Thyroid Dose
Acute Phase

Obtained from BNL
9/9/80

410331

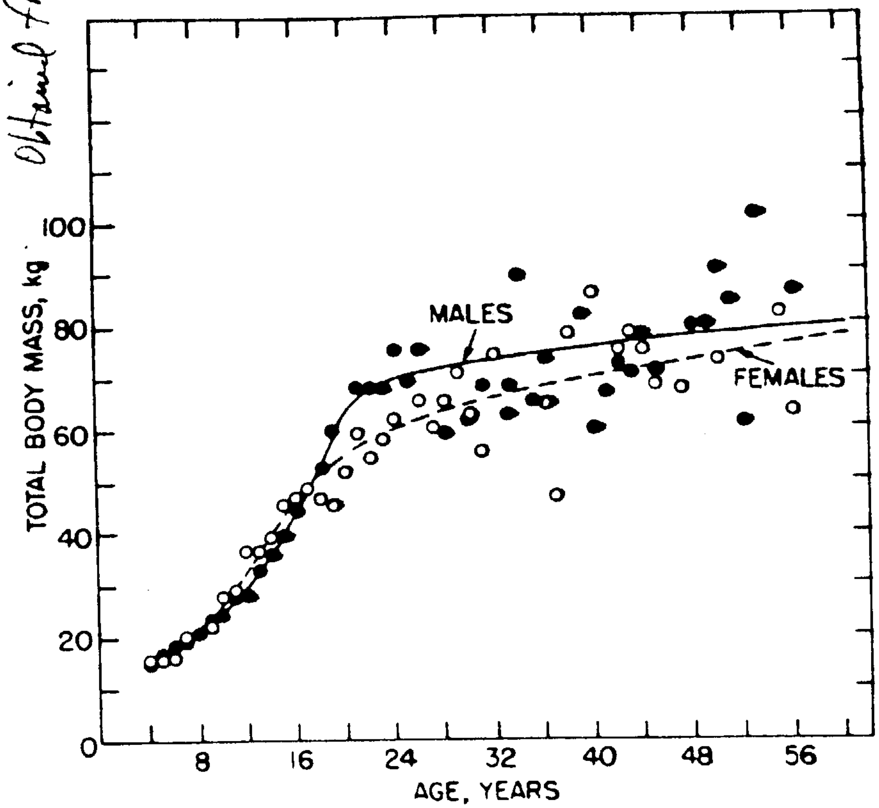


Fig. 1 Body Mass as a Function of Age for Residents of Rongelap Atoll

from 1979 Med Survey

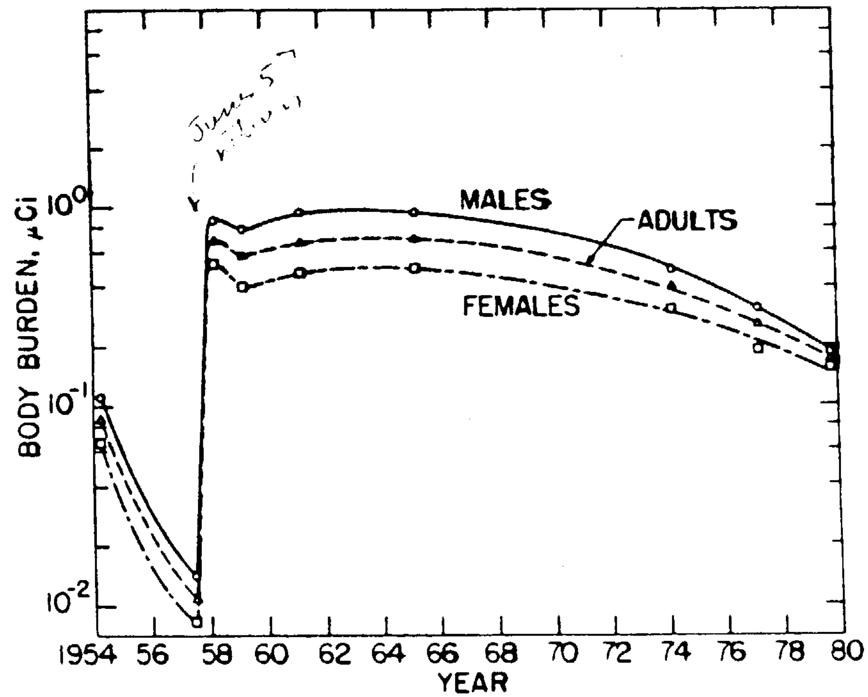


Fig. 2 Mean Adult ^{137}Cs Body Burden History at Rongelap Atoll

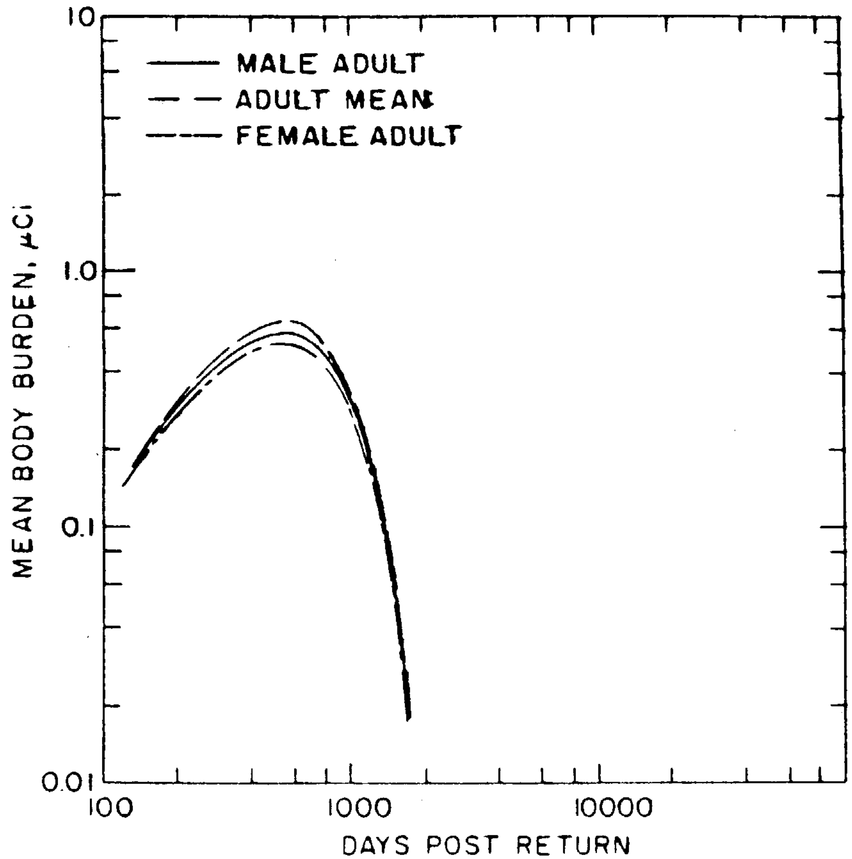


Fig. 3 Mean Adult ^{65}Zn Body Burden History at Rongelap Atoll

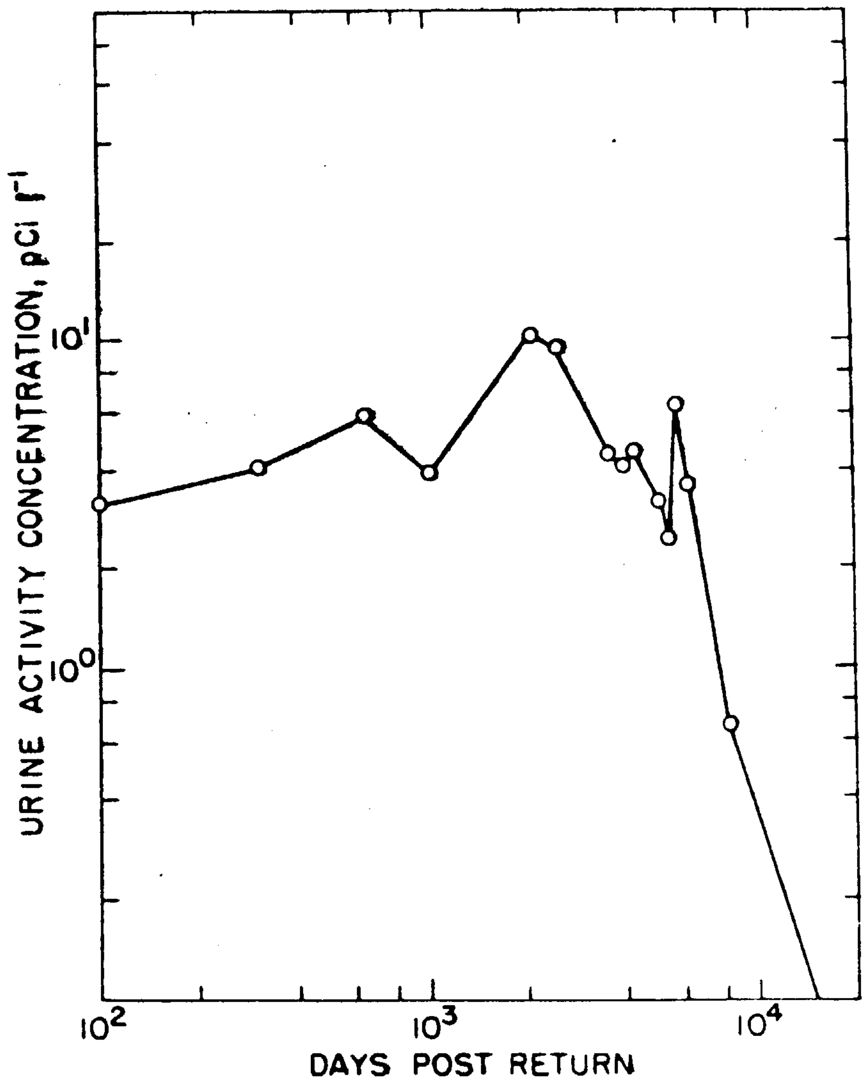


Fig. 4 Mean Adult ^{90}Sr Urine Activity Concentration History at Rongelap Atoll

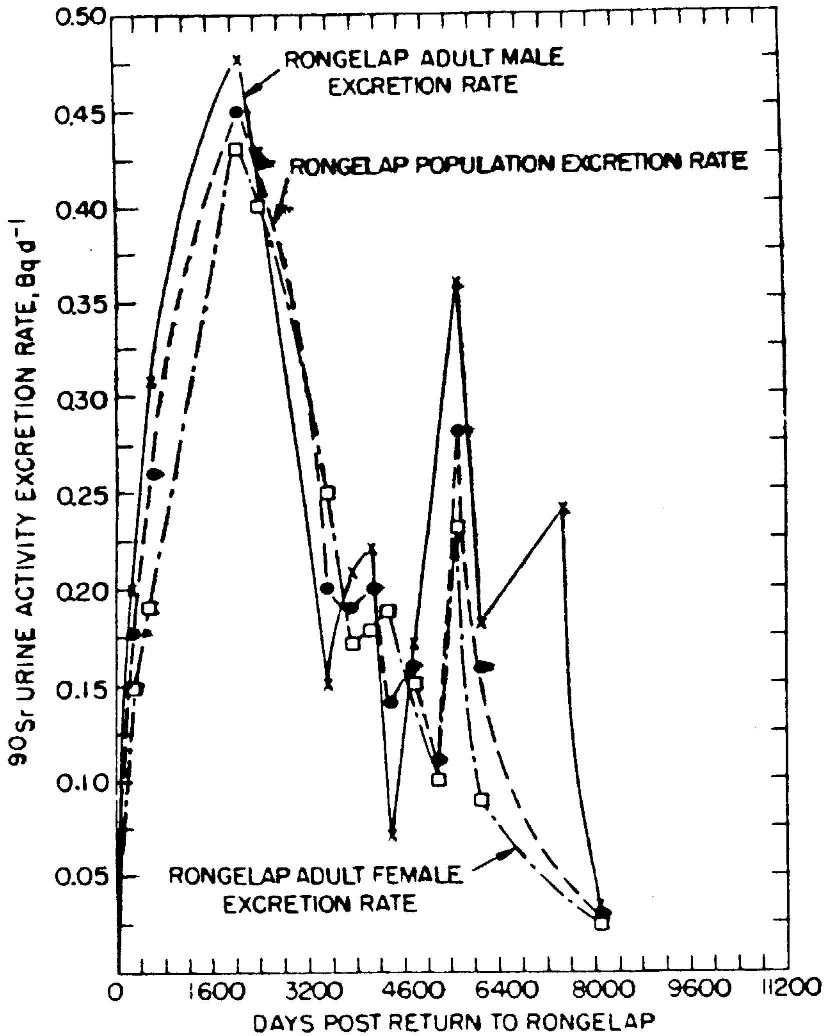


Fig. 5 Mean Adult ^{90}Sr Urine Activity Excretion Rate at Rongelap Atoll

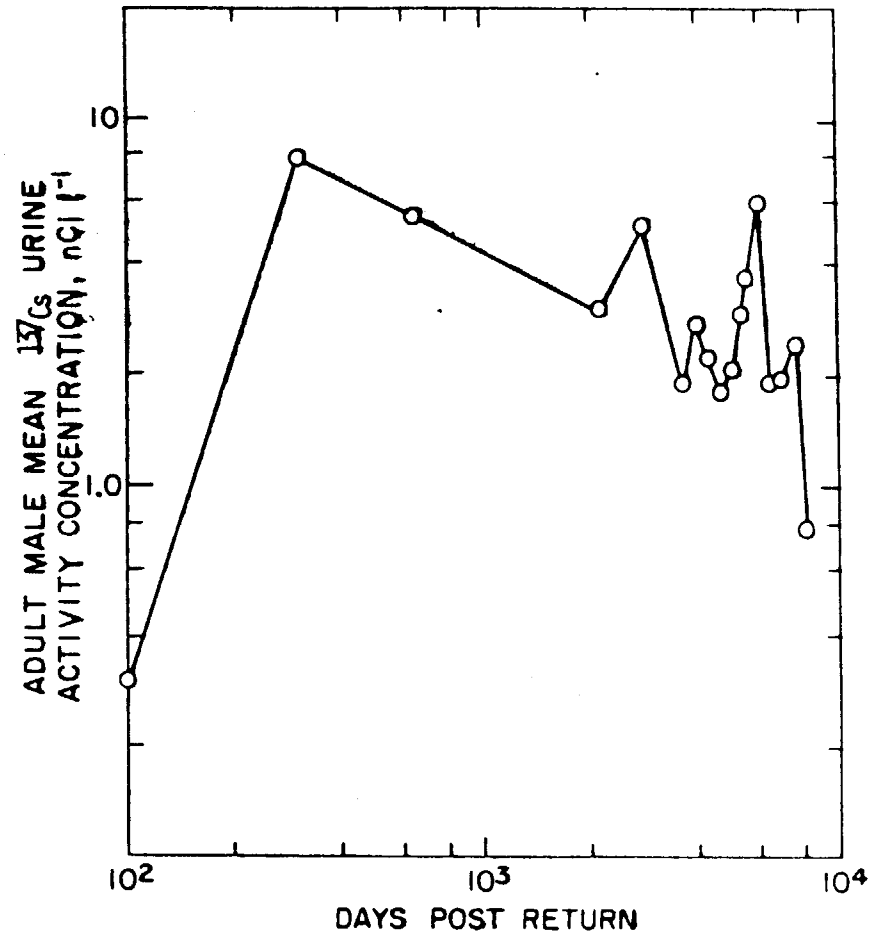


Fig. 6 Mean Adult Male ^{137}Cs Urine Activity Concentration History at Rongelap Atoll

