# Environmental Measurements Laboratory

THE HIGH ALTITUDE SAMPLING PROGRAM: RADIOACTIVITY IN THE STRATOSPHERE - FINAL REPORT

Robert Leifer and Z. Russell Juzdan

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## ABSTRACT

Radioactivity data are presented from Project Airstream (aircraft) for the year 1983 and for Project Ashcan (balloon) for the years 1982 and 1984. Due to budgetry constraints both Projects Airstream and Ashcan have been terminated. This will be the final report containing radioactivity data collected during projects airstream and ashcan. Included are gross gamma, gamma spectral and radiochemical analyses of filter samples. Quality control samples submitted along with the air filter samples were analyzed and the results are presented. Low activity on many of the filters precludes the estimation of the stratospheric inventories of $^{239,240}$Pu and $^{90}$Sr. Based on data with count errors < 20%, the mean Northern Hemisphere stratospheric $^{90}$Sr and $^{239,240}$Pu concentration for November 1983 was 0.2 $\pm$ 0.1 and 0.009 $\pm$ 0.006 Bq/1000 scm, repectively.

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# I. PREFACE

The High Altitude Sampling Program (HASP) was comprised of two separate studies, balloon sampling under Project Ashcan and aircraft sampling under Project Airstream. In Project Ashcan, large polyethylene balloons were used as sampling platforms, and provided samples in the altitude range 20-27 km. Project Airstream employed a WB-57F aircraft (operated by the National Aeronautics and Space Administration, Johnson Space Center) as the sampling platform and provides samples from 6 to 19 km. Both studies shared the following objectives:

(1) To document the concentration of radioactivity and stable constituents in the stratosphere as a function of latitude, altitude and season.

(2) To compute stratospheric burdens of critical tracers.

(3) To test and (possibly modify or) develop stratospheric transport models.

(4) To supply data for other scientific programs in studying the ultimate deposition of these tracers in the environment.

As in the past, HASP has provided a major source of data for prediction of future dose to man from nuclear tests as developed in the 1972, 1977, and 1982 reports of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

Because of budgetary changes, the November 1983 Airstream cycle represents the final data set collected under HASP. The final study under Project Ashcan (Cosmos-1402) occurred in 1984.

## II. INTERPRETATIVE REPORT

### A. UPDATING STRATOSPHERIC RADIONUCLIDE INVENTORIES TO NOVEMBER 1983

#### SUMMARY

The 1983 results from the final missions flown under Project Airstream are presented. The 1983 missions included two flights in September and a full scale November 1983 (15 flights) cycle. Only the November 1983 filter samples were analyzed for $^{90}Sr$ and $^{239,240}Pu$. Based on data with count errors < 20%, the mean Northern Hemisphere stratospheric $^{90}Sr$ and $^{239,240}Pu$ concentration for November 1983 was 0.2 $\pm$ 0.1 and 0.009 $\pm$ 0.006 Bq/1000 scm, repectively. No inventories could be calculated because the activity on a large number of filters was below the analytical detection limits.

#### INTRODUCTION

Due to funding reductions, the only sampling flights under Project Airstream conducted during 1983 consisted of a limited mission in September and a full November cycle. The limited cycle in September included two flights which provided samples from 20°N to 40°N. The November cycle covered flights from the equator to 75°N. Detailed information on flight schedules is given in Section III of this report.

#### RESULTS

More than one third of the samples analyzed for $^{90}Sr$ and $^{239,240}Pu$ in the November 1983 cycle had counting errors > 50% due to low activity on the filters. Based on data with count errors < 20% the mean Northern Hemisphere stratospheric $^{90}Sr$ and $^{239,240}Pu$ concentrations for November 1983 were 0.2 $\pm$ 0.1 and 0.009 $\pm$ 0.006 Bq/1000 scm, repectively. The July 1982 mean Northern Hemisphere stratospheric $^{90}Sr$ and $^{239,240}Pu$ concentration, calculated from the previous published inventories (Leifer et al. 1984), is 0.5 $\pm$ 0.1 and 0.013 $\pm$ 0.002 Bq/1000 scm, respectively. The concentration reduction from July 1982 to November 1983 is evident but must be considered only as an approximation. The gamma emitting nuclides $^{95}Zr$, $^{137}Cs$ and $^{144}Ce$ were not detectible on our filters.

#### STRATOSPHERIC INVENTORIES

Figure II-1 illustrates the hemispheric and total stratospheric burdens of $^{90}Sr$ from 1963 to July 1982. Because of low atmospheric $^{90}Sr$ concentrations in November 1983, the July 1982 inventories or burdens of $^{90}Sr$ in kCi represent the final reportable inventory for publication. The inventories shown in Figure II-1 are based on previously published EML reports (see REFERENCE Section).

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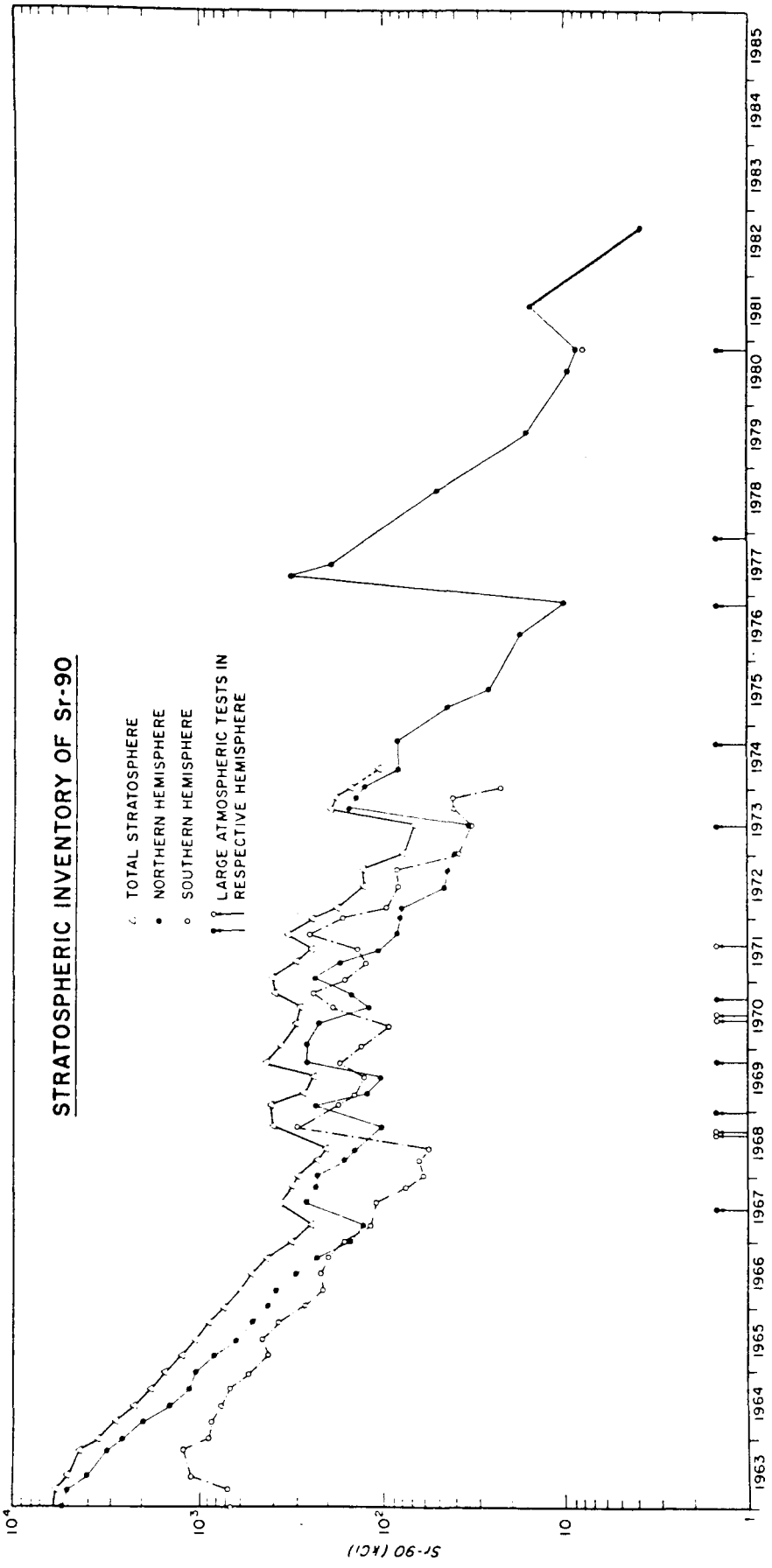


**Figure II-1. Stratospheric inventory of $^{90}Sr$ in the Northern and Southern Hemispheres (kCi) from 1963-1982.**

# III. DATA REPORTS

## A. PROJECT AIRSTREAM

### SUMMARY

Project Airstream was a study of radioactivity and non-nuclear compounds in the lower stratosphere with the WB-57F aircraft as a sampling platform conducted by the Environmental Measurements Laboratory (EML). The aircraft was flown by the National Aeronautics and Space Administration under the direction of the Johnson Space Center, Houston, Texas. This project is an outgrowth of the Defense Atomic Support Agency's Project Stardust. The first Airstream mission was flown in August 1967.

This report contains radioactivity data from the missions flown in September 1983 and November 1983. Previous reports containing results from this program are given in the REFERENCE Section (1-41).

### FLIGHT SCHEDULE

Airstream missions were generally scheduled for April, July and October with a $\pm$ 1 month slippage. Because NASA has only one WB-57F aircraft assigned to this project, the time to complete the cycle was ~ 20 days.

Figure III-1 details the trajectory, and Figure III-2 shows the latitude and altitude coverage of missions flown by NASA. Starting with the July 1977 mission, flights were limited to the Northern Hemisphere (75°N to 0°) and included three vertical profiles at 5°N, 29°N and 61°N.

Flights originated from the following Air Force Bases:

| | | |
|---|---|---|
| Elmendorf AFB, AK | 61°15'N | 149°48'W |
| McChord AFB, WA | 47°09'N | 122°29'W |
| Ellington AFB, TX | 29°37'N | 95°10'W |
| Howard AFB, PCZ | 08°55'N | 79°36'W |

Two flight patterns were generally used. One took a north-westerly track from Ellington AFB, Texas to McChord AFB, Washington (Figure III-1). The flights towards the Canadian border fly directly north from Ellington AFB, Texas at 15.2 and 19.2 km along 95°10'W to permit greater latitude coverage. This is indicated by the double dashed line in Figure III-1.

