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CHEMISTRY—RADIATION
AND RADIOCHEMISTRY

UCC

POST OFFICE BOX P
OAK RIDGE, TENNESSEE

DATE: July 17, 1956

SUBJECT: Zirconium-95 as a Fission Monitor

TO: M. T. Robinson

FROM: W. A. Brooksbank

CLASSIFICATION CANCELLEDDATE MAR 13 1957 *jet*

For The Atomic Energy Commission

H. P. Caneel
Chief, Declassification Branch**LEGAL NOTICE**

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At your request, a study was undertaken to determine the feasibility of using Zr-95 (instead of Cs-137) as a fission monitor. Two samples of enriched uranium were irradiated as solutions for 2.375 d in Hole 10, graphite reactor. They were allowed to decay for 10 days before analysis. Cesium-137 was determined by the perchloric acid method. The separated activity mounts were compared with the Argonne Cs-137 primary standards. The data is given below.

Cs-137 c/m (ccy) / 100 λ of original solutions

Sample # 1-1	4723	Sample # 2-1	16,687
-2	4592	-2	15,987
-3	4632	-3	15,791
-4	4652	-4	15,427
	<u>Average 4650 c/m</u>		<u>Average 15973</u>

Primary Cs-137 standards from Argonne 2.42×10^{13} fissions (5-56)

#1 6173

#3 6202

Average 6186 c/m

#4 6182

All counts are second shelf, G-M #91, E. I. Wyatt, Standard Factor 0.994.

Sample #1 $\frac{2.42 \times 10^{13}}{6186} \times 4.65 \times 10^4 = 1.82 \times 10^{14}$ fissions/ml

Sample #2 $\frac{2.42 \times 10^{13}}{6186} \times 1.597 \times 10^5 = 6.25 \times 10^{14}$ fissions/ml

Zirconium-95 was separated and gamma counted through the lead absorber.

The data is given below:

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Zr-95 separated from two solutions.

c/n (ccy)

Sample #1-1	36,566	c/n/ml at 1440 6-14-56	d/n/ml at 0 time
-2	36,909 Ave. 36382	dil. factor $0.1/5 \times 1/10 \times 1$	
-3	36,324	(500)	8.94×10^7 d/n/ml
-4	35,729	1.82×10^7 c/n/ml	

Sample #2-1	5946	c/n/ml at 1440 6-14-56	
-2	---- Ave. 5958	dil. factor $0.05/5 \times 1/100 \times 1$	
-3	5784	(10^4)	
-4	6145	5.96×10^7 c/n/ml	2.93×10^8 d/n/ml

γ counts - E. I. Wyatt scintillation counter through lead absorber,
corrected for standard factor.

$$d/n = \frac{0.941 \times ccb}{0.214}$$

From the growth equation below the fission yield (fy) can be
calculated:

$$A = N \times f \times \sigma \times s \times fy$$

Experiment #1	95% enriched	0.878 ng U/ml	7.35×10^{11} n/sec/cm ² from Co-60
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$$fy = \frac{(1.49 \times 10^6)(235)}{(8.78 \times 10^{-4})(0.95)(6.02 \times 10^{23})(7.35 \times 10^{11})(580 \times 10^{-24})(2.53 \times 10^{-2})} = .0647$$

Experiment #2	93% enriched	3.144 ng U/ml	7.35×10^{11} n/sec/cm ² from Co-60
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$$fy = \frac{(1.88 \times 10^6)(235)}{(3.144 \times 10^{-3})(0.93)(6.02 \times 10^{23})(7.35 \times 10^{11})(580 \times 10^{-24})(2.53 \times 10^{-2})} = .0604$$

Average 0.0626

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Using the absolute value of the fission yield obtained above,
the number of fissions/ml are:

$$\text{Experiment \#1} \quad \frac{(8.79 \times 10^7)(2.375 \times 24 \times 60)}{(0.0626)(2.53 \times 10^{-2})} = 1.94 \times 10^{14}$$

$$\text{Experiment \#2} \quad \frac{(2.93 \times 10^8)(2.375 \times 24 \times 60)}{(0.0626)(2.53 \times 10^{-2})} = 6.32 \times 10^{14}$$

As a further check, and to compare directly with the Cs-137
primary standards.

$$\text{Experiment \#1} \quad \frac{(8.97 \times 10^7)(2.375 \times 24 \times 60)}{(x)(2.53 \times 10^{-2})} = 1.82 \times 10^{14} = 0.0666$$

$$\text{Experiment \#2} \quad \frac{(2.93 \times 10^8)(2.375 \times 24 \times 60)}{(x)(2.53 \times 10^{-2})} = 6.25 \times 10^{14} = 0.0634$$

$$\text{Average} = 0.065$$

Based on available data, I recommend the last value be used
in the determination.

W. A. Brooksbank, Jr.
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