



October 15, 2009

Mr. Frank Hagar  
Northgate Environmental Management, Inc.  
1100 Quail St., Suite 102  
Newport Beach, California 92660

Re: Tronox Henderson  
Work Order: 235945

Dear Mr. Hagar:

GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on August 25, 2009, September 11, 2009, September 16, 2009 and September 17, 2009. This original data report has been prepared and reviewed in accordance with GEL's standard operating procedures.

Our policy is to provide high quality, personalized analytical services to enable you to meet your analytical needs on time every time. We trust that you will find everything in order and to your satisfaction. If you have any questions, please do not hesitate to call me at (843) 556-8171, ext. 4453.

Sincerely,

Edith Kent  
Project Manager

Chain of Custody: 2027.001.00622, 2027.001.00733, 2027.001.00778 and 2027.001.00796  
Enclosures

**Tronox LLC**  
**Tronox Henderson**  
**SDG:235945**

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# **Case Narrative**

**CASE NARRATIVE**  
**for**  
**Tronox LLC**  
**Tronox Henderson**  
**SDG:235945**

**October 15, 2009**

**Laboratory Identification:**

GEL Laboratories LLC  
2040 Savage Road  
Charleston, South Carolina 29407  
(843) 556-8171

**Summary**

**Sample receipt**

The samples arrived at GEL Laboratories LLC, Charleston, South Carolina on August 25, 2009, September 11, 2009, September 16, 2009 and September 17, 2009 for analysis. Shipping container temperatures were checked, documented, and within specifications. The samples were delivered with proper chain of custody documentation and signatures. All sample containers arrived without any visible signs of tampering or breakage. There was no time of collection on the sample container for SA128-29BSPLP. The collection time on the chain of custody was used.

**Items of Note**

The SDG was initially closed after the 14 day time limit expired on September 10, 2009. However, the lab received additional samples prior to the SPLP fluid being ordered on September 11, 16, and 17. Permission was given by the client to add those samples to the SDG. The SDG was closed on September 17, 2009 with the due date for the SDG being calculated from that date. Please refer to the attached e-mails for further details.

**QC Issues**

The following samples did not meet the Tronox QA program sample result uncertainty limit of <30% for Alpha Spec Uranium with the results between 2 and 5 times the MDA and were counted for the maximum time: 235945005 and 235945006. The following samples did not meet the Tronox QA program sample tracer yield requirements of 70-120% for Alpha Spec Uranium due to matrix issues: and 235945005. The following samples did not meet the Tronox QA program sample result uncertainty limit of <30% for Alpha Spec Thorium with the results greater than 5 times the MDA and were counted for the maximum time: and 235945003. In the Thorium batch, samples 235945004, 235945005, 235945006, and the tumble blank did not meet the Tronox QA program required detection limits. If a larger aliquot size had been used it would most likely have resulted in lower tracer yields. The Thorium method blank did not meet the contract detection limits in order to keep the aliquot size consistent with sample aliquots. Samples were counted the maximum count time to achieve the lowest possible MDAs. Sample 235945003 and the lab DUP did not meet the Tronox QA program sample result uncertainty limit of <30% for Alpha Spec Thorium with the results between 2 and 5 times the MDA and was counted for the maximum time. For the Uranium batch, the lab DUP did not meet the Tronox QA program required detection limits due to limited aliquot size. Also, the lab DUP did not meet thr Tronox QA program required tracer yield requirements of 70-120%. Please refer to the attached e-mail for further details.

**Sample Identification**

The laboratory received the following samples:

<b><u>Laboratory ID</u></b>	<b><u>Client ID</u></b>
235945001	SA64-10BSPLP
235945002	SA102-10BSPLP
235945003	SA102-30BSPLP

235945004	SA30-9BSPLP
235945005	SA128-10BSPLP
235945006	SA128-29BSPLP

**Case Narrative**

Sample analyses were conducted using methodology as outlined in GEL Laboratories, LLC (GEL) Standard Operating Procedures. Any technical or administrative problems during analysis, data review, and reduction are contained in the analytical case narratives in the enclosed data package.

**Data Package**

The enclosed data package contains the following sections: Case Narrative, Chain of Custody, Cooler Receipt Checklist, Data Package Qualifier Definitions and data from the following fractions: Radiochemistry.

This data package, to the best of my knowledge, is in compliance with technical and administrative requirements.



Edith Kent

Project Manager

**Chain of Custody  
and  
Supporting  
Documentation**



1100 Quail Street, Suite 102, Newport Beach, CA 92660 (949) 260-9253

# CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

COC No. 2027.001.00622  
Page: 2 of 2  
Cooler # 1 of 1  
Collection Area: II

235941%

Required Ship to Lab:		Required Project Information:		Required Invoice Information:		TAT: Standard 30 day		Rush	Mark One								
Lab Name:	GEL Laboratories, LLC	Site ID #:	TRONOX LLC, HENDERSON	Send Invoice to:	Susan Crowley Tronox LLC			<input checked="" type="checkbox"/>									
Address:	2040 Savage Road Charleston, SC 29407	Project #:	2027.001	Address:	PO Box 55												
Lab PM:	Edith M. Kent	Site Address:	560 W. Lake Mead Drive Henderson	City/State:	Henderson, NV 89009	Phone #:	(949)260-9253										
Phone/Fax:	(949)556-8171	State:	NV	Reimbursement project?	<input checked="" type="checkbox"/>	Non-reimbursement project?											
Lab PM email:	emk@gel.com	Site PM Name:	Derrick Willis	Send EDD to:	frank.hagar@ngem.com	CC Hardcopy report to:	PDF Electronic Version Only										
Applicable Lab Guide #:		Phone/Fax:	949-375-7004	CC Hardcopy report to:	derrick.willis@ngem.com												
<b>SAMPLE ID</b> One Character per box. (A-Z, 0-9 / -) <b>Samples IDs MUST BE UNIQUE</b>		<b>VALID MATRIX CODES</b> MATRIX: WP WATER, WSW WASTE WATER, WWC WASTE COOLANT, WWP WASTE PRODUCT, WWS WASTE SLAG, WOT WASTE OIL, WOC WASTE OTHER, WAT WASTE ANIMAL TISSUE, WAA WASTE AMBIENT AIR, WAAE AMBIENT AIR, WAAE AMBIENT AIR															
#	ITEM	SAMPLE TYPE	SAMPLE DATE	SAMPLE TIME	# OF CONTAINERS	FIELD FILTERED? (Y/N)	UNPRESERVED	H2SO4	HNO3	HCl	NaOH	NH2SO3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.	
1	SA64-10BSPLP	G	8/24/2009	8:34	1	N	X								X X X X	1 Liter Nalgene	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
Additional Comments/Special Instructions:		RELINQUISHED BY / AFFILIATION		DATE		TIME		ACCEPTED BY / AFFILIATION		DATE		TIME		SAMPLE RECEIPT CONDITIONS		Temp in OC	
Samples are SPLPs and require two leachates: pH adjusted water and pore water.		Patrick Ferringer		8/24/09		8:34		Patrick Ferringer		8/25/09		08:50		Y/N Y/N Y/N Y/N Y/N		Y/N Y/N Y/N Y/N Y/N	
FULL DIGESTION SPECIFICATION Radionuclides* includes Thorium (isotopic) and Uranium (isotopic) by EML HASL 300 modified(alpha spectroscopy)		SHIPPING METHOD: (mark as appropriate)		SAMPLER NAME AND SIGNATURE		DATE SIGNED		TIME		SIGNATURE OF SAMPLER		DATE SIGNED		TIME		TRIP BLANK?	
All PDF reports and EDDs will be uploaded to: Northgate Environmental Management, Inc. FTP site address provided to labs Notifications provided to:		US MAIL		Patrick Ferringer		8/24		1440		Patrick Ferringer		8/24		1440		Sample Intact?	



**SAMPLE RECEIPT & REVIEW FORM**

Client: Kees / Northwest SDG/ARCOC/Work Order: 2359411  
 Received By: MK Date Received: 8-25-09

Suspected Hazard Information

COC/Samples marked as radioactive?  Yes  No \*If Counts > x2 area background on samples not marked "radioactive", contact the Radiation Safety Group of further investigation.

Classified Radioactive II or III by RSO?  Yes  No Maximum Counts Observed\*: over 20

COC/Samples marked containing PCBs?  Yes  No

Shipped as a DOT Hazardous?  Yes  No Hazard Class Shipped: \_\_\_\_\_ UN#: \_\_\_\_\_

Samples identified as Foreign Soil?  Yes  No

Sample Receipt Criteria		Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Circle Applicable: seals broken    damaged container    leaking container    other (describe)
2	Samples requiring cold preservation within 0 ≤ 6 deg. C?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	ice bags    blue ice    Preservation Method: dry ice <u>none</u> other (describe)
3	Chain of custody documents included with shipment?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>doc</u>
4	Sample containers intact and sealed?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Circle Applicable: seals broken    damaged container    leaking container    other (describe)
5	Samples requiring chemical preservation at proper pH?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6	VOA vials free of headspace (defined as < 6mm bubble)?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's and containers affected:
7	Are Encore containers present?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	(if yes, immediately deliver to Volatiles laboratory)
8	Samples received within holding time?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Id's and tests affected:
9	Sample ID's on COC match ID's on bottles?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's affected:
11	Number of containers received match number indicated on COC?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's affected:
12	COC form is properly signed in relinquished/received sections?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Comments:

FX 7968 8736 7534

PM (or PMA) review: Initials EM Date 8/25/09

20090853527

2359419



1100 Quail Street, Suite 102, Newport Beach, CA 92660  
(949) 260-9293

**CHAIN-OF-CUSTODY / Analytical Request Document**  
The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

COC No. 2027.001.00733  
Page: 2 of 2  
Cooler # 1 of 1  
Collection Area: II

Required Ship to Lab:		Required Project Information:		Required Invoice Information:		TAT: Standard 30 day		Rush		Mark One																										
Lab Name: GEL Laboratories, LLC		Site ID #: TRONOX LLC, HENDERSON		Send Invoice to: Susan Crowley Tronox LLC		If Rush, Date due																														
Address: 2040 Savage Road		Project #: 2027.001		Address: PO Box 55		QC level Required: Standard		Special		EPA Stage Mark one																										
Charleston, SC 29407		Site Address: 560 W. Lake Mead Drive		City/State: Henderson, NV 89009		Phone #: (949) 260-9293				4																										
Lab PM: Edith M. Kent		City: Henderson		State: NV		Reimbursement project? <input checked="" type="checkbox"/>		Non-reimbursement project? <input type="checkbox"/>		Mark one																										
Phone/Fax: (843) 556-4171		Site PM Name: Derrick Willis		Send EDD to: frank.hagar@ngem.com		Reimbursement project? <input checked="" type="checkbox"/>		Non-reimbursement project? <input type="checkbox"/>		Mark one																										
Lab PM email: emk@gel.com		Phone/Fax: 949-375-7004		Site PM Email: derrick.willis@ngem.com		Send EDD to: frank.hagar@ngem.com		Reimbursement project? <input checked="" type="checkbox"/>		Mark one																										
Applicable Lab Quote #:		Site PM Email: derrick.willis@ngem.com		CC Hardcopy report to: PDF Electronic Version Only		Send EDD to: frank.hagar@ngem.com		Reimbursement project? <input checked="" type="checkbox"/>		Mark one																										
		CC Hardcopy report to: see additional comments below																																		
#	ITEMS	SAMPLE ID One Character per box. (A-Z, 0-9 / -)	Samples IDs MUST BE UNIQUE	SHIPMENT CODES		MATRIX	WATER	WASTE	SLUDGE	SOLID	BIOMASS	SLURRY	GAS	LIQUID	SOLID	OTHER	PRESERVATIVES	FIELD FILTERED? (Y/N)	# OF CONTAINERS	SAMPLE TIME	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	RECEIVED BY / AFFILIATION	DATE	TIME	TEMP IN OC	SAMPLES ON	TEMP IN OC	SAMPLE INTACT?	TRIP BLANK?			
				W	W																													W	W	W
1		SA102-10BSPLP		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	7:12	9/10/2009	9:10	1700	Mike Ferringer gel	9/10/09	0910	26°C	Y/N	Y/N	Y/N	Y/N				
2		SA102-30BSPLP		W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	7:45	9/10/2009														
3																																				
4																																				
5																																				
6																																				
7																																				
8																																				
9																																				
10																																				
11																																				
12																																				
13																																				

Additional Comments/Special Instructions:  
Samples are SPLPs and require two leachates: pH adjusted water and pore water.

FULL DIGESTION SPECIFICATION  
Radionuclides\* includes Thorium (isotopic) and Uranium (isotopic) by EML  
HASL 300 modified (alpha spectroscopy)

All PDF reports and EDDs will be uploaded to:  
Northgate Environmental Management, Inc.  
FTP site address provided to labs  
Notifications provided to:

SHIPPING METHOD: (mark as appropriate)  
UPS COURIER  (PRINT Name of SAMPLER: Patrick Ferringer)  
US MAIL  (SIGNATURE of SAMPLER: [Signature])  
(DATE SIGNED: 9/10 Time: 1416)



SAMPLE RECEIPT & REVIEW FORM

Client: <u>Kell/Northeast</u>		SDG/ARCOC/Work Order: <u>2359417</u>	
Received By: <u>MK</u>		Date Received: <u>9-11-09</u>	
Suspected Hazard Information	Yes	No	*If Counts > x2 area background on samples not marked "radioactive", contact the Radiation Safety Group of further investigation.
COC/Samples marked as radioactive?		<input checked="" type="checkbox"/>	Maximum Counts Observed*: <u>cpm 50</u>
Classified Radioactive II or III by RSO?		<input checked="" type="checkbox"/>	
COC/Samples marked containing PCBs?		<input checked="" type="checkbox"/>	
Shipped as a DOT Hazardous?		<input checked="" type="checkbox"/>	Hazard Class Shipped: _____ UN#: _____
Samples identified as Foreign Soil?		<input checked="" type="checkbox"/>	

Sample Receipt Criteria		Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	<input checked="" type="checkbox"/>			Circle Applicable: seals broken    damaged container    leaking container    other (describe)
2	Samples requiring cold preservation within 0 ≤ 6 deg. C?		<input checked="" type="checkbox"/>		ice bags    blue ice    Preservation Method: dry ice <u>none</u> other (describe) <u>26°C</u>
3	Chain of custody documents included with shipment?	<input checked="" type="checkbox"/>			
4	Sample containers intact and sealed?	<input checked="" type="checkbox"/>			Circle Applicable: seals broken    damaged container    leaking container    other (describe)
5	Samples requiring chemical preservation at proper pH?		<input checked="" type="checkbox"/>		Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6	VOA vials free of headspace (defined as < 6mm bubble)?		<input checked="" type="checkbox"/>		Sample ID's and containers affected:
7	Are Encore containers present?			<input checked="" type="checkbox"/>	(If yes, immediately deliver to Volatiles laboratory)
8	Samples received within holding time?	<input checked="" type="checkbox"/>			Id's and tests affected:
9	Sample ID's on COC match ID's on bottles?	<input checked="" type="checkbox"/>			Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?	<input checked="" type="checkbox"/>			Sample ID's affected:
11	Number of containers received match number indicated on COC?	<input checked="" type="checkbox"/>			Sample ID's affected:
12	COC form is properly signed in relinquished/received sections?	<input checked="" type="checkbox"/>			

Comments:

FX 7979 2d62 25dB

PM (or PMA) review: Initials ER Date 9/11/09



**SAMPLE RECEIPT & REVIEW FORM**

Client: <u>Kerr/NorKante</u>		SDG/ARCOC/Work Order: <u>2359417</u>	
Received By: <u>MK</u>		Date Received: <u>9-16-09</u>	
Suspected Hazard Information	Yes	No	*If Counts > x2 area background on samples not marked "radioactive", contact the Radiation Safety Group of further investigation.
COC/Samples marked as radioactive?		<input checked="" type="checkbox"/>	Maximum Counts Observed*: <u>off rd</u>
Classified Radioactive II or III by RSO?		<input checked="" type="checkbox"/>	
COC/Samples marked containing PCBs?		<input checked="" type="checkbox"/>	
Shipped as a DOT Hazardous?		<input checked="" type="checkbox"/>	Hazard Class Shipped: _____ UN#: _____
Samples identified as Foreign Soil?		<input checked="" type="checkbox"/>	

Sample Receipt Criteria		Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	<input checked="" type="checkbox"/>			Circle Applicable: seals broken    damaged container    leaking container    other (describe)
2	Samples requiring cold preservation within 0 ≤ 6 deg. C?		<input checked="" type="checkbox"/>		Preservation Method: ice bags    blue ice    dry ice <u>none</u> other (describe) <u>ddc</u>
3	Chain of custody documents included with shipment?	<input checked="" type="checkbox"/>			
4	Sample containers intact and sealed?	<input checked="" type="checkbox"/>			Circle Applicable: seals broken    damaged container    leaking container    other (describe)
5	Samples requiring chemical preservation at proper pH?		<input checked="" type="checkbox"/>		Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6	VOA vials free of headspace (defined as < 6mm bubble)?		<input checked="" type="checkbox"/>		Sample ID's and containers affected:
7	Are Encore containers present?			<input checked="" type="checkbox"/>	(If yes, immediately deliver to Volatiles laboratory)
8	Samples received within holding time?	<input checked="" type="checkbox"/>			Id's and tests affected:
9	Sample ID's on COC match ID's on bottles?	<input checked="" type="checkbox"/>			Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?	<input checked="" type="checkbox"/>			Sample ID's affected:
11	Number of containers received match number indicated on COC?	<input checked="" type="checkbox"/>			Sample ID's affected:
12	COC form is properly signed in relinquished/received sections?	<input checked="" type="checkbox"/>			

Comments:

FX 7969 4768 2895

PM (or PMA) review: Initials EMC Date 9/16/09

20090853 527

2359412



1100 Quail Street, Suite 102, Newport Beach, CA 92660  
(949) 260-9293

**CHAIN-OF-CUSTODY / Analytical Request Document**  
The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

COC No. 2027.001.00796  
Page: 2 of 2  
Cooler # 1 of 1  
Collection Area: II

Required Ship to Lab:		Required Project Information:		Required Invoice Information:		TAT: Standard 30 day		Rush		Mark One	
Lab Name: GEL Laboratories, LLC		Site ID #: TRONOX LLC, HENDERSON		Send Invoice to: Susan Crowley Tronox, LLC				<input checked="" type="checkbox"/>			
Address: 2040 Savage Road		Project #: 2027.001		Address: PO Box 95							
Charleston, SC 29407		Site Address: 560 W. Lake Mead Drive		City/State: Henderson, NV		Phone #: (949) 260-9293					
Lab PM: Edith M. Kent		City: Henderson		State: NV		Reimbursement project? <input checked="" type="checkbox"/>		Non-reimbursement project? <input type="checkbox"/>		Mark one	
Phone/Fax: (843) 556-6171		Site PM Name: Derrick Willis		Send EDD to: Frank Hagar		Send EDD to: Frank Hagar		Special EPA Stage		Mark one	
Lab PM email: emk@gel.com		Phone/Fax: 949-375-7004		CC Hardcopy report to: PDF Electronic Version Only		CC Hardcopy report to: PDF Electronic Version Only		EPA Stage 1 Read		Mark one	
Applicable Lab Quote #:		Site PM Email: derrick.willis@ngem.com		CC Hardcopy report to: see additional comments below		CC Hardcopy report to: see additional comments below		EPA Stage 2 Read		Mark one	
								EPA Stage 3 Read		Mark one	
#	ITEM	SAMPLE ID	MATRIX CODE	SAMPLE TYPE	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives	Requested Analytes	Comments/Lab Sample ID.
1		SA128-10BSPPLP	SO	G	9/16/2009	9:58	1	N	Unpreserved		1 Liter Nalgene
2		SA128-29BSPPLP	SO	G	9/16/2009	10:28	1	N	Unpreserved		1 Liter Nalgene
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											

Additional Comments/Special Instructions:  
Samples are SPLPs and require two leachates: pH adjusted water and pore water.

FULL DIGESTION SPECIFICATION  
Radionuclides: includes Thorium (isotopic) and Uranium (isotopic) by EMIL  
HASL 300 modified(alpha spectroscopy)

All PDF reports and EDDs will be uploaded to:  
Northgate Environmental Management, Inc.  
FTP site address provided to labs  
Notifications provided to:

RELINQUISHED BY / AFFILIATION: Patrick Ferringer  
DATE: 9/16/2009  
TIME: 9:58 AM

ACCEPTED BY / AFFILIATION: Patrick Ferringer  
DATE: 9/16/2009  
TIME: 10:28 AM

SHIPPING METHOD (mark as appropriate): UPS MAIL  
COURIER: FEDEX  
SIGNATURE OF SAMPLER: Patrick Ferringer  
DATE SIGNED: 9/16  
TIME: 1:35 PM

SAMPLER NAME AND SIGNATURE: Patrick Ferringer

Temp in OC: Y/N  
Samples on Ice: Y/N  
Sample Intact?: Y/N  
Trip Blank?: Y/N



SAMPLE RECEIPT & REVIEW FORM

Client: <u>Kerr/Northeast</u>		SDG/ARCO/Work Order:	
Received By: <u>MK</u>		Date Received: <u>9-17-09</u>	
Suspected Hazard Information	Yes	No	*If Counts > x2 area background on samples not marked "radioactive", contact the Radiation Safety Group of further investigation.
COC/Samples marked as radioactive?		<input checked="" type="checkbox"/>	Maximum Counts Observed*: <u>cp-ko</u>
Classified Radioactive II or III by RSO?		<input checked="" type="checkbox"/>	
COC/Samples marked containing PCBs?		<input checked="" type="checkbox"/>	
Shipped as a DOT Hazardous?		<input checked="" type="checkbox"/>	Hazard Class Shipped: UN#:
Samples identified as Foreign Soil?		<input checked="" type="checkbox"/>	

Sample Receipt Criteria		Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	<input checked="" type="checkbox"/>			Circle Applicable: seals broken    damaged container    leaking container    other (describe)
2	Samples requiring cold preservation within 0 ≤ 6 deg. C?		<input checked="" type="checkbox"/>		ice bags    blue ice    Preservation Method: dry ice <u>none</u> other (describe) <u>dd<sup>c</sup></u>
3	Chain of custody documents included with shipment?	<input checked="" type="checkbox"/>			
4	Sample containers intact and sealed?	<input checked="" type="checkbox"/>			Circle Applicable: seals broken    damaged container    leaking container    other (describe)
5	Samples requiring chemical preservation at proper pH?		<input checked="" type="checkbox"/>		Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6	VOA vials free of headspace (defined as < 6mm bubble)?		<input checked="" type="checkbox"/>		Sample ID's and containers affected:
7	Are Encore containers present?			<input checked="" type="checkbox"/>	(If yes, immediately deliver to Volatiles laboratory)
8	Samples received within holding time?	<input checked="" type="checkbox"/>			Id's and tests affected:
9	Sample ID's on COC match ID's on bottles?	<input checked="" type="checkbox"/>			Sample ID's and containers affected:
10	Date & time on COC match date & time on bottles?			<input checked="" type="checkbox"/>	Sample ID's affected: <u>see below</u>
11	Number of containers received match number indicated on COC?				Sample ID's affected:
12	COC form is properly signed in relinquished/received sections?				

Comments:

SA 128-29BSPLP - no time on container

FX 7979 3903 3899

PM (or PMA) review: Initials

ga

Date

9/17/09

**Subject:** Re: GEL Closed SPLP SDGs 235941 and 235945

**From:** Edie Kent <emk@gel.com>

**Date:** Fri, 11 Sep 2009 10:34:48 -0400

**To:** carnold@ngem.com

**CC:** Heather.Shaffer@gel.com, Frank.Hagar@ngem.com, Derrick.Willis@ngem.com, hea01394@gel.com

Cindy:

We received two more SPLP samples today and we have not yet received the SPLP fluid from our supplier so haven't started analysis. Is it acceptable to add these two samples to these SDGs?

Edie

[carnold@ngem.com](mailto:carnold@ngem.com) wrote:

I saw that - and checked my post which said 10 calendar days. We're good.

----- Original Message ----- On 9/10/2009 9:26 PM Edie Kent wrote:

Cindy:

These were actually at 14 days on Tuesday when you made the change but since we were unable to check yesterday on any SDGs that were open that met the 14 day criteria, we were unable to close until today.

Edie

[carnold@ngem.com](mailto:carnold@ngem.com) wrote:

> Thank you Heather and Edie - glad to see the new procedure in place.

> Cindy

>

>

> ----- Original Message ----- On 9/10/2009 8:57 PM Heather Shaffer

> wrote:

> GEL has closed the attached soil SDGs for SPLP analysis, as we have  
> not received any further SPLP analysis and the 14 day time limit is  
> up. The turnaround time will begin from today. Attached is a list of  
> the samples in the SDG. As soon as we have completed the login review,  
> you will receive the full receipt package for these SDG.

>

> Thank you,

> Heather

>

>-- Heather Shaffer Project Manager Assistant GEL Laboratories, LLC 2040 Savage Road  
Charleston, SC (USA) 29407 Main: 843.556.8171 x 4505 Fax: 843.766.1178 E-mail:

[heather.shaffer@gel.com](mailto:heather.shaffer@gel.com) Web: [www.gel.co](http://www.gel.co)

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E-mail: [emk@gel.com](mailto:emk@gel.com)  
Web: [www.gel.com](http://www.gel.com)

**Subject:** RE: SPLP Sample Received Today - Please Advise

**From:** carnold@ngem.com

**Date:** Wed, 16 Sep 2009 22:07:44 +0000

**To:** emk@gel.com, Cindy.Arnold@ngem.com, Frank.Hagar@ngem.com, Derrick.Willis@ngem.com, Team.Kent@gel.com, vivian.willis@verdant-solutions.com

No problem - please add. Thanks, Cindy

----- Original Message ----- On 9/16/2009 7:08 PM Edie Kent wrote:

Cindy:

We received a sample for SPLP analysis today, COC# 2027.001.00778.

Since we are retumbling SDGs 233413 and 233415, we have not started the

SDGs 235941 and 235945 which were closed last week. Do you have a

problem with today's sample being added to SDGs 235941 and 235945?

Edie

--

Edith M. Kent

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**Subject:** RE: Re: SPLP Sample Received Today - Please Advise

**From:** carnold@ngem.com

**Date:** Thu, 17 Sep 2009 15:15:55 +0000

**To:** emk@gel.com, carnold@ngem.com

**CC:** Frank.Hagar@ngem.com, Derrick.Willis@ngem.com, Team.Kent@gel.com, vivian.willis@verdant-solutions.com

Thanks fine - please add.

----- Original Message ----- On 9/17/2009 3:13 PM Edie Kent wrote:

Cindy:

We received two more SPLPs today. I checked with the lab and they are not ordering the fluid until tomorrow since they are still working on the re-extracts for the other two SDGs. If it is acceptable, I will add anything we receive today and tomorrow and those will be the last that I add to SDGs 235941 and 235945.

Edie

carnold@ngem.com wrote:

>

> No problem - please add. Thanks, Cindy

>

> ----- Original Message ----- On 9/16/2009 7:08 PM Edie Kent wrote:

> Cindy:

> We received a sample for SPLP analysis today, COC# 2027.001.00778.

> Since we are retumbling SDGs 233413 and 233415, we have not started the

> SDGs 235941 and 235945 which were closed last week. Do you have a  
> problem with today's sample being added to SDGs 235941 and 235945?

>

> Edie

>

> --

> Edith M. Kent

> Project Manager

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**Subject:** SDG 235945 QC Issues - Alpha Spec Th, Alpha Spec U

**From:** Edie Kent <emk@gel.com>

**Date:** Thu, 15 Oct 2009 17:02:23 -0400

**To:** Cindy Arnold <Cindy.Arnold@ngem.com>, Derrick Willis <Derrick.Willis@ngem.com>, Team Kent <Team.Kent@gel.com>

**CC:** Martha Harrison <Martha.Harrison@gel.com>

The following are the QC issues regarding this SDG for Alpha Spec Th and Alpha Spec U:

**\*Thorium Issues:\***

The following samples did not meet the Tronox QA program detection limit requirements for Th-228: 235945004, 235945005, 235945006, and the tumble blank. The method blank does not meet the detection limit requirements for Th-230 due to keeping the blank aliquot consistent with the sample aliquots. The samples were analyzed with an appropriate aliquot for the method and matrix. If a larger aliquot had been used it would most likely have resulted in lower tracer yields. The samples were counted the maximum count time to achieve the lowest possible MDAs.

Sample 235945003 did not meet the Tronox QA program sample result uncertainty limit of <30% for Th-232 with activity greater than 5 times the MDA and was counted the maximum possible count time.

The lab DUP did not meet the Tronox QA program sample result uncertainty limit of <30% for Th-232 with activity between 2 and 5 times the MDA and was counted the maximum possible count time.

Sample 235945003 did not meet the Tronox QA program sample result uncertainty limit of <30% for Th-230 with activity between 2 and 5 times the MDA and was counted the maximum possible count time.

**\*Uranium Issues:\***

Sample 235945006 did not meet the Tronox QA program sample result uncertainty limit of <30% for U-238 with activity between 2 and 5 times the MDA and was counted the maximum possible count time.

Sample 235945005 did not meet the Tronox QA program sample result uncertainty limit of <30% for U-235/236 with activity between 2 and 5 times the MDA and was counted the maximum possible count time.

The lab DUP did not meet the Tronox QA program required detection limit for U235/236 due to limited aliquot size. To maintain the quality of the data, a larger aliquot was not used, attempting to meet the client's yield recovery criteria and preventing tailing from the U-233/234 region of interest. The sample was counted the maximum possible count time to achieve the lowest possible MDA.

Sample 235945005 and the lab DUP did not meet the Tronox QA program required tracer yield requirements of 70-120%. With yields of 64.0% and 52.5% respectively, the samples met GEL's standard tracer yield requirements. The blank and LCS met the contract requirements.

This will be noted in the case narrative.

Edie

--

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# **Laboratory Certifications**

**List of current GEL Certifications as of 15 October 2009**

<b>State</b>	<b>Certification</b>
Arizona	AZ0668
Arkansas	88-0651
CLIA	42D0904046
California – NELAP	01151CA
Colorado	GEL
Connecticut	PH-0169
Dept. of Navy	NFESC 413
EPA Region 5	WG-15J
Florida – NELAP	E87156
Georgia	E87156 (FL/NELAP)
Georgia DW	967
Hawaii	N/A
ISO 17025	2567.01
Idaho	SC00012
Illinois – NELAP	200029
Indiana	C-SC-01
Kansas – NELAP	E-10332
Kentucky	90129
Louisiana – NELAP	03046
Maryland	270
Massachusetts	M-SC012
Nevada	SC00012
New Jersey – NELAP	SC002
New Mexico	FL NELAP E87156
New York – NELAP	11501
North Carolina	233
North Carolina DW	45709
Oklahoma	9904
Pennsylvania – NELAP	68-00485
South Carolina	10120001/10120002
Tennessee	TN 02934
Texas – NELAP	T104704235-07B-TX
U.S. Dept. of Agriculture	S-52597
Utah – NELAP	GEL
Vermont	VT87156
Virginia	00151
Washington	C1641



# RADIOLOGICAL ANALYSIS

**Radiochemistry Case Narrative  
Tronox LLC (KERR)  
SDG 235945**

**Method/Analysis Information**

**Product:** Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water)  
Analytical Method: DOE EML HASL-300, Th-01-RC Modified  
Prep Method: EPA 1312  
Analytical Batch Number: 906826  
Prep Batch Number: 905076

<b>Sample ID</b>	<b>Client ID</b>
235945001	SA64-10BSPLP
235945002	SA102-10BSPLP
235945003	SA102-30BSPLP
235945004	SA30-9BSPLP
235945005	SA128-10BSPLP
235945006	SA128-29BSPLP
1201929717	TCLP Blank (TB)
1201934058	Method Blank (MB)
1201934060	235945001(SA64-10BSPLP) Sample Duplicate (DUP)
1201934062	235945001(SA64-10BSPLP) Matrix Spike (MS)
1201934063	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

**SOP Reference**

Procedure for preparation, analysis and reporting of analytical data are controlled by GEL Laboratories LLC as Standard Operating Procedure (SOP). The data discussed in this narrative has been analyzed in accordance with GL-RAD-A-038 REV# 12.

**Calibration Information:**

**Calibration Information**

All initial and continuing calibration requirements have been met.

**Standards Information**

Standard solution(s) for these analyses are NIST traceable and used before the expiration date(s).

**Sample Geometry**

All counting sources were prepared in the same geometry as the calibration standards.

**Quality Control (QC) Information:****Blank Information**

The blank volume is representative of the sample volumes in this batch.

**Designated QC**

The following sample was used for QC: 235945001 (SA64-10BSPLP).

**QC Information**

Refer to Non-Conformance Report.

**Technical Information:****Holding Time**

All sample procedures for this sample set were performed within the required holding time.

**Sample Re-prep/Re-analysis**

Samples were recounted due to a suspected blank false positive.

**Miscellaneous Information:****NCR Documentation**

Nonconformance reports are generated to document any procedural anomalies that may deviate from referenced SOP or contractual documents. The following NCR was generated for this SDG: NCR 746586 was generated due to RDL less than MDA. 1. Samples 235941004, 235941005, 235941006, 235945004, 235945005, 235945006, 1201929716 (Tumbler blank) do not meet the detection limits for Th-228. The method blank 1201934058 does not meet the detection limits for Th-230 due to keeping the blank aliquot consistent with the sample aliquots. 2. Samples 235941003 and 235945003 have Thorium-232 activity greater than five times the MDA and uncertainty greater than 30% of that activity. Samples 235941001, 1201934059, and 1201934060 have Thorium-232 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. Samples 235941003 and 235945003 have Thorium-230 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. 1. The samples were analyzed with an appropriate aliquot for the method and matrix. Additionally, the samples were counted for the maximum count time of 1000 minutes to achieve the lowest possible MDA's. PM notified, reporting results. 2. Samples were all counted the maximum count time of 1000 minutes to achieve the best possible uncertainties. PM notified, reporting results.

**Manual Integration**

No manual integrations were performed on data in this batch.

**Additional Comments**

The Th-232 Tumbler blank 1201929717 (TB) result is greater than the MDA, but less than the detection limit.

**Qualifier information**

Manual qualifiers were not required.

## **Method/Analysis Information**

**Product:** Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water)  
Analytical Method: DOE EML HASL-300, U-02-RC Modified  
Prep Method: EPA 1312  
Analytical Batch Number: 906828  
Prep Batch Number: 905076

<b>Sample ID</b>	<b>Client ID</b>
235945001	SA64-10BSPLP
235945002	SA102-10BSPLP
235945003	SA102-30BSPLP
235945004	SA30-9BSPLP
235945005	SA128-10BSPLP
235945006	SA128-29BSPLP
1201929717	TCLP Blank (TB)
1201934075	Method Blank (MB)
1201934077	235945001(SA64-10BSPLP) Sample Duplicate (DUP)
1201934079	235945001(SA64-10BSPLP) Matrix Spike (MS)
1201934080	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

### **SOP Reference**

Procedure for preparation, analysis and reporting of analytical data are controlled by GEL Laboratories LLC as Standard Operating Procedure (SOP). The data discussed in this narrative has been analyzed in accordance with GL-RAD-A-011 REV# 17.

### **Calibration Information:**

#### **Calibration Information**

All initial and continuing calibration requirements have been met.

#### **Standards Information**

Standard solution(s) for these analyses are NIST traceable and used before the expiration date(s).

#### **Sample Geometry**

All counting sources were prepared in the same geometry as the calibration standards.

### **Quality Control (QC) Information:**

#### **Blank Information**

The blank volume is representative of the sample volume in this batch.

### **Designated QC**

The following sample was used for QC: 235945001 (SA64-10BSPLP).

### **QC Information**

Refer to Non-Conformance Report.

### **Technical Information:**

#### **Holding Time**

All sample procedures for this sample set were performed within the required holding time.

#### **Sample Re-prep/Re-analysis**

None of the samples in this sample set required reprep or reanalysis.

### **Miscellaneous Information:**

#### **NCR Documentation**

Nonconformance reports are generated to document any procedural anomalies that may deviate from referenced SOP or contractual documents. The following NCR was generated for this SDG: NCR 745034 was generated due to RDL less than MDA. 1. The duplicate sample, 1201934077, does not meet the required detection limit for U235/236. 2. Sample 235945005 and the duplicate, 1201934077, did not meet the client's tracer yield requirement of 70 - 120%. 3. Samples 235941006 and 235945006 have Uranium-238 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. Samples 235945005 has Uranium-235/236 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. 1. A larger aliquot was not used to maintain the quality of the data, attempting to meet the client's yield recovery criteria and preventing tailing from the U-233/234 region of interest. The sample was counted 1000 minutes to achieve the lowest possible MDA. PM notified, reporting results. 2. With yields of 64.0% and 52.5%, respectively, the samples do meet the GEL standard tracer yield requirement. The blank and LCS meet the client's tracer yield requirements. PM notified, reporting results. 3. Samples were all counted the maximum count time of 1000 minutes to achieve the best possible uncertainties. PM notified, reporting results.

#### **Manual Integration**

No manual integrations were performed on data in this batch.

#### **Additional Comments**

Additional comments were not required for this sample set.

#### **Qualifier information**

Manual qualifiers were not required.

#### **Method/Analysis Information**

**Product:** GFPC, Radium-228, SPLP, Fluid 3  
**Analytical Method:** EPA 904.0/SW846 9320 Modified  
**Prep Method:** EPA 1312  
**Analytical Batch Number:** 906803  
**Prep Batch Number:** 905076

<b>Sample ID</b>	<b>Client ID</b>
235945001	SA64-10BSPLP
235945002	SA102-10BSPLP
235945003	SA102-30BSPLP
235945004	SA30-9BSPLP
235945005	SA128-10BSPLP
235945006	SA128-29BSPLP
1201929717	TCLP Blank (TB)
1201933967	Method Blank (MB)
1201933969	235945001(SA64-10BSPLP) Sample Duplicate (DUP)
1201933971	235945001(SA64-10BSPLP) Matrix Spike (MS)
1201933972	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

**SOP Reference**

Procedure for preparation, analysis and reporting of analytical data are controlled by GEL Laboratories LLC as Standard Operating Procedure (SOP). The data discussed in this narrative has been analyzed in accordance with GL-RAD-A-009 REV# 15.

**Calibration Information:**

**Calibration Information**

All initial and continuing calibration requirements have been met.

**Standards Information**

Standard solution(s) for these analyses are NIST traceable and used before the expiration date(s).

**Sample Geometry**

All counting sources were prepared in the same geometry as the calibration standards.

**Quality Control (QC) Information:**

**Blank Information**

The blank volume is representative of the sample volume in this batch.

**Designated QC**

The following sample was used for QC: 235945001 (SA64-10BSPLP).

**QC Information**

All of the QC samples met the required acceptance limits.

**Technical Information:****Holding Time**

All sample procedures for this sample set were performed within the required holding time.

**Sample Re-prep/Re-analysis**

Samples 1201929717 (TB), 235945004 (SA30-9BSPLP) and 235945005 (SA128-10BSPLP) were recounted due to high MDAs. Samples 235945002 (SA102-10BSPLP) and 235945003 (SA102-30BSPLP) were recounted due to client uncertainty requirements. Sample 235945006 (SA128-29BSPLP) was re-eluted in order to verify activity.

**Chemical Recoveries**

All chemical recoveries meet the required acceptance limits for this sample set.

**Miscellaneous Information:****NCR Documentation**

Nonconformance reports are generated to document any procedural anomalies that may deviate from referenced SOP or contractual documents. The following NCR was generated for this SDG: NCR 746044 was generated due to Container scanning event for custody missed. 1. Samples 235941001, 235941002, 235941003, 235941004, 235941005, 235941006, 235945001, 235945002, 235945003, 235945004, 235945005, and 235945006 were not scanned into batch. Sample custody was maintained at all times. 1. Reporting results. Analyst has been instructed on proper scanning procedure.

**Additional Comments**

Additional comments were not required for this sample set.

**Qualifier information**

Manual qualifiers were not required.

**Method/Analysis Information**

<b>Product:</b>	<b>Lucas Cell, Radium-226, SPLP 3</b>
Analytical Method:	EPA 903.1 Modified
Prep Method:	EPA 1312
Analytical Batch Number:	907303
Prep Batch Number:	905076

<b>Sample ID</b>	<b>Client ID</b>
235945001	SA64-10BSPLP
235945002	SA102-10BSPLP
235945003	SA102-30BSPLP
235945004	SA30-9BSPLP
235945005	SA128-10BSPLP
235945006	SA128-29BSPLP
1201929717	TCLP Blank (TB)
1201935051	Method Blank (MB)
1201935052	235945006(SA128-29BSPLP) Sample Duplicate (DUP)
1201935053	235945006(SA128-29BSPLP) Matrix Spike (MS)
1201935054	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

### **SOP Reference**

Procedure for preparation, analysis and reporting of analytical data are controlled by GEL Laboratories LLC as Standard Operating Procedure (SOP). The data discussed in this narrative has been analyzed in accordance with GL-RAD-A-008 REV# 12.

### **Calibration Information:**

#### **Calibration Information**

All initial and continuing calibration requirements have been met.

#### **Standards Information**

Standard solution(s) for these analyses are NIST traceable and used before the expiration date(s).

#### **Sample Geometry**

All counting sources were prepared in the same geometry as the calibration standards.

### **Quality Control (QC) Information:**

#### **Blank Information**

The blank volume is representative of the sample volume in this batch.

#### **Designated QC**

The following sample was used for QC: 235945006 (SA128-29BSPLP).

#### **QC Information**

All of the QC samples met the required acceptance limits.

### **Technical Information:**

#### **Holding Time**

All sample procedures for this sample set were performed within the required holding time.

#### **Sample Re-prep/Re-analysis**

Sample 1201935054 (LCS) was recounted due to low recovery.



**Miscellaneous Information:**

**NCR Documentation**

Nonconformance reports are generated to document any procedural anomalies that may deviate from referenced SOP or contractual documents. The following NCR was generated for this SDG:

NCR 746439 was generated due to Other. 1. Samples 235945001 and 235945002 have Radium-226 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. Samples were all counted the maximum count time of 30 minutes to achieve the best possible uncertainties. 1. PM notified, reporting results.

**Additional Comments**

Sample 1201935054 (LCS) has a sample recovery of 74.7%. The matrix spike sample has a spike recovery of 94.2%.

**Qualifier information**

Manual qualifiers were not required.

**Certification Statement**

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless otherwise noted in the analytical case narrative.

**Review Validation:**

GEL requires all analytical data to be verified by a qualified data validator. In addition, all data designated for CLP or CLP-like packaging will receive a third level validation upon completion of the data package.

**The following data validator verified the information presented in this case narrative:**

**Reviewer/Date:**                                 *Pamela Weller* 10/15/09

**COMPANY - WIDE NONCONFORMANCE REPORT**

<b>Mo.Day Yr.</b> 13-OCT-09	<b>Division:</b> Radiochemistry	<b>Quality Criteria:</b> Specifications	<b>Type:</b> Process
<b>Instrument Type:</b> ALPHA SPECTROMETER	<b>Test / Method:</b> DOE EML HASL-300, U-02-RC Modified	<b>Matrix Type:</b> Solid	<b>Client Code:</b> KERR
<b>Batch ID:</b> 906828	<b>Sample Numbers:</b> See Below		

**Potentially affected work order(s)(SDG): 235941,235945**

**Application Issues:**

RDL less than MDA

**Specification and Requirements  
Nonconformance Description:**

1. The duplicate sample, 1201934077, does not meet the required detection limit for U235/236.
2. Sample 235945005 and the duplicate, 1201934077, did not meet the client's tracer yield requirement of 70 - 120%.
3. Samples 235941006 and 235945006 have Uranium-238 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity.  
Samples 235945005 has Uranium-235/236 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity.

**NRG Disposition:**

1. A larger aliquot was not used to maintain the quality of the data, attempting to meet the client's yield recovery criteria and preventing tailing from the U-233/234 region of interest. The sample was counted 1000 minutes to achieve the lowest possible MDA. PM notified, reporting results.
2. With yields of 64.0% and 52.5%, respectively, the samples do meet the GEL standard tracer yield requirement. The blank and LCS meet the client's tracer yield requirements. PM notified, reporting results.
3. Samples were all counted the maximum count time of 1000 minutes to achieve the best possible uncertainties. PM notified, reporting results.

**Originator's Name:**

Joseph Moulden 13-OCT-09

**Data Validator/Group Leader:**

Scott Moreland 13-OCT-09

**COMPANY - WIDE NONCONFORMANCE REPORT**

<b>Mo.Day Yr.</b> 14-OCT-09	<b>Division:</b> Radiochemistry	<b>Quality Criteria:</b> Specifications	<b>Type:</b> Process
<b>Instrument Type:</b> GFPC	<b>Test / Method:</b> EPA 904.0/SW846 9320 Modified	<b>Matrix Type:</b> Solid	<b>Client Code:</b> KERR
<b>Batch ID:</b> 906803	<b>Sample Numbers:</b> See Below		
<b>Potentially affected work order(s)(SDG): 235941,235945</b>			
<b>Application Issues:</b> Container scanning event for custody missed			
<b>Specification and Requirements</b> <b>Nonconformance Description:</b>		<b>NRG Disposition:</b>	
1. Samples 235941001, 235941002, 235941003, 235941004, 235941005, 235941006, 235945001, 235945002, 235945003, 235945004, 235945005, and 235945006 were not scanned into batch. Sample custody was maintained at all times.		1. Reporting results. Analyst has been instructed on proper scanning procedure.	

**Originator's Name:**

Nat Long 14-OCT-09

**Data Validator/Group Leader:**

Heather McCarty 14-OCT-09

**COMPANY - WIDE NONCONFORMANCE REPORT**

<b>Mo.Day Yr.</b> 15-OCT-09	<b>Division:</b> Radiochemistry	<b>Quality Criteria:</b> SOP	<b>Type:</b> Process
<b>Instrument Type:</b> LUCAS CELL DETECTOR	<b>Test / Method:</b> EPA 903.1 Modified	<b>Matrix Type:</b> Liquid	<b>Client Code:</b> KERR
<b>Batch ID:</b> 907303	<b>Sample Numbers:</b> 235945001		
<b>Potentially affected work order(s)(SDG): 235945</b>			
<b>Application Issues:</b> Other			
<b>Specification and Requirements</b>		<b>NRG Disposition:</b>	
<b>Nonconformance Description:</b>  1. Samples 235945001 and 235945002 have Radium-226 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. Samples were all counted the maximum count time of 30 minutes to achieve the best possible uncertainties.		1. PM notified, reporting results.	

**Originator's Name:**  
Lesley Anderson      15-OCT-09

**Data Validator/Group Leader:**  
Dana Hunt                      15-OCT-09

**COMPANY - WIDE NONCONFORMANCE REPORT**

<b>Mo.Day Yr.</b> 15-OCT-09	<b>Division:</b> Radiochemistry	<b>Quality Criteria:</b> Specifications	<b>Type:</b> Process
<b>Instrument Type:</b> ALPHA SPECTROMETER	<b>Test / Method:</b> DOE EML HASL-300, Th-01-RC Modified	<b>Matrix Type:</b> Solid	<b>Client Code:</b> KERR
<b>Batch ID:</b> 906826	<b>Sample Numbers:</b> See Below		

**Potentially affected work order(s)(SDG): 235941,235945**

**Application Issues:**

RDL less than MDA

**Specification and Requirements  
Nonconformance Description:**

1. Samples 235941004, 235941005, 235941006, 235945004, 235945005, 235945006, 1201929716 (Tumbler blank) do not meet the detection limits for Th-228. The method blank 1201934058 does not meet the detection limits for Th-230 due to keeping the blank aliquot consistent with the sample aliquots.
2. Samples 235941003 and 235945003 have Thorium-232 activity greater than five times the MDA and uncertainty greater than 30% of that activity. Samples 235941001, 1201934059, and 1201934060 have Thorium-232 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity. Samples 235941003 and 235945003 have Thorium-230 activity between two and five times the MDA and uncertainty greater than 30% of that respective activity.

**NRG Disposition:**

1. The samples were analyzed with an appropriate aliquot for the method and matrix. Additionally, the samples were counted for the maximum count time of 1000 minutes to achieve the lowest possible MDA's. PM notified, reporting results.
2. Samples were all counted the maximum count time of 1000 minutes to achieve the best possible uncertainties. PM notified, reporting results.

**Originator's Name:**

Jessica Downey 15-OCT-09

**Data Validator/Group Leader:**

Eric Brimstin 15-OCT-09

# SAMPLE DATA SUMMARY

# GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

## Certificate of Analysis Report for

KERR003 Tronox LLC

Client SDG: 235945 GEL Work Order: 235945

**The Qualifiers in this report are defined as follows:**

- \* A quality control analyte recovery is outside of specified acceptance criteria
- \*\* Analyte is a surrogate compound
- U Analyte was analyzed for, but not detected above the MDL, MDA, or LOD.
- h Preparation or preservation holding time was exceeded

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the detection limit.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Edith Kent.



Reviewed by \_\_\_\_\_

# GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

## Certificate of Analysis

Company : Northgate Environmental Management, Inc.  
 Address : 1100 Quail St., Suite 102  
 Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
 Project: **Tronox Henderson**

Client Sample ID:	SA64-10BSPLP	Project:	KERRHenderson
Sample ID:	235945001	Client ID:	KERR003
Matrix:	SO		
Collect Date:	24-AUG-09 08:34		
Receive Date:	25-AUG-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
<b>Rad Alpha Spec Analysis</b>												
<i>Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Thorium-228		0.488	+/-0.0675	0.038	0.030	pCi/L		MXA	10/12/09	1709	906826	1
Thorium-230		0.845	+/-0.0841	0.0263	0.030	pCi/L						
Thorium-232		0.109	+/-0.0299	0.0064	0.030	pCi/L						
<i>Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Uranium-233/234	h	1.60	+/-0.117	0.0246	0.030	pCi/L		MXA	10/08/09	2117	906828	2
Uranium-235/236	h	0.0384	+/-0.0228	0.0263	0.030	pCi/L						
Uranium-238	h	1.04	+/-0.096	0.0377	0.030	pCi/L						
<b>Rad Gas Flow Proportional Counting</b>												
<i>GFPC, Radium-228, SPLP, Fluid 3 "As Received"</i>												
Radium-228	Uh	1.00	+/-1.25	2.13	3.00	pCi/L		JXC5	10/08/09	1136	906803	3
<b>Rad Radium-226</b>												
<i>Lucas Cell, Radium-226, SPLP 3 "As Received"</i>												
Radium-226		1.91	+/-0.736	0.834	1.00	pCi/L		KSD1	10/14/09	0845	907303	4

**The following Prep Methods were performed**

Method	Description	Analyst	Date	Time	Prep Batch
EPA 1312	EPA 1312 Synthetic Leaching-Reagent Water	RXD2	09/22/09	1500	905076

**The following Analytical Methods were performed**

Method	Description	Analyst Comments
1	DOE EML HASL-300, Th-01-RC Modified	
2	DOE EML HASL-300, U-02-RC Modified	
3	EPA 904.0/SW846 9320 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Actinium-227 Tracer	Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"			103	(15%-125%)
Uranium-232 Tracer	Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"			86.1	(15%-125%)



# GEL LABORATORIES LLC

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID: SA64-10BSPLP  
Sample ID: 235945001

Project: KERRHenderson  
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Barium-133 Tracer		GFPC, Radium-228, SPLP, Fluid 3 "As Received"					84.6			(15%-125%)	

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID:	SA102-10BSPLP	Project:	KERRHenderson
Sample ID:	235945002	Client ID:	KERR003
Matrix:	SO		
Collect Date:	10-SEP-09 07:12		
Receive Date:	11-SEP-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
<b>Rad Alpha Spec Analysis</b>												
<i>Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Thorium-228		0.216	+/-0.0427	0.031	0.030	pCi/L		MXA	10/12/09	1709	906826	1
Thorium-230		0.191	+/-0.0377	0.0178	0.030	pCi/L						
Thorium-232		0.162	+/-0.034	0.00557	0.030	pCi/L						
<i>Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Uranium-233/234		0.787	+/-0.0853	0.0262	0.030	pCi/L		MXA	10/08/09	2117	906828	2
Uranium-235/236		0.0409	+/-0.0256	0.0323	0.030	pCi/L						
Uranium-238		0.501	+/-0.0678	0.0181	0.030	pCi/L						
<b>Rad Gas Flow Proportional Counting</b>												
<i>GFPC, Radium-228, SPLP, Fluid 3 "As Received"</i>												
Radium-228	U	1.22	+/-1.34	2.26	3.00	pCi/L		JXC5	10/08/09	1355	906803	3
<b>Rad Radium-226</b>												
<i>Lucas Cell, Radium-226, SPLP 3 "As Received"</i>												
Radium-226		1.23	+/-0.550	0.448	1.00	pCi/L		KSD1	10/14/09	0845	907303	4

**The following Prep Methods were performed**

Method	Description	Analyst	Date	Time	Prep Batch
EPA 1312	EPA 1312 Synthetic Leaching-Reagent Water	RXD2	09/22/09	1500	905076

**The following Analytical Methods were performed**

Method	Description	Analyst Comments
1	DOE EML HASL-300, Th-01-RC Modified	
2	DOE EML HASL-300, U-02-RC Modified	
3	EPA 904.0/SW846 9320 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Actinium-227 Tracer	Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"			119	(15%-125%)
Uranium-232 Tracer	Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"			79.5	(15%-125%)

# GEL LABORATORIES LLC

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID: SA102-10BSPLP  
Sample ID: 235945002

Project: KERRHenderson  
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Barium-133 Tracer		GFPC, Radium-228, SPLP, Fluid 3 "As Received"					79.8			(15%-125%)	

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID:	SA102-30BSPLP	Project:	KERRHenderson
Sample ID:	235945003	Client ID:	KERR003
Matrix:	SO		
Collect Date:	10-SEP-09 07:45		
Receive Date:	11-SEP-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
<b>Rad Alpha Spec Analysis</b>												
<i>Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Thorium-228		0.155	+/-0.044	0.0415	0.030	pCi/L		MXA	10/12/09	1709	906826	1
Thorium-230		0.0819	+/-0.0288	0.019	0.030	pCi/L						
Thorium-232		0.072	+/-0.0262	0.00744	0.030	pCi/L						
<i>Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Uranium-233/234		0.455	+/-0.0603	0.0224	0.030	pCi/L		MXA	10/08/09	2117	906828	2
Uranium-235/236		0.0325	+/-0.019	0.0192	0.030	pCi/L						
Uranium-238		0.352	+/-0.0541	0.0292	0.030	pCi/L						
<b>Rad Gas Flow Proportional Counting</b>												
<i>GFPC, Radium-228, SPLP, Fluid 3 "As Received"</i>												
Radium-228	U	1.07	+/-1.61	2.73	3.00	pCi/L		JXC5	10/08/09	1355	906803	3
<b>Rad Radium-226</b>												
<i>Lucas Cell, Radium-226, SPLP 3 "As Received"</i>												
Radium-226	U	0.259	+/-0.419	0.746	1.00	pCi/L		KSD1	10/14/09	0915	907303	4

**The following Prep Methods were performed**

Method	Description	Analyst	Date	Time	Prep Batch
EPA 1312	EPA 1312 Synthetic Leaching-Reagent Water	RXD2	09/22/09	1500	905076

**The following Analytical Methods were performed**

Method	Description	Analyst Comments
1	DOE EML HASL-300, Th-01-RC Modified	
2	DOE EML HASL-300, U-02-RC Modified	
3	EPA 904.0/SW846 9320 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Actinium-227 Tracer	Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"			86.9	(15%-125%)
Uranium-232 Tracer	Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"			81.7	(15%-125%)

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID: SA102-30BSPLP  
Sample ID: 235945003

Project: KERRHenderson  
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Barium-133 Tracer		GFPC, Radium-228, SPLP, Fluid 3 "As Received"						73.6		(15%-125%)	

# GEL LABORATORIES LLC

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## Certificate of Analysis

Company : Northgate Environmental Management, Inc.  
 Address : 1100 Quail St., Suite 102  
 Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
 Project: **Tronox Henderson**

Client Sample ID:	SA30-9BSPLP	Project:	KERRHenderson
Sample ID:	235945004	Client ID:	KERR003
Matrix:	SO		
Collect Date:	15-SEP-09 11:25		
Receive Date:	16-SEP-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
<b>Rad Alpha Spec Analysis</b>												
<i>Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Thorium-228	U	0.0252	+/-0.0248	0.0402	0.030	pCi/L		MXA	10/12/09	1709	906826	1
Thorium-230	U	0.0148	+/-0.0125	0.0162	0.030	pCi/L						
Thorium-232	U	0.0148	+/-0.0125	0.0162	0.030	pCi/L						
<i>Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Uranium-233/234		0.0426	+/-0.0204	0.0219	0.030	pCi/L		MXA	10/08/09	2117	906828	2
Uranium-235/236	U	0.00	+/-0.00679	0.0188	0.030	pCi/L						
Uranium-238	U	0.0198	+/-0.0165	0.0244	0.030	pCi/L						
<b>Rad Gas Flow Proportional Counting</b>												
<i>GFPC, Radium-228, SPLP, Fluid 3 "As Received"</i>												
Radium-228	U	1.94	+/-1.72	2.76	3.00	pCi/L		JXC5	10/08/09	1424	906803	3
<b>Rad Radium-226</b>												
<i>Lucas Cell, Radium-226, SPLP 3 "As Received"</i>												
Radium-226	U	0.225	+/-0.492	0.908	1.00	pCi/L		KSD1	10/14/09	0915	907303	4

**The following Prep Methods were performed**

Method	Description	Analyst	Date	Time	Prep Batch
EPA 1312	EPA 1312 Synthetic Leaching-Reagent Water	RXD2	09/22/09	1500	905076

**The following Analytical Methods were performed**

Method	Description	Analyst Comments
1	DOE EML HASL-300, Th-01-RC Modified	
2	DOE EML HASL-300, U-02-RC Modified	
3	EPA 904.0/SW846 9320 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Actinium-227 Tracer	Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"			103	(15%-125%)
Uranium-232 Tracer	Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"			90.0	(15%-125%)

# GEL LABORATORIES LLC

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID: SA30-9BSPLP  
Sample ID: 235945004

Project: KERRHenderson  
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Barium-133 Tracer		GFPC, Radium-228, SPLP, Fluid 3 "As Received"					73.8			(15%-125%)	

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## Certificate of Analysis

Company : Northgate Environmental Management, Inc.  
 Address : 1100 Quail St., Suite 102  
 Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
 Project: **Tronox Henderson**

Client Sample ID:	SA128-10BSPLP	Project:	KERRHenderson
Sample ID:	235945005	Client ID:	KERR003
Matrix:	SO		
Collect Date:	16-SEP-09 09:58		
Receive Date:	17-SEP-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
<b>Rad Alpha Spec Analysis</b>												
<i>Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Thorium-228	U	0.0297	+/-0.0288	0.0469	0.030	pCi/L		MXA	10/12/09	1709	906826	1
Thorium-230		0.394	+/-0.0588	0.0214	0.030	pCi/L						
Thorium-232		0.0291	+/-0.017	0.0171	0.030	pCi/L						
<i>Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"</i>												
Uranium-233/234		0.587	+/-0.079	0.026	0.030	pCi/L		MXA	10/08/09	2117	906828	2
Uranium-235/236		0.0403	+/-0.0228	0.0101	0.030	pCi/L						
Uranium-238		0.427	+/-0.068	0.030	0.030	pCi/L						
<b>Rad Gas Flow Proportional Counting</b>												
<i>GFPC, Radium-228, SPLP, Fluid 3 "As Received"</i>												
Radium-228	U	2.14	+/-1.70	2.67	3.00	pCi/L		JXC5	10/08/09	1424	906803	3
<b>Rad Radium-226</b>												
<i>Lucas Cell, Radium-226, SPLP 3 "As Received"</i>												
Radium-226	U	0.408	+/-0.447	0.733	1.00	pCi/L		KSD1	10/14/09	0915	907303	4

**The following Prep Methods were performed**

Method	Description	Analyst	Date	Time	Prep Batch
EPA 1312	EPA 1312 Synthetic Leaching-Reagent Water	RXD2	09/22/09	1500	905076

**The following Analytical Methods were performed**

Method	Description	Analyst Comments
1	DOE EML HASL-300, Th-01-RC Modified	
2	DOE EML HASL-300, U-02-RC Modified	
3	EPA 904.0/SW846 9320 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Actinium-227 Tracer	Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"			97.7	(15%-125%)
Uranium-232 Tracer	Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"			64.0	(15%-125%)



# GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID: SA128-10BSPLP  
Sample ID: 235945005

Project: KERRHenderson  
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Barium-133 Tracer		GFPC, Radium-228, SPLP, Fluid 3 "As Received"					85.5			(15%-125%)	

# GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID:	SA128-29BSPLP	Project:	KERRHenderson
Sample ID:	235945006	Client ID:	KERR003
Matrix:	SO		
Collect Date:	16-SEP-09 10:28		
Receive Date:	17-SEP-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
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**Rad Alpha Spec Analysis**

*Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"*

Thorium-228	U	0.00548	+/-0.018	0.0351	0.030	pCi/L	MXA	10/12/09	1709	906826	1	
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Thorium-230	U	0.00237	+/-0.00465	0.00712	0.030	pCi/L						
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Thorium-232	U	0.00	+/-0.00657	0.0182	0.030	pCi/L						
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*Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"*

Uranium-233/234		0.150	+/-0.035	0.0219	0.030	pCi/L	MXA	10/08/09	2117	906828	2	
-----------------	--	-------	----------	--------	-------	-------	-----	----------	------	--------	---	--

Uranium-235/236	U	0.00245	+/-0.0107	0.0235	0.030	pCi/L						
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Uranium-238		0.0852	+/-0.0266	0.019	0.030	pCi/L						
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**Rad Gas Flow Proportional Counting**

*GFPC, Radium-228, SPLP, Fluid 3 "As Received"*

Radium-228		2.40	+/-1.48	2.19	3.00	pCi/L	JXC5	10/12/09	1804	906803	3	
------------	--	------	---------	------	------	-------	------	----------	------	--------	---	--

**Rad Radium-226**

*Lucas Cell, Radium-226, SPLP 3 "As Received"*

Radium-226	U	0.202	+/-0.421	0.774	1.00	pCi/L	KSD1	10/14/09	0915	907303	4	
------------	---	-------	----------	-------	------	-------	------	----------	------	--------	---	--

**The following Prep Methods were performed**

Method	Description	Analyst	Date	Time	Prep Batch
EPA 1312	EPA 1312 Synthetic Leaching-Reagent Water	RXD2	09/22/09	1500	905076

**The following Analytical Methods were performed**

Method	Description	Analyst Comments
1	DOE EML HASL-300, Th-01-RC Modified	
2	DOE EML HASL-300, U-02-RC Modified	
3	EPA 904.0/SW846 9320 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Actinium-227 Tracer	Alphaspec Thorium, SPLP, Fluid 3 (Reagent Water) "As Received"			95.4	(15%-125%)
Uranium-232 Tracer	Alphaspec Uranium, SPLP, Fluid 3 (Reagent Water) "As Received"			84.9	(15%-125%)

# GEL LABORATORIES LLC

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## Certificate of Analysis

Company : Northgate Environmental  
Management, Inc.  
Address : 1100 Quail St., Suite 102  
Newport Beach, California 92660

Report Date: October 15, 2009

Contact: Mr. Frank Hagar  
Project: **Tronox Henderson**

Client Sample ID: SA128-29BSPLP  
Sample ID: 235945006

Project: KERRHenderson  
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Barium-133 Tracer		GFPC, Radium-228, SPLP, Fluid 3 "As Received"					78.6			(15%-125%)	

# QUALITY CONTROL DATA

# GEL LABORATORIES LLC

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## QC Summary

Report Date: October 15, 2009

Page 1 of 4

Northgate Environmental Management, Inc.

1100 Quail St., Suite 102  
Newport Beach, California

Contact: Mr. Frank Hagar

Workorder: 235945

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
<b>Rad Alpha Spec</b>											
Batch	906826										
QC1201934060	235945001	DUP									
Thorium-228		0.488		0.470	pCi/L	3.79		(0% - 20%)	MXA1	10/12/09	17:10
		+/-0.0675		+/-0.0753							
Thorium-230		0.845		0.853	pCi/L	0.921		(0% - 20%)			
		+/-0.0841		+/-0.0871							
Thorium-232		0.109		0.107	pCi/L	1.56		(0% - 20%)			
		+/-0.0299		+/-0.0385							
QC1201934063	LCS										
Thorium-228			U	0.0122	pCi/L					10/12/09	17:09
				+/-0.0202							
Thorium-230	2.68			2.32	pCi/L		86.6	(75%-125%)			
				+/-0.145							
Thorium-232			U	0.00	pCi/L			(75%-125%)			
				+/-0.0112							
QC1201934058	MB										
Thorium-228			U	0.0162	pCi/L					10/12/09	11:42
				+/-0.0149							
Thorium-230			U	-0.0113	pCi/L						
				+/-0.0108							
Thorium-232			U	-0.00677	pCi/L						
				+/-0.00989							
QC1201934062	235945001	MS									
Thorium-228		0.488		0.214	pCi/L					10/12/09	17:10
		+/-0.0675		+/-0.0522							
Thorium-230	2.68	0.845		3.28	pCi/L		90.9	(75%-125%)			
		+/-0.0841		+/-0.174							
Thorium-232		0.109		0.0603	pCi/L			(75%-125%)			
		+/-0.0299		+/-0.0246							
QC1201929717	TB										
Thorium-228			U	0.0199	pCi/L					10/12/09	17:09
				+/-0.0189							
Thorium-230			U	0.0101	pCi/L						
				+/-0.0122							
Thorium-232				0.0152	pCi/L						
				+/-0.0122							
Batch	906828										
QC1201934077	235945001	DUP									
Uranium-233/234		h 1.60		1.75	pCi/L	9.20		(0% - 20%)	MXA1	10/08/09	21:17
		+/-0.117		+/-0.155							
Uranium-235/236		h 0.0384	U	0.0393	pCi/L	2.28		(0% - 100%)			
		+/-0.0228		+/-0.0332							
Uranium-238		h 1.04		1.04	pCi/L	0.307		(0% - 20%)			

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## QC Summary

Workorder: 235945

Page 2 of 4

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
<b>Rad Alpha Spec</b>											
Batch	906828										
QC1201934080	LCS			+/-0.096							
Uranium-233/234				+/-0.121							
				3.10	pCi/L				MXA1	10/08/09	21:17
				+/-0.167							
Uranium-235/236				0.132	pCi/L						
				+/-0.0405							
Uranium-238	3.15			3.46	pCi/L		110	(75%-125%)			
				+/-0.176							
QC1201934075	MB										
Uranium-233/234			U	0.00351	pCi/L					10/08/09	21:17
				+/-0.0132							
Uranium-235/236			U	6.38E-10	pCi/L						
				+/-0.0128							
Uranium-238			U	0.00216	pCi/L						
				+/-0.00735							
QC1201934079	235945001	MS									
Uranium-233/234			h	1.60	pCi/L					10/08/09	21:17
				+/-0.117							
Uranium-235/236			h	0.0384	pCi/L						
				+/-0.0228							
Uranium-238	3.15		h	1.04	pCi/L		118	(75%-125%)			
				+/-0.096							
QC1201929717	TB										
Uranium-233/234			U	0.0173	pCi/L					10/08/09	21:17
				+/-0.0171							
Uranium-235/236			U	0.0025	pCi/L						
				+/-0.011							
Uranium-238			U	-0.00202	pCi/L						
				+/-0.0119							
<b>Rad Gas Flow</b>											
Batch	906803										
QC1201933969	235945001	DUP									
Radium-228			Uh	1.00	pCi/L	0.00			N/A	JXC5	10/08/09 11:36
				+/-1.25							
QC1201933972	LCS										
Radium-228	39.8			43.7	pCi/L		110	(75%-125%)		10/08/09	11:36
				+/-4.45							
QC1201933967	MB										
Radium-228			U	2.01	pCi/L					10/08/09	11:36
				+/-1.54							
QC1201933971	235945001	MS									
Radium-228	80.7		Uh	1.00	pCi/L		112	(75%-125%)		10/08/09	11:36
				+/-1.25							
QC1201929717	TB										
Radium-228			U	1.88	pCi/L					10/08/09	14:25
				+/-1.71							

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## QC Summary

Workorder: 235945

Page 3 of 4

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
<b>Rad Ra-226</b>											
Batch	907303										
QC1201935052	235945006	DUP									
Radium-226			U	0.202	U	0.487	pCi/L	0.00	N/A	KSD1	10/14/09 09:55
				+/-0.421		+/-0.584					
QC1201935054	LCS										
Radium-226	60.4					45.1	pCi/L	74.7*	(75%-125%)		10/14/09 12:25
						+/-3.17					
QC1201935051	MB										
Radium-226			U			-0.211	pCi/L				10/14/09 09:55
						+/-0.358					
QC1201935053	235945006	MS									
Radium-226	121		U	0.202		114	pCi/L	94.2	(75%-125%)		10/14/09 09:55
				+/-0.421		+/-7.34					
QC1201929717	TB										
Radium-226			U			0.481	pCi/L				10/14/09 09:15
						+/-0.480					

**Notes:**

The Qualifiers in this report are defined as follows:

- \*\* Analyte is a surrogate compound
- < Result is less than value reported
- > Result is greater than value reported
- A The TIC is a suspected aldol-condensation product
- B For General Chemistry and Organic analysis the target analyte was detected in the associated blank.
- BD Results are either below the MDC or tracer recovery is low
- C Analyte has been confirmed by GC/MS analysis
- D Results are reported from a diluted aliquot of the sample
- F Estimated Value
- H Analytical holding time was exceeded
- J Value is estimated
- M M if above MDC and less than LLD
- M Matrix Related Failure
- N/A RPD or %Recovery limits do not apply.
- ND Analyte concentration is not detected above the detection limit
- NJ Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- R Sample results are rejected
- U Analyte was analyzed for, but not detected above the MDL, MDA, or LOD.
- UI Gamma Spectroscopy--Uncertain identification
- X Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Y QC Samples were not spiked with this compound

# GEL LABORATORIES LLC

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## QC Summary

Workorder: 235945

Page 4 of 4

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
^	RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.										
h	Preparation or preservation holding time was exceeded										

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more.

