701408

015

LA-UR-76-2097

TITLE:

CESIUM-137 WHOLE-BODY CONTENT FOR NORMAL NEW MEXICO POPULATION

FILE BARCODE
00130002

AUTHOR(S):

R. G. Thomas
C. R. Richmond
J. E. Furchner
E. C. Anderson

SUBMITTED TO:

Health Physics Society Midyear Topical Symposium on Natural Radioactivity in Man's Environment.

By acceptance of this article for publication, the publisher recognizes the Government's license rights in any copyright and the Government and its authorized representatives have unrestricted right to reproduce in whole or in part said article under any copyright secured by the publisher.

The Los Alamos Scientific Laboratory requests that the publisher identify this article as work performed under the auspices of the USERDA

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

An Affirmative Action/Equal Opportunity Employer

NOTICE

UNITED STATES
ENERGY RESEARCH AND
DEVELOPMENT ADMINISTRATION
CONTRACT W-7405-ENG-36

MASTER

LANL

0006385

00130002.001

CESIUM-137 WHOLE BODY CONTENT IN A NORMAL NEW MEXICO POPULATION

R. G. Thomas, C. R. Richmond*, J. E. Furchner, and E. C. Anderson,
Mammalian Biology Group, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545

Abstract

A fairly consistent population of normal New Mexicans has been whole body counted periodically, for almost 20 years. Availability of the same individuals has not always been possible but the size of any group over one counting period has rarely been below 40 individuals. Nanocuries of cesium-137 and grams of potassium have been the primary measurements, the latter determined through potassium-40 counting. The whole-body gamma ray counting has been performed using a large liquid scintillation detector, designed and built at the Los Alamos Scientific Laboratory. The data are generally expressed in terms of picocuries of cesium-137 per gram of body potassium (pCi/gK). Following the peaks of high level atmospheric testing (early to mid-1960s) the levels rose, approaching 120 pCi/gK. For the five year period beginning in 1964 there was a steady decline. During the years of 1969 through 1973 the whole-body levels were essentially constant at approximately 20 pCi/gK. A gradual decline occurred over the next two years, reaching the current level of about 10 pCi/gK. A group of 100 individuals was counted during the summer of 1976 and these data are presented, showing that they follow a normal distribution.

Introduction

Interest in ^{137}Cs as a global contaminant from atmospheric testing of nuclear weapons has continued since Mi and Ma (Mi56) first identified its presence in man by whole-body counting techniques. Body burdens of ^{137}Cs in selected populations have been monitored for many years by several laboratories, and the behavior and fate of ^{137}Cs have been studied in a variety of organisms and ecosystems. A recent report by Le, et al. (Le76) has summarized most of the ^{137}Cs body burden information collected through 1975. These authors also list the biological half-lives in man that have been reported over the past two decades. These range from 0.1 year to infinity, with the next lowest value being 5.4 years. The highest average peak values for ^{137}Cs content in persons in the USA have been reported by Sh, et. al. (Sh73) from the Brookhaven National Laboratory, to have reached 180 pCi/gK during the summer of 1964. The authors correlated this peak with the atmospheric tests of the USSR and US that were carried out in mid-to late 1962. The sharpest rise occurred during the spring of the year associated with heavy rainfall. All authors have shown a decline in the Cs/K ratio since the 1964 peak, although

* now at Oak Ridge National Laboratory

This work was performed under the auspices of the U. S. Energy Research and Development Administration.

LANL

000b38b

00130002.002

this decline has not been without periods of plateaus and shoulders.

The data to be presented are a continuation of the measurements made at the Los Alamos Scientific Laboratory (LASL) from 1956 to the present. Although one may wonder why such measurements continue to be made, it is an effort that may prove of considerable ecological interest when all information is correlated. A comprehensive understanding of the movement of ^{137}Cs through the biosphere and its temporal variations in man is of particular importance as it represents the largest body of knowledge available on the subject of environmental contamination by a radioactive material and its ultimate deposition in man.