### AIR FILTER SAMPLES

Air filter samples are collected along the flight tract at latitude increments of ~ 3 to 4° at each of the prescribed altitudes using the U-1 foil system. This system permits the sequential insertion of up to 12 IPC No. 1478 filter papers (diameter 41.6 cm). The U-1 foil system is located in the

sampling duct near the bomb bay on the right side of the aircraft. A butterfly valve is used on the U-1 foil system for sealing the sampling duct during non-sampling periods. The volume of air sampled by each filter is calculated by the methods developed under Project Stardust and updated by Krajewski (1969), and is reported as standard cubic meters (scm) under the ICAO standard atmosphere (760 mm Hg and 15°C).

## STABLE TRACER MEASUREMENTS

Analysis of water soluble tracers in the filters were carried out by Los Alamos National Laboratory. Los Alamos was responsible for cleaning of filters for Airstream to minimize background concentrations of various water soluble stable tracers. They subsequently analyzed for inorganic ions such as sulfate, nitrate and ammonium. Results of analyses for these stable tracers will be reported separately by Los Alamos.

The filters were handled by Los Alamos, where they were cut into sixths under 'clean room' conditions. To minimize the impact of any heterogeneity of debris on the filter, opposite sixths were combined into composite thirds. One third was analyzed for water soluble inorganic ions by Los Alamos; one third was analyzed by EML for gamma-emitting nuclides; and one third was reserved for the EML library of stratospheric samples.

## TOTAL GAMMA AND GAMMA SPECTRUM MEASUREMENTS

At EML the one-third fraction intended for nuclide analysis was folded and placed in a plastic box (8 cm x 6.5 x 3.1 cm deep) for a gross gamma measurement using an 8'' x 4'' NaI (Tl) crystal. The total gamma activity is integrated between 100 keV and 2.0 MeV, and the gamma concentration is reported as counts per minute (cpm) per 100 scm on the counting date.

Based upon the results of the gamma measurements, the sections of several filters were usually combined into appropriate composite samples. The composite samples were compressed into 6 cm diameter by 3.5 cm depth aluminum cans. The samples were submitted for gamma spectral analysis at EML by lithium drifted germanium diode detectors. The detectors are closed-end coaxial diodes of ~ 50 $cm^3$ volume with the following characteristics for the 1.33 MeV photon of $^{60}Co$:

| | |
|---|---|
| Point Source Efficiency at Diode Face: | 1.2 - 1.7% |
| Resolution: | 2.1 - 2.6 keV |
| Peak-to-Compton: | about 30 to 1 |

The diode responses are stored in 3000 channels of a computer-based pulse height analyzer. A computer program resolves and reduces these spectral data by least squares fitting and has a subroutine which adjusts for the density of the sample. The nuclides of interest from the diode spectrometry were $^{7}Be$, $^{95}Zr$, $^{137}Cs$ and $^{144}Ce$. The germanium diode systems were calibrated with standard solutions prepared at EML. An efficiency versus energy curve were prepared (shown in Figure III-3), which illustrates the interrelation between standards and which lends greater reliability to the estimated individual photon energy efficiencies.

## RADIOCHEMICAL ANALYSIS

After the gamma measurements are completed, the composite samples are either stored or sent to contractor laboratories for detailed radiochemical analyses. Filters from the November 1983 mission were analyzed radiochemically for $^{90}Sr$ and $^{239,240}Pu$ by the EAL Corporation, Richmond, CA. Nuclide concentrations from radiochemical analyses are reported as Becquerels/kscm (Bq/kscm).

## DATA PRESENTATION

One standard deviation of the counting error for all data in this report is $< \pm 20\%$ unless annotated with the symbols:

- ~: One standard deviation of the counting error is between $\pm$ 20 to 50%.
- *f*: One standard deviation of the counting error is between $\pm$ 51 to 100%.
- *: Activity is not detectable. This designation is applied to data when one standard deviation of the counting error is $> \pm 100\%$.
- ?: The nuclide concentration of a specific sample is considered suspect because it is inconsistent with the concentration of the same nuclide in adjacent samples in space and time or because it is inconsistent with other nuclides in the same sample.

The nuclide activity for each sample is corrected for the normal radiochemical parameters such as chemical yield and detection efficiency.

## 1983 RESULTS

The total gamma measurements from the September and November 1983 flights are reported in Tables III-1 and III-2, respectively. The gamma spectral analyses from the September and November 1983 flights are reported in Tables III-3 and III-4, respectively. Included in Table III-4 are $^{90}Sr$ and $^{239,240}Pu$ radiochemical analyses data.

The samples in these tables are grouped according to altitude of collection ending with 19.2 km. Within each altitude group, the samples are then listed with decreasing latitude. The 1/3 fractions of each individual filter making up the composite are listed immediately below the composite sample number. In the case of duplicates, the 1/2 fraction reported in the tables is one half of the 1/3 section and is in reality 1/6 of the exposed filter.

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Table III-1

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 6.1 KM

| | |
|---|---|
| SAMPLE NO. | 14926 |
| MISSION/FLIGHT | 2d/928 |
| DATE | 9/30/83 |
| TIME | 1553-1608 |
| LAT. | 29N-29N |
| LONG. | 95W- 95W |
| VOL. OF AIR (100 scm) | 1.480 |
| GROSS GAMMA (cpm/100 scm) | 5. |
| COUNT DATE | 11/10/83 |



VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 9.1 KM

| | |
|---|---|
| SAMPLE NO. | 14927 |
| MISSION/FLIGHT | 28/928 |
| DATE | 9/30/83 |
| TIME | 1612-1627 |
| LAT. | 29N-29N |
| LONG. | 95W- 95W |
| VOL. OF AIR (100 scm) | 1.270 |
| GROSS GAMMA (cpm/100 scm) | 1. |
| COUNT DATE | 11/10/83 |



VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 12.2 KM

| | |
|---|---|
| SAMPLE NO. | 14929 |
| MISSION/FLIGHT | 28/928 |
| DATE | 9/30/83 |
| TIME | 1532-1702 |
| LAT. | 29N-29N |
| LONG. | 94W- 95W |
| VOL. OF AIR (100 scm) | 2.040 |
| GROSS GAMMA (cpm/100 scm) | 2. |
| COUNT DATE | 11/10/83 |



VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 13.7 KM

| | |
|---|---|
| SAMPLE NO. | 14930 |
| MISSION/FLIGHT | 28/928 |
| DATE | 9/30/83 |
| TIME | 1705-1735 |
| LAT. | 30N-29N |
| LONG. | 95W- 94W |
| VOL. OF AIR (100 scm) | 1.890 |
| GROSS GAMMA (cpm/100 scm) | 10. |
| COUNT DATE | 11/10/83 |



VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 15.2 KM

| | |
|---|---|
| SAMPLE NO. | 14932 |
| MISSION/FLIGHT | 28/928 |
| DATE | 9/30/83 |
| TIME | 1738-1808 |
| LAT. | 29N-28N |
| LONG. | 94W- 97W |
| VOL. OF AIR (100 scm) | 1.630 |
| GROSS GAMMA (cpm/100 scm) | 8. |
| COUNT DATE | 11/10/83 |



VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 16.8 KM

| SAMPLE NO. | 14953 | 14952 | 14951 | 14950 | 14933 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 28/928 | 28/928 | 28/928 | 28/928 | 28/928 |
| DATE | 9/28/83 | 9/28/83 | 9/28/83 | 9/28/83 | 9/30/83 |
| TIME | 1855-1922 | 1820-1855 | 1743-1820 | 1709-1743 | 1812-1842 |
| LAT. | 45N-42N | 42N-38N | 38N-34N | 34N-30N | 30N-28N |
| LONG. | 93W- 93W | 93W- 93W | 93W- 98W | 93W- 93W | 96W- 94W |
| VOL. OF AIR (100 scm) | 1.220 | 1.600 | 1.720 | 1.620 | 1.300 |
| GROSS GAMMA (cpm/100 scm) | 44. | 50. | 28. | 39. | 43. |
| COUNT DATE | 11/10/83 | 11/10/83 | 11/10/83 | 11/10/83 | 11/10/83 |

| SAMPLE NO. | 14938 | 14939 | 14941 | 14942 |
|---|---|---|---|---|
| MISSION/FLIGHT | 28/928 | 28/928 | 28/928 | 28/928 |
| DATE | 9/29/83 | 9/29/83 | 9/29/83 | 9/29/83 |
| TIME | 1640-1652 | 1652-1813 | 1813-1848 | 1848-1905 |
| LAT. | 29N-28N | 28N-26N | 26N-22N | 22N-20N |
| LONG. | 93W- 94W | 94W- 94W | 94W- 94W | 94W- 94W |
| VOL. OF AIR (100 scm) | 0.570 | 3.910 | 1.740 | 0.840 |
| GROSS GAMMA (cpm/100 scm) | 56. | 8. | 33. | 23. |
| COUNT DATE | 11/10/83 | 11/10/83 | 11/10/83 | 11/10/83 |

VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 18.3 KM

| | |
|---|---|
| SAMPLE NO. | 14934 |
| MISSION/FLIGHT | 28/928 |
| DATE | 9/30/83 |
| TIME | 1850-1920 |
| LAT. | 30N-29N |
| LONG. | 93W- 95W |
| VOL. OF AIR (100 scm) | 0.930 |
| GROSS GAMMA (cpm/100 scm) | 55. |
| COUNT DATE | 11/10/83 |



VP : VERTICAL PROFILE

Table III-1 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE SEPTEMBER 1983 MISSION

