SUMMARY OF RADIOLOGICAL MONITORING OF PERSONNEL AND ENVIRONMENT AT BIKINI ATOLL, 1969 - 1975

410058

Background

In 1946, before Operation Crossroads, the residents of Bikini were evacuated. After stays at Rongerik and Kwajalein which proved unsatisfactory, they were relocated on Kili Island in the southern Marshalls, which also proved unsatisfactory. The Eniwetok people were relocated at Ujelang atoll, to the west, after their evacuation. Among these displaced people there has always been a strong desire, with emotional and nostalgic overtones, to return to their home islands. After the 1958 moratorium on atmospheric nuclear testing, radiological surveys were carried out at Bikini and later at Eniwetok atoll in order to assess the radiological conditions with regard to rehabitation by the people. In 1967 the principle isotopes contributing to the gamma radiation field on Bikini and Enue Islands were ^{137}Cs, ^{60}Co, ^{125}Sb, and ^{155}Eu; small amounts of Pu were also found. Considerable variation was seen in the contamination of individual islands comprising the atolls of Bikini and Eniwetok since different tests had been conducted on various ones. The contamination of Rongelap and Utirik was more uniform, due largely to fallout from a single detonation, Bravo.

In 1968 an AEC ad hoc committee reviewed the survey results for Bikini and decided that Eneu and Bikini Islands were safe for habitation, with certain measures recommended to reduce exposure. In 1969 a group of about 30 Marshallese people settled in a workcamp on Eneu Island at Bikini Atoll to carry out the rehabilitation program. Many of the group commuted to Bikini Island, about seven miles away, where they worked during the day. By early 1972 three Bikini families (about 50 people) plus 20-30 workmen moved to Bikini Island and lived on the southern end of the island in frame buildings remaining from the earlier Weapons Test Program. The Bikini families later moved into several of the concrete houses in the southern sector near the lagoon. The size of the population living on Bikini has increased to about 119 people as of September, 1976.

Radiological monitoring of personnel on Bikini Atoll by radiochemical urine analyses has been done annually and whole-body counting in 1974 by the Brookhaven National Laboratory (BNL) medical team as specified by the ad hoc committee. Radiological monitoring of the environment has been largely carried out by the University of Washington, Lawrence Livermore Radiation Laboratory and more recently, also by a BNL Health Physics group.

In view of the low levels of radiation to which the Bikini people are exposed, medical examinations have not been done on them, though when physicians with the BNL medical team have been at Bikini they have held sick call and examined and treated individuals needing medical attention. At these times no health problem or sickness was noted which could be related to radiation exposure. At a meeting at ERDA Headquarters recently it was decided that on the basis of radiation exposure, medical examinations of the Bikini people were not indicated, but because of the psychological effect of living on these test islands an annual medical checkup on all individuals moving to Bikini and Eniwetok should be done.

FINDINGS

I. Personnel Monitoring

The MPC's and MPBBs of the ICRP have largely been used in radiological evaluation in this report.

A. Whole-Body Counting

To perform this analysis, tons of radiation-free lead brick were shipped to the Marshalls and a "shadow shield" type counting facility was set up in an air conditioned trailer and transported to the outer islands on the ERDA vessel (LCU-LIKTANUR). These measurements have been under the direction of Dr. Stanton Cohn at BNL.

Gamma spectroscopy for ^{137}Cs was carried out on individuals living at Bikini and Rongelap in 1974. The mean levels for these populations is presented in Table I. Individual data for the Bikini people is presented in Appendix I. Based on this direct bioassay counting technique the ^{137}Cs levels of the Bikini inhabitants were about ¼ of those of the Rongelap people. These values are well below the maximum permissible body burdens.

B. Radiochemical Urine Analyses

These analyses have been carried out by the Health and Safety Laboratory of ERDA in New York City. The mean urine levels of ^{137}Cs, ^{90}Sr, and $^{239-240}Pu$ for inhabitants of Bikini and Rongelap, 1970 - 1976, are summarized in Table II and individual data for the bikini people are presented in Appendix I.