Methods

Approximately 40 normal Los Alamos Scientific Laboratory employees have been whole-body counted periodically (weekly or monthly) beginning in 1956. Two primary channels are used to analyze the body content of ^{137}Cs and ^{40}K. The counters (HUMCO I and [illegible] II) are 4π liquid scintillation type with a geometrical efficiency of nearly 100 per cent (An56; Va62). The subject remains supine in a cylindrical cavity 18 inches in diameter and 72 inches long inside the scintillation fluid containing vessel. Counting time is 200 seconds and two consecutive counts are recorded. All data at present are computer analyzed and read out as shown in Table 1. The data are normally reported as pCi ^{137}Cs/gK although the other information is useful. Each subject is weighed prior to counting so that the total mass of potassium per kg body weight can be computed. The total grams of potassium are used in the reporting procedure.

During the summer of 1976 a total of 100 subjects were counted to gain a more accurate insight into the present counter accuracy and ^{137}Cs distribution at the lower levels encountered under present non-atmospheric testing conditions. The levels of ^{137}Cs had fallen considerably during the past three years and it was beginning to be a worry that the counter (perhaps due to deterioration of fluid or phototubes) was giving inaccuracies. By counting this number of subjects over a short period of time it was felt that many seeming inequities might be assessed.

Results

The ^{137}Cs/K ratios for the years 1956 to the present are shown in Figure 1. Also indicated are time spans during which the "dirtiest" atmospheric weapons testing occurred. Figures 2-4 show the data collected on the 100 individuals whole-body counted during the summer of 1976. The data are presented in nCi ^{137}Cs, grams of potassium and pCi ^{137}Cs/gK, respectively. The plots are on normal probability paper with the abscissae being in terms of percent of individuals with less than the stated value of body burden plotted on the linear ordinate.

LANL

0006387

00130002.003

Discussion

The data in Figure 1 show the time-lag of ^{137}Cs buildup following the late 1950s and early 1960s atmospheric tests. The time-lag after each large series appears to be about two years to reach a peak level. The decline is at approximately the same rate as the increase but there may not be obvious correlation between the two. A leveling off occurred between 1968 and 1973, at which time another decrease occurred. Although most testing during this period was in the Southern Hemisphere, there was apparently enough fallout in the Northern Hemisphere to maintain this level. The decline from 1973 to present stable levels probably represents the response to a reduced rate of atmospheric injection.

Figures 2-4 are significant from the viewpoint that all represent normal distributions of data. A random distribution of persons regarding sex and weight was included in this large group (100 individuals) and the K content appears normally distributed. Similarly (Figure 3) the ^{137}Cs contents were normally distributed with a mean whole-body value of 1.3 nCi. The combination of the two sets of data led to the data in Figure 4 in which the median Cs/K ratio is seen to be 10.3 pCi/g. Some reports in the past have debated whether such data were log-normally or normally distributed but at least in this group of persons, they clearly show a normal distribution.

The information in Figure 5 was taken from Le, et al. (Le76) and the LASL values were plotted with them. Clearly the information from all sources is similar although data were collected from various sections of North America.

The worth of such data as presented is not always obvious. However, obtaining the information such as was done at LASL in the summer of 1976 requires little time, effort or money. The project will continue until such time that levels are too low to interpret or that the collecting of further data appears meaningless. Correlations with the environment have been attempted in the past and will continue as part of the future effort.

LANL

0006388

00130002.004

ACKNOWLEDGEMENTS

The authors wish to acknowledge the work of the following persons who have intermittently been involved in the whole-body measurements over a period of many years: J. S. Wilson, [illegible] A. Drake, J. E. London, and J. M. Bingham.

LANL

0006389

00130002.005

References

An56 Anderson E. C., 1956, "The Los Alamos Human Counter", Brit. J. Radiol., Suppl. 7, 27.

Le76 Lewis J. T., Grossman L. W., Kereiakes J. G. and Saenger E. L., 1976, "Cesium-137 Body Burdens and Half-Life in a Group of Adult Males in Cincinnati, Ohio", Health Phys. 30, 315.

Mi56 Miller C. and Marinelli L., 1956, "Gamma-ray Activity of Contemporary Man", Science 124, 122.

Sh73 Shukla K., Dombrowski C. and Cohn S., 1973, "Fallout ^{137}Cs Levels in Man Over a 12 Year Period", Health Phys. 24, 555.

Va62 Van Dilla M. A. and Anderson E. C., 1962, "Human Counters Using Liquid Scintillators", Whole Body Counting, (Vienna: IAEA).

LANL

0006390

00130002.006

Figures

Figure 1: Whole body concentration of ^{137}Cs as pCi/gK. Individual points were generally the mean of no less than 40 counts during any one time period.