^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.

\* Indicates that a Quality Control parameter was not within specifications.

For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.



**RAW DATA**

# URANIUM

### Radiochemistry Batch Checklist, Rev 9

Batch# 906828      Product: U      Date: 10/13/09

Criteria:	Yes	No	Comments
Sample Solids are less than or equal to 100 mg for GAB.			N/A
Samples have been blank corrected (if required)			N/A
If activity less 10* MDA/ MDC, error is 150% or less of sample activity. If greater 10* MDA/ MDC, error is 40% or less. If below the MDA/ MDC, error is okay.	✓		
Instrument source check is within limits.	✓		
Instrument bkg check is within limits.			
Method RDL/ LLD has been met.		✓	NCR 745034
If duplicate activities are less 5* MDA/ MDC, then RPD is 100% or less. If greater 5* MDA/ MDC, then RPD 20% or less. If below the MDA/ MDC, the RPD is 0%.	✓		
Or meets the client's required RER acceptance criteria.			
Tracer yield is 15-125% . Carrier yield 25-125%.			
Or meets the client's contract acceptance criteria.		✓	NCR 745034
Method blank is less than the RDL/ LLD. (If rad samples, < 5% of lowest activity)	✓		
Sample was run within hold time.	✓		
Sample was correctly preserved if required.	✓		
Smears Taken for Radioactive batches.	✓		
Method Spike and LCS are within 75-125% or meets the client's contract acceptance criteria.	✓		
No blank spaces on data forms.			
All line outs initialed and dated.	✓		
No transcription errors are apparent.			
Aux data is correct.			N/A
Client Special requirements page has been checked.	✓		
Raw Data and/ or spectrum are included and properly stasuted.	✓		
QC data entered into QC database and batch is in REVW	✓		
Hit notification complete (if necessary)			N/A
Batch entered into Case Narrative.	✓		
Batch non-conformances completed, if applicable.	✓		NCR 745034
Batch non-conformances second reviewed and disposition verified to be completed.	✓		NCR 745034
Aliquot Correction completed if required.			N/A
Review sample historical results if available (If REMF, results above MDC have been verified by historical results, recount or re-analysis.)	✓		

GEL Laboratories, LLC

revised 8/1/08

Primary Review Performed By: Japl MR 10/13/09

Secondary Review Performed By: Butch 10/13/09

10/4 10/15  
VSR

# Uranium Que Sheet

02-OCT-09

Batch #: 906828 Analyst: MXAI First Client Due Date: 15-OCT-09 Internal Due Date: 04-OCT-09

Tracer Isotope: U-232 U-236 Tracer Code: 1783-6 Expiration Date: 1/15/10 Vol: 0.1 uL  
 LCS Isotope: U-238 LCS Code: 1163-6 Expiration Date: 4/16/10 Vol: 0.1 uL  
 Spike Isotope: U-238 Spike Code: 1163-6 Expiration Date: 4/16/10 Vol: 0.1 uL  
 Prep Date: 10/6/09 Initials: MDA Pipet ID: 2971058 Balance ID: 16750707

Witness: KM 10-6-09

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collection Date	Pos.	Label #	Wet/Dry Aliquot (g) (f)	U Det #
235941001-1	SA64-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	24-AUG-09	1	101	0.800	159
235941002-1	SA102-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	2	102	0.800	160
235941003-1	SA102-30BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	3	103	0.800	7
235941004-1	SA30-9BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	15-SEP-09	4	104	0.800	8
235941005-1	SA128-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	5	105	0.800	9
235941006-1	SA128-29BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	6	106	0.800	10
235945001-1	SA64-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	24-AUG-09	7	107	0.800	11
235945002-1	SA102-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	8	108	0.800	12
235945003-1	SA102-30BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	9	109	0.800	13
235945004-1	SA30-9BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	15-SEP-09	10	110	0.800	14
235945005-1	SA128-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	11	111	0.800	15
235945006-1	SA128-29BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	12	112	0.800	16
1201929716-1	TB for batch 905075	TB		.03 pCi/L	SOIL	QC ACCOUNT	15-SEP-09	13	113	0.800	17
1201929717-1	TB for batch 905076	TB		.03 pCi/L	SOIL	QC ACCOUNT	15-SEP-09	14	114	0.800	18
1201934075-1	MB for batch 906828	MB		.03 pCi/L	SOIL	QC ACCOUNT	15-SEP-09	15	115	0.800	19
1201934076-1	SA64-10BSPLP(235941001DUP)	DUP		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	16	116	0.800	20
1201934077-1	SA64-10BSPLP(235945001DUP)	DUP		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	17	117	0.800	21
1201934078-1	SA64-10BSPLP(235941001MS)	MS		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	18	118	0.800	22
1201934079-1	SA64-10BSPLP(235945001MS)	MS		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	19	119	0.800	23
1201934080-1	LCS for batch 906828	LCS		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	20	120	0.800	24

Choose SOP used: GL-RAD-A-011  
GL-RAD-A-038  
 GL-RAD-A-045  
 GL-RAD-A-043

Solid Sample Dissolution by: LEACH or DIGESTION  
 Circle One

Data Reviewed By: Sup ML - 10/13/09  
See 10/13/09

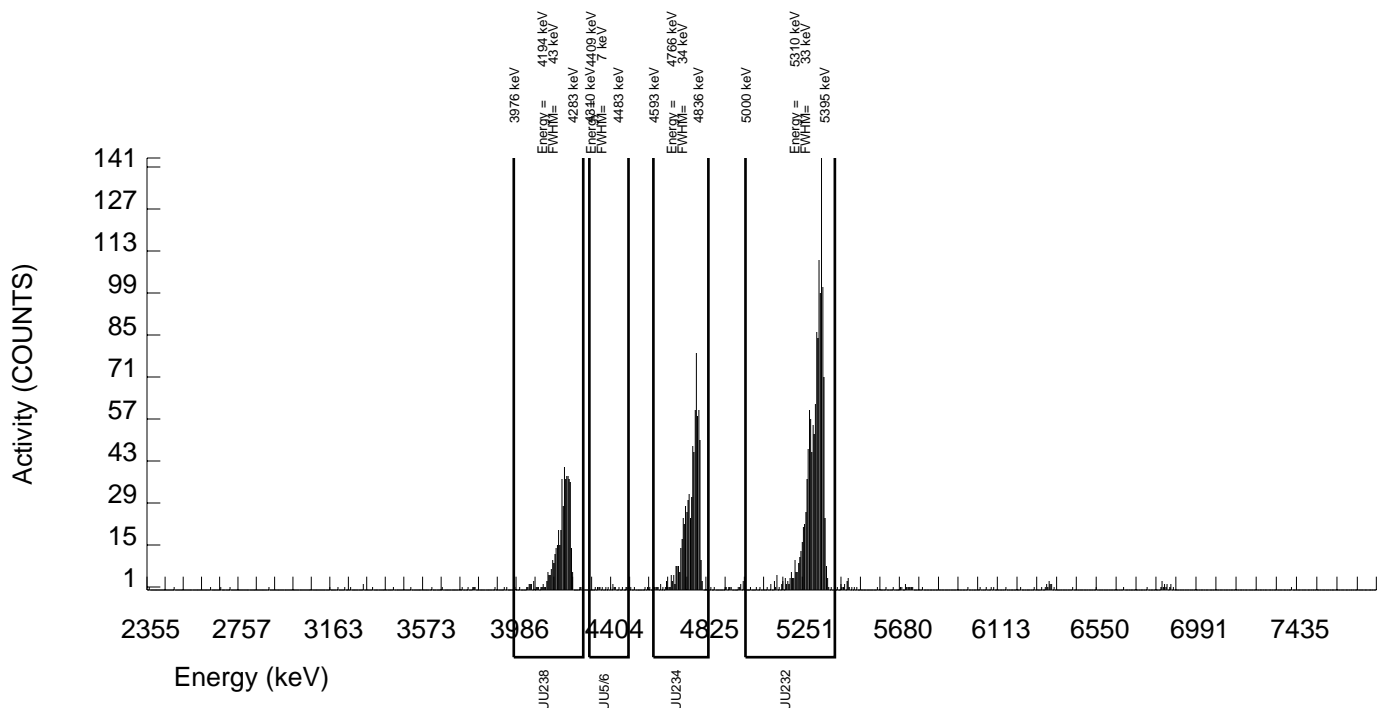
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 24-AUG-2009 00:00:00		SAMPLE ID : S0235945001_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :72531 AVERAGE %EFFICIENCY :29.4476 % YIELD : 86.088		COUNT DATE: 8-OCT-2009 21:17:38 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.26067 dpm RESULTS : 4.52881 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B011.CNF;1072 BKG DATE : 4-OCT-2009 EFF FILE : W011.CNF;305 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	723.000	718.657	3.000	1.7321	100.0000	1.60E+00	2.46E-01	2.46E-02	8.95E-03	1.17E-01
U232	5302.100	1339.000	1332.000	7.000	2.6458	100.0000	2.96E+00	4.32E-01	3.40E-02	1.37E-02	1.60E-01
U-235	4391.000	16.000	14.000	2.000	1.4142	80.90000	3.84E-02	2.34E-02	2.63E-02	9.03E-03	2.28E-02
U-238	4184.730	477.000	468.000	9.000	3.0000	100.0000	1.04E+00	1.70E-01	3.77E-02	1.55E-02	9.60E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity



GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828  
SAMPLE DATE : 10-SEP-2009 00:00:00

SAMPLE ID : S0235945002\_UU  
SAMPLE QTY: 0.800 L

DETECTOR NUMBER :67594  
AVERAGE %EFFICIENCY :29.9316  
% YIELD : 79.546

COUNT DATE: 8-OCT-2009 21:17:38  
ELAPSED LIVE TIME(SEC): 60000.00  
ANALYST :MXA1

MS/MSD  
ID : 1163-G  
ISOTOPE : U-238  
PCI/L : 3.149E+00

LCS/LCSD  
ID : 1163-G  
ISOTOPE : U-238  
PCI/L : 3.149E+00

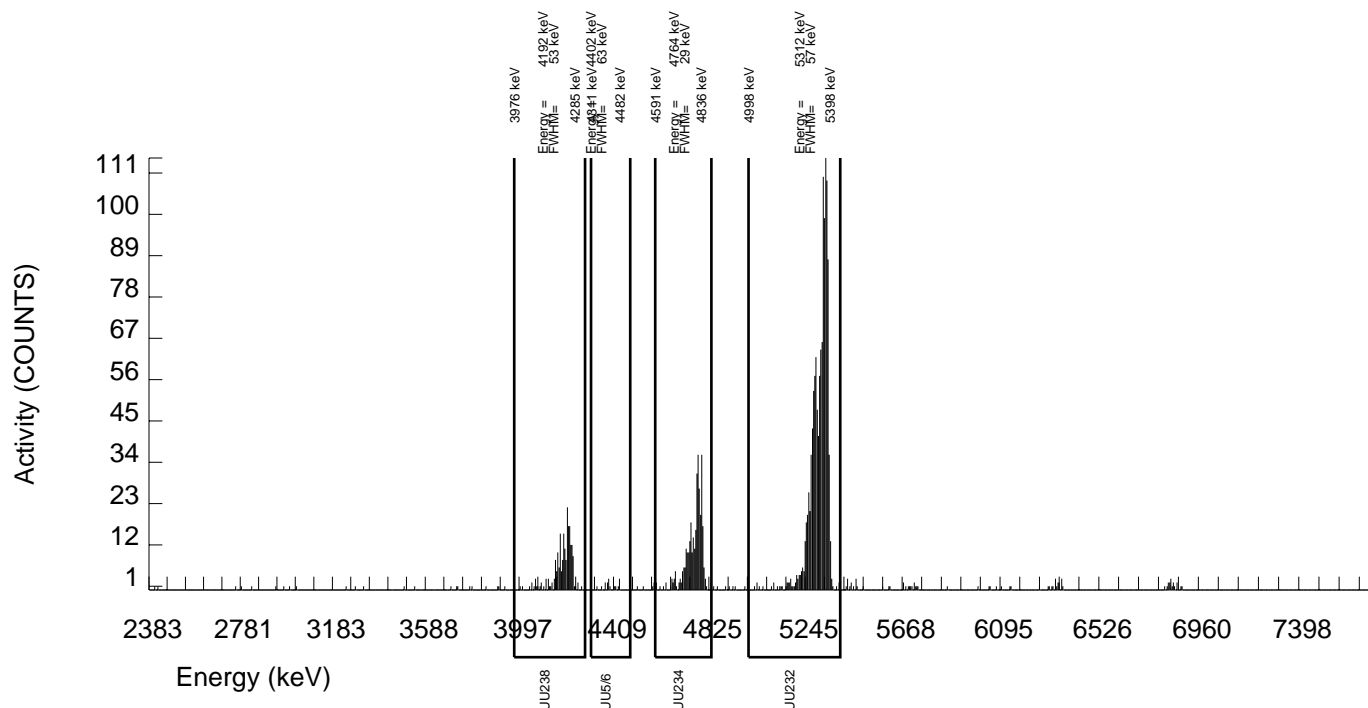
TRACER  
ID : 1283-E  
ISOTOPE : U232  
NOMINAL : 5.25831 dpm  
RESULTS : 4.18276 dpm

LIB FILE : ENV\_ALPHA\_UU.N  
BKG FILE : B012.CNF;1074  
BKG DATE : 4-OCT-2009  
EFF FILE : W012.CNF;306  
CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	337.000	332.739	3.000	1.7321	100.0000	7.87E-01	1.37E-01	2.62E-02	9.53E-03	8.53E-02
U232	5302.100	1260.000	1251.000	9.000	3.0000	100.0000	2.96E+00	4.36E-01	4.01E-02	1.65E-02	1.65E-01
U-235	4391.000	17.000	14.000	3.000	1.7321	80.90000	4.09E-02	2.62E-02	3.23E-02	1.18E-02	2.56E-02
U-238	4184.730	213.000	212.000	1.000	1.0000	100.0000	5.01E-01	9.62E-02	1.81E-02	5.50E-03	6.78E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity



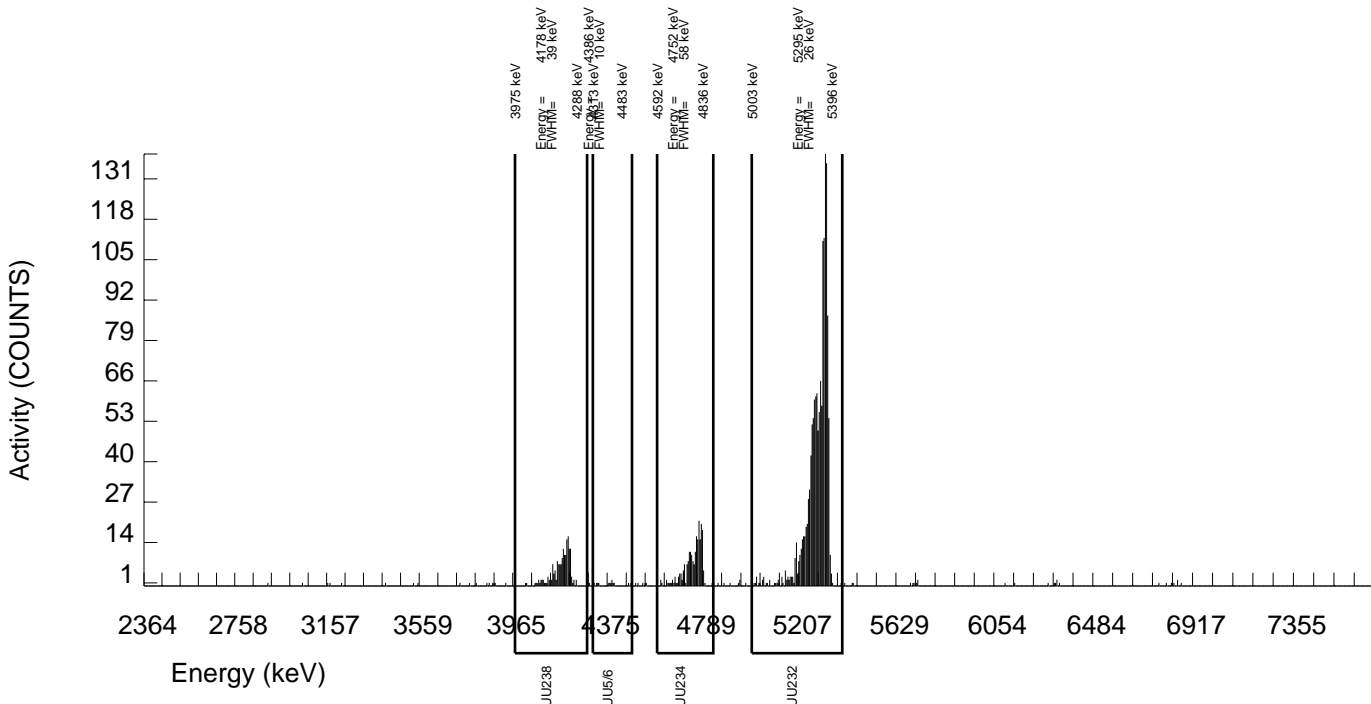
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 10-SEP-2009 00:00:00		SAMPLE ID : S0235945003_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :78790 AVERAGE %EFFICIENCY :34.0254 % YIELD : 81.721		COUNT DATE: 8-OCT-2009 21:17:39 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25831 dpm RESULTS : 4.29716 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B013.CNF;1051 BKG DATE : 4-OCT-2009 EFF FILE : W013.CNF;318 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	229.000	224.527	3.000	1.7321	100.0000	4.55E-01	8.58E-02	2.24E-02	8.16E-03	6.03E-02
U232	5302.100	1466.000	1461.000	5.000	2.2361	100.0000	2.96E+00	4.26E-01	2.72E-02	1.05E-02	1.52E-01
U-235	4391.000	14.000	13.000	1.000	1.0000	80.90000	3.25E-02	1.95E-02	1.92E-02	5.82E-03	1.90E-02
U-238	4184.730	180.000	174.000	6.000	2.4495	100.0000	3.52E-01	7.19E-02	2.92E-02	1.15E-02	5.41E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity



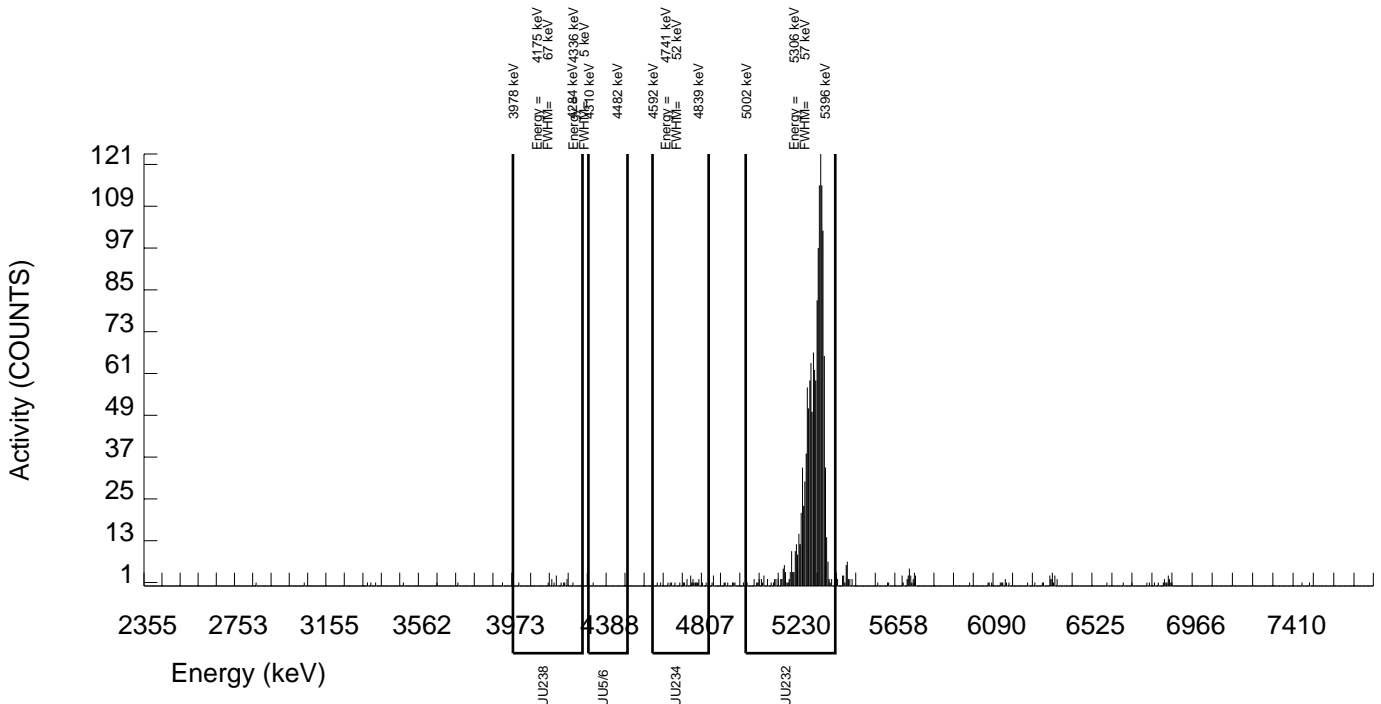
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 15-SEP-2009 00:00:00		SAMPLE ID : S0235945004_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :67616 AVERAGE %EFFICIENCY :31.5461 % YIELD : 90.014		COUNT DATE: 8-OCT-2009 21:17:39 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25762 dpm RESULTS : 4.73260 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B014.CNF;1052 BKG DATE : 4-OCT-2009 EFF FILE : W014.CNF;317 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	26.000	21.496	3.000	1.7321	100.0000	4.26E-02	2.12E-02	2.19E-02	7.99E-03	2.04E-02
U232	5302.100	1502.000	1492.000	10.000	3.1623	100.0000	2.96E+00	4.25E-01	3.51E-02	1.46E-02	1.51E-01
U-235	4391.000	1.000	0.000	1.000	1.0000	80.90000	0.00E+00	6.80E-03	1.88E-02	5.70E-03	6.79E-03
U-238	4184.730	14.000	10.000	4.000	2.0000	100.0000	1.98E-02	1.67E-02	2.44E-02	9.23E-03	1.65E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity





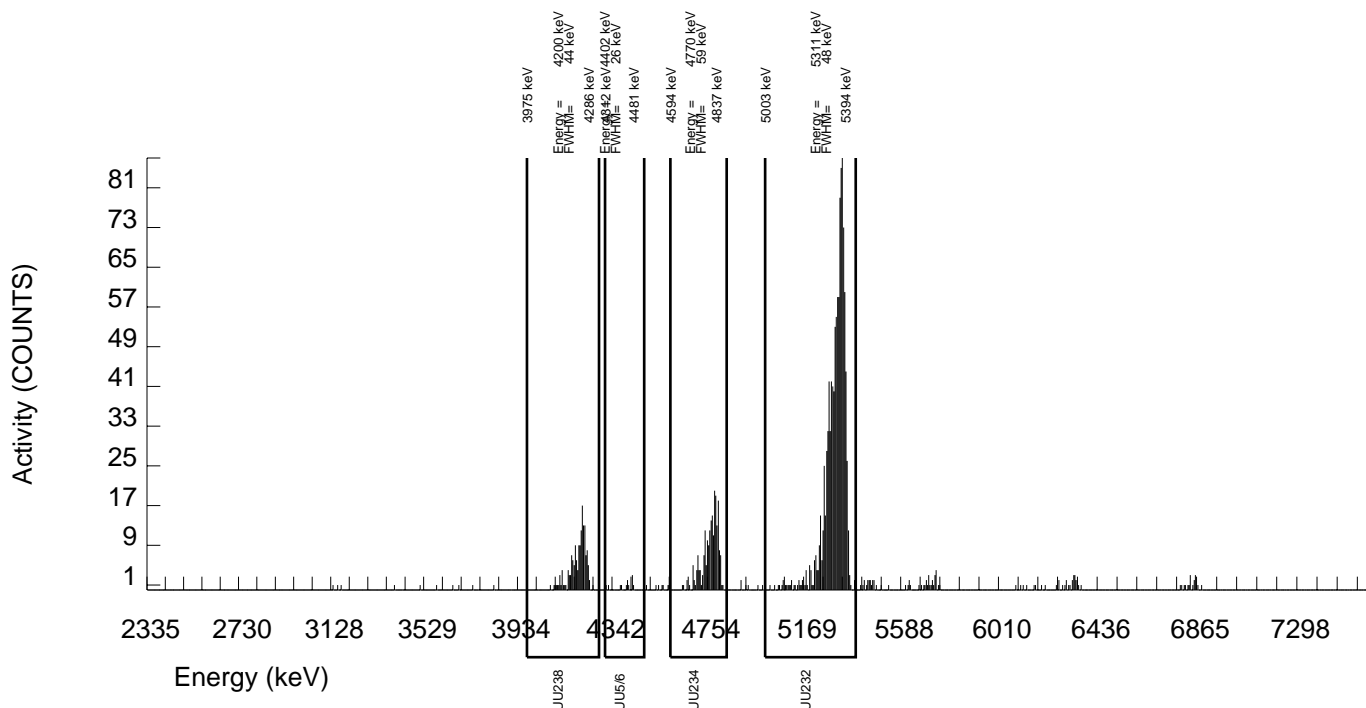
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 16-SEP-2009 00:00:00		SAMPLE ID : S0235945005_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :61581 AVERAGE %EFFICIENCY :32.3931 % YIELD : 63.983		COUNT DATE: 8-OCT-2009 21:17:39 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25748 dpm RESULTS : 3.36389 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B015.CNF;1071 BKG DATE : 4-OCT-2009 EFF FILE : W015.CNF;321 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	219.000	215.902	2.000	1.4142	100.0000	5.87E-01	1.13E-01	2.60E-02	8.94E-03	7.90E-02
U232	5302.100	1099.000	1089.000	10.000	3.1623	100.0000	2.96E+00	4.45E-01	4.82E-02	2.00E-02	1.77E-01
U-235	4391.000	12.000	12.000	0.000	0.0000	80.90000	4.03E-02	2.35E-02	1.01E-02	0.00E+00	2.28E-02
U-238	4184.730	160.000	157.000	3.000	1.7321	100.0000	4.27E-01	8.99E-02	3.00E-02	1.09E-02	6.80E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity



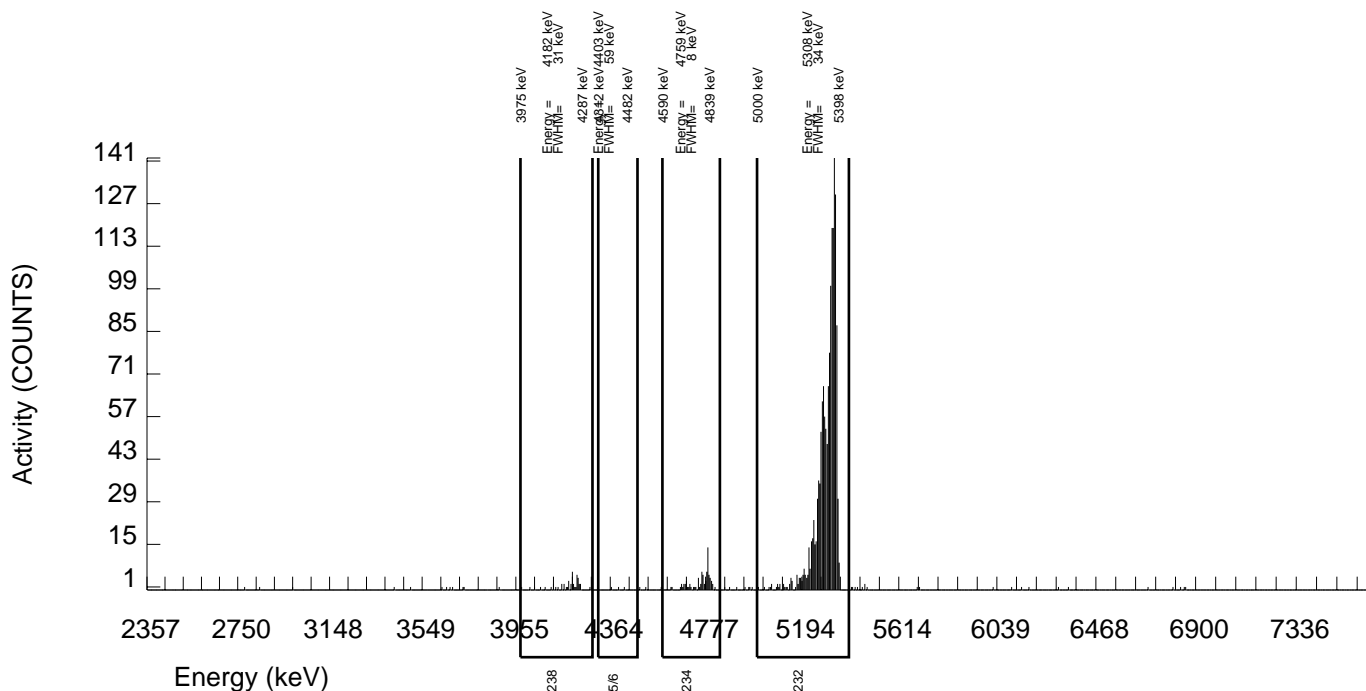
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 16-SEP-2009 00:00:00		SAMPLE ID : S0235945006_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :78774 AVERAGE %EFFICIENCY :33.4821 % YIELD : 84.923		COUNT DATE: 8-OCT-2009 21:17:39 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25748 dpm RESULTS : 4.46483 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B016.CNF;1047 BKG DATE : 4-OCT-2009 EFF FILE : W016.CNF;303 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	80.000	75.494	3.000	1.7321	100.0000	1.49E-01	4.04E-02	2.19E-02	7.98E-03	3.50E-02
U232	5302.100	1500.000	1494.000	6.000	2.4495	100.0000	2.96E+00	4.25E-01	2.85E-02	1.13E-02	1.51E-01
U-235	4391.000	3.000	1.000	2.000	1.4142	80.90000	2.45E-03	1.07E-02	2.34E-02	8.05E-03	1.07E-02
U-238	4184.730	45.000	43.000	2.000	1.4142	100.0000	8.52E-02	2.90E-02	1.90E-02	6.51E-03	2.66E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity



GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828  
SAMPLE DATE : 15-SEP-2009 00:00:00

SAMPLE ID : S1201929717\_UU  
SAMPLE QTY: 0.800 L

DETECTOR NUMBER :78782  
AVERAGE %EFFICIENCY :32.3239  
% YIELD : 86.082

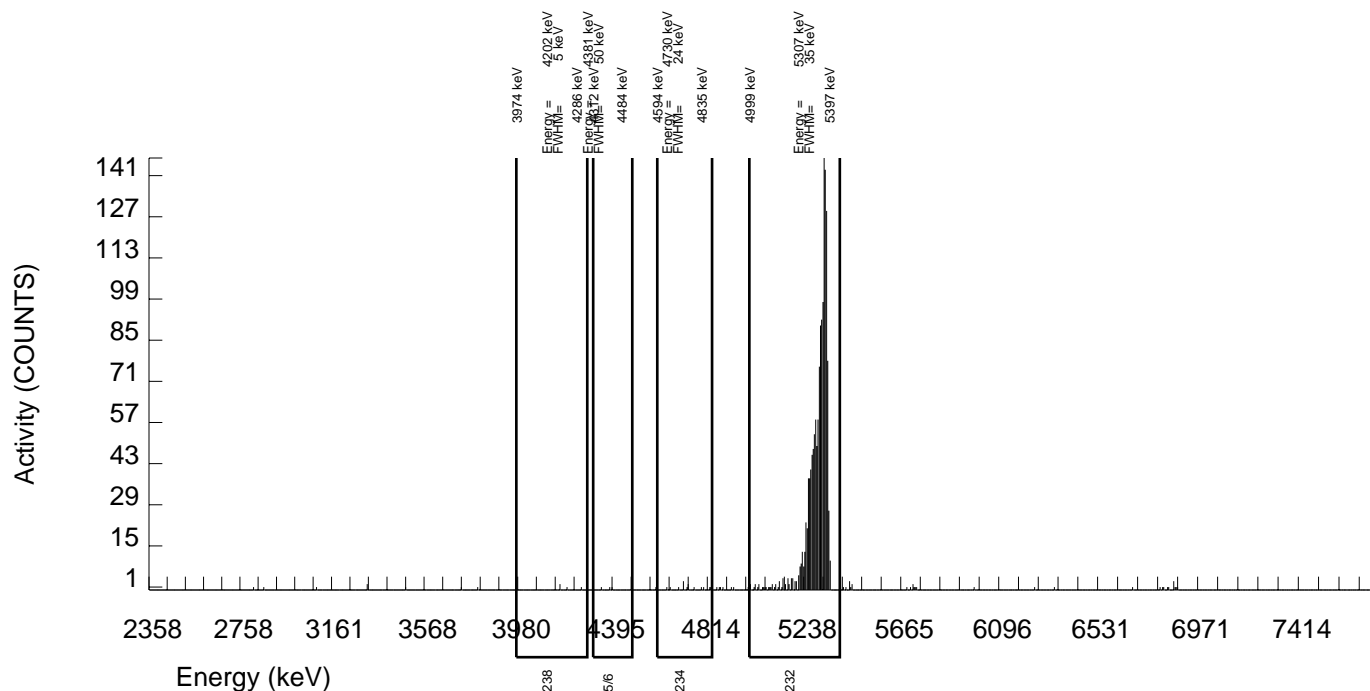
COUNT DATE: 8-OCT-2009 21:17:39  
ELAPSED LIVE TIME(SEC): 59999.99  
ANALYST :MXA1

MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25762 dpm RESULTS : 4.52586 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B018.CNF;1046 BKG DATE : 4-OCT-2009 EFF FILE : W018.CNF;298 CAL DATE : 6-OCT-2009
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NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	15.000	8.526	5.000	2.2361	100.0000	1.73E-02	1.72E-02	2.71E-02	1.05E-02	1.71E-02
U232	5302.100	1471.000	1462.000	9.000	3.0000	100.0000	2.96E+00	4.26E-01	3.43E-02	1.41E-02	1.53E-01
U-235	4391.000	3.000	1.000	2.000	1.4142	80.90000	2.50E-03	1.10E-02	2.40E-02	8.23E-03	1.10E-02
U-238	4184.730	4.000	-1.000	5.000	2.2361	100.0000	-2.02E-03	1.19E-02	2.71E-02	1.05E-02	1.19E-02

NOTE: Corrections made to U-3/4 net area due to tracer impurity



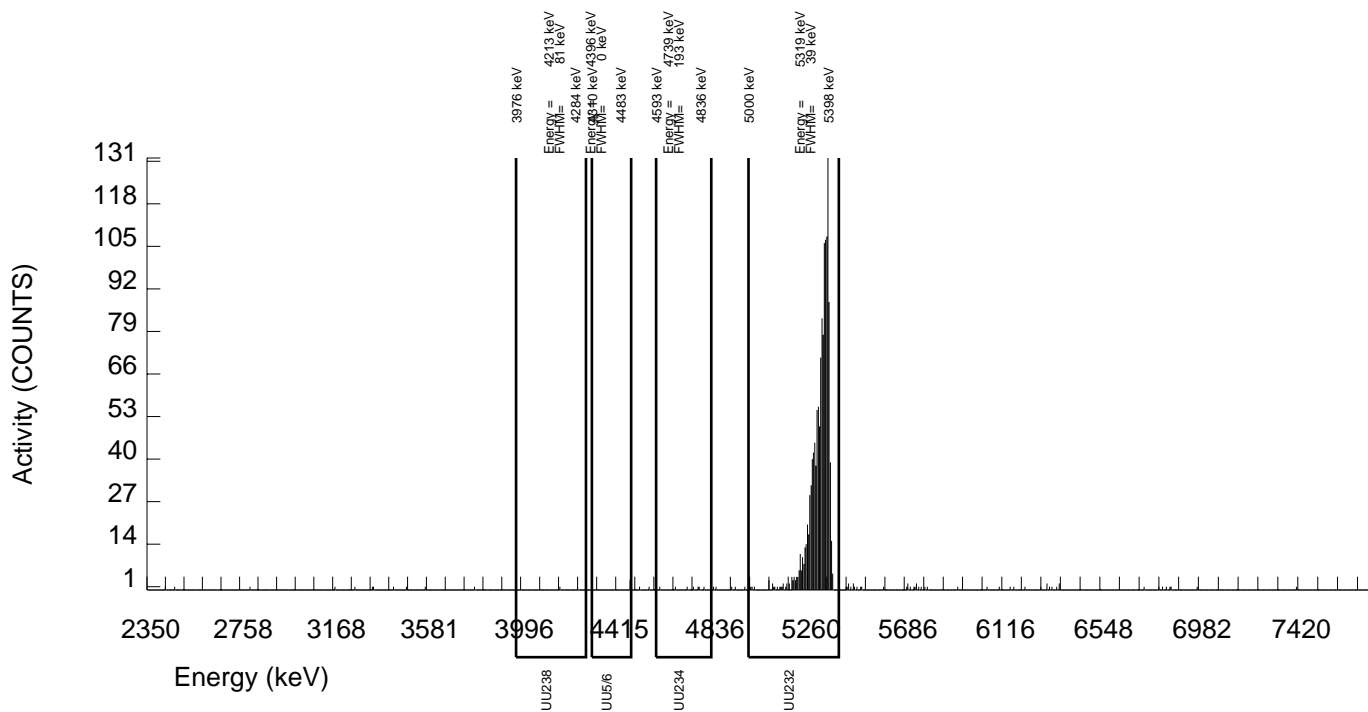
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 6-OCT-2009 00:00:00.		SAMPLE ID : S1201934075_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :78786 AVERAGE %EFFICIENCY :29.1980 % YIELD : 89.105		COUNT DATE: 8-OCT-2009 21:17:40 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25471 dpm RESULTS : 4.68221 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B019.CNF;1060 BKG DATE : 4-OCT-2009 EFF FILE : W019.CNF;298 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	7.000	1.622	4.000	2.0000	100.0000	3.51E-03	1.32E-02	2.66E-02	1.01E-02	1.32E-02
U232	5302.100	1369.000	1367.000	2.000	1.4142	100.0000	2.96E+00	4.30E-01	2.07E-02	7.12E-03	1.57E-01
U-235	4391.000	3.000	0.000	3.000	1.7321	80.90000	6.38E-10	1.28E-02	2.96E-02	1.08E-02	1.28E-02
U-238	4184.730	2.000	1.000	1.000	1.0000	100.0000	2.16E-03	7.35E-03	1.66E-02	5.03E-03	7.35E-03

NOTE: Corrections made to U-3/4 net area due to tracer impurity



GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828  
SAMPLE DATE : 24-AUG-2009 00:00:00

SAMPLE ID : S1201934077\_UU  
SAMPLE QTY: 0.800 L

DETECTOR NUMBER :67047  
AVERAGE %EFFICIENCY :30.3654  
% YIELD : 52.461

COUNT DATE: 8-OCT-2009 21:17:40  
ELAPSED LIVE TIME(SEC): 59999.99  
ANALYST :MXA1

MS/MSD  
ID : 1163-G  
ISOTOPE : U-238  
PCI/L : 3.149E+00

LCS/LCSD  
ID : 1163-G  
ISOTOPE : U-238  
PCI/L : 3.149E+00

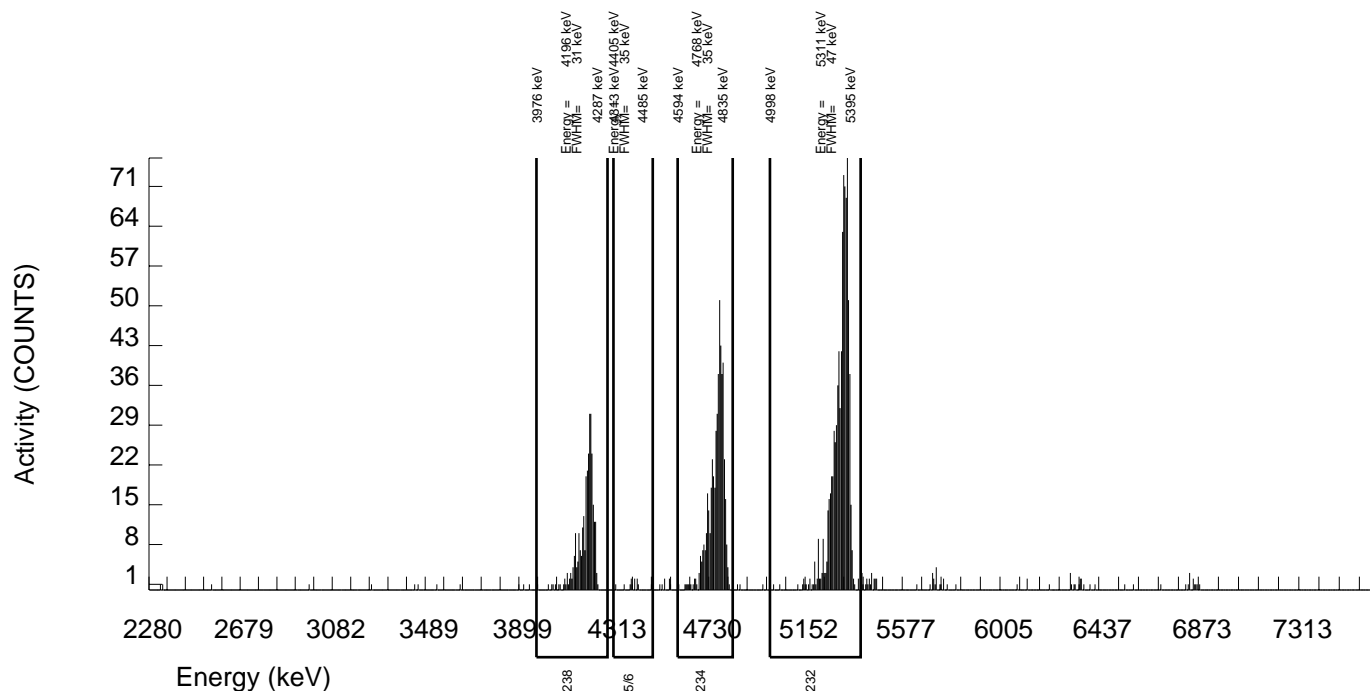
TRACER  
ID : 1283-E  
ISOTOPE : U232  
NOMINAL : 5.26067 dpm  
RESULTS : 2.75979 dpm

LIB FILE : ENV\_ALPHA\_UU.N  
BKG FILE : B021.CNF;1063  
BKG DATE : 4-OCT-2009  
EFF FILE : W021.CNF;320  
CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	500.000	495.156	4.000	2.0000	100.0000	1.75E+00	2.93E-01	4.35E-02	1.64E-02	1.55E-01
U232	5302.100	848.000	837.000	11.000	3.3166	100.0000	2.96E+00	4.67E-01	6.52E-02	2.73E-02	2.03E-01
U-235	4391.000	12.000	9.000	3.000	1.7321	80.90000	3.93E-02	3.36E-02	4.83E-02	1.76E-02	3.32E-02
U-238	4184.730	299.000	295.000	4.000	2.0000	100.0000	1.04E+00	1.91E-01	4.35E-02	1.64E-02	1.21E-01

NOTE: Corrections made to U-3/4 net area due to tracer impurity



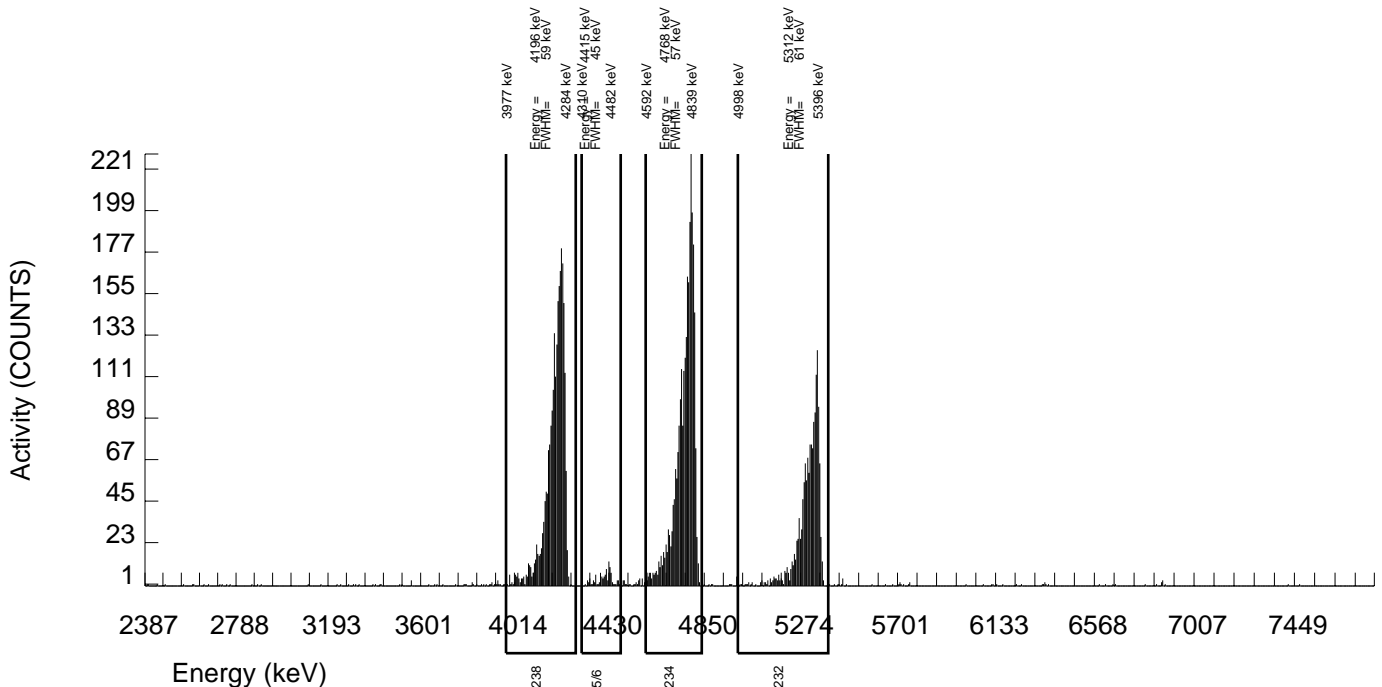
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 24-AUG-2009 00:00:00		SAMPLE ID : S1201934079_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :78264 AVERAGE %EFFICIENCY :32.9430 % YIELD : 86.255		COUNT DATE: 8-OCT-2009 21:17:40 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.26067 dpm RESULTS : 4.53760 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B023.CNF;1067 BKG DATE : 4-OCT-2009 EFF FILE : W023.CNF;293 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	2708.000	2702.495	4.000	2.0000	100.0000	5.36E+00	7.47E-01	2.44E-02	9.22E-03	2.02E-01
U232	5302.100	1501.000	1493.000	8.000	2.8284	100.0000	2.96E+00	4.25E-01	3.21E-02	1.31E-02	1.51E-01
U-235	4391.000	108.000	107.000	1.000	1.0000	80.90000	2.62E-01	6.12E-02	1.87E-02	5.70E-03	5.01E-02
U-238	4184.730	2412.000	2406.000	6.000	2.4495	100.0000	4.77E+00	6.68E-01	2.85E-02	1.13E-02	1.91E-01

NOTE: Corrections made to U-3/4 net area due to tracer impurity



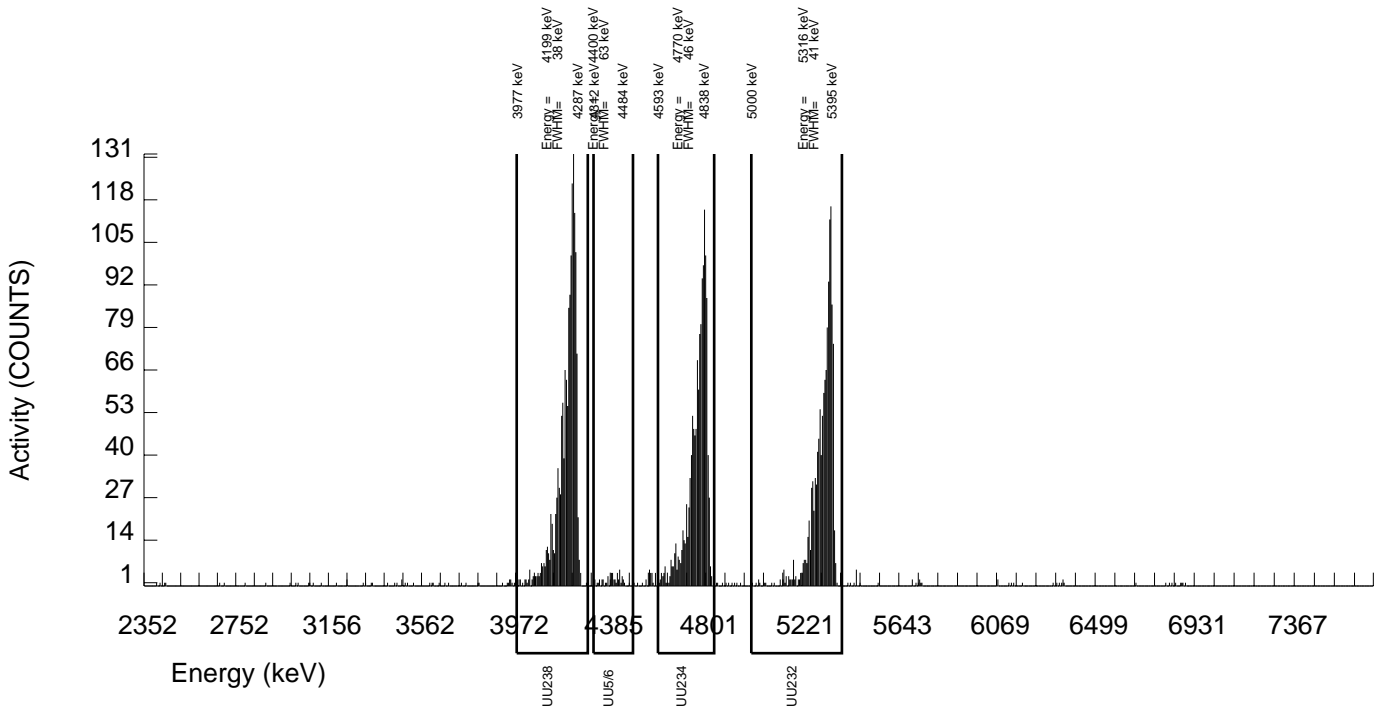
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906828 SAMPLE DATE : 6-OCT-2009 00:00:00.		SAMPLE ID : S1201934080_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :76542 AVERAGE %EFFICIENCY :32.6547 % YIELD : 74.427		COUNT DATE: 8-OCT-2009 21:17:40 ELAPSED LIVE TIME(SEC): 59999.99 ANALYST :MXA1	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 3.149E+00	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.25471 dpm RESULTS : 3.91095 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B024.CNF;1060 BKG DATE : 4-OCT-2009 EFF FILE : W024.CNF;292 CAL DATE : 6-OCT-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
U-3/4	4763.020	1342.000	1336.713	4.000	2.0000	100.0000	3.10E+00	4.53E-01	2.85E-02	1.08E-02	1.67E-01
U232	5302.100	1287.000	1277.000	10.000	3.1623	100.0000	2.96E+00	4.34E-01	4.10E-02	1.70E-02	1.64E-01
U-235	4391.000	49.000	46.000	3.000	1.7321	80.90000	1.32E-01	4.43E-02	3.17E-02	1.15E-02	4.05E-02
U-238	4184.730	1499.000	1495.000	4.000	2.0000	100.0000	3.46E+00	5.03E-01	2.85E-02	1.08E-02	1.76E-01

NOTE: Corrections made to U-3/4 net area due to tracer impurity



# THORIUM



### Radiochemistry Batch Checklist, Rev 9

Batch# 906826 Product: Th Date: 10/15/09

Criteria:	Yes	No	Comments
Sample Solids are less than or equal to 100 mg for GAB.			NA
Samples have been blank corrected (if required)			NA
If activity less 10* MDA/ MDC, error is 150% or less of sample activity. If greater 10* MDA/ MDC, error is 40% or less. If below the MDA/ MDC, error is okay.	/		
Instrument source check is within limits.	/		
Instrument bkg check is within limits.	/		
Method RDL/ LLD has been met.		/	NCR# 746886
If duplicate activities are less 5* MDA/ MDC, then RPD is 100% or less. If greater 5* MDA/ MDC, then RPD 20% or less. If below the MDA/ MDC, the RPD is 0%.	/		
Or meets the client's required RER acceptance criteria.	/		
Tracer yield is 15-125% . Carrier yield 25-125%.	/		
Or meets the client's contract acceptance criteria.	/		
Method blank is less than the RDL/ LLD. (If rad samples, < 5% of lowest activity)	/		
Sample was run within hold time.	/		
Sample was correctly preserved if required.			NA
Smears Taken for Radioactive batches.			NA
Method Spike and LCS are within 75-125% or meets the client's contract acceptance criteria.	/		
No blank spaces on data forms.	/		
All line outs initialed and dated.	/		
No transcription errors are apparent.	/		
Aux data is correct.			NA
Client Special requirements page has been checked.	/		
Raw Data and/ or spectrum are included and properly stasured.	/		
QC data entered into QC database and batch is in REVW	/		
Hit notification complete (if necessary)			NA
Batch entered into Case Narrative.	/		
Batch non-conformances completed, if applicable.	/		NCR# 746886
Batch non-conformances second reviewed and disposition verified to be completed.	/		NCR# 746886
Aliquot Correction completed if required.			NA
Review sample historical results if available (If REMF, results above MDC have been verified by historical results, recount or re-analysis.)	/		

GEL Laboratories, LLC

revised 8/1/08

Primary Review Performed By: [Signature] 10/15/09

Secondary Review Performed By: [Signature] 10/15/09

10/14-10/15  
KELOR

# Thorium (Ac-227 Tracer) Que Sheet

06-OCT-09

Batch #: 906826 Analyst: MXAI First Client Due Date: 15-OCT-09 Internal Due Date: 04-OCT-09  
 Tracer Isotope: Ac-227 Tracer Code: 0387-B-102 Expiration Date: 7/23/10 Vol: 0.1uL Ac-227 Separation Date/Time: 10/7/09 AT 0800 AM  
 LCS Isotope: Th-230 LCS Code: A2796-J Expiration Date: 4/13/10 Vol: 0.1uL  
 Spike Isotope: Th-230 Spike Code: A2796-J Expiration Date: 4/13/10 Vol: 0.1uL  
 Prep Date: 10/6/09 Initials: MDA Pipet ID: 2971058 Balance ID: 16750207 Witness: KM 10-6-09

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collection Date	Pos.	Label #	Wet/Dry Aliquot (g/1/1)	Th Det #
235941001-1	SA64-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	24-AUG-09	1	121	0.800	185 175
235941002-1	SA102-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	2	122	0.800	186 176
235941003-1	SA102-30BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	3	123	0.800	187 177
235941004-1	SA30-9BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	15-SEP-09	4	124	0.800	188 178
235941005-1	SA128-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	5	125	0.800	189 179
235941006-1	SA128-29BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	6	126	0.800	190 180
235945001-1	SA64-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	24-AUG-09	7	127	0.800	191 181
235945002-1	SA102-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	8	128	0.800	192 182
235945003-1	SA102-30BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	10-SEP-09	9	129	0.800	193 183
235945004-1	SA30-9BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	15-SEP-09	10	130	0.800	194 184
235945005-1	SA128-10BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	11	131	0.800	195 185
235945006-1	SA128-29BSPLP	SAMPLE		.03 pCi/L	SOIL	KERR003	16-SEP-09	12	132	0.800	196 186
1201929716-1	TB for batch 905075	TB		.03 pCi/L	SOIL	QC ACCOUNT	15-SEP-09	13	133	0.800	197 189
1201929717-1	TB for batch 905076	TB		.03 pCi/L	SOIL	QC ACCOUNT	15-SEP-09	14	134	0.800	198 188
1201934058-1	MB for batch 906826	MB		.03 pCi/L	SOIL	QC ACCOUNT	15-SEP-09	15	135	0.800	199 207
1201934059-1	SA64-10BSPLP(235941001DUP)	DUP		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	16	136	0.800	200 189
1201934060-1	SA64-10BSPLP(235945001DUP)	DUP		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	17	137	0.800	201 190
1201934061-1	SA64-10BSPLP(235941001MS)	MS		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	18	138	0.800	202 191
1201934062-1	SA64-10BSPLP(235945001MS)	MS		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	19	139	0.800	203 192
1201934063-1	LCS for batch 906826	LCS		.03 pCi/L	SOIL	QC ACCOUNT	24-AUG-09	20	140	0.800	204 174

CP 10/15/09

*[Handwritten Signature]*  
 Date: 10/15/09

Solid Sample Dissolution by: LEACH or DIGESTION Data Reviewed By: [Signature]

Choose SOP Used GL-RAD-A-038

- GL-RAD-A-045
- GL-RAD-A-043
- GL-RAD-A-032

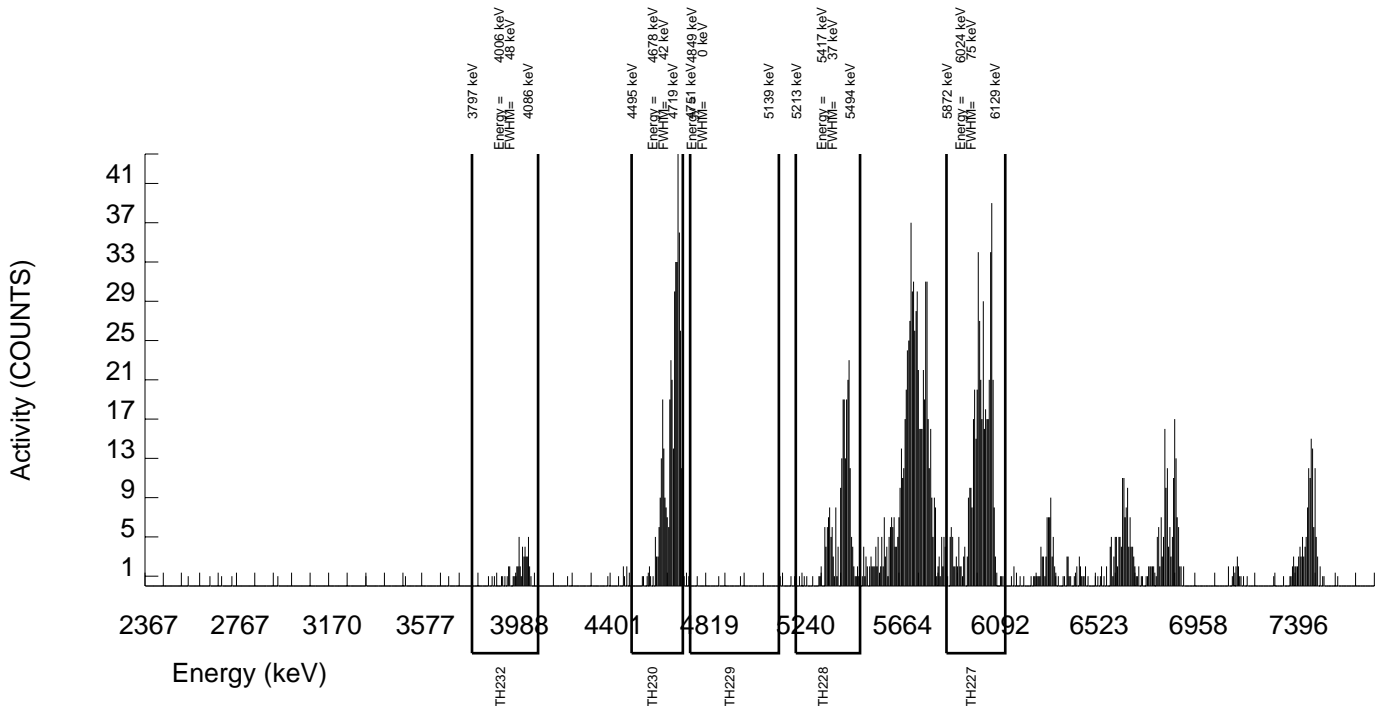
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 24-AUG-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S0235945001_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74439 AVERAGE %EFFICIENCY :25.6899 % YIELD : 102.725		COUNT DATE:12-OCT-2009 17:09:43 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 4.00465 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B181.CNF;134 BKG DATE : 11-OCT-2009 EFF FILE : W181.CNF;41 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	486.000	478.000	8.000	2.8284	57.44000	2.20E+00	2.32E-01	7.42E-02	3.02E-02	2.00E-01
TH-228	5363.000	233.000	217.606	9.000	3.0000	99.94000	4.88E-01	7.24E-02	3.80E-02	1.57E-02	6.75E-02
TH229	4900.000	4.000	-1.000	5.000	2.2361	99.52000	-2.14E-03	1.26E-02	2.87E-02	1.12E-02	1.26E-02
TH-230	4625.000	400.000	396.000	4.000	2.0000	100.0000	8.45E-01	9.56E-02	2.63E-02	9.93E-03	8.41E-02
TH-232	3972.000	51.000	51.000	0.000	0.0000	100.0000	1.09E-01	3.04E-02	6.40E-03	0.00E+00	2.99E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 10-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.	SAMPLE ID : S0235945002_TH SAMPLE QTY: 0.800 L
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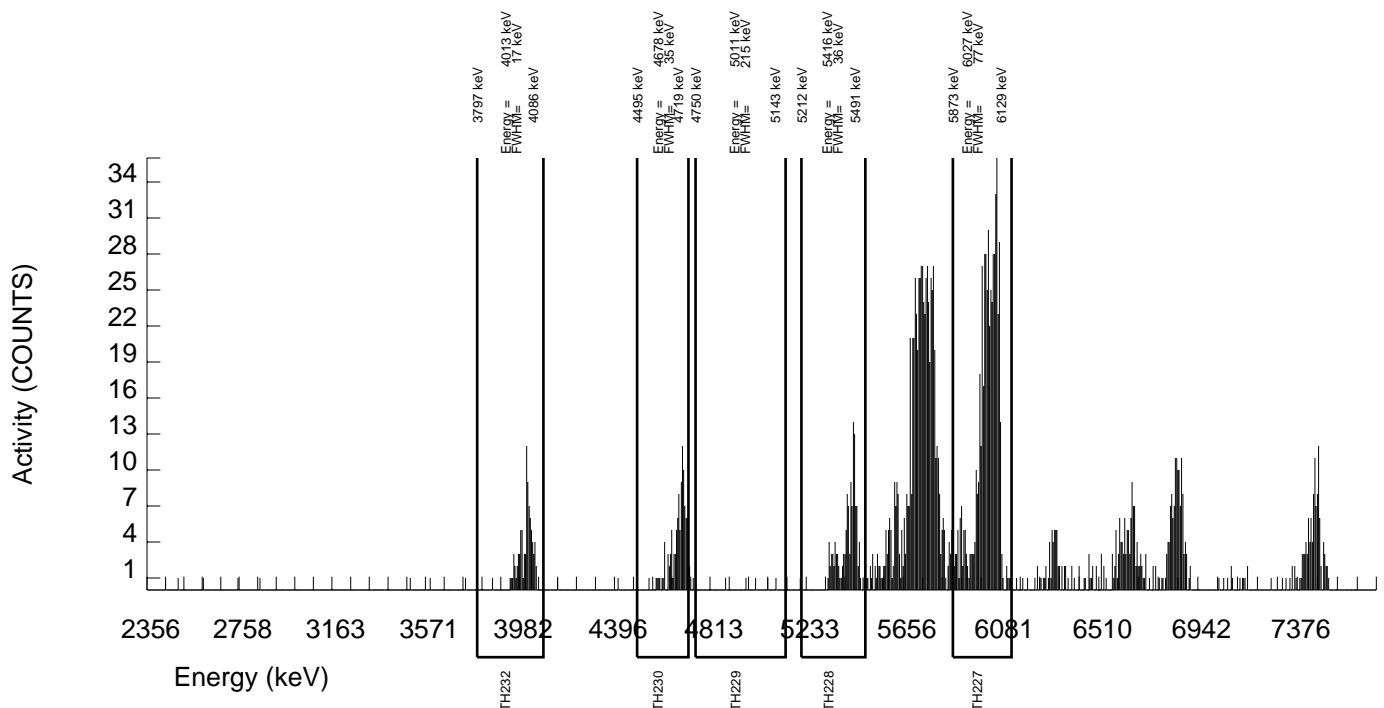
DETECTOR NUMBER :74440 AVERAGE %EFFICIENCY :25.5522 % YIELD : 118.619	COUNT DATE:12-OCT-2009 17:09:45 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1
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MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 4.62428 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B182.CNF;134 BKG DATE : 11-OCT-2009 EFF FILE : W182.CNF;41 CAL DATE : 21-SEP-2009
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NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	551.000	549.000	2.000	1.4142	57.44000	2.20E+00	2.19E-01	3.83E-02	1.32E-02	1.84E-01
TH-228	5363.000	128.000	112.657	8.000	2.8284	99.94000	2.16E-01	4.43E-02	3.10E-02	1.26E-02	4.27E-02
TH229	4900.000	5.000	1.000	4.000	2.0000	99.52000	1.87E-03	1.10E-02	2.30E-02	8.69E-03	1.10E-02
TH-230	4625.000	105.000	103.000	2.000	1.4142	100.0000	1.91E-01	3.91E-02	1.78E-02	6.11E-03	3.77E-02
TH-232	3972.000	87.000	87.000	0.000	0.0000	100.0000	1.62E-01	3.51E-02	5.57E-03	0.00E+00	3.40E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



