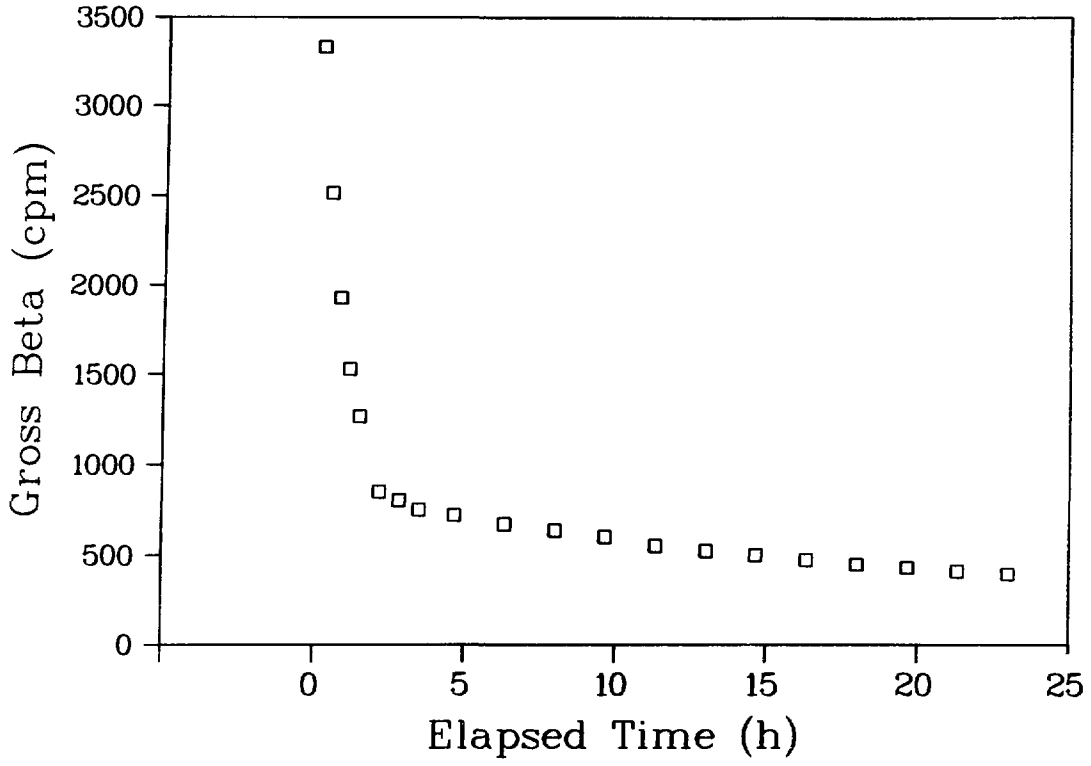

Fig. 7.
Gross beta activity decline due to radon-thoron decay.

$$\bar{c} = \frac{\sum_{i=1}^{N} v_i t_i c_i}{\sum_{i=1}^{N} v_i t_i}$$

where

$\bar{c}$ = annual mean (station or group) of atmospheric radioactive species concentration.
c_i = atmospheric radioactive species concentration for station or group i during t_i.
N = total number of samples during year for a station or group.
t_i = length of routine sampling period for station or group i.
v_i = air volume sampled for station or group i during t_i.

Standard deviations for station and group means are similarly weighted by using the following equation.

$$s_{\bar{c}} = \left\{ \frac{\left[N \sum_{i=1}^{N} (v_i t_i c_i)^2 \Big/ \left(\sum_{i=1}^{N} v_i t_i \right)^2 \right] \left[N \sum_{i=1}^{N} (v_i t_i c_i)^2 \Big/ \left(\sum_{i=1}^{N} v_i t_i c_i \right)^2 - 1 \right]}{N-1} \right\}^{1/2}$$

where

$s_{\bar{c}}$ = standard deviation of $\bar{c}$.

To indicate the precision of the maximums and minimums, an uncertainty term representing twice the propagated measurement uncertainty (2s) is reported with the maximum or minimum value.

Measurements of the air samples require that chemical and/or instrumental backgrounds be subtracted to obtain net values. Thus, net values lower than the minimum detection limit of the system are sometimes obtained (Table II). Individual measurements often result in values of zero or negative numbers because of statistical fluctuations in the measurements. Although a negative value does not represent a physical reality, a valid long-term average of many measurements can be obtained only if the very small or negative values are included in the population.[13] For this reason, a primary value for an air sampling result is the actual value obtained from an individual measurement or group of measurements. This primary value is used in making subsequent statistical analyses and in evaluating the real environmental impact of Laboratory operations.

