

Hydroic Note
Acute Phase

Obtained from BNL
9/9/80

402924

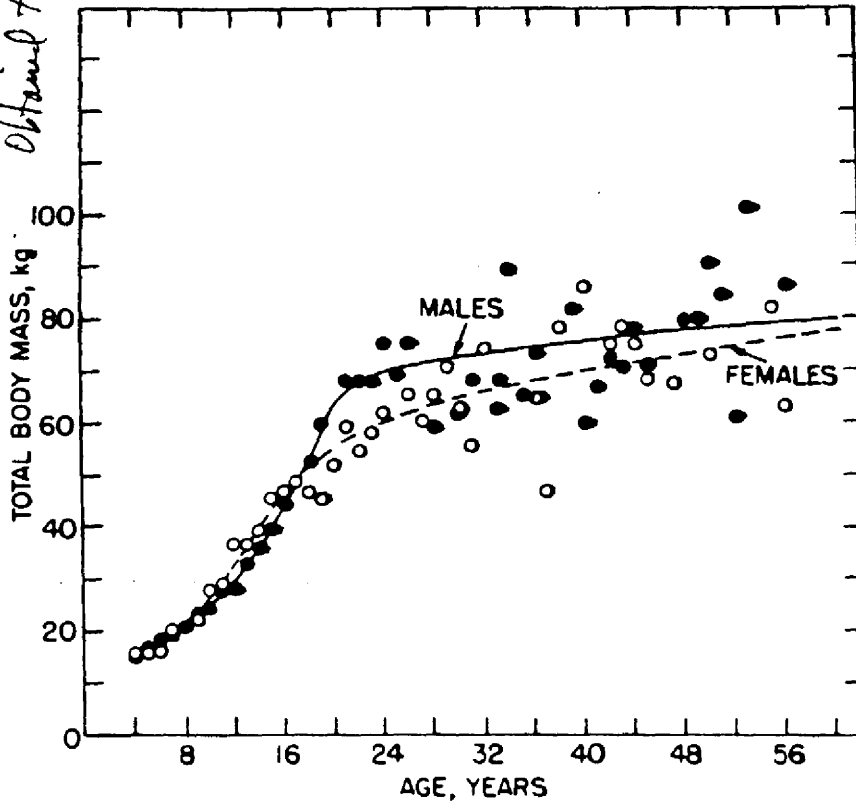


Fig. 1 Body Mass as a Function of Age for Residents of Rongelap Atoll

from 1979 Med Survey

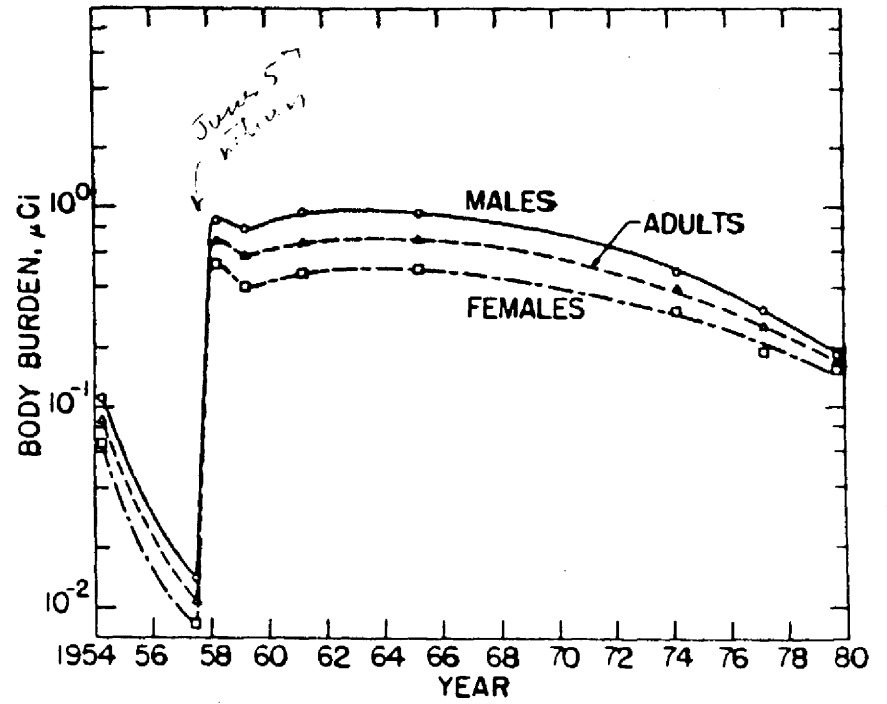


Fig. 2 Mean Adult ¹³⁷Cs Body Burden History at Rongelap Atoll

June 54 Ufirik

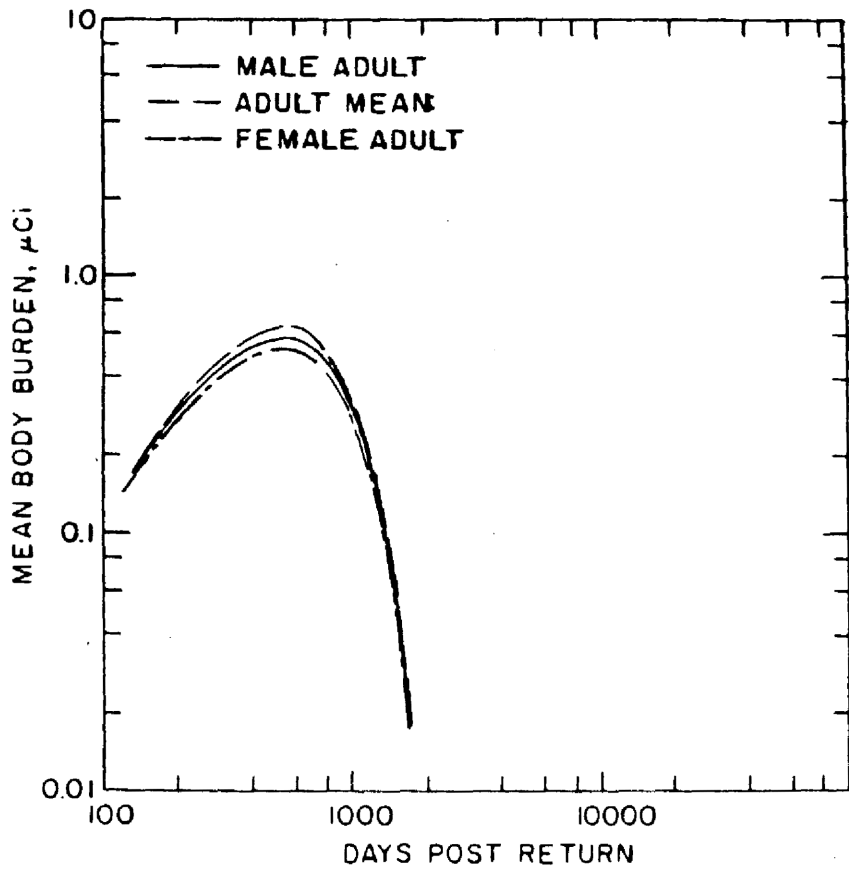


Fig. 3 Mean Adult ^{65}Zn Body Burden History at Rongelap Atoll

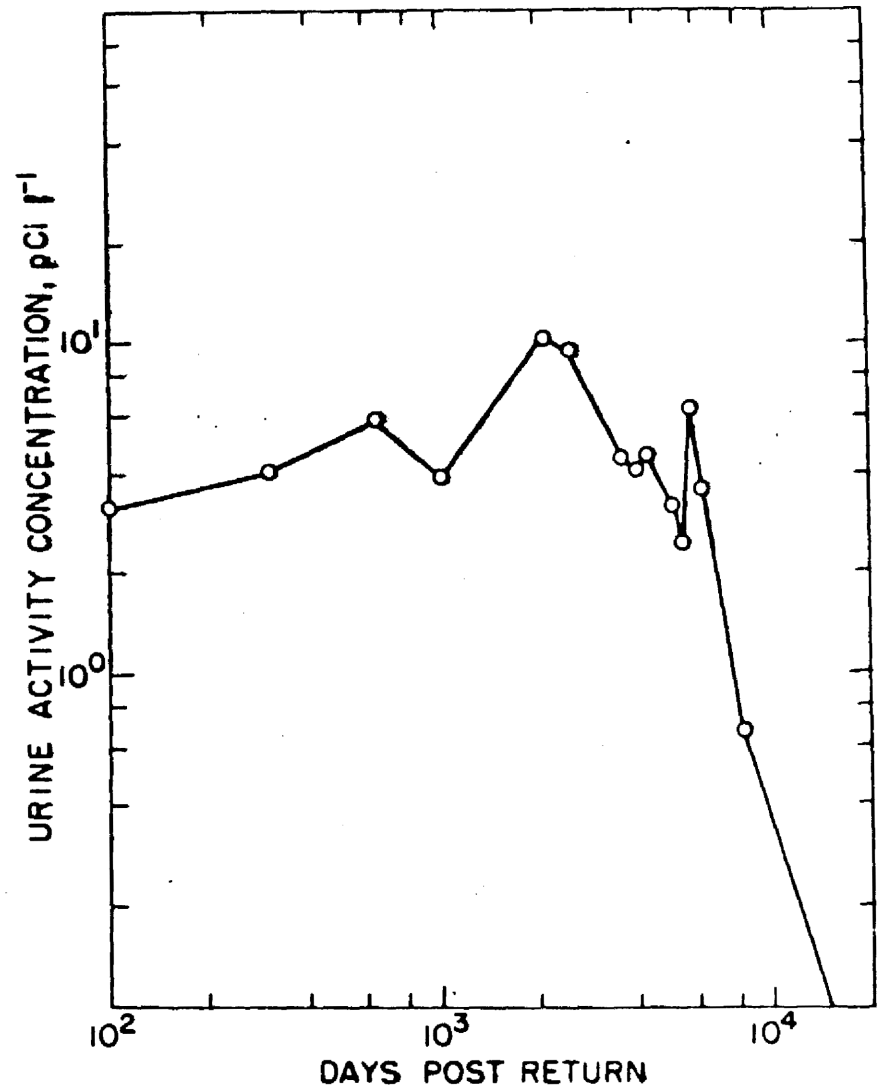


Fig. 4 Mean Adult ^{90}Sr Urine Activity Concentration History at Rongelap Atoll

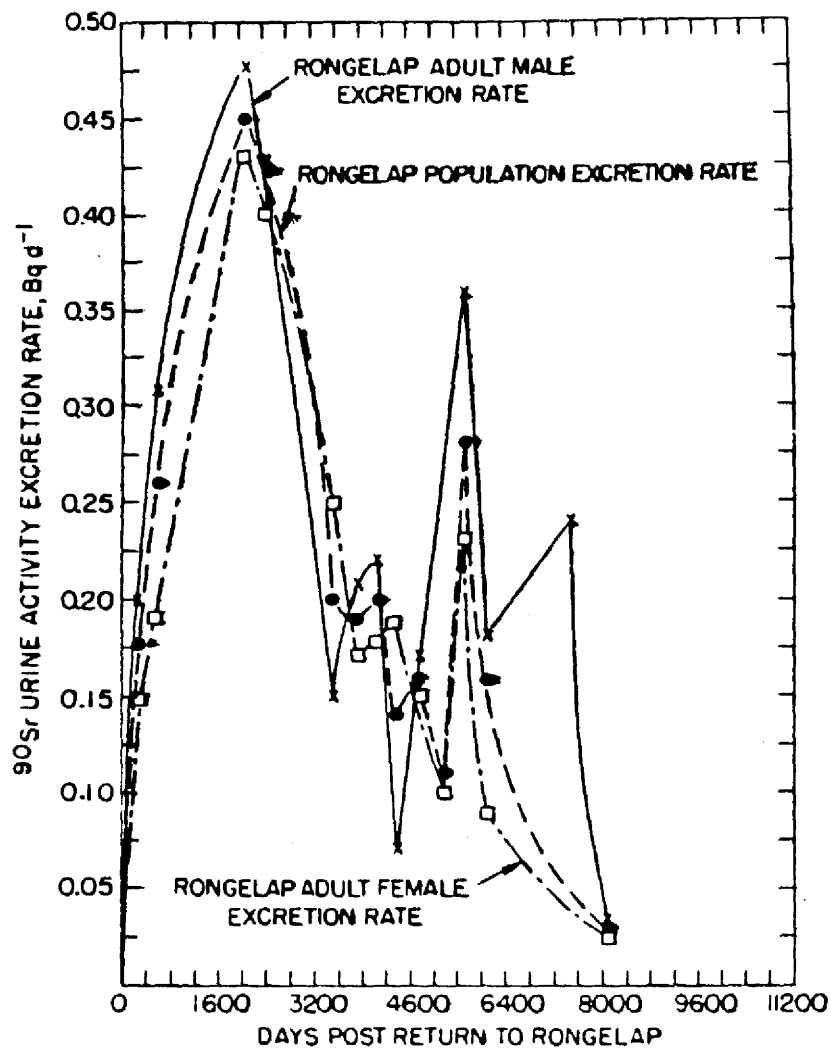


Fig. 5 Mean Adult ^{90}Sr Urine Activity Excretion Rate at Rongelap Atoll

