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ABSTRACTS

Colorimetric determination of Zirconium in Thorium-Zirconium Alloys

A modification of a commonly-used procedure for the determination of zirconium is presented. Zirconium is precipitated with p-dimethyl-amino asophenylarsonic acid, and the red color of a hydrochloric-hydrofluoric acid solution of the precipitate is measured spectrophotometrically.

Determination of Uranium with Dibenzoylmethane (p. 8-9) *R. E. Meyer*

In connection with the separation of uranium with tributyl phosphate, it is desirable to determine the uranium content directly in the organic phase. The use of dibenzoylmethane is being investigated. The reagent is highly sensitive and selective. Fifty micrograms of uranium were determined in the presence of milligram quantities of diverse ions.

The Preparation and Testing of Spectrographic Gallium Oxide Standards

Spectrographic gallium oxide standards have been prepared and their suitability determined for use as standards for gallium metal analysis.

Radiometric Measurements (p. 12-15) *R. E. Meyer*

The gamma ray method for the determination of U^{235} is under consideration. Preliminary measurements indicate that using a gamma ray spectrometer, the U^{235} content could be measured to 1% by measurement of the 0.184 Mev gamma radiation.

Mass Spectrometry (p. 16) *J. Hasson*

A mass spectrometer is being modified for the analysis of U^{235} . A resolution has been obtained to adequately measure masses 330 and 333.

Neutron Activation Analyses (p. 17) *D. Hanson*

The neutron source has been utilized for the routine analysis of U^{235} .

The Instrumentation of Uranium and Nitric Acid Analyses

Uranium pilot plant feed solutions were polarographically measured using a sulfuric acid-sodium-sulfate medium. Molybdenum and vanadium interfere in this medium. At a uranium concentration of 1 g/l an error of several percent was obtained on the process solutions.

The method of proportionating the polarographic medium and the

uranium process solution is still under study.

Vanadium Distribution Study

The vanadium distribution between 25% tributyl phosphate and 5 N nitric acid for the range 0.34 to 5.5 g/l vanadium was found to be 0.00037 ± 0.00005 . In the presence of uranium, the distribution was unaffected.

Nitric Acid Insoluble and Uranium Determinations from the Acid Insolubles of Uranium Feed Materials

Results of the uranium content of the nitric acid insoluble obtained from various uranium feed materials are tabulated. From less than 0.01 to 0.07 percent of the total uranium is contained in the nitric acid insoluble based on the original sample.

Reactivity of Uranium Trioxide

Several samples of Mallinckrodt uranium trioxide were tested for use as a reactivity standard. Substantially the same reactivity was found for the samples and one was selected for packaging and distribution.

Radium Analysis

Synthetic standards were prepared to permit self-absorption corrections to be made in the gamma ray-method of radium analysis. The method of preparation of the standards is presented.

Standards Program, Thorium Metal

Analyses are continuing for the uranium, carbon and nitrogen content of a proposed thorium metal standard.

UNCLASSIFIED REPORTS AND PUBLICATIONS

NEL 108 "Separation of Rare Earths from Thorium Nitrate"

NEL 117 "Quarterly Progress Report for the Period Ending
June 30, 1955 - Unclassified Section"

Eberle, A. R., M. W. Lerner and G. J. Petretic, "Determination of
Oxygen in Calcium Metal", Anal. Chem. 27, 1431-3 (1955)

Eberle, A. R. and M. W. Lerner, "Separation and Determination of
Scandium; Spectrophotometric Method Using Alizarin Red S",
Anal. Chem. 27, 1551-4 (1955).

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in Glass", Anal. Chim. Acta 13, 439 (1955).

COLORIMETRIC DETERMINATION OF ZIRCONIUM IN THORIUM-ZIRCONIUM ALLOYS

A. R. Eberle, L. J. Pinto and M. W. Lerner

The applicability of p-dimethylaminoazophenylarsonic acid to the colorimetric determination of zirconium in thorium-zirconium alloys containing from 0.05 to 2 percent zirconium has been studied. The procedure commonly used with the reagent¹⁻⁵ has been modified. A complete report of this study is in the process of preparation.

Zirconium is precipitated with p-dimethylaminoazophenylarsonic acid and the precipitate is dissolved in hydrochloric-hydrofluoric acid to yield a red solution. The color intensity of the solution is measured spectrophotometrically. The effects of pH, thorium and reagent concentration on the precipitation of the zirconium azo-arsenate were investigated and the optimum conditions were established for the analysis of thorium-zirconium alloys.

