RMIS View/Print Document Cover Sheet

This document was retrieved from the Boeing ISEARCH System.

Accession #: D196050043

Document #: SD-CP-LB-036

Title/Desc:

METHOD PERFORMANCE FOR RADIOANALYTICAL CHEMISTRY

2. To: (Receiving Organization) S. A. Catlow T6-50 H. K. Mezmarich T6-16 J. R. Prilucik T6-24				3. From: (Originating Organization) Radioanalytical Chemistry				4. Related EDT No.: NA			
5. Proj./Prog./Dept./Div.: NA				6. Cog. Engr.: S. A. Catlow				7. Purchase Order No.: NA			
8. Originator Remarks:								9. Equip./Component No.: NA			
								10. System/Bldg./Facility: 222-S Laboratory			
								12. Major Assm. Dwg. No.: NA			
11. Receiver Remarks:								13. Permit/Permit Application No.: NA			
								14. Required Response Date: NA			
15. DATA TRANSMITTED								(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted				Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-CP-LB-036	NA	0	Method Performance for Radioanalytical Chemistry				N/A	1	1	
16. KEY											
Approval Designator (F)			Reason for Transmittal (G)					Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)			1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)					1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged			
(G)	(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)								(G)	(H)
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1		Cog.Eng. S. A. Catlow	<i>[Signature]</i>	8/24/95							
1		Cog. Mgr. J. R. Prilucik	<i>[Signature]</i>	8/24/95							
		QA									
		Safety									
		Env.									
18.		19.				20.				21. DOE APPROVAL (if required) Ctrl. No.	
<i>[Signature]</i> Signature of EDT Originator		<i>[Signature]</i> Authorized Representative Date for Receiving Organization				<i>[Signature]</i> Cognizant Manager Date				☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	

RELEASE AUTHORIZATION

Document Number: WHC-SD-CP-LB-036, REV 0

Document Title: Method Performance for Radioanalytical Chemistry

Release Date: 9/1/95

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz

TRADEMARK DISCLAIMER. 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 or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy. Printed in the United States of America. To obtain copies of this report, contact:

Westinghouse Hanford Company - Document Control Services
P.O. Box 1970, Mailstop H6-08, Richland, WA 99352
Telephone: (509) 372-2420; Fax: (509) 376-4989

SUPPORTING DOCUMENT

1. Total Pages *16* / *17* *cm3*
7/1/95

2. Title

Method Performance for Radioanalytical Chemistry

3. Number

WHC-SD-CP-LB-036

4. Rev No.

0

5. Key Words

Analytical, Qualification, Radionuclide,
Separation

6. Author

Name: S. A. Catlow

S. A. Catlow
Signature

Organization/Charge Code 75920 / *158E04*

7. Abstract

This document provides method qualification data for radioanalytical procedures as required by WHC-SD-CP-QAPP-016. A short description of the methodology, the original source(s) of the methodology, a MDC example, and precision and accuracy from historic data.

8.

RELEASE STAMP

CONTENTS

1.0	PURPOSE.....	1-1
2.0	GENERAL INFORMATION.....	2-1
3.0	PROCEDURE QUALIFICATION DATA.....	3-1

LIST OF APPENDICES

A.	STRONTIUM-90 BY CARBONATE PRECIPITATION.....	A-1
B.	TRITIUM BY DISTILLATION.....	B-1
C.	PLUTONIUM BY ION EXCHANGE.....	C-1
D.	AMERICIUM BY ION EXCHANGE AND LIQUID EXTRACTION.....	D-1
E.	PLUTONIUM BY TTA EXTRACTION.....	E-1
F.	GAMMA ENERGY ANALYSIS.....	F-1
G.	GROSS ALPHA AND GROSS BETA.....	G-1
H.	TECHNETIUM-99 BY LIQUID EXTRACTION.....	H-1
I.	IODINE BY SOLVENT EXTRACTION.....	I-1
J.	AMERICIUM/CURIUM BY TRU-SPEC EXTRACTION.....	J-1
K.	NEPTUNIUM BY SOLVENT EXTRACTION.....	K-1
L.	CARBON-14 BY PERSULFATE OXIDATION.....	L-1
M.	PROETHIUM-147 BY SOLVENT EXTRACTION.....	M-1
N.	URANIUM BY KINETIC PHOSPHORESCENCE.....	N-1