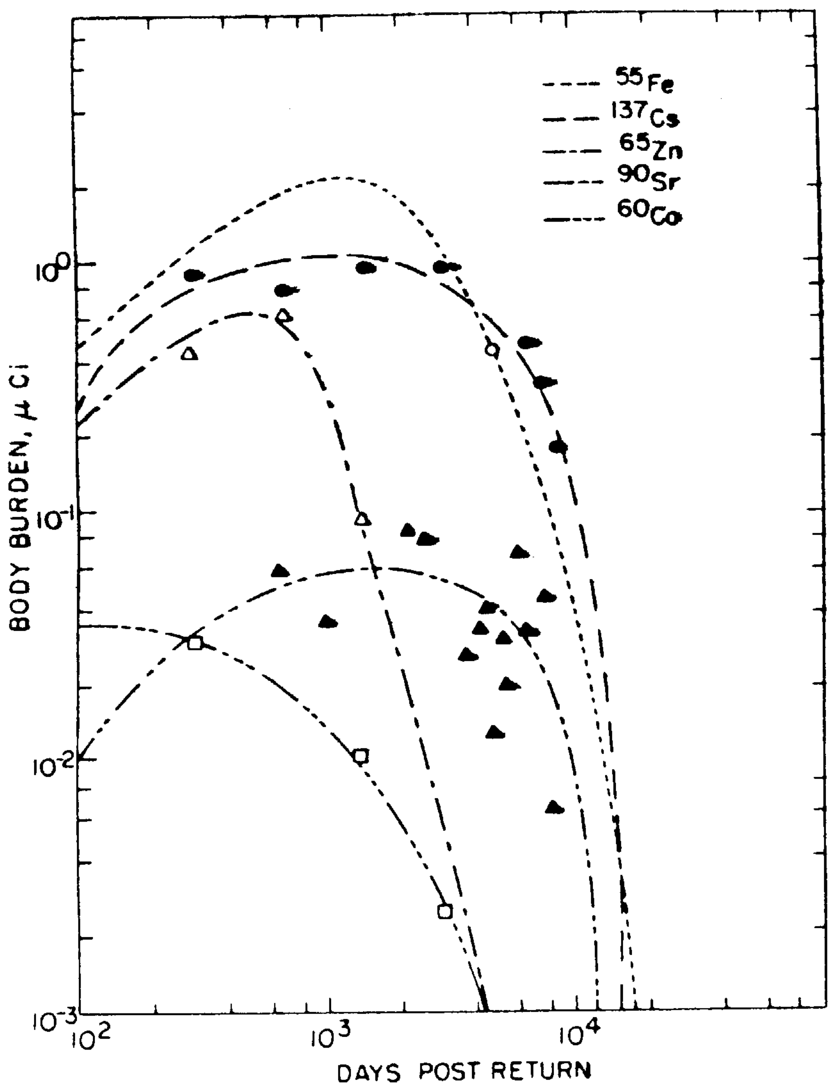


Fig. 7 Composite Nuclide Body Burden History for Adults at Rongelap Atoll

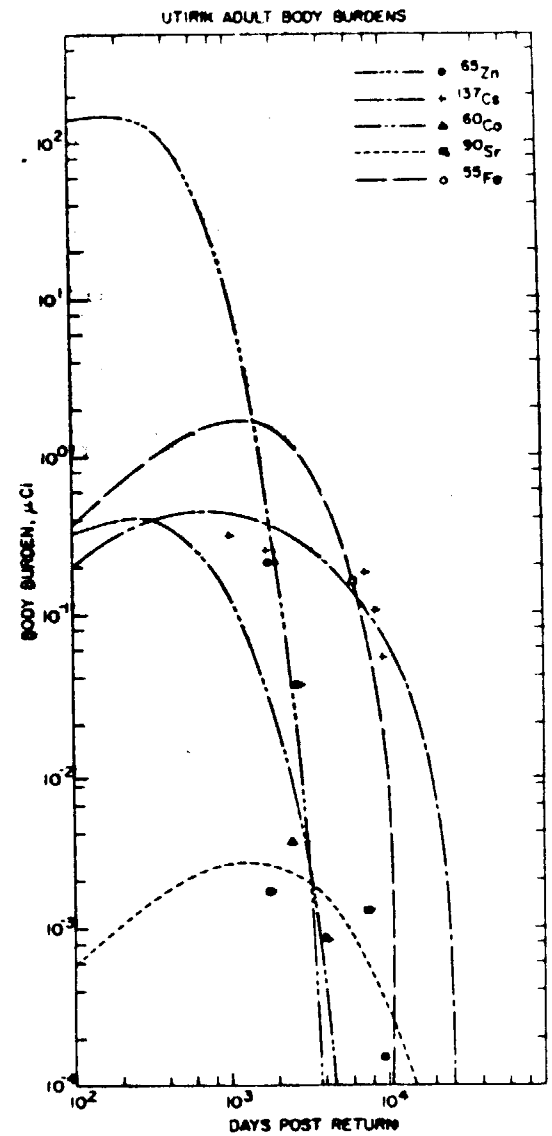


Fig. 8 Composite Nuclide Body Burden History for Adults at Utirik Atoll

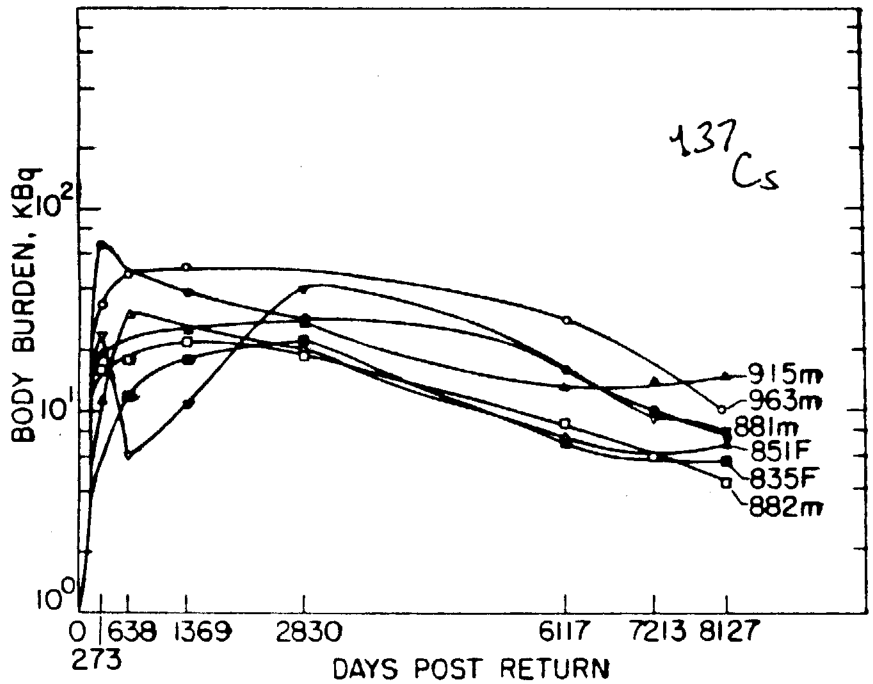


Fig. 9 Individual Male and Female Body Burden Histories Randomly Chosen from the Rongelap Atoll Population

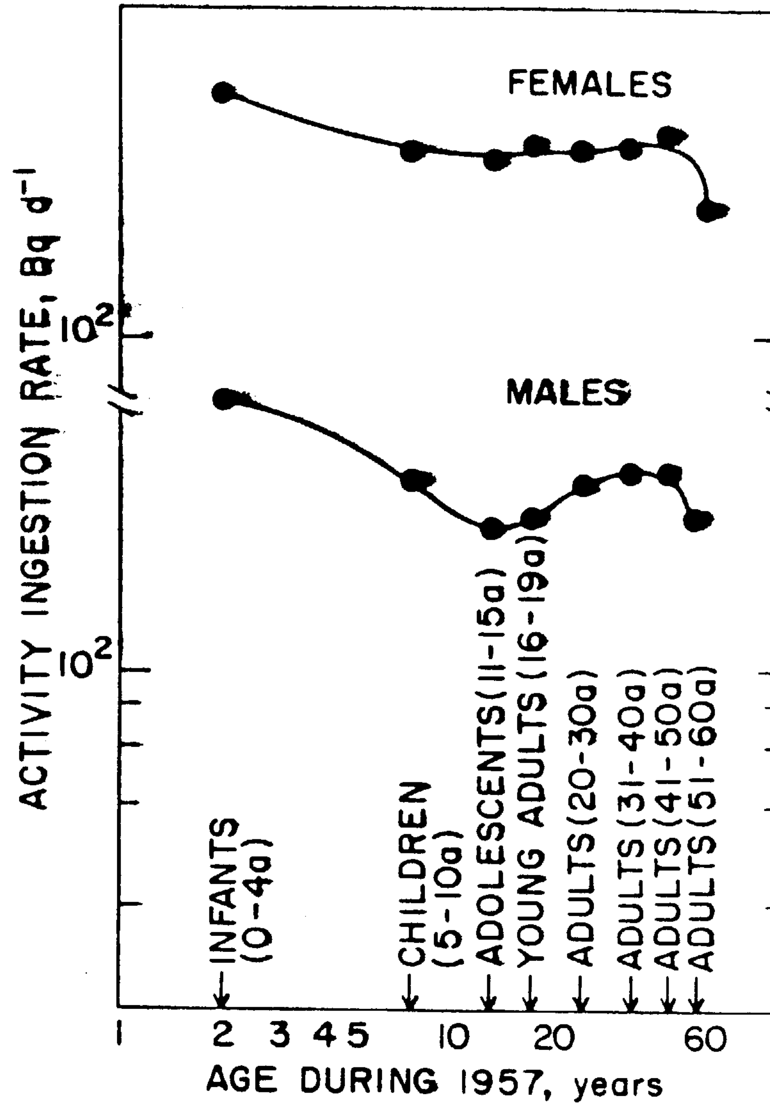


Fig. 10 Age and Sex Group Mean Values for ^{137}Cs Activity Ingestion Rate Referenced to Mid-1957 for Rongelap Atoll

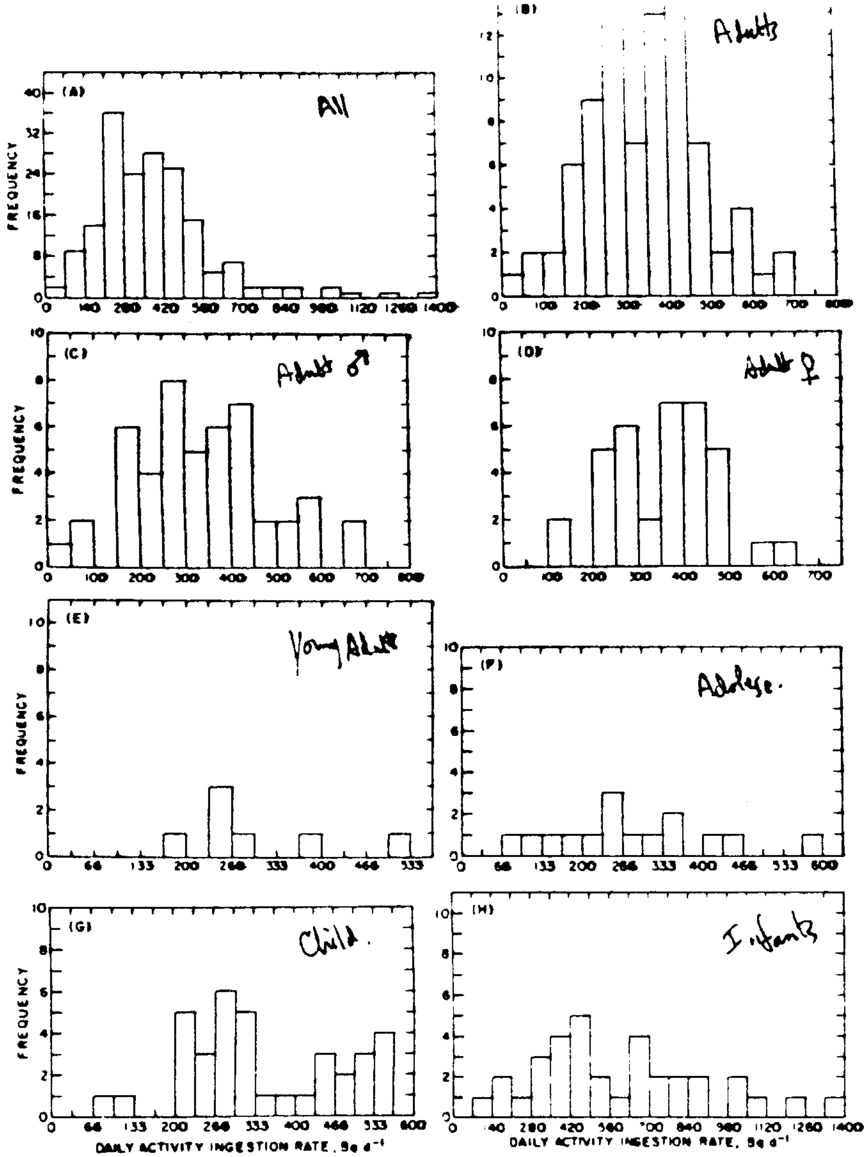


Fig. 11 ^{137}Cs Daily Activity Ingestion Rate for (A) All Residents (B) Adults (C) Adult Males (D) Adult Females (E) Young Adults (F) Adolescents (G) Children and (H) Infants on Rongelap Referenced to June 1957

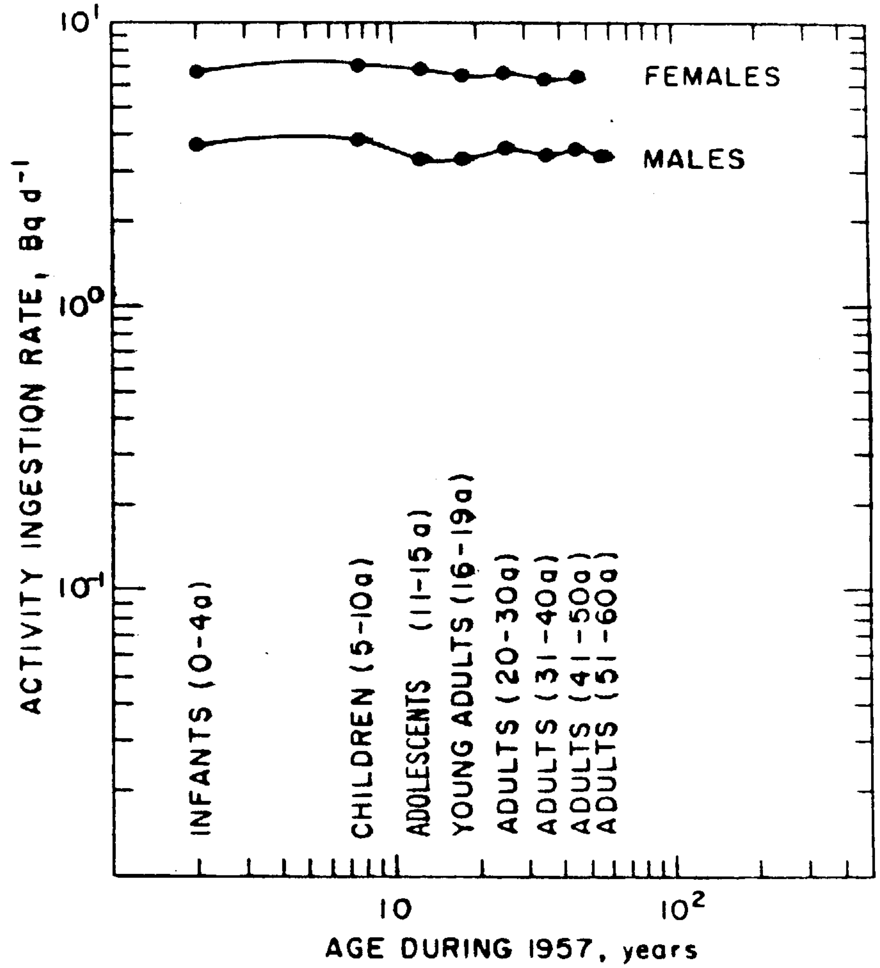


Fig. 12 Age and Sex Group Mean Values for ^{90}Sr Activity Ingestion Rate Referenced to Mid-1957 for Rongelap Atoll

