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HW-25239

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August 4, 1952

Atomic Energy Commission  
Hanford Operations Office  
Richland, Washington

Attention: K.L. Englund, Chief  
Health Physics & Biology Branch

Gentlemen:

SUBJECT: TOXICITY OF I<sup>131</sup> IN SHEEP

Ref: Your file OH:KLE, KL Englund to HM Parker, 7/7/52

Transmitted with this letter are five copies of an informal recapitulation of the subject problem (Document #HW-25239), as requested by you on 7/7/52.

Supporting evidence for the biological data is available in our regular report series, to which the requesting office has access. In view of the greatly increased time required to formalize the review by addition of references and polishing of presentation, we have decided that such steps were unnecessary. If preferred, such changes could be made, probably by early September.

Very truly yours,

H. M. Parker

Director  
RADIOLOGICAL SCIENCES DEPT.

HM Parker:swc

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August 4, 1952

RECAPITULATION OF TOLERABLE CONCENTRATION OF  
RADIOIODINE ON EDIBLE PLANTS

The previous defining document on the above topic (Document #7-3217 dated 1/14/46, declassified 8/25/50) is now grossly out-of-date. The purpose of the present document is to sketch the changes in the intervening period and to arrive at an acceptable current limit.

Earlier Considerations

For sheep, the original value was  $5 \times 10^{-4}$   $\mu\text{Ci I}^{131}/\text{gm}$ . For animals generally, the original value was  $2 \times 10^{-4}$   $\mu\text{Ci I}^{131}/\text{gm}$ . These figures were based on 1 rep per-day irradiation to the gland, based on 1 rep = 83 ergs/gm.

After the initial war period, it was deemed illogical by some to accept 1 rep per day for this organ when other organs were conventionally held to 0.1 rep per day. At about the same time, the general permissible limit was under discussion for reduction from 0.1 rep per day to 0.3 rep per week. Also, the value of the rep was changed to 1 rep = 93 ergs/gm.

These three factors reduced the tolerable concentration on plants by a factor of

$$\frac{10}{1} \times \frac{7}{3} \times \frac{83}{93} = \text{about } \underline{20}.$$

A new contamination limit of  $10^{-5}$   $\mu\text{Ci I}^{131}/\text{gm}$  was therefore established.

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This limit is still in use at this location. At this stage, the limit is entirely a calculated one, based on these assumptions.

Permissible beta-gamma irradiation in the thyroid = 0.3 ray/week

Iodine uptake = 20% of ingested amount

Biological elimination rate from the thyroid is negligible.

For sheep specifically, mass of thyroid = 20 gm

and Daily food consumption = 3 lbs.

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In our opinion, each of these assumptions is incorrect.

It was such considerations that led us to the extensive direct experiment on feeding of  $I^{131}$  to sheep at this location.

#### Present Conclusions

After two years of study, preliminary results may be summarized as follows:

1. Animals fed 5  $\mu\text{C}$   $I^{131}$ /day show no evidence of damage.

We now assume that 0.5  $\mu\text{C}$ /day will certainly be safe.

2. The ratio:  $\frac{\text{Amount of } I^{131} \text{ in thyroid}}{\text{Amount fed daily}}$  is a

seasonally variable quantity in the range of 2 to 6.

The value 4 is assumed to be a good annual average.

3. An extensive literature study (Anatomical and Physiological data on Domestic Animals, by L.K. Bustad, Document #HW-2447, 5/8/52) indicates that for sheep the thyroid mass is about 8 gm, and the daily intake of range food, assuming no water, is 8 kg. The smaller thyroid mass has been amply confirmed in the local experiment. The greatly increased food intake is perhaps somewhat questionable, but is undoubtedly more realistic than the 1946 data.

With these assumptions, we conveniently bypass the argument on percent uptake and biological elimination rate. \*

Tolerable concentration on vegetation becomes

$$\frac{0.5 \mu\text{C/day}}{8000 \text{ gm/day}} = \sim 6 \times 10^{-5} \mu\text{C/gm}$$

A calculated value for cattle becomes  $3 \times 10^{-5} \mu\text{C/gm}$

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\* Our experimental value for effective combined half-life is about 4 days. This is compatible with a percent uptake ranging between 30% and 100%, with an average of about 65%.

