BEST AVAILABLE COPY

U[redacted]DECLASSIFIED

[redacted]

(CLASSIFICATION)

HANFORD TECHNICAL RECORD

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DOCUMENT NO.

HW-66026

SERIES AND COPY NO.

[redacted] [redacted]

DATE

September 1, 1960

TITLE

T D

MPC'S FOR INGESTION OF RARE EARTHS
IN COLUMBIA RIVER WATER

[redacted] CONTAINS RESTRICTED [redacted] 1954. ITS TRANS[redacted]TS CONT[redacted] MANNER TO AN UNAUTHORIZED [redacted]

☐ OTHER OFFICIAL CLASSIFIED INFORMATION

THIS MATERIAL CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U. S. C., SECS. 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

AUTHOR

M. W. McConiga

CIRCULATING COPY
RECEIVED 300 AREA
SEP 1 3 1960
RETURN TO
TECHNICAL INFORMATION FILES

[redacted] LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE [redacted]S [redacted]ED GUARDED AREA. WHILE IT IS YOUR POSS[redacted]SIGNED RECEIPT FROM CLASSIFIED FILES, IT IS YOUR[redacted] OF THIS PROJECT AND [redacted] PERSON. ITS TRANSMITTAL TO, AND STORAGE [redacted]CE [redacted]ED, [redacted] RELATED ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE [redacted] TO SIG[redacted] SPACE PROVIDED BELOW.

ROUTE TO:	PAYROLL NO.	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE
~~P. C. Jermen~~	~~356~~	~~1209 H~~	SEP 14 '60	[illegible]
~~R. B. Hall~~				[illegible]
[illegible]	12429		MAR 7 - 1962	[illegible] 11-15-62
~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	[illegible]	
[redacted]				

RECORD COPY

THIS DOCUMENT IS PUBLICLY AVAILABLE

w/ll

Indefinite Retention

Disposal Date

DECLASSIFIED

C-3195-MS (7 - 55) A.E.C.-G.E.-RICHLAND, WASH.

Authority

[redacted] [redacted]

(CLASSIFICATION)

[redacted] [redacted]

HW-66026

DECLASSIFIED

DISTRIBUTION

1 - F. E. Holt - P. O. Jackson
2 - P. C. Jerman - R. B. Hall
3 - R. L. Junkins - I. C. Nelson
4 - A. R. Keene
5 - M. W. McConiga - G. D. Brown
6 - J. M. Nielsen - W. B. Silker
7 - A. J. Stevens
8 - J. W. Vanderbeek
9 - 300 File
10 - Record Copy

This document consists of 8 pages, ~~[redacted] of 10 copies,~~ [redacted]

September 1, 1960

Classification Cancelled (Change to UNCLASSIFIED)
By Authority of TID-1381 Suppl 12-31-71
By L. Pope 4/26/72

MPC'S FOR INGESTION OF RARE EARTHS IN COLUMBIA RIVER WATER

by

M. W. McConiga

Environmental Monitoring
Radiation Monitoring Operation
Hanford Laboratories Operation

SPECIAL RE-REVIEW
FINAL DETERMINATION
DECLASSIFICATION CONFIRMED
BY [signature] DATE 8-25-81
BY [signature] DATE 9-11-81

[redacted]

This document contains restricted data as defined in the [redacted] dis- c[redacted] contents in any manner to an ~~unauthorized~~ person is [redacted]

[redacted]

DECLASSIFIED

THIS DOCUMENT IS PUBLICLY AVAILABLE

[redacted] DECLASSIFIED [redacted]

MPC'S FOR INGESTION OF RARE EARTHS IN COLUMBIA RIVER WATER

Introduction

Radioactive rare earths and other radionuclides are discharged into the Columbia River in cooling water from the HAPO reactors. Two analyses of the quantities and relative abundances of nuclides of the rare earth and yttrium analytical group in reactor effluent were started in October, 1956[1]. Provisional MPC's for the rare earth group in drinking water derived from the Columbia River were established from the analyses based on individual rare earth MPC's of National Bureau of Standards Handbook 52 and the HAPO Radiation Protection Standards, HW-25457 Rev. 1.