ALTITUDE 19.2 KM

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 14954 | 14956 | 14957 | 14958 | 14959 |
| MISSION/FLIGHT | 28/928 | 28/928 | 28/928 | 28/928 | 28/928 |
| DATE | 9/28/83 | 9/28/83 | 9/28/83 | 9/28/83 | 9/28/83 |
| TIME | 1943-1959 | 2000-2036 | 2036-2112 | 2112-2148 | 2148-2213 |
| LAT. | 47N-45N | 45N-41N | 41N-37N | 37N-33N | 33N-33N |
| LONG. | 93W- 92W | 92W- 92W | 92W- 93W | 93W- 93W | 93W- 94W |
| VOL. OF AIR (100 scm) | 0.410 | 0.912 | 0.917 | 0.902 | 0.637 |
| GROSS GAMMA (cpm/100 scm) | 90. | 77. | 68. | 75. | 71. |
| COUNT DATE | 11/10/83 | 11/10/83 | 11/10/83 | 11/10/83 | 11/10/83 |

| | | | | |
|---|---|---|---|---|
| SAMPLE NO. | 14947 | 14946 | 14945 | 14943 |
| MISSION/FLIGHT | 28/928 | 28/928 | 28/928 | 28/928 |
| DATE | 9/29/83 | 9/29/83 | 9/29/83 | 9/29/83 |
| TIME | 2040-2112 | 2015-2040 | 1950-2015 | 1937-1950 |
| LAT. | 30N-26N | 26N-23N | 23N-20N | 20N-19N |
| LONG. | 94W- 93W | 94W- 94W | 94W- 94W | 93W- 94W |
| VOL. OF AIR (100 scm) | 0.838 | 0.660 | 0.670 | 0.360 |
| GROSS GAMMA (cpm/100 scm) | 38. | 29. | 36. | 33. |
| COUNT DATE | 11/10/83 | 11/10/83 | 11/10/83 | 11/10/83 |

Table III-2

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 3.0 KM

| | |
|---|---|
| SAMPLE NO. | 15061 |
| MISSION/FLIGHT | 29/928 |
| DATE | 11/20/83 |
| TIME | 1832-1847 |
| LAT. | 62N-62N |
| LONG. | 148W-147W |
| VOL. OF AIR (100 scm) | 2.416 |
| GROSS GAMMA (cpm/100 scm) | 0. |
| COUNT DATE | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 6.1 KM

| | | |
|---|---|---|
| SAMPLE NO. | 15062 | 15133 |
| MISSION/FLIGHT | 29/928 | 29/928 |
| DATE | 11/20/83 | 11/27/83 |
| TIME | 1850-1905 | 2020-2035 |
| LAT. | 63N-62N | 21N-20N |
| LONG. | 146W-145W | 158W- 59W |
| VOL. OF AIR (100 scm) | 1.946 | 2.067 |
| GROSS GAMMA (cpm/100 scm) | 5. | 0. |
| COUNT DATE | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 9.1 KM

| | |
|---|---|
| SAMPLE NO. | 15134 |
| MISSION/FLIGHT | 29/928 |
| DATE | 11/27/83 |
| TIME | 2033-2053 |
| LAT. | 20N-18N |
| LONG. | 159W-159W |
| VOL. OF AIR (100 scm) | 1.714 |
| GROSS GAMMA (cpm/100 scm) | 2. |
| COUNT DATE | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 12.2 KM

| SAMPLE NO. | 15041 | 15040 | 15038 | 15037 | 15136 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/18/83 | 11/18/83 | 11/18/83 | 11/18/83 | 11/27/83 |
| TIME | 1959-2037 | 1932-1959 | 1903-1931 | 1832-1903 | 2057-2127 |
| LAT. | 75N-71N | 71N-68N | 68N-65N | 65N-62N | 21N-19N |
| LONG. | 149W-148W | 149W-148W | 150W-149W | 150W-150W | 159W-158W |
| VOL. OF AIR (100 scm) | 3.504 | 2.443 | 2.452 | 2.750 | 2.853 |
| GROSS GAMMA (cpm/100 scm) | 34. | 26. | 19. | 32. | 3. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 13.7 KM

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15034 | 15033 | 15032 | 15029 | 15028 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/17/83 | 11/17/83 | 11/17/83 | 11/17/83 | 11/17/83 |
| TIME | 1857-1939 | 1830-1857 | 1800-1830 | 1738-1800 | 1714-1738 |
| LAT. | 60N-57N | 57N-55N | 55N-53N | 53N-51N | 51N-49N |
| LONG. | 139W-146W | 135W-139W | 131W-135W | 128W-131W | 126W-128W |
| VOL. OF AIR (100 scm) | 3.350 | 2.114 | 2.337 | 1.706 | 1.815 |
| GROSS GAMMA (cpm/100 scm) | 33. | 21. | 44. | 32. | 33. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| | | | |
|---|---|---|---|
| SAMPLE NO. | 15026 | 15025 | 15137 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 |
| DATE | 11/17/83 | 11/17/83 | 11/27/83 |
| TIME | 1652-1714 | 1633-1652 | 2129-2159 |
| LAT. | 49N-47N | 47N-45N | 23N-21N |
| LONG. | 124W-126W | 124W-124W | 158W-158W |
| VOL. OF AIR (100 scm) | 1.644 | 1.433 | 2.472 |
| GROSS GAMMA (cpm/100 scm) | 33. | 23. | 4. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 14.9 KM

| | | |
|---|---|---|
| SAMPLE NO. | 15073 | 15121 |
| MISSION/FLIGHT | 29/928 | 29/928 |
| DATE | 11/21/83 | 11/26/83 |
| TIME | 1835-1902 | 2042-2119 |
| LAT. | 60N-57N | 20N-16N |
| LONG. | 150W-150W | 158W-158W |
| VOL. OF AIR (100 scm) | 1.617 | 2.405 |
| GROSS GAMMA (cpm/100 scm) | 22. | 2. |
| COUNT DATE | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 15.2 KM

| SAMPLE NO. | 15053 | 15052 | 15050 | 15049 | 15074 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/19/83 | 11/19/83 | 11/19/83 | 11/19/83 | 11/21/83 |
| TIME | 1938-2000 | 1915-1938 | 1849-1915 | 1825-1849 | 1902-1930 |
| LAT. | 75N-72N | 72N-69N | 69N-66N | 66N-63N | 57N-54N |
| LONG. | 148W-148W | 149W-148W | 149W-149W | 150W-149W | 150W-150W |
| VOL. OF AIR (100 scm) | 1.296 | 1.368 | 1.535 | 1.382 | 1.649 |
| GROSS GAMMA (cpm/100 scm) | 56. | 45. | 38. | 59. | 25. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| SAMPLE NO. | 15076 | 15077 | 15022 | 15021 | 15020 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/21/83 | 11/21/83 | 11/16/83 | 11/16/83 | 11/16/83 |
| TIME | 1930-1957 | 1957-2025 | 2023-2120 | 1954-2023 | 1927-1954 |
| LAT. | 54N-51N | 51N-48N | 47N-45N | 45N-43N | 43N-41N |
| LONG. | 150W-150W | 150W-150W | 117W-124W | 113W-117W | 110W-113W |
| VOL. OF AIR (100 scm) | 1.632 | 1.699 | 3.467 | 1.743 | 1.615 |
| GROSS GAMMA (cpm/100 scm) | 31. | 26. | 29. | 38. | 29. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| SAMPLE NO. | 15019 | 15017 | 15016 | 15014 | 15013 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/16/83 | 11/16/83 | 11/16/83 | 11/16/83 | 11/16/83 |
| TIME | 1857-1927 | 1827-1856 | 1802-1827 | 1732-1801 | 1650-1732 |
| LAT. | 41N-39N | 39N-37N | 37N-35N | 35N-33N | 33N-30N |
| LONG. | 107W-110W | 104W-107W | 102W-104W | 99W-102W | 96W- 99W |
| VOL. OF AIR (100 scm) | 1.834 | 1.858 | 1.617 | 1.880 | 2.757 |
| GROSS GAMMA (cpm/100 scm) | 11. | 18. | 30. | 30. | 24. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| SAMPLE NO. | 15145 | 15139 | 15109 | 15112 |
|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/26/83 | 11/27/83 | 11/25/83 | 11/25/83 |
| TIME | 1927-1954 | 2202-2232 | 2248-2323 | 0036-0103 |
| LAT. | 24N-22N | 23N-20N | 20N-16N | 8N- 5N |
| LONG. | 157W-154W | 158W-158W | 158W-159W | 158W-158W |
| VOL. OF AIR (100 scm) | 1.767 | 1.968 | 2.517 | 1.910 |
| GROSS GAMMA (cpm/100 scm) | 15. | 6. | 3. | 13. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 16.8 KM

| SAMPLE NO. | 15042 | 15043 | 15044 | 15045 | 15046 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/18/83 | 11/18/83 | 11/18/83 | 11/18/83 | 11/18/83 |
| TIME | 2052-2130 | 2130-2158 | 2158-2228 | 2228-2253 | 2253-2322 |
| LAT. | 75N-71N | 71N-68N | 68N-65N | 65N-62N | 62N-59N |
| LONG. | 149W-148W | 148W-149W | 149W-149W | 149W-149W | 149W-148W |
| VOL. OF AIR (100 scm) | 1.600 | 1.175 | 1.245 | 1.034 | 1.183 |
| GROSS GAMMA (cpm/100 scm) | 34. | 38. | 36. | 52. | 19. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| SAMPLE NO. | 15085 | 15086 | 15088 | 15089 | 15092 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/22/83 | 11/22/83 | 11/22/83 | 11/22/83 | 11/22/83 |
| TIME | 1904-1930 | 1930-1956 | 1957-2020 | 2020-2041 | 2042-2106 |
| LAT. | 59N-57N | 57N-55N | 55N-53N | 53N-51N | 51N-49N |
| LONG. | 145W-140W | 140W-136W | 136W-133W | 133W-130W | 130W-126W |
| VOL. OF AIR (100 scm) | 1.054 | 1.063 | 0.976 | 0.908 | 1.049 |
| GROSS GAMMA (cpm/100 scm) | 52. | 71. | 51. | 26. | 33. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| SAMPLE NO. | 15093 | 15094 | 15005 | 15004 | 15002 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/22/83 | 11/22/83 | 11/15/83 | 11/15/83 | 11/15/83 |
| TIME | 2106-2129 | 2129-2146 | 1825-1851 | 1759-1825 | 1734-1759 |
| LAT. | 49N-47N | 47N-45N | 45N-42N | 42N-39N | 39N-36N |
| LONG. | 126W-124W | 124W-124W | 95W- 96W | 95W- 95W | 95W- 95W |
| VOL. OF AIR (100 scm) | 1.034 | 0.763 | 1.143 | 1.171 | 1.117 |
| GROSS GAMMA (cpm/100 scm) | 6. | 46. | 52. | 50. | 61. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| SAMPLE NO. | 15001 | 15154 | 15157 | 15153 | 15152 |
|---|---|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/15/83 | 11/28/83 | 11/28/83 | 11/28/83 | 11/28/83 |
| TIME | 1707-1732 | 2242-2329 | 1825-1857 | 2204-2242 | 2130-2204 |
| LAT. | 36N-33N | 36N-34N | 36N-27N | 34N-32N | 32N-30N |
| LONG. | 95W- 95W | 137W-131W | 131W- 94W | 141W-137W | 145W-141W |
| VOL. OF AIR (100 scm) | 1.135 | 2.224 | 1.880 | 1.819 | 1.646 |
| GROSS GAMMA (cpm/100 scm) | 39. | 25. | 10. | 35. | 16. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