Figure 2: Whole body content of ^{137}Cs in 100 individuals counted in the summer of 1976. Data in nanocuries of ^{137}Cs are plotted as a normal-probability function.

Figure 3: Whole body potassium of 100 individuals as estimated from ^{40}K counting.

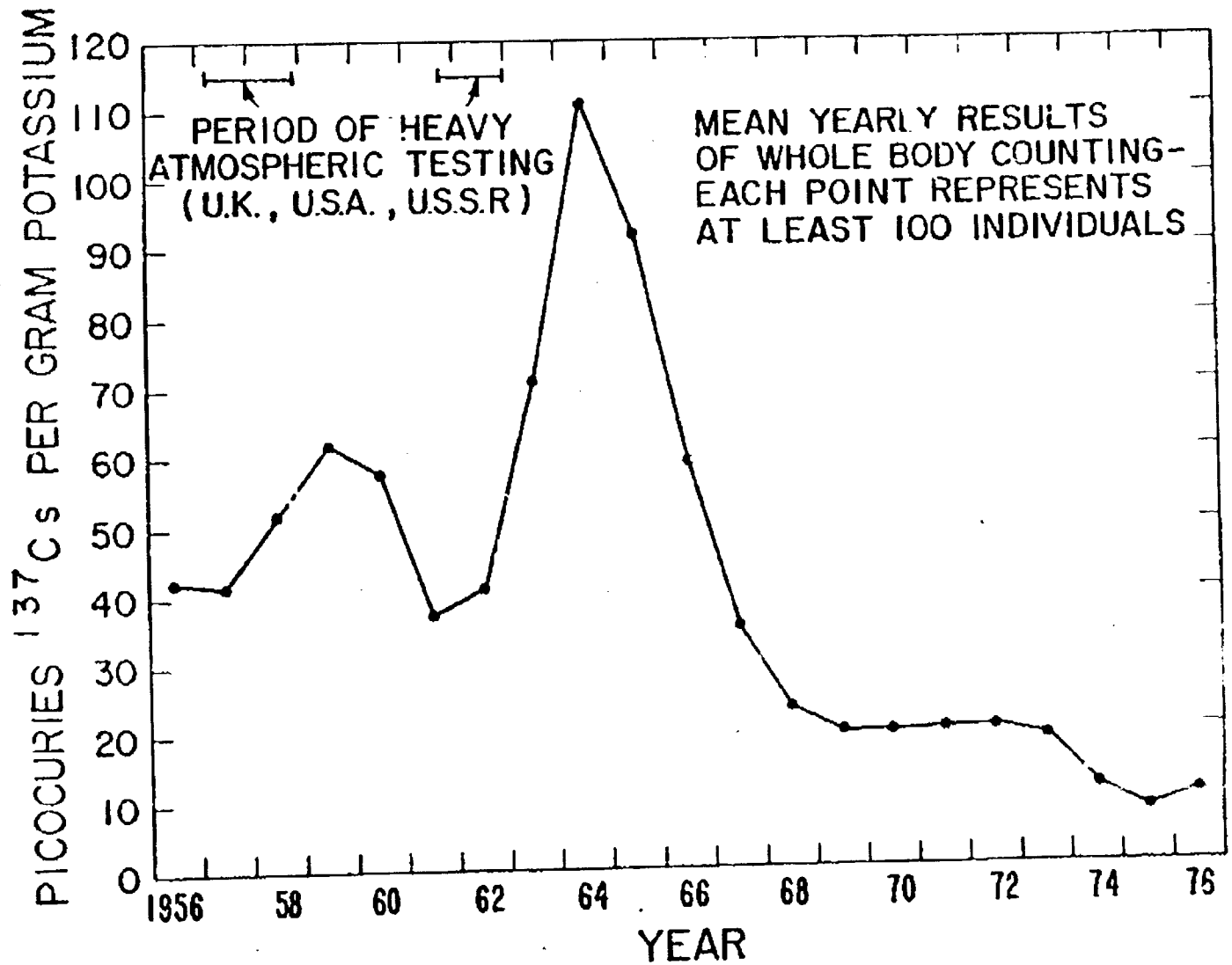
Figure 4: Concentration of whole body ^{137}Cs as pCi/gK. Data are plotted on linear-probability paper to indicate their normal distribution.