A third analysis was begun in April, 1960[2] to determine if relative abundances of rare earth nuclides in reactor effluent had changed with operational changes. MPC's for the rare earth mixture in drinking water were calculated from isotopic concentrations of the 1960 analysis and MPC's of NBS Handbook 69.

Summary

Results of the 1960 analysis plus a recalculation from corrected isotopic concentrations of the 1956 analyses indicate that limits in use since 1956 for rare earths in drinking water (GI tract, 3×10^{-4} μc/cc; bone, 0.5 μc/cc) are more restrictive than necessary and limits nearer the calculated values are recommended as follows: GI tract, 4×10^{-4} μc/cc and bone, 0.6 μc/cc.

Discussion

The 1960 analysis was made on a composite of effluent from six operating reactors rather than from single reactors as was done previously. Some of the nuclides could not be measured directly but were estimated from cross section and relative

 DECLASSIFIED [redacted]

abundance data using logical irradiation and decay periods. Except for terbium-160, no rare earths heavier than europium were identified and beta decay components were ascribed to the yttrium nuclide with a similar half-life. Since some of the beta components may have been partly caused by heavy rare earths, there is a possibility of error, however not of a magnitude which would significantly alter MPC's. The components concerned were of the order of 10^{-7} μc/cc.

Results

The following listings compare an average of two previous analyses and the most recent analysis as to number of rare earth nuclides detected, their concentrations, and in the latter case, the analyst's estimate of the maximum range of error.

TABLE I

	Average of Reactor Effluent Analyses October 1956	Analysis of Reactor Effluent Completed June 1960	
Isotope	Concentration Times 10^{-6} μc/cc at 24 Hours After Discharge From Reactor	Concentration Times 10^{-6} μc/cc at 24 Hours After Discharge From Reactor	Maximum Estimated Error
Y^{90}	2.2	3.5	± 50%
Y^{91}	0.35	1.1	+ 25% - 90%
Y^{92}	0.4	0.55	+ 50% - 100%
Y^{93}	2.9	2.7	+ 50% - 100%
La^{140}	3.4	13.0	± 15%
La^{141}	0.24	-	-
Ce^{141}	0.8	5.2*	± 25%
Ce^{143}	1.1	1.4	± 25%
Ce^{144}	-	2.6	± 25%
Pr^{142}	0.8	3.6	± 30%
Pr^{143}	0.25	1.8	± 15%
Pr^{145}	0.25	0.23	± 30%
Nd^{147}	0.37	0.57	± 30%
Pm^{149}	0.2	0.13*	± 100%
Pm^{151}	0.1	-	-
Sm^{153}	6.7	9.9	± 15%
Sm^{156}	0.5	-	-
Eu^{152} (9.3 h)	1.9	17.0	± 25%
Eu^{152} (13 y)	0.006	0.76*	± 50%
Eu^{154}	0.0003	0.03*	-
Eu^{155}	0.015	0.4*	-
Eu^{156}	0.25	6.3*	± 30%
Eu^{157}	1.3	1.8	± 100%
Tb^{160}	-	0.35	± 25%

* Denotes isotopes not measured directly.

[redacted] [redacted]

DECLASSIFIED

Interpretation

Rare earth group MPC's were calculated from the 1956 analyses as 3.6×10^{-4} μc/cc for the GI tract and 0.65 μc/cc for bone. A lower set of MPC's, recommended to allow for variations in isotopic ratios, etc., and used since 1956, were 3.0×10^{-4} μc/cc for the GI tract, and 0.5 μc/cc for bone.

The Y^{90} concentration reported on the analyses was later found to be four times too high. When recalculated, the MPC_{Bone} changed only slightly, but the MPC_{GI} changed from 3.6×10^{-4} μc/cc to 4.6×10^{-4} μc/cc.

Rare earth group MPC's calculated in Table 2 from the 1960 analyses are 3.8×10^{-4} μc/cc for the GI tract and 0.56 μc/cc for bone. MPC's for other organs of possible interest, kidney and total body, are also shown in Table 2.

