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URANIUM IN THE TISSUE OF OCCUPATIONALLY EXPOSED WORKERS

Evan E. Campbell, James F. McInroy, and H. F. Schulte

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Since 1959, the Los Alamos Scientific Laboratory (LASL) Industrial Hygiene Group has obtained human necropsy material for analysis. The analysis consists of plutonium and uranium measurements by variations of the methods routinely used in the bioassay program to determine these elements in the urine of workers potentially exposed to either or both of these elements. The original intent of the tissue analysis program was to assess the validity of estimates of plutonium body content by urine analysis and the validity of industrial hygiene controls as determined by uranium in workers' urine. The data accumulated in this program for plutonium found in autopsy tissue have been reported in LA-4875[1] and LA-4876[2].

During this study some 350 cases were analyzed for uranium. The object of these analyses was to detect and determine the amount of uranium in the tissue of deceased occupationally exposed uranium workers. While many non-occupational (general population) cases were analyzed, it was not a primary objective of this program to establish the normal levels of these cases. The program is continuing with a greater emphasis on collecting occupationally exposed cases.

I. TISSUE SAMPLES

A. Sample Selection

The cooperating pathologists provide samples from as many autopsies as permissible. No attempt is made to exclude any case. Most of the cases, however, are from residents of Los Alamos, New Mexico, and the surrounding area with a few cases from other states. Los Alamos is essentially a single-industry town with a population of approximately 17,000. The industry includes a research facility involved with the fabrication and use of both depleted and enriched uranium in various forms. Some tissue samples have been obtained from outside this geographic area, but in general, occupational histories have not been available. A routine set of tissues include lymph nodes (hilar), lung, kidney, liver and a vertebral wedge.

B. Autopsy Samples

The pathologist packages each tissue sample separately in a plastic bag. These tissues are frozen until released by the pathologist for chemical processing. Small sections of the tissue are preserved for histopathology and other clinical analyses.

Lung. Both lungs are normally received and treated without special preparation. Small amounts of tissue other than lung normally accompany the sample. No attempt is made to separate the lower bronchial lymph nodes or pulmonary lymphatic tissue from the lung tissue itself. The weight recorded normally represents both lungs.

Liver. The whole organ is normally received.

Kidney. At least one kidney has been used in each case. Every attempt is made to obtain both kidneys for analysis.

Lymph Nodes. A sample of lymphatic tissue of the tracheobronchial (hilar) region is received for analysis. Usually, it includes only the lymph nodes of

that region and is only a small part of the total lymph node mass associated with the respiratory tract. In some cases, adnexal tissue associated with the lymph nodes is included in the analysis thus adding an uncertainty to the real weight of the lymph node and consequently the uranium concentration.

Bone. Bone samples are normally wedges from the 4th and 5th lumbar vertebrae; ribs and sternum are occasionally obtained. The bone weights include only a small amount of adnexal tissue. The marrow is included in all bone samples analyzed unless specified. Each bone sample is analyzed separately and identified.

II. ANALYTICAL PROCEDURE

A. Method

1. Each tissue is placed in an appropriately sized vessel for dry ashing. The liver and lung are placed in porcelain evaporating dishes and the other tissues are placed in Pyrex beakers of appropriate sizes.

2. The samples are placed on shelves in a muffle furnace to prevent direct heating of the vessel. The temperature-programmed muffle furnace is operated from 200 to 500°C, reaching maximum temperature in 24 h. The samples are maintained at 500°C for 24 h.

3. After the sample cools in the furnace, the residue is transferred to a 300-cm^3 beaker. The ashing liver and lung dishes are thoroughly washed with 2N HNO_3. The washings are combined with their respective residues and evaporated to dryness. Other ashed tissues do not require transferring and are handled directly in their respective beakers.

4. Each residue is heated repeatedly with HNO_3 and HF until it is white. From 1968 to 1971, 50% H_2O_2 was used in conjunction with the HNO_3 to speed the ashing process. The use of this reagent was discontinued because of the high metal content present as the stabilizing agent and only 30% unstabilized H_2O_2 is now employed. Excess HF is removed by repeated evaporation with HNO_3.

5. Each residue is finally dissolved in 2N HNO_3 and transferred to a volumetric flask. Except for an occasional lung and bone sample, the procedure brings about complete dissolution of the residue. The following volumes are normally used to store each sample prior to analysis:

Liver	1000-cm^3	Lymph Nodes	50-cm^3
Lung	1000-cm^3	Bone	250-cm^3
Kidney	100-cm^3		

6. Each sample is mixed well and stored at <21°C pending analyses of groups of samples for uranium, plutonium or other nuclides.

B. Normal Uranium Determination

1. A 0.1 cm^3 aliquot of each tissue solution is transferred to a platinum dish. This solution is evaporated to dryness, fused with sodium fluoride containing 2% lithium fluoride and the uranium fluorescence measured in a modified Jarrel Ash fluorometer. Three determinations are made on each solution. The method has adequate sensitivity (5 µg/liter), but has poor precision. The recovery of uranium (% ± 1σ) from 500 g of spiked beef liver is shown in Table 1.

Blank samples varied from 0 to 5 µg per liter based on the apparent concentration of uranium in solution.

The sample is returned to storage pending analyses for other nuclides and any other metal of interest.

3. The fluorometric procedure is affected by quenching when the iron concentration is high. In order to eliminate this effect, an aliquot of the tissue solution is reduced with ascorbic acid and the uranium extracted with tri-

isooctylamine. An aliquot of the extracting solution is placed directly on a sodium fluoride-lithium fluoride pellet and fused in the usual manner*.

C. Radiometric Method

When it is known that samples originated from a former uranium worker exposed to enriched uranium, or, the gravimetric method indicated an exposure to uranium, the samples are analyzed radiometrically; the uranium is isolated by anion exchange, electroplated and counted by alpha pulse height analysis using ^{232}U an internal tracer.

III. BIOASSAY SAMPLING OF EMPLOYEES POTENTIALLY EXPOSED TO URANIUM

A. Routine Urine Sampling Program:

The routine urine sampling program for both normal (gravimetric) and for enriched (radiometric) uranium has varied considerably depending on the work load within the uranium work areas at the laboratory. In most studies on the surveillance of exposure, a bi-weekly sampling schedule is followed. Until 1972, urine samples were collected in standard spot urine sampling bottles (plastic coated cones) without preservatives and analyzed immediately. In recent years, the number of urine samples collected in the overall bioassay program have increased, resulting in an increased time lapse between collection and analysis. To facilitate this, urine samples are now being collected in high impact polystyrene screw-cap bottles and acidified with HNO_3 to prevent wall losses.

NOTE: The concentration of uranium in urine shows a significant reduction with time on standing. Pyrex sample bottles are preferred but not economical. No uranium has been observed in the uric acid crystals that form when HNO_3 is used as a preservative.

1. Normal and Depleted Uranium (Gravimetric) In Urine

Three 0.1 cm^3 aliquots of urine are placed on platinum dishes, evaporated to dryness, ashed by flaming, fused with a NaF flux (2% LiF) and the fluorescence is determined in a fluorophotometer. The precision of the method has a relative standard deviation of ± 25% for concentrations less than 50 ug/liter and ± 7% for higher values.

2. Enriched Uranium (Radiometric) In Urine

During some of the early urine analyses, the uranium was electroplated directly from the urine with an acid-oxalate-electrolyte on silver. The procedure was changed in 1954 to a di(2-ethyl-hexyl) phosphate extraction of an alkaline earth concentration of the uranium from a 24 h urine sample which was then plated directly on platinum. The method was further changed in 1957 to an alkaline earth co-precipitation concentration, followed by ashing, anion exchange isolation and by direct plating on 2.2 cm diameter stainless steel plates and alpha counted by gas flow proportional counting. Since 1960, the following procedure has been employed:

The uranium in seventy-five ml of urine is precipitated at 80°C as the phosphate by the alkaline earth co-precipitation method. The precipitate is separated by centrifugation, ashed with HNO_3, converted to the chloride, dissolved in 8N HCl and isolated on a Bio-Rad AG 1 X 10 anion exchange resin column. The column is eluted with dilute HCl and the eluate evaporated to dryness. The isolated uranium is redissolved and transferred to a 2.2 cm diameter stainless steel disc and counted in a gas flow proportional counter for 50 min. The counter background is 0.02 counts per minute with an efficiency of 0.47 counts per disintegration. The accuracy of the method at 25 dis/min per liter is approximately 80% with a precision at 1σ of ± 15% in routine use.

*Procedure to be published by M. F. Milligan and Patricio Trujillo.

IV. RESULTS

A. General Population

During the program for the determination of plutonium in autopsy tissue from the general population covered by this report (1959-1972), aliquots of all ashed tissue sample solutions were screened for uranium. The relatively high detection level accepted for the evaluation of occupational exposure cases precluded the determination of the actual uranium concentration in the tissue of the general population. The detection limit for each organ analyzed is shown in Table 2. In the 350 cases not suspected of having any occupational exposure to uranium, only a few tissues showed a positive result. In four of these cases the lung, lymph nodes, and kidney was positive, and in the remaining cases only one, or occasionally two, of the organs from the same case indicated a positive value. The distribution of only positive values is shown in Table 2. These data are apparently not different than tissue concentrations reported elsewhere[3]. Occupational histories were not complete and the residence listed was the area in which the person died and not necessarily his major residential area.