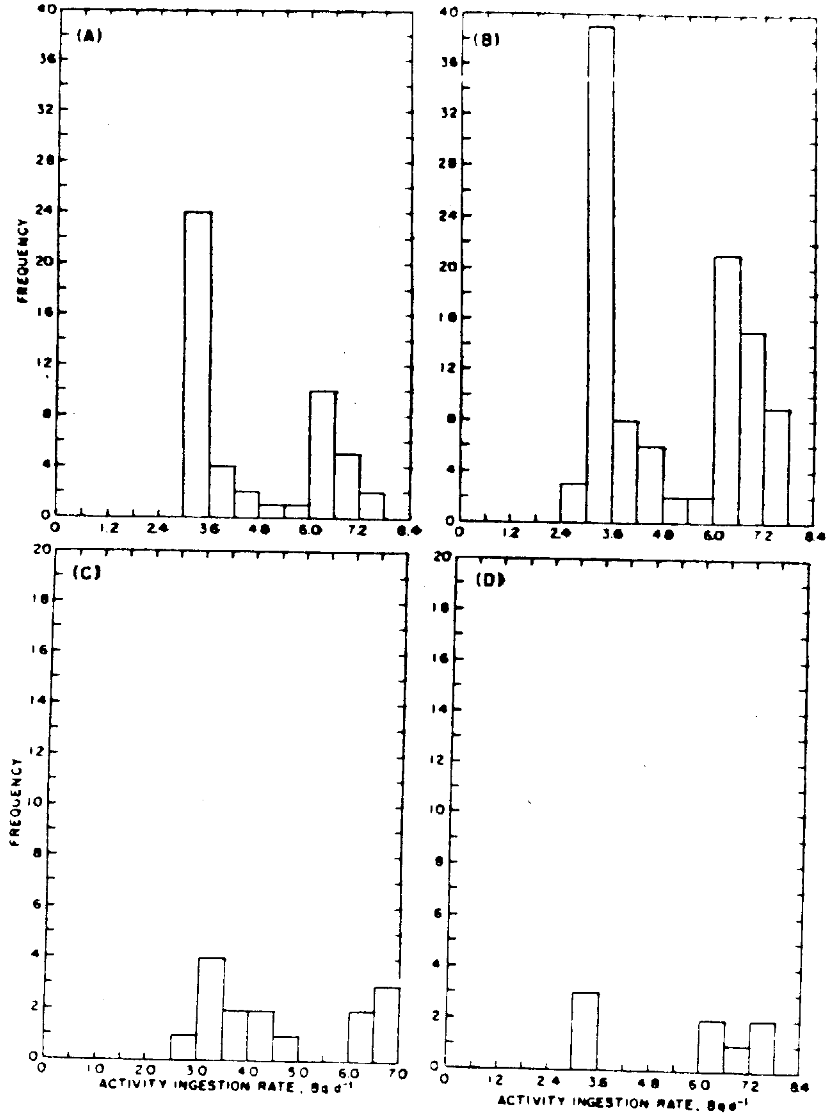


Fig. 13a ^{90}Sr Daily Activity Ingestion Rate for (A Adults (B) All Residents (C) Infants and (D) Adolescents on Rongelap

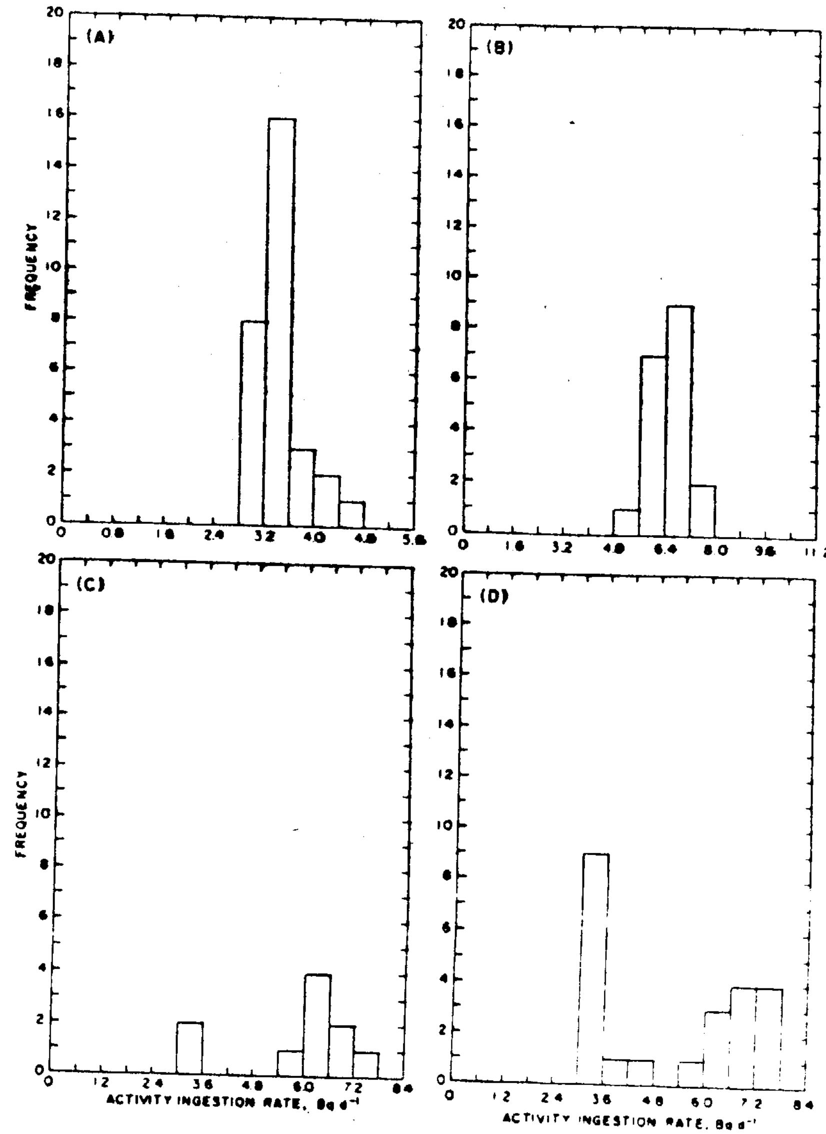


Fig. 13b ^{90}Sr Daily Activity Ingestion Rate for (A) Adult Males (B) Adult Females (C) Young Adults and (D) Children on Rongelap

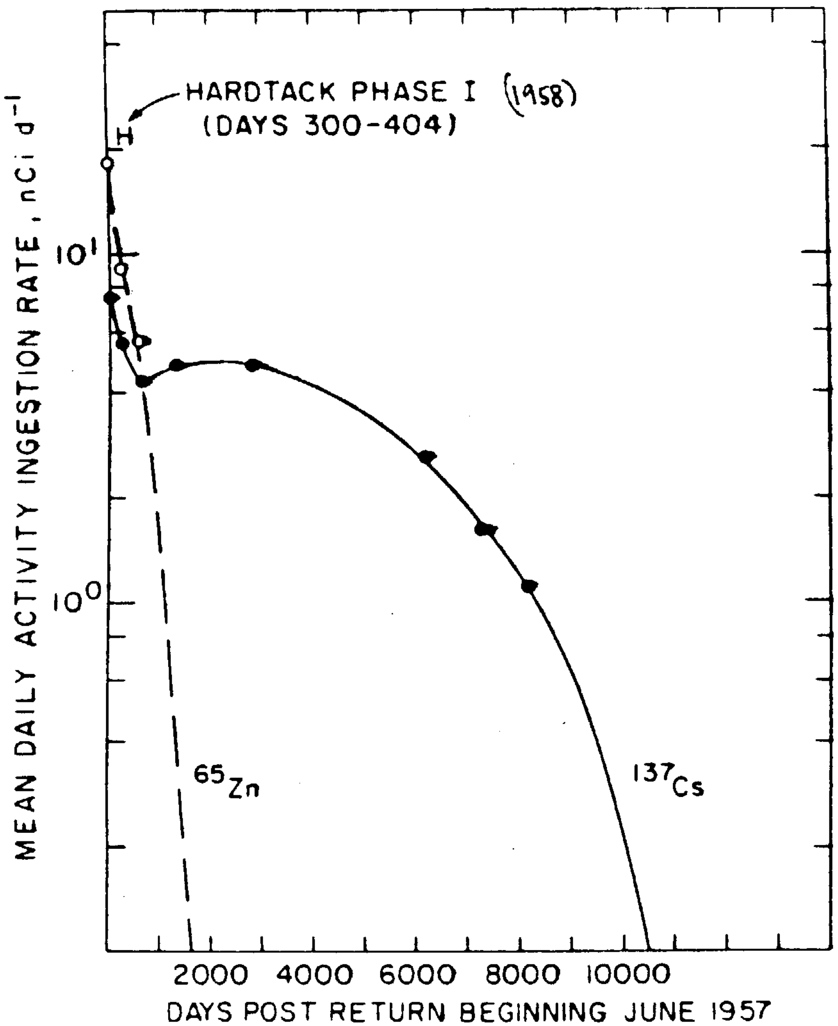


Fig. 14 Adult Mean Daily Activity Ingestion Rate for ^{137}Cs and ^{65}Zn at Rongelap Referenced to Mid-1957

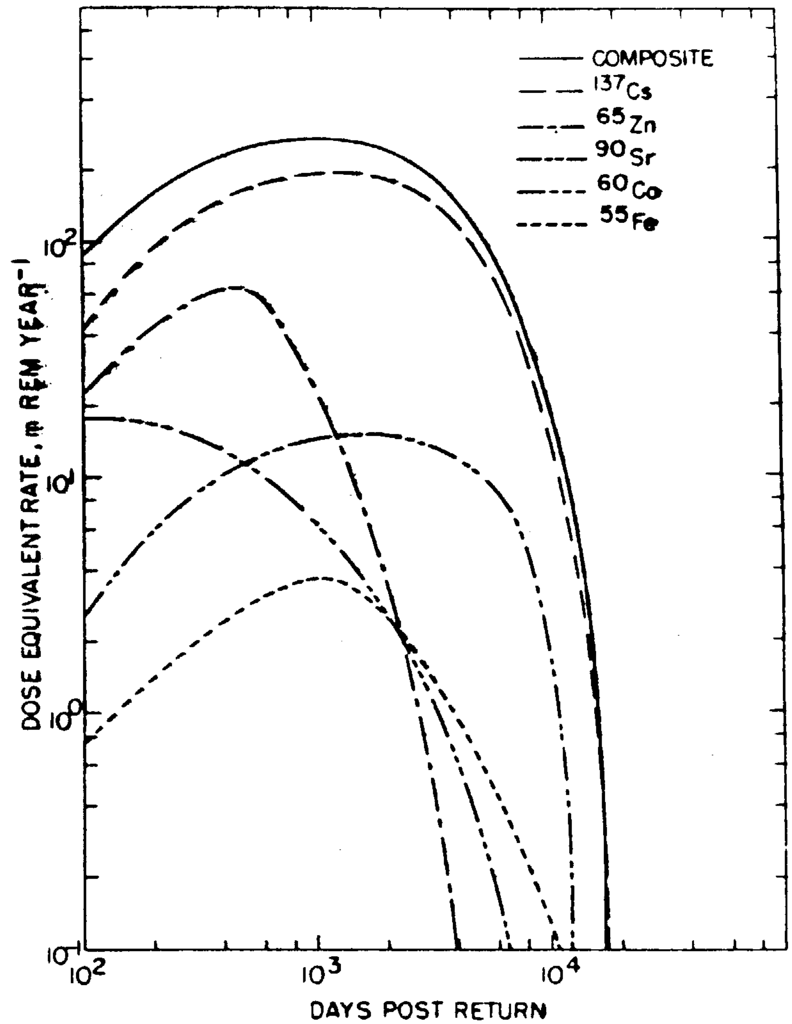


Fig. 15 Adult Mean Total Body Dose Equivalent Rate at Rongelap Atoll Post Mid-1957

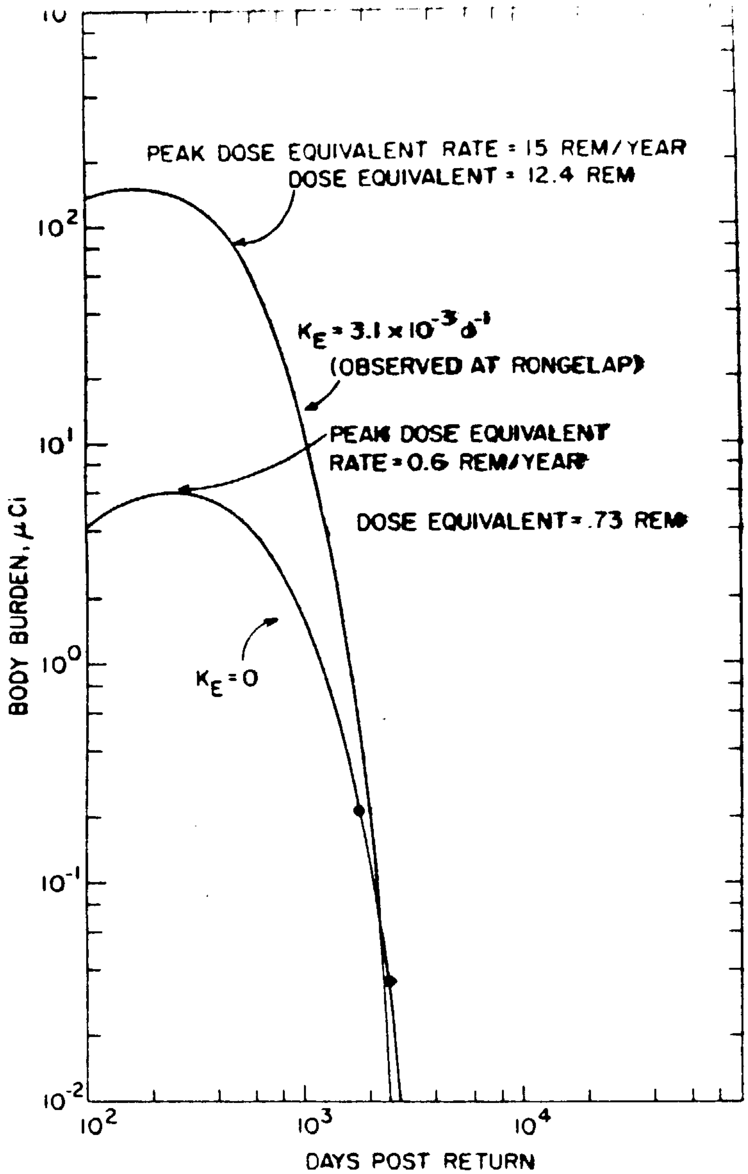


Fig. 16 Mean Adult ^{65}Zn Body Burden, Peak Dose Equivalent Rate and Dose Equivalent for Utirik Atoll