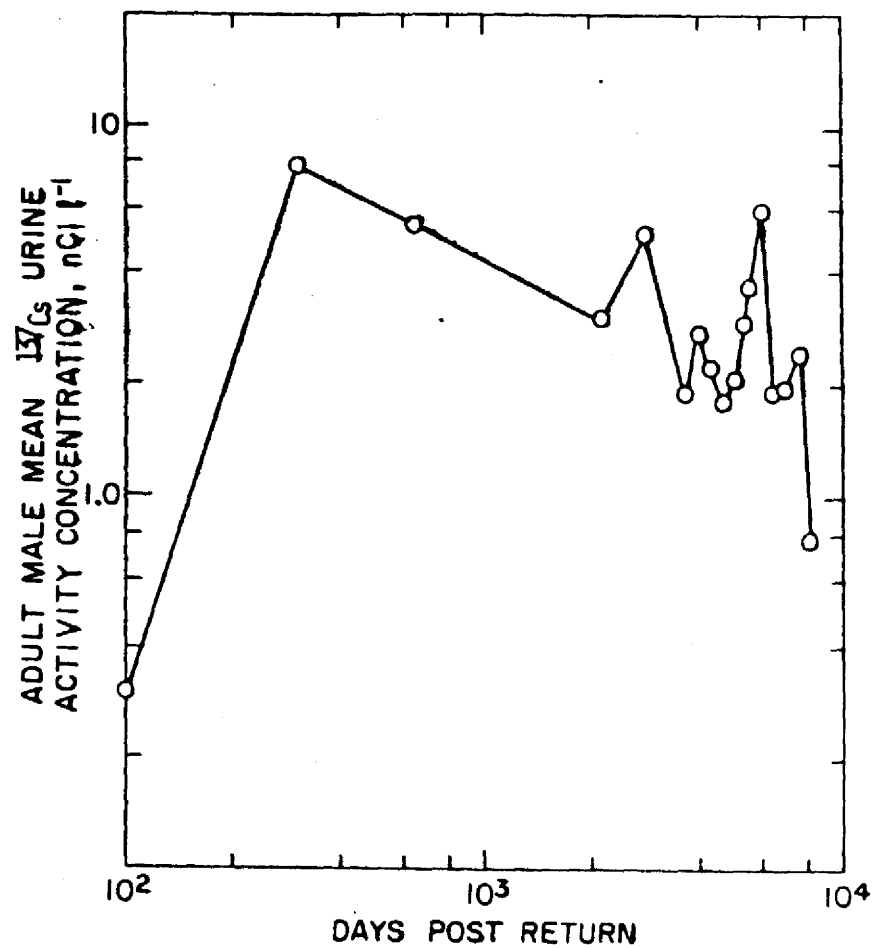


Fig. 6 Mean Adult Male ^{137}Cs Urine Activity Concentration History at Rongelap Atoll

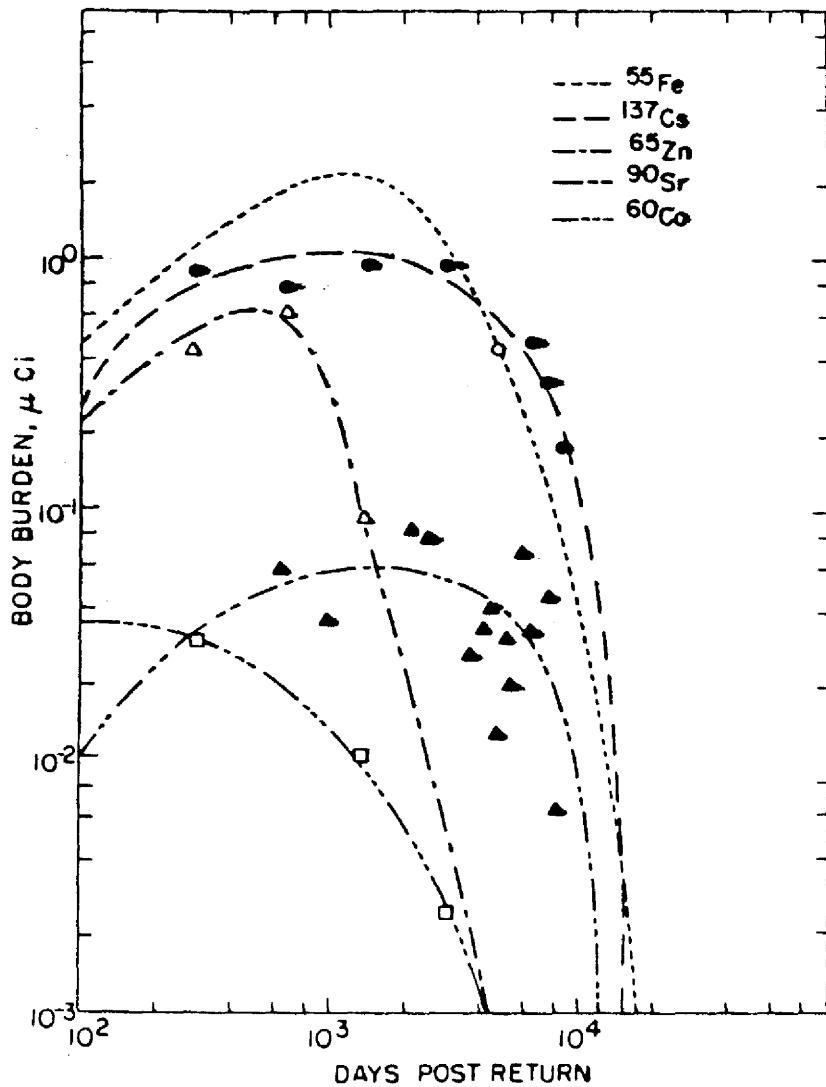


Fig. 7 Composite Nuclide Body Burden History for Adults at Rongelap Atoll

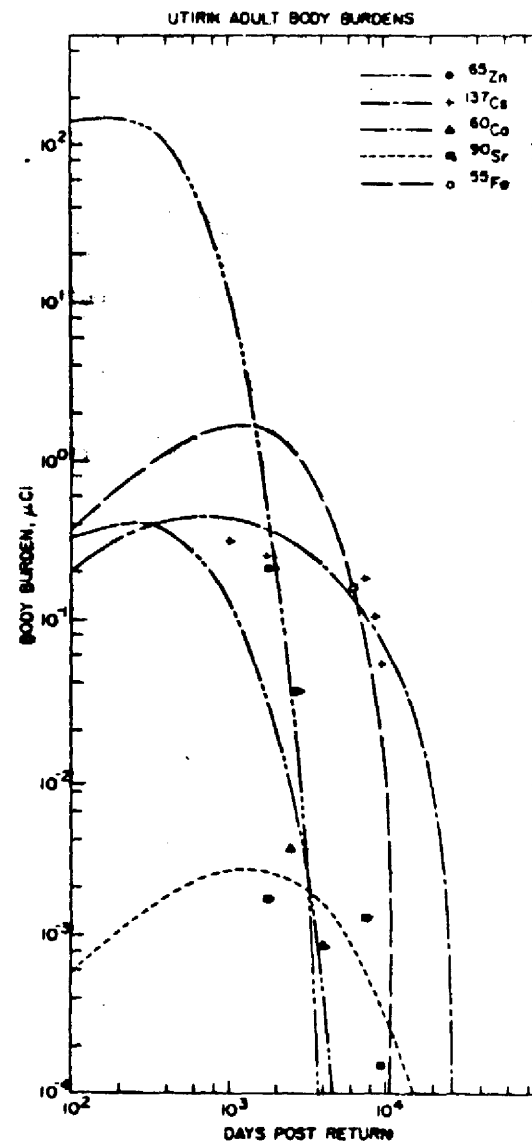


Fig. 8 Composite Nuclide Body Burden History for Adults at Utiirik Atoll

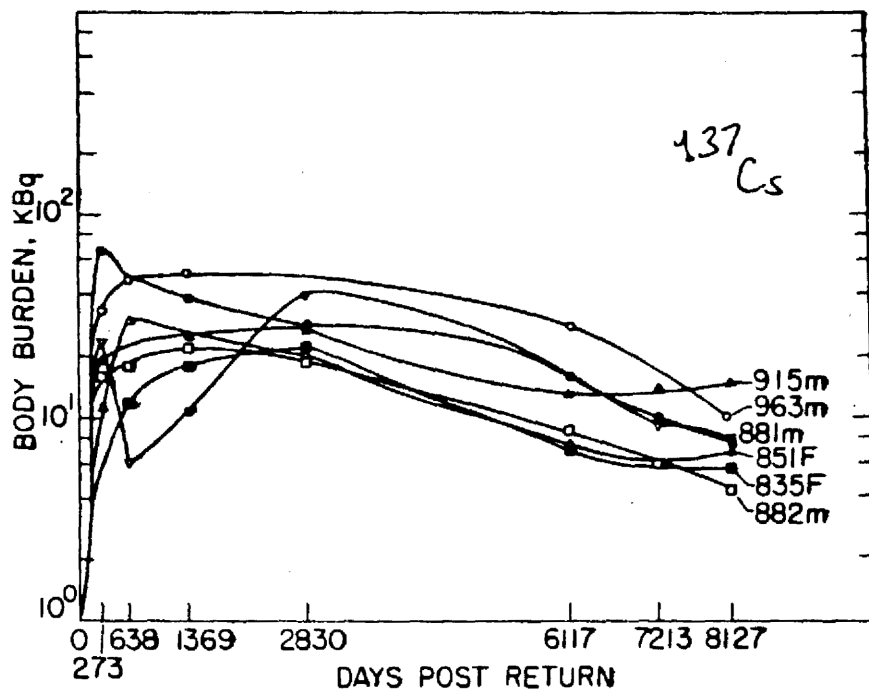


Fig. 9 Individual Male and Female Body Burden Histories Randomly Chosen from the Rongelap Atoll Population

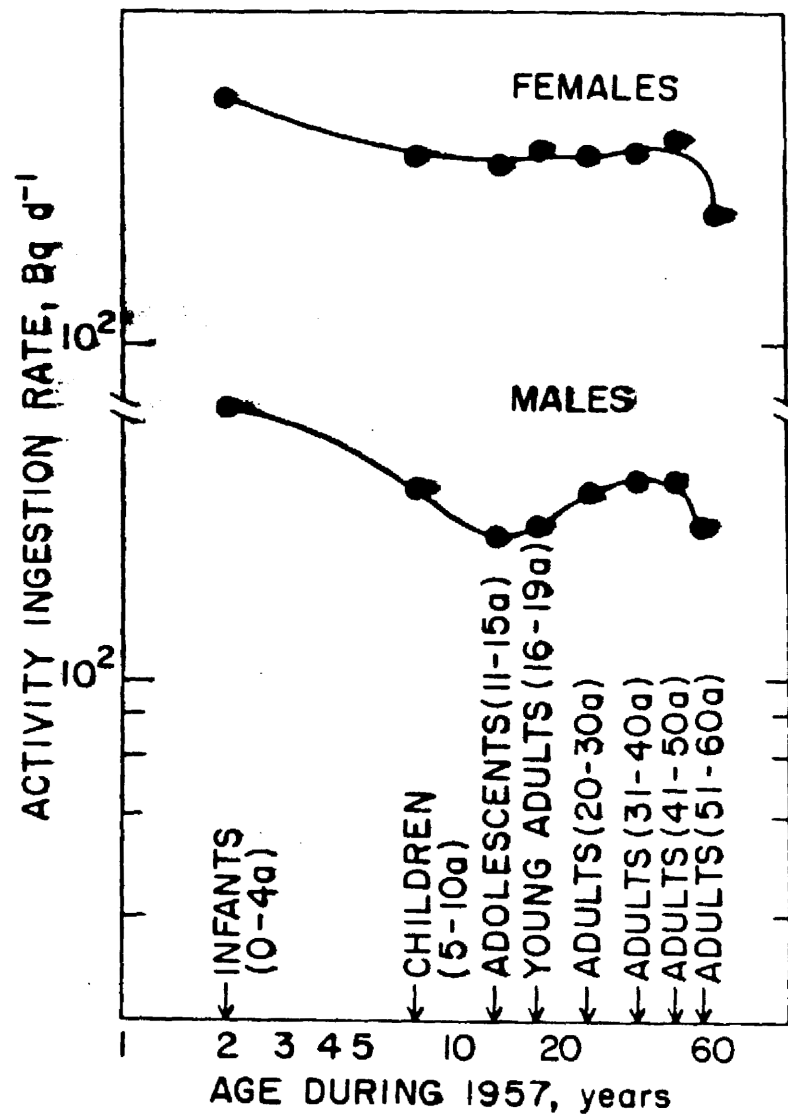


Fig. 10 Age and Sex Group Mean Values for ¹³⁷Cs Activity Ingestion Rate Referenced to Mid-1957 for Rongelap Atoll