B. Occupationally Exposed Cases

The autopsy cases obtained locally included a few former employees of the Los Alamos Scientific Laboratory (LASL). At the present time, over 130 workers at this Laboratory have signed autopsy release permits to allow the removal of organs during autopsy for scientific study. An additional 129 employees have authorized the release of their medical records for inclusion in a study of the biological effects of their exposures to radioisotopes being conducted by the U.S. Transuranium Registry. Other workers with recorded exposures are being encouraged to participate in this study. The cases included in this report have been grouped in the Appendix on the basis of their potential exposure to uranium. Table A-I lists the cases with a known high potential for exposure. These cases include workers that handled uranium either in its pure or chemically treated forms and/or were directly exposed to contaminated dust or fumes during the course of their work. Table A-II contains those cases suspected of being exposed at sometime during their employment at LASL. The actual exposure potentials for many cases in this Table are uncertain but the employee could have been in an area where uranium was present. For example, a person employed as a security guard may have, as part of his assignment, walked through a uranium facility and, therefore, could have had a potential exposure. If there existed any possibility for exposure, even though we were uncertain, the case was listed in Table A-II. Table A-III contains those cases that were analyzed for uranium as part of a routine procedure since they were former employees of LASL but had no suggestion in their work history that they had a potential exposure to uranium.

Some of the cases with positive analyses for uranium are presented individually along with details of their exposure potential, urine excretion if available, and the tissue concentration at the time of death. Medical records, exposure history, work history, accidents, air sampling results, urine bioassay, etc. are given when available.

Case No.	- 1-054	Sex	- Male
Occupation	- Machinist (Foreman)	Weight	- 78 kg
Cause of Death	- Heart Attack	Age at Death	- 60 years
HEW Code No.	- 434.1	Year of Death	- 1959
		Employed	- 16 years

The foreman worked as the head of a uranium machine shop from 1943 to 1948 and was promoted to shop foreman in 1951 with other administrative assignments from 1946-1951. The air concentration found in the shop prior to 1950 was 29 µg U/m^3 during machining. As a foreman in a shops department he had only occasional encounters with uranium aerosols. No urine samples were collected during his employment. The concentration of uranium in the only tissues received was consistent with the early potential exposure.

Case No.	- 1-058	Sex	- Male
Occupation	- Machinist	Weight	- NA
Cause of Death	- Heart Attack	Age at Death	- 50 years
HEW Code No.	- 420.1	Year of Death	- 1959
		Employed	- 9 years

The machinist worked in a depleted uranium fabrication shop. The breathing zone air concentration during the working period varied up to approximately 25 µg U/m^3 depending on the work load and improvements in industrial hygiene controls. These controls and the urinary excretion of this and other machinists in the shop were described by Campbell et al.[-] in 1959. The urinary excretion of 9 uranium workers in the shop decreased from an average of 50 µg U/liter in 1954 to 10 µg U/liter in 1958 (Figure 1). The urinary excretion pattern shown by this machinist (Table 4) clearly follows the trend of the group. The uranium exposure was primarily to dust even though fumes from metal turning fires and overheated uranium machining were occasionally suspended in the general room air. The particle size was estimated by Hyatt et al.,[5] to be 0.4 to 3.9 µm MMD (Mass Median Diameter) depending on the operation and activity in the shop.

The machinist worked with a large piece of uranium during the day prior to his death that evening. There were no significant pathological findings that could be related to a potential exposure.

The concentrations of uranium in the post mortem tissues are shown in Table 5. The high concentration of uranium in the lymph nodes confirms the earlier exposures indicated by the urinary excretion levels during the period from 1950-1955. The ratio of concentration of uranium in the lung to that in the lymph would probably not be meaningful for modeling purposes because of the high potential for exposure less than a half day prior to death. An inhalation exposure that day would have increased the lung burden but would not have resulted in significant transport of the uranium to the lymphatic system.

Case No.	- 1-128	Sex	- Male
Occupation	- Mechanical Technician	Weight	- 71 kg
Cause of Death	- Asphyxia	Age at Death	- 31 years
HEW Code No.	- 926.7	Year of Death	- 1961
		Employed	- 6 years

The employee worked in a very low potential exposure job on the Security Force, but also worked part time as a technician for two years. For the 4 years prior to his death he was employed full time as a mechanical technician involved with uranium, containing various degrees of enrichment and also had occasional exposure potential to ^{140}Ba - ^{140}La. During the period from May 1957 to February 1961, a total of 28 urine samples were collected with all analyses indicating less than 5 µg per liter. No significant exposure data were reported during his employment.

Analysis of available tissue for uranium is shown in Table 6.

Case No.	- 1-150	Sex	- Male
Occupation	- Machine Repair Tech.	Weight	- 63 kg
Cause of Death	- Heart Attack	Age at Death	- 51 years
HEW Code No.	- 433.1	Year of Death	- 1961
		Employed	- 8 years

The technician repaired various machines in shops performing machining operations on normal, depleted and enriched uranium, as well as some assignments in plutonium fabrication areas. Below are tabulated the working hours in each area.

Area (Potential Exposure)	Hours (3-1-59 to 1-1-61)
Plutonium	552
Enriched Uranium	100
Depleted or Normal Uranium	270
Balance	303

No significant exposure data are recorded. During the few months prior to his death, he was assigned full time in an enriched uranium machine shop for maintenance of the machines. No urine samples were analyzed for uranium during the time of his employment. Tissue concentrations of uranium are shown in Table 7.

Case No.	- 2-004	Sex	- Male
Occupation	- HP Laborer	Weight	- 68.2 kg
Cause of Death	- Lung Cancer	Age at Death	- 68 years
HEW Code No.	- 163.0	Year of Death	- 1967
		Employed	- 12 years

As a laborer, he was assigned to truck operations which handled contaminated trash. The trash was sealed in boxes for disposal. During the 12 years of exposure potential (1946-1958) approximately 12 high nose swipe counts and no reportable incidents were documented. No urine samples were analyzed for uranium during his employment nor can any estimation be made of his exposure to uranium.

The laborer died about 9 years after his resignation. Only routine autopsy samples were available for analysis, and the results are shown in Table 8.

Case No.	- 2-030	Sex	- Male
Occupation	- HP Monitor	Weight	- 62 kg
Cause of Death	- Heart Attack	Age at Death	- 42 years
HEW Code No.	- 456.1	Year of Death	- 1962
		Employed	- 10 years

The Health Physicist monitor was assigned to a plutonium processing facility. During the 13 years of employment, approximately 5 high nose swipe counts were observed during the handling of plutonium with only one reported exposure incident (1958) involving enriched uranium in a graphite-box explosion. No urine samples were analyzed for uranium during the period of his employment. The results of the analysis of tissues for uranium are shown in Table 9.

Case No.	- 2-098	Sex	- Male
Occupation	- Physicist	Weight	- 62 kg
Cause of Death	- Malignant Melanoma	Age at Death	- 46 years
HEW Code No.	- 199.0	Year of Death	- 1962
		Employed	- 10 years

The employee had no significant exposure potential to uranium having worked in a nondestructive testing facility where units were inspected by x-ray. No urine samples were collected for uranium analysis and no significant exposure data were recorded. The results of the tissue analysis are shown in Table 10.

Case No.	- 2-126	Sex	- Male
Occupation	- Chemist	Weight	- 79 kg
Cause of Death	- Cirrhosis	Age at Death	- 52 years
HEW Code No.	- 581.1	Year of Death	- 1962
		Employed	- 7 years

The case was directly involved in the disposal of liquid radioactive wastes, including uranium, in a waste disposal plant. No exposure data or urine samples analyzed for uranium are recorded.

Case No.	- 3-014	Sex	- Male
Occupation	- Physicist	Weight	- 77 kg
Cause of Death	- Cardiac	Age at Death	- 55
HEW Code No.	- 420.1	Year of Death	- 1965
		Employed	- 23 years

As a physicist, this case was directly involved with early reactor development and weapon testing. His exposure potential to uranium during his 23 years of employment was minimal during the first eight years. His primary exposure to any uranium was associated with fall-out from weapons testing. No significant uranium exposure data are recorded. No urine samples were collected for uranium analysis.

Case No.	- 7-016	Sex	- Male
Occupation	- Machinist	Weight	- 54 kg
Cause of Death	- Heart Attack	Age at Death	- 62 years
HEW Code No.	- 420.1	Year of Death	- 1971
		Employed	- 26 years

The machinist was employed in a normal or depleted uranium shop for 26 years with an occasional low exposure potential to enriched uranium for 14 years prior to retirement. The air concentration during his early work varied up to 25 μg U/m^3 with a particle size range of 0.4 to 2.9 μm (MMD)[5] depending on the operation and activity in the shop. The air concentration during the later 14 years of work was less than 5 μg U/m^3.

The machinist died of a heart attack 6 months after his retirement. He was known to have extremely fixed but somewhat peculiar dietary habits and was a nonsmoker who use self-administered medicinals of various types and bordered on hypochondria. His daily intake of alcohol was sufficient to cause the cirrhosis of the liver observed at autopsy.

The urinary excretion pattern of uranium during the machinist's employment is shown in Table 13. In July of 1967, several urine analyses were higher than normal and inconsistent with the work load in the uranium shop and also

were inconsistent with the observed air concentrations and other employees' urinary excretion patterns. His excretion of uranium varied with an average concentration of approximately 50 µg/liter, except for an 11-day period where 2 daily samples were collected at 11 AM and 4 PM under controlled conditions with a total excretion of approximately 400, 82, 94, 400, 280, 195, 230, 168, 50, 200, 275, 60, 21, 21 . . . µg U/day. This excretion pattern was inconsistent with his work load. Three other machinists in the same shop used as positive controls had no significant excretion of uranium (<5 µg/liter) during the same period. A large number of urine samples were collected during the ensuing 7 months in an attempt to identify the excretion pattern. Every effort was made to determine the source of the uranium observed in the urine. The uranium was determined by alpha pulse height analysis to be depleted uranium similar to that normally worked by the machinist. No change in his exposure, personal habits or physiology would account for the increased urinary uranium excretion or the diurnal variability observed. Urine samples collected during a period of time during which the machinist was removed from the uranium work were similar to the previous pattern. Samples collected at home or at the shop were found to contain levels that were randomly distributed from zero (<5 µg/liter) to ≈100 µg/liter. Constant surveillance of the fluorimetric uranium analysis indicated that the fluctuations were not related to either the analytical techniques or the urine collection procedures. Breathing zone and general room air samples were found to be <10 µg U/m^3. Omission of the various medicinals had no effect on the random excretion rates observed. Removal of the machinist to other nonuranium work areas had little effect on his uranium excretion pattern until the middle of 1968 when an apparent expected and low level excretion pattern was reestablished. During the last 20 months prior to his retirement, no significant uranium urinary excretion was observed.

