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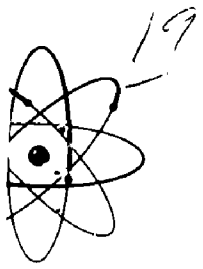

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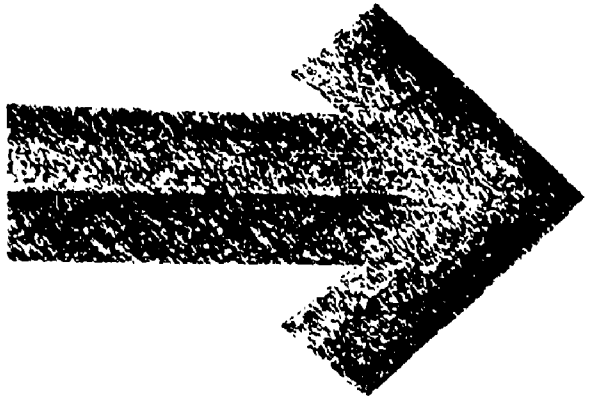

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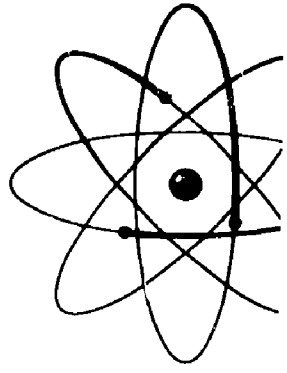

United States Atomic Energy Commission
Division of Technical Information

OTI-131(May 1962)

$1.60

USAEC Division of Technical Information Extension, Oak Ridge, Tennessee

US ARMY MEDICAL RESEARCH UNIT, EUROPE

APO 180, New York, N.Y.

ANNUAL PROGRESS REPORT

Report Control Symbol MEDDH-288

1 July 1962 - 30 June 1963

ANNUAL PROGRESS REPORT

Abstract

Project No. 6x64-14-001 - Biological and Medical Aspects of Ionizing Radiation
Task No. 6x64-14-001-04 - Biological Hazard of Fallout
Name and Address of Reporting Installation:

US Army Medical Research Unit, Europe
APO 180, New York, N.Y.

Period Covered by the Report:

1 July 1962 - 30 June 1963

Professional Authors of the Report:

Edward J. Huycke, Major, MC
Jon W. Blumenstock, 1st Lt, MSC
Erich Oberhausen, Ph. D. *

Report Control Symbol:

MEDDH-238

Security Classification:

Unclassified

Continued assays of normal persons in the Whole Body Counting Facility have revealed increased levels of radiocesium-137 during this fiscal year. Follow-up of patients with carcinoma of the thyroid has continued. Clinical studies concerning total body fat, fat adsorption and whole body potassium have been accomplished. A major renovation of the Whole Body Counting Facility was accomplished. Fission products determinations in both milk and rain samples were performed during the first half of the fiscal year.

* Institute of Biophysics of the University of the Saar

ANNUAL PROGRESS REPORT

Title Page

Project No. 6x64-14-001 - Biological and Medical Aspects of Ionizing Radiation

Task No. 6x64-14-001-04 - Biological Hazard of Fallout

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ANNUAL PROGRESS REPORT

Table of Contents

ANNUAL PROGRESS REPORT

I. Description of Task

The unit's mission is to study radioactivity in man. A two pi liquid scintillation counter, located in Landstuhl, Germany has served as the primary means of conducting these studies.

II. Progress Report

1. Instrumentation

A major renovation of the two-pi liquid scintillation counter was accomplished during January through April 1963.

