ANALYSIS OF ROCKY FLATS BUIILDING RUBBLE FOR PLUTONIUM

Prepared by

James Benetti, Dennis Farmer,
Eleanor Strickland and George Dilbeck

Submitted to

U.S. Environmental Protection Agency
Region 8
Denver, Colorado

June 2000

AUG 2000
RECEIVED
RECORDS CENTER

Publication #0001

United States Environmental Protection Agency . Center for Radioanalysis and Quality Assurance
Office of Radiation and Indoor Air . Las Vegas, Nevada

ADMIN RECORD

SW-A-004098

Y 40

ANALYSIS OF ROCKY FLATS BUILDING RUBBLE SAMPLES FOR PLUTONIUM

James Benetti
U.S. Environmental Protection Agency
Las Vegas, Nevada

BACKGROUND: Public concern exists that fines from rubble from decontaminated and demolished buildings at the Rocky Flats Environmental Technology Site (RFETS) may contain sufficient plutonium to constitute an inhalation hazard to nearby residents. The DOE Contractor, Kaiser Hill Inc., agreed to collect samples of 779 Cluster building rubble at the 980 Storage Pad, and to analyze them for radioactive materials. USEPA Region 8 also decided to collect colocated samples (not split samples) from the same rubble pile as an independent check of the plutonium content of the pile. This approach effectively doubles the sampling density of the pile, and provides a second set of data from an independent laboratory, but does not attempt to confirm the results of Kaiser Hill's laboratory, since uniform split samples were deemed nearly impossible to obtain. .

Upon verbal request of Mr. Mark Aguilar, USEPA Region 8, it was agreed that nine samples of rubble fines, collected by Mark Aguilar and Richard Graham of the same office would be received by the Radiation and Indoor Environments National Laboratory (R&IE), Las Vegas, Nevada, and would be analyzed for plutonium isotopes. On March 10, 2000, the samples were delivered to the custody of R&IE, Center for Radioanalysis and Quality Assurance. The samples were analyzed from April 19 through May 2, 2000.

SUMMARY OF METHOD: Since public concern appears to be associated with the fraction of rubble fines which could be transported via the air pathway, it was decided to screen the samples and perform the analysis upon the finest fraction obtainable, rather than to grind and homogenize the sample. All samples were screened through eight inch U.S. Testing standard sieves ranging from 40 to 200 mesh and repackaged into fractions greater than 40 mesh, between 40 and 200, and less than 200 mesh. Between 10 and 20 grams of fractions less than 200 mesh (less than 70 microns), were obtained from each sample. All sieves were decontaminated and oven dried for each sample to avoid cross contamination. For the matrix blank and spike samples, a quantity of cinder block fines (screened to less than 200 mesh) obtained from the exterior surface of a clean building at Rocky Flats were used.

Approximately half gram aliquots were obtained from the screened fractions of each sample and the matrix. Plutonium tracer (Reference solution 950296 - Pu 242, 4.4269 dpm/mL, 1.000 mL/sample) was added to all samples, and spike (Reference solution 980335 B-1 -Pu 239/240, 4.073 pCi/mL, 1.000 mL) was added to matrix sample number 12. The tracer and spike solutions used are dilutions of Standard Reference Material 4334E, and EPA Solution Number 94002-1, respectively, both traceable to the National Institute of Standards and Technology (certificates provided in Attachment B) .

All samples were ashed to destroy organic material (100 °C for 1 hour, followed by 700 °C for

2

24 hours), then placed in CEM microwave digestion vessels with 9 mL of aqua regia ($HCl:HNO_3$ in ratio 3:1) and 3 mL of hydrofluoric acid. A reagent blank (no tracer added - see below) was included at this stage. A four stage microwave temperature controlled protocol developed for digestion of epoxy paint/cement was performed. Samples were cooled and vented and 30 mL of 4% boric acid was added to each sample, and a two stage temperature controlled microwave protocol was run to complex the fluoride ion. All samples emerged from this process as clear liquids, ie digestion was essentially 100%.

Following digestion, each sample was added to 50 mL of HNO_3 and boiled down to 50 mL to remove halides. Sample volume was then adjusted to 100 mL, and sample normality was adjusted to 8N. Plutonium oxidation state was adjusted by adding 0.2 gram $NaNO_2$. No "salting out" of samples was observed. Samples were then introduced to ion exchange columns (1x8 Dowex resin) conditioned with 8N HNO_3. The plutonium fraction was eluted with NH_4I in concentrated HCl and evaporated to dryness with 20 mL HNO_3. Dried samples were taken up in concentrated HCl with hydrogen peroxide and 0.2 g $NaNO_2$, and introduced into second columns conditioned with HCl, eluted with NH_4I in HCl and evaporated to dryness as above.

The purified, dried plutonium fractions were then taken up in a mixture of concentrated H_2SO_4, HNO_3 and H_2O_2, heated until the sulfuric acid fumed, and adjusted to pH between 1.8 and 2.2 using NH_4OH. Electrodeposition (Talvatie method) of samples on to stainless steel discs, was performed for 1 hour at current of 1 Ampere. This was followed by alpha spectroscopic analysis (count time 1000 minutes) using ion-implanted silicon charged particle detectors (PIPs) having a nominal energy resolution of 20-25 kiloelectron volts (kev) at full width half maximum..

RESULTS: Table 1 shows the summary of results of the analyses of all samples including quality control samples. Attachment A contains the analytical reports and alpha spectra for each sample and quality control results for the batch. Plutonium 239/240 at levels greater than the 2 sigma uncertainty above the minimum detectible concentration was detected in 7 of the 9 samples (CENTER, N, SE, S, SW, W, and NW - see the attached graphic), with values ranging from 0.08 - 0.12 pCi/g. In addition, sample NE shows a possible detect for Pu 239/240 at a level less than the 2 sigma uncertainty above the MDC. Plutonium 238 was not detected in any of the samples.

QUALITY CONTROL: R&IE quality control policy requires that at least 10% of all samples be used for quality control purposes. In this batch, the reagent and matrix blanks and the matrix spike samples were introduced for quality control. Review of the counting data for the reagent and matrix blanks indicates that no detectible plutonium was introduced through contaminated reagents or via the cement matrix. (Since tracer was not added to the reagent blank, one must look at the actual counts in each plutonium peak region in sample 10, where it is obvious that nothing is present above the instrument background. The analysis of data which the data processing software provides is predicated on the presence of a known amount of tracer, and in the absence of tracer it is not meaningful.) Review of the matrix spike data indicates a detected plutonium 239/240 activity which is within 4.3% of that predicted - this is acceptable within the

limits of uncertainty of the measurement. Finally, the recovery data for all samples (with the exception of the reagent blank which contained no tracer) average 84.2%, ranging from 64.4% to 92.3 % which is well above the R&IE recovery flag level and in the upper echelon of expected recoveries.

Reg 8 ID #	R&IE ID #	Recovery %	Pu238 (pci/g)	MDC (Pu238)	2 sigma err (Pu 238)	Pu 239/240 (pci/g)	MDC (Pu239/40)	2 sigma err (Pu239/40)
CENTER	729008	88.41%	9.320E-03	2.599E-02	1.440E-02	8.254E-02	2.155E-02	3.863E-02
N	729009	85.91%	-1.450E-03	2.347E-02	2.908E-03	1.493E-01	2.830E-02	5.614E-02
NE	729010	90.71%	-1.374E-03	3.331E-02	9.912E-03	4.947E-02	3.034E-02	3.097E-02
E	729011	92.34%	1.709E-02	2.567E-02	1.820E-02	2.104E-02	2.567E-02	1.992E-02
SE	729012	87.99%	-1.380E-03	3.344E-02	9.952E-03	7.037E-02	3.047E-02	3.692E-02
S	729013	90.57%	8.538E-03	1.157E-02	1.214E-02	1.252E-01	2.778E-02	5.041E-02
SW	729014	64.44%	1.111E-02	4.088E-02	2.035E-02	1.166E-01	1.505E-02	5.389E-02
W	729015	73.52%	1.828E-02	2.689E-02	2.040E-02	1.196E-01	3.669E-02	5.327E-02
NW	729016	86.99%	4.207E-03	3.096E-02	1.287E-02	1.192E-01	2.737E-02	4.873E-02
REAG BLK	999999	NA ***	ND	NA***	NA***	ND	NA***	NA***
MX BLNK	729017	91.17%	0.000E+00	1.116E-02	0.000E+00	-1.373E-03	2.221E-02	2.752E-03
MX SPIKE	729018	74.37%	-8.597E-08	3.764E-02	1.181E-02	7.658E+00	3.328E-02	1.217E+00

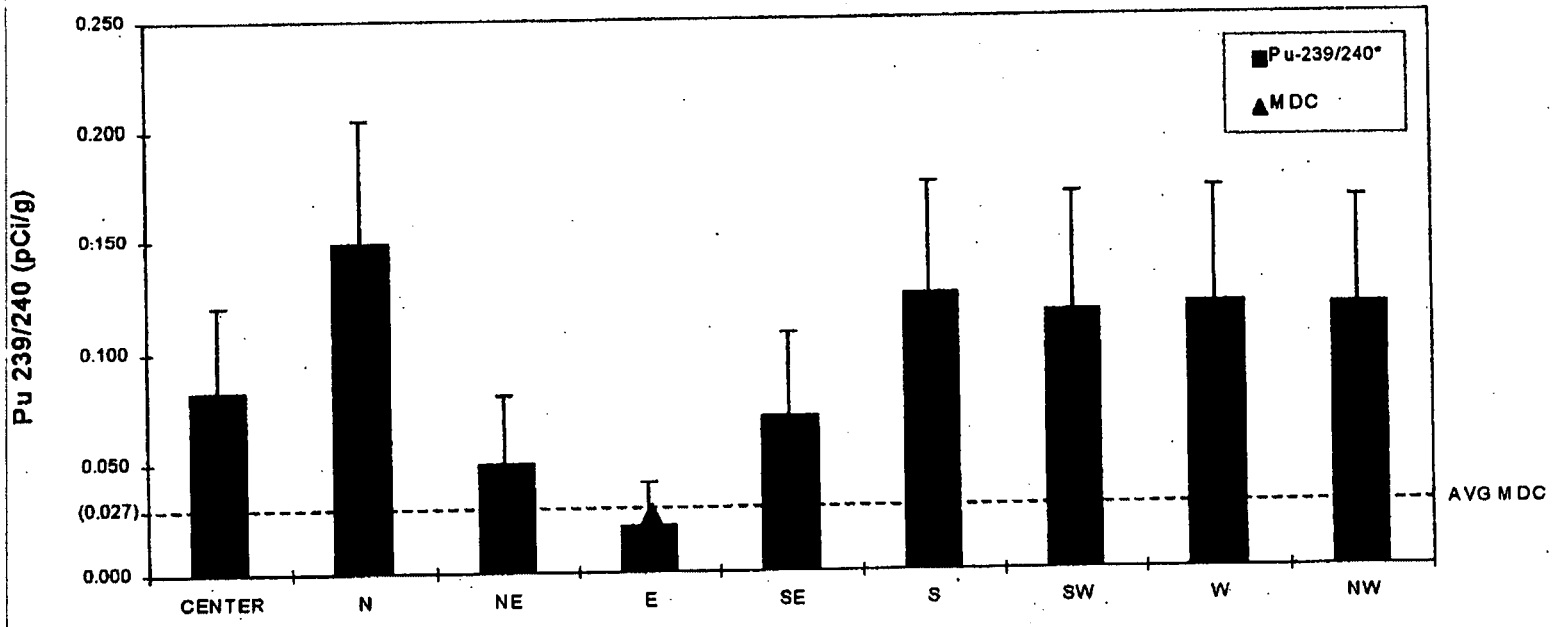
Table 1: Summary Results for All Samples

*** Reagent Blank did not contain tracer. Software calculations based on the assumption that tracer was present are not meaningful.