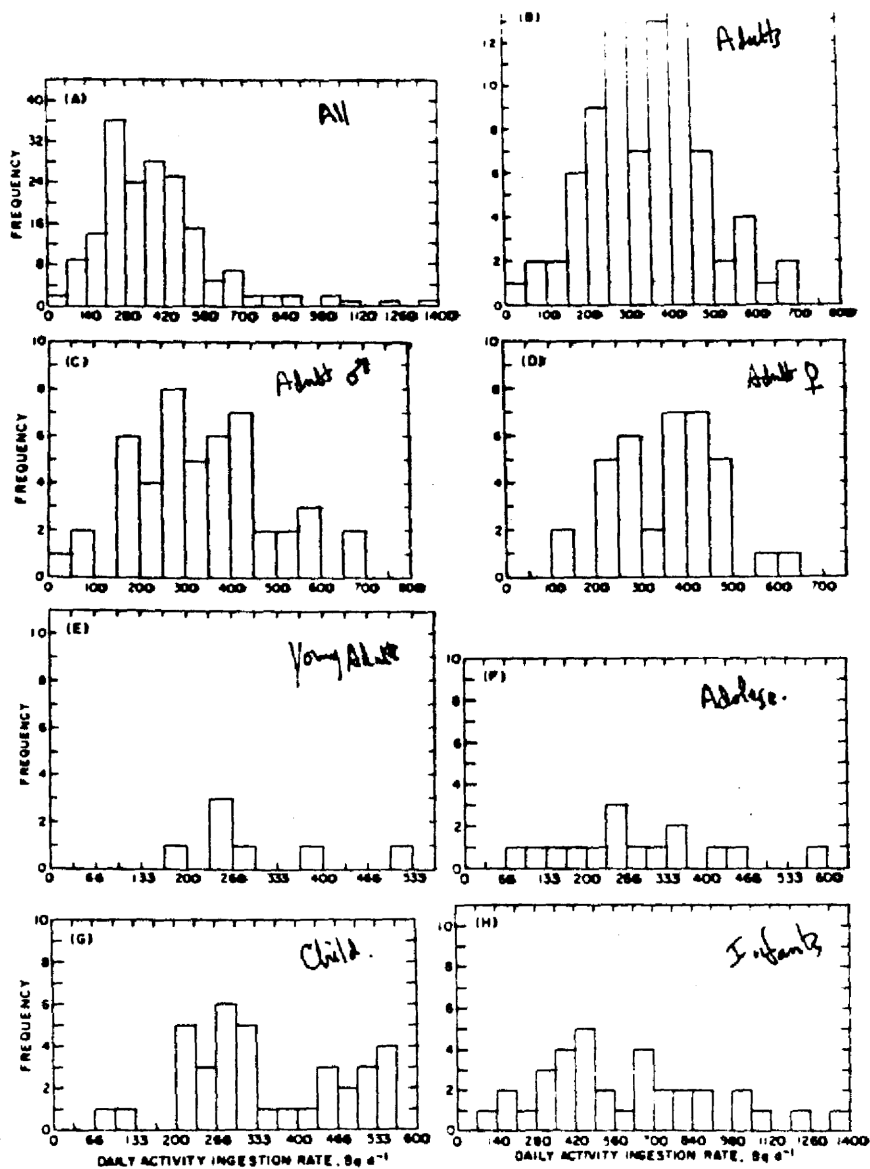


Fig. 11 ^{137}Cs Daily Activity Ingestion Rate for (A) All Residents (B) Adults (C) Adult Males (D) Adult Females (E) Young Adults (F) Adolescents (G) Children and (H) Infants on Rongelap Referenced to June 1957

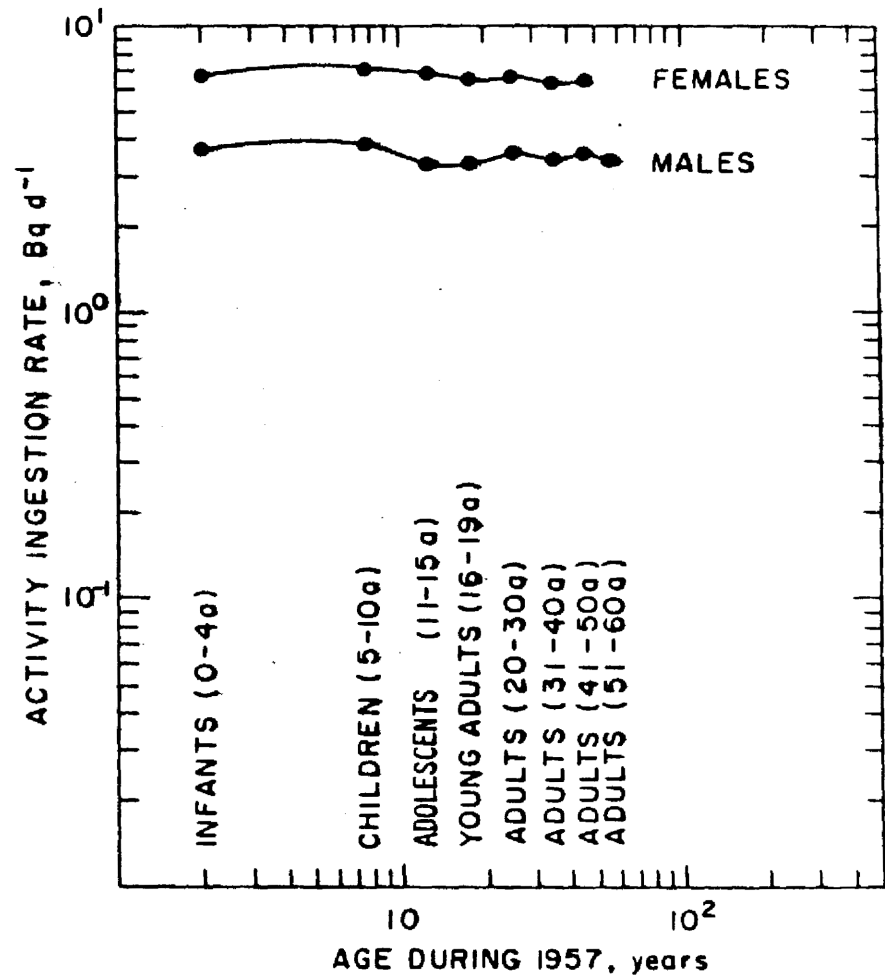


Fig. 12 Age and Sex Group Mean Values for ^{90}Sr Activity Ingestion Rate Referenced to Mid-1957 for Rongelap Atoll

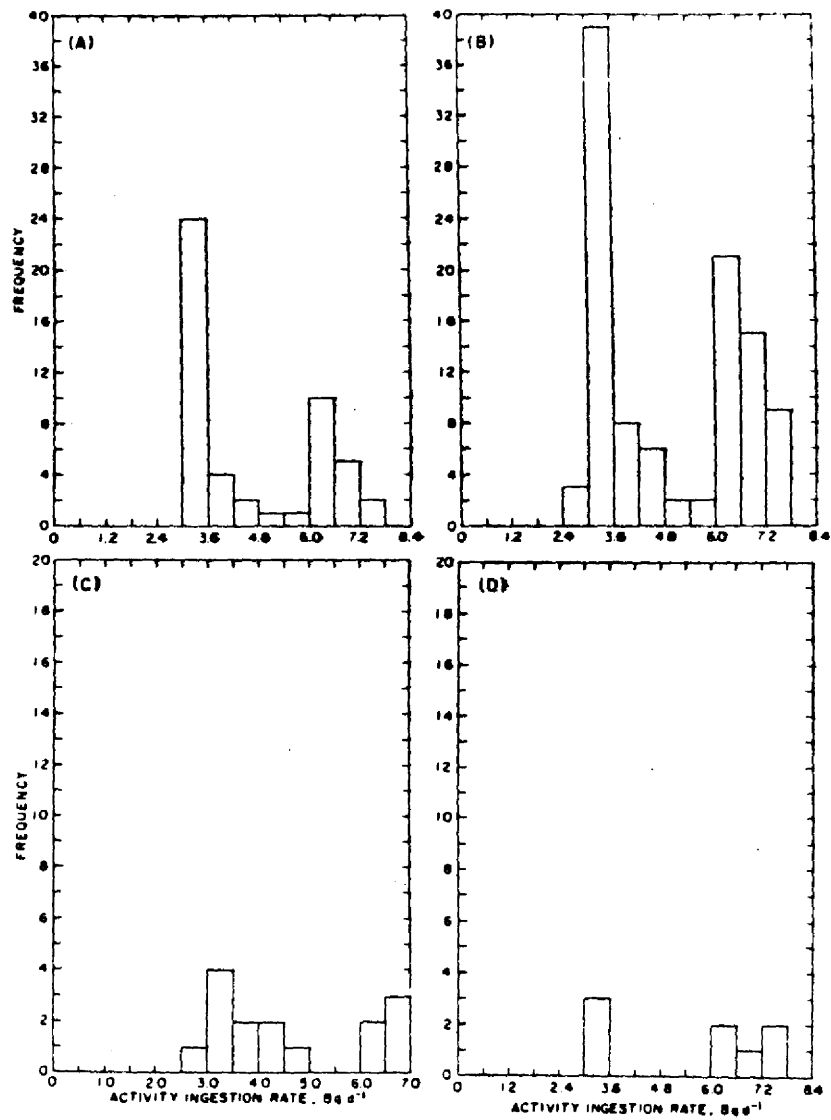


Fig. 13a ^{90}Sr Daily Activity Ingestion Rate for (A) Adults (B) All Residents (C) Infants and (D) Adolescents on Rongelap

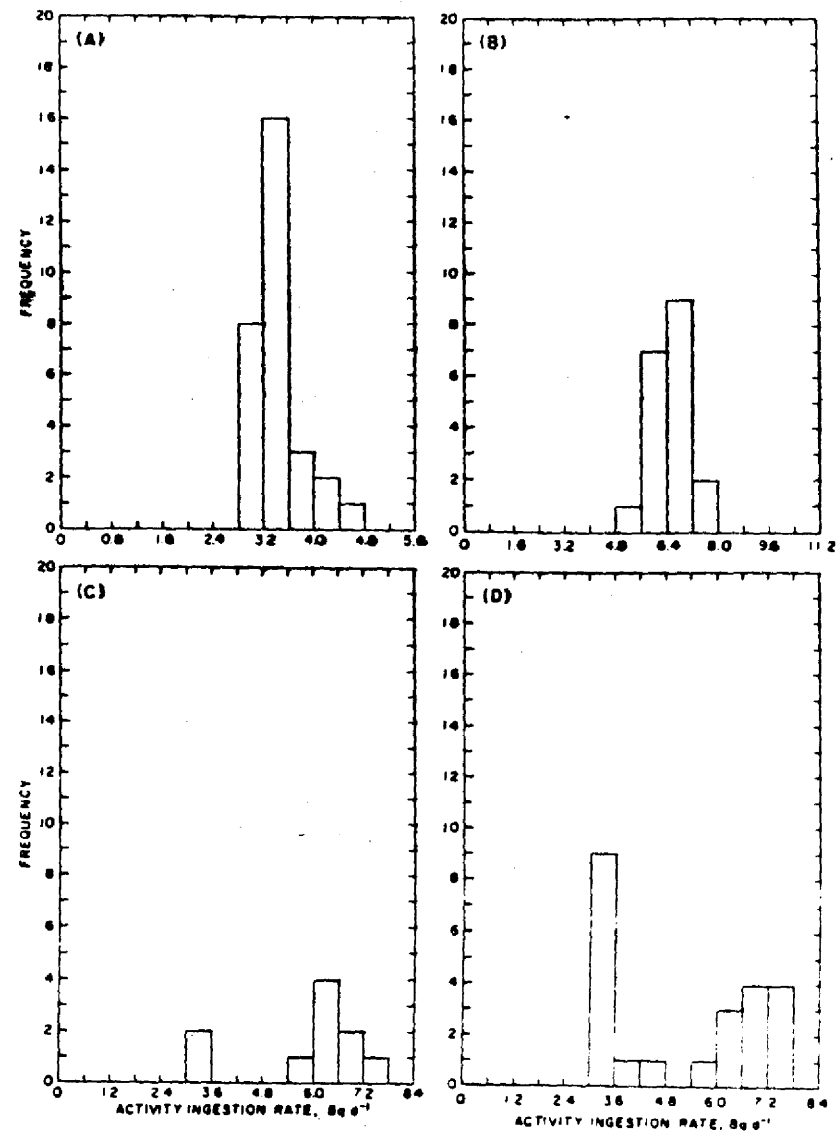


Fig. 13b ^{90}Sr Daily Activity Ingestion Rate for (A) Adult Males (B) Adult Females (C) Young Adults and (D) Children on Rongelap

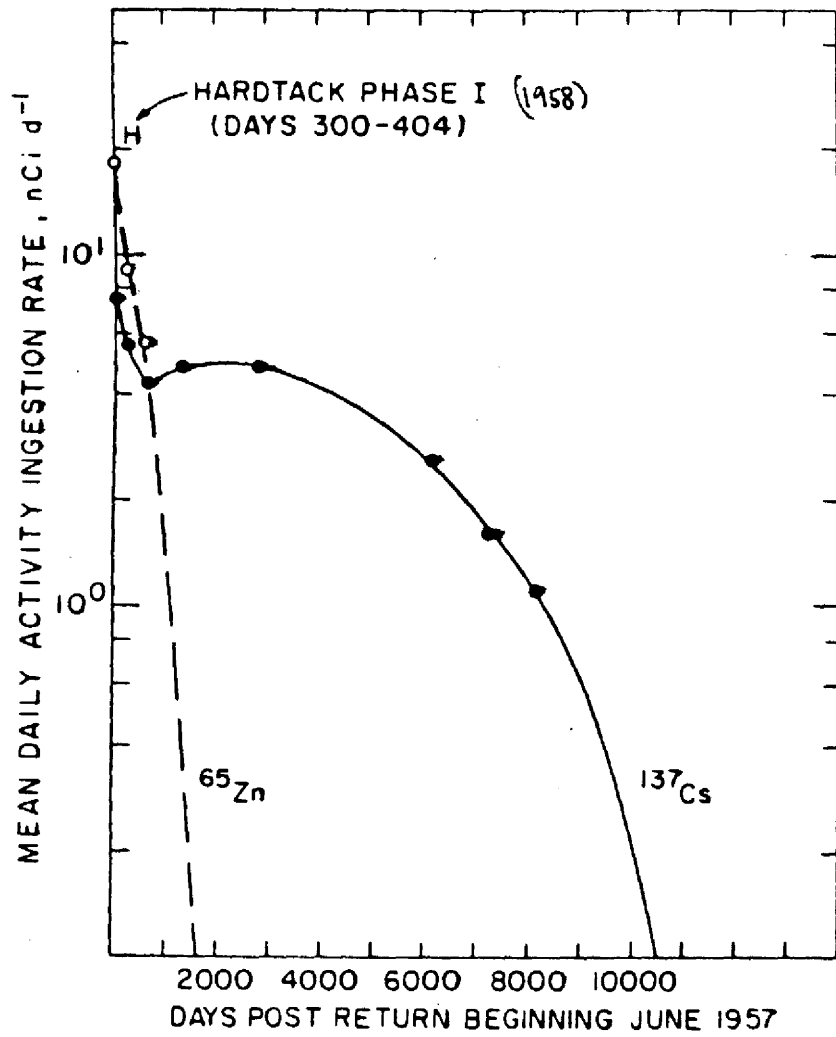


Fig. 14 Adult Mean Daily Activity Ingestion Rate for ^{137}Cs and ^{65}Zn at Rongelap Referenced to Mid-1957