Figure 5: This Figure was taken from Le, et. al. (Le76) and the points from LASL added. Data show the close agreement between all five investigations.

LANL

0006391

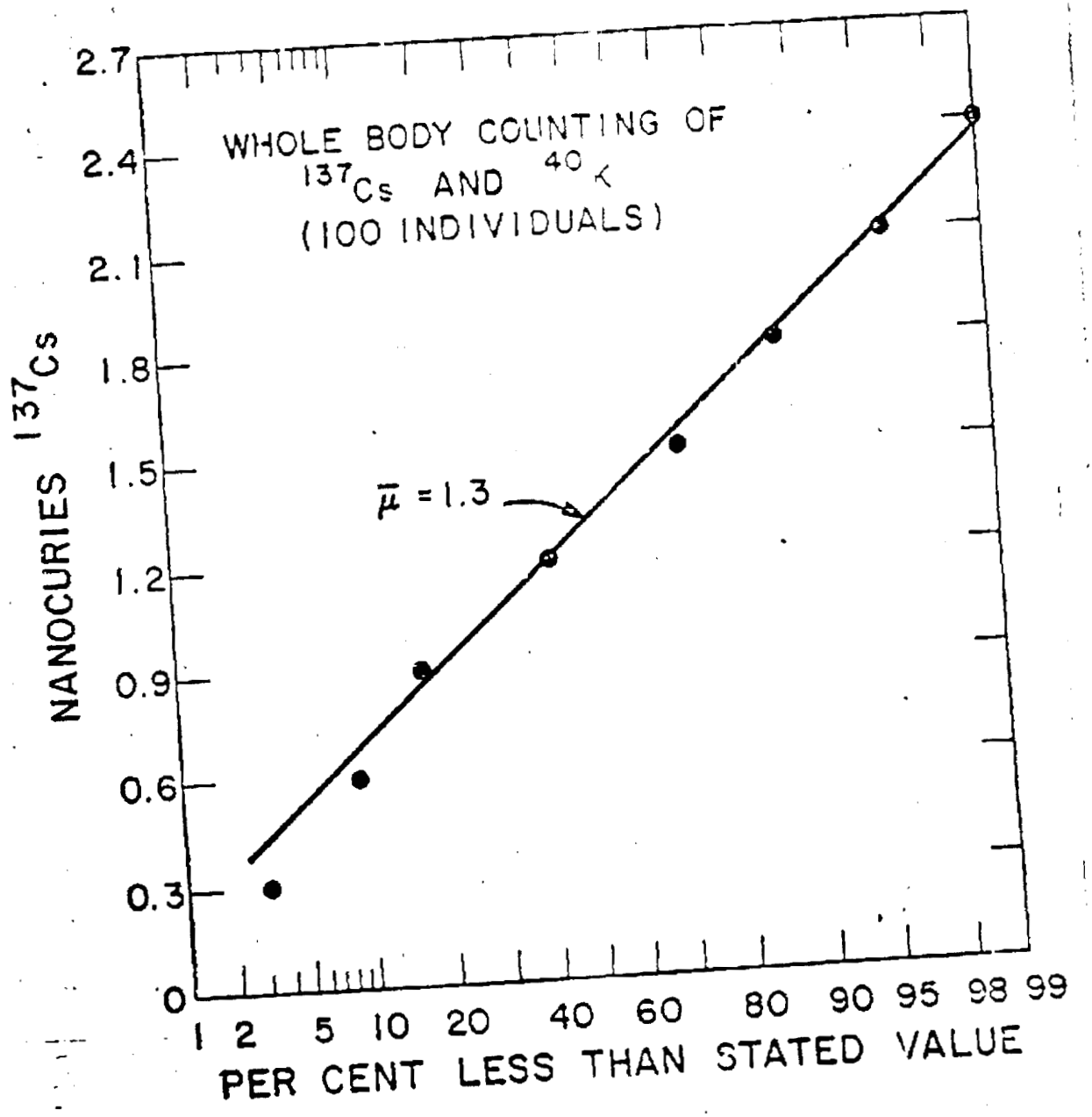
00130002.007



LANL

0006392

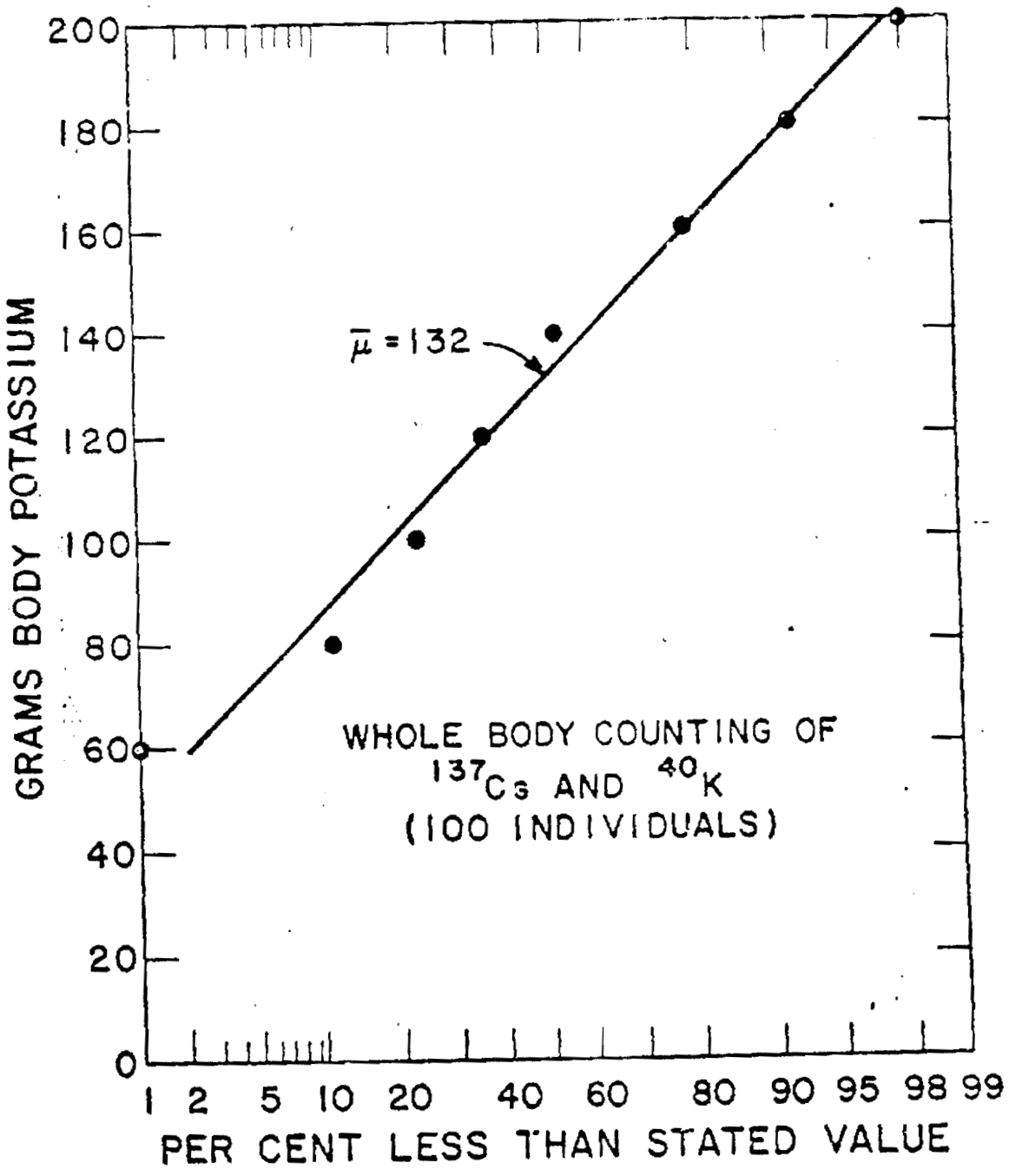
00130002.008



LANL

00069393