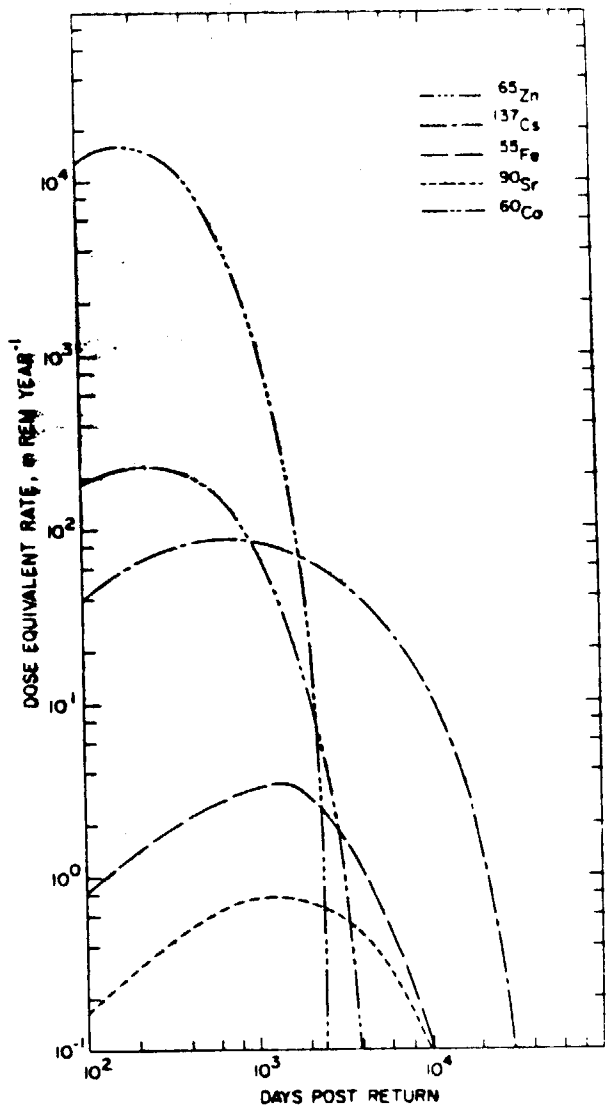


Fig. 17 Adult Mean Total Body Dose Equivalent Rate at Utirik Atoll Post Mid-1954

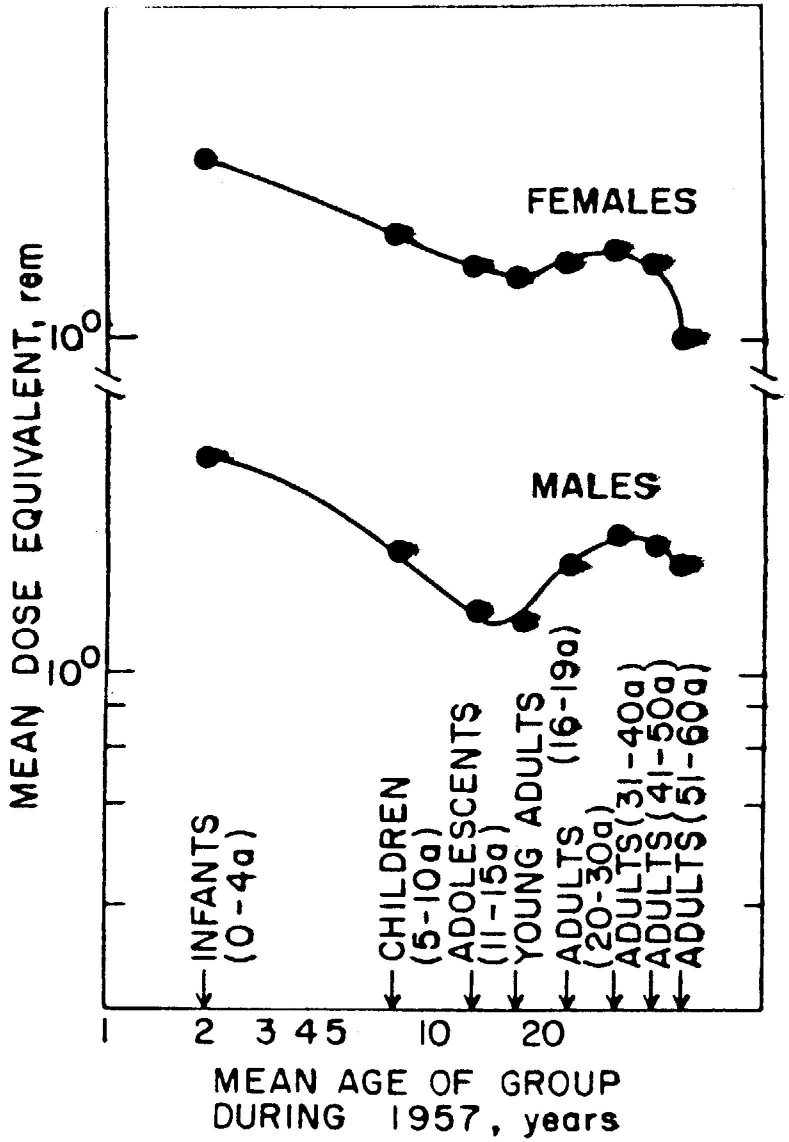


Fig. 18 ^{137}Cs Mean Dose Equivalent for Various Mid-1957 Age Groups for the Interval 1957 to 1980 at Rongelap Atoll

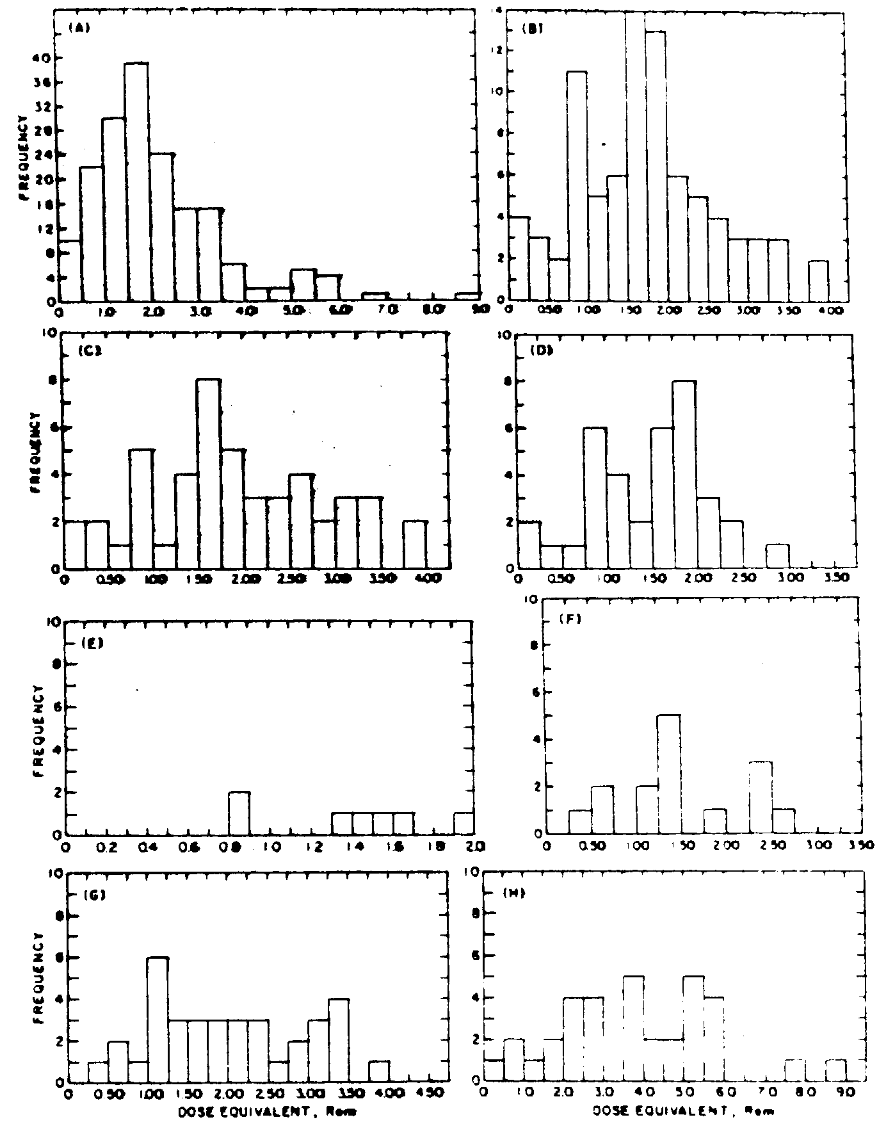


Fig. 19 ^{137}Cs **Dose Equivalent to (A) All Residents (B) Adults (C) Adult Males (D) Adult Females (E) Young Adults (F) Adolescents (G) Children and (H) Infants on Rongelap.**

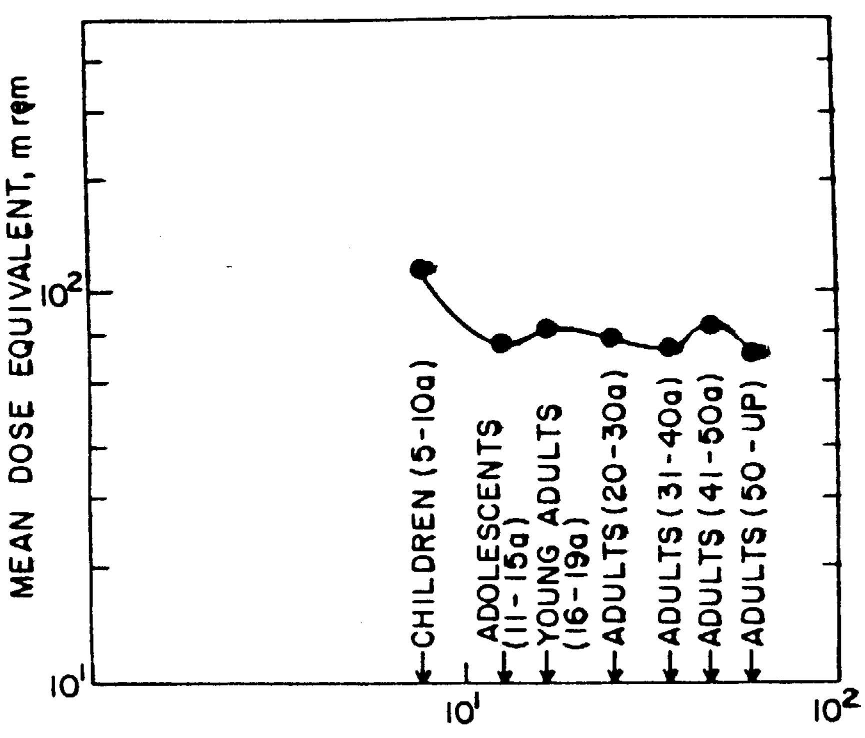


Fig. 20 ^{65}Zn Mean Dose Equivalent for Various Mid-1957 Age Groups for the Interval 1957 to 1980 at Rongelap Atoll

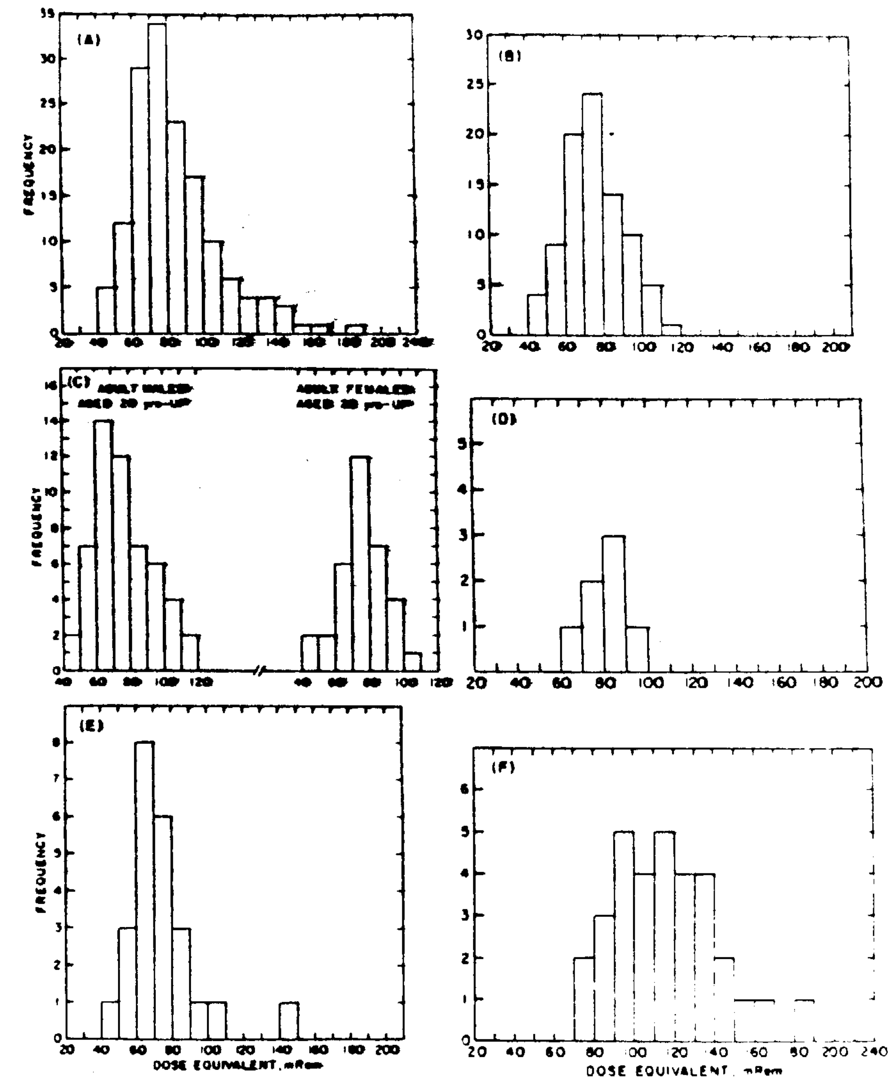


Fig. 21 ^{65}Zn Dose Equivalent to (A) All Residents (B) Adults (C) Adult Males and Females (D) Adolescents (E) Children and (F) Infants on Rongelap Atoll.

