

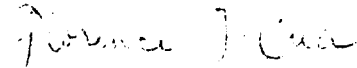
show excretion levels are too much higher than the minimum detectable level of the equipment. The last table, Table 4, shows that the internal whole body dose equivalent contributes 65% of the total whole body dose equivalent for 1978. The internal dose equivalent is mainly due to the ^{137}Cs body burden. The contribution of ^{90}Sr to whole body equivalent rate is negligible, being 1/60 of the bone dose equivalent rate. However, ^{90}Sr is harmful primarily as a bone seeker, thus, comparison in terms of maximum permissible bone dose equivalent rate would be more appropriate for this radionuclide.

October 18, 1978

Sources of error are indicated and the assumptions made are expressed where needed. The results quoted are generally conservative. New information from an on-going Marshall Island control-urine sampling and a parametric study to determine the effect of non-constant, non-continuous uptake and difference in time post uptake and pre-bio-assay sampling, will establish the extent of the conservativeness of these results.

Please feel free to call me (FTS 666-2503) if you have questions on the ⁹⁰Sr results.

Sincerely,



Florence T. Cua
BNL Marshall Islands
Radiological Safety Program

FTC/slg
Enclosure

cc: R. Conard
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6005	4/24/78	0.43	0.40	6.5	6.0
6068	4/23/78	1.7	1.8	26.0	27.0
6007	4/24/78	0.51	0.43	7.7	6.5
6017	4/24/78	8.2	9.2	123	138
6086	4/24/78	6.5	7.3	98.0	110
6028	4/24/78	0.74	0.82	11.0	12.0
6096	4/25/78	1.5	1.6	23.0	24.0
6070	4/23/78	8.9	10.0	134	150
6003	4/24/78	6.8	7.7	102	116
6126	4/24/78	1.6	1.6	24.0	24.0
6017	4/24/78	4.8	5.3	72.0	80.0
6019	4/24/78	5.2	5.6	78.0	84.0
2123	4/24/78	1.5	1.3	23.0	20.0
6076	4/24/78	0.33	0.34	5.0	5.1
863	4/23/78	3.8	4.0	57.0	60.0
6126	6/14/78	0.43	0.41	6.5	6.2
6125	4/5/77	1.2	1.3	18.0	20.0
6028	4/5/77	2.1	3.0	41.0	45.0
966	4/5/77	4.2	4.1	63.0	71.0
6117	4/5/77	0.36	0.39	5.4	5.9
934	4/25/78	3.0	3.3	45.0	50.0
525	4/23/78	0.22	0.19	3.3	2.9
6063	4/25/78	0.78	0.81	12.0	12.0
6113	4/25/78	0.61	0.64	9.2	9.6
6046	4/25/78	0.96	0.89	14.0	13.0
6112	4/26/78	0.45	0.40	6.8	6.0
6130	4/25/78	4.5	4.7	68.0	71.0
6035	4/25/78	4.1	4.5	62.0	68.0
6111	4/25/78	0.27	0.23	4.1	3.5
6065	4/25/78	4.1	4.3	62.0	65.0
6108	4/25/78	1.4	1.5	21.0	23.0
6045	4/24/78	0.33	0.28	5.0	4.2
6122	4/25/78	2.2	2.5	33.0	38.0
6061	4/25/78	1.9	2.1	29.0	32.0
6115	4/24/78	0.55	0.47	8.3	7.1
6059	4/25/78	0.55	0.49	8.3	7.4
6127	4/26/78	1.1	1.2	17.0	18.0
6011	4/26/78	12.0	13.0	180	195
6132	4/26/78	2.2	2.1	33.0	32.0

continuation of Table 1

For non-radiation worker, maximum permissible bone burden: 200 nCi³

Maximum permissible bone dose equivalent rate: 3000 $\frac{\text{mRem}^4}{\text{year}}$

¹ICRP 20 (1972) Alkaline Earth Metabolism in Adult Man

$$\text{Retention Function } R(t) = 0.40 e^{-0.25t} + 0.45 (t + 0.20)^{-0.18} \\ (0.555 e^{-6.5 \times 10^{-5}t} + 0.445 e^{-2.60 \times 10^{-4}t})$$

²ICRP 10A (1969) The Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes

$$\text{Retention Function } R(t) = 0.73 e^{-\frac{0.693t}{3}} + 0.10 e^{-\frac{0.693t}{44}} + 0.17 e^{-\frac{0.693t}{4000}}$$

³ICRP 2 (1959) Permissible Dose for Internal Radiation

⁴NCRP 39 (1971) Basic Radiation Protection Criteria

Note: 1 has more physiological basis than 2.

Table 2
Mean ⁹⁰Sr Annual Bone Burden (nCi) and
 Bone Dose Equivalent Rate (mRem/year)-ICRP 20 and
 ICRP 10A Models

<u>Population</u>	<u>Collection Date</u>	<u>ICRP 20</u>		<u>ICRP 10A</u>	
		<u>nCi</u>	<u>mRem/year</u>	<u>nCi</u>	<u>mRem/year</u>
Adult Male	4/78	\bar{X} 2.9	44.0	3.3	49.0
		+1 σ +2.4	+43.0	+3.3	+49.0
n=23		Range 0.29-8.9	4.4-134	0.25-10	3.8-150
Adult Female	4/78	\bar{X} 1.6	24.0	1.7	25.0
		+1 σ +1.5	+23.0	+1.6	+24.0
n=16		Range 0.22-4.5	3.3-67.	0.23-7.7	2.9-116
Children Male	4/78	\bar{X} 5.0	76.0	5.4	81.0
		+1 σ +5.9	+88.0	+6.6	+99.0
n=3		Range 1.1-12 ¹	17-180	1.2-13.	18-195

Note: All reported values in Tables 1 and 2 are calculated assuming constant continuous uptake of ⁹⁰Sr for the entire residence period of the individual in Bikini. It also assumes no ⁹⁰Sr intake during urine sampling.