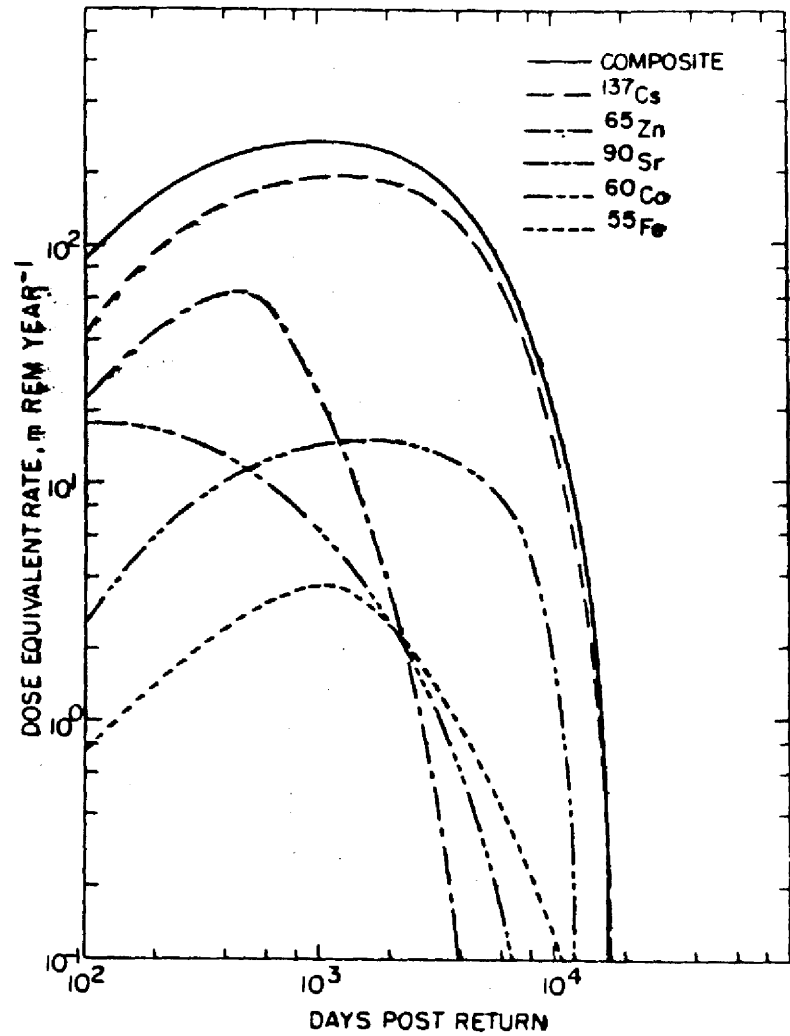


Fig. 15 Adult Mean Total Body Dose Equivalent Rate at Rongelap Atoll Post Mid-1957

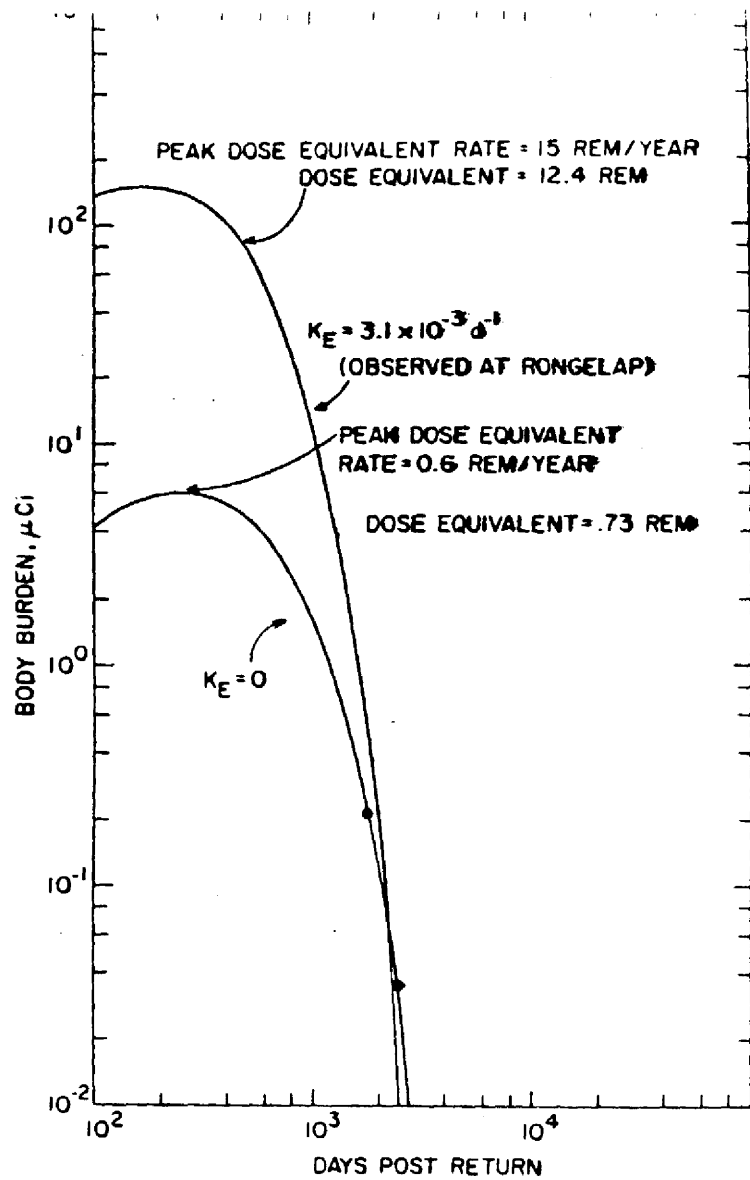


Fig. 16 Mean Adult ^{65}Zn Body Burden, Peak Dose Equivalent Rate and Dose Equivalent for Utirik Atoll

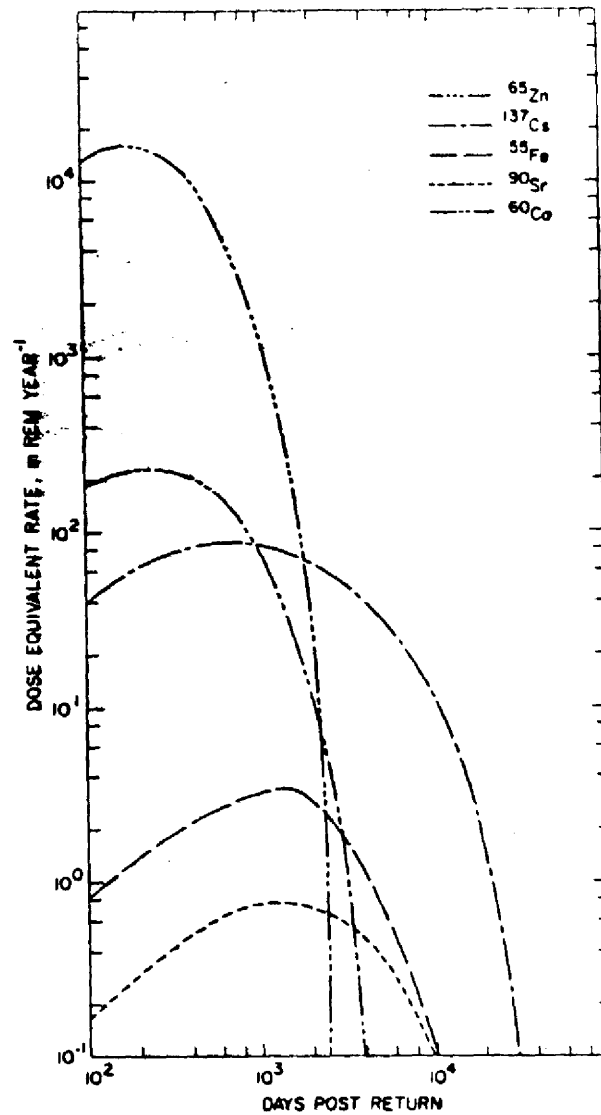


Fig. 17 Adult Mean Total Body Dose Equivalent Rate at Utirik Atoll Post Mid-1954

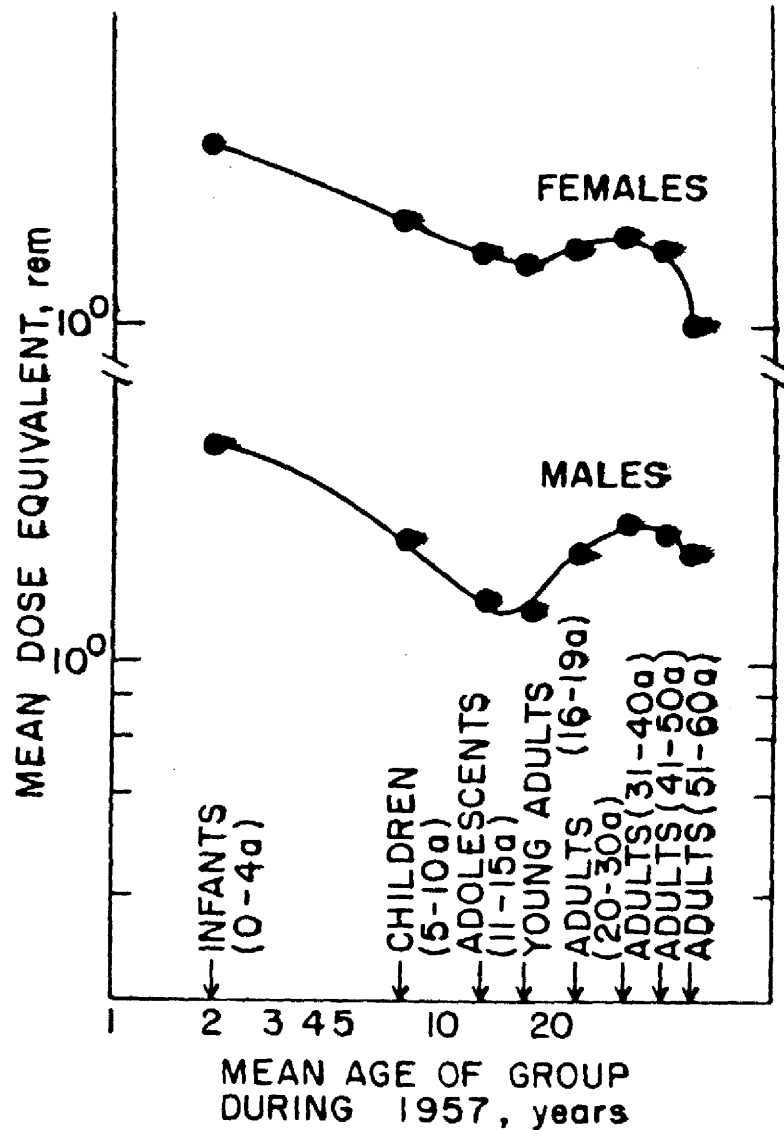


Fig. 18 ¹³⁷Cs Mean Dose Equivalent for Various Mid-1957 Age Groups for the Interval 1957 to 1980 at Rongelap Atoll

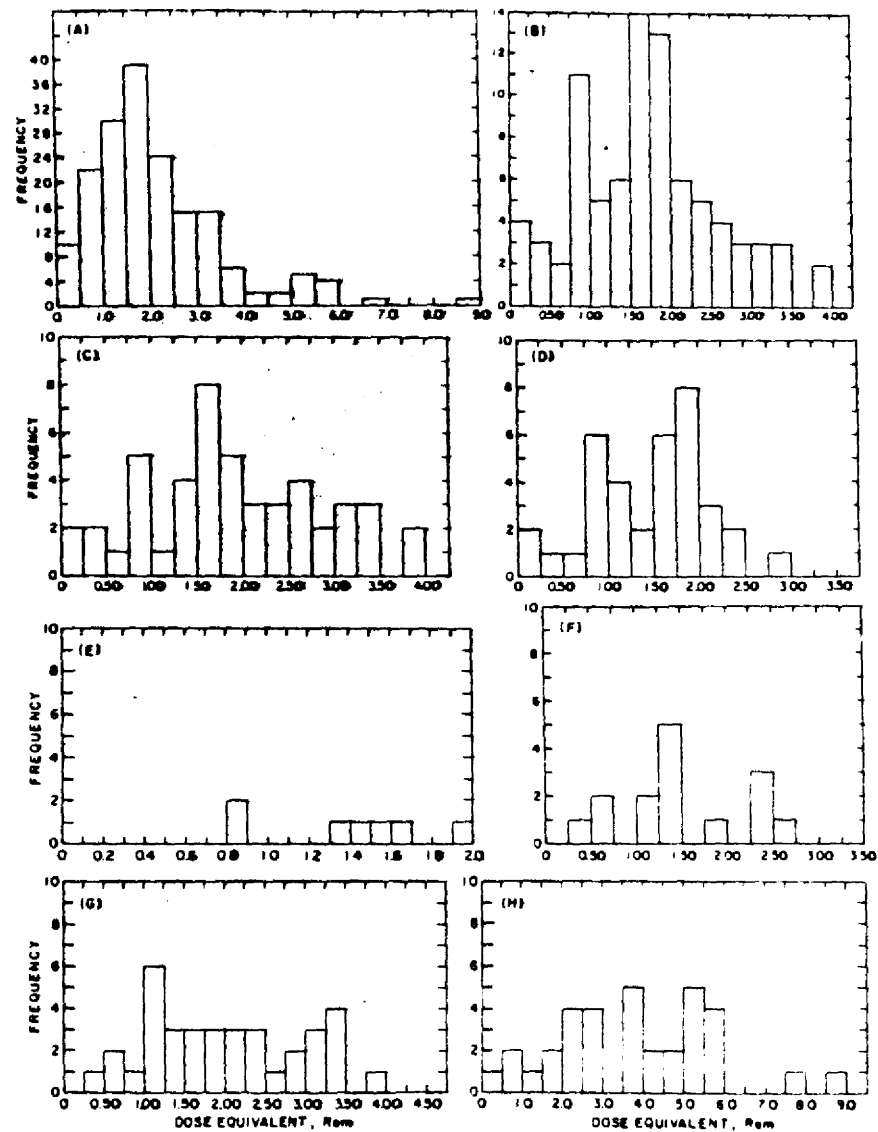


Fig. 19 ¹³⁷Cs Dose Equivalent to (A) All Residents (B) Adults (C) Adult Males (D) Adult Females (E) Young Adults (F) Adolescents (G) Children and (H) Infants on Rongelap.