The comparative analyses in Table I and the decay curves in Figure 1 indicate that there has been no great change in the concentrations of rare earth nuclides in the effluent from the HAPO reactors between 1956 and 1960. No change in limits is necessary on that basis. However, it is recommended that the MPC's adopted and in use since 1956 be changed to coincide more nearly with calculated limits. The recommended MPC's for rare earths in drinking water derived from the Columbia River are: GI tract: 4×10^{-4} μc/cc
bone: 0.6 μc/cc

DECLASSIFIED

[redacted]

DECLASSIFIED [redacted]

TABLE 2

CALCULATED DRINKING WATER MPC'S FOR THE RARE EARTH GROUP IN REACTOR EFFLUENT AGED 24 HOURS

Rare Earth Isotope	NBS Handbook 69 MPC's x 10^{-6} μc/cc				Isotopic Concen. x 10^{-6} μc/cc	$\frac{C}{\Sigma C}$	$\frac{C/\Sigma C}{MPC_{GI}}$	$\frac{C/\Sigma C}{MPC_{Bone}}$	$\frac{C/\Sigma C}{MPC_{Total\ Body}}$	$\frac{C/\Sigma C}{MPC_{Kidney}}$
	GI	Bone	Total Body	Kidney						
Y^{90}	200	4,000,000	30,000,000	--	3.5	.04799	240.	.01199	.00159	--
Y^{91}	300	300,000	2,000,000	--	1.1	.01508	50.3	.05026	.00754	--
Y^{92}	600	40,000,000	300,000,000	--	0.55	.00754	12.6	.00018	.00002	--
Y^{93}	300	20,000,000	90,000,000	--	2.7	.03702	123.	.000185	.00041	--
La^{140}	200	20,000,000	20,000,000	--	13.0	.1783	892.	.00891	.00891	--
Ce^{141}	900	5,000,000	10,000,000	7,000,000	5.2	.07131	79.	.01426	.00713	.01018
Ce^{143}	400	20,000,000	50,000,000	40,000,000	1.4	.01919	48.	.00095	.00038	.00047
Ce^{144}	100	80,000	300,000	200,000	2.6	.03565	357.	.44187	.11883	.17825
Pr^{142}	300	30,000,000	90,000,000	60,000,000	3.6	.04936	164.5	.00164	.00054	.00082
Pr^{143}	500	4,000,000	10,000,000	9,000,000	1.8	.02468	49.4	.00617	.00246	.00274
Pr^{145}	---	238,000	---	--	0.23	.00315	--	.01323	--	--
Nd^{147}	600	6,000,000	10,000,000	5,000,000	0.57	.00781	13.	.00130	.00078	.00156
Pm^{149}	400	20,000,000	50,000,000	40,000,000	0.13	.00178	4.45	.00008	.00003	.00004
Sm^{153}	800	50,000,000	100,000,000	80,000,000	9.9	.1358	170.	.00271	.00136	.00169
Eu^{152}(9.3 h)	600	90,000,000	200,000,000	100,000,000	17.0	.2331	389.	.00259	.00116	.00233
Eu^{152}(13 y)	800	200,000	200,000	90,000	0.76	.0104	13.	.05200	.05200	.11555
Eu^{154}	200	30,000	80,000	30,000	0.038	.00052	2.6	.01733	.00650	.01733
Eu^{155}	2000	800,000	1,000,000	700,000	0.4	.00548	2.74	.00685	.00548	.00782
Eu^{156}	--	66,666	--	--	6.3	.0864	--	1.1296	--	--
Eu^{157}	--	2,000,000	--	--	1.8	.0247	--	.0124	--	--
Tb^{160}	400	800,000	1,000,000	1,000,000	0.35	.0048	12.	.0060	.00480	.00480
					ΣC = 72.92		2610.6	1.78	.2199	.34358