Based on these data the ^{137}Cs urinary levels of the Bikini people were about 1/3 those of the Rongelap people over the same period and this ratio agreed reasonably well with that of the gamma spectrographic data in 1974.

^{90}Sr levels in the Bikini people over the past six years appear to be about the same as noted in the Rongelap people.

$^{239-240}Pu$ findings are shown in Table II. Urine samples analyzed before October, 1975 are not reported since the samples were too small and the counting error too large for any reliable measurement of plutonium. Nasal swabs on 10 people, analyzed in 1974, were negative for plutonium. Again, however, there was probably insufficient material for analysis. In October,

TABLE I

Mean Cesium-137 Levels Obtained by Whole Body Counting - 1974

	Male			Female		
	No.	nCi	nCi/kg body wt.*	No.	nCi	nCi/kg body wt.*
Bikini	8	128	1.84 (0.43-5.11)	13	73	1.15 (0.22-3.26)
Utirik	9	262	4.05 (2.64-6.84)	13	133	2.13 (0.96-3.85)
Rongelap	22	475	7.76 (4.37-16.3)	24	304	5.13 (2.71-13.46)
BNL med. team	4	2.93	0.0352(0.0134-.0791)			

* MPC 43 nCi/kg

TABLE II

RADIOCHEMICAL ANALYSES OF URINE (DATA IN AVERAGE pCi/liter)*

Year	No. in group	Av. vol. ml	^{90}Sr	^{137}Cs	$^{239-240}Pu$
Rongelap					
1970	20	895	3.5	2700	
1971	15	534	3.7	2400	
1972	18	460	2.4	2600	
1973	11	249	6.5	4600	
1974	14	557	2.8	4500	
1975 (Mar)	14	753	4.6	2100	
1976 (Mar)	17**	679	4.6	2100	0.009 ± .002
	1	1250			0.014 ± .007
Utirik					
1974	11	542	1.3	1300	
Bikini					
1970	Pooled		1.2	1150	
	Urine G	1100	2.2		
	Urine M	930	1.9		
	HASL* control	3000	1.0	120	
	HASL control	1000	1.6		
1971	Pooled	2670	1.7	1830	
1972	Pooled	2700	4.2	0910	
1973	13	304	6.7	1300	
1974	8	165	2.3	1300	
	10	649			
1975 (Mar)	8	360	7.3	1800	
(Oct)	18	510	3.1	1300	
	Pooled	9319			0.01 ± .002
1976 (Mar)	24**	480	4.7 ± 4.6	1600 ± 800	0.009 ± .002
N.Y. City (1976)	Pooled	20,000			0.0009 ± .0004
	1	500	0.9	8.0	
	1	500	0.8	10.0	

*Analytical error terms associated with ^{90}Sr and ^{137}Cs analyses were usually less than 10 percent.

** Pooled for Pu analysis.

of residents of New York City (0.009 $\pm$ 0.0004 p Ci/liter) at that time as reported by HASL. The finding of about the same levels of $^{239-240}Pu$ in the urine samples from people living on Rongelap at this time was unexpected.

II. Environmental Monitoring

A. Radiochemical Analyses are presented in the following Tables:

1. Animal
   a. Coconut Crabs, Table III
   b. Other animals, Table IV
2. Plants, Table V
3. Well water, Table VI
4. Soil, air and house dust, Table VII

B. External Gamma Radiation, Table VIII

III. Analyses in Progress

Presently the following samples are being analyzed: urine - Wotje Atoll, pooled sample; Bikini, pooled; and 8 individual samples; Ebeye, pooled; [redacted] analyzed are several soil samples from Rongelap, animal samples (pig, chickens, crabs from Rongelap and Bikini), and water from Bikini cisterns.