Using the available data, it was estimated that the lung burden of nontransportable uranium was ≈15 mg or 30% of a permissible burden for depleted uranium[7] in mid 1967. After an additional 3 months of study, the estimate appeared high, but variability was too great to warrant a more precise estimation.

No significant gross or microscopic pathology other than that consistent with cirrhosis of the liver and heart attack were observed. Only the routine tissue samples became available for chemical analysis. The results of the analyses are shown on Table 14.

Case No.	- 7-096	Sex	- Female
Occupation	- Recovery Process Operator	Weight	- 48 kg
Cause of Death	- Leukemia	Age at Death	- 61
HEW Code N.	- 204.3	Year of Death	- 1972
		Employed	- 28 years

The employee worked as a recovery process operator. She entered the hospital in May of 1972 and died of acute granulocytic leukemia in October of that year at the age of 61. Exposure and bioassay data will be published as soon as practical. Tissue concentrations are shown in Table 15.

Code No.	- 10-002	Sex	- Male
Occupation	- Chemical Operator	Weight	- NA
Cause of Death	- Granulocytic Leukemia	Age at Death	- 65
HEW Code No.	- 204.1	Year of Death	- 1972
		Employed	- 25 years

This person was a chemical technician for 25 years. He died of rapidly progressive granulocytic leukemia and severe coronary artery disease. Exposure and bioassay data will be published as soon as practical. Radiometric analyses results of his tissue concentrations are shown in Table 16.

V. Comments

The concentration of uranium in the tissue of autopsy cases known to have had a high potential for occupational exposure (Table A-I) to the element were significantly different from the tissue concentrations found in non-occupationally (general population) exposed cases. All cases in this group but three had measurable concentrations of uranium in more than one organ. Two of the cases (2-030 and 2-100) not having a positive value in more than one tissue were health physics monitors in a plutonium fabrication area where the uranium concentration would be minimal. They may have been assigned occupationally to areas where the potential exposure to uranium was high. Case 5-138 was a metallurgical technician that worked with a variety of metals, primarily plutonium, with occasional work with uranium under primitive conditions. A limited amount of lymphatic and tumor tissue were taken as biopsy specimens and analyzed for uranium and plutonium. Table 17 summarizes the data presented in this paper.

The very low lung to liver and lung to skeleton ratios of uranium burden

DISCUSSION

TESSMER: With the tissue concentrations, were you able to see a constant ratio in any of them? In other words, as you looked at each case, did you find relatively constant distribution in the four tissues that you are dealing with?

CAMPBELL: No, we did not find a constant ratio. Probably because of the difference in time, from the time of exposure to the time of death, and also the type of exposure the man had. While these were machinists, they perform a large number of different types of machine operations.

TESSMER: Did you have enough cases for a comparison?

CAMPBELL: There were not enough cases in each type of category.

TESSMER: At least one of the cases seemed to have an exceptionally high concentration in the lymph. When you say lymph, do you mean lymphoid tissue, lymph glands collected as such?

CAMPBELL: The reference is to trachial bronchial lymph nodes.

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TABLE 1

RECOVERY OF URANIUM FROM BEEF LIVER

µgU added	% Recovered ± 1σ
108	97 ± 3%
54	93 ± 4%
27	76 ± 6%

TABLE 2

URANIUM IN TISSUE OF UNEXPOSED POPULATION

TISSUE	MINIMUM DETECTABLE LEVEL MDL[2] (ngU/g)	TISSUES WITH POSITIVE URANIUM VALUES[1] NUMBER OF TISSUES	CONCENTRATION RANGE (ngU/g WET SAMPLE) THIS STUDY	PREVIOUSLY REPORTED
LUNG	5	18	10 - 68	6 - 89
LYMPH NODES	2[3]	22[4]	4 - 62[4]	---
LIVER	2.5	3	5,20,10	8 - 93
KIDNEY	1	21	1 - 110	20 - 30
BONE	2	2	10,30	4 - 28

(1) 35 out of 350 cases gave a positive value in at least one tissue.
(2) MDL - Minimum detectable level based on a detection limit of 5 µg U/liter of solution analyzed.
(3) The detection limit varies significantly depending on the weight of lymph nodes received and the volume analyzed.
(4) Detection limit and results vary with weight and volume; the reported values may be underestimated because of adnexal tissue.

TABLE 3

URANIUM IN TISSUE OF CASE 1-054

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Weight)
LUNG	354	11
LYMPH NODES	25.4	488

TABLE 4

URINARY EXCRETION OF URANIUM IN CASE 1-058

YEAR	NUMBER OF SAMPLES	NO. OF POSITIVE SAMPLES	URANIUM CONCENTRATION (ug/liter AVERAGE	MAXIMUM VALUE
1950	36	34	29.6	250
1951	19	12	21.7	73
1952	19	19	44.3	120
1953	15	15	53	250
1954	50	50	46.6	210
1955	49	48	35.2	230
1956	19	17	13	28
1957	6	5	8	14
1958	9	6	7	16

TABLE 5

URANIUM IN THE TISSUES OF CASE 1-058[1]

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Tissue)
Vertebrae	124	31
Rib	163	20
Sternum	99	39
Femur	143	10
Marrow	7	<MDL
Lungs	1020	833
Liver	1320	5
Kidney	222	113
Spleen	383	<MDL
Tracheobronchial LN	22[2]	>545[3]
Mediastinal LN	44[2]	57
Mesenteric LN	1.4	<MDL

[1]Case referred to in Wash 1251, June 1974[5].

[2]The presence of adnexal tissue causes the calculated uranium concentration to be low.

TABLE 6

URANIUM IN THE TISSUE OF CASE 1-128

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Weight)
LUNG	802	21
KIDNEY	307	26
LIVER	1776	<MDL
LYMPH NODES	15	<MDL

TABLE 7

URANIUM IN TISSUES OF CASE 1-150

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM WET WEIGHT OF SAMPLE (ng U/g)	(Dis/min per Kg)[1]
LIVER	1717	<MDL	-
LUNGS	1120	38	75
KIDNEYS	332	<MDL	3.7
TRACHEOBRONCHIAL LN	36	17	<MDL

[1]Independent radiometric measurements.

TABLE 8

URANIUM IN THE TISSUES OF CASE 2-004

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Weight)
LIVER	1375	<MDL
LUNGS	1360	11
KIDNEY	280	2
TRACHEOBRONCHIAL LN	5	<MDL

TABLE 9

URANIUM IN THE TISSUE OF CASE 2-030

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Weight)
LIVER	1015	<MDL
LUNG	677	9
KIDNEY	127	<MDL
TRACHEOBRONCHIAL LN	12	<MDL
VERTEBRAE	14	<MDL

TABLE 10

URANIUM IN THE TISSUE OF CASE 2-098

ORGAN	ORGAN WEIGHT RECEIVED	CONCENTRATION OF URANIUM (ng U/g Wet Weight Tissue)
LIVER	3411	Lost During Analysis
LUNG	605	18
KIDNEY	179	<MDL
LYMPH NODE	14	28
VERTEBRAE	31	90

TABLE 11

URANIUM IN THE TISSUES OF CASE 2-126

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Weight Tissue)
LIVER	2395	10
LUNG	1580	<MDL
LYMPH NODE	11	<MDL
KIDNEY	368	14
VERTEBRAE	300	<MDL

TABLE 12

URANIUM IN THE TISSUES OF CASE 3-014

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM (ng U/g Wet Weight Tissue)
LIVER	1995	<MDL
LUNG	1003	578
LYMPH NODE	16	875
KIDNEY	105	<MDL
RIB	5	<MDL

TABLE 13

URINARY EXCRETION OF URANIUM IN CASE 7-016

YEAR	NUMBER OF SAMPLES	POSITIVE SAMPLES	URANIUM CONCENTRATION (μgU/liter)	
			AVERAGE	MAXIMUM VALUE
1957	1	0	-	-
1958	9	8	9.2	19
1959	13	7	5	19
1960	4	1	-	7
1961	10	9	21	79
1963	7	5	13	38
1964	10	7	9	20
1965	46	27	14	124
1966	11	4	3	
1967	301 (74 days)	253 (68 days)	A	288
1968	13	4	3	11
1969	10	0	-	-
1970	10	0	-	-
1971	1	0	-	-

TABLE 14

URANIUM IN THE TISSUE OF CASE 7-016

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM WET WEIGHT OF SAMPLE (ngU/gm)	(Dis/min per Kg)
Liver	2002	<MDL	1.43
Lung	1018	88	101
Kidney	221	54	30
Tracheobronchial LN	2.8	<MDL	<MDL
Vertebrae	90	<MDL	<MDL