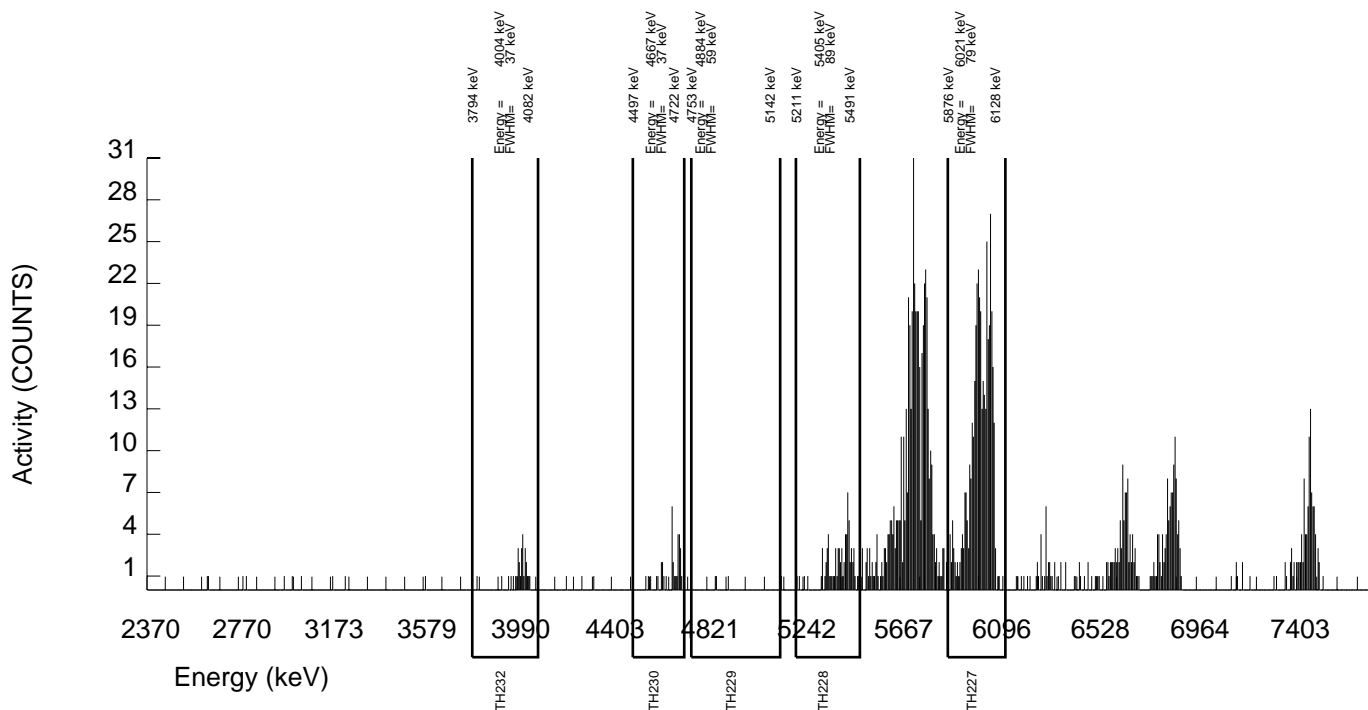
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 10-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S0235945003_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74441 AVERAGE %EFFICIENCY :26.1199 % YIELD : 86.873		COUNT DATE:12-OCT-2009 17:09:48 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 3.38665 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B183.CNF;134 BKG DATE : 11-OCT-2009 EFF FILE : W183.CNF;41 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	418.000	411.000	7.000	2.6458	57.44000	2.20E+00	2.46E-01	8.18E-02	3.29E-02	2.16E-01
TH-228	5363.000	74.000	60.502	8.000	2.8284	99.94000	1.55E-01	4.48E-02	4.15E-02	1.69E-02	4.40E-02
TH229	4900.000	3.000	-1.000	4.000	2.0000	99.52000	-2.49E-03	1.29E-02	3.07E-02	1.16E-02	1.29E-02
TH-230	4625.000	34.000	33.000	1.000	1.0000	100.0000	8.19E-02	2.91E-02	1.90E-02	5.77E-03	2.88E-02
TH-232	3972.000	29.000	29.000	0.000	0.0000	100.0000	7.20E-02	2.65E-02	7.44E-03	0.00E+00	2.62E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



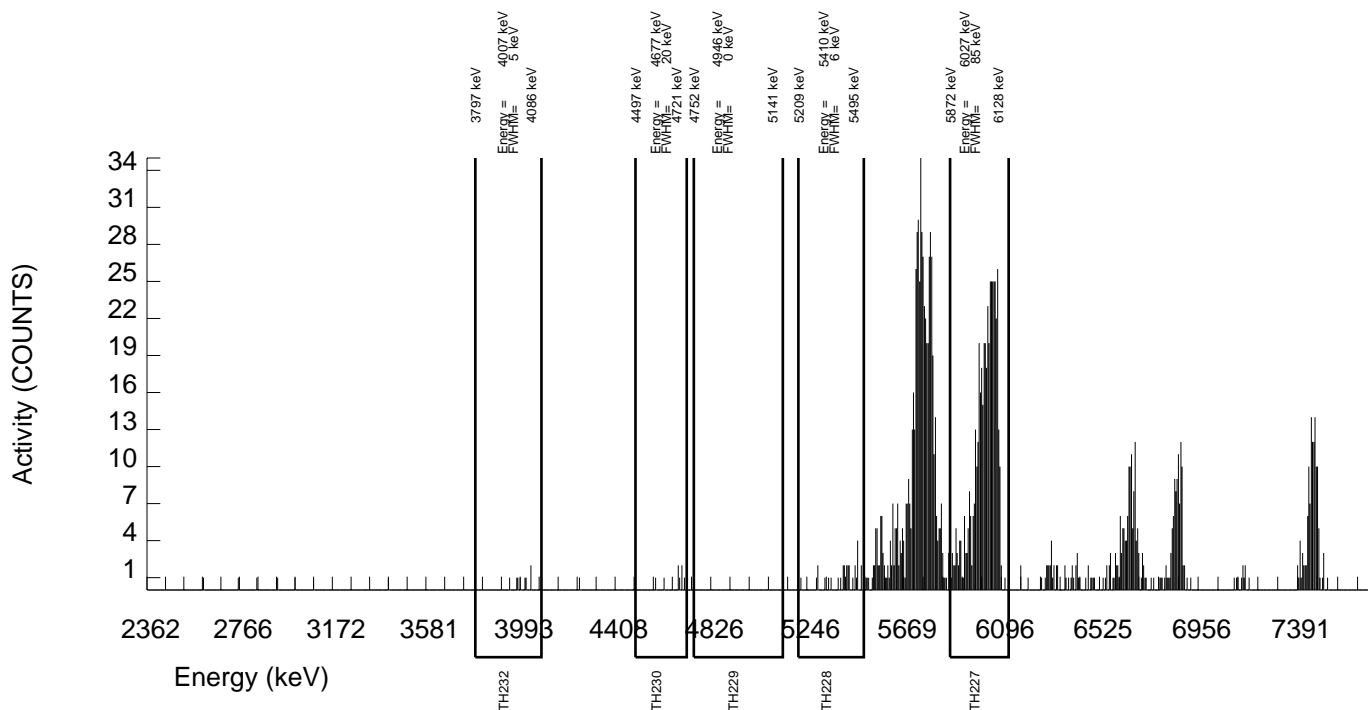
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 15-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S0235945004_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74442 AVERAGE %EFFICIENCY :25.8458 % YIELD : 102.746		COUNT DATE:12-OCT-2009 17:09:50 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 4.00549 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B184.CNF;136 BKG DATE : 11-OCT-2009 EFF FILE : W184.CNF;41 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	487.000	481.000	6.000	2.4495	57.44000	2.20E+00	2.31E-01	6.57E-02	2.60E-02	1.99E-01
TH-228	5363.000	29.000	11.566	11.000	3.3166	99.94000	2.52E-02	2.48E-02	4.02E-02	1.68E-02	2.48E-02
TH229	4900.000	0.000	-2.000	2.000	1.4142	99.52000	-4.26E-03	7.23E-03	2.04E-02	7.01E-03	7.23E-03
TH-230	4625.000	8.000	7.000	1.000	1.0000	100.0000	1.48E-02	1.25E-02	1.62E-02	4.93E-03	1.25E-02
TH-232	3972.000	8.000	7.000	1.000	1.0000	100.0000	1.48E-02	1.25E-02	1.62E-02	4.93E-03	1.25E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



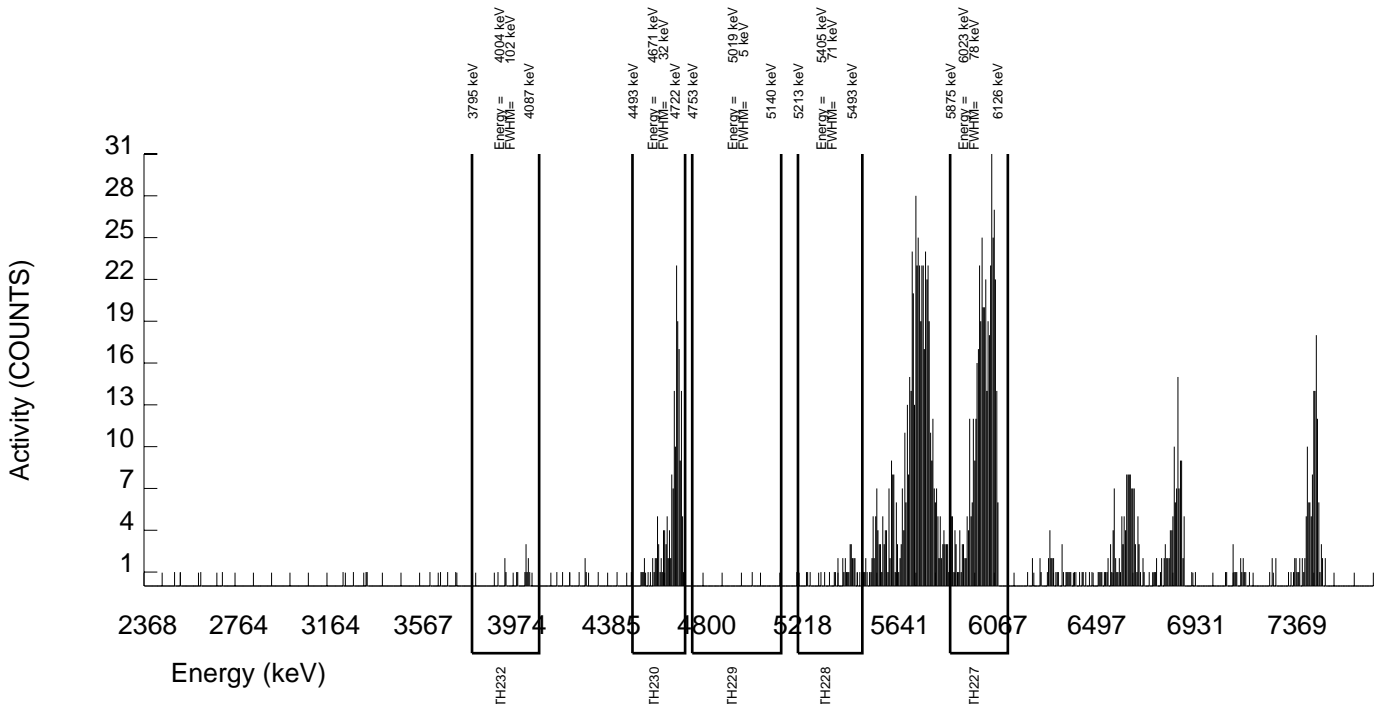
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 16-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S0235945005_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :68615 AVERAGE %EFFICIENCY :25.7805 % YIELD : 97.653		COUNT DATE:12-OCT-2009 17:09:52 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 3.80693 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B185.CNF;116 BKG DATE : 11-OCT-2009 EFF FILE : W185.CNF;41 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	463.000	456.000	7.000	2.6458	57.44000	2.20E+00	2.36E-01	7.37E-02	2.96E-02	2.05E-01
TH-228	5363.000	33.000	12.900	14.000	3.7417	99.94000	2.97E-02	2.89E-02	4.69E-02	2.00E-02	2.88E-02
TH229	4900.000	1.000	0.000	1.000	1.0000	99.52000	0.00E+00	6.23E-03	1.72E-02	5.23E-03	6.23E-03
TH-230	4625.000	178.000	176.000	2.000	1.4142	100.0000	3.94E-01	6.25E-02	2.14E-02	7.36E-03	5.88E-02
TH-232	3972.000	14.000	13.000	1.000	1.0000	100.0000	2.91E-02	1.71E-02	1.71E-02	5.20E-03	1.70E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 16-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.	SAMPLE ID : S0235945006_TH SAMPLE QTY: 0.800 L
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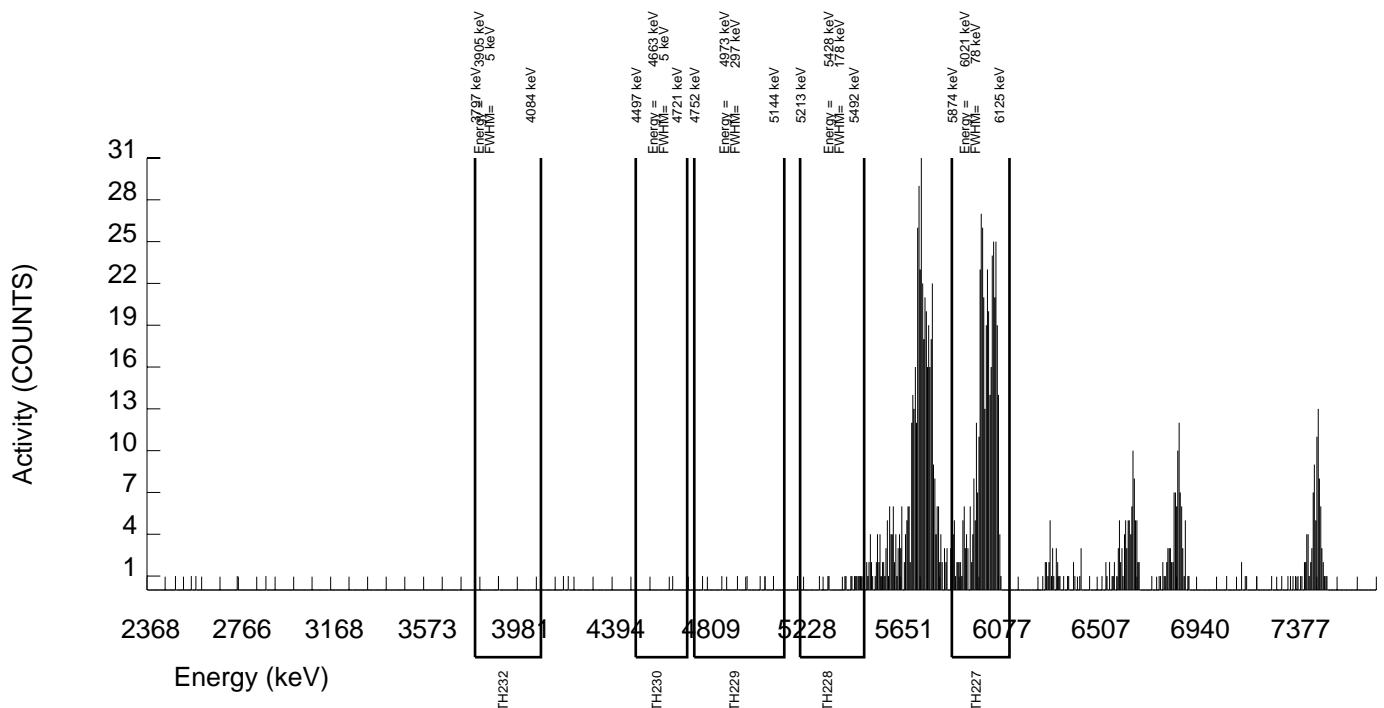
DETECTOR NUMBER :68616 AVERAGE %EFFICIENCY :24.8843 % YIELD : 95.402	COUNT DATE:12-OCT-2009 17:09:55 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1
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MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89841 dpm RESULTS : 3.71915 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B186.CNF;116 BKG DATE : 11-OCT-2009 EFF FILE : W186.CNF;42 CAL DATE : 21-SEP-2009
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NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	434.000	430.000	4.000	2.0000	57.44000	2.20E+00	2.41E-01	6.28E-02	2.38E-02	2.09E-01
TH-228	5363.000	14.000	2.248	6.000	2.4495	99.94000	5.48E-03	1.80E-02	3.51E-02	1.39E-02	1.80E-02
TH229	4900.000	7.000	4.000	3.000	1.7321	99.52000	9.53E-03	1.48E-02	2.64E-02	9.60E-03	1.48E-02
TH-230	4625.000	1.000	1.000	0.000	0.0000	100.0000	2.37E-03	4.65E-03	7.12E-03	0.00E+00	4.65E-03
TH-232	3972.000	1.000	0.000	1.000	1.0000	100.0000	0.00E+00	6.58E-03	1.82E-02	5.52E-03	6.57E-03

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.





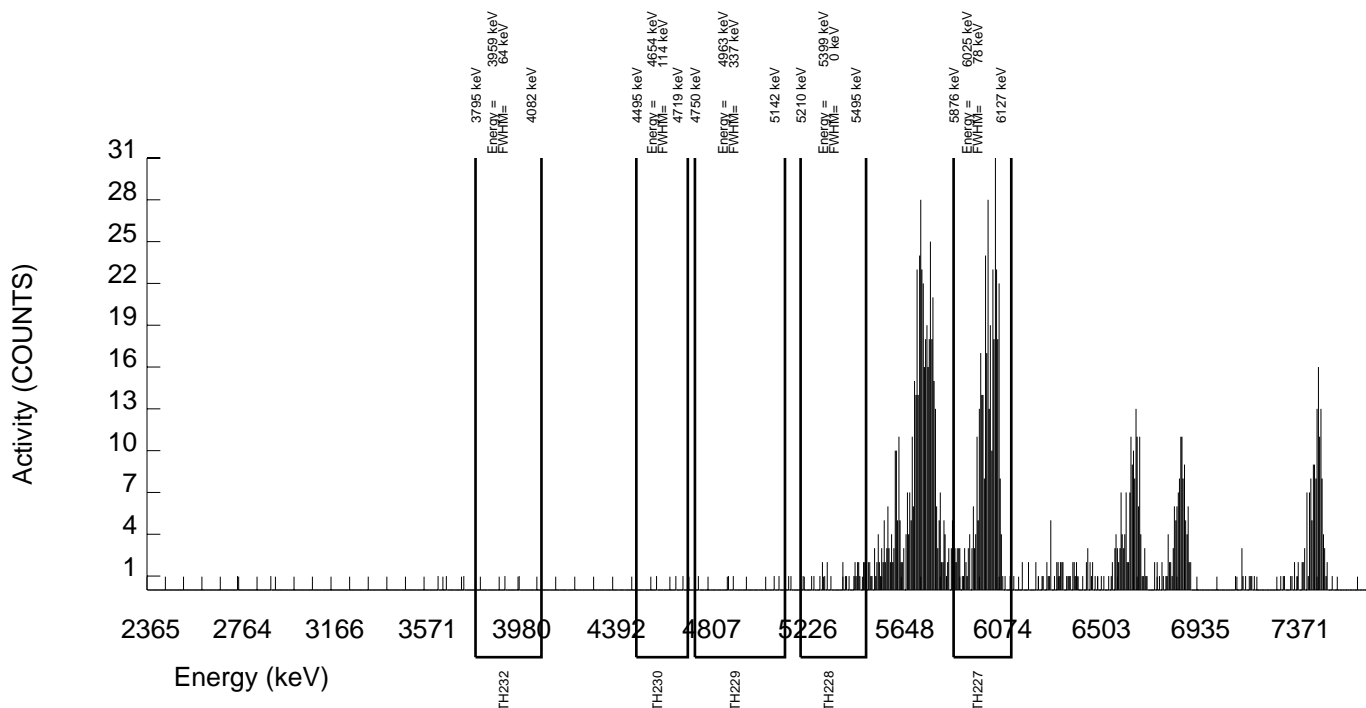
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 15-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S1201929716_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :68622 AVERAGE %EFFICIENCY :26.1313 % YIELD : 89.004		COUNT DATE:14-OCT-2009 19:09:10 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 3.46975 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B189.CNF;116 BKG DATE : 11-OCT-2009 EFF FILE : W189.CNF;41 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	395.000	390.000	5.000	2.2361	57.44000	2.20E+00	2.54E-01	7.54E-02	2.93E-02	2.21E-01
TH-228	5363.000	28.000	14.054	7.000	2.6458	99.94000	3.51E-02	2.60E-02	3.82E-02	1.54E-02	2.59E-02
TH229	4900.000	5.000	-2.000	7.000	2.6458	99.52000	-4.87E-03	1.65E-02	3.72E-02	1.50E-02	1.65E-02
TH-230	4625.000	3.000	1.000	2.000	1.4142	100.0000	2.42E-03	1.06E-02	2.32E-02	7.96E-03	1.06E-02
TH-232	3972.000	2.000	1.000	1.000	1.0000	100.0000	2.42E-03	8.22E-03	1.85E-02	5.63E-03	8.22E-03

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



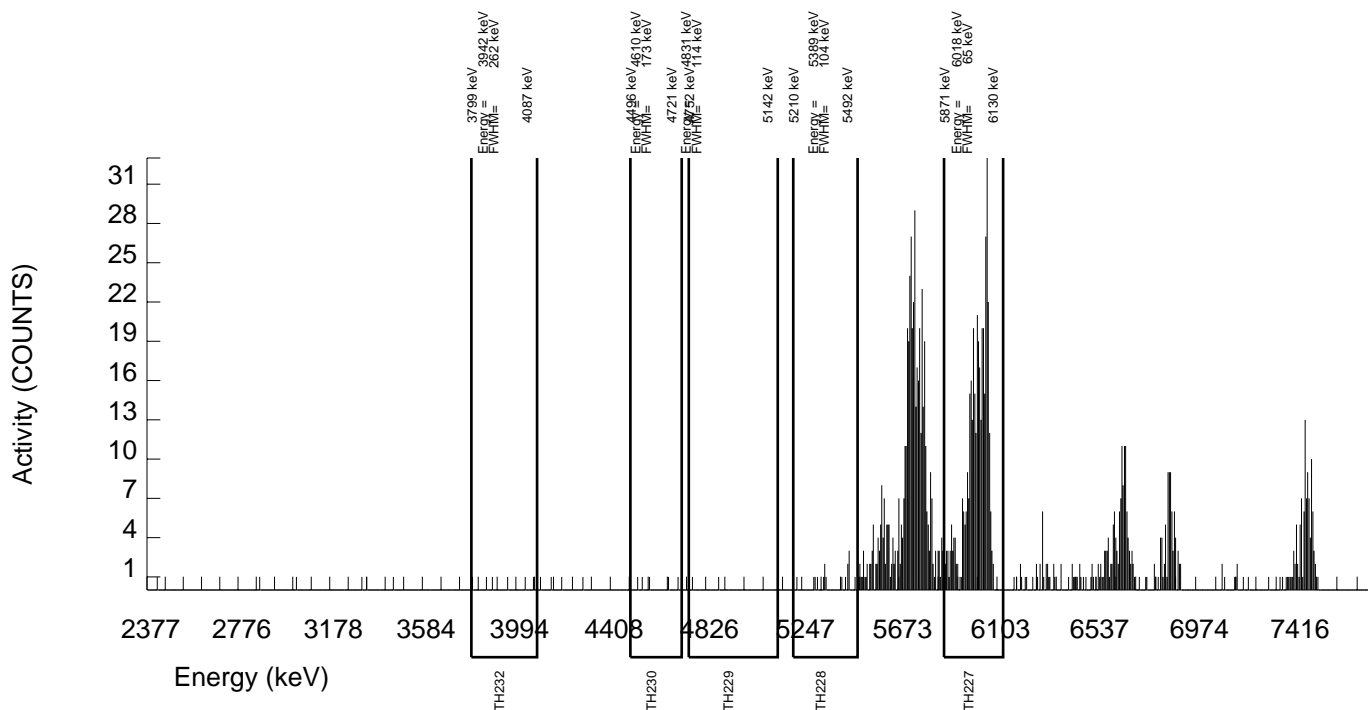
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 15-SEP-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S1201929717_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :68621 AVERAGE %EFFICIENCY :25.7368 % YIELD : 86.236		COUNT DATE:12-OCT-2009 17:09:59 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89841 dpm RESULTS : 3.36182 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B188.CNF;116 BKG DATE : 11-OCT-2009 EFF FILE : W188.CNF;43 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	402.000	402.000	0.000	0.0000	57.44000	2.20E+00	2.45E-01	1.64E-02	0.00E+00	2.15E-01
TH-228	5363.000	16.000	7.623	3.000	1.7321	99.94000	1.99E-02	1.89E-02	2.89E-02	1.05E-02	1.89E-02
TH229	4900.000	2.000	0.000	2.000	1.4142	99.52000	0.00E+00	9.99E-03	2.44E-02	8.39E-03	9.99E-03
TH-230	4625.000	5.000	4.000	1.000	1.0000	100.0000	1.01E-02	1.22E-02	1.94E-02	5.90E-03	1.22E-02
TH-232	3972.000	6.000	6.000	0.000	0.0000	100.0000	1.52E-02	1.22E-02	7.61E-03	0.00E+00	1.22E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



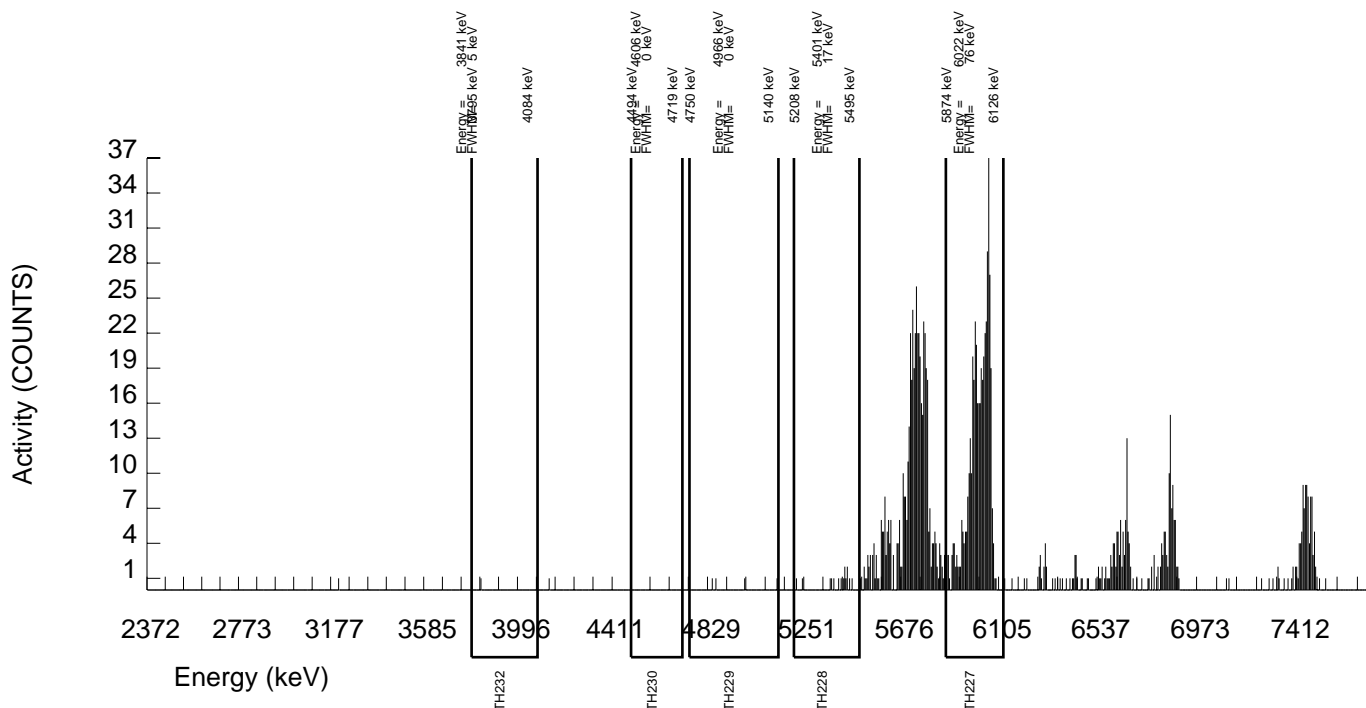
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 6-OCT-2009 00:00:00. AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S1201934058_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :78910 AVERAGE %EFFICIENCY :25.7346 % YIELD : 97.007		COUNT DATE:12-OCT-2009 11:42:32 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 3.78175 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B207.CNF;62 BKG DATE : 11-OCT-2009 EFF FILE : W207.CNF;38 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	458.000	456.000	2.000	1.4142	57.44000	2.20E+00	2.35E-01	4.61E-02	1.58E-02	2.02E-01
TH-228	5363.000	15.000	7.127	2.000	1.4142	99.94000	1.62E-02	1.49E-02	2.18E-02	7.48E-03	1.49E-02
TH229	4900.000	4.000	-2.000	6.000	2.4495	99.52000	-4.53E-03	1.40E-02	3.26E-02	1.29E-02	1.40E-02
TH-230	4625.000	0.000	-5.000	5.000	2.2361	100.0000	-1.13E-02	1.08E-02	3.02E-02	1.17E-02	1.08E-02
TH-232	3972.000	1.000	-3.000	4.000	2.0000	100.0000	-6.77E-03	9.89E-03	2.78E-02	1.05E-02	9.88E-03

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



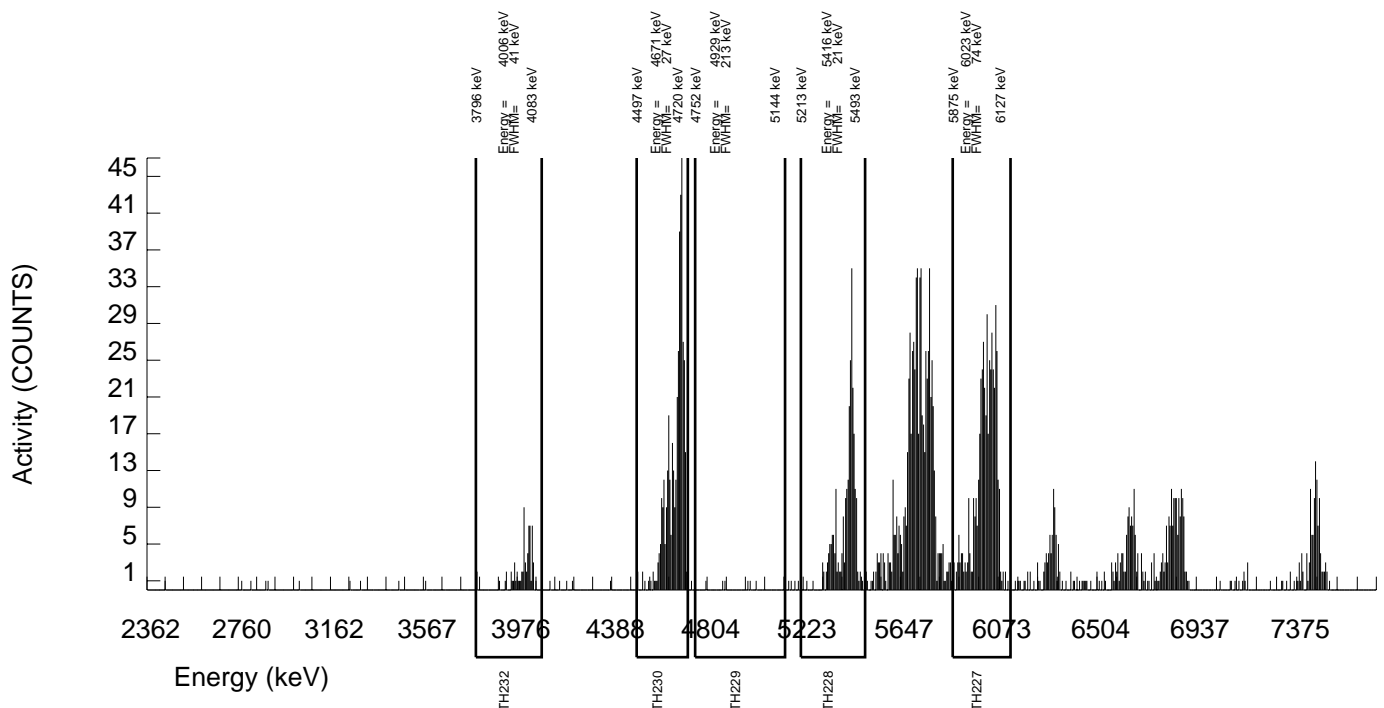
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 24-AUG-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S1201934060_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :68623 AVERAGE %EFFICIENCY :26.1986 % YIELD : 100.310		COUNT DATE:12-OCT-2009 17:10:05 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89841 dpm RESULTS : 3.91049 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B190.CNF;116 BKG DATE : 11-OCT-2009 EFF FILE : W190.CNF;42 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	493.000	476.000	17.000	4.1231	57.44000	2.20E+00	2.36E-01	1.02E-01	4.42E-02	2.04E-01
TH-228	5363.000	256.000	208.633	41.000	6.4031	99.94000	4.70E-01	7.95E-02	7.39E-02	3.36E-02	7.53E-02
TH229	4900.000	6.000	-32.000	38.000	6.1644	99.52000	-6.89E-02	2.80E-02	6.82E-02	3.09E-02	2.80E-02
TH-230	4625.000	414.000	398.000	16.000	4.0000	100.0000	8.53E-01	9.85E-02	4.63E-02	1.99E-02	8.71E-02
TH-232	3972.000	67.000	50.000	17.000	4.1231	100.0000	1.07E-01	3.89E-02	4.75E-02	2.06E-02	3.85E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



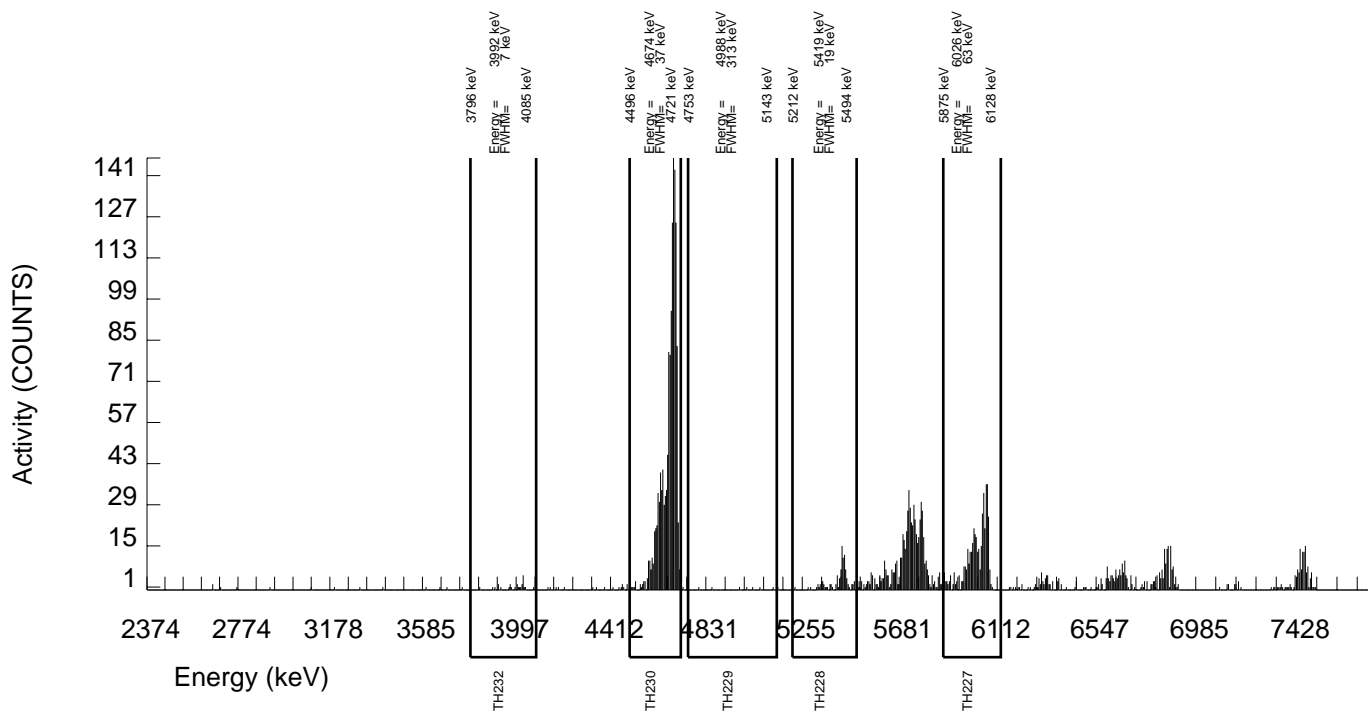
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 24-AUG-2009 00:00:00 AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S1201934062_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74430 AVERAGE %EFFICIENCY :25.4458 % YIELD : 91.779		COUNT DATE:12-OCT-2009 17:10:09 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89841 dpm RESULTS : 3.57791 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B192.CNF;116 BKG DATE : 11-OCT-2009 EFF FILE : W192.CNF;48 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	431.000	423.000	8.000	2.8284	57.44000	2.20E+00	2.44E-01	8.39E-02	3.41E-02	2.13E-01
TH-228	5363.000	103.000	84.342	13.000	3.6056	99.94000	2.14E-01	5.35E-02	5.01E-02	2.13E-02	5.22E-02
TH229	4900.000	7.000	3.000	4.000	2.0000	99.52000	7.27E-03	1.58E-02	2.98E-02	1.13E-02	1.57E-02
TH-230	4625.000	1362.000	1361.000	1.000	1.0000	100.0000	3.28E+00	2.49E-01	1.85E-02	5.61E-03	1.74E-01
TH-232	3972.000	26.000	25.000	1.000	1.0000	100.0000	6.03E-02	2.48E-02	1.85E-02	5.61E-03	2.46E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



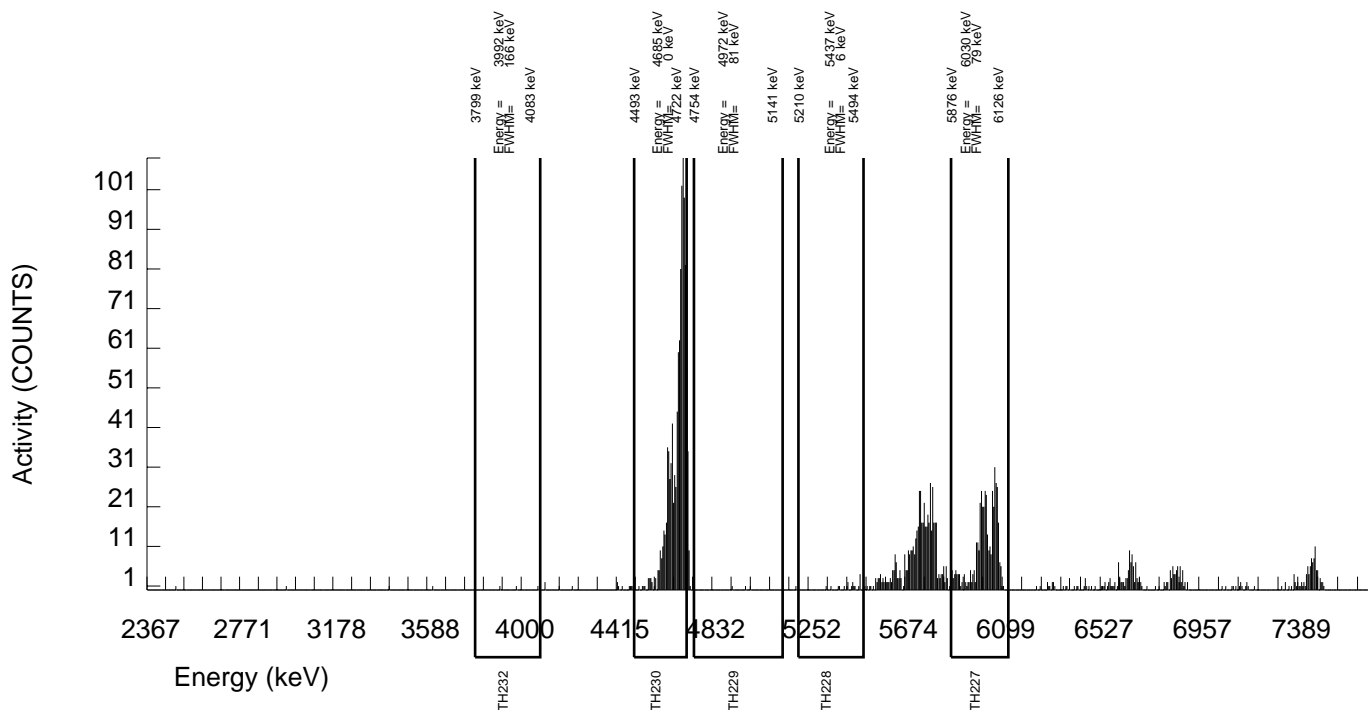
GEL Laboratories LLC  
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 906826 SAMPLE DATE : 6-OCT-2009 00:00:00. AC-227 SEPARATION : 7-OCT-2009 08:00:00.		SAMPLE ID : S1201934063_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74432 AVERAGE %EFFICIENCY :25.3327 % YIELD : 95.019		COUNT DATE:12-OCT-2009 17:09:25 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :MXA1	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 2.675E+00	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.89842 dpm RESULTS : 3.70425 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B174.CNF;134 BKG DATE : 11-OCT-2009 EFF FILE : W174.CNF;41 CAL DATE : 21-SEP-2009

NUCLIDE ACTIVITY SUMMARY

NUCLIDE	ENERGY	GROSS AREA	NET AREA	BKG AREA	BKG Sg	%ABUN	ACTIVITY pCi/L	TPU 1.96-SIGMA	MDA pCi/L	Lc pCi/L	UNC pCi/L
AC-227	5994.040	442.000	436.000	6.000	2.4495	57.44000	2.20E+00	2.40E-01	7.25E-02	2.87E-02	2.09E-01
TH-228	5363.000	18.000	5.168	7.000	2.6458	99.94000	1.22E-02	2.02E-02	3.61E-02	1.45E-02	2.02E-02
TH229	4900.000	3.000	-4.000	7.000	2.6458	99.52000	-9.40E-03	1.46E-02	3.60E-02	1.45E-02	1.46E-02
TH-230	4625.000	996.000	993.000	3.000	1.7321	100.0000	2.32E+00	1.92E-01	2.59E-02	9.43E-03	1.45E-01
TH-232	3972.000	3.000	0.000	3.000	1.7321	100.0000	0.00E+00	1.12E-02	2.59E-02	9.43E-03	1.12E-02

NOTE: Ac-227 results decay corrected to separation date/time.  
NOTE: Corrections made to Th-228 net area due to Ra-223 ingrowth from tracer.



# RADIUM 228

### Radiochemistry Batch Checklist, Rev 9

Batch# 906803 Product: radium228 Date: 10/14/09

Criteria:	Yes	No	Comments
Sample Solids are less than or equal to 100 mg for GAB.			NA
Samples have been blank corrected (if required)			NA
If activity less 10* MDA/ MDC, error is 150% or less of sample activity. If greater 10* MDA/ MDC, error is 40% or less. If below the MDA/ MDC, error is okay.	✓		
Instrument source check is within limits.	✓		
Instrument bkg check is within limits.	✓		
Method RDL/ LLD has been met.	✓		
If duplicate activities are less 5* MDA/ MDC, then RPD is 100% or less. If greater 5* MDA/ MDC, then RPD 20% or less. If below the MDA/ MDC, the RPD is 0%.	✓		
Or meets the client's required RER acceptance criteria.			
Tracer yield is 15-125% . Carrier yield 25-125%.	✓		
Or meets the client's contract acceptance criteria.			
Method blank is less than the RDL/ LLD. (If rad samples, < 5% of lowest activity)	✓		
Sample was run within hold time.	✓		
Sample was correctly preserved if required.	✓		
Smears Taken for Radioactive batches.	✓		
Method Spike and LCS are within 75-125% or meets the client's contract acceptance criteria.	✓		
No blank spaces on data forms. All line outs initialed and dated. No transcription errors are apparent.	✓		
Aux data is correct.			NA
Client Special requirements page has been checked.	✓		
Raw Data and/ or spectrum are included and properly stated.	✓		
QC data entered into QC database and batch is in REVW	✓		
Hit notification complete (if necessary)			NA
Batch entered into Case Narrative.	✓		
Batch non-conformances completed, if applicable.			NA
Batch non-conformances second reviewed and disposition verified to be completed.			NA
Aliquot Correction completed if required.			NA
Review sample historical results if available (If REMP, results above MDC have been verified by historical results, recount or re-analysis.)	✓		

GEL Laboratories, LLC

revised 8/1/08

Primary Review Performed By:

*William Y. III*

10/15  
KERK

Secondary Review Performed By:

*Heavenly McCarty* 10/14/09



# Radium-228 Que Sheet


10/05/2009

Batch #: 906803      Analyst: JXC5      First Client Due Date: 10/15/2009      Internal Due Date: 10/04/2009  
 Spike Isotope: Radium-228      Spike Code: 0503-B      Expiration Date: 9-11-10      Vol: 0.1  
 LCS Isotope: Radium-228      LCS Code: 0503-B      Expiration Date: 9-11-10      Vol: 0.1  
 Tracer Isotope: Barium-133      Tracer Code: 0112-1      Expiration Date: 2-17-10      Vol: 0.1  
 Prep Date: 10-5-09      Initials: EF      Pipet ID: 2766953      Balance ID: 51204863

Ac-228 Ingrow: 10-6-09 / 1800  
 Ac-228 Separation Date/Time: 10-8-09 / 0910  
 Witness: MS 10-5-09

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collect Date & Time	Pos. #	Vol (mL)	Det #	Ba Yield (%)	Gamma Det. #
235941001-1	SA64-10BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	24-AUG-09 08:34 AM	1	200	IA	86.40	
235941002-1	SA102-10BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	10-SEP-09 07:12 AM	2	200	IB	77.58	
235941003-1	SA102-30BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	10-SEP-09 07:45 AM	3	200	IC	70.50	
235941004-1	SA30-9BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	15-SEP-09 11:25 AM	4	200	ID	89.05	
235941005-1	SA128-10BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	16-SEP-09 09:58 AM	5	200	2A	76.35	
235941006-1	SA128-29BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	16-SEP-09 10:28 AM	6	200	2B	74.32	8A
235945001-1	SA64-10BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	24-AUG-09 08:34 AM	7	200	2C	84.56	
235945002-1	SA102-10BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	10-SEP-09 07:12 AM	8	200	2D	79.82	13D
235945003-1	SA102-30BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	10-SEP-09 07:45 AM	9	200	3A	73.61	14B
235945004-1	SA30-9BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	15-SEP-09 11:25 AM	10	200	3E	73.79	1B
235945005-1	SA128-10BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	16-SEP-09 09:58 AM	11	200	3D	85.45	2C
235945006-1	SA128-29BSPLP	SAMPLE		3 pCi/L	SOIL	KERR003	16-SEP-09 10:28 AM	12	200	4A	83.79	
1201929716-1	TB for batch 905075	TB		3 pCi/L	SOIL	QC ACCOUNT	15-SEP-09 11:25 AM	13	200	4C	77.58	7A
1201929717-1	TB for batch 905076	TB		3 pCi/L	SOIL	QC ACCOUNT	15-SEP-09 11:25 AM	14	200	4D	71.61	7C
1201933967-1	MB for batch 906803	MB		3 pCi/L	SOIL	QC ACCOUNT	24-AUG-09 08:34 AM	15	200	5A	77.42	
1201933968-1	SA64-10BSPLP(235941001DUP) DUP	DUP		3 pCi/L	SOIL	QC ACCOUNT	24-AUG-09 08:34 AM	16	200	5B	71.82	16A
1201933969-1	SA64-10BSPLP(235945001DUP) DUP	DUP		3 pCi/L	SOIL	QC ACCOUNT	24-AUG-09 08:34 AM	17	200	5C	82.81	
1201933970-1	SA64-10BSPLP(235941001MS) MS	MS		3 pCi/L	SOIL	QC ACCOUNT	24-AUG-09 08:34 AM	18	100	5D	76.78	
1201933971-1	SA64-10BSPLP(235945001MS) MS	MS		3 pCi/L	SOIL	QC ACCOUNT	24-AUG-09 08:34 AM	19	100	6A	79.27	
1201933972-1	LCS for batch 906803	LCS		3 pCi/L	SOIL	QC ACCOUNT	24-AUG-09 08:34 AM	20	200	6B	81.61	

MS 07/14/09

Data Reviewed By:       Healey, McCarty 10/14/09



# Radium-228 Liquid

Filename : RA228.XLS  
 File type : Excel  
 Version # : 1.2.5

Batch : 906803  
 Analyst : JXC5  
 Prep Date : 10/5/2009

Ra-228 Abundance : 1  
 Ra-228 Method Uncertainty : 0.1268

Spike S/N : 0503-B  
 Spike Exp Date : 9/11/2010  
 Spike Activity (dpm/ml) : 176.73  
 Spike Volume Added : 0.10

Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml  
 Pipet, 1 ml Stdev : +/- 0.005480 ml

Procedure Code : GFC28RAL  
 Parname : Radium-228  
 Required MDA : 3 pCi/L  
 Halfife of Ra-228 : 5.75 years  
 Halfife of Ac-228 : 6.13 hours

LCS S/N : 0503-B  
 LCS Exp Date : 9/11/2010  
 LCS Activity (dpm/ml) : 176.73  
 LCS Volume Added : 0.10

Tracer S/N : 0112-J  
 Tracer Exp Date : 2/17/2010  
 Tracer Volume Added : 0.10

Geometry: CeF on 25mm Filter

Pos.	Sample Characteristics			Tracer Calculations			Tracer Samp.			Tracer	
	Sample ID	Sample Aliquot L	Sample Aliquot StDev. L	Tracer Concentration (cpm) (Ba-133 Ref.)	Tracer Ref. Count Uncertainty (cpm)	Tracer Concentration (cpm) (Ba-133 Samp.)	Tracer Count Uncertainty (cpm)	Tracer Aliquot (mL)	Tracer Aliquot StDev. (mL)	Tracer Aliquot (mL)	Tracer Aliquot StDev. (mL)
1	235941001.1	0.2000	1.6007E-05	325.1	3.39%	280.9	3.68%	0.1	0.000701	0.1	0.000701
2	235941002.1	0.2000	1.6007E-05	325.1	3.39%	252.2	3.91%	0.1	0.000701	0.1	0.000701
3	235941003.1	0.2000	1.6007E-05	325.1	3.39%	229.2	4.13%	0.1	0.000701	0.1	0.000701
4	235941004.1	0.2000	1.6007E-05	325.1	3.39%	289.5	3.62%	0.1	0.000701	0.1	0.000701
5	235941005.1	0.2000	1.6007E-05	325.1	3.39%	248.2	3.95%	0.1	0.000701	0.1	0.000701
6	235941006.1	0.2000	1.6007E-05	290.1	3.61%	211.6	4.32%	0.1	0.000701	0.1	0.000701
7	235945001.1	0.2000	1.6007E-05	325.1	3.39%	274.9	3.72%	0.1	0.000701	0.1	0.000701
8	235945002.1	0.2000	1.6007E-05	325.1	3.39%	259.5	3.85%	0.1	0.000701	0.1	0.000701
9	235945003.1	0.2000	1.6007E-05	325.1	3.39%	239.3	4.03%	0.1	0.000701	0.1	0.000701
10	235945004.1	0.2000	1.6007E-05	325.1	3.39%	239.9	4.02%	0.1	0.000701	0.1	0.000701
11	235945005.1	0.2000	1.6007E-05	325.1	3.39%	277.8	3.70%	0.1	0.000701	0.1	0.000701
12	235945006.1	0.2000	1.6007E-05	290.1	3.61%	228.0	4.14%	0.1	0.000701	0.1	0.000701
13	1201929716.1	0.2000	1.6007E-05	325.1	3.39%	252.2	3.91%	0.1	0.000701	0.1	0.000701
14	1201929717.1	0.2000	1.6007E-05	325.1	3.39%	232.8	4.09%	0.1	0.000701	0.1	0.000701
15	1201933967.1	0.2000	1.6007E-05	325.1	3.39%	251.7	3.91%	0.1	0.000701	0.1	0.000701
16	1201933968.1	0.2000	1.6007E-05	325.1	3.39%	233.5	4.09%	0.1	0.000701	0.1	0.000701
17	1201933969.1	0.2000	1.6007E-05	325.1	3.39%	269.2	3.77%	0.1	0.000701	0.1	0.000701
18	1201933970.1	0.1000	1.1370E-05	325.1	3.39%	249.6	3.93%	0.1	0.000701	0.1	0.000701
19	1201933971.1	0.1000	1.1370E-05	325.1	3.39%	257.7	3.86%	0.1	0.000701	0.1	0.000701
20	1201933972.1	0.2000	1.6007E-05	325.1	3.39%	265.3	3.80%	0.1	0.000701	0.1	0.000701

How  
 10/14/09

Count raw Data										Calibration Data										Calculated									
Pos.	Detector ID	Counting Time (min.)	Gross Counts Alpha	Gross Counts Beta	Beta cpm	Count Start Date/Time	Separation Date/Time	Ra-228 Decay	Ac-228 Decay	Ac-228 Count Correction	Sample Recovery %	Sample Recovery Error %	Counted on	Calibration Date	Calibration Due Date	Detector Efficiency (cpm/dpm)	Detector Efficiency Error (cpm/dpm)	Weekly Bkg Count Time (min.)	cpm										
1	1A	60	4	46	0.767	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	86.40%	2.69%	PIC	7/2/2009	7/31/2010	0.6503	0.00600	500	0.330										
2	1B	60	6	32	0.533	10/8/2009 11:36	10/8/2009 9:10	0.991	0.759	1.058	77.58%	2.77%	PIC	7/2/2009	7/31/2010	0.6282	0.00409	500	0.352										
3	1C	60	10	83	1.383	10/8/2009 11:36	10/8/2009 9:10	0.991	0.759	1.058	70.50%	2.85%	PIC	7/2/2009	7/31/2010	0.6176	0.00344	500	0.846										
4	1D	60	8	41	0.683	10/8/2009 11:36	10/8/2009 9:10	0.992	0.759	1.058	89.05%	2.67%	PIC	7/2/2009	7/31/2010	0.6043	0.00511	500	0.494										
5	2A	60	10	71	1.183	10/8/2009 11:36	10/8/2009 9:10	0.993	0.759	1.058	76.35%	2.79%	PIC	7/2/2009	7/31/2010	0.6172	0.00349	500	0.524										
6	2A	60	7	39	0.650	10/12/2009 18:03	10/12/2009 16:15	0.991	0.814	1.058	72.94%	2.98%	PIC	7/2/2009	7/31/2010	0.6172	0.00349	1000	0.510										
7	2C	60	10	34	0.567	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	84.56%	2.70%	PIC	7/2/2009	7/31/2010	0.5969	0.00575	500	0.408										
8	13D	380	58	355	0.934	10/8/2009 13:55	10/8/2009 9:10	0.991	0.984	1.400	79.82%	2.75%	PIC	7/2/2009	7/31/2010	0.6377	0.00816	500	0.820										
9	14B	380	117	412	1.084	10/8/2009 13:55	10/8/2009 9:10	0.991	0.984	1.400	73.61%	2.81%	PIC	7/2/2009	7/31/2010	0.6266	0.00816	500	0.994										
10	1B	70	2	39	0.557	10/8/2009 14:24	10/8/2009 9:10	0.992	0.553	1.067	73.79%	2.81%	PIC	7/2/2009	7/31/2010	0.6282	0.00409	500	0.352										
11	2C	70	7	46	0.657	10/8/2009 14:24	10/8/2009 9:10	0.993	0.553	1.067	85.45%	2.70%	PIC	7/2/2009	7/31/2010	0.5969	0.00575	500	0.408										
12	2D	60	9	53	0.883	10/12/2009 18:04	10/12/2009 16:15	0.991	0.814	1.058	78.59%	2.92%	PIC	7/2/2009	7/31/2010	0.6119	0.00479	1000	0.493										
13	7A	70	16	41	0.586	10/8/2009 14:25	10/8/2009 9:10	0.992	0.552	1.067	77.58%	2.77%	PIC	7/2/2009	7/31/2010	0.6180	0.00816	500	0.382										
14	7C	70	6	35	0.500	10/8/2009 14:25	10/8/2009 9:10	0.992	0.552	1.067	71.61%	2.84%	PIC	7/2/2009	7/31/2010	0.6178	0.00816	500	0.310										
15	5A	60	4	49	0.817	10/8/2009 11:36	10/8/2009 9:10	0.999	0.759	1.058	77.42%	2.77%	PIC	7/2/2009	7/31/2010	0.6258	0.00816	500	0.506										
16	10A	70	3	26	0.371	10/8/2009 14:25	10/8/2009 9:10	0.985	0.552	1.067	71.82%	2.84%	PIC	7/2/2009	7/31/2010	0.6389	0.00816	500	0.338										
17	5C	60	16	79	1.317	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	82.81%	2.72%	PIC	7/2/2009	7/31/2010	0.6368	0.00816	500	0.946										
18	5D	60	20	487	8.117	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	76.78%	2.78%	PIC	7/2/2009	7/31/2010	0.6237	0.00816	500	1.350										
19	6A	60	22	501	8.350	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	79.27%	2.75%	PIC	7/2/2009	7/31/2010	0.6221	0.00816	500	1.340										
20	6B	60	41	469	7.817	10/8/2009 11:36	10/8/2009 9:10	0.999	0.759	1.058	81.61%	2.73%	PIC	7/2/2009	7/31/2010	0.6163	0.00816	500	0.828										

Handwritten signature and date: *Handwritten*  
10/14/09

- Notes:  
 1 - Results are decay corrected to Sample Date/Time  
 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date  
 3 - Spike Nominals are decay corrected to Sample Date/Time  
 \* - RPD changed to 0% due to activity below MDA for 1201933969.1

Results Pos.	Decision Level pCi/L	Critical Level pCi/L	Required MDA pCi/L	MDA pCi/L	Sample Act. Conc. pCi/L	Sample Act. Error pCi/L	Net Count Rate CPM	Net Count Rate Error CPM	2 SIGMA Counting Uncertainty pCi/L	2 SIGMA Total Prop. Uncertainty pCi/L	Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
1	1.0691	0.7548	3	1.8019	2.5529	0.2669	0.4367	0.1159	1.3283	1.4785		SAMPLE				
2	1.2270	0.8663	3	2.0573	1.1780	0.5409	0.1813	0.0979	1.2471	1.2827		SAMPLE				
3	2.1292	1.5032	3	3.3700	3.9074	0.2942	0.5373	0.1573	2.2421	2.4533		SAMPLE				
4	1.3142	0.9279	3	2.1494	1.1121	0.5882	0.1893	0.1113	1.2808	1.3116		SAMPLE				
5	1.5453	1.0910	3	2.5174	4.4215	0.2204	0.6593	0.1441	1.8943	2.2034		SAMPLE				
6	1.4495	1.0234	3	2.3744	0.9176	0.7613	0.1400	0.1065	1.3681	1.3881		SAMPLE				
7	1.2829	0.9058	3	2.1270	1.0011	0.6390	0.1587	0.1013	1.2526	1.2782		SAMPLE				
8	1.5881	1.0859	3	2.2564	1.2234	0.5613	0.1142	0.0640	1.3441	1.3798		SAMPLE				
9	1.8692	1.3197	3	2.7327	1.0666	0.7718	0.0902	0.0696	1.6124	1.6352		SAMPLE				
10	1.6675	1.1773	3	2.7597	1.9391	0.4546	0.2051	0.0931	1.7244	1.7937		SAMPLE				
11	1.6317	1.1520	3	2.6722	2.1405	0.4064	0.2481	0.1010	1.7010	1.7860		SAMPLE				
12	1.3344	0.9421	3	2.1910	2.3953	0.3174	0.3903	0.1233	1.4836	1.6046		SAMPLE				
13	1.6814	1.1871	3	2.7664	1.8639	0.4700	0.2037	0.0956	1.7136	1.7783		TB				
14	1.6417	1.1581	3	2.7431	1.8941	0.4647	0.1900	0.0881	1.7125	1.7787		TB				
15	1.4685	1.0968	3	2.3978	2.0146	0.3903	0.3107	0.1209	1.5370	1.6205		MB				
16	1.6649	1.1755	3	2.7637	0.3220	2.3139	0.0334	0.0773	1.4600	1.4624	235941001.1	DUP	155.2%	2.1027	80.7094	108.4%
17	1.8706	1.3207	3	2.9434	2.2394	0.4175	0.3707	0.1544	1.8282	1.9151	235945001.1	DUP	0.0%	1.0541	80.7094	112.2%
18	4.9212	3.4744	3	7.6141	90.0311	0.0621	6.7687	0.3715	9.6868	24.9116	235941001.1	MS			80.7094	112.2%
19	4.7622	3.3622	3	7.3705	90.5912	0.0609	7.0100	0.3766	9.5397	24.9781	235945001.1	MS			80.7094	112.2%
20	1.8101	1.2779	3	2.8683	43.6705	0.0593	6.9887	0.3632	4.486	11.9809		LCS			39.8039	109.7%

Handwritten: 7/10/10/10/09

SampleID	Instr	Time (min.)	Alpha Counts	Beta Counts	Count Start Time	Count End Time	Machine
235941001	1A	60	4	46	10/8/2009 11:36	10/8/2009 12:36	PIC
235941002	1B	60	6	32	10/8/2009 11:36	10/8/2009 12:36	PIC
235941003	1C	60	10	83	10/8/2009 11:36	10/8/2009 12:36	PIC
235941004	1D	60	8	41	10/8/2009 11:36	10/8/2009 12:36	PIC
235941005	2A	60	10	71	10/8/2009 11:36	10/8/2009 12:36	PIC
235941006	2A	60	7	39	10/12/2009 18:03	10/12/2009 19:03	PIC
235945001	2C	60	10	34	10/8/2009 11:36	10/8/2009 12:36	PIC
235945002	13D	380	58	355	10/8/2009 13:55	10/8/2009 20:15	PIC
235945003	14B	380	117	412	10/8/2009 13:55	10/8/2009 20:15	PIC
235945004	1B	70	2	39	10/8/2009 14:24	10/8/2009 15:34	PIC
235945005	2C	70	7	46	10/8/2009 14:24	10/8/2009 15:34	PIC
235945006	2D	60	9	53	10/8/2009 14:24	10/8/2009 15:34	PIC
1201929716	7A	70	16	41	10/12/2009 18:04	10/12/2009 19:04	PIC
1201929717	7C	70	6	35	10/8/2009 14:25	10/8/2009 15:35	PIC
1201933967	5A	60	4	49	10/8/2009 14:25	10/8/2009 15:35	PIC
1201933968	10A	70	3	26	10/8/2009 14:25	10/8/2009 15:35	PIC
1201933969	5C	60	16	79	10/8/2009 11:36	10/8/2009 12:36	PIC
1201933970	5D	60	20	487	10/8/2009 11:36	10/8/2009 12:36	PIC
1201933971	6A	60	22	501	10/8/2009 11:36	10/8/2009 12:36	PIC
1201933972	6B	60	41	469	10/8/2009 11:36	10/8/2009 12:36	PIC

7444  
0/14/09

ASSAY 6-Oct-09 22:05:50

Protocol id 9 228\_REC2  
Time limit 180  
Count limit 50000  
Isotope Ba-133  
Protocol date 9-Apr-07 10:02:22  
Run id. 96

POS	RACK	BATCH	TIME	COUNTS	CPM	ERROR	% RECOVERY	COUNT TIME
1	90	1	180	1067	325.1	3.39		22:05:52
2	90	2	180	934	280.9	3.68	86.40	22:09:03
3	90	3	180	848	252.2	3.91	77.58	22:12:15
4	90	4	180	779	229.2	4.13	70.50	22:15:26
5	90	5	180	960	289.5	3.62	89.05	22:18:37
6	68	6	180	836	248.2	3.95	76.35	22:22:02
<del>7</del>	<del>68</del>	<del>7</del>	<del>180</del>	<del>816</del>	<del>241.6</del>	<del>4.01</del>	<del>74.32</del>	<del>22:25:19</del> m 10/14/07
8	68	8	180	916	274.9	3.72	84.56	22:28:25
9	68	9	180	870	259.5	3.85	79.82	22:31:36
10	68	10	180	809	239.3	4.03	73.61	22:34:47
11	60	11	180	811	239.9	4.02	73.79	22:38:12
12	60	12	180	924	277.8	3.7	85.45	22:41:23
<del>13</del>	<del>60</del>	<del>13</del>	<del>180</del>	<del>908</del>	<del>272.4</del>	<del>3.74</del>	<del>83.79</del>	<del>22:44:35</del> n 10/14/05
14	60	14	180	848	252.2	3.91	77.58	22:47:46
15	60	15	180	789	232.8	4.09	71.61	22:50:58
16	74	16	180	846	251.7	3.91	77.42	22:54:22
17	74	17	180	792	233.5	4.09	71.82	22:57:34
18	74	18	180	899	269.2	3.77	82.81	23:00:45
19	74	19	180	840	249.6	3.93	76.78	23:03:56
20	74	20	180	864	257.7	3.86	79.27	23:07:08
21	77	21	180	887	265.3	3.8	81.61	23:10:32

END OF ASSAY

HW  
10/14/09

ASSAY 12-Oct-09 13:06:39

Protocol id 9 228\_REC2  
Time limit 180  
Count limit 50000  
Isotope Ba-133  
Protocol date 9-Apr-07 10:02:22  
Run id. 28

POS	RACK	BATCH	TIME	COUNTS	CPM	ERROR	% RECOVERY	COUNT TIME
1	72	1	180	961	290.1	3.61		13:06:47
2	72	2	180	726	211.6	4.32	72.94	13:09:58
3	72	3	180	775	228	4.14	78.59	13:13:10
4	72	4	180	815	241.3	4.01	83.18	13:16:21
5	72	5	180	809	239.2	4.03	82.45	13:19:32

END OF ASSAY

> \* MB + LS  
were re-eluted  
in order to verify the  
accuracy of the procedure

MCW  
10/14/09



### Radium-228 Liquid

Filename : RA228.XLS  
 File type : Excel  
 Version # : 1.2.5

Spike S/N : 0503-B  
 Spike Exp Date : 9/11/2010  
 Spike Activity (dpm/ml): 176.73  
 Spike Volume Added: 0.10

Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml  
 Pipet, 1 ml Stdev : +/- 0.005480 ml

LCS S/N : 0503-B  
 LCS Exp Date : 9/11/2010  
 LCS Activity (dpm/ml): 176.73  
 LCS Volume Added: 0.10

Batch : 906803  
 Analyst : JXC5  
 Prep Date : 10/5/2009

Procedure Code : GFC28RAL  
 Paramname : Radium-228  
 Required MDA : 3 pCi/L  
 Half-life of Ra-228 : 5.75 years  
 Half-life of Ac-228 : 6.13 hours