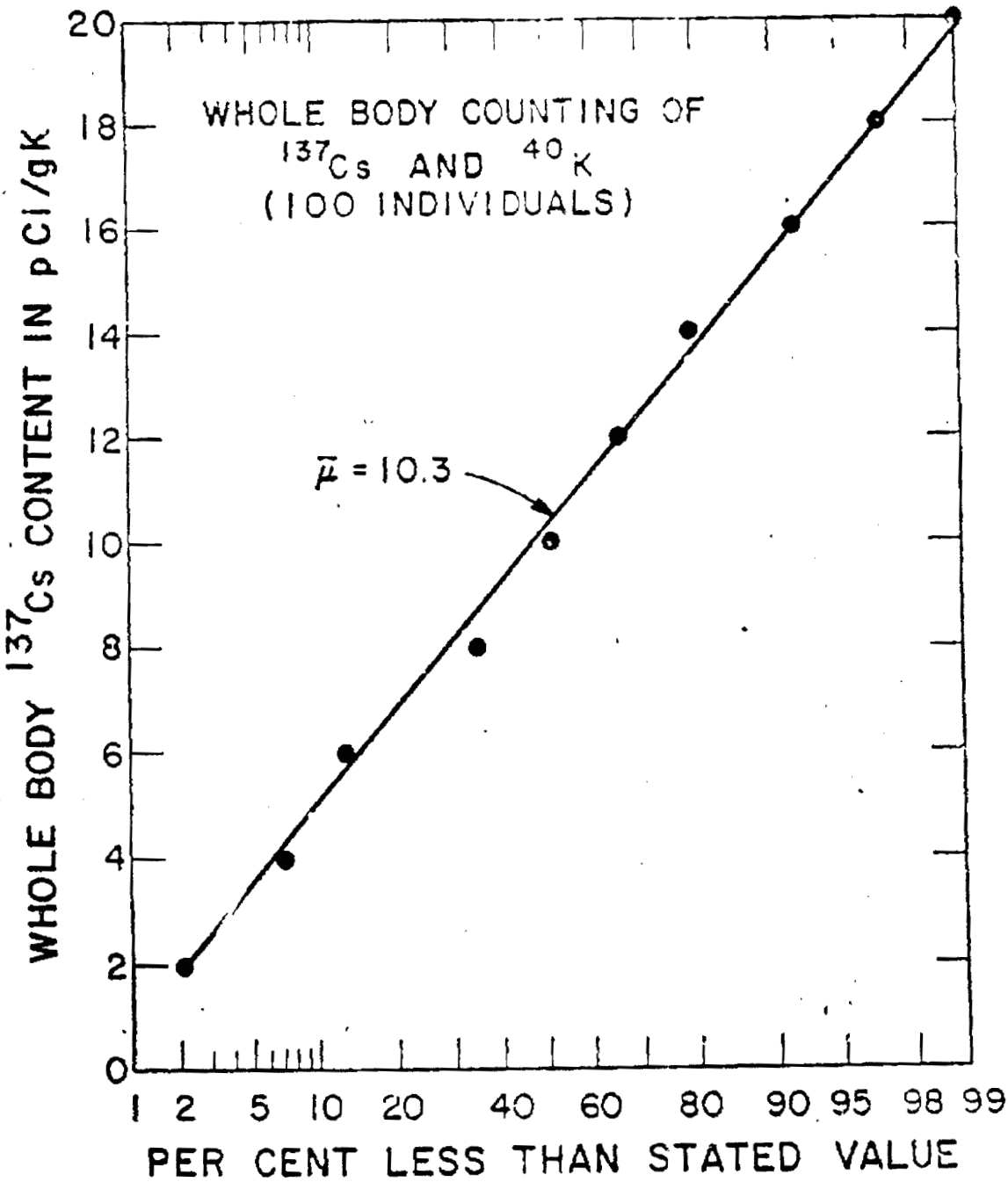
00130002.009



LANL

0006394

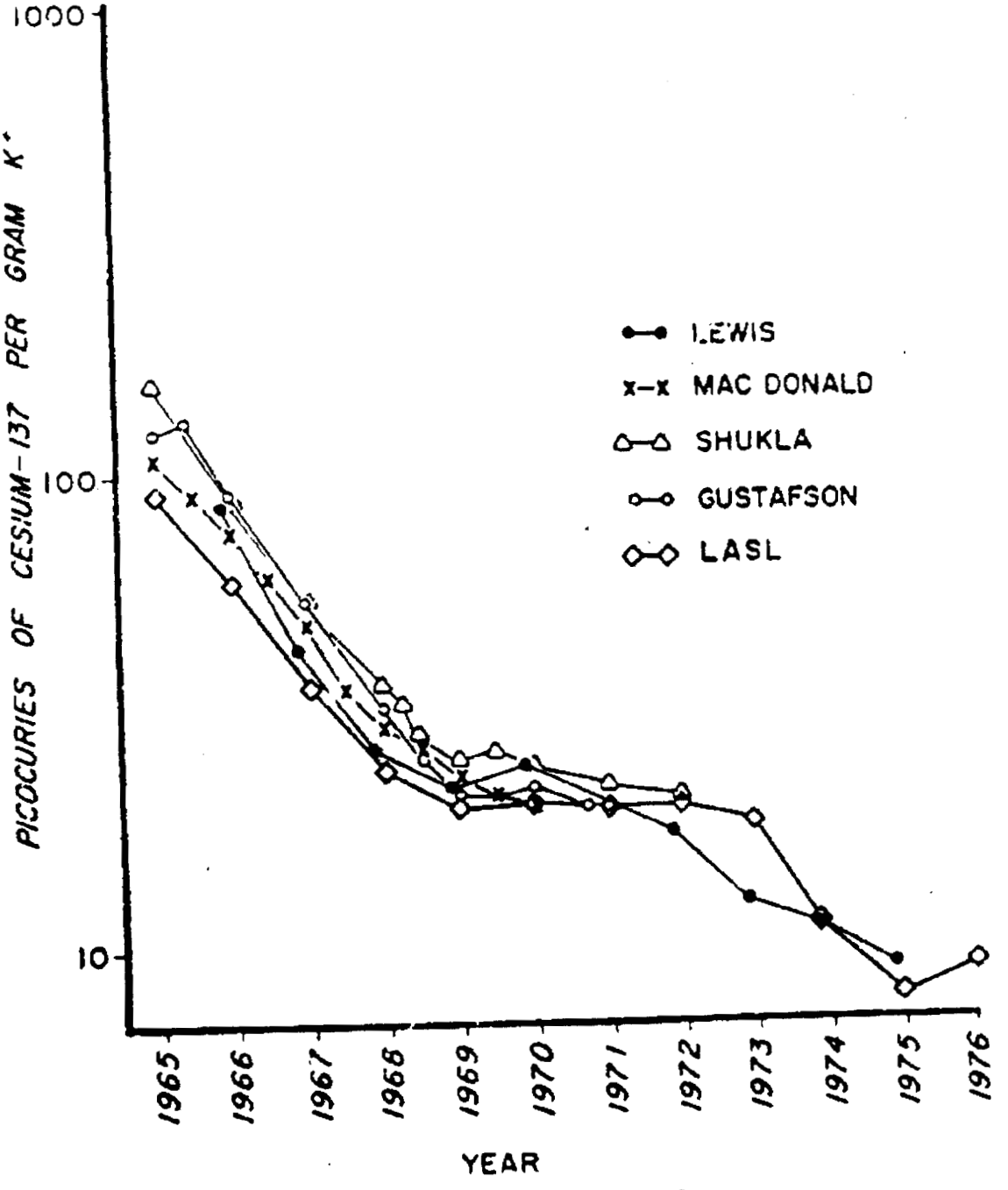
00130002.010



LANL

0006395

00130002.011



LANL

0006396

00130002.012

Table

Table 1: Typical Computer Readout from HUMCO II.

LANL

Table 1

Typical Computer Readout from HUMCO II

CL	SERIAL	NO	AGE	WGT	GNK/KG	PCCS/GNK	GN K	NC CS	PCCS/KG
14	005185	01	54	67.2	2.07	14.24	139.5	1.95	29.16
14	005185	01	54	67.2	2.03	14.63	136.9	2.00	29.61
14	005186	05	47	79.8	1.76	8.63	140.5	1.21	15.20
14	005186	05	47	79.8	1.74	8.67	139.3	1.20	15.15
14	005187	03	46	75.2	1.61	16.53	121.2	2.00	26.61
14	005187	03	46	75.2	1.62	14.36	121.8	1.75	23.27
14	005192	05	47	80.2	1.71	14.43	137.2	1.96	24.76
14	005192	05	47	80.3	1.70	14.38	136.1	1.95	24.43
14	005193	09	59	93.0	1.69	15.61	157.8	2.46	26.49
14	005193	09	59	93.0	1.68	14.16	157.1	2.22	23.94

LANL

0006398

00130002.014

END

DATE FILMED

3 / 9 / 77

LANL

0006399

00130002.015