TABLE 15

URANIUM IN THE TISSUES OF CASE 7-096

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM Dis/Min ^{234}U/kg Wet Weight
LYMPH	2.9	250
SPLEEN	156	6
LUNG	1074	123
VERTEBRAE	246	37
KIDNEY	391	3
FEMUR	318	6
LIVER	1640	4
RIB	58	31

TABLE 16

URANIUM IN THE TISSUES OF CASE 10-002

ORGAN	ORGAN WEIGHT RECEIVED (g)	CONCENTRATION OF URANIUM Dis/min ^{234}U/kg Wet Weight
LYMPH	33	459
LUNG	1002	40
AORTA & ADRENAL TISSUE	556	7
KIDNEY	408	2
LIVER	2481	0.35
BONE	6	2.8

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TABLE 17

SUMMARY OF SIGNIFICANT TISSUE CONCENTRATIONS OF URANIUM IN POTENTIALLY EXPOSED WORKERS

CASE NO	OCCUPATION	YEAR EMPLOYED	YEAR DIED	TISSUE CONCENTRATION OF URANIUM (ug/kg) LUNG	L.N.	LIVER	KIDNEY	BONE	URINE SAMPLES COLLECTED	AVERAGE LAST YEAR
1-054	Machinist	1943	1959	11	488	NA	NA	NA	0	--
1-058	Machinist	1950	1959	833	545	5	113	31	201	40
1-128	Technician	1955	1961	21	<MDL	<MDL	26	NA	28	0
1-150	Machinist	1951	1961	38	17	<MDL	<MDL	NA	1	--
2-004	Laborer	1946	1961	11	<MDL	<MDL	2	NA	0	--
2-098	Physicist	1946	1962	18	28	NA	<MDL	90	0	--
3-014	Physicist	1943	1965	578	875	<MDL	<MDL	<MDL (rib)	0	--
5-080	Metallurgist	1956	1970	37	284	NA	<MDL	<MDL	0	--
7-016	Machinist	1957	1971	88	<MDL	<MDL	54	<MDL	456	0

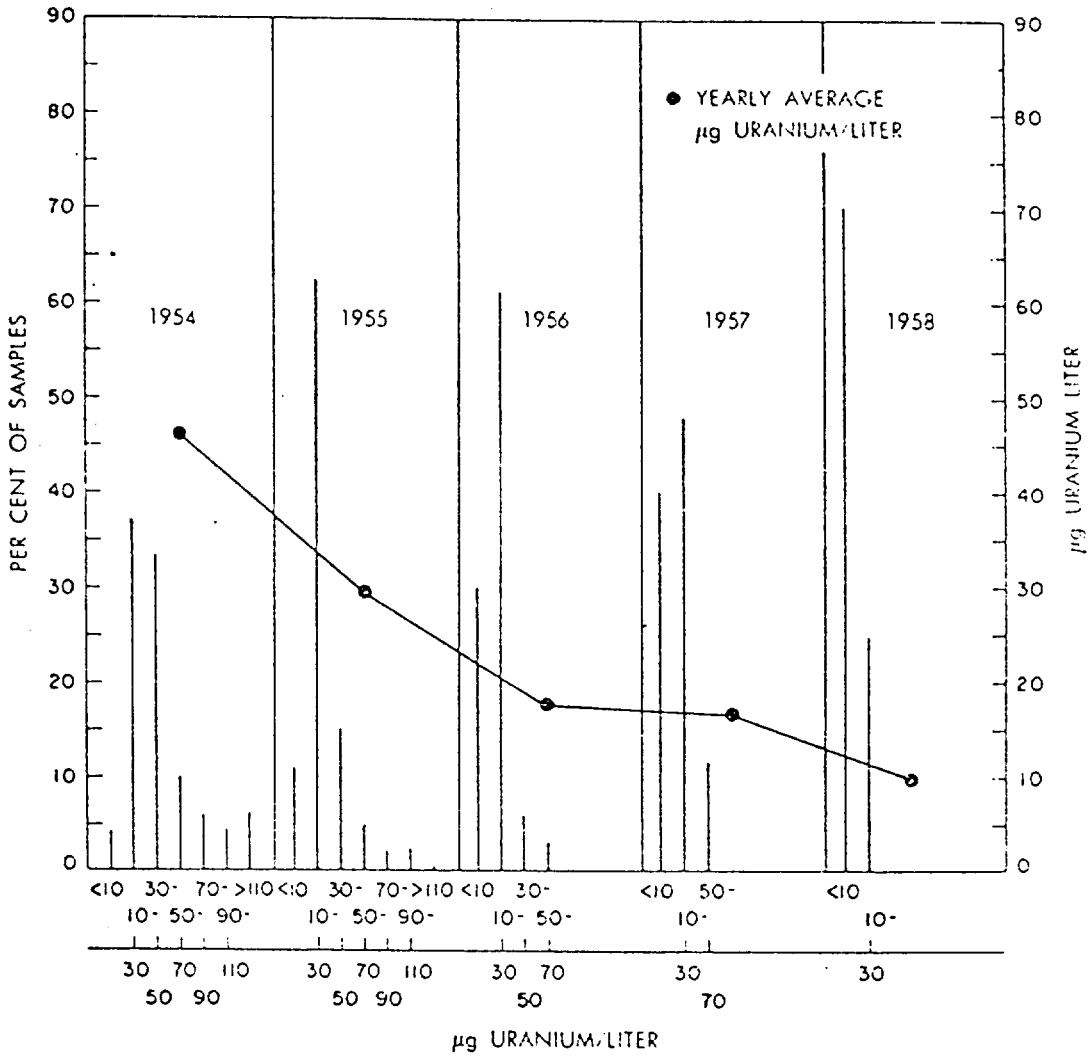

FIGURE 1

Frequency and distribution of uranium excretion levels for nine tubailoy machinists over a 5-year period

APPENDIX

AUTOPSY INFORMATION AND TISSUE ANALYSIS DATA FOR CASES HAVING A POTENTIAL OCCUPATIONAL EXPOSURE TO URANIUM

The Table contains the available background information on each case:

1) Case Number - A unique number assigned to each case at the time the tissues are received by this Laboratory.
2) Occupation - A general description of the major work responsibilities of the individuals.
3) Resident - The city of residence at the time of death.
4) State - The state in which the city is located.
5) Cause of Death - The primary cause of death as identified by the attending pathologist.
6) HEW Code Number - A standarized numerical identification of disease and/or physical disabilities developed and published by the Department of Health, Education and Welfare.
7) Sex - Male (M) or female (F)
8) Age - Age at the time of death.
9) Years - Years of employment.
10) Year- Year of death.
11) Kg - Weight (Kg) at time of death.

Any of the above information not available to us is identified as "NA".

Also included in the Table is information about the tissues and the analytical results.

1) Tissue- Identification of the tissue analyzed.
2) Wet Weight of Sample - The weight (g) of the tissue as received from the pathologist. The specimen has usually had a small piece (≈5-10g) removed for histological examination and a 20g sample is removed by this Laboratory and preserved for future analysis.
3) Volume of Sample - The volume (cm^3) of 2N HNO_3 in which the ashed tissue sample is dissolved and stored until analyzed.
4) Volume Sample Analyzed - The aliquot of the above solution taken for analysis.
5) Uranium Mass per Volume Analyzed - The measured mass (µg) of uranium in the volume of solution analyzed.
6) Uranium Mass per Organ Weight - The extrapolated mass (µg) of uranium in the tissue analyzed.
7) Uranium Mass per Kilogram Tissue - The concentration expressed in µg Uranium/kg tissue.
8) Uranium Mass per Standard Organ - The extrapolated mass (µg) of uranium in the ICRP Committee IV standard man organ weight. See Table A-II

Two methods were used in the fluorometric analysis of uranium (see text for a description of each method). The minimum detectable level (MDL) for each method was a function of the background, the count statistics, the size of the aliquot analyzed, etc. Therefore, the use of larger aliquots increased the sensitivity and resulted in the variation in MDL observed in samples where an aliquot greater than 0.1 cm^3 was analyzed.

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TABLE A-I. EMPLOYEES WITH POTENTIAL OCCUPATIONAL EXPOSURES TO URANIUM

*<MDL = MINIMUM DETECTABLE LEVEL BASED ON SAMPLE WEIGHT, VOLUME OF SOLUTION, TOTAL COUNTS, BACKGROUND AND RECOVERY STATISTICS

			TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
CASE NO.	1-054	SEX M	LUNG	354.0	200	.1	.002	3.80	10.73	10.73
OCCUPATION	MACHINIST	AGE 60	LYMPH NOD	25.4	25	.1	.050	12.40	488.19	7.32
RESIDENT	LOS ALAMOS	YEARS 10								
STATE	NEW MEXICO									
CAUSE OF DEATH	CARDIAC	YEAR 1959								
MEM CODE NO.	434.1	KG 78								
CASE NO.	1-058	SEX M	LIVER	1320.0	1000	.1	.001	7.00	5.30	9.55
OCCUPATION	MACHINIST	AGE 50	LUNG	1020.0	1000	.1	.095	650.00	833.33	833.33
RESIDENT	LOS ALAMOS	YEARS 36	LYMPH NOD	22.0	100	.1	.012	12.00	545.45	8.19
STATE	NEW MEXICO		LYMPH NOD	44.0	50	.1	.005	2.50	56.82	.85
CAUSE OF DEATH	CARDIAC	YEAR 1959	LYMPH NOD	1.4	50	.1	<MDL			
MEM CODE NO.	429.1	KG NA	KIDNEY	222.0	100	.1	.025	25.00	112.61	34.91
			SPLEEN	323.0	100	.1	<MDL			
			VERTEBRAE	124.0	100	.1	.004	3.90	31.45	314.52
			RIB	163.0	250	.1	.003	3.25	19.94	199.39
			STERNUM	99.0	100	.1	.004	3.90	39.39	393.94
			FEMUR	143.0	100	.1	.001	1.40	9.79	97.69
			MARROW	7.0	50	.1	<MDL			
CASE NO.	1-128	SEX M	LIVER	1776.0	1000	.1	<MDL			
OCCUPATION	TECHNICIAN	AGE 31	LUNG	902.0	1000	.1	.002	17.00	21.23	21.20
RESIDENT	LOS ALAMOS	YEARS 06	LYMPH NOD	15.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	307.0	100	.1	.008	8.00	26.06	8.08
CAUSE OF DEATH	ASPHYXIA	YEAR 1961								
MEM CODE NO.	962.7	KG 71								
CASE NO.	1-150	SEX M	LIVER	1717.0	1000	.1	<MDL			
OCCUPATION	MACHINIST	AGE 51	LUNG	1129.0	1000	.1	.004	43.00	38.09	38.09
RESIDENT	LOS ALAMOS	YEARS 08	LYMPH NOD	36.0	50	.1	.001	.60	16.67	.25
STATE	NEW MEXICO		KIDNEY	332.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1961								
MEM CODE NO.	433.1	KG 63								
CASE NO.	2-004	SEX M	LIVER	1375.0	1000	.1	<MDL			
OCCUPATION	HP CARPER	AGE 69	LUNG	1349.0	1000	.1	.001	15.00	11.03	11.03
RESIDENT	LOS ALAMOS	YEARS 11	LYMPH NOD	5.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	290.0	100	.1	.001	.70	2.50	.77
CAUSE OF DEATH	LUNG CANCER	YEAR 1961								
MEM CODE NO.	163.0	KG 68								
CASE NO.	2-030	SEX M	LIVER	1815.0	1000	.1	<MDL			
OCCUPATION	HP MONITOR	AGE 66	LUNG	677.0	1000	.1	.001	6.00	8.86	8.86
RESIDENT	LOS ALAMOS	YEARS 13,	LYMPH NOD	12.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	127.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1962	VERTEBRAE	14.0	50	.1	<MDL			
MEM CODE NO.	456.1	KG 62								
CASE NO.	2-100	SEX M	LIVER	2088.0	1000	.1	<MDL			
OCCUPATION	HP MONITOR	AGE 44	LUNG	546.0	1000	.1	.001	15.00	27.47	27.47
RESIDENT	LOS ALAMOS	YEARS 15	LYMPH NOD	6.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	263.0	100	.1	<MDL			
CAUSE OF DEATH	PERITONITIS	YEAR 1962	VERTEBRAE	355.0	500	.1	<MDL			
MEM CODE NO.	434.0	KG 77								
CASE NO.	3-014	SEX M	LIVER	1935.0	1000	.1	<MDL			
OCCUPATION	PHYSICIST	AGE 59	LUNG	1367.0	1000	.1	.058	580.00	578.27	578.27
RESIDENT	LOS ALAMOS	YEARS 23	LYMPH NOD	14.0	50	.1	.028	14.00	875.00	13.12
STATE	NEW MEXICO		KIDNEY	135.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1965	RIB	5.0	50	.1	<MDL			
MEM CODE NO.	429.1	KG 77								
CASE NO.	5-040	SEX M	LUNG	577.0	500	10.0	.433	21.59	37.26	37.26
OCCUPATION	METALLURGIST	AGE 65	LYMPH NOD	8.0	25	5.0	.455	2.27	284.37	4.27
RESIDENT	LOS ALAMOS	YEARSNA	KIDNEY	343.0	100	10.0	< .033			
STATE	NEW MEXICO		VERTEBRAE	125.0	250	10.0	< .030			
CAUSE OF DEATH	BAD HEART	YEAR 1970								
MEM CODE NO.	429.1	KG 95								
CASE NO.	5-138	SEX M	LYMPH NOD	1.2	25	5.0	.033	.15	125.00	1.87
OCCUPATION	METALLURGIST	AGE 59	TUMOR	.8	100	5.0	< .015			
RESIDENT	LOS ALAMOS	YEARS NA								
STATE	NEW MEXICO									
CAUSE OF DEATH	BIOPSY SAMPL	YEAR 1971								
MEM CODE NO.	229.0	KG 79								
CASE NO.	7-018	SEX M	LIVER	2302.0	1000	.1	<MDL			
OCCUPATION	MACHINIST	AGE 62	LUNG	1918.0	1000	.1	.009	90.00	88.41	88.41
RESIDENT	LOS ALAMOS	YEARS NA	LYMPH NOD	2.4	25	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	221.0	100	.1	.012	12.00	54.32	16.83
CAUSE OF DEATH	HEART ATTACK	YEAR 1971	VERTEBRAE	90.0	200	.1	<MDL			
MEM CODE NO.	420.1	KG 54								

TABLE A-II. EMPLOYEES WITH LOW POTENTIAL EXPOSURE TO URANIUM

*<MDL = MINIMUM DETECTABLE LEVEL BASED ON SAMPLE WEIGHT, VOLUME OF SOLUTION, TOTAL COUNTS, BACKGROUND AND RECOVERY STATISTICS

			TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
✓ CASE NO.	2-095A	SEX M	LIVER	1710.0	1000	.1	<MDL			
OCCUPATION	PLUMBER	AGE 39	LUNG	1160.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 11	LYMPH NOD	5.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	323.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY HEM	YEAR 1962	VERTEBRAE	297.0	250	.1	<MDL			
MEM CODE NO.	420.1	KG 61								
✓ CASE NO.	2-064	SEX M	LIVER	1358.0	1000	.1	<MDL			
OCCUPATION	CARPENTER	AGE 49	LUNG	809.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS NA	LYMPH NOD	12.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	255.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1962	VERTEBRAE	167.0	250	.1	<MDL			
MEM CODE NO.	429.1	KG 73								
✓ CASE NO.	2-066	SEX M	LIVER	2025.0	1000	.1	<MDL			
OCCUPATION	TECHNICIAN	AGE 48	LUNG	940.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 11	LYMPH NOD	13.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	254.0	100	.1	<MDL			
CAUSE OF DEATH	DRUGS	YEAR 1962	VERTEBRAE	385.0	500	.1	<MDL			
MEM CODE NO.	932.0	KG NA								
✓ CASE NO.	2-068A	SEX M	LIVER	1406.0	1000	.1	<MDL			
OCCUPATION	ENGINEER	AGE 43	LUNG	1059.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 14	LYMPH NOD	7.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	282.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1962	VERTEBRAE	253.0	500	.1	<MDL			
MEM CODE NO.	429.1	KG 73								
✓ CASE NO.	2-088A	SEX M	LIVER	3713.0	1000	.1	<MDL			
OCCUPATION	TRUCK DRIVER	AGE 52	LUNG	703.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 22	LYMPH NOD	13.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	224.0	100	.1	<MDL			
CAUSE OF DEATH	LIVER CANCER	YEAR 1962								
MEM CODE NO.	156.0	KG 83								
✓ CASE NO.	2-094	SEX M	LIVER	995.0	1000	.1	<MDL			
OCCUPATION	MICROSCOPIST	AGE 62	LUNG	825.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 14	LYMPH NOD	9.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	251.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1962								
MEM CODE NO.	434.0	KG NA								
CASE NO.	2-098	SEX M	LUNG	805.0	1000	.1	.001	11.90	18.18	18.18
OCCUPATION	PHYSICIST	AGE 59	LYMPH NOD	14.0	50	.1	.001	.65	29.57	.43
✓ RESIDENT	LOS ALAMOS	YEARS 16	KIDNEY	279.0	100	.1	<MDL			
STATE	NEW MEXICO		VERTEBRAE	31.0	250	.1	.001	2.82	90.32	993.23
CAUSE OF DEATH	MALIG. MELANOMA	YEAR 1962								
MEM CODE NO.	190.9	KG NA								
CASE NO.	2-126	SEX M	LIVER	2345.0	1000	.1	.002	25.00	10.66	10.79
OCCUPATION	CHEMIST	AGE 52	LUNG	1583.0	1000	.1	<MDL			
✓ RESIDENT	LOS ALAMOS	YEARS 07	LYMPH NOD	11.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	348.0	250	.1	.002	5.00	13.59	4.21
CAUSE OF DEATH	CIRRHOSIS	YEAR 1962	VERTEBRAE	309.0	500	.1	<MDL			
MEM CODE NO.	581.1	KG 79								
CASE NO.	3-016	SEX M	LIVER	1995.0	1000	.1	<MDL			
OCCUPATION	METALLURGIST 3	AGE 50	LUNG	625.0	1000	.1	<MDL			
✓ RESIDENT	OS ALAMOS	YEARS19	LYMPH NOD	2.0	50	.1	<MDL			
STATE	EW MEXICO		KIDNEY	228.0	100	.1	<MDL			
CAUSE OF DEATH	BRAIN TUMOR	YEAR 1965	VERTEBRAE	55.0	250	.1	<MDL			
MEM CODE NO.	223.2	KG 75								
CASE NO.	3-022A	SEX M	LIVER	1150.0	1000	.1	<MDL			
OCCUPATION	AEC PRO FORCE	AGE 51	LUNG	1250.0	1000	.1	<MDL			
✓ RESIDEN	LOS ALAMOS	YEARS 10	LYMPH NOD	9.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	210.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY THROMBO	YEAR 1965	VERTEBRAE	153.0	250	.1	<MDL			
MEM CODE NO.	420.1	KG NA								
CASE NO.	3-088	SEX M	LIVER	2000.0	1000	.1	<MDL			
OCCUPATION	FIREMAN	AGE 43	LUNG	1710.0	1000	.1	<MDL			
✓ RESIDENT	LOS ALAMOS	YEARS 17	LYMPH NOD	9.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	350.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1965	VERTEBRAE	55.0	100	.1	<MDL			
MEM CODE NO.	420.1	KG NA								

				TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
CASE NO.	3-102	SEX M		LIVER	2365.0	1000	.1	<MDL			
OCCUPATION	ENGINEER	AGE 49		LUNG	1152.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 14		LYMPH NOD	6.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	350.0	100	.1	<MDL			
CAUSE OF DEATH	CARDIAC ARREST	YEAR 1969		VERTEBRAE	130.0	250	.1	<MDL			
MEM CODE NO.	433.1	KG 82									
CASE NO.	5-004	SEX M		LIVER	1240.0	500	10.0	< .040			
OCCUPATION	PHYSICIST	AGE 69		LUNG	652.0	500	10.0	< .040			
RESIDENT	LOS ALAMOS	YEARSNA		KIDNEY	245.0	250	10.0	< .040			
STATE	NEW MEXICO			VERTEBRAE	100.0	100	5.0	.050	1.00	10.00	100.00
CAUSE OF DEATH	GNSHTWND IN HEAD	YEAR 1970									
MEM CODE NO.	E979.8	KG NA									
CASE NO.	5-07A	SEX M		LIVER	1726.0	500	10.0	< .070			
OCCUPATION	LABORER	AGE 44		LUNG	1045.0	500	10.0	< .043			
RESIDENT	LOS ALAMOS	YEARSNA		LYMPH NOD	20.0	25	5.0	< .050			
STATE	NEW MEXICO			KIDNEY	464.0	100	10.0	< .090			
CAUSE OF DEATH	HEPATIC FAILURE	YEAR 1970		VERTEBRAE	90.0	200	10.0	< .090			
MEM CODE NO.	583.9	KG 64									
CASE NO.	5-10R	SEX M		LIVER	2050.0	500	10.0	< .033			
OCCUPATION	PRO FORCE	AGE 53		LUNG	1090.0	500	10.0	< .040			
RESIDENT	LOS ALAMOS	YEARSNA		LYMPH NOD	6.0	25	5.0	< .825			
STATE	NEW MEXICO			KIDNEY	250.0	100	10.0	< .033			
CAUSE OF DEATH	HEART ATTACK	YEAR 1970		VERTEBRAE	99.0	200	10.0	< .039			
MEM CODE NO.	420.1	KG NA									
CASE NO.	5-11A	SEX F		LIVER	1263.0	500	10.0	< .030			
OCCUPATION	TECHNICIAN	AGE 52		LUNG	688.0	1000	10.0	< .040			
RESIDENT	LOS ALAMOS	YEARS 20		LYMPH NOD	8.0	25	1.0	< .031			
STATE	NEW MEXICO			KIDNEY	200.0	100	10.0	< .030			
CAUSE OF DEATH	CANCER BREAST	YEAR 1970		VERTEBRAE	126.0	200	10.0	< .030			
MEM CODE NO.	170.0	KG 62									
CASE NO.	7-006	SEX M		LIVER	1800.0	1000	10.0	< .040			
OCCUPATION	PRO FORCE	AGE 52		LUNG	1322.0	1000	10.0	< .033			
RESIDENT	LOS ALAMOS	YEARS 14		LYMPH NOD	2.5	25	5.0	< .075			
STATE	NEW MEXICO			KIDNEY	360.0	100	10.0	< .043			
CAUSE OF DEATH	CARCINOMA LUNGS	YEAR 1971									
MEM CODE NO.	163.0	KG 95									
CASE NO.	7-066	SEX M		LIVER	1281.0	1000	10.0	< .040			
OCCUPATION	CHEMIST	AGE 41		LUNG	744.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 28		KIDNEY	128.0	100	10.0	< .060			
STATE	NEW MEXICO			BLOOD	200.0	100	10.0	< .050			
CAUSE OF DEATH	TRAUMA	YEAR 1972		MUSCLE	742.0	250	10.0	< .050			
MEM CODE NO.	E918.3	KG 58		SPLEEN	80.0	100	10.0	< .040			
				THYROID	12.0	100	10.0	< .030			
				TEETH	8.0	100	10.0	< .040			
				FEMUR	64.0	200	10.0	< .040			
				VERTEBRAE	132.0	500	10.0	< .043			
CASE NO.	7-072	SEX M		LIVER	1883.0	1000	10.0	< .060			
OCCUPATION	CHEMIST	AGE 56		LUNG	875.0	1000	10.0	< .033			
RESIDENT	LOS ALAMOS	YEARS 24		LYMPH NOD	4.8	25	5.0	< .030			
STATE	NEW MEXICO			KIDNEY	374.0	100	10.0	< .050			
CAUSE OF DEATH	CARCIN. STOMACH	YEAR 1972		VERTEBRAE	49.0	200	10.0	< .040			
MEM CODE NO.	151.0	KG 85									
CASE NO.	7-074	SEX M		LIVER	1692.0	1000	10.0	< .050			
OCCUPATION	PHYSICIST	AGE 42		LUNG	941.0	1000	10.0	< .040			
RESIDENT	LOS ALAMOS	YEARS 14		LYMPH NOD	4.8	25	5.0	< .035			
STATE	NEW MEXICO			KIDNEY	242.0	100	10.0	.140	1.40	5.79	1.79
CAUSE OF DEATH	AUTO ACCIDENT	YEAR 1972		VERTEBRAE	48.0	200	10.0	< .040			
MEM CODE NO.	E825.0	KG 76									

TABLE A-III. EMPLOYEES WITH NO KNOWN EXPOSURE TO URANIUM

*<MDL = MINIMUM DETECTABLE LEVEL BASED ON SAMPLE WEIGHT, VOLUME OF SOLUTION, TOTAL COUNTS, BACKGROUND AND RECOVERY STATISTICS

			TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
CASE NO.	1-058	SEX M	LIVER	2052.0	1000	.1	<MDL			
OCCUPATION	MATHEMATICIAN	AGE 36	LUNG	712.1	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 07	LYMPH NOD	22.5	25	.1	<MDL			
STATE	NEW MEXICO		LYMPH NOD	14.0	25	.1	<MDL			
CAUSE OF DEATH	BAC ENDOCARDITIS	YEAR 1960	KIDNEY	308.0	250	.1	.001	1.83	5.84	1.81
MEX CODE NO.	430.0	KG NA	SPLEEN	784.0	250	.1	.003	6.30	8.25	1.68
CASE NO.	1-074	SEX M	LIVER	1354.0	1000	.1	<MDL			
OCCUPATION	MACHINIST	AGE 48	LUNG	1340.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 37	LYMPH NOD	2.0	25	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	287.0	100	.1	<MDL			
CAUSE OF DEATH	CIRRHOSIS	YEAR 1960								
MEX CODE NO.	156.0	KG NA								
CASE NO.	1-090	SEX M	LIVER	1720.0	1000	.1	<MDL			
OCCUPATION	ACCOUNTANT	AGE 54	LUNG	336.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 12	LYMPH NOD	9.3	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	347.0	100	.1	<MDL			
CAUSE OF DEATH	MULTIPLE MYELOMA	YEAR 1960								
MEX CODE NO.	203.0	KG 93								
CASE NO.	1-094	SEX F	LIVER	1529.0	1000	.1	<MDL			
OCCUPATION	CLERK	AGE 46	LUNG	592.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 11	LYMPH NOD	14.5	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	221.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY OCCLUS	YEAR 1960								
MEX CODE NO.	420.1	KG NA								
CASE NO.	1-126	SEX M	LIVER	1745.0	1000	.1	<MDL			
OCCUPATION	TECHNICIAN	AGE 40	LUNG	1043.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 03	LYMPH NOD	18.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	286.0	100	.1	<MDL			
CAUSE OF DEATH	SKULL FRACTURE	YEAR 1961								
MEX CODE NO.	933.0	KG NA								
CASE NO.	1-139	SEX M	LIVER	2134.0	1000	.1	<MDL			
OCCUPATION	MACHINIST	AGE 58	LUNG	1115.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 11	LYMPH NOD	20.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	325.0	100	.1	<MDL			
CAUSE OF DEATH	LUNG CANCER	YEAR 1961								
MEX CODE NO.	163.0	KG NA								
CASE NO.	1-132	SEX M	LIVER	2179.0	1000	.1	<MDL			
OCCUPATION	DRAFTSMAN	AGE 32	LUNG	925.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 05	LYMPH NOD	5.3	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	410.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY OCCLUS	YEAR 1961								
MEX CODE NO.	420.1	KG NA								
CASE NO.	1-136	SEX M	LIVER	1741.0	1000	.1	<MDL			
OCCUPATION	MACHINIST	AGE 59	LUNG	939.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 11	LYMPH NOD	15.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	282.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY OCCLUS	YEAR 1961								
MEX CODE NO.	420.1	KG NA								
CASE NO.	1-140	SEX M	LIVER	2316.0	1000	.1	<MDL			
OCCUPATION	CLERK	AGE 38	LUNG	921.0	1000	.1	.002	16.09	17.37	17.37
RESIDENT	LOS ALAMOS	YEARS 14	LYMPH NOD	9.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	515.0	100	.1	<MDL			
CAUSE OF DEATH	PUL INFARCTION	YEAR 1961								
MEX CODE NO.	455.0	KG NA								
CASE NO.	2-002	SEX F	LIVER	1894.0	1000	.1	<MDL			
OCCUPATION	CLERK	AGE 32	LUNG	1122.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 16	LYMPH NOD	6.3	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	282.0	100	.1	<MDL			
CAUSE OF DEATH	LEUKEMIA	YEAR 1961								
MEX CODE NO.	204.0	KG NA								
CASE NO.	2-014	SEX M	LIVER	1550.0	1000	.1	<MDL			
OCCUPATION	ELECTRICIAN	AGE 63	LUNG	515.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 15	LYMPH NOD	22.5	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	252.0	100	.1	<MDL			
CAUSE OF DEATH	THROMBO EMBOLI	YEAR 1961								
MEX CODE NO.	420.1	KG NA								