Typical results on the analysis of synthetic thorium-zirconium samples are tabulated in Table 1.

TABLE 1

ANALYSIS OF SYNTHETIC THORIUM-ZIRCONIUM SAMPLES

<u>Zirconium Present, %</u>	<u>Zirconium Found, %</u>
0.050	0.050
0.100	0.100
0.200	0.208
0.500	0.502
0.800	0.812
1.00	1.00
1.50	1.51
2.00	1.98

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DETERMINATION OF URANIUM WITH DIBENZOYLMETHANE

M. W. Lerner and A. R. Eberle

Dibenzoylmethane, a recently described¹⁻² colorimetric reagent for uranium, has been found to be a selective and sensitive reagent for the determination of uranium in a large variety of materials when it is used in conjunction with a tributyl phosphate separation. The customary procedure in the tributyl phosphate separation of washing the uranium out of the tributyl phosphate before determination has been eliminated by developing the color directly in the organic phase. Quantities of uranium down to 0.1 microgram per milliliter of extractant can be determined.

A tributyl phosphate-ethyl acetate (70:30) extraction is made from a 5 N nitric acid solution of the sample. The organic phase is washed with 5 N nitric acid to remove all impurities except thorium and zirconium. The acid in the organic phase is neutralized and the color is developed by the addition of dibenzoylmethane.

The interference due to zirconium can be eliminated by developing the color in the presence of calcium versenate. Thorium is separated by extracting the uranium from a 7.5 M hydrochloric acid solution of the sample and by washing the organic phase with 7.5 M hydrochloric acid prior to the basic procedure³.

Synthetic solutions containing definite amounts of diverse ions and 50% of uranium as uranyl nitrate were analyzed with the results shown in Table 1. The quantities of impurities used were selected arbitrarily; they are not maximum quantities.

REFERENCES

1. Yoe, J. H., F. Will, and R. A. Black, Anal. Chem., **25**, 1200 (1953).
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TABLE 1

RECOVERY OF URANIUM IN THE PRESENCE OF DIVERSE IONS

<u>Impurity</u>	<u>U Added, γ</u>	<u>U Found, γ</u>
250 mg. each of Be, Mg, Ca, Sr, Cd, 10 mg. of Ba	50	49,50
100 mg. each of Hg(II), Mn(II) Bi, Ag	50	48,48
10 mg. each of Y, Ce (III), La, Ga, Sm, In, Sc	50	52,51
25 mg. MoO ₄ ⁻⁻	50	48,48
50 mg. each of VO ₃ ⁻ , Co, Ti	50	49,49
250 mg. each of Ni, Pb, Zn	50	50,49
250 mg. Fe (III)	50	50,50
250 mg. Cr (III)	50	48,49
5 mg. ZrO ⁺⁺	50	48,50
250 mg. Th	50	47,48

THE PREPARATION AND TESTING OF SPECTROGRAPHIC GALLIUM OXIDE STANDARDS

H. G. Yuster

Work has been completed on the preparation and testing of gallium oxide standards.

Table 1 lists the impurity elements and their concentrations, based on gallium metal, in four standards designated A, B, C, and D. Standard A, also called the master standard, was prepared by adding the impurities in solution form to dry purified gallium oxide. After completing the addition of all impurity elements, the master standard was dried in an oven at 105°C and finally ignited in a furnace at 700°C for a period of one hour. The resulting standard was then thoroughly ground and mixed in an agate mortar until homogenous. Standard A was then used to prepare the three remaining standards by dilution with pure gallium oxide base material. The preparations of the master standard and the base material were carried out in platinum.

TABLE 1

IMPURITIES IN GALLIUM OXIDE STANDARDS

Element	Concentration in ppm			
	A	B	C	D
Fe	1000	500	200	100
Zn	1000	500	200	100
Al	200	100	40	20
Mg	200	100	40	20
Mo	200	100	40	20
Na	200	100	40	20
Pb	200	100	40	20
Sn	200	100	40	20
Li	100	50	20	10
B	10	5	2	1
Be	4	2	0.4	0.2

Smooth analytical curves were obtained from average values of five separate determinations on each standard. Very briefly, the method involved a direct current arc burn of 7 mg. charge consisting of two-thirds sample and one-third graphite.