1.0 PURPOSE

The purpose of this document is to provide method qualification data for radioanalytical separation procedures as required by WHC-SD-CP-QAPP-016. The document is presented as general information followed by a series of appendices. Each appendix is for a radionuclide separation or determination methodology. Each methodology may be represented by more than one Analytical Procedure. Appendices may be added, amended, or deleted as the needs of the laboratory change.

2.0 GENERAL INFORMATION

Radionuclide separation methods cover a wide range of decontamination requirements. The determination of gamma emitting isotopes may require no separation at all to removal of all potential interfering gamma emitters. Separation methods for some radionuclides may include the addition of other radionuclides as tracers or the use of non-radioactive elements to "carry" the radionuclide of interest through the separation scheme. As an example, the analysis of 10 picocuries of strontium-90, requires the separation, decontamination, and presenting for counting of approximately 7×10^{-14} grams of Sr-90. However, because the radionuclide can be counted as it decays, the addition of non-radioactive strontium can be used to determine losses through the separation scheme and a correction for those losses applied. The use of tracers and carriers for many radionuclide separation provides less need for predetermined matrix effects.

3.0 PROCEDURE QUALIFICATION DATA .

The procedure qualification data presented in the appendices may include a short description of the methodology, the original source(s) of the methodology, a minimum detectable concentration example, and precision and accuracy from historic LMCS data. Many of the methods for radionuclide separations have been in use at this facility for many years. The original development or method testing data have been lost, transferred to unknown locations, or stored as a government document. Minimum detectable activities (MDA) are determined by counter background, count time, counter efficiency and abundance of the energy or particle being counted. Therefore, a posteriori MDA can be calculated using the formula presented in WHC-SD-CP-QAPP-016. Minimum detectable concentrations (MDC) are dependent on the sample size as well and can be calculated from the MDA.

APPENDIX A

Strontium-90 by Carbonate Precipitation

Strontium is separated from other radionuclides by precipitation as a carbonate and as a nitrate. In old waste, radionuclide interferences are minimal. Activity determination is by gas flow proportional beta counting. This method of strontium separation was adapted from EML Procedure Manual (HASL-300), Environmental Measurement Laboratory, New York, NY., Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington, DC., Book of ASTM Standards, Part 23, Water; Atmospheric Analysis. In a collaborative study of two sets of paired samples the average recoveries were 99, 99, 96, and 93 percent. the precision at the 95% confidence level was 10 and 12 percent (from Standard Methods).

The minimum detectable activity (MDA) is based on detector background, detector efficiency, counting time, and carrier recovery. A typical minimum detectable concentration (MDC) for a 250 milliliter sample, a background of 12 counts per minute, a counting time of 10 minutes, a Sr-90 counting efficiency of 45%, and a carrier recovery of 90 percent is 1.9×10^{-2} pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-220-101	S376	99.44	5.32
LA-220-102	S381	99.65	6.66
LA-220-103	E034	93.56	8.32
LA-220-104	E344	100.08	4.54

APPENDIX B

Tritium by Distillation

Tritium as tritiated water is separated from other radionuclides by simple distillation. A "hold-back" mixture is added to the sample to prevent potentially volatile radionuclides from also distilling and contaminating the distillate. Separations are generally excellent and interferences are minimal. Activity determination is by liquid scintillation beta counting. This method was adapted from Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington, DC. and Book of ASTM Standards, Section 11, Vol. 11.02 Water(II). Samples with tritium activity above 200 pCi/mL can be analyzed with a precision of less than 6% (from Standard Methods).