DISCUSSION: The plutonium results which exceed MDC in this analysis (7 or 8 "hits", ranging from 0.05 - 0.12 pCi/g) show a fairly tight distribution, and all lie above the range of plutonium in soils due to global fallout (nominally 0.005 to 0.025 pCi/g). Levels of activity such as these, even associated with the resuspendable and respirable fractions of the soil do not give cause for immediate alarm. It is readily calculated using dose conversion factors from Federal Guidance Document 11, that it would be required to inhale some 22 kilograms/year of dust having the highest concentrations seen in this analysis, to receive a 10 millirem annual radiation dose (the annual dose limit for radionuclides in the Clean Air Act), assuming that the activity is uniformly distributed among all particles in the fraction. Inhalation of this much dust is highly improbable.

It is interesting to compare the results of this analysis with those of the Kaiser Hill contract laboratory, Sanford Cohen and Associates, Montgomery, Alabama, although one must be cautious in doing so: the samples taken by EPA are, at best, colocated samples to those taken by Kaiser Hill, and details of the sample preparation (ie whether samples were sieved or ground),

Rocky Flats Environmental Technology Site



Radioanalytical Results
779 Cluster Building Rubble
980 Storage Pad

* 2σ uncertainty shown as error bar (I).

5

and count times are not known. Of the nine samples analyzed by SCA, two have detectible plutonium above MDC values. Since SCA's MDC values are somewhat higher than ours, it appears that their findings are fairly consistent with ours in eight of the nine samples. However, SCA sample five has a plutonium detect at 2.35 pCi/g, which is nearly 19 times higher than our highest value. This could indicate that plutonium in the rubble is not uniformly distributed, and that there could be localized hot spots or even hot particles present. If this were the case, it should give rise to somewhat more concern about the potential for exposure via the air pathway. It might be economical and prudent to stabilize the rubble fines by covering the pile or applying soil cement as a preventative measure. (It is our understanding that this step was taken by Kaiser Hill shortly after the sampling.)

It is possible to explore further, the potential for hot particles of resuspendable size to be present in the rubble. Our laboratory could apply the finest fraction remaining from each sample in a thin layer on unexposed photographic film (autoradiography) or sheets of CR 39 plastic (alpha track etch detector) to detect the presence of localized radioactive particles. This method could be refined to isolate the hot spots in the fines fraction in order to perform selective analysis.

R&IE Radichemistry Section
Plutonium Analysis Worksheet
Alpha Spectroscopy
(Form RQA-014, Revision 1)

Date: 4-19-00

Analyst: J. BENETTI

Reviewer:

TRACER INFORMATION		SPIKE INFORMATION (QC Samples Only)	
Tracer Activity: 4.4269	dpm/ml	Spike Activity: 4.073	~~dpm~~ pCi/ml
Amount used: 1.000	mL	Amount used: 1.000	mL
Reference Soln: 950296		Reference Soln: 980335 B-1	
Pipette Check 1.0024 (Range 0.9950 -1.0050 g)			
Balance used B1			

BATCH PU-0002

Page ____ of ____

	Sample ID	PC	ST	DESCRIPTION	Vol / Mass:	Units:	Det #
1	729008	90	102	CENTER (RFETS) #1 FINES <200 MESH	0.5529	8	1
2	729009	90	102	N #2	0.5632	8	2
3	729010	90	102	NE #3	0.5542	8	3
4	729011	90	102	E #4	0.5529	8	4
5	729012	90	102	SE #5	0.5606	8	5
6	729013	90	102	S #6	0.5437	8	6
7	729014	90	102	SW #7	0.5573	8	7
8	729015	90	102	W #8	0.5479	8	8
9	729016	90	102	NW #9	0.5518	8	9
10	999999	90	102	REAGENT BLANK #10	43 ml.		10
11	729017	90	102	MATRIX BLANK #11	0.5589	8	13
12	729018	90	102	MATRIX SPIKE #12	0.5449	8	14

COMMENTS:

(Rev. 4/99)

7

Review of QA results (Backgrounds PU) 1-MAY-2000 15:35:40

Detector	Parameter	Flag	Filename
1	ALL	Passed	B_001_26apr00
2	ALL	Passed	B_002_26apr00
3	ALL	Passed	B_003_26apr00
4	ALL	Passed	B_004_26apr00
5	ALL	Passed	B_005_26apr00
6	ALL	Passed	B_006_26apr00
7	ALL	Passed	B_007_26apr00
8	ALL	Passed	B_008_26apr00
9	ALL	Passed	B_009_26apr00
10	ALL	Passed	B_010_26apr00
11	OFFLINE		
12	OFFLINE		
13	ALL	Passed	B_013_26apr00
14	ALL	Passed	B_014_26apr00

APPROVAL DATE: 5/1/00 APPROVAL TIME: 16:15hrs

APPROVED BY: J. Bonetti PROCEDURE # PU0002

RF-RUBBLE

Report completed at 1-MAY-2000 15:36:19

COPY

8

Review of QA results (Daily Pulser Check) 1-MAY-2000 16:34:08

Detector	Parameter	Flag	Filename
1	ALL	Passed	D_001_NONE
2	ALL	Passed	D_002_NONE
3	ALL	Passed	D_003_NONE
4	ALL	Passed	D_004_NONE
5	ALL	Passed	D_005_NONE
6	ALL	Passed	D_006_NONE
7	ALL	Passed	D_007_NONE
8	ALL	Passed	D_008_NONE
9	ALL	Passed	D_009_NONE
10	ALL	Passed	D_010_NONE
11	OFFLINE		
12	OFFLINE		
13	ALL	Passed	D_013_NONE
14	ALL	Passed	D_014_NONE

APPROVAL DATE: 5/1/00 APPROVAL TIME: 16:30 hrs

APPROVED BY: J. Benetti PROCEDURE # PU0002

ROCKY FLATS — RUBBLE

Report completed at 1-MAY-2000 16:34:26

COPY

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:48:39

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$001-729008_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	001-729008
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.530E-01 gram
SAMPLE TITLE:	PU-1 CENT	DETECTOR NUMBER:	001
ACQ DATE:	1-MAY-2000 16:40	AVERAGE EFFICIENCY:	23.09%
ELAPSED LIVE TIME:	60003.	RECOVERY:	88.41%
TRACER ID:	950296-PU	TRACER FWHM (kev):	30.49
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:39	EFF CAL DATE:	5-JAN-2000 14:39
BKG FILENAME:	B_001_26APR00	BKG ELAPSED TIME:	180004.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	2.33	0.67	99.9	9.320E-03	1.440E-02	2.599E-02
PU-239	5147.7	20.67	0.33	99.9	8.254E-02	3.863E-02	2.155E-02
PU242	4890.7	907.33	0.67	100.4	3.606E+00	4.362E-01	2.586E-02

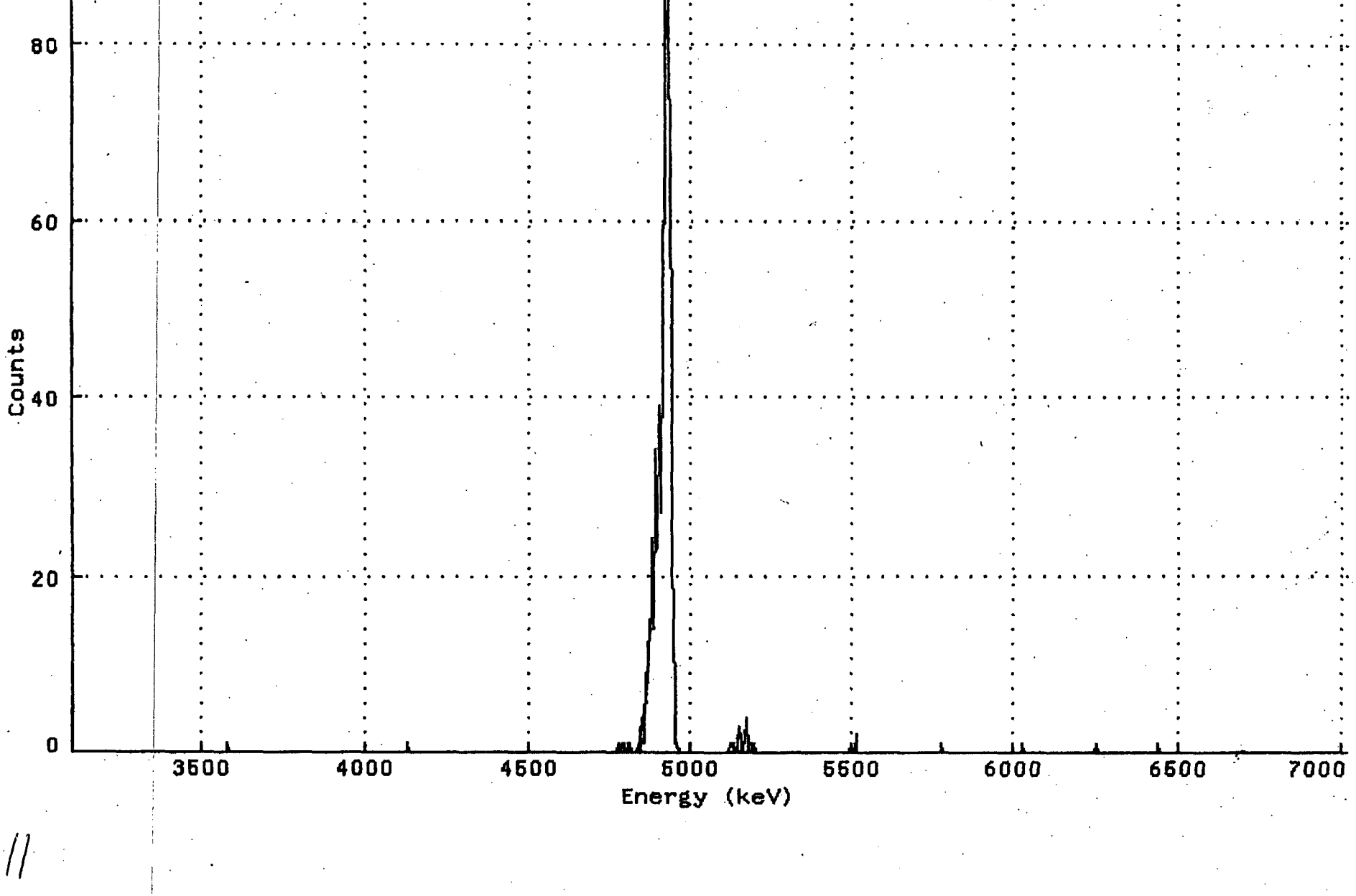
****

James Benetti — 5/2/00
Analyst — Date

Dennis Faine — 5/2/00
Reviewer — Date

10

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$001-729008_PU.CNF;1
Title : 001
Sample Title: PU-1 CENT
Start Time: 1-MAY-2000 16:40: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.08981E+03
Real Time : 0 16:40:03.00 Sample ID : 001-729008 Energy Slope : 4.11396E+00
Live Time : 0 16:40:03.00 Sample Type: PU Energy Quad : -2.76900E-04



//

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:49:21

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$002-729009_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	002-729009
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.630E-01 gram
SAMPLE TITLE:	PU-2 N	DETECTOR NUMBER:	002
ACQ DATE:	1-MAY-2000 16:41	AVERAGE EFFICIENCY:	21.43%
ELAPSED LIVE TIME:	60004.	RECOVERY:	85.91%
TRACER ID:	950296-PU	TRACER FWHM (kev):	25.08
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:39	EFF CAL DATE:	5-JAN-2000 14:39
BKG FILENAME:	B_002_26APR00	BKG ELAPSED TIME:	180004.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	-0.33	0.33	99.9	-1.450E-03	2.908E-03	2.347E-02
PU-239	5147.7	34.33	0.67	99.9	1.493E-01	5.614E-02	2.830E-02
PU242	4890.7	818.33	0.67	100.4	3.542E+00	4.359E-01	2.816E-02