Table 2 contains a tabulation of the wave lengths of the analytical lines used in the work on the standards.

TABLE 2
SPECTROCHEMICAL ANALYTICAL DATA

<u>Element</u>	<u>Line</u>	<u>Internal Standard</u>	<u>Analytical Range (ppm)</u>
Fe	3047.60	3004.06	50-2000
Zn	3345.02	-	50-2000
Al	3082.15	3004.06	50-400
Al	3961.52	3004.06	10-400
Mg	2802.69	2691.29	10-400
Mo	3170.34	3004.06	10-400
Pb	2833.06	3004.06	10-400
Sn	3175.01	3004.06	10-100
Be	2348.61	2691.29	0.5-4.0
B	2497.73	Visual	2-20
Li	6707.84	Visual	2-20
Na	5895.92	Visual	10-400

RADIOMETRIC MEASUREMENTS

R. C. Meyer

Uranium Isotopic Analysis by Gamma-Ray Measurements

In analyzing the gamma ray spectra of uranium samples of various isotopic compositions it was noticed that the 0.090 and 0.184 Mev peak heights varied. This prompted an investigation of this variation for isotopic analysis of uranium. Work along this line has been referred to in another publication¹; however no details are given.

The portions of the decay schemes² of interest for uranium, are given in Table 1. This decay scheme indicated that the 0.184 gamma radiation of U^{235} would permit the determination of U^{235} since it is the only radiation of that energy. If measurements are made soon after ether extraction there will be very little interference from the 2.5 Mev beta of UX_2 . However, as UX_2 grows in the base line of the 0.184 Mev gamma increases and so does the top of the 0.184 peak. As long as the time of extraction is known a correction can be applied.

A Gamma-Ray Single-Channel Scintillation Spectrometer with a NaI crystal was used for gamma ray measurement. Both a rate meter and a scaler were used for determining the counting rate.

All samples used were in the form of U_3O_8 which had been purified by ether-extraction. A Lusteroid test tube or a square bottom $3/4$ " by $3/4$ " plastic pill box is used to hold the sample of exactly 500 mg. The pill boxes were used because there was less self-absorption due to a thinner layer of sample. This increased the count over those obtained in test tubes by 50%.

First an attempt was made to filter out the UX_2 betas. Using the rate meter, runs were made with no filter, with 617 mg/cm² of lead, and with 1234 mg/cm² of lead. While the betas were almost eliminated with the 1234 mg/cm² absorber the weak 0.184 gamma peak was reduced to such an extent that filtration was not useful for the size sample being used. All further studies were made with no filter.

To indicate the U^{235} composition, the counting rate of a 500-mg. sample was used. This counting was based only on the 0.184 Mev peaks. With improvements on the present counting equipment it appears that uranium of normal U^{235} content could be measured with a precision of 1%.

A block diagram of the apparatus is shown in Figure 1.

TABLE 1
SIGNIFICANT DECAY PRODUCTS OF U^{238} AND U^{235}
(Energies in Mev)

	U^{238} , 4.5×10^9 y	U^{235} , 7.1×10^8 y
α	4.2	4.4
γ	0.05	0.09, 0.14, 0.184*, 0.29, 0.36
	UX_1 , 24.1d	UY , 25.6h
β	0.2	0.02
γ	0.09	0.06, 0.085*, 0.11, 0.12, 0.17, 0.21, 0.23
	UX_2 , 1.1m	
β	2.5	
γ	0.39, 1.5	
	U^{234} , 2.5×10^5 y	Pa^{231} , 3.4×10^4 y
α	4.8	5.0
γ	0.05, 0.10, 0.12	0.04, 0.06, 0.08, 0.10, 0.20, 0.26, 0.30, 0.33, 0.36, 0.38
	Th^{230}	Ac^{227}

*strongest

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FIGURE 1. BLOCK DIAGRAM FOR DETECTION SYSTEM

Alpha Energy Ionization Chamber

A Frisch Grid Alpha Ionization Chamber is being fabricated. This type of chamber should have a resolution of 2% or better and an efficiency of 30 - 40%.

The chamber being built is similar to that reported by J. Howard Parsons³.

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3. Parsons, J. H., Mon-C-416 (1947).