2. Computer Data Processing. Several components comprise the data management system for air sampling results and their general interactions are represented schematically in Fig. 8. For clarity, the components have been lettered and will be described sequentially.

a. All air sampling analytical results produced by the Analytical Chemistry Section of H-8 are stored in the H8DATA data base.

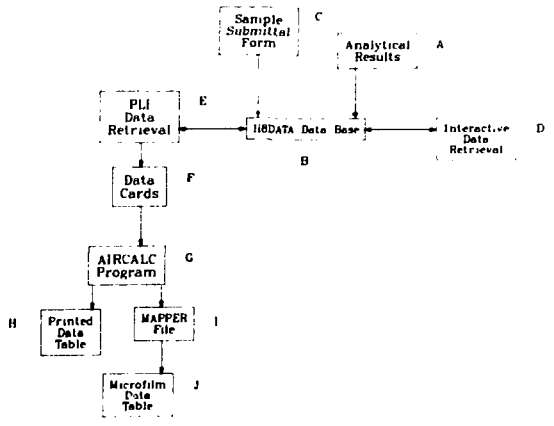

Fig. 8.
Flow chart of data management system.

b. H8DATA is the analytical results data base, which is implemented via the System 2000[14] data management facility.

c. Sample identification and related information are submitted to H8DATA by running a FORTRAN code written for that purpose. A typical computer-generated sample submittal form is shown in Table III.

d. Air sampling results are accessed interactively by using simple retrieval commands in System 2000.

e. Air sampling results are accessed externally by a FORTRAN program (CARD) using System 2000's Procedural Language Interface. CARD

TABLE II

DETECTION LIMITS FOR ANALYSES OF AIR SAMPLES

Parameter	Approximate Air Volume Sampled (m^3)	Count Time	Detection Limit Concentration
Tritium	3	100 min	10^{-12} μCi/mℓ
^{238}Pu	1.2×10^4	8×10^4 s	2×10^{-18} μCi/mℓ
^{239}Pu	1.2×10^4	8×10^4 s	3×10^{-18} μCi/mℓ
^{241}Am	2.5×10^5	8×10^4 s	2×10^{-18} μCi/mℓ
Gross alpha	3.8×10^3	100 min	3×10^{-18} μCi/mℓ
Gross beta	3.8×10^3	100 min	3×10^{-18} μCi/mℓ
Uranium	2.5×10^4	60 s	1 pg/m^3

TABLE III

COMPUTER-GENERATED SAMPLE SUBMITTAL FORM

Alpha, Beta, H-3
Sampling Period 08/27/79-09/25/79
Date Submitted 09/26/79
Period Number 9
Submitted by T. Gunderson
Airnet Samples

Sample Type (C6)	Date (C4)		Sample Location (C5)		Sample Number (C1)		Sample Owner (C2)
*TG(F,	09/25/79	,	Española	,	79.02128	,	TG);
*TG(F,	09/25/79	,	Pojoaque	,	79.02129	,	TG);
*TG(F,	09/25/79	,	Santa Fe	,	79.02130	,	TG);
*TG(F,	09/25/79	,	Barranca	,	79.02131	,	TG);
*TG(F,	09/25/79	,	Arkansas	,	79.02132	,	TG);
*TG(F,	09/25/79	,	Cumbres	,	79.02133	,	TG);
*TG(F,	09/25/79	,	48th St	,	79.02134	,	TG);
*TG(F,	09/25/79	,	LA Airport	,	79.02135	,	TG);
*TG(F,	09/25/79	,	Bayo STP	,	79.02136	,	TG);
*TG(F,	09/25/79	,	Fulf Stat	,	79.02137	,	TG);
*TG(F,	09/25/79	,	Royal Ct	,	79.02138	,	TG);
*TG(F,	09/25/79	,	White Rock	,	79.02139	,	TG);
*TG(F,	09/25/79	,	Pajarito A	,	79.02140	,	TG);
*TG(F,	09/25/79	,	Bandelier	,	79.02141	,	TG);
*TG(F,	09/25/79	,	TA-21 DP	,	79.02142	,	TG);
*TG(F,	09/25/79	,	TA-6	,	79.02143	,	TG);
*TG(F,	09/25/79	,	TA-53 LMPF	,	79.02144	,	TG);
*TG(F,	09/25/79	,	Well PM-1	,	79.02145	,	TG);
*TG(F,	09/25/79	,	TA-52 Beta	,	79.02146	,	TG);
*TG(F,	09/25/79	,	TA-16 S	,	79.02147	,	TG);
*TG(F,	09/25/79	,	Booster P2	,	79.02148	,	TG);
*TG(F,	09/25/79	,	TA-54 G	,	79.02149	,	TG);
*TG(F,	09/25/79	,	TA-49	,	79.02150	,	TG);
*TG(F,	09/25/79	,	TA-33	,	79.02151	,	TG);
*TG(F,	09/25/79	,	TA-39	,	79.02152	,	TG);
*TG(F,	09/25/79	,	Route 1 B.	,	79.02153	,	TG);
*TG(F,	09/25/79	,	Route 2 B.	,	79.02154	,	TG);