Tracer S/N : 0112-J  
 Tracer Exp Date : 2/17/2010  
 Tracer Volume Added: 0.10

Geometry: CeF on 25mm Filter

Pos.	Sample Characteristics		Sample Date/Time	Tracer Calculations		Tracer Rel. Count Uncertainty (cpm)	Tracer Concentration (cpm) (Ba-133 Ref.)	Tracer Concentration (cpm) (Ba-133 Samp.)	Tracer Count Uncertainty (cpm)	Tracer Aliquot (mL)	Tracer Aliquot StDev. (mL)
	Sample ID	Sample Aliquot L		Sample Aliquot L	Tracer Concentration (cpm) (Ba-133 Ref.)						
1	235941001.1	0.2000	1.6007E-05	8/24/2009 8:34	325.1	3.39%	280.9	280.9	3.68%	0.1	0.000701
2	235941002.1	0.2000	1.6007E-05	9/10/2009 7:12	325.1	3.39%	252.2	252.2	3.91%	0.1	0.000701
3	235941003.1	0.2000	1.6007E-05	9/10/2009 7:45	325.1	3.39%	229.2	229.2	4.13%	0.1	0.000701
4	235941004.1	0.2000	1.6007E-05	9/15/2009 11:25	325.1	3.39%	289.5	289.5	3.62%	0.1	0.000701
5	235941005.1	0.2000	1.6007E-05	9/16/2009 9:58	325.1	3.39%	248.2	248.2	3.95%	0.1	0.000701
6	235941006.1	0.2000	1.6007E-05	9/16/2009 10:28	290.1	3.61%	211.6	211.6	4.32%	0.1	0.000701
7	235945001.1	0.2000	1.6007E-05	8/24/2009 8:34	325.1	3.39%	274.9	274.9	3.72%	0.1	0.000701
8	235945002.1	0.2000	1.6007E-05	9/10/2009 7:12	325.1	3.39%	259.5	259.5	3.85%	0.1	0.000701
9	235945003.1	0.2000	1.6007E-05	9/10/2009 7:45	325.1	3.39%	239.3	239.3	4.03%	0.1	0.000701
10	235945004.1	0.2000	1.6007E-05	9/15/2009 11:25	325.1	3.39%	239.9	239.9	4.02%	0.1	0.000701
11	235945005.1	0.2000	1.6007E-05	9/16/2009 9:58	325.1	3.39%	277.8	277.8	3.70%	0.1	0.000701
12	235945006.1	0.2000	1.6007E-05	9/16/2009 10:28	290.1	3.61%	228.0	228.0	4.14%	0.1	0.000701
13	1201929716.1	0.2000	1.6007E-05	9/15/2009 11:25	325.1	3.39%	252.2	252.2	3.91%	0.1	0.000701
14	1201929717.1	0.2000	1.6007E-05	9/15/2009 11:25	325.1	3.39%	232.8	232.8	4.08%	0.1	0.000701
15	1201933967.1	0.2000	1.6007E-05	10/5/2009 0:00	290.1	3.61%	241.3	241.3	4.01%	0.1	0.000701
16	1201933968.1	0.2000	1.6007E-05	8/24/2009 8:34	325.1	3.39%	233.5	233.5	4.09%	0.1	0.000701
17	1201933969.1	0.2000	1.6007E-05	8/24/2009 8:34	325.1	3.39%	269.2	269.2	3.77%	0.1	0.000701
18	1201933970.1	0.1000	1.1370E-05	8/24/2009 8:34	325.1	3.39%	249.6	249.6	3.93%	0.1	0.000701
19	1201933971.1	0.1000	1.1370E-05	8/24/2009 8:34	325.1	3.39%	257.7	257.7	3.86%	0.1	0.000701
20	1201933972.1	0.2000	1.6007E-05	10/5/2009 0:00	290.1	3.61%	239.2	239.2	4.03%	0.1	0.000701

VERIFICATION ONLY

Count raw Data		Calculated										Calibration Data				Detector Efficiency		Weekly Bkg Count	
Pos.	Detector ID	Counting Time (min.)	Gross Counts Alpha	Beta cpm	Count Start Date/Time	Separation Date/Time	Ra-228 Decay	Ac-228 Decay	Ac-228 Count Correction	Sample Recovery %	Sample Recovery Error %	Counted on	Calibration Date	Calibration Due Date	Detector Efficiency (cpm/dpm)	Detector Efficiency Error (cpm/dpm)	cpm	Time (min.)	
1	1A	60	4	0.767	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	86.40%	2.69%	PIC	7/2/2009	7/31/2010	0.6303	0.00600	0.330	500	
2	1B	60	6	0.533	10/8/2009 11:36	10/8/2009 9:10	0.991	0.759	1.058	77.58%	2.77%	PIC	7/2/2009	7/31/2010	0.6282	0.00409	0.352	500	
3	1C	60	10	1.383	10/8/2009 11:36	10/8/2009 9:10	0.991	0.759	1.058	70.50%	2.85%	PIC	7/2/2009	7/31/2010	0.6176	0.00344	0.846	500	
4	1D	60	8	0.683	10/8/2009 11:36	10/8/2009 9:10	0.993	0.759	1.058	89.05%	2.67%	PIC	7/2/2009	7/31/2010	0.6043	0.00511	0.494	500	
5	2A	60	10	1.183	10/8/2009 11:36	10/8/2009 9:10	0.991	0.814	1.058	76.35%	2.79%	PIC	7/2/2009	7/31/2010	0.6172	0.00349	0.524	500	
6	2A	60	7	0.650	10/12/2009 18:03	10/12/2009 16:15	0.991	0.814	1.058	72.94%	2.98%	PIC	7/2/2009	7/31/2010	0.6172	0.00349	0.510	1000	
7	2C	60	10	0.567	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	84.56%	2.70%	PIC	7/2/2009	7/31/2010	0.5969	0.00575	0.408	500	
8	13D	380	58	0.934	10/8/2009 13:55	10/8/2009 9:10	0.991	0.584	1.400	79.82%	2.75%	PIC	7/2/2009	7/31/2010	0.6377	0.00816	0.820	500	
9	14B	380	117	1.084	10/8/2009 13:55	10/8/2009 9:10	0.991	0.584	1.400	73.61%	2.81%	PIC	7/2/2009	7/31/2010	0.6266	0.00816	0.994	500	
10	1B	70	2	0.557	10/8/2009 14:24	10/8/2009 9:10	0.992	0.553	1.067	73.79%	2.81%	PIC	7/2/2009	7/31/2010	0.6282	0.00409	0.352	500	
11	2C	70	7	0.657	10/8/2009 14:24	10/8/2009 9:10	0.993	0.553	1.067	85.45%	2.70%	PIC	7/2/2009	7/31/2010	0.5969	0.00575	0.408	500	
12	2D	60	9	0.883	10/12/2009 18:04	10/12/2009 16:15	0.991	0.814	1.058	78.59%	2.92%	PIC	7/2/2009	7/31/2010	0.6119	0.00479	0.493	1000	
13	7A	70	16	0.586	10/8/2009 14:25	10/8/2009 9:10	0.992	0.552	1.067	77.58%	2.77%	PIC	7/2/2009	7/31/2010	0.6180	0.00816	0.382	500	
14	7C	70	6	0.500	10/8/2009 14:25	10/8/2009 9:10	0.992	0.552	1.067	71.61%	2.84%	PIC	7/2/2009	7/31/2010	0.6178	0.00816	0.310	500	
15	5A	60	10	0.963	10/12/2009 18:04	10/12/2009 16:15	0.997	0.814	1.058	83.18%	2.87%	PIC	7/2/2009	7/31/2010	0.6258	0.00816	0.486	1000	
16	10A	70	3	0.371	10/8/2009 14:25	10/8/2009 9:10	0.985	0.552	1.067	71.82%	2.84%	PIC	7/2/2009	7/31/2010	0.6389	0.00816	0.338	500	
17	5C	60	16	1.317	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	82.81%	2.72%	PIC	7/2/2009	7/31/2010	0.6388	0.00816	0.946	500	
18	5D	60	20	8.117	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	76.78%	2.78%	PIC	7/2/2009	7/31/2010	0.6237	0.00816	1.350	500	
19	6A	60	22	8.350	10/8/2009 11:36	10/8/2009 9:10	0.985	0.759	1.058	79.27%	2.75%	PIC	7/2/2009	7/31/2010	0.6221	0.00816	1.340	500	
20	9A	60	7	8.000	10/12/2009 18:04	10/12/2009 16:15	0.997	0.814	1.058	82.45%	2.88%	PIC	7/2/2009	7/31/2010	0.6496	0.00816	0.449	1000	

VERIFICATION ONLY

- Notes:  
 1 - Results are decay corrected to Sample Date/Time  
 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date  
 3 - Spike Nominals are decay corrected to Sample Date/Time  
 \* - RPD changed to 0% due to activity below MDA for 1201933969.1

Pos.	Decision Level pCi/L	Critical Level pCi/L	Required MDA pCi/L	MDA pCi/L	Sample Act. Conc. pCi/L	Sample Act. Error pCi/L	Net Count Rate CPM	Net Count Rate Error CPM	2 SIGMA		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
									Counting Uncertainty pCi/L	Total Prop. Uncertainty pCi/L						
1	1.0691	0.7548	3	1.8019	2.5529	0.2669	0.4967	0.1159	1.3283	1.4785		SAMPLE				
2	1.2270	0.8663	3	2.0573	1.1780	0.5409	0.1813	0.0979	1.2471	1.2827		SAMPLE				
3	2.1292	1.5032	3	3.3700	3.9074	0.2942	0.5373	0.1573	2.2421	2.4533		SAMPLE				
4	1.3142	0.9279	3	2.1494	1.1121	0.5882	0.1893	0.1113	1.2808	1.3116		SAMPLE				
5	1.5453	1.0910	3	2.5174	4.4215	0.2204	0.6593	0.1441	1.8943	2.2034		SAMPLE				
6	1.4495	1.0234	3	2.3744	0.9176	0.7613	0.1400	0.1065	1.3681	1.3881		SAMPLE				
7	1.2829	0.9058	3	2.1270	1.0011	0.6390	0.1587	0.1013	1.2526	1.2782		SAMPLE				
8	1.5381	1.0859	3	2.2564	1.2234	0.5613	0.1142	0.0640	1.3441	1.3798		SAMPLE				
9	1.8692	1.3197	3	2.7327	1.0666	0.7718	0.0902	0.0696	1.6124	1.6352		SAMPLE				
10	1.8675	1.1773	3	2.7597	1.9391	0.4546	0.2051	0.0931	1.7244	1.7937		SAMPLE				
11	1.6317	1.1520	3	2.6722	1.2405	0.4064	0.2491	0.1010	1.7010	1.7860		SAMPLE				
12	1.3343	0.9421	3	2.1909	2.3952	0.3174	0.3903	0.1233	1.4836	1.6046		SAMPLE				
13	1.6814	1.1871	3	2.7664	1.8639	0.4700	0.2037	0.0856	1.7136	1.7783		TB				
14	1.6417	1.1591	3	2.7431	1.8841	0.4647	0.1900	0.0881	1.7125	1.7787		TB				
15	1.2167	0.8590	3	1.9998	2.8028	0.2629	0.4973	0.1299	1.4349	1.6034		MB				
16	1.6649	1.1755	3	2.7637	0.3220	2.3139	0.0334	0.0773	1.4600	1.4624	235941001.1	DUP	155.2%	2.1027		
17	1.8706	1.3207	3	2.9434	2.2394	0.4175	0.3707	0.1544	1.8282	1.9151	235945001.1	DUP	0.0%	1.0541		
18	4.9212	3.4744	3	7.6141	90.0311	0.0621	6.7667	0.3715	9.8868	24.9116	235941001.1	MS			80.7094	108.4%
19	4.7622	3.3622	3	7.3705	90.5912	0.0609	7.0100	0.3766	9.5397	24.9781	235945001.1	MS			80.7094	112.2%
20	1.1366	0.8025	3	1.8788	41.3581	0.0569	7.5510	0.3658	3.9266	11.2677		LCS			39.8039	103.9%

VERIFICATION ONLY

# RADIUM 226

### Radiochemistry Batch Checklist, Rev 9

Batch# 907303

Product: Pa-224

Date: 10/15/2009

Criteria:	Yes	No	Comments
Sample Solids are less than or equal to 100 mg for GAB.			N/A
Samples have been blank corrected (if required)			N/A
If activity less 10* MDA/ MDC, error is 150% or less of sample activity. If greater 10* MDA/ MDC, error is 40% or less. If below the MDA/ MDC, error is okay.	✓		
Instrument source check is within limits.	✓		
Instrument bkg check is within limits.	✓		
Method RDL/ LLD has been met.			
If duplicate activities are less 5* MDA/ MDC, then RPD is 100% or less. If greater 5* MDA/ MDC, then RPD 20% or less. If below the MDA/ MDC, the RPD is 0%. Or meets the client's required RER acceptance criteria.	✓		
Tracer yield is 15-125% . Carrier yield 25-125%. Or meets the client's contract acceptance criteria.	✓		
Method blank is less than the RDL/ LLD. (If rad samples, < 5% of lowest activity)	✓		
Sample was run within hold time.	✓		
Sample was correctly preserved if required.	✓		
Smears Taken for Radioactive batches.			N/A
Method Spike and LCS are within 75-125% or meets the client's contract acceptance criteria.	✓		
No blank spaces on data forms. All line outs initialed and dated. No transcription errors are apparent.	✓		
Aux data is correct.			N/A
Client Special requirements page has been checked.	✓		
Raw Data and/ or spectrum are included and properly stated.	✓		
QC data entered into QC database and batch is in REVW	✓		
Hit notification complete (if necessary)			N/A
Batch entered into Case Narrative.	✓		
Batch non-conformances completed, if applicable.	✓		N/A NCR 746439
Batch non-conformances second reviewed and disposition verified to be completed.	✓		N/A NCR 746439
Aliquot Correction completed if required.			N/A
Review sample historical results if available (if REMF, results above MDC have been verified by historical results, recount or re-analysis.)	✓		

GEL Laboratories, LLC

revised 8/1/08

Primary Review Performed By:

Maria Marietta

Secondary Review Performed By:

Shelby 10/15/09

# Radium-226 Que Sheet

29-SEP-09

GEL Laboratories, Radiochemistry Division

Batch #: 907303

Analyst: KSDI

First Client Due Date: 10/15/2009

Internal Due Date: 10/04/2009

Spike Isotope: Radium-226

Spike Code: W226H

Expiration Date: 11/10

Vol: 0.1

End Initial/Degas Date/Time: 10/10/09 11:45

LCS Isotope: Radium-226

LCS Code: W226H

Expiration Date: 11/10

Vol: 0.1

End LN De-em Date: 10/14/09

Bkg Count Time: 30 (Min)

Sample Count Time: 30 (Min)

Start Count Date: 10/14/09

Witness: MS 10-8-09

Prep Date: 10/10/09

Pipet ID: W226H

Balance ID: S226H03

Initials: KL

W226H05

Sample I	Client Description	Type	Hazard Code	Matrix	Min CRDL	Client	Position (Label)	Aliquot (mL or g)	End LN De-em Time	Start Count Time	Cell #	Det #	Bkg counts	Total Counts
235945001-1	SA64-10BSPLP	SAMPLE	SOIL	SOIL	1 pCi/L	KERR003	1	200	0540	0845	611	4	8	45
235945002-1	SA102-10BSPLP	SAMPLE	SOIL	SOIL	1 pCi/L	KERR003	2	200	0540	0845	702	7	1	22
235945003-1	SA102-30BSPLP	SAMPLE	SOIL	SOIL	1 pCi/L	KERR003	3	200	0610	0915	209	2	8	11
235945004-1	SA30-9BSPLP	SAMPLE	SOIL	SOIL	1 pCi/L	KERR003	4	200	0610	0915	311	3	8	12
235945005-1	SA128-10BSPLP	SAMPLE	SOIL	SOIL	1 pCi/L	KERR003	5	200	0610	0915	505	5	4	14
235945006-1	SA128-29BSPLP	SAMPLE	SOIL	SOIL	1 pCi/L	KERR003	6	200	0610	0915	606	6	7	11
1201929717-1	TB for batch 905076	TB	SOIL	QC ACCOUNT	1 pCi/L	QC ACCOUNT	7	200	0610	0915	703	7	4	19
1201935051-1	MB for batch 907303	MB	SOIL	QC ACCOUNT	1 pCi/L	QC ACCOUNT	8	200	0640	0915	210	2	8	4
1201935052-1	SA128-29BSPLP(235945006DUP)	DUP	SOIL	QC ACCOUNT	1 pCi/L	QC ACCOUNT	9	200	0640	0915	308	3	8	16
1201935053-1	SA128-29BSPLP(235945006MS)	MS	SOIL	QC ACCOUNT	1 pCi/L	QC ACCOUNT	10	100	0640	0915	511	5	8	940
1201935054-1	LCS for batch 907303	LCS	SOIL	QC ACCOUNT	1 pCi/L	QC ACCOUNT	11	200	0640	0915	705	7	3	940

\*26.10.13.09

Comments:

Data Reviewed By: Nana Maniatt

# Radium-226 Liquid

Filename : RA226.XLS  
 File type : Excel  
 Version # : 1.2.4

Spike S/N : 0638-H  
 Spike Exp Date : 7/17/2010  
 Spike Activity (dpm/ml): 268.22  
 Spike Volume Added: 0.10

Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml  
 Pipet, 1 ml Stdev : +/- 0.005480 ml

Batch : 907303

Analyst : KSD1  
 Prep Date : 10/7/2009

Re-226 Abundance : 1  
 Re-226 Method Uncertainty : 0.0918

LCS S/N : 0638-H  
 LCS Exp Date : 7/17/2010  
 LCS Activity (dpm/ml): 268.22  
 LCS Volume Added: 0.10

Procedure Code : LUC26RAL  
 Parmname : Radium-226  
 Required MDA : 1 pCi/L  
 Half-life of Ra-226 : 1600 years  
 Half-life of Rn-222: 3.823 days  
 Batch counted on : LUCAS CELL DETECTOR  
 BKG Count time : 30 min

Sample Characteristics			Count Raw Data				Weekly Background					
Pos.	Sample ID	Sample Aliquot L	Sample Aliquot StDev. L	Sample Date/Time	Cell Number	Counting Time (min.)	Gross Counts	Gross CPM	Counts	CPM	Count Time (min.)	Detector Efficiency (cpm/dpm)
1	235945001.1	0.2000	1.6007E-05	8/24/2009 8:34	611	30	45	1.500	8	0.267	30	2.3070
2	235945002.1	0.2000	1.6007E-05	9/10/2009 7:12	702	30	22	0.733	1	0.033	30	2.0330
3	235945003.1	0.2000	1.6007E-05	9/10/2009 7:45	209	30	11	0.367	6	0.200	30	2.2910
4	235945004.1	0.2000	1.6007E-05	9/15/2009 11:25	311	30	12	0.400	8	0.267	30	2.1140
5	235945005.1	0.2000	1.6007E-05	9/16/2009 9:58	505	30	14	0.467	6	0.200	30	2.3310
6	235945006.1	0.2000	1.6007E-05	9/16/2009 10:28	606	30	11	0.367	7	0.233	30	2.3480
7	1201929717.1	0.2000	1.6007E-05	9/15/2009 11:25	703	30	15	0.500	6	0.200	30	2.2210
8	1201935051.1	0.2000	1.6007E-05	10/7/2009 0:00	210	30	4	0.133	8	0.267	30	2.2530
9	1201935052.1	0.2000	1.6007E-05	9/16/2009 10:28	308	30	16	0.533	8	0.267	30	1.9500
10	1201935053.1	0.1000	1.1370E-05	9/16/2009 10:28	511	30	948	31.600	8	0.267	30	1.9590
11	1201935054.1	0.2000	1.6007E-05	10/7/2009 0:00	705	30	789	26.300	3	0.100	30	2.1070

Detector Efficiency Error (cpm/dpm)	Cell Calibration Date	Cell Calibration Due Date	De-Gas Date/Time	Rn-222 Ingrow		Count Start Date/Time	Rn-222 Corrections		Ra-226 Decay	
				End Date/Time	De-Gas to Ingrowth		Ingrowth to Count	During Count		
0.06605	8/4/2009	8/4/2010	10/8/2009 12:45	10/14/2009 5:40	10/14/2009 8:45	10/14/2009 8:45	0.645	0.977	1.002	1.000
0.06519	9/30/2009	9/30/2010	10/8/2009 12:45	10/14/2009 5:40	10/14/2009 8:45	10/14/2009 8:45	0.645	0.977	1.002	1.000
0.07722	12/19/2008	12/19/2009	10/8/2009 12:45	10/14/2009 6:10	10/14/2009 9:15	10/14/2009 9:15	0.646	0.977	1.002	1.000
0.06082	2/4/2009	2/4/2010	10/8/2009 12:45	10/14/2009 6:10	10/14/2009 9:15	10/14/2009 9:15	0.646	0.977	1.002	1.000
0.14377	3/25/2009	3/25/2010	10/8/2009 12:45	10/14/2009 6:10	10/14/2009 9:15	10/14/2009 9:15	0.646	0.977	1.002	1.000
0.06605	8/4/2009	8/4/2010	10/8/2009 12:45	10/14/2009 6:10	10/14/2009 9:15	10/14/2009 9:15	0.646	0.977	1.002	1.000
0.06519	9/30/2009	9/30/2010	10/8/2009 12:45	10/14/2009 6:10	10/14/2009 9:15	10/14/2009 9:15	0.646	0.977	1.002	1.000
0.07722	12/19/2008	12/19/2009	10/8/2009 12:45	10/14/2009 6:40	10/14/2009 9:55	10/14/2009 9:55	0.647	0.976	1.002	1.000
0.06082	2/4/2009	2/4/2010	10/8/2009 12:45	10/14/2009 6:40	10/14/2009 9:55	10/14/2009 9:55	0.647	0.976	1.002	1.000
0.14377	3/25/2009	3/25/2010	10/8/2009 12:45	10/14/2009 6:40	10/14/2009 9:55	10/14/2009 9:55	0.647	0.976	1.002	1.000
0.06519	9/30/2009	9/30/2010	10/8/2009 12:45	10/14/2009 6:40	10/14/2009 12:25	10/14/2009 12:25	0.647	0.957	1.002	1.000



- Notes:  
 1 - Results are decay corrected to Sample Date/Time  
 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date  
 3 - Spike Nominals are decay corrected to Sample Date/Time

\* - RPD changed to 0% due to activity below MDA for 1201935052.1

Pos.	Decision Level pCi/L	Critical Level pCi/L	Required MDA pCi/L	MDA pCi/L	Sample Act. Conc. pCi/L	Sample Act. Error pCi/L	Net Count Rate CPM	Net Count Rate Error CPM	2 SIGMA		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
									Counting Uncertainty pCi/L	Total Prop. Uncertainty pCi/L						
1	0.4808	0.3394	1	0.8336	1.9086	0.2076	1.2333	0.2427	0.7361	0.8490		SAMPLE				
2	0.1929	0.1362	1	0.4480	1.2292	0.2375	0.7000	0.1599	0.5502	0.6135		SAMPLE				
3	0.4184	0.2954	1	0.7463	0.2592	0.8282	0.1667	0.1374	0.4189	0.4233		SAMPLE				
4	0.5236	0.3696	1	0.9078	0.2247	1.1197	0.1333	0.1491	0.4924	0.4948		SAMPLE				
5	0.4112	0.2903	1	0.7335	0.4076	0.5772	0.2667	0.1491	0.4466	0.4669		SAMPLE				
6	0.4409	0.3113	1	0.7743	0.2023	1.0627	0.1333	0.1414	0.4206	0.4230		SAMPLE				
7	0.4316	0.3047	1	0.7698	0.4812	0.5133	0.3000	0.1528	0.4803	0.4919		TB				
8	0.4908	0.3465	1	0.8511	-0.2107	0.8695	-0.1333	0.1155	0.3576	0.3578		MB				
9	0.5671	0.4004	1	0.9833	0.4868	0.6154	0.2667	0.1633	0.5843	0.5937	235945006.1	DUP	0.0%		120.8231	94.2%
10	1.1290	0.7971	1	1.9577	113.8738	0.1475	31.3333	1.0306	7.3414	38.7729	235945006.1	MS			60.4101	74.7%
11	0.3275	0.2312	1	0.6347	45.1076	0.0744	26.2000	0.9381	3.1655	10.4454		LCS				

# METHOD CALIBRATION DATA

# ALPHA SPECTROSCOPY

## Alpha Spectroscopy Calibration Sources

The following is a summary of the procedure performed for preparing mixed alpha calibration standards:

A calibration stock solution was prepared by combining the following in a volumetric flask and diluting to 50 ml (51.4561 grams). These individual standards were first verified by direct precipitation of small aliquots of each standard (as described in Attachment I).

Isotope	Serial #	amount used (g)	dpm (note 1)
Gd-148	64445-278	0.2471	212.159287
Np-237	4341	1.8075	204.438594
Cm-244	4320A	7.2704	240.144737

Note 1: Dpm values are decay corrected to 2/7/2003.

Forty one weighted aliquots were then directly precipitated using Neodymium Flouride /HF system. The sources were then mounted on 0.1Poly-propylene filters and taped securely to 1 inch stainless steel planchettes for counting in an Alpha Spectroscopy system. The liquid fraction that passes through the filter is collected, traced with Am-241 and prepared for counting using the identical procedure. These samples are counted to ensure there is no more than 1% loss in the filtering processes. All sources pass this requirement. The DPM information for each source is listed in attachment II.

Certificate files were then created on the Alpha system used for acquisition and processing of data. Each source is assigned a name (AESS-001 through AESS-041). The information for the source activities is entered into the certificate files appropriate for the detector being used.

For example: If source AESS-001 is used for calibrating detector 25, the source data is entered into the certificate file name [env\_alpha.cer]U025.cer.

The computer software uses these certificate files to calculate an energy calibration and determine the efficiency of the detector after counting the source.

*Ante Hill*  
4/1/03

2002 Alpha Eff Source Stock Verification

Curium-244

Isotope	Value pCi/g
SSTOCK2002A2_AM	106.000
SSTOCK2002B2_AM	106.000
SSTOCK2002C2_AM	106.000

Mean Value (Counting) = 106.000 98.04%  
 Stdev = 0

Target = 108.1230 pCi/g  
 Lower Limit = 106  
 Upper Limit = 106  
 Rule 1 Pass/Fail Pass  
 Two sigma = 0  
 10 % of Mean = 10.6  
 Rule 2 (Pass/Fail) Pass

PASS  
 Fair 3/2/0

Neptunium-237

Isotope	Value pCi/g
SSTOCK2002A2_AM	90.100
SSTOCK2002B2_AM	87.200
SSTOCK2002C2_AM	93.500

Mean Value (Counting) = 90.267 98.02%  
 Stdev = 3.153305144

Target = 92.0900 pCi/g  
 Lower Limit = 83.96005638  
 Upper Limit = 96.57327696  
 Rule 1 Pass/Fail Pass  
 Two sigma = 6.306610289  
 10 % of Mean = 9.026666667  
 Rule 2 (Pass/Fail) Pass

Gadolinium-148

Isotope	Value pCi/g
SSTOCK2002A2_AM	95.080
SSTOCK2002B2_AM	93.750
SSTOCK2002C2_AM	96.560

Mean Value (Counting) = 95.463 99.81%  
 Stdev = 1.503074627

Target = 95.6460 pCi/g  
 Lower Limit = 92.45718408  
 Upper Limit = 98.46948259  
 Rule 1 Pass/Fail Pass  
 Two sigma = 3.006148253  
 10 % of Mean = 9.546333333  
 Rule 2 (Pass/Fail) Pass

The analyst prepared three standard verification sources for the mixed alpha stock standard using 0.1030 g for source #1, 0.1035 g for source #2 and 0.1028 g for source #3. Each standard was combined with 1.0 mL of Am-243 standard 0454-A and 0.1 mL of Nd carrier in a disposable centrifuge tube. Four mL of 2 M HCl was added to each standard and then diluted with 4 mL of DI water. 5 mL of ascorbic acid was added to each sample then one mL of 48% HF was added to precipitate Nd (and Curium) fluoride. After 30 minutes, each sample was filtered following routine procedures for alpha spectroscopy source preparation. Each source was counted using routine alpha spec procedures. pCi/L values for the Mixed Alpha Stock were calculated and compared to Am-243 certified values.

① The rule failed because the 3 results from 3 sources were the same. Therefore, the stdev was zero. The intent of this rule is to ensure an appropriate amount of counts are achieved for proper determinations. ~~Since~~ For each standard the # of counts achieved was just under 10000 which has a counting error of nearly 1%. Because the standard's bias is < 2% from the known value the standard is acceptable.

Robertson 02/20/03

Attachment II

Mixed alpha Reference date = 2/7/2003		Stock Dpm/g	Reference date	Half-life (years)	amount used for mixed	Dpm/g mixed	Decay corr dpm/g
Isotope	Source						
Gd-148	64445-278 (0502)	44354.59289	9/5/2002	74.60	0.2471	212.9974853	212.159287
Np-237	Srm 4341 (0493)	5820	3/1/1992	2.14E+06	1.8075	204.4393182	204.438594
Cm-244	SRM 4320a (0490)	2223.6	2/1/1996	18.1	7.2704	314.1796879	240.144737
Source	Amount of standard used	dpm Gd-148	dpm Np-237	dpm Cm-244	dps Gd-148	dps Np-237	dps Cm-244
AESS-001	1.0362	219.839	211.839	248.838	3.664	3.531	4.147
AESS-002	1.0344	219.458	211.471	248.406	3.658	3.525	4.140
AESS-003	1.034	219.373	211.390	248.310	3.656	3.523	4.138
AESS-004	1.0331	219.182	211.206	248.094	3.653	3.520	4.135
AESS-005	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-006	1.0331	219.182	211.206	248.094	3.653	3.520	4.135
AESS-007	1.0348	219.542	211.553	248.502	3.659	3.526	4.142
AESS-008	1.0363	219.861	211.860	248.862	3.664	3.531	4.148
AESS-009	1.0352	219.627	211.635	248.598	3.660	3.527	4.143
AESS-010	1.0346	219.500	211.512	248.454	3.658	3.525	4.141
AESS-011	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-012	1.0367	219.946	211.941	248.958	3.666	3.532	4.149
AESS-013	1.0396	220.561	212.534	249.654	3.676	3.542	4.161
AESS-014	1.0368	219.967	211.962	248.982	3.666	3.533	4.150
AESS-015	1.0363	219.861	211.860	248.862	3.664	3.531	4.148
AESS-016	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-017	1.0356	219.712	211.717	248.694	3.662	3.529	4.145
AESS-018	1.0359	219.776	211.778	248.766	3.663	3.530	4.146
AESS-019	1.0349	219.564	211.574	248.526	3.659	3.526	4.142
AESS-020	1.0361	219.818	211.819	248.814	3.664	3.530	4.147
AESS-021	1.0348	219.542	211.553	248.502	3.659	3.526	4.142
AESS-022	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-023	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-024	1.0343	219.436	211.451	248.382	3.657	3.524	4.140
AESS-025	1.0364	219.882	211.880	248.886	3.665	3.531	4.148
AESS-026	1.0336	219.288	211.308	248.214	3.655	3.522	4.137
AESS-027	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-028	1.0366	219.924	211.921	248.934	3.665	3.532	4.149

Attachment II

AESS-029	1.0355	219.691	211.696	248.670	3.662	3.528	4.144
AESS-030	1.0349	219.564	211.574	248.526	3.659	3.526	4.142
AESS-031	1.0343	219.436	211.451	248.382	3.657	3.524	4.140
AESS-032	1.0326	219.076	211.103	247.973	3.651	3.518	4.133
AESS-033	1.0308	218.694	210.735	247.541	3.645	3.512	4.126
AESS-034	1.0314	218.821	210.858	247.685	3.647	3.514	4.128
AESS-035	1.0303	218.588	210.633	247.421	3.643	3.511	4.124
AESS-036	1.0343	219.436	211.451	248.382	3.657	3.524	4.140
AESS-037	1.0353	219.649	211.655	248.622	3.661	3.528	4.144
AESS-038	1.0373	220.073	212.064	249.102	3.668	3.534	4.152
AESS-039	1.0334	219.245	211.267	248.166	3.654	3.521	4.136
AESS-040	1.0346	219.500	211.512	248.454	3.658	3.525	4.141
AESS-041	1.0352	219.627	211.635	248.598	3.660	3.527	4.143



0490  
0491

# National Institute of Standards & Technology

## Certificate

### Standard Reference Material 4320A Curium-244 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive curium-244 nitrate and nitric acid dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of alpha-particle counting instruments and for the monitoring of radiochemical procedures.

#### Radiological Hazard

The SRM ampoule contains curium-244 with a total activity of approximately 200 Bq. Curium-244 decays by alpha-particle emission to plutonium-240, which also decays by alpha-particle emission. None of the alpha particles escape from the SRM ampoule. During the decay process X-rays and gamma rays with energies from 40 keV to 1100 keV are also emitted. Most of these photons escape from the SRM ampoule but their intensities are so small that they do not represent a radiation hazard. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]\*. The SRM should be used only by persons qualified to handle radioactive material.

#### Chemical Hazard

The SRM ampoule contains nitric acid ( $\text{HNO}_3$ ) with a concentration of 1 mole per liter of water. The solution is corrosive and represents a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2. The ampoule should be opened only by persons qualified to handle both radioactive material and strong acid solution.

#### Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least February 2006.

The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) both because of the radioactivity and because of the strong acid.

#### Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M.R. Hutchinson, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas of the Radioactivity Group.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by N.M. Trahey.

Gaithersburg, Maryland 20899  
February 1996 (Text only revised November 1997)

Thomas E. Gills, Chief  
Standard Reference Materials Program



### Recommended Procedure for Opening the SRM Ampoule

- 1) If the SRM solution is to be diluted, it is recommended that the diluting solution have a composition comparable to that of the SRM solution.
- 2) Wear eye protection, gloves, and protective clothing and work over a tray with absorbent paper in it. Work in a fume hood. In addition to the radioactive material, the solution contains strong acid and is corrosive.
- 3) Shake the ampoule to wet all of the inside surface of the ampoule. Return the ampoule to the upright position.
- 4) Check that all of the liquid has drained out of the neck of the ampoule. If necessary, gently tap the neck to speed the process.
- 5) Holding the ampoule upright, score the narrowest part of the neck with a scribe or diamond pencil.
- 6) Lightly wet the scored line. This reduces the crack propagation velocity and makes for a cleaner break.
- 7) Hold the ampoule upright with a paper towel, a wiper, or a support jig. Position the scored line away from you. Using a paper towel or wiper to avoid contamination, snap off the top of the ampoule by pressing the narrowest part of the neck away from you while pulling the tip of the ampoule towards you.
- 8) Transfer the solution from the ampoule using a pycnometer or a pipet with dispenser handle.  
**NEVER PIPETTE BY MOUTH**
- 9) Seal any unused SRM solution in a flame-sealed glass ampoule, if possible, to minimize the evaporation loss.

See also reference [4]\*.

PROPERTIES OF SRM 4320A  
(Certified values are shown in bold type)

Source identification number	NIST SRM 4320A		
Physical Properties:			
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule		
Ampoule specifications	Body outside diameter	(16.5 ± 0.5) mm	
	Wall Thickness	(0.60 ± 0.04) mm	
	Barium content	Less than 2.5%	
	Lead-oxide content	Less than 0.02%	
	Other heavy elements	Trace quantities	
Solution density	(1.030 ± 0.002) g·mL <sup>-1</sup> at 22.8 °C [b]*		
Solution mass	Approximately 5.15 g		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L <sup>-1</sup> )	Mass Fraction (g·g <sup>-1</sup> )
	H <sub>2</sub> O	54	0.94
	HNO <sub>3</sub>	1.0	0.06
	HCl	<0.001	<4 × 10 <sup>-5</sup>
	<sup>244</sup> Cm +3	5 × 10 <sup>-11</sup>	1 × 10 <sup>-11</sup>
Radiological Properties:			
Radionuclide	Curium-244		
Reference time	1230 EST, 1 February 1996 [c]		
Massic activity of the solution [d]	37.06 Bq·g <sup>-1</sup> 24.12 Bq·g <sup>-1</sup>		
Relative expanded uncertainty (k=2)	0.68% [e] [f]		
Alpha-particle-emitting daughters	Plutonium-240: (0.22 ± 0.11) Bq·g <sup>-1</sup> [b] [c]		
Alpha-particle-emitting impurities	Curium-243: (0.005 ± 0.004) Bq·g <sup>-1</sup> [b] [g]		
Photon-emitting impurities	None detected [h]		
Half lives used in the decay corrections	Curium-244: (18.10 ± 0.02) a [i] Plutonium-240: (6563 ± 7) a [i]		
Calibration method	Two 4π liquid-scintillation counting systems		

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- [i] The stated uncertainty is the standard uncertainty. See reference [5].
- [j] Relative standard uncertainty of the input quantity  $x_i$ .
- [k] The relative change in the output quantity  $y$  divided by the relative change in the input quantity  $x_i$ . If  $|\partial y/\partial x_i| \cdot (x_i/y) = 1.0$ , then a 1% change in  $x_i$  results in a 1% change in  $y$ . If  $|\partial y/\partial x_i| \cdot (x_i/y) = 0.05$ , then a 1% change in  $x_i$  results in a 0.05% change in  $y$ .
- [m] Relative component of combined standard uncertainty of output quantity  $y$ , rounded to two significant figures or less. The relative component of combined standard uncertainty of  $y$  is given by  $u_i(y)/y = |\partial y/\partial x_i| \cdot u(x_i)/y = |\partial y/\partial x_i| \cdot (x_i/y) \cdot u(x_i)/x_i$ . The numerical values of  $u(x_i)/x_i$ ,  $|\partial y/\partial x_i| \cdot (x_i/y)$ , and  $u_i(y)/y$ , all dimensionless quantities, are listed in columns 3, 4, and 5, respectively. Thus, the value in column 5 is equal to the value in column 4 multiplied by the value in column 3. The input quantities are independent, or very nearly so. Hence the covariances are zero or negligible.
- [n] The relative standard uncertainty of  $\lambda \cdot t$  is determined by the relative standard uncertainty of  $\lambda$  (i.e., of the half life). The relative standard uncertainty of  $t$  is negligible.
- [p]  $|\partial y/\partial x_i| \cdot (x_i/y) = |\lambda \cdot t|$
- [q] The live time is determined by counting the pulses from a gated oscillator.
- [r] The standard uncertainty given is for the detected Cm-243 impurity.  $|\partial y/\partial x_i| \cdot (x_i/y) = \{(\text{response per Bq of impurity})/(\text{response per Bq of Cm-244})\} \cdot \{(\text{Bq of impurity})/(\text{Bq of Cm-244})\}$ .
- [s] The standard uncertainty for each undetected impurity that might reasonably be expected to be present is estimated to be equal to the estimated limit of detection for that impurity, i.e.  $u(x_i)/x_i = 100\%$ .  $|\partial y/\partial x_i| \cdot (x_i/y) = \{(\text{response per Bq of impurity})/(\text{response per Bq of Cm-244})\} \cdot \{(\text{Bq of impurity})/(\text{Bq of Cm-244})\}$ . Thus  $u_i(y)/y$  is the relative change in  $y$  if the impurity were present with a massic activity equal to the estimated limit of detection.

#### REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900.
- [2] International Organization for Standardization (ISO), *Guide to the Expression of Uncertainty in Measurement*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900. (Listed under ISO miscellaneous publications as "ISO Guide to the Expression 1993".)
- [3] B. N. Taylor and C. E. Kuyatt, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, 1994. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20407, U.S.A.
- [4] National Council on Radiation Protection and Measurements Report No. 58, *A Handbook of Radioactivity Measurements Procedures*, Second Edition, 1985. Available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814 U.S.A.
- [5] Evaluated Nuclear Structure Data File (ENSDF), February 1996.



# CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

64445-278

Gd-148 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master liquid radionuclide solution source. The master source was calibrated by liquid scintillation counting.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

ISOTOPE:	Gd-148
ACTIVITY (dps):	<u>3.759 E3</u>
HALF-LIFE:	<u>74.6 years</u>
CALIBRATION DATE:	September 5, 2002 12:00 EST
TOTAL UNCERTAINTY*:	2.7%
SYSTEMATIC:	1.9%
RANDOM:	0.8%

99% confidence level.

5.08493 grams 0.1M HCl solution.

P O NUMBER 3207RD, Item 1

SOURCE PREPARED BY:

M.D. Currie  
M.D. Currie, Radiochemist

Q A APPROVED:

W.M. [Signature] 9-6-02

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# National Institute of Standards & Technology

## Certificate

### Standard Reference Material 4341 Radioactivity Standard

Radionuclide	Neptunium-237
Source identification	SRM 4341
Source description	Liquid in flame-sealed NIST borosilicate-glass ampoule <sup>(1)</sup> *
Solution mass	Approximately 5 grams
Solution composition	Neptunium-237 in 2 mol·L <sup>-1</sup> nitric acid
Reference time	March 1992
Radioactivity concentration	97.0 Bq·g <sup>-1</sup>
Overall uncertainty	1.28 percent <sup>(2)</sup>
Photon-emitting impurities	None detected <sup>(3)</sup>
Alpha-particle-emitting impurities	None detected <sup>(4)</sup>
Half life	(2.14 ± 0.11) × 10 <sup>6</sup> years <sup>(5)</sup>
Measuring instrument	NIST "0.8π" α defined-solid-angle counter with scintillation 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

## NOTES

(1) Approximately five milliliters of solution. Ampoule specifications:

body diameter	$16.5 \pm 0.5$ mm
wall thickness	$0.60 \pm 0.04$ mm
barium content	less than 2.5 percent
lead oxide content	less than 0.02 percent
other heavy elements	trace quantities

(2) The overall uncertainty was formed by taking three times the quadratic combination of the standard deviations of the mean, or approximations thereof, for the following:

a) alpha-particle-emission-rate measurements	0.34 percent
b) background	0.01 percent
c) livetime	0.10 percent
d) detection efficiency	0.16 percent
e) count-rate-vs-energy extrapolation to zero energy	0.10 percent
f) half life	0.00 percent
g) gravimetric measurements	0.10 percent
h) alpha-emitting impurities	0.10 percent

(3) The protactinium-233 daughter of neptunium-237 is approximately in equilibrium.  
The limit of detection for photon-emitting impurities is

$0.19 \gamma \cdot s^{-1} \cdot g^{-1}$  for energies between 30 and 307 keV and  
 $0.01 \gamma \cdot s^{-1} \cdot g^{-1}$  for energies between 317 and 1750 keV,

provided that the impurity photons are separated in energy by 5 keV or more from photons emitted in the decay of neptunium-237 and progeny.

(4) The limit of detection for alpha-particle-emitting impurities is

$0.10 \alpha \cdot s^{-1} \cdot g^{-1}$  for energies between 1.0 and 4.3 MeV and  
 $0.05 \alpha \cdot s^{-1} \cdot g^{-1}$  for energies between 4.9 and 10 MeV.

(5) Evaluated Nuclear Structure Data File (ENSDF), February 1990.

For further information please contact Dr. J.M. Robin Hutchinson at NIST.  
Telephone: (301) 975-5532  
FAX: (301) 926-7416

## Subsection 1: Energy Calibration

The Energy Calibration energy=Cal\_Zero+(e1\*C)+(e2\*C^2)

where : Cal\_Zero = Energy Calibration Zero  
e1 = Energy Calibration Slope  
e2 = Energy Calibration Quadratic  
C = Channel

Instrument : CHAMBER 161  
Detector : 70321  
Calibration Date/Time : 21-SEP-2009 14:45:33  
Calibration Source Id : AESS-001

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.798
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
Energy Calibration Zero : 2376.675  
Energy Calibration Slope : 4.903314  
Energy Calibration Quadratic : 3.3071014E-04  
Energy Calibration Range : 7744.000

Instrument : CHAMBER 162  
Detector : 70323  
Calibration Date/Time : 21-SEP-2009 14:45:43  
Calibration Source Id : AESS-007

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
Energy Calibration Zero : 2372.249  
Energy Calibration Slope : 4.921350  
Energy Calibration Quadratic : 3.0858925E-04  
Energy Calibration Range : 7735.000

Instrument : CHAMBER 163  
Detector : 70324  
Calibration Date/Time : 21-SEP-2009 14:46:06  
Calibration Source Id : AESS-002

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
Energy Calibration Zero : 2383.315  
Energy Calibration Slope : 4.921310  
Energy Calibration Quadratic : 3.3110939E-04  
Energy Calibration Range : 7770.000

Instrument : CHAMBER 164  
 Detector : 70325  
 Calibration Date/Time : 21-SEP-2009 14:46:16  
 Calibration Source Id : AESS-008  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2381.492  
 Energy Calibration Slope : 4.935361  
 Energy Calibration Quadratic : 3.1875577E-04  
 Energy Calibration Range : 7770.000

Instrument : CHAMBER 165  
 Detector : 72544  
 Calibration Date/Time : 21-SEP-2009 14:46:29  
 Calibration Source Id : AESS-003  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2386.890  
 Energy Calibration Slope : 4.958474  
 Energy Calibration Quadratic : 2.9448030E-04  
 Energy Calibration Range : 7773.000

Instrument : CHAMBER 166  
 Detector : 74545  
 Calibration Date/Time : 21-SEP-2009 14:47:27  
 Calibration Source Id : AESS-009  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2376.522  
 Energy Calibration Slope : 4.921530  
 Energy Calibration Quadratic : 3.3686910E-04  
 Energy Calibration Range : 7769.000



Instrument : CHAMBER 167  
 Detector : 72546  
 Calibration Date/Time : 21-SEP-2009 14:48:04  
 Calibration Source Id : AESS-004

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2378.613  
 Energy Calibration Slope : 4.924971  
 Energy Calibration Quadratic : 3.2533024E-04  
 Energy Calibration Range : 7763.000

Instrument : CHAMBER 168  
 Detector : 72547  
 Calibration Date/Time : 21-SEP-2009 14:48:25  
 Calibration Source Id : AESS-010

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2381.283  
 Energy Calibration Slope : 4.946027  
 Energy Calibration Quadratic : 3.0436489E-04  
 Energy Calibration Range : 7765.000

Instrument : CHAMBER 169  
 Detector : 72548  
 Calibration Date/Time : 21-SEP-2009 14:48:47  
 Calibration Source Id : AESS-005

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.001
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2384.302  
 Energy Calibration Slope : 4.926007  
 Energy Calibration Quadratic : 3.2111545E-04  
 Energy Calibration Range : 7765.000

Instrument : CHAMBER 170  
 Detector : 72549  
 Calibration Date/Time : 21-SEP-2009 14:49:16  
 Calibration Source Id : AESS-011  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2384.736  
 Energy Calibration Slope : 4.931669  
 Energy Calibration Quadratic : 3.3333997E-04  
 Energy Calibration Range : 7784.000

Instrument : CHAMBER 171  
 Detector : 78260  
 Calibration Date/Time : 21-SEP-2009 14:49:40  
 Calibration Source Id : AESS-006  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.120  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2375.901  
 Energy Calibration Slope : 4.923372  
 Energy Calibration Quadratic : 3.1892414E-04  
 Energy Calibration Range : 7752.000

Instrument : CHAMBER 172  
 Detector : 78772  
 Calibration Date/Time : 21-SEP-2009 14:49:54  
 Calibration Source Id : AESS-012  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.801  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2374.003  
 Energy Calibration Slope : 4.928030  
 Energy Calibration Quadratic : 3.2592146E-04  
 Energy Calibration Range : 7762.000

Instrument : CHAMBER 173  
 Detector : 74431  
 Calibration Date/Time : 21-SEP-2009 14:50:04  
 Calibration Source Id : AESS-013  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.801  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2368.870  
 Energy Calibration Slope : 4.977422  
 Energy Calibration Quadratic : 2.7764533E-04  
 Energy Calibration Range : 7757.000

Instrument : CHAMBER 174  
 Detector : 74432  
 Calibration Date/Time : 21-SEP-2009 14:50:13  
 Calibration Source Id : AESS-019  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2361.911  
 Energy Calibration Slope : 5.039232  
 Energy Calibration Quadratic : 2.0001861E-04  
 Energy Calibration Range : 7732.000

Instrument : CHAMBER 175  
 Detector : 74433  
 Calibration Date/Time : 21-SEP-2009 14:50:24  
 Calibration Source Id : AESS-014  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.801  
 CM-244 4320A 2/28/10 5795.020 5795.019  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2364.263  
 Energy Calibration Slope : 4.969145  
 Energy Calibration Quadratic : 2.8674255E-04  
 Energy Calibration Range : 7753.000

Instrument : CHAMBER 176  
 Detector : 74434  
 Calibration Date/Time : 21-SEP-2009 14:50:36  
 Calibration Source Id : AESS-020  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2359.390  
 Energy Calibration Slope : 5.025916  
 Energy Calibration Quadratic : 2.3010977E-04  
 Energy Calibration Range : 7747.000

Instrument : CHAMBER 177  
 Detector : 74435  
 Calibration Date/Time : 21-SEP-2009 14:50:46  
 Calibration Source Id : AESS-015  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2363.896  
 Energy Calibration Slope : 4.971116  
 Energy Calibration Quadratic : 2.8296176E-04  
 Energy Calibration Range : 7751.000

Instrument : CHAMBER 178  
 Detector : 74436  
 Calibration Date/Time : 21-SEP-2009 14:50:57  
 Calibration Source Id : AESS-021  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2357.960  
 Energy Calibration Slope : 4.995038  
 Energy Calibration Quadratic : 2.5281982E-04  
 Energy Calibration Range : 7738.000

Instrument : CHAMBER 179  
 Detector : 74437  
 Calibration Date/Time : 21-SEP-2009 14:51:07  
 Calibration Source Id : AESS-016  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2362.475  
 Energy Calibration Slope : 4.962544  
 Energy Calibration Quadratic : 2.9229760E-04  
 Energy Calibration Range : 7751.000

Instrument : CHAMBER 180  
 Detector : 74438  
 Calibration Date/Time : 21-SEP-2009 14:51:16  
 Calibration Source Id : AESS-022  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2357.168  
 Energy Calibration Slope : 5.024229  
 Energy Calibration Quadratic : 2.2182068E-04  
 Energy Calibration Range : 7735.000

Instrument : CHAMBER 181  
 Detector : 74439  
 Calibration Date/Time : 21-SEP-2009 14:51:26  
 Calibration Source Id : AESS-017  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2361.833  
 Energy Calibration Slope : 4.977290  
 Energy Calibration Quadratic : 2.7170058E-04  
 Energy Calibration Range : 7743.000

Instrument : CHAMBER 182  
 Detector : 74440  
 Calibration Date/Time : 21-SEP-2009 14:51:42  
 Calibration Source Id : AESS-023

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.675
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2351.365  
 Energy Calibration Slope : 5.006705  
 Energy Calibration Quadratic : 2.3110739E-04  
 Energy Calibration Range : 7721.000

Instrument : CHAMBER 183  
 Detector : 74441  
 Calibration Date/Time : 21-SEP-2009 14:51:54  
 Calibration Source Id : AESS-018

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2365.306  
 Energy Calibration Slope : 4.968304  
 Energy Calibration Quadratic : 2.8504903E-04  
 Energy Calibration Range : 7752.000

Instrument : CHAMBER 184  
 Detector : 74442  
 Calibration Date/Time : 21-SEP-2009 14:52:17  
 Calibration Source Id : AESS-024

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2357.045  
 Energy Calibration Slope : 5.026213  
 Energy Calibration Quadratic : 2.2053947E-04  
 Energy Calibration Range : 7735.000

Instrument : CHAMBER 185  
 Detector : 68615  
 Calibration Date/Time : 21-SEP-2009 14:52:26  
 Calibration Source Id : AESS-025

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2363.439  
 Energy Calibration Slope : 4.921171  
 Energy Calibration Quadratic : 2.9912216E-04  
 Energy Calibration Range : 7716.000

Instrument : CHAMBER 186  
 Detector : 68616  
 Calibration Date/Time : 21-SEP-2009 14:52:35  
 Calibration Source Id : AESS-031

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2362.841  
 Energy Calibration Slope : 4.954493  
 Energy Calibration Quadratic : 2.7342763E-04  
 Energy Calibration Range : 7723.000

Instrument : CHAMBER 187  
 Detector : 68620  
 Calibration Date/Time : 21-SEP-2009 14:52:45  
 Calibration Source Id : AESS-026

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2375.999  
 Energy Calibration Slope : 4.962572  
 Energy Calibration Quadratic : 3.0889659E-04  
 Energy Calibration Range : 7782.000

Instrument : CHAMBER 188  
 Detector : 68621  
 Calibration Date/Time : 21-SEP-2009 14:57:16  
 Calibration Source Id : AESS-032

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2372.483  
 Energy Calibration Slope : 4.952415  
 Energy Calibration Quadratic : 3.0726261E-04  
 Energy Calibration Range : 7766.000

Instrument : CHAMBER 189  
 Detector : 68622  
 Calibration Date/Time : 21-SEP-2009 14:53:03  
 Calibration Source Id : AESS-027

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2360.450  
 Energy Calibration Slope : 4.959707  
 Energy Calibration Quadratic : 2.6419348E-04  
 Energy Calibration Range : 7716.000

Instrument : CHAMBER 190  
 Detector : 68623  
 Calibration Date/Time : 21-SEP-2009 14:53:12  
 Calibration Source Id : AESS-033

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2356.994  
 Energy Calibration Slope : 4.952447  
 Energy Calibration Quadratic : 2.7996209E-04  
 Energy Calibration Range : 7722.000



Instrument : CHAMBER 191  
 Detector : 68624  
 Calibration Date/Time : 21-SEP-2009 14:53:21  
 Calibration Source Id : AESS-028

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2375.194  
 Energy Calibration Slope : 4.970817  
 Energy Calibration Quadratic : 3.1015038E-04  
 Energy Calibration Range : 7791.000

Instrument : CHAMBER 192  
 Detector : 74430  
 Calibration Date/Time : 21-SEP-2009 14:53:32  
 Calibration Source Id : AESS-034

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2368.673  
 Energy Calibration Slope : 4.975485  
 Energy Calibration Quadratic : 3.0052042E-04  
 Energy Calibration Range : 7779.000

Instrument : CHAMBER 193  
 Detector : 68627  
 Calibration Date/Time : 21-SEP-2009 14:53:41  
 Calibration Source Id : AESS-029

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2366.307  
 Energy Calibration Slope : 4.926867  
 Energy Calibration Quadratic : 3.0849138E-04  
 Energy Calibration Range : 7735.000

Instrument : CHAMBER 194  
 Detector : 68635  
 Calibration Date/Time : 21-SEP-2009 14:53:50  
 Calibration Source Id : AESS-035  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.001  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2363.136  
 Energy Calibration Slope : 4.944215  
 Energy Calibration Quadratic : 2.9438949E-04  
 Energy Calibration Range : 7735.000

Instrument : CHAMBER 195  
 Detector : 68636  
 Calibration Date/Time : 21-SEP-2009 14:53:59  
 Calibration Source Id : AESS-030  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2364.925  
 Energy Calibration Slope : 4.962630  
 Energy Calibration Quadratic : 2.7555652E-04  
 Energy Calibration Range : 7736.000

Instrument : CHAMBER 196  
 Detector : 68637  
 Calibration Date/Time : 21-SEP-2009 14:54:08  
 Calibration Source Id : AESS-036  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.798  
 CM-244 4320A 2/28/10 5795.020 5795.021  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2367.455  
 Energy Calibration Slope : 4.936808  
 Energy Calibration Quadratic : 2.9704699E-04  
 Energy Calibration Range : 7734.000

Instrument : CHAMBER 197  
 Detector : 78894  
 Calibration Date/Time : 21-SEP-2009 14:42:21  
 Calibration Source Id : AESS-037

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2367.634  
 Energy Calibration Slope : 4.977818  
 Energy Calibration Quadratic : 2.8380580E-04  
 Energy Calibration Range : 7763.000

Instrument : CHAMBER 198  
 Detector : 78895  
 Calibration Date/Time : 21-SEP-2009 14:54:28  
 Calibration Source Id : AESS-043

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2368.665  
 Energy Calibration Slope : 4.961154  
 Energy Calibration Quadratic : 2.8666743E-04  
 Energy Calibration Range : 7749.000

Instrument : CHAMBER 199  
 Detector : 78896  
 Calibration Date/Time : 21-SEP-2009 14:54:37  
 Calibration Source Id : AESS-038

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2369.988  
 Energy Calibration Slope : 4.975040  
 Energy Calibration Quadratic : 2.8448759E-04  
 Energy Calibration Range : 7763.000

Instrument : CHAMBER 200  
 Detector : 78900  
 Calibration Date/Time : 21-SEP-2009 14:54:46  
 Calibration Source Id : AESS-044  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2368.958  
 Energy Calibration Slope : 4.954888  
 Energy Calibration Quadratic : 3.0549458E-04  
 Energy Calibration Range : 7763.000

Instrument : CHAMBER 201  
 Detector : 78902  
 Calibration Date/Time : 21-SEP-2009 14:54:55  
 Calibration Source Id : AESS-039  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2361.867  
 Energy Calibration Slope : 4.974102  
 Energy Calibration Quadratic : 2.9147897E-04  
 Energy Calibration Range : 7761.000

Instrument : CHAMBER 202  
 Detector : 78903  
 Calibration Date/Time : 21-SEP-2009 14:55:05  
 Calibration Source Id : AESS-045  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2354.252  
 Energy Calibration Slope : 4.963346  
 Energy Calibration Quadratic : 2.8640320E-04  
 Energy Calibration Range : 7737.000

Instrument : CHAMBER 203  
 Detector : 78905  
 Calibration Date/Time : 21-SEP-2009 14:55:14  
 Calibration Source Id : AESS-040  
 Cal. Isotopes    Source Id    Expiration Date    Standard Energy    Actual Energy  
   GD-148        6445-278      2/28/10            3183.000        3183.000  
   NP-237        4341          2/28/10            4768.800        4768.799  
   CM-244        4320A        2/28/10            5795.020        5795.021  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2365.971  
 Energy Calibration Slope : 4.956215  
 Energy Calibration Quadratic : 3.0086067E-04  
 Energy Calibration Range : 7757.000

Instrument : CHAMBER 204  
 Detector : 78907  
 Calibration Date/Time : 21-SEP-2009 14:55:23  
 Calibration Source Id : AESS-046  
 Cal. Isotopes    Source Id    Expiration Date    Standard Energy    Actual Energy  
   GD-148        6445-278      2/28/10            3183.000        3183.000  
   NP-237        4341          2/28/10            4768.800        4768.801  
   CM-244        4320A        2/28/10            5795.020        5795.019  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2364.131  
 Energy Calibration Slope : 4.970463  
 Energy Calibration Quadratic : 2.7864033E-04  
 Energy Calibration Range : 7746.000

Instrument : CHAMBER 205  
 Detector : 78908  
 Calibration Date/Time : 21-SEP-2009 14:55:32  
 Calibration Source Id : AESS-041  
 Cal. Isotopes    Source Id    Expiration Date    Standard Energy    Actual Energy  
   GD-148        6445-278      2/28/10            3183.000        3183.000  
   NP-237        4341          2/28/10            4768.800        4768.799  
   CM-244        4320A        2/28/10            5795.020        5795.021  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2369.855  
 Energy Calibration Slope : 4.963379  
 Energy Calibration Quadratic : 2.9518205E-04  
 Energy Calibration Range : 7762.000

Instrument : CHAMBER 206  
 Detector : 78909  
 Calibration Date/Time : 21-SEP-2009 14:55:41  
 Calibration Source Id : AESS-047  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2367.801  
 Energy Calibration Slope : 4.940775  
 Energy Calibration Quadratic : 3.1145863E-04  
 Energy Calibration Range : 7754.000

Instrument : CHAMBER 207  
 Detector : 78910  
 Calibration Date/Time : 21-SEP-2009 14:55:50  
 Calibration Source Id : AESS-042  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2367.063  
 Energy Calibration Slope : 4.985894  
 Energy Calibration Quadratic : 2.7485727E-04  
 Energy Calibration Range : 7761.000

Instrument : CHAMBER 208  
 Detector : 78911  
 Calibration Date/Time : 21-SEP-2009 14:56:00  
 Calibration Source Id : AESS-048  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2366.635  
 Energy Calibration Slope : 4.964264  
 Energy Calibration Quadratic : 3.0284186E-04  
 Energy Calibration Range : 7768.000

## Subsection 2: Background Calibration

Instrument : CHAMBER 161  
 Detector : 70321  
 Background Analysis Date/Time : 20-SEP-2009 15:51:51  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.771	3300.133	1.000000	0.3000000	100.0000	95.00000
NP-237	4437.452	4905.776	11.00000	3.300000	30.15113	95.00000
CM-244	5533.229	5885.267	9.000000	2.700000	33.33334	95.00000

Instrument : CHAMBER 162  
 Detector : 70323  
 Background Analysis Date/Time : 20-SEP-2009 15:51:55  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2992.239	3298.296	1.000000	0.3000000	100.0000	95.00000
NP-237	4436.702	4904.841	3.000000	0.9000000	57.73503	95.00000
CM-244	5531.500	5882.828	10.00000	3.000000	31.62278	95.00000

Instrument : CHAMBER 163  
 Detector : 70324  
 Background Analysis Date/Time : 20-SEP-2009 15:52:00  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.643	3300.046	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4435.946	4905.743	20.00000	6.000000	22.36068	95.00000
CM-244	5535.155	5882.911	12.00000	3.600000	28.86751	95.00000

Instrument : CHAMBER 164  
 Detector : 70325  
 Background Analysis Date/Time : 20-SEP-2009 15:52:04  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.351	3300.390	2.000000	0.6000000	70.71068	95.00000
NP-237	4432.597	4902.599	13.00000	3.900000	27.73501	95.00000
CM-244	5531.973	5884.930	9.000000	2.700000	33.33334	95.00000

Instrument : CHAMBER 165  
 Detector : 72544  
 Background Analysis Date/Time : 20-SEP-2009 15:52:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.177	3299.087	2.000000	0.6000000	70.71068	95.00000
NP-237	4432.981	4902.991	5.000000	1.500000	44.72136	95.00000
CM-244	5531.772	5884.104	7.000000	2.100000	37.79645	95.00000

Instrument : CHAMBER 166  
 Detector : 74545  
 Background Analysis Date/Time : 20-SEP-2009 15:52:13  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.972	3298.535	1.000000	0.3000000	100.0000	95.00000
NP-237	4435.387	4905.732	7.000000	2.100000	37.79645	95.00000
CM-244	5530.676	5884.311	9.000000	2.700000	33.33334	95.00000

Instrument : CHAMBER 167  
 Detector : 72546  
 Background Analysis Date/Time : 20-SEP-2009 15:52:18  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.306	3300.867	1.000000	0.3000000	100.0000	95.00000
NP-237	4436.966	4901.435	16.00000	4.800000	25.00000	95.00000
CM-244	5530.518	5883.394	9.000000	2.700000	33.33334	95.00000

Instrument : CHAMBER 168  
 Detector : 72547  
 Background Analysis Date/Time : 20-SEP-2009 15:52:22  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.229	3301.657	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4434.347	4904.144	14.00000	4.200000	26.72612	95.00000
CM-244	5532.888	5885.320	10.00000	3.000000	31.62278	95.00000



Instrument : CHAMBER 169  
 Detector : 72548  
 Background Analysis Date/Time : 20-SEP-2009 15:52:26  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.054	3301.559	7.000000	2.100000	37.79645	95.00000
NP-237	4437.192	4906.601	22.00000	6.600000	21.32007	95.00000
CM-244	5535.250	5882.471	13.00000	3.900000	27.73501	95.00000

Instrument : CHAMBER 170  
 Detector : 72549  
 Background Analysis Date/Time : 20-SEP-2009 15:52:31  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.361	3298.395	1.000000	0.3000000	100.0000	95.00000
NP-237	4436.739	4902.328	14.00000	4.200000	26.72612	95.00000
CM-244	5533.108	5887.023	12.00000	3.600000	28.86751	95.00000

Instrument : CHAMBER 171  
 Detector : 78260  
 Background Analysis Date/Time : 20-SEP-2009 15:52:36  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.303	3297.640	3.000000	0.9000000	57.73503	95.00000
NP-237	4432.543	4901.594	10.00000	3.000000	31.62278	95.00000
CM-244	5535.033	5887.339	8.000000	2.400000	35.35534	95.00000

Instrument : CHAMBER 172  
 Detector : 78772  
 Background Analysis Date/Time : 20-SEP-2009 15:52:40  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.091	3301.893	2.000000	0.6000000	70.71068	95.00000
NP-237	4433.700	4903.740	15.00000	4.500000	25.81989	95.00000
CM-244	5533.343	5886.514	6.000000	1.800000	40.82483	95.00000

Instrument : CHAMBER 173  
 Detector : 74431  
 Background Analysis Date/Time : 20-SEP-2009 15:52:45  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.339	3299.195	1.000000	0.3000000	100.0000	95.00000
NP-237	4435.469	4905.977	7.000000	2.100000	37.79645	95.00000
CM-244	5534.997	5887.255	28.00000	8.400001	18.89822	95.00000

Instrument : CHAMBER 174  
 Detector : 74432  
 Background Analysis Date/Time : 20-SEP-2009 15:52:49  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.852	3301.015	5.000000	1.500000	44.72136	95.00000
NP-237	4435.608	4905.341	7.000000	2.100000	37.79645	95.00000
CM-244	5531.406	5886.389	21.00000	6.300000	21.82179	95.00000

Instrument : CHAMBER 175  
 Detector : 74433  
 Background Analysis Date/Time : 20-SEP-2009 15:52:53  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.886	3298.444	3.000000	0.9000000	57.73503	95.00000
NP-237	4434.203	4904.756	10.00000	3.000000	31.62278	95.00000
CM-244	5534.062	5886.590	23.00000	6.900000	20.85144	95.00000

Instrument : CHAMBER 176  
 Detector : 74434  
 Background Analysis Date/Time : 20-SEP-2009 15:52:58  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.225	3302.172	2.000000	0.6000000	70.71068	95.00000
NP-237	4432.630	4903.602	3.000000	0.9000000	57.73503	95.00000
CM-244	5532.053	5883.416	19.00000	5.700000	22.94157	95.00000

Instrument : CHAMBER 177  
 Detector : 74435  
 Background Analysis Date/Time : 20-SEP-2009 15:53:02  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.707	3298.313	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
NP-237	4434.012	4904.435	5.000000	1.500000	44.72136	95.00000
CM-244	5533.475	5885.809	18.00000	5.400000	23.57022	95.00000

Instrument : CHAMBER 178  
 Detector : 74436  
 Background Analysis Date/Time : 20-SEP-2009 15:53:06  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.348	3300.873	3.000000	0.9000000	57.73503	95.00000
NP-237	4432.820	4902.942	9.000000	2.700000	33.33334	95.00000
CM-244	5530.837	5887.508	19.00000	5.700000	22.94157	95.00000

Instrument : CHAMBER 179  
 Detector : 74437  
 Background Analysis Date/Time : 20-SEP-2009 15:53:11  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2992.396	3300.692	2.000000	0.6000000	70.71068	95.00000
NP-237	4435.850	4906.313	3.000000	0.9000000	57.73503	95.00000
CM-244	5535.639	5882.885	32.00000	9.600000	17.67767	95.00000

Instrument : CHAMBER 180  
 Detector : 74438  
 Background Analysis Date/Time : 20-SEP-2009 15:53:16  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.663	3299.349	1.000000	0.3000000	100.0000	95.00000
NP-237	4433.569	4903.757	13.00000	3.900000	27.73501	95.00000
CM-244	5530.967	5886.867	29.00000	8.700001	18.56953	95.00000