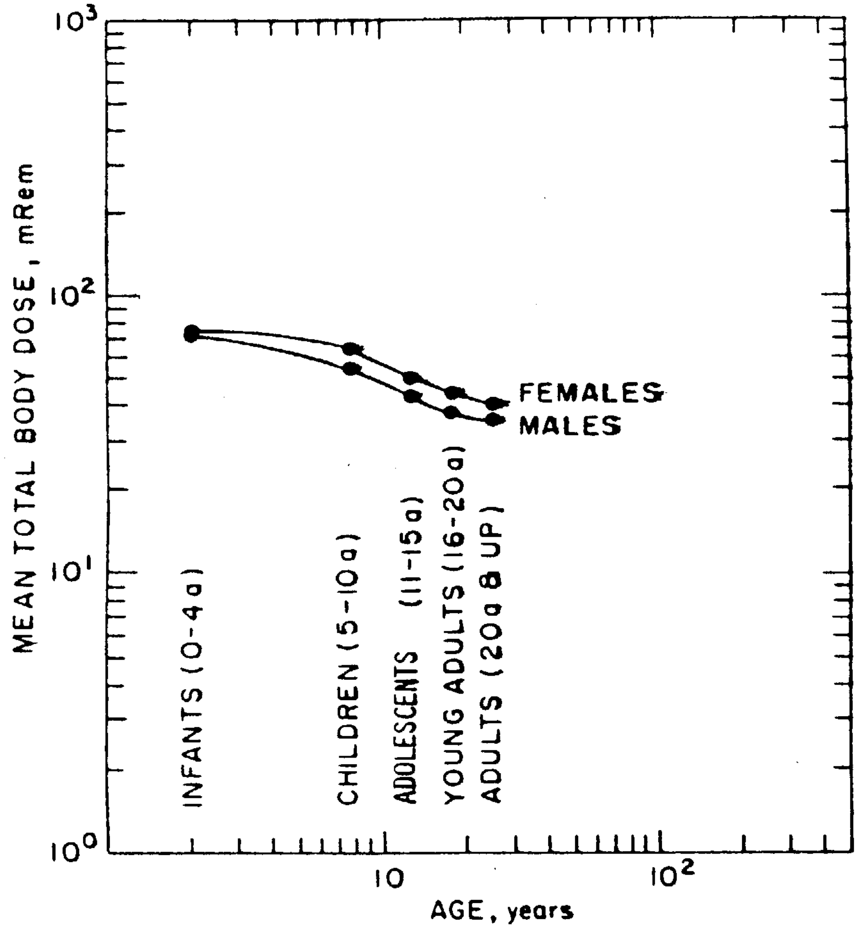


Fig. 22 Age and Sex Group Mean Values for ^{90}Sr Dose Equivalent for the Interval 1957 to 1980 at Rongelap Atoll

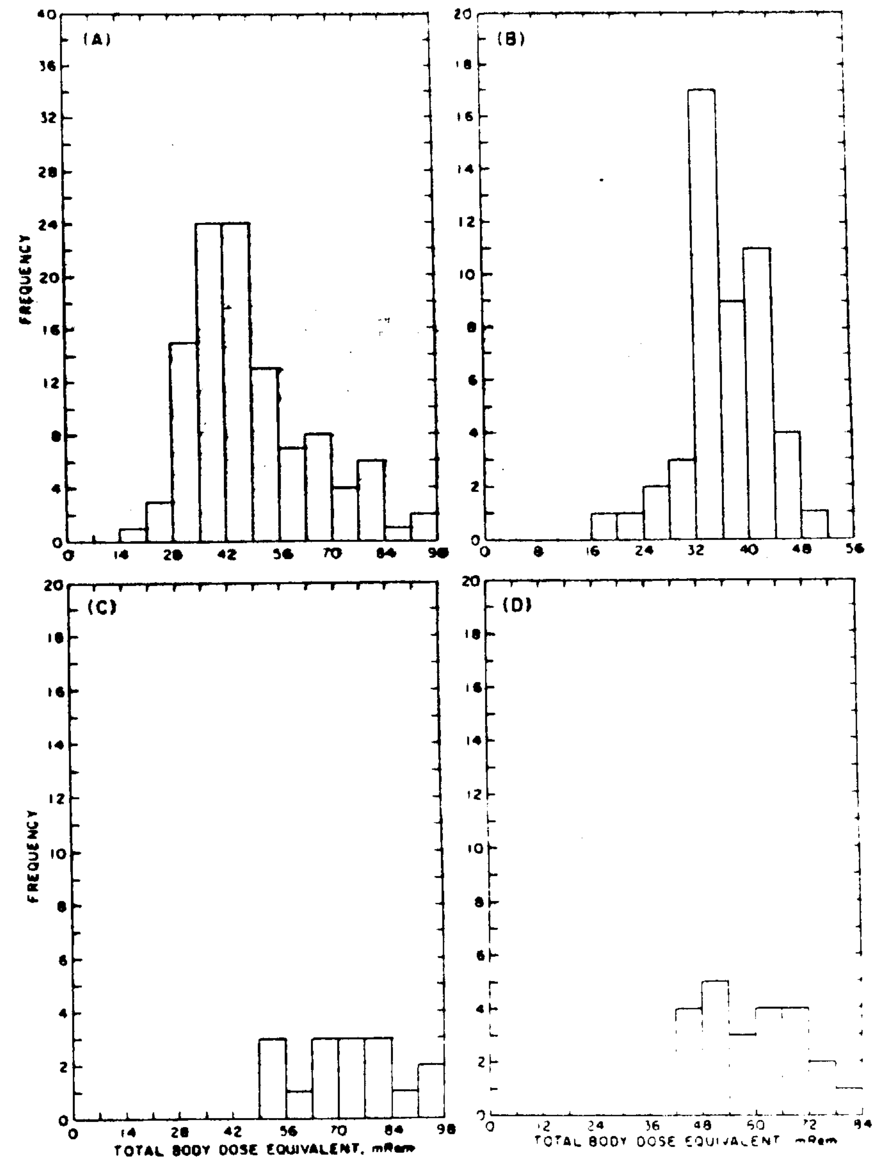


Fig. 23a ^{90}Sr Dose Equivalent for (A) All Residents (B) Adults (C) Infants and (D) Children on Rongelap

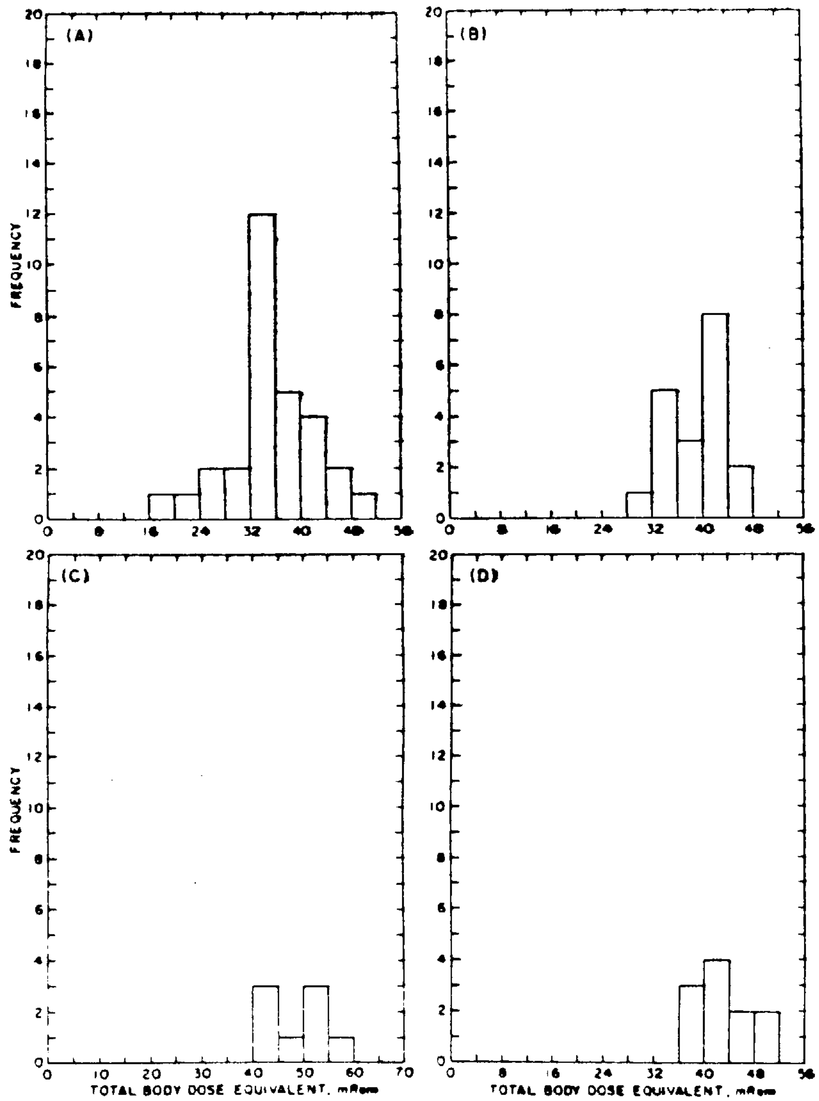


Fig. 23b ^{90}Dose Equivalent for
(A) Adult Males (B) Adult Females
(C) Adolescents and (D) Young Adults
on Rongelap

