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ABSTRACT

An estimate is made of the radiation dose to the chyote children following the Bravo event of March 1, 1954. The available mental data are used to estimate the dose under two alternate assumptions mode of intake: (a) all of the intake was by inhalation, and (b) all of intake was by oral ingestion. It is concluded that the most probable dose the thryoid of a 3 - 4 year old girl is in the range 700 - 1400 rad.

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RETINATE OF RADIATION DOBE TO MAYROTHE DETAILS ROUGHLAP CHILDREN FOLLOWING THE BRAYO EVENT

Ralph A. James

Lawrence Radiation Laboratory, University of California
Livermore, California
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General Information

The cloud arrival time is given (1) as H + 4 to 6 hours. The cloud passage is less well known but probably lies in the 8 - 16 hours. In all calculations we will assume that cloud passage may the interval H + 6 to H + 18.

The residents of Rongelap were evacuated at H + 51 hours. Reliable dose rate measurements were not obtained at that time but the gamma dose is 3 feet above the ground was measured as 375 mr/hr seven days after the detonation. Assuming t^{-1.2} decay the H + 24 hour dose rate was then ~3.8 R/hr

The sources of exposure to the thyroid which must be considered are:

- (1) Whole body gamma dose.
- (2) Internal deposition of iodine isotopes.

Whole Body Gamma Dose

The whole body dose was estimated (1) to be 175 R. The exact method of making this estimate is not given, so an independent estimate is made below. In particular, it appears that this estimate does not include the dose from the cloud but only from fallout.

If we assume a linear buildup of fallout from H + 6 to H + 18.

decay during this interval and use the reading of 375 mr/hr at seven days
the estimated dose from fallout during cloud passage is 47 R. The dose
the fallout from H + 18 to evacuation at H + 51 is 114 R. Experience from
Sedan indicates that the dose from the cloud, itself, is approximately equa-

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OBEIDINE BASSAGE

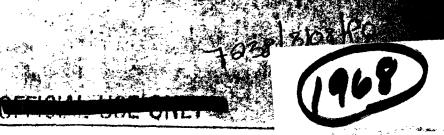
to the does from all 1 mingres of them 47 + 47 5214 = 208 R

within the error of the peasurements the house tions, this estimate, which does not contain the effect of time indoors, does not differ light the will, therefore, take the average whole body gamma eggs.

Internal Deposition of Todine Isotopea

Unfortunately, no direct measurement was possible indine content of individuals from Rongelan. Trine sample is which the average thyroid burden of 1 has been estated. Scientific Laboratory collected pooled 24-hour samples 1 day, point tion and estimated (2) the 1-day thyroid content as 11.2 mc of 1 collected samples from each member of the exposed group 4 and 6 ml. detonation and, by an indirect method, estimated the average thyroid as 6.4 mc 1 1 day. (3,4) The LASL estimate of 11.2 mc was obtained direct counting of 1 in the urine and should be more reliable than me NRDL estimate. The value of 11.2 mc will be used as a basis for all of ing considerations. This estimate was based on the assumption of 0 ing considerations are the same two based on the assumption of 0 ing considerations. This estimate was based on the assumption of 0 ing considerations are the same two based on the assumption of 0 ing considerations. This estimate was based on the assumption of 0 ing considerations are the same two of 0.05 - 0.2% should be placed on this number (5) (see appendix) to the fore, take 5.6 - 22.4 mc as the range of adult 1 thyroid burden.

The pooled samples represent all age groups. The number of finitial in these age groups and the volume of urine from each age group.



The urine samples are polyter, rough, the life is a presumably also those of this are

Associated with this I are the shorter lived colored.

I 135. If the iodine entered by way of inhalation, he imper (1) 100 to H + 18. On the other hand, if water (and (cod)) is the time of ingestion would be extended from H + 6

indine isotopes. These are: (1) radioactive decay before inhala on ingention, (2) differences in the fission yields of the chains, and average energy deposited in the thyroid per disintegration. These accompresented in Table I for I¹³³ and I¹³⁵. In the case of inhalation, unit distribution in the cloud was assumed. For oral ingestion it was assumed that, on the average, 1/3 of the intake occurred at H + 10 and 2/3 at H

Table I

Ratio of Doses for the Two Modes of Intake

	Inhalation		
	1155 1151 1155 1151		
Decay Fission yield(6) Energy	0,68 0 91 1.38 23 2.00 1.50		
Net Factor	1.85	4.02	



The dose to the Chyrold large to the dose due to I alone for inhalation.

ingestion. Delay in reaching the chyrold after thought to the lower these factors somewhat. However, the been neglected and would approximately domestic to the second of the chirolage of the chyrold.

I before reaching the thyroid.

We can now proceed to estimate the dose to the thyroids of old girls assuming (1) inhalation as the mode of interest.

1. Inhalation: The ratio of volume of air respired by a second to that of an adult can be estimated in two ways: (a) row the maximum of oxygen intake (7) and (b) from the vital capacity (8) and maximum respiration rate. (7) Both methods give a ratio of ~0.3. The thyroid burden of children would then be ~3.4 µc with a range of 1.7 - 6.8 µc.