****

James Benetti
Analyst

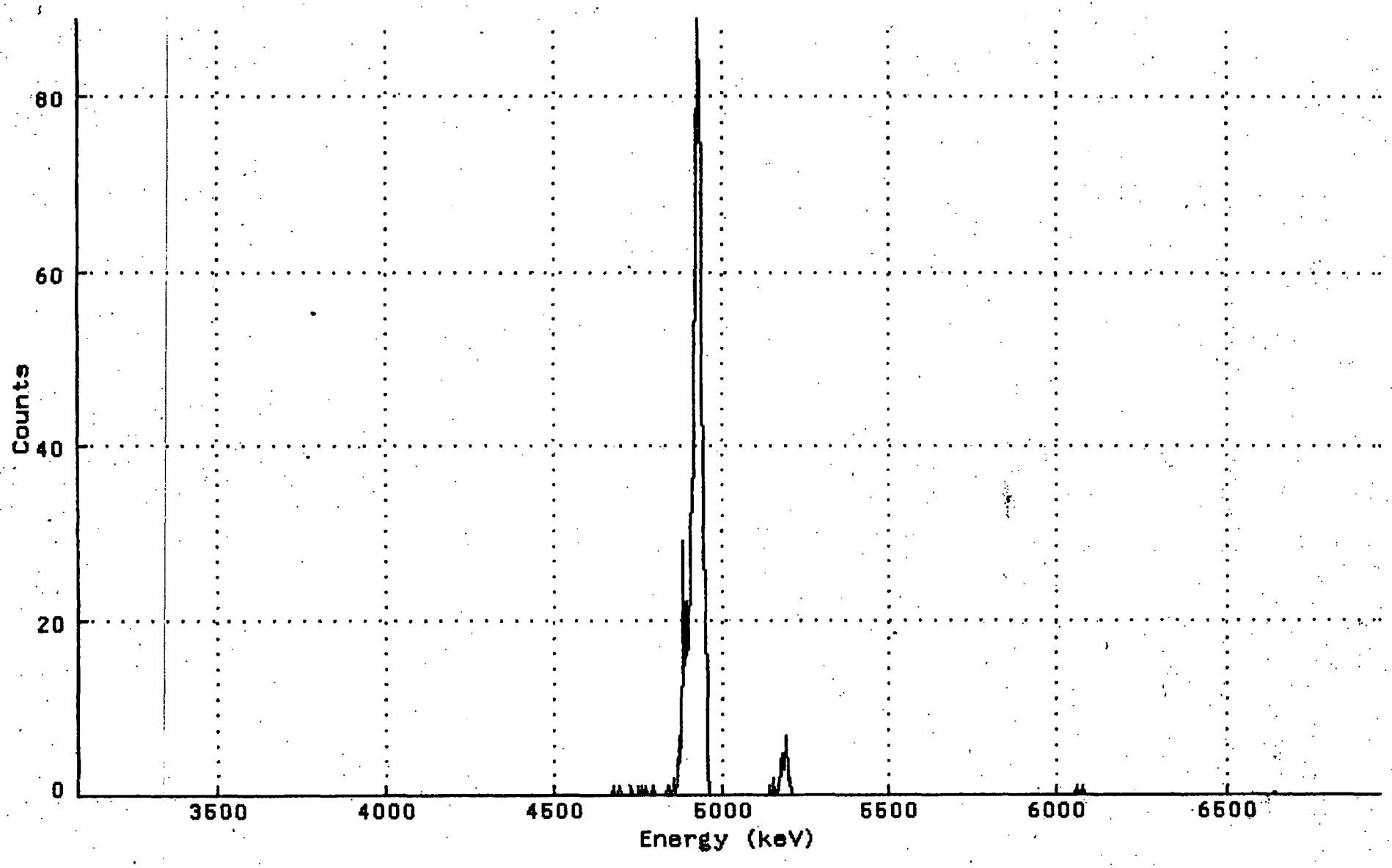
5/2/00
Date

Denn Fam
Reviewer

5/2/00
Date

12

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$002-729009_PU.CNF;1
Title : 002
Sample Title: PU-2 N
Start Time: 1-MAY-2000 16:41: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.07486E+03
Real Time : 0 16:40:04.00 Sample ID : 002-729009 Energy Slope : 4.03519E+00
Live Time : 0 16:40:04.00 Sample Type: PU Energy Quad : -2.44627E-04



13

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:50:17

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$003-729010_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	003-729010
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.530E-01 gram
SAMPLE TITLE:	PU-3 NE	DETECTOR NUMBER:	003
ACQ DATE:	1-MAY-2000 16:42	AVERAGE EFFICIENCY:	21.80%
ELAPSED LIVE TIME:	60002.	RECOVERY:	90.71%
TRACER ID:	950296-PU	TRACER FWHM (kev):	32.44
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:39	EFF CAL DATE:	5-JAN-2000 14:39
BKG FILENAME:	B_003_26APR00	BKG ELAPSED TIME:	180006.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	-0.33	1.33	99.9	-1.374E-03	9.912E-03	3.331E-02
PU-239	5147.7	12.00	1.00	99.9	4.947E-02	3.097E-02	3.034E-02
PU242	4890.7	879.00	1.00	100.4	3.606E+00	4.388E-01	3.019E-02

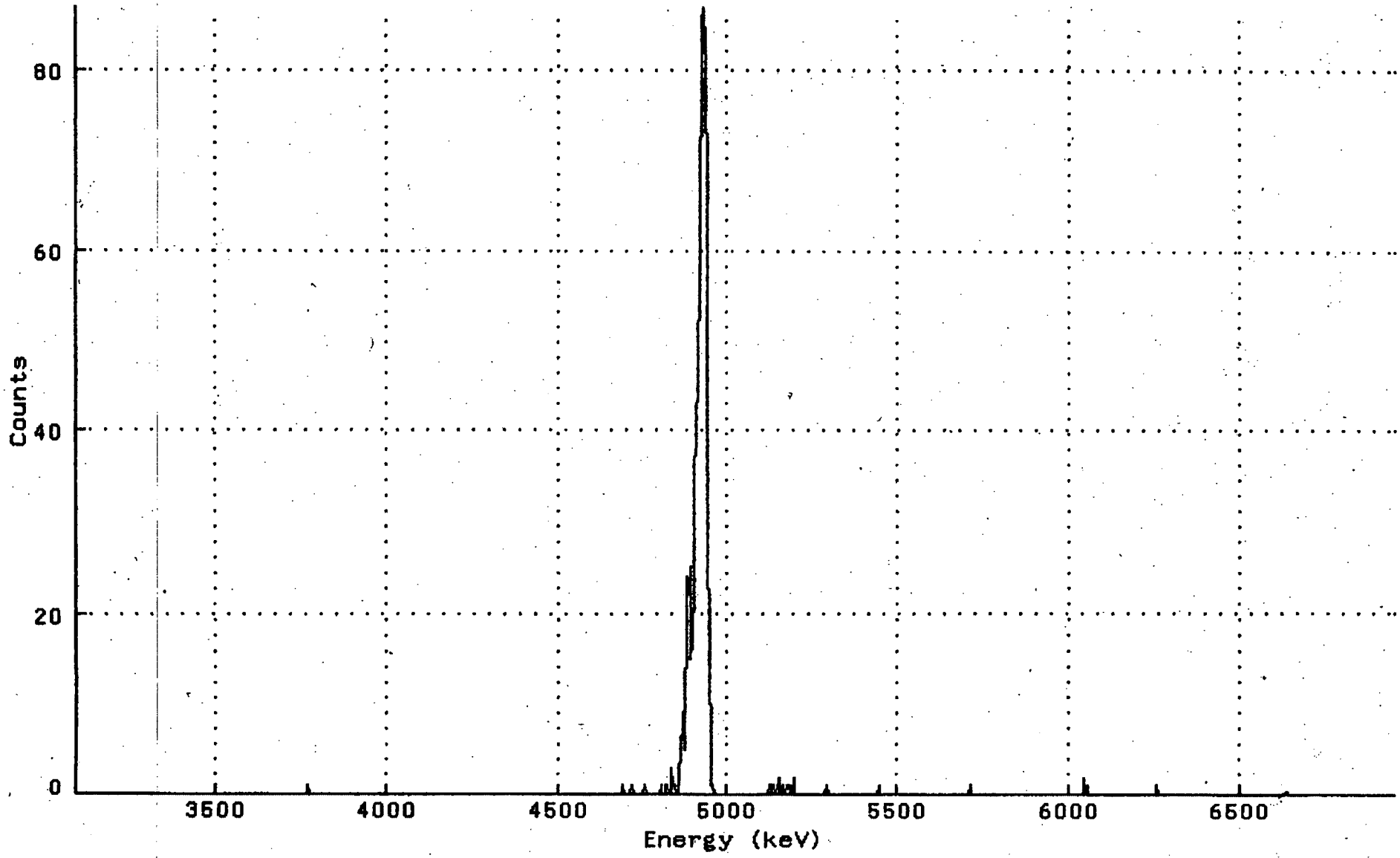
****

James Benetti — Analyst — 5/2/00 Date

Denny Faman — Reviewer — 5/2/00 Date

14

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$003-729010_PU.CNF;1
Title : 003
Sample Title: PU-3 NE
Start Time: 1-MAY-2000 16:42: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.08218E+03
Real Time : 0 16:40:02.00 Sample ID : 003-729010 Energy Slope : 4.01865E+00
Live Time : 0 16:40:02.00 Sample Type: PU Energy Quad : -2.40077E-04



15

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:50:59

Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$004-729011_PU.CNF

BATCH ID:	PU0002	SAMPLE ID:	004-729011
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.530E-01 gram
SAMPLE TITLE:	PU-4 E	DETECTOR NUMBER:	004
ACQ DATE:	1-MAY-2000 16:43	AVERAGE EFFICIENCY:	22.38%
ELAPSED LIVE TIME:	60002.	RECOVERY:	92.34%
TRACER ID:	950296-PU	TRACER FWHM (kev):	27.38
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:39	EFF CAL DATE:	5-JAN-2000 14:39
BKG FILENAME:	B_004_26APR00	BKG ELAPSED TIME:	180000.

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	4.33	0.67	99.9	1.709E-02	1.820E-02	2.567E-02
PU-239	5147.7	5.33	0.67	99.9	2.104E-02	1.992E-02	2.567E-02
PU242	4890.7	918.67	0.33	100.4	3.606E+00	4.355E-01	2.118E-02