MASS SPECTROMETRY

J. Hasson

A Nier Isotope Ratio Mass Spectrometer made by the Consolidated Engineering Corporation has been modified to extend its mass range to substances with an m/e of greater than 300.

NEUTRON ACTIVATION ANALYSES

D. Aaron

About one hundred samples of uranium material of widely varying isotopic content were analyzed for their uranium 235 content by the neutron activation technique described in previous reports ^{1,2,3}.

In the past the analytical method had been applied only to material of low uranium 235 content. Currently, samples are being received which vary in isotopic composition over a wide range. As in the case of the materials of low uranium 235 content, the specific activity of the uranium samples of high uranium 235 content was found to be proportional to the amount of uranium 235 contained.

A change in the original equipment was made in order to minimize the influence of strong beta and weak gamma radiations resulting from the activation, namely, the use of a lead cask 1 mm. in thickness as a filter for the sample tube.

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3. Meyer, R. C. and J. E. Hudgens, NYO-2042 (1954) p. 21-24.

THE INSTRUMENTATION OF URANIUM AND NITRIC ACID ANALYSES

H. W. Bertram and E. S. Roszkowski

The study of the continuous polarographic determination of uranium in process streams^{1,2} has been continued. The work on the removal of the interference of molybdenum and vanadium on the polarographic wave of uranium included a more extensive study of the sulfate medium. Various ratios of H_2SO_4 and Na_2SO_4 (from 0 to 1.0 molar of each) were used, keeping the sulfate ion concentration constant. These media were used to study the uranium wave and the effect of adding Mo, V and HNO_3 . The tests revealed a minimum overall interference at a 0.2 molar hydrogen ion concentration. For further studies, therefore, a medium of 0.1 molar H_2SO_4 , 0.1 molar Na_2SO_4 and $4 \times 10^{-4}\%$ thymol was used.

Calibration curves were made for this medium using both pure uranium and the three ore feed samples previously described². These curves are shown in Figure 1 and indicate that at uranium concentrations of less than one gram per liter a maximum error of $\pm 3.5\%$ can be expected. Additional data is required to verify the magnitude of interference for more representative feed solutions.

A second phase of the problem requires the accurate proportioning of the uranium solution with the polarographic medium. Continuous studies with the proportioning pump² gave errors in dilution of $\pm 3-4\%$. A method of gravity-flow dilution through a capillary was tried whereby a constant head was maintained by a continuous overflow. This method proved unsatisfactory due to erratic flows caused by the variation in viscosity of the feed solutions. Other methods of proportioning are being investigated.

The nitric acid determination by pH measurement has been temporarily discontinued until an instrument for this purpose can be constructed.

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FIGURE 1. CALIBRATION CURVES FOR URANIUM FEED SOLUTIONS AND A PURE STANDARD SOLUTION

VANADIUM DISTRIBUTION STUDY

F. D. Haisten and E. S. Roszkowski

The distribution of vanadium in 5 N nitric acid aqueous solution in contact with diethyl ether and tributyl phosphate was studied¹⁻². Data was obtained for the distribution of vanadium between nitric acid and 75% kerosene-25% tributyl phosphate.

For the determination of the distribution of vanadium in the presence of uranium the vanadium must be separated from the uranium prior to its determination. An adaptation of the cupferron extraction-oxine colorimetric procedure was used².

The vanadium distribution between 25% TBP and 5 N nitric acid for the range 0.34 to 5.5 g/l of vanadium was found to be 0.00037 ± 0.00005 . In the presence of 200 g/l of uranium the distribution was found to be about the same over the range 0.9 to 1.9 g/l of vanadium.

Previously reported vanadium distributions by this laboratory between diethyl ether and 3 N and 5 N nitric acid were found to be 0.004 and 0.016 respectively over the range 1.5 to 12.0 g/l vanadium¹⁻². As with the TBP-5 N nitric acid system the presence of 200 g/l of uranium did not appreciably change the distribution ratio. Furman³ in his study of the ether-aqueous uranium system found distribution ratios for vanadium (organic to aqueous) of 0.0005 in the absence of nitric acid, and 0.0019 in the presence of 0.8 N nitric acid and ammonium nitrate.

This study has been temporarily suspended.

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2. Haisten, F. D., NBL-117 (1955) p. 31-34.
3. Furman, N. H., R. J. Mundy, and G. H. Morrison, AECD 2938.

