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Public Law 109-163 National Defense Authorization Act for Fiscal Year 2006 Section 1055 Preservation of records Pertaining to Radioactive Fallout for Nuclear Weapons Testing within the DoD is a responsibility assumed by the NTPR Program. Decl; assified reports or portions thereof are to be made available to the public.

This report has been reviewed by both the DOE and Air Force. Copies of their responses for their reviews are attached. The redactions required have been made. There are no DTRA equities in the remaining portions. Technical was at DTRA

was performed by Paul K. Blake PhD (J9-NTSN)

Jeff McAninch, PhD (J9-NTES)

Review was performed after DOE and USAF reductions, and no concerns about plans field material were noted,

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- P.X. Blike, PhD -

Report of

## OPERATION

# TZWILLIAM



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# Report of Operation FITZWILLIAM

Vol. IV

Introduction

Copy No.  $\frac{50}{}$ 

NUCLEAR DETECTION

BY

RADIOCHEMICAL ANALYSIS

UNITED STATES AIR FORCE



SECRET (RACK - AUTH: CS, USAF 4 NOV 1952

## DEPARTMENT OF THE AIR FORCE Headquarters United States Air Force Washington 25, D. C.

AFOAT-1/AAG 370.009

SUBJECT: (Secret) Corrections to Volumes IV and V, Report of Operation FITZWILLIAM (Secret)

TO: Chief, Armed Forces Special Weapons Project

P. 0. Box 2610 Weshington 25, D. C.

1. Attention is invited to Volume IV (Tabs A, B & C) and Volume V (Tab A), Report of Operation FITZWILLIAM (Secret), copies of which were forwarded to your office on 13 and 15 October 1952, respectively.

- 2. Some of the material assembled and permanently bound into tabs listed above consisted of parts of separate reports which were formerly classified TOP SECRET but were downgraded to SECRET prior to becoming a part of the final report of Operation FITZWILLIAM (Secret). All tabs were properly classified SECRET when printed and bound for final distribution; however, inadvertently, the TOP SECRET category was not deleted and thus constitutes an erroneous classification of those pages affected.
- 3. Request all TOP SECRET markings in tabs listed in paragraph 1, above, be deleted, with this letter as authority therefor.

FOR THE CHIEF OF STAFF:

ROBERT A. HESIER

Major, USAF

Assit Executive AFOAT-1

Office for Atomis Energy, DCS/O

0-8071-52/53

SECTION

(This document consists of 1 page, Copy No. 3 of 100 Copies, Series A.)

## Report of Operation FITZWILLIAM

## Introduction to Volume IV

## NUCLEAR DETECTION BY RADIOCHEMICAL ANALYSIS

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## II. INTRODUCTION

This volume summarizes the data pertinent to radiochemical analysis of the atomic debris collected on both aerial and ground filter papers during the SANDSTONE (Unclassified) atomic tests conducted at Eniwetok, Marshall Islands, during April and May 1948. These radiochemical analyses took place primarily at three field analysis stations which were set up at Kwajalein, Marshall Islands; at Hickam Field, Honolulu, Territory of Hawaii; and at North Field, Guam. The gross decay of fission products collected on these aerial and ground filters was also studied over an extended period of time.

Gaseous samples collected during these tests were analyzed for the gaseous fission product xenon at the laboratories of Tracerlab, Inc., Boston, Massachusetts.

The prime purpose of these radiochemical assays was to determine whether or not irrefutable evidence could be obtained that fission products which result from an atomic bomb explosion and collected on aerial filters during flights made at certain strategic dates from certain strategic locations. The answer to the above is unquestionably in the affirmative, since radiochemical analysis proved the presence of Test XRAY fission products collected on aerial papers from strategic

Due to the fact that the radiochemical program was investigated on a "crash" basis, the analyses were only semi-quantitative. Nevertheless these analyses showed that quantitation of the methods following further

## III. RADIOCHEMICAL ANALYSIS OF FILTER PAPERS

## A. Collection of Activity.

The fission product activity was collected on an 8 x 18 inch Chemical Warfare Type V-5 filter paper. This paper was chosen because it was considered to be the best paper immediately available for the purpose, being a reasonable compromise between collection efficiency and flow rate. The paper is comprised of asbestos and cellulose fibers with a cotton backing support.

The radioactive particles were collected from the air through insertion of this paper in a filter box mounted on the underside of B-29 aircraft. The filter box held two papers and the papers were changed during flight at varying intervals which ranged from 1 to 3 hours. The volume of air passing through the filter paper at the normal speed of a B-29 was about 30,000 cu. ft. per hour.

Activity was also collected from the air at several ground level stations by means of an electrically power-blown unit which held a single 8 x 18 inch filter paper.

Unless the filter papers exposed during aerial reconnaissance had a counting rate of at least twice background, they were not subjected to radiochemical analysis. Generally, the selected paper was cut in half, one-half was subjected to chemical analysis and the remaining half was saved for possible future investigation pertaining to long-lived fission products and fissionable material.

B. Radiochemical Isotopes Investigated and Analytical Procedures
Pertaining Thereto.

In view of the short time available for chemical prepatory work, the analytical scheme
shown in Figure 1.

The chemical separation procedures finally developed are outlined below:

The filter paper

Figures 1, 2, 3, and 4
and pages 4 through 7
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### V. CAS ANALYSIS

Due to the short half life and high fission yield of the fission produce xenon-133, it was reasonable to assume that the collection of gaseous samples in the neighborhood of an atomic cloud and the subsequent isolation and purification of xenon would result in a radioactive count due to the fission products Xe-133 with a half life of 5.3 days, and possibly Xe-135 with a half life of 9.3 hours.

The procedure used was based upon the work of S. Allan Kline. A total of 129 tanks of compressed air collected by planes based on Kwajalein, 42 purified xenon samples collected from the air and separated by the Air Reduction

No active xenon whatsoever was found in any of the above samples.

Sales Company at Emeryville, California,

## VI. AIRBORNE CONTAMINATION

About four weeks following Operation SANDSTONE (Unclassified), an appreciable number of the aerial filter papers resulting from routine flights out of Guam contained significant quantities of radioactive material. A detailed investigation of these filter papers conclusively proved this activity was due to fission products. Further, detailed radiochemical studies and gross half life decay unequivocally demonstrated that the original source of this activity was due to the SANDSTONE (Unclassified) tests. The source of the activity was fission product contamination present in the filter boxes and overall contamination of the planes. Replacement of these filter boxes and decontamination of the planes were recommended.

## VII. PARTICULATE NATURE OF THE ATOMIC DEBRIS

Previous to Operation SANDSTONE (Unclassified), it had been tacitly assumed that following an atomic explosion the fission products, upon reaching normal air temperatures, would remain gaseous (monomolecular) in nature and would attach themselves as they traversed through the air to dust particles or condensation nuclei. The collection of these particles containing small quantities of fission products by aerial filters would result in fission product activity. Thus, a radioautograph of the filter paper containing atomic debris should produce a continuous darkening of the film. Radioautographs of aerial filter papers showed the surprising result that the activity was highly concentrated and produced small spots rather than the expected uniform distribution. Figure 5 is a reproduction of a typical radioautograph. There is no evidence whatsoever of diffusion and hence the fission product activity as collected on the papers by serial filtration during the tests is comprised of a relatively small number of separate particles in which an extremely large number of fission atoms are contained. It is reasonable to assume that these fission products, along with the inert material associated with the bomb and that portion of the tower which was vaporized, must have been condensed out to form particles as the fire ball cooled. Three hundred of these particles from Tests XRAY, YOKE and ZEBRA have been isolated. They contain a large number of fission product atoms; they are predominantly spherical, and those isolated range in size from 2 to 45 microns.

REPRODUCTION OF A TYPICAL RADICAUTOGRAPH

## VIII. NATURAL ACTIVITY

Previous to Operation SANDSTONE (Unclassified), control operations by means of both aerial and ground filtration were carried out. In many cases radioactive substances were collected on these filters. This radioactivity, which proved to be due to the presence of natural activity (thorium and radium decay products) in the air, resulted from the diffusion of radon and thoron into the atmosphere. The natural activities were present predominantly on ground filters rather than aerial filters, because the measurements were carried out more rapidly following removal from the ground blowers and also because the concentration of radium and thorium decay products decreases markedly with increasing altitude. These natural radioisotopes apparently attach themselves to the dust particles and the condensation nuclei ever present in the atmosphere, and hence are collected on the Type V-5 Chemical Warfare filter paper. Both chemical studies and decay data proved that this activity resulted from the collection of radium B and its radioactive daughter radium C and thorium B on the filter paper. This is shown in Figure 6, where the beta activity of a 30-50 minute half life is attributed to the radium series, while the beta activity with the 10-15 hour half life was identified as thorium B. Hence one must use care in interpreting gross decay data as fission product activity up to three days following collection.

> Figure 6 deleted by Dir Force

## IX. GHOSS DECAY

Way and Wigner have shown from theoretical considerations that the decay of gross fission products is given by the following equation:

$$A = \frac{k}{t^{1.2}}$$

where A is the gross beta activity in counts per minute at time t, and k is a constant. From this, it can be seen that the net beta counts per minute as a function of time should yield a straight line on log-log paper with a slope of 1.2. The gross decay of the filter papers as measured on thin-walled glass Geiger tubes was followed for 25,000 hours. These data are shown in Figure 7. The experimentally determined exponent in this case was 1.0 rather than 1.2. This procedure shows promise as a simple method of determining time of explosion, provided that reproducible and uniform thin-walled wrap-around Geiger tubes can be developed.

Figure 7 deleted by Air Force

### X. EVALUATION OF THE DATA

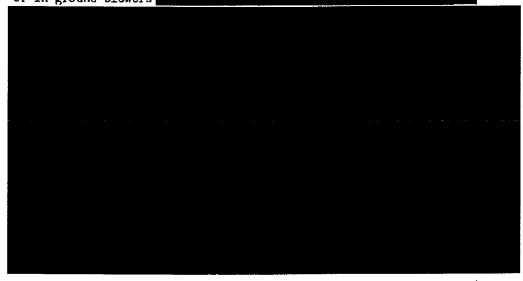
The radiochemical analyses carried out on Operation FITZWILLIAM demonstrated that irrevocable evidence of an atomic explosion can be obtained by means of atomic cloud interception through aerial filtration

The collection of gaseous samples demonstrated that insignificant quantities of the fission product radioactive xenon in the gaseous state are present in the atomic cloud.

It has been proved that the fission product activity is contained in particles which apparently result from the condensation of all material which is vaporized and which is presumably present within the fire ball.

The fission products are entrapped in these particles and thus, unlike natural activity, do not attach themselves to dust particles and condensation nuclei ever present in the atmosphere.

Type V-5 Chemical Warfare filter paper used either in aerial filters or in ground blowers



It is recommended that further research and development be carried out to quantitate the radiochemical procedures used, to investigate a more judicious selection of the fission products to be isolated, to investigate in detail the chemical and physical properties of the particulate nature of the atomic bomb debris, to develop a more satisfactory filter paper, to develop a more efficient means of aerial filtration, and to develop instrumentation which is specifically designed to assay extremely low levels of activity; this program to be

Page 14 deleted by Air Force.

## XI. PARTICIPATING PERSONNEL

## Tracerlab, Inc.

- F. C. Henriques, Jr. Project Director
- W. C. Peacock Field Director
- D. W. Atchley Field Director (Temporary)
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Dr. Frank McKenna

Dr. Clayton S. Wynn

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REPORT I

SEPTEMBER, 1948

## REPORT OF FIELD PHASE OF RADIOCHEMICAL ANALYSIS OF FILTERS

Department of the Air Force Contract No. W28-099 ac-405 with TRACERLAB, INC., 55 Oliver St., Boston, Mass., for Research and Analysis of Radioactive Samples

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FINAL REPORT FITZWILLIAM

Headquarters United States Air Force Deputy Chief of Staff, Operations Assistant for Atomic Energy

F. C. Henriques, Jr.

Contractor's Representative

L. R. Zumwalt

In Charge of Preparation of Report

W. C. Peacock, J. W. Jones, L. Burris, Jr. E. H. Turk, W. Karp, J. G. Whitney and A. DeHaan, Jr. Assisting in Preparation of Report

X- 2:-



REPORT I

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## REPORT I CONTRACT W28-099 ac-407

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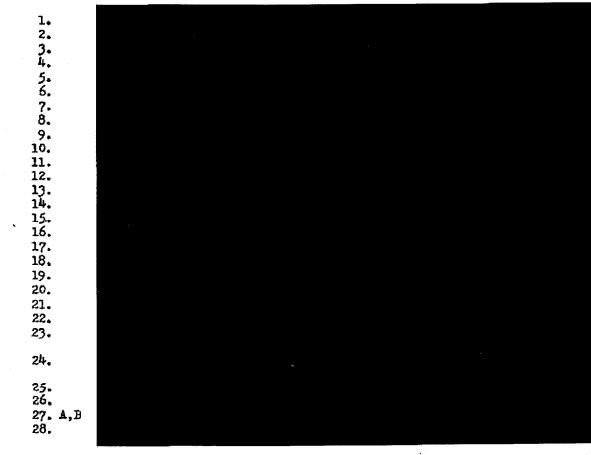
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|--------------------------------------|---|
| 29. A.B<br>30. A.B<br>31. A.B<br>32. | Absorption Curve, Sample K-0128-8, Kwajalein<br>Absorption Curve, Sample K-0497-8A, Test Y, Kwajalein<br>Absorption Curve, Sample K-0735-8B, Test Z, Kwajalein<br>Decay Curve for Sample K-0808-4 |
| 33.<br>34.<br>35.<br>36.             | Decay Curve for Sample HK-0808-C<br>Decay Curve for Sample HK-0284-7  |
| 37.<br>38.<br>39.                    | Decay Curve for Sample HK-0284-5  |
| 40.                                  | Decay Curve for Sample K-0735. Small Portion of Filter Paper, Using Thin End Window Counter   |
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| . 43.<br>144.                        | Decay Curve for Sample K-0808, Gross Leach Aliquot and Ash<br>Tracerlab E-8 Filtration Apparatus  |
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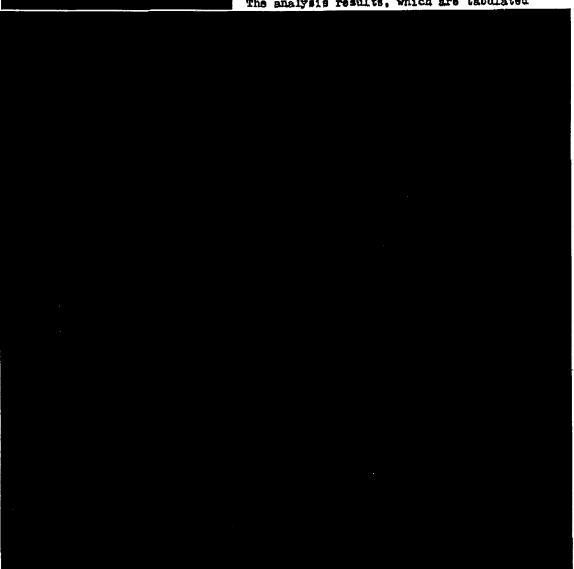
## 1.0 ABSTRACT

In connection with Project Fitzwilliam carried out during the Sandstone tests, radiochemical analyses were made of air-borne activities collected on filter papers and gaseous radioactivities present in air eamples. The filter analyses were made at three field stations: Rickam Field, T. H.; Kwajalein, M. I.; and Northfield, Guam. The analysis of air samples was carried out at the Boston Laboratories of Tracerlab, Inc.

The methods of analysis which were developed for this work are given.

and their limitations noted. Analyses were carried out for

The analysis results, which are tabulated



A set of recommendations are included which should be useful if radiochemical analysis operations are to be conducted in the field for other atombomb tests.

## 2.0 INTRODUCTION

In connection with Project Fitzwilliam, Tracerlab, Inc., was requested by Headquarters of U. S. Air Force, AFMSW-1 to conduct the radiochemical analysis of filter papers on which radioactivities have been collected and also to analyze gas samples for radioactive content. In accordance with the plan of Project Fitzwilliam,

Since the decision for carrying out the project was made rather late (Tracerlab was informed of the program only about six weeks ahead of the time necessary for the establishment of field laboratories and actually contracted for the work about two weeks later), this undertaking was a "crash" program. Only a very short time was available for preparation, and therefore, the work was to provide for only a preliminary exploration of the possibilities of detecting fission-product activities collected

It was realized at the outset that there would be considerable difficulty in securing the necessary personnel for participating in the project and in preparing for the work.