James C Benett
Analyst

5/2/00
Date

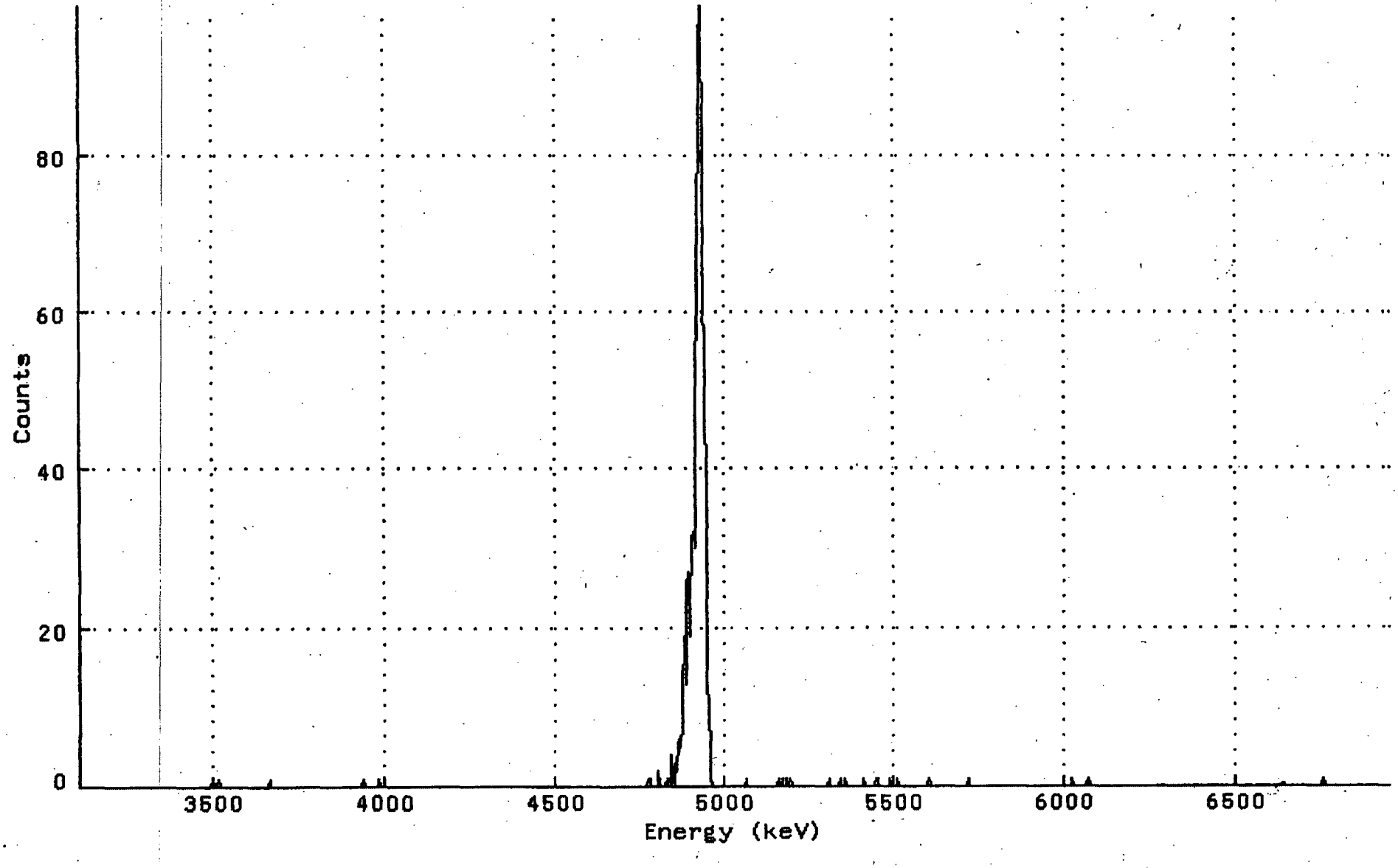
Dennis Fain
Reviewer

5/2/00
Date

16

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$004-729011_PU.CNF;1
Title : 004
Sample Title: PU-4 E

Start Time: 1-MAY-2000 16:43:	Sample Time: 1-MAY-2000 00:00:	Energy Offset: 3.10027E+03
Real Time : 0 16:40:02.00	Sample ID : 004-729011	Energy Slope : 3.98170E+00
Live Time : 0 16:40:02.00	Sample Type: PU	Energy Quad : -2.24756E-04



17

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:52:01

Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$005-729012_PU.CNF

BATCH ID:	PU0002	SAMPLE ID:	005-729012
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.610E-01 gram
SAMPLE TITLE:	PU-5 SE	DETECTOR NUMBER:	005
ACQ DATE:	1-MAY-2000 16:44	AVERAGE EFFICIENCY:	22.07%
ELAPSED LIVE TIME:	60003.	RECOVERY:	87.99%
TRACER ID:	950296-PU	TRACER FWHM (kev):	27.24
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:40	EFF CAL DATE:	5-JAN-2000 14:40
BKG FILENAME:	B_005_26APR00	BKG ELAPSED TIME:	180001.

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	-0.33	1.33	99.9	-1.380E-03	9.952E-03	3.344E-02
PU-239	5147.7	17.00	1.00	99.9	7.037E-02	3.692E-02	3.047E-02
PU242	4890.7	863.00	2.00	100.4	3.554E+00	4.336E-01	3.825E-02

James Benetti
Analyst

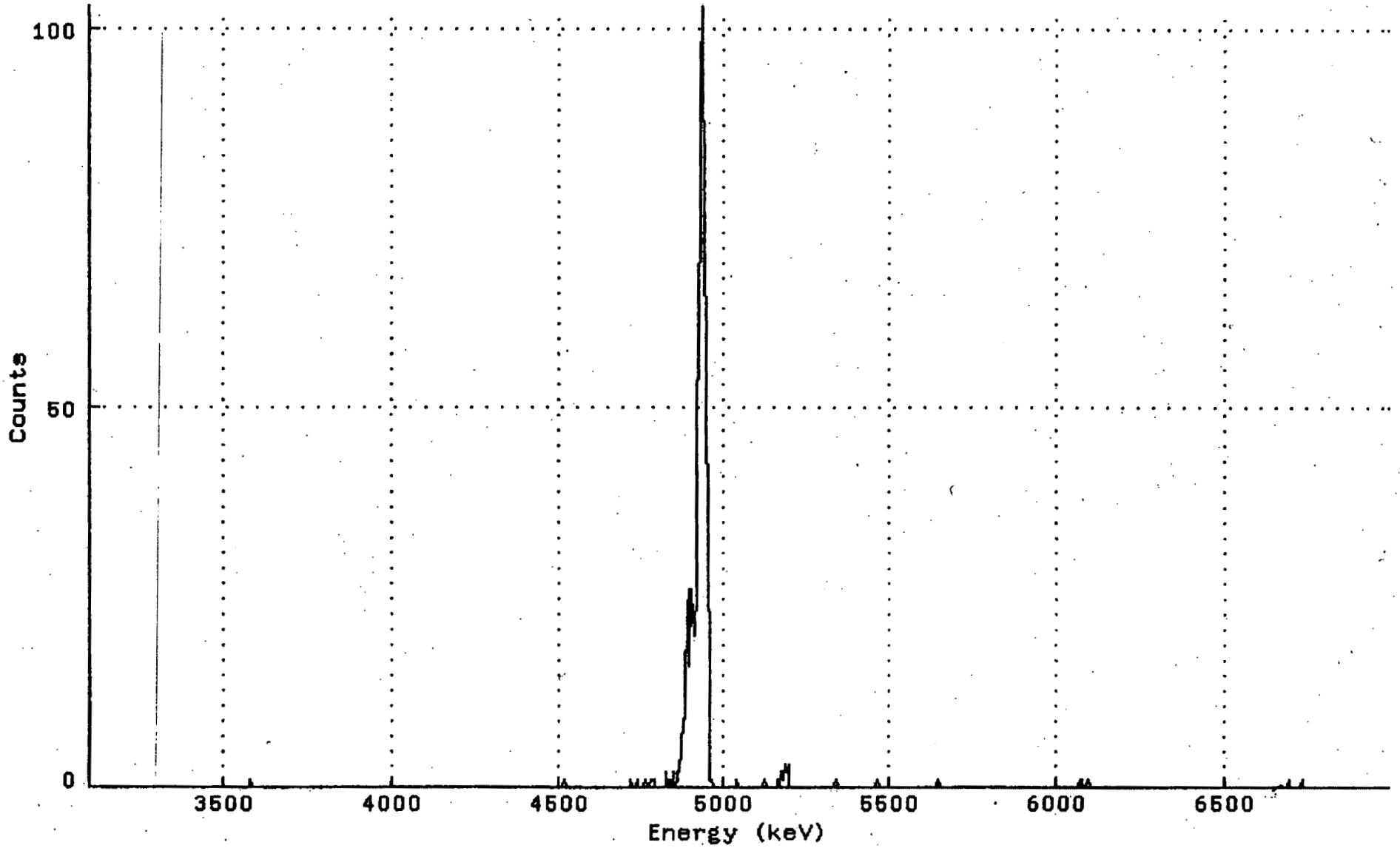
5/2/00
Date

Dennis Jones
Reviewer

5/2/00
Date

18

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$005-729012_PU.CNF;1
Title : 005
Sample Title: PU-5 SE
Start Time: 1-MAY-2000 16:44: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.08657E+03
Real Time : 0 16:40:03.00 Sample ID : 005-729012 Energy Slope : 4.05933E+00
Live Time : 0 16:40:03.00 Sample Type: PU Energy Quad : -2.44211E-04



19

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:52:42

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$006-729013_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	006-729013
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.440E-01 gram
SAMPLE TITLE:	PU-6 S	DETECTOR NUMBER:	006
ACQ DATE:	1-MAY-2000 16:45	AVERAGE EFFICIENCY:	21.44%
ELAPSED LIVE TIME:	60000.	RECOVERY:	90.57%
TRACER ID:	950296-PU	TRACER FWHM (kev):	28.60
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:40	EFF CAL DATE:	5-JAN-2000 14:40
BKG FILENAME:	B_006_26APR00	BKG ELAPSED TIME:	180000.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	2.00	0.00	99.9	8.538E-03	1.214E-02	1.157E-02
PU-239	5147.7	29.33	0.67	99.9	1.252E-01	5.041E-02	2.778E-02
PU242	4890.7	863.00	1.00	100.4	3.666E+00	4.474E-01	3.126E-02

****

James Benetti
Analyst

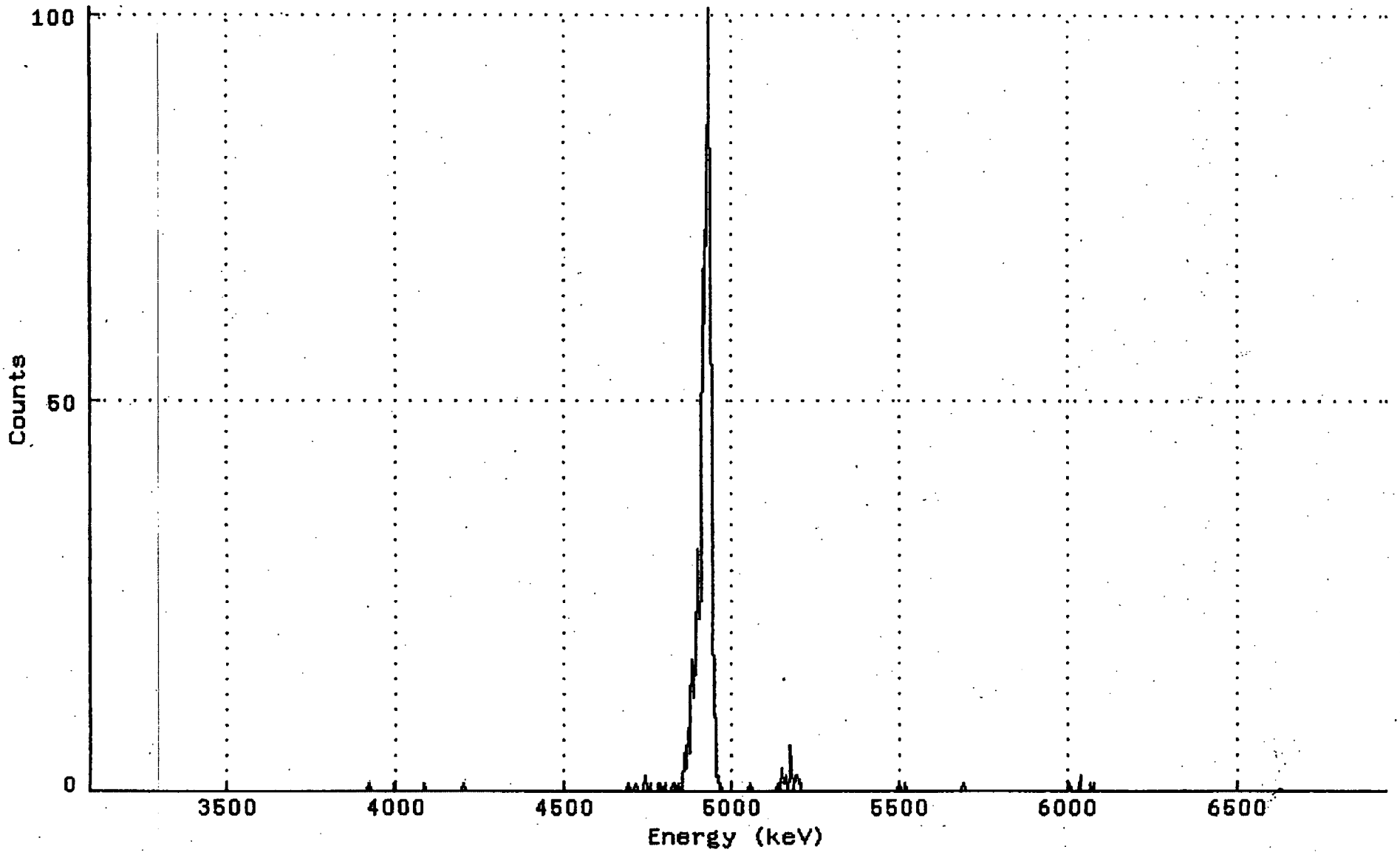
5/2/00
Date

Dennis Kamm
Reviewer

5/2/00
Date

20

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$006-729013_PU.CNF;1
Title : 006
Sample Title: PU-6 S
Start Time: 1-MAY-2000 16:45: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.08489E+03
Real Time : 0 16:40:00.00 Sample ID : 006-729013 Energy Slope : 4.04169E+00
Live Time : 0 16:40:00.00 Sample Type: PU Energy Quad : -2.74555E-04