The minimum detectable activity (MDA) is based on detector background, detector efficiency, and counting time. A typical minimum detectable concentration (MDC) for a 5 milliliter sample, a background of 18 counts per minute, a counting time of 50 minutes and an efficiency of 0.30 is 6.1×10^{-1} pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-218-114	R907	95.44	7.17

APPENDIX C

Plutonium by Ion Exchange

Plutoniums are separated from other alpha emitting radionuclides by adsorption onto an anion resin. After removal of potential interferences, the plutoniums are eluted and mounted for alpha energy counting. A radio-tracer (Pu-236 or Pu-242) are added for recovery determination. Both Pu-238 and Pu-239 are determined from a single sample, however, Pu-239 and Pu-240 can not be separated and are generally reported as Pu-239/240. Decontamination from other alphas are generally very good. Sample matrix may have some effect on plutonium recovery, however, the use of a tracer allows for correction due to any loss. Neptunium-237 may interfere with the determination of the Pu-242 tracer recovery. Activity is determined from the ratio of sample counts to tracer counts. The procedures were adapted from EML Procedure Manual (HASL-300), Environmental Measurement Laboratory, New York, NY. and the Book of ASTM Standards, Section 11, Vol. 11.02 Water(II). A collaborative study of bias and precision by Standard Methods is presented in the following table.

Bq/L	Bias %	Precision $S_{(o)}$	$S_{(t)}$
Pu-238			
0.166	-11	0.0117	0.0205
0.125	+3.2	0.00629	0.00870
0.0088	-4.6	0.00122	0.00125
Pu-239			
0.482	-7.3	0.0207	0.0548
0.074	-6.3	0.00362	0.0416
0.016	-2.1	0.00149	0.00214

The minimum detectable activity (MDA) is based on the ability of the data reduction software to determine identifiable peaks. Peak determination is affected by detector efficiency, counting time, and the quality of the mount. Because the ratio of sample activity to tracer activity is the method used to calculate sample concentration the activity of the tracer added and recovered also affects the MDA. A graduated ability to determine the minimum ratio detectable is used. A typical minimum detectable concentration (MDC) for a 250 milliliter sample, a counting time of 480 minutes, and a tracer activity of 66.85 dpm and a recovery of 65 percent is 6.15 pCi/L.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-503-156	R211	102.79	11.14
LA-943-123	E347	98.08	6.99
LA-943-127	(Development)	96.8	0.5

APPENDIX D

Americium by Ion Exchange and Liquid Extraction

Americium is separated from most other alpha emitting radionuclides by ion exchange. The Americium which does not adsorb on the anion resin is further decontaminated by liquid extraction prior to mounting for alpha energy counting. Curium isotopes because of similar chemistry can also be determined by this method. A radio-tracer (Am-243) is added for recovery determination. Decontamination from other alphas is generally very good, however, other radionuclides may accompany the Americium causing high beta/gamma activity on the mount. Sample matrix may have some affect on recovery but is corrected for by use of the tracer. Activity is determined from the ratio of sample counts to tracer counts. The procedure was adapted from SD-CP-TI-121, W. I. Winters, WHC. Under development conditions an accuracy and precision of 94.4% and 10.5% respectively were achieved.

The minimum detectable activity (MDA) is based on the ability of the data reduction software to determine identifiable peaks. Peak determination is affected by detector efficiency, counting time, and the quality of the mount. Because the ratio of sample activity to tracer activity is the method used to calculate sample concentration the activity of the tracer added and recovered also affects the MDA. A graduated ability to determine the minimum ratio detectable is used. A typical minimum detectable concentration (MDC) for a 250 milliliter sample, a counting time of 480 minutes, and a tracer activity of 113.7 dpm and a recovery of 65 percent is 15.8 pCi/L.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-943-123	E350	96.25	7.36

APPENDIX E

Plutonium by TTA Extraction

Plutonium is separated from other alpha emitters and from the bulk of contaminants by extraction into an organic solvent as a complex of TTA (thenoyltrifluoroacetone). The TTA solution is mounted for alpha counting. A radio-tracer can be added for recovery correction. Alpha energy counting is required when tracer is used. Interferences include neptunium-237 if present at high activity, and some metals such as Zr(IV) and Fe(III). Activity determination for un-tracered samples is by alpha counting. For tracer added samples, activity is determined from the ratio of sample counts to tracer counts. This method was adapted from the Analytical Technical Manual, HW 53368, Hanford Atomic Products Operation, Richland, WA. Accuracy and precision were not reported.