It was also realized that without preparatory research and previous experience in the collection and analysis of air-borne fission activities, it would not be possible to achieve the ultimate in sensitivity or precision. Hevertheless, it was expected that semi-quantitative results would be obtained which would be useful, and accordingly, the analysis project was to be undertaken. This work was done under contracts W28-099 ac-405 and W28-099 ac-407, negotiated by Watson Laboratories and administered by the Air Material Command of the United States Air Force. The work undertaken by Tracerlab was given the code name

The work which this report covers is limited with one exception (tabulation of results of "ground filter" analysis) to that carried out in accordance with Item 1 of Contract W28-099 ac-105. This item is entitled. "Research and Services Required to Analyze Radioisotope Materials in the Field." The provisions of Item 1 are given in full in Section 6.1. In brief, Item 1 required that the contractor man and equip four analysis stations at locations designated by the Readquarters of the USAF. Three of these stations were located outside of the continental United States and one within the continental United States. In the way of analysis, it was required that the total, "primary," beta and gamma activity of filter-paper samples be measured, and furthermore that those samples exhibiting redicactivity would be analyzed by the use of simple absorber foil techniques, and, if possible, by a rough chemical separation of the basic radiochemical groups. Alpha-activity analyses were required if alpha activity existed in the samples in sufficient quantity, but the carrying out of alpha

analysis was left to the discretion of the contractor. Also analyses of gas samples were required, if such samples were made available.

In carrying out the provisions of the contract, three field stations were set up: one at Northfield, Guam; one at Kwajalein, Marshall Islands; and one at Hickam Field, Territory of Hawaii. These stations were equipped to do the radiochemical analysis of filter papers on which air-borne activities were collected. Each station was manned by four to six technically trained civilians. The staff of the stations were augmented by officers and enlisted personnel, who assisted in the work. The station for conducting gas analysis was set up in Boston, Massachusetts, at the Tracerlab laboratory.

In carrying out the analyses at the field stations, the total activity of all papers received was determined.

The next section gives a complete discussion of the radiochemical analysis of the filter papers as carried out in the field, together with conclusions which can be drawn from this work. The section following this gives a discussion of the methods used and the results obtained in the gas-analysis work. Next, recommendations for future work are given which are based on experience gained in the field work. The final section is the Appendix. Wherever possible, in the course of the development of the text, detailed information, data. procedures, and calculations are entered in the Appendix.

## 3.0 RADIOCHEMICAL ANALYSIS OF FILTER PAPERS

## 3.1 Development and Application of Procedures for Analysis of Air-Borns Fission Activities

Several conditions had to be satisfied in order that radiochemical analyses for air-borne fission activities could be made. Firstly, it was necessary to collect enough activity from the air to permit reliable activity measurements, and secondly, it was necessary to remove the activity from the collector in an efficient and reproducible manner before further concentrating it for radiochemical analysis. Thirdly, it was necessary to develop and apply satisfactory methods of radiochemical analysis, and finally, it was desirable to check on the radiochemical purity of fractions asparated in the analysis.

## 3.11 Collection of Activity

For the collection of the activity, a special 8- x 18-inch filter paper (Chemical Corpe Type V-5) was used. The V-5 filter paper was not tested previously for filtering out fission activities in the air but was considered the best paper immediately available for the project. It is understood that the paper was designed by the Chemical Corps to be about 99 per cent effective in filtering out particles

when a pressure differential of one inch of water existed across the paper (Ref. 5). However, under the conditions of collection in Project Fitswilliam, a much larger pressure differential than one inch of water existed across the paper, and it is very probable that the effectiveness of the filter paper in stopping small particles was considerably decreased. This decrease in efficiency may have some bearing on the possible fractionation of activities and will be discussed more fully later. The paper is composed of asbestos and cellulose fibers, and these are supported by a cotton mesh backing. The asbestos is used because its fibers are among the finest known. A complete chemical analysis of the filter paper made by the Chemical Corps is given in Section 6.2.

The data as to the collection details and time of collection of all filter papers to be mentioned in this report are given in Section 6.91 entitled Filter Paper Code Data.

The papers obtained by Ewajalein-based planes or at the Ewajalein ground station were completely sheathed in brown wrapping paper after collection in order to prevent contamination of personnel and equipment, since many of the papers were highly radicactive and some of the radicactivity tended to come off the paper. Papers obtained at other locations were left uncovered. After exposure, each filter paper was counted by wrapping it around a sensitive, self-quenching Geiger-Muller tube (19 inches in length, 2 inches in diameter, with thin glass walls, Ca. 50 mg/cm<sup>2</sup>, and manufactured by the Radiation Counter Laboratory of Chicago, Ill.). The tube was housed in a massive lead cylinder (walls 2 inches thick) to reduce counts caused by adjacent samples and radiation. The counts were recorded by a scale-of-64 counter, Model LS-64, manufactured by the El-Tropics Co., Inc., of Philadelphia, Pa.

Activity was collected from the air by an air sampling device which was placed on the underside of B-29 aircraft at the position of the rear belly turret. The sampling device held two papers, on each of which was collected about the same amount of activity. Generally, these papers were changed every hour during a reconnaissance flight.

Activity was also collected from the air at several ground level stations by use of the Air Material Command electrically-powered blower unit, which accommodated a single filter paper.

ance with Contract W28-099 ac-407, the work on the analysis of the filter paper obtained using ground-located collecting units is reported separately (Ref. 6). However, for comparison purposes the analysis results obtained with these papers are also tabulated in this report.

To accomplish this, the selected paper was cut in two along the short axis, and one of the halves was subjected to a leaching process to recover activity from the paper in order to carry out the analysis. The other half was saved for possible alpha analysis to be done at a later date at Tracerlab in Boston. The other paper was placed in reserve in case a recheck of the field analysis was necessary.

It was observed by scanning the papers with a G-M tube probe of an SU-3 Tracerlab Laboratory Monitor that the deposition of activity on the paper was not uniform, and consequently, there was no assurance that the activity was exactly halved when the paper was halved. When two halves of a paper were separately counted, it was found that the net counting rates would occasionally differ from one another by as much as 40 per cent.

## 3.12 Analytical Procedure and Techniques

<sup>-</sup> Background is the counting rate observed with no source of activity in the counting position. Background is subtracted from the total counting rate to obtain the net counting rate.

In the limited time available, it was not practical to train personnel in more than this small number of analyses, nor was there sufficient activity collected on many of the filter navers to permit analysis for a large number of fission activities.

A tentative analytical procedure was developed in Boston, based mainly on radiochemical methods

(Ref. 1). During the course of the tests, the tentative procedure developed in Boston was slightly modified as the need for certain changes became apparent. A detailed write-up of these procedure changes and the reasons for making them is given in Section 6.3.

It should be made clear that in these procedures the determination of a per cent of activity of a particular radioelement is not quantitative since the technique of weighing the carrier precipitate of a given element to determine percentage recovery was not employed, and also certain limitations are imposed by the counting techniques (see Sub-section 6.43). However, quantitative procedures are not necessary to prove the presence of active fission elements, which was the primary objective of the work. Every effort was made to obtain reproducible results by using care and consistency in following the analytical methods and techniques.

The filter paper was leached with hot, dilute (1 N) hydrochloric or nitric acid in Test X, but the leach was changed to a nixture of hot concentrated nitric and hydrochloric acids (1 volume of concentrated nitric and two volumes of concentrated hydrochloric) in Tests Y and Z. Five milligrams

were added to the leach solution to promote consistent leaching. The filter paper, which was thoroughly disintegrated by the leaching treatment, was filtered off and transferred to a crucible where it was asked over a Meeker burner. The ask was transferred to a glass crystallizing dish and counted to determine the amount of unleached activity.

By AirForce.

The filtered leach solution was evaporated to a known convenient volume (generally 25 ml.) and the gross beta activity determined -taking a known portion (generally 1 or 2 ml. out of the 25), evaporating to dryness in a glass crystallizing dish, and counting.

The individual fission products were purified from contaminating activities and isolated in the following manner. In Tests Y and Z, three fractions of the leach solution of known size were taken, one for

One- and two- fraction procedures, the details of which are given in Sub-section 6.32, were tried in Test X, but the three-fraction procedure is deemed the best and forms the basis for the following discussion. The fractions were not necessarily equal in size. since they were chosen to yield an adequate activity of the radioslement being analyzed for, whenever possible.

In making the analysis. This procedure is

presented in block form on the following page, and additional details are given in Sub-section 6.35.

During Test Z at Kwajalein, a radiochemical analysis of some of A separate the more active filter papers was made and aliquot was taken of the leach solution.

and

mounted and counted. Details of the procedure are given in Sud-section 6.34.

All precipitates were filtered on 1-inch Whatman #42 filter paper. The precipitate was either air-dried or dried with ether, and the precipitate together with the filter paper was mounted for counting on brass planchets during Test X and on simple rectangular cards of 1/16-inch cardboard during Tests Y and Z. The precipitates were uncovered in Test X, but in Tests I and Z were covered with cellophane, 3.4 mg/cm2, to avoid precipitate loss. Samcles were counted using the following Tracerlab equipment: the TGC-2 thin mica window Geiger tube housed in the SC-9A Shielded Manual Sample Changer

## ANALYTICAL PROCEDURE

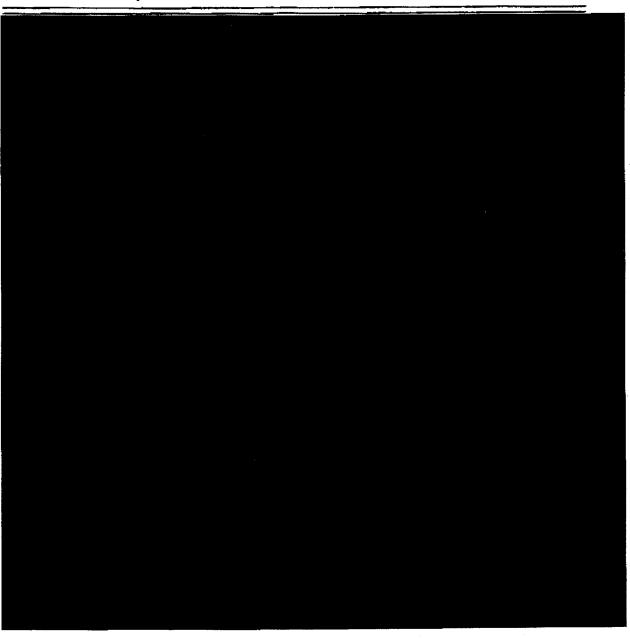
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## TEST Z

Basis: One-half filter paper

Leach filter paper for 20 minutes at the boiling point with mixture composed of 30 ml of concentrated HNO, and 60 ml of concentrated HCl and containing 5 mg each of

adjust volume of leach to 25 ml (or convenient known volume) and take aliquot for gross leach activity. Divide the remainder into three fractions.



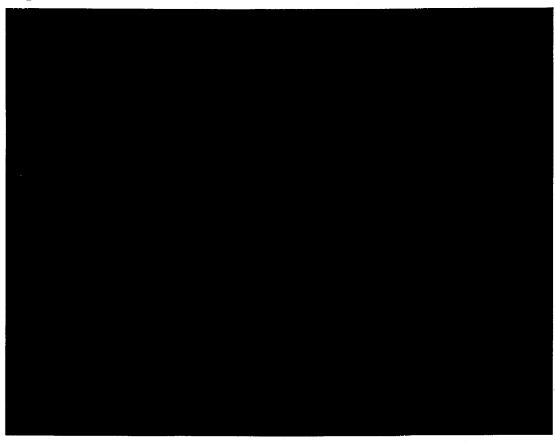
with Preamplifier which was connected to either an SC-IA Autoscaler or an SC-2 \*64\* Scaler. In some cases in the taking of absorption and decay data, the SC-6 Automatic Sample Changer was used. The total counting rate of a sample was corrected for background and coincidence loss but was not corrected for self-absorption, absorption by the cellophane, self-scattering, or backscattering.\* Consistency was observed in the counting techniques so that the magnitude of the scattering and absorption corrections would remain

constant. The details of the mounting and counting techniques are given in

## 3.13 Absorption and Decay Data

Section 6.4.

In order to study the characteristics of radiation from separated and unseparated fission activities and to verify the radiochemical purity of the fractions separated, absorption and decay data were obtained. The absorption data were taken and analyzed in accordance with the method developed by Feather (Ref. 2).



## 3.2 Results of Bedjochemical Analysis

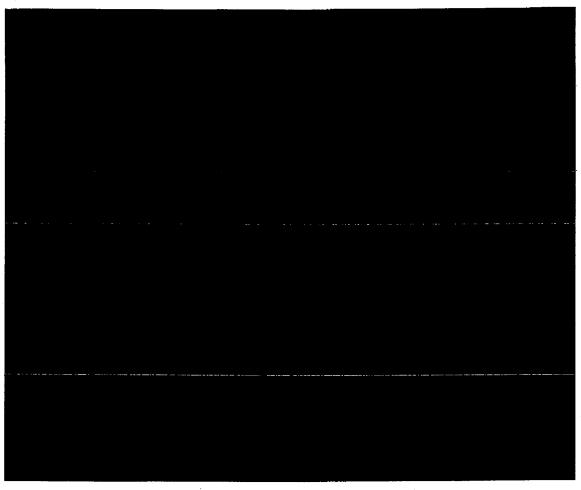
## 3.21 Analytical Results

3.211 General

A breakdown of samples by laboratory and test is presented in Table 1. The results of all radio-chemical analyses performed prior to June 1, 1948, is given in Section 6.5. The data include ground stations and air-filter papers. The tabulation is complete for artificial activities, and no elimination of doubtful values has been made.

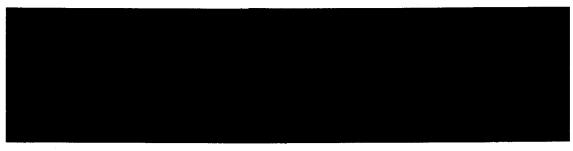
3.212

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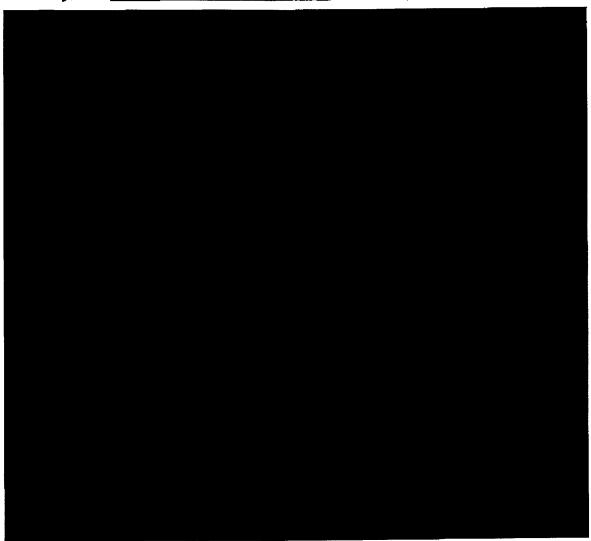


## 3.213 Reproducibility of Radiochemical Analyses

At Kwajalein during Test Z, multiplicate analyses were made of aliquots of several leach solutions to find out the reproducibility and precision of the analysis for a given fraction. Tables 2, 3, 4, and 5 summarize these analyses.



Pages 25 through 36 with Figures 12 through 19 and Tables 2 through 5 are deleted by Air Tarce.



3.215 Use of Radiochemical Analysis to Distinguish Fission Products from Natural Activities



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TABLE 6
NATURAL ACTIVITY PAPERS

| Filter Paper No. | Wrap-Around<br>Net C/M at<br>Hickam | Fraction     |       |       |       |   |
|------------------|-------------------------------------|--------------|-------|-------|-------|---|
| STATEL PAPER NA. |                                     | 4,6          | 5     | 7     | 8     |   |
| <b>F-0040</b>    | 148                                 |              | P     |       | March | Ā |
| F-0037           | 488                                 |              |       | -     | ***   | A |
| F-0036           | 542                                 |              | war-4 | 44 to |       | A |
| <b>F-0</b> 034   | 512                                 | way san pala |       | 7     |       | A |
| F-0035           | 751                                 | Ŧ            | P     | A     | A     |   |

 $P = \beta$  activity present

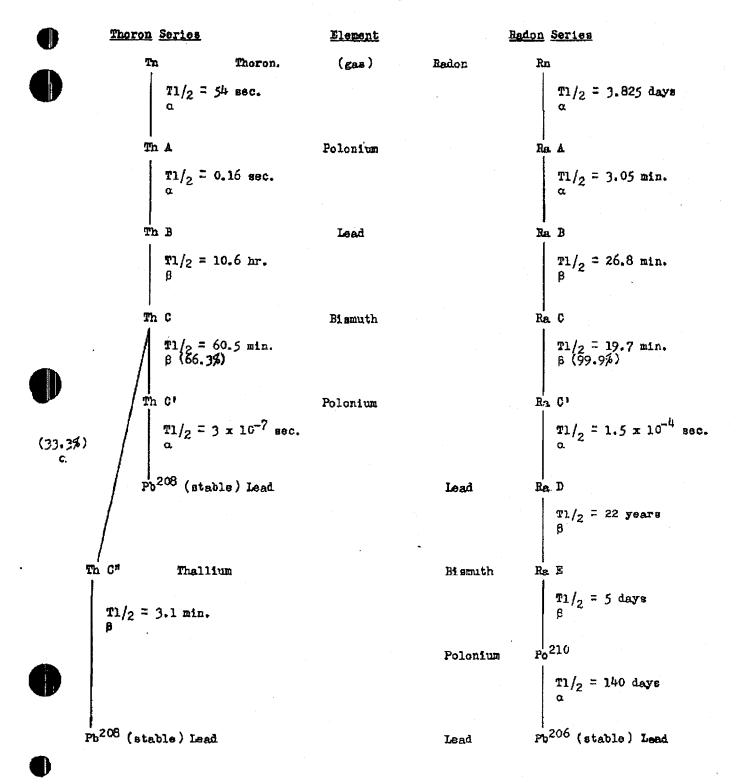
 $A = \beta$  activity absent

T = Trace of beta activity (10 c/m)

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TABLE 7

DECAY OF NATURAL ACTIVITIES



#### 3.22 Absorption Results

#### 3.221 Introduction

Beta-radiation absorption measurements of the separated fractions were made to prove that the desired radioelement had been isolated and to establish whether or not impurities were present. It was also of interest to determine which isotopes of a given radioelement were present, and in what ratio these isotopes were present.