Instrument : CHAMBER 181  
 Detector : 74439  
 Background Analysis Date/Time : 20-SEP-2009 15:53:20  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.239	3302.087	2.000000	0.6000000	70.71068	95.00000
NP-237	4432.597	4902.658	3.000000	0.9000000	57.73503	95.00000
CM-244	5530.942	5882.719	27.00000	8.100000	19.24501	95.00000

Instrument : CHAMBER 182  
 Detector : 74440  
 Background Analysis Date/Time : 20-SEP-2009 15:53:24  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.945	3300.794	1.000000	0.3000000	100.0000	95.00000
NP-237	4432.572	4902.020	5.000000	1.500000	44.72136	95.00000
CM-244	5533.775	5884.077	33.00000	9.900001	17.40777	95.00000

Instrument : CHAMBER 183  
 Detector : 74441  
 Background Analysis Date/Time : 20-SEP-2009 15:53:29  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.798	3299.272	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4434.624	4904.963	5.000000	1.500000	44.72136	95.00000
CM-244	5533.945	5886.272	42.00000	12.60000	15.43033	95.00000

Instrument : CHAMBER 184  
 Detector : 74442  
 Background Analysis Date/Time : 20-SEP-2009 15:53:33  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.768	3299.551	1.000000	0.3000000	100.0000	95.00000
NP-237	4434.041	4904.303	1.000000	0.3000000	100.0000	95.00000
CM-244	5531.580	5887.500	28.00000	8.400001	18.89822	95.00000

Instrument : CHAMBER 185  
 Detector : 68615  
 Background Analysis Date/Time : 20-SEP-2009 15:53:38  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.255	3299.191	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
NP-237	4436.568	4904.026	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
CM-244	5534.840	5885.460	35.00000	10.50000	16.90309	95.00000

Instrument : CHAMBER 186  
 Detector : 68616  
 Background Analysis Date/Time : 20-SEP-2009 15:53:42  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.448	3298.893	1.000000	0.3000000	100.0000	95.00000
NP-237	4434.968	4903.217	3.000000	0.9000000	57.73503	95.00000
CM-244	5534.439	5884.968	30.00000	9.000000	18.25742	95.00000

Instrument : CHAMBER 187  
 Detector : 68620  
 Background Analysis Date/Time : 20-SEP-2009 15:53:46  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.069	3299.571	4.000000	1.200000	50.00000	95.00000
NP-237	4436.508	4902.892	10.00000	3.000000	31.62278	95.00000
CM-244	5534.129	5882.618	35.00000	10.50000	16.90309	95.00000

Instrument : CHAMBER 188  
 Detector : 68621  
 Background Analysis Date/Time : 20-SEP-2009 15:53:50  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.307	3299.196	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
NP-237	4433.812	4904.473	3.000000	0.9000000	57.73503	95.00000
CM-244	5534.433	5887.575	21.00000	6.300000	21.82179	95.00000

Instrument : CHAMBER 189  
 Detector : 68622  
 Background Analysis Date/Time : 20-SEP-2009 15:53:55  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.567	3302.212	2.000000	0.6000000	70.71068	95.00000
NP-237	4433.165	4906.352	5.000000	1.500000	44.72136	95.00000
CM-244	5531.737	5887.138	29.00000	8.700001	18.56953	95.00000

Instrument : CHAMBER 190  
 Detector : 68623  
 Background Analysis Date/Time : 20-SEP-2009 15:53:59  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.470	3297.949	3.000000	0.9000000	57.73503	95.00000
NP-237	4434.559	4903.208	45.00000	13.50000	14.90712	95.00000
CM-244	5535.128	5886.122	75.00000	22.50000	11.54701	95.00000

Instrument : CHAMBER 191  
 Detector : 68624  
 Background Analysis Date/Time : 20-SEP-2009 15:54:03  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.297	3300.325	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4434.026	4906.466	4.000000	1.200000	50.00000	95.00000
CM-244	5533.499	5882.588	39.00000	11.70000	16.01282	95.00000

Instrument : CHAMBER 192  
 Detector : 74430  
 Background Analysis Date/Time : 20-SEP-2009 15:54:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.254	3299.423	1.000000	0.3000000	100.0000	95.00000
NP-237	4433.037	4905.173	6.000000	1.800000	40.82483	95.00000
CM-244	5531.571	5885.579	27.00000	8.100000	19.24501	95.00000

Instrument : CHAMBER 193  
 Detector : 68627  
 Background Analysis Date/Time : 20-SEP-2009 15:54:11  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.990	3298.419	3.000000	0.9000000	57.73503	95.00000
NP-237	4433.001	4901.628	20.00000	6.000000	22.36068	95.00000
CM-244	5534.240	5885.963	35.00000	10.50000	16.90309	95.00000

Instrument : CHAMBER 194  
 Detector : 68635  
 Background Analysis Date/Time : 20-SEP-2009 15:54:15  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.781	3297.998	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4434.565	4903.602	2.000000	0.6000000	70.71068	95.00000
CM-244	5531.095	5882.711	16.00000	4.800000	25.00000	95.00000

Instrument : CHAMBER 195  
 Detector : 68636  
 Background Analysis Date/Time : 20-SEP-2009 15:54:19  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.560	3297.508	1.000000	0.3000000	100.0000	95.00000
NP-237	4435.548	4904.654	6.000000	1.800000	40.82483	95.00000
CM-244	5531.770	5882.945	25.00000	7.500000	20.00000	95.00000

Instrument : CHAMBER 196  
 Detector : 68637  
 Background Analysis Date/Time : 20-SEP-2009 15:54:23  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.197	3301.025	2.000000	0.6000000	70.71068	95.00000
NP-237	4436.299	4904.887	12.00000	3.600000	28.86751	95.00000
CM-244	5531.851	5883.206	21.00000	6.300000	21.82179	95.00000

Instrument : CHAMBER 197  
 Detector : 78894  
 Background Analysis Date/Time : 20-SEP-2009 15:54:27  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.248	3298.244	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
NP-237	4435.410	4906.453	2.000000	0.6000000	70.71068	95.00000
CM-244	5531.008	5883.783	22.00000	6.600000	21.32007	95.00000

Instrument : CHAMBER 198  
 Detector : 78895  
 Background Analysis Date/Time : 20-SEP-2009 15:54:30  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.256	3301.357	1.000000	0.3000000	100.0000	95.00000
NP-237	4435.341	4905.168	3.000000	0.9000000	57.73503	95.00000
CM-244	5533.514	5885.508	20.00000	6.000000	22.36068	95.00000

Instrument : CHAMBER 199  
 Detector : 78896  
 Background Analysis Date/Time : 20-SEP-2009 15:54:35  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.267	3300.107	3.000000	0.9000000	57.73503	95.00000
NP-237	4436.748	4902.339	6.000000	1.800000	40.82483	95.00000
CM-244	5531.913	5884.562	27.00000	8.100000	19.24501	95.00000

Instrument : CHAMBER 200  
 Detector : 78900  
 Background Analysis Date/Time : 20-SEP-2009 15:54:38  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.062	3301.136	2.000000	0.6000000	70.71068	95.00000
NP-237	4436.203	4901.740	14.00000	4.200000	26.72612	95.00000
CM-244	5531.761	5884.914	26.00000	7.800000	19.61161	95.00000



Instrument : CHAMBER 201  
 Detector : 78902  
 Background Analysis Date/Time : 20-SEP-2009 15:54:42  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.184	3302.217	1.000000	0.3000000	100.0000	95.00000
NP-237	4434.609	4905.994	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
CM-244	5531.184	5884.407	20.00000	6.000000	22.36068	95.00000

Instrument : CHAMBER 202  
 Detector : 78903  
 Background Analysis Date/Time : 20-SEP-2009 15:54:47  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.216	3297.484	1.000000	0.3000000	100.0000	95.00000
NP-237	4437.369	4902.276	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
CM-244	5530.984	5883.177	24.00000	7.200000	20.41241	95.00000

Instrument : CHAMBER 203  
 Detector : 78905  
 Background Analysis Date/Time : 20-SEP-2009 15:54:51  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.199	3298.236	9.000000	2.700000	33.33334	95.00000
NP-237	4432.988	4903.526	7.000000	2.100000	37.79645	95.00000
CM-244	5533.164	5886.048	26.00000	7.800000	19.61161	95.00000

Instrument : CHAMBER 204  
 Detector : 78907  
 Background Analysis Date/Time : 20-SEP-2009 15:54:55  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.792	3298.277	15.00000	4.500000	25.81989	95.00000
NP-237	4433.265	4903.277	16.00000	4.800000	25.00000	95.00000
CM-244	5531.668	5883.589	51.00000	15.30000	14.00280	95.00000

Instrument : CHAMBER 205  
 Detector : 78908  
 Background Analysis Date/Time : 20-SEP-2009 15:54:58  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.853	3298.183	1.000000	0.3000000	100.0000	95.00000
NP-237	4433.644	4904.311	4.000000	1.200000	50.00000	95.00000
CM-244	5533.979	5886.811	26.00000	7.800000	19.61161	95.00000

Instrument : CHAMBER 206  
 Detector : 78909  
 Background Analysis Date/Time : 20-SEP-2009 15:55:02  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.264	3297.560	2.000000	0.6000000	70.71068	95.00000
NP-237	4435.483	4905.550	2.000000	0.6000000	70.71068	95.00000
CM-244	5534.828	5887.642	15.00000	4.500000	25.81989	95.00000

Instrument : CHAMBER 207  
 Detector : 78910  
 Background Analysis Date/Time : 20-SEP-2009 15:55:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.540	3298.860	2.000000	0.6000000	70.71068	95.00000
NP-237	4436.642	4902.427	8.000000	2.400000	35.35534	95.00000
CM-244	5532.022	5884.565	36.00000	10.80000	16.66667	95.00000

Instrument : CHAMBER 208  
 Detector : 78911  
 Background Analysis Date/Time : 20-SEP-2009 15:55:11  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.900	3300.465	2.000000	0.6000000	70.71068	95.00000
NP-237	4437.256	4903.414	3.000000	0.9000000	57.73503	95.00000
CM-244	5534.200	5882.369	22.00000	6.600000	21.32007	95.00000

### Subsection 3: Efficiency Calibration

Instrument : CHAMBER 161  
 Detector : 70321  
 Standard ID : AESS-001  
 Standard Reference Date : 20-FEB-2008 09:54:53  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:18  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:45:33  
 Average Efficiency : 0.3689128  
 Average Efficiency Error : 1.0123267E-02  
 Confidence : 95.00000

Cal. Isteps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	208.6698	28-FEB-2010	2989.771	3300.133	21764.00	0.3527895	1.5079973E-02	62.09401
NP-237	171.0024	28-FEB-2010	4437.452	4905.776	19466.00	0.3793849	1.9163225E-02	75.59914
CM-244	158.1060	28-FEB-2010	5533.229	5885.267	17188.00	0.3849835	1.9471968E-02	61.24743

Instrument : CHAMBER 162  
 Detector : 70323  
 Standard ID : AESS-007  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:25  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:45:43  
 Average Efficiency : 0.3711489  
 Average Efficiency Error : 1.0169771E-02  
 Confidence : 95.00000

Cal. Isteps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.7342	28-FEB-2010	2992.239	3298.296	21845.00	0.3574707	1.5279390E-02	61.21131
NP-237	205.0260	28-FEB-2010	4436.702	4904.841	23392.00	0.3802952	1.9176660E-02	80.07285
CM-244	199.6806	28-FEB-2010	5531.500	5882.828	21627.00	0.3837951	1.9366477E-02	60.40187

Instrument : CHAMBER 163  
 Detector : 70324  
 Standard ID : AESS-002  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:32  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:46:06  
 Average Efficiency : 0.3784813  
 Average Efficiency Error : 1.0368052E-02  
 Confidence : 95.00000

Cal. Isteps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	200.1144	28-FEB-2010	2988.643	3300.046	21830.00	0.3690017	1.5772363E-02	62.20918
NP-237	200.4990	28-FEB-2010	4435.946	4905.743	23254.00	0.3865025	1.9490723E-02	75.42545
CM-244	196.5558	28-FEB-2010	5535.155	5882.911	21361.00	0.3848922	1.9424047E-02	59.52460

Instrument : CHAMBER 164  
 Detector : 70325  
 Standard ID : AESS-008  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:39  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:46:16  
 Average Efficiency : 0.3791597  
 Average Efficiency Error : 1.0381414E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.0418	28-FEB-2010	2988.351	3300.390	22809.00	0.3744951	1.5998594E-02	58.40551
NP-237	209.2716	28-FEB-2010	4432.597	4902.599	23895.00	0.3805439	1.9185850E-02	71.09055
CM-244	199.6488	28-FEB-2010	5531.973	5884.930	21669.00	0.3846071	1.9407105E-02	56.87473

Instrument : CHAMBER 165  
 Detector : 72544  
 Standard ID : AESS-003  
 Standard Reference Date : 15-FEB-2008 13:12:27  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:46  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:46:29  
 Average Efficiency : 0.3786044  
 Average Efficiency Error : 1.0371909E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	202.9740	28-FEB-2010	2991.177	3299.087	21994.00	0.3665624	1.5666667E-02	68.94492
NP-237	203.2080	28-FEB-2010	4432.981	4902.991	23569.00	0.3865909	1.9492906E-02	76.46336
CM-244	197.2236	28-FEB-2010	5531.772	5884.104	21676.00	0.3894331	1.9650551E-02	69.10842

Instrument : CHAMBER 166  
 Detector : 74545  
 Standard ID : AESS-009  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:52  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:47:27  
 Average Efficiency : 0.3925645  
 Average Efficiency Error : 1.0746635E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.3736	28-FEB-2010	2991.972	3298.535	23250.00	0.3867014	1.6516251E-02	56.08769
NP-237	204.0192	28-FEB-2010	4435.387	4905.732	24303.00	0.3970365	2.0014562E-02	79.13438
CM-244	197.2128	28-FEB-2010	5530.676	5884.311	22089.00	0.3967021	2.0013960E-02	55.09056

Instrument : CHAMBER 167  
 Detector : 72546  
 Standard ID : AESS-004  
 Standard Reference Date : 14-FEB-2008 09:35:18  
 Calibration Analysis Date/Time : 21-SEP-2009 09:28:59  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:48:04  
 Average Efficiency : 0.3871779  
 Average Efficiency Error : 1.0602054E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.1222	28-FEB-2010	2989.306	3300.867	22941.00	0.3765221	1.6084069E-02	55.09563
NP-237	204.2586	28-FEB-2010	4436.966	4901.435	24233.00	0.3953844	1.9931784E-02	76.26476
CM-244	198.8100	28-FEB-2010	5530.518	5883.394	22180.00	0.3953461	1.9944822E-02	56.09549

Instrument : CHAMBER 168  
 Detector : 72547  
 Standard ID : AESS-010  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:07  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:48:25  
 Average Efficiency : 0.3895916  
 Average Efficiency Error : 1.0669101E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	202.0008	28-FEB-2010	2989.229	3301.657	22631.00	0.3790159	1.6193239E-02	61.00068
NP-237	202.9926	28-FEB-2010	4434.347	4904.144	24065.00	0.3951014	1.9918641E-02	83.09320
CM-244	196.2330	28-FEB-2010	5532.888	5885.320	22172.00	0.4003809	2.0198891E-02	61.18747

Instrument : CHAMBER 169  
 Detector : 72548  
 Standard ID : AESS-005  
 Standard Reference Date : 14-FEB-2008 09:35:18  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:13  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:48:47  
 Average Efficiency : 0.3742271  
 Average Efficiency Error : 1.0248713E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	210.7452	28-FEB-2010	2990.054	3301.559	22666.00	0.3638192	1.5543718E-02	59.25828
NP-237	209.5938	28-FEB-2010	4437.192	4906.601	23965.00	0.3810294	1.9209908E-02	71.80399
CM-244	202.7478	28-FEB-2010	5535.250	5882.471	21940.00	0.3834514	1.9346640E-02	60.12471

Instrument : CHAMBER 170  
 Detector : 72549  
 Standard ID : AESS-011  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:20  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:49:16  
 Average Efficiency : 0.3642089  
 Average Efficiency Error : 9.9735176E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	212.8284	28-FEB-2010	2991.361	3298.395	22497.00	0.3575987	1.5279310E-02	63.36363
NP-237	214.4868	28-FEB-2010	4436.739	4902.328	23611.00	0.3668730	1.8498441E-02	80.98635
CM-244	208.4184	28-FEB-2010	5533.108	5887.023	21846.00	0.3714186	1.8740255E-02	58.50939

Instrument : CHAMBER 171  
 Detector : 78260  
 Standard ID : AESS-006  
 Standard Reference Date : 14-FEB-2008 09:35:18  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:26  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:49:40  
 Average Efficiency : 0.3810605  
 Average Efficiency Error : 1.0438851E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.6952	28-FEB-2010	2991.303	3297.640	22193.00	0.3685752	1.5750948E-02	59.60153
NP-237	204.7038	28-FEB-2010	4432.543	4901.594	23828.00	0.3879591	1.9560140E-02	73.97815
CM-244	195.0060	28-FEB-2010	5535.033	5887.339	21671.00	0.3938129	1.9871602E-02	62.27898

Instrument : CHAMBER 172  
 Detector : 78772  
 Standard ID : AESS-012  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:32  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:49:54  
 Average Efficiency : 0.3822589  
 Average Efficiency Error : 1.0466043E-02  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.2200	28-FEB-2010	2990.091	3301.893	22979.00	0.3769604	1.6102478E-02	57.80247
NP-237	205.8930	28-FEB-2010	4433.700	4903.740	24203.00	0.3917651	1.9749530E-02	76.25694
CM-244	203.1954	28-FEB-2010	5533.343	5886.514	21835.00	0.3808052	1.9213919E-02	58.76520

Instrument : CHAMBER 173  
 Detector : 74431  
 Standard ID : AESS-013  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:38  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:50:04  
 Average Efficiency : 0.2602993  
 Average Efficiency Error : 7.1600322E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.6544	28-FEB-2010	2990.339	3299.195	15911.00	0.2643020	1.1349737E-02	50.51283
NP-237	210.2526	28-FEB-2010	4435.469	4905.977	15987.00	0.2534239	1.2828780E-02	57.29033
CM-244	201.9108	28-FEB-2010	5534.997	5887.255	14946.00	0.2621880	1.3283902E-02	53.12511

Instrument : CHAMBER 174  
 Detector : 74432  
 Standard ID : AESS-019  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:43  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:50:13  
 Average Efficiency : 0.2533270  
 Average Efficiency Error : 6.9733807E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	204.6468	28-FEB-2010	2989.852	3301.015	14930.00	0.2467540	1.0608066E-02	48.02879
NP-237	202.9140	28-FEB-2010	4435.608	4905.341	15850.00	0.2603388	1.3180215E-02	57.62176
CM-244	199.3140	28-FEB-2010	5531.406	5886.389	14432.00	0.2563750	1.2995369E-02	54.02073

Instrument : CHAMBER 175  
 Detector : 74433  
 Standard ID : AESS-014  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:50  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:50:24  
 Average Efficiency : 0.2543943  
 Average Efficiency Error : 6.9960668E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	214.7088	28-FEB-2010	2989.886	3298.444	16030.00	0.2525296	1.0842831E-02	50.61414
NP-237	211.7160	28-FEB-2010	4434.203	4904.756	16439.00	0.2587745	1.3095257E-02	57.23130
CM-244	207.3882	28-FEB-2010	5534.062	5886.590	14808.00	0.2528055	1.2810053E-02	51.72563

Instrument : CHAMBER 176  
 Detector : 74434  
 Standard ID : AESS-020  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 21-SEP-2009 09:29:58  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:50:36  
 Average Efficiency : 0.2547762  
 Average Efficiency Error : 7.0115663E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	205.5870	28-FEB-2010	2991.225	3302.172	15206.00	0.2502103	1.0753103E-02	46.19209
NP-237	203.4984	28-FEB-2010	4432.630	4903.602	15838.00	0.2594141	1.3133497E-02	58.51922
CM-244	197.1096	28-FEB-2010	5532.053	5883.416	14295.00	0.2569134	1.3024328E-02	51.87393

Instrument : CHAMBER 177  
 Detector : 74435  
 Standard ID : AESS-015  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:03  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:50:46  
 Average Efficiency : 0.2659749  
 Average Efficiency Error : 7.3150843E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	204.0270	28-FEB-2010	2989.707	3298.313	15952.00	0.2645041	1.1357911E-02	48.05111
NP-237	200.6460	28-FEB-2010	4434.012	4904.435	16053.00	0.2666638	1.3498317E-02	54.07773
CM-244	195.9270	28-FEB-2010	5533.475	5885.809	14787.00	0.2673737	1.3548458E-02	55.83525

Instrument : CHAMBER 178  
 Detector : 74436  
 Standard ID : AESS-021  
 Standard Reference Date : 19-FEB-2008 15:31:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:10  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:50:57  
 Average Efficiency : 0.2584701  
 Average Efficiency Error : 7.1088150E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	208.3608	28-FEB-2010	2991.348	3300.873	15813.00	0.2566991	1.1024418E-02	46.60859
NP-237	210.1548	28-FEB-2010	4432.820	4902.942	16293.00	0.2583858	1.3076977E-02	58.74612
CM-244	200.7390	28-FEB-2010	5530.837	5887.508	14803.00	0.2611073	1.3230741E-02	51.69608



Instrument : CHAMBER 179  
 Detector : 74437  
 Standard ID : AESS-016  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:16  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:51:07  
 Average Efficiency : 0.2656665  
 Average Efficiency Error : 7.3066968E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	204.0534	28-FEB-2010	2992.396	3300.692	16018.00	0.2655541	1.1402219E-02	48.47999
NP-237	199.3962	28-FEB-2010	4435.850	4906.313	16096.00	0.2690641	1.3619361E-02	58.18980
CM-244	198.6402	28-FEB-2010	5535.639	5882.885	14727.00	0.2625763	1.3306193E-02	54.75912

Instrument : CHAMBER 180  
 Detector : 74438  
 Standard ID : AESS-022  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:22  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:51:16  
 Average Efficiency : 0.2482043  
 Average Efficiency Error : 6.8309689E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	209.6724	28-FEB-2010	2988.663	3299.349	15136.00	0.2442104	1.0496107E-02	47.14516
NP-237	206.8830	28-FEB-2010	4433.569	4903.757	15632.00	0.2518027	1.2750288E-02	52.81374
CM-244	203.0208	28-FEB-2010	5530.967	5886.867	14358.00	0.2504804	1.2697529E-02	50.18464

Instrument : CHAMBER 181  
 Detector : 74439  
 Standard ID : AESS-017  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:28  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:51:26  
 Average Efficiency : 0.2568994  
 Average Efficiency Error : 7.0653898E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	210.0798	28-FEB-2010	2988.239	3302.087	16106.00	0.2593535	1.1134949E-02	50.88416
NP-237	208.5846	28-FEB-2010	4432.597	4902.658	16106.00	0.2573713	1.3027404E-02	57.22441
CM-244	205.5828	28-FEB-2010	5530.942	5882.719	14695.00	0.2531832	1.2830525E-02	53.69027

Instrument : CHAMBER 182  
 Detector : 74440  
 Standard ID : AESS-023  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:34  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:51:42  
 Average Efficiency : 0.2555217  
 Average Efficiency Error : 7.0314407E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	207.4764	28-FEB-2010	2990.945	3300.794	15263.00	0.2488660	1.0694612E-02	45.64035
NP-237	207.4998	28-FEB-2010	4432.572	4902.020	16228.00	0.2606671	1.3193036E-02	52.09262
CM-244	199.8804	28-FEB-2010	5533.775	5884.077	14703.00	0.2605115	1.3201850E-02	48.97062

Instrument : CHAMBER 183  
 Detector : 74441  
 Standard ID : AESS-018  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:39  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:51:54  
 Average Efficiency : 0.2611987  
 Average Efficiency Error : 7.1849022E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	202.1856	28-FEB-2010	2990.798	3299.272	15703.00	0.2627467	1.1285488E-02	47.53299
NP-237	208.8990	28-FEB-2010	4434.624	4904.963	16100.00	0.2568786	1.3002539E-02	53.88460
CM-244	198.1458	28-FEB-2010	5533.945	5886.272	14750.00	0.2635892	1.3357328E-02	53.93570

Instrument : CHAMBER 184  
 Detector : 74442  
 Standard ID : AESS-024  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:45  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:52:17  
 Average Efficiency : 0.2584583  
 Average Efficiency Error : 7.1114316E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.5218	28-FEB-2010	2988.768	3299.551	15277.00	0.2539344	1.0912240E-02	50.31911
NP-237	205.6662	28-FEB-2010	4434.041	4904.303	16050.00	0.2601255	1.3167357E-02	58.63404
CM-244	198.3060	28-FEB-2010	5531.580	5887.500	14754.00	0.2635180	1.3353555E-02	51.04471

Instrument : CHAMBER 185  
 Detector : 68615  
 Standard ID : AESS-025  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:51  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:52:26  
 Average Efficiency : 0.2578048  
 Average Efficiency Error : 7.1078530E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	195.5670	28-FEB-2010	2988.255	3299.191	14889.00	0.2575537	1.1072870E-02	57.86859
NP-237	167.9916	28-FEB-2010	4436.568	4904.026	13054.00	0.2590211	1.3147981E-02	60.38557
CM-244	157.2432	28-FEB-2010	5534.840	5885.460	11412.00	0.2569523	1.3071318E-02	57.79462

Instrument : CHAMBER 186  
 Detector : 68616  
 Standard ID : AESS-031  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 21-SEP-2009 09:30:57  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:52:35  
 Average Efficiency : 0.2488432  
 Average Efficiency Error : 6.8683540E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	193.6650	28-FEB-2010	2991.448	3298.893	14023.00	0.2449313	1.0542010E-02	55.63848
NP-237	162.9186	28-FEB-2010	4434.968	4903.217	12465.00	0.2550169	1.2953850E-02	61.88278
CM-244	153.1968	28-FEB-2010	5534.439	5884.968	10759.00	0.2485880	1.2658793E-02	53.78214

Instrument : CHAMBER 187  
 Detector : 68620  
 Standard ID : AESS-026  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:03  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:52:45  
 Average Efficiency : 0.2500139  
 Average Efficiency Error : 7.3307389E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	199.5072	28-FEB-2010	2991.069	3299.571	14686.00	0.2490046	1.2619531E-02	51.85893
NP-237	168.0294	28-FEB-2010	4436.508	4902.892	12870.00	0.2552532	1.2959577E-02	54.96236
CM-244	160.5822	28-FEB-2010	5534.129	5882.618	11163.00	0.2461146	1.2524742E-02	53.45123

Instrument : CHAMBER 188  
 Detector : 68621  
 Standard ID : AESS-032  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:08  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:57:16  
 Average Efficiency : 0.2573678  
 Average Efficiency Error : 7.0972578E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	195.2364	28-FEB-2010	2991.307	3299.196	14948.00	0.2589918	1.1133890E-02	51.99499
NP-237	165.9822	28-FEB-2010	4433.812	4904.473	12790.00	0.2568368	1.3041135E-02	63.01558
CM-244	153.7938	28-FEB-2010	5534.433	5887.575	11106.00	0.2556783	1.3012402E-02	52.96853

Instrument : CHAMBER 189  
 Detector : 68622  
 Standard ID : AESS-027  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:15  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:03  
 Average Efficiency : 0.2613129  
 Average Efficiency Error : 7.6623494E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	193.4238	28-FEB-2010	2989.567	3302.212	14738.00	0.2577560	1.3062426E-02	55.08699
NP-237	161.6154	28-FEB-2010	4433.165	4906.352	12695.00	0.2618049	1.3294927E-02	59.92243
CM-244	148.1754	28-FEB-2010	5531.737	5887.138	11072.00	0.2645886	1.3466716E-02	57.86366

Instrument : CHAMBER 190  
 Detector : 68623  
 Standard ID : AESS-033  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:22  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:12  
 Average Efficiency : 0.2619864  
 Average Efficiency Error : 7.2268778E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	192.4158	28-FEB-2010	2990.470	3297.949	14602.00	0.2566898	1.1039688E-02	51.16143
NP-237	161.7816	28-FEB-2010	4434.559	4903.208	12864.00	0.2647705	1.3443264E-02	59.23622
CM-244	147.2670	28-FEB-2010	5535.128	5886.122	11129.00	0.2671734	1.3597734E-02	49.90292

Instrument : CHAMBER 191  
 Detector : 68624  
 Standard ID : AESS-028  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:28  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:21  
 Average Efficiency : 0.2625601  
 Average Efficiency Error : 7.6934313E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	199.6542	28-FEB-2010	2991.297	3300.325	15252.00	0.2584319	1.3090833E-02	50.79485
NP-237	168.1992	28-FEB-2010	4434.026	4906.466	13308.00	0.2637113	1.3382300E-02	58.03377
CM-244	156.7614	28-FEB-2010	5533.499	5882.588	11769.00	0.2657853	1.3513734E-02	53.41747

Instrument : CHAMBER 192  
 Detector : 74430  
 Standard ID : AESS-034  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:34  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:32  
 Average Efficiency : 0.2544576  
 Average Efficiency Error : 7.0170104E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	200.5488	28-FEB-2010	2990.254	3299.423	14893.00	0.2511986	1.0799594E-02	50.05982
NP-237	167.2962	28-FEB-2010	4433.037	4905.173	12941.00	0.2578104	1.3088287E-02	62.20525
CM-244	154.4388	28-FEB-2010	5531.571	5885.579	11163.00	0.2558767	1.3021424E-02	54.21256

Instrument : CHAMBER 193  
 Detector : 68627  
 Standard ID : AESS-029  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:40  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:41  
 Average Efficiency : 0.2615199  
 Average Efficiency Error : 7.6632542E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	201.5742	28-FEB-2010	2991.990	3298.419	15396.00	0.2583720	1.3086254E-02	50.38469
NP-237	169.7700	28-FEB-2010	4433.001	4901.628	13286.00	0.2607451	1.3232258E-02	58.19065
CM-244	154.8234	28-FEB-2010	5534.240	5885.963	11618.00	0.2656835	1.3511403E-02	53.47323

Instrument : CHAMBER 194  
 Detector : 68635  
 Standard ID : AESS-035  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:45  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:50  
 Average Efficiency : 0.2542233  
 Average Efficiency Error : 7.0097935E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	198.6666	28-FEB-2010	2990.781	3297.998	14819.00	0.2523236	1.0848935E-02	51.65903
NP-237	168.2934	28-FEB-2010	4434.565	4903.602	13013.00	0.2577325	1.3083202E-02	59.92809
CM-244	158.8128	28-FEB-2010	5531.095	5882.711	11369.00	0.2534982	1.2896180E-02	53.05344

Instrument : CHAMBER 195  
 Detector : 68636  
 Standard ID : AESS-030  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:51  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:53:59  
 Average Efficiency : 0.2554399  
 Average Efficiency Error : 7.4881674E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	198.9792	28-FEB-2010	2989.560	3297.508	14812.00	0.2518228	1.2760897E-02	51.28571
NP-237	166.3758	28-FEB-2010	4435.548	4904.654	12878.00	0.2579744	1.3097576E-02	59.53444
CM-244	157.1856	28-FEB-2010	5531.770	5882.945	11394.00	0.2567084	1.3059122E-02	52.18182

Instrument : CHAMBER 196  
 Detector : 68637  
 Standard ID : AESS-036  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 21-SEP-2009 09:31:58  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:54:08  
 Average Efficiency : 0.2560611  
 Average Efficiency Error : 7.0601865E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	201.3204	28-FEB-2010	2989.197	3301.025	14971.00	0.2515414	1.0813317E-02	54.46194
NP-237	167.4312	28-FEB-2010	4436.299	4904.887	13068.00	0.2600951	1.3202412E-02	58.47227
CM-244	156.4188	28-FEB-2010	5531.851	5883.206	11431.00	0.2587482	1.3162114E-02	55.12206

Instrument : CHAMBER 197  
 Detector : 78894  
 Standard ID : AESS-037  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:04  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:42:21  
 Average Efficiency : 0.2524827  
 Average Efficiency Error : 6.9639706E-03  
 Confidence : 95.00000

Cal. Isteps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	197.7372	28-FEB-2010	2989.248	3298.244	14631.00	0.2502923	1.0764122E-02	53.79660
NP-237	167.1294	28-FEB-2010	4435.410	4906.453	12637.00	0.2520285	1.2799331E-02	65.84109
CM-244	154.7664	28-FEB-2010	5531.008	5883.783	11198.00	0.2561660	1.3035372E-02	58.58810

Instrument : CHAMBER 198  
 Detector : 78895  
 Standard ID : AESS-043  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:10  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:54:28  
 Average Efficiency : 0.2546443  
 Average Efficiency Error : 7.0217522E-03  
 Confidence : 95.00000

Cal. Isteps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	197.7708	28-FEB-2010	2988.256	3301.357	14781.00	0.2528079	1.0870277E-02	53.58070
NP-237	168.7422	28-FEB-2010	4435.341	4905.168	12907.00	0.2549473	1.2943417E-02	60.79170
CM-244	156.3252	28-FEB-2010	5533.514	5885.508	11347.00	0.2569917	1.3074390E-02	55.00752

Instrument : CHAMBER 199  
 Detector : 78896  
 Standard ID : AESS-038  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:15  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:54:37  
 Average Efficiency : 0.2501853  
 Average Efficiency Error : 6.8995738E-03  
 Confidence : 95.00000

Cal. Isteps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	200.1408	28-FEB-2010	2991.267	3300.107	14889.00	0.2516318	1.0818291E-02	52.50020
NP-237	170.0886	28-FEB-2010	4436.748	4902.339	12711.00	0.2490705	1.2648016E-02	63.29102
CM-244	157.7460	28-FEB-2010	5531.913	5884.562	11110.00	0.2493175	1.2688680E-02	53.66205

Instrument : CHAMBER 200  
 Detector : 78900  
 Standard ID : AESS-044  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:21  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:54:46  
 Average Efficiency : 0.2682398  
 Average Efficiency Error : 7.3923203E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	194.4510	28-FEB-2010	2988.062	3301.136	15568.00	0.2708094	1.1633540E-02	50.91508
NP-237	166.6248	28-FEB-2010	4436.203	4901.740	13553.00	0.2710442	1.3750886E-02	57.22134
CM-244	155.8290	28-FEB-2010	5531.761	5884.914	11543.00	0.2622247	1.3336830E-02	45.01981

Instrument : CHAMBER 201  
 Detector : 78902  
 Standard ID : AESS-039  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:27  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:54:55  
 Average Efficiency : 0.2589892  
 Average Efficiency Error : 7.1445713E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	192.2418	28-FEB-2010	2988.184	3302.217	14648.00	0.2577410	1.1084234E-02	45.65341
NP-237	159.1506	28-FEB-2010	4434.609	4905.994	12631.00	0.2645504	1.3435334E-02	55.65960
CM-244	151.7142	28-FEB-2010	5531.184	5884.407	10948.00	0.2554961	1.3006385E-02	45.41114

Instrument : CHAMBER 202  
 Detector : 78903  
 Standard ID : AESS-045  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:32  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:55:05  
 Average Efficiency : 0.2665268  
 Average Efficiency Error : 7.3516225E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	186.9936	28-FEB-2010	2989.216	3297.484	14828.00	0.2682285	1.1532663E-02	43.97738
NP-237	160.8066	28-FEB-2010	4437.369	4902.276	12547.00	0.2600848	1.3209904E-02	52.01093
CM-244	145.8384	28-FEB-2010	5530.984	5883.177	11169.00	0.2711185	1.3796896E-02	50.67951



Instrument : CHAMBER 203  
 Detector : 78905  
 Standard ID : AESS-040  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:39  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:55:14  
 Average Efficiency : 0.2582881  
 Average Efficiency Error : 7.1221651E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	194.4828	28-FEB-2010	2990.199	3298.236	14936.00	0.2597386	1.1166240E-02	50.45560
NP-237	166.8174	28-FEB-2010	4432.988	4903.526	12999.00	0.2597034	1.3183516E-02	56.72982
CM-244	155.0100	28-FEB-2010	5533.164	5886.048	11164.00	0.2549590	1.2974691E-02	53.05425

Instrument : CHAMBER 204  
 Detector : 78907  
 Standard ID : AESS-046  
 Standard Reference Date : 19-FEB-2008 19:35:48  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:45  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:55:23  
 Average Efficiency : 0.2496188  
 Average Efficiency Error : 6.8885502E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	194.7474	28-FEB-2010	2989.792	3298.277	14212.00	0.2467715	1.0618629E-02	52.28694
NP-237	164.6658	28-FEB-2010	4433.265	4903.277	12386.00	0.2506330	1.2732573E-02	55.30292
CM-244	151.3824	28-FEB-2010	5531.668	5883.589	10818.00	0.2527654	1.2870559E-02	51.63226

Instrument : CHAMBER 205  
 Detector : 78908  
 Standard ID : AESS-041  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:51  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:55:32  
 Average Efficiency : 0.2549397  
 Average Efficiency Error : 7.0272260E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.9034	28-FEB-2010	2989.853	3298.183	15200.00	0.2521578	1.0836856E-02	49.40310
NP-237	171.2268	28-FEB-2010	4433.644	4904.311	13124.00	0.2554664	1.2966554E-02	56.83091
CM-244	159.5796	28-FEB-2010	5533.979	5886.811	11652.00	0.2584914	1.3144889E-02	54.55809

Instrument : CHAMBER 206  
 Detector : 78909  
 Standard ID : AESS-047  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 21-SEP-2009 09:32:57  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:55:41  
 Average Efficiency : 0.2541434  
 Average Efficiency Error : 7.0085586E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	197.4804	28-FEB-2010	2990.264	3297.560	14794.00	0.2533972	1.0895449E-02	48.44042
NP-237	168.3948	28-FEB-2010	4435.483	4905.550	12839.00	0.2541331	1.2903095E-02	60.11407
CM-244	154.6032	28-FEB-2010	5534.828	5887.642	11143.00	0.2552143	1.2987950E-02	53.79968

Instrument : CHAMBER 207  
 Detector : 78910  
 Standard ID : AESS-042  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 21-SEP-2009 09:33:03  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:55:50  
 Average Efficiency : 0.2573462  
 Average Efficiency Error : 7.1005006E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	188.7090	28-FEB-2010	2989.540	3298.860	14353.00	0.2572728	1.1068305E-02	52.62569
NP-237	159.6558	28-FEB-2010	4436.642	4902.427	12327.00	0.2573162	1.3072978E-02	61.37923
CM-244	150.5208	28-FEB-2010	5532.022	5884.565	10951.00	0.2574795	1.3107520E-02	49.75304

Instrument : CHAMBER 208  
 Detector : 78911  
 Standard ID : AESS-048  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 21-SEP-2009 09:33:08  
 Calibration Count Time : 300.0000  
 Efficiency Calibration Date/Time : 21-SEP-2009 14:56:00  
 Average Efficiency : 0.2510063  
 Average Efficiency Error : 6.9273296E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	191.8350	28-FEB-2010	2991.900	3300.465	14140.00	0.2493222	1.0729297E-02	51.69543
NP-237	161.5530	28-FEB-2010	4437.256	4903.414	12240.00	0.2525304	1.2831211E-02	60.66938
CM-244	151.1856	28-FEB-2010	5534.200	5882.369	10757.00	0.2518900	1.2826865E-02	52.12144

## Subsection 1: Energy Calibration

The Energy Calibration energy=Cal\_Zero+(e1\*C)+(e2\*C^2)

where : Cal\_Zero = Energy Calibration Zero  
 e1 = Energy Calibration Slope  
 e2 = Energy Calibration Quadratic  
 C = Channel

Instrument : CHAMBER 001  
 Detector : 78788  
 Calibration Date/Time : 6-OCT-2009 07:29:51  
 Calibration Source Id : AESS-001

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3191.115
NP-237	4341	2/28/10	4768.800	4810.887
CM-244	4320A	2/28/10	5795.020	5833.201

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2494.949  
 Energy Calibration Slope : 4.926322  
 Energy Calibration Quadratic : 6.9237419E-04  
 Energy Calibration Range : 8266.000

Instrument : CHAMBER 002  
 Detector : 78266  
 Calibration Date/Time : 6-OCT-2009 07:29:59  
 Calibration Source Id : AESS-002

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3184.362
NP-237	4341	2/28/10	4768.800	4775.667
CM-244	4320A	2/28/10	5795.020	5814.376

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2451.222  
 Energy Calibration Slope : 5.048168  
 Energy Calibration Quadratic : 4.0239695E-04  
 Energy Calibration Range : 8042.000

Instrument : CHAMBER 003  
 Detector : 67617  
 Calibration Date/Time : 6-OCT-2009 07:30:06  
 Calibration Source Id : AESS-003

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3185.123
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5794.595

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2594.451  
 Energy Calibration Slope : 5.544409  
 Energy Calibration Quadratic : 3.9863368E-04  
 Energy Calibration Range : 8690.000

Instrument : CHAMBER 004  
 Detector : 64279  
 Calibration Date/Time : 6-OCT-2009 07:30:14  
 Calibration Source Id : AESS-004

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.337
NP-237	4341	2/28/10	4768.800	4768.766
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2537.632  
 Energy Calibration Slope : 5.123945  
 Energy Calibration Quadratic : 3.3953955E-04  
 Energy Calibration Range : 8141.000

Instrument : CHAMBER 005  
 Detector : 67612  
 Calibration Date/Time : 6-OCT-2009 07:30:22  
 Calibration Source Id : AESS-005

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.737
NP-237	4341	2/28/10	4768.800	4768.711
CM-244	4320A	2/28/10	5795.020	5794.886

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2393.780  
 Energy Calibration Slope : 4.993768  
 Energy Calibration Quadratic : 3.3310769E-04  
 Energy Calibration Range : 7857.000

Instrument : CHAMBER 006  
 Detector : 67613  
 Calibration Date/Time : 6-OCT-2009 07:30:30  
 Calibration Source Id : AESS-006

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5794.796

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2373.272  
 Energy Calibration Slope : 4.963299  
 Energy Calibration Quadratic : 3.0817042E-04  
 Energy Calibration Range : 7779.000

Instrument : CHAMBER 007  
 Detector : 67607  
 Calibration Date/Time : 6-OCT-2009 07:30:44  
 Calibration Source Id : AESS-007

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3180.649
NP-237	4341	2/28/10	4768.800	4768.154
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2429.447  
 Energy Calibration Slope : 5.132570  
 Energy Calibration Quadratic : 3.1622002E-04  
 Energy Calibration Range : 8017.000

Instrument : CHAMBER 008  
 Detector : 78788  
 Calibration Date/Time : 6-OCT-2009 07:30:59  
 Calibration Source Id : AESS-008

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.630
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2371.041  
 Energy Calibration Slope : 4.987834  
 Energy Calibration Quadratic : 2.8972572E-04  
 Energy Calibration Range : 7782.000

Instrument : CHAMBER 009  
 Detector : 72528  
 Calibration Date/Time : 6-OCT-2009 07:31:08  
 Calibration Source Id : AESS-009

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.920
CM-244	4320A	2/28/10	5795.020	5795.109

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2372.286  
 Energy Calibration Slope : 4.951155  
 Energy Calibration Quadratic : 3.2705130E-04  
 Energy Calibration Range : 7785.000

Instrument : CHAMBER 010  
 Detector : 72529  
 Calibration Date/Time : 6-OCT-2009 07:31:16  
 Calibration Source Id : AESS-010

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.215
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2372.865  
 Energy Calibration Slope : 4.958590  
 Energy Calibration Quadratic : 2.7677300E-04  
 Energy Calibration Range : 7741.000

Instrument : CHAMBER 011  
 Detector : 72531  
 Calibration Date/Time : 6-OCT-2009 07:31:24  
 Calibration Source Id : AESS-011

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.001
NP-237	4341	2/28/10	4768.800	4768.798
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2349.996  
 Energy Calibration Slope : 5.000451  
 Energy Calibration Quadratic : 3.0306034E-04  
 Energy Calibration Range : 7788.000

Instrument : CHAMBER 012  
 Detector : 67594  
 Calibration Date/Time : 6-OCT-2009 07:31:31  
 Calibration Source Id : AESS-012

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.350
NP-237	4341	2/28/10	4768.800	4769.126
CM-244	4320A	2/28/10	5795.020	5795.277

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2377.866  
 Energy Calibration Slope : 4.952454  
 Energy Calibration Quadratic : 2.8195331E-04  
 Energy Calibration Range : 7745.000

Instrument : CHAMBER 013  
 Detector : 78790  
 Calibration Date/Time : 6-OCT-2009 07:31:39  
 Calibration Source Id : AESS-013  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2358.748  
 Energy Calibration Slope : 4.906792  
 Energy Calibration Quadratic : 3.0364850E-04  
 Energy Calibration Range : 7702.000

Instrument : CHAMBER 014  
 Detector : 67616  
 Calibration Date/Time : 6-OCT-2009 07:31:47  
 Calibration Source Id : AESS-014  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.015  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.127  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2349.895  
 Energy Calibration Slope : 4.951089  
 Energy Calibration Quadratic : 3.2694533E-04  
 Energy Calibration Range : 7763.000

Instrument : CHAMBER 015  
 Detector : 61581  
 Calibration Date/Time : 6-OCT-2009 07:32:05  
 Calibration Source Id : AESS-015  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.330  
 NP-237 4341 2/28/10 4768.800 4769.738  
 CM-244 4320A 2/28/10 5795.020 5795.260  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2330.553  
 Energy Calibration Slope : 4.907706  
 Energy Calibration Quadratic : 2.7204648E-04  
 Energy Calibration Range : 7641.000

Instrument : CHAMBER 016  
 Detector : 78774  
 Calibration Date/Time : 6-OCT-2009 07:32:13  
 Calibration Source Id : AESS-016  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.851  
 CM-244 4320A 2/28/10 5795.020 5795.196  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2351.961  
 Energy Calibration Slope : 4.895100  
 Energy Calibration Quadratic : 3.0339885E-04  
 Energy Calibration Range : 7683.000

Instrument : CHAMBER 017  
 Detector : 78791  
 Calibration Date/Time : 6-OCT-2009 07:32:21  
 Calibration Source Id : AESS-017  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2366.693  
 Energy Calibration Slope : 4.965857  
 Energy Calibration Quadratic : 3.0423133E-04  
 Energy Calibration Range : 7771.000

Instrument : CHAMBER 018  
 Detector : 78782  
 Calibration Date/Time : 6-OCT-2009 07:32:30  
 Calibration Source Id : AESS-018  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.799  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2353.444  
 Energy Calibration Slope : 4.965840  
 Energy Calibration Quadratic : 3.1234659E-04  
 Energy Calibration Range : 7766.000



Instrument : CHAMBER 019  
 Detector : 78786  
 Calibration Date/Time : 6-OCT-2009 07:32:38  
 Calibration Source Id : AESS-019  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3182.407  
 NP-237 4341 2/28/10 4768.800 4768.801  
 CM-244 4320A 2/28/10 5795.020 5794.577  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2344.952  
 Energy Calibration Slope : 5.076295  
 Energy Calibration Quadratic : 2.1271234E-04  
 Energy Calibration Range : 7766.000

Instrument : CHAMBER 020  
 Detector : 78787  
 Calibration Date/Time : 6-OCT-2009 07:32:46  
 Calibration Source Id : AESS-020  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3182.428  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2340.289  
 Energy Calibration Slope : 4.979540  
 Energy Calibration Quadratic : 2.9817302E-04  
 Energy Calibration Range : 7752.000

Instrument : CHAMBER 021  
 Detector : 67047  
 Calibration Date/Time : 6-OCT-2009 07:32:53  
 Calibration Source Id : AESS-021  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.800  
 CM-244 4320A 2/28/10 5795.020 5795.020  
  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2274.903  
 Energy Calibration Slope : 4.967343  
 Energy Calibration Quadratic : 2.8605422E-04  
 Energy Calibration Range : 7661.000

Instrument : CHAMBER 022  
 Detector : 72530  
 Calibration Date/Time : 6-OCT-2009 07:33:01  
 Calibration Source Id : AESS-022

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.526
NP-237	4341	2/28/10	4768.800	4768.612
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2375.246  
 Energy Calibration Slope : 4.989795  
 Energy Calibration Quadratic : 2.6628541E-04  
 Energy Calibration Range : 7764.000

Instrument : CHAMBER 023  
 Detector : 78264  
 Calibration Date/Time : 6-OCT-2009 07:33:09  
 Calibration Source Id : AESS-023

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4769.391
CM-244	4320A	2/28/10	5795.020	5795.544

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2381.539  
 Energy Calibration Slope : 4.989902  
 Energy Calibration Quadratic : 2.9515647E-04  
 Energy Calibration Range : 7801.000

Instrument : CHAMBER 024  
 Detector : 76542  
 Calibration Date/Time : 6-OCT-2009 07:33:17  
 Calibration Source Id : AESS-024

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.021

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2347.455  
 Energy Calibration Slope : 4.979314  
 Energy Calibration Quadratic : 2.5380100E-04  
 Energy Calibration Range : 7712.000

Instrument : CHAMBER 025  
 Detector : 45-149AA5  
 Calibration Date/Time : 6-OCT-2009 07:33:25  
 Calibration Source Id : AESS-025

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.347
NP-237	4341	2/28/10	4768.800	4768.152
CM-244	4320A	2/28/10	5795.020	5794.713

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2322.748  
 Energy Calibration Slope : 4.869743  
 Energy Calibration Quadratic : 3.0884167E-04  
 Energy Calibration Range : 7633.000

Instrument : CHAMBER 026  
 Detector : 78204  
 Calibration Date/Time : 6-OCT-2009 07:33:33  
 Calibration Source Id : AESS-026

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2358.710  
 Energy Calibration Slope : 4.925373  
 Energy Calibration Quadratic : 3.5054228E-04  
 Energy Calibration Range : 7770.000

Instrument : CHAMBER 027  
 Detector : 42484  
 Calibration Date/Time : 6-OCT-2009 07:33:41  
 Calibration Source Id : AESS-027

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2362.008  
 Energy Calibration Slope : 4.972083  
 Energy Calibration Quadratic : 3.1753408E-04  
 Energy Calibration Range : 7786.000

Instrument : CHAMBER 028  
 Detector : 78792  
 Calibration Date/Time : 6-OCT-2009 07:33:49  
 Calibration Source Id : AESS-028

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.773
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2311.782  
 Energy Calibration Slope : 4.951570  
 Energy Calibration Quadratic : 3.3065694E-04  
 Energy Calibration Range : 7729.000

Instrument : CHAMBER 029  
 Detector : 33454  
 Calibration Date/Time : 6-OCT-2009 07:33:57  
 Calibration Source Id : AESS-029

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.714
CM-244	4320A	2/28/10	5795.020	5794.973

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2351.378  
 Energy Calibration Slope : 4.883624  
 Energy Calibration Quadratic : 3.0947028E-04  
 Energy Calibration Range : 7677.000

Instrument : CHAMBER 030  
 Detector : 33447  
 Calibration Date/Time : 6-OCT-2009 07:34:05  
 Calibration Source Id : AESS-030

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.487
NP-237	4341	2/28/10	4768.800	4768.571
CM-244	4320A	2/28/10	5795.020	5794.696

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2380.179  
 Energy Calibration Slope : 4.949189  
 Energy Calibration Quadratic : 3.2416798E-04  
 Energy Calibration Range : 7788.000

Instrument : CHAMBER 031  
 Detector : 67042  
 Calibration Date/Time : 6-OCT-2009 07:34:14  
 Calibration Source Id : AESS-031

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3178.485
NP-237	4341	2/28/10	4768.800	4763.577
CM-244	4320A	2/28/10	5795.020	5784.311

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2386.162  
 Energy Calibration Slope : 4.992230  
 Energy Calibration Quadratic : 3.1948058E-04  
 Energy Calibration Range : 7833.000

Instrument : CHAMBER 032  
 Detector : 67041  
 Calibration Date/Time : 5-OCT-2009 12:57:42  
 Calibration Source Id : AESS-032

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3249.733
NP-237	4341	2/28/10	4768.800	4694.923
CM-244	4320A	2/28/10	5795.020	5711.124

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2545.489  
 Energy Calibration Slope : 5.772886  
 Energy Calibration Quadratic : -1.6971683E-04  
 Energy Calibration Range : 8279.000

Instrument : CHAMBER 033  
 Detector : 78785  
 Calibration Date/Time : 6-OCT-2009 07:34:25  
 Calibration Source Id : AESS-033

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.497
NP-237	4341	2/28/10	4768.800	4768.585
CM-244	4320A	2/28/10	5795.020	5794.944

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2381.359  
 Energy Calibration Slope : 4.947021  
 Energy Calibration Quadratic : 3.3134225E-04  
 Energy Calibration Range : 7795.000

Instrument : CHAMBER 034  
 Detector : 61586  
 Calibration Date/Time : 5-OCT-2009 12:58:01  
 Calibration Source Id : AESS-034

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3065.840
NP-237	4341	2/28/10	4768.800	4856.741
CM-244	4320A	2/28/10	5795.020	5712.891

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2510.695  
 Energy Calibration Slope : 6.785102  
 Energy Calibration Quadratic : -2.1083013E-03  
 Energy Calibration Range : 7248.000

Instrument : CHAMBER 035  
 Detector : 78202  
 Calibration Date/Time : 6-OCT-2009 07:34:40  
 Calibration Source Id : AESS-035

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.483
NP-237	4341	2/28/10	4768.800	4768.621
CM-244	4320A	2/28/10	5795.020	5794.770

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2342.224  
 Energy Calibration Slope : 4.946784  
 Energy Calibration Quadratic : 3.4308483E-04  
 Energy Calibration Range : 7767.000

Instrument : CHAMBER 036  
 Detector : 78203  
 Calibration Date/Time : 6-OCT-2009 07:34:48  
 Calibration Source Id : AESS-036

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.258
NP-237	4341	2/28/10	4768.800	4768.727
CM-244	4320A	2/28/10	5795.020	5794.642

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2357.440  
 Energy Calibration Slope : 4.922200  
 Energy Calibration Quadratic : 3.4371525E-04  
 Energy Calibration Range : 7758.000

Instrument : CHAMBER 037  
 Detector : 45-149BB5  
 Calibration Date/Time : 6-OCT-2009 07:34:56  
 Calibration Source Id : AESS-037

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.527
NP-237	4341	2/28/10	4768.800	4768.017
CM-244	4320A	2/28/10	5795.020	5794.616

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2385.636  
 Energy Calibration Slope : 4.924255  
 Energy Calibration Quadratic : 2.8162368E-04  
 Energy Calibration Range : 7723.000

Instrument : CHAMBER 038  
 Detector : 72532  
 Calibration Date/Time : 6-OCT-2009 07:35:05  
 Calibration Source Id : AESS-038

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.767
NP-237	4341	2/28/10	4768.800	4768.632
CM-244	4320A	2/28/10	5795.020	5794.766

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2379.982  
 Energy Calibration Slope : 4.937870  
 Energy Calibration Quadratic : 3.2812863E-04  
 Energy Calibration Range : 7780.000

Instrument : CHAMBER 039  
 Detector : 45-149BB2  
 Calibration Date/Time : 6-OCT-2009 07:35:14  
 Calibration Source Id : AESS-039

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.115
NP-237	4341	2/28/10	4768.800	4768.246
CM-244	4320A	2/28/10	5795.020	5794.630

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2389.792  
 Energy Calibration Slope : 4.909894  
 Energy Calibration Quadratic : 3.1996722E-04  
 Energy Calibration Range : 7753.000

Instrument : CHAMBER 040  
 Detector : 78773  
 Calibration Date/Time : 6-OCT-2009 07:35:30  
 Calibration Source Id : AESS-040  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3182.559  
 NP-237 4341 2/28/10 4768.800 4768.646  
 CM-244 4320A 2/28/10 5795.020 5794.847  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2360.177  
 Energy Calibration Slope : 4.882975  
 Energy Calibration Quadratic : 3.4291152E-04  
 Energy Calibration Range : 7720.000

Instrument : CHAMBER 041  
 Detector : 78205  
 Calibration Date/Time : 6-OCT-2009 07:35:39  
 Calibration Source Id : AESS-041  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3182.828  
 NP-237 4341 2/28/10 4768.800 4768.646  
 CM-244 4320A 2/28/10 5795.020 5794.888  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2360.361  
 Energy Calibration Slope : 4.946325  
 Energy Calibration Quadratic : 3.4809459E-04  
 Energy Calibration Range : 7790.000

Instrument : CHAMBER 042  
 Detector : 78793  
 Calibration Date/Time : 6-OCT-2009 07:35:48  
 Calibration Source Id : AESS-042  
 Cal. Isotopes Source Id Expiration Date Standard Energy Actual Energy  
 GD-148 6445-278 2/28/10 3183.000 3183.000  
 NP-237 4341 2/28/10 4768.800 4768.747  
 CM-244 4320A 2/28/10 5795.020 5795.021  
 Energy/Channel Equation : see above  
 Energy Calibration Zero : 2379.531  
 Energy Calibration Slope : 4.893367  
 Energy Calibration Quadratic : 3.4989952E-04  
 Energy Calibration Range : 7757.000



Instrument : CHAMBER 043  
 Detector : 76543  
 Calibration Date/Time : 6-OCT-2009 07:35:57  
 Calibration Source Id : AESS-043

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.800
CM-244	4320A	2/28/10	5795.020	5794.779

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2371.808  
 Energy Calibration Slope : 4.912579  
 Energy Calibration Quadratic : 3.4951454E-04  
 Energy Calibration Range : 7769.000

Instrument : CHAMBER 044  
 Detector : 79459  
 Calibration Date/Time : 6-OCT-2009 07:36:05  
 Calibration Source Id : AESS-044

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.661
NP-237	4341	2/28/10	4768.800	4768.597
CM-244	4320A	2/28/10	5795.020	5794.998

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2361.626  
 Energy Calibration Slope : 4.929942  
 Energy Calibration Quadratic : 3.4448382E-04  
 Energy Calibration Range : 7771.000

Instrument : CHAMBER 045  
 Detector : 78783  
 Calibration Date/Time : 6-OCT-2009 07:36:13  
 Calibration Source Id : AESS-045

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.801
CM-244	4320A	2/28/10	5795.020	5795.019

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2364.945  
 Energy Calibration Slope : 4.934100  
 Energy Calibration Quadratic : 3.3029157E-04  
 Energy Calibration Range : 7764.000

Instrument : CHAMBER 046  
 Detector : 76544  
 Calibration Date/Time : 6-OCT-2009 07:36:20  
 Calibration Source Id : AESS-046

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.824
NP-237	4341	2/28/10	4768.800	4768.715
CM-244	4320A	2/28/10	5795.020	5794.886

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2362.032  
 Energy Calibration Slope : 4.898512  
 Energy Calibration Quadratic : 3.3288871E-04  
 Energy Calibration Range : 7727.000

Instrument : CHAMBER 047  
 Detector : 46-089B1  
 Calibration Date/Time : 6-OCT-2009 07:36:28  
 Calibration Source Id : AESS-047

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3182.590
NP-237	4341	2/28/10	4768.800	4768.728
CM-244	4320A	2/28/10	5795.020	5794.910

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2353.630  
 Energy Calibration Slope : 4.972837  
 Energy Calibration Quadratic : 3.0568099E-04  
 Energy Calibration Range : 7766.000

Instrument : CHAMBER 048  
 Detector : 42483  
 Calibration Date/Time : 6-OCT-2009 07:36:36  
 Calibration Source Id : AESS-048

Cal. Isotopes	Source Id	Expiration Date	Standard Energy	Actual Energy
GD-148	6445-278	2/28/10	3183.000	3183.000
NP-237	4341	2/28/10	4768.800	4768.799
CM-244	4320A	2/28/10	5795.020	5795.020

Energy/Channel Equation : see above  
 Energy Calibration Zero : 2369.578  
 Energy Calibration Slope : 4.962992  
 Energy Calibration Quadratic : 2.7933731E-04  
 Energy Calibration Range : 7745.000

## Subsection 2: Background Calibration

Instrument : CHAMBER 001  
 Detector : 78788  
 Background Analysis Date/Time : 4-OCT-2009 12:27:05  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.441	3300.886	1.000000	0.2400001	100.0000	95.00000
NP-237	4434.241	4902.002	8.000000	1.920000	35.35534	95.00000
CM-244	5533.622	5884.936	11.00000	2.640001	30.15113	95.00000

Instrument : CHAMBER 002  
 Detector : 78266  
 Background Analysis Date/Time : 4-OCT-2009 12:27:05  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.849	3300.306	3.000000	0.7200001	57.73503	95.00000
NP-237	4432.986	4901.899	8.000000	1.920000	35.35534	95.00000
CM-244	5531.074	5885.833	2.000000	0.4800001	70.71068	95.00000

Instrument : CHAMBER 003  
 Detector : 67617  
 Background Analysis Date/Time : 4-OCT-2009 12:27:05  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.114	3299.375	3.000000	0.7200001	57.73503	95.00000
NP-237	4432.687	4905.323	10.00000	2.400001	31.62278	95.00000
CM-244	5531.736	5884.280	8.000000	1.920000	35.35534	95.00000

Instrument : CHAMBER 004  
 Detector : 64279  
 Background Analysis Date/Time : 4-OCT-2009 12:27:05  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.168	3298.189	1.000000	0.2400001	100.0000	95.00000
NP-237	4436.994	4901.306	9.000000	2.160001	33.33334	95.00000
CM-244	5535.543	5883.828	5.000000	1.200000	44.72136	95.00000

Instrument : CHAMBER 005  
 Detector : 67612  
 Background Analysis Date/Time : 4-OCT-2009 12:27:05  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2987.683	3298.337	7.000000	1.680000	37.79645	95.00000
NP-237	4434.065	4904.748	8.000000	1.920000	35.35534	95.00000
CM-244	5531.539	5883.696	3.000000	0.7200001	57.73503	95.00000

Instrument : CHAMBER 006  
 Detector : 67613  
 Background Analysis Date/Time : 4-OCT-2009 12:27:05  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.420	3302.030	1.000000	0.2400001	100.0000	95.00000
NP-237	4433.957	4905.615	11.00000	2.640001	30.15113	95.00000
CM-244	5531.576	5885.432	12.00000	2.880001	28.86751	95.00000

Instrument : CHAMBER 007  
 Detector : 67607  
 Background Analysis Date/Time : 4-OCT-2009 12:27:06  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2987.453	3300.644	2.000000	0.4800001	70.71068	95.00000
NP-237	4436.233	4906.179	16.00000	3.840001	25.00000	95.00000
CM-244	5534.716	5882.592	17.00000	4.080001	24.25356	95.00000

Instrument : CHAMBER 008  
 Detector : 78788  
 Background Analysis Date/Time : 4-OCT-2009 12:27:06  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.927	3298.611	4.000000	0.9600002	50.00000	95.00000
NP-237	4433.414	4905.734	3.000000	0.7200001	57.73503	95.00000
CM-244	5532.110	5885.974	8.000000	1.920000	35.35534	95.00000

Instrument : CHAMBER 009  
 Detector : 72528  
 Background Analysis Date/Time : 4-OCT-2009 12:27:06  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.258	3299.443	1.000000	0.2400001	100.0000	95.00000
NP-237	4436.364	4903.243	6.000000	1.440000	40.82483	95.00000
CM-244	5535.592	5884.904	13.00000	3.120001	27.73501	95.00000

Instrument : CHAMBER 010  
 Detector : 72529  
 Background Analysis Date/Time : 4-OCT-2009 12:27:06  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.986	3299.677	4.000000	0.9600002	50.00000	95.00000
NP-237	4436.858	4905.650	6.000000	1.440000	40.82483	95.00000
CM-244	5532.380	5883.357	12.00000	2.880001	28.86751	95.00000

Instrument : CHAMBER 011  
 Detector : 72531  
 Background Analysis Date/Time : 4-OCT-2009 12:27:06  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.941	3300.792	4.000000	0.9600002	50.00000	95.00000
NP-237	4435.381	4904.777	5.000000	1.200000	44.72136	95.00000
CM-244	5534.525	5885.025	14.00000	3.360001	26.72612	95.00000

Instrument : CHAMBER 012  
 Detector : 67594  
 Background Analysis Date/Time : 4-OCT-2009 12:27:06  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.284	3298.664	6.000000	1.440000	40.82483	95.00000
NP-237	4435.039	4903.648	10.00000	2.400001	31.62278	95.00000
CM-244	5535.566	5886.583	15.00000	3.600001	25.81989	95.00000

Instrument : CHAMBER 013  
 Detector : 78790  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.792	3302.000	2.000000	0.4799997	70.71068	95.00000
NP-237	4437.046	4903.690	5.000000	1.199999	44.72136	95.00000
CM-244	5533.535	5883.676	16.00000	3.839998	25.00000	95.00000

Instrument : CHAMBER 014  
 Detector : 67616  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.991	3302.405	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
NP-237	4434.801	4901.898	3.000000	0.7199996	57.73503	95.00000
CM-244	5534.536	5884.005	16.00000	3.839998	25.00000	95.00000

Instrument : CHAMBER 015  
 Detector : 61581  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.090	3297.900	5.000000	1.199999	44.72136	95.00000
NP-237	4434.643	4904.243	4.000000	0.9599994	50.00000	95.00000
CM-244	5530.383	5883.387	22.00000	5.279996	21.32007	95.00000

Instrument : CHAMBER 016  
 Detector : 78774  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.478	3297.993	3.000000	0.7199996	57.73503	95.00000
NP-237	4435.680	4906.563	4.000000	0.9599994	50.00000	95.00000
CM-244	5535.188	5884.657	3.000000	0.7199996	57.73503	95.00000

Instrument : CHAMBER 017  
 Detector : 78791  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2992.179	3300.868	2.000000	0.4799997	70.71068	95.00000
NP-237	4432.980	4904.604	5.000000	1.199999	44.72136	95.00000
CM-244	5530.423	5884.153	5.000000	1.199999	44.72136	95.00000

Instrument : CHAMBER 018  
 Detector : 78782  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.144	3298.062	0.000000E+00	0.000000E+00	0.000000E+00	95.00000
NP-237	4436.722	4903.896	7.000000	1.679999	37.79645	95.00000
CM-244	5530.923	5885.427	2.000000	0.4799997	70.71068	95.00000

Instrument : CHAMBER 019  
 Detector : 78786  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2987.942	3301.658	2.000000	0.4799997	70.71068	95.00000
NP-237	4435.742	4904.552	7.000000	1.679999	37.79645	95.00000
CM-244	5531.315	5884.461	9.000000	2.159998	33.33334	95.00000

Instrument : CHAMBER 020  
 Detector : 78787  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2987.612	3302.259	3.000000	0.7199995	57.73503	95.00000
NP-237	4437.248	4904.603	18.00000	4.319997	23.57022	95.00000
CM-244	5531.524	5885.796	9.000000	2.159998	33.33334	95.00000

Instrument : CHAMBER 021  
 Detector : 67047  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.083	3300.146	3.000000	0.7199995	57.73503	95.00000
NP-237	4432.482	4903.692	11.000000	2.639998	30.15113	95.00000
CM-244	5533.850	5886.843	27.000000	6.479995	19.24501	95.00000

Instrument : CHAMBER 022  
 Detector : 72530  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2987.964	3302.384	2.000000	0.4799997	70.71068	95.00000
NP-237	4434.585	4905.188	4.000000	0.9599993	50.00000	95.00000
CM-244	5534.052	5886.085	13.000000	3.119998	27.73501	95.00000