VP : VERTICAL PROFILE

: III-2 (Cont'd)

TOTAL GAMMA CONCENTNS FROM THE NOVEMBER 1983 MISSION

ODE 16.8 KM

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15149 | 15 | 15158 | 15146 | 15160 |
| MISSION/FLIGHT | 29/928 | 29/8 | 29/928 | 29/928 | 29/928 |
| DATE | 11/28/83 | 28/3 | 11/28/83 | 11/28/83 | 11/28/83 |
| TIME | 2059-2130 | 2059 | 1857-1924 | 1954-2026 | 1924-1952 |
| LAT. | 30N-28N | V-26N | 27N-24N | 26N-24N | 24N-21N |
| LONG. | 148W-145W | 148W | 94W- 94W | 154W-151W | 94W- 94W |
| VOL. OF AIR (100 scm) | 1.531 | .685 | 1.620 | 1.670 | 1.720 |
| GROSS GAMMA (cpm/100 scm) | 31. | 28. | 14. | 30. | 12. |
| COUNT DATE | 1/27/84 | /84 | 1/27/84 | 1/27/84 | 1/27/84 |

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15140 | 22 | 15123 | 15124 | 15125 |
| MISSION/FLIGHT | 29/928 | 29 | 29/928 | 29/928 | 29/928 |
| DATE | 11/27/83 | 83 | 11/25/83 | 11/26/83 | 11/26/83 |
| TIME | 2235-2305 | 252 | 2152-2228 | 2228-2256 | 2256-2320 |
| LAT. | 22N-20N | 2N | 12N- 8N | 8N- 5N | 5N- 2N |
| LONG. | 158W-158W | 158W | 158W-159W | 159W-159W | 159W-159W |
| VOL. OF AIR (100 scm) | 1.528 | 35 | 1.969 | 1.383 | 1.242 |
| GROSS GAMMA (cpm/100 scm) | 9. | 2. | 13. | 11. | 0. |
| COUNT DATE | 1/27/84 | /84 | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 18.0 KM

| | | |
|---|---|---|
| SAMPLE NO. | 15054 | 15126 |
| MISSION/FLIGHT | 29/928 | 29/928 |
| DATE | 11/19/83 | 11/26/83 |
| TIME | 2014-2054 | 2325-2344 |
| LAT. | 75N-71N | 5N- 3N |
| LONG. | 149W-149W | 159W-159W |
| VOL. OF AIR (100 scm) | 1.290 | 0.658 |
| GROSS GAMMA (cpm/100 scm) | 50. | 26. |
| COUNT DATE | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 18.3 KM

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15097 | 15098 | 15100 | 15101 | 15103 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/23/83 | 11/23/83 | 11/23/83 | 11/23/83 | 11/23/83 |
| TIME | 1830-1910 | 1910-1951 | 1951-2017 | 2032-2111 | 2111-2147 |
| LAT. | 45N-42N | 42N-39N | 39N-37N | 36N-33N | 33N-30N |
| LONG. | 128W-135W | 135W-139W | 139W-142W | 143W-147W | 147W-150W |
| VOL. OF AIR (100 scm) | 1.679 | 1.393 | 0.886 | 1.348 | 1.291 |
| GROSS GAMMA (cpm/100 scm) | 32. | 60. | 61. | 33. | 35. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15104 | 15105 | 15106 | 15141 | 15118 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/23/83 | 11/23/83 | 11/23/83 | 11/27/83 | 11/25/83 |
| TIME | 2147-2223 | 2223-2257 | 2257-2321 | 2311-2341 | 0343-0419 |
| LAT. | 30N-27N | 27N-24N | 24N-22N | 23N-19N | 20N-16N |
| LONG. | 150W-153W | 153W-156W | 156W-157W | 158W-158W | 158W-158W |
| VOL. OF AIR (100 scm) | 1.328 | 1.259 | 0.885 | 1.081 | 1.314 |
| GROSS GAMMA (cpm/100 scm) | 50. | 44. | 51. | 40. | 42. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| | | | |
|---|---|---|---|
| SAMPLE NO. | 15117 | 15115 | 15113 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 |
| DATE | 11/25/83 | 11/25/83 | 11/25/83 |
| TIME | 0306-0343 | 0230-0305 | 0214-0229 |
| LAT. | 16N-13N | 12N- 8N | 8N- 6N |
| LONG. | 158W-158W | 157W-158W | 157W-157W |
| VOL. OF AIR (100 scm) | 1.411 | 1.327 | 0.550 |
| GROSS GAMMA (cpm/100 scm) | 24. | 16. | 0. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 |

VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 18.9 KM

| | | | |
|---|---|---|---|
| SAMPLE NO. | 15055 | 15056 | 15006 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 |
| DATE | 11/19/83 | 11/19/83 | 11/15/83 |
| TIME | 2054-2122 | 2122-2150 | 1924-1956 |
| LAT. | 71N-68N | 68N-65N | 47N-43N |
| LONG. | 149W-149W | 149W-149W | 96W- 96W |
| VOL. OF AIR (100 scm) | 0.746 | 0.728 | 0.860 |
| GROSS GAMMA (cpm/100 scm) | 74. | 30. | 79. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 983 MISSION

ALTITUDE 19.2 KM

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15057 | 15058 | 15082 | 15081 | 15080 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/19/83 | 11/19/83 | 11/21/83 | 11/21/83 | 11/21/83 |
| TIME | 2150-2216 | 2216-2243 | 2211-2236 | 2146-2211 | 2122-2146 |
| LAT. | 65N-62N | 62N-59N | 59N-56N | 56N-53N | 53N-50N |
| LONG. | 149W-150W | 150W-150W | 150W-150W | 150W-150W | 150W-150W |
| VOL. OF AIR (100 scm) | 0.642 | 0.660 | 0.635 | 0.645 | 0.623 |
| GROSS GAMMA (cpm/100 scm) | 19. | 55. | 101. | 51. | 99. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |

| | | | | | |
|---|---|---|---|---|---|
| SAMPLE NO. | 15079 | 15007 | 15008 | 15161 | 15142 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/21/83 | 11/15/83 | 11/15/83 | 11/28/83 | 11/27/83 |
| TIME | 2056-2122 | 1956-2029 | 2029-2056 | 2055-2126 | 2348-0018 |
| LAT. | 50N-47N | 43N-39N | 39N-36N | 24N-21N | 23N-20N |
| LONG. | 150W-150W | 96W- 96W | 96W- 95W | 94W- 94W | 158W-158W |
| VOL. OF AIR (100 scm) | 0.692 | 0.835 | 0.669 | 0.782 | 0.805 |
| GROSS GAMMA (cpm/100 scm) | 0. | 42. | 51. | 38. | 51. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 19.5 KM

| SAMPLE NO. | 15009 | 15010 | 15128 |
|---|---|---|---|
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 |
| DATE | 11/15/83 | 11/15/83 | 11/26/83 |
| TIME | 2056-2122 | 2122-2146 | 0011-0047 |
| LAT. | 36N-33N | 33N-30N | 12N- 8N |
| LONG. | 95W- 95W | 95W- 95W | 159W-158W |
| VOL. OF AIR (100 scm) | 0.629 | 0.553 | 0.843 |
| GROSS GAMMA (cpm/100 scm) | 56. | 94. | 23. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 19.8 KM

| | | | | |
|---|---|---|---|---|
| SAMPLE NO. | 15165 | 15164 | 15129 | 15127 |
| MISSION/FLIGHT | 29/928 | 29/928 | 29/928 | 29/928 |
| DATE | 11/28/83 | 11/28/83 | 11/26/83 | 11/26/83 |
| TIME | 2150-2217 | 2126-2150 | 0047-0122 | 2344-0011 |
| LAT. | 30N-27N | 27N-24N | 16N-12N | 8N- 5N |
| LONG. | 94W- 94W | 94W- 94W | 158W-158W | 159W-159W |
| VOL. OF AIR (100 scm) | 0.601 | 0.531 | 0.789 | 0.638 |
| GROSS GAMMA (cpm/100 scm) | 50. | 45. | 13. | 30. |
| COUNT DATE | 1/27/84 | 1/27/84 | 1/27/84 | 1/27/84 |



VP : VERTICAL PROFILE

Table III-2 (Cont'd)

TOTAL GAMMA CONCENTRATIONS FROM THE NOVEMBER 1983 MISSION

ALTITUDE 20.1 KM

| | |
|---|---|
| SAMPLE NO. | 15130 |
| MISSION/FLIGHT | 29/928 |
| DATE | 11/26/83 |
| TIME | 0122-0156 |
| LAT. | 20N-16N |
| LONG. | 158W-157W |
| VOL. OF AIR (100 scm) | 0.732 |
| GROSS GAMMA (cpm/100 scm) | 41. |
| COUNT DATE | 1/27/84 |

Table III-3

Radionuclide Analysis of September 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 12.2 km | | | | | | | | | | |
| 14990 | 14929 | 29-29 | 95-94 | 0.20 | $^{144}$Ce: | * | $^{7}$Be: | 109~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| Altitude: 13.7 km | | | | | | | | | | |
| 14988 | 14930 | 30-29 | 95-94 | 0.19 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| Altitude: 15.2 km | | | | | | | | | | |
| 14987 | 14932 | 29-28 | 97-94 | 0.16 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| Altitude: 16.8 km | | | | | | | | | | |
| 14977 | 14953 | 45-42 | 93-93 | 0.12 | $^{144}$Ce: | * | $^{7}$Be: | 320~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14978 | 14952 | 42-38 | 93-93 | 0.16 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14979 | 14951 | 38-34 | 98-93 | 0.17 | $^{144}$Ce: | * | $^{7}$Be: | 260~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14980 | 14950 | 34-30 | 93-93 | 0.16 | $^{144}$Ce: | * | $^{7}$Be: | 272 | $^{137}$Cs: | 0.5~ |
| | | | | | $^{95}$Zr: | * | | | | |
| 14981 | 14933 | 30-28 | 96-94 | 0.13 | $^{144}$Ce: | * | $^{7}$Be: | 269~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14982 | 14938 | 29-28 | 94-93 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | 400~ | $^{137}$Cs: | 1.8~ |
| | | | | | $^{95}$Zr: | * | | | | |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-3 (Cont'd)