21

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:53:21

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$007-729014_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	007-729014
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.540E-01 gram
SAMPLE TITLE:	PU-7 SW	DETECTOR NUMBER:	007
ACQ DATE:	1-MAY-2000 16:46	AVERAGE EFFICIENCY:	22.74%
ELAPSED LIVE TIME:	60003.	RECOVERY:	64.44%
TRACER ID:	950296-PU	TRACER FWHM (kev):	29.65
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:40	EFF CAL DATE:	5-JAN-2000 14:40
BKG FILENAME:	B_007_26APR00	BKG ELAPSED TIME:	180001.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	2.00	1.00	99.9	1.111E-02	2.035E-02	4.088E-02
PU-239	5147.7	21.00	0.00	99.9	1.166E-01	5.389E-02	1.505E-02
PU242	4890.7	651.33	1.67	100.4	3.599E+00	4.608E-01	4.815E-02

****

James Benetti
Analyst

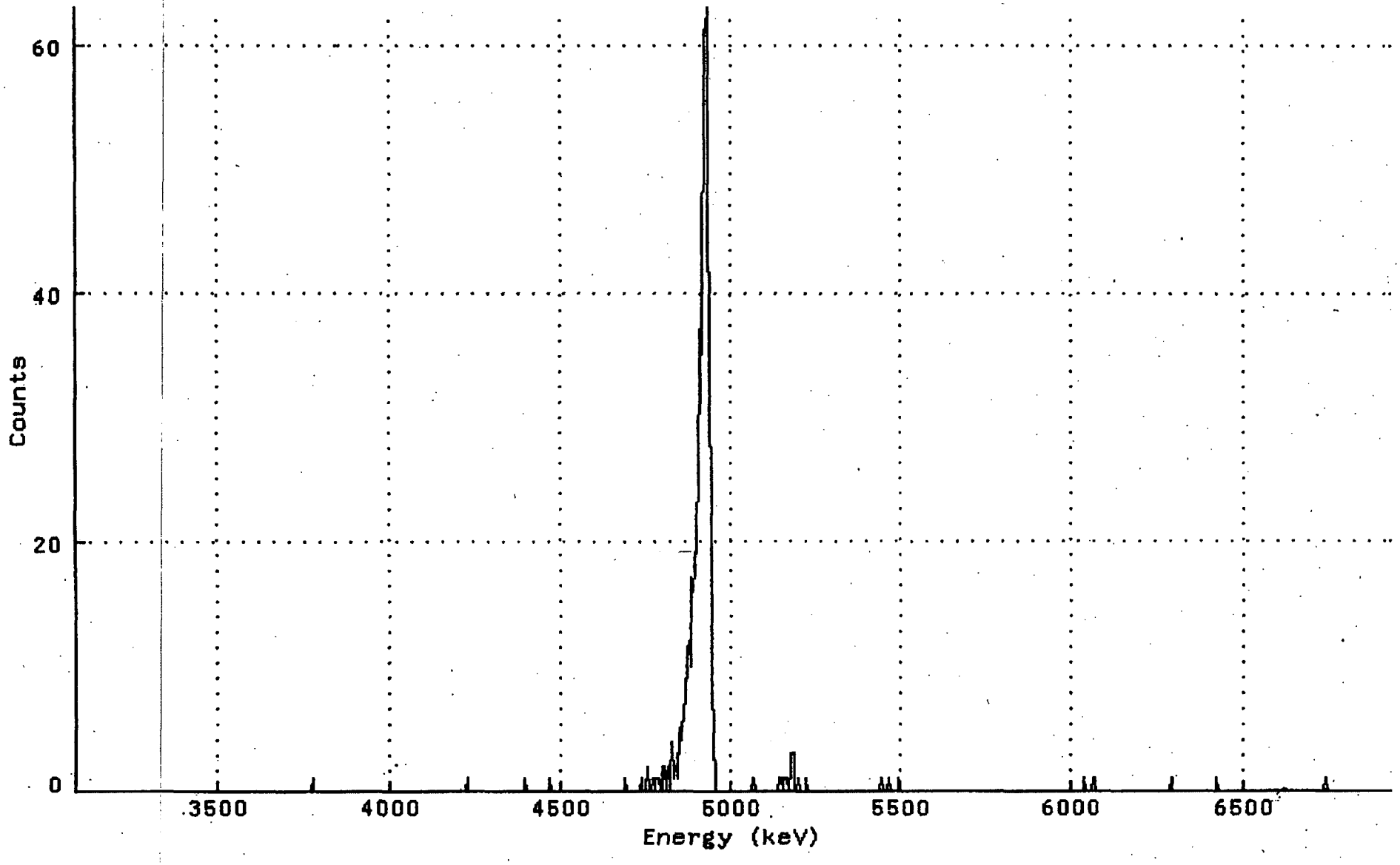
5/2/00
Date

Dennis Farmer
Reviewer

5/2/00
Date

22

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$007-729014_PU.CNF;1
Title : 007
Sample Title: PU-7 SW
Start Time: 1-MAY-2000 16:46: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.07537E+03
Real Time : 0 16:40:04.00 Sample ID : 007-729014 Energy Slope : 4.03741E+00
Live Time : 0 16:40:03.00 Sample Type: PU Energy Quad : -2.73464E-04



23

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:53:59

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$008-729015_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	008-729015
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.480E-01 gram
SAMPLE TITLE:	PU-8 W	DETECTOR NUMBER:	008
ACQ DATE:	1-MAY-2000 16:48	AVERAGE EFFICIENCY:	22.45%
ELAPSED LIVE TIME:	60002.	RECOVERY:	73.52%
TRACER ID:	950296-PU	TRACER FWHM (kev):	25.17
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:40	EFF CAL DATE:	5-JAN-2000 14:40
BKG FILENAME:	B_008_26APR00	BKG ELAPSED TIME:	180000.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	3.67	0.33	99.9	1.828E-02	2.040E-02	2.689E-02
PU-239	5147.7	24.00	1.00	99.9	1.196E-01	5.327E-02	3.669E-02
PU242	4890.7	733.67	1.33	100.4	3.639E+00	4.559E-01	4.007E-02

****

James Benetti
Analyst

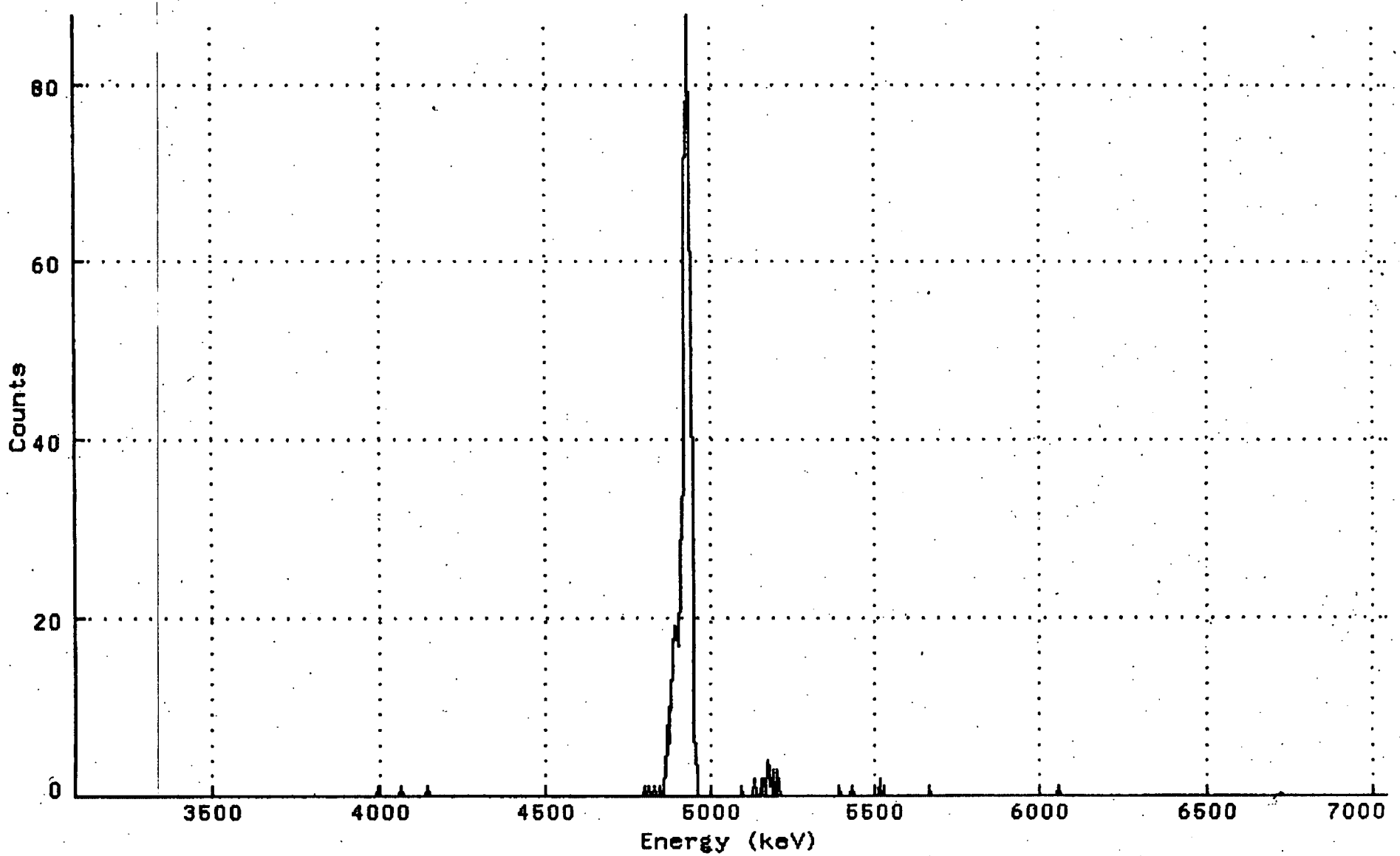
5/2/00
Date

Denn Farm
Reviewer

5/2/00
Date

24

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$008-729015_PU.CNF;1
Title : 008
Sample Title: PU-8 W
Start Time: 1-MAY-2000 16:48: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.07387E+03
Real Time : 0 16:40:02.00 Sample ID : 008-729015 Energy Slope : 4.15796E+00
Live Time : 0 16:40:02.00 Sample Type: PU Energy Quad : -2.84365E-04



25

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:54:43

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$009-729016_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	009-729016
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.520E-01 gram
SAMPLE TITLE:	PU-9 NW	DETECTOR NUMBER:	009
ACQ DATE:	1-MAY-2000 16:49	AVERAGE EFFICIENCY:	22.32%
ELAPSED LIVE TIME:	60004.	RECOVERY:	86.99%
TRACER ID:	950296-PU	TRACER FWHM (kev):	25.06
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	7-JAN-2000 13:40	EFF CAL DATE:	7-JAN-2000 13:40
BKG FILENAME:	B_009_26APR00	BKG ELAPSED TIME:	180002.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	1.00	1.00	99.9	4.207E-03	1.287E-02	3.096E-02
PU-239	5147.7	28.33	0.67	99.9	1.192E-01	4.873E-02	2.737E-02
PU242	4890.7	863.00	1.00	100.4	3.612E+00	4.407E-01	3.081E-02