Assuming the Rongelap children are similar to those of New York children, the mass of the thyroid of the children is 2.5 ± 0.6 grams.

The most probable dose from I¹³¹ is then 150 rad and the dose from a isotopes is 510 rad. If we consider the range of thyroid burden (1.7 and and the variation in thyroid weight (1.9 - 3.1 gms), the dose is in the range of 200 - 1350 rad.

2. Oral Ingestion: At the time of the event the Rongelap people were on water ration of one pint per day. They were warned not to drink yeter aft the event but most of them admitted they drank water anyway. (10) The of collecting water by runoff from roofs into gisterns makes it very likely that this was the main source of oral ingestion. There are reports that this was the main source of oral ingestion. There are reports that the "water turned of March 1 (D-Day). The village do reported that the "water turned yellow." As far as food is concerned, and most likely source is dried fish. Fish were dried on open racks. However

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in the interviews none of them listed to the time before evacuation. This the series to assume that children drank the same amounts of the same intake as adults; i.e. the list have listed to the same of the same of the same of the same intake as adults; i.e. the list have listed to the same of the same of

The most probable dose from I is then to the tall 1270 rad. Considering a range in the thyroid purion [5:1, 22]. thyroid weight range of 1.9 - 5:1 ras; the large of 1.9 - 5:1 ras.

Incidentally, LASL assumed this mode of intake and calculate of 150 rad. (2) The thyroid weight used was not given but was probably grams. We would calculate 160 rad, in very good agreement visa in estimate.

Summary : -

Thyroid Dose (Rads) to Rongelap Girls Ages 3 - 4

_				
	Inhalation			Oral Ingestion
	Min	Max	Most Probable	Min Max Most Probable
Whole Body	150	200	175	150 200 775
Radioiodine	200	1350	510	520 3300 + 1270
Total	350	1550	685	670 3500 3 1445

The actual intake was undoubtedly a combination of the NG will intake. The most probable dose is, therefore, in the range 700 - 100



150 (4)

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Pallout Material and Determination of the TID-5358, Some Effect of the Time of

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Cohn, Rinehart, Gong, Robertson, Kilne, Bond and Cronkise, Child Deposition of Radionuclides in Human Beings and Animals. Charter 11D-5358.

Cohn, Rinehart, Gong, Robertson, Milne; Charman and Bond; Western Radioactive Contamination of Human Beings Accidentally Exposed to Radioac Fallout Material, "USNRDL-TR-86.

⁵Ng, Yook, private communication (1964).

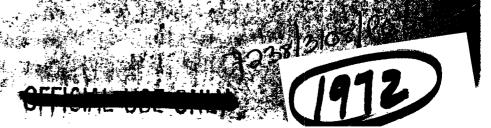
The fission yields for U²³⁸ with high energy neutrons as given by Weaver, Strom and Kileen, NRDL-TR-633, were used.

Handbook of Biological Data, William B. Spector, Editor, p 352 (V. 3 Saunders, Philadelphia, 1956).

8_{Document Geigy Scientific Tables, 5th Ed., p 254 (S. Karger, Basel)} Switzerland, 1959).

9Mochizviki, Mowafy and Pasternack, Health Physics, 2, 1299-1301 (1965)

10 Sharp and Chapman, "Exposure of Marshall Islanders and American.
Military Personnel to Fallout," WT-958, 1957.



Unaverse

CALCULATE AND WAS A STATE OF THE STATE OF TH

short period following opposes of the second that could be second for uninary radiological was assumed that could be the provided and that the release of the could be degradation in the extrathyroidal hormonal space can be assuming first order kinetics. Ranges for normal biological being indine in the thyroid and normal turnover rate of extrathyrother were selected from the best available data in the literature. The provider radiological was assumed to be exponential with a half-period of laws as the second for the indine released when extrathyroidal degraded was assumed to be excreted in urine.

Rates of urinary radioiodine excretion were calculated from the remaining expression shown below.

$$\frac{dI_{U}}{dt} = 0.60LKI_{Tf} \frac{e^{-(K+\lambda)t} - e^{-(L+\lambda)t}}{L-K} \frac{e^{-(J+K+\lambda)t} - e^{-(J+K+\lambda)t}}{L-J-K}$$

I, = radioiodine content of urine

L = rate of turnover of extrathyroidal thyroxine.

K = rate constant for the release of dodine from the the

Imf = peak redicioding content of the thyroid

> = physical decay constant for 1

J = rate constant for the uptake of radiologine in the three

t = time



A summany of the calculation and a summany of the calculation at the c

Urinary Radiolodine Excrete

J day ⁻¹	day ⁻¹ x 10 ³	day 1 20
3.7	4.85	7.2
3.7	4.85	13.8
3.7	17-15	7.2
3.7	17-15	13.8

On the basis of these calculations the normal range of Urinary indine excretion at 15 days was estimated to be 0.05 to 0.2% of the beak thyroid content.

The problem outlined above is a practical application of an analysis study on the uptake and excretion of iodine in man which will be described more fully in a UCRL report entitled, "The Dynamics of Todine in Man."