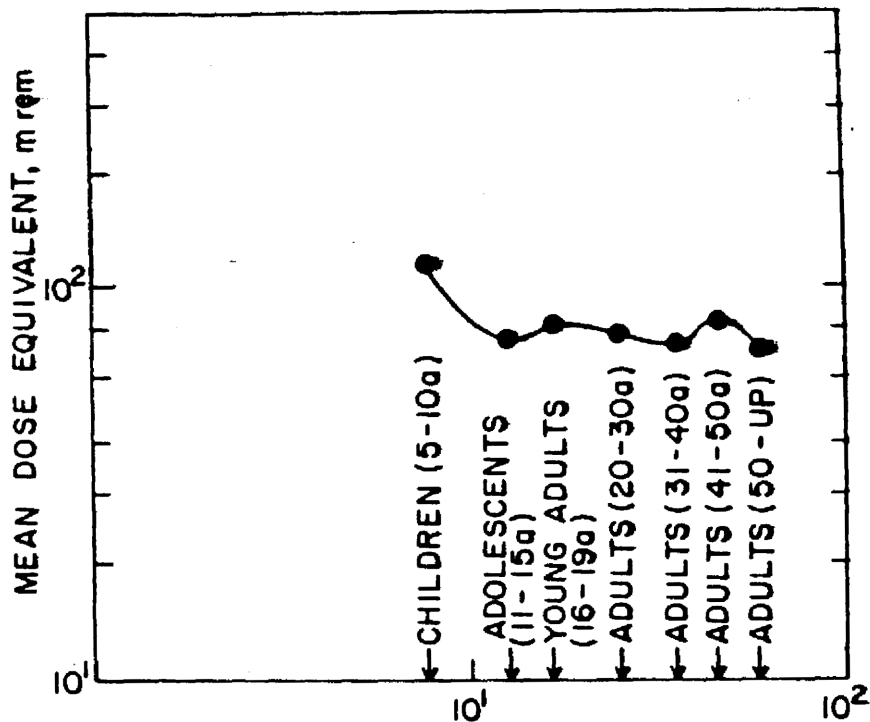


Fig. 20 ^{65}Zn Mean Dose Equivalent for Various Mid-1957 Age Groups for the Interval 1957 to 1980 at Rongelap Atoll

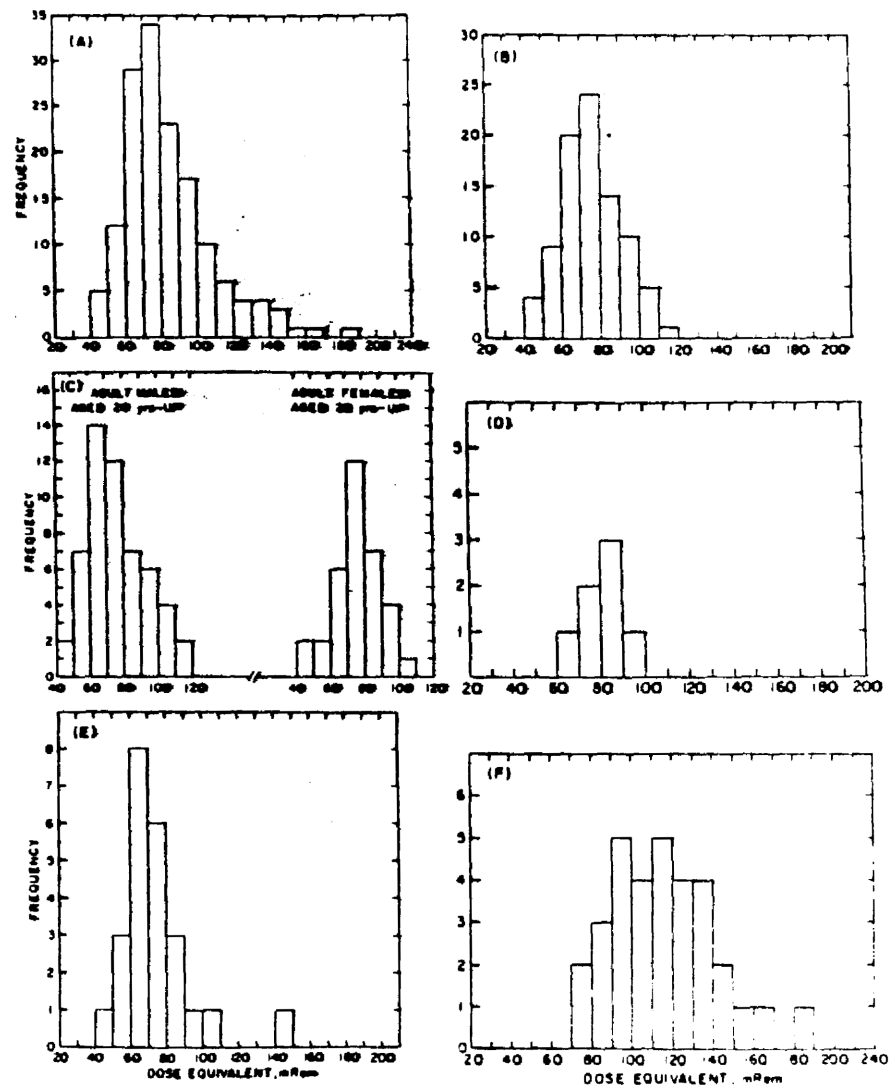


Fig. 21 ^{65}Zn Dose Equivalent to (A) All Residents (B) Adults (C) Adult Males and Females (D) Adolescents (E) Children and (F) Infants on Rongelap Atoll.

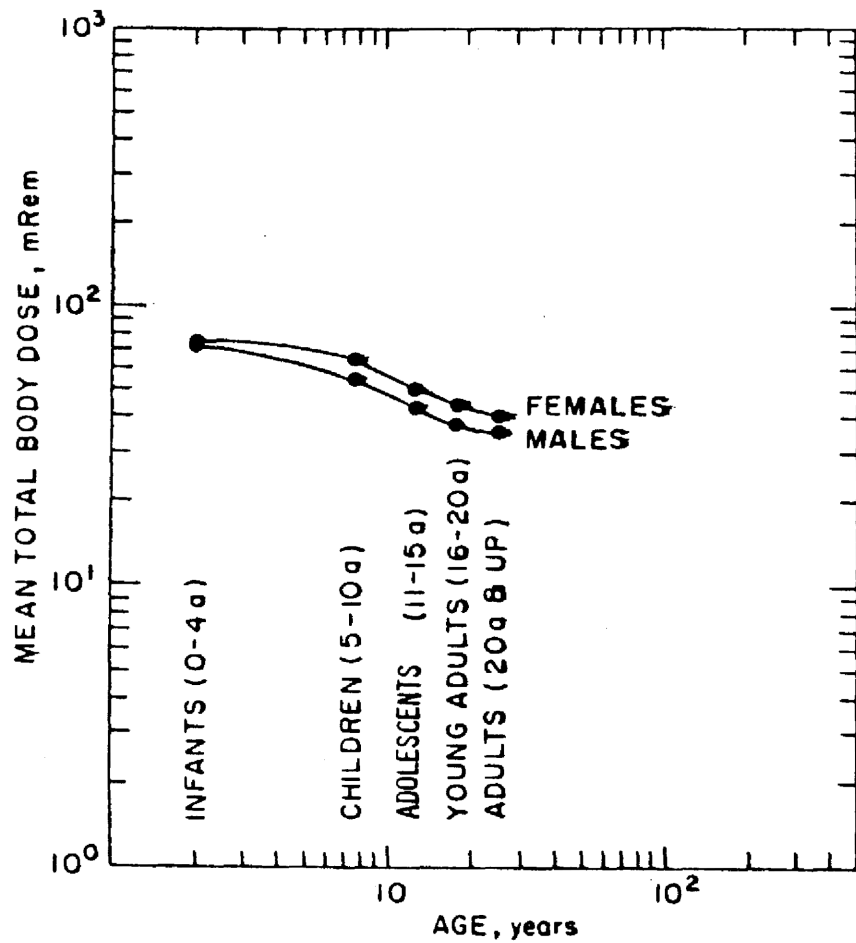


Fig. 22 Age and Sex Group Mean Values for ⁹⁰Sr Dose Equivalent for the Interval 1957 to 1980 at Rongelap Atoll

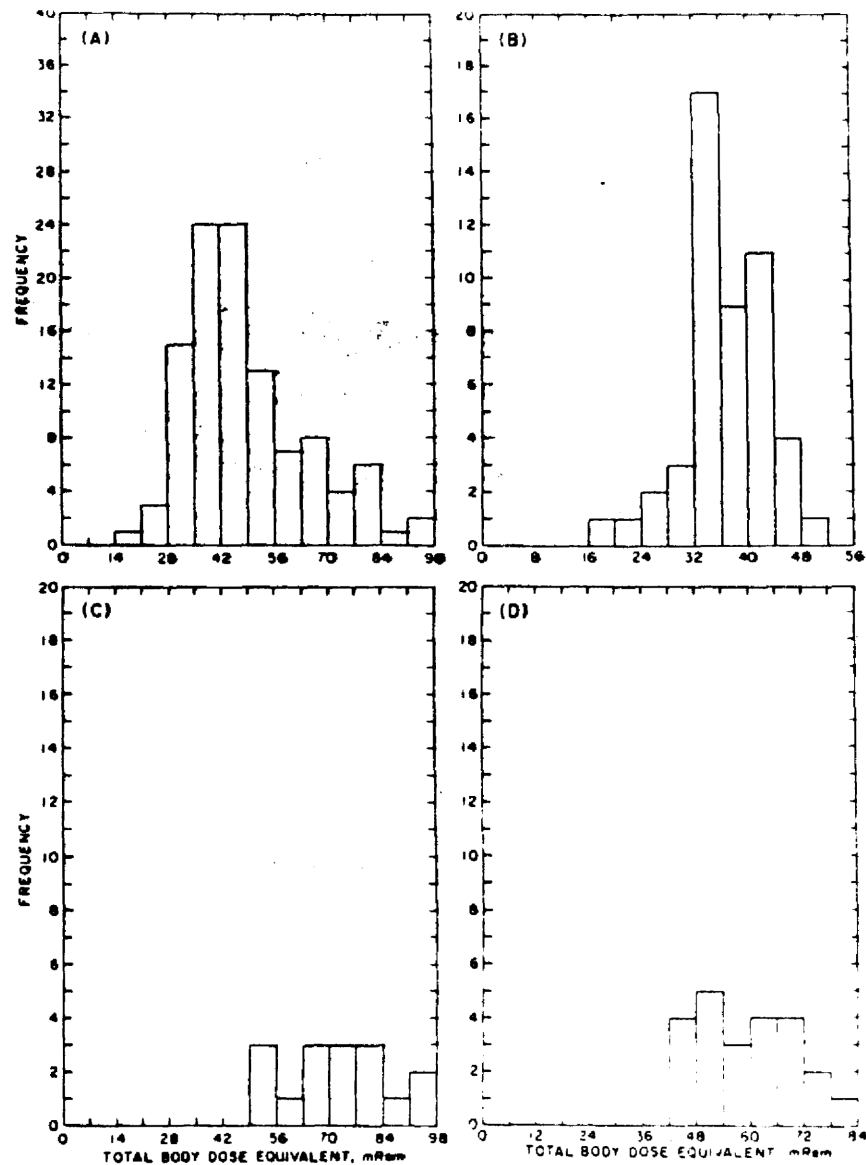


Fig. 23a ⁹⁰Sr Dose Equivalent for (A) All Residents (B) Adults (C) Infants and (D) Children on Rongelap