NITRIC ACID INSOLUBLES AND URANIUM DETERMINATIONS FROM THE ACID INSOLUBLES OF URANIUM FEED MATERIALS

T. J. Siddons and J. P. Highfill

Comparative data of the nitric acid insolubles and the uranium content of the insolubles, from ten types of uranium feed material, are tabulated.

The determinations are made by refluxing 10 g. samples for five minutes, just under the boiling temperature, with 45% nitric acid (by volume). The ratio of 45% nitric acid to sample is 2 ml. of acid per gram of sample. Following the digestion, the sides of the flask are washed down and 2 ml. of distilled water are added for each gram of sample. The five minute refluxing period is repeated and the solutions are allowed to cool. The insoluble residues are collected by filtering the solutions through #42 Whatman papers. The residues are washed with hot water until the total volume of solution is 200 ml. The papers are dried and then ignited at 1000°C. The residues are allowed to cool to room temperature and the weights of insoluble matter obtained. The residues are then decomposed and the uranium content determined fluorimetrically.

TABLE 1

NITRIC ACID INSOLUBLE AND URANIUM CONTENT OF THE INSOLUBLES
FROM DIFFERENT TYPES OF URANIUM FEED MATERIALS

NEL No.	Material	% U (Total)	Wt. Insol. Residue, g.	% Insol. Residue	% U (Insol. Residue)	% Insol. U (Based on Original Sample)
C-2332	Rifle	70.06	0.1117	1.12	1.6	0.018
C-2332	"		0.1115	1.12	1.4	0.016
C-2333	"	71.39	0.1231	1.23	1.7	0.02
C-2333	"		0.1250	1.25	1.7	0.02
C-2334	Uravan	69.41	0.0760	0.76	2.7	0.020
C-2334	"		0.0724	0.72	3.0	0.022
C-2335	"	70.30	0.0517	0.52	5.1	0.027
C-2335	"		0.0523	0.52	5.2	0.027
C-2336	Climax	54.43	0.3054	6.11	0.61	0.03
C-2336	"		0.2859	5.72	0.55	0.03
C-2337	"	50.98	0.9103	9.10	0.10	0.009
C-2337	"		0.8305	8.31	0.09	0.008
C-2338	Galigher	74.48	0.1393	1.39	0.09	0.001
C-2338	"		0.1412	1.41	0.09	0.001
C-2339	"	73.28	0.1348	1.35	0.07	0.001
C-2339	"		0.1806	1.81	0.07	0.001
C-2340	Naturita	71.65	0.1693	1.13	0.06	0.0007
C-2340	"		0.1707	1.14	0.06	0.0006
C-2341	"	69.85	0.1017	1.02	0.11	0.0011
C-2341	"		0.1071	1.07	0.09	0.0010
C-2342	Durango	69.62	0.2720	2.72	0.17	0.005
C-2342	"		0.2625	2.63	0.17	0.005
C-2343	"	74.79	0.1995	2.00	0.08	0.002
C-2343	"		0.1936	1.94	0.05	0.001
C-2344	Vitro	48.97	0.3249	6.50	0.15	0.009
C-2344	"		0.3293	6.59	0.14	0.010

TABLE 1 Cont'd

NBL No.	Material	% U (Total)	Wt. Insol. Residue, g.	% Insol. Residue	% U (Insol. Residue)	% Insol. U (Based on Original Sample)
C-2345	Vitro	53.90	0.1436	2.87	0.36	0.009
C-2345	"		0.1394	2.79	0.33	0.010
C-2346	Anaconda	63.01	0.0168	0.08	9.1	0.008
C-2346	"		0.0170	0.08	9.7	0.008
C-2347	"	64.19	0.0078	0.08	14.0	0.011
C-2347	"		0.0077	0.08	13.0	0.010
C-2348	National Lead	67.55	0.4092	4.09	0.16	0.006
C-2348	"		0.4075	4.08	0.18	0.007
C-2349	"	68.45	0.2046	4.09	0.05	0.002
C-2349	"		0.2051	4.10	0.05	0.002
C-2350	Kerr-McGee	70.33	0.0955	0.96	3.8	0.038
C-2350	"		0.1001	1.00	3.6	0.035
C-2351	"	69.36	0.1617	1.62	3.3	0.051
C-2351	"		0.1557	1.56	2.9	0.047

REACTIVITY OF URANIUM TRIOXIDE

F. D. Haisten, H. W. Bertram and E. S. Roszkowski

Production grade UO_3 should be of relatively uniform reactivity to maintain constant operating conditions in the reduction and hydrofluorination of the material. The cause of variations in reactivity of pot denitrated UO_3 has long been the subject of considerable interest¹. Such variables as temperature and time of denitration, particle size, crystal structure and nitrate content have been considered, but no positive correlation has been made with reactivity. Swinehart² is currently engaged in an extensive study of these and other variables.