retrieves data from H8DATA and outputs it to cards.

f. Air sampling results are punched on cards.
g. A FORTRAN code named AIRCALC reads air sampling results from data cards and performs a statistical analysis.
h. The statistical analysis by AIRCALC is output to a line printer. A typical table is shown in Table IV.
i. AIRCALC's statistical summary is written as a MAPPER[15] (a computer graphics package) file.
j. MAPPER reads the file and outputs the statistical summary to microfilm.

E. Radiation Dose Calculations

One means of evaluating the significance of atmospheric releases of radioactivity at LASL is to interpret potential exposures to the public in terms of standards or natural background. For internal exposures, doses are estimated by multiplying measured annual average concentrations in air, after subtracting regional backgrounds, by standard breathing rates[16] to determine annual intakes via inhalation. These intakes are multiplied by appropriate dose conversion factors[3] to convert intakes into annual doses and 50-year dose commitments for various organs. Dose commitment factors for tritium include an increase by a factor of 1.5 over inhalation intake to account for skin absorption of tritium. External doses from cloud immersion are calculated on the basis of standard models.[3,16]

Doses are calculated for three categories.

1. Maximum dose at a site bo ·iary.
2. Dose to individual or population groups where highest dose rates occur.
3. The whole body cumulative dose for the population (average dose times population exposed to that dose) within an 80 km radius of the Laboratory.

The primary environmental dose criteria for DOE facilities like LASL are given in ERDA Manual Chapter 0524[2] and are used for routine dose comparisons required by ERDA Manual Chapter 0513[1] (see Section I).

III. EMERGENCY RESPONSE AIR SAMPLING PROGRAM

A. Introduction

Accident scenarios postulated for LASL involve airborne releases of tritium, plutonium, beryllium, noble (nonreactive) gases, and iodines. Because of their short duration, most accidents involving release of airborne materials are monitored only by the fixed network of air sampling stations (Fig. 1 and Table I). For longer duration airborne releases, for spills (where solutions may evaporate, leaving behind radioactive residues that can be resuspended), and for documentation of post-accident conditions following a short duration airborne release, seven mobile air sampling trailers are available.

B. Sampling Hardware and Analytical Methods

1. Meteorological Support. Meteorological information to predict cloud dispersal of an unplanned release is obtained from the Meteorology Section of Group H-8. Wind speed, wind direction, Pasquill category, cloud cover, estimate of release rate, etc. are fed into a computer program named PANIC. PANIC generates a map of LASL with contaminant concentration isopleths. This map is used to position mobile air sampling trailers in areas most likely to be in the path of the contaminated air mass and to select those routine air sampling stations most likely to be in the cloud's path. Should LASL's main computer be down, a backup program to calculate plume dispersal can be run on a desk calculator. Instructions for hand calculations of plume dispersal are also available to all emergency response personnel.

2. Mobile Air Sampling Trailers. Seven mobile air sampling trailers are available during or after unplanned releases. Each trailer has a gasoline-powered electric generator that supplies electricity to two high-volume air pumps. Each pump pulls air at a flow rate of ~1 m^3/min through a 15 cm by 23 cm glass fiber filter and a charcoal cartridge. The filter

TABLE IV

COMPUTER-GENERATED (AIRCALC), STATISTICAL SUMMARY OF LONG-LIVED ATMOSPHERIC GROSS-BETA CONCENTRATIONS

(concentrations in 10^{-15} μCi/mℓ)