Radionuclide Analysis of September 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 16.8 km (cont'd) | | | | | | | | | | |
| 14983 | 14939 | 28-26 | 94-94 | 0.39 | $^{144}$Ce: | * | $^{7}$Be: | 77~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14984 | 14941 | 26-22 | 94-94 | 0.17 | $^{144}$Ce: | * | $^{7}$Be: | 188~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14985 | 14942 | 22-20 | 94-94 | 0.08 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | 1.4~ |
| | | | | | $^{95}$Zr: | * | | | | |
| Altitude: 18.3 km | | | | | | | | | | |
| 14975 | 14934 | 30-29 | 95-93 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | 430~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| Altitude: 19.2 km | | | | | | | | | | |
| 14965D | 14954 | 47-45 | 93-92 | 0.04 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | 4.5~ |
| | | | | | $^{95}$Zr: | * | | | | |
| 14967 | 14956 | 45-41 | 92-92 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | 481~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14968 | 14957 | 41-37 | 93-92 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | 547~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14969D | 14958 | 37-33 | 93-93 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | 643~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14970 | 14959 | 33-33 | 94-93 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | 571~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-3 (Cont'd)

Radionuclide Analysis of September 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 19.2 km (cont'd) | | | | | | | | | | |
| 14971 | 14947 | 30-26 | 94-93 | 0.08 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14972 | 14946 | 26-23 | 94-94 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14973 | 14945 | 23-20 | 94-94 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14974 | 14943 | 20-19 | 94-93 | 0.04 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |
| 14991D | 14954 | 47-45 | 93-92 | 0.04 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | 2.9~ |
| | | | | | $^{95}$Zr: | * | | | | |
| 14992D | 14958 | 37-33 | 93-93 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | | | | |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 3.0 km | | | | | | | | | | |
| 15251 | 15061 | 62-62 | 148-147 | 0.24 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.001$f$ | $^{90}$Sr: | 0.01~ |
| Altitude: 6.1 km | | | | | | | | | | |
| 15252 | 15062 | 63-62 | 146-145 | 0.19 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.004$f$ | $^{90}$Sr: | 0.02? |
| 15253 | 15133 | 21-20 | 158- 59 | 0.21 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.002$f$ | $^{90}$Sr: | 0.03~ |
| Altitude: 9.1 km | | | | | | | | | | |
| 15254 | 15134 | 20-18 | 159-159 | 0.17 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.004$f$ | $^{90}$Sr: | 0.03$f$ |
| Altitude: 12.2 km | | | | | | | | | | |
| 15247 | 15041,15040 15038 | 75-65 | 150-148 | 0.84 | $^{144}$Ce: | * | $^{7}$Be: | 359 | $^{137}$Cs: | 0.4~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.007 | $^{90}$Sr: | 0.12 |
| 15248 | 15037 | 65-62 | 150-150 | 0.27 | $^{144}$Ce: | * | $^{7}$Be: | 373 | $^{137}$Cs: | 0.5 |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | 0.17 |
| 15255 | 15136 | 21-19 | 159-158 | 0.29 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.004$f$ | $^{90}$Sr: | 0.02~ |

*: Not detectable.
~: Counting error is 20-50%.
$f$: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of Novemb r 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 13.7 km | | | | | | | | | | |
| 15240 | 15034 | 60-57 | 146-139 | 0.34 | $^{144}$Ce: | * | $^{7}$Be: | 315 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.002ƒ | $^{90}$Sr: | 0.22 |
| 15241 | 15033 | 57-55 | 139-135 | 0.21 | $^{144}$Ce: | * | $^{7}$Be: | 341 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.011 | $^{90}$Sr: | 0.13~ |
| 15242 | 15032 | 55-53 | 135-131 | 0.23 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.008 | $^{90}$Sr: | 0.30 |
| 15243 | 15029 | 53-51 | 131-128 | 0.17 | $^{144}$Ce: | * | $^{7}$Be: | 275 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.011~ | $^{90}$Sr: | 0.06? |
| 15244 | 15028 | 51-49 | 128-126 | 0.18 | $^{7}$Be: | 284 | $^{95}$Zr: | * | $^{137}$Cs: | * |
| | | | | | $^{144}$Ce: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | 0.03ƒ |
| 15245 | 15026 | 49-47 | 126-124 | 0.16 | $^{144}$Ce: | * | $^{7}$Be: | 397 | $^{137}$Cs: | 1.0~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.007~ | $^{90}$Sr: | 0.11 |
| 15246 | 15025 | 47-45 | 124-124 | 0.14 | $^{144}$Ce: | * | $^{7}$Be: | 222 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.026~ | $^{90}$Sr: | 0.09 |
| 15256 | 15137 | 23-21 | 158-158 | 0.25 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.002? | $^{90}$Sr: | 0.01~ |
| Altitude: 14.9 km | | | | | | | | | | |
| 15238 | 15073 | 60-57 | 150-150 | 0.16 | $^{144}$Ce: | * | $^{7}$Be: | 328~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.013~ | $^{90}$Sr: | 0.27 |
| 15239 | 15121 | 20-16 | 158-158 | 0.24 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.002ƒ | $^{90}$Sr: | 0.08~ |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 15.2 km | | | | | | | | | | |
| 15225 | 15053,15052, 15050 | 75-66 | 149-148 | 0.42 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{90}$Sr: | 0.217 | $^{90}$Sr: | 0.01~ |
| 15226 | 15049 | 66-63 | 150-149 | 0.14 | $^{144}$Ce: | * | $^{7}$Be: | 619 | $^{137}$Cs: | 0.9~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.008~ | $^{90}$Sr: | 0.12? |
| 15227 | 15074,15076, 15077 | 57-48 | 150-150 | 0.50 | $^{7}$Be: | 25~ | $^{95}$Zr: | * | $^{137}$Cs: | * |
| | | | | | $^{144}$Ce: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | 0.09 |
| 15228 | 15022,15021 | 47-43 | 124-113 | 0.52 | $^{144}$Ce: | * | $^{7}$Be: | 349 | $^{137}$Cs: | 0.5~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.005~ | $^{90}$Sr: | 0.09 |
| 15229 | 15020 | 43-41 | 113-110 | 0.16 | $^{144}$Ce: | * | $^{7}$Be: | 212~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.003*f* | $^{90}$Sr: | 0.03 |
| 15230 | 15019 | 41-39 | 110-107 | 0.18 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | 0.07 |
| 15231 | 15017 | 39-37 | 107-104 | 0.19 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.009~ | $^{90}$Sr: | 0.12*f* |
| 15232 | 15116 | 37-35 | 104-102 | 0.16 | $^{7}$Be: | 288~ | $^{137}$Cs: | * | $^{95}$Zr: | * |
| | | | | | $^{239}$Pu: | 0.012~ | $^{90}$Sr: | 0.13~ | | |

*: Not detectable.
~: Counting error is 20-50%.
*f*: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 15.2 km (cont'd) | | | | | | | | | | |
| 15233 | 15014 | 35-33 | 102- 99 | 0.19 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.008~ | $^{90}$Sr: | 0.06ƒ |
| 15234 | 15013 | 33-30 | 99- 96 | 0.28 | $^{7}$Be: | 253~ | $^{137}$Cs: | 1.0~ | $^{95}$Zr: | * |
| | | | | | $^{239}$Pu: | 0.004~ | $^{90}$Sr: | 0.15 | | |
| 15235 | 15145 | 24-22 | 157-154 | 0.18 | $^{144}$Ce: | * | $^{7}$Be: | 218~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.011~ | $^{90}$Sr: | * |
| 15236 | 15109 | 20-16 | 159-158 | 0.25 | $^{144}$Ce: | * | $^{7}$Be: | 69~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.003ƒ | $^{90}$Sr: | 0.03? |
| 15237 | 15112 | 8- 5 | 158-158 | 0.19 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | 0.10ƒ |
| 15258 | 15139 | 23-20 | 158-158 | 0.20 | $^{144}$Ce: | * | $^{7}$Be: | 104~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.007~ | $^{90}$Sr: | 0.02ƒ |
| Altitude: 16.8 km | | | | | | | | | | |
| 15209 | 15042,15043, 15044 | 75-65 | 149-148 | 0.40 | $^{144}$Ce: | * | $^{7}$Be: | 538 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.007 | $^{90}$Sr: | 0.05 |
| 15210 | 15045 | 65-62 | 149-149 | 0.10 | $^{144}$Ce: | * | $^{7}$Be: | 755 | $^{137}$Cs: | 2.5~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.003? | $^{90}$Sr: | 0.19 |
| 15211 | 15046 | 62-59 | 149-148 | 0.12 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.005ƒ | $^{90}$Sr: | 0.07ƒ |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 16.8 km (cont'd) | | | | | | | | | | |
| 15212 | 15085,15086, 15088 | 59–53 | 145–133 | 0.31 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: 411 | $^{239}$Pu: 0.008~ | $^{137}$Cs: * | $^{90}$Sr: 0.22 |
| 15213 | 15089,15092 | 53–49 | 133–126 | 0.20 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: 253~ | $^{239}$Pu: 0.009~ | $^{137}$Cs: * | $^{90}$Sr: 0.19 |
| 15215 | 15093 | 49–47 | 126–124 | 0.10 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: * | $^{239}$Pu: 0.019~ | $^{137}$Cs: * | $^{90}$Sr: 0.39 |
| 15216D | 15094,15005, 15004,15002 | 47–36 | 124– 95 | 0.42 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: 152 | $^{239}$Pu: 0.004~ | $^{137}$Cs: 0.4~ | $^{90}$Sr: 0.08 |
| 15217 | 15001 | 36–33 | 95– 95 | 0.11 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: 339~ | $^{239}$Pu: 0.008~ | $^{137}$Cs: * | $^{90}$Sr: 0.11~ |
| 15218 | 15154,15153 | 36–32 | 141–131 | 0.40 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: 249 | $^{239}$Pu: 0.006~ | $^{137}$Cs: * | $^{90}$Sr: 0.09 |
| 15219 | 15157 | 36–27 | 131– 94 | 0.19 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: * | $^{239}$Pu: 0.006~ | $^{137}$Cs: * | $^{90}$Sr: 0.02*f* |
| 15220 | 15152 | 32–30 | 145–141 | 0.16 | $^{95}$Zr: * | $^{239}$Pu: 0.009~ | $^{137}$Cs: * | $^{90}$Sr: 0.06 | $^{144}$Ce: * | |
| 15221 | 15149,15148 | 30–26 | 151–145 | 0.32 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: 263 | $^{239}$Pu: 0.005~ | $^{137}$Cs: 0.5 | $^{90}$Sr: 0.04~ |
| 15222 | 15158 | 27–24 | 94– 94 | 0.16 | $^{144}$Ce: * | $^{95}$Zr: * | $^{7}$Be: * | $^{239}$Pu: 0.001? | $^{137}$Cs: * | $^{90}$Sr: 0.04*f* |