The general method of determining the energies of the beta radiations from a sample is to determine quantitatively the extent to which these radiations are able to penetrate matter. The measurements were made by interposing between the sample and the G-M tube window aluminum absorbers of increasing thickness and taking a count after each new interposition of the absorber. A semi-logarithmic plot of net counts per minute versus absorber thickness was then constructed, and analyzed by the method developed by Feather (Ref. 2) to determine the maximum ranges of the beta radiations present. The Feather method is based on the assumption that the absorption curves of simple beta emitters (or of the individual components of complex emitters) are of about the same shape when the logarithm of counting rate is plotted against fraction of range. To carry out the analysis, an analyzer is prepared, using a standard beta emitter of known range. This is placed on the logarithmic scale, and the marks on the analyzer give the logarithm of the counting rate, which corresponds to the thickness of aluminum absorber equivalent to 0, 0.1, 0.2, 0.3, 0.4, etc., of the total range (tenthranges) of any given beta particle. UX2 was used as the standard beta emitter in preparing Feather analyzers for this work.

If several radiations are present, a complex absorption curve is obtained, which may be considered the sum of the curves which are the absorption curves of the separate radiations. In practice, a complex curve may be broken down into its separate components, provided the beta components are sufficiently different in energy (at least by a factor of 2), and provided that no more than two or three components are present. The process of breaking down an absorption curve is first to subtract the gamme background, if any, and then subtract the beta components, one by one, starting with the most energetic and working toward the weakest component. The result is to obtain a set of component absorption curves which when added together duplicate the original complex.

The counting rates shown by the several curves at zero absorber are approximately proportional to the activity of the components and from these counting rates, the proportions of the component isotopes in a sample can be evaluated. The range of each beta component is determined by the usual Feather analyzer technique.

After a determination of the range, the energy of each beta radiation component can be determined from a range-energy plot (see Fig. 21).

Page 43 with Figure 21 deleted by Air Force Representative absorption curves for each of the separated fractions and for each of the mixed-activity fractions are presented. Feather ranges were determined at one-tenth values of the range of each beta component and are given on the absorption graphs. The energies of the component radiations were then determined and compared with the literature values of the energies of the various isotopes of the isolated radioelement (Ref. 3).

#### 3.222 Mixed-Activity Fractions

Absorption measurements of each of the mixed-activity fractions (ash, leach aliquot, the second the radiation characteristic of each of these fractions. The beta-absorption curves for the fractions (Figs. 22, 23, and 24) are very similar in shape, and each shows a gamma background of approximately 0.4 per cent of the total beta radiation. Although known to be composed of a number of fission-product isotopes, each absorption curve yielded to an absorption analysis and exhibits two predominant beta components of 1.35 to 1.7 Mev and ca. 0.4 Mev in energy.

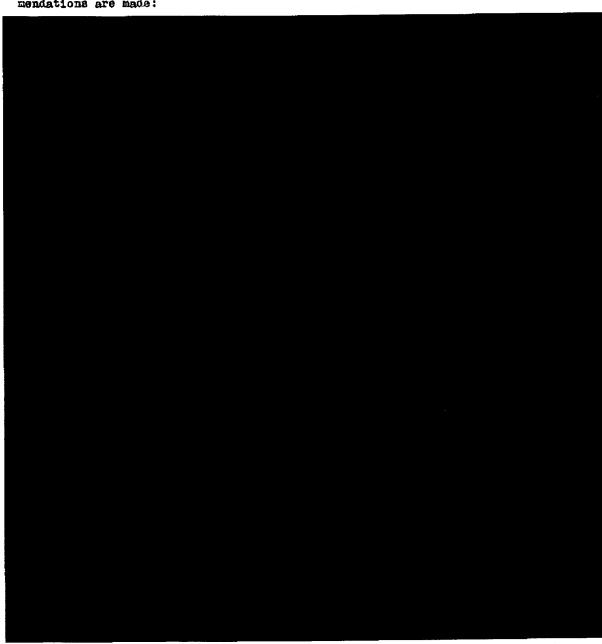
The fact that psuedo-beta components were obtained from a mixture of activities is evidence that an absorption analysis alone does not provide conclusive identification of the presence of a particular isotope. Hovever, the identification of a given isotope of an element becomes more conclusive if the chemistry for separating the element is known to yield the slement in a high degree of purity, and becomes practically positive if both the half-life and the energy of the beta radiation as obtained from decay and absorption analyses for the isotope of the separated element agree with the reported values for this isotope. Since the methods used in the field were not designed for high decontamination of an isolated element, the absorption analyses of the isolated redicelements provide evidence that suspected isctopes of the isolated radioelements are present, but this evidence must be supported by a decay analysis before identification of an isotope is certain. In interpreting the results of absorption measurements of an isolated radioelement, an experimentally determined energy value for a component of the beta radiation which is within 20 per cent of the beta energy reported in the literature is considered a reasonable identification.

3.223

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### 5.0 RECOMMENDATIONS

If in the event of other atom-bomb tests, it should prove desirable to conduct radiochemical analysis operations in the field, the following recommendations are made:

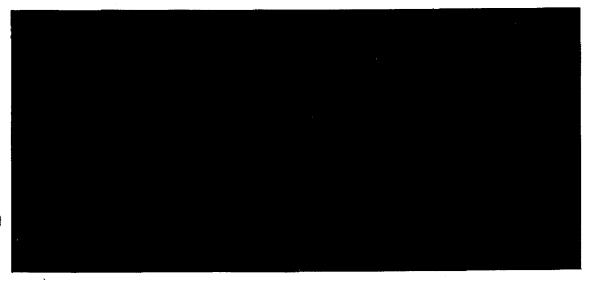


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## 6.0 APPENDIX

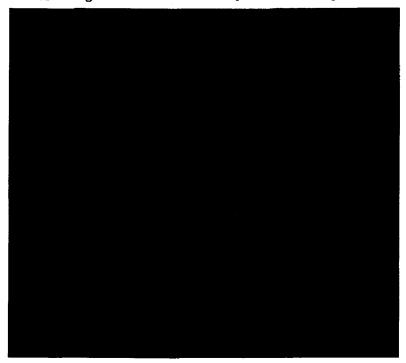
# 6.1 Extract from Contract W28-099 ac-405

Item I: Research and Services Required to Analyze Radioactive Isotope Samples in the Field



#### 6.2 Chemical Analysis of Type V-5 Filter Paper

Following is the chemical analysis of the Type V-5 filter paper\*:



<sup>\* -</sup> Private Communication, letter from Colonel H. W. Ehrgott, USAF Executive AFNSW-1, Special Weapons Group, to Dr. F. C. Henriques, Jr., Tracerlab, Inc., Boston

#### 6.3 Detailed Analytical Procedures

#### 6.31 Introduction

The analytical procedures as used in the various tests are presented in detail in this section. The difficulties encountered with a procedure and the results of deviations made from the procedures are discussed after the presentation of the procedures.

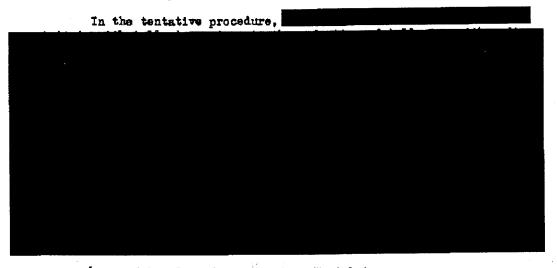
#### 6.32 Procedure Developed in Boston

The tentative analytical procedure shown in block form in Table 17 was developed in Boston during the week that was available there for devising an analytical scheme. It was based mainly upon findings from a literature survey.

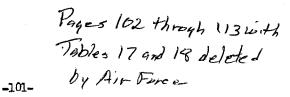
#### 6.33 Tust I Procedure

1

Before Test I it was realized that the above procedure had several faults. The modified procedure which was used is given in Table 18.



6.331 Other Procedures Tried at Kwajalein



#### 6.4 Details of Mounting and Counting Techniques

#### 6.41 General

During the tests enlisted military personnel were trained in the operation of the counters and in Tests Y and Z handled all or part of the decay and absorption measurements at the several field stations. They were also trained in slide rule operation for calculating counting rates and were instructed in making the necessary background and coincidence corrections of the counting ratio. A few helped plot decay and absorption curves.

#### 6.42 Methods of Mounting and Counting

All precipitates were deposited and dried on 1-inch circles of Whatman #42 filter paper (see Fig. 44 for description of filtration apparatus). In Test I the filter papers with the precipitates were mounted on Tracerlab E-7 brass planchets and secured in place by close-fitting brass sleeves which fastened down the protruding filter-paper edges. The planchet with filter paper and sleeve is illustrated in Fig. 45. Because the precipitates were flaky in nature and were not covered, occasional loss of some precipitate from the planchet occurred. This loss of precipitate could not be tolerated because of the serious errors introduced in decay measurements.

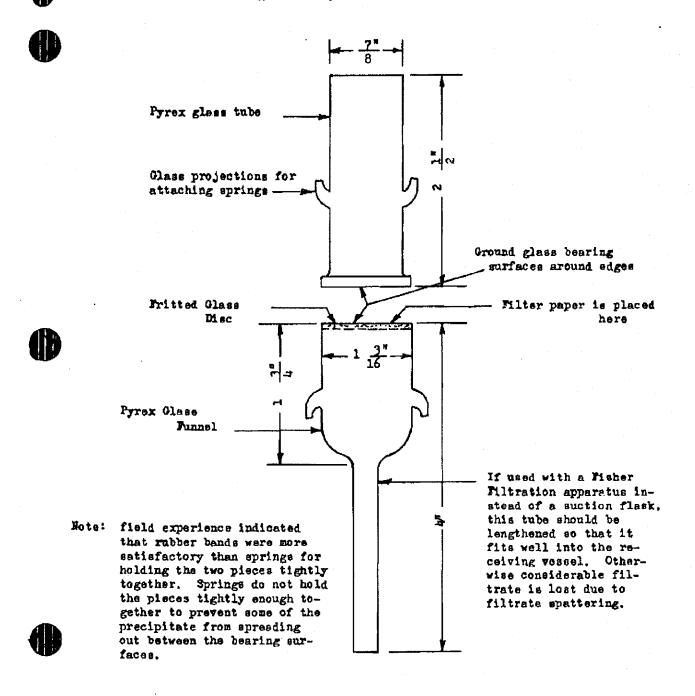
Because of this drawback in the use of planchets, the precipitates obtained during Tests I and Z were mounted on flat pieces of 1/16 inch cardboard and were covered with cellophane. The card used at Guam and Kwajalein was 1 15/16 inches x 4 1/2 inches and was placed on top of the sample slide for insertion into the sample changer. The card used at Hickam was 2 2/32 inches in width and approximately 5 inches in length. To use this card, it is necessary to remove the metal sample slide and to fit the card into the sample-slide grooves for insertion into the changer. The latter-type card is the more satisfactory one because it is held more rigidly in place in the counter. Another advantage of the cards is that, being flat, they are very easily filed. Sketches of the cards are given in Fig. 46.

The samples were glued in place on the cards and then covered with cellophane, 3.4 mg/cm<sup>2</sup> in weight, which was fastened to the card with glue or scotch tape. It is probably not necessary to glue the papers in place if the cellophane is stretched tightly enough to prevent movement of the paper. In fact, it has been discovered advantageous not to glue the papers in place because then they can be easily removed should the need to do so arise.

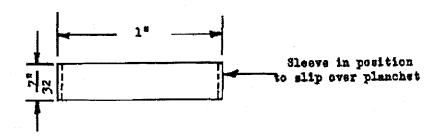
The leach-solution aliquots were evaporated to dryness in glass crystallizing dishes, I inch in diameter and 5/16 inch in height, and were counted directly in the dish. The filter-paper ash was also transferred to a glass crystallizing dish for counting.

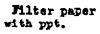
Fig. 44

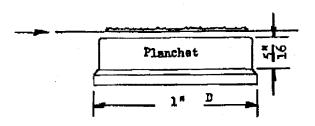
#### TRACERIAB & 8 FILTRATION APPARATUS



#### PLANCHET ASSEMBLY

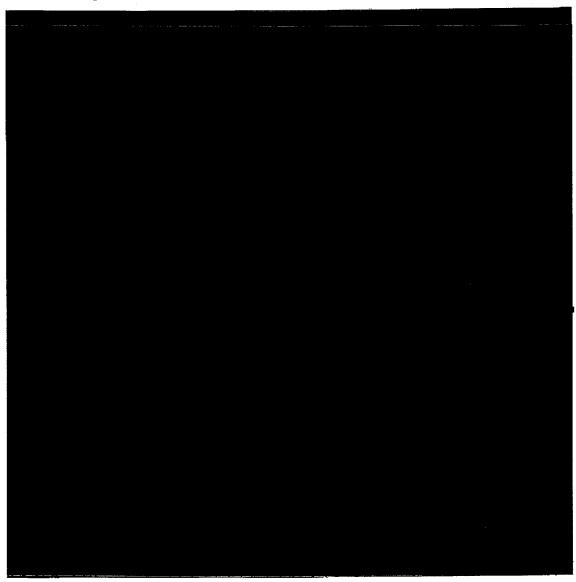






#### 6.5 Tabulation of Analytical Results

Tabulated below are the results of all filter-paper analyses completed prior to June 1, 1948. The data are segregated by test and station. The tabulation is complete, and no elimination of doubtful values has been made.



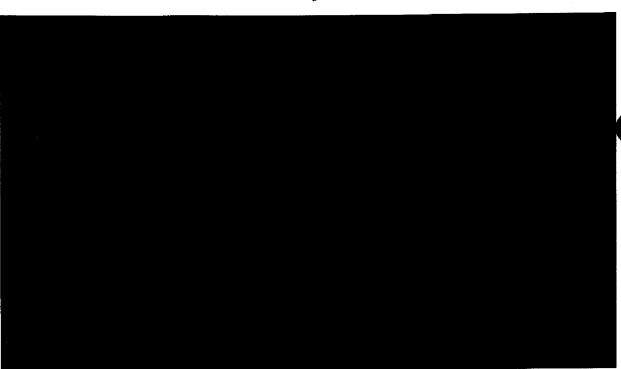
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#### 6.9 Sample Code Data

#### 6.91 Filter Papers

In the following table data are presented for each of the filter papers mentioned in this report. The filter papers are arranged numerically in alphabetical order using the one- or two-letter station code as enumerated on page 138 of this report. For each filter the following information is presented: the test which caused the activity on the filter paper, the time at the beginning of the exposure of the paper, the altitude at which the activity was picked up, the geographical position at the beginning and at the end of the exposure, and the net counts per minute as first measured. "T. H." in the Net C/M column indicates that the filter paper was too radioactive to be counted.

TABLE 31



Page 171 though 181 with remainder of Table 31 deleted by Air Force

#### 6.92 Tank Samples

The detailed collection data for all gaseous tank samples are presented below in Table 32. These samples were collected at various locations over the Pacific. In the case of the samples numbered "514-," only average values for the altitude, location, and time-of-sampling period were received. However, with the others more specific data were available.

Samples numbered 308-A1, 308-A2, etc., indicate flights originating from Fairfield-Suisun, while those numbered 308-1, 308-2, etc., indicate flights originating from Barber Point, Rawaiian Islands.





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#### 6.93 Air Reduction Samoles

The detailed collection data on all samples received from the Air Raduction Company, Emeryville, California, are presented below in Table 33.