DISCUSSION

The body burdens of ^{137}Cs and ^{90}Sr of the people living on Bikini were well below the ICRP guidelines. While the ^{137}Cs levels were only about 1/4

[redacted]

	1975	edible	0.4	2.7	1.9
" Arbur Is.		skeleton	26.4	1.4	8.3
" Kabelle		edible	2.4	21.3	8.2
Island		skeleton	0.1	8.8	14.8
"		edible	0.8	14.6	5.1
		skeleton	24.1	5.0	2.2
Bikini		whole	23.3	11.8	1.5
	1970	"	24.8	14.8	0.07
	1971	"	132.0	11.4	
		"	412.0	8.6	
	1973	"	45.7	9.3	
	1974	muscle	16.0	380.0	18.0
		hepatopancreas	36.0	93.0	25.0
		skeleton	160.0	70.0	21.0
Enue	"			0.3	

ANIMAL DATA (1974)

BLE IV OTHER THAN CRABS

Atoll	Sample	^{90}Sr pCi/kg*	^{137}Cs nCi/kg*	$^{239-240}Pu$ pCi/kg*
	Pig			
Rongelap	meat	10	11.0	
(Kabelle)	organs	5	3.4	2.2
	bones	11,000	6.0	7.0
" Rongelap	Pig			
Island	meat	1.5	2.0	
	bones	1,600	0.9	0.4
"	chicken meat	4	0.7	
	bones	480	0.6	0.8
	" meat	36	1.1	
	bones	3,500	0.6	0.6
Bikini Island	chicken meat	8	0.7	
	bones	750	0.8	0.9
Rongelap	Rat 1	350	3.6	
Island	" 2	280	4.2	
	" 3	540	4.3	
Bikini Is.	Rat 1	6,000	8.1	6.7
	Fish	60		4.0
	(dry wt.)	240		20.0
		180		45.0
	" surgeon muscle			<.001 dpm/g

* Wet weight except dry wt. for fish.

TABLE V

PLANTS

Year	Atoll/Island	Tissue	^{90}Sr Range	^{90}Sr Avg.	^{137}Cs Range	^{137}Cs Avg.	^{239}Pu Range	^{239}Pu Avg.	^{241}Am Range	^{241}Am Avg.
			1. Bread Fruit (pCi/g dry)							
74 75	Bikini/Bikini	leaves	251 - 446	332	29 - 95	53	.043-.148	.10		
74	Rongelap	leaves	23		27					
75	Wotho	leaves	.21		.35					
		fruit	<.08		1.7					
75	Bigej			- no data -						
76	Bikini/Bikini	fruit	42 - 48	45						
			2. Pandanus (pCi/g dry)							
74 75	Bikini	leaves	41 - 402	170	37 - 1035	508	.031-.20	.087		
		fruit	34 - 255	138	3524 - 3665	3591	.001-.01	.005		
74	Rongelap	leaves	11		13					
		fruit		- no data -						
75	Wotho	leaves		- no data -						
75	Bigej	leaves	<.10		.92					
		fruit	.15		.55 - 1	.78				
76	Bikini/Bikini	fruit	61 - 172	118						
			3. Coconut (pCi/g dry)							
74 75	Bikini	leaves	5.2 - 35	15.7	58 - 649	154	.018-.96	.205		
74	Rongelap	leaves	2.1		4.2					
75	Bigej	meat	<.15		1.2-2.3	1.75				
75	Wotho	leaves	.10		.70					
			4. Messerschmidia (pCi/g dry)							
74	Bikini	leaves	235		305					
75		leaves	15 - 384	102			.07 -.985	.478		
74	Rongelap	leaves		- no data -						
75	Bigej	leaves	.16		2.3					
75	Wotho	leaves		- no data -						
76	Nam/Bikini	leaves	168 - 322	248						