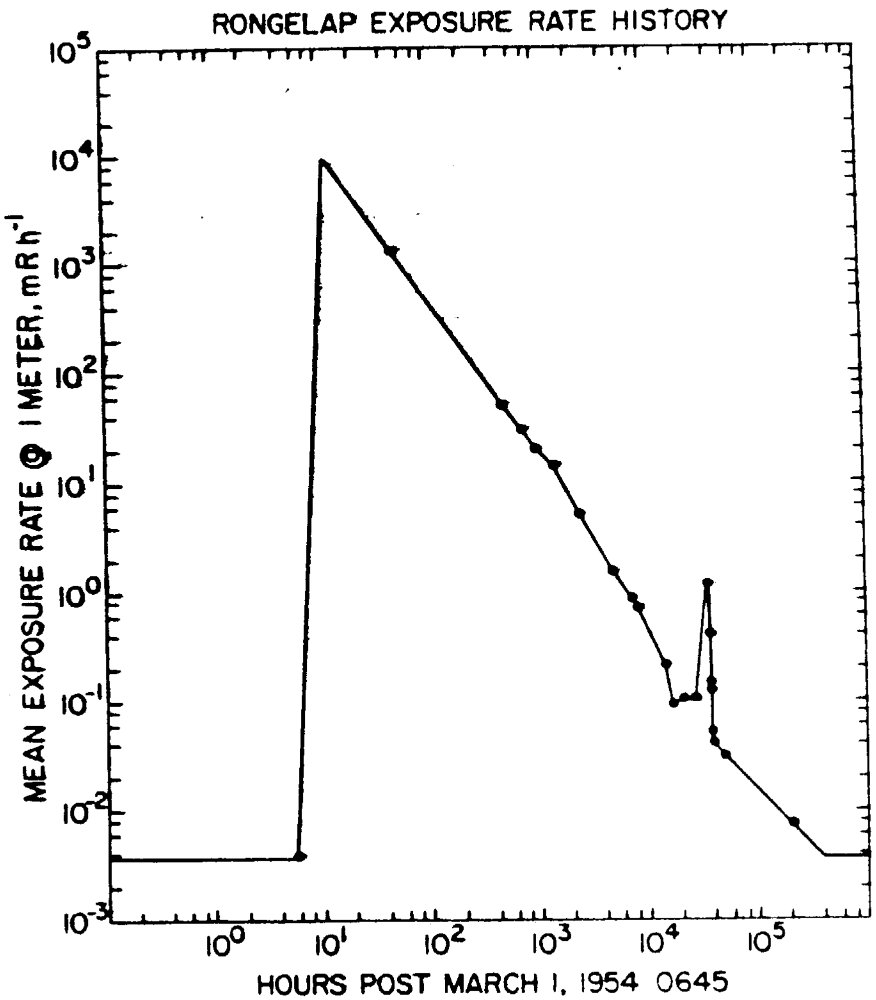


Fig. 24 Rongelap External
Exposure Rate History
Post Bravo

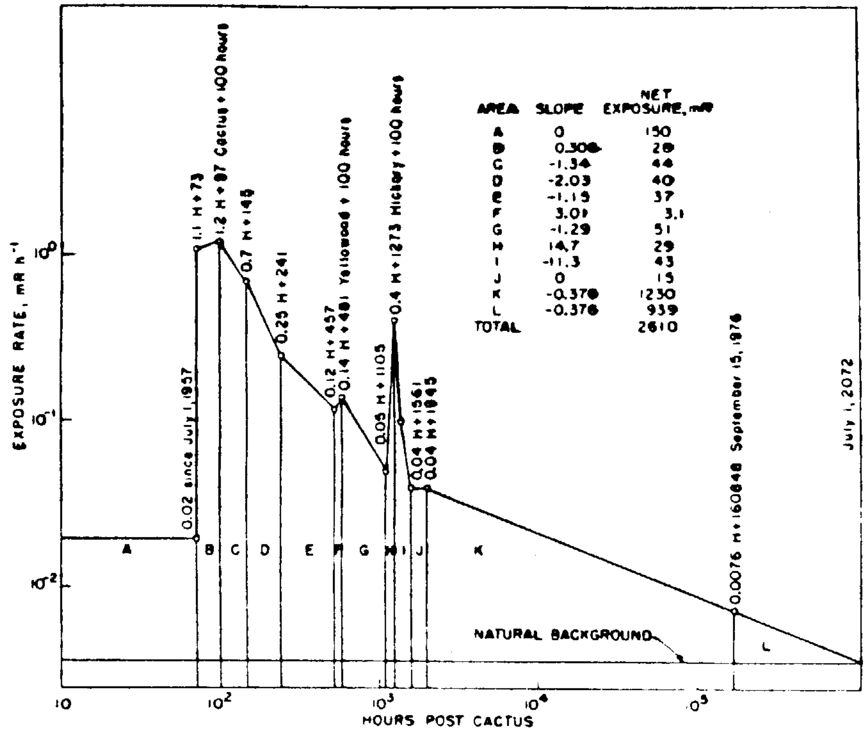


Fig. 25 Rongelap External
Exposure Rate History
Post Cactus

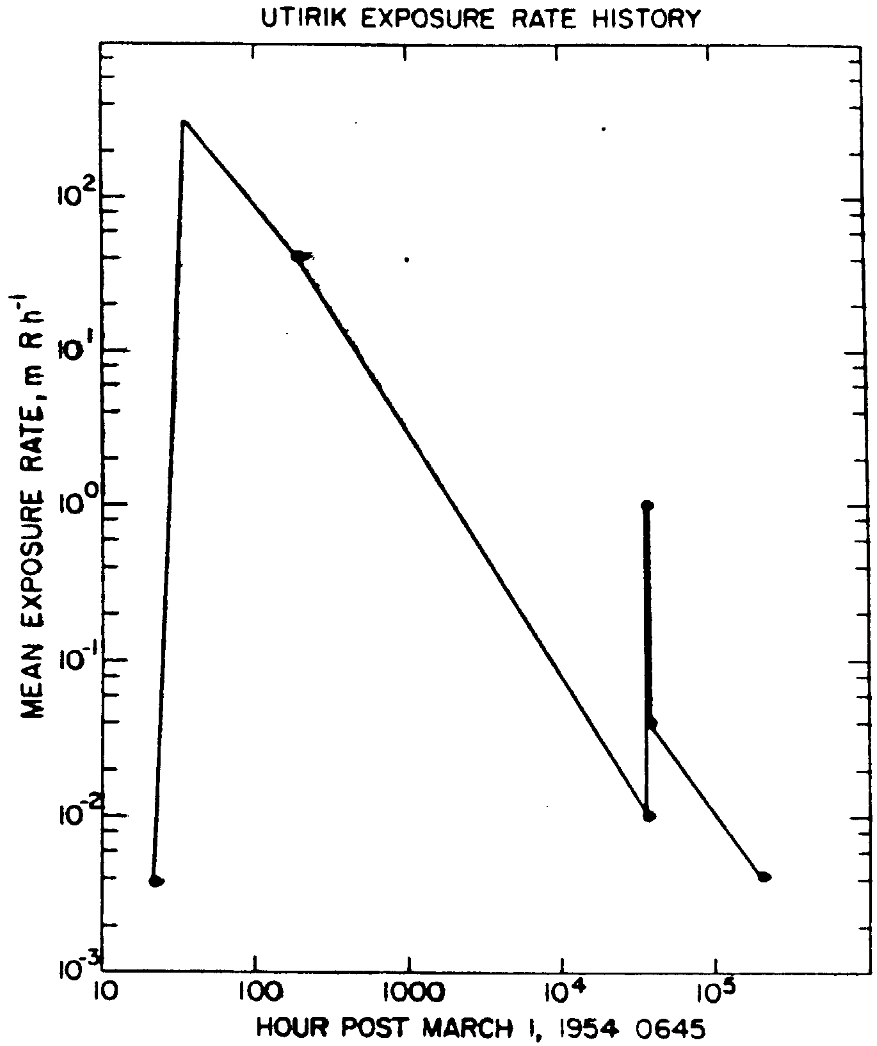


Fig. 26 Utirik External
Exposure Rate History
Post Bravo

Table 1

Rongelap Body Burdens

	Adult Males		Adult Females		Adults		
	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	Days Post Return Days
^{60}Co	2.9×10^{-5}	NA	1.7×10^{-5}	NA	2.3×10^{-5}	NA	1
	1.0×10^{-2}	37	7.8×10^{-3}	37	9.0×10^{-3}	74	1370
	2.5×10^{-3}	45	2.0×10^{-3}	45	2.2×10^{-3}	90	2831
^{65}Zn	4.3×10^{-2}	NA	3.8×10^{-2}	NA	4.1×10^{-2}	NA	1
	4.3×10^{-1}	30	3.8×10^{-1}	12	4.1×10^{-1}	42	304
	6.2×10^{-1}	32	5.0×10^{-1}	27	5.6×10^{-1}	59	639
	9.5×10^{-2}	38	8.5×10^{-2}	23	9.0×10^{-2}	61	1370
^{55}Fe	4.3×10^{-1}	28	4.0×10^{-1}	32	4.1×10^{-1}	60	4626
^{90}Sr	1.9×10^{-4}	NA	1.4×10^{-4}	NA	1.7×10^{-4}	NA	1
	3.7×10^{-3}	11	2.8×10^{-3}	4	3.4×10^{-3}	15	304
	5.7×10^{-3}	24	3.5×10^{-3}	16	4.8×10^{-3}	40	639
	3.7×10^{-3}	9	1.6×10^{-3}	4	3.0×10^{-3}	13	1370
	8.8×10^{-3}	12	7.9×10^{-3}	13	8.4×10^{-3}	25	2100
	7.9×10^{-3}	11	7.4×10^{-3}	7	7.7×10^{-3}	18	2466
	2.8×10^{-3}	12	4.6×10^{-3}	12	3.7×10^{-3}	24	3561
	3.9×10^{-3}	11	3.1×10^{-3}	11	3.5×10^{-3}	22	3927
	4.1×10^{-3}	11	3.3×10^{-3}	13	3.6×10^{-3}	24	4292
	1.3×10^{-3}	8	3.3×10^{-3}	11	2.5×10^{-3}	19	4657
	3.1×10^{-3}	8	2.8×10^{-3}	7	3.0×10^{-3}	15	5022
	2.0×10^{-3}	5	1.4×10^{-3}	7	1.6×10^{-3}	12	5388
	6.6×10^{-3}	4	4.2×10^{-3}	7	4.3×10^{-3}	13	5753
	3.3×10^{-3}	10	1.7×10^{-3}	4	2.8×10^{-3}	14	6118
	4.4×10^{-3}	23	NA	0	NA	NA	7579
	6.3×10^{-4}	24	4.6×10^{-4}	19	5.5×10^{-4}	43	8097
^{137}Cs	1.4×10^{-2}	NA	8.4×10^{-3}	NA	1.1×10^{-2}	NA	1
	8.7×10^{-1}	NA	5.2×10^{-1}	NA	6.8×10^{-1}	NA	304
	7.9×10^{-1}	47	4.1×10^{-1}	49	5.7×10^{-1}	96	639
	9.5×10^{-1}	37	4.7×10^{-1}	37	6.7×10^{-1}	74	1370
	9.4×10^{-1}	44	4.9×10^{-1}	45	6.8×10^{-1}	89	2831
	4.8×10^{-1}	22	3.0×10^{-1}	24	3.9×10^{-1}	46	6118
	3.0×10^{-1}	30	1.9×10^{-1}	21	2.5×10^{-1}	51	7213
	1.8×10^{-1}	19	1.5×10^{-1}	18	1.7×10^{-1}	37	8097

NA = Not available

Table 2

Utirik Body Burdens

	Adult Males		Adult Females		Adults		
	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	Days Post Return Days
^{60}Co							
D	4.0×10^{-3}		3.1×10^{-3}		3.5×10^{-3}		2464
D	9.7×10^{-4}		7.6×10^{-4}		8.7×10^{-4}		3924
^{65}Zn	3.5×10^{-1}*	2	-		-		
	2.7×10^{-1}	14	1.6×10^{-1}	15	2.1×10^{-1}	29	1734
D	3.7×10^{-2}		3.3×10^{-2}		3.5×10^{-2}		2464
^{55}Fe							
D	1.7×10^{-1}		1.6×10^{-1}		1.6×10^{-1}		6114
^{90}Sr							
	1.4×10^{-3}	5	2.4×10^{-3}	2	1.7×10^{-3}	7	1734
	1.2×10^{-3}	5	1.3×10^{-3}	6	1.3×10^{-3}	11	7213
	NA	12	NA	12	NA	24	8669
	1.5×10^{-4}	14	1.5×10^{-4}	17	1.5×10^{-4}	31	9225
^{137}Cs							
	4.1×10^{-1}	NA	2.7×10^{-1}	NA	3.3×10^{-1}	NA	1004
	2.9×10^{-1}	15	2.0×10^{-1}	15	2.5×10^{-1}	30	1734
	2.6×10^{-1}	9	1.3×10^{-1}	13	1.8×10^{-1}	22	7213
	1.2×10^{-1}	27	7.8×10^{-2}	21	1.0×10^{-1}	48	8309
	6.2×10^{-2}	19	4.3×10^{-2}	17	5.3×10^{-2}	36	9225

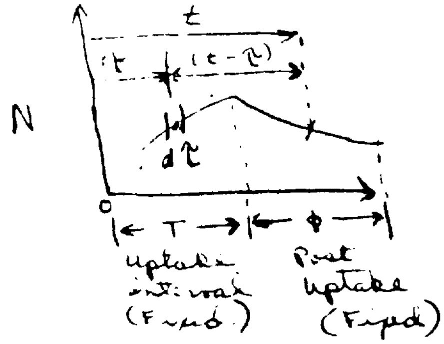
D = Ratio derived body burden
NA = Not available
* = Measured at Argonne National Laboratory

Table 4

Total Body Dosimetric and Physiologic Data

Nuclide $^{A}_{Z}X$	Compartment Deposition Fraction X_i	Compartment Removal Rate Constant K_i d^{-1}	GI Tract to Blood Transfer f_1	Fraction Excreted in Urine f_u	Decay Constant λ d^{-1}	Significant Progeny $^{A}_{Z}X$	Branching Ratio
$^{137}_{55}Cs$	0.13 0.87	0.50 0.0051	1.0	0.90	6.3×10^{-5}	$^{137m}_{56}Ba$	0.946
$^{65}_{30}Zn$	0.25 0.75	0.058 0.0022	0.35	0.25	2.8×10^{-3}	$^{65*}_{29}Cu$	0.49
$^{90}_{38}Sr$	0.89 0.059 0.051	0.21 7.1×10^{-4} 1.0×10^{-4}	0.20	0.85	6.5×10^{-5}	$^{90}_{39}Y$ $^{90*}_{40}Zr$	1.0 0.0002
$^{60}_{27}Co$	0.5 0.3 0.1 0.1	1.4 0.12 0.012 8.7×10^{-4}	0.05	0.70	3.6×10^{-4}	$^{60*}_{28}Ni$	1.0
$^{55}_{26}Fe$	1.0	3.5×10^{-4}	0.1	0.0	7.0×10^{-3}	-	

DEVELOPMENT OF DOSIMETRIC EQUATIONS



$f_1 P(\tau) = f_1 P^0 e^{-(k_e+\lambda)\tau}$, GI tract to blood function

$r(t-\tau) \equiv \sum_i x_i e^{-(\lambda+k_i)(t-\tau)}$, whole body retention function

Instantaneous number of atoms inputed into blood during $d\tau$,

$$f_1 P^0 e^{-(k_e+\lambda)\tau} d\tau .$$

instantaneous number of atoms at time $t-\tau$ that remain following input during $d\tau$,

$$f_1 P^0 e^{-(k_e+\lambda)\tau} d\tau \; r(t-\tau) .$$

Instantaneous number of atoms @ $t-\tau$ that remain following input during T,

$$N = \int_{\tau=0}^{\tau=T} f_1 P^0 e^{-(k_e+\lambda)\tau} d\tau \; r(t-\tau) .$$

$$N = f_1 P^0 \int_{t=0}^{t=T} \sum_i x_i e^{(k_e+\lambda)\tau} e^{-(\lambda+k_i)t} e^{(\lambda+k_i)\tau} d\tau$$

$$N = f_1 P^0 \sum_i x_i e^{-(k_i+\lambda)t} \left(e^{(k_i-k_e)T} - 1 \right)$$

for $t = T$

$$\lambda N = \lambda P^\circ f_i \sum_i x_i \frac{\left(e^{-(\lambda+K_e)T} - e^{-(\lambda+K_i)T}\right)}{K_i - K_e}$$

for $t = T + \phi$

$$\lambda N = \lambda P^\circ f_i \sum_i x_i \frac{\left(e^{-(\lambda+K_e)T} - e^{-(\lambda+K_i)T}\right) e^{-(K_i}}{K_i - K_e}$$

for $t = T + \phi$ and initial contamination

$$\lambda N = \lambda P^\circ f_i \sum_i x_i \frac{\left(e^{-(\lambda+K_e)T} - e^{-(\lambda+K_i)T}\right) e^{-(\lambda+K_i)\phi}}{K_i - K_e} + q_0^\circ \sum_i x_i e^{-(K_i}$$

Utirik June '54 to Jan '80
Rong June '57 to " "

Chronic Phase

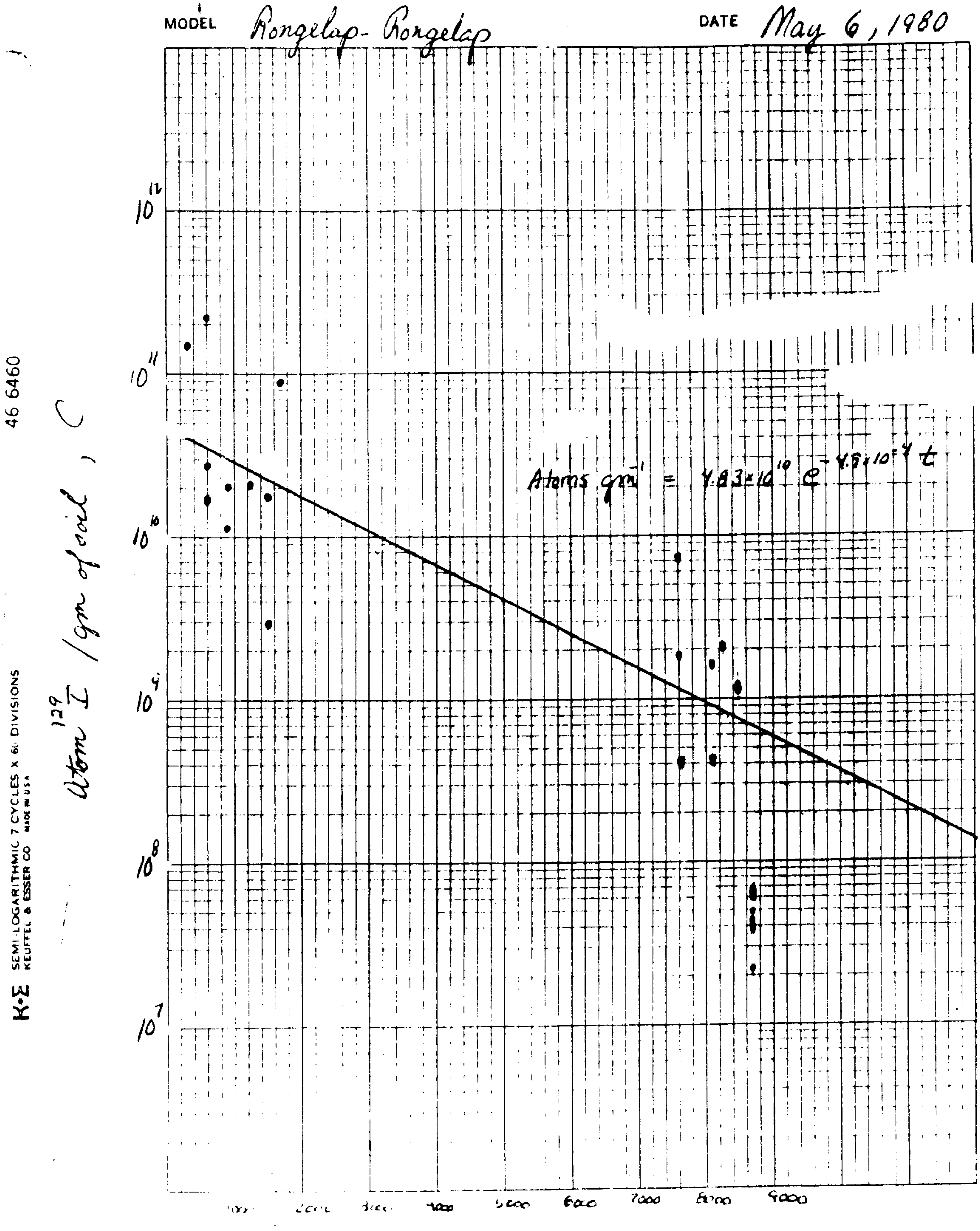
D.E and Committed Dose Equivalent Summary, Rem

	Total Body		Thyroid	
Nuclide	Utirik Adults	Rongelap Adults	Utirik Adults	Rongelap Adults
^{90}Sr	.0118	.0267	.000749	.00169
^{55}Fe	.0329	.0230	.0594	.0415
^{137}Cs	1.13	1.71	1.55	2.35
^{60}Co	.507	.0143	.359	.0101
^{65}Zn	12.5	.0757	11.1	.0672
Internal	14.2	1.85	13.1	2.47
External	3.19	2.02	3.19	2.02
Total	17.4	3.87	16.3	4.49

	Red Marrow		Testes-Ovaries	
^{90}Sr	.0537	.123	.000749-.000749	.00169-.00169
^{55}Fe	.0603	.0422	.0583-.0620	.0736-.0433
^{137}Cs	1.70	2.57	1.54-1.74	2.33-2.63
^{60}Co	.629	.0177	.443-1.78	0.12-.0502
^{65}Zn	17.2	.103	11.3-16.3	.0685-.0988
Internal	19.6	2.86	13.3-19.9	2.49-2.82
External	3.19	2.02	3.19	2.02
Total	22.8	4.88	16.5-23.1	4.51-4.84

	Lower Large Intestine Wall		Liver	
^{90}Sr	.225	.567	.000671	.00152
^{55}Fe	.0666	.0465	.115	.0804
^{137}Cs	.591	.895	1.81	2.74
^{60}Co	4.66	.132	.792	.0223
^{65}Zn	15.0	.0910	16.5	.136
Internal	20.5	1.73	19.2	2.98
External	3.19	2.02	3.19	2.02
Total	23.7	3.75	22.4	5.00

I-129 Average Atom Density of Soil Samples



Soil Samples

Soil samples consisted of entire first inch of soil. Since, $\bar{x}$, the ~~mean free path~~ relaxation depth is 3 cm, the soil sample does not represent a kernel. It expresses the average activity in the sample.

The total number of atoms in an areal plot 2.54 cm deep is

$$\int_0^{2.54} N\,dx = \int_0^{2.54} N_o e^{-\mu x}\,dx ,$$

where $N_o \equiv$ atoms cm^{-3} at depth $x = 0$,

$N \equiv$ atoms cm^{-3} at depth x,

$\mu \equiv$ instantaneous fraction of atom concentration remaining at depth x.

The average atom concentration is

$$\frac{\int_0^{2.54} N_o e^{-\mu x}\,dx}{2.54 \text{ cm}} .$$

The average atom density, C, is

$$C = \frac{N_o\left[1 - e^{-2.54\mu}\right]}{\mu\,\rho_{soil}\,(2.54 \text{ cm})} .$$

The total number of atoms cm^{-2} in an areal plot of infinite depth

$$C_A = \int_0^{\infty} N_o e^{-\mu x}\,dx = \frac{N_o}{\mu} .$$

Soil Samples

Thus,

$$C_A = 6.23\,C, \text{ atoms cm}^{-2},$$

where C has units of atoms I-129 per gm.