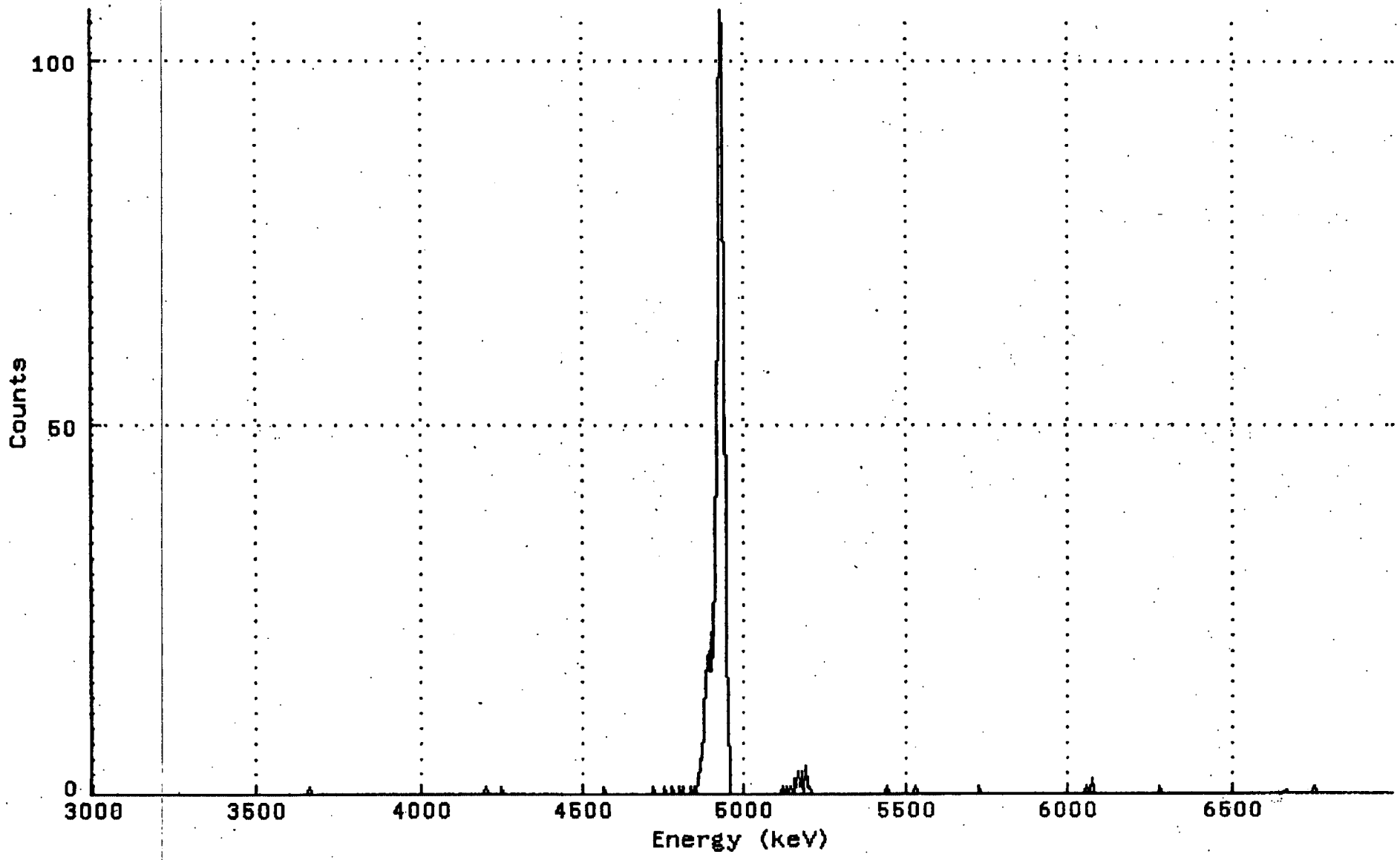
****

James Benetti — Analyst — 5/2/00 — Date

Dennis Farmer — Reviewer — 5/2/00 — Date

26

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$009-729016_PU.CNF;1
Title : 009
Sample Title: PU-9 NW
Start Time: 1-MAY-2000 16:49: Sample Time: 1-MAY-2000 00:00: Energy Offset: 2.98295E+03
Real Time : 0 16:40:04.00 Sample ID : 009-729016 Energy Slope : 4.20950E+00
Live Time : 0 16:40:04.00 Sample Type: PU Energy Quad : -2.90752E-04



27

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:56:03

****
Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$010-999999_PU.CNF
****

BATCH ID:	PU0002	SAMPLE ID:	010-999999
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	1.000E+00 gram
SAMPLE TITLE:	PU-10 RB	DETECTOR NUMBER:	010
ACQ DATE:	1-MAY-2000 16:51	AVERAGE EFFICIENCY:	22.43%
ELAPSED LIVE TIME:	60001.	RECOVERY:	0.17%
TRACER ID:	950296-PU	TRACER FWHM (kev):	65.04
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	5-JAN-2000 14:40	EFF CAL DATE:	5-JAN-2000 14:40
BKG FILENAME:	B_010_26APR00	BKG ELAPSED TIME:	180003.

****

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	-0.33	4.33	99.9	-4.008E-01	5.682E+00	1.490E+01
PU-239	5147.7	-0.33	2.33	99.9	-4.008E-01	4.107E+00	1.180E+01
PU242	4890.7	1.67	1.33	100.4	1.994E+00	4.446E+00	9.666E+00

****

*** Chemical Recovery < 25.0% *** — Tracer not added - disregard machine computed results: net area (counts) in

PU 238 = -0.33
Pu 239 = -0.33
Pu 242 = 1.67

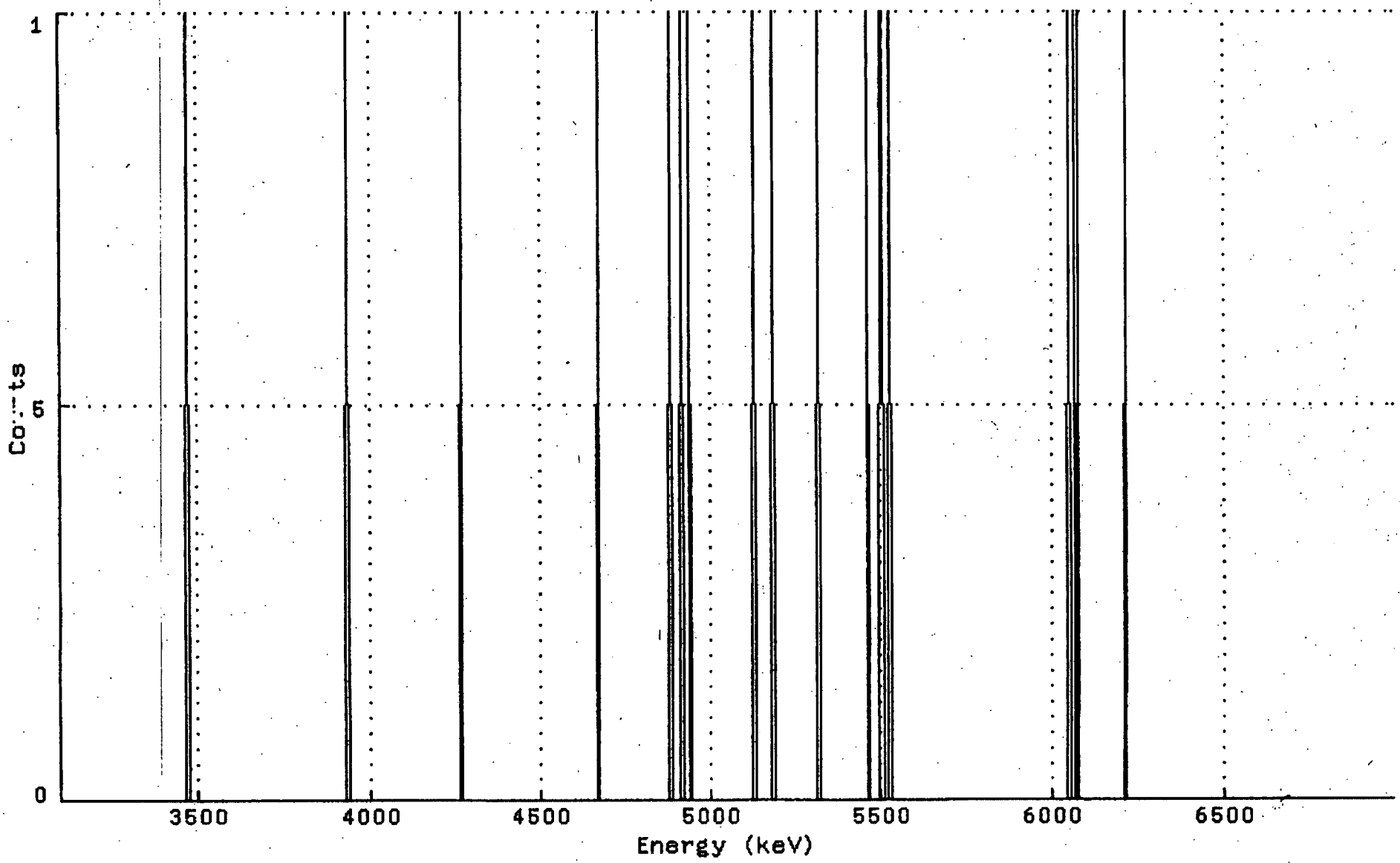
indicates that reagent blank is free of contamination

James Bennett — Analyst — 5/2/00 Date

Dennis Tarn — Reviewer — 5/2/00 Date

28

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$010-999999_PU.CNF;1
Title : 010
Sample Title: PU-10 RB
Start Time: 1-MAY-2000 16:51: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.08886E+03
Real Time : 0 16:40:01.00 Sample ID : 010-999999 Energy Slope : 4.06524E+00
Live Time : 0 16:40:01.00 Sample Type: PU Energy Quad : -2.65022E-04



29

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:56:57

Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$013-729017_PU.CNF

BATCH ID:	PU0002	SAMPLE ID:	013-729017
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.590E-01 gram
SAMPLE TITLE:	PU-11 MB	DETECTOR NUMBER:	013
ACQ DATE:	1-MAY-2000 16:52	AVERAGE EFFICIENCY:	21.49%
ELAPSED LIVE TIME:	60000.	RECOVERY:	91.17%
TRACER ID:	950296-PU	TRACER FWHM (kev):	24.71
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	6-JAN-2000 12:26	EFF CAL DATE:	6-JAN-2000 12:26
BKG FILENAME:	B_013_26APR00	BKG ELAPSED TIME:	180002.