PLANTS

ar	Atoll/Island	Tissue	^{90}Sr Range	Avg.	^{137}Cs Range	Avg.	^{239}Pu Range	Avg.	^{241}Am Range	Avg.
			5. Scaveola (pCi/g dry)							
74	Bikini	leaves	33		110					
75		leaves	31 - 169	92			.07-.931	.252		
74	Rongelap	leaves	3.0		27					
75	Bigej	leaves	<.17		.95					
75	Wotho	leaves	- no data -							
76	Nam/Bikini	leaves	89 - 198	123						
			6. Papaya (pCi/g dry)							
74	Bikini	fruit	81		1050		<.002			
75		fruit	74 - 79	76			.001-.009	.005		
75	Wotho	fruit	<.15		0.32					
		rind	<.14		15					
		seeds	<.14		12					
			7. Squash (pCi/g dry)							
74	Bikini/	fruit	10		794					
	Bikini	fruit	5				.003			
			8. Banana (pCi/g dry)							
74	Bikini	fruit	7.9		16					
75		fruit	9.33				.002			
		skin	90				.18			
			9. Arrowroot (pCi/g dry)							
75	Bikini	tubers					.239			

TABLE VI

RADIOCHEMICAL ANALYSES OF WELL WATER (pCi/liter) AND SLUDGE FROM WATER CISTERNS (pCi/g. dried sludge) FROM BIKINI

Year	Sample	Vol.,ml	^{90}Sr*	^{137}Cs**	^{3}H	$^{239-240}Pu$***
1971	"good well"	1830	6.0 ± 17%	600 ± 1%	770 ± 40%	0.04 ± 25%
	"bad well"	1830	25 ± 3%	850 ± 1%	1040 ± 30%	0.05 ± 20%
	"good well" (closed)	1810	103 ± 2%	1044 ± 1%		0.058 ± 15%
	"good well" (opened)	1980	125 ± 3%	818 ± 1%		5.76 ± 6%
	drinking water (camp area)	3580	0.46 ± 4%	1.53 ± 8%		0.004 ±100%
1972	well water	1000	15.4 ± 9%	800 ± 1%		
	drinking water	1960	0.61 ± 6%	1.8 ± 8%		
1973	new well	60	52	600		0.38 ± 40%
	B-1 well	225	11	724		0.08 ± 50%
1975	Sludge from water cisterns (6 samples)					2.91-4.02 ± 3%
1976	Slude from cisterns (6 samples)	1000	2.8-7.8 ± 4%			1.25-4.83 ± 6%

*MPC 4 x 10^3 pCi/1

**MPC 2 x 10^5 pCi/1

***MPC 3 x 10^5 pCi/1

Atoll/Island	Ye[illegible]
Bikini/Bikini	19[illegible]
	19[illegible]
	19[illegible]
	19[illegible]
Kwajalein/Bigej	19[illegible]
Wotho/Wotho	19[illegible]
	19[illegible]
Bikini/Bikini	19[illegible]
Rongelap/Rongolap	19[illegible]
Nam/Bikini	19[illegible]

*MPC for Pu establishe[illegible]

Bikini/Bikini	19[illegible]

*MPC is 6×10^{-3} pCi/M[illegible]

Bikini/Bikini	19[illegible]
Bikini/Bikini	19[illegible]