In April 1963 the old scintillation fluid was replaced by Arapahoe HF type, and the six Dumont K-1328 tubes were replaced by Dumont K-2328 type. Entirely new photomultiplier bleeder circuits were made utilising designs from Los Alamos Scientific Laboratories with slight modifications. A voltage distribution panel was constructed by this Unit to permit separate high voltage adjustment of each tube. The anodes are connected in parallel and fed into a pre-amplifier (Los Alamos Type 270 QN); this is a charge sensitive type of pre-amplifier and has a unity gain. The signal then is fed into a linear amplifier with a variable gain of 32 to 1000. The overall gain used in normal operation is approximately 700. The output from the amplifier is then fed into 3 pulse height analysers, and a

modified output is fed into a multichannel analyzer for a precise check on the entire spectrum (normal settings: 0 to 1.8 MeV) The three pulse height analyzers are set for Cs-137, K-40 and I-131 respectively, and fed into 3 scalers. The pulse height analyzers were adjusted with a precision pulser to the following voltages:

	Threshold	Width
Cs-137	3.76 V	10.42 V
K-40	10.42 V	24.6 V
I-131	2.5 V	5.90 V

The analyzers now used are limited by being unable to accept amplified pulses below 2 volts.

Gain balance of the photomultiplier was achieved by placing a Co-60 source in front of each tube and adjusting the high voltage to produce a peak in channal 65 on the multichannal analyzer. Then the focus of each tube was adjusted for maximum count rate. The noise level of the detector is 52 KEV. With a Cs-137 source in front of each tube, a pulse height of approximately 40 millivolts is obtained from each tube.

Figure 1 demonstrates the resolution of the detector system as it is set to count normal people.

Figure 2 demonstrates the background spectrum of the renovated system.