¹ Sample from boy named Junia

Maximum permissible bone burden for non-radiation worker: 200 nCi
 Maximum permissible bone dose equivalent rate: 3,000 $\frac{\text{mRem}}{\text{year}}$

Table 3
 Excretion Data and Annual Bone Burden
 (Calculated Where Possible) for Four Marshall Island Visitors
 to BNL in June 1978

<u>Island</u>	<u>Name</u>	<u>Collection Date</u>	<u>⁹⁰Sr pCi/liter +1σ</u>	<u>Annual Bone Burden (nCi) ICRP 20</u>
Bikini	Jendrik	6/14 - 6/16, 1978	1.59 ± 0.75	0.43
Majuro	Kessai Note	6/14 - 6/16, 1978	0.95 ± 0.78 0.47 MDL ¹	
Majuro	Oscar DeBrum	6/14 - 6/16, 1978	0.90 ± 0.47 0.31 MDL	
Majuro	Atasi Balos	6/14 - 6/16, 1978	0.21 ± 0.54 0.21 MDL	

¹Control urine sampling for the Marshall Islands is currently underway. Since no such data is available at this time, the values are compared with minimum detectable activity.

Table 4
 Summary of Contribution to Yearly and Cumulative Dose Equivalent to the Bikini Adult Population

Source of Contribution to the Dose Equivalent	1970 mRem	1971 mRem	1972 mRem	1973 mRem	1974 mRem	1975 mRem	1976 mRem	1977 mRem	1978 mRem	8 Year Total mRem	
(1) External Dose (Whole Body)	235	227	219	213	206	200	195	190	183	1868	
(2) Internal (Whole Body) CS-137	n=21 (0.105+ 0.085 μ Ci) 17 + 14	n=21 (0.105+ 0.085 μ Ci) 17 + 14	n=21 (0.105+ 0.085 μ Ci) 17 + 14	n=21 (0.105+ 0.085 μ Ci) 17 + 14	n=21 (0.105+ 0.085 μ Ci) 17 + 14	n=21 (0.105+ 0.085 μ Ci) 17 + 14	(0.268+ 0.220 μ Ci) 45 +37	(0.612+ 0.427 μ Ci) 102 +71	n=42 (1.122+ 0.639 μ Ci) 187+107	n=68 (2.073+ 1.237 μ Ci) 345+207	770+248
Total (Whole Body)	252	244	236	230	223	245	297	377	529	2633	
(4) Internal (Bone) Sr-90	pooled (1.65+ 0.48pCi/l) 2.3+0.66	pooled (1.74+ 1.45pCi/l) 4.2+3.5	pooled (4.2pCi/l) 17	n=14 (6.7+ 4.4pCi/l) 36+24	n=11 (2.0+ 1.6pCi/l) 13+11	N.D. Assume 1977	N.D. Assume 1977	N.D. Assume 1977	n=4 (3.89+ 2.48pCi/l) 32+25	n=39 (5.77+ 3.9pCi/l) 36+37	205+>63

Maximum permissible whole body dose equivalent rate - 500 mRem/year

Maximum permissible bone dose equivalent rate - 3,000 mRem/year

N.D. - No Data

- (1) Initial data were taken from 1975 UCRL Report 51879 Rev. 1 living pattern #2, adult population only.
- (2) Data taken from 1974, 1977 and 1978 WEC reports c/o Robert Miltenberger. Body burdens of 1970-1974 assumed to be constant at the 1974 level due to lack of data on individuals prior to 1974.
- (3) Body burden for ¹³⁷Cs in the years 1975 and 1976 were obtained from interpolation between 1974 and 1977 data.
- (4) ICRP 20 model was used. For the year 1970-1974, the (pCi/liter) values reported are mean values, however, the dose equivalent values are the conservative values, assuming 1.4 liter/day excretion for all and an uptake interval of 0.5 years for 1970, 1 year for 1971, 2 years for 1972, 3 years for 1973 and 4 years for 1974. The 1977 and 1978 dose equivalent values are the mean of the individual dose equivalent values. The residence time on the island of an individual was considered the uptake time of ⁹⁰Sr for the individual.
- (5) The standard deviation (1 σ) reported gives an idea of the variability among individuals in the population. Error in the whole body counting procedure would have a worst case value of +25%, whereas error in the urine analysis program would be typically +20% due to counting statistics and +25% due to the assumption of daily excretion of 1.4 liter for men and 1 liter for women and children when in fact they are excreting less.

REPOSITORY PNNL
COLLECTION Marshall Islands
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FOLDER Bepini - 1978

DOCUMENT DOES NOT CONTAIN ECI

Reviewed by J. Schaeffer Date 4/30/97