Instrument : CHAMBER 023  
 Detector : 78264  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.638	3299.478	1.000000	0.2399998	100.0000	95.00000
NP-237	4435.178	4902.738	5.000000	1.199999	44.72136	95.00000
CM-244	5535.207	5884.203	9.000000	2.159998	33.33334	95.00000

Instrument : CHAMBER 024  
 Detector : 76542  
 Background Analysis Date/Time : 4-OCT-2009 12:27:07  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.966	3297.612	2.000000	0.4799997	70.71068	95.00000
NP-237	4436.826	4905.796	10.000000	2.399998	31.62278	95.00000
CM-244	5532.191	5882.702	15.000000	3.599998	25.81989	95.00000



Instrument : CHAMBER 025  
 Detector : 45-149AA5  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.746	3299.065	1.000000	0.2399998	100.0000	95.00000
NP-237	4432.780	4902.204	14.00000	3.359998	26.72612	95.00000
CM-244	5534.306	5882.901	126.0000	30.23998	8.908708	95.00000

Instrument : CHAMBER 026  
 Detector : 78204  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.886	3302.127	3.000000	0.7199996	57.73503	95.00000
NP-237	4437.039	4903.756	11.00000	2.639998	30.15113	95.00000
CM-244	5531.113	5886.264	100.0000	23.99998	10.00000	95.00000

Instrument : CHAMBER 027  
 Detector : 42484  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.480	3297.801	3.000000	0.7199996	57.73503	95.00000
NP-237	4433.015	4906.280	9.000000	2.159999	33.33334	95.00000
CM-244	5534.576	5884.449	114.0000	27.35998	9.365858	95.00000

Instrument : CHAMBER 028  
 Detector : 78792  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.311	3300.074	1.000000	0.2399998	100.0000	95.00000
NP-237	4434.084	4901.937	2.000000	0.4799997	70.71068	95.00000
CM-244	5535.676	5885.791	98.00000	23.51999	10.10153	95.00000

Instrument : CHAMBER 029  
 Detector : 33454  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.479	3300.442	1.000000	0.2399998	100.0000	95.00000
NP-237	4436.521	4901.727	4.000000	0.9599994	50.00000	95.00000
CM-244	5535.072	5884.352	103.0000	24.71998	9.853293	95.00000

Instrument : CHAMBER 030  
 Detector : 33447  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.805	3301.805	1.000000	0.2399998	100.0000	95.00000
NP-237	4432.561	4904.188	11.00000	2.639998	30.15113	95.00000
CM-244	5530.498	5884.744	92.00000	22.07999	10.42572	95.00000

Instrument : CHAMBER 031  
 Detector : 67042  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.831	3300.223	1.000000	0.2400000	100.0000	95.00000
NP-237	4434.171	4903.758	10.00000	2.400000	31.62278	95.00000
CM-244	5534.159	5885.214	82.00000	19.68000	11.04315	95.00000

Instrument : CHAMBER 032  
 Detector : 67041  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.995	3298.824	4.000000	0.9600002	50.00000	95.00000
NP-237	4437.720	4906.375	20.00000	4.800001	22.36068	95.00000
CM-244	5535.070	5886.840	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000

Instrument : CHAMBER 033  
 Detector : 78785  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.828	3297.761	1.000000	0.2400000	100.0000	95.00000
NP-237	4434.037	4906.047	6.000000	1.440000	40.82483	95.00000
CM-244	5533.039	5882.356	81.00000	19.44000	11.11111	95.00000

Instrument : CHAMBER 034  
 Detector : 61586  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.293	3300.824	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4433.347	4902.684	39.00000	9.360002	16.01282	95.00000
CM-244	5532.745	5886.121	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000

Instrument : CHAMBER 035  
 Detector : 78202  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.104	3299.576	3.000000	0.7200001	57.73503	95.00000
NP-237	4433.307	4901.387	22.00000	5.280001	21.32007	95.00000
CM-244	5530.369	5886.338	100.0000	24.00000	10.00000	95.00000

Instrument : CHAMBER 036  
 Detector : 78203  
 Background Analysis Date/Time : 4-OCT-2009 12:27:09  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.103	3300.014	5.000000	1.200000	44.72136	95.00000
NP-237	4433.320	4904.469	13.00000	3.120001	27.73501	95.00000
CM-244	5530.632	5885.034	110.0000	26.40000	9.534626	95.00000

Instrument : CHAMBER 037  
 Detector : 45-149BB5  
 Background Analysis Date/Time : 4-OCT-2009 12:27:10  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.587	3301.234	2.000000	0.4799997	70.71068	95.00000
NP-237	4436.459	4902.555	17.000000	4.079997	24.25356	95.00000
CM-244	5531.113	5885.586	108.00000	25.91998	9.622504	95.00000

Instrument : CHAMBER 038  
 Detector : 72532  
 Background Analysis Date/Time : 4-OCT-2009 12:27:10  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2992.305	3299.659	2.000000	0.4799997	70.71068	95.00000
NP-237	4433.641	4904.628	9.000000	2.159998	33.33334	95.00000
CM-244	5535.538	5884.077	99.00000	23.75998	10.05038	95.00000

Instrument : CHAMBER 039  
 Detector : 45-149BB2  
 Background Analysis Date/Time : 4-OCT-2009 12:27:10  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.574	3299.018	6.000000	1.439999	40.82483	95.00000
NP-237	4435.951	4903.816	10.00000	2.399998	31.62278	95.00000
CM-244	5530.396	5887.164	114.0000	27.35998	9.365858	95.00000

Instrument : CHAMBER 040  
 Detector : 78773  
 Background Analysis Date/Time : 4-OCT-2009 12:27:10  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.816	3300.322	4.000000	0.9599993	50.00000	95.00000
NP-237	4435.336	4903.074	12.00000	2.879998	28.86751	95.00000
CM-244	5535.365	5887.334	91.00000	21.83998	10.48285	95.00000

Instrument : CHAMBER 041  
 Detector : 78205  
 Background Analysis Date/Time : 4-OCT-2009 12:27:10  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.124	3297.496	2.000000	0.4799997	70.71068	95.00000
NP-237	4436.407	4904.667	7.000000	1.679999	37.79645	95.00000
CM-244	5534.009	5884.821	95.00000	22.79998	10.25978	95.00000

Instrument : CHAMBER 042  
 Detector : 78793  
 Background Analysis Date/Time : 4-OCT-2009 12:27:10  
 Background Count Time : 60000.00

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.688	3301.802	3.000000	0.7199995	57.73503	95.00000
NP-237	4434.270	4903.204	11.00000	2.639998	30.15113	95.00000
CM-244	5531.941	5884.925	95.00000	22.79998	10.25978	95.00000

Instrument : CHAMBER 043  
 Detector : 76543  
 Background Analysis Date/Time : 4-OCT-2009 12:27:11  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.342	3297.639	2.000000	0.4800001	70.71068	95.00000
NP-237	4434.322	4904.954	5.000000	1.200000	44.72136	95.00000
CM-244	5530.582	5884.754	83.00000	19.92000	10.97643	95.00000

Instrument : CHAMBER 044  
 Detector : 79459  
 Background Analysis Date/Time : 4-OCT-2009 12:27:11  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2988.267	3300.630	4.000000	0.9600002	50.00000	95.00000
NP-237	4435.598	4902.170	15.00000	3.600001	25.81989	95.00000
CM-244	5534.541	5884.074	72.00000	17.28000	11.78511	95.00000

Instrument : CHAMBER 045  
 Detector : 78783  
 Background Analysis Date/Time : 4-OCT-2009 12:27:11  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2991.885	3299.172	2.000000	0.4800001	70.71068	95.00000
NP-237	4433.040	4904.041	15.000000	3.600001	25.81989	95.00000
CM-244	5535.023	5883.628	65.000000	15.600000	12.40347	95.00000

Instrument : CHAMBER 046  
 Detector : 76544  
 Background Analysis Date/Time : 4-OCT-2009 12:27:11  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.512	3299.742	7.000000	1.680000	37.79645	95.00000
NP-237	4436.725	4904.975	9.000000	2.160001	33.33334	95.00000
CM-244	5532.384	5884.423	62.000000	14.880000	12.70001	95.00000

Instrument : CHAMBER 047  
 Detector : 46-089B1  
 Background Analysis Date/Time : 4-OCT-2009 12:27:11  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2990.110	3299.327	4.000000	0.9600002	50.00000	95.00000
NP-237	4433.432	4905.913	14.000000	3.360001	26.72612	95.00000
CM-244	5532.890	5887.284	84.000000	20.160000	10.91089	95.00000

Instrument : CHAMBER 048  
 Detector : 42483  
 Background Analysis Date/Time : 4-OCT-2009 12:27:11  
 Background Count Time : 59999.99

Cal. Isotopes	Start Energy	End Energy	Counts in 1000 min	Counts during Cal	% Error	Confidence
GD-148	2989.285	3302.359	4.000000	0.9600002	50.00000	95.00000
NP-237	4435.788	4905.185	14.000000	3.360001	26.72612	95.00000
CM-244	5532.778	5884.266	43.000000	10.320000	15.24986	95.00000

### Subsection 3: Efficiency Calibration

Instrument : CHAMBER 001  
 Detector : 78788  
 Standard ID : AESS-001  
 Standard Reference Date : 20-FEB-2008 09:54:53  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:14  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:29:51  
 Average Efficiency : 0.1170641  
 Average Efficiency Error : 3.9776261E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	208.6698	28-FEB-2010	2989.441	3300.886	15102.00	0.3061090	1.3157059E-02	61.46019
NP-237	171.0024	28-FEB-2010	4434.241	4902.002	12075.00	0.2941744	1.4950445E-02	67.35207
CM-244	158.1060	28-FEB-2010	5533.622	5884.936	2908.000	8.1477851E-02	2.3455921E-03	0.0000000E+00

Instrument : CHAMBER 002  
 Detector : 78266  
 Standard ID : AESS-002  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:14  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:29:59  
 Average Efficiency : 0.3076868  
 Average Efficiency Error : 8.4732752E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	200.1144	28-FEB-2010	2990.849	3300.306	14496.00	0.3063846	1.3178788E-02	51.06155
NP-237	200.4990	28-FEB-2010	4432.986	4901.899	14871.00	0.3090017	1.5656555E-02	68.37519
CM-244	196.5558	28-FEB-2010	5531.074	5885.833	13662.00	0.3082083	1.5634416E-02	56.27949

Instrument : CHAMBER 003  
 Detector : 67617  
 Standard ID : AESS-003  
 Standard Reference Date : 15-FEB-2008 13:12:27  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:14  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:30:06  
 Average Efficiency : 0.2978793  
 Average Efficiency Error : 8.2169715E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	202.9740	28-FEB-2010	2990.114	3299.375	15107.00	0.3148319	1.3531940E-02	61.56522
NP-237	203.2080	28-FEB-2010	4432.687	4905.323	14701.00	0.3013868	1.5273048E-02	71.07141
CM-244	197.2236	28-FEB-2010	5531.736	5884.280	12300.00	0.2766226	1.4054317E-02	62.68796

Instrument : CHAMBER 004  
 Detector : 64279  
 Standard ID : AESS-004  
 Standard Reference Date : 14-FEB-2008 09:35:18  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:14  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:30:14  
 Average Efficiency : 0.3330874  
 Average Efficiency Error : 9.1611817E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.1222	28-FEB-2010	2991.168	3298.189	15835.00	0.3249832	1.3956737E-02	53.14224
NP-237	204.2586	28-FEB-2010	4436.994	4901.306	16601.00	0.3385996	1.7132787E-02	66.35686
CM-244	198.8100	28-FEB-2010	5535.543	5883.828	15230.00	0.3398514	1.7214326E-02	54.23206

Instrument : CHAMBER 005  
 Detector : 67612  
 Standard ID : AESS-005  
 Standard Reference Date : 14-FEB-2008 09:35:18  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:14  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:30:22  
 Average Efficiency : 0.3013134  
 Average Efficiency Error : 8.2950471E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	210.7452	28-FEB-2010	2987.683	3298.337	14884.00	0.2987357	1.2843589E-02	51.38546
NP-237	209.5938	28-FEB-2010	4434.065	4904.748	15311.00	0.3043405	1.5414570E-02	62.09734
CM-244	202.7478	28-FEB-2010	5531.539	5883.696	13801.00	0.3019906	1.5316823E-02	51.74085

Instrument : CHAMBER 006  
 Detector : 67613  
 Standard ID : AESS-006  
 Standard Reference Date : 14-FEB-2008 09:35:18  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:14  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:30:30  
 Average Efficiency : 0.3128007  
 Average Efficiency Error : 8.6130099E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.6952	28-FEB-2010	2988.420	3302.030	14687.00	0.3050137	1.3116646E-02	53.96157
NP-237	204.7038	28-FEB-2010	4433.957	4905.615	15465.00	0.3147306	1.5938818E-02	69.02951
CM-244	195.0060	28-FEB-2010	5531.576	5885.432	14195.00	0.3228947	1.6370744E-02	57.32907



Instrument : CHAMBER 007  
 Detector : 67607  
 Standard ID : AESS-007  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:17  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:30:44  
 Average Efficiency : 0.2955749  
 Average Efficiency Error : 8.1434380E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.7342	28-FEB-2010	2987.453	3300.644	14117.00	0.2888602	1.2431225E-02	50.32896
NP-237	205.0260	28-FEB-2010	4436.233	4906.179	14776.00	0.3002093	1.5212398E-02	59.19152
CM-244	199.6806	28-FEB-2010	5534.716	5882.592	13553.00	0.3010390	1.5272615E-02	52.85068

Instrument : CHAMBER 008  
 Detector : 78788  
 Standard ID : AESS-008  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:17  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:30:59  
 Average Efficiency : 0.3210347  
 Average Efficiency Error : 8.8313380E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.0418	28-FEB-2010	2988.927	3298.611	15677.00	0.3218499	1.3824582E-02	47.50993
NP-237	209.2716	28-FEB-2010	4433.414	4905.734	15957.00	0.3176950	1.6082633E-02	61.53691
CM-244	199.6488	28-FEB-2010	5532.110	5885.974	14553.00	0.3233571	1.6388621E-02	51.82884

Instrument : CHAMBER 009  
 Detector : 72528  
 Standard ID : AESS-009  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:17  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:31:08  
 Average Efficiency : 0.3396772  
 Average Efficiency Error : 9.3389135E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.3736	28-FEB-2010	2991.258	3299.443	16227.00	0.3374861	1.4487664E-02	44.72154
NP-237	204.0192	28-FEB-2010	4436.364	4903.243	16817.00	0.3434230	1.7374199E-02	63.92683
CM-244	197.2128	28-FEB-2010	5535.592	5884.904	15084.00	0.3390961	1.7178258E-02	51.67406

Instrument : CHAMBER 010  
 Detector : 72529  
 Standard ID : AESS-010  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:17  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:31:16  
 Average Efficiency : 0.3096452  
 Average Efficiency Error : 8.5257888E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	202.0008	28-FEB-2010	2991.986	3299.677	14638.00	0.3065297	1.3182675E-02	47.56829
NP-237	202.9926	28-FEB-2010	4436.858	4905.650	15178.00	0.3115173	1.5779816E-02	55.62252
CM-244	196.2330	28-FEB-2010	5532.380	5883.357	13814.00	0.3122560	1.5837347E-02	50.91301

Instrument : CHAMBER 011  
 Detector : 72531  
 Standard ID : AESS-011  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:17  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:31:24  
 Average Efficiency : 0.2944759  
 Average Efficiency Error : 8.1076277E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	212.8284	28-FEB-2010	2989.941	3300.792	14675.00	0.2916705	1.2543053E-02	45.84192
NP-237	214.4868	28-FEB-2010	4435.381	4904.777	15380.00	0.2987521	1.5130637E-02	61.26926
CM-244	208.4184	28-FEB-2010	5534.525	5885.025	13828.00	0.2942874	1.4925800E-02	50.20320

Instrument : CHAMBER 012  
 Detector : 67594  
 Standard ID : AESS-012  
 Standard Reference Date : 14-FEB-2008 13:39:25  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:17  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:31:31  
 Average Efficiency : 0.2993155  
 Average Efficiency Error : 8.2423287E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	206.2200	28-FEB-2010	2991.284	3298.664	14664.00	0.3007817	1.2935068E-02	50.95671
NP-237	205.8930	28-FEB-2010	4435.039	4903.648	14736.00	0.2981648	1.5109295E-02	64.69898
CM-244	203.1954	28-FEB-2010	5535.566	5886.583	13673.00	0.2984623	1.5139968E-02	53.22255

Instrument : CHAMBER 013  
 Detector : 78790  
 Standard ID : AESS-013  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:19  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:31:39  
 Average Efficiency : 0.3402545  
 Average Efficiency Error : 9.3525015E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.6544	28-FEB-2010	2991.792	3302.000	16395.00	0.3405460	1.4616546E-02	48.69087
NP-237	210.2526	28-FEB-2010	4437.046	4903.690	17018.00	0.3372298	1.7058531E-02	69.07110
CM-244	201.9108	28-FEB-2010	5533.535	5883.676	15613.00	0.3429781	1.7367329E-02	52.85673

Instrument : CHAMBER 014  
 Detector : 67616  
 Standard ID : AESS-014  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:19  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:31:47  
 Average Efficiency : 0.3154615  
 Average Efficiency Error : 8.6780824E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	214.7088	28-FEB-2010	2988.991	3302.405	15631.00	0.3079327	1.3227411E-02	51.00696
NP-237	211.7160	28-FEB-2010	4434.801	4901.898	16325.00	0.3212697	1.6259110E-02	66.04585
CM-244	207.3882	28-FEB-2010	5534.536	5884.005	15018.00	0.3210322	1.6264105E-02	55.65382

Instrument : CHAMBER 015  
 Detector : 61581  
 Standard ID : AESS-015  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:19  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:05  
 Average Efficiency : 0.3239309  
 Average Efficiency Error : 8.9143794E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	204.0270	28-FEB-2010	2988.090	3297.900	15299.00	0.3171847	1.3630020E-02	55.09682
NP-237	200.6460	28-FEB-2010	4434.643	4904.243	16005.00	0.3323445	1.6823623E-02	72.65751
CM-244	195.9270	28-FEB-2010	5530.383	5883.387	14390.00	0.3257269	1.6511347E-02	59.39601

Instrument : CHAMBER 016  
 Detector : 78774  
 Standard ID : AESS-016  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:19  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:13  
 Average Efficiency : 0.3348206  
 Average Efficiency Error : 9.2087686E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	204.0534	28-FEB-2010	2988.478	3297.993	15871.00	0.3290119	1.4129218E-02	47.19107
NP-237	199.3962	28-FEB-2010	4435.680	4906.563	16392.00	0.3425145	1.7333448E-02	68.63850
CM-244	198.6402	28-FEB-2010	5535.188	5884.657	15037.00	0.3358302	1.7013419E-02	50.23811

Instrument : CHAMBER 017  
 Detector : 78791  
 Standard ID : AESS-017  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:19  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:21  
 Average Efficiency : 0.2974587  
 Average Efficiency Error : 8.1904847E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	210.0798	28-FEB-2010	2992.179	3300.868	14719.00	0.2963764	1.2744716E-02	46.79632
NP-237	208.5846	28-FEB-2010	4432.980	4904.604	15110.00	0.3018124	1.5289096E-02	64.17606
CM-244	205.5828	28-FEB-2010	5530.423	5884.153	13661.00	0.2947841	1.4953489E-02	50.85275

Instrument : CHAMBER 018  
 Detector : 78782  
 Standard ID : AESS-018  
 Standard Reference Date : 14-FEB-2008 17:45:04  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:19  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:30  
 Average Efficiency : 0.3232387  
 Average Efficiency Error : 8.8925390E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	202.1856	28-FEB-2010	2989.144	3298.062	15553.00	0.3254129	1.3979518E-02	44.73234
NP-237	208.8990	28-FEB-2010	4436.722	4903.896	16034.00	0.3197786	1.6187187E-02	61.57305
CM-244	198.1458	28-FEB-2010	5530.923	5885.427	14462.00	0.3237990	1.6412353E-02	48.65820

Instrument : CHAMBER 019  
 Detector : 78786  
 Standard ID : AESS-019  
 Standard Reference Date : 19-FEB-2008 11:05:22  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:21  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:38  
 Average Efficiency : 0.2919804  
 Average Efficiency Error : 8.0469577E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	204.6468	28-FEB-2010	2987.942	3301.658	13855.00	0.2863555	1.2327870E-02	46.10098
NP-237	202.9140	28-FEB-2010	4435.742	4904.552	14627.00	0.3003190	1.5219935E-02	61.83296
CM-244	199.3140	28-FEB-2010	5531.315	5884.461	13136.00	0.2922035	1.4831048E-02	56.75883

Instrument : CHAMBER 020  
 Detector : 78787  
 Standard ID : AESS-020  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:21  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:46  
 Average Efficiency : 0.3461189  
 Average Efficiency Error : 9.5147844E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	205.5870	28-FEB-2010	2987.612	3302.259	16442.00	0.3383054	1.4519696E-02	48.46275
NP-237	203.4984	28-FEB-2010	4437.248	4904.603	17255.00	0.3532113	1.7864209E-02	69.81705
CM-244	197.1096	28-FEB-2010	5531.524	5885.796	15588.00	0.3508011	1.7763764E-02	55.01109

Instrument : CHAMBER 021  
 Detector : 67047  
 Standard ID : AESS-021  
 Standard Reference Date : 19-FEB-2008 15:31:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:21  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:32:53  
 Average Efficiency : 0.3036543  
 Average Efficiency Error : 8.3605787E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	208.3608	28-FEB-2010	2991.083	3300.146	14662.00	0.2976273	1.2799400E-02	53.30055
NP-237	210.1548	28-FEB-2010	4432.482	4903.692	15497.00	0.3072018	1.5557135E-02	62.81018
CM-244	200.7390	28-FEB-2010	5533.850	5886.843	13999.00	0.3090917	1.5674066E-02	53.79641

Instrument : CHAMBER 022  
 Detector : 72530  
 Standard ID : AESS-022  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:21  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:01  
 Average Efficiency : 0.3151155  
 Average Efficiency Error : 8.6721405E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	209.6724	28-FEB-2010	2987.964	3302.384	15259.00	0.3078506	1.3229508E-02	51.15461
NP-237	206.8830	28-FEB-2010	4434.585	4905.188	16173.00	0.3257087	1.6485624E-02	62.30558
CM-244	203.0208	28-FEB-2010	5534.052	5886.085	14453.00	0.3157637	1.6005291E-02	52.81313

Instrument : CHAMBER 023  
 Detector : 78264  
 Standard ID : AESS-023  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:21  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:09  
 Average Efficiency : 0.3294301  
 Average Efficiency Error : 9.0611009E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	207.4764	28-FEB-2010	2989.638	3299.478	15787.00	0.3218794	1.3824158E-02	49.26515
NP-237	207.4998	28-FEB-2010	4435.178	4902.738	16470.00	0.3306996	1.6734598E-02	63.46927
CM-244	199.8804	28-FEB-2010	5535.207	5884.203	15311.00	0.3397900	1.7210081E-02	51.23116

Instrument : CHAMBER 024  
 Detector : 76542  
 Standard ID : AESS-024  
 Standard Reference Date : 14-FEB-2008 21:55:55  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:21  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:17  
 Average Efficiency : 0.3265466  
 Average Efficiency Error : 8.9866361E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.5218	28-FEB-2010	2988.966	3297.612	15184.00	0.3155952	1.3563512E-02	53.26322
NP-237	205.6662	28-FEB-2010	4436.826	4905.796	16470.00	0.3336236	1.6882595E-02	64.50421
CM-244	198.3060	28-FEB-2010	5532.191	5882.702	15051.00	0.3366388	1.7054273E-02	54.72839

Instrument : CHAMBER 025  
 Detector : 45-149AA5  
 Standard ID : AESS-025  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:24  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:25  
 Average Efficiency : 0.3275933  
 Average Efficiency Error : 9.0299817E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	195.5670	28-FEB-2010	2990.746	3299.065	15305.00	0.3310509	1.4225741E-02	57.64912
NP-237	167.9916	28-FEB-2010	4432.780	4902.204	13189.00	0.3270416	1.6598335E-02	67.26674
CM-244	157.2432	28-FEB-2010	5534.306	5882.901	11497.00	0.3235089	1.6456075E-02	59.53814

Instrument : CHAMBER 026  
 Detector : 78204  
 Standard ID : AESS-026  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:24  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:33  
 Average Efficiency : 0.3117441  
 Average Efficiency Error : 9.1406014E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	199.5072	28-FEB-2010	2989.886	3302.127	14629.00	0.3101691	1.5720192E-02	50.46342
NP-237	168.0294	28-FEB-2010	4437.039	4903.756	12744.00	0.3159511	1.6043676E-02	62.50089
CM-244	160.5822	28-FEB-2010	5531.113	5886.264	11219.00	0.3092745	1.5738295E-02	52.20251

Instrument : CHAMBER 027  
 Detector : 42484  
 Standard ID : AESS-027  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:24  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:41  
 Average Efficiency : 0.3377378  
 Average Efficiency Error : 9.8986309E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	193.4238	28-FEB-2010	2988.480	3297.801	15205.00	0.3325215	1.6844572E-02	45.70711
NP-237	161.6154	28-FEB-2010	4433.015	4906.280	13169.00	0.3394597	1.7228922E-02	62.64782
CM-244	148.1754	28-FEB-2010	5534.576	5884.449	11435.00	0.3415364	1.7374527E-02	49.08809

Instrument : CHAMBER 028  
 Detector : 78792  
 Standard ID : AESS-028  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:24  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:49  
 Average Efficiency : 0.2998267  
 Average Efficiency Error : 8.7975496E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	199.6542	28-FEB-2010	2991.311	3300.074	14132.00	0.2994205	1.5182513E-02	43.09942
NP-237	168.1992	28-FEB-2010	4434.084	4901.937	12215.00	0.3025812	1.5374796E-02	56.18161
CM-244	156.7614	28-FEB-2010	5535.676	5885.791	10538.00	0.2975542	1.5158846E-02	48.81636

Instrument : CHAMBER 029  
 Detector : 33454  
 Standard ID : AESS-029  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:24  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:33:57  
 Average Efficiency : 0.3147998  
 Average Efficiency Error : 9.2300801E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	201.5742	28-FEB-2010	2991.479	3300.442	14764.00	0.3098317	1.5701165E-02	55.43900
NP-237	169.7700	28-FEB-2010	4436.521	4901.727	12812.00	0.3144220	1.5964665E-02	72.65047
CM-244	154.8234	28-FEB-2010	5535.072	5884.352	11212.00	0.3205570	1.6312657E-02	62.69990

Instrument : CHAMBER 030  
 Detector : 33447  
 Standard ID : AESS-030  
 Standard Reference Date : 15-FEB-2008 09:06:52  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:24  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:34:05  
 Average Efficiency : 0.3252787  
 Average Efficiency Error : 9.5355082E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	198.9792	28-FEB-2010	2988.805	3301.805	14768.00	0.3139574	1.5910186E-02	59.95137
NP-237	166.3758	28-FEB-2010	4432.561	4904.188	13305.00	0.3331409	1.6905690E-02	72.98332
CM-244	157.1856	28-FEB-2010	5530.498	5884.744	11719.00	0.3301300	1.6787019E-02	60.55718



Instrument : CHAMBER 031  
 Detector : 67042  
 Standard ID : AESS-031  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:26  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:34:14  
 Average Efficiency : 0.3165053  
 Average Efficiency Error : 8.7338677E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	193.6650	28-FEB-2010	2989.831	3300.223	14524.00	0.3172176	1.3644255E-02	86.51537
NP-237	162.9186	28-FEB-2010	4434.171	4903.758	12697.00	0.3246664	1.6487148E-02	124.4390
CM-244	153.1968	28-FEB-2010	5534.159	5885.214	10665.00	0.3081662	1.5695792E-02	83.37914

Instrument : CHAMBER 032  
 Detector : 67041  
 Standard ID : AESS-032  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:26  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 5-OCT-2009 12:57:42  
 Average Efficiency : 0.3013491  
 Average Efficiency Error : 8.3197737E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	195.2364	28-FEB-2010	2988.995	3298.824	7474.000	0.3038873	1.3079208E-02	0.0000000E+00
NP-237	165.9822	28-FEB-2010	4437.720	4906.375	2.000000	0.3021212	1.5355161E-02	265.5527
CM-244	153.7938	28-FEB-2010	5535.070	5886.840	0.0000000E+00	0.2971950	1.5144484E-02	0.0000000E+00

Instrument : CHAMBER 033  
 Detector : 78785  
 Standard ID : AESS-033  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:26  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:34:25  
 Average Efficiency : 0.3128877  
 Average Efficiency Error : 8.6370576E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	192.4158	28-FEB-2010	2989.828	3297.761	14059.00	0.3090549	1.3301339E-02	52.12262
NP-237	161.7816	28-FEB-2010	4434.037	4906.047	12256.00	0.3156150	1.6036268E-02	59.37875
CM-244	147.2670	28-FEB-2010	5533.039	5882.356	10505.00	0.3157493	1.6086496E-02	51.20487

Instrument : CHAMBER 034  
 Detector : 61586  
 Standard ID : AESS-034  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:26  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 5-OCT-2009 12:58:01  
 Average Efficiency : 0.2220411  
 Average Efficiency Error : 6.4285840E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	200.5488	28-FEB-2010	2988.293	3300.824	11391.00	0.2895562	1.2467581E-02	89.70998
NP-237	167.2962	28-FEB-2010	4433.347	4902.684	1.000000	0.3134575	1.5920211E-02	6.785102
CM-244	154.4388	28-FEB-2010	5532.745	5886.121	0.0000000E+00	0.1645078	8.5068326E-03	0.0000000E+00

Instrument : CHAMBER 035  
 Detector : 78202  
 Standard ID : AESS-035  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:26  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:34:40  
 Average Efficiency : 0.3042172  
 Average Efficiency Error : 8.3945282E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	198.6666	28-FEB-2010	2991.104	3299.576	14244.00	0.3032596	1.3048678E-02	49.52762
NP-237	168.2934	28-FEB-2010	4433.307	4901.387	12373.00	0.3062045	1.5555969E-02	61.22158
CM-244	158.8128	28-FEB-2010	5530.369	5886.338	10896.00	0.3035987	1.5457427E-02	58.22495

Instrument : CHAMBER 036  
 Detector : 78203  
 Standard ID : AESS-036  
 Standard Reference Date : 18-FEB-2008 11:28:15  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:26  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:34:48  
 Average Efficiency : 0.3253655  
 Average Efficiency Error : 8.9688124E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	201.3204	28-FEB-2010	2988.103	3300.014	15239.00	0.3201576	1.3758717E-02	56.44998
NP-237	167.4312	28-FEB-2010	4433.320	4904.469	13097.00	0.3258525	1.6539684E-02	72.79517
CM-244	156.4188	28-FEB-2010	5530.632	5885.034	11762.00	0.3327303	1.6918454E-02	53.84407

Instrument : CHAMBER 037  
 Detector : 45-149BB5  
 Standard ID : AESS-037  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:29  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:34:56  
 Average Efficiency : 0.3567447  
 Average Efficiency Error : 9.8222708E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	197.7372	28-FEB-2010	2990.587	3301.234	16270.00	0.3480281	1.4939565E-02	72.94692
NP-237	167.1294	28-FEB-2010	4436.459	4902.555	14545.00	0.3625170	1.8373555E-02	81.14367
CM-244	154.7664	28-FEB-2010	5531.113	5885.586	12738.00	0.3642576	1.8497935E-02	70.65152

Instrument : CHAMBER 038  
 Detector : 72532  
 Standard ID : AESS-038  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:29  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:35:05  
 Average Efficiency : 0.3441179  
 Average Efficiency Error : 9.4756875E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	200.1408	28-FEB-2010	2992.305	3299.659	16131.00	0.3409107	1.4636146E-02	59.05025
NP-237	170.0886	28-FEB-2010	4433.641	4904.628	14132.00	0.3461397	1.7550293E-02	64.09210
CM-244	157.7460	28-FEB-2010	5535.538	5884.077	12357.00	0.3467269	1.7615909E-02	57.18062

Instrument : CHAMBER 039  
 Detector : 45-149BB2  
 Standard ID : AESS-039  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:29  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:35:14  
 Average Efficiency : 0.3544333  
 Average Efficiency Error : 9.7644692E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	192.2418	28-FEB-2010	2988.574	3299.018	15783.00	0.3472402	1.4913449E-02	62.39804
NP-237	159.1506	28-FEB-2010	4435.951	4903.816	13978.00	0.3658909	1.8554559E-02	71.68822
CM-244	151.7142	28-FEB-2010	5530.396	5887.164	12142.00	0.3541290	1.7997203E-02	73.21387

Instrument : CHAMBER 040  
 Detector : 78773  
 Standard ID : AESS-040  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:29  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:35:30  
 Average Efficiency : 0.3195167  
 Average Efficiency Error : 8.8120243E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	194.4828	28-FEB-2010	2990.816	3300.322	14717.00	0.3200646	1.3763377E-02	48.66933
NP-237	166.8174	28-FEB-2010	4435.336	4903.074	12848.00	0.3208383	1.6289845E-02	67.76543
CM-244	155.0100	28-FEB-2010	5535.365	5887.334	11118.00	0.3174615	1.6157331E-02	51.18541

Instrument : CHAMBER 041  
 Detector : 78205  
 Standard ID : AESS-041  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:29  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:35:39  
 Average Efficiency : 0.3288728  
 Average Efficiency Error : 9.0603521E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	203.9034	28-FEB-2010	2989.124	3297.496	15761.00	0.3269444	1.4042080E-02	47.53713
NP-237	171.2268	28-FEB-2010	4436.407	4904.667	13629.00	0.3316104	1.6822139E-02	66.71667
CM-244	159.5796	28-FEB-2010	5534.009	5884.821	11858.00	0.3289023	1.6721375E-02	49.54688

Instrument : CHAMBER 042  
 Detector : 78793  
 Standard ID : AESS-042  
 Standard Reference Date : 18-FEB-2008 15:31:47  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:29  
 Calibration Count Time : 239.9998  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:35:48  
 Average Efficiency : 0.3337009  
 Average Efficiency Error : 9.2022466E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	188.7090	28-FEB-2010	2991.688	3301.802	14699.00	0.3294593	1.4167678E-02	48.24435
NP-237	159.6558	28-FEB-2010	4434.270	4903.204	12831.00	0.3347926	1.6998671E-02	59.09972
CM-244	150.5208	28-FEB-2010	5531.941	5884.925	11524.00	0.3388561	1.7235642E-02	51.74503

Instrument : CHAMBER 043  
 Detector : 76543  
 Standard ID : AESS-043  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:31  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:35:57  
 Average Efficiency : 0.3418410  
 Average Efficiency Error : 9.4167739E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	197.7708	28-FEB-2010	2991.342	3297.639	15680.00	0.3353467	1.4404230E-02	54.31265
NP-237	168.7422	28-FEB-2010	4434.322	4904.954	14182.00	0.3501596	1.7753214E-02	67.72367
CM-244	156.3252	28-FEB-2010	5530.582	5884.754	12123.00	0.3433350	1.7448707E-02	56.73003

Instrument : CHAMBER 044  
 Detector : 79459  
 Standard ID : AESS-044  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:31  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:36:05  
 Average Efficiency : 0.3497279  
 Average Efficiency Error : 9.6306484E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	194.4510	28-FEB-2010	2988.267	3300.630	16147.00	0.3512200	1.5078514E-02	47.50124
NP-237	166.6248	28-FEB-2010	4435.598	4902.170	13952.00	0.3487979	1.7688267E-02	63.48624
CM-244	155.8290	28-FEB-2010	5534.541	5884.074	12267.00	0.3486014	1.7712867E-02	53.61492

Instrument : CHAMBER 045  
 Detector : 78783  
 Standard ID : AESS-045  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:31  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:36:13  
 Average Efficiency : 0.3405233  
 Average Efficiency Error : 9.3887197E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	186.9936	28-FEB-2010	2991.885	3299.172	15056.00	0.3405590	1.4638593E-02	42.74657
NP-237	160.8066	28-FEB-2010	4433.040	4904.041	12962.00	0.3357659	1.7045524E-02	58.07777
CM-244	145.8384	28-FEB-2010	5535.023	5883.628	11379.00	0.3455315	1.7578544E-02	44.01299

Instrument : CHAMBER 046  
 Detector : 76544  
 Standard ID : AESS-046  
 Standard Reference Date : 19-FEB-2008 19:35:48  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:31  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:36:20  
 Average Efficiency : 0.3396066  
 Average Efficiency Error : 9.3588978E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	194.7474	28-FEB-2010	2989.512	3299.742	15390.00	0.3342214	1.4360611E-02	48.90350
NP-237	164.6658	28-FEB-2010	4436.725	4904.975	13538.00	0.3425081	1.7376650E-02	72.80901
CM-244	151.3824	28-FEB-2010	5532.384	5884.423	11782.00	0.3446751	1.7524688E-02	50.87139

Instrument : CHAMBER 047  
 Detector : 46-089B1  
 Standard ID : AESS-047  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:31  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:36:28  
 Average Efficiency : 0.3425100  
 Average Efficiency Error : 9.4339019E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	197.4804	28-FEB-2010	2990.110	3299.327	16029.00	0.3433048	1.4740521E-02	55.95443
NP-237	168.3948	28-FEB-2010	4433.432	4905.913	13798.00	0.3413330	1.7312385E-02	72.11221
CM-244	154.6032	28-FEB-2010	5532.890	5887.284	11964.00	0.3425916	1.7414661E-02	59.97544

Instrument : CHAMBER 048  
 Detector : 42483  
 Standard ID : AESS-048  
 Standard Reference Date : 19-FEB-2008 00:32:27  
 Calibration Analysis Date/Time : 5-OCT-2009 13:55:31  
 Calibration Count Time : 240.0000  
 Efficiency Calibration Date/Time : 6-OCT-2009 07:36:36  
 Average Efficiency : 0.3160317  
 Average Efficiency Error : 8.7210629E-03  
 Confidence : 95.00000

Cal. Istps	DPM	Exp. Date	Start Engy	End Engy	Counts	EFF.	EFF Err	Resolution
GD-148	191.8350	28-FEB-2010	2989.285	3302.359	14301.00	0.3153065	1.3566012E-02	58.11379
NP-237	161.5530	28-FEB-2010	4435.788	4905.185	12134.00	0.3128656	1.5899187E-02	65.94836
CM-244	151.1856	28-FEB-2010	5532.778	5884.266	10934.00	0.3204127	1.6311672E-02	55.35687

# LUCAS CELL COUNTERS

# General Engineering Laboratories

2040 Savage Road, Charleston, SC 29414  
 (843)556-8171

## Lucas Cell Calibration Package

	YES	NO	Comments
1) Is all calibration standard information enclosed for: the primary standard certificate? the secondary standard(s) documentation? standard preparation information? standard < 1 Year old or verified?	✓	✓	
	✓	✓	
	✓	✓	
	✓	✓	
2) Is the efficiency calibration report included ?	✓	✓	
3) Is the raw count data included for: Cell constant determination? Plateau generation?	✓	✓	
	✓	✓	
4) Are the calibration verifications included?	✓	✓	
5) Are the instrument settings included: HVPS settings?	✓	✓	
	✓	✓	
6) Has the CELLEFF.xls file been updated ?	✓	✓	
7) Have the calibration dates been updated in ALPHALIMS ?	✓	✓	

Prepared By: Kelli Donnell

Date: 12/19/08

Reviewed By: Mark G. Adams

Date: 12/19/08

Effective Date: 12/19/08



NU 12/19/08

### Ra-226 Cell Constants

Standard Reference date: 12/15/1999  
 standard ID: 0299-G  
 Volume added (mL): 0.1  
 Standard Reference Activity (DPM/mL): 2446.35

Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/Time flushed to cell	Date/Time end of degas	bkg cpm	total counts	count time min	cpm	Known activity dpm	11 (days) end-degas to flush	12 (days) end-flush to count	13 (days) Std Ref Date to count	Decay from Std Ref Date to count
201	2.021	Average	9/15/2008 15:45	9/15/2008 9:05	9/12/2008 13:20	0.267	5596	30	186.53	243.02	2.82292	0.27778	3198	0.9962
201	2.043	Stddev	9/18/2008 13:00	9/18/2008 8:10	9/15/2008 9:05	0.267	5949	30	198.30	243.02	2.96181	0.20139	3201	0.9962
201	1.915		9/25/2008 19:35	9/25/2008 9:15	9/22/2008 10:00	0.267	5361	30	178.70	243.02	2.96875	0.49056	3208	0.9962
202	2.436	Average	9/15/2008 16:20	9/15/2008 9:35	9/12/2008 13:20	0.267	6779	30	225.97	243.02	2.84375	0.28125	3198	0.9962
202	2.209	Stddev	9/18/2008 13:50	9/18/2008 8:45	9/15/2008 9:35	0.267	6425	30	214.17	243.02	2.96528	0.21181	3201	0.9962
202	2.137		10/21/2008 13:50	10/20/2008 13:45	10/13/2008 16:00	0.267	9248	30	308.27	243.02	6.90625	1.00347	3234	0.9962
203	2.255	Average	9/15/2008 16:50	9/15/2008 10:00	9/12/2008 13:20	0.267	6300	30	210.00	243.02	2.86111	0.28472	3198	0.9962
203	2.273	Stddev	9/18/2008 14:25	9/18/2008 9:15	9/15/2008 10:00	0.267	6613	30	220.43	243.02	2.96875	0.21528	3201	0.9962
203	2.234		9/25/2008 21:00	9/25/2008 10:15	9/22/2008 10:00	0.267	6298	30	209.93	243.02	3.01042	0.44782	3208	0.9962
204	2.184	Average	9/15/2008 17:25	9/15/2008 10:30	9/12/2008 13:20	0.267	6132	30	204.40	243.02	2.88194	0.28819	3198	0.9962
204	2.300	Stddev	9/18/2008 14:55	9/18/2008 9:35	9/15/2008 10:30	0.267	6671	30	222.37	243.02	2.96181	0.22222	3201	0.9962
204	2.096		9/30/2008 14:05	9/30/2008 9:10	9/28/2008 9:45	0.133	7535	30	251.17	243.02	3.97569	0.20486	3213	0.9962
205	1.677	Average	10/21/2008 8:30	10/20/2008 14:05	10/13/2008 16:00	0.267	7584	30	252.80	243.02	6.32014	0.76736	3233	0.9962
205	1.730	Stddev	9/18/2008 16:00	9/18/2008 10:05	9/15/2008 10:55	0.167	4989	30	166.63	243.02	2.96528	0.24653	3201	0.9962
205	1.990		9/30/2008 14:45	9/30/2008 9:40	9/28/2008 9:45	0.187	7170	30	239.00	243.02	3.89653	0.21181	3213	0.9962
206	2.240	Average	9/15/2008 21:10	9/15/2008 11:25	9/12/2008 13:20	0.233	6216	30	207.20	243.02	2.32014	0.40825	3198	0.9962
206	2.293	Stddev	9/18/2008 16:35	9/18/2008 10:25	9/15/2008 11:25	0.267	6604	30	220.13	243.02	2.95833	0.25694	3201	0.9962
206	2.245		9/30/2008 15:20	9/30/2008 10:15	9/28/2008 9:45	0.267	8125	30	270.83	243.02	4.02083	0.21181	3213	0.9962
207	2.187	Average	9/15/2008 21:40	9/15/2008 11:50	9/12/2008 13:20	0.267	6084	30	203.13	243.02	2.33750	0.40972	3198	0.9962
207	2.141	Stddev	9/18/2008 17:55	9/18/2008 10:40	9/15/2008 11:50	0.267	6105	30	203.50	243.02	2.95139	0.30208	3201	0.9962
207	2.110		9/30/2008 16:00	9/30/2008 10:45	9/28/2008 9:45	0.233	7656	30	255.20	243.02	4.04167	0.21675	3213	0.9962
208	2.239	Average	9/15/2008 22:15	9/15/2008 12:15	9/12/2008 13:20	0.267	6288	30	208.60	243.02	2.85486	0.41667	3198	0.9962
208	2.243	Stddev	9/18/2008 19:30	9/18/2008 11:00	9/15/2008 12:15	0.133	6374	30	212.47	243.02	2.94786	0.41290	3201	0.9962
208	2.148		9/30/2008 16:55	9/30/2008 11:10	9/28/2008 9:45	0.695	7691	30	236.03	243.02	4.96989	0.89569	3213	0.9962
209	2.471	Average	9/15/2008 22:45	9/15/2008 13:50	9/12/2008 13:20	0.033	7073	30	235.77	243.02	3.02083	0.37153	3198	0.9962
209	2.212	Stddev	9/18/2008 19:15	9/18/2008 11:15	9/15/2008 13:50	0.067	6170	30	205.67	243.02	2.89236	0.33333	3201	0.9962
209	2.420		9/30/2008 17:25	9/30/2008 11:40	9/28/2008 9:45	0.100	8795	30	293.17	243.02	4.07986	0.23958	3213	0.9962
210	2.320	Average	9/15/2008 23:15	9/15/2008 14:15	9/12/2008 13:20	0.033	6665	30	222.17	243.02	3.03819	0.37500	3198	0.9962
210	2.210	Stddev	9/18/2008 19:45	9/18/2008 11:30	9/15/2008 14:15	0.100	6142	30	204.73	243.02	2.88542	0.34375	3201	0.9962
210	2.230		9/30/2008 18:00	9/30/2008 12:05	9/28/2008 9:45	0.033	8116	30	270.53	243.02	4.09722	0.24653	3213	0.9962
211	2.140	Average	9/15/2008 23:50	9/15/2008 14:30	9/12/2008 13:20	0.033	6150	30	205.00	243.02	3.04661	0.36889	3198	0.9962
211	2.238	Stddev	9/18/2008 22:20	9/18/2008 12:35	9/15/2008 14:30	0.133	6207	30	206.90	243.02	2.92014	0.40625	3201	0.9962
211	2.136		9/30/2008 18:30	9/30/2008 13:35	9/28/2008 9:45	0.100	7917	30	263.90	243.02	4.15972	0.20486	3213	0.9962
212	2.405	Average	9/16/2008 0:20	9/15/2008 14:50	9/12/2008 13:20	0.033	6926	30	230.87	243.02	3.06250	0.39563	3198	0.9962
212	2.315	Stddev	9/18/2008 22:55	9/18/2008 12:50	9/15/2008 14:50	0.267	6405	30	213.50	243.02	2.91667	0.42014	3201	0.9962
212	2.244		9/30/2008 19:50	9/30/2008 14:00	9/28/2008 9:45	0.267	8287	30	276.23	243.02	4.17708	0.24306	3213	0.9962

NU 12/19/08

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# Verification for Ra-226 Standard 0299-G

4/2/2008	Isotope	Detector CPM	BKG CPM	NET CPM	Detector Eff	Mass. Used (G)	Source DPM/G
D. Roy	0299-G N1	2536.9600	52.4000	2484.5600	1.917186	0.5057	2562.667649
	0299-G N2	2520.2500	52.4000	2467.8500	1.917186	0.5056	2545.935781
	0299-G N3	2532.5000	52.4000	2480.1000	1.917186	0.5042	2565.677715
						Average =	2558.093715

Mean Value (Counting) = 2558.093715  
 Stdev = 10.63610098

Certificate Value = 2437.6 dpm/mL  
 Lower Limit = 2536.821513 dpm/mL  
 Upper Limit = 2579.365917 dpm/mL  
 Rule 1 Pass/Fail Fail \*exception taken due to full recovery of standard  
 Two sigma = 21.27220197 dpm/mL  
 10 % of Mean = 255.8093715 dpm/mL  
 Rule 2 (Pass/Fail) Pass

## Verification Rules

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.
- Rule 3 = The determined mean value shall be within 10% of the certificate value.

The analyst prepared three standard verification sources for Ra-226 source 0299-G by transferring portions of the standard into tared glass liquid scintillation vials. One mL of DI Water and ten mLs of Ready Gel liquid scintillation cocktail was added to each vial and the vials were shaken to mix. A Blank vial was prepared in a similar fashion using 1 mL of DI water and 10 mL of Ready Gel cocktail. The standard verification vials and Background source were dark adapted for two hours and counted on LSC Gold for Radium source standard verification. The Ra-226 efficiency calibration which was used for verification calculations was performed on 4/02/08 using source 0024-A (Ra-226). Calibration data is recorded in this logbook under Ra-226 0024. Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

BAD.SOP.M-001

Net 12/19/08  
 11/11/08  
 Nancy E. Johnson 4/9/08  
 Daniel Dwyer 4/10/08



# Standard Traceability Log Rad

Source Material Info		A Solution Material Info	
Parent Code:	0299	Isotope:	Radium-226
Prepared By:	Angela Johnson	Prepared By:	Angela Johnson
Carrier Conc:	0.5 M HCL	Prep Date:	09/15/2000
Reference Date:	12/15/1999	Verification Date:	01/23/2008
Ampoule Mass (g):	5.0368 g	Expiration Date:	01/23/2009
Uncertainty:	+/- 2.5 %	Primary Code:	0299-A
LogBook No:	RC S 027 128	Dilution(mL):	100 mL
		Mass of Parent(g):	4.6634 g
		Density(g/mL):	1.0012
		Balance ID:	

### Calculations Converting parent activity to dpm/mL|dpm/g

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$$

### Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
08/26/2003	Angela Johnson	1.9909	100	0299-E	2434.34 dpm/mL	11/04/2004	11/04/2005
08/26/2003	Angela Johnson	1.9872	100	0299-F	2429.82 dpm/mL	08/26/2004	08/26/2005
04/05/2005	Amanda Fehr	5.0018	250	0299-G	2446.3471 dpm/mL	04/02/2008	04/02/2009

GEL Laboratories LLC  
Version 1.0 9/18/2000

*all the 12/19/08*  
*len 12/19/08*



## General Engineering Laboratories Verification Source Preparation Sheet

Applicable SOP Number <u>GLRAD A-008</u>	Isotope <u>Ra-226</u>
Date Standards Prepared <u>4/5/08</u>	Cocktail Type Used <u>NA</u>
Standard ID <u>0299-G</u>	Matrix of Vial/Planchett <u>NA</u> <u>NA</u> <u>NA</u>
Amount Used (g or ml) <u>0.1</u>	Type of Scintillation Vial <u>NA</u>
Standard Activity (DPM/g or ml) <u>2446.347</u>	Pipette ID Used <u>1429303</u>
Reference Date <u>12/15/99</u>	Balance ID Used <u>36040216</u>
Expiration Date <u>4/2/09</u>	Quenching Agent <u>NA</u>
Residue/Carrier Agent <u>0.5 M HCl</u>	

	Standard Number	Quenching Vol (uL) Residue Volume (mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
14	Cal 14				
13	Cal 13				
43	Cal 43				
15	Cal 15				
44	Cal 44				
46	Cal 46				
36	Cal 36				
19	Cal 19				
47	Cal 47				
37	Cal 37				
42	Cal 42				

*See table*

Prepared By: <u>Kelli S. Deroso</u>	Date: <u>12/19/08</u>
Reviewed By: <u>M. G. Johnson</u>	Date: <u>12/19/08</u>

Rev 1 RLM 9/10/97

0299

UKAS ACCREDITED CALIBRATION LABORATORY No. 0146

Reference time for solution number R4/131/89:	1200 GMT on 15 December 1999
Radioactive concentration of radium-226:	43.75 kilobecquerels per gram of solution
which is equivalent to:	1.183 microcuries per gram of solution
Mass of solution:	5.0368 grams
Total activity of radium-226:	220.4 kilobecquerels
which is equivalent to:	5.956 microcuries
Recommended half life:	1600 years

Method of measurement:  
The activity of the solution was measured using a high pressure re-entrant ionisation chamber calibrated with a large number of absolutely standardised solutions.

Calibration date: 15 December 1999  
The calibration date is provided for added information only, and must not be confused with the reference date on pages 1 and 2 of the certificate. It is the reference date that must be used in all calculations relating to the values of activity.

Expanded uncertainty in the radioactive concentration quoted above:  $\pm 2.5\%$   
Combined Type A uncertainty:  $\pm 0.2\%$   
Combined Type B uncertainty:  $\pm 1.3\%$

Radiochemical The estimated activities of any radioactive impurities found by high-resolution gamma ray spectrometry, or in any other examination of the solution, are listed below expressed as percentages of the activity of the principal radionuclide at the reference time.

Carrier free in 0.5M HCl

This product meets the quality assurance requirements for achieving traceability to NIST as defined in ANSI N42.22-1995.

1 year = 365.25 days

At the reference date radium-226 was shown to be in radioactive equilibrium with its daughter nuclides down the decay chain to polonium-214 and thallium-210, the precursors of lead-210. The ionisation chamber was calibrated using a standard supplied by the National Institute of Standards and Technology, Washington DC, USA.

*Handwritten:* 12/19/99  
12/19/98

# Ra-226 WATER

Batch : LCSVER  
Date : 10/31/2008  
Analyst : KSD1

Procedure Code : LUC26RAL

Parname : Radium-226

MDA : 1 pCi/L

Instrument Used : LUCAS CELL DETECTOR

Bkg Count Time: 30 min

Sample ID	Sample Vol L	Count Time min	Gross counts cts	Cell # num	Cell Const. num	BKG cpm	Ra-226 MDA pCi/L	Ra-226 RESULT pCi/L	Ra-226 ERROR pCi/L	COUNT DATE/TIME
VER 1	0.500	30	1014	201	1.993	0.267	0.3504	22.1841	1.3817	11/17/2008 15:10
VER 2	0.500	30	1056	202	2.261	0.267	0.3089	20.3702	1.2427	11/17/2008 15:45
VER 3	0.500	30	726	203	2.254	0.267	0.5419	24.4866	1.8110	10/30/2008 16:05
VER 4	0.500	30	737	204	2.193	0.267	0.5519	25.3188	1.8580	10/30/2008 18:20
VER 5	0.500	30	937	205	1.799	0.267	0.3882	22.6936	1.4718	11/17/2008 16:20
VER 6	0.500	30	780	206	2.259	0.267	0.5373	26.1045	1.8604	10/30/2008 20:20
VER 7	0.500	30	711	207	2.146	0.267	0.5705	25.2245	1.8858	10/30/2008 22:00
VER 3	<del>0.500</del>	<del>30</del>	<del>593</del>	<del>208</del>	<del>2.283</del>	<del>0.267</del>	<del>0.5132</del>	<del>16.9552</del>	<del>1.4723</del>	<del>11/20/2008 16:40</del>
VER 9	0.500	30	630	209	2.291	0.133	0.4042	21.0513	1.6596	10/30/2008 23:40
VER 10	0.500	30	691	210	2.253	0.033	0.2527	23.7356	1.7736	10/31/2008 1:15
VER 11	0.500	30	1067	211	2.171	0.267	0.3314	22.0840	1.3401	11/17/2008 21:55
VER 12	0.500	30	648	212	2.322	0.133	0.4223	22.6294	1.7586	10/31/2008 9:15

12/19/08  
KSD

12/19/08  
KSD

Sample ID	Sample Dup	Det #	Run Date	Sample Type	Standard ID	NC	NC units	Recovery/RPD
201		2	11/17/2008 10:20	LCS	0638-F	24.10	pCi/L	92%
202		2	11/17/2008 10:45	LCS	0638-F	24.10	pCi/L	85%
203		2	10/30/2008 11:05	LCS	0638-F	24.10	pCi/L	102%
204		2	10/30/2008 12:30	LCS	0638-F	24.10	pCi/L	105%
205		2	11/17/2008 11:10	LCS	0638-F	24.10	pCi/L	94%
206		2	10/30/2008 13:10	LCS	0638-F	24.10	pCi/L	108%
207		2	10/30/2008 13:25	LCS	0638-F	24.10	pCi/L	105%
208		2	11/20/2008 11:45	LCS	0638-F	24.10	pCi/L	70% <i>W</i>
209		2	10/30/2008 14:05	LCS	0638-F	24.10	pCi/L	87% <i>W</i>
210		2	10/30/2008 14:25	LCS	0638-F	24.10	pCi/L	98% <i>W</i>
211		2	11/17/2008 12:20	LCS	0638-F	24.10	pCi/L	92%
212		2	10/30/2008 14:55	LCS	0638-F	24.10	pCi/L	94%

*W*  
*12/18/08*

DEGASSING DATE/TIME	DE-EMAN. DATE/TIME	DEGASS-DE-EM	dE-EM-COUNT	constant	constant	constant	Net CPM	Ingrowth constant
11/10/2008 15:35	11/17/2008 10:20	162.75	4.83	0.7073	0.9642	1.0019	33.5333	0.6833
11/10/2008 15:35	11/17/2008 10:45	163.17	5.00	0.7083	0.9630	1.0019	34.9333	0.6833
10/27/2008 14:20	10/30/2008 11:05	68.75	5.00	0.4049	0.9630	1.0019	23.9333	0.3907
10/27/2008 14:20	10/30/2008 12:30	70.17	5.83	0.4113	0.9569	1.0019	24.3000	0.3943
11/10/2008 15:35	11/17/2008 11:10	163.58	5.17	0.7092	0.9617	1.0019	30.9667	0.6833
10/27/2008 14:20	10/30/2008 13:10	70.83	7.17	0.4142	0.9473	1.0019	25.7333	0.3931
10/27/2008 14:20	10/30/2008 13:25	71.08	8.58	0.4153	0.9373	1.0019	23.4330	0.3900
11/17/2008 11:10	11/20/2008 11:45	72.58	4.92	0.4219	0.9696	1.0019	17.5900	0.4073
10/27/2008 14:20	10/30/2008 14:05	71.75	9.58	0.4182	0.9302	1.0019	20.8670	0.3898
10/27/2008 14:20	10/30/2008 14:25	72.08	10.83	0.4197	0.9215	1.0019	23.0003	0.3875
11/10/2008 15:35	11/17/2008 12:20	164.75	9.58	0.7117	0.9302	1.0019	35.3000	0.6633
10/27/2008 14:20	10/30/2008 14:55	72.58	18.33	0.4219	0.8707	1.0019	21.4670	0.3681

*W*  
*12/18/08*

*W*  
*12/19/08*  
*W*  
*12/18/08*





# Verification for Ra-226 Standard 0638-F

D Roy  
12/27/2007

Isotope	Detector CPM	BKG CPM	NET CPM	Detector Eff Mass. Used (mL)	Source DPM/mL
0638-F N1	1239.9000	31.5000	1208.4000	4.624018	261.3311626
0638-F N2	1222.8000	31.5000	1191.3000	4.624018	257.6330801
0638-F N3	1219.4000	31.5000	1187.9000	4.624018	256.8977889
					Average = 258.6206772

Mean Value (Counting) = 258.6206772  
 Stdev = 2.375965421

Certificate Value = 267.1  
 Lower Limit = 253.8687464  
 Upper Limit = 263.3726081  
 Rule 1 Pass/Fail Fail  
 Two sigma = 4.751930843  
 10 % of Mean = 25.86206772  
 Rule 2 (Pass/Fail) Pass

\*exception taken due to full recovery of standard

96.8384646 Pass  
 0.00918707 Rule 3 (Pass/Fail)

## Verification Rules

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.
- Rule 3 = The determined mean value shall be within 5% of the certificate value.

The analyst prepared three standard verification sources for Ra-226 source 0638-F by transferring portions of the standard into tared glass liquid scintillation vials. One mL of DI Water and 10 mL Ready Gel liquid scintillation cocktail was added to each vial and the vials were shaken to mix. A Blank vial was prepared in a similar fashion using 1 mL of DI water and 10 mL of Ready Gel cocktail. The standard verification vials and Background source were dark adapted for two hours and counted on LSC YELLOW using source standard verification. The Ra-226 efficiency calibration which was used for verification calculations was performed on 12/27/07 using source 0024-A (Ra-226). Calibration data is recorded in this logbook under Ra-226 (0024-A). Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

Reference RAD SOP M-001

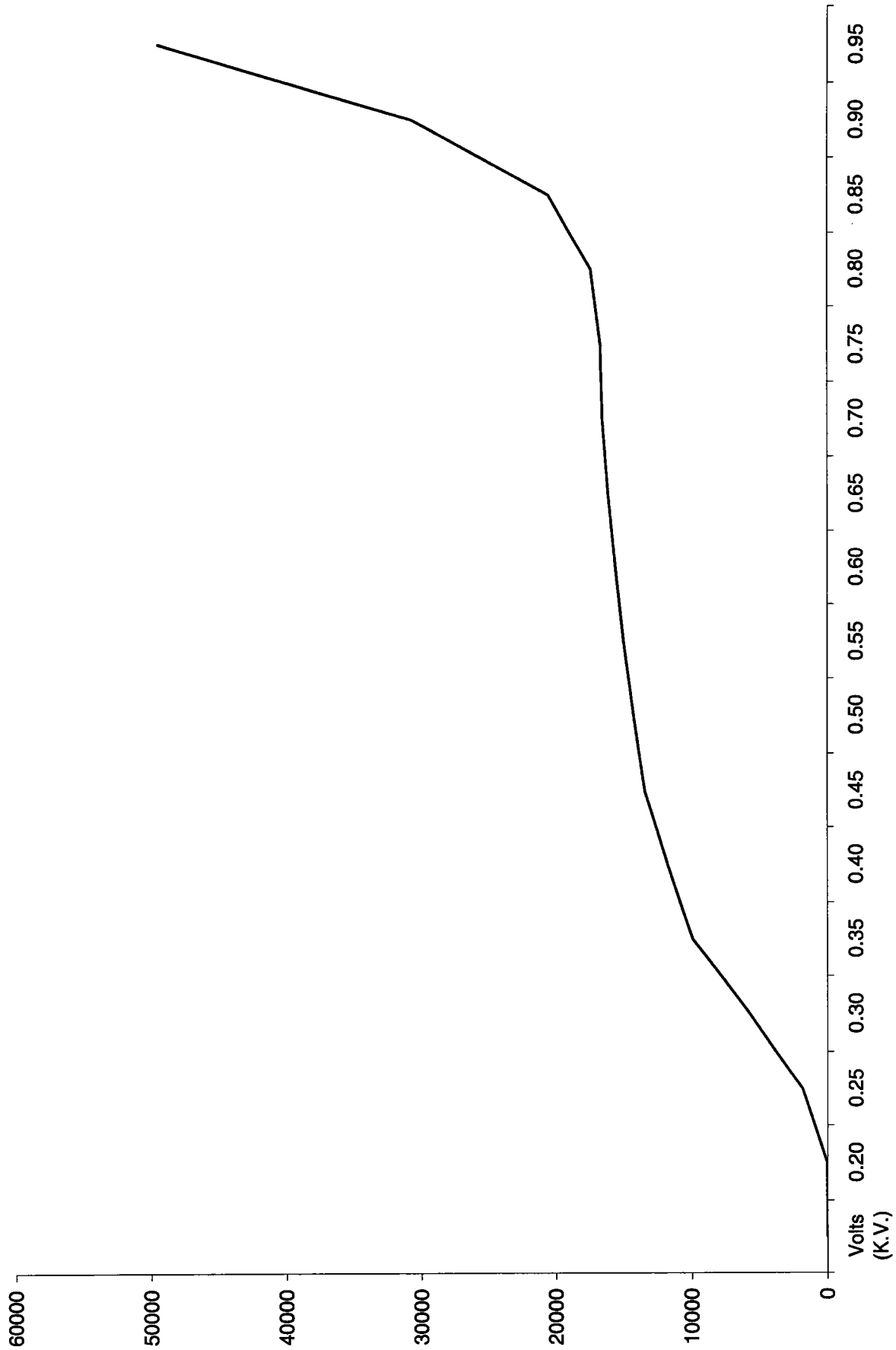
12/19/08

*Handwritten signature and date:*  
 1/4/07  
 Amanda L. Fehr 1/4/07









mut 12/19/08  
12/19/08

201	1.993	12/19/2008
202	2.261	12/19/2008
203	2.254	12/19/2008
204	2.193	12/19/2008
205	1.799	12/19/2008
206	2.259	12/19/2008
207	2.146	12/19/2008
209	2.291	12/19/2008
210	2.253	12/19/2008
211	2.171	12/19/2008
212	2.322	12/19/2008

Next  
12/19/08

# General Engineering Laboratories

2040 Savage Road, Charleston, SC 29414

(843)556-8171

## Lucas Cell Calibration Package

	YES	NO	Comments
1) Is all calibration standard information enclosed for: the primary standard certificate? the secondary standard(s) documentation? standard preparation information? standard < 1 Year old or verified?	✓		
	✓		
	✓		
	✓		
2) Is the efficiency calibration report included ?	✓		
3) Is the raw count data included for: Cell constant determination? Plateau generation?	✓		
	✓		
4) Are the calibration verifications included?	✓		
5) Are the instrument settings included: HVPS settings?	✓		
6) Has the CELLEFF.xls file been updated ?	✓		
7) Have the calibration dates been updated in ALPHALIMS ?	✓		

Prepared By: Kellipanel

Date: 2/3/09

Reviewed By: W. G. Hens

Date: 2/4/09

Effective Date: 2/4/09

# Ra-226 Cell Constants

Standard Reference date: 12/15/1999  
standard ID: 0299-G  
Volume added (mL): 0.1  
Standard Reference Activity (DPM/mL): 2446.35

Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/Time flushed to cell	Date/Time end of degas	bkg cpm	total counts	count time min	cpm	Known activity dpm	t1 (days) end-degas to flush	t2 (days) end-flush to count	t3 (days) Std Ref Date to count	Decay from Std Ref Date to count
301	1.867	Average	1/20/2009 11:05	1/19/2009 10:10	1/19/2009 15:45	0.267	9355	30	311.83	243.67	9.76736	1.03819	3324	0.9961
301	2.184	Stdev	1/29/2009 11:50	1/29/2009 8:50	1/28/2009 13:00	0.267	6239	30	207.97	243.67	2.82639	0.12500	3333	0.9961
301	2.011		1/26/2009 14:35	1/26/2009 9:25	1/22/2009 9:10	0.267	7282	30	242.73	243.67	4.01042	0.21528	3331	0.9961
302	2.082	Average	1/30/2009 11:30	1/30/2009 8:30	1/28/2009 13:00	0.267	7401	30	246.70	243.67	3.81250	0.12500	3334	0.9961
302	2.225	Stdev	1/29/2009 13:30	1/29/2009 9:20	1/28/2009 13:00	0.233	6335	30	211.17	243.67	2.84722	0.17361	3334	0.9961
302	2.086		1/26/2009 15:30	1/26/2009 9:55	1/22/2009 9:10	0.267	7555	30	251.83	243.67	4.03125	0.23264	3331	0.9961
303	1.958	Average	1/20/2009 13:40	1/19/2009 11:00	1/19/2009 15:45	0.267	9695	30	323.17	243.67	9.80208	1.11111	3325	0.9961
303	2.218	Stdev	1/22/2009 20:35	1/22/2009 10:05	1/19/2009 15:00	0.267	5938	30	197.93	243.67	2.79514	0.43750	3327	0.9961
303	2.231		1/26/2009 17:20	1/26/2009 10:25	1/22/2009 9:10	0.267	8028	30	267.60	243.67	4.05208	0.28819	3331	0.9961

305	1.897	Average	1/20/2009 14:50	1/19/2009 11:35	1/19/2009 15:45	0.200	9357	30	311.90	243.67	9.82639	1.13542	3325	0.9961
305	2.191	Stdev	1/22/2009 21:50	1/22/2009 11:05	1/19/2009 15:00	0.267	5921	30	197.37	243.67	2.83681	0.44792	3327	0.9961
305	2.083		1/26/2009 23:00	1/26/2009 11:20	1/22/2009 9:10	0.267	7280	30	242.67	243.67	4.09028	0.48611	3331	0.9961
306	1.730	Average	1/20/2009 15:20	1/19/2009 11:50	1/19/2009 15:45	0.167	8521	30	284.03	243.67	9.83681	1.14593	3325	0.9961
306	1.891	Stdev	1/29/2009 14:30	1/29/2009 10:20	1/28/2009 13:00	0.233	4869	30	162.30	243.67	2.88889	0.17361	3334	0.9961
306	1.821		1/26/2009 23:30	1/26/2009 11:50	1/22/2009 9:10	0.267	6387	30	212.90	243.67	4.11111	0.48611	3331	0.9961
307	1.818	Average	1/20/2009 15:50	1/19/2009 12:05	1/19/2009 15:45	0.267	8944	30	298.13	243.67	9.84722	1.15625	3325	0.9961
307	2.095	Stdev	1/30/2009 12:55	1/30/2009 9:10	1/28/2009 13:00	0.267	7442	30	248.07	243.67	3.84028	0.15625	3335	0.9961
307	1.881		1/27/2009 0:05	1/26/2009 12:10	1/22/2009 9:10	0.267	6598	30	219.93	243.67	4.12500	0.49653	3331	0.9961
308	2.129	Average	1/29/2009 15:50	1/29/2009 11:05	1/28/2009 13:00	0.133	6149	30	204.97	243.67	2.92014	0.19792	3334	0.9961
308	1.858	Stdev	1/23/2009 9:35	1/22/2009 13:45	1/19/2009 15:00	0.267	4829	30	160.97	243.67	2.94792	0.82639	3327	0.9961
308	1.862		1/27/2009 8:30	1/26/2009 13:15	1/22/2009 9:10	0.267	6226	30	207.53	243.67	4.17014	0.80208	3331	0.9961
309	1.857	Average	1/20/2009 17:20	1/19/2009 13:35	1/19/2009 15:45	0.033	9149	30	304.97	243.67	9.90972	1.15625	3325	0.9961
309	1.964	Stdev	1/23/2009 10:30	1/22/2009 14:05	1/19/2009 15:00	0.267	5100	30	170.00	243.67	2.96181	0.85069	3327	0.9961
309	1.810		1/27/2009 9:05	1/26/2009 13:30	1/22/2009 9:10	0.267	6046	30	201.53	243.67	4.18056	0.81597	3331	0.9961

311	2.140	Average	1/29/2009 16:40	1/29/2009 11:20	1/28/2009 13:00	0.267	6176	30	205.87	243.67	2.93056	0.22222	3334	0.9961
311	2.212	Stdev	1/23/2009 12:20	1/22/2009 14:25	1/19/2009 15:00	0.267	5698	30	189.93	243.67	2.97569	0.91319	3328	0.9961
311	1.988		1/27/2009 10:15	1/26/2009 13:45	1/22/2009 9:10	0.267	6607	30	220.23	243.67	4.19097	0.85417	3331	0.9961
312	1.871	Average	1/20/2009 19:16	1/19/2009 14:10	1/19/2009 15:45	0.100	9135	30	304.50	243.67	9.93403	1.21250	3325	0.9961
312	2.014	Stdev	1/29/2009 17:10	1/29/2009 11:35	1/28/2009 13:00	0.167	5814	30	193.80	243.67	2.94097	0.23264	3334	0.9961
312	1.946		1/27/2009 11:10	1/26/2009 14:00	1/22/2009 9:10	0.267	6446	30	214.87	243.67	4.20139	0.88194	3331	0.9961

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Ra-226 Verification Sheet

Cal for #3

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
<del>Cal 43</del>	<del>500</del>	<del>11/21/09 1500</del>	<del>11/22/09 0410</del>	<del>11/21/09 1525</del>	<del>301</del>	<del>3</del>	<del>8</del>	<del>6110</del>
<del>Cal 44</del>	<del>500</del>	<del>11/21/09 1500</del>	<del>11/22/09 0605</del>	<del>11/21/09 1605</del>	<del>302</del>	<del>3</del>	<del>8</del>	<del>6498</del>
Cal 119	500	11/19/09 1500	11/22/09 1005	11/22/09 2035	303	3	8	5938
Cal 130	500	11/19/09 1500	11/22/09 1035	11/22/09 2120	304	3	8	5240
Cal 142	500	11/19/09 1500	11/22/09 1105	11/22/09 2150	305	3	8	5921
<del>Cal 144</del>	<del>500</del>	<del>11/19/09 1500</del>	<del>11/22/09 1135</del>	<del>11/22/09 1840</del>	<del>306</del>	<del>3</del>	<del>8</del>	<del>5393</del>
<del>Cal 15</del>	<del>500</del>	<del>11/19/09 1500</del>	<del>11/22/09 1320</del>	<del>11/23/09 0950</del>	<del>307</del>	<del>3</del>	<del>8</del>	<del>5870</del>
Cal 114	500	11/19/09 1500	11/22/09 1345	11/23/09 0935	308	3	8	4824
Cal 13	500	11/19/09 1500	11/22/09 1405	11/23/09 1000	309	3	8	5100
Cal 28	500	11/19/09 1500	11/22/09 1425	11/23/09 1020	311	3	8	5698
<del>Cal 36</del>	<del>500</del>	<del>11/19/09 1500</del>	<del>11/22/09 1440</del>	<del>11/23/09 1135</del>	<del>312</del>	<del>3</del>	<del>8</del>	<del>5881</del>
<del>Cal 27</del>	<del>500</del>	<del>11/19/09 1500</del>	<del>11/22/09</del>					

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Ra-226 Verification Sheet

Call for #3

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
Ca143	500	1122109 0910	1126109 0955	1126109 1455	301	3	8	7282
Ca147	500	1122109 0910	1126109 0955	1126109 1530	302	3	8	1555
Ca119	500	1122109 0910	1126109 1025	1126109 1600	303	3	8	8028
<del>Ca130</del>	<del>500</del>	<del>1122109 0910</del>	<del>1126109 1050</del>	<del>1126109 1645</del>	<del>304</del>	<del>3</del>		<del>5162</del>
Ca142	500	1122109 0910	1126109 1100	1126109 2300	305	3	8	7280
Ca144	500	1122109 0910	1126109 1150	1126109 2330	306	3	8	6387
Ca115	500	1122109 0910	1126109 1210	1127109 0005	307	3	8	6598
Ca114	500	1122109 0910	1126109 1315	1127109 0830	308	3	8	6226
Ca113	500	1122109 0910	1126109 1330	1127109 0905	309	3	8	6046
Ca128	500	1122109 0910	1126109 1345	1127109 1015	311	3	8	6607
Ca136	500	1122109 1510	1126109 1400	1127109 1110	312	3	8	6446
<del>Ca137</del>								

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# Verification for Ra-226 Standard 0299-G

4/2/2008	Isotope	Detector CPM	BKG CPM	NET CPM	Detector Eff	Standard Mass. Used (G)	Source DPM/G
D. Roy	0299-G N1	2536.9600	52.4000	2484.5600	1.917186	0.5057	2562.667649
	0299-G N2	2520.2500	52.4000	2467.8500	1.917186	0.5056	2545.935781
	0299-G N3	2532.5000	52.4000	2480.1000	1.917186	0.5042	2565.677715
						Average =	2558.093715

Mean Value (Counting) = 2558.093715  
 Stdev = 10.63610098

104.944421 Pass  
 0.00415782 Rule 3 (Pass/Fail)

Certificate Value = 2437.6 dpm/mL  
 Lower Limit = 2536.821513 dpm/mL  
 Upper Limit = 2579.365917 dpm/mL  
 Rule 1 Pass/Fail Fail \*exception taken due to full recovery of standard  
 Two sigma = 21.27220197 dpm/mL  
 10 % of Mean = 255.8093715 dpm/mL  
 Rule 2 (Pass/Fail) Pass

## Verification Rules

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.
- Rule 3 = The determined mean value shall be within 10% of the certificate value.