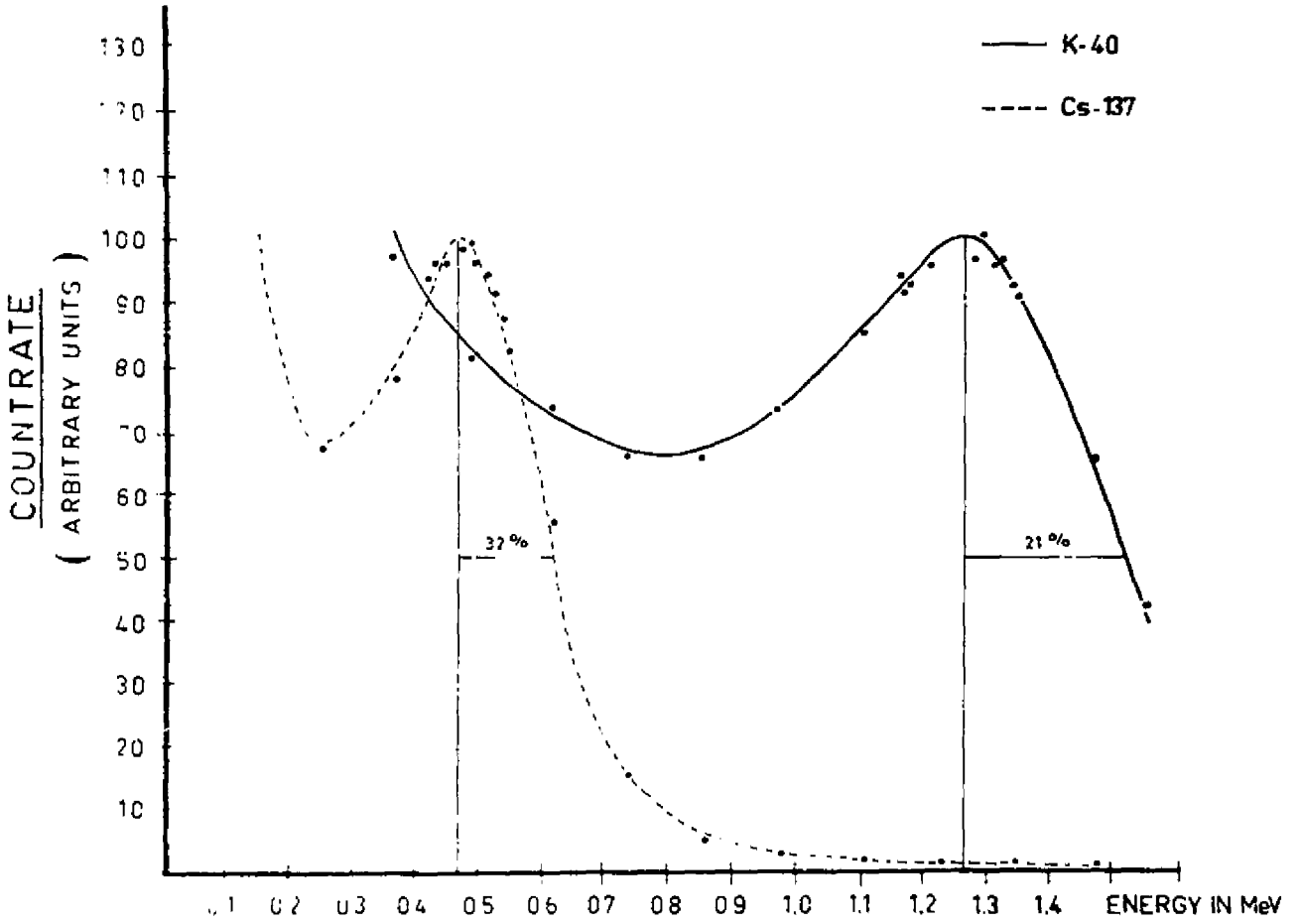
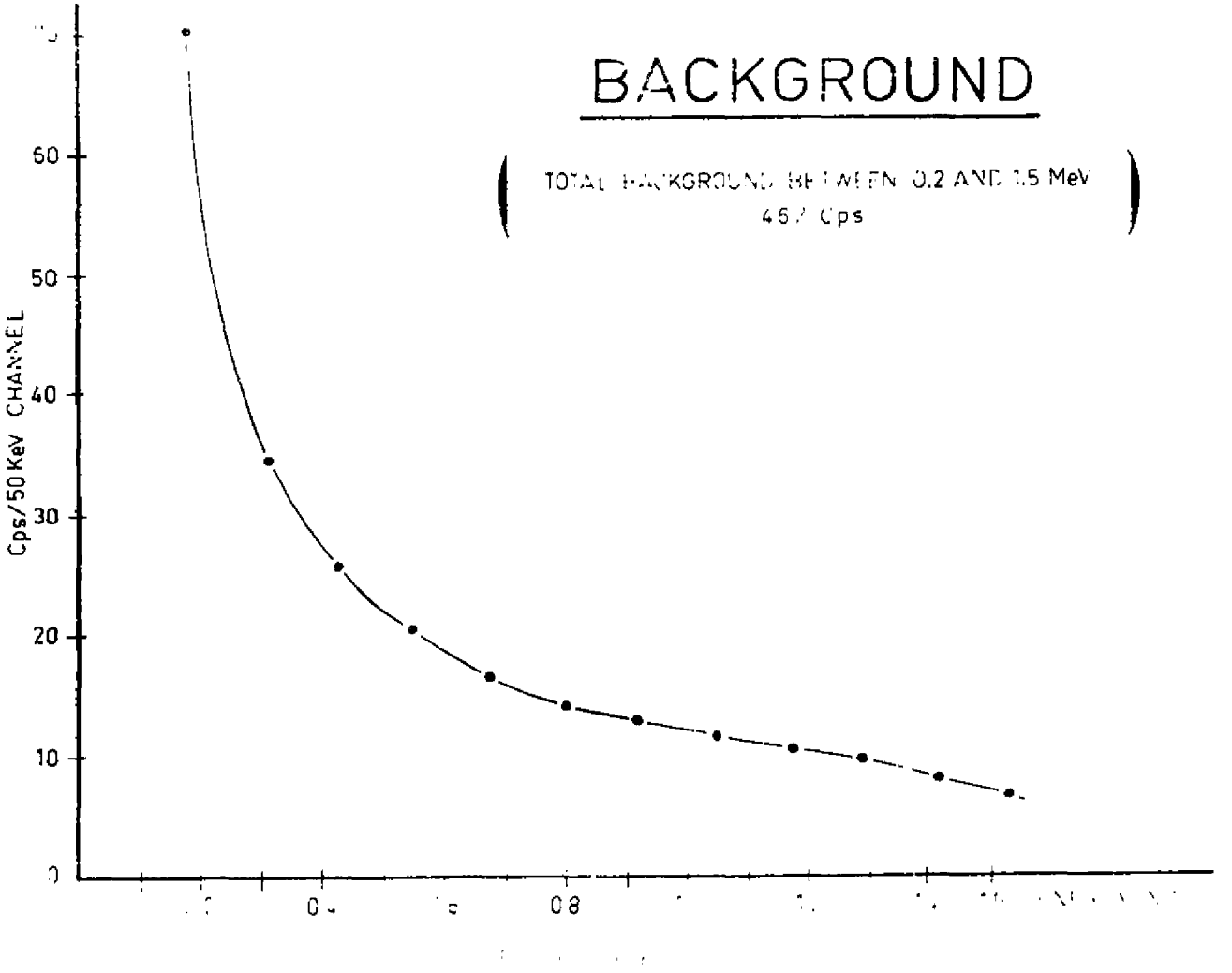