TABLE 33
AIR DEDUCTION SAMPLE CODE DATA

| Semola No. | Time and Date          | Processed Volume (Cu. It.) | Semple Volume<br>(CC)<br>at 22°C and 1 atm. |
|------------|------------------------|----------------------------|---|
| 1          | 0405402 to 0416302 May | 3,300                      | 3   |
| 2          | 0521002 to 0514302 May | 5,300                      | 23  |
| 3          | 051845% to 061700% Hay | 6,800                      | 36  |
| 4•         | 062055% to 071630% May | 6,000                      | 150   |
| 44         | Sample tube empty      | mon receival               |   |
| 5*         | 072000% to 081830% May | 6,900                      | 105   |
| 6          | Not receive            | rad                        |   |
| 7-         | 092130Z to 101630Z May | 5,800                      | 130   |
| 8*         | 102015Z to 111630Z May | 6,200                      | 105   |
| 9          | 112035Z to 121635Z May | 6,100                      | 130   |
| 10*        | 122040Z to 131620Z May | 6.000                      | 116   |
| 11*        | 132015Z to 141615Z May | 6,100                      | 145   |
| 12*        | 142010Z to 151610Z May | 6,550                      | 140   |
| 13*        | 1519452 to 161545Z Hey | 6,900                      | 135   |
| 14*        | 1619252 to 171625Z May | 7.300                      | 35  |
|            |                        |                            |   |

<sup>\* -</sup> Samples processed in Boston

TABLE 33 (Cont.)

AIR REDUCTION SAMPLE CODE DATA

| Sample Mo. | Time and Date           | Processed Volume (Ou. Ft.) | Sample Volume<br>(OC)<br>at 22°G and 1 Atm. |
|------------|-------------------------|----------------------------|---|
| 15*        | 172000Z to 181600Z Hay  | 6,150                      | 26  |
| 16*        | 181940Z to 191540Z May  | 6,100                      | 30  |
| 17•        | 192020Z to 201620Z Kay  | 6,200                      | . 30  |
| 18•        | 202040Z to 211640Z May  | 6,000                      | 36  |
| 19 •       | 212030% to 221630% May  | 6,200                      | 32  |
| 20*        | 222030Z to 231600Z May  | 6,023                      | 18.5  |
| 21*        | 2319552 to 2415552 New  | 6,200                      | 96.9  |
| 22*        | 242045% to 251645% May  | 6,100                      | 100   |
| 23*        | 252010% to 261610% May  | 6,200                      | 100   |
| 24+        | 262010Z to 271610Z May  | 6,150                      | 124   |
| 25*        | 272010Z to 281610Z May  | 6,150                      | 125   |
| 26 ▼       | 2820302 to 2916302 May  | 6,000                      | 127   |
| 27*        | 292015% to 301615% May  | 6,100                      | 135   |
| 28*        | 011800Z to 021600Z Juns | 6.450                      | 136.2                                       |
| 29*        | 022010Z to 031610Z June | 6.150                      | 134   |
| 30•        | 032010Z to 041610Z June | 6,100                      | 72.8  |
| 31*        | 042004Z to 051604Z June | 6,000                      | 72.8  |
| 32*        | 0519302 to 0616002 June | 6,155                      | 92  |

<sup>• -</sup> Samples processed in Boston

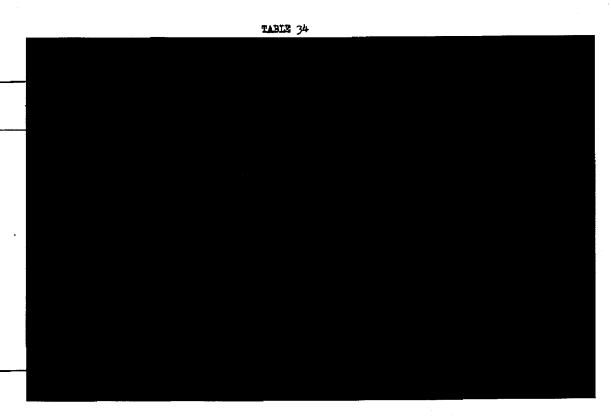
TABLE 33 (Cont.)

| Samle No.    | Time and Date           | Processed Volume<br>(Cu. Ft.) | Sample Volume<br>(CC)<br>at 22°C and 1 Atm. |
|--------------|-------------------------|-------------------------------|---|
| 33           | Broken in tr            | ensit                         |   |
| 34.          | 072015Z to 081515Z June | 5.800                         | 84.2  |
| 35◆          | 082110Z to 091510Z June | 5.450                         | 76.4  |
| 36*          | 091930Z to 101530Z June | 6,100                         | 109.7                                       |
| 37           | Broken in tr            | ansit                         |   |
| 38•          | 1120202 to 1215202 June | 5,800                         | 67.6  |
| 39*          | 121930Z to 131630Z June | 6,500                         | 6.8   |
| 40+          | 131930Z to 141530Z June | 6,100                         | 120,4                                       |
| <b>47.</b> * | 142020Z to 151520Z June | 5,800                         | 88  |

<sup>\* -</sup> Samples processed in Boston

#### 6.94 Accumulator Samules

Six samples were received from West Coast locations collected in "accumulators" constructed by Cleveland Wire Works, Euclid, Ohio. The detailed collection data for these are presented in Table 34.



#### 7.0 PERSONNEL OF FIELD LABORATORIES

In the following a listing is given by field laboratory of Tracerlab and Air Force personnel who directly contributed to the technical work done in connection with Contract W28-099 ac-405, Field Phase, under direction of Dr. F. C. Henriques, Jr., Tracerlab Technical Director.

#### HICKAM LABORATORY

#### Tracerlab Personnel

Dr. W. C. Peacock, Technical Direction of Field Operations

Mr. J. W. Jones, In charge of laboratory

Mr. J. W. Gryder, chemist

Mr. O. F. Noss, Jr., chemist

Miss J. G. Whitney, statistician

Miss T. J. Colson, secretary

#### Air Force Personnel

Capt. C. E. Davis

Lt. W. E. Petigo

S/Sgt. E. A. Anderson

Sgt. Pilson

Sgt. Baker

Sgt. G. Adams

Sgt. Johnson

Sgt. Trapp

#### KWAJALEIN LABORATORY

#### Tracerlab Personnel

Dr. L. R. Zumwalt, Field Supervisor and in charge of laboratory

Mr. L. Burris, Jr., chemist

Mr. R. A. Brightsen, chemist

Kr. Y. Sakakura, chemist

Mr. D. F. Comstock, technician

Mr. A. Thomas, electronic engineer

Mrs. M. J. Barker, secretary



#### REPERENCES

(1)

- (2) Feather, N., PROC. CAMERIDGE PHIL. SOC. 34, 599 (1938); eee also Glendenin, L. E., NUCLEONICS 2, 12 (1948)
- (4) Way, R. and Wigner, E. P., PHYS. REV. 23, 1318 (1948)
- (5) Spence. R. W., Private Communication
- (6) REPORT III, Analysis Phase, Contract W28-099 ac-407 (Phase II CC-55)
- (7) Peacock, W. C., PHYS. REV. 72, 1049 (1947)

(8)

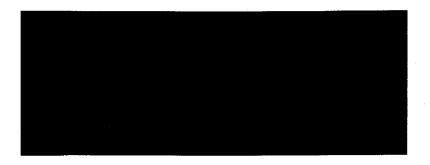
(9) Grummit, V. E. and Wilkinson, G., NATURE 161, 520 (1948)

(10)

- (11) Spence, R. W., Private Communication
- (12) REPORT II, Contract ¥28-099 ac-405
- (13) Cady and Cady, ANAL. ED., IND. AND ENG. CHEM. <u>17</u>, 760-6 (1945)
   Ibid <u>19</u>, 919 (1947)
   Damkohler, G. Z., EIECTROCHEM. <u>41</u>, 74-80 (1935)
   Moreau and Lepape, COMPT, REND. <u>183</u>, 171-5 (1926)
- (14) Kline, S. Allan, Notebook 259B Manhattan Project, Los Alamos Laboratory
- (15) Balcar, F. R. (Dr.), Research Laboratory, Air Reduction Company, Private Communication







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REPORT 11

OCTOBER, 1948

# REPORT ON ANALYSIS OF LONG HALF-LIFE CONSTITUENTS OF ACTIVITIES COLLECTED ON FILTERS

Department of the Air Force Contract No. W28-099 ac-405 with TRACEREAB, INC., 55 Oliver St., Boston, Mass., for Research and Analysis of Radioactive Samples

# TAB B, VOLUME IV

FINAL REPORT FITZWILLIAM

Headquarters United States Air Force Deputy Chief of Staff, Operations Assistant for Atomic Energy

F. C. Henriques, Jr.

Contractor's Representative

L. R. Zumwalt

In Charge of Preparation of Report

W. C. Peacock, J. W. Jones, J. W. Gryder and W. Karp Assisting in Preparation of Report



REPORT II

OCTOBER, 1948

# REPORT ON ANALYSIS OF LONG HALF-LIFE CONSTITUENTS OF ACTIVITIES COLLECTED ON FILTERS

Department of the Air Force Contract No. W28-099 ac-405 with TRACERLAB, INC., 55 Oliver St., Boston, Mass., for Research and Analysis of Radioactive Samples

F. C. Henriques, Jr.
Contractor's Representative

L. R. Zumwait
In Charge of Preparation of Report

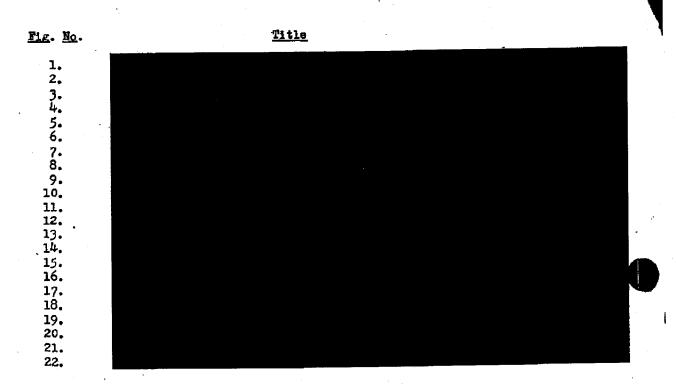
W. C. Peacock, J. W. Jones, J. W. Gryder and W. Karp

Assisting in Preparation of Report



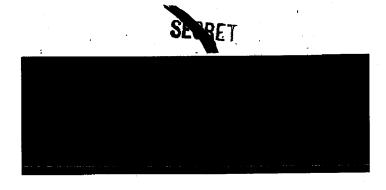
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| Ω                                |   |



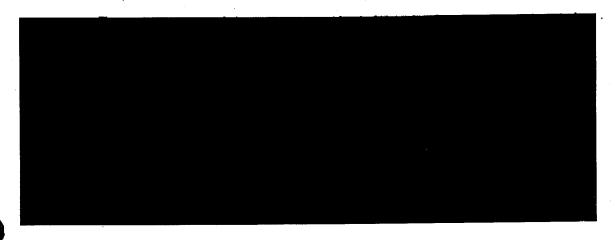
#### REPORT II CONTRACT W28-099 ac-405

#### 1.0 ABSTRACT

After the completion of the field phase of Project Fitzwilliam, part of Operation Sandstone, analysis of filter papers from ground blower and airburne collectors for fission-product activities was continued at Tracerlab laboratories at Hickam Field, T. H., and Boston, Massachusetts. This report covers work carried out during the period June 1, 1948, to September 1, 1948. (The field phase is covered in Report I of this contract.)

Decay studies of separated fractions obtained in the course of radiochemical analysis in the field were continued to obtain additional information about the radiochemical purity of these separated fission products. A discussion of these results and the impurities found is included.

A study was made of air-borne filter papers collected in flights out of Guam after June 1, 1948. It was found that these activities originated in the Sandstone tests and had remained on the surfaces of the aircraft used for these flights.



#### 2.0 INTRODUCTION

In accordance with Item 2 of Contract W28-099 ac-405, after the termination of the radiochemical analysis work carried out during the Sandstons Test, as a part of Project Fitzwilliam, analysis was made of long half-life constituents of activities collected on filters. Item 2 reads as follows:

\*At the termination of the field problem, or concurrently if feasible, those samples which exhibit outstanding activity in the field analysis will be returned to the Tracerlab laboratories in Boston for a more detailed radio-chemical analysis. In this analysis an attempt will be made to isolate and identify as many isotopes as possible by ordinary radiochemical means. If quantitative results on a percentage basis can be obtained without undue difficulty, it is desirable but not necessarily a mandatory requirement of the contract.

This report covers the work done under Item 2 of the contract and represents work done over the period June 1, 1948, to September 1, 1948.

As the project developed, it became evident that it would be desirable to conduct work on the analysis of long half-lived constituents in two locations instead of a single location. Accordingly, some of the work was carried on at the field laboratory at Hickam Field, T. H., which was continued in operation after termination of the field phase of the work. The remainder of the work was carried out at the Tracerlab laboratories in Boston. One reason for continuing the operation of the Hickam Field laboratory was the necessity of having a laboratory where analyses could be made of activities collected in the Pacific Ocean area after June 1, 1948 (the date of termination of the field work in connection with Project Fitzwilliam) under the interim net operation.

The decision that a continued surveillance of air-borne activities was desirable made it necessary to extend the analysis work done after the completion of the field phase. On the other hand, extensive detailed analysis of filter papers collected in the field was not necessary as originally contemplated since analyses of constituents on a percentage basis were obtained in the field. All active filters collected after June first were analyzed, together with a number of filters collected prior to this date.

Decay studies of separated fractions obtained in the course of radiochemical analysis in the field were continued for the purpose of obtaining additional information about the radiochemical purity of these separated fractions. Also, the decay measurements of the unseparated activity on filter papers collected during field operations were obtained.

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#### 3.0 CONTINUATION OF ANALYSIS OF FILTER PAPERS

#### 3.1 Methods and Limitations

#### 3.11 Fission-Product Analysis

In carrying out the analysis of filter papers after June 1, 1948, whether collected prior to the end of field operations or subsequent to this date, the analysis procedure as developed for Test Z was used. The development of this procedure, the details of the analysis, and methods of mounting and counting samples are given in full in Report I of this contract.

The tabular outline for the Test Z chemical procedure is given as follows (Table 1). It is to be noted, however, that after July first the procedure was modified slightly in

Another test of the analysis procedure was made where the as carried out in the procedure outlined above, was compared with the results obtained by using the classical method for the (Ref. 1).

The chief limitations of the analytical procedure are as follows:

a. The analyses as carried out were, strictly speaking, not quantitative since the technique of

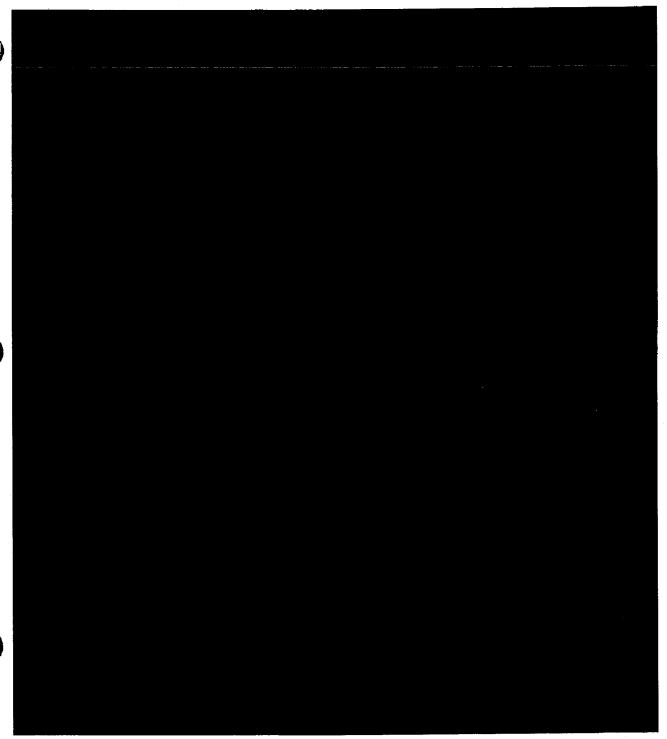
b.

c. Limitations are also imposed on the quantitativeness of these determinations by the counting techniques which were used, and this is discussed in full in Report I of Contract W28-099 ac-405.