*: Not detectable.
~: Counting error is 20–50%.
*f*: Counting error is 51–100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 16.8 km (cont'd) | | | | | | | | | | |
| 15223 | 15146,15160 | 26-21 | 154- 94 | 0.34 | $^{144}$Ce: | * | $^{7}$Be: | 148~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.00[illegible] | $^{90}$Sr: | 0.06 |
| 15224D | 15122,15123, 15124,15125 | 16- 1 | 159-158 | 0.63 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.00[illegible] | $^{90}$Sr: | 0.01? |
| 15249D | 15122,15123, 15124,15125 | 16- 2 | 159-158 | 0.63 | $^{144}$Ce: | * | $^{7}$Be: | 42~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.00[illegible] | $^{90}$Sr: | 0.02f |
| 15250D | 15094,15005, 15004,15002 | 47-36 | 124- 95 | 0.42 | $^{144}$Ce: | * | $^{7}$Be: | 171 | $^{137}$Cs: | 0.4~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.003~ | $^{90}$Sr: | 0.12 |
| 15259 | 15140 | 22-20 | 158-158 | 0.15 | $^{144}$Ce: | * | $^{7}$Be: | 149~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.011~ | $^{90}$Sr: | 0.07~ |
| Altitude: 18.0 km | | | | | | | | | | |
| 15206 | 15054 | 75-71 | 149-149 | 0.13 | $^{144}$Ce: | * | $^{7}$Be: | 677 | $^{137}$Cs: | 0.7~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.013~ | $^{90}$Sr: | 0.02? |
| 15207 | 15126 | 5- 3 | 159-159 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.008f | $^{90}$Sr: | 0.05f |

*: Not detectable.
~: Counting error is 20-50%.
f: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 18.3 km | | | | | | | | | | |
| 15198 | 15097,15098 | 45-39 | 139-128 | 0.31 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.011 | $^{90}$Sr: | 0.27 |
| 15199 | 15100 | 39-37 | 142-139 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | 382~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.007~ | $^{90}$Sr: | 0.33ƒ |
| 15200 | 15101,15103 | 36-30 | 150-143 | 0.26 | $^{144}$Ce: | * | $^{7}$Be: | 330 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | * |
| 15201 | 15104,15105, 15106 | 30-22 | 157-150 | 0.35 | $^{144}$Ce: | * | $^{7}$Be: | 338 | $^{137}$Cs: | 0.6 |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.007~ | $^{90}$Sr: | 0.03 |
| 15202 | 15118,15117 | 20-13 | 158-158 | 0.27 | $^{144}$Ce: | * | $^{7}$Be: | 293 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.006~ | $^{90}$Sr: | 0.09 |
| 15203 | 15115,15113 | 12- 6 | 158-157 | 0.19 | $^{7}$Be: | 229 | $^{137}$Cs: | * | $^{95}$Zr: | * |
| | | | | | $^{239}$Pu: | 0.010~ | $^{90}$Sr: | 0.01ƒ | | |
| 15260 | 15141 | 23-19 | 158-158 | 0.11 | $^{144}$Ce: | * | $^{7}$Be: | 429 | $^{137}$Cs: | 0.9~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.014~ | $^{90}$Sr: | 0.38 |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 18.9 km | | | | | | | | | | |
| 15195 | 15055 | 71-68 | 149-149 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | 790 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.005? | $^{90}$Sr: | * |
| 15196 | 15056 | 68-65 | 149-149 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | 440~ | $^{137}$Cs: | 1.4~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.018~ | $^{90}$Sr: | 0.06 |
| 15197 | 15006 | 47-43 | 96- 96 | 0.09 | $^{144}$Ce: | * | $^{7}$Be: | 448 | $^{137}$Cs: | 1.6~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.004? | $^{90}$Sr: | 0.11~ |
| Altitude: 19.2 km | | | | | | | | | | |
| 15185 | 15057 | 65-62 | 150-149 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | 2.9ƒ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.019~ | $^{90}$Sr: | 0.41~ |
| 15186 | 15058 | 62-59 | 150-150 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | 553ƒ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.011~ | $^{90}$Sr: | 0.30~ |
| 15187 | 15082 | 59-56 | 150-150 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | 435 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.013~ | $^{90}$Sr: | 0.13ƒ |
| 15188 | 15081 | 56-53 | 150-150 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | 637 | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.023~ | $^{90}$Sr: | 0.47~ |
| 15189 | 15080 | 53-50 | 150-150 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | 719~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.025~ | $^{90}$Sr: | 0.19? |
| 15190 | 15007,15008 | 43-36 | 96- 95 | 0.15 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | * | $^{90}$Sr: | 0.23~ |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.

Table III-4 (Cont'd)

Radionuclide Analysis of November 1983 Composites

| Composite No. | Filter(s) | Range Lat. (°N) | Range Long. (°W) | Volume (kscm) | Concentration (Bq/kscm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude: 19.2 km (cont'd) | | | | | | | | | | |
| 15192 | 15161 | 24-21 | 94- 94 | 0.08 | $^{7}$Be: | 436~ | $^{137}$Cs: | * | $^{95}$Zr: | * |
| | | | | | $^{239}$Pu: | 0.003ƒ | $^{90}$Sr: | 0.08? | | |
| 15261 | 15142 | 23-20 | 158-158 | 0.08 | $^{144}$Ce: | * | $^{7}$Be: | 328 | $^{137}$Cs: | 1.1~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.017~ | $^{90}$Sr: | 0.50~ |
| Altitude: 19.5 km | | | | | | | | | | |
| 15181 | 15009,15010 | 36-30 | 95- 95 | 0.12 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.003ƒ | $^{90}$Sr: | * |
| 15182 | 15128 | 12- 8 | 159-158 | 0.08 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.019 | $^{90}$Sr: | 0.66 |
| Altitude: 19.8 km | | | | | | | | | | |
| 15176 | 15165,15164 | 30-24 | 94- 94 | 0.11 | $^{144}$Ce: | * | $^{7}$Be: | 385 | $^{137}$Cs: | 1.3~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.014~ | $^{90}$Sr: | 0.05? |
| 15177 | 15129 | 16-12 | 158-158 | 0.08 | $^{144}$Ce: | * | $^{7}$Be: | 343~ | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.008~ | $^{90}$Sr: | * |
| 15178 | 15127 | 8- 5 | 159-159 | 0.06 | $^{144}$Ce: | * | $^{7}$Be: | 258~ | $^{137}$Cs: | 1.6~ |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.002? | $^{90}$Sr: | 0.32ƒ |
| Altitude: 20.1 km | | | | | | | | | | |
| 15175 | 15130 | 20-16 | 158-157 | 0.07 | $^{144}$Ce: | * | $^{7}$Be: | * | $^{137}$Cs: | * |
| | | | | | $^{95}$Zr: | * | $^{239}$Pu: | 0.024~ | $^{90}$Sr: | 0.30~ |

*: Not detectable.
~: Counting error is 20-50%.
ƒ: Counting error is 51-100%.
?: Data suspect.
D: Composite-type = duplicate.