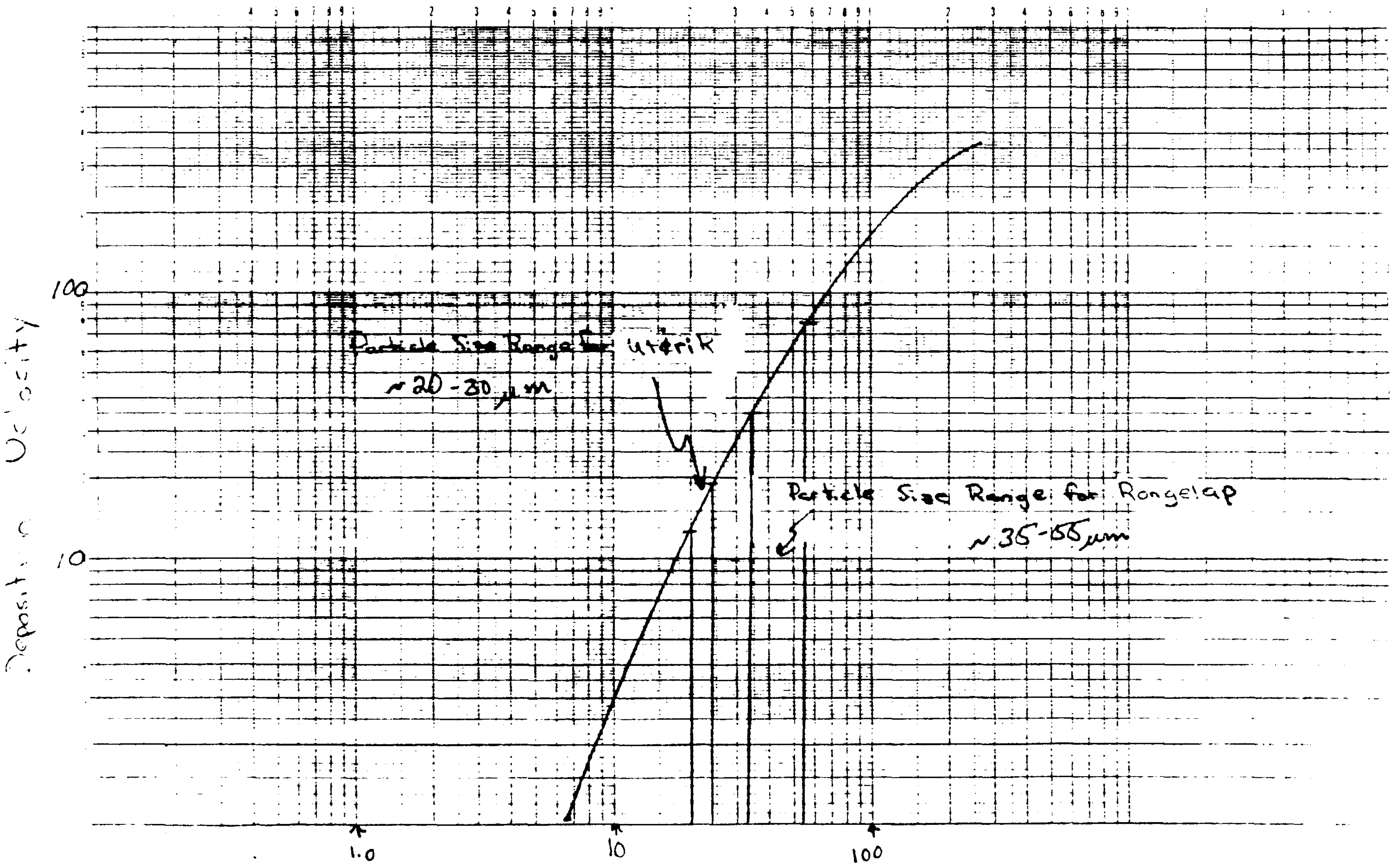
At one year post Bravo I-129 ingrowth had finished. Soil samples were taken post the ingrowth interval, thus the corrected I-129 deposited after fallout deposition is

$$C_A = 6.23 \times 4.83 \times 10^{10} \times .659 = {}^{*}\underline{1.98 \times 10^{11} \text{ atoms cm}^{-2}}$$

Additionally, the maximum and minumum values for I-129 atoms in Rongelap soil are taken from the graph. This results in a maximum and minimum value of approximately 8 times the mean value.

* Sondhaus suggests documenting upper & lower bounds on "μ" & resultant C_A values

Deposition Velocity vs Particle Size*



[illegible] of [illegible] Isotope Atoms [illegible] 10,000 Fissions

Thermonuclear Fission of [illegible] at Times

Post Creation

t Hours	I-125 Atoms	I-131 Atoms	I-132 Atoms	I-133 Atoms	I-134 Atoms	I-135 Atoms
0	7.62×10^{-4}	4.34×10^{1}	4.60×10^{0}	1.40×10^{2}	$[illegible].20 \times 10^{1}$	$2.53 \times 10^{[illegible]}$
2	1.68×10^{1}	3.04×10^{2}	8.99×10^{0}	5.01×10^{2}	2.02×10^{2}	4.49×10^{2}
4	4.63×10^{1}	3.50×10^{2}	1.13×10^{1}	5.22×10^{2}	6.63×10^{1}	3.60×10^{2}
6	7.31×10^{1}	3.52×10^{2}	1.24×10^{1}	5.01×10^{2}	1.66×10^{1}	2.92×10^{2}
8	9.13×10^{1}	3.52×10^{2}	1.30×10^{1}	4.71×10^{2}	3.86×10^{0}	2.37×10^{2}
10	1.10×10^{2}	3.51×10^{2}	1.31×10^{1}	4.42×10^{2}	8.52×10^{-1}	1.92×10^{2}
12	1.22×10^{2}	3.50×10^{2}	1.31×10^{1}	4.13×10^{2}	1.83×10^{-1}	1.56×10^{2}
14	1.31×10^{2}	3.50×10^{2}	1.30×10^{1}	3.81×10^{2}	3.87×10^{-2}	1.26×10^{2}
16	1.37×10^{2}	3.49×10^{2}	1.28×10^{1}	3.62×10^{2}	8.09×10^{-3}	1.02×10^{2}
18	1.42×10^{2}	3.48×10^{2}	1.27×10^{1}	3.39×10^{2}	1.68×10^{-3}	8.30×10^{1}
20	1.45×10^{2}	3.47×10^{2}	1.25×10^{1}	3.17×10^{2}	3.47×10^{-4}	6.73×10^{1}
22	1.48×10^{2}	3.45×10^{2}	1.22×10^{1}	2.97×10^{2}	7.16×10^{-5}	5.46×10^{1}
24	1.49×10^{2}	3.44×10^{2}	1.20×10^{1}	2.78×10^{2}	1.47×10^{-5}	4.42×10^{1}
26	1.51×10^{2}	3.43×10^{2}	1.18×10^{1}	2.60×10^{2}	3.03×10^{-6}	3.59×10^{1}
28	1.52×10^{2}	3.42×10^{2}	1.16×10^{1}	2.43×10^{2}	6.23×10^{-7}	2.91×10^{1}
30	1.53×10^{2}	3.40×10^{2}	1.14×10^{1}	2.28×10^{2}	1.28×10^{-7}	2.36×10^{1}
32	1.53×10^{2}	3.39×10^{2}	1.12×10^{1}	2.13×10^{2}	2.62×10^{-8}	1.91×10^{1}
34	1.54×10^{2}	3.38×10^{2}	1.10×10^{1}	1.99×10^{2}	5.38×10^{-9}	1.55×10^{1}
36	1.54×10^{2}	3.36×10^{2}	1.08×10^{1}	1.87×10^{2}	1.10×10^{-9}	1.26×10^{1}
38	1.54×10^{2}	$3.3[illegible] \times 10^{2}$	1.06×10^{1}	1.75×10^{2}	2.27×10^{-10}	1.02×10^{1}
40	1.54×10^{2}	3.33×10^{2}	1.04×10^{1}	1.63×10^{2}	4.67×10^{-11}	8.26×10^{0}
Peak	1.85×10^{2}	3.52×10^{2}	1.31×10^{1}			

Borg - what about other thyroid-seeking nuclides?
See Shellabarger, Van Middlesworth @ ORNL
Jan Wolf @ NIH

I-129 Deposition

i	~20 min intervals Interval, H + Hour	Particle Radius, µm	F Fraction of Total Atoms Deposited During Interval*	I Ingrowth Factor, I-129 atoms at mid / I-129 atoms at H+1
1	5.5 – 5.825	55.6 – 53.3	.0927	.563
2	5.825 – 6.150	53.3 – 51.3	.0891	.600
3	6.150 – 6.475	51.3 – 49.4	.0888	.619
4	6.475 – 6.800	49.3 – 48.2	.0581	.656
5	6.800 – 7.125	48.2 – 47.0	.0556	.684
6	7.125 – 7.45	47.0 – 46.0	.0532	.712
7	7.45 – 7.775	46.0 – 45.0	.0512	.740
8	7.775 – 8.10	45.0 – 44.1	.0491	.768
9	8.10 – 8.425	44.1 – 43.2	.0468	.791
10	8.425 – 8.750	43.2 – 42.4	.0454	.813
11	8.750 – 9.075	42.4 – 41.6	.0434	.835
12	9.075 – 9.40	41.6 – 40.9	.0418	.856
13	9.40 – 9.725	40.9 – 40.2	.0404	.877
14	9.725 – 10.050	40.2 – 39.5	.0386	.898
15	10.050 – 10.375	39.5 – 38.9	.0376	.918
16	10.375 – 10.70	38.9 – 38.2	.0361	.932
17	10.70 – 11.025	38.2 – 37.7	.0346	.946
18	11.025 – 11.350	37.7 – 37.1	.0336	.960
19	11.350 – 11.675	37.1 – 36.6	.0325	.973
20	11.675 – 12.0	36.6 – 36.1	.0313	.986

* These fractions are relative to total I-129 atoms at H + 12 and are not corrected for ingrowth, however they correct for non-uniform

Areal Concentration of Iodine Isotopes

The areal deposition during interval i is given by the product of, C_A, the total number of I-129 atoms per cm^2 after fallout deposition, the fraction of I-129 atoms deposited during interval i, and the ingrowth factor. Thus

$$A_i = C_A \times F \times I .$$

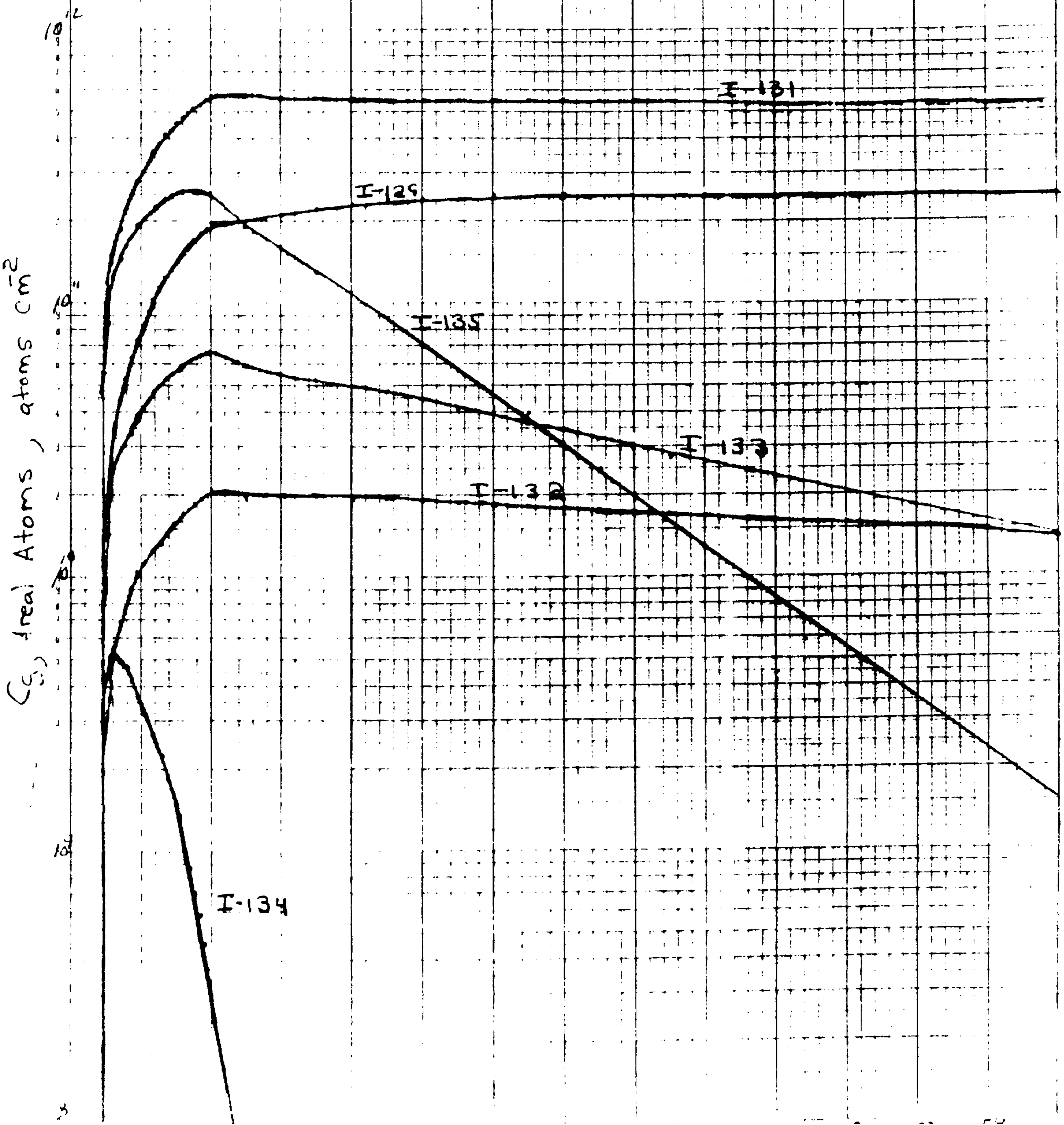
The above equation was used to determine the number of I-129 atoms per cm^2 versus time post detonation (Graph). The areal concentrations of the remaining iodine isotopes were determined from the instantaneous ratio of the number of iodine isotope atoms to I-129 atoms per 10,000 thermonuclear fissions of U-238 at times post creation (Table).

To obtain a point on graph , the following [illegible] relationship was used,

C_g, the number of I-129 atom cm^{-2} on the ground at the end of interval two =

atoms cm^{-2} fallen during interval one $\times$ $\frac{\text{atoms of I-129 at end } t}{\text{atoms of I-129 at mid } t}$.

AREAL IODINE ISOTOPE ATOMS
ON RONGELAP POST BRAVO



Activity Ingested By Rongelapese

WT-938 → Depth of H_2O = .67 ft = 20.4 cm

→ Drank 1 pt day^{-1} = 19.7 cm^3 hr^{-1}

Nuclide	Area During Deposition, atom cm^{-2} hr	Activity* Ingested, µCi	Thyroid Rem
I-131	2.92×10^{12}	76.	138.
I-132	8.14×10^{10}	179.	11.6
I-133	2.80×10^{12}	672.	303.
I-134	1.48×10^{10}	85.	2.54
I-135	1.24×10^{12}	940.	151.
Total			605.