Station Location	LASL Coordinates	Cumulative Data (12/18/78 to 09/24/79) Air Volume (m^3)	No. Monthly Samples	No. Samples <MDL	Maximum Concentration (±2s)	Minimum Concentration (±2s)	Mean Concentration (±2s)	Mean as % CG
Regional Stations (28-44 km)—Uncontrolled Areas								
1. Española	---	62419	9	0	37 ± 10	21 ± 6.0	26.7 ± 15.0	0.026
2. Pojoaque	---	56628	9	0	132 ± 34	18 ± 4.0	29.0 ± 17.0	0.028
3. Santa Fe	---	63534	9	0	44 ± 12	9.2 ± 2.4	24.6 ± 22.8	0.024
Regional Group Summary	---	182581	27	0	132 ± 34	9.2 ± 6.0	26.7 ± 18.1	0.026
Perimeter Stations (0-4 km)—Uncontrolled Areas								
4. Barranca School	N180 E130	65280	9	0	62 ± 16	1.5 ± 0.3	32.4 ± 34.1	0.032
5. Arkansas Ave.	N170 E020	55111	8	0	52 ± 14	19.0 ± 4.0	34.6 ± 18.5	0.034
6. Cumbres School	N150 E090	62595	9	0	55 ± 14	18.0 ± 4.0	34.2 ± 22.9	0.034
7. 48th Street	N110 E000	62408	9	0	42 ± 10	13.0 ± 3.4	29.7 ± 20.0	0.029
8. LA Airport	N110 E160	69741	9	0	35 ± 8	17.0 ± 4.0	26.1 ± 13.7	0.026
9. Bayo STP	N110 E260	71416	9	0	45 ± 12	18.0 ± 4.0	28.1 ± 23.4	0.028
10. Gulf Station	N100 E100	63515	9	0	55 ± 14	4.5 ± 1.2	31.2 ± 26.0	0.031
11. Royal Crest	N080 E080	59576	9	2	48 ± 12	0.0 ± 0.1	16.4 ± 29.1	0.016
12. White Rock	S090 E430	61662	9	0	35 ± 10	19.0 ± 4.0	24.7 ± 11.3	0.024
13. Pajarito Acres	S210 E370	63033	9	0	59 ± 16	24.0 ± 6.0	34.2 ± 21.5	0.034
14. Bandelier	S270 E200	59971	9	0	60 ± 16	18.0 ± 4.0	29.7 ± 30.4	0.029
Perimeter Group Summary		694308	98	2	62 ± 16	0.0 ± 0.1	29.2 ± 24.8	0.029
Onsite Stations—Controlled Areas								
15. TA-21	N090 E170	57415	9	0	58 ± 14	24.0 ± 6.0	33.5 ± 23.3	0.00083
16. TA-6	N060 W050	64971	9	0	52 ± 14	12.0 ± 3.0	23.1 ± 22.7	0.00057
17. TA-53 (LAMPF)	N060 E190	59758	9	0	49 ± 12	10.1 ± 2.6	32.7 ± 25.8	0.00081
18. Well PM-1	N030 E310	64320	9	0	47 ± 12	22.0 ± 6.0	32.7 ± 16.7	0.00081
19. TA-[illegible]	N020 E170	68573	9	0	53 ± 14	18.0 ± 4.0	28.0 ± 28.2	0.00070
20. TA-16	S030 W080	57822	9	0	55 ± 14	16.0 ± 4.0	27.8 ± 24.6	0.00069
21. Booster P-2	S030 E190	68454	9	1	44 ± 12	0.0 ± 0.1	21.1 ± 34.8	0.00052
22. TA-54	S080 E260	70620	9	0	57 ± 14	23.0 ± 6.0	37.3 ± 23.0	0.00093
23. TA-49	S100 E040	67175	9	0	55 ± 14	21.0 ± 6.0	32.3 ± 31.9	0.00080
24. TA-33	S250 E230	69099	9	0	58 ± 14	26.0 ± 6.0	35.9 ± 26.3	0.00089
25. TA-39	S210 E210	57263	9	0	38 ± 10	11.6 ± 3.0	22.9 ± 28.6	0.00057
Onsite Group Summary		705470	99	1	58 ± 14	0.0 ± 0.1	29.8 ± 28.3	0.00074
All Group Summary		1582359	224	3	132 ± 34	0.0 ± 0.1	29.2 ± 25.9	0.029

is analyzed by any or all of the methods discussed in Section II-C, and can also be analyzed by gamma-spectroscopy to identify particular radionuclides. The charcoal cartridge can be analyzed for iodine (see Section III.B.6) if necessary. Each trailer is equipped with a hitch so that it can be easily towed to a desired sampling location.