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	0.00	0.00	99.9	0.000E+00	0.000E+00	1.116E-02
PU-239	5147.7	-0.33	0.33	99.9	-1.373E-03	2.752E-03	2.221E-02
PU242	4890.7	870.67	0.33	100.4	3.567E+00	4.348E-01	2.210E-02

James Benetti
Analyst

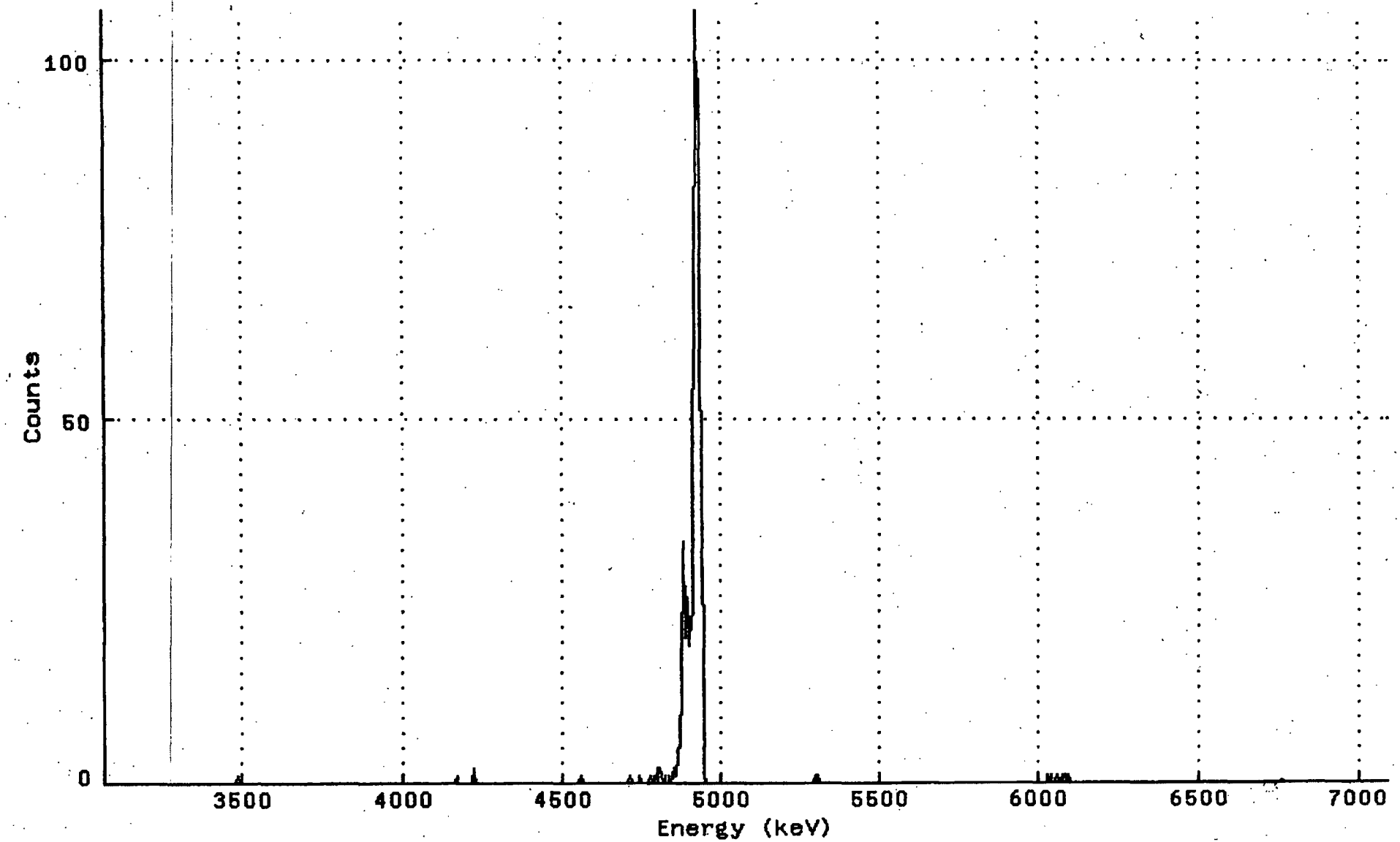
5/2/00
Date

Dennis Tarr
Reviewer

5/2/00
Date

30

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$013-729017_PU.CNF;1
Title : 013
Sample Title: PU-11 MB
Start Time: 1-MAY-2000 16:52: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.05515E+03
Real Time : 0 16:40:01.00 Sample ID : 013-729017 Energy Slope : 4.15873E+00
Live Time : 0 16:40:00.00 Sample Type: PU Energy Quad : -2.18631E-04



31

RADIATION & INDOOR ENVIRONMENTS NAT'L LABORATORY
CENTER FOR RADIOANALYSIS & QUALITY ASSURANCE

ALPHA SPECTROMETRY REPORT
2-MAY-2000 09:57:48

Spectral File: ND_AMS_ARCHIVE_S:S_PU0002$014-729018_PU.CNF

BATCH ID:	PU0002	SAMPLE ID:	014-729018
SAMPLE DATE:	1-MAY-2000 00:00	ALIQUOT:	5.550E-01 gram
SAMPLE TITLE:	PU-12 MS	DETECTOR NUMBER:	014
ACQ DATE:	1-MAY-2000 16:56	AVERAGE EFFICIENCY:	21.36%
ELAPSED LIVE TIME:	60002.	RECOVERY:	74.37%
TRACER ID:	950296-PU	TRACER FWHM (kev):	24.16
LAMBDA VALUE:	1000.	ROI TYPE:	STANDARD
TRACER DPM AT SAMPLE DATE:	4.427	CONFIDENCE FACTOR:	4.65
SAMPLE MATRIX:	SOIL	LLD CONSTANT:	2.71
ENERGY CAL DATE:	6-JAN-2000 12:26	EFF CAL DATE:	6-JAN-2000 12:26
BKG FILENAME:	B_014_26APR00	BKG ELAPSED TIME:	180003.

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	NET AREA	BKG	%ABN	ACTIVITY pCi/ gram	TPU/ERROR 2-SIGMA	MDC pCi/ gram
PU-238	5487.1	0.00	1.00	99.9	-8.597E-08	1.181E-02	3.764E-02
PU-239	5147.7	1497.33	0.67	99.9	7.658E+00	1.217E+00	3.328E-02
PU242	4890.7	706.00	1.00	100.4	3.593E+00	4.535E-01	3.746E-02

James Benetti
Analyst

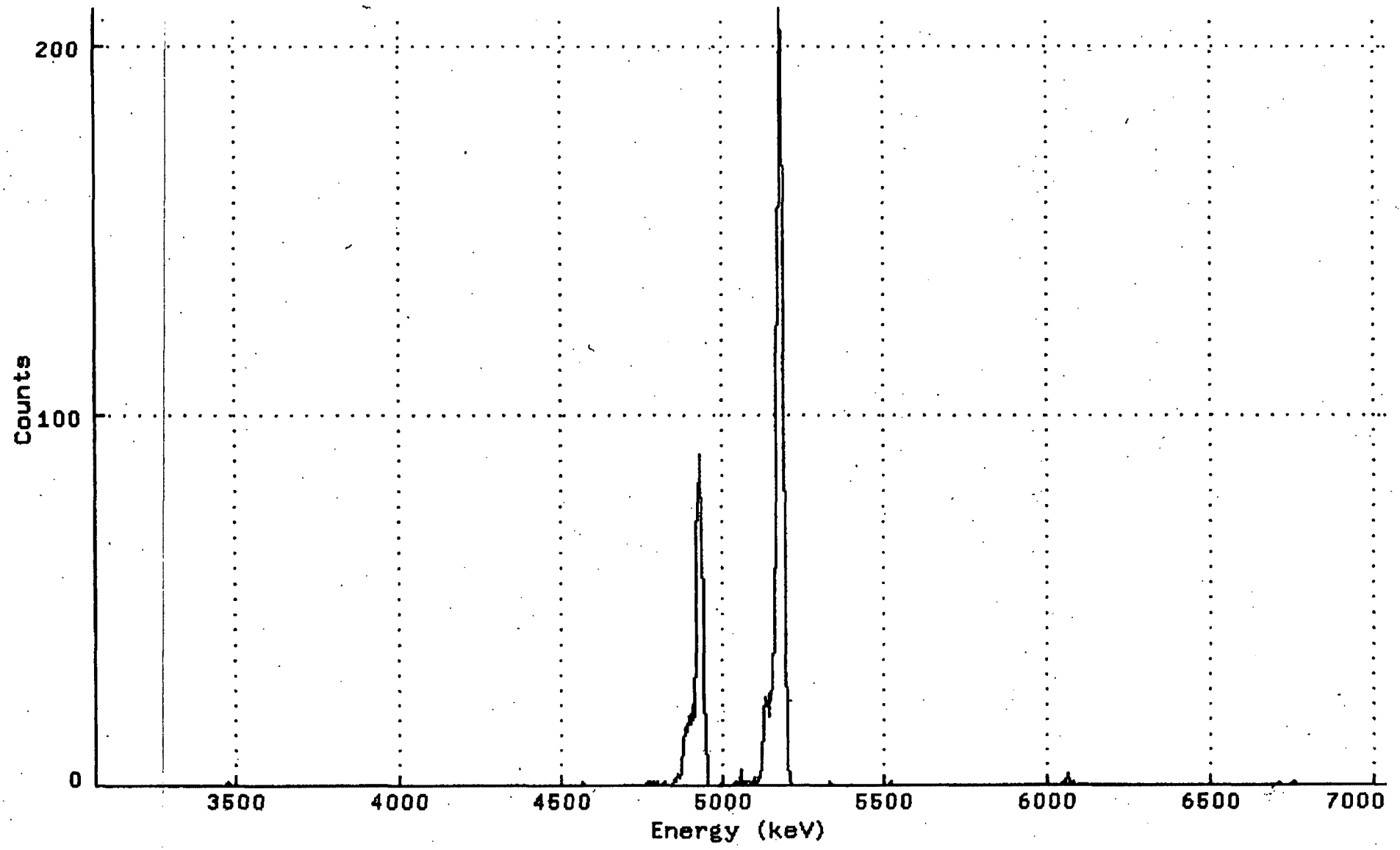
5/2/00
Date

Denn Farm
Reviewer

5/2/00
Date

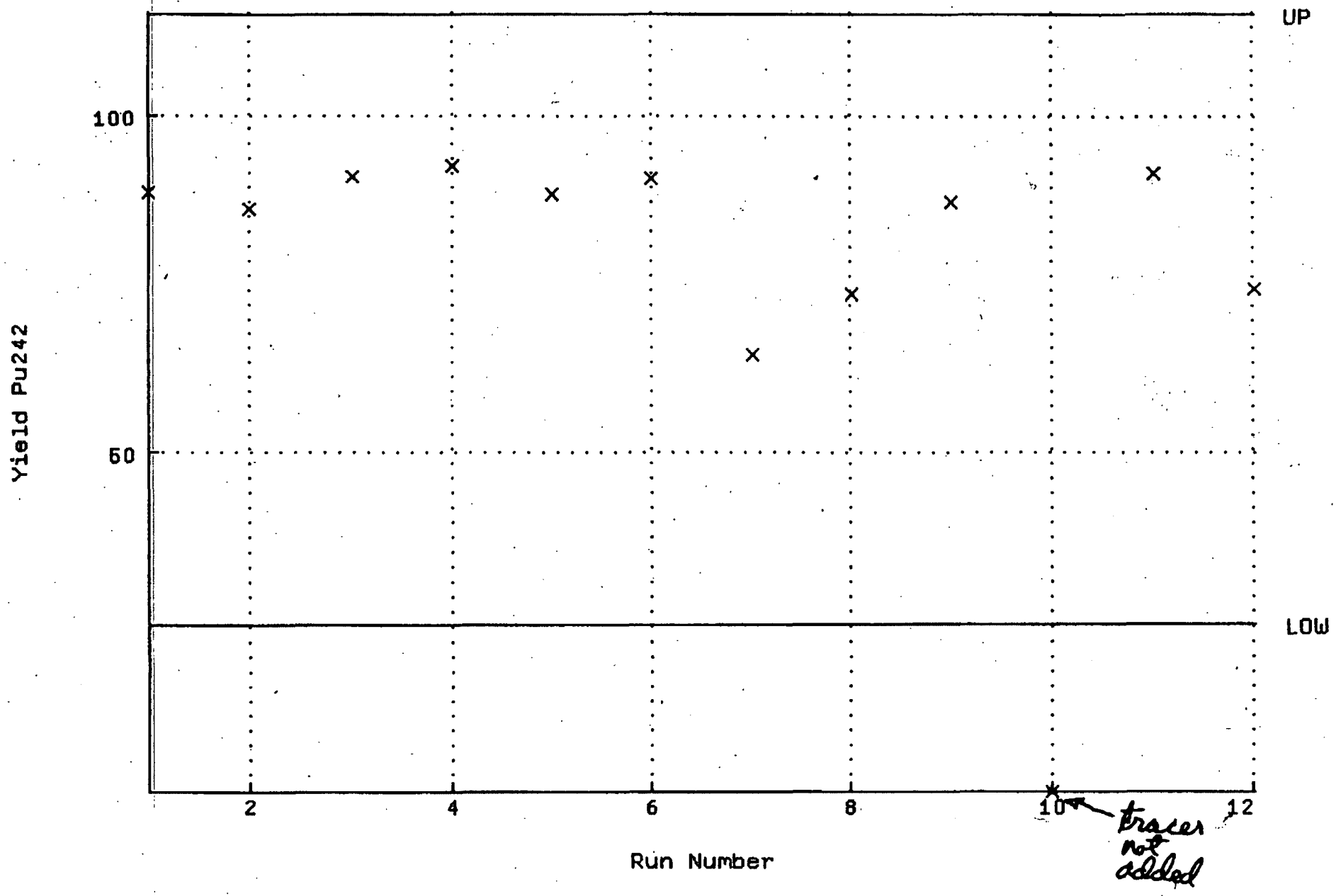
32

Spectrum : DKA200:[ALPHA.ALUSR.ARCHIVE.S]S_PU0002$014-729018_PU.CNF;1
Title : 014
Sample Title: PU-12 MS
Start Time: 1-MAY-2000 16:56: Sample Time: 1-MAY-2000 00:00: Energy Offset: 3.05990E+03
Real Time : 0 16:40:02.00 Sample ID : 014-729018 Energy Slope : 4.16545E+00
Live Time : 0 16:40:02.00 Sample Type: PU Energy Quad : -2.82410E-04



