Dr. John C. Bugher, M.D., Director Division of Biology and Medicins

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REVIEWER

May 13, 1954

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A.

Gordon M. Dunning, Health Physicist Biophysics Branch, Division of Biology and Medicine

ESTIMATED RADIATION DOSE TO THIROID OF NATIVES FROM RONGELAP

This memorandum is in reply to your request for an estimate of additional doses to the thyroid of the Rongelap natives due to the fact that tellurium, as a precursor to iodine, may be present in the gut after ingestion of fallout material. The tellurium, in turn, might disintegrate into radioactive iodine while in the gut, with subsequent deposition of the iodine in the thyroid.

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There are some 17 radioactive isotopes of tellurium but only 7 of these are produced in fission. Of these, 6 are not of interest (4 have too short a half-life, 1 leads to stable_iodine-127 and 1 leads to iodine-129 with a half-life of $2-4 \times 10^7$ years). The remaining radioisotope is tellurium-132, with a half-life of 77 hours leading to iodine-132 with a half-life of 2.4 hours. (Incidentally there is no tellium precursor that is of interest here.)

Without having the original data of LASL I have accepted their estimate that there were ingested and/or inhaled the products of 5×10^{13} fissions, assumed they were all ingested, and then proceeded to calculate the dose to the thyroid from (a) I¹³¹ (b) each shortlived iodine isotope of interest and (c) the added dose coming from $T^{132}-I^{132}$. The calculations show that $T^{132}-I^{132}$ will produce an added dosage of about 26%.

The best estimated percentage absorption and deposition of iodine is yet to be determined. The best estimate I can turn up to date is still the 20% quoted in NBS Handbook 52. However, I will continue to search for additional information. In the meantime the table below indicates the magnitude of doses to the thyroid if one assumes 20, 50, and 100% absorption and deposition. Incidentally, it may be noted that the calculations below based on 20% (the number assumed by LASL) show estimated doses to the thyroid from I^{131} and from shorter lived indine isotopes to be in good agreement with those estimated by LASL, i.e., 50 reps for I¹³¹ and 80 reps for shortlived iodine isotopes.

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DOSE TO THIROID (REPS)

	Assuming 100% Retention		Assuming 50% Retention		Assuming 20% Retention	
131	255	255	128	128	51	51
132	27=	(5k)**	74*	(27)**	5 *	(10)**
133	370	570	185	185	74	74
135	60	60	30	30	12	12
132(Te ¹³²)	185=	(370)**	93*	(185)**	37*	(74)**
Total	897=	(1109)**	150*	(555)**	189*	(221)**

* If assume that one-half of the I¹³² (half-life 2.4 hours) present in the gut is deposited in the thyroid. ** If assume all of the I¹³² (half-life 2.4 hours) present in the gut is deposited

in thyroid.

Most probable estimate of ratio of doses to thyroid is:

$$\frac{1^{132,133,135} / 1^{132} (7 - 132)}{131} \approx 2.5$$

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ANNEX

Calculations of Dose to Thyroid

131 T

Assume: inhalation and/or ingestion of 5×10^{13} fissions

At D / 1 there are 0.017 d/m/10 300 fissions or 8.5 x 10⁷ d/m/5 x 10¹³ fissions or 38.3 µc intake of I¹³¹ or 1.4 x 10¹² atoms intake of I¹³¹ (Average energy 0.22 MeV)

Dose (reps) = $\frac{(1.35 \times 10^{12})^{\circ}(0.22)(1.6 \times 10^{-6})}{(20)(03)} = 255$ eps

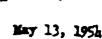
+ Correction for biological decay.

1¹³²

Assume: inhalation and/or ingestion of 5×10^{13} fissions At D / 1, I^{132} intake is 1.1 x 10^{11} atoms The average mean energy of I^{132} is about 0.55 meV or 2.5 times that of I^{131} . Thus, the energy equivalent to I^{131} would be $(1.1 \times 10^{11})(2.5) = 2.75 \times 10^{11}$ atoms of I^{131} However, due to the short half-life of I^{132} (2.4 hrs) assume that the energy equivalent of 1.5 x 10^{11} atoms of I^{131} reaches the thyroid. Thus, the ratio of doses $\frac{131}{7137} = 9.0$

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133

Assume: inhalation and/or ingestion of 5 x 10^{13} fissions At $D \neq 1$, I^{133} intake is 1.24 x 10^{12} atoms

The average mean energy of 1133 is about 0.36 or 163 times that of 1131.

Thus, the ratio of doses $\frac{131}{7133} \approx 0.7$

135 I

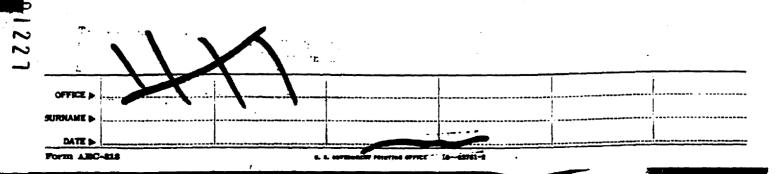
Assume: inhalation and/or ingestion of 5 x 10^{13} fissions At D / 1, I¹³⁵ intake is 2.36 x 10^{11} atoms.

The average mean energy of I¹³⁵ is about 0.3 mey or 1.36 that of I¹³¹.

Thus, the energy equivalent to I¹³¹ would be

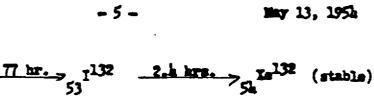
(2.36 x 10¹¹)(1.36) = 3.2 x 10¹¹ atoms of I¹³¹ emergy equivalent.

Thus, ratio of doses $\frac{1}{135} = \frac{1}{2}$





52⁷⁰132



Assume: inhalation and/or ingestion of 5 x 10^{13} fissions.

At $B \neq 1$, Te¹³² intake 100 pc

or 1.5 x 10¹² atoms

Assume: the time spent in the gut is 77 hrs.

Then, 7.3 x 10^{11} atoms of Te¹³² will have disintegrated into 7.3 x 10^{11} atoms of 1^{132} .

The average mean energy of I¹³² is about 0.55 Hev or 2.5 times that of I¹³¹.

Thus, the energy equivalent to 131 would be

 $(7.3 \times 10^{11})(2.5) = 1.8 \times 10^{12}$ atoms of I¹³¹.

However, due to the short half-life of I^{132} (2.4 hrs), assume that only the energy equivalent of 1 x 10^{12} atoms of I^{131} reaches the thyroid.

Thus, the ratio of doses $\frac{131}{132(10132)} \approx 1.4$.

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