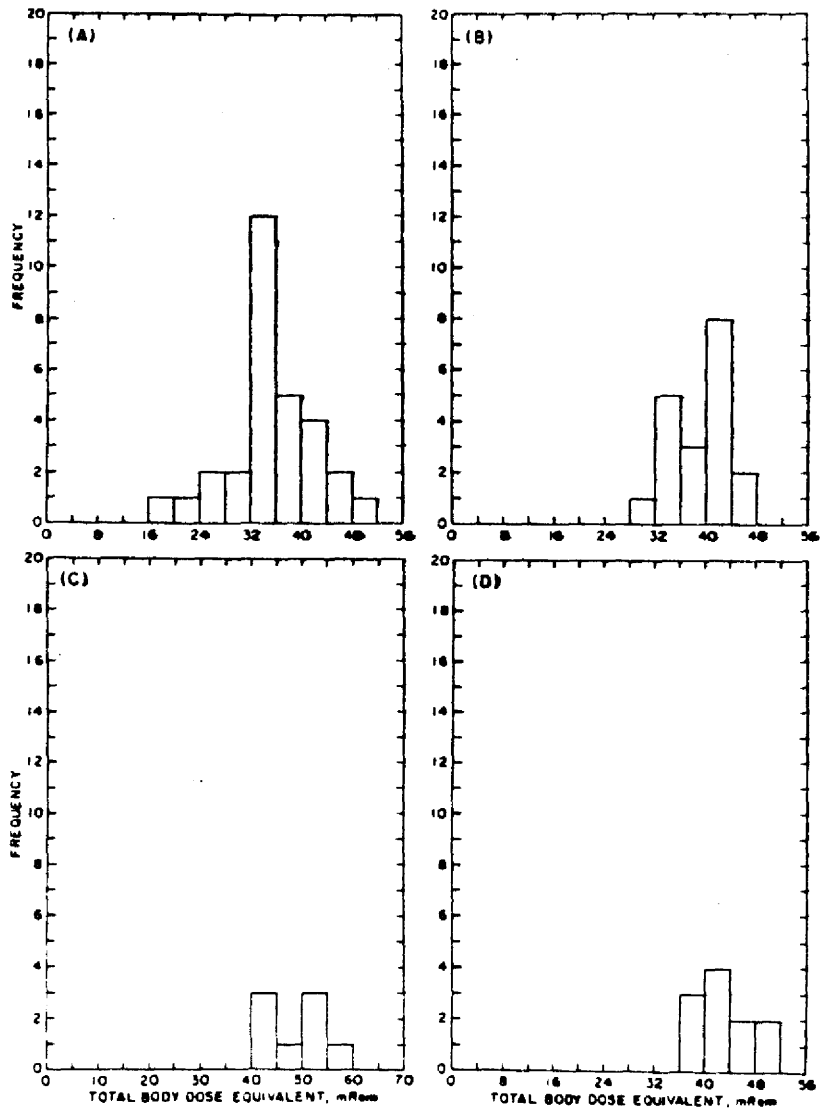


Fig. 23b ⁹⁰ Dose Equivalent for
 (A) Adult Males (B) Adult Females
 (C) Adolescents and (D) Young Adults
 on Rongelap

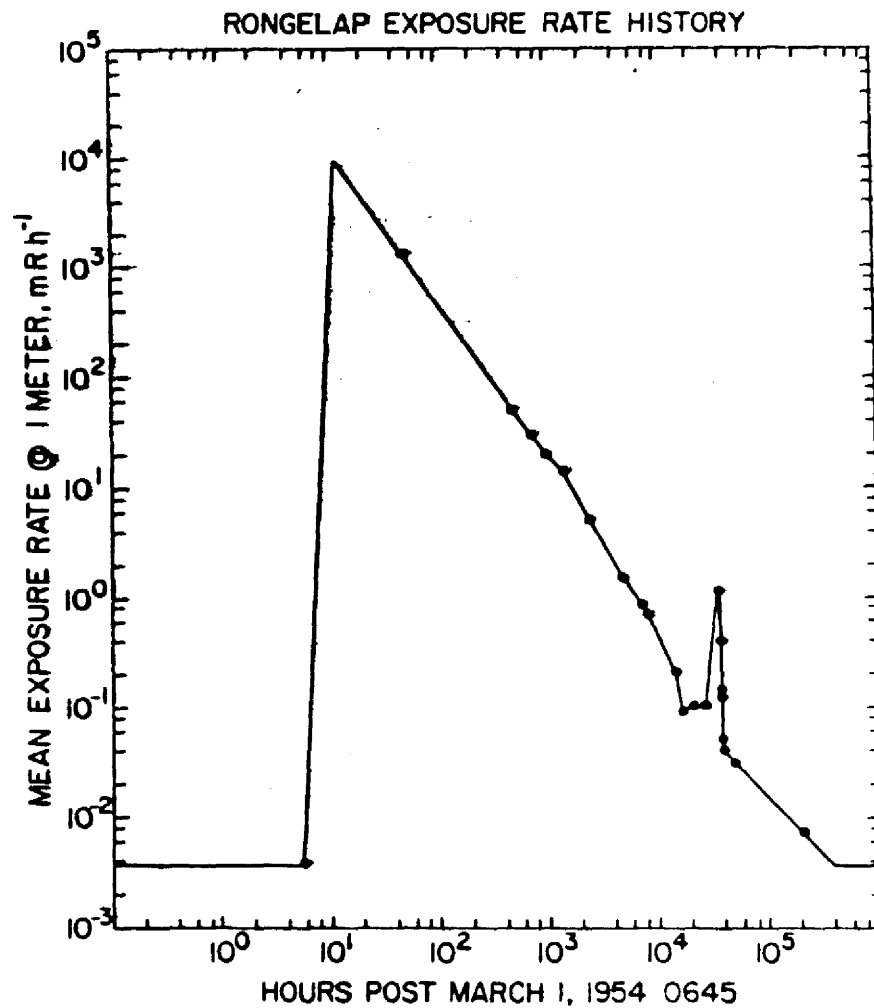


Fig. 24 Rongelap External
 Exposure Rate History
 Post Bravo

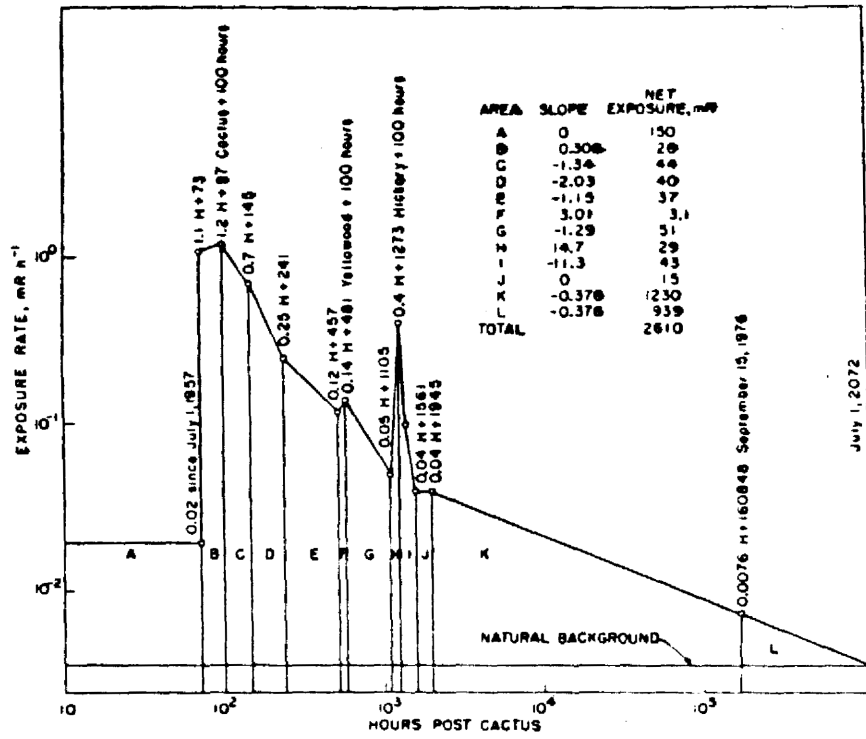


Fig. 25 Rongelap External Exposure Rate History Post Cactus

UTIRIK EXPOSURE RATE HISTORY

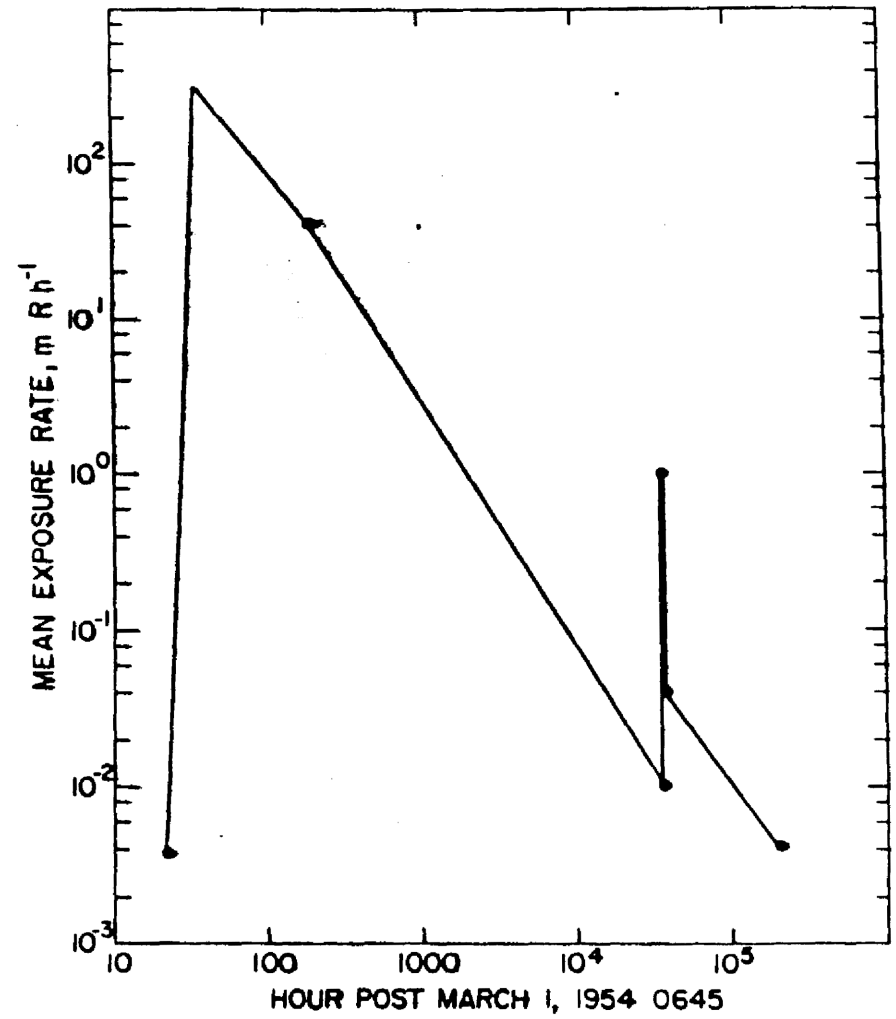


Fig. 26 Utirik External Exposure Rate History Post Bravo

Table 1

Rongelap Body Burdens

	Adult Males		Adult Females		Adults		Days Post Return Days
	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	
^{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}	26	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		Days Post Return Days
	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	Body Burden μCi	Number of Persons	
^{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

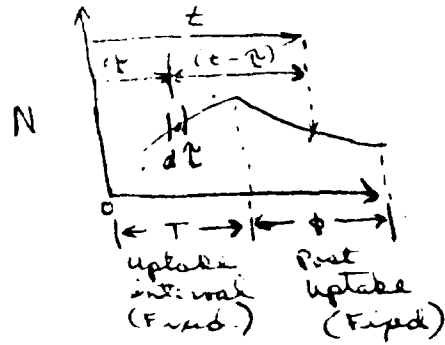
* = Measured at Argonne National Laboratory

Table 4

Total Body Dosimetric and Physiologic Data

Nuclide	Compartment Deposition Fraction	Compartment Removal Rate Constant	GI Tract to Blood Transfer	Fraction Excreted in Urine	Decay Constant	Significant Progeny	Branching Ratio
$\begin{smallmatrix} A \\ Z \end{smallmatrix} X$	x_i	$K_{i,d}^{-1}$	f_l	f_u	$\lambda_{d^{-1}}$	$\begin{smallmatrix} A \\ Z \end{smallmatrix} Y$	
$\begin{smallmatrix} 137 \\ 55 \end{smallmatrix} \text{Cu}$	0.13 0.87	0.50 0.0051	1.0	0.90	6.3×10^{-5}	$\begin{smallmatrix} 137m \\ 56 \end{smallmatrix} \text{Ba}$	0.946
$\begin{smallmatrix} 65 \\ 30 \end{smallmatrix} \text{Zn}$	0.25 0.75	0.058 0.0022	0.35	0.25	2.8×10^{-3}	$\begin{smallmatrix} 65* \\ 29 \end{smallmatrix} \text{Cu}$	0.49
$\begin{smallmatrix} 90 \\ 38 \end{smallmatrix} \text{Sr}$	0.89 0.059 0.051	0.21 7.1×10^{-4} 1.0×10^{-4}	0.20	0.85	6.5×10^{-5}	$\begin{smallmatrix} 90 \\ 39 \end{smallmatrix} \text{Y}$ $\begin{smallmatrix} 90* \\ 40 \end{smallmatrix} \text{Zr}$	1.0 0.0002
$\begin{smallmatrix} 60 \\ 27 \end{smallmatrix} \text{Co}$	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}	$\begin{smallmatrix} 60* \\ 28 \end{smallmatrix} \text{Ni}$	1.0
$\begin{smallmatrix} 55 \\ 26 \end{smallmatrix} \text{Fe}$	1.0	3.5×10^{-4}	0.1	0.0	7.0×10^{-3}		

DEVELOPMENT OF DOSIMETRIC EQUATIONS



$$f_i P(t) = f_i P^0 e^{-(k_e + \lambda)t} \quad \text{GI tract to blood function}$$

$$r(t-\tau) = \sum_i \chi_i e^{-(\lambda + \kappa_i)(t-\tau)} \quad \text{, whole body retention function}$$

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

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

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

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

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

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

$$N = f_i P^0 \int_0^T \sum_i \chi_i e^{-(k_e + \lambda)\tau} e^{-(\lambda + \kappa_i)(t-\tau)} d\tau$$

$$N = f_i P^0 \sum_i \chi_i e^{-(\kappa_i + \lambda)t} \left(\frac{e^{(\kappa_i - k_e)T} - 1}{\kappa_i - k_e} \right)$$

for $t = T$

$$\lambda_N = \lambda P^0 f_i \approx \sum_i \lambda_i \frac{(e^{-(\lambda+\kappa_e)T} - e^{-(\lambda+\kappa_i)T})}{\kappa_i - \kappa_e}$$

for $t = T + \phi$

$$\lambda_N = \lambda P^0 f_i \approx \sum_i \lambda_i \frac{(e^{-(\lambda+\kappa_e)T} - e^{-(\lambda+\kappa_i)T}) e^{-\lambda\phi}}{\kappa_i - \kappa_e}$$

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

$$\lambda_N = \lambda P^0 f_i \approx \frac{\sum_i \lambda_i (e^{-(\lambda+\kappa_e)T} - e^{-(\lambda+\kappa_i)T}) e^{-\lambda\phi}}{\kappa_i - \kappa_e} + q_0 \sum_i \lambda_i e^{-\lambda\phi}$$

Chronic Phase
D.E. and Committed Dose Equivalent Summary, Rem

Utirik June '59 to Jan '80
Rongelap June '57 to " "

Nuclide	<u>Total Body</u>		<u>Thyroid</u>	
	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
	<u>Red Marrow</u>		<u>Testes-Ovaries</u>	
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
	<u>Lower Large Intestine Wall</u>		<u>Liver</u>	
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

Soil Samples

Soil samples consisted of entire first inch of soil. Since, \bar{x} , the ^{relaxation depth} ~~mean free path~~ 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

$$\int_0^{2.54} N dx = \int_0^{2.54} N_0 e^{-\mu x} dx,$$

where N_0 = atoms cm^{-3} at depth $x=0$,

N = atoms cm^{-3} at depth x ,

μ = instantaneous fraction of atom concentration remaining at depth x .