# TABLE 1

# ANALYTICAL PROCEDURE

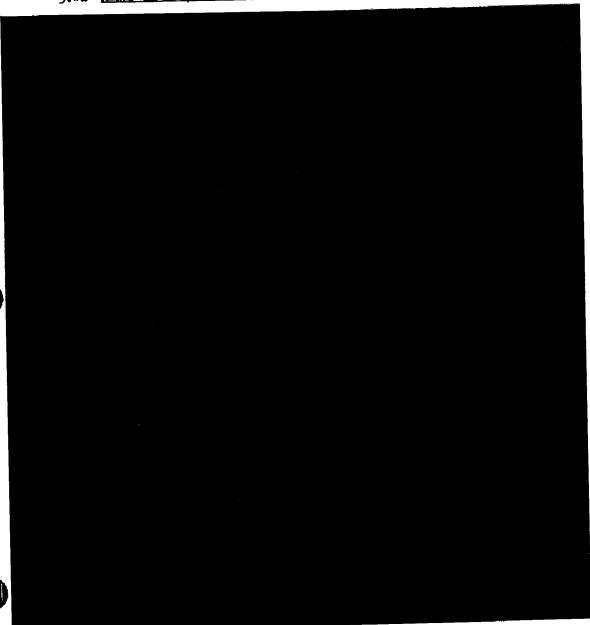
TEST Z



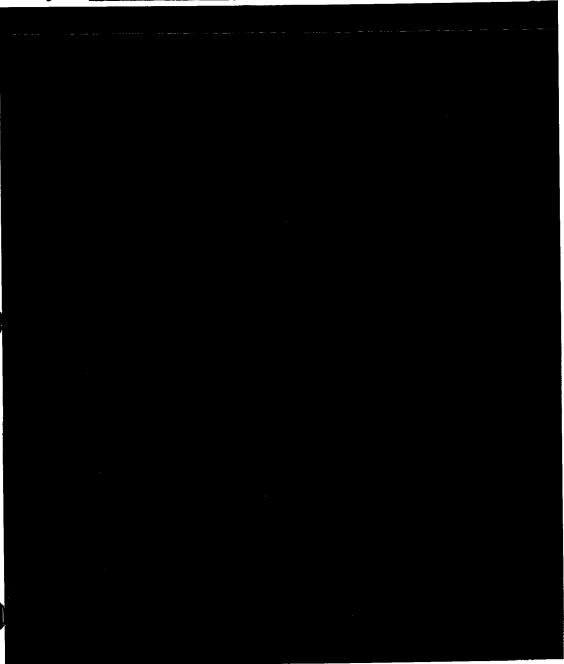
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# 3.2 Analysis Results

# 3.21 Analysis of Filters Collected Prior to June 1, 1948



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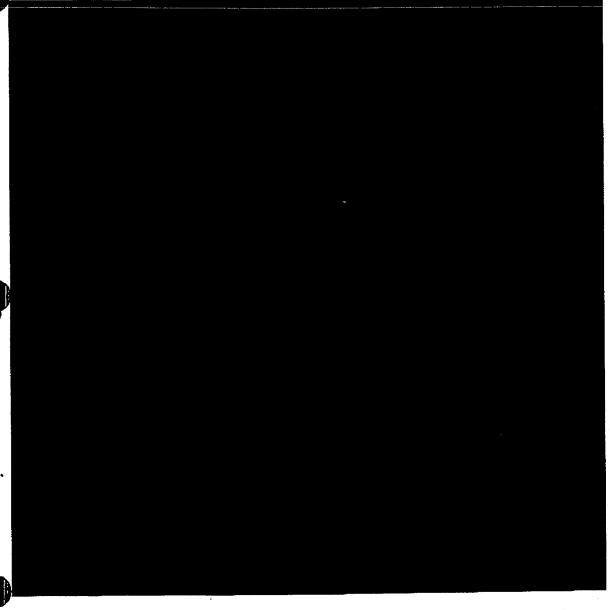
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REPRODUCTION OF A TYPICAL RADIOAUTOGRAPH

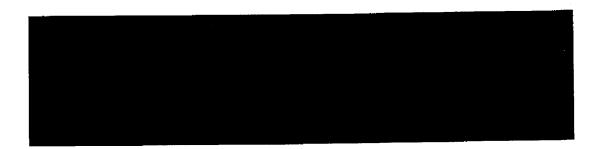
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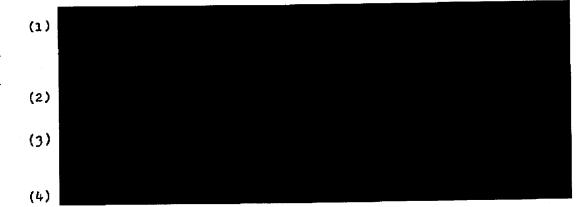
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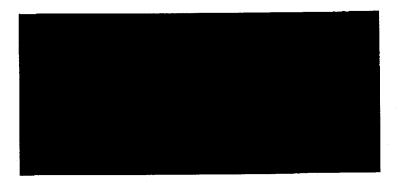
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## REFERENCES



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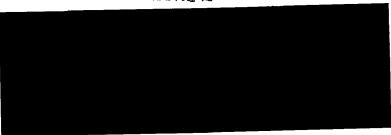


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# TAB C, VOLUME IV

OCTOBER, 1948

REPORT III

# FINAL REPORT FITZWILLIAM

Headquarters United States Air Force Deputy Chief of Staff, Operations Assistant for Atomic Energy

REPORT ON

GROUND FILTER ANALYSIS

Department of the Air Force Contract No. W28-099 ac-407 with TRACERLAB, INC., 55 Oliver St., Boston, Mass., for Services and Equipment for Radiological Training and Monitoring

ANALYSIS PHASE

F. C. Henriques, Jr. Contractor's Representative

L. R. Zumwalt In Charge of Preparation of Report

W. C. Peacock, J. W. Jones, W. Karp and J. G. Whitney Assisting in Preparation of Report





REPORT III

OCTOBER, 1948

# REPORT ON GROUND FILTER ANALYSIS

Department of the Air Force Contract
No. W28-099 ac-407 with TRACERLAB, INC.,
55 Oliver St., Boston, Mass., for Services
and Equipment for Radiological Training
and Monitoring

# ANALYSIS PHASE

F. C. Henriques, Jr. Contractor's Representative

L. R. Zumwalt In Charge of Preparation of Report

W. C. Peacock, J. W. Jones, W. Karp and J. G. Whitney
Assisting in Preparation of Report



# REPORT III CONTRACT W28-099 ac-407

# GROUND FILTER ANALYSIS

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| 9.                               | Summary of Analysis Data, Ground Filters - Test Z<br>Station Identification<br>Ground Filter Stations Where Natural Radioactivity Was<br>Observed<br>Decay of Natural Activities  |

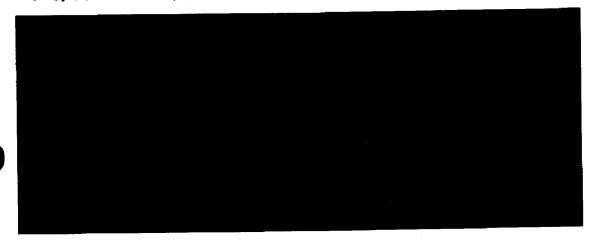


### REPORT III CONTRACT W28-099 ac-407

### 1.0 ABSTRACT

As part of Project Fitzeilliam during the Operation Sandstone test, samples of air-borne

Exposed filters which contained sufficient activity were sent for assay to radiochemical analysis laboratories operated in the field by Tracerlab, Inc. The principal laboratory for analysis of ground filters was located at Hickam Field, T. H. The locations of the other two laboratories were Ewajalein, M. I., and Northfield, Guan.





09-059C

### 2.0 INTRODUCTION

This report is concerned with Item III of Contract No. W28-099 ac-/407 entitled "Analysis Phase." The reports on the training phase and monitoring field phase have been submitted in the form of Report I and Report II of this contract. Item III of this contract is quoted below:

"The contractor will prepare fifty (50) copies of a final report covering the analysis of long half-life radioactive constituents of filter papers taken at monitoring sites which are considered to be sufficiently active to warrant further analysis and investigation. The analysis of these filter papers will be carried on in manner similar to that described in Item II of Contract W28-099 ac-405. Final phase report to be rendered thirty (30) days after analysis has been completed."

The results of chemical analysis of ground filter papers is given below, but much of the detailed discussion of the chemical procedures used, their reproducibility and significance is covered in Report I and . Report II of Contract No. W28-099 ac-405.



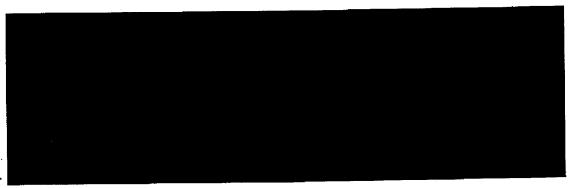
Filter papers have been analyzed from all stations that sent in papers measuring more than twice background on arrival. Among the papers thus selected the most active papers were analyzed in order to get maximum accuracy in the radiochemical analysis.

A study has been made of the decay of natural activity collected on ground filters. Results of this study are given in this report.

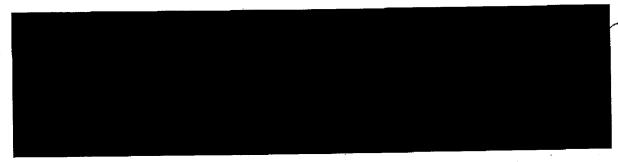
### 3.0 RADIOCHEMICAL ANALYSIS FROCEDURES

### 3.1 General

A discussion of the method of collecting activities and the development of procedures for the analysis of fission activity collected on filters was discussed in great detail in Report I of Contract W28-099 ac-405. A less detailed discussion of the procedures will be given in this report.



### 3.2 Procedure for Test X



### 3.3 Procedure for Test Y

On the basis of a meeting held at Kwajalein, prior to Test Y, an improved procedure was adopted for the radiochemical analysis of filter papers. This procedure is given in Table 2.

For reference purposes the detailed analytical procedure as actually followed by the chemiats in the laboratory is given in Sub-section 6.11. This procedure was carefully followed at all three analysis stations.

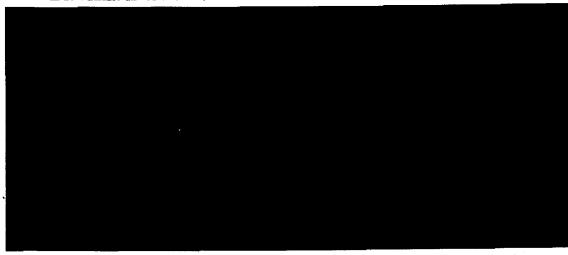
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### 3.4 Procedure for Test Z

Prior to Test Z another meeting was held at Kwajalein, where an improved radiochemical analysis procedure to be followed during Test Z was agreed upon. This was based on the experience gained in the prior tests. The analytical procedure for filter-paper analysis used in Test Z is given in Table 3.

The detailed procedure as followed by the chemists in the laboratory is given in Sub-section 6.12.

### 3.5 Limitation of the Analytical Procedures



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### 4.0 RESULTS

### 4.1 ANALYTICAL RESULTS

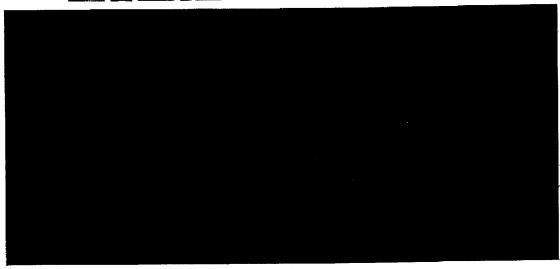
### 4.11 General

The radiochemical analysis of activities collected on ground filters was carried out along with air-borne filter analysis. The results presented are for ground filters alone. The combined results are presented and discussed in detail in Report I Contract W28-099 ac-405.

The results of all ground filter analysis for Test X, Y, and Z are presented in Table 4, Table 5, and Table 6, respectively. The per cent activity in a fraction, or the yield, is defined as 100 times the ratio of the counting rate for a given fraction to the counting rate for the gross leach, both expressed for the entire sample. During Test X no gross leach measurements were made, and therefore, ratios of the activity of fractions are presented instead of yield percentages.

The station at which the filter paper was exposed is indicated by the index letters of the filter-paper number. These index letters are identified in Table 7. The ground-filter papers from Kwajalein and Quam were analyzed at the respective field laboratories at these locations, while all other papers were analyzed at the Hickam field laboratory.

### 4.12 Yield and Ratio Curves



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TABLE 9

### DECAY OF HATURAL ACTIVITIES

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TABLE 10

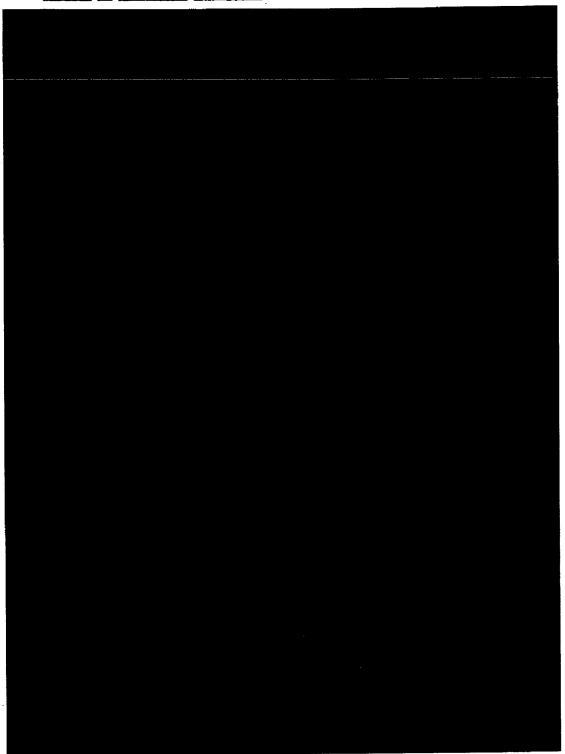
CALCULATED RADON-TEORON RATIOS

| Station                    | <u>Dates</u>                    | No. of Filter Decay<br>Curves Analyzed | Average Value<br>Activity Ratio (R) | Radon (n3)<br>Thoron (n4) |
|----------------------------|---------------------------------|--|-------------------------------------|---------------------------|
| SPOKANE                    | 25 April 48<br>to<br>20 June 48 | 78                                     | 35.4                                | 54.8                      |
| COLD PAY,<br>Alaska        | 26 April 48<br>to<br>6 June 48  | 20                                     | 37.6                                | 58.4                      |
| MARCE FIELD,<br>California | 22 April 48<br>to<br>4 June 48  | 26                                     | 26.7                                | 40.5                      |

# 5.0 CONCLUSIONS

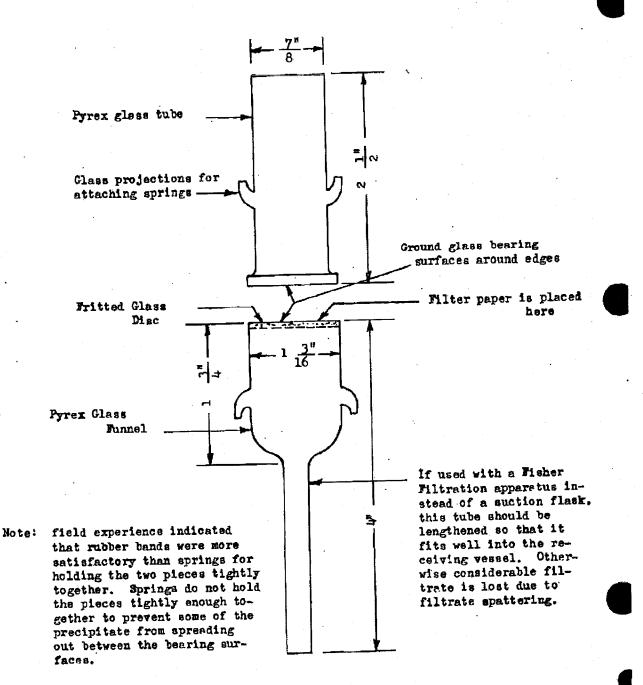
| paper collec             | conclusions to be drawn from the chemical analysis of filter tions at ground level                           |
|--------------------------|--|
| this reason cases extend | some of the conclusions given below are also given and in some<br>ed in Report I of Contract W28-099 ac-405. |
| e.                       |  |
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| c.                       |  |
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# 6.1 DETAILS OF ANALYTICAL PROCEDURES

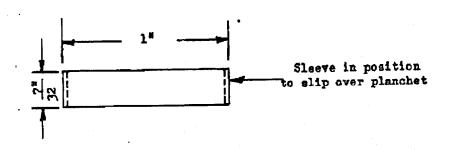


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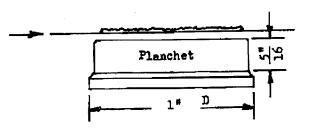
# TRACERIAB E-8 FILTRATION APPARATUS



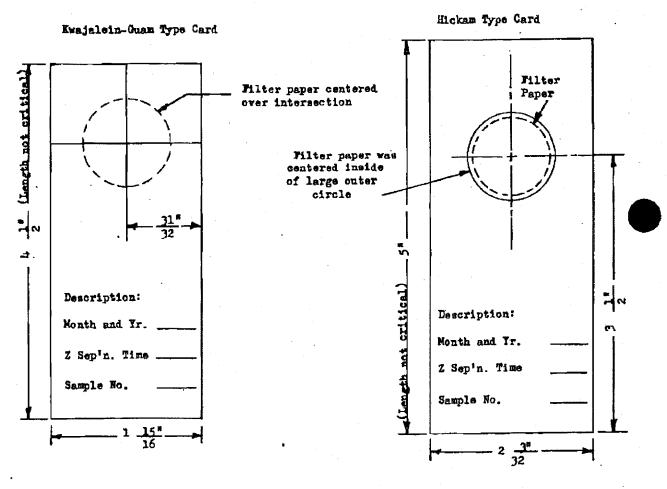
PLANCHET ASSEMBLY



Filter paper with ppt.