**Figure III-1. Airstream flight profile.**

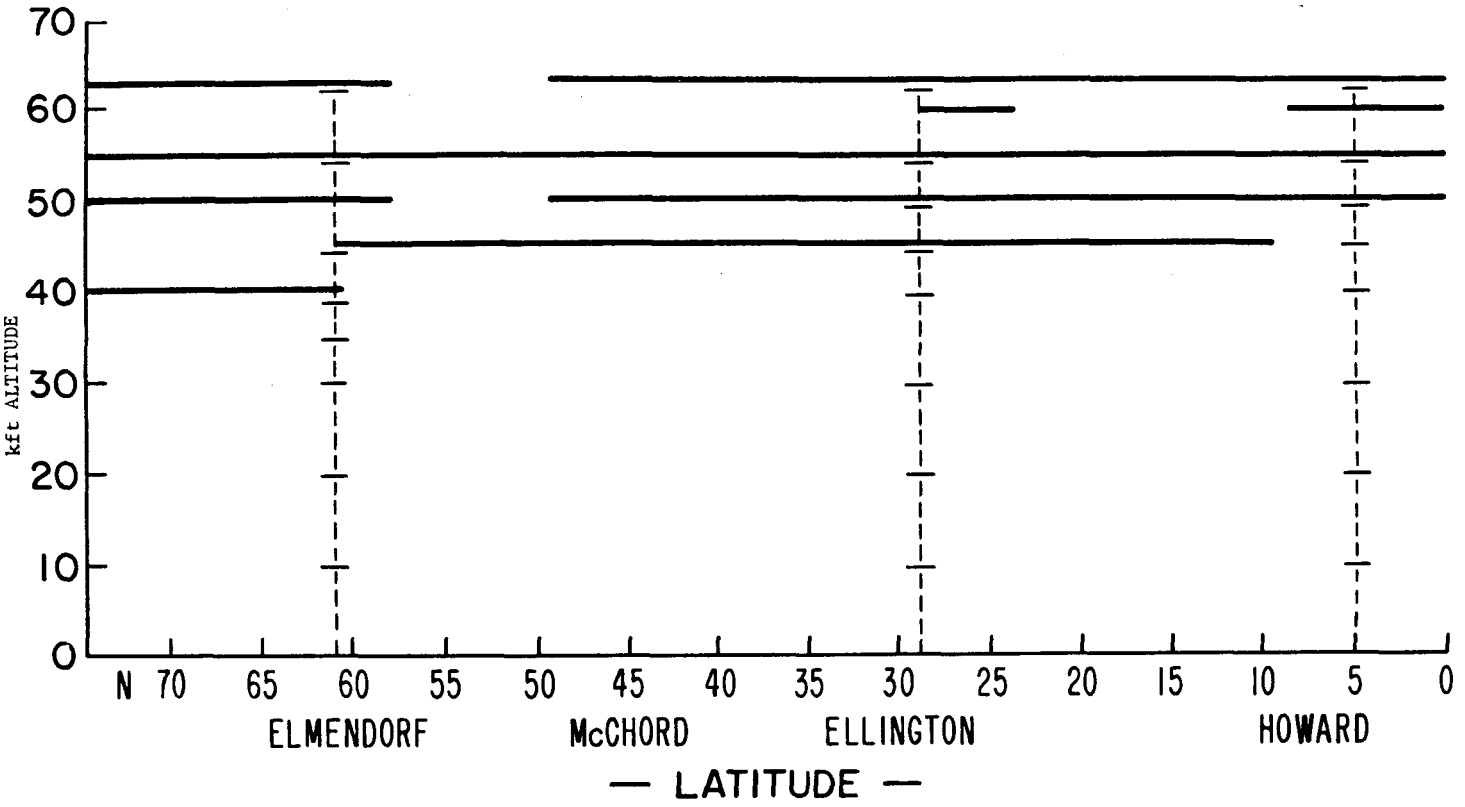


Figure III-2. Airstream latitude and altitude coverage.

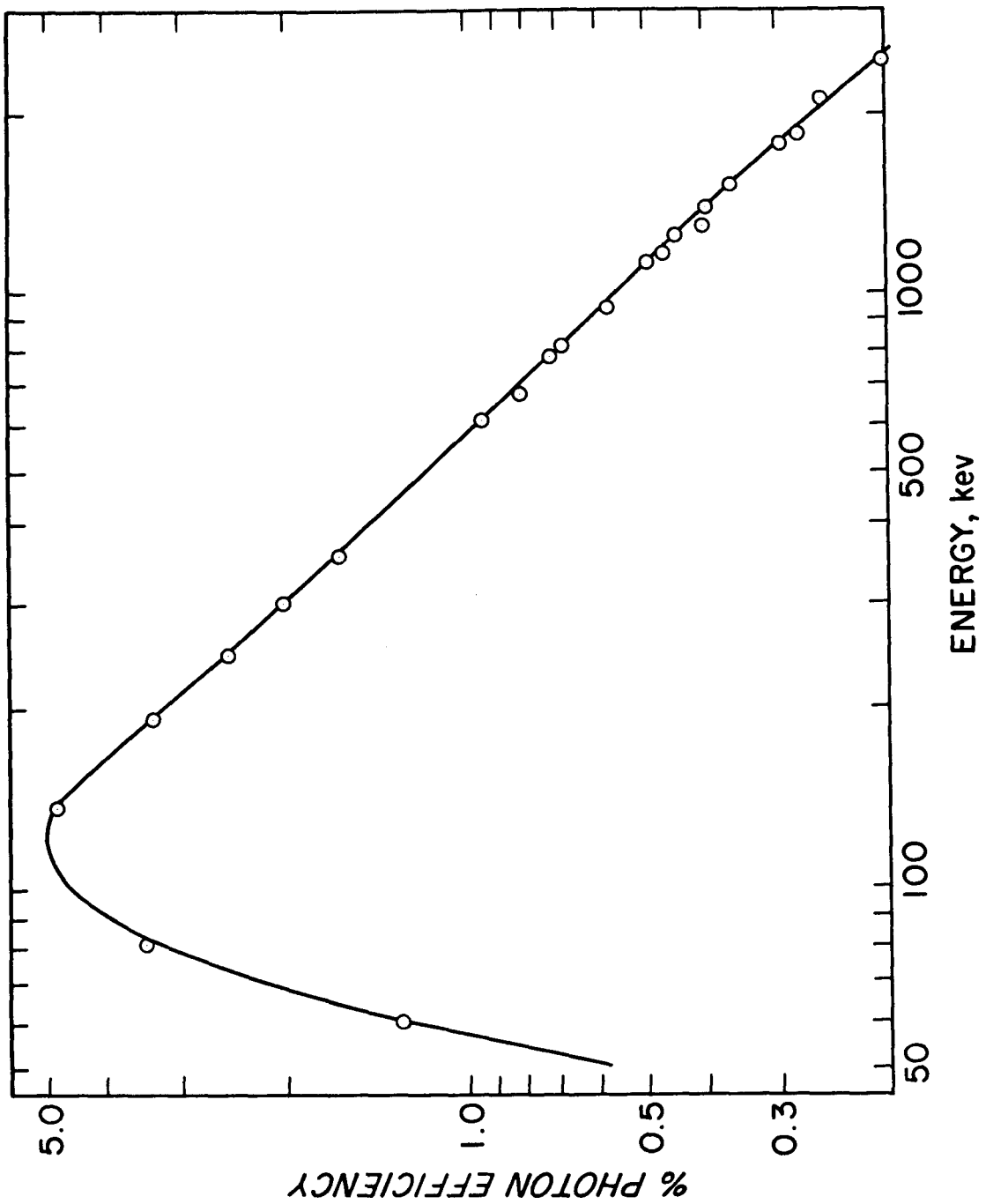


Figure III-3. Calibration curve of germanium (Li) diode spectrometer.

## B. QUALITY CONTROL

To evaluate EML's gamma-ray spectrometry and the contractor's radiochemistry, blind blanks, reference samples and duplicates are routinely submitted for analysis. Some blanks represent pre-washed filters exposed at altitudes for 5 seconds in filter position number 4 or 7 of the U-1 foil system. It has been shown that these blanks can be contaminated by stratospheric particulates as a result of their short exposure time and because of leakage of sealant gaskets in the U-1 system (1). In recent missions non-exposed blanks carried aboard the aircraft have been substituted for the exposed blanks and analyzed to indicate the contamination experienced by filters when they are simply installed and stored in the aircraft. To test the degree of contamination introduced by normal laboratory analyses only, appropriate sizes of filter material taken from stock are also submitted as blind blanks.

The duplicates are identical composites of one sixth of each filter. To reduce the effect of heterogeneity of debris on the filter and thereby improve the quality of the duplicate, each one sixth is made up of opposite one twelfths of the original filter.

Reference samples for radiochemistry are unwashed and unexposed filters of IPC-1478 paper onto which calibrated solutions of various nuclides have been evaporated. These calibrated solutions are available from a number of sources and are recalibrated at EML. Generally, the agreement between EML's value and the reported value is very good.

For gamma-ray spectrometry, prepared reference samples are made by mixing calibrated solutions of gamma emitting radionuclides with 1% solution of Agar-Agar. These were found to be a reliable index of quality control for spectrometry because of the uniform distribution of radioactivity within the sample (2). The Agar-Agar reference samples are used exclusively to evaluate the quality of the gamma ray spectrometric analyses. The sample numbers of the reference samples are changed after each analysis so that they can be reused many times. Because of a reduction in activity due to radioactive decay, it is desirable to prepare a new set every year.

The results of blanks and duplicates used to evaluate the gamma spectral analyses of $^{7}Be$, $^{95}Zr$, $^{137}Cs$ and $^{144}Ce$ in the September 1983 flights are presented in Tables III-5. The data on the blanks are all acceptable.

The quality control results for blanks, reference samples and duplicates used for the November 1983 mission are given in Tables III-6. The $^{239,240}Pu$ measurements on the reference samples are all acceptable. The $^{90}Sr$ reference samples show a negative bias, which at the present time cannot be explained.

## REFERENCES

1. Krey, P. W.
'Project Airstream'
USAEC Report HASL-281, January (1973)

2. Ibid, USAEC Report HASL-268, April (1974)

Table III-5

Quality Control

Airstream, September 1983

| Sample No. (Ref. date) | Concentration (Bq/kscm ± % S.D.) | | | |
|---|---|---|---|---|
| | $^{7}Be$ | $^{95}Zr$ | $^{137}Cs$ | $^{144}Ce$ |
| **Blanks** | | | | |
| Blank IPC paper 14993 | * | * | * | * |
| Unexposed blanks 14986 | * | * | * | * |
| Unexposed blanks 14976 | * | * | * | * |
| **Duplicates** | | | | |
| 14986 | * | * | 2.9±43 | * |
| 14976 (9/28/83) | * | * | 4.5±36 | * |
| % deviation between duplicates | - | - | 43 | - |
| 14992 | Lost | | | |
| 14976 (9/28/83) | 642.9±44 | * | * | * |
| % deviation between duplicates | - | - | - | - |

* Not detectable

Table III-6

Quality Control

Airstream, November 1983

| Sample No. (Ref. date) | | Concentration (Bq ± S.D.) | | | | | |
|---|---|---|---|---|---|---|---|
| | | $^{7}Be$ | $^{95}Zr$ | $^{137}Cs$ | $^{144}Ce$ | $^{90}Sr$ | $^{239,240}Pu$ |
| **Blanks** | | | | | | | |
| Blank IPC paper | | | | | | | |
| 15179 | | * | * | * | * | 0.003±480 | * |
| 15194 | | * | * | * | * | 0.004±225 | |
| Unexposed Blanks | | | | | | | |
| 15184 | | * | * | * | * | 0.006± 29 | |
| 15205 | | * | * | * | * | 0.004± 60 | |
| Exposed Blanks | | | | | | | |
| 15193 | | * | * | * | * | 0.002±197 | |
| 15204 | | * | * | * | * | 0.009± 53 | |
| **Standards** | | | | | | | |
| 15180 | added | 649 | 18 | 4.8 | 12.7 | - | - |
| 11/15/83 | found | 647± 5 | * | 6.9±5 | 19.1±22 | - | - |
| | % Dev. | -0.3 | - | +43 | +50 | - | - |
| 15183 | added | 346 | 18 | 3.9 | 10.2 | - | - |
| 11/15/83 | found | 337±15 | * | 5.5±8 | 16.9±38 | - | - |
| | % Dev. | -2.6 | - | +41 | +66 | - | - |
| 15208 | added | 269 | 19 | 7.5 | 13.5 | - | - |
| 11/15/83 | found | 268±18 | * | 8.1±7 | 19.9±32 | - | - |
| | % Dev. | -0.3 | - | +8 | +48 | - | - |
| 15214 | added | 346 | 20 | 5.8 | 13.5 | - | - |
| 11/15/83 | found | 315±17 | * | 7.4±7 | 19.2±33 | - | - |
| | % Dev. | -1.4 | - | +27 | +42 | - | - |