The average atom concentration is

$$\frac{\int_0^{2.54} N_0 e^{-\mu x} dx}{2.54 \text{ cm}}$$

The average atom density, C , is

$$C = \frac{N_0 [1 - e^{-2.54\mu}]}{\mu f_{\text{soil}} (2.54 \text{ cm})}$$

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

$$C_A = \int_0^{\infty} N_0 e^{-\mu x} dx = \frac{N_0}{\mu}$$

Soil Samples

Thus,

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

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

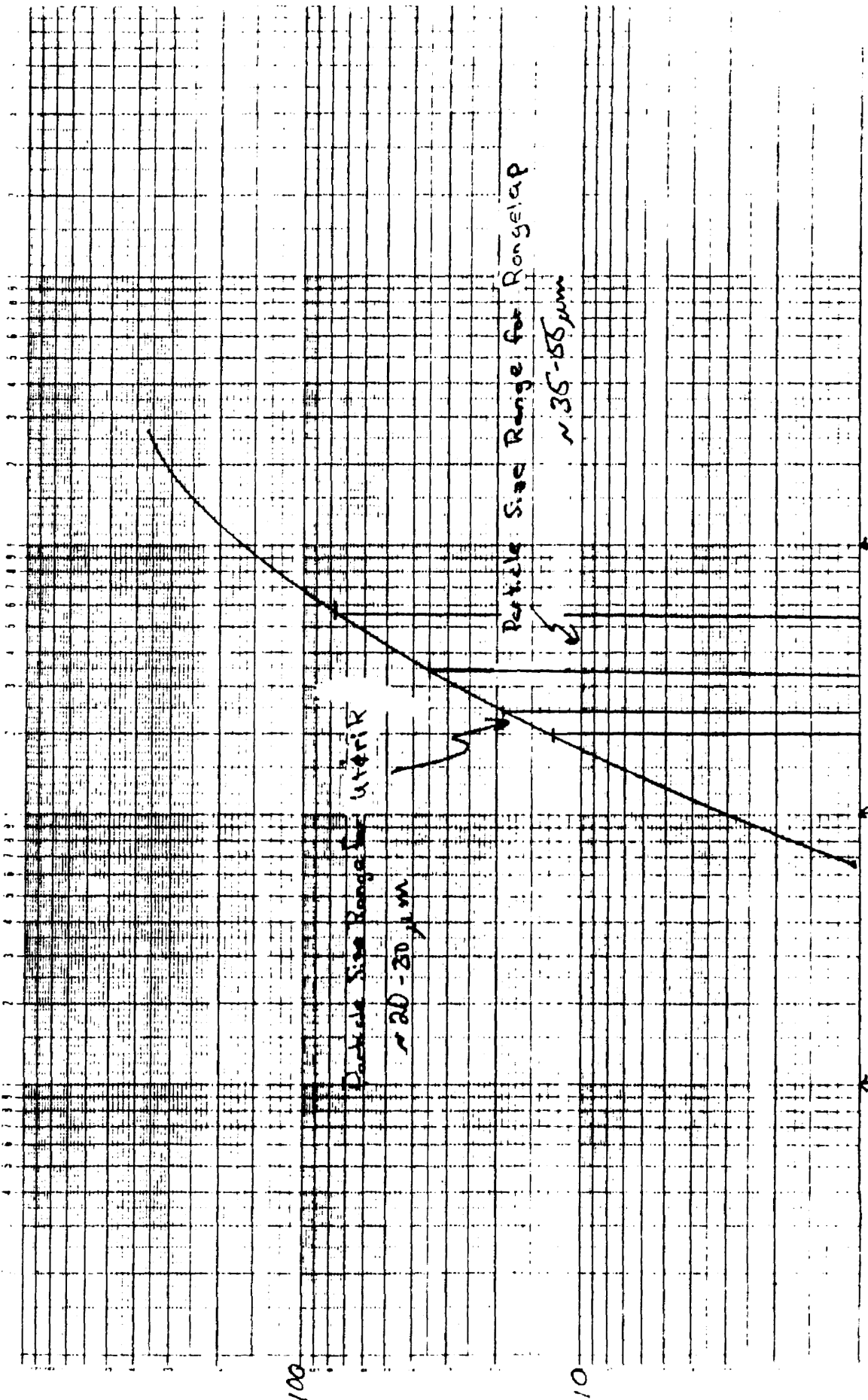
At one year post Bravo I-129 ingrowth had finished. Soil samples were taken post the ingrowth interval, thus the corrected I-129 deposited after fallout deposition is

$$C_A = 6.23 \times 4.83 \times 10^{10} \times .659 = \underline{\underline{* 1.98 \times 10^9 \text{ atoms cm}^{-2}}}$$

Additionally, the maximum and minimum 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.

* Sandhu's suggest bounding upper + lower bound as $\mu \pm$ resultant C_A values

Deposition Velocity vs Particle Size *



Particle Radius, μ

10,000 Fissions

⑤

Thermal Neutron Fission of ^{235}U at times
Post Creation

t Hours	I-129 Atoms	I-131 Atoms	I-132 Atoms	I-133 Atoms	I-134 Atoms	I-135 Atoms
0	7.62×10^{-11}	4.34×10^1	4.80×10^0	1.40×10^2	5.20×10^1	2.53×10^1
2	1.68×10^1	3.04×10^2	8.59×10^0	5.01×10^2	2.02×10^2	4.44×10^2
4	4.63×10^1	3.50×10^2	1.13×10^1	5.22×10^2	4.63×10^1	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	9.43×10^1	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	3.35×10^2	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 hydrogen-seeking nuclides?

See Shellabarger, Van Middelwater @ ORNL
Jan Wolf @ NIH

I-129 Deposition

⑥

L	~20 min intervals	Particle Radius, μM	F	I
	Interval H + Hour		Fraction of Total Atoms Deposited During Interval*	Ingrowth Factor, $\frac{\text{I-129 atoms at mic}}{\text{I-129 atoms at H}}$
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 distribution of final atoms as a function of

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-235 at times post creation (Table).

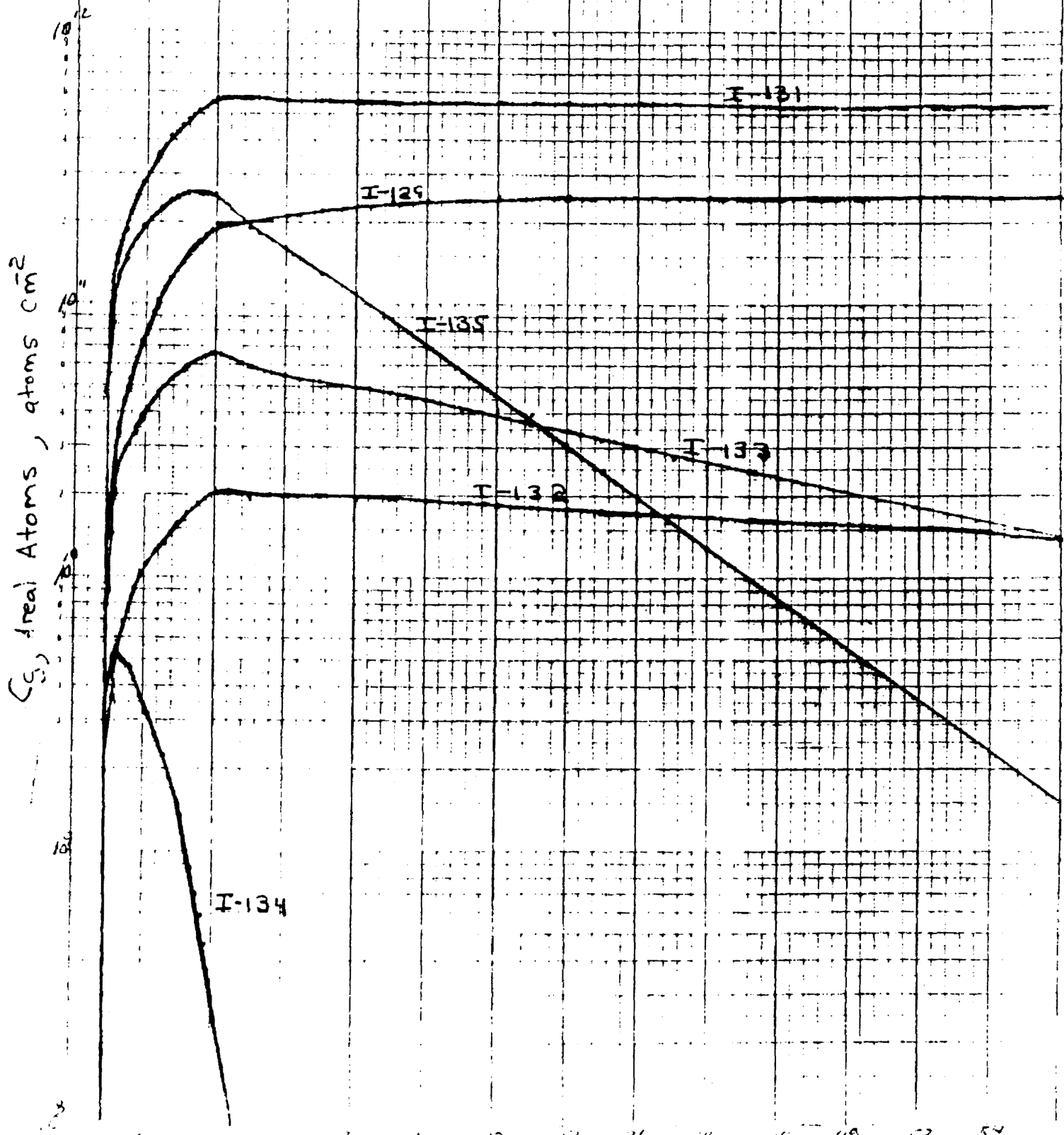
To obtain a point on graph , the following relationship was used,

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

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

$$+ \text{atoms } \text{cm}^{-2} \text{ fallen during interval two} \times \frac{\text{atoms of I-129 at end } t}{\text{atoms of I-129 at md } t}$$

AREAL IODINE ISOTOPE ATOMS ON RONGELAP POST BRAVO



Activity Ingested By Rongelapese

WT-938 → Depth of H₂O = .67 ft = 20.4 cm
 → Drank 1 pt day⁻¹ = 19.7 cm³ hr⁻¹

Nuclide	Area During Deposition, atom cm ² hr	Activity # Ingested, μ Ci	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, μ Ci	Thyroid Rem
I-131	2.15×10^{13}	558.	1910
I-132	7.50×10^{11}	1649.	107
I-133	1.52×10^{13}	3649.	1642
I-134	2.83×10^{10}	1.62	.49
I-135	2.58×10^{12}	1961.	319
Total			3074.