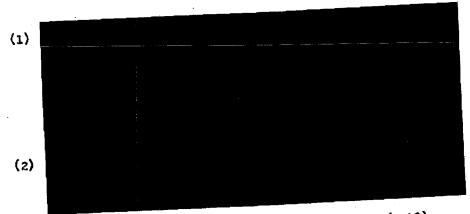
### MOUNTING CARDS



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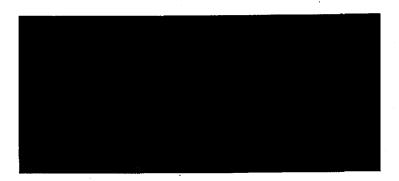


# REVERENCES



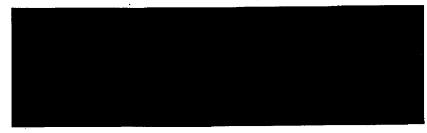
- (3) Way, K., and Wigner, E. P., PHYS. REV., 73, 1318 (1948), particularly eq. 19
- (4) Feather, N., PROC. CAMBRIDGE PHIL. SOC., 24, 599 (1938); see also, Glendenin, L. E., NUCLEONICS 2, 12 (1948)
- (5) Summarized in private communication with Prof. Robley D. Evans





TRACIELAS INC. 35 GIVIS STEET, COSTON TO, MASS





# Report of Operation FITZWILLIAM

Vol IV

X-11,00

Tab D

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REPORT ON EVALUATION AND LONG RANGE
PLANNING PHASE
by
TRACERLAB INC.

UNITED STATES AIR FORCE



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REPORT IV

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REPORT ON

APRIL, 1949

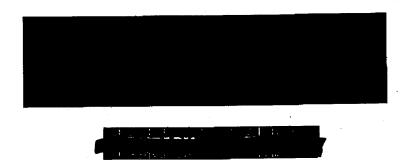
# EVALUATION AND LONG RANGE PLANNING PHASE

Department of the Air Force Contract
No. w28-099 ac-407 with TRACERLAB, INC.,
55 Oliver St., Boston, Mass., for Services
and Equipment for Radiological Training
and Monitoring

F. C. Henriques, Jr.

Contractor's Representative
and In Charge of Preparation of Report

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Assisting in Preparation of Report



# REPORT III CONTRACT W28-099 ac-40?

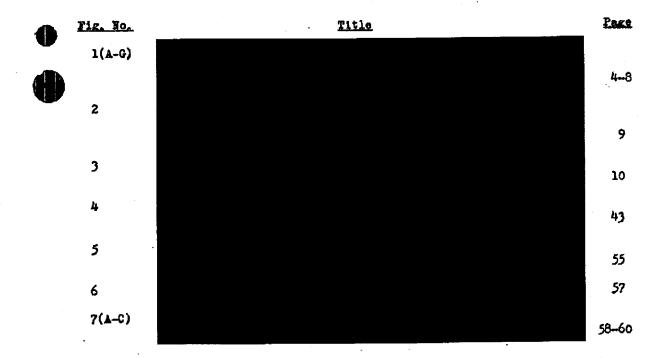
# EVALUATION AND LONG RANGE PLANNING PHASE

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### 2. INTRODUCTION

This report is concerned with Item IV of Contract W28-099 ac-407, entitled "Long Range Planning and Consultation Phase". The reports on the training phase, monitoring field phase, and chemical analysis phase have been submitted as Raports I. II, and III, respectively, of the present contract. Item IV, the subject of the present contract, is quoted below:

"The contractor will furnish (50) copies of a final report on an evaluation and recommendation of the entire radiological monitoring problem and will make recommendations for procedures to be followed in the event that a similar project is initiated at some future date. This will involve a study of the equipment requirements, qualifications of required personnel, time required to train personnel, method of recording and reporting of radiological data, methods of analysis of radioactive samples and any other studies which are deemed to be necessary for a complete staff study of monitoring radioactive contamination."

The first portion of this report describes the automatic recording equipment which was installed

The daily averages of the data obtained from these installations are summarized and evaluated. Recommendations with respect to improvement of the equipment, further usage and/or discontinuance, are given. The monitoring data which were the result of the collection on filter paper of fission products contained in the air are evaluated from an overall point of view. Similar svaluation with recommendations for improvement has been made for the auxiliary counting equipment which is required to monitor these filter papers. The types of errors which resulted from the routine reporting and recording of this radiological data are listed and the means for reducing these errors to an absolute minimum through equipment redesign, personnel training, revision of the data sheets, and certain procedural changes are enumerated.

The problem of airborne contamination, which was due to the passage of certain of the aircraft stationed at Kwajalein and/or Guam through the atomic cloud during the Fitzwilliam tests, is considered in detail.

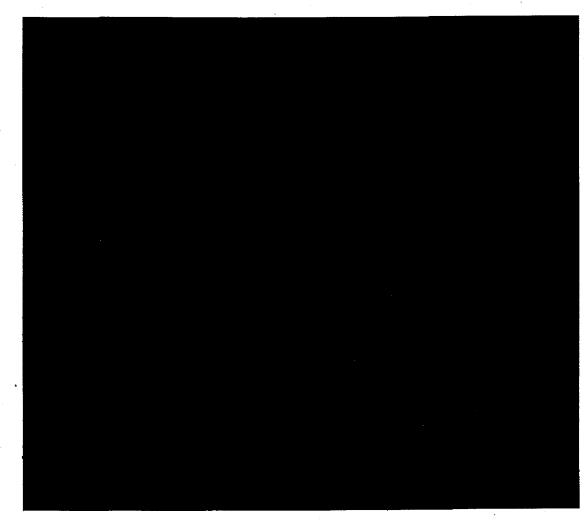
An overall evaluation of the entire radiochemical program and the recommendations pertaining thereto are given. This evaluation is considered from two points of view: (a) with respect to the chemical procedures which were actually used during the Fitzwilliam tests and shortly thereafter, and (b) with respect to radiochemical procedures which should evolve following further research and development. In the latter case the practical limitations due to the complexity of the problem and the low level of radioactivities to be expected are enumerated.

Finally, the errata in previously published reports of this series which pertain to work done under AF Contracts #28-099 ac-405 and ac-407 are listed.

### 3. SUMMARY OF DATA, EVALUATION, AND RECOMMENDATIONS

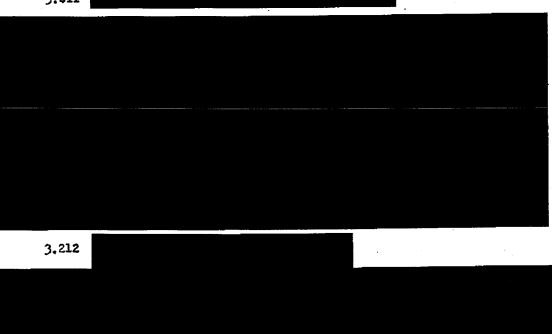
### PERTAINING TO THE MONITORING PROGRAM

| 3.1 Automatic Recording Field Monitors   |
|--|
| The ground radiological monitors automatically recorded the counting rate due to the activity in the neighborhood of these monitors throughout the three Fitzvilliam tests.  which consisted primarily of a battery of seven nested Geiger counters; were fed into a General Radio counting rate meter which in turn actuated an Esterline-Angus recorder.  Esterline-Angus recorder.  The Geiger counter impulses actuated a standard scaling unit and the total number of counts divided by 64 were automatically recorded on a Traffic counter at 15 minute intervals. The details of this instrumentation, together with recommendations for improvement, are given in full in Reports I and II of Air Force Contract W28-099 ac-407.  Tradiological monitors consisted of a Wells Survey high pressure ionization chamber whose data were recorded by means of a Leeds and Northrup Speedomax recorder. The details of this equipment are similarly |
| described in the above mentioned reports.  |
| There was a  |
|  |
| 3.11 Summary of Data and Conclusions   |
| The data obtained from the  the arrows indicate the blast dates of Sandstone tests X, Y  |
| and Z, respectively. A perusal of these figures will show that in certain instances  |
| The data in Figures 1 through 3 are summarized in Table 1 where  |
| the degree of reliability of the indications for these tests is stated. An   |
| Pages 4 through 14 with Figures 1 through 3 and Table 1 deleted by   |
| Air Free.  |



# 3.2 Collection of Radiosotive Substances

# 3.21 Ground Collection



The filter paper employed in this unit was an 8x18" sheet of Chemical Warfare V5. This filter paper was far more satisfactory from a radio-chemical point of view than the Air Material Type 8; further, it appears to have a considerably greater retentivity for fine particles and is as yet sufficiently porous to allow quite high flow rates. The primary disadvantage of this filter paper is its asbestos and uranium content. It is, therefore, recommended that research and development work he undertaken to devise a filter paper for both routine surveyance and Sandstone type tests which would have essentially the same properties as the V5 paper except that it would be of an ashless nature or completely soluble in some non-aqueous solvent, and its uranium content would be essentially zero. It is further believed, as described in Section 5.291 of this report, that the porosity of this paper can be improved to a considerable degree and yet its retentivity for these radio-active substances would be at least as great as the V5 paper.

### 3.22 Airborne Collection

This unit consisted of an especially prepared air scoop which was attached to the rear belly gun turret of B-29 airplanes. These air scoops were designed to hold duplicate 18x8" filter papers. It is believed that by appropriate redesign of these scoops the efficiency of collection using the V5 paper can be improved by approximately a factor of four. This can be done by taking advantage of both Venturi and Ramjet effects. It is further recommended that the redesigned air scoops be placed in a location where no air passing through the air scoop touches the airplane, and that the air scoop consist of a plastic

disposal unit, if possible. Keeping these factors in mind, it is also recommended that the air scoop be positioned where air flow is maximum.

The type of filter paper used in these tests was the Chemical Warfars V5. The description and recommendations for the improvement of this paper are given in the previous section.

### 3.23 Filter Paper Routine Monitoring Equipment

This equipment consisted of a large, thin-walled, all-glass Geiger tube, a cylindrical lead shield (the purpose of which was to reduce the background count), and a coaxial cable to attach the tube and its lead shield to a scaler. The details of these individual items are given in Reports I and II of AF Contract W28-099 ac-407.

### 3.231 The Wrap-Around Counter

The wrap-around counter is an all-glass G-M tube approximately 20" long and 1-3/4" in diameter. Its diameter is such that the 18x8" filter paper just wraps around circumferentially. The wall thickness of these counters was supposedly 30 mg/cm2. However, numerous counters have now been broken open and the wall thicknesses determined. They have been found to vary between 50 and 200 mg/cm<sup>2</sup>. In view of this, it is apparent that it is extremely difficult to correlate beta ray measurements made with one counter with respect to another. The fill of these counters is unknown, but sufficient information is available to state that either the majority of the counters are slow leakers or they have a finite shelf life; due to apparent absorption of quench gas on the cathode surface, the overall life of these counters is apparently less than 108 counts. It is therefore obvious that further work must be done to develop a satisfactory counter for this purpose. It is to be recommended that this counter be of all metal design and have a wall thickness less than 50 mg/cm2. Thin Dural or stainless steel meets this specification. They should be filled at greater than atmospheric pressure so that the rigidity and ruggedness of the counter will be maximal and are nearly independent of the fabrication materials. Fills must be developed which do not result in a finite shelf life, and the counter life should be greater than 108 counts. The use of a thin metal foil for the sensitive area will enable the counters to be manufactured with very reproducible and constant wall thickness. These factors will result in counters of constant sensitivity and, therefore, data obtained with one counter will be useful in evaluating data obtained with another.

### 3.232 The Lead Shield

The purpose of the lead shield was to reduce the cosmic and local radiation background and to provide a rigid mount for the G-M tube. Infortunately the majority of the lead shields in use were contaminated with radioactive lead and therefore the reduction in cosmic and local radiation was not nearly so large as one would expect. This shield was so constructed that it was extremely difficult to insert the filter paper in a reproducible fashion and to prevent contamination of the tube by the more active papers. It is recommended that these shields be redesigned with the above views in mind after the new wrap-around counter is developed.

3.233 As pointed out in Report II of AF Contract W28-099 ac-407, there were appreciable 3.24 Late in the organizational phase of the Fitzvilliam experiment it was decided therefrom. This procedure was followed in certain of the stations. Pertinent data from the stations which reported such collections are given in Table 2.

# 3.25 Air and Ground Filter Paper Monitoring Data

Ground filter papers were exposed in blowers in such a way that approximately passed through an 8x18" sheet of Chemical Warfare Paper V5 in the "AMC" installation. The installations within

Pages 19 through 28 with Tables 2 and 3 deleted -18 - by Air Force.



It is apparent from Table 3 that ground collection is of only

In summary, if one were to evaluate the strategic importance of all ground monitoring procedures from the point of view of routine surveyance undertaken in the Fitzwilliam operation, plus any conceivable improvements which are obtainable during the next few years, it is believed that for routine surveyance and future tests airborne collection

### 3.3 The Recording and Reporting of the Filter Paper Data

The data sheets and the messageforms for recording and reporting the radiological data obtained during the Fitzwilliam operation are reproduced on pages 30 to 39 of this report. In general, this procedure worked quite well, but in order to ascertain both the accuracy of the operators in recording the data and the overall general usefulness of the data sheets themselves, a detailed study has been made of all of the original data sheets which pertained to all of the ground and air filter papers.

### 3.31 The Types of Errors

The error made by the personnel are summarized in Table 4, according to stations. An inspection of this table shows that, except for certain locations, a relatively small percentage of total errors were made considering the intensity of the operations during the Sandstone tests. Those locations which showed by far the highest percentage of errors were certain of the United States Steamships. This is not an unexpected finding in view of the operational difficulties aboard these ships plus the fact that the operators on the ships did not receive the full course given at Fairfield Suisum which is described in Report I of AF Contract W28-099 ac-407. With the view towards improvement in the data sheets, in the material to be presented in a course of instruction to possible operators for either routine surveyance or further tests, and in the equipment to obviate possibilities of error, it is of interest to list the kind of errors found. For convenience, these errors are broken down into four groupings which are identical to the column headings of Table 4.



# FLIGHT DATA

| d erms of feet and indicate he period the filter paper  |
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| erms of feet and indicate   |
| erms of feet and indicate   |
| erms of feet and indicate<br>he period the filter paper   |
|   |
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| e:  |
|   |
| South Latitude  |
| <sup>o</sup> ₩ to 90°₩5   |
| °W * 180°W6   |
| °_125 # 90°_225?  |
| or " Oor8   |
| QUIPMENT  |
| SCALER NO   |
| . 7 . 8 . 9.  |
| eading Total Counts   |
| lighte Counts per Min.  |
| •   |
| Maria de la compansa |
| Background count  |
| Counts per Minute   |
|   |
|   |

The above net count is transmitted directly as obtained and not coded. Negative net counts to be designated by 000.



# DATA SHEET: G-H METER (EA) AND TRAFFIC COUNTER (TR)

|  | 2  | 3  | 4                                     |
|--|--|--|---------------------------------------|
| Roadine                                | Scale Factor                                       | Av.Counts per Min.   | Code                                  |
| 1.                                     |  |  |                                       |
| 2.                                     |  |  |                                       |
| 3.                                     |  |  |                                       |
| 4.                                     |  |  |                                       |
| 5.                                     |  | . •  |                                       |
| 6.                                     |  |  |                                       |
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| 10.                                    |  |  |                                       |
| n.                                     |  |  |                                       |
| 12.                                    |  |  | · · · · · · · · · · · · · · · · · · · |
| over period o                          | of one hour or stamp<br>for TR is 1.07. So<br>tch. | erline-Angus recorder e<br>ed hourly reading of Tr<br>als factor for EA is se<br>nearest whole number. | affic Counter.<br>tting of Scale      |
| 3 = Multiply Colu<br>4 = First two fig | pures from Column 3                                | rounded to nearest sign<br>f figures in Column 3 1   | ess one.                              |
| 3 = Multiply Column 4 = First two fig  | pures from Column 3                                | f figures in Column 3 1  | ess one.                              |



# DATA SHEET: FILTER PAPER EQUIPMENT

| 1         | S             | 3              | 4             |              | 5              | 6                 | 7                 | 8               | 9                  | 10   |
|-----------|---------------|----------------|---------------|--------------|----------------|-------------------|-------------------|-----------------|--------------------|------|
| FP<br>No. | Time<br>FP on | Time<br>FP off | Time<br>Start | T<br>Ct. Sto | ime<br>p Ct. R | Scaler<br>egister | Reading<br>Lights | Total<br>Counts | Counts<br>Per Min. | Code |
|           |               |                |               |              |                |                   |                   |                 | •                  |      |
|           |               |                |               |              |                |                   |                   |                 |                    |      |
|           |               |                |               |              |                |                   |                   |                 |                    |      |
|           |               |                |               |              |                |                   |                   |                 |                    |      |
|           | -             |                |               |              |                | •                 |                   |                 |                    |      |
|           |               |                |               |              |                |                   |                   |                 |                    |      |
|           |               |                |               |              |                | •                 |                   |                 |                    |      |
|           |               | •              |               |              |                |                   |                   |                 |                    |      |
|           | . ·           |                |               |              |                |                   |                   |                 |                    |      |
|           |               |                |               |              |                | •                 |                   |                 |                    |      |

Filter papers with counting rates of at least twice background shall be sent to Honolulu base immediately.