K-40
Cs-137
COUNTRATE
(ARBITRARY UNITS)
130
120
110
100
90
80
70
60
50
40
30
20
10
32 %
21 %
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
ENERGY IN MeV

FIGURE 1

BACKGROUND

TOTAL BACKGROUND BETWEEN 0.2 AND 1.5 MeV
46.7 Cps



Efficiency of the new system is defined below:

For a person with average body weight (70 kg) and average height (1.70 m) the following values for the efficiencies are obtained.

Potassium-40

K-channel:	0.431	cps/g Potassium
Cs-channel:	0.276	cps/g Potassium
I-channel:	0.210	cps/g Potassium

Cesium-137

K-channel:	0.206	cps/nc Cesium-137	0.6 %
Cs-channel:	4.48	cps/nc Cesium-137	12.1 %
I-channel:	3.51	cps/nc Cesium-137	9.5 %

Iodine-131

K-channel:	0.02	cps/nc Iodine-131	20.1 %
Cs-channel:	0.43	cps/nc Iodine-131	1.2 %
I-channel:	1.15	cps/nc Iodine-131	3.1 %

Background

K-channel:	180 cps
Cs-channel:	210 cps
I-channel:	160 cps

2 Measurement of Radioactivity in Normal People

a Cesium

The cesium-137 content of an additional 2131 persons was determined during the period 1 July 1962 to 30 June 1963. The majority of these people are residents of Germany. Figure 3 shows the monthly averages of the cesium concentrations measured since June 1959. It is demonstrated that since July 1962 an increase of the cesium concentration occurred which still continues. This increase is related to the nuclear test explosions in the atmosphere that have taken place since September 1961. It is of note that this increase in the cesium concentrations in human beings could be measured only after 8 months following the resumption of test explosions. See Table 1. This may be caused by the fact that the most frequently consumed foodstuffs until July 1962 were grown during the period of the minor fallout rate during the year 1961. With the beginning of the new harvest and its subsequent consumption, the increase of the cesium concentration in human beings was noticed. This confirms the earlier conclusion that the cesium concentration in human beings shows the fall-out rate with a certain delay.

The cesium-137 measurements are calculated with the assistance of the US Army Depot in Kaiserslautern, Germany. The results are entered on I.B.M. cards, a set of which is forwarded to Walter Reed Army Institute of Research at monthly intervals, and subsequently published by the U.S. Department of Health, Education, and Welfare in their Radiological Health Data Reports.

TABLE 1

Patients without Radiological History, only

	Months	Patients	Micromicrocuries Cesium-137 per Kg Weight
1962	January	68	58.76
	February	299	52.72
	March	250	51.10
	April	167	51.29
	May	387	57.94
	June	246	57.99
	July	282	65.71
	August	167	77.51
	September	376	94.62
	October	192	107.41
	November	606	93.00
	December	109	91.90
1963	January	-	-
	February	-	-
	March	199	131.87
	April	14	147.02
	May	297	145.18