The minimum detectable activity (MDA) is based on detector background, detector efficiency, counting time, and mount volume. A typical minimum detectable concentration (MDC) for a 1 milliliter sample, a background of 5 counts per minute, a counting time of 30 minutes, a detector efficiency of 0.5, and a mount volume of 0.5 milliliters is 3.6 pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-943-101	S359	102.45	5.57
(with Tracer)			

APPENDIX F

Gamma Energy Analysis

Gamma energy analysis requires no separation. Matrix affects are approximated by calibration with a material with a density near that of the material to be analyzed and in a geometry that is repeatable. Although not always possible, interferences from other radionuclides is minimized by using energies that are unique to the isotope of interest. Because of the complexity of gamma spectra, calibration, and peak integration, activity determination is by computer software provided by the gamma analysis vendor.

The MDA is based on counting time, detector efficiency, background, branching intensity of the gamma used to quantify the activity, and the presence of other gamma and beta emitting radionuclides, type of sample and geometry. Typical MDCs of several radionuclides of common interest for detector #4, a count time of 3000 seconds, and a 500 milliliter liquid sample are:

Radionuclide	MDC in pCi/L
Co-60	38.1
Zr-95	62.1
Ru-106	309
Sb-125	106
Cs-134	33.2
Cs-137	74.8
Eu-154	104
Np-237	264
Am-241	287

Precision and accuracy estimates are based on historic LMCS data for procedure number LA-548-121.

Nuclide	Volume(mL)	EDP Code	Accuracy	Precision
Cs-137	500	E345	98.03	4.77
Co-60	500	E346	98.18	2.06
Cs-137	125	S383	105.50	3.97
Co-60	125	S382	103.80	5.00
Cs-137	22	R901	101.46	3.22
Co-60	22	R905	100.31	2.87

Appendix G

Gross Alpha and Gross Beta

Samples are prepared for gross alpha gross beta counting by evaporating an aliquot of aqueous sample in a stainless steel dish. The sample aliquot or aliquots can be added directly to the dish, allowing the sample to evaporate between additions if need be. Larger samples can be evaporated in a beaker until the volume is reduced sufficiently so that the remaining liquid can be transferred to the dish for complete drying. Samples that do not fill the dish require the addition of water so that the entire dish is covered as final evaporation begins. Sample matrix can effect the results by causing absorption of alpha and beta particles. Some radionuclides may be volatilized during the bring process. Tritium is lost due to evaporation. Activity is determined by counting with a detector calibrated with Cs-137 for beta and Am-241 for alpha. This method was adapted from Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington, DC. and the Book of ASTM Standards, Section 11, Vol. 11.02 Water(II). Precision and bias as determined by a collaborative study for Standard Methods in a study of two sets of paired water samples. For alpha the average recoveries were 86, 87, 84, and 82% The precision at the 95% confidence level was 20 and 24% for the two sets of pairs. For beta the average recoveries were 99, 100, 100, and 100%. The precision was 12 and 18%.

The minimum detectable activity (MDA) is based on detector background, detector efficiency, and counting time. A typical alpha minimum detectable concentration (MDC) for a 500 milliliter sample, a background of 0.5 counts per minute, and a counting time of 30 minutes is 1.9×10^{-2} pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	Dish	Nuclide	EDP Code	Accuracy	Precision
LA-508-113	4.5 in	Alpha	E341	104.13	7.33
LA-508-113	4.5 in	Beta	E342	107.71	9.10
LA-508-101	2 in	Alpha	S510	99.67	9.74
LA-508-101	2 in	Beta	S515	95.61	6.46

APPENDIX H

Technetium-99 by Liquid Extraction

Technetium is separated from bulk contamination by extraction in to methylytricaprylammonium chloride. The organic phase is washed with acid and base to remove the remaining contaminants. An aliquot of the organic is counted by liquid scintillation. The extraction of technetium is not complete, therefore, a second sample with a spike added is also analyzed and a correction for recovery is made to determine the sample activity. This method is adapted from SD-RE-LB-001, S. G. Metcalf, Richland WA. During development the average spike recovery and relative standard deviation were 92.5% and 5.2% respectively.