### CALIBRATION DATA SHEET

|                    |  | ading with Std. at TV plus 125 v_                   | . <b></b> - |
|--------------------|--|---|-------------|
|                    |  | ng (15 min) as decimal at threshol Selector setting |             |
|                    |  | in) as decimal at threshold plus                    |             |
| <del>-</del>       |  | selector setting                                    |             |
| Average recorder   | reading x scale selecto                    | or setting = counts/min.                            |             |
| ,                  |  | lard count at threshold plus 75 vo                  |             |
| Start time         | Stop time_                                 | Register Reading                                    |             |
| Lights             |  | СРМ   |             |
| 15 minute standard | d count at threshold pl                    | lus 125 volta.                                      |             |
| Start time         | Stop time                                  | Register Reading_                                   |             |
|                    |  | CPM Code  |             |
| Lights             |  | ( 1 T.4 mhts  |             |
|                    | = Register reading x 64<br>Time in minutes |   |             |

| MECOACECORIA        | MESSAGE CENTER NO. | TRANSMITTING MEANS   | CRYPTOG           | RAPH OR CLEAR | TEXT            |
|---------------------|--------------------|----------------------|-------------------|---------------|-----------------|
| MESSAGEFORM         |                    |                      |                   |               | •               |
|                     | PRECEDENCE         | TRANSMISSION INSTR   | DETIONS           | ORIGINATOR    | DATE-TIME GROUP |
| V                   |                    |                      |                   |               |                 |
| CTION INFORM        | ATIOH              | EXEMPT               | OPERATING SIGNALS |               | GROUP COUNT     |
|                     |                    | OR SIGNAL CENTER ONL | · v               | a - 18        | 61              |
| FROM: (Originator)  | SPACE ABOVE FO     | M STONAL CENTER ONL  | SECURITY C        | LASSIFICATI   | ON              |
| ACTION TO:          |                    |                      | wre er            | ENCE FOR      |                 |
| •                   |                    |                      | ACTION            | IMFO          | MATION          |
| •                   |                    | <u> </u>             | RIGINAL MESSAGE   | !             |                 |
| •                   |                    |                      |                   | NOTHER MESSAG | E<br>SIFICATION |
| NFORMATION TO:      |                    |                      |                   |               |                 |
|                     |                    | <del></del>          |                   |               |                 |
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|                     |                    |                      | 100               |               | 7               |
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|                     |                    |                      |                   | •             |                 |
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|                     |                    |                      |                   |               |                 |
| SECURITY CLASSIFICA | ITION              | SIGNATURE            | AUTHORIZATI       | ON            |                 |
|                     |                    | 1                    |                   |               |                 |
| ORIGINATING AGEN    |                    |                      |                   |               |                 |

Message Form 2 - Automatic Recording Device Reports and Ground-Air Filter Observation Report

(Report to be made every 12 hours.)

| ST | CULNCE | NO. OF DIGITS | DATA   |
|----|--------|---------------|--|
| ,  | 1 .    | 1             | International Meteorological Organization List   |
|    | S      | 3             | Weather Station International Index Number   |
| •  | 3      | 6             | Date-time group (GMT) at termination of 12 readings reported   |
|    | 4-15   | 3             | Each 3 digits for one of the 12 resaings reported, one at the end of each hour   |
|    | 16     | 3             | Three zeros indicating the end of the automatic recording device report. At stations with no ground-air filters, this will mark the end of a message.      |
|    | 17-28  | 3             | Ground-air filter report. Filter readings in per minute. When number of filters is less than 12, the remaining boxes through 28 will be filled with zeros. |
|    | 29     | 3             | Three zeros indicating the end of filter readings  |
|    | 30     | _3            | Background readings for filters  |
|    | TOTAL  | 91            |  |

Note: Where a given station is equipped with only one of the above instruments, i.e., either an automatic recording device or a ground-air filter, but not both, the message form blanks allotted for entering data of the missing instrument will be filled in with zeros.



Message Form #2 Supplemental Instruction Sheet for Automatic Recording Device. Reports and Ground Air Filter Observation Report.

The following message sequence is to be transmitted by each station at twelve-hour intervals. The two twelve-hour report periods may be selected to suit the convenience of the station, but once selected must not be changed.

Sequence 1--1 digit--The International Meteorological Organiztion list number is to be obtained from the Air Weather Service officer, Naval Aerological officer or the Weather Bureau office at the station.

Sequence 2--3 digits--is the weather station international index mumber assigned to the station and may also be obtained from the above-mentioned officers.

Sequence 3-6 digits-is the date-time group. The first two figures are to be the CMT day of the month at the end of the observation period being reported and the remaining four figures are to be the time in Greenwich Mean Time at the end of the period of observation. GMT may be obtained from the AWS, Aerological or Weather Bureau Officers. GMT must be used for recording all data.

Sequence 4 to 15--12 groups of 3 digits each--to be used for report on automatic recording device. Enter in each group of 3 digits the coded data for each hour of the preceding twelve-hour period. Enter the coded data for the first hour in the first group and so on. If no data is available during one or more of the one-hour periods due to equipment failure, or other causes, the code 999 must be inserted in the appropriate group. The same code 999 must also be inserted in the appropriate group for the hour lost during calibration and testing.

Sequence 16--3 digits--consists of a group of three zeros. indicating the end of the report on the automatic recording device.

## SECRET

Measage Form #2 Supplemental Instruction Sheet for Automatic Recording Device, Reports and Ground Air Filter Observation Report.

Page 2

At stations with no ground air filters this will mark the end of the message, and the observer will so notify the communications officer.

Sequence 17 to 28-12 groups of 3 digits each-to be used for report on ground air filters. The code data for each measurement of a filter is to be inserted in the group corresponding to the last hour in which the filter was in the blower unit. The other hours are to be indicated by filling the appropriate groups with 000.

Example I. A filter is in the blower unit for three hours. It will be reported by two groups of 000 followed by the group containing the coded data for that filter.

Example II. Filters are removed from the blower unit every hour. Each group will then contain the coded data for a filter.

For stations required to submit filter reports at regularly scheduled intervels, missing data due to equipment failure is to be indicated by the group 999 inserted in the hour group which would ordinarily contain the data for this measurement period. If less than the required number of filters are measured during the twelve hour period, due to causes other than equipment failure, the unused groups are to be filled with 000. It is of the utmost importance that no group be left empty.

Sequence 29--3 digits--consists of three zeros indicating the end of the ground air filter readings.

Sequence 30--3 digits--Insert here the coded data for the measurement made on an unexposed sheet of filter paper selected from the interior of the pile of blank filter sheets. This measurement is to be made at a convenient time within the twelve hours covered by the report on ground air filters.



## Hessage Form 1 - Aircraft Observation Report

| SEQUENCE  | no. of<br><u>Digits</u> | DATA  |
|-----------|-------------------------|---|
| ı         | 1                       | International Meteorological Organization List (1 thru - )  |
| 2         | 3                       | Weather Station International Index Number  |
| 3         | lı,                     | Test Sample Number, arbitrarily and serially assigned by station beginning with 9991.   |
| dą.       | 6                       | Date Time Group at beginning of aircraft observation (GMT)  |
| 5         | 3                       | Length of observation in minutes.   |
| 6         | i                       | Standard Code Number for the Octant of the Globe at beginning of observation  |
| 7         | <u>L</u> ę              | Latitude of aircraft at time of beginning of observation.   |
| 8         | 4                       | Longitude of aircraft at time of beginning of observation (hundred digit will be understood by reference to Octant and will not be included in message)   |
| 9         | 2                       | Altitude of aircraft during observation in thousands of feet  |
| <b>10</b> | 1                       | Standard Code Number for the Octants of the Globe at conclusion of observation  |
| 11        | Į.                      | Latitude of aircraft at time of conclusion of observation.  |
| 12        |                         | Longitude of aircraft at time of conclusion of observation (hundreds digit will be understood by reference of Octant and will not be included in message) |
| 13        | <u>.3</u> .             | Wrap-around net rate per minute in code   |
| TOTAL     | 40                      |   |

This form may also be used by Naval craft equipped with ground air filter. Weather station designators will be assigned a designator beginning with List No. 9.

|   | MESSAGEFOR         | M                | ESSAGE CENTER NO. | TRANSMITTING W | EANS     | CRYPTOGRA                                    | PH OR CLEAR | TEXT            |
|---|--------------------|------------------|-------------------|----------------|----------|--|-------------|-----------------|
|   |                    |                  | RECEDENCE         | TRANSMISSIO    | H INSTRI | UCTIONS                                      | ORIGINATOR  | DATE-TIME GROUP |
| ) | ACTION             | NR<br>INPORMATIO | H                 | <u> </u>       | EXEMPT   | OPERATING SIGNALS                            |             | GROUP COUNT     |
|   | FROM: (Originator) | 15 <u>5 - 1</u>  | SPACE ABOVE FO    | R SIGNAL CENT  | er onl   | SECURITY CL                                  | ASSIFICATI  | ON              |
|   | ACTION TO:         | -                |                   |                |          | PRECEDE                                      | NCE FOR     | RMATION         |
|   | •                  |                  | •                 |                | 00       | RIGINAL MESSAGE REFERS TO AND IDENTIFICATION | THER MESSAG | E<br>RFICATION  |
|   | INFORMATION TO:    |                  |                   |                |          | , DENIGRACION                                |             |                 |
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|   |                    |                  | ·                 |                |          |  |             |                 |
|   |                    |                  |                   |                |          |  |             |                 |
|   |                    |                  |                   |                |          |  |             |                 |
|   | SECURITY CLAS      | SSIFICATIO       | ON                | SIGNATURE      |          | AUTHORIZATIO                                 | N           | <u> </u>        |
|   | SYMBOL             | GAGENCY.         | DATE-TIME GROUP   | OFFICIAL TITLE |          |  | PAG         | GE OF           |

WD AGD FORM 11-168 This form supersedes WD AGO Form 11-158, 29 Aug 44, 15 JUN 1845 11-168 and WD AGO Form 801, 12 Mar 43, which are absolute-

16-46301-1 P. S. COVERNMENT PRINTING OFFICE

#### 3.311 Numerical Errors

r.

These are all errors which resulted in incorrect listing of gross, net, or background counts per minute on the data sheets. They are primarily simple arithmetical errors, as follows:

Errors in multiplication, division, addition, or subtraction.

Division by incorrect time interval due to the continued usage of the time interval for the previous paper.

Division by an unaccountable time interval while another counting time interval is listed on the data sheet.

In certain instances the filter papers were too active to measure and only a portion of the paper was used. This resulted in two errors: (a) the readings were divided by the fraction of paper counted before the subtraction of background, and (b) the net counting rate was not divided by the fraction of paper at all.

The reading was multiplied by 64 which was then entered as the register reading and was again multiplied by 64 to give the counting rate.

Powers of 10 errors, e.g. recording 36600 instead of 3660.

Direct addition of the interpolate values to the register reading, followed by multiplication by 64.

Numerical errors in the background computation which thus affected the net counts per minute.

Failure to reset register after each reading and neglecting to subtract the previous reading which resulted in a cumulative count. This is especially true in decay data.

Neglecting to list on the original data sheets gross count and/or register plus interpolate light readings and listing only net counts per minute.

Copying errors in transposing data from computation sheets to data sheets.

The rounding off of values inconsistently and incorrectly. (Minor error)

Making use of a slide rule and listing data to more than three significant figures. (Kinor error)

Listing gross counts and background counts to three significant figures and then listing net counts per minute to six or more significant figures. (Minor error)

Ignoring interpolate lights completely. (Minor error)

The primary source of these numerical mistakes is due in part to arithmetical computations which are carried out by the operator, in part by the judgment required by the operator in rendering decisions as to the fraction of filter paper to be counted or the time interval to be used, and in part by not carrying out specific instructions.

The seriousness of these numerical errors is best shown by Fig. 4 which plots the fraction of the total numerical errors which exceed a specified percentage error. An inspection of this figure shows that 42% of the numerical mistakes were in error by at least 5%, 22% were in error by at least 10%, 4% were in error by at least 20%, and 1% were in error by at least 50%. Thus, it can be stated that an exceedingly small fraction of the total number of errors were of serious magnitude.

#### 3.312 Time and Date Errors

Time errors are those errors which result in an incorrect GMT time for the collection or measurement of the filter papers, as follows:

Using and reporting data in terms of local time rather than GMT time.

Incorrect date which was due to measurements during a twelve-hour interval starting in one day and continuing into the next.

Time and/or date not recorded at all on data sheets.

Only one time and date given on a data sheet but data sheet used for more than one filter paper which may or may not have been measured consecutively.

#### 3.313 Coding Errors

Coding errors are all errors which resulted in the transmittal of data which were not identical to that on the original data sheet. The coding method used was to report the first two significant figures and the third figure represented the total number of integers minus one. These coding errors may be summarized as follows:

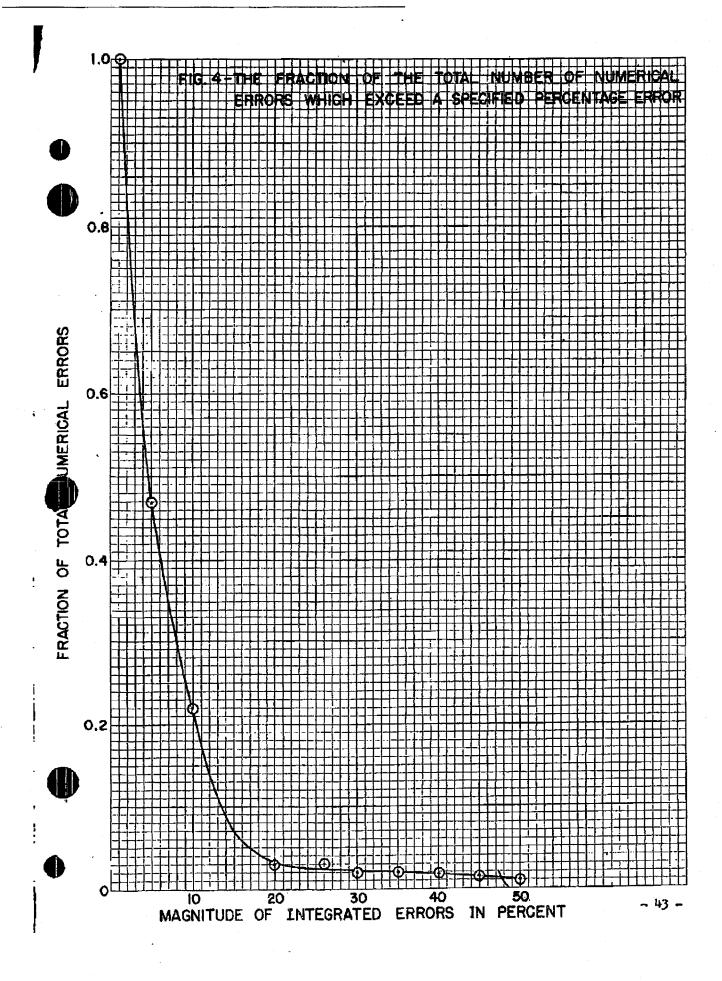
Neglecting to subtract one from the total number of integers, resulting in a ten-fold increase in the reported counting rate.

The addition of one rather than subtraction, which resulted in a factor of one hundred increase in the reported counting rate.

No apparent correlation between the improperly coded numbers on the Messageform with respect to the net counts per minute listed on the data sheet.

Intermittent coding.

Failure to code after instructions to begin coding.



The coding of those decay readings which should neither have been coded nor sent.

Coding to only one significant figure, for example 3500 coded as 403. Second significant figure incorrect because of improper rounding off. (Minor error)

#### 3.314 Miscellaneous Errors

These errors include all miscellaneous errors, such as numbering errors, flight data errors, etc.

#### Numbering Errors .-

Numbering anew daily, weekly, or monthly, using an identical set of numbers repeatedly, which makes identification of the filter papers with respect to flight and/or collection date impossible.

In a series of filter papers from one station, no numbers listed on the papers but no vacant numbers in the series to assign to these.

Identical sets of numbers used for both air and ground filter papers at a station and thus there is no means of distinguishing between them.

Usage of alphabetical designations with no explanation of their significance.

#### Flight Data Errors .-

Incorrect position and/or altitude of filter paper insertion information due to incorrect copying from previous sheet.

Omission of position and/or altitude in flight data sheets.

Incorrect recording of original flight data pertaining to position, time and time interval of exposure.

#### Other Errors .-

No records of when station is inoperative and thus no positive means of ascertaining whether data exists or is missing.

Some of the data sheets have been copied and/or retyped, which resulted in errors of transposition.

No information on original data sheets except net counts per minute, which renders checking impossible.

Data completely illegible.

Failure to follow the requested calibration instructions with respect to determining Geiger tube thresholds, plateaus, curves, and changes in sensitivity by comparison with standard.

Failure to make routine determinations of background.

Listing data in code only with no further information on data

Reporting ground filter paper readings as air filter paper readings, and vice versa.