1001080

				TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
CASE NO.	2-020	SEX F		LIVER	2421.0	1000	.1	<MDL			
OCCUPATION	CLERK	AGE 47		LUNG	810.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 20		LYMPH NOD	8.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	255.0	100	.1	<MDL			
CAUSE OF DEATH	CANCER OF RECTUM	YEAR 1961									
MEM CODE NO.	154.0	KG NA									
CASE NO.	2-070	SEX M		LIVER	1768.0	1000	.1	<MDL			
OCCUPATION	ELECT TECH	AGE 54		LYMPH NOD	10.0	50	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 05		KIDNEY	240.0	100	.1	<MDL			
STATE	NEW MEXICO			VERTEBRAE	251.0	250	.1	<MDL			
CAUSE OF DEATH	CARDIAC	YEAR 1962									
MEM CODE NO.	429.1	KG NA									
CASE NO.	2-132	SEX M		LIVER	5300.0	1000	.1	<MDL			
OCCUPATION	REPAIRMAN	AGE 79		LUNG	1650.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 10		LYMPH NOD	18.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	475.0	250	.1	.001	1.53	3.14	.97
CAUSE OF DEATH	PNEUMONIA	YEAR 1962									
MEM CODE NO.	490.9	KG NA									
CASE NO.	2-142	SEX M		LIVER	2055.0	1000	.1	<MDL			
OCCUPATION	ELECT TECH	AGE 47		LUNG	793.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 15		LYMPH NOD	21.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	385.0	100	.1	<MDL			
CAUSE OF DEATH	PULMON EMPHYSEMA	YEAR 1963		VERTEBRAE	385.0	500	.1	<MDL			
MEM CODE NO.	465.0	KG NA									
CASE NO.	2-144	SEX M		LIVER	1889.0	1000	.1	<MDL			
OCCUPATION	BUYER	AGE 45		LUNG	1720.0	1000	.1	.002	19.00	11.05	11.65
RESIDENT	LOS ALAMOS	YEARS 05		LYMPH NOD	25.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	330.0	100	.1	<MDL			
CAUSE OF DEATH	PNEUMONIA	YEAR 1963		VERTEBRAE	344.0	500	.1	<MDL			
MEM CODE NO.	434.2	KG NA									
CASE NO.	3-020	SEX M		LIVER	2745.0	1000	.1	<MDL			
OCCUPATION	DRAFTSMAN	AGE 46		LUNG	710.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 10		LYMPH NOD	18.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	150.0	100	.1	<MDL			
CAUSE OF DEATH	CARCINOMA COLON	YEAR 1966		VERTEBRAE	120.0	250	.1	<MDL			
MEM CODE NO.	198.0	KG 81									
CASE NO.	3-022	SEX M		LIVER	2720.0	1000	.1	<MDL			
OCCUPATION	ENGINEER	AGE 53		LUNG	1160.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 23		LYMPH NOD	29.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	155.0	100	.1	<MDL			
CAUSE OF DEATH	MYCOSIS FUNGOIDS	YEAR 1956		VERTEBRAE	145.0	250	.1	<MDL			
MEM CODE NO.	205.0	KG 99									
CASE NO.	3-044	SEX M		LIVER	1673.0	1000	.1	<MDL			
OCCUPATION	MACHINIST	AGE 57		LUNG	1432.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 13		LYMPH NOD	2.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	292.0	100	.1	<MDL			
CAUSE OF DEATH	CARCIN. STOMACH	YEAR 1967									
MEM CODE NO.	151.0	KG 70									
CASE NO.	3-058	SEX M		LIVER	1720.0	1000	.1	<MDL			
OCCUPATION	PHYSICIST	AGE 41		LUNG	1130.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 14		LYMPH NOD	13.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	340.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY OCCLUSS	YEAR 1967		VERTEBRAE	60.0	250	.1	<MDL			
MEM CODE NO.	420.1	KG 71		HEART	330.0	100	.1	<MDL			
CASE NO.	3-070	SEX M		LIVER	1723.0	1000	.1	<MDL			
OCCUPATION	TECHNICIAN	AGE 51		LUNG	830.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 21		LYMPH NOD	5.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	330.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY OCCLUSS	YEAR 1967		VERTEBRAE	50.0	100	.1	<MDL			
MEM CODE NO.	420.1	KG 72									
CASE NO.	3-072	SEX M		LIVER	1375.0	1000	.1	<MDL			
OCCUPATION	CARETAKER	AGE 43		LUNG	1260.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 24		LYMPH NOD	4.0	50	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	345.0	100	.1	<MDL			
CAUSE OF DEATH	CIRRHOSIS	YEAR 1969		VERTEBRAE	63.0	100	.1	<MDL			
MEM CODE NO.	581.0	KG 64									
CASE NO.	3-094	SEX F		LIVER	1390.0	1000	.1	<MDL			
OCCUPATION	CLERK	AGE 61		LUNG	1055.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 21		LYMPH NOD	7.0	100	.1	<MDL			
STATE	NEW MEXICO			KIDNEY	255.0	100	.1	<MDL			
CAUSE OF DEATH	CORONARY OCCLUSS	YEAR 1968		VERTEBRAE	32.0	100	.1	<MDL			
MEM CODE NO.	420.1	KG NA									

			TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
CASE NO.	3-046	SEX F	LIVER	1710.0	1000	.1	<MDL			
OCCUPATION	PHOTO PRINTER	AGE 74	LUNG	920.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 03	LYMPH NOD	5.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	425.0	100	.1	<MDL			
CAUSE OF DEATH	DIABETES MELL	YEAR 1969	VERTEBRAE	43.0	100	.1	<MDL			
MEM CODE NO.	260.0	RG 52								
CASE NO.	3-108	SEX M	LUNG	970.0	1000	10.0	< .050			
OCCUPATION	TECHNICIAN	AGE 69	LYMPH NOD	6.0	50	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 24	KIDNEY	252.0	100	10.0	< .030			
STATE	NEW MEXICO		VERTEBRAE	120.0	250	10.0	< .050			
CAUSE OF DEATH	PNEUMONIA	YEAR 1969								
MEM CODE NO.	493.9	RG MA								
CASE NO.	5-024	SEX M	LIVER	2022.0	1000	10.0	< .060			
OCCUPATION	PHYSICIST	AGE 47	LUNG	632.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 05	LYMPH NOD	4.0	50	10.0	< .030			
STATE	NEW MEXICO		KIDNEY	352.0	100	10.0	< .033			
CAUSE OF DEATH	HEART ATTACK	YEAR 1969	VERTEBRAE	90.0	100	10.0	< .030			
MEM CODE NO.	420.1	RG 75								
CASE NO.	5-040	SEX F	LIVER	1099.0	1000	.1	<MDL			
OCCUPATION	MICROSCOPIST	AGE 45	LUNG	1364.0	1000	.1	<MDL			
RESIDENT	LOS ALAMOS	YEARS 25	LYMPH NOD	22.0	50	.1	<MDL			
STATE	NEW MEXICO		KIDNEY	89.0	100	.1	<MDL			
CAUSE OF DEATH	MYCARDIAL INFARC	YEAR 1969	VERTEBRAE	110.0	250	.1	<MDL			
MEM CODE NO.	420.1	RG 61								
CASE NO.	5-114	SEX F	LIVER	125.0	500	10.0	< .030			
OCCUPATION	SECTY-LAB TECH	AGE 49	VERTEBRAE	188.0	250	10.0	< .050			
RESIDENT	LOS ALAMOS	YEARS 25								
STATE	NEW MEXICO									
CAUSE OF DEATH	CIRRHOSIS	YEAR 1970								
MEM CODE NO.	581.1	RG 49								
CASE NO.	5-116	SEX M	LIVER	1863.0	500	5.0	< .030			
OCCUPATION	COMMUNICATIONS	AGE 45	LUNG	1229.0	1000	10.0	< .060			
RESIDENT	LOS ALAMOS	YEARS 14	LYMPH NOD	7.0	25	5.0	< .025			
STATE	NEW MEXICO		KIDNEY	394.0	100	10.0	< .033			
CAUSE OF DEATH	ASTHMA	YEAR 1973	VERTEBRAE	56.0	200	10.0	< .020			
MEM CODE NO.	241.9	RG 76								
CASE NO.	5-150	SEX M	LIVER	1693.0	1000	10.0	< .043			
OCCUPATION	CHEMIST	AGE 41	LUNG	1359.0	1000	10.0	< .043			
RESIDENT	LOS ALAMOS	YEARS 11	KIDNEY	345.0	100	10.0	< .040			
STATE	NEW MEXICO									
CAUSE OF DEATH	HEART ATTACK	YEAR 1971								
MEM CODE NO.	420.1	RG 74								
CASE NO.	7-004	SEX M	LIVER	2820.0	1000	10.0	< .043			
OCCUPATION	ACCOUNTANT	AGE 76	LUNG	590.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 24	LYMPH NOD	4.7	25	5.0	.075	.37	79.79	1.21
STATE	NEW MEXICO		KIDNEY	230.0	100	10.0	< .030			
CAUSE OF DEATH	CARCINOMA COLON	YEAR 1971	VERTEBRAE	100.0	250	10.0	< .060			
MEM CODE NO.	198.9	RG MA								
CASE NO.	7-028	SEX M	LIVER	1962.0	1000	10.0	< .033			
OCCUPATION	DESIGN ENGINEE	AGE 59	LUNG	1288.0	1000	10.0	< .033			
RESIDENT	LOS ALAMOS	YEARS 24	LYMPH NOD	11.3	25	5.0	< .033			
STATE	NEW MEXICO		KIDNEY	351.0	100	10.0	< .033			
CAUSE OF DEATH	BAD HEART	YEAR 1971	VERTEBRAE	87.3	200	10.0	< .030			
MEM CODE NO.	434.1	RG 60								
CASE NO.	7-054	SEX F	LIVER	1612.0	1000	10.0	< .043			
OCCUPATION	CHEM LAB TECH	AGE 48	LUNG	848.0	1000	10.0	< .043			
RESIDENT	LOS ALAMOS	YEARS 24	KIDNEY	255.0	100	10.0	< .033			
STATE	NEW MEXICO		VERTEBRAE	95.0	200	10.0	< .030			
CAUSE OF DEATH	HEART ATTACKS	YEAR 1972								
MEM CODE NO.	429.1	RG 75								
CASE NO.	7-058	SEX M	LIVER	1253.0	1000	10.0	< .030			
OCCUPATION	LABORER	AGE 69	LUNG	912.0	1000	10.0	< .030			
RESIDENT	VELARDE	YEARSNA	LYMPH NOD	6.6	25	2.0	.510	6.37	955.91	14.69
STATE	NEW MEXICO		KIDNEY	186.0	100	10.0	< .030			
CAUSE OF DEATH	PNEUMONIA	YEAR 1972								
MEM CODE NO.	493.9	RG 49								
CASE NO.	7-070	SEX M	LIVER	2239.0	1000	10.0	< .030			
OCCUPATION	MACHINIST	AGE 50	LUNG	1621.0	1000	10.0	.060	6.00	3.70	3.70
RESIDENT	LOS ALAMOS	YEARS 19	LYMPH NOD	4.7	25	5.0	< .025			
STATE	NEW MEXICO		KIDNEY	393.0	100	10.0	< .033			
CAUSE OF DEATH	HEART ATTACK	YEAR 1972	VERTEBRAE	99.0	500	10.0	< .030			
MEM CODE NO.	420.1	RG MA								