TABLE VIII

EXTERNAL EXPOSURE DATA

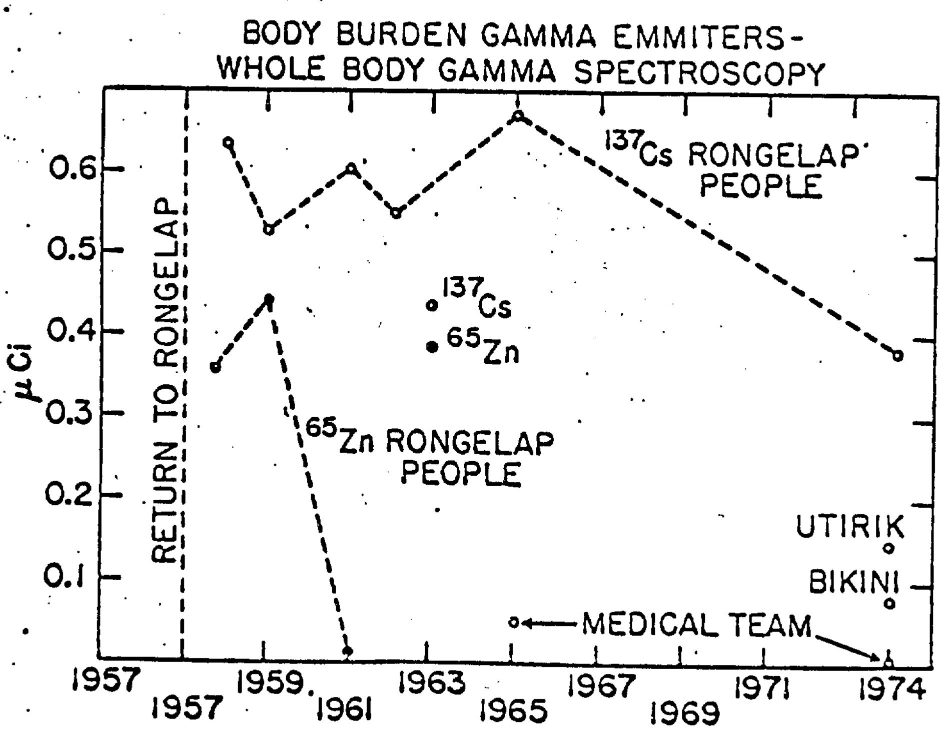
Location	Annual Exposure	Source of Data
Bikini I.	200 mR	UCRL 51879 Rev 1
Eneu I.	120 mR	" " "
Utirik I.	36 mR	BNL field measurements, 1976
Rongelap I.	63 mR	" " " "
BNL (Long Is. NY)	70 mR	" " " "
Colorado Rocky Mtns.	200 mR typical 400 mR maximum	

of those presently measured in the Rongelap people the ^{90}Sr levels were about the same. Since the Bikini inhabitants have been subsisting largely on imported food these findings would seem to indicate that they are eating some plant foods grown locally, though their consumption is forbidden. The limited intake of domestic livestock would indicate that this is a minor source. Fortunately, pandanus and breadfruit, the two main plant sources of these isotopes are not available yet in any great quantity and measures are being considered to transplant these plants to Enue (the nearby less contaminated island) in order to remove the temptation for eating them. The drinking water from the wells and catchments would not appear to offer a significant contribution to the body burdens since the radionuclides present are well below the MPC. Marine life at Bikini has been reported to contain very low levels of radionuclides and apparently offers no problem. The coconut crabs have high enough levels of these radionuclides to be banned from the diet of the Bikinians and are very scarce in any event. The present body burdens of ^{137}Cs and ^{90}Sr in the Bikini people would not seem to be a cause for concern. It is interesting that there is a relatively higher Sr-Cs ratio in the Bikini people than noted in the Rongelap people. Attempts will be made to determine if this disparity is due to differences between the two isotopes in the environment of the two atolls.

The graphs in Figures 1 and 2 show that the estimated mean body burdens of ^{90}Sr and ^{137}Cs for the Bikini people are well below the maximum values noted in the Rongelap people. The mean of the Rongelap group reached a peak of 6 - 11% of the maximum permissible ^{90}Sr level (for general populations) in 1961-1965 and about 22% of the ^{137}Cs level in about 1965.

External radiation levels on Bikini are higher than on Rongelap and represent the chief source of radiation exposure to the people living there.

Fig. 1



BODY BURDEN GAMMA EMMITERS-
WHOLE BODY GAMMA SPECTROSCOPY
μCi
0.6
0.5
0.4
0.3
0.2
0.1
RETURN TO RONGELAP
137Cs RONGELAP PEOPLE
137Cs
65Zn
65Zn RONGELAP PEOPLE
UTIRIK
BIKINI
MEDICAL TEAM
1957
1957
1959
1961
1963
1965
1967
1969
1971
1974

Fig. 2

Recent surveys show that the interior of the island had higher gamma readings than had been originally recorded and it was deemed advisable to recommend suspension of plans for construction of new housing in the interior of the island. The radiation levels in the village area along the lagoon are considered satisfactory for habitation. It was recommended that Enue be established as the village center and also be made the "garden" island for local produce. This recommended change in policy, about two years ago, has been the cause of considerable unrest and dissatisfaction among the Bikini people and some apprehansion about the radiological safety of those living at Bikini. These events have led to threatened legal action against ERDA.