3. Emergency Tritium Sampling and Analysis. After an accidental tritium release, atmospheric water vapor is collected by frost buildup on a cold "finger" of metal exposed to the atmosphere. A thermos bottle is filled with liquid nitrogen and a metal strip is placed in the bottle. As the metal cools, the portion of metal above the bottle collects frost. This frost is scraped into a scintillation vial and analyzed by the method described in Section II.C.2. Air temperature and relative humidity at sampling time are noted so that the tritium-in-water concentrations can be converted to atmospheric concentrations. As previously mentioned, a new sampler capable of measuring both HTO and HT is being developed at LASL and will be used for emergency tritium sampling in the near future.

4. Emergency Plutonium and Beryllium Sampling and Analysis. Both plutonium and beryllium are solids and therefore each would escape as airborne particulates during an accidental release. Consequently, each could be collected on filters either in the routine air sampling network or on the mobile trailers. The filters are analyzed for plutonium by the method described in Section II.C.3 and by gamma-spectroscopy. Gamma-spectroscopy is also used to analyze the filters for beryllium.

5. Emergency Noble Gas Sampling and Analysis. Presently H-8 does not have the capability of directly measuring concentrations of radioactive noble gases like radiokrypton and radioxenon. The usual monitoring procedure[17] is to collect the nonreactive gases by taking a whole-air sample. The gas fraction of interest is then separated from the air sample using cryogenic and gas-chromatographic techniques and analyzed by liquid scintillation counting. However, because both radiokrypton and radioxenon (and some other radioactive noble gases) are gamma-emitters, their presence can be measured indirectly by the routine thermoluminescent dosimeter (TLD) network[11] (Fig. 1). Currently, the TLD network consists of 31 locations. There are regional stations in the neighboring communities of Española, Pojoaque, and Santa Fe, sixteen are on LASL's perimeter, and twelve are within LASL's boundary. Dosimeters are always in the field, so the appropriate ones can be retrieved and read after an unplanned release of any gamma-emitting noble gas.

6. Emergency Iodine Sampling and Analysis. Iodine (^{131}I) is a gas, so it is not collected by filters, but by charcoal cartridges either in the routine air sampling network or on the mobile trailers. The charcoal is analyzed by gamma-spectroscopy to detect any ^{131}I that is present.

C. Data Analysis and Dose Calculations

After all samples have been analyzed, measured air concentrations of contaminant(s) are compared with the predicted concentration(s) by PANIC and any discrepancies evaluated. The measured concentrations are also compared to the relevant radiation concentration guides in ERDA Manual Chapter 0524.[2] Radiation dose calculations are made using the methods discussed in Section II.E.

D. Response to Atmospheric Nuclear Tests

Air sample collection begins the first morning after receiving news of an atmospheric nuclear test. Initial samples taken before fallout arrives serve as background samples to indicate what normal radioactivity levels are for that time of year. If the test was conducted in the People's Republic of China, the first fallout generally reaches Los Alamos in four to six days, depending on meteorological conditions. A second pass of the fallout cloud usually occurs ten to twelve days after the test.

The air sampling station located onsite from which samples are routinely collected on a five times per week schedule (Monday through Friday), and the offsite Española station, are used to collect special 24 h samples during the time there is a possibility of detecting airborne radioactivity from a test. Filters from these two stations are counted for gross alpha and gross beta activities 5 h after collection. This procedure allows radon and some thoron

activity to decay (Fig. 7) so the data can be more accurately interpreted.

The gross alpha/gross beta ratio for normal atmospheric radioactivity is about 1/1. This ratio decreases to 1/2 or less when fission fallout products are present. Thus the gross alpha/gross beta ratio is very useful in determining if fallout is present.

Any sample with gross beta activity exceeding ten times normal background levels is analyzed by gamma-spectroscopy. Radionuclide identification and concentration estimates are derived from these spectral measurements. This ten times normal background level also serves as a threshold level. Additional environmental samples (milk, grass, etc.) are collected and analyzed (especially for ^{131}I and ^{90}Sr) when this threshold level is exceeded.

All data collected, whether positive or negative, are reported daily to Director of the Division of Operational and Environmental Safety (DOES) at DOE Headquarters in Washington, D.C. DOES compiles air sampling results from other DOE installations and works closely with the Environmental Protection Agency in keeping the public informed of any possible health hazards from the fallout.

IV. SUMMARY

The environmental and emergency response air sampling capabilities of Group H-8 at LASL have been described. Both sampling programs are conducted to evaluate potential population exposure from inhaled radionuclides or from external radiation caused by airborne radioactivity. The environmental program is sufficient in scope to detect short-term fluctuations and long-term trends in atmospheric levels of radioactivity originating onsite. The emergency response program is designed to respond to both onsite unplanned releases and atmospheric nuclear tests.

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