33

QA filename : DKA200:[ALPHA.ALUSR.QA.Y]PU0002_Y_PU_SOIL.QAF;1
Parameter Name : NCLSP1-PU242 (Yield Pu242)
Start/End Dates : 1-MAY-2000 16:40:08 through 1-MAY-2000 16:56:04
Lower/Upper Lmts: 25.0000 through 115.000



34

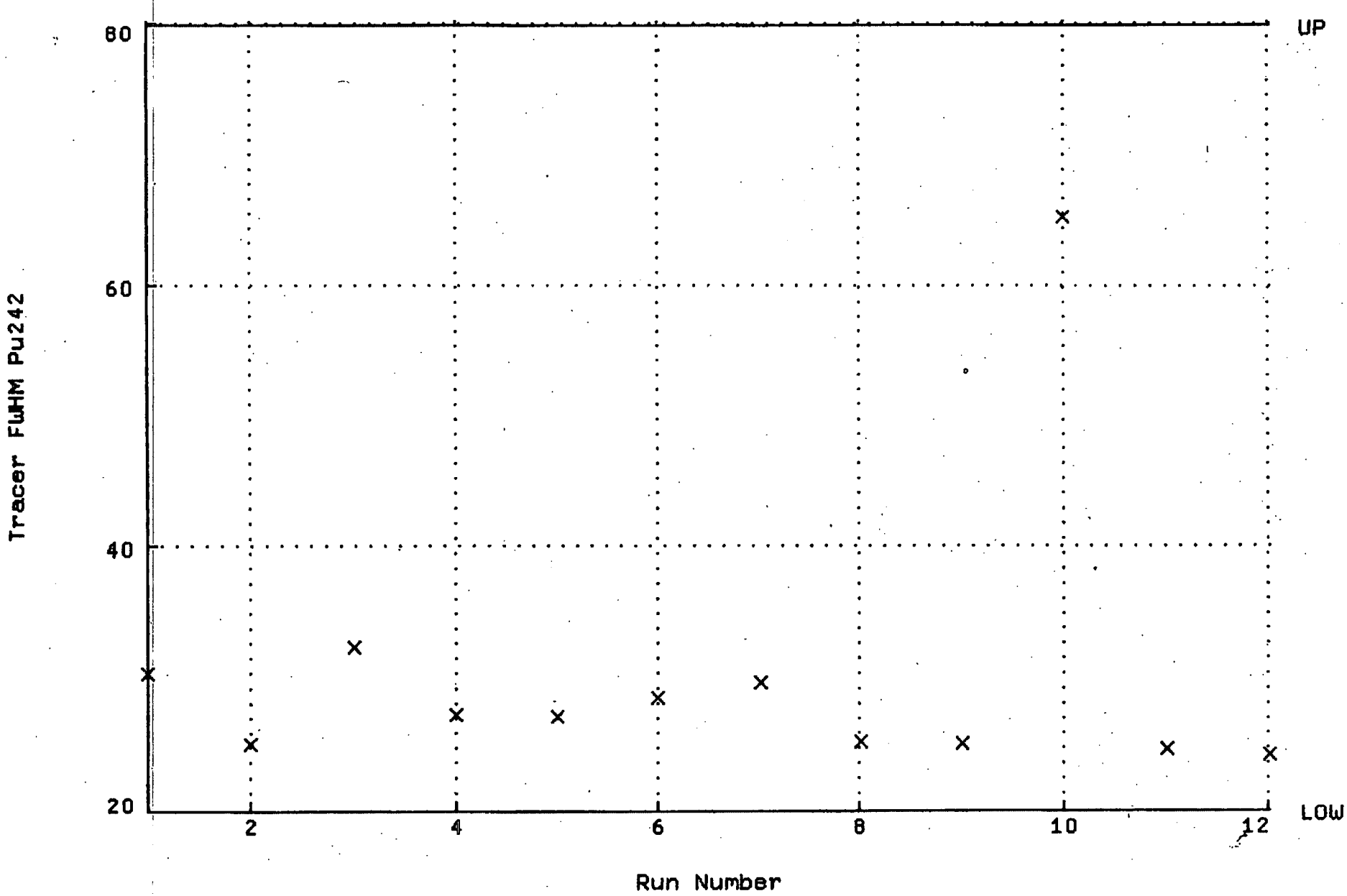
VMS Quality Assurance Report V1.3 Generated 2-MAY-2000 09:58:01

QA filename : DKA200:[ALPHA.ALUSR.QA.Y]PU0002_Y_PU_SOIL.QAF;1

Parameter Name	: NCLSP1-PU242		
Description	: Yield Pu242		
Parameter Units	: %	Parameter Type	: CONFIGURATION
Num Points Used	: 12	Num Records Read	: 12
Start Date	: 1-MAY-2000 16:40:08	End Date	: 1-MAY-2000 16:56:04
Minimum Value	: 0.167213	Minimum Date	: 1-MAY-2000 16:51:32
Maximum Value	: 92.3364	Maximum Date	: 1-MAY-2000 16:43:38
Out-of-range Test	: BOUNDARY	Test Source	: QAANALYZE COMMAND
Lower Limit	: 25	Upper Limit	: 115

Measurement Time	Sample ID	Value	Flags
1-MAY-2000 16:40:08	PU0002_001-72900	88.4088	
1-MAY-2000 16:41:43	PU0002_002-72900	85.9090	
1-MAY-2000 16:42:35	PU0002_003-72901	90.7147	
1-MAY-2000 16:43:38	PU0002_004-72901	92.3364	
1-MAY-2000 16:44:52	PU0002_005-72901	87.9925	
1-MAY-2000 16:45:47	PU0002_006-72901	90.5750	
1-MAY-2000 16:46:41	PU0002_007-72901	64.4374	
1-MAY-2000 16:48:48	PU0002_008-72901	73.5231	
1-MAY-2000 16:49:44	PU0002_009-72901	86.9888	
1-MAY-2000 16:51:32	PU0002_010-99999	0.167213	Below (tracer not added)
1-MAY-2000 16:52:44	PU0002_013-72901	91.1694	
1-MAY-2000 16:56:04	PU0002_014-72901	74.3667	

QA filename : DKA200:[ALPHA.ALUSR.QA.Y]PU0002_Y_PU_SOIL.QAF;1
Parameter Name : PSFWHM-PU242 (Tracer FWHM Pu242)
Start/End Dates : 1-MAY-2000 16:40:08 through 1-MAY-2000 16:56:04
Lower/Upper Lmts: 20.0000 through 80.0000



36

VMS Quality Assurance Report V1.3 Generated 2-MAY-2000 09:58:04

QA filename : DKA200:[ALPHA.ALUSR.QA.Y]PU0002_Y_PU_SOIL.QAF;1

Parameter Name	: PSFWHM-PU242		
Description	: Tracer FWHM Pu242		
Parameter Units	: KEV	Parameter Type	: CONFIGURATION
Num Points Used	: 12	Num Records Read	: 12
Start Date	: 1-MAY-2000 16:40:08	End Date	: 1-MAY-2000 16:56:04
Minimum Value	: 24.1627	Minimum Date	: 1-MAY-2000 16:56:04
Maximum Value	: 65.0438	Maximum Date	: 1-MAY-2000 16:51:32
Out-of-range Test	: BOUNDARY	Test Source	: QAANALYZE COMMAND
Lower Limit	: 20	Upper Limit	: 80

Measurement Time	Sample ID	Value	Flags
1-MAY-2000 16:40:08	PU0002_001-72900	30.4873	
1-MAY-2000 16:41:43	PU0002_002-72900	25.0831	
1-MAY-2000 16:42:35	PU0002_003-72901	32.4355	
1-MAY-2000 16:43:38	PU0002_004-72901	27.3842	
1-MAY-2000 16:44:52	PU0002_005-72901	27.2447	
1-MAY-2000 16:45:47	PU0002_006-72901	28.6006	
1-MAY-2000 16:46:41	PU0002_007-72901	29.6497	
1-MAY-2000 16:48:48	PU0002_008-72901	25.1708	
1-MAY-2000 16:49:44	PU0002_009-72901	25.0559	
1-MAY-2000 16:51:32	PU0002_010-99999	65.0438	
1-MAY-2000 16:52:44	PU0002_013-72901	24.7055	
1-MAY-2000 16:56:04	PU0002_014-72901	24.1627	

Review of QA results (Tracer Yields/FWHM) 2-MAY-2000 09:58:05

Detector	Parameter	Flag	Filename
1	ALL	Passed	S_PU0002$001-729008_PU
2	ALL	Passed	S_PU0002$002-729009_PU
3	ALL	Passed	S_PU0002$003-729010_PU
4	ALL	Passed	S_PU0002$004-729011_PU
5	ALL	Passed	S_PU0002$005-729012_PU
6	ALL	Passed	S_PU0002$006-729013_PU
7	ALL	Passed	S_PU0002$007-729014_PU
8	ALL	Passed	S_PU0002$008-729015_PU
9	ALL	Passed	S_PU0002$009-729016_PU
10	YIELD-PU242	Below	S_PU0002$010-999999_PU
13	ALL	Passed	S_PU0002$013-729017_PU
14	ALL	Passed	S_PU0002$014-729018_PU

ND_AMS_QA_Y:PU0002_Y_PU_SOIL.QAF

APPROVAL DATE: 5/2/00 APPROVAL TIME: 1100 hr.

APPROVED BY: J. Benetti PROCEDURE # RQA-502, 606

Report completed at 2-MAY-2000 09:58:24

National Institute of Standards & Technology

Certificate

THIS IS A PHOTOCOPY OF THE CER[illegible] WHICH IS BEING MAILED TO YOU UNDER SEPARATE COVER.

Standard Reference Material 4334E
Radioactivity Standard

Radionuclide	Plutonium-242
Source identification	4334E
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule (1)*
Solution mass	Approximately 5.8 grams
Solution composition	Plutonium-242 in 5 mol·L^{-1} nitric acid (2)
Reference time (Purification time)	1200 EST, 18 December 1989
Radioactivity concentration	26.37 Bq·g^{-1}
Overall uncertainty	1.12 percent (3)
Radionuclidic impurities	See Table 1 (4)
Half life	(3.733 ± 0.012) x 10^5 years (5)
Measuring instrument	Two 4$\pi\alpha$ liquid-scintillation counters, a calibrated germanium detector system, and a silicon surface-barrier detector

This standard reference material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M. Robin Hutchinson, Acting Group Leader.

Gaithersburg, MD
January 1993

William P. Reed, Chief
Standard Reference Materials Program

*Notes on back

39

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P.O. BOX 93478
LAS VEGAS, NEVADA 89193-3478
702/798-2100

Calibration Certificate

Description

Principal Radionuclide	Pu-239
Total Mass of this Solution	Approx. 5 grams
Total Activity	Approx. 62 nanocuries
Half-life	24,110 ± 30 years
Activity Concentration	12.4 nanocuries/gram
Date and Time of Standardization	February 2, 1995 0400 hours PST
Solution Number	94002-1

Measurement

Method of Measurement:

The activity of the primary solution was measured by liquid scintillation counting. The activity of the dilution was also measured by liquid scintillation counting.

Activity of daughter radionuclide:

The principal activity was accompanied at the quoted time by :
[ ] of the daughter nuclide..... [ ]

Useful Life

We recommend that this solution should not be used after..... 2001