The analyst prepared three standard verification sources for Ra-226 source 0299-G by transferring portions of the standard into tared glass liquid scintillation vials. One mL of DI Water and ten mLs of Ready Gel liquid scintillation cocktail was added to each vial and the vials were shaken to mix. A Blank vial was prepared in a similar fashion using 1 mL of DI water and 10 mL of Ready Gel cocktail. The standard verification vials and Background source were dark adapted for two hours and counted on LSC Gold for Radium source standard verification. The Ra-226 efficiency calibration which was used for verification calculations was performed on 4/02/08 using source 0024-A (Ra-226). Calibration data is recorded in this logbook under Ra-226 0024. Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

IRAD-SOP-M-001

*Handwritten notes:*  
 5/10/08  
 M. N. J.  
 1.5 ml water for 3 vials



# Standard Traceability Log Rad

Source Material Info		A Solution Material Info	
Parent Code:	0299	Isotope:	Radium-226
Prepared By:	Angela Johnson	Prepared By:	Angela Johnson
Carrier Conc:	0.5 M HCL	Prep Date:	09/15/2000
Reference Date:	12/15/1999	Verification Date:	01/23/2008
Ampoule Mass (g):	5.0368 g	Expiration Date:	01/23/2009
Uncertainty:	+/- 2.5 %	Primary Code:	0299-A
LogBook No:	RC S 027 128	Dilution(mL):	100 mL
		Mass of Parent(g):	4.6634 g
		Density(g/mL):	1.0012
		Balance ID:	

### Calculations Converting parent activity to dpm/mL|dpm/g

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$$

### Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
08/26/2003	Angela Johnson	1.9909	100	0299-E	2434.34 dpm/mL	11/04/2004	11/04/2005
08/26/2003	Angela Johnson	1.9872	100	0299-F	2429.82 dpm/mL	08/26/2004	08/26/2005
04/05/2005	Amanda Fehr	5.0018	250	0299-G	2446.3471 dpm/mL	04/02/2008	04/02/2009

GEL Laboratories LLC  
Version 1.0 9/18/2000

LD 2/3/09  
ALLA 2/4/09

## General Engineering Laboratories Verification Source Preparation Sheet

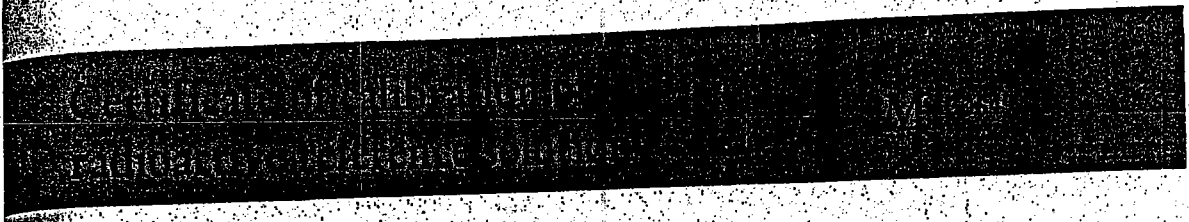
Applicable SOP Number GL RAD A 008 Isotope RA 226  
 Date Standards Prepared 4/15/09 Cocktail Type Used NA  
 Standard ID 02896 Matrix of Vial/Planchett NA  
 Amount Used (g or ml) 0.1 Matrix of Vial/Planchett NA  
 Standard Activity (DPM/g or ml) 2446.347 Matrix of Vial/Planchett NA  
 Reference Date 12/15/99 Pipette ID Used 1429303  
 Expiration Date 4/12/09 Balance ID Used 30040216  
 Residue/Carrier Agent 0.5 M HCl Quenching Agent NA

	Standard Number	Quenching Vol (uL) Residue Volume (mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
43	Cal 43				
47	Cal 47				
19	Cal 19				
30	Cal 30				
42	Cal 42				
44	Cal 44				
15	Cal 15				
14	Cal 14				
13	Cal 13				
28	Cal 28				
36	Cal 36				

1.00  
 2/3/09

Prepared By: Kelli Brown Date: 2/3/09  
 Reviewed By: Henry J. Jones Date: 2/4/09

0299



UKAS ACCREDITED CALIBRATION LABORATORY No. 0146

Reference time for solution number R4/131/89:	1200 GMT on 15 December 1999
Radioactive concentration of radium-226:	43.75 kilobecquerels per gram of solution
which is equivalent to:	1.183 microcuries per gram of solution
Mass of solution:	5.0368 grams
Total activity of radium-226:	220.4 kilobecquerels
which is equivalent to:	5.956 microcuries
Recommended half life:	1600 years

Method of measurement:  
The activity of the solution was measured using a high pressure re-entrant ionisation chamber calibrated with a large number of absolutely standardised solutions.

Calibration date: 15 December 1999  
The calibration date is provided for added information only, and must not be confused with the reference date on pages 1 and 2 of the certificate. It is the reference date that must be used in all calculations relating to the values of activity.

Expanded uncertainty in the radioactive concentration quoted above:  $\pm 2.5\%$

- Combined Type A uncertainty:  $\pm 0.2\%$
- Combined Type B uncertainty:  $\pm 1.3\%$

Radiochemical purity: The estimated activities of any radioactive impurities found by high-resolution gamma ray spectrometry, or in any other examination of the solution, are listed below expressed as percentages of the activity of the principal radionuclide at the reference time.

Chemical form: Carrier free in 0.5M HCL

Conformance: This product meets the quality assurance requirements for achieving traceability to NIST as defined in ANSI N42.22-1995.

1 year = 365.25 days

At the reference date radium-226 was shown to be in radioactive equilibrium with its daughter nuclides down the decay chain to polonium-214 and thallium-210, the precursors of lead-210. The ionisation chamber was calibrated using a standard supplied by the National Institute of Standards and Technology, Washington DC, USA.

KB 21/3/09  
WMA 21/11/09

# Ra-226 WATER

Batch : LCSVER  
 Date : 1/2/2009  
 Analyst : KSD1

Procedure Code : LUC26RAL  
 Parmname : Radium-226

MDA : 1 pCi/L

Instrument Used : LUCAS CELL DETECTOR

Bkg Count Time: 30 min

Sample ID	Sample Vol L	Count Time min	Gross counts cts	Cell # num	Cell Const. num	BKG cpm	Ra-226 MDA pCi/L	Ra-226 RESULT pCi/L	Ra-226 ERROR pCi/L	COUNT DATE/TIME
1	0.500	30	656	301	2.021	0.267	0.4919	20.0589	1.5634	1/30/2009 15:05
1	0.500	30	655	302	2.131	0.267	0.5554	22.6149	1.7640	2/2/2009 13:40
2	0.500	30	914	303	2.136	0.267	0.4647	26.4838	1.7397	1/30/2009 15:40
3	0.500	30	791	305	2.057	0.267	0.4845	23.8718	1.6891	1/30/2009 17:05
4	0.500	30	768	306	1.747	0.267	0.5709	27.2885	1.9605	1/30/2009 17:37
2	0.500	30	720	307	1.931	0.267	0.6113	27.3779	2.0335	2/2/2009 14:15
5	0.500	30	730	308	1.950	0.267	0.5149	23.3957	1.7254	1/30/2009 19:05
6	0.500	30	764	309	1.877	0.267	0.5908	28.0944	2.0238	1/31/2009 10:20
7	0.500	30	594	311	2.114	0.267	0.5510	20.3087	1.6667	1/31/2009 17:20
8	0.500	30	542	312	1.944	0.267	0.8009	26.8983	2.3154	2/2/2009 8:25

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 CW

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Sample ID	Cell #	Det #	Run Date	Sample Type	Standard ID	NC	NC units	Recovery/RPD
1	301	3	1/30/2009 10:40	LCS	0638-F	24.10	pCi/L	83%
2	302	3	2/2/2009 9:15	LCS	0638-F	24.10	pCi/L	94%
2	303	3	1/30/2009 11:05	LCS	0638-F	24.10	pCi/L	110%
3	305	3	1/30/2009 11:30	LCS	0638-F	24.10	pCi/L	99%
4	306	3	1/30/2009 11:45	LCS	0638-F	24.10	pCi/L	113%
2	307	3	2/2/2009 9:40	LCS	0638-F	24.10	pCi/L	114%
5	308	3	1/30/2009 12:00	LCS	0638-F	24.10	pCi/L	97%
3	309	3	1/30/2009 13:05	LCS	0638-F	24.10	pCi/L	117%
7	311	3	1/30/2009 13:20	LCS	0638-F	24.10	pCi/L	84%
8	312	3	1/30/2009 13:40	LCS	0638-F	24.10	pCi/L	112%

DEGASSING DATE/TIME	DE-EMAN. DATE/TIME	DEGASS-DE-EM	dE-EM-COUNT	constant	constant	Net CPM	Ingrowth constant
1/26/2009 16:05	1/30/2009 10:40	90.58	4.42	0.9672	1.0019	21.6000	0.4800
1/30/2009 10:00	2/2/2009 9:15	71.25	4.42	0.9672	1.0019	21.5667	0.4032
1/26/2009 16:05	1/30/2009 11:05	91.00	4.58	0.9660	1.0019	30.1997	0.4809
1/26/2009 16:05	1/30/2009 11:30	91.42	5.58	0.9587	1.0019	26.1000	0.4788
1/26/2009 16:05	1/30/2009 11:45	91.67	5.87	0.9567	1.0019	25.3330	0.4787
1/30/2009 10:00	2/2/2009 9:40	71.67	4.58	0.9660	1.0019	23.7330	0.4044
1/26/2009 16:05	1/30/2009 12:00	91.92	7.08	0.9479	1.0019	24.0667	0.4753
1/26/2009 16:05	1/30/2009 13:05	93.00	21.25	0.8518	1.0019	25.1997	0.4305
1/26/2009 16:05	1/30/2009 13:20	93.25	28.00	0.8095	1.0019	19.5330	0.4099
1/26/2009 16:05	1/30/2009 13:40	93.58	66.75	0.6041	1.0019	17.7997	0.3067

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 LEWA 2141.04



Ra-226 Verification Sheet

#3

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
VER 1	500	11/20/09 1605	11/20/09 1040	11/20/09 1505	301	3	8	656
VER 2	500	11/20/09 1605	11/20/09 1105	11/20/09 1540	303	3	8	914
VER 3	500	11/20/09 1605	11/20/09 1130	11/30/09 1705	305	3	8	791
VER 4	500	11/20/09 1605	11/20/09 1145	<del>11/30/09 1737</del> 1.31.09 1020	306	3	8	768
VER 5	500	11/20/09 1605	11/30/09 1000	<del>11/30/09 1905</del> 1.31.09 1020	308	3	8	730
VER 6	500	11/20/09 1605	11/30/09 1305	1.31.09 1020	309	3	8	764
VER 7	500	11/20/09 1605	11/20/09 1320	13/09 1720	311	3	8	594
VER 8	500	11/20/09 1605	11/20/09 1340	11/09 0845	312	3	8	542
<del>VER 9</del>	500	11/20/09 1605						
VER 10	500	11/20/09 1605						
VER 11	500	11/20/09 1605						
VER 12	500	11/20/09 1605						

VER 10  
2/8/09

12/21/09



## Verification for Ra-226 Standard 0638-F

	Isotope	Value	Uncertainty
D. Roy	0638-F #1	24.629	1.7426
2/2/2009	0638-F #2	24.438	1.7557
	0638-F #3	22.791	1.6808
<b>Mean Value (Counting) =</b>	23.953	99.60	<b>Pass</b>
<b>Stdev =</b>	1.010781096		<b>Rule 3 (Pass/Fail)</b>
<b>Target =</b>	24.05		
<b>Lower Limit =</b>	21.93100448		
<b>Upper Limit =</b>	25.97412886		
<b>Rule 1 Pass/Fail</b>	<b>Pass</b>		
<b>Two sigma =</b>	2.021562191		
<b>10 % of Mean =</b>	2.395256667		
<b>Rule 2 (Pass/Fail)</b>	<b>Pass</b>		

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements**
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.**
- Rule 3 = The determined mean value shall be within 5% of the certificate value.**

The analyst prepared three standard verification sources for standard 0638-F using 0.1 mL for each source. Each source was counted using routine Lucas cell procedures. Calibration for 0299-G was used in this verification.

140 2/4/09  
*[Signature]*  
 Amanda L. Lehn  
 2/4/09

## General Engineering Laboratories Verification Source Preparation Sheet

Applicable SOP Number GL-RAD-008 Isotope Pb-226  
 Date Standards Prepared <sup>2/11/09</sup> 2/13/2007 Cocktail Type Used N/A  
 Standard ID 0630-F Matrix of Vial/Planchett N/A  
 Amount Used (g or ml) 0.1 ml Type of Scintillation Vial N/A  
 Standard Activity (DPM/g or mL) 267.519 dpm/ml Pipette ID Used 1429303  
 Reference Date 1/23/2004 Balance ID Used N/A  
 Expiration Date 2/14/09 Quenching Agent N/A  
 Residue/Carrier Agent 0.1 ml H<sub>2</sub>O

	Standard Number	Quenching Vol (uL)/ Residue Volume (mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
1	Ver 1				
2	Ver 2				
3	Ver 3				
4	Ver 4				
5	Ver 5				
6	Ver 6				
7	Ver 7				
8	Ver 8				
9	Ver 9				
10	Ver 10				
11	Ver 11				
12	Ver 12				

*LO 2/13/09*

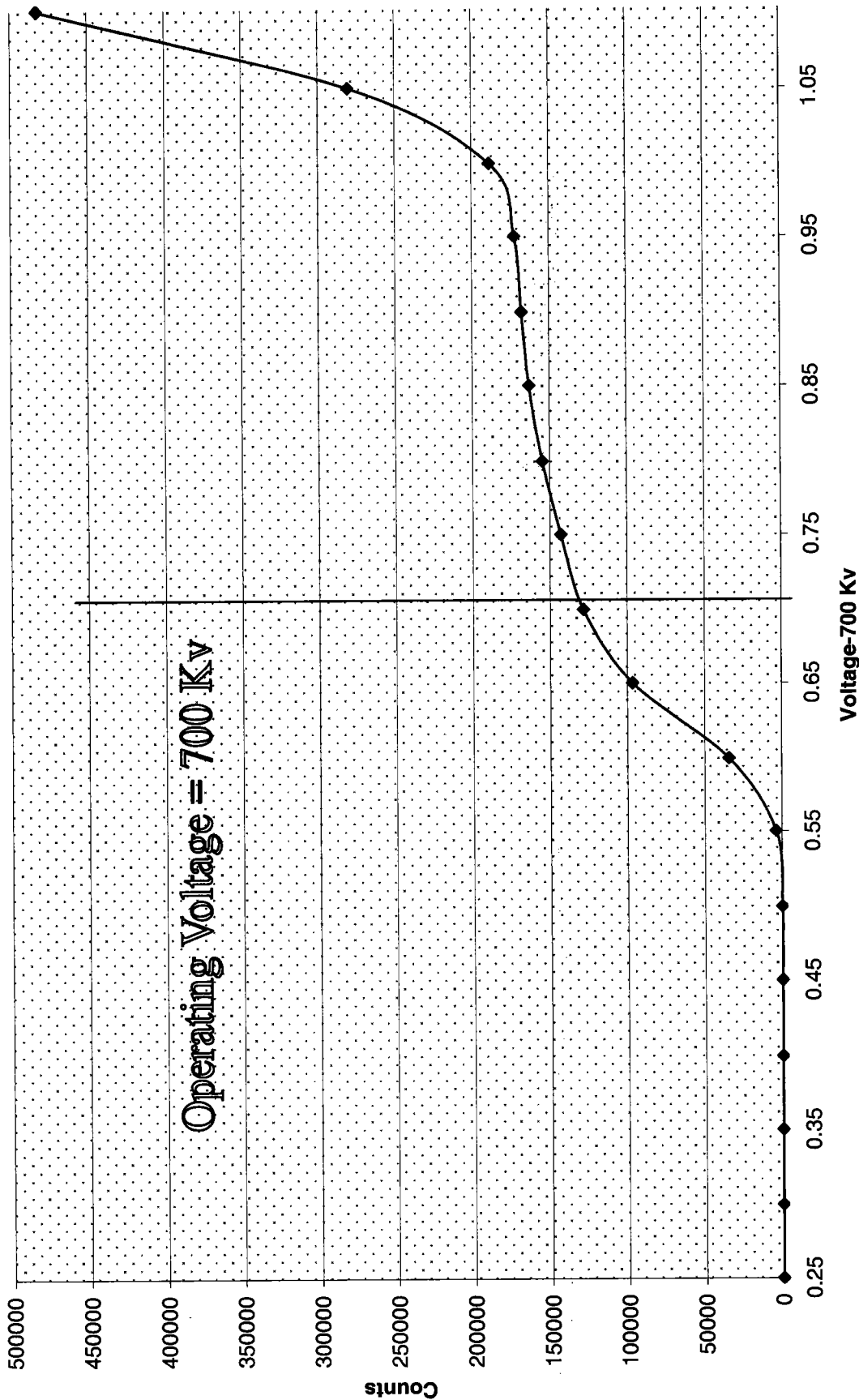
Prepared By: Kelli Brunell Date 2/13/09  
 Reviewed By: [Signature] Date 2/14/09

## Voltage Curve 1-09

Voltage Curve Ludlum # 3				
Volts	Counts	Date	Time	Detector
0.00	0	1/20/2009	13:45	3
0.05	0	1/20/2009	13:46	3
0.10	0	1/20/2009	13:47	3
0.15	0	1/20/2009	13:48	3
0.20	0	1/20/2009	13:49	3
0.25	0	1/20/2009	14:00	3
0.30	0	1/20/2009	14:01	3
0.35	0	1/20/2009	14:02	3
0.40	0	1/20/2009	14:03	3
0.45	0	1/20/2009	14:04	3
0.50	0	1/20/2009	14:05	3
0.55	3914	1/20/2009	14:06	3
0.60	34392	1/20/2009	14:07	3
0.65	96643	1/20/2009	14:08	3
0.70	128361	1/20/2009	14:09	3
0.75	142888	1/20/2009	14:10	3
0.80	154583	1/20/2009	14:11	3
0.85	163087	1/20/2009	14:12	3
0.90	167801	1/20/2009	14:13	3
0.95	172317	1/20/2009	14:14	3
1.00	188508	1/20/2009	14:15	3

KLA 2/4/09  
 LW  
 2/3/09

Ludlum 3 Voltage Curve



2/12/72  
MCA

KO 213109

301	2.021	2/4/2009
302	2.131	2/4/2009
303	2.136	2/4/2009
305	2.057	2/4/2009
306	1.747	2/4/2009
307	1.931	2/4/2009
308	1.950	2/4/2009
309	1.877	2/4/2009
311	2.114	2/4/2009
312	1.944	2/4/2009

RE UT  
2/4/09

~~RE UT~~  
2/4/09  
RE UT  
2/4/09

# General Engineering Laboratories

2040 Savage Road, Charleston, SC 29414  
(843)556-8171

## Lucas Cell Calibration Package (501-512)

	YES	NO	Comments
1) Is all calibration standard information enclosed for: the primary standard certificate? the secondary standard(s) documentation? standard preparation information? standard < 1 Year old or verified?	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
2) Is the efficiency calibration report included?	<input checked="" type="checkbox"/>		
3) Is the raw count data included for: Cell constant determination? Plateau generation?	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
4) Are the calibration verifications included?	<input checked="" type="checkbox"/>		
5) Are the instrument settings included: HVPS settings?	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
6) Has the CELLEFF.xls file been updated?	<input checked="" type="checkbox"/>		
7) Have the calibration dates been updated in ALPHALIMS?	<input checked="" type="checkbox"/>		

Prepared By: Kelli S. Dancer

Date: 3/24/09

Reviewed By: Angela Johnson

Date: 3/25/09

Effective Date: 3/25/09



# Ra-226 Cell Constants

standard ID: 0299-E  
Volume added (mL): 0.1  
Standard Reference Activity (DPM/mL): 2434.34

Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/time flushed to cell	Date/time end of degas	total counts	count time min	Known activity dpm	t1 (days) end-degas to flush	t2 (days) end-flush to count	t3 (days) Std Ref Date to count	Decay from Std Ref Date to count	
501	1.927	15	3/6/2009 7:50	3/3/2009 8:15	2/25/2009 14:00	5281	30	176.03	243.03	5.76042	2.98264	3369	0.9960
501	2.086	9	3/11/2009 10:40	3/10/2009 12:50	3/5/2009 14:00	7611	30	253.70	243.03	4.95139	0.90972	3374	0.9960
501	2.247	42	3/12/2009 13:30	3/12/2009 9:10	3/6/2009 15:25	10210	30	340.33	243.03	5.73958	0.18056	3376	0.9960
502	1.772	16	3/18/2009 8:25	3/17/2009 12:50	3/10/2009 14:00	7951	30	265.03	243.03	6.95739	0.81597	3381	0.9960
502	2.045	14	3/11/2009 11:15	3/10/2009 13:20	3/5/2009 14:00	7474	30	249.13	243.03	4.97222	0.91319	3374	0.9960
502	1.816	19	3/12/2009 14:20	3/12/2009 9:35	3/6/2009 15:25	8243	30	274.77	243.03	5.75694	0.19792	3376	0.9960
503	1.581	46	3/6/2009 9:20	3/5/2009 9:20	2/25/2009 14:00	7250	30	241.67	243.03	7.80556	1.00000	3369	0.9960
503	1.633	42	3/19/2009 20:15	3/19/2009 15:15	3/12/2009 12:10	8282	30	276.07	243.03	7.12847	0.20833	3383	0.9960
503	1.588	44	3/12/2009 14:50	3/12/2009 10:00	3/6/2009 15:25	7214	30	240.47	243.03	5.77431	0.20139	3378	0.9960
504	1.592	47	3/6/2009 10:30	3/5/2009 9:40	2/25/2009 14:00	7262	30	242.07	243.03	7.81944	1.03472	3369	0.9960
504	1.611	34	3/11/2009 12:30	3/10/2009 14:05	3/5/2009 14:00	5889	30	196.30	243.03	5.00347	0.93403	3375	0.9960
504	1.641	19	3/19/2009 20:50	3/19/2009 15:30	3/12/2009 12:10	8310	30	277.00	243.03	7.13889	0.22222	3383	0.9960
505	2.364	16	3/6/2009 12:40	3/5/2009 10:05	2/25/2009 14:00	10654	30	355.13	243.03	7.83681	1.10764	3370	0.9960
505	2.438	23	3/11/2009 13:00	3/10/2009 14:30	3/5/2009 14:00	8924	30	297.47	243.03	5.02083	0.93750	3375	0.9960
505	2.190	7	3/12/2009 17:01	3/12/2009 10:50	3/6/2009 15:25	9884	30	329.47	243.03	5.80903	0.25764	3376	0.9960
506	1.902	25	3/6/2009 13:10	3/5/2009 10:30	2/25/2009 14:00	8576	30	285.87	243.03	7.85417	1.11111	3370	0.9960
506	2.124	47	3/11/2009 13:30	3/10/2009 15:05	3/5/2009 14:00	7804	30	260.13	243.03	5.04514	0.93403	3375	0.9960
506	1.965	13	3/12/2009 17:40	3/12/2009 11:15	3/6/2009 15:25	8954	30	298.47	243.03	5.82639	0.26736	3376	0.9960
507	1.708	23	3/6/2009 13:45	3/5/2009 10:55	2/25/2009 14:00	7695	30	256.50	243.03	7.87153	1.11806	3370	0.9960
507	1.722	25	3/11/2009 14:20	3/10/2009 15:27	3/5/2009 14:00	6315	30	210.50	243.03	5.06042	0.95347	3375	0.9960
507	1.674	43	3/12/2009 18:30	3/12/2009 11:35	3/6/2009 15:25	7535	30	251.17	243.03	5.84028	0.28819	3376	0.9960
508	1.605	39	3/6/2009 14:20	3/5/2009 11:25	2/25/2009 14:00	7236	30	241.20	243.03	7.89236	1.12153	3370	0.9960
508	1.497	44	3/19/2009 21:30	3/19/2009 15:45	3/12/2009 12:10	7581	30	252.03	243.03	7.14931	0.23958	3383	0.9960
508	1.499	3	3/12/2009 20:45	3/12/2009 12:10	3/6/2009 15:25	6680	30	222.67	243.03	5.86458	0.35764	3376	0.9960
509	1.730	28	3/6/2009 14:50	3/5/2009 11:45	2/25/2009 14:00	7795	30	259.83	243.03	7.90625	1.12847	3370	0.9960
509	1.857	39	3/11/2009 15:25	3/10/2009 16:05	3/5/2009 14:00	6810	30	227.00	243.03	5.08681	0.97222	3375	0.9960
509	1.806	36	3/12/2009 21:20	3/12/2009 12:35	3/6/2009 15:25	8049	30	268.30	243.03	5.88194	0.36458	3376	0.9960
510	1.460	9	3/6/2009 15:25	3/5/2009 12:10	2/25/2009 14:00	6578	30	219.27	243.03	7.92361	1.13542	3370	0.9960
510	1.433	28	3/11/2009 16:05	3/10/2009 16:20	3/5/2009 14:00	5246	30	174.87	243.03	5.09722	0.98958	3375	0.9960
510	1.481	35	3/12/2009 21:55	3/12/2009 12:50	3/6/2009 15:25	6589	30	219.63	243.03	5.89236	0.37847	3376	0.9960
511	1.839	34	3/6/2009 16:30	3/5/2009 13:20	2/25/2009 14:00	8316	30	277.20	243.03	7.97222	1.13194	3370	0.9960
511	1.995	46	3/11/2009 16:50	3/10/2009 16:35	3/5/2009 14:00	7283	30	242.77	243.03	5.10764	1.01042	3375	0.9960
511	2.041	37	3/12/2009 22:40	3/12/2009 13:10	3/6/2009 15:25	9088	30	302.27	243.03	5.90625	0.39583	3376	0.9960
512	1.796	48	3/11/2009 17:35	3/10/2009 16:50	3/5/2009 14:00	6542	30	218.07	243.03	5.11806	1.03125	3375	0.9960
512	2.100	38	3/12/2009 23:15	3/12/2009 13:30	3/6/2009 15:25	9322	30	310.73	243.03	5.92014	0.40625	3376	0.9960
512	1.972	48	3/18/2009 13:00	3/17/2009 14:00	3/6/2009 14:00	8653	30	288.43	243.03	7.00000	0.95833	3382	0.9960

\*Backgrounds are not significant enough to be considered in calculations. ANSI N42.25-1997 (B.2).

ERR 0.143768 <- Put in Machines.xls (Lucas Cell Tab)

Calibration  
Ra-226 Verification-Sheet  
3/16/09

Cal # 5

no 3124109  
3119109

3/16/09

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
Cal 15	500	2/25/09 1400	3/3/09 0815	3/6/09 0750	501	5	8	5781
<del>Cal 14</del>	<del>500</del>	<del>2/25/09 1400</del>	<del>2/25/09 0845</del>	<del>3/6/09 0840</del>	<del>502</del>	<del>5</del>	<del>1</del>	<del>4700</del>
		2/25/09 1400	3/3/09		503	5	100 313109	6800
Cal 46	500	2/25/09 1400	3/5/09 0920	3/6/09 0900	503	5	3	7250
Cal 47	500	2/25/09 1400	3/5/09 0940	3/6/09 1030	504	5	1	7262
Cal 48	500	2/25/09 1400	3/5/09 1005	3/6/09 1040	505	5	3	10654
Cal 45	500	2/25/09 1400	3/5/09 1030	3/6/09 1016	506	5	8	8576
Cal 23	500	2/25/09 1400	3/5/09 1055	3/6/09 1345	507	5	4	7695
Cal 39	500	2/25/09 1400	3/5/09 1125	3/6/09 1420	508	5	1	7236
Cal 28	500	2/25/09 1400	3/5/09 1145	3/6/09 1450	509	5	8	7795
Cal 9	500	2/25/09 1400	3/5/09 1210	3/6/09 1525	510	5	2	6578
Cal 34	500	2/25/09 1400	3/5/09 1220	3/6/09 1630	511	5	6	8316

Calibration

Ra-226 Verification Sheet

219 3116109

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
Cal 9	500	3/5/09 1400	3/10/09 1250	3/11/09 1040	501	5	8	7611
Cal 14	500	3/5/09 1400	3/10/09 1370	3/11/09 1115	502	5	5	7474
<del>Cal 15</del>	<del>500</del>	<del>3/5/09 1400</del>	<del>3/10/09 1345</del>	<del>3/11/09 1155</del>	<del>503</del>	<del>5</del>	<del>8</del>	<del>7352</del>
Cal 16	500	3/5/09 1400	3/10/09 1405	3/11/09 1230	504	5	4	5889
Cal 17	500	3/5/09 1400	3/10/09 1430	3/11/09 1280	505	5	2	8924
Cal 17	500	3/5/09 1400	3/10/09 1505	3/11/09 1530	506	5	8	7804
<del>Cal 18</del>	<del>500</del>	<del>3/5/09 1400</del>	<del>3/10/09 1527</del>	<del>3/11/09 1410</del>	<del>507</del>	<del>5</del>	<del>4</del>	<del>6315</del>
<del>Cal 19</del>	<del>500</del>	<del>3/5/09 1400</del>	<del>3/10/09 1550</del>	<del>3/11/09 1455</del>	<del>508</del>	<del>5</del>	<del>4</del>	<del>6443</del>
Cal 29	500	3/5/09 1400	3/10/09 1605	3/11/09 1525	509	5	8	6810
Cal 28	500	3/5/09 1400	3/10/09 1620	3/11/09 1610	510	5	3	5246
Cal 44	500	3/5/09 1400	3/10/09 1635	3/11/09 1650	511	5	8	7283
Cal 48	500	3/5/09 1400	3/10/09 1650	3/11/09 1735	512	5	8	6542

219 3124109

219 3124109

219 3124109

219 3116109



Calibration  
 Ra-226 Verification Sheet  
 3/25/09

Cal #5's

VO  
 3/24/09  
 VO  
 3/24/09

3/25/09  
 3/25/09

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
Cal 114	500	3/10/09 1400	3/17/09 1250	3/18/09 0825	502	5	5	7951
<del>Cal 119</del>	<del>500</del>	<del>3/16/09 1400</del>	<del>3/17/09 1325</del>	<del>3/18/09 0855</del>	<del>503</del>	<del>5</del>		<del>6855</del>
<del>Cal 128</del>	<del>500</del>	<del>3/16/09 1400</del>	<del>3/17/09 1345</del>	<del>3/18/09 1005</del>	<del>504</del>	<del>5</del>		<del>6804</del>
Cal 140	500	3/10/09 1400	3/17/09 1400	3/18/09 1300	512	5	8	8053
Cal 125	500	3/15/09 1400	3/16/09 1527	3/17/09 1420	507	5	4	6315

3/24/09

# Ra-226 Calibration Sheet

Standard ID: 0124109  
 Volume Added (mL): 1.1  
 Expiration Date: 4/12/09

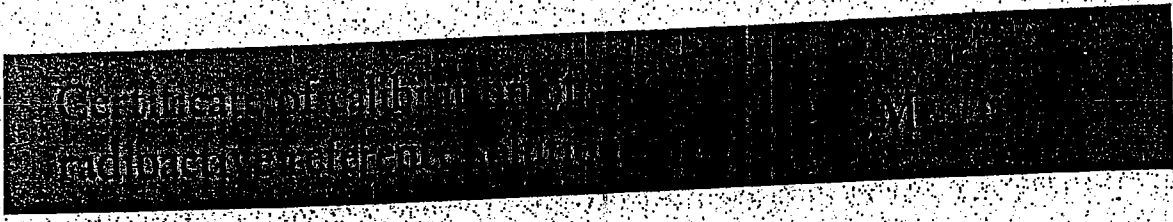
Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 42	500	3/12/09 1210	3/12/09 1515	3/19/09 2015	503	85	8282
Cal 19	500	3/12/09 1210	3/12/09 1530	3/19/09 2030	504	5	8310
Cal 44	500	3/12/09 1210	3/12/09 1545	3/19/09 2130	508	5	7561
<del>Cal 30</del>	<del>500</del>	<del>3/12/09 1210</del>	<del>3/12/09 1600</del>	<del>3/19/09 2200</del>	<del>509</del>	<del>5</del>	<del>7942</del>

3/25/09  
 3/25/09

8-21-00

Nycomed Amersham plc  
Amersham Laboratories

0299



Nycomed Amersham plc  
Radiation & Radioactivity  
Calibration Laboratory  
Amersham Laboratories  
White Lion Road  
Amersham  
Buckinghamshire  
HP7 9LL

ISSUED  
FOR:

AEA Technology plc  
Isotrak  
Amersham Laboratories  
White Lion Road  
Amersham  
Buckinghamshire  
HP7 9LL

ion Principal radionuclide: Radium-226

Product code: RAY44  
Solution number: R4/131/89

ment Reference time: 1200 GMT on 15 December 1999

data Nuclear data quoted on this certificate are taken from the Joint European File, Version 2.2.

ion of The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2.00$ , which  
inties for a  $t$ -distribution with  $v_{eff} = \infty$  effective degrees of freedom corresponds to a coverage probability of approximately  
95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Unless indicated, all other uncertainties are expressed at the confidence level associated with one standard  
uncertainty.

The format used for the uncertainties in the values of radionuclidic purity is illustrated in the following examples;

6.5(21)	-	6.5 ± 2.1
6.54(21)	-	6.54 ± 0.21
6.543(21)	-	6.543 ± 0.021

ved

Date of 252 17<sup>th</sup> December 1999



# Standard Traceability Log Rad

Source Material Info	
Parent Code:	0299
Prepared By:	Angela Johnson
Carrier Conc:	0.5 M HCL
Reference Date:	12/15/1999
Ampoule Mass (g):	5.0368 g
Uncertainty:	+/- 2.5 %
LogBook No:	RC S 027 128

A Solution Material Info	
Isotope:	Radium-226
Prepared By:	Angela Johnson
Prep Date:	09/15/2000
Verification Date:	01/23/2008
Expiration Date:	01/23/2009
Primary Code:	0299-A
Dilution(mL):	100 mL
Mass of Parent(g):	4.6634 g
Density(g/mL):	1.0012
Balance ID:	

### Calculations Converting parent activity to dpm/mL|dpm/g

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$$

### Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
08/26/2003	Angela Johnson	1.9909	100	0299-E	2434.34 dpm/mL	11/04/2004	11/04/2005
08/26/2003	Angela Johnson	1.9872	100	0299-F	2429.82 dpm/mL	08/26/2004	08/26/2005
04/05/2005	Amanda Fehr	5.0018	250	0299-G	2446.3471 dpm/mL	04/02/2008	04/02/2009

GEL Laboratories LLC  
Version 1.0 9/18/2000

*Kelli Dorell*



# Verification for Ra-226 Standard 0299-G

4/2/2008	Isotope	Detector CPM	BKG CPM	NET CPM	Detector Eff	Standard Mass. Used (G)	Source DPM/G
D. Roy	0299-G N1	2536.9600	52.4000	2484.5600	1.917186	0.5057	2562.667649
	0299-G N2	2520.2500	52.4000	2467.8500	1.917186	0.5056	2545.935781
	0299-G N3	2532.5000	52.4000	2480.1000	1.917186	0.5042	2565.677715
						Average =	2558.093715

Mean Value (Counting) = 2558.093715  
 Stdev = 10.63610098

Certificate Value = 2437.6 dpm/mL  
 Lower Limit = 2536.821513 dpm/mL  
 Upper Limit = 2579.365917 dpm/mL  
 Rule 1 Pass/Fail = **Fail** \*exception taken due to full recovery of standard  
 Two sigma = 21.27220197 dpm/mL  
 10 % of Mean = 255.8093715 dpm/mL  
 Rule 2 (Pass/Fail) = **Pass**

### Verification Rules

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.
- Rule 3 = The determined mean value shall be within 10% of the certificate value.

The analyst prepared three standard verification sources for Ra-226 source 0299-G by transferring portions of the standard into tared glass liquid scintillation vials. One mL of DI Water and ten mLs of Ready Gel liquid scintillation cocktail was added to each vial and the vials were shaken to mix. A Blank vial was prepared in a similar fashion using 1 mL of DI water and 10 mL of Ready Gel cocktail. The standard verification vials and Background source were dark adapted for two hours and counted on LSC Gold for Radium source standard verification. The Ra-226 efficiency calibration which was used for verification calculations was performed on 4/02/08 using source 0024-A (Ra-226). Calibration data is recorded in this logbook under Ra-226 0024. Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

BAD.SOP.M-001

*Handwritten notes:*  
 New Source 3/24/09  
 4/19/08  
 David Dwyer 4/10/08

**General Engineering Laboratories**  
**Verification Source Preparation Sheet**  
*Calibration*

Applicable SOP Number GL RAD-A-008 Isotope RA-226  
 Date Standards Prepared 4/15/09 Cocktail Type Used NA  
 Standard ID 0249-G Matrix of Vial/Planchett NA  
 Amount Used (g or ml) 0.1 NA  
 Standard Activity (DPM/g or ml) 2446.347 Type of Scintillation Vial NA  
 Reference Date 12/15/99 Pipette ID Used 1429303  
 Expiration Date 4/2/09 Balance ID Used 36240216  
 Residue/Carrier Agent D.5M HCl Quenching Agent NA

	Standard Number	Quenching Vol (uL) Residue Volume (mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
15	Ca115				
46	Ca146				
47	Ca147				
16	Ca116				
25	Ca125				
23	Ca123				
39	Ca139				
28	Ca128				
9	Ca19				
34	Ca134				
42	Ca142				
19	Ca119				
44	Ca144				
7	Ca17				
13	Ca113				

VLD 3/24/09

Prepared By: Kelli D'Amico Date 3/24/09  
 Reviewed By: \_\_\_\_\_ Date \_\_\_\_\_

Rev 1 RLM 9/10/97

**General Engineering Laboratories**  
**Verification Source Preparation Sheet**  
*Calibration*

*3/25/09*

Applicable SOP Number GLDMP-A-008 Isotope DIA 226

Date Standards Prepared 4/5/09 Cocktail Type Used NA

Standard ID 02946 Matrix of Vial/Planchett NA  
NA  
NA

Amount Used (g or ml) 0.1 Type of Scintillation Vial NA

Standard Activity (DPM/g or mL) 2146.347 Pipette ID Used 1429303

Reference Date 12/15/99 Balance ID Used 3604026

Expiration Date 4/2/09 Quenching Agent NA

Residue/Carrier Agent 0.5M HCl

	Standard Number	Quenching Vol (uL)/ Residue Volume (mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
<i>43</i>	<i>Cal 43</i>				
<i>3</i>	<i>Cal 3</i>				
<i>36</i>	<i>Cal 36</i>				
<i>35</i>	<i>Cal 35</i>				
<i>37</i>	<i>Cal 37</i>				
<i>38</i>	<i>Cal 38</i>				

*160 3/24/09*

Prepared By: Kelli Duce Date 3/24/09

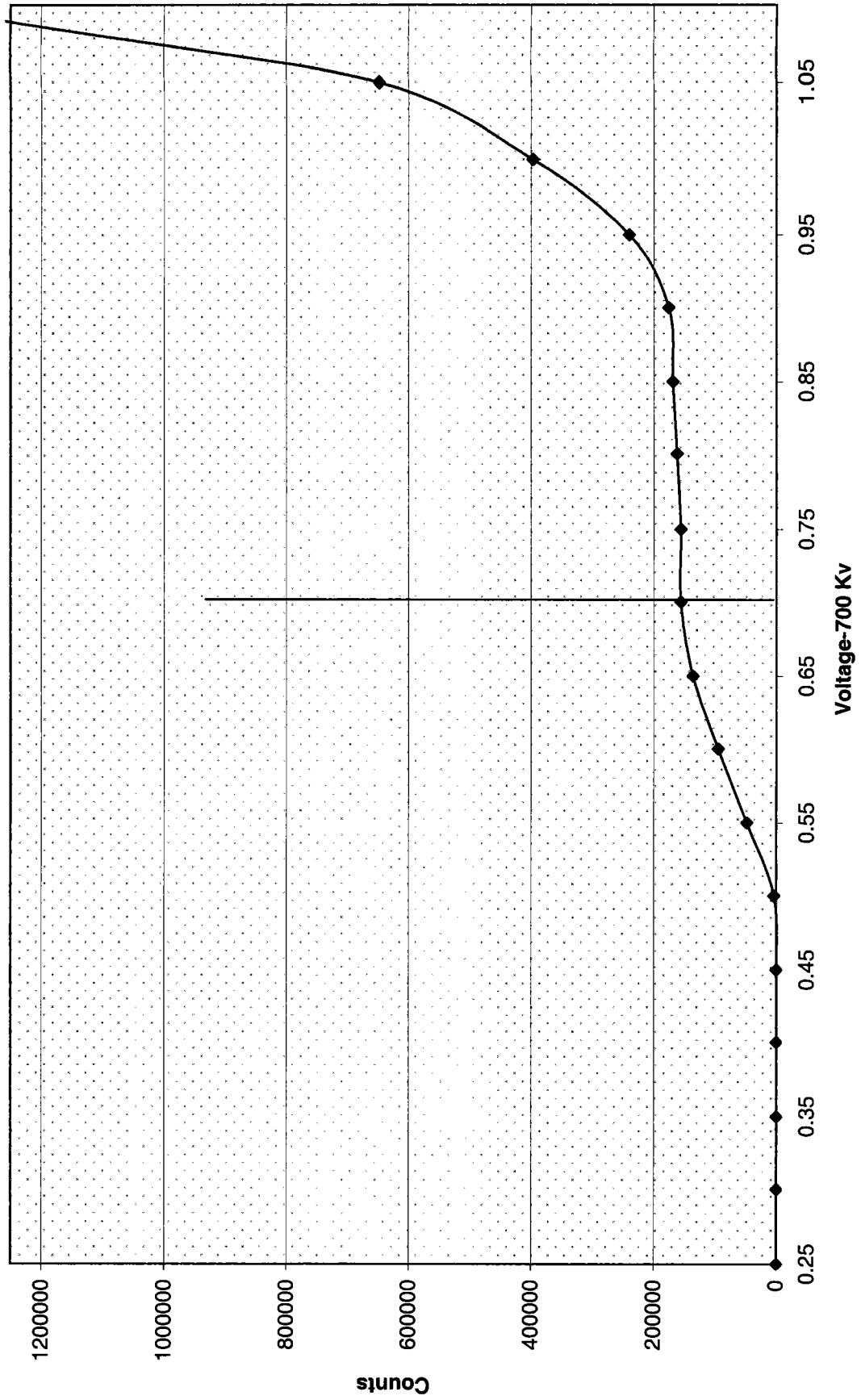
Reviewed By: \_\_\_\_\_ Date \_\_\_\_\_

Voltage

Voltage Curve Ludlum # 5				
Volts	Counts	Date	Time	Detector
0.00	0	2/25/2009	9:20	5
0.05	0	2/25/2009	9:20	5
0.10	0	2/25/2009	9:20	5
0.15	0	2/25/2009	9:20	5
0.20	0	2/25/2009	9:20	5
0.25	0	2/25/2009	9:20	5
0.30	0	2/25/2009	9:20	5
0.35	0	2/25/2009	9:20	5
0.40	0	2/25/2009	9:20	5
0.45	0	2/25/2009	9:20	5
0.50	3611	2/25/2009	9:20	5
0.55	47984	2/25/2009	9:20	5
0.60	94752	2/25/2009	9:20	5
0.65	135854	2/25/2009	9:20	5
0.70	155952	2/25/2009	9:20	5
0.75	155696	2/25/2009	9:20	5
0.80	161972	2/25/2009	9:20	5
0.85	168840	2/25/2009	9:20	5
0.90	175598	2/25/2009	9:20	5
0.95	239969	2/25/2009	9:20	5
1.00	397249	2/25/2009	9:20	5

UD 3/25/09

# Ludlum 5 Voltage Curve



KAP 3/24/09

# Ra-226 WATER

Batch : LCSVER  
 Date : 2/20/2008  
 Analyst : DXM2

Procedure Code : LUC26RAL  
 Parmname : Radium-226  
 MDA : 1 pCi/L

Bkg Count Time: 30 min Instrument Used : LUCAS CELL DETECTOR

Sample ID	Sample Vol L	Count Time min	Gross counts cts	Cell # num	Cell Const. num	BKG cpm	Ra-226 MDA pCi/L	Ra-226 RESULT pCi/L	Ra-226 ERROR pCi/L	COUNT DATE/TIME
Ver 1	0.500	30	766	501	2.087	0.267	0.6041	28.8142	2.0728	3/16/2009 15:10
Ver 2	0.500	30	537	502	1.878	0.167	0.5682	23.0223	1.9747	3/16/2009 19:25
Ver 3	0.500	30	518	503	1.601	0.267	0.8071	25.9035	2.2832	3/16/2009 20:20
Ver 4	0.500	30	701	504	1.615	0.267	0.6021	26.2570	1.9774	3/20/2009 19:00
Ver 5	0.500	30	680	505	2.331	0.033	0.2559	23.5744	1.7758	3/16/2009 22:00
Ver 6	0.500	30	893	506	2.004	0.267	0.4859	27.0593	1.7988	3/20/2009 19:40
Ver 7	0.500	30	488	507	1.701	0.267	0.7287	22.0004	2.0008	3/16/2009 23:00
Ver 8	0.500	30	544	508	1.534	0.033	0.3760	27.7023	2.3344	3/16/2009 23:30
Ver 9	0.500	30	768	509	1.798	0.267	0.5430	25.9694	1.8657	3/20/2009 20:50
Ver 10	0.500	30	432	510	1.458	0.033	0.3700	21.6379	2.0476	3/17/2009 5:00
Ver 11	0.500	30	577	511	1.959	0.267	0.5934	21.2369	1.7694	3/17/2009 5:35
Ver 12	0.500	30	723	512	1.956	0.267	0.5945	26.7349	1.9815	3/17/2009 6:10

Sample ID	Sample Dup	Det #	Run Date	Sample Type	Standard ID	NC	NC units	Recovery/RPD
501		5	3/16/2009 15:10	LCS	0638-F	24.05	pCi/L	120%
502		5	3/16/2009 19:25	LCS	0638-F	24.05	pCi/L	96%
503		5	3/16/2009 20:20	LCS	0638-F	24.05	pCi/L	108%
504		5	3/20/2009 19:00	LCS	0638-F	24.05	pCi/L	109%
505		5	3/16/2009 22:00	LCS	0638-F	24.05	pCi/L	98%
506		5	3/20/2009 19:40	LCS	0638-F	24.05	pCi/L	113%
507		5	3/16/2009 23:00	LCS	0638-F	24.05	pCi/L	91%
508		5	3/16/2009 23:30	LCS	0638-F	24.05	pCi/L	115%
509		5	3/20/2009 20:50	LCS	0638-F	24.05	pCi/L	108%
510		5	3/17/2009 5:00	LCS	0638-F	24.05	pCi/L	90%
511		5	3/17/2009 5:35	LCS	0638-F	24.05	pCi/L	88%
512		5	3/17/2009 6:10	LCS	0638-F	24.05	pCi/L	111%

DEGASSING DATE/TIME	DE-EMAN. DATE/TIME	DEGASS-DE-EM	dE-EM-COUNT	constant	constant	constant	Net CPM	Ingrowth constant
3/13/2009 15:30	3/16/2009 9:45	66.25	5.42	0.3936	0.9599	1.0019	25.2667	0.3785
3/13/2009 15:30	3/16/2009 10:10	66.67	9.25	0.3955	0.9325	1.0019	17.7333	0.3695
3/13/2009 15:30	3/16/2009 10:30	67.00	9.83	0.3970	0.9284	1.0019	17.0000	0.3693
3/16/2009 14:00	3/20/2009 13:05	95.08	5.92	0.5122	0.9563	1.0019	23.1000	0.4908
3/13/2009 15:30	3/16/2009 11:25	67.92	10.58	0.4012	0.9232	1.0019	22.6333	0.3711
3/16/2009 14:00	3/20/2009 13:20	95.33	6.33	0.5131	0.9533	1.0019	29.5000	0.4901
3/13/2009 15:30	3/16/2009 13:50	70.33	9.17	0.4120	0.9331	1.0019	15.9997	0.3852
3/13/2009 15:30	3/16/2009 13:50	70.33	9.67	0.4120	0.9296	1.0019	18.1000	0.3837
3/16/2009 14:00	3/20/2009 13:45	95.75	7.08	0.5147	0.9479	1.0019	25.3333	0.4888
3/13/2009 5:30	3/16/2009 14:25	80.92	14.58	0.4571	0.8957	1.0019	14.3667	0.4103
3/13/2009 5:30	3/16/2009 14:45	81.25	14.83	0.4585	0.8941	1.0019	18.9663	0.4107
3/13/2009 5:30	3/16/2009 15:00	81.50	15.17	0.4595	0.8918	1.0019	23.8330	0.4106

Ra-226 Verification Sheet

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
NUN 1	500	3/16/09 1530	3/16/09 0945	3/16/09 1510 <del>3/16/09 1510</del> <del>3/16/09 1510</del> <del>3/16/09 1510</del>	501	5	8	766
NUN 2	500	3/13/09 1530	3/16/09 1010	3/16/09 1925	502	5	85 <del>140 3/12/09</del>	537
NUN 3	500	3/13/09 1530	3/16/09 1030	3/16/09 2020	503	5	8	518
<del>NUN 4</del>	<del>500</del>	<del>3/13/09 1530</del>	<del>3/16/09 1100</del>	<del>3/16/09 2115</del>	<del>504</del>	<del>5</del>	<del>8</del>	<del>577</del>
NUN 5	500	3/13/09 1530	3/16/09 1125	3/16/09 2200	505	5	8 <del>140 3/12/09</del>	680
<del>NUN 6</del>	<del>500</del>	<del>3/13/09 1530</del>	<del>3/16/09 1155</del>	<del>3/16/09 2230</del>	<del>506</del>	<del>5</del>	<del>8</del>	<del>707</del>
NUN 7	500	3/13/09 1530	3/16/09 1320	3/16/09 2300	507	5	8	488
NUN 8	500	3/13/09 1530	3/16/09 1350	3/16/09 2330	508	5	8 <del>140 3/12/09</del>	544
<del>NUN 9</del>	<del>500</del>	<del>3/13/09 1530</del>	<del>3/16/09 1410</del>	<del>3/17/09 0445</del> <del>3/17/09 0515</del> <del>3/17/09 0545</del>	<del>509</del>	<del>5</del>	<del>8</del>	<del>640</del>
NUN 10	500	3/13/09 1530	3/16/09 1415	3/17/09 0500	510	5	8 <del>140 3/12/09</del>	432
NUN 11	500	3/13/09 1530	3/16/09 1445	3/17/09 0535	511	5	8	577
NUN 12	500	3/13/09 1530	3/16/09 1500	3/17/09 0610	512	5	8	723

140  
3/24/09

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3/24/09

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3/24/09

3/25/09  
3/25/09

3/17/09  
140



# Ra-226 Verification Sheet

Standard ID: 0638F

Volume Added (mL): 0.1

Expiration Date: 12/10

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background Counts	Total Counts
<del>VEN 1</del>	<del>500</del>	<del>3/16/09 1400</del>	<del>3/20/09 1245</del>	<del>3/20/09 1820</del>	<del>501</del>	<del>5</del>	<del>8</del>	<del>70</del>
VEN 2	500	3/16/09 1400	3/20/09 1305	3/20/09 1900	504	5	8	701
VEN 3	500	3/16/09 1400	3/20/09 1320	3/30/09 1940	506	5	8	893
VEN 4	500	3/16/09 1400	3/20/09 1345	3/30/09 2050	509	5	8	768

3/20/09

VEN 3/20/09

VEN 3/20/09



# GEL Standard Traceability Log Rad

Source Material Info		A Solution Material Info	
Parent Code:	0638	Isotope:	Radium-226
Prepared By:	Amanda Fehr	Prepared By:	Amanda Fehr
Carrier Conc:	0.1M HCl	Prep Date:	01/16/2006
Reference Date:	01/23/2004	Verification Date:	03/04/2007
Ampoule Mass (g):	5.01065 g	Expiration Date:	03/04/2008
Uncertainty:	+/- 3.3 %	Primary Code:	0638-A
LogBook No:	RC-S-037-037	Dilution(mL):	100 mL
		Mass of Parent(g):	4.8398 g
		Density(g/mL):	1.0266
		Balance ID:	38080204

### Calculations Converting parent activity to dpm/mL|dpm/g

$(\text{Mass of parent(g)}) * (\text{Parm Activity (dps)}) * (\text{conversion dpm to dps}) / (\text{Ampoule Mass(g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/mL)}$
$(\text{Mass of parent(g)}) * (\text{Parm Activity (dps)}) * (\text{conversion dpm to dps}) / \text{Density} / (\text{Ampoule Mass (g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/g)}$
$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13636.6133 \text{ dpm/mL}$
$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (1.0266 \text{ g/mL}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13282.9676 \text{ dpm/g}$

### Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
01/17/2006	Amanda Fehr	2.1041	100	0638-B	279.0211 dpm/mL	01/17/2007	01/17/2008
07/17/2006	Mary Aders	2.1313	100	0638-C	282.6281 dpm/mL	07/26/2006	07/26/2007
03/28/2007	Daniel Roy	2.1025	100	0638-D	279.2744 dpm/ml	04/08/2007	04/08/2008
03/28/2007	Daniel Roy	45.468	250	0638-E	2415.7999 dpm/ml	04/09/2008	04/08/2009
12/18/2007	Daniel Roy	2.014	100	0638-F	267.519 dpm/ml	02/02/2009	02/02/2010
02/12/2008	Daniel Roy	.5004	100	0638-G	66.468 dpm/ml	03/04/2008	03/04/2009
07/23/2008	Daniel Roy	5.0607	250	0638-H	268.8845 dpm/ml	07/23/2008	07/23/2009

## Verification for Ra-226 Standard 0638-F

D. Roy 2/2/2009	<b>Isotope</b>	<b>Value</b>	<b>Uncertainty</b>
	0638-F #1	24.629	1.7426
	0638-F #2	24.438	1.7557
	0638-F #3	22.791	1.6808
<b>Mean Value (Counting) =</b>	23.953	99.60	<b>Pass</b>
<b>Stdev =</b>	1.010781096		<b>Rule 3 (Pass/Fail)</b>
<b>Target =</b>	24.05		
<b>Lower Limit =</b>	21.93100448		
<b>Upper Limit =</b>	25.97412886		
<b>Rule 1 Pass/Fail</b>	<b>Pass</b>		
<b>Two sigma =</b>	2.021562191		
<b>10 % of Mean =</b>	2.395256667		
<b>Rule 2 (Pass/Fail)</b>	<b>Pass</b>		

**Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements**

**Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.**

**Rule 3 = The determined mean value shall be within 5% of the certificate value.**

The analyst prepared three standard verification sources for standard 0638-F using 0.1 mL for each source. Each source was counted using routine Lucas cell procedures. Calibration for 0299-G was used in this verification.

140 3124109

# General Engineering Laboratories

2040 Savage Road, Charleston, SC 29414  
(843)556-8171

## Lucas Cell Calibration Package

	YES	NO	Comments
1) Is all calibration standard information enclosed for: the primary standard certificate?	✓		
the second standard(s) documentation?	✓		
standard preparation information?	✓		
standard < 1 Year old or verified?	✓		
2) Is the efficiency calibration report included ?	✓		
3) Is the raw count data included for: Cell constant determination?	✓		
Plateau generation?	✓		
4) Are the calibration verifications included?	✓		
5) Are the instrument settings included: HVPS settings?	✓		
6) Has the CELLEFF.xls file been updated ?	✓		
7) Have the calibration dates been updated in ALPHALIMS ?	✓		

Prepared By: KDD/Denee

Date: 8/4/09

Reviewed By: Angela Denee

Date: 8/6/09

Effective Date: 8/4/09

KD 8/6/09

# Ra-226 Cell Constants

Standard Reference date: 12/15/1999  
 Standard ID: 0299-G  
 Volume added (mL): 0.1  
 Standard Reference Activity (DPM/mL): 2446.3471

Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/time flushed to cell	Date/time end of degas	total counts	count time min	Known activity dpm	t1 (days) end-degas to flush	t2 (days) end-flush to count	t3 (days) Std Ref Date to count	Decay from Std Ref Date to count
601	2.164	Average	5/26/2009 13:30	5/26/2009 9:30	5/19/2009 14:00	10883	30	362.77	6.81250	0.16667	3451	0.9959
601	2.253	Stdev	5/22/2009 12:55	5/22/2009 9:15	5/19/2009 14:00	6378	30	212.60	2.80208	0.15278	3447	0.9959
601	2.126		5/29/2009 14:45	5/29/2009 9:50	5/22/2009 10:45	10735	30	357.83	6.96181	0.20486	3454	0.9959
602	2.007	Average	5/29/2009 15:20	5/29/2009 10:15	5/22/2009 10:45	10133	30	337.77	6.97917	0.21181	3454	0.9959
602	2.194	Stdev	5/26/2009 14:05	5/26/2009 9:55	5/19/2009 14:00	11033	30	367.77	6.82986	0.17361	3451	0.9959
602	2.304		6/2/2009 14:45	6/2/2009 11:30	5/29/2009 9:50	8575	30	285.83	4.06944	0.13542	3458	0.9959
604	2.244	Average	6/2/2009 15:50	6/2/2009 11:50	5/29/2009 9:50	8321	30	277.37	4.08333	0.16667	3458	0.9959
604	2.076	Stdev	5/29/2009 15:55	5/29/2009 10:45	5/22/2009 12:00	10451	30	348.37	6.94792	0.21528	3454	0.9959
604	2.079		5/26/2009 15:45	5/26/2009 10:20	5/19/2009 14:00	10372	30	345.73	6.84722	0.22569	3451	0.9959
605	2.096	Average	5/26/2009 16:15	5/26/2009 10:50	5/19/2009 14:00	10474	30	349.13	6.86806	0.22569	3451	0.9959
605	2.228	Stdev	5/22/2009 16:25	5/22/2009 10:45	5/19/2009 14:00	6318	30	210.60	2.86458	0.23611	3447	0.9959
605	2.122		5/29/2009 17:15	5/29/2009 11:05	5/22/2009 12:50	10587	30	352.90	6.92708	0.25694	3454	0.9959
606	2.543	Average	5/29/2009 17:45	5/29/2009 13:10	5/26/2009 9:30	7816	30	260.53	3.15278	0.19097	3454	0.9959
606	2.202	Stdev	5/26/2009 16:45	5/26/2009 12:25	5/22/2009 12:00	8057	30	268.57	4.01736	0.18056	3451	0.9959
606	2.298		6/2/2009 18:20	6/2/2009 12:55	5/29/2009 9:50	8495	30	283.17	4.12847	0.22569	3458	0.9959
607	2.454	Average	6/2/2009 19:00	6/2/2009 13:10	5/29/2009 9:50	9057	30	301.90	4.13889	0.24306	3458	0.9959
607	2.572	Stdev	5/29/2009 19:00	5/29/2009 13:25	5/26/2009 9:55	7832	30	261.07	3.14583	0.23264	3454	0.9959
607	2.325		5/26/2009 17:15	5/26/2009 12:50	5/22/2009 12:00	8527	30	284.23	4.03472	0.18403	3451	0.9959
609	2.277	Average	5/26/2009 19:20	5/26/2009 13:10	5/22/2009 12:00	8261	30	275.37	4.04861	0.25694	3451	0.9959
609	2.280	Stdev	5/22/2009 19:20	5/22/2009 12:00	5/19/2009 14:00	6473	30	215.77	2.91667	0.30556	3447	0.9959
609	2.392		5/29/2009 19:40	5/29/2009 13:45	5/26/2009 10:20	7261	30	242.03	3.14236	0.24653	3454	0.9959
611	2.488	Average	5/29/2009 20:20	5/29/2009 14:00	5/26/2009 10:50	7510	30	250.33	3.13194	0.26389	3454	0.9959
611	2.245	Stdev	5/26/2009 22:00	5/26/2009 13:25	5/22/2009 12:00	8010	30	267.00	4.05903	0.35764	3451	0.9959
611	2.187		6/2/2009 19:50	6/2/2009 13:25	5/29/2009 9:50	8052	30	268.40	4.14931	0.26736	3458	0.9959

EffErr 0.066051 ← Put in Machines.xls (Lucas Cell Tab)

Backgrounds are not significant enough to be included in calculations ANSI N42.25-1997 (B.2).