MONTHLY Cs-137 LEVELS IN GENERAL POPULATION

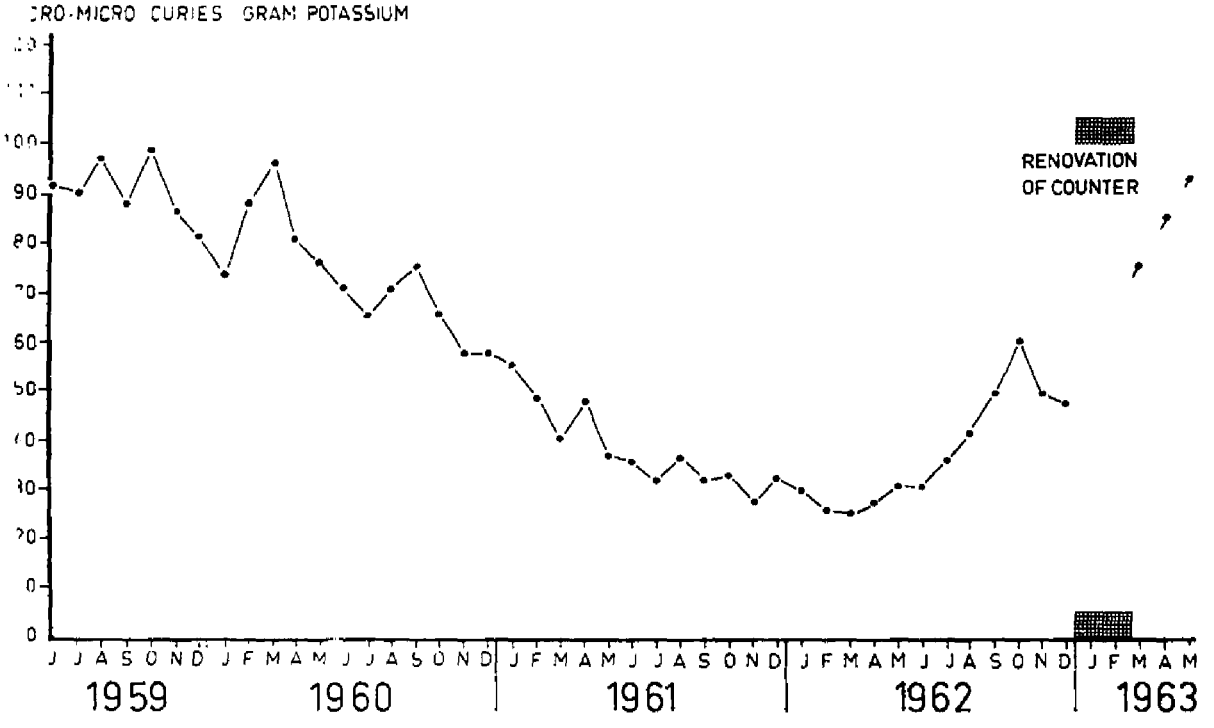


FIGURE 3

The exact evaluation of measurements of earlier years showed that the cesium content expressed in pc/g potassium depends on the age of the person. Refer to Unit's Annual Report, FY 62. The ratio of cesium/potassium is smallest for children and increases continuously to the age of 22 years, and from that point it remains constant. If it is assumed that the nourishment of children and of adults has the same ratio of cesium/potassium, the explanation of this result would be that the discrimination factor between cesium and potassium is a function of age.

b. Potassium

In all the normal 2131 people measured for their cesium-137 content the natural potassium has also been evaluated. A first check of the measured values showed that they fit very well with the previously established relationship between potassium content and age. Refer to this Unit's Annual Report, FY 62.

3. Clinical Studies

a. Carcinoma of Thyroid Follow-ups

Twenty-five patients with histologic proof of carcinoma of the thyroid gland have undergone follow-up examinations at varying intervals over the past thirty months. All these patients had undergone surgical total thyroidectomy, and, if necessary, further ablation of any small residuals of thyroid tissue by means of radioiodine-131 therapy.

The technique of radioisotopic follow-up studies of these patients is as follows. A thyroid stimulating hormone response is secured by either of two methods: (1) cessation of replacement thyroid medication one month prior to the testing period; or (2) intramuscular injections of thirty units Thyroid Stimulating Hormone over a period of three days immediately prior to the testing period. With this latter method, it is not necessary to stop the replacement thyroid medication at any time prior to, during, or following the testing period.