The minimum detectable activity (MDA) is based on detector background, detector efficiency, counting time and spike recovery. A typical minimum detectable concentration (MDC) for a 500 milliliter sample, a background of 50 counts per minute, a counting time of 20 minutes and an efficiency of 0.92, and a recovery of 65% is 85 pCi/L.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-438-111	S364	100.20	8.61
LA-438-101	S363	98.65	6.95

APPENDIX I

Iodine by Solvent Extraction

Iodine is separated from the bulk of contaminants by extraction into methylene chloride after equilibration with an iodine carrier. A second extraction aids in decontamination followed by a cation exchange to assist in the removal of radioactive cations. The iodine is precipitated as palladium iodide for recovery determination and redissolved for gamma energy analysis. Separation is generally very good, however, when Cs-137 activity is very high some may be physically carried through the separation and may interfere with the gamma energy analysis. This method was adapted from the Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington, DC. and the Book of ASTM Standards, Section 11, Vol. 11.02 Water(II). No accuracy and precision were given.

The MDA is based on counting time, detector efficiency, background, branching intensity of the gamma used to quantify the activity, and the presence of other gamma and beta emitting radionuclides, and carrier recovery. A typical MDC for a 500 mL sample, a 65% recovery, and counted for 100 minutes is 10 pCi/L.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-378-101	E329	86.77	11.98
LA-378-103	S928	91.24	12.23

APPENDIX J

Americium/Curium by TRU-Spec Extraction

Americium and curium isotopes are separated from other alpha emitting radionuclides by extraction from a liquid matrix into a solid phase CMPO. The CMPO has been put onto a resin bead by Eichrom Industries. After removal of interfering radioisotopes, the americium and curiums are eluted and mounted for alpha energy analysis. Americium-243 is added for recovery determination. Both americium-241 and curium-243/244 are determined from a single sample. (Curium-243 and curium-244 cannot be separated and are reported as curium-243/244.) Decontamination is generally good. Sample matrix may have some effect on americium and curium recoveries, but use of a tracer allows for correction. Activity is determined from the ratio of sample counts to tracer counts. The procedure was adapted from a distribution by Eichrom Industries: Kaye, J.H., R. S. Strebin, and R.D. Orr, 1994, *Rapid, Quantitative Analysis of Americium, Curium, and Plutonium isotopes in Hanford Samples Using Extraction Chromatography and Precipitation Plating*.

The minimum detectable activity (MDA) is based on the ability of the data reduction software to determine identifiable peaks. Peak determination is affected by detector efficiency, counting time, and the quality of the mount. Because the ratio of the sample activity to tracer activity is the method used to calculate the sample concentration the activity of the tracer added and recovered also affects the MDA. A graduated ability to determine the minimum ratio detectable is used. A typical minimum detectable concentration (MDC) for a 1 milliliter sample, counting time of 480 minutes, a tracer activity of 947.2 dpm, and a tracer recovery of 80% is 53 pCi/mL.

Precision and accuracy based on development data:

Accuracy: 97.87%
Precision: 3.19%

Precision and accuracy for procedure LA-953-103 based on historic LabCore data:

Accuracy: 94.81%
Precision: 10.48%

APPENDIX K

Neptunium by Solvent Extraction

Neptunium is separated from other alpha emitting radionuclides by extraction into tri-iso-octylamine (TIOA). The neptunium is scrubbed from the TIOA to separate it from plutonium and then re-extracted into TTA. An aliquot of the TTA is mounted for alpha counting. High concentration of uranium (approximately 0.2 molar) will interfere with the neptunium extraction. This procedure is for small samples (250 uL or less). This method was adapted from the Analytical Technical Manual, HW 53368, Hanford Atomic Products Operation, Richland, WA. Accuracy and precision were not reported.