Nuclide	Area Post Deposition, atom cm^{-2} hr	Activity* Ingested, µCi	Thyroid Rem
I-131	2.15×10^{13}	558.	1010
I-132	7.50×10^{11}	1649.	107
I-133	1.52×10^{13}	3649.	1642
I-134	2.83×10^{8}	1.62	.49
I-135	2.58×10^{12}	1961.	314
Total			3074.

* Activity Ingested = $\dfrac{\int_0^{\tau} \text{Areal Atoms } d\tau}{\text{Depth of Water}}$ × Water Intake Rate × Decay Constant

where τ = deposition or post deposition interval.

Air Concentrations of Iodine Isotopes

Time Integral of Volumetric concentration is equal to the ratio amount of deposition per unit area and the deposition velocity, thus during interval i

$$\int_0^{t_i} C_i \, dt = \frac{A_i}{V_i} .$$

Thus,

$$C_i = \frac{A_i}{V_i \, t_i} .$$

where

$t_i \equiv$ length of interval, 335 hours,

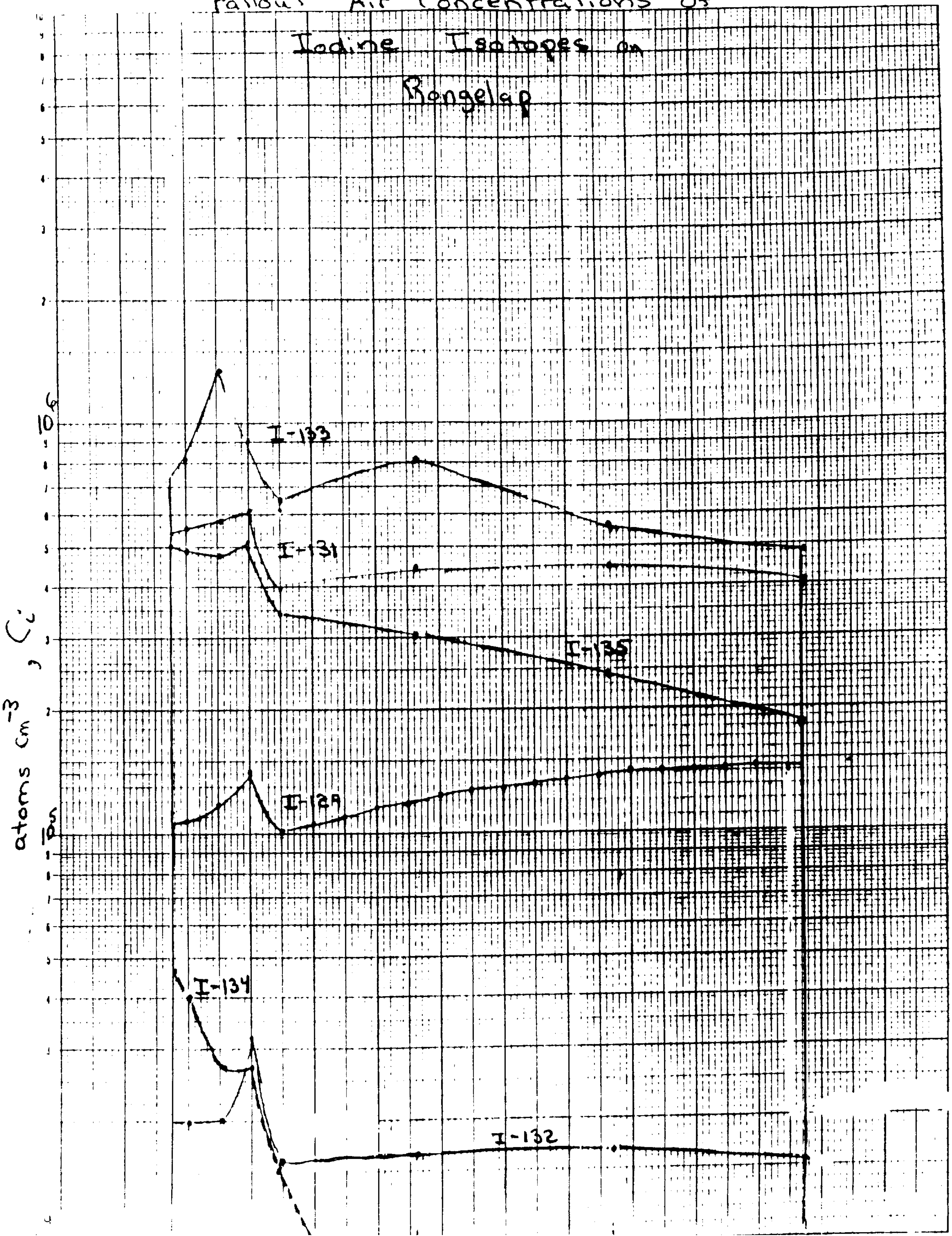
$V_i \equiv$ average deposition velocity during interval,

$A_i \equiv$ areal deposition during t_i.

The above analysis was used for I-129 and a graph of I-129 atoms per cm^3 versus time post detonation was drawn (Graph 4). The air concentrations of the remaining Iodine isotopes were determined from the instantaneous ratio of the number of iodine isotope atoms to I-129 atoms per 10,000 thermonuclear fissions of

Graph 4

Fallout Air Concentrations of Iodine Isotopes on Rongelap



Activity Inhaled During Fallout on Rongelap

Thyroid Rem μCi^{-1} (30-100 μ)	
.844	I-131
.0085	I-132
.163	I-133
.0145	I-134
.045	I-135

Breathing Rate = 8.328×10^{5} cm^{3} h^{-1}

Atoms Inhaled = Area of Atom Concentration Curve on Graph 4 × Breathing Rate.

Nuclide	Inhaled μCi	Thyroid Rem
I-131	69	58
I-132	2118	18
I-133	833	136
I-134	218	3.2
I-135	1293	58
Total		273 Rem

Resuspension of Iodine Atoms

Resuspended Concentration in Air = areal atoms on ground × resuspension factor

$$C_r = C_g \times K,$$

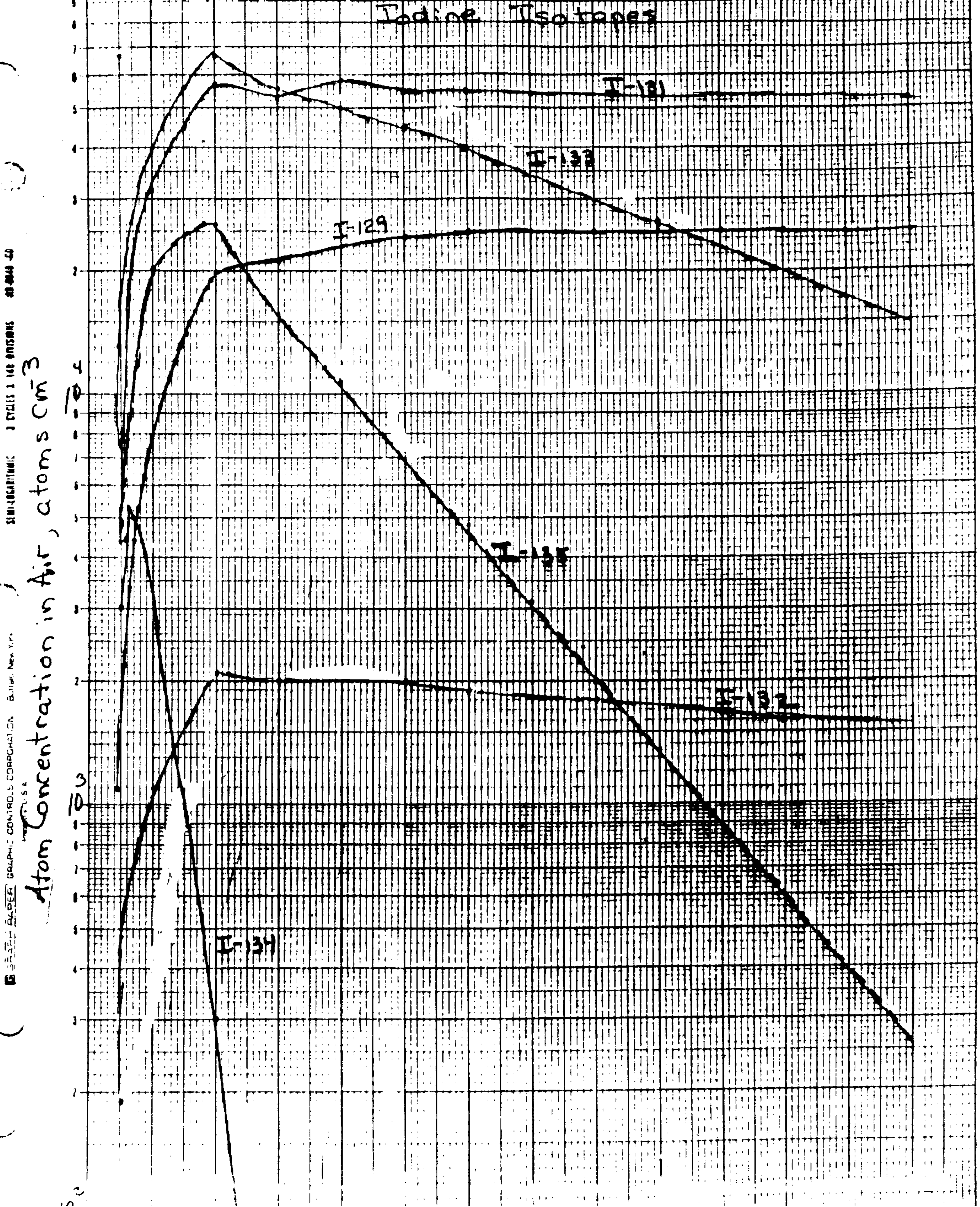
where C_r = resuspended air conc., atoms cm^{-3}

C_g = areal atoms, graph 3, atom cm^{-2},

$K = 10^{-7}\ cm^{-1}$, UNSCEAR A/AC.82/R.369.

The above expression was used to develop the resuspended air concentration of I-129 atoms post detonation. Resuspension occured during and post fallout cloud passage. The resuspended air concentrations of the remaining iodine isotopes were determined from the instantaneous ratio of the number of iodine isotope atoms to I-129 atoms per 10,000 thermonuclear fissions of U-238 at times post creation (Table 1). The resuspended air concentrations are shown on graph 5.

Resuspended Air Concentrations of Iodine Isotopes



Activity Inhaled Due To Resuspension on Rongelap

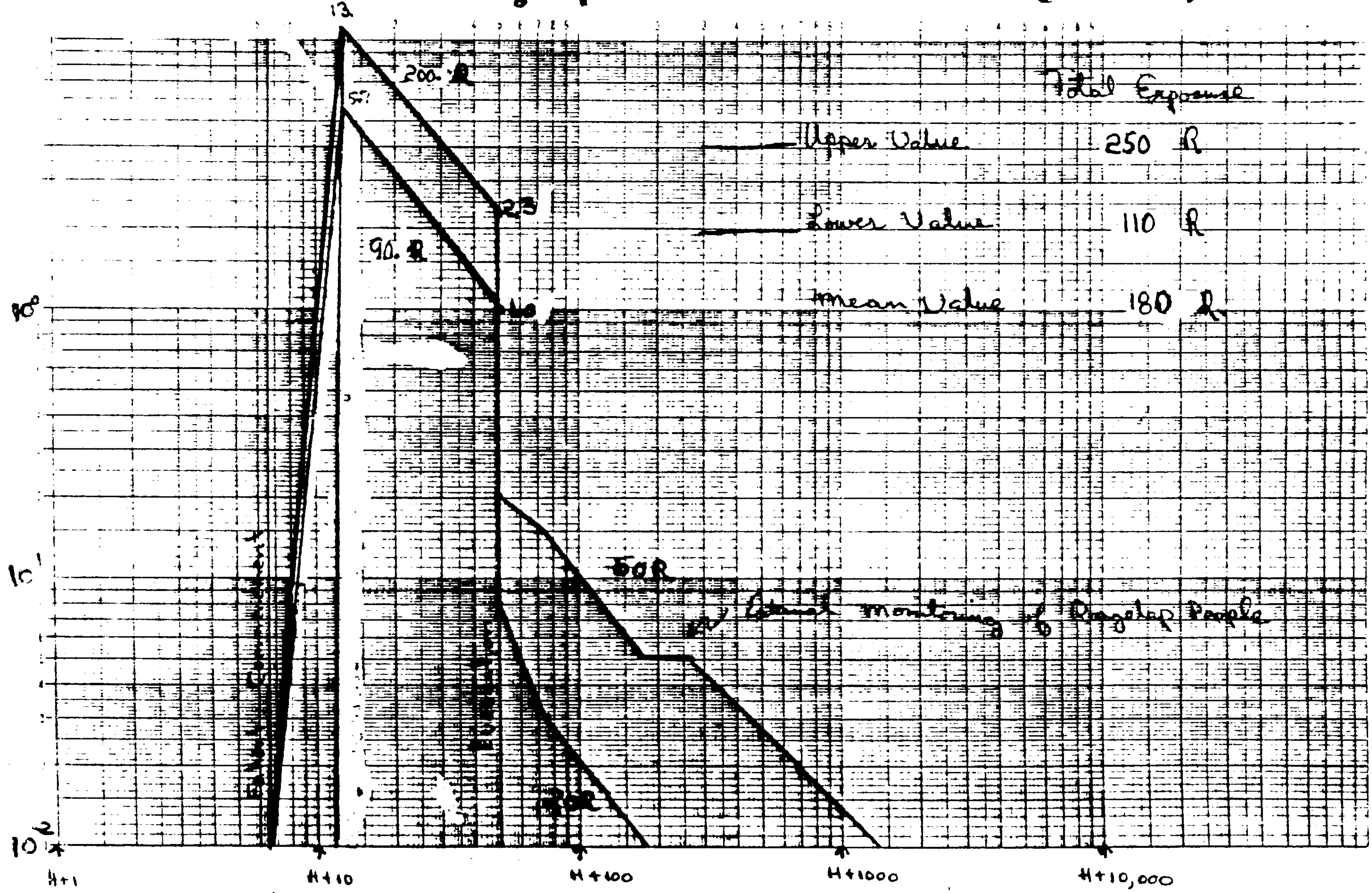
Atoms Inhaled = Area of Atom Concentration Curve on Graph 5 × Breathing Rate

During Deposition (H + 5.5 to H + 12)

Nuclide	Atoms Inhaled	μCi/Atom	Activity Inhaled, μCi	Rem/μCi	Thyroid Rem
I-131	1.82×10^{11}	2.7×10^{-11}	4.9	.844	4.1
I-132	6.71×10^{9}	2.3×10^{-9}	15.4	.0085	.13
I-133	2.33×10^{11}	2.5×10^{-10}	58.3	.163	9.5
I-134	1.24×10^{10}	6.0×10^{-9}	74.4	.015	1.1
I-135	1.04×10^{11}	7.9×10^{-10}	82.3	.045	3.7
Post Deposition (H+12 to H+51)					
I-131	1.72×10^{12}		46.4		39.
I-132	5.47×10^{10}		126		1.1
I-133	7.84×10^{11}		196		32.
I-134	4.32×10^{5}		—		—
I-135	2.2×10^{11}		174		7.8

Total 98.4

Rongelap External Exposure (WT 938)* Graph 6



Hours Post Castle Bravo

External Exposure of Marshall Islanders and Military Personnel ...

ACUTE PHASE

Rongelap

Adult Male Thyroid Dose Summary

	Rem
Direct inhalation of passing cloud	273
Ingestion of water during deposition	605
Ingestion of water post deposition	3070
Resuspended and inhaled during deposition	18
Resuspended and inhaled post deposition	80
External exposure during residence	51.9
External exposure after evacuation	25.6
TOTAL	4160