Seven patients have undergone both the testing procedures mentioned above. Results obtained from each of the seven patients tested by both procedures were similar within one standard deviation. It is now the policy to give three intramuscular injections of Thyroid Stimulating Hormone rather than stop the replacement thyroid medication. Cessation of thyroid replacement medication for one month entails a moderate amount of patient morbidity; this is not present with use of the protocol utilizing Thyroid Stimulating Hormone.

Of especial note is the freedom from morbidity, precision of data, ease of procedures for patient, doctor and technician, and greatly reduced radiation dosage to the patient by this adopted method.

On the first day of the test, the patient receives 1 to 2 microcuries of radioiodine-131 orally. On that day and the succeeding three days retention percentage values of radioiodine-131 are determined by means of the Whole Body Counter.

Experience in twenty-two determinations has revealed that patients with no clinical or laboratory evidence of metastatic functioning thyroidal tissue have a mean retention of 2.6 % radioiodine-131 at the end of 72 hours. One standard deviation is plus or minus 1.5 %. In contrast, eight patients with demonstrable recurrent or metastatic thyroidal carcinoma had a mean retention of 8.2 % radioiodine-131 at the end of 72 hours. One standard deviation of this measurement is plus or minus 3.3 %.

This work has been done in conjunction with Capt. Thomas A. Verdon, MC, Chief, Radioisotope Clinic, 2nd General Hospital.

c. Potassium Measurement of Patients with Cirrhosis of Liver

These measurements, started last year in cooperation with the Medical Clinic of the University of the Saar, have been continued. In addition to the measurement of the total potassium content in the whole body counter, the total body water content for each patient was determined by use of antipyrine. Adequate exogenous potassium was given to all patients before the studies so that previous possibly inadequate alimentation would not influence the results. In comparison with 39 normal persons measured, those patients with compensated and those with decompensated cirrhosis of the liver and ascites showed a reduced total potassium content. The following averages were obtained for the different age groups of persons measured.

	Total Potassium	Total Body Water
Normal Persons	3622 meq.	41.9 kg.
Compensated cirrhosis of the liver	3296 meq.	39.6 kg.
Decompensated cirrhosis of the liver	2805 meq.	47.4 kg.

Repeat measurements of the same persons showed that by natriuretic treatment of decompensated cirrhosis of the liver, the total potassium content remained an average constant.

In general it was determined that with cirrhosis of the liver as well as in the absence of potassium deficiency, a reduction of the total potassium exists, and this reduction was revealed to be independent of ascites or manifested edema.

c. Total Body Fat Determinations

Body fat determination studies were performed with the Whole Body Counter on sixty young, healthy US Air Force pilots. The Whole Body Counter method was ultimately compared with a tritiated whole body water method as well as with an anthropometric system developed by von Doebeln.

The subjects were measured in the Whole Body Counter for two one hundred second counts to determine the amount of radiopotassium-40 present. Prior to measuring the potassium content, the height and weight of the subject was taken. The total body potassium is ascertained from the radiopotassium-40 present within the body. In control subjects the

deviation in determining the body potassium by use of the Whole Body Counter ranged from 1 to 2 percent variance per subject per year. The percentage of body fat can be calculated with the following formulation:

$$\text{Lean Body Mass, Kg} = \frac{\text{Total Body Potassium, Gm}}{\text{Factor (Gm K/Kg)}}$$

Total Body Weight, Kg - Lean Body Mass, Kg = Body Fat, Kg.

$$\text{Percentage Body Fat} = \frac{\text{Body Fat, Kg}}{\text{Total Body Weight, Kg}} \times 100$$

The factor (Gm K/Kg) is taken as 2.4 Gm K/Kg lean body mass. This figure has been arrived at by assays of the body tissues and found to be a reasonably constant value for the estimation of lean body mass. Determination of this factor was not done by this Unit.