The minimum detectable activity (MDA) is based on detector background, detector efficiency, and counting time. A typical minimum detectable concentration (MDC) for a 250 microliter sample, a background of 0.5 counts per minute, and a counting time of 30 minutes is 1.9×10^{-2} pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-933-141	S380	79.81	13.07

APPENDIX L

Carbon-14 by Persulfate Oxidation

Carbon carbonates and organic compounds are converted to carbon dioxide. Organic materials are oxidized using persulfate with a silver catalyst. The resulting carbon dioxide is scrubbed to remove possible counting interferences such as nitrogen dioxide. The carbon dioxide is trapped in a commercially available liquid carbon dioxide absorber and counted by liquid scintillation. Not all organic compounds are oxidized by the persulfate. Aromatic and long chain aliphatic hydrocarbons are not oxidized, however, in Hanford samples if these compounds were present the C-14 would most likely be of natural origin and low level. This method was adapted from a letter from INEL. No accuracy and precision were given.

The minimum detectable activity (MDA) is based on detector background, detector efficiency, and counting time. A typical minimum detectable concentration (MDC) for a 1 milliliter sample, a background of 54 counts per minute, a counting time of 50 minutes and an efficiency of 0.85 is 2.5 pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-348-104	R909	86.72	6.01

APPENDIX M

Promethium-147 by Solvent Extraction

Promethium is separated from the bulk contaminants by extraction into di-(2-ethylhexyl) phosphoric acid (HDEHP). The promethium is back extracted into dilute nitric acid, washed with HDEHP, and an aliquot of the nitric acid is used for liquid scintillation counting. The decontamination from radionuclides with a valence of plus three is not complete. Correction for americium, and the europiums must be made if present. High levels of cesium have also been known to interfere. This procedure was adapted from Britt, Jr., R. D.: "The Radiochemical Determination of Promethium-147 in Fission Products", Anal. Chem., 1961, Vol. 33 pp. 602-604 and Johnson, W. C.; and Campbell, M. H.; An Improved Method for separating Promethium-147 with Di-(2-ethylhexyl)-Phosphoric Acid, HW-SA-3549 (1964). Under development conditions an accuracy of 99.6% with a precision of 2.4% was achieved on standards at an activity level of 0.01 uCi/L with only one interfering radionuclide.

The minimum detectable activity (MDA) is based on detector background, detector efficiency, counting time. A typical minimum detectable concentration (MDC) for a 5 milliliter sample, a background of 50 counts per minute, a counting time of 20 minutes and an efficiency of 0.92, and no interferences is 30 pCi/mL.

Precision and accuracy estimates are based on historic LMCS data.

Procedure #	EDP Code	Accuracy	Precision
LA-613-101	S365	101.21	8.30

APPENDIX N

Uranium by Kinetic Phosphorescence

The concentration of trace uranium is determined using a kinetic phosphorescence analyzer (KPA). An aliquot of sample is evaporated to dryness in the presence of nitric acid to remove potential interferences, then mixed with an uranium complexing agent. Sample phosphorescence is induced using a pulsed nitrogen laser; the uranium concentration is determined by measuring the number of photons produced by the phosphorescent decay of the uranium complex. Procedures were adapted from the Chemchek Instruments, Inc. KPA Operation and Service Manual. During original development, an accuracy of 100.4% and precision of 7.1% were achieved.

To determine a detection level for the KPA, a solution near the noise level of the instrument is prepared and analyzed ten times for standard deviation. The detection limit of the instrument may be defined as three times the standard deviation of the background, or noise level. This limit is calculated for each instrument every six months, or as required by the responsible scientist. A typical detection limit for the KPA is on the order of 1 E-8 G/L .

Precision and accuracy estimates based on historic LMCS data are as follows:

Procedure #	EDP Code	Accuracy	Precision
LA-925-008	E340	100.88	4.18
LA-925-009	S225	98.61	5.66