

## Attachment 2

The Determination of Internally Deposited Radioactive Isotopes  
 in the  
 Marshallese People  
 by  
 Excretion Analysis<sup>#</sup>

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pertinent to estimate body burden, burden expected at equilibrium, and daily intake of  $\text{Sr}^{90}$  from these excretion levels.

The metabolic behavior of strontium as outlined in Supplement #6 of the British Journal of Radiology was used to estimate body burden, etc. from urinary excretion levels of strontium<sup>90</sup> (Appendix). The fraction of strontium absorbed from the gastro-intestinal tract is 0.6 and the biological excretion rate from the total body is 190 days. Of the absorbed fraction, 0.25/0.60, about 42 percent is deposited in bone and the biological half-life is 4000 days. Assuming that the absorbed fraction is excreted entirely in urine, the mean body burden of the exposed Rongelap group in March 1958 was 2 muc ( $\pm$  52 percent). This is about nine percent of the expected equilibrium value of 23 muc. The estimated burden of strontium<sup>90</sup> for March 1958 is probably too low and compares with levels measured in stillborn children in the U. S. several years ago (8). The daily intake of strontium<sup>90</sup> is estimated to be about 15 micromicrocuries or 15 Sunshine Units (assuming a daily calcium intake of one gram).

Dunning (2) reported that the average concentration of strontium<sup>90</sup> in the Marshallese food supply could be about 360 Sunshine Units, but this would reduce to well under 100 Sunshine Units if the consumption of high  $\text{Sr}^{90}$  content foods were eliminated. With the elimination of pandanus and land crabs the diet used by Dunning indicated that the intake of strontium<sup>90</sup> would be 17 Sunshine Units per day. This compares favorably with the estimated intake of about 15 micromicrocuries from excretion analysis.

#### Zinc<sup>65</sup> Excretion Levels and Body Burden

In early 1957 Miller (9) detected  $\text{Zn}^{65}$  in selected residents of Rongelap and Utirik by whole body gamma-ray spectrometry. Body burden ranged from 29.5 to 73.0 muc for the Rongelap residents, and 482 and 229 muc was detected in two subjects from Utirik. The Rongelap subjects were residing on Majuro at this time.

Miller obtained an effective half-time of 110 days for the elimination of  $Zn^{65}$ , and for the two subjects from Utirik the urinary to fecal excretion ratio was 1/9.

Assuming the excretion to be entirely exponential and 10 percent of the body burden of  $Zn^{65}$  excreted in urine, the March 1958 urinary excretion levels of 174 and 342 micromicrocuries indicate body burden, equilibrium body burden, and daily intake as follows:

	RONGELAP	
	1954 Exposed Group	Control Group (Unexposed 1954)
Body Burden (March 1958):	280 muc ( $\pm 49\%$ )	540 muc ( $\pm 90\%$ )
Equilibrated Body Burden:	330 muc	650 muc
Daily Intake:	2100 uuc/day #	4100 uuc/day #
Percent Equilibration:	85.0 percent	83.0 percent

The mean body burden estimated from 1958 excretion analysis for all Rongelap subjects showed a ten-fold increase over the 1957 whole body measurements. This increase correlates with the return of these people to Rongelap atoll from Majuro. Also the 1958 Rongelap  $Zn^{65}$  burdens are comparable with the Utirik subjects in 1957, and the Utirik subjects would have been in equilibrium in 1957 (half time of 110 days for the elimination of zinc<sup>65</sup>).

The estimated intake of zinc<sup>65</sup> (2000 to 4000 uuc per day) can not be accounted for by  $Zn^{65}$  activity levels reported in foodstuffs. Although this radio-nuclide reportedly accounts for a large fraction of the total activity in fish, this amounts to only about six uuc per pound of muscle up to 75 uuc per pound of whole fish (2) or at most four percent of the estimated intake.

#### CONCLUSIONS.

Since resettlement of the Marshallese people on Rongelap atoll in July 1957, the urinary excretion level of cesium<sup>137</sup> has increased about 140 fold and about

# Assuming 100 percent absorption from the GI Tract

held for strontium<sup>90</sup>. Zinc<sup>65</sup> was readily detected in samples from the March 1958 medical survey.

The estimated mean body burden at equilibrium for cesium<sup>137</sup> is about 1.5 microcuries or about 1/6 of the tolerance recommended by the International Commission for Radiological Protection for non-industrial populations. For strontium<sup>90</sup> the mean body burden of the exposed Rongelap group in March 1958 was estimated to be two millimicrocuries. This is about nine percent of the expected equilibrium value of 23 millimicrocuries. The equilibrated strontium<sup>90</sup> burden is about 1/5 of tolerance. The estimated mean body burden of zinc<sup>65</sup> for Rongelap subjects in March 1958 is about 85 percent of the equilibration value of 0.6 microcuries and the equilibration value is 1/70 of tolerance.