The subjects of the tritiated water study were given one millicurie of tritium in the form of tritiated water orally. One hour after administration of the tritiated water, a ten ml. blood sample was withdrawn in a heparinized syringe. The blood was subsequently processed by centrifuge, then two ml. of plasma pipetted off and two ml. of 5 % trichloracetic acid added to precipitate the protein. One-quarter milliliter of this supernate was added to 19.5 ml. of a Dioxan scintillation fluid and counted in a Tri-Carb Counter for five minutes and then compared against a known standard. From data received from the Tri-Carb Counter, a ratio was determined between the

counts of each sample and its replicate sample containing the standard solution. This ratio is proportional to both the subject's whole body water and his lean body mass (this ratio is represented by A in the following formula).

$$\text{Volume, Whole Body Water milliters} = \frac{1.0\text{mc}}{A \times 4 \times 2 \times 10\text{-}5}$$

$$\text{Lean Body Mass, Kg} = \frac{\text{Volume in liters}}{0.73}$$

1.0 mc = The amount of tritiated water ingested

4 = The dilution factor

$2\text{x}10^{-5}$ = mc/ml of standard solution

0.73 = The constant factor

A third method involved von Doebeln's anthroprometric system of physical measurement of the body. These measurements were the right and left femoral condylar breadth and the right and left bistyloid radioulnar breadth. Height and weight were also recorded. The formula developed for the prediction of fat-free weight (FFW) is as follows:

$$FFW = 15.1 \ (H^2FR)^{0.712}$$

where height, H, is expressed in meters; the sum of the right and left femoral condylar breadth, F, in decimeters; and the sum of the right and left bistyloid radioulnar breadth R, in decimeters.

The results indicate that the Whole Body Counter is as good a method of determining body fat as any other method and probably a great deal more accurate. The potassium-40 determination method and the whole body water method were within ± 4 % of one another. Whereas, the anthropometric system, which is only a good estimation, and the potassium-40 method found approximately 50 % of the results within ± 5 % of one another.

The subjects are to be followed on a continuing basis with tests run every six months to strenghten and verify the conclusions drawn from the original body fat determination.

d. Miscellaneous Clinical Studies

Radioiodine-131 Triolean adsorption studies were done on 5 patients. Patients were given approximately 1 microcurie I-131 Triolean orally along with a liquid meal containing 500 Calories of fat. The patient was then counted daily in the Whole Body Counter for 3 days. Body retention of I-131 was calculated.

This method of doing the Triolean adsorption study has the following advantages over the standard protocol involving Triolean: (1) dose of I-131 is 10 to 100 times smaller than with conventional stool or blood assay methods; and (2) there is no necessity for obtaining, processing or handling stool or blood samples. The prinicipal disadvantage is that the test requires 72 hours to complete.

Radioiodine-131 Hippuran was given to 8 patients in the performance of the scintillation renogram. These patients were counted in the Whole Body Counter at various time intervals over a period of 72 hours to determine the effective half-life of the radioiodinated Hippuran. Calibration against suitable standards will be accomplished in the near future so that a calculation of the whole body radiation dose resulting from this screening test can be calculated.

Radiocobalt-60 Vitamin B-12 was given orally to 3 patients. Their retention of this compound was then followed for seven days, at daily intervals in the Whole Body Counter. From these results, it was determined that accurate results could be obtained in 72 hours, if and only if, the patient had had two bowel movements after ingesting the radiocobalt-60 Vitamin B-12.

This test does not require the use of 1 milligram of stable Vitamin B-12 as a "flushing dose". The test also does not require the collection and processing of any urine samples.

4. Measurements of Radium and Thorium Burdens

The research program of measuring persons with deposits of the radionuclides of the natural uranium-radium and thorium series has continued. This program is made in collaboration with the Institute of Biophysics of the University of the Saar.

The examination of each person includes the following:

a. Evaluation of the body burdens of the different radionuclides by measurement in the Whole Body Counter.

b. Measurements of radon (Rn-222) and thoron (Rn-220) concentrations of expired air.

c. Measurements of the concentrations of the different radionuclides in blood, urine and feces.

Prior to 1 July 1963 forty persons with thorotrast deposits and twenty-four persons with radium burdens have been measured. About half of these have been measured several times to follow the time variation of their body burden. The highest body burdens so far detected are 1 uc of radium-228 and 16.5 uc of radium-226.