* Not detectable

Table III-6 (Cont'd)

Quality Control

Airstream, November 1983

| Sample No. (Ref. date) | | Concentration (Bq/kscm ± % S.D.) | | | | | |
|---|---|---|---|---|---|---|---|
| | | $^{7}Be$ | $^{95}Zr$ | $^{137}Cs$ | $^{144}Ce$ | $^{90}Sr$ | $^{239,240}Pu$ |
| | | | | Standards (Cont'd) | | | |
| 15174 | added | - | - | - | - | 0.19 | 0.02 |
| 11/15/83 | found | - | - | - | - | 0.16±3 | 0.02±7 |
| | % Dev. | - | - | - | - | 15.7 | -0.5 |
| 15262 | added | - | - | - | - | 0.25 | 0.02 |
| 11/15/83 | found | - | - | - | - | 0.20±5 | 0.02±7 |
| | % Dev. | - | - | - | - | 23.9 | 10.4 |
| | | | | Duplicates | | | |
| 15216 | | 151.7±15 | * | * | * | 0.003±480 | * |
| 15250 (11/15/83) | | 170.5+13 | * | * | * | 0.004±225 | |
| % deviation between duplicates | | 12 | - | - | - | - | - |
| 15224 | | * | * | * | * | * | * |
| 15249 | | 42.4±20 | * | * | * | * | * |
| % deviation between duplicates | | - | - | - | - | - | - |

* Not detectable

## C. PROJECT ASHCAN

### SUMMARY

This section contains gamma spectral analyses from samples collected in calendar years 1982 and 1984. No samples were available for analysis in 1983.

### INTRODUCTION

The U. S. Department of Energy's program for measuring upper atmospheric nuclear debris collected by balloon borne filtering devices has been in continuous operation since 1956. Previous reports on this program are listed in References 1 through 32.

### LAUNCH SITES AND COLLECTION PARAMETERS

For the period of this report, balloon flights were usually made at altitudes of 21, 24 and 27 km at the locations given in Table III-7 by the Physical Science Laboratory of New Mexico State University, in cooperation with Air Force Geophysical Laboratory. On some occasions due to mechanical difficulties, the exact altitude was missed or the flight failed completely. Information pertaining to the collection of the balloon samples can be obtained from New Mexico State University. Altitude data are obtained from barometric readings on the balloon gondola and refer to pressure altitude in the ICAO Standard Atmosphere. The entire sample is collected within $\pm$ 0.6 km of the predominant altitude unless annotated with the symbol J. This symbol indicates that:

1. The altitude varies greater than the allowed $\pm$ km, or
2. The altitude is estimated or uncertain because of flight operational difficulties, or
3. The volume assigned to the filter is uncertain or estimated. This could include flight operational difficulties.

### SAMPLING UNITS

Collections at the lower altitudes are made with the 'Direct Flow Sampler'. This system utilizes one square foot of I.P.C No. 1478 filter paper together with a Westinghouse motor and a Torrington 704 blower. A discussion of this sampling unit has been presented by Wood (33). A modification to the sampling door to provide a better seal has been developed by the Air Resources Laboratories. This modified unit has been flight tested and is in use.

Samples at the higher altitudes are collected by an Air Ejector Pump, referred to as unit AE, using two square feet of I.P.C. No. 1478 filter paper. The air is drawn through the filter by the aspirator action of escaping nitrogen gas released downstream of the filter. This sampler was developed by the Applied Science Division, Litton Systems, Inc. under Contract AT (11-1)-401 to the U. S. Atomic Energy Commission (34).

A larger model Air Ejector system identified as the HV3K allows for greater volumes of air to be sampled at higher altitudes. This sampling unit was also developed by the Applied Science Division, Litton Systems, Inc. The HV3K uses 8 square feet of IPC filter paper and is capable of filtering about 50% more volume at higher sampling altitudes than the air ejector.

## ANALYSIS

The filters were forwarded to EML for analyses where they were coded with a sample number. When samples are split for duplicate analysis, each half is assigned a separate number. Two types of analyses are made: a non-destructive gamma measurement at EML, and an individual radionuclide assay at a contractor laboratory.

All samples are compressed and sealed into a 6 cm diameter by 3.5 cm depth aluminum can. The samples are then analyzed spectrometrically for $^{7}Be$, $^{95}Zr$, $^{137}Cs$, and $^{144}Ce$ by lithium drifted germanium diode systems. These systems have been described earlier in reports on Project Airstream (8-32). In brief, the detectors are closed-ended coaxial diodes of ~ 50 $cm^3$. The diode responses are stored in 3000 channels of a computer based pulse height analyzer. A computer program resolves and reduces these spectra by least squares fitting.

## QUALITY CONTROL PROGRAM

Because the handling and analysis of the balloon samples are very similar to Airstream and because the balloon program is small in terms of number of samples, the results of the Airstream quality control program are used in connection with the few balloon quality control samples for quality determinations when these balloon samples are available.

## RESULTS

### Gamma Spectral Analyses

The results for samples collected in 1982 and 1984 are reported in Table III-8. The concentrations are expressed in units of Bequerels per 1000 standard (Bq/kscm) at collection. The volume of air filtered is computed at 1013 millibars and 15°C such that 1 scm = 1.225 kg of air.

### Radionuclide Analyses

No $^{239}Pu$ or $^{90}Sr$ analyses were made on 1982 and 1984 filters.

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   'High Altitude Balloon Sampling Program'
   USAEC Report HASL-L40, P. L66, OCTOBER (1963)

4. Ibid, HASL-149, p. 54, October (1964)

5. Ibid, HASL-155, p. 211, January (1965)

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7. Ibid, HASL-161, p. 216, July (1965)

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9. Ibid, HASL-172, p. II-21, July (1966)

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'High Altitude Balloon Sampling Program'
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USDOE Report EML-434, November (1984)

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'Development of Sampling Equipment Used in the Upper Atmosphere Monitoring Program'
USAEC Report HASL-115, p. 155, October (1961)

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'Air Ejector Particle Sampler, A Progress Report'
Litton Systems, Inc., Report No. 2584, September 1, 1964

TABLE III-7

High Altitude Balloon Launching Sites*

| Location | Latitude (°N) |
|---|---|
| Eielson Air Force Base,AK | 65 |
| Holloman AirForce Base,NM | 33 |
| Albrook Air Force Base, Panama Canal Zone | 9 |

* Flight organization - Air Force Geophysical Laboratory.

TABLE III-8

Stratospheric Radionuclide Concentrations From Balloon Samples#

| EML J | Sample date | Altitude (km) | Volume (scm) | (Bq/kscm + % S.D.) $^{7}Be$ | $^{137}Cs$ |
|---|---|---|---|---|---|
| 3903 | 5/12/82 | 19.4 | 117.1 | 270 ± 6 | 3.7 ± 15 |
| 3904 | 5/12/82 | 19.4 | 128.5 | 247 ± 3 | 2.9 ± 9 |
| 3919 | 8/ 5/82 | 26.5 | 39.2 | 162 ± 13 | 6.8 ± 13 |
| 3921 | 8/17/82 | 19.2 | 117.4 | 349 ± 2 | 3.1 ± 9 |
| 3938 | 10/29/82 | 25.0 | 79.6 | 224 ± 32 | 0.9 ± 29 |
| 3939 | 11/ 5/82 | 25.1 | 63.9 | 315 ± 27 | 0.7 ± 33 |
| 6003* | 2/28/84 | 36.0 | 92.3 | 74 ± 16 | A |
| 6012 | 3/13/84 | 26.6 | 60.5 | 366 ± 9 | A |
| 6013** | 3/13/84 | 31.9 | 17.9 | 259 ± 25 | A |

#: Latitude 33 N; Hollman AFB, NM
A: Below limit of detection
J: Collection unit DFS (direct flow unit), except
*: Collection unit HV3K
**: Collection unit AE (air ejector)

## IV. ACKNOWLEDGEMENT

Projects Ashcan and Airstream have provided a wealth of scientific data that has been utilized by scientists throughout the world. The last flights under Project Airstream were in November 1983. The Ashcan program also ended at the same time but some special flights associated with Cosmos-1402 did occur in 1984. So many people made the program the success it was that it would be difficult to name all. We would like to acknowledge the support of the personnel of the following organizations.

The participating organizations included:

Atomic Energy Commission (AEC)

Energy Research Development Administration (ERDA)

Department of Energy (DOE)

- The Office of Health and Environmental Research (OHER)
- Los Alamos National Laboratory (LNL)
- Argonne National Laboratory (ANL)
- Savannah River Laboratory (SRL)

Air Force (AF)

- The Air Force Geophysical Laboratory (AFGL)
- 58th Weather Reconaissance Squadron, Air Weather Service
- 59th Weather Reconaissance Squadron, Air Weather Service
- 4th Weather Group, Air Weather Service
- Elmendorf AFB, AK
- Eielson AFB, AK
- Albrook AFB, PCZ
- Ellington AFB, TX
- Holloman AFB, NM
- Howard AFB, PCZ
- McChord AFB, WA
- Hickam AFB, HI
- Goodfellow AFB, TX
- Kirtland AFB, NM
- Foss Field, SD
- Mendoza Air Field, Argentina
- Mildura Air Field, Australia

National Aeronautical Space Administration (NASA), The Johnson Space Center

National Oceanographic and Atmospheric Administration (NOAA), The Air Resources Laboratory (ARL)

National Center for Atmospheric Research (NCAR)

New Mexico State University (NMSU), Physical Science Laboratory (PSL)

Department of Supply, Commonwealth of Australia

Sandia Corporation, NM

Litton Systems, MN (previously called General Mills, Inc.)

Controls for Radiation Inc., MA

Teledyne Isotopes Inc., NJ

Northrop Inc., TX

Radiochemistry Center, IAEA Nuclear, IL

EAL Inc. (formely LFE Trapelo Division/West and Tracerlab Richmond, CA)



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