#### 3.32 Recommendations

sheet.

It is apparent that, although there was a relatively small percentage of serious errors, it would be worthwhile to take steps to reduce the types of errors which occurred as much as possible. This can be done primarily in three ways, namely through the redesign of equipment, improvements in the training of personnel, and revising the data sheets which are provided for the recording of the data.

#### 3.321 Equipment Redesign

Equipment redesign would obviate most of the arithmetical errors and those errors which were due to incorrect usage of time intervals for counting. Thus this routine monitoring equipment should consist of a completely automatic scaler which counts a predetermined number of Geiger tube discharge pulses. This would lead to a fixed statistical error for all of the stations and would simplify intercorrelation of all of the data. It would also be advantageous to design a counts per minute clock which could be attached to this predetermined scaler and which would therefore yield a direct reading instrument requiring no computations whatsoever.

#### 3.322 Training of Personnel

In general, the personnel who operated the field stations during the Fitzwilliam tests was completely satisfactory. It is, therefore, recommended for further tests or for routine surveyance that officers be used who have a background in electronics and who have had a course of instruction essentially identical to that described in Report I of AF Contract W28-099 sc-407. It is believed, however, that certain improvements can be made by giving more emphasis to the significance of the data taken. Repeated instructions should be given as to the use of the data sheets and the coding method until it becomes completely automatic. Each officer should be briefed as to the inter-relation-ship between GMT time and local time. Coding errors can be obviated to a considerable degree by repeated instructions until each officer receives 100% on tests of this nature.

#### 3.323 Revision of Data Sheets

Although in theory the present coding system is satisfactory, it has resulted in appreciable errors of transmittal. It is, therefore, recommended that:

A three digit code still be used but that it be changed such that the first digit represents the total number of digits in the result and the last two represent the first two significant figures, correctly rounded off. This should eliminate the confusion which has resulted from subtracting unity from the total number of digits.

Space be provided on the data sheets for time and date in local as well as GMT and for the coded value to be sent.

Each filter paper (flight and ground) should have written on it, aside from the filter paper number now recorded, a code word for the station where it is counted plus the aircraft number, if it is a flight filter paper.

A space should be provided on the filter paper data sheet for the portion of the paper used for counting.

A space should be added to the flight data sheet for the air-craft number.

Net counts per minute on the flight data sheets should be coded, using the recommended altered code.

There should be a place on the flight data sheet for the coded date.

The coded net counting rate for the standard sample used to calibrate the wrap-around counter should be transmitted. This can be done by making use of sequence 29 of Messageform 2.

Space should be provided on Messageform 1 for the aircraft number.

#### 3.324 Procedural Changes

Any time when it is required to count filter papers and the station is inoperative, this should be noted on a filter paper data sheet, as well as the presently used scheme of transmitting it on the Messageform by means of "999".

Particular emphasis should be given to instructing personnel to use a continuous numbering method and to account for each filter paper which has been exposed. In rare cases where the filter paper has been mislaid, it is recommended that a blank filter paper with the complete history of the missing filter paper written on it be inserted. If at any time the missing paper is found, the blank paper should be removed. In no case choild any station be allowed to set up its own numbering system in a haphazard manner.

In order to distinguish between ground papers and air papers, it is recommended that following the code and the station where the counting is taking place, the letters "G" and "A", respectively, should be used to designate the type.

A regular report should be supplied to all stations on the types of errors which have been encountered by all operators with advice as to means of elimination.

Data sheets should be routinely inspected by the field supervisors during their routine inspection tour, and all errors should be pointed out to the operator with recommendations for elimination.

#### 4. AIRBORNE CONTAMINATION

| 4.1 | History     | -          | <u> </u> |      |   |   | _        |
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|     |             |            |          |      |   |   |          |
| 4.2 | Radiologica | al Surveys | •        |      | * | • |          |
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|     |             |            |          |      |   |   |          |

Pages 49 through 52 with Tables 5,6, and 7 deleted by Air Force.

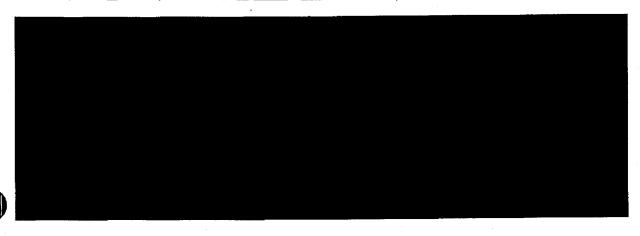
#### 4.31 Radiochemical Yield Data

Table 8 is a summary of all radiochemical yield data and pertinent information obtained on these hot air filter papers and aircraft wipings. All yields were calculated by dividing the total activity in a given fraction by the total leached activity obtained from the counting rate of the leach aliquot. An inspection of this table shows that all filters which were analyzed originated on aircraft 45-21833 or 45-21831, except filter paper number G-1397 which originated on 45-21823. Column VII shows the ratio of the leached activity to the wrap-around count on half the filter paper (VII = VI/V); this radio is a rough index of the efficiency of the leaching process.

The variance in the respective chemical yields of a given fraction is to be noted; for example, the ash varies by a factor of 8.5. from a minimum of 4\$\mathbf{\eta}\$ to a maximum of 34\$\mathbf{\eta}\$. Other fractions show variations involving even larger factors. Upon further examination of Table 8, one discovers that certain correlations do exist which are best explained by illustration. The yields of the Sr

This abnormal distribution of activity among the chemical fractions can be readily attributed to the following four factors: (1) the relatively low activity levels of the semples and the resultant low counting rates of the separated fractions; (2) the absence of radiochemical balance techniques which enable one to determine recovery efficiency by taking as the true radiochemical yield the product of the apparent radiochemical yield and the ratio of the weights of inactive carrier added and recovered; (3) the incomplete separation and purification of the chemical fractions (i.e., contamination); and (4) the lack of reproducibility of the leaching process. Considering the preceding information, it is probable that no significant differences exist in the radiochemical assays of these filter papers and, more important, certainly none between the aircraft wipings and the air filter paper. In view of this there is little doubt that the artificial activity present on the flight filter paper is the result of contaminated aircraft.

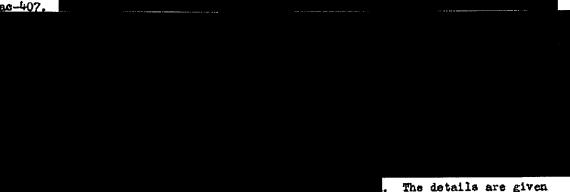
#### 4.32 Turther Proof of the Presence of Pission Product Activity



Pages 54 though 62 with Tables 8 ml9 and Figures 5 through 7 deleted by AirForce,

## 5. OVERALL EVALUATION OF THE ENTIRE RADIOCHEMICAL PROGRAM AND RECOMMENDATIONS PERTAINING THERETO

During the Fitzwilliam operation, three chemical laboratories were maintained in the field for the purpose of undertaking radiochemical assays as soon as practicable on both the exposed ground and air filters. The methods of analysis used and the papers so analyzed are described in detail in Reports I and II of AF Contract W28-099 ac-405, and Report III of AF Contract W28-099



in Report II of AF Contract W28-099 ac-405.

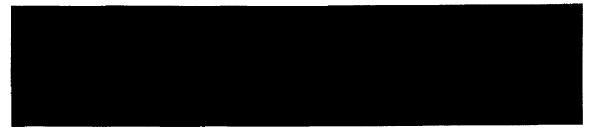
It is useful to appraise the accuracy with which this information was attained during the Fitzwilliam field operations, and it is of interest to evaluate the information which is believed to be theoretically obtainable following further research and development. This section consists of two main subsections, one which considers the former and the other the latter.

## 5.1 The Evaluation and Accuracy of the Radiochemical Procedures Used During the Fitzwilliam Tests

#### 5.11 Gaseous Fission Products

The data in Report 1 of AF Contract W28-099 ac-405 indicate that no gaseous fission products could be found except in the immediate vicinity of the atomic explosion. A consideration of the volume of air that could presumably be collected by this method indicates that it is not worthwhile to pursus this possible means of collection.

#### 5.12 Aggregate Nature of the Fission Product Activity



The importance of these data with respect to further research and development is discussed in Sections 5.291 and 5.292 of this report.

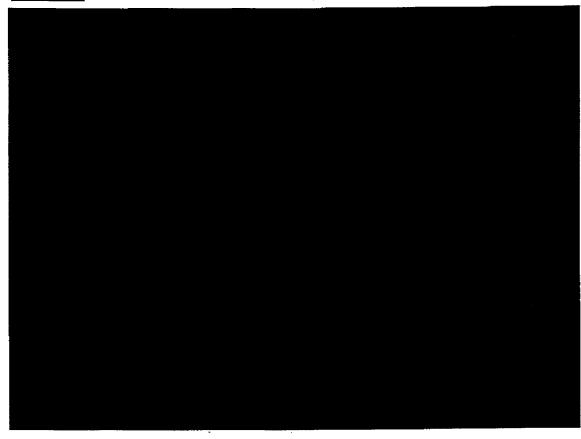
#### 5.13 Fission Products

Considerations of the data given in Reports I and II of AF Contract W28-099 ac-405. Report III of AF Contract W28-099 ac-407, and Section 4.0 of this report, indicate that radiochemical analyses can irrefutably prove that fission products are present on all filter papers, provided that gross counts greater than 300 counts per minute are attributable to artificial radioactivity as assayed on the wrap-around counter at the time the paper is received at the chemical laboratory field station.

5.14

In order to obtain an annraisal

The results of this analysis are given in the following.

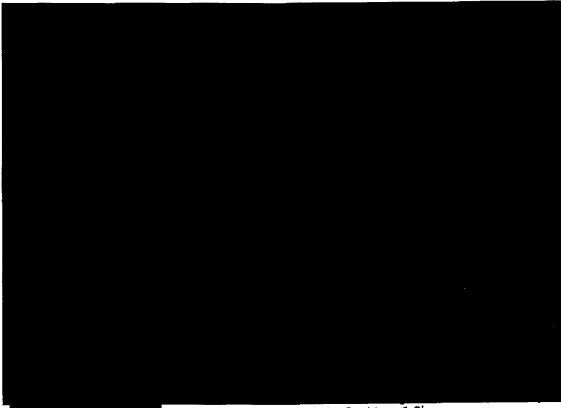


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| In making a determination  In making a determination  The possible use  Is discussed in Sections 2.13 and 3.23 of Report II of Contract W28-099 ac-405. The information presented indicates that  Evaluation of Information to be Obtained from a Radiochemical Program Following Further Research and Development  5.21 Introduction  The following section is an evaluation of  This section cains a description of the information believed to be theoretically obtainable, secription of practical limitations to be expected, and a number of recommendate made on the basis of these considerations. |                           |                              |                             |
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| The possible use  is discussed in Sections 2.13 and 3.23 of Report II of Contract W28-099 ac-W05. The information presented indicates that  Evaluation of Information to be Obtained from a Radiochemical Program Following Further Research and Development  5.21 Introduction  The following section is an evaluation of  This section teams a description of the information believed to be theoretically obtainable, secription of practical limitations to be expected, and a number of recommenda-   | In making a de            | termination                  |                             |
| The possible use  is discussed in Sections 2.13 and 3.23 of Report II of Contract W28-099 ac-W05. The information presented indicates that  Evaluation of Information to be Obtained from a Radiochemical Program Following Further Research and Development  5.21 Introduction  The following section is an evaluation of  This section teams a description of the information believed to be theoretically obtainable, secription of practical limitations to be expected, and a number of recommenda-   |                           |                              |                             |
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| is discussed in Sections 2.13 and 3.23 of Report II of Contract W28-099 ac-405. The information presented indicates that  Evaluation of Information to be Obtained from a Radiochemical Program Following Further Research and Development  5.21 Introduction  The following section is an evaluation of  Evaluation of the information believed to be theoretically obtainable, escription of practical limitations to be expected, and a number of recommenda-   | ned in Report I of AF Con | tract W28-099 ac-405.        |                             |
| is discussed in Sections 2.13 and 3.23 of Report II of Contract W28-099 ac-405. The information presented indicates that  Evaluation of Information to be Obtained from a Radiochemical Program Following Further Research and Development  5.21 Introduction  The following section is an evaluation of  Evaluation of the information believed to be theoretically obtainable, escription of practical limitations to be expected, and a number of recommenda-   |                           |                              |                             |
| is discussed in Sections 2.13 and 3.23 of Report II of Contract W28-099 ac-405. The information presented indicates that  Evaluation of Information to be Obtained from a Radiochemical Program Following Further Research and Development  5.21 Introduction  The following section is an evaluation of  Evaluation of the information believed to be theoretically obtainable, escription of practical limitations to be expected, and a number of recommenda-   |                           |                              |                             |
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These sections are considered separately below.

#### 5.22 Identification of Fission Products and/or Fissionable Material



is considered in detail in Section 5.24.

5.23

5.231

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## 5.28 Practical Limitations to the Producement of Information

| (see Section 5.2931).  possible and as large a sample must be collected as is practically feasible.  Data collected during the Fitzwilliam tests indicate  5.282 |                              |  |   |                    |             |
|--|------------------------------|--|---|--------------------|-------------|
| possible and as large a sample must be collected as is practically feasible.  Data collected during the Fitzwilliam tests indicate                               | 5,281                        |  |   |                    | · · · · · · |
| possible and as large a sample must be collected as is practically feasible.  Data collected during the Fitzwilliam tests indicate                               |                              | (sec. Se   | ction 5,2931).                          |                    |             |
|  |                              |  |   |                    |             |
|  |                              |  |   |                    |             |
| 5.282  | possible and<br>Data collect | as large a sample must<br>ed during the Fitzwilli. | be collected as is<br>am tests indicate | practically feasit | ole.        |
|  | 5.282                        |  |   |                    |             |
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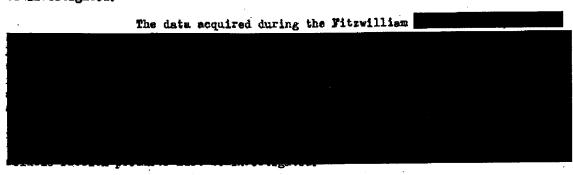
# 5.29 Recommendations for Research and Development Pertaining to Radiochemical Analyses and Assay Program

Considerations of the information that might be expected to be obtainable in theory from material collected to be obtained in theory from material collected to be obtained by the commendations detailed below.

#### 5.291 Recommendations for the Collection Program

Since the collection of material from a blast is so intimately connected with the requirements of the radiochemical treatment of that material, the recommendation is made that these problems be closely integrated. The following aspects of collection should be studied in detail:

(a) A general study should be made of all methods and techniques presently used for the removal of foreign material from gases, with special emphasis on the particular requirements imposed by the long range datection program. This includes the removal of radioactive substances from air masses by passage through suitable solid or liquid materials, e.g. filter paper, filter mats, filter cloth, liquid spray, etc. The possibility of using electrostatic precipitators which are especially designed for airborne collection should also be investigated.



- (b) Of the methods and techniques studied, referred to above, those which appear most promising should be more carefully considered, and developed to the point where they may be used in conjunction with, or in place of filter papers,
- (c) A considerable effort should be put into the development of a filter paper better suited to the particular requirements of the long range detection program than the Chemical Warfare paper V5 used in the Fitzwilliam tests. This paper contains about 4% asbestos which interferes considerably with

radiochemical separations. The paper to be developed should also have other specific properties such as high chemical purity.

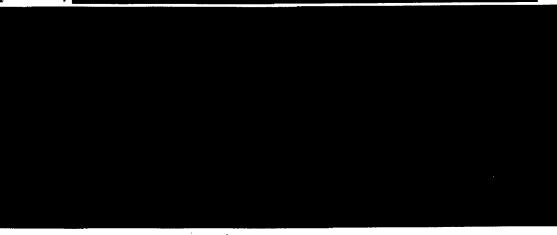
Further, the paper development should be carried out with a view towards obtaining more desirable collection properties, such as high collection efficiency and low pressure drop through the paper at the flow rates involved.



(c) The filter paper housing attached to the rear belly gun turret of the B-29's in the Fitzwilliam operation should be improved, as stated in Section 3.22.

#### 5.292 Recommendations for a Particle Study Program

The discovery of particles on the filter papers from the Fitzwilliam tests was made late in the course of AF Contracts W28-099 ac-405 and ac-407. This aspect of the problem is of sufficient import to warrant considerable further study. Effort should be directed toward the study of methods of isolation of the particles,



#### 5.293 Recommendations for the Radiochemical Program

During the Fitzwilliam tests it was decided to limit the analytical scheme primarily

Previous to the tests, a tentative analytical procedure was devised in a two-week period which was mainly based upon the radiochemical methods Fitzwilliam operation these procedures were modified slightly as the need for Detailed information pertaining to these procedures is given in Report I of AF Contract W28-099 ac-405. It should be pointed out that in making use of these procedures during the Fitzwilliam operation, 5.2931 discussed in Section 5.282,

> Pages 8) through 85 with Table 16 are deleted by -80 - Air Farce,







