NOTICE

**CERTAIN DATA
CONTAINED IN THIS
DOCUMENT MAY BE
DIFFICULT TO READ
IN MICROFICHE
PRODUCTS.**

DECLASSIFIED

NW 13908

HW-13208

Classification Cancelled (Change to

DeclassifiedBy Authority of RLO-LG-4AE Eyzler 10-10-90O. Cleaver 11-6-90AV HK ETC 11-6-90Due to film deterioration,
portions of this document
may be illegible.

PNL 10-90

Copy # 1-O. V. Smiset
 2-O. M. Patterson
 3-W. M. Hart
 4-F. O. Tabb
 5-thru #8 - Extra
 9-700
 10-300
 11-Pink
 12-Yellow ←

MAY 28 1949

May 3, 1949

TO: O. V. Smiset

FROM: F. O. Tabb

300 AREA
 CLASSIFIED FILES

RE: IODINE CALCULATIONS FOR RALA PRODUCTION

The necessity of complete removal of all the radioactive isotopes of iodine was discussed in general terms in the document "Iodine Conditions In Connection with Rala Production" - Tabb, F. O. to Smiset, O. V., HW-12911. It is the purpose of this document to enlarge upon this phase of operation.

Present operation is concerned with I^{131} - 8 days half-life. The other iodine isotopes have much shorter half-lives and decay out during the cooling period. However, for the production of Rala, metal will be dissolved 24 to 48 hours after pile shutdown and the short half-lived isotopes must be considered from the primary source of direct fission. Another factor to be considered is the parent-daughter relationship between Te^{132} - half-life of 70 hours, and I^{132} resulting in a build-up of this isotope. The following table lists the curies per slug of the individual isotopes present:

Curies of Each Iodine Isotope Present

<u>Time</u>	<u>I^{131}</u>	<u>I^{132}</u>	<u>I^{132} from Te^{132}</u>	<u>I^{133}</u>	<u>I^{135}</u>	<u>Total</u>
0	71.5	96.6	0	120.5	180.5	439.0
3 Hrs.		40.0	99.7		110.5	
6		20.7	93.8		80.8	
9		7.1	91.8		69.5	
12		4.4	88.8	82.9	43.0	
18		1	85.4		23.5	
24	65.5		78.1	66.7	12.7	213.0

DECLASSIFIED

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

-2-

Curies of Each Iodine Isotope Present - Cont'd.

<u>Time</u>	<u>I¹³¹</u>	<u>I¹³²</u>	<u>I¹³² from I¹³¹</u>	<u>I¹³³</u>	<u>I¹³⁵</u>	<u>Total</u>
48	61.6		68.2	26.8	1.1	151.6
72	55.3		48.8	12.6		116.7
96	52.8		38.7	8.9		97.1
120	48.3		30.7	2.7		79.7
144	42.8		24.1	1.3		67.9
168	38.8		19.1			57.9
192	35.7		15.0			50.7

From the data presented in Table I, the percent of each isotope present may be calculated. This data appears in Table II.

Percent of Iodine Isotopes Present

<u>Time</u>	<u>I¹³¹</u>	<u>I¹³²</u>	<u>I¹³³</u>	<u>I¹³⁵</u>
24 Hrs.	30.7	36.3	26.8	8.9
48 Hrs.	40.8	41.0	17.7	0.7
72 Hrs.	47.4	41.6	10.8	-
96 Hrs.	54.2	40.0	6.1	-
120 Hrs.	58.2	38.5	3.4	-
144 Hrs.	62.7	35.8	1.9	-
168 Hrs.	67.0	33.0	-	-
192 Hrs.	70.4	29.6	-	-

The principle problem involved with the isotopes of Iodine is that of internal radiation effect to the thyroid. The intensity of this effect is based on the available beta energy, as the gamma energy is not absorbed by the thyroid tissue. The available beta energy differs in each of the isotopes, and so a tolerance figure must be calculated integrating the total energy present from the given percents of the isotopes present at any given time. Tolerance for I¹³¹ has been calculated, but is based on an exposure of 1 r per day. (Proposed Revision of Tolerance for I¹³¹-Parker, H.M. 7-3042.)

HW 13808

-8-

However, a new tolerance figure of 300 mrep per week is recommended by The National Committee on Radiation Protection. This calculation corrected for the new tolerance would be:

$$I^{131} - \lambda = \frac{.083}{8} = 0.007 \text{ day}$$

$$\text{Available energy} = .6x.36 = .21$$

$$Q_0 = \frac{26x10^6 \times .3}{61x2.1x10^6x7} = 0.094 \mu\text{c}$$

$$0.084x0.087 = 7.3x10^{-3} \mu\text{c}$$

$$7.3x10^{-3}x6 = 3.66x10^{-2} \mu\text{c}$$

$$\frac{3.66x10^{-2}}{6x10^3} = 4.66x10^{-6} \mu\text{c/l or}$$

$$4.66x10^{-16} \text{ curies/oo}$$

Using the same method the maximum permissible concentration of the other Iodine isotopes would be:

$$I^{132} - \lambda = \frac{.093}{1} = 0.093 \text{ day}$$

$$\text{Available energy} = 1.0 + 2.1 = 3.1$$

$$80\% \text{ of each present } \frac{3.1}{2} = 1.55$$

$$1.55 \times .36 = .542$$

$$Q_0 = \frac{26x10^6 \times .3}{61x6.42x10^6x7} = .0324 \mu\text{c}$$

$$.0324x6.93 = 2.24x10^{-1} \mu\text{c}$$

$$2.24x10^{-1}x6 = 11.3x10^{-1}$$

$$\frac{11.3x10^{-1}}{6x10^3} = 1.4x10^{-4} \mu\text{c/l or}$$

$$1.4x10^{-13} \text{ curies/oo}$$

$$I^{133} - \lambda = \frac{.093}{.92} = .783 \text{ day}$$

$$\text{Available Energy} = 1.3x.36 = .43$$

$$Q_0 = \frac{26x10^6 \times .3}{61x4.3x10^6x7} = 0.0416 \mu\text{c}$$

DECLASSIFIED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

-4-

$$0.0415 \times 0.753 = 0.0312 \mu\text{e}$$

$$0.0312 \times 8 = .156 \mu\text{e}$$

$$\frac{.156}{8 \times 10^3} = 1.9 \times 10^{-5} \mu\text{e/l or}$$

$$1.9 \times 10^{-14} \text{ curies/cc}$$

$$I_{135} = \frac{.083}{.278} = 2.5$$

$$\text{Available Energy} = 1.4 \times .35 = .45$$

$$Q_D = \frac{25 \times 10^6 \times .3}{61 \times 4.0 \times 10^6 \times 7} = 0.0395 \mu\text{e}$$

$$0.0395 \times 2.5 = .1 \mu\text{e}$$

$$.1 \times 8 = .8 \mu\text{e}$$

$$\frac{.8}{8 \times 10^3} = 6.25 \times 10^{-5} \mu\text{e/l or}$$

$$6.25 \times 10^{-14} \text{ curies/cc}$$

The integrated maximum permissible concentration may be calculated by substituting the values for any given time in the following equation:

$$T = \frac{1}{\frac{2I_{131}}{t_1} + \frac{2I_{132}}{t_2} + \frac{2I_{133}}{t_3} + \frac{2I_{135}}{t_4}}$$

Where: T is the integrated maximum permissible concentration

t_1 is the maximum permissible concentration of I_{131}

t_2 is the maximum permissible concentration of I_{132}

t_3 is the maximum permissible concentration of I_{133}

t_4 is the maximum permissible concentration of I_{135}

The percentage of each isotope present at any given time is shown in Table II. From this data the following maximum permissible concentrations have been calculated:

<u>Time</u>	<u>Maximum Permissible Concentration</u>
24	1.18×10^{-14} curies/cc
48	9.69×10^{-15} curies/cc
72	8.9×10^{-15} curies/cc
96	8.04×10^{-15} curies/cc
120	7.86×10^{-15} curies/cc
144	7.12×10^{-15} curies/cc
168	6.7×10^{-15} curies/cc
192	6.4×10^{-15} curies/cc

The number of curies of the iodine isotopes necessary to give the maximum permissible concentration may be calculated as follows:

$$\begin{aligned} \text{Curies of I} = & \text{Maximum Permissible Concentration} \times \text{Dissolving} \\ & \text{time in minutes} \times \text{Dilution Factor of top of} \\ & \text{stack to ground} \times \text{Air Flow up the stack} \times \\ & \text{Conversion factor from ft}^3 \text{ to cc} \end{aligned}$$

This data is shown in Table III, along with the total number of curies of iodine present. It can be seen from this that if the dissolving takes place 48 hours after Pile shutdown only 11.89 curies of the total 42,600 curies available can be emitted from the stack using 58,880 cu. ft. of air flow, a stack to ground dilution factor of 10^3 and a dissolving time of 12 hours.

TABLE III

<u>Time</u>	<u>Total Curies I Present</u>	<u>Max. Per. Conc.</u>	<u>Tot. Curies to produce Max. Per. Conc.</u>
24	89,800	1.18×10^{-14}	14.14
48	42,600	9.69×10^{-15}	11.89

-6-

TABLE IX - Cont'd.

Time	Total Curies I Present	Max. Per. Conc.	Tot. Curies to produce Max. Per. Conc.
72	32,800	8.9×10^{-15}	10.82
96	27,300	8.04×10^{-15}	9.79
120	22,400	7.56×10^{-15}	9.32
144	19,100	7.12×10^{-15}	8.69
168	16,300	6.7×10^{-15}	8.16
192	14,200	6.4×10^{-15}	7.80

F. O. Tamm
F. O. TAMM

END

DATE FILMED

12 / 03 / 90