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TO: W. D. Norwood, M. D.
Supt. Medical Department

January 14, 1946

HW--7-3217

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TOLERABLE CONCENTRATION OF RADIO-IODINE ON EDIBLE PLANTS

The deposition of radio-iodine in significant amounts on the ground within the reservation and over an extensive area in the South East quadrant outside the reservation indicated the need for a statement of the hazard magnitude of such a disposition. The limiting hazard may be due either to direct radiation from the contaminated surfaces or to the ingestion of significant amounts of radio-iodine by man or animals. In the former case, the routine radiation survey mechanism would serve to locate and eliminate the potential hazard. This report considers the problems of ingestion by man and animals. END

Uptake of I^{131} by Animals

A report by J. G. Hamilton, "Summary of Iodine Physiology and Metabolic Studies Using Radioactive Isotopes of Iodine", CH-2257, 10-18-44, contains a review of most of the pre-project information on iodine uptake in animals.

A curve based on the results of Chaikoff and of LeBlond in rats, of Hamilton and Soley in man, and of Herts in rabbits showed an average thyroid uptake of 52% of the administered dose of carrier free radio-iodine. In the same review, it is noted that Chaikoff found an average uptake after 24 hours of 20% in rabbits, sheep and guinea pigs. LeBlond has reported a value of 35% in dogs. K. S. Cole in Metallurgical Laboratory reports has consistently observed a 10% deposition in the thyroid gland of rats for material supplied by inhalation. Recent measurements by J. G. Hamilton, "Technical Progress Report on the Metabolic Studies of Plutonium", Document 7487 MUC BSS 540, have shown uptake in rats ranging from about 5% to 25%, with the larger values associated with low total administered dose. The quantitative recovery of iodine from tissue is sometimes in doubt, because methods vigorous enough to release the iodine

from its chemical combination may produce losses due to volatility. Hence, experimental values not checked by a material balance may be low. It appears that all the experimental work has been done either with free iodine or with inorganic salts. There is now some evidence that iodine deposited on vegetation forms organic compounds. Iodine consumed in this form may be assimilated more or less readily by the animal. In view of the present uncertainties in the iodine uptake in the thyroid glands of animals, it will be assumed that an uptake of 20% of the ingested amount is representative in all cases. It will be further conjectured that the mechanism is the same for domestic fowl. In the human case, it has been generally accepted that a radiation dosage-rate of 1 r/day to the thyroid gland is tolerable. The same limit will be assumed valid for all animals concerned.

Tolerable Concentration in Vegetation

Required data on domestic animals was supplied by Captain L. Jamieson, Manhattan District, through the courtesy of Major A. A. White. Some supplementary information came from local farm sources.

Animal	Estimated Weight of Thyroid Gland (gm)	Tolerable * Daily Increment of I^{131} (μc)	Daily Food Consumption Lbs.	Tolerable Concentration of I^{131} in Vegetation μc/gm
Man	25	0.85	2 **	9×10^{-4}
Horse	30	1.0	15	1.5×10^{-4}
Cattle	30	1.0	10	2×10^{-4}
Sheep	20	0.7	3	5×10^{-4}
Swine	25	0.85	6	3×10^{-4}
Turkey	10	0.35	1	8×10^{-4}
Hen	5	0.2	1/2	8×10^{-4}

The given food consumption of horses and cattle is probably excessive in view of the sparseness of the local range, and the general prevalence of supplementary feeding. If one-half the food were contaminated the effective tolerable concentration would be nearly the same for all farm animals, and could be taken as 3×10^{-4} μc/gm. This would be safe for man by a comfortable margin. The value is well below that at which the external radiation hazard is significant.

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* See report by H. M. Parker to File, "Proposed Revision of Tolerances for I^{131}," 7-3042, dated 12-17-45.

** The food consumption is restricted to the amount of locally grown produce - leafy vegetables, fruit, etc. Presumably wheat fields in the area will be contaminated, but the time interval required to process and deliver the grain should reduce the hazard to negligible proportions.

Water Requirements

In the absence of other sources of contamination, the tolerable concentration of radio-iodine in drinking water would be as follows:

Animal	Water Consumption liter/day	Tolerable Concentration μc/liter
Horse	40	2.5×10^{-2}
Cattle	400	2.5×10^{-3}
Sheep	5	0.14
Swine	8	0.1
Hen	0.1	2

In the practical case, one has to assume that the farm animals would be supplied with relatively clean water from a large source. The hazardous condition would be to drink from a shallow pond, contaminated by absorption of iodine from the air or by the collection of rain water. The value for sheep on the range might be significant. Experiments are being made to determine the ratio of water contamination to adjacent ground contamination. Provisionally, it seems unlikely that a ground contamination of 3×10^{-4} μc/gm would be associated with a water contamination as high as ~ 0.1 μc/liter. The limiting iodine hazard for farm animals therefore probably arises from the contamination of edible plants. This can be supposed to be supplemented by:

(1) Direct absorption from radio-iodine vapor in the air

(2) Licking the body or other objects on which radio-iodine has been deposited

(3) Drinking radio-iodized water.

More information is clearly required on all these points, preferably by a direct check of animal thyroid activity. In the interim, one could reasonably make a small correction to the calculated concentration on plants and assume the following limits:

Permanently tolerable concentration on edible plants = 2×10^{-4} μc I^{131}/gm
Temporary limit (up to 3 months) = 10^{-3} μc/gm
Transitory limit (one day) = 2×10^{-2} μc/gm

The provisional nature of these values is re-emphasized, pending study of the following points:

(1) The chemical combination of iodine in plants

(2) Relative absorbability of inorganic and organic iodine compounds in the digestive tract

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(3) The contamination of available drinking water in zones of ground contamination

(4) Direct tests of thyroid activity in animals.

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4/3/05