The estimated bone marrow dose from both external and internal sources to the residents of Bikini island and Enue island (at Bikini) compared with such estimates for residents of Rongelap, Utirik and people in Denver and Long Island in the U.S.A. are presented in Table IX. The estimates for Bikini were based on people living in the present village area. With low natural radiation that exists in the Marshalls and fewer medical x-rays, the annual bone marrow dose estimated for the Bikini people, though higher than that for the Rongelap and Utirik people is not as great as in inhabitants of Denver, Colorado.

The plutonium problem. The finding of low levels of Pu in the urine of the Bikini and Rongelap people has been the cause of some concern. The levels, even though about ten times those measured in New Yorkers, as reported by HASL, appeared to be well below the urine concentrations associated with the MPBB. The confirmation of the original finding in a repeated analysis of Bikini urine and the finding of similar levels in the Rongelap people has indicated the need for more extensive study of the problem. The unexpected detection of similar levels of Pu in the Rongelap people has created speculation that perhaps the Marshall Islands have generally higher levels of Pu

TABLE IX

Estimated Dose to Bone Marrow (mrem/yr)*

SOURCE	BIKINI	ENUE	RONGELAP	UTIRIK	USA DENVER	USA LONG ISLAND
Natural	80	80	80	80	325	190
Medical Dental	0	0	10	10	70	70
Contamination Gamma	165	7	20	7		
Internal	21	21	68	31		
TOTAL	266	108	178	128	395	260

* Dose on Marshall Islands based on personnel and environmental data.

due to their proximity to the test sites. If this hypothesis is correct, an increase in levels in Pu could be related to the absorption from soil, food and water of the contaminated island, or perhaps absorption directly from exposure to the fallout following the detonations during the testing program. This is the reason for study of environmental samples and urine from people of remote Marshall Islands. A comparison of the urinary levels in Marshallese born after the 1958 nuclear weapon testing moratorium compared with those living during the testing program may be of help in this regard and such a study has been initiated.

It is important to determine the source and route of absorption of Pu in the Marshallese. Gastrointestinal absorption via the food chain would seem to be much less important than the inhalation route. Plant foods grown on Bikini Island have had very low levels of Pu and this is probably largely from contamination on the outside of the fruit. Low levels of the nuclide are present in livestock and greater amounts in coconut crabs, but both of these are minor sources of food. Marine life also has low levels of $^{239-240}Pu$. From these findings and the reputed very low level absorption of Pu from the G.I. tract, absorption of $^{239-240}Pu$ from the food chain would appear to be a minor source of contamination.

With regard to the inhalation route, only limited data are available on $^{239-240}Pu$ and ^{241}Am levels of Bikini soil and resuspended dust analysis. Recent, limited data indicate that soil levels in 1970-1975 for Pu ranged from 3 to 43 p Ci/g. The Eniwetok task group established 40 p Ci/g for soil in a safe upper level. Limited air sampling indicates barely detectable amounts of $^{239-240}Pu$ resuspended in the air on Bikini island (see Table VII). A comprehensive year around air sampling program is currently being scoped to begin in the northern Marshalls next year. The dust collected from houses on Bikini had only a fraction of the amount found in the soil. This is reassuring in view of the importance of the inhalation route of absorption and the fact that the people spend the majority of their time in their homes. Recently, an article was published in the local Marshall Island paper saying "dangerous levels" of Pu were found in the Bikini people. This caused considerable apprehension among those living at Bikini. This problem has been added to the many problems involved in their rehabilitation. Unfortunately statements by both ERDA and the BNL groups on radiological safety have been looked upon with some degree of suspicion by the people. The people on Bikini badly need a statement of reassurance about their radiological safety by experts in the field, other than the BNL group.