			TISSUE	WET WEIGHT SAMPLE (GRAM)	VOLUME OF SAMPLE (CC)	VOLUME SAMPLE ANALYZED (CC)	URANIUM MASS PER VOL ANAL (MICROGRAM)	URANIUM MASS PER ORGAN WGT (MICROGRAM)	URANIUM MASS PER KG TISSUE (MICROGRAM)	URANIUM MASS PER STD. ORGAN (MICROGRAM)
CASE NO.	7-076	SEX M	LIVER	2404.0	1000	10.0	< .040			
OCCUPATION	MAINT MECH	AGE 72	LUNG	1490.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 29	KIDNEY	379.0	100	10.0	< .050			
STATE	NEW MEXICO		VERTEBRAE	204.0	500	10.0	< .040			
CAUSE OF DEATH	RPTRD ANEURYSM	YEAR 1972								
MEM CODE NO.	022.0	KG 93								
CASE NO.	7-082	SEX M	LIVER	1687.0	1000	10.0	< .050			
OCCUPATION	ELECT TECH	AGE 54	LUNG	911.0	1000	5.0	< .070			
RESIDENT	LOS ALAMOS	YEARS 24	LYMPH NOD	3.0	25	10.0	< .030			
STATE	NEW MEXICO		KIDNEY	324.0	100	5.0	< .060			
CAUSE OF DEATH	HEART ATTACK	YEAR 1972	VERTEBRAE	237.0	500	10.0	< .050			
MEM CODE NO.	420.1	KG 68								
CASE NO.	7-084	SEX M	LIVER	1306.0	1000	10.0	< .040			
OCCUPATION	PIPEFITTER	AGE 58	LUNG	1582.0	1000	10.0	< .043			
RESIDENT	LOS ALAMOS	YEARS 26	LYMPH NOD	4.6	25	5.0	< .030			
STATE	NEW MEXICO		KIDNEY	392.0	100	5.0	< .040			
CAUSE OF DEATH	CARCINOMA LUNGS	YEAR 1972	VERTEBRAE	94.0	500	10.0	< .030			
MEM CODE NO.	163.0	KG 76								
CASE NO.	7-088	SEX M	LIVER	1470.0	1000	10.0	< .030			
OCCUPATION	JANITOR	AGE 71	LUNG	1497.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 13	LYMPH NOD	1.0	25	5.0	< .030			
STATE	NEW MEXICO									
CAUSE OF DEATH	HEART ATTACK	YEAR 1972								
MEM CODE NO.	420.1	KG 84								
CASE NO.	7-108	SEX M	LIVER	1444.0	1000	10.0	< .030			
OCCUPATION	MED DOCTOR	AGE 42	LUNG	587.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 2	KIDNEY	216.0	100	10.0	< .030			
STATE	NEW MEXICO									
CAUSE OF DEATH	AUTO ACCIDENT	YEAR 1972								
MEM CODE NO.	E825.0	KG NA								
CASE NO.	7-118	SEX M	LIVER	2032.0	1000	10.0	< .030			
OCCUPATION	ECHNICIAN	AGE 59	LUNG	1944.0	1000	10.0	< .033			
RESIDENT	LOS ALAMOS	YEARS 7	LYMPH NOD	3.1	25	5.0	.125	.67	217.74	3.27
STATE	NEW MEXICO		KIDNEY	423.0	100	10.0	< .030			
CAUSE OF DEATH	HEART ATTACK	YEAR 1973	GONAD	35.0	50	10.0	< .030			
MEM CODE NO.	420.1	KG 119	SPLEEN	253.0	100	10.0	< .030			
			VERTEBRAE	119.0	500	10.0	< .030			
CASE NO.	7-120	SEX M	LIVER	1649.0	1000	10.0	< .030			
OCCUPATION	CLERK	AGE 51	LUNG	1443.0	1000	10.0	< .030			
RESIDENT	LOS ALAMOS	YEARS 30	KIDNEY	380.0	100	10.0	< .073			
STATE	NEW MEXICO		GONAD	30.3	50	5.0	* .015			
CAUSE OF DEATH	MYOCARDIAL INFAR	YEAR 1973	SPLEEN	273.0	100	10.0	< .030			
MEM CODE NO.	420.1	KG NA	THYROID	2.0	25	5.0	< .025			
			VERTEBRAE	121.0	500	10.0	< .030			
CASE NO.	7-124	SEX F	LUNG	930.0	1000	10.0	< .030			
OCCUPATION	CLERK	AGE 44	LYMPH NOD	2.4	25	5.0	< .015			
RESIDENT	LOS ALAMOS	YEARS 21	KIDNEY	220.0	100	10.0	< .033			
STATE	NEW MEXICO		GONAD	9.1	25	5.0	< .025			
CAUSE OF DEATH	OVERDOSE	YEAR 1973	SPLEEN	145.0	100	1.0	< .003			
MEM CODE NO.	972+	KG 56	THYROID	5.0	50	10.0	* .040			
			VERTEBRAE	80.0	200	10.0	< .038			
			RIB	33.0	200	10.0	* .033			
CASE NO.	11-010	SEX M	LIVER	1277.0	1000	10.0	< .043			
OCCUPATION	MACHINIST	AGE 79	LUNG	1474.0	1000	10.0	< .033			
RESIDENT	LOS ALAMOS	YEARSNA	LYMPH NOD	7.3	25	10.0	.225	.55	75.34	1.13
STATE	NEW MEXICO		KIDNEY	323.0	100	10.0	< .043			
CAUSE OF DEATH	ATHEROSCLEROSIS	YEAR 1973	GONAD	31.0	50	10.0	* .033			
MEM CODE NO.	450.	KG 73	SPLEEN	92.0	100	10.0	< .033			
			THYROID	11.0	50	10.0	.110	.65	59.09	.95
	LAN FOR OFFICIAL		VERTEBRAE	242.0	500	10.0	< .040			
			RIB	53.0	200	10.0	< .019			

TABLE A-IV. STANDARD MAN ORGAN WEIGHTS

THE FOLLOWING ORGAN WEIGHTS ARE USED IN THE CALCULATION OF THE ACTIVITY PER STANDARD ORGAN IN THE FOLLOWING TABLES. FROM INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION TASK GROUP REPORT ON STANDARD MAN (IN PREPARATION). NOTE. WHERE A STANDARD WEIGHT HAS NOT BEEN DOCUMENTED. THE VALUE LISTED IS UNITY AND THE ACTIVITY REPORTED IS THAT OF THE ACTUAL WEIGHT OF THE TISSUE ANALYZED.

ADULT MALE (70 KG, 174 CM)	
TISSUE OR ORGAN	WEIGHT (GRAMS)
LUNG	1000
LIVER	1800
KIDNEYS (2)	310
LYMPH NODES (TB)	1
RIB (SKELETON)	10000
VERTEBRAE (SKELETON)	10000
GONAD - TESTES (2)	60
SPLEEN	180
HEART	350
MUSCLE	28000
STERNUM (SKELETON)	10000
FEMUR (SKELETON)	10000
THYROID	1
BRAIN	1400
BONE (SKELETON)	10000
BLOOD (WHOLE)	5500
TUMOR	1
ADNEXTAL TISSUE	1
BILE (WITH GALL BLADDER)	1
AORTA AND ATTACHED L.N.	1
STOMACH	150
PLEURA, LUNG	1
TEETH	1