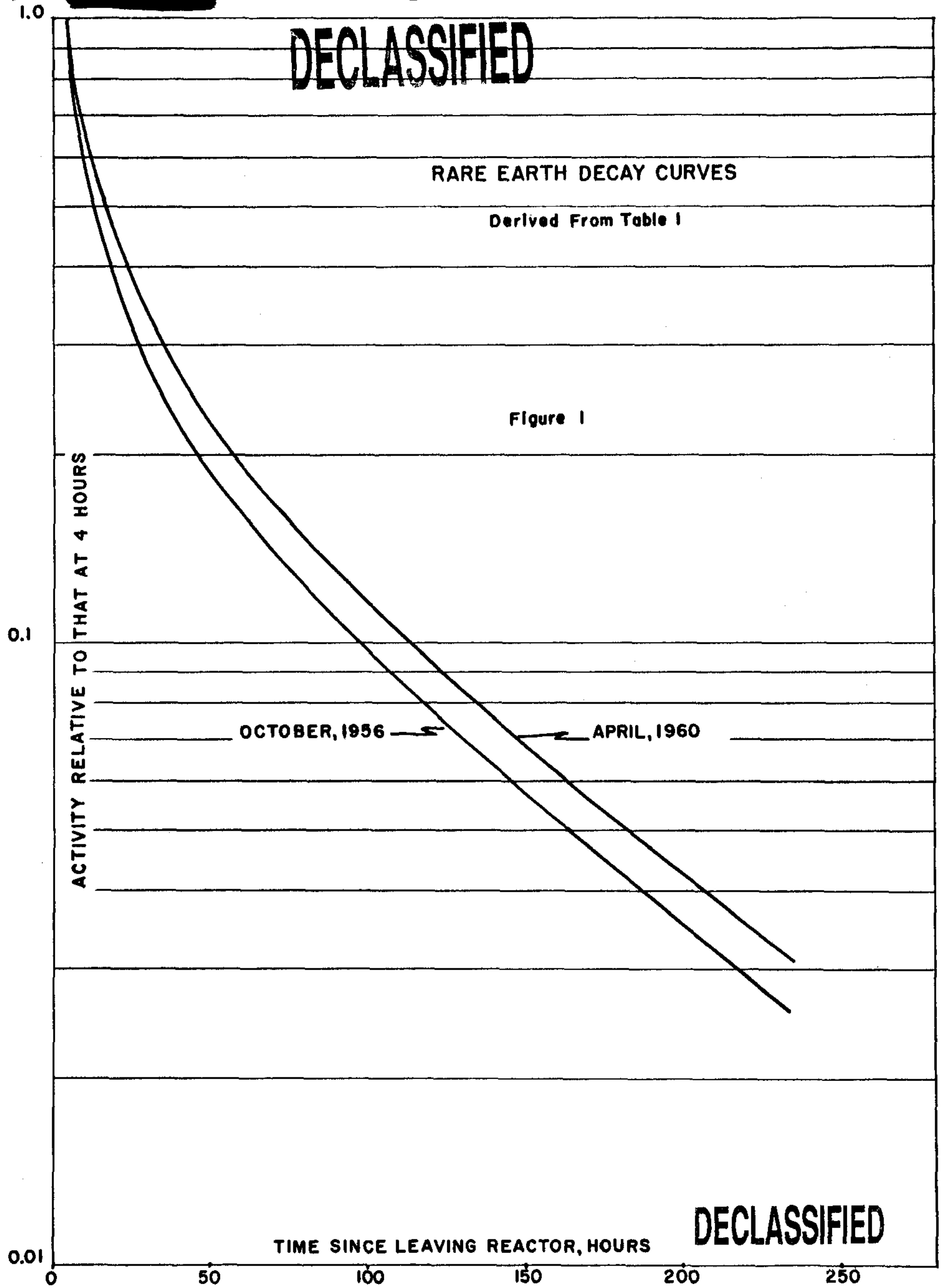
MPC_{GI} is $\frac{-1}{2611}$ = 3.8 x 10^{-4} μc/cc

$MPC_{Total\ Body}$ is $\frac{1}{.2199}$ = 4.5 μc/cc

MPC_{Bone} is $\frac{1}{1.78}$ = 0.56 μc/cc

MPC_{Kidney} is $\frac{1}{.344}$ = 2.9 μc/cc

DECLASSIFIED [redacted]



RARE EARTH DECAY CURVES

Derived From Table I

Figure I

[redacted]

BIBLIOGRAPHY

1. Silker, W. B., and L. J. Kirby - Separation and Determination of Radioactive Rare Earths in Reactor Effluent Water. HW-48021 (Declassified), January 7, 1957.

2. Jackson, P. O. - Rare Earth Analysis on a Composite Reactor Effluent Water Sample. HW-66015 (Confidential-Undocumented), June 17, 1960.