The BNL team is also desirous of further guidance by the experts in handling the plutonium problem. Can any reliable measurement of body burden or lung burden of $^{239-240}Pu$ be derived indirectly from the present urine data? Are there other suggestions about deriving body burdens indirectly"? Is it feasible to perform <u>in vivo</u> counting procedures for $^{239-240}Pu$ or ^{241}Am in these people? <u>In vivo</u> counting is generally considered impractical, particularly under field conditions. The assay could possibly be performed in the whole-body counting facility on the ship. Should several Marshallese with measureable urine Pu be brought to the U.S. for counting? Would the body burdens or ^{90}Sr and ^{137}Cs already present in these people interfere with such counting? The BNL team would welcome advice and assistance on these and other problems related to the Pu contamination.

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APPENDIX I

INDIVIDUAL RADIOLOGICAL MONITORING DATA - BIKINI

(Urine Levels - amt/1; ^{137}Cs Body Burdens - 1974, nCi)

No.	Age	Sex	1973			1974				1975 (Mar.)			1975 (Oct.)			1976 (Mar.)			1976 (Oct.)		
			^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	^{137}Cs** nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.
B1	46	F				<0.1	0.5	58	1.5												
B2	20	F											2.2	2.0	1						
B3			5.5	2.6	2			72													
B4	62	M						78	2	4.5	2.1	3				4.8	2.9	4			
B5			18.9	1.3																	
B6			2.0	0.4																	
B7	24	M						95	1												
B8	31	F						108	3												
B9	16	F											8.2	2.9	1						
10	26	M								4.7	1.9	1.5									
11	32	M				3.2	1.7	156	6												
12	51	M						290	0.5	12.0	2.1	1.5	2.9	0.9	2						
13	32	M	2.2	0.6	1			81	2				2.1	0.8	3.5						
14	24	M				<0.2	1.5		2				5.7	2.1	3						
15	57	M						51	2							2.3	0.3	4			
16	25	F																			
17	56	F											4.8	2.5	1						
18	47	F						116	2												
19		M				2.4	0.8		3												
20	25	F						73	3							2.4	1.2	5			
21			5.7	1.1																	
22	32	M						103	4												
23	24	M								6.6	1.5	1.5									
24	41	M	7.8	2.0	1			122	2	18.0	3.0	3									
25	44	M								2.4	0.4	2.5	1.9	2.0	3	6.8		4			

No.	Age
B26	32
B27	18
B28	15
B29	56
B30	33
B31	46
B32	59
B33	44
B34	49
B35	27
B36	17
B37	22
B38	16
B39	49
B40	
B41	62
B4[illegible]	56
B43	16
B44	30
B45	44
B46	
B47	29
B48	37
B49	45
B50	47

[illegible]

INDIVIDUAL RADIOLOGICAL MONITORING DATA - BIKINI

(Urine Levels - amt/1; ^{137}Cs Body Burdens - 1974, nCi)

			1973			1974				1975 (Mar.)			1975 (Oct.)			1976 (Mar.)			1976 (Oct.)		
No.	Age	Sex	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	^{137}Cs** nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs. Bik.	^{90}Sr pCi	^{137}Cs nCi	Yrs Bik
B51	33	M				3.0	0.6	222	2							6.8	2.8	4			
B52	19	M						77	1												
B53	46	M						156	1	0.5	0.5	2				2.3	1.4	3			
B54	51	M						72	5												
B55	56	M														2.8	1.1	3			
b.	54	F														5.1	3.2	6			
B57	24	M														3.0	1.0	3			
B58	22	F														7.6	0.9	4			
B59	20	M														4.3	1.9	3			
B60	24	M														1.5	1.6	2			
B61	30	M														5.5	1.1	3			

**Gamma Spectrographic analyses - body burdens.