5. Radioactivity of Rain

From July to November 1962 weekly samples of the precipitation that fall over an area of approximately 0.1 square meter have been collected in plastic bags. Following evaporation of the water, the folded plastic bags are measured with the NaI crystal which has been calibrated for iodine-131, ruthenium-103, ruthenium-106, zirconium-95/niobium-95, barium-140/lanthanum-140. From the gamma-ray spectra obtained, simultaneous equation were employed to calculate the amount of these radionuclides in the precipitation. Assuming that the same quantity of radioactive material per square meter falls to the earth's surface and remains there until it decays, we have calculated the accumulated radioactivity on the ground. This calculation demonstrated that the

short lived isotopes Iodine-131 and Barium-140/Lanthanum-140 have been important during this time because there has been a greater number of nuclear tests. The amounts of zirconium-95/niobium-95, ruthenium-103 and ruthenium-106 remained fairly constant during the observation period.

The program of counting rain samples was discontinued in November 1962.

6. Radioactivity in Milk

Whole fresh milk was counted weekly from various European collecting points. This was carried out in cooperation with the USAREUR Medical Laboratory, Veterinary Section. The procedure for counting the milk samples was described in the previous annual report and was not changed except the counting time was increased from 5,000 to 10,000 seconds per sample. Table 2.

The concentration of radiocesium-137 decreased gradually in all milk samples from July 1962 through December 1962. The radioiodine-131 increased through September 1962 at which time the concentration began to decrease as illustrated by Table 3.

The program of counting whole fresh milk was discontinued as of January 1963.

TABLE 2

Micromicrocuries Cesium-137 per Liter of Fresh Whole Milk

Place of Collection	Month of Collection					
	Jul 62	Aug 62	Sep 62	Oct 62	Nov 62	Dec 62
Denmark (Aarhus)	91	84	101	69	61	35
Holland (Dordrecht)	230	205	193	172	176	-
Holland (Tilburg)	-	-	-	102	117	-
Germany (Frankfurt)	265	214	210	157	173	-
Luxembourg	61	58	46	42	38	37
Austria (Steinach)	353	285	172	-	198	-

TABLE 3

Micromicrocuries Iodine-131 per Liter of Fresh Whole Milk

Denmark (Aarhus)	7	7	79	52	66	14
Holland (Dordrecht)	7	14	102	73	54	-
Holland (Tilburg)	-	-	-	27	30	-
Germany (Frankfurt)	4	9	146	64	64	-
Luxembourg	8	15	91	62	32	7
Austria (Steinach)	7	26	94	-	25	-

7. Training Procedures

Various training lectures in nuclear medicine and radioisotopic procedures have been given to the professional staffs of the 130th Station Hospital, Heidelberg; 2nd General Hospital, Landstuhl; and 97th General Hospital, Frankfurt. These lectures have been given in conjunction with Capt. Thomas A. Verdon, MC, Chief, Radioisotope Clinic, 2nd General Hospital.

Lectures in nuclear medicine in field operations have been given to the professional staff 20th Station Hospital, Nuernberg, in conjunction with Col. S.W. Cavender, MC, Commanding Officer, USA Nuclear Medical Research Detachment, Europe. Assistance has also been given this Detachment in the form of nuclear medical lectures for short courses in Medical Operations in Nuclear Warfare.

8. Monitoring of Military Personnel

A program has been initiated to monitor by means of the Whole Body Counting Facility military personnel who are occupationally exposed to sealed radioisotopic sources. These sources are utilized for calibration of field Radiac equipment. This will be a continuing program with assays performed on the personnel every three to four months. Reports of gamma ray emitting radioisotopic burdens of these personnel will be given to the Medical Officer responsible for the health of these men.

III. Summary

Continued monitoring of a normal population for body burdens of of radiocesium-137 has revealed a steady increase during this fiscal year as a result of the nuclear weapon test series. The Whole Body Counting Facility has undergone an extensive renovation to improve its functioning. Studies involving the potassium concentration of patients with cirrhosis of the liver and people with radium and thorium burdens have continued in cooperation with the Medical Faculty of the University of the Saar. Various clinical studies, involving thyroid disease and intestinal adsorption have been expanded. The Whole Body Counting Facility has been utilized in ascertaining total body fat values of military personnel. Monitoring of military personnel occupationally exposed to radioisotopes has been initiated. The projects involving fission products in rain water and milk have been terminated.

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