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Human Permissible Exposure

The U.S. limit for  $I^{131}$  in drinking water is  $3 \times 10^{-5}$   $\mu\text{c/cc}$  with an assumed intake of 2,200 cc per day.

Permissible Daily intake =  $6.6 \times 10^{-2}$   $\mu\text{c}$ .

For vegetation at  $6 \times 10^{-5}$   $\mu\text{c/gm}$ ,

Permissible fresh vegetation intake = 1100 gm per day.

But this limit applies to "radiation workers".

For the public, we would not wish to accept more than 10% of this value.

.. Permissible vegetation intake = 110 gm per day.

Such intakes do not seem entirely infeasible in areas of market gardening.

Therefore, we prefer the present limit.

Permissible concentration on vegetation =  $10^{-5}$   $\mu\text{c } I^{131}$  per gram

Translation of Atmospheric Contamination

At this location, we prefer to work directly from the vegetation contamination for 4 reasons:

- (1) it is directly related to the principal hazard.
- (2) elementary sampling methods have adequate sensitivity.
- (3) a multiplicity of samples can be obtained with minimum equipment.
- (4) samples can be collected in public areas without alarming the residents.

The question posed by the United Kingdom source refers to the air concentration.

Under conditions similar to those in southeastern Washington, air contamination leads to  $I^{131}$  deposition on vegetation according to the empirical relation

$$\frac{I^{131} \text{ deposited } (\mu\text{c per gm per day})}{\text{Air concentration } (\mu\text{c per cc})} = \sim 7 \times 10^6$$

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Therefore, at equilibrium,

$$\frac{\text{Vegetation contamination } (\mu\text{c per gm})}{\text{Air concentration } (\mu\text{c per cc})} = 11.5 \times 7 \times 10^6 = 8.1 \times 10^7$$

which equals  $10^8$ , within the limits of accuracy.For vegetation at the recommended  $10^{-5} \mu\text{c/gm}$ ,

$$\text{Permissible air concentration} = 10^{-13} \mu\text{c I}^{131}/\text{cc}$$

This value may be in error by a factor of 5 for other regions.

As it stands, it is 4 orders of magnitude more restrictive than the "official" permissible concentration in air, and is 3 orders of magnitude more restrictive than a semi-official public exposure value. This is an outstanding example of the risk of making permissible exposure calculations from physical considerations only.

According to our calculations, the "official"  $3 \times 10^{-9} \mu\text{c/cc}$  of the handbooks leads to a daily intake in sheep of  $\sim 2500 \mu\text{c/day}$ . In our experiments,  $240 \mu\text{c/day}$  is extremely damaging to sheep.

#### Summary

1. In the present state of experimental work, sheep will be undamaged if fed  $5 \mu\text{c I}^{131}/\text{day}$ .

For safety, we set the limit at  $0.5 \mu\text{c I}^{131}/\text{day}$ .

2. The corresponding limit on vegetation is  $6 \times 10^{-5} \mu\text{c I}^{131}/\text{gm}$ .
3. Other animals may need somewhat smaller limits, and in any case this is uncomfortably close to causing worry about humans eating fresh garden produce.

4. Therefore, we use a working limit of  $10^{-5} \mu\text{c/gm}$ .

5. The corresponding limit for air contamination is not known precisely.

It is, in our experience over semi-arid range terrain, about  $10^{-13} \mu\text{c I}^{131}/\text{cc}$ .

6. In any case, it is some 3 or 4 orders of magnitude lower than the conventional breathing limit for humans.

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Summary - continued.

7. We anticipate that the final limit for sheep will be raised to about  $3 \times 10^{-4}$   $\mu\text{c/gm}$  vegetation.
8. Whether this could be used in the field will depend on experiments on other animals and on a "home economics" type of study on the actual hazard to humans. Plans for both these studies have been made here.

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