* Activity Ingested = $\frac{\int_0^t \text{Areal Atoms } dA}{\text{Depth of Water}} \times \text{Water Intake Rate} \times \text{Decay Constant}$

where t = 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, ~~325~~ hours,

$V_i \equiv$ average deposition velocity during interval,

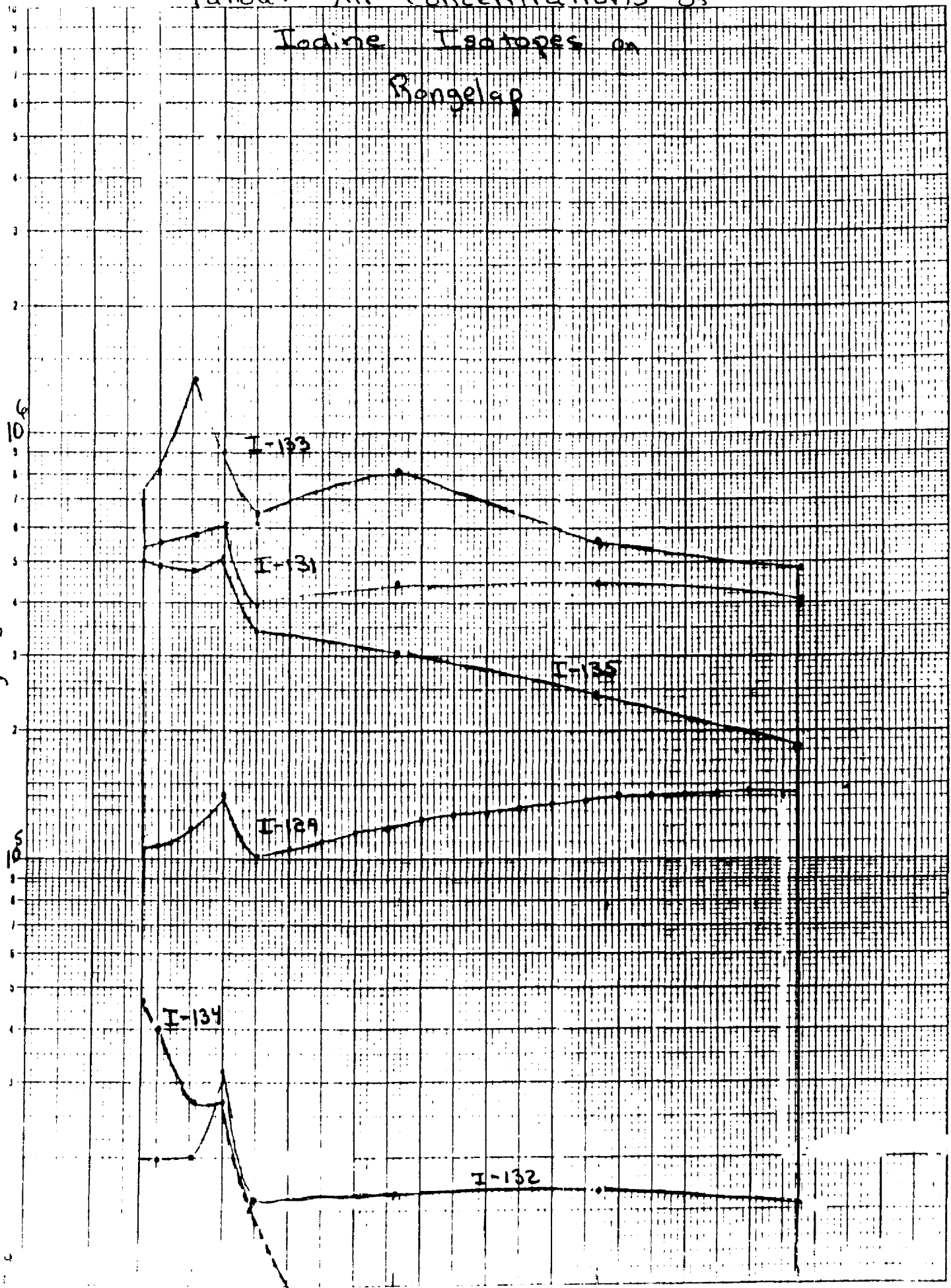
$A_i \equiv$ areal deposition during interval

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

Fallout Air Concentrations of Iodine Isotopes on Rongelap

65 4500-242-5 SURVEILLANCE AND MONITORING DIVISION, BUREAU OF RADIATION PHYSICS, U.S. DEPARTMENT OF COMMERCE, WASHINGTON, D.C. 20540

atoms cm^{-3} , Ci



Activity Inhaled During Fallout on Rongelap

Thyroid
Rem μCi^{-1}
(30-100 μ)

Breathing Rate = $8.729 \times 10^5 \text{ cm}^3 \text{ h}^{-1}$

.844	I-131
.0085	I-132
.163	I-133
.0145	I-134
.045	I-135

Atoms Inhaled =

Area of Atom Concentration
Curve on Graph 4
x 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	68
Total		273 Rem

Resuspension of Iodine Atoms

Resuspended Concentration
in Air = areal atoms on ground \times
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} ,

$K = 10^{-7} \text{ cm}^{-1}$, UNSCEAR A/AC.02/B.369.

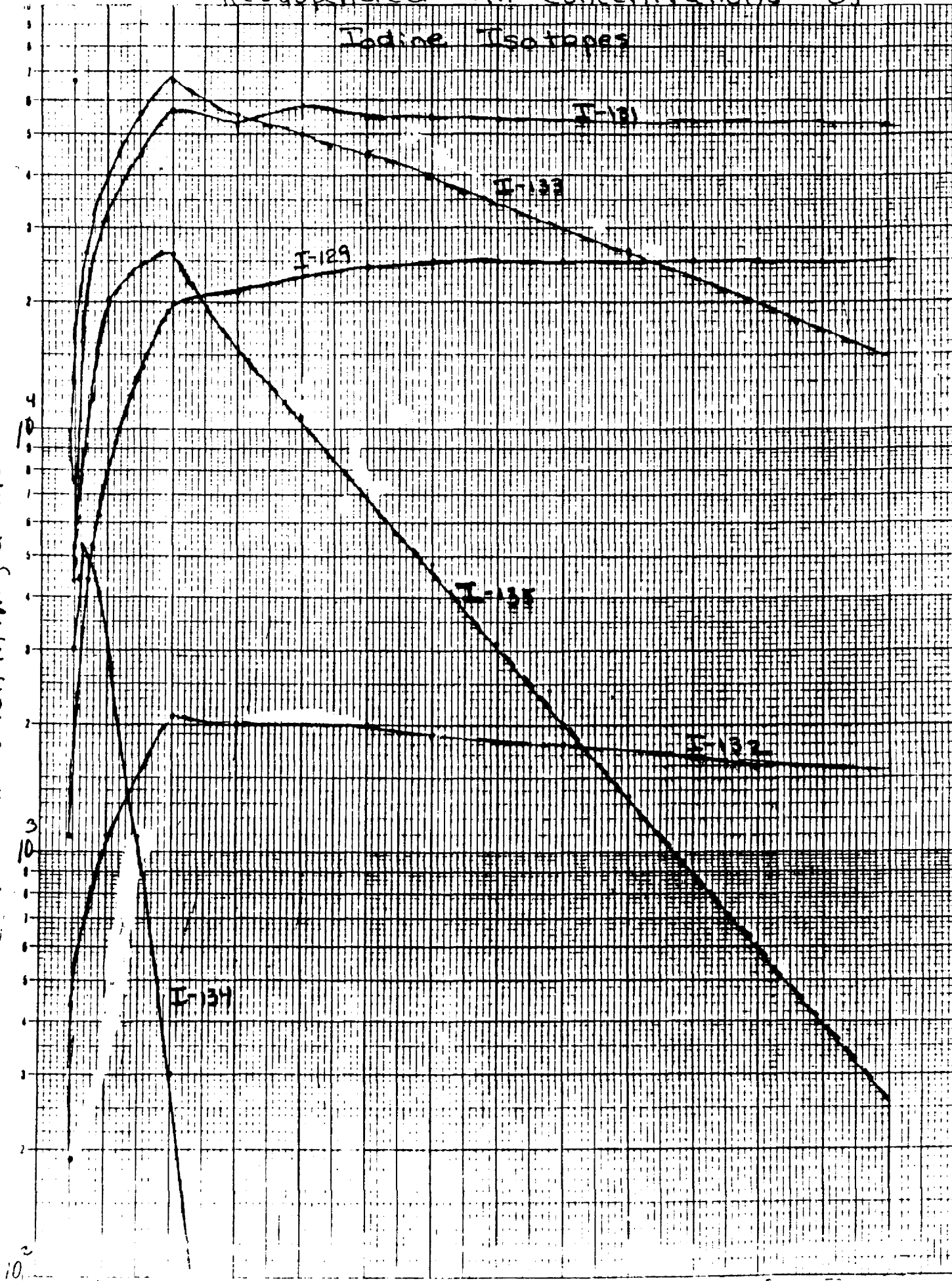
The above expression was used to develop the resuspended air concentration of I-129 atoms post detonation. Resuspension occurred during and post fallout cloud passage. The resuspended air concentrations of the remaining iodine isotopes were determined from the instantaneous ratio of the number of iodine isotope atoms to I-129 atoms per 10,000 thermonuclear fissions of U-238 at times post creation (Table 4). The resuspended air concentrations are shown on graph 5.

Resuspended Air Concentrations of
Iodine Isotopes

SEMI-LOGARITHMIC 3 CYCLES X 100 DIVISIONS 40-8000-20

GRAPHIC CONTROLS CORPORATION Buffalo, New York U.S.A.

Atom Concentration in Air, atoms cm^{-3}



Activity Inhaled Due To Resuspension on Bongelap

$$\text{Atoms Inhaled} = \text{Area of Atom Concentration Curve on Graph 5} \times \text{Breathing Rate}$$

During Deposition (H+5.5 to H+12)

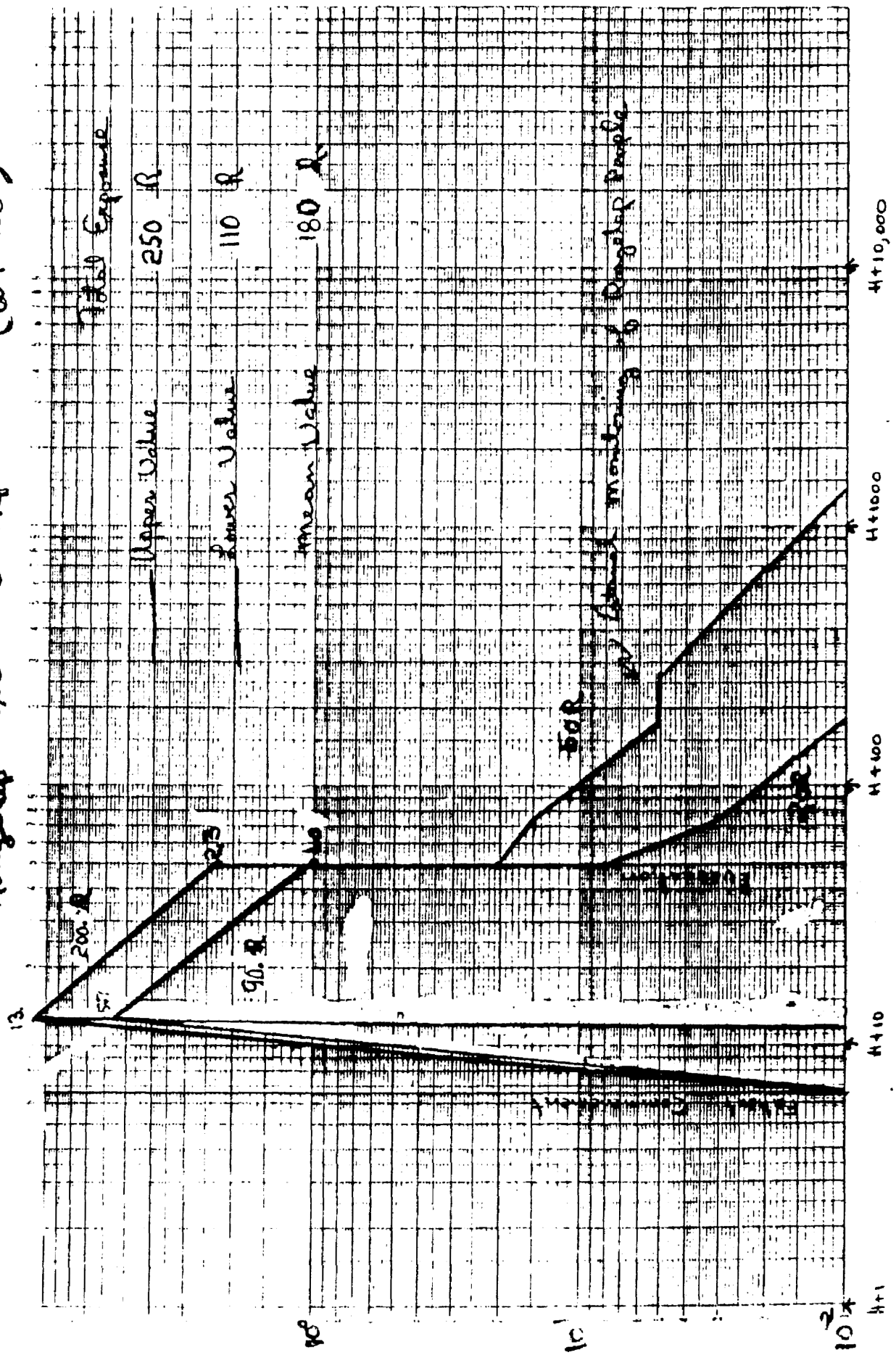
Nuclide	Atoms Inhaled	$\mu\text{Ci}/\text{Atom}$	Activity Inhaled, μCi	Rem/ μCi	Thyroid Rem
I-131	1.82×10^{11}	2.7×10^{-11}	4.9	.044	4.1
I-132	6.71×10^9	2.3×10^{-9}	15.4	.0085	.13
I-133	2.33×10^{11}	2.5×10^{-10}	58.3	.163	9.5
I-134	1.24×10^{10}	6.0×10^{-9}	74.4	.015	1.1
I-135	1.04×10^4	7.9×10^{-4}	82.2	.045	3.7

Post Deposition (H+12 to H+51)

I-131	1.72×10^{12}		46.4		39.
I-132	5.97×10^{10}		126		1.1
I-133	7.84×10^4		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

ACUTE PHASE

17

Rongelap

Adult Male Thyroid Dose Summary

	<u>Rem</u>
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	91.9
External exposure after evacuation	25.6
TOTAL	4160