Fox reported a laboratory test³ for the evaluation of UO_3 as feed material and has since revised the method, using a high reduction temperature⁴ to more closely simulate plant conditions. The evaluation of this test on current UO_3 production is being made.

The current test involves the hydrogen reduction of the UO_3 at 925°C for two hours followed by hydrofluorination of the resulting UO_2 at 600°C for three hours. Each sample is run with a standard sample of UO_3 . After analyzing the samples for the percent of ammonium oxalate insoluble (UO_2) the reactivity ratio is calculated by the following equation:

$$R = \frac{100-B}{100-A}$$

where: A = % AOI for standard
 B = % AOI for unknown, and
 R = Reactivity ratio.

Several runs were made by this method on three Mallinckrodt UO_3 samples which have been proposed as reactivity standards. The tests indicated substantially the same reactivity for the three samples. Evaluation of these samples made at Oak Ridge by the thermobalance⁵ also showed the samples to have comparable reactivities. One of these samples has been selected to serve as a reactivity standard, and it will also be considered as a general UO_3 standard.

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RADIUM ANALYSIS

L. C. Nelson

One of the several corrections in the gamma ray method of radium analysis is the self-absorption of gamma rays in the sample materials and the aqueous radium standards. The magnitude of this correction is evaluated in three ways. In one method, the slope of the curve for ion current per gram of sample as a function of the number of grams contained in the sample is calculated for a large number of vials. In a second method, the absorption of radium by representative ores and residues is determined by using a radium source and a sodium iodide crystal scintillation counter. The third method uses synthetic samples composed of the carbonates of calcium, strontium, barium, lead and a mixture of calcium and lead, homogeneously mixed with a known amount of radium. These synthetic samples are to be used in conjunction with the method for the analyses of radium in ores and residues (K-65's)¹.

The preparation of these synthetic samples have been completed and have been prepared from a 50 microgram National Bureau of Standards' standard. The desired amount of the metal nitrate was dissolved in distilled water, an aliquot of a 50 ml. solution of one of the 50 microgram standards was added and the mixture precipitated as the carbonate according to the procedure of Teicher². The procedure gives a dense, easily washed precipitate with very small losses due to solubility. The procedure had to be modified somewhat for solutions containing lead. In all cases the supernatant, after centrifugation, was tested for complete precipitation of the metal carbonate and, after washing, the precipitate was dried at 110°C overnight (about 16 hours). The precipitate was then transferred, quantitatively, to a sample vial, and packed uniformly avoiding air spaces. The supernatant was evaporated to a small volume and poured into similar vials, in order that the amount of radium lost in the above procedure may be measured. A similar aliquot of each 50 microgram standard was also taken and placed in a sample vial to be used as a control. All vials were then sealed and the radon allowed to grow to equilibrium. Each vial has also been leak tested to insure an air tight seal.

REFERENCES

1. Hudgens, J. E., C. Zyskowski, L. Nelson and R. Meyer, NBL-107 (1955) p. 61.
2. Teicher, H., Anal. Chem. **27**, 1416 (1955).

STANDARDS PROGRAM - THORIUM METAL

M. W. Lerner and C. G. Goldbeck

One hundred pounds of a thorium ingot, National Lead Company ingot number 3-105, NBL Sample No. C-2125, have been cut in approximately one and a half pound lots, fifty pounds of metal being cut from each end of the bar. A systematic study of the uniformity of the material is being made.

Uranium analyses have been completed on a number of lots comprising the first fifty pounds with the tributyl phosphate-oxine method¹. Carbon and nitrogen determinations on all of these lots are also being made. The analyses of the second fifty pounds are nearly completed. The results are being evaluated statistically.

REFERENCES

1. Eberle, A. R. and M. W. Lerner, NBL-117 (1955) p. 23-26.