*Original of 9/16/09*  
*WJ 8/16/09*

601	2.181	8/4/2009
602	2.168	8/4/2009
604	2.133	8/4/2009
605	2.149	8/4/2009
606	2.348	8/4/2009
607	2.45	8/4/2009
609	2.316	8/4/2009
611	2.307	8/4/2009

<b>Lucas</b>	<b>Ra-226</b>	
Oldest Cal	01/23/2008	
<b>Detector</b>	<b>Eff Error</b>	<b>Cal Date</b>
1	0.0958	8/29/2008
2	0.0772	12/19/2008
3	0.0608	1/23/2008
4	0.1237	3/2/2009
5	0.1438	3/25/2009
6	0.0661	8/4/2009
7	0.0855	11/21/2008



**General Engineering Laboratories  
Calibration Source Preparation Sheet**

Applicable SOP Number GL-RAD-A-008

Isotope Ra226

Date Standards Prepared 4/5/05

Cocktail Type Used NA

Standard ID 0299-G

Matrix of Vial/Planchett NA

Amount Used (g or ml) 0.1

NA  
NA

Standard Activity (DPM/g or mL) 2446.3471

Type of Scintillation Vial NA

Reference Date 12/15/99

Pipette ID Used 1429303

Expiration Date 1/26/10

Balance ID Used 38080204

Residue/Carrier Agent 0.1M HCl

Quenching Agent NA

	Standard Number	Quenching Vol (uL)/ Residue Volume(mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
1	cal 1				
2	cal 2				
3	cal 3				
4	cal 4				
5	cal 5				
6	cal 6				
7	cal 7				
8	cal 8				
9	cal 9				
10	cal 10				
11	cal 11				
12	cal 12				

JBG  
8/4/09

JBG  
8/4/09

Prepared By: Kelli Rowell Date 8/4/09

Reviewed By: Angel J Gh Date 8/4/09

Rev 1 RLM 9/10/97



# Ra-226 Calibration Sheet

Standard ID: ~~0299-6~~ 0299-6  
 Volume Added (mL): 0.1 19 816109  
 Expiration Date: ~~1126110~~ 1126110  
 19 814109

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 1	500	5/19/09 1400	5/22/09 0915	5/20/09 1255	601	6	6318
<del>Cal 2</del>	<del>500</del>	<del>5/19/09 1400</del>	<del>5/22/09 0945</del>	<del>5/22/09 1325</del>	<del>602</del>	<del>6</del>	<del>6358</del>
<del>Cal 3</del>	<del>500</del>	<del>5/19/09 1400</del>	<del>5/22/09 1010</del>	<del>5/22/09 1420</del>	<del>604</del>	<del>6</del>	<del>4600</del>
Cal 4	500	5/19/09 1400	5/22/09 1045	5/22/09 1625	605	6	6318
<del>Cal 5</del>	<del>500</del>	<del>5/19/09 1400</del>	<del>5/22/09 1115</del>	<del>5/22/09 1700</del>	<del>606</del>	<del>6</del>	<del>6494</del>
<del>Cal 6</del>	<del>500</del>	<del>5/19/09 1400</del>	<del>5/22/09 1140</del>	<del>5/22/09 1735</del>	<del>607</del>	<del>6</del>	<del>6428</del>
Cal 7	500	5/19/09 1400	5/22/09 1200	5/22/09 1920	609	6	6473
<del>Cal 8</del>	<del>500</del>	<del>5/19/09 1400</del>	<del>5/22/09 1250</del>	<del>5/22/09 2035</del>	<del>611</del>	<del>6</del>	<del>6455</del>
Cal 9							
Cal 10							
Cal 11							
Cal 12							

100 814109  
 100 814109  
 100 814109  
 100 814109  
 6162-100 814109

19 814109

19 814109  
 100 816109





EEC

8-21-00

Nycomed Amersham plc  
Amersham Laboratories

0299

CALIBRATION  
No. 0146

ISSUED BY: Nycomed Amersham plc  
Radiation & Radioactivity  
Calibration Laboratory  
Amersham Laboratories  
White Lion Road  
Amersham  
Buckinghamshire  
HP7 9LL

ISSUED FOR: AEA Technology plc  
Isotrak  
Amersham Laboratories  
White Lion Road  
Amersham  
Buckinghamshire  
HP7 9LL

Description Principal radionuclide: Radium-226

Product code: RAY44  
Solution number: R4/131/89

Measurement Reference time: 1200 GMT on 15 December 1999

Nuclear data Nuclear data quoted on this certificate are taken from the Joint European File, Version 2.2.

Expression of uncertainties The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2.00$ , which for a  $t$ -distribution with  $\nu_{eff} = \infty$  effective degrees of freedom corresponds to a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Unless indicated, all other uncertainties are expressed at the confidence level associated with one standard uncertainty.

The format used for the uncertainties in the values of radionuclidic purity is illustrated in the following examples;

6.5(21)	-	6.5 ± 2.1
6.54(21)	-	6.54 ± 0.21
6.543(21)	-	6.543 ± 0.021

Approved  
Signature

Date of issue

17<sup>th</sup> December 1999

## Verification for Ra-226 Standard 0299-G

M. Aders 1/26/2009	Isotope	Value DPM	Uncertainty
	0299-A #1	220.970	0.2670
	0299-A #2	241.730	0.2670
	0299-A #3	257.470	0.2670
<b>Mean Value (Counting) =</b>	240.057	98.52	<b>Pass</b>
<b>Stdev =</b>	18.30744475		<b>Rule 3 (Pass/Fail)</b>
<b>Target =</b>	243.67		
<b>Lower Limit =</b>	203.4417772		
<b>Upper Limit =</b>	276.6715562		
<b>Rule 1 Pass/Fail</b>	<b>Pass</b>		
<b>Two sigma =</b>	36.6148895		
<b>10 % of Mean =</b>	24.00566667		
<b>Rule 2 (Pass/Fail)</b>	<b>Fail</b>	<b>*exception taken due to full recovery of standard</b>	

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements**
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.**
- Rule 3 = The determined mean value shall be within 5% of the certificate value.**

The analyst prepared three standard verification sources for standard 0299-A using 0.1 mL for each source. Each standard was degassed and transferred according to SOP GL-RAD-A-008. Each source was counted using Ra-226 procedures.

*M. Aders 241.730*  
*August 9th 8/4/09*

# Ra-226 Cell Constants

Standard Reference date: 12/15/1999  
standard ID: 0299-G  
Volume added (mL): 0.1  
Standard Reference Activity (DPM/mL): 2446.35

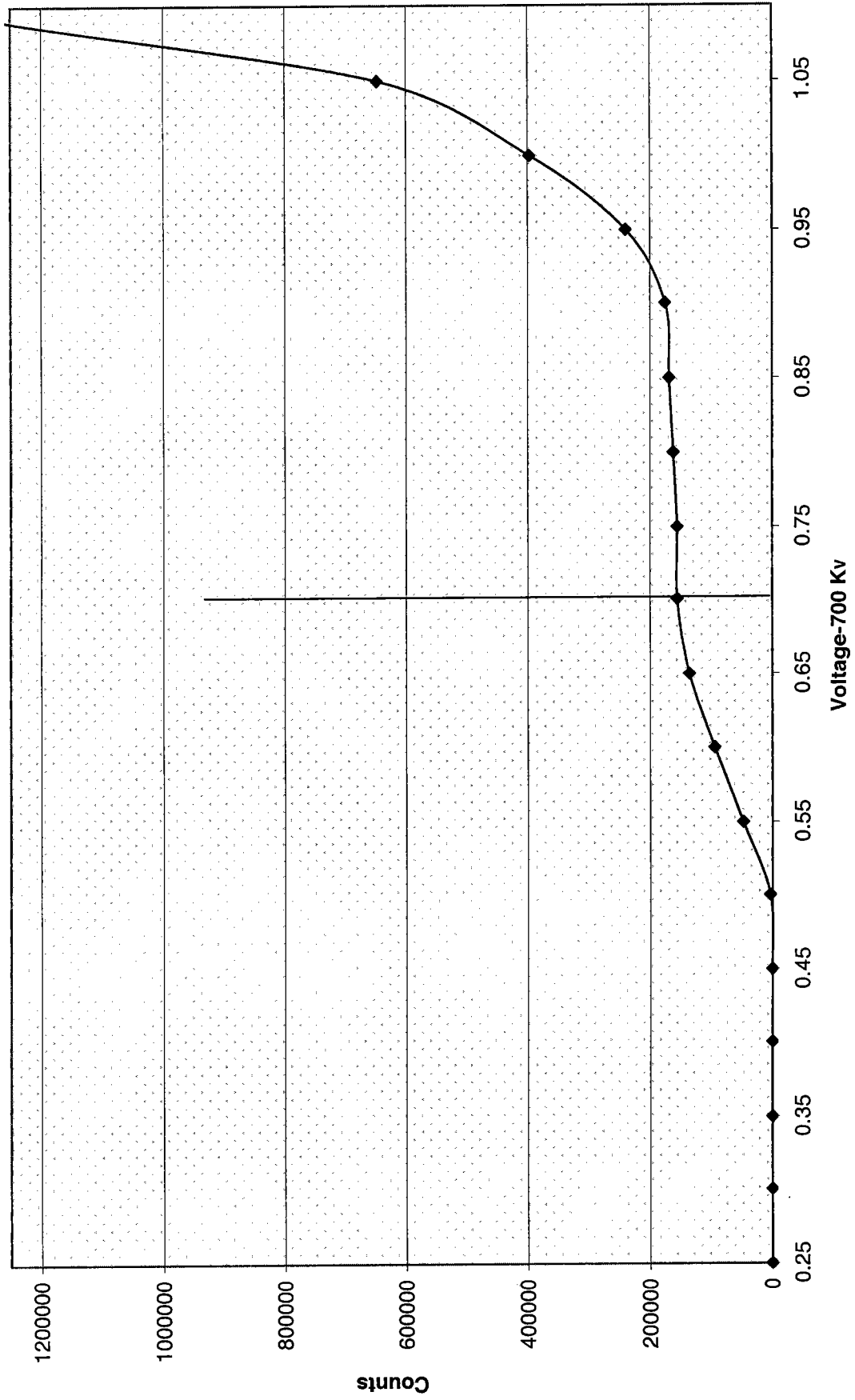
Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/Time flushed to cell	Date/time end of degas	bkg cpm	total counts	count time min	cpm	Known activity dpm	t1 (days) end-degas to flush	t2 (days) end-flush to count	t3 (days) Std Ref Date to count	Decay from Std Ref Date to count
301	2.021	43	39839.60764	39839.39236	39835.38194	0.267	7282	30	242.73	243.6698	4.01041667	0.2152778	3330.607639	0.996055555
302	2.131	47	39839.64583	39839.41319	39835.38194	0.267	7555	30	251.83	243.6698	4.03125	0.2326389	3330.645833	0.996055551
303	2.136	19	39839.72222	39839.43403	39835.38194	0.267	8028	30	267.60	243.6697	4.05208333	0.2881944	3330.722222	0.996055419



Voltage Curve Ludlum # 6				
Volts	Counts	Date	Time	Detector
0.00	0	5/20/2009	9:00	6
0.05	0	5/20/2009	9:01	6
0.10	0	5/20/2009	9:02	6
0.15	0	5/20/2009	9:03	6
0.20	0	5/20/2009	9:04	6
0.25	0	5/20/2009	9:05	6
0.30	0	5/20/2009	9:06	6
0.35	0	5/20/2009	9:07	6
0.40	0	5/20/2009	9:08	6
0.45	512	5/20/2009	9:09	6
0.50	3625	5/20/2009	9:10	6
0.55	47990	5/20/2009	9:11	6
0.60	94752	5/20/2009	9:12	6
0.65	135854	5/20/2009	9:13	6
0.70	155952	5/20/2009	9:14	6
0.75	155700	5/20/2009	9:15	6
0.80	161972	5/20/2009	9:16	6
0.85	168860	5/20/2009	9:17	6
0.90	175598	5/20/2009	9:18	6
0.95	239969	5/20/2009	9:19	6
1.00	397270	5/20/2009	9:20	6

*W 8/4/09*

Ludlum 6 Voltage Curve



WGS

# Ra-226 WATER

Batch : LCSVER  
Date : 6/2/2009  
Analyst : KSD1

Procedure Code : LUC26RAL  
Parmname : Radium-226

MDA : 1 pCi/L

Instrument Used : LUCAS CELL DETECTOR

Bkg Count Time: 30 min

Sample ID	Sample Vol L	Count Time min	Gross counts cts	Cell # num	Cell Const. num	BKG cpm	Ra-226 MDA pCi/L	Ra-226 RESULT pCi/L	Ra-226 ERROR pCi/L	COUNT DATE/TIME
ver 1	0.800	30	1018	601	2.181	0.267	0.2115	13.4431	0.8356	6/8/2009 15:35
ver 2	0.800	30	994	602	2.168	0.100	0.1442	13.2563	0.8279	6/8/2009 16:05
ver 3	0.800	30	955	604	2.133	0.167	0.1786	12.9119	0.8254	6/8/2009 16:40
ver 4	0.800	30	1144	605	2.149	0.267	0.2143	15.3201	0.8971	6/8/2009 17:15
ver 5	0.800	30	1046	606	2.348	0.233	0.1867	12.8971	0.7895	6/8/2009 18:30
ver 6	0.800	30	1001	607	2.450	0.267	0.1893	11.8239	0.7413	6/8/2009 19:15
ver 7	0.800	30	1060	609	2.316	0.267	0.2007	13.2848	0.8089	6/8/2009 20:05
ver 8	0.800	30	943	611	2.307	0.267	0.2053	12.0754	0.7806	6/8/2009 23:10

Handwritten notes: 8/6/09 and 8/16/09

Sample ID	Cell #	Det #	Run Date	Sample Type	Standard ID	NC	NC units	Recovery/RPD
ver 1	601	6	6/8/2009 15:35	LCS	0638-F	15.03	pCi/L	89%
ver 2	602	6	6/8/2009 16:05	LCS	0638-F	15.03	pCi/L	88%
ver 3	604	6	6/8/2009 16:40	LCS	0638-F	15.03	pCi/L	86%
ver 4	605	6	6/8/2009 17:15	LCS	0638-F	15.03	pCi/L	102%
ver 5	606	6	6/8/2009 18:30	LCS	0638-F	15.03	pCi/L	86%
ver 6	607	6	6/8/2009 19:15	LCS	0638-F	15.03	pCi/L	79%
ver 7	609	6	6/8/2009 20:05	LCS	0638-F	15.03	pCi/L	88%
ver 8	611	6	6/8/2009 23:10	LCS	0638-F	15.03	pCi/L	80%

DEGASSING DATE/TIME	DE-EMAN. DATE/TIME	DEGASS-DE-EM	dE-EM-COUNT	constant	constant	constant	Net CPM	Ingrowth constant
6/2/2009 12:40	6/8/2009 12:15	143.58	3.33	0.6618	0.9751	1.0019	33.6667	0.6466
6/2/2009 12:40	6/8/2009 12:40	144.00	3.42	0.6628	0.9745	1.0019	33.0333	0.6472
6/2/2009 12:40	6/8/2009 13:05	144.42	3.58	0.6639	0.9733	1.0019	31.6663	0.6474
6/2/2009 12:40	6/8/2009 13:30	144.83	3.75	0.6650	0.9721	1.0019	37.8667	0.6476
6/2/2009 12:40	6/8/2009 13:50	145.17	4.67	0.6658	0.9654	1.0019	34.6333	0.6440
6/2/2009 12:40	6/8/2009 14:15	145.58	5.00	0.6668	0.9630	1.0019	33.0997	0.6434
6/2/2009 12:40	6/8/2009 14:35	145.92	5.50	0.6677	0.9593	1.0019	35.0667	0.6417
6/2/2009 12:40	6/8/2009 15:00	146.33	8.17	0.6687	0.9402	1.0019	31.1663	0.6299

Handwritten notes:   
 8/16/09   
 11/18/10/09





0638

**CERTIFICATE OF CALIBRATION**  
**Standard Radionuclide Source**

67519-278

Ra-226 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated using a germanium gamma spectrometer system.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

Analytics maintains traceability to the National Institute of Standards and Technology through participation in a Measurements Assurance Program as described in USNRC Reg. Guide 4.15, Revision 1, February 1979.

ISOTOPE:	Ra-226
ACTIVITY (dps):	2.353 E4
HALF-LIFE:	1.600 E3 years
CALIBRATION DATE:	January 23, 2004 12:00 EST
RELATIVE EXPANDED UNCERTAINTY (k=2):	3.3%

Impurities:  $\gamma$ -impurities (other than decay products) <0.1%

5.01065 grams 0.1M HCl solution with 50  $\mu$ g/g Ba carrier.

P O NUMBER 3231RD, Item 5

SOURCE PREPARED BY:

M. D. Currie  
M. D. Currie, Radiochemist

Q A APPROVED:

RCW 1/26/04

# Standard Traceability Log Rad

Source Material Info	
Parent Code:	0638
Prepared By:	Amanda Fehr
Carrier Conc:	0.1M HCl
Reference Date:	01/23/2004
Ampoule Mass (g):	5.01065 g
Uncertainty:	+/- 3.3 %
LogBook No:	RC-S-037-037

A Solution Material Info	
Isotope:	Radium-226
Prepared By:	Amanda Fehr
Prep Date:	01/16/2006
Verification Date:	04/09/2009
Expiration Date:	04/09/2010
Primary Code:	0638-A
Dilution(mL):	100 mL
Mass of Parent(g):	4.8398 g
Density(g/mL):	1.0266
Balance ID:	38080204

## Calculations Converting parent activity to dpm/mL|dpm/g

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (dps)}) * (\text{conversion dpm to dps}) / (\text{Ampoule Mass(g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (dps)}) * (\text{conversion dpm to dps}) / \text{Density} / (\text{Ampoule Mass (g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/g)}$$

$$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13636.6133 \text{ dpm/mL}$$

$$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (1.0266 \text{ g/mL}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13282.9676 \text{ dpm/g}$$

WMO 8/14/09



## Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
01/17/2006	Amanda Fehr	2.1041	100	0638-B	279.0211 dpm/mL	01/17/2007	01/17/2008
07/17/2006	Mary Aders	2.1313	100	0638-C	282.6281 dpm/mL	07/26/2006	07/26/2007
03/28/2007	Daniel Roy	2.1025	100	0638-D	279.2744 dpm/ml	04/08/2007	04/08/2008
03/28/2007	Daniel Roy	45.468	250	0638-E	2415.7999 dpm/ml	04/09/2009	04/09/2010
12/18/2007	Daniel Roy	2.014	100	0638-F	267.519 dpm/ml	02/02/2009	02/02/2010
02/12/2008	Daniel Roy	.5004	100	0638-G	66.468 dpm/ml	03/02/2009	03/02/2010
07/23/2008	Daniel Roy	5.0607	250	0638-H	268.8845 dpm/ml	07/17/2009	07/17/2010

GEL Laboratories LLC  
Version 1.0 9/18/2000

W084116

# Verification for Ra-226 Standard 0638-F

D. Roy 2/2/2009	Isotope	Value	Uncertainty
	0638-F #1	24.629	1.7426
	0638-F #2	24.438	1.7557
	0638-F #3	22.791	1.6808
<b>Mean Value (Counting) =</b>	23.953	99.60	<b>Pass</b>
<b>Stdev =</b>	1.010781096		<b>Rule 3 (Pass/Fail)</b>
<b>Target =</b>	24.05		
<b>Lower Limit =</b>	21.93100448		
<b>Upper Limit =</b>	25.97412886		
<b>Rule 1 Pass/Fail</b>	<b>Pass</b>		
<b>Two sigma =</b>	2.021562191		
<b>10 % of Mean =</b>	2.395256667		
<b>Rule 2 (Pass/Fail)</b>	<b>Pass</b>		

Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements

Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.

Rule 3 = The determined mean value shall be within 5% of the certificate value.

The analyst prepared three standard verification sources for standard 0638-F using 0.1 mL for each source. Each source was counted using routine Lucas cell procedures. Calibration for 0299-G was used in this verification.

*Handwritten notes:*  
 0638-F #1  
 2/2/2009  
 Amanda [Signature]

# Radium-226 Que Sheet

General Engineering Laboratories, Radiochemistry Division

02/03/2009

Analyst: KSDI

First Client Due Date:

Internal Due Date: 02/07/2009

Batch #: 838839

Spike Isotope: Radium-226 Spike Code: 003-P

Expiration Date: 12/27/08

Nom Conc:

LCS Isotope: Radium-226 LCS Code: 003-P

Expiration Date: 12/27/08

Nom Conc:

Prep Date: 12/27/08

Pipet ID: \_\_\_\_\_

Initials: VSD

Witness: \_\_\_\_\_

Sample Count Time: 30 (Min)

Bkg Count Time: 30 (Min)

Sample I	Client Description	Type	Hazard Code	Matrix	Min CRDL	Client	Vol (mL)	End Init Degas Date/Tin	End LN Date/Time	De-em Date/Time	Start Count Date/Time	Cell #	Det #	Bkg counts	Total Counts
1201770521-1	LCS for batch 838839	LCS	GROUND	WAJ 1	1 pCi/L	QC ACCOUNT	5.0	1/26/09 10:05	1/26/09 11:30	1/30/09 17:05	1/30/09 17:05	305	3	9	741
1201770522-1	LCS for batch 838839	LCS	GROUND	WAJ 1	1 pCi/L	QC ACCOUNT	5.0	1/26/09 10:05	1/26/09 11:45	1/30/09 17:57	1/30/09 17:57	304	3	9	748
1201770523-1	LCS for batch 838839	LCS	GROUND	WAJ 1	1 pCi/L	QC ACCOUNT	5.0	1/26/09 10:05	1/26/09 12:00	1/30/09 17:55	1/30/09 17:55	305	3	9	748

Comments:

Instrument ID#:

LUCAS-5028, LUCAS-13617, LUCAS-90899, LUCAS-162753, LUCAS-132286, LUC-6-17055

Data Reviewed By:

WJ Slivers

# Radium-226 Liquid

Filename : RA226.XLS  
 File type : Excel  
 Version # : 1.2.3

Spike S/N : N/A  
 Spike Exp Date : N/A  
 Spike Activity (dpm/ml): N/A  
 Spike Volume Added: N/A  
 Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml  
 Pipet, 1 ml Stdev : +/- 0.005480 ml

Batch : 838839  
 Analyst : KSD1  
 Prep Date : 1/26/2009  
 Ra-226 Abundance : 1  
 Ra-226 Method Uncertainty : 0.0918

Procedure Code : LUC26RAL  
 Parmname : Radium-226  
 Required MDA : 1 pCi/L  
 Half-life of Ra-226 : 1600 years  
 Half-life of Rn-222: 3.823 days  
 Batch counted on : LUCAS CELL DETECTOR  
 BKG Count time : 30 min

LCS S/N : 0638-F  
 LCS Exp Date : 12/20/2008  
 LCS Activity (dpm/ml): 266.94  
 LCS Volume Added: 0.10

Sample Characteristics		Count Raw Data				Weekly Background			Detector Efficiency		
Sample ID	Sample Aliquot L	Sample Aliquot StDev. L	Sample Date/Time	Cell Number	Counting Time (min.)	Gross Counts	Gross CPM	Counts	CPM	Count Time (min.)	Efficiency (cpm/dpm)
1201770521.1	0.5000	2.0256E-05	1/26/2009 0:00	305	30	791	26.367	8	0.267	30	1.9930
1201770522.1	0.5000	2.0256E-05	1/26/2009 0:00	306	30	768	25.600	8	0.267	30	1.9500
1201770523.1	0.5000	2.0256E-05	1/26/2009 0:00	308	30	730	24.333	8	0.267	30	2.0010

*Handwritten notes:*  
 UNSM105  
 1/26/09

Detector Efficiency Error (cpm/dpm)	Cell Calibration Date	Cell Calibration Due Date	De-Gas Date/Time	Rn-222 Ingrowth		Count Start Date/Time	Rn-222 Corrections		Ra-226 Decay
				End Date/Time	De-Gas to Ingrowth		Ingrowth to Count	During Count	
0.06082	1/23/2008	1/22/2009	1/26/2009 16:05	1/30/2009 11:30	1/30/2009 17:05	0.499	0.959	1.002	1.000
0.06082	1/23/2008	1/22/2009	1/26/2009 16:05	1/30/2009 11:45	1/30/2009 17:37	0.500	0.957	1.002	1.000
0.06082	1/23/2008	1/22/2009	1/26/2009 16:05	1/30/2009 12:00	1/30/2009 19:05	0.501	0.948	1.002	1.000

K0816104  
*[Handwritten signature]*

- Notes.  
 1 - Results are decay corrected to Sample Date/Time  
 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date  
 3 - Spike Nominals are decay corrected to Sample Date/Time

Results Decision Level pCi/L	Critical Level pCi/L	MDA pCi/L	Sample Act.		Net Count Rate CPM	Net Count Rate Error CPM	2 SIGMA Counting Uncertainty pCi/L		2 SIGMA Total Prop. Uncertainty pCi/L		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
			Conc. pCi/L	Error pCi/L			2 SIGMA Counting Uncertainty pCi/L	2 SIGMA Total Prop. Uncertainty pCi/L								
0.2932	0.2070	0.5083	24.6287	0.0707	26.1000	0.9422	1.7426	5.5940	LCS					24.0486	102.4%	
0.2997	0.2116	0.5196	24.4384	0.0710	25.3333	0.9286	1.7557	5.5591	LCS					24.0486	101.6%	
0.2942	0.2077	0.5101	22.7906	0.0715	24.0667	0.9055	1.6808	5.1982	LCS					24.0486	94.8%	

11/28/10  
(15)

# General Engineering Laboratories

2040 Savage Road, Charleston, SC 29414  
(843)556-8171

## Lucas Cell Calibration Package

(701-712)

	YES	NO	Comments
1) Is all calibration standard information enclosed for: the primary standard certificate? the second standard(s) documentation? standard preparation information? standard < 1 Year old or verified?	✓		
	✓		
	✓		
	✓		
2) Is the efficiency calibration report included ?	✓		
3) Is the raw count data included for: Cell constant determination? Plateau generation?	✓		
	✓		
4) Are the calibration verifications included?	✓		
5) Are the instrument settings included: HVPS settings?	✓		
	✓		
6) Has the CELLEFF.xls file been updated ?	✓		
7) Have the calibration dates been updated in ALPHALIMS ?	✓		

Prepared By: Kelli Spence

Date: 9/30/09

Reviewed By: Angela G

Date: 9/30/09

Effective Date: 9/30/09

# Ra-226 Cell Constants

Standard Reference date : 12/15/1999  
 standard ID : 0299-H  
 Volume added (mL) : 0.1  
 Standard Reference Activity (DPM/mL) : 2483.21

Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/Time flushed to cell	Date/Time end of degas	cpm	total counts	count time	Known activity dpm	t1 (days) end-degas to flush	t2 (days) end-flush to count	t3 (days) Std Ref Date to count	Decay from Std Ref Date to count	
701	2.180	Average	2.107	Cal 12	9/21/2009 17:00	9/18/2009 17:00	6158	30	205.27	243.02	2.82986	0.17014	3569	0.9958
701	2.025	Sidev	0.078	Cal 1	9/15/2009 17:45	9/15/2009 13:45	6595	15	439.67	243.02	14.13542	0.16667	3563	0.9958
701	2.117	Cal 1	9/18/2009 18:15	9/18/2009 13:20	9/15/2009 10:00	3219	15	214.60	243.02	3.13889	0.20486	3566	0.9958	
702	2.101	Average	2.033	Cal 2	9/24/2009 18:05	9/24/2009 14:05	3014	15	200.93	243.02	2.87847	0.16667	3572	0.9958
702	2.020	Sidev	0.063	Cal 2	9/15/2009 18:10	9/15/2009 14:10	6583	15	438.87	243.02	14.15278	0.16667	3563	0.9958
702	1.977	Cal 11	9/21/2009 17:25	9/21/2009 13:20	9/18/2009 17:00	5611	30	187.03	243.02	2.84722	0.17014	3569	0.9958	
703	2.218	Average	2.221	Cal 10	9/21/2009 18:00	9/21/2009 13:45	6317	30	210.57	243.02	2.86458	0.17708	3569	0.9958
703	2.279	Sidev	0.057	Cal 3	9/24/2009 18:25	9/24/2009 14:35	3282	15	219.47	243.02	2.89931	0.15972	3572	0.9958
703	2.165	Cal 3	9/18/2009 19:00	9/18/2009 14:55	9/15/2009 10:00	3364	15	224.27	243.02	3.20486	0.17014	3566	0.9958	
704	2.302	Average	2.235	Cal 9	9/21/2009 18:35	9/21/2009 14:20	6599	30	219.97	243.02	2.89889	0.17708	3569	0.9958
704	2.255	Sidev	0.079	Cal 4	9/24/2009 18:45	9/24/2009 15:00	3274	15	218.27	243.02	2.91667	0.15625	3572	0.9958
704	2.148	Cal 4	9/18/2009 19:15	9/18/2009 15:20	9/15/2009 10:00	3356	15	223.73	243.02	3.22222	0.16319	3566	0.9958	
705	2.032	Average	2.107	Cal 5	9/18/2009 19:40	9/18/2009 15:45	3187	15	212.47	243.02	3.23958	0.16319	3566	0.9958
705	2.090	Sidev	0.084	Cal 5	9/24/2009 19:05	9/24/2009 15:25	3050	15	203.33	243.02	2.93403	0.15278	3572	0.9958
705	2.198	Cal 8	9/21/2009 19:10	9/21/2009 14:45	9/18/2009 17:00	6321	30	210.70	243.02	2.90625	0.18403	3569	0.9958	
706	2.093	Average	2.142	Cal 7	9/21/2009 20:07	9/21/2009 15:05	6013	30	200.43	243.02	2.92014	0.20972	3569	0.9958
706	2.109	Sidev	0.071	Cal 6	9/24/2009 19:25	9/24/2009 15:45	3089	15	205.93	243.02	2.94792	0.15278	3572	0.9958
706	2.223	Cal 6	9/18/2009 19:55	9/18/2009 16:10	9/15/2009 10:00	3505	15	233.67	243.02	3.25694	0.15625	3566	0.9958	
707	2.154	Average	2.275	Cal 7	9/18/2009 20:15	9/18/2009 16:30	3406	15	227.07	243.02	3.27083	0.15625	3566	0.9958
707	2.386	Sidev	0.116	Cal 7	9/24/2009 19:45	9/24/2009 16:05	3506	15	233.73	243.02	2.96181	0.15278	3572	0.9958
707	2.287	Cal 6	9/21/2009 20:35	9/21/2009 15:25	9/18/2009 17:00	6586	30	219.53	243.02	2.93403	0.21528	3569	0.9958	
708	2.253	Average	2.188	Cal 8	9/24/2009 20:00	9/24/2009 16:30	3330	15	222.00	243.02	2.97917	0.14583	3572	0.9958
708	2.110	Sidev	0.180	Cal 1	9/28/2009 18:35	9/28/2009 15:05	7591	30	253.03	243.02	3.92014	0.14583	3576	0.9958
708	1.923	Cal 8	9/18/2009 20:25	9/18/2009 16:50	9/15/2009 10:00	3055	15	203.67	243.02	3.28472	0.14931	3566	0.9958	
709	2.088	Average	2.285	Cal 9	9/18/2009 21:03	9/18/2009 17:15	3324	15	221.60	243.02	3.30208	0.15833	3566	0.9958
709	2.352	Sidev	0.168	Cal 4	9/21/2009 21:50	9/21/2009 16:20	6823	30	227.43	243.02	2.97222	0.22917	3569	0.9958
709	2.400	Cal 9	9/24/2009 20:20	9/24/2009 16:45	9/21/2009 17:00	3554	15	236.93	243.02	2.98958	0.14931	3572	0.9958	
710	2.512	Average	2.409	Cal 3	9/21/2009 22:21	9/21/2009 16:35	7291	30	243.03	243.02	2.98284	0.24028	3569	0.9958
710	2.436	Sidev	0.119	cal 10	9/24/2009 20:50	9/24/2009 17:00	3611	15	240.73	243.02	3.00000	0.15972	3572	0.9958
710	2.279	Cal 10	9/18/2009 21:20	9/18/2009 17:30	9/15/2009 10:00	3635	15	242.39	243.02	3.31250	0.15972	3566	0.9958	
711	2.212	Average	2.242	Cal 11	9/18/2009 21:37	9/18/2009 17:45	3536	15	235.73	243.02	3.32292	0.16111	3566	0.9958
711	2.302	Sidev	0.052	Cal 11	9/24/2009 22:05	9/24/2009 17:15	6283	15	226.33	243.02	3.01042	0.20139	3572	0.9958
711	2.211	Cal 2	9/21/2009 22:52	9/21/2009 16:55	9/18/2009 17:00	6432	30	214.40	243.02	2.99653	0.24792	3569	0.9958	
712	2.292	Average	2.069	Cal 1	9/21/2009 23:40	9/21/2009 17:10	6657	30	221.90	243.02	3.00694	0.27083	3569	0.9958
712	1.928	Sidev	0.195	Cal 11	9/15/2009 22:15	9/15/2009 17:35	6263	15	417.53	243.02	14.29514	0.19444	3563	0.9958
712	1.989	Cal 12	9/24/2009 22:27	9/24/2009 17:30	9/21/2009 17:00	2998	15	195.87	243.02	3.02083	0.20625	3572	0.9958	

EffEr 0.065186 <- Put in Machines.xls (Lucas Cell Tab)

A19  
9/30/09



#7

**Ra-226 Calibration Sheet**

Standard ID: 0299-H  
 Volume Added (mL): 0.1  
 Expiration Date: 8/1/10 \* 15 min

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 1	500	9/11/09 10:30	9/15/09 13:45	9/15/09 17:45	701	7	6595
Cal 2	500	9/11/09 10:30	9/15/09 14:10	9/15/09 18:10	702	7	6583
Cal 3	500	9/11/09 10:30	9/15/09 14:35	9/15/09 18:45	703	7	5072
Cal 4		9/11/09 10:30	9/15/09 15:15	9/15/09 19:00	704	7	6039
Cal 5		9/11/09 10:30	9/15/09 15:40	9/15/09 19:15	705	7	5579
Cal 6		9/11/09 10:30	9/15/09 16:05	9/15/09 19:45	706	7	5347
Cal 7		9/11/09 10:30	9/15/09 16:30	9/15/09 20:00	707	7	5376
Cal 8		9/11/09 10:30	9/15/09 16:45	9/15/09 20:30	708	7	6203
Cal 9		9/11/09 10:30	9/15/09 17:05	9/15/09 21:10	710	7	6458
Cal 10		9/11/09 10:30	9/15/09 17:20	9/15/09 21:55	711	7	5935
Cal 11	500	9/11/09 10:30	9/15/09 17:35	9/15/09 22:15	712	7	6263

9/13/09

9/13/09

9/13/09

9/13/09

9/13/09

9/13/09

9/13/09

9/13/09

9/13/09

9/13/09

# Ra-226 Calibration Sheet

Standard ID: 62M-4  
 Volume Added (mL): 0.1  
 Expiration Date: 6/11/10

\* 15min

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 1	500	<del>9/15/09</del> 9/15/09	9/18/09 1320	9/18/09 1815	101	7	3219
<del>Cal 2</del>	<del>500</del>	<del>9/15/09</del> 1000	<del>9/18/09</del> 1425	<del>9/18/09</del> 1835	<del>102</del>	<del>7</del>	<del>3420</del>
Cal 3	500	9/15/09 1000	9/18/09 1455	9/18/09 1900	103	7	3364
Cal 4	500	9/15/09 1000	9/18/09 1520	9/18/09 1915	104	7	3356
Cal 5	500	9/15/09 1000	9/18/09 1545	9/18/09 1940	105	7	3187
Cal 6	500	9/15/09 1000	9/18/09 1610	9/18/09 1965	106	7	3505
Cal 7	500	9/15/09 1000	9/18/09 <del>1630</del> 1630	9/18/09 2015	107	7	3406
Cal 8	500	9/15/09 1000	9/18/09 1650	9/18/09 2025	108	7	3055
Cal 9	500	9/15/09 1000	9/18/09 1715	9/18/09 2103	109	7	3324
Cal 10	500	9/15/09 1000	9/18/09 1730	9/18/09 2120	110	7	3635
Cal 11	500	9/15/09 1000	9/18/09 1745	9/18/09 <del>2137</del> 2142	111	7	3536
Cal 12	500	9/11/09 1000	9/18/09 1800	9/18/09 2218	112	7	5663

10/1/09

11/09/130105

\* 9/30/09

11/09/130105

# Ra-226 Calibration Sheet

Standard ID: 02944  
 Volume Added (mL): 0.1  
 Expiration Date: 9/1/10

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 17	500	9/18/09 1700	9/21/09 1555	9/21/09 1700	701	7	6158
Cal 11	500	9/18/09 1700	9/21/09 1520	9/21/09 1725	702	7	5611
Cal 10	500	9/18/09 1700	9/21/09 1545	9/21/09 1800	703	7	6317
Cal 9	500	9/18/09 1700	9/21/09 1420	9/21/09 1835	704	7	6599
Cal 8	500	9/18/09 1700	9/21/09 1445	9/21/09 1910	705	7	6321
Cal 7	500	9/18/09 1700	9/21/09 1505	9/21/09 2007	706	7	6013
Cal 6	500	9/18/09 1700	9/21/09 1525	9/21/09 2035	707	7	6586
<del>Cal 5</del>	<del>500</del>	<del>9/18/09 1700</del>	<del>9/21/09 1505</del>	<del>9/21/09 2112</del>	<del>708</del>	<del>7</del>	<del>7155</del>
Cal 4	500	9/18/09 1700	9/21/09 1620	9/21/09 2150	709	7	6823
Cal 3	500	9/18/09 1700	9/21/09 1635	9/21/09 2221	710	7	7291
Cal 2	500	9/18/09 1700	9/21/09 1655	9/21/09 2252	711	7	6432
Cal 1	500	9/18/09 1700	9/21/09 1710	9/21/09 2340	712	7	6657

9/21/09

UN 0120109

9/30/09

# Ra-226 Calibration Sheet

Standard ID: 01199-1

Volume Added (mL): 0.1

Expiration Date: 07/10

\* 15 min counts

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
<del>Cal 1</del>	<del>500</del>	<del>01/21/09 1700</del>	<del>01/21/09 1730</del>	<del>01/24/09 1745</del>	<del>701</del>	<del>7</del>	<del>3125</del>
Cal 2	500	01/21/09 1700	01/24/09 1705	01/24/09 1805	702	7	3014
Cal 3	500	01/21/09 1700	01/24/09 1735	01/24/09 1825	703	7	3292
Cal 4	500	01/21/09 1700	01/24/09 1900	01/24/09 1845	704	7	3274
Cal 5	500	01/21/09 1700	01/24/09 1525	01/24/09 1905	705	7	3050
Cal 6	500	01/21/09 1700	01/24/09 1945	01/24/09 1925	706	7	3089
Cal 7	500	01/21/09 1700	01/24/09 1605	01/24/09 1945	707	7	3506
Cal 8	500	01/21/09 1700	01/24/09 1630	01/24/09 2000	708	7	3330
Cal 9	500	01/21/09 1700	01/24/09 1645	01/24/09 2020	709	7	3554
Cal 10	500	01/21/09 1700	01/24/09 1700	01/24/09 2050	710	7	3611
Cal 11	500	01/21/09 1700	01/24/09 1715	01/24/09 2205	711	7	3395
Cal 12	500	01/21/09 1700	01/24/09 1730	01/24/09 2227	712	7	2938

01/24/09

01/24/09

01/30/09





ee'd

8-21-00

Nycomed Amersham plc  
Amersham Laboratories

0299



CALIBRATION  
No. 0148



ISSUED  
BY:

Nycomed Amersham plc  
Radiation & Radioactivity  
Calibration Laboratory  
Amersham Laboratories  
White Lion Road  
Amersham  
Buckinghamshire  
HP7 9LL

ISSUED  
FOR:

AEA Technology plc  
Isotrak  
Amersham Laboratories  
White Lion Road  
Amersham  
Buckinghamshire  
HP7 9LL

Description Principal radionuclide: Radium-226

Product code: RAY44  
Solution number: R4/131/89

Measurement Reference time: 1200 GMT on 15 December 1999

Nuclear data Nuclear data quoted on this certificate are taken from the Joint European File, Version 2.2.

Expression of uncertainties The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2.00$ , which for a  $t$ -distribution with  $v_{eff} = \infty$  effective degrees of freedom corresponds to a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Unless indicated, all other uncertainties are expressed at the confidence level associated with one standard uncertainty.

The format used for the uncertainties in the values of radionuclidic purity is illustrated in the following examples;

6.5(21)	-	6.5 ± 2.1
6.54(21)	-	6.54 ± 0.21
6.543(21)	-	6.543 ± 0.021

Approved  
Signature

Date of  
issue

17<sup>th</sup> December 1999

WD91280109

Nycomed

# GEL Standard Traceability Log Rad

Source Material Info		A Solution Material Info	
Parent Code:	0299	Isotope:	Radium-226
Prepared By:	Angela Johnson	Prepared By:	Angela Johnson
Carrier Conc:	0.5 M HCL	Prep Date:	09/15/2000
Reference Date:	12/15/1999	Verification Date:	01/23/2008
Ampoule Mass (g):	5.0368 g	Expiration Date:	01/23/2009
Uncertainty:	+/- 2.5 %	Primary Code:	0299-A
LogBook No:	RC S 027 128	Dilution(mL):	100 mL
		Mass of Parent(g):	4.6634 g
		Density(g/mL):	1.0012
		Balance ID:	

## Calculations Converting parent activity to dpm/mL/dppm/g

$$(\text{Mass of parent(g)}) * (\text{Parent Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)}) * (\text{Parent Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$$

## Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
08/26/2003	Angela Johnson	1.9909	100	0299-E	2434.34 dpm/mL	11/04/2004	11/04/2005
08/26/2003	Angela Johnson	1.9872	100	0299-F	2429.82 dpm/mL	08/26/2004	08/26/2005
04/05/2005	Amanda Fehr	5.0018	250	0299-G	2446.3471 dpm/mL	01/26/2009	01/26/2010
08/07/2009	Mary Aders	5.0767	250	0299-H	2483.2133 dpm/mL	08/07/2009	08/07/2010

GEL Laboratories LLC  
Version 1.0 9/18/2000



## Verification for Ra-226 Standard 0299-H

M. Aders 8/7/2009	Isotope	Value	Uncertainty
	0299-H	111.440	2.5408
	0299-H	115.924	2.5878
	0299-H	111.780	2.5407
<b>Mean Value (Counting) =</b>	113.048	101.49	<b>Pass</b>
<b>Stdev =</b>	2.496414563		<b>Rule 3 (Pass/Fail)</b>
<b>Target =</b>	111.39		
<b>Lower Limit =</b>	108.0550709		
<b>Upper Limit =</b>	118.0407291		
<b>Rule 1 Pass/Fail</b>	<b>Pass</b>		
<b>Two sigma =</b>	4.992829126		
<b>10 % of Mean =</b>	11.30479		
<b>Rule 2 (Pass/Fail)</b>	<b>Pass</b>		

**Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements**

**Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.**

**Rule 3 = The determined mean value shall be within 5% of the certificate value.**

The analyst prepared three standard verification sources for Ra-226 source 0299-H by transferring portions of the degassed standard into tared glass liquid scintillation vials. 10 mL of DI Water and 10 mL of mineral oil were added to each vial and the vials were shaken. A Blank vial was prepared in a similar fashion using 10 mL of DI Water and 10 mL of mineral oil. The standard verification vials and Background source were dark adapted for two hours and counted on LSC Red using source standard verification. Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

Reference RAD SOP M-001

*Handwritten signature: Amanda L. Fein 8/13/09*

# Radon-222 Liquid

Filename : RN222.XLS  
 File type : Excel  
 Version # : 1.2.4

Spike S/N : N/A  
 Spike Exp Date : N/A  
 Spike Activity (dpm/ml) : N/A  
 Spike Volume Added : N/A  
 Spike Date/Time : 8/7/2009 14:00

LCS S/N : 0299-H  
 LCS Exp Date : 8/7/2010  
 LCS Activity (dpm/ml) : 2472.85  
 LCS Volume Added : 0.10

Batch : 891920  
 Analyst : MLA  
 Prep Date : 8/7/2009

Procedure Code : LSC22RNL  
 Parname : Radon-222  
 Required MDA : 200 pCi/L  
 Half-life of Radon-222 : 3.823 days

Rn-222 Abundance : 1  
 Rn-222 Method Uncertainty : 0.1111  
 Geometry : 10ML MINERAL OIL/10ML  
 Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml

Sample Characteristics		Sample Aliquot		Sample Date/Time	Count raw Data				Background	Count	Sample
Pos.	Sample ID	Sample Aliquot L	Sample Aliquot StDev. L	Sample Date/Time	Rack Position #	Counting Time (min.)	Quench#	Gross cpm	Count Time (min.)	Start Date/Time	Decay
1	1201897268.1	1.0000	2.0399E-05	8/7/2009 0:00	8-2	15	43.3	517.53	15	8/12/2009 7:48	0.380
2	1201897269.1	1.0000	2.0399E-05	8/7/2009 0:00	8-3	15	44.6	538.8	15	8/12/2009 8:04	0.380
3	1201897270.1	1.0000	2.0399E-05	8/7/2009 0:00	8-4	15	45	520.6	15	8/12/2009 8:20	0.379

0.379

Calibration Data				Detector				Backgrounds			Correction Factors			Net Sample
Pos.	Counted on	Calibration Date	Calibration Due Date	Detector Efficiency (cpm/dpm)	Detector Efficiency Error (cpm/dpm)	Rack Position #	Count Start Date/Time	Spike Date/Time	Rn-222 Ingrowth	Rn-222 Count Correction	Net Sample Activity for MS pCi/L			
1	LSCRED	7/28/2009	7/31/2010	3.5654	0.00792	8-1	8/12/2009 7:31	8/7/2009 14:00	0.577	0.577				
2	LSCRED	7/28/2009	7/31/2010	3.5654	0.00792	8-1	8/12/2009 7:31	8/7/2009 14:00	0.578	0.578				
3	LSCRED	7/28/2009	7/31/2010	3.5654	0.00792	8-1	8/12/2009 7:31	8/7/2009 14:00	0.579	0.579				

6/24/09  
8/13/09

- Notes:  
 1 - Results are decay corrected to Sample Date/Time  
 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date  
 3 - Spike Nominals are decay corrected to Sample Date/Time

Pos.	Decision Level pCi/L	Critical Level pCi/L	Required MDA pCi/L	MDA pCi/L	Sample Act. Conc. pCi/L	Sample Act. Error pCi/L	Net Count Rate CPM	Net Count Rate CPM	Net Count Rate Error CPM	2 SIGMA		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
										Counting Uncertainty pCi/L	Total Prop. Uncertainty pCi/L						
1	0.5420	0.3827	200	0.8092	111.4397	0.0141	509.0600	592.17	5.9217	2.5408	24.4606		LCS			111.3896	100.0%
2	0.5412	0.3821	200	0.8080	115.9238	0.0139	530.3300	6.0403	6.0403	2.5678	25.4391		LCS			111.3896	104.1%
3	0.5404	0.3816	200	0.8068	111.7802	0.0140	512.1300	5.9390	5.9390	2.5407	24.5345		LCS			111.3896	100.4%

REV 2/13/04

12 AUG 2009 07:48

ID: R14-232

12 AUG 2009 07:48

USER: IC COMMENT: RED

PRESET TIME : 15.00  
 DATA CALC : CPM HH : YES SAMPLE REPEATS : 1 PRINTER : EDIT  
 COUNT BLANK : NO ICW : NO REPLICATES : 1 RS232 : EDIT  
 TWO PHASE : NO AQW : NO CYCLE REPEATS : 1 DISK : OFF  
 SCINTILLATOR : LIQUID LUMEX : NO LOW SAMPLE RES : 0  
 LOW LEVEL : YES HALF LIFE CORRECTION DATE : none

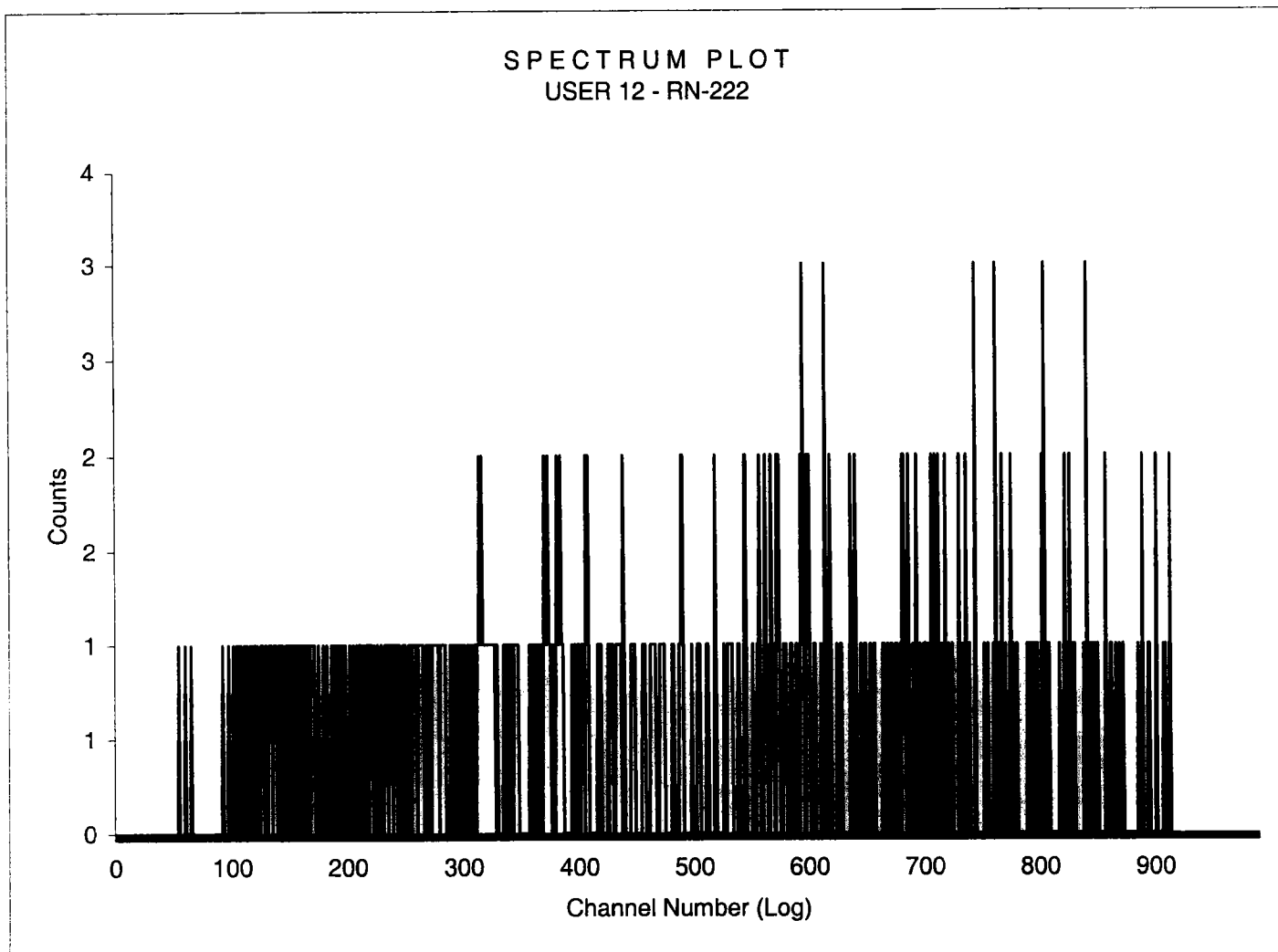
CHAN: 600.0 - 975.0 %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0  
 CHAN: 0.0 - 900.0 %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0

ALPHA-BETA DISCRIMINATION: NO

SAM NO	POS	TIME MIN	HH	WIND1 RAW CPM	WIND2 RAW CPM	WIND1		WIND2		LUMEX %	ELAPSED TIME
						CPM	%ERROR	CPM	%ERROR		
1	3-1	15.00	39.1	9.47	27.73	9.47	17.75	27.73	9.81	0.07	15.00
2	3-2	15.00	43.3	517.53	607.33	517.53	2.27	607.33	2.10	0.07	15.00
3	3-3	15.00	44.6	538.80	628.67	538.80	2.22	628.67	2.06	0.07	15.00
4	3-4	15.00	45.0	520.60	610.00	520.60	2.26	610.00	2.09	0.07	15.00

COX team

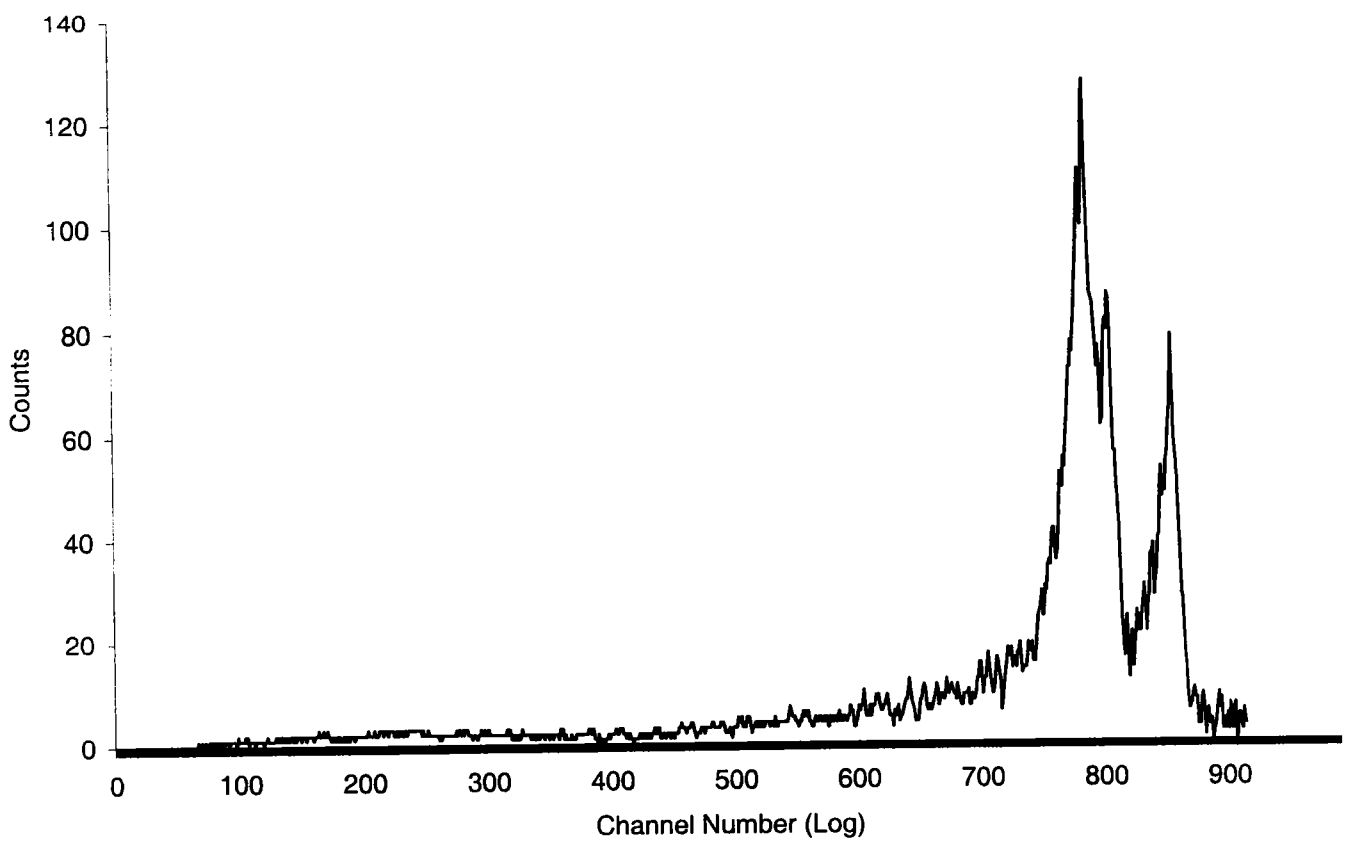
Sample Count Start Time:	12 Aug 2009 07:31:52		
Data Capture Date	12 Aug 2009 07:47:25		
User Filename	S12081208-1A.XLS		
	U12081208-1A.XLS		
Spectrum Type	Log Counts		
User Number	12		
User Id	RN-222		
User Comment	RED		
Isotope Name	14C		
Scintillator	LIQUID		
Sample, Rack-Pos, Time:	1	8-1	15.00
H#, Total Counts:	39.1	422	
Start, End, X-Axis:	0	990	Channel Number



*Handwritten:* 07:31:52

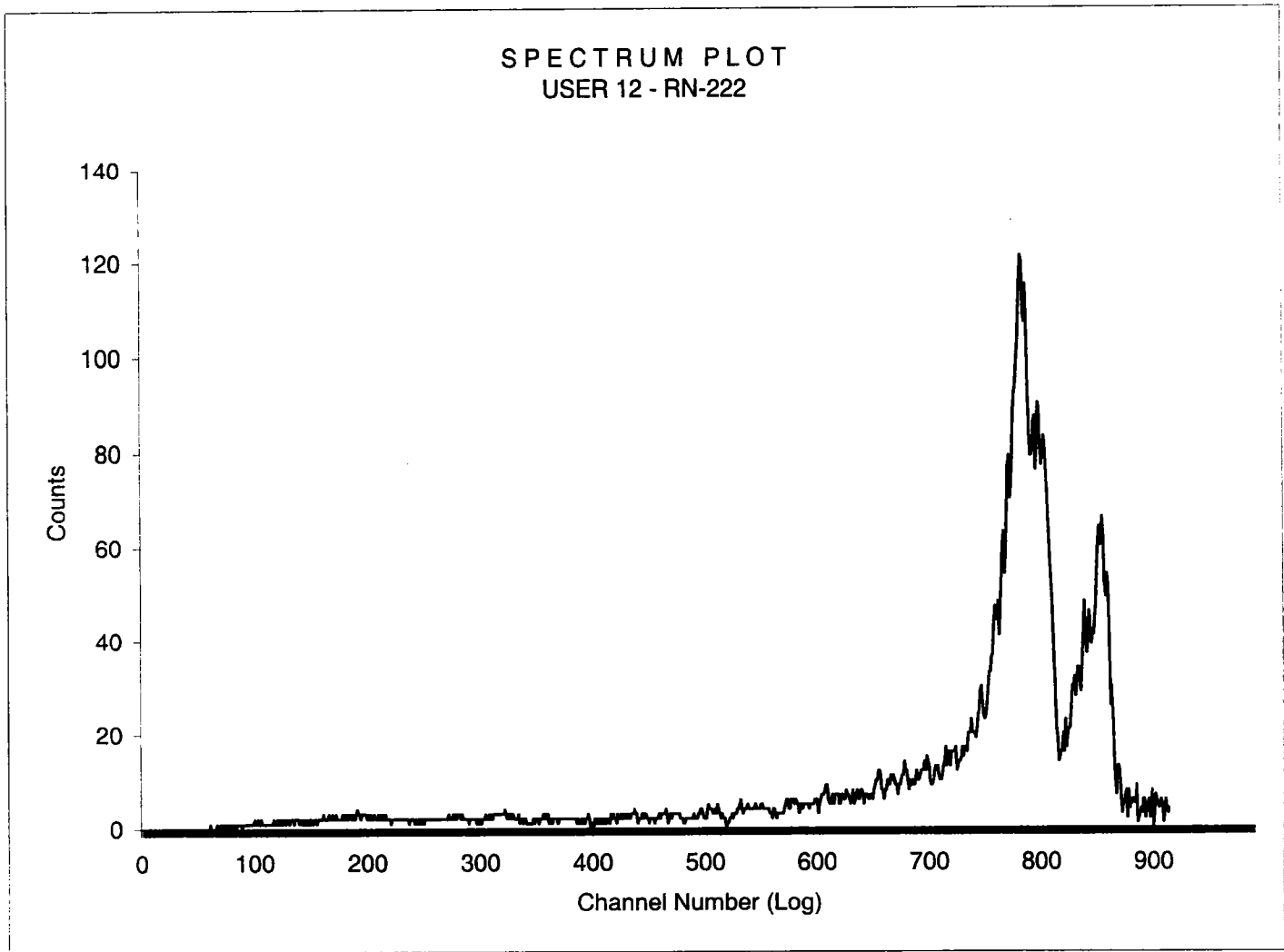
Sample Count Start Time:	12 Aug 2009 07:48:04		
Data Capture Date	12 Aug 2009 08:03:28		
User Filename	S12081208-2A.XLS		
	U12081208-1A.XLS		
Spectrum Type	Log Counts		
User Number	12		
User Id	RN-222		
User Comment	RED		
Isotope Name	14C		
Scintillator	LIQUID		
Sample, Rack-Pos, Time:	2	8-2	15.00
H#, Total Counts:	43.3	9166	
Start, End, X-Axis:	0	990	Channel Number

SPECTRUM PLOT  
USER 12 - RN-222



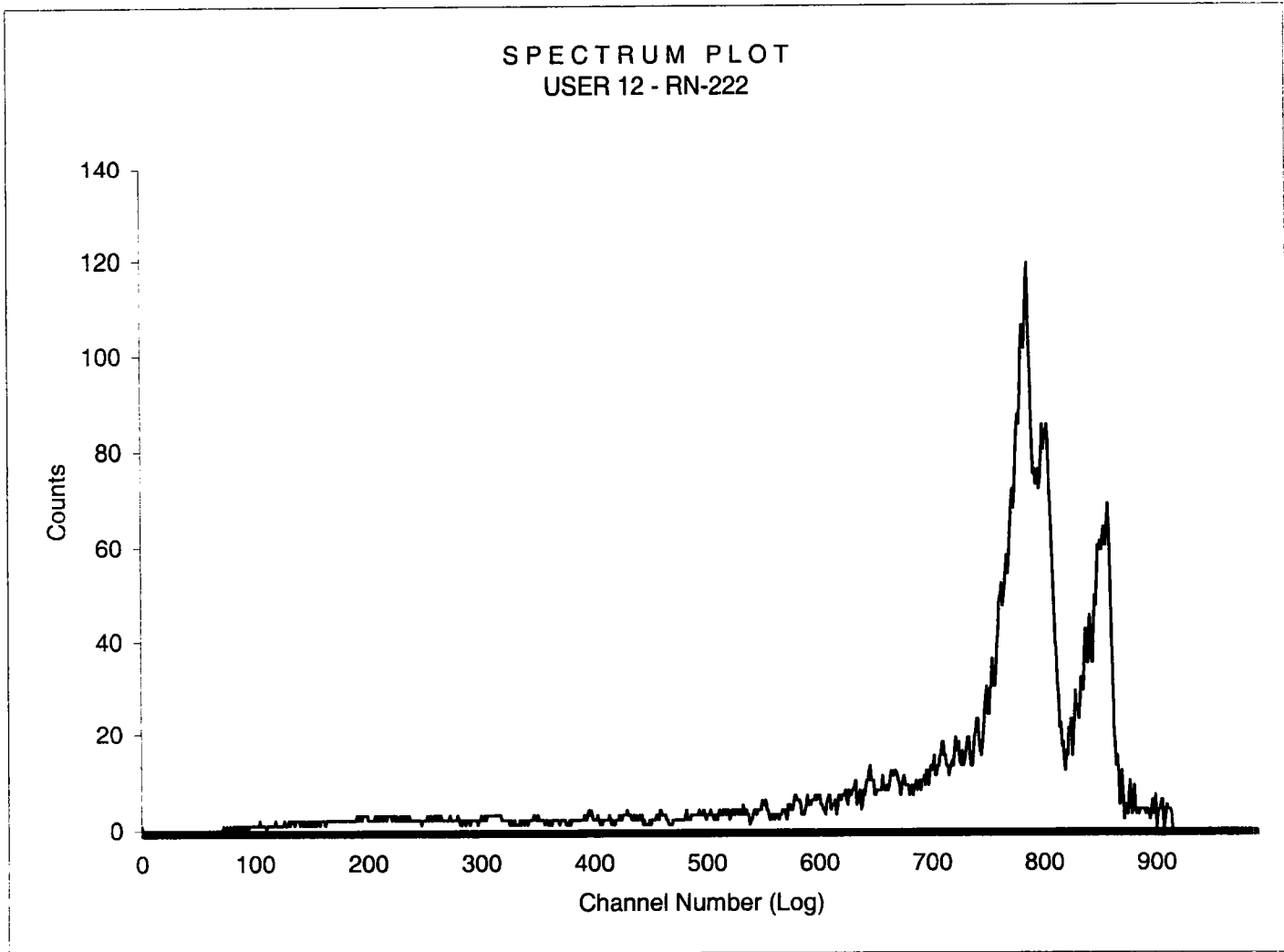
*Handwritten:*  
3/13/07

Sample Count Start Time: 12 Aug 2009 08:04:11  
Data Capture Date: 12 Aug 2009 08:19:35  
User Filename: S12081208-3A.XLS  
U12081208-1A.XLS  
Spectrum Type: Log Counts  
User Number: 12  
User Id: RN-222  
User Comment: RED  
Isotope Name:  $^{14}\text{C}$   
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 3 8-3 15.00  
H#, Total Counts: 44.6 9492  
Start, End, X-Axis: 0 990 Channel Number





Sample Count Start Time: 12 Aug 2009 08:20:17  
Data Capture Date: 12 Aug 2009 08:35:41  
User Filename: S12081208-4A.XLS  
U12081208-1A.XLS  
Spectrum Type: Log Counts  
User Number: 12  
User Id: RN-222  
User Comment: RED  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 4 8-4 15.00  
H#, Total Counts: 45.0 9197  
Start, End, X-Axis: 0 990 Channel Number



# Radon 222 Que Sheet

08/07/2009

Batch #: 891920      Analyst: MLA      First Client Due Date: 08/17/2009  
 Spike Isotope: Radium-226      Spike Code: 0299-A      Expiration Date: 08/17/09      Vol: 1  
 LCS Isotope: Radium-226      LCS Code: 0299-A      Expiration Date: 08/17/09      Vol: 1  
 Prep Date: 08/07/09      Pipet ID: 270968      Initials: MLA      Witness: MLA

Comments

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collection Date	Label	Wet/Dry Sample Mass (g/mL)	LSC Rack #	Time Spike Added
1201897268-1	LCS for batch 891920	LCS	.2 pCi/mL	DRINKING WATQC ACCOUNT	20-JUL-09 12:00 PM						1400
1201897269-1	LCS for batch 891920	LCS	.2 pCi/mL	DRINKING WATQC ACCOUNT	20-JUL-09 12:00 PM						1400
1201897270-1	LCS for batch 891920	LCS	.2 pCi/mL	DRINKING WATQC ACCOUNT	20-JUL-09 12:00 PM						1400

Bkg Rack #:

311

Comments: \_\_\_\_\_ Data Reviewed By: \_\_\_\_\_

Instrument Used: LS6000 (Red) 7065155, LS6500 (Black) 7069123, LS6500 (Blue) 7067083, LS6500 (Green) 7067404  
 Wallac (Yellow) 4040127, Wallac (Pink) 2200082, Purple 7069123, Silver 7060656

GEL Laboratories LLC, Radiochemistry Division

08/17/09

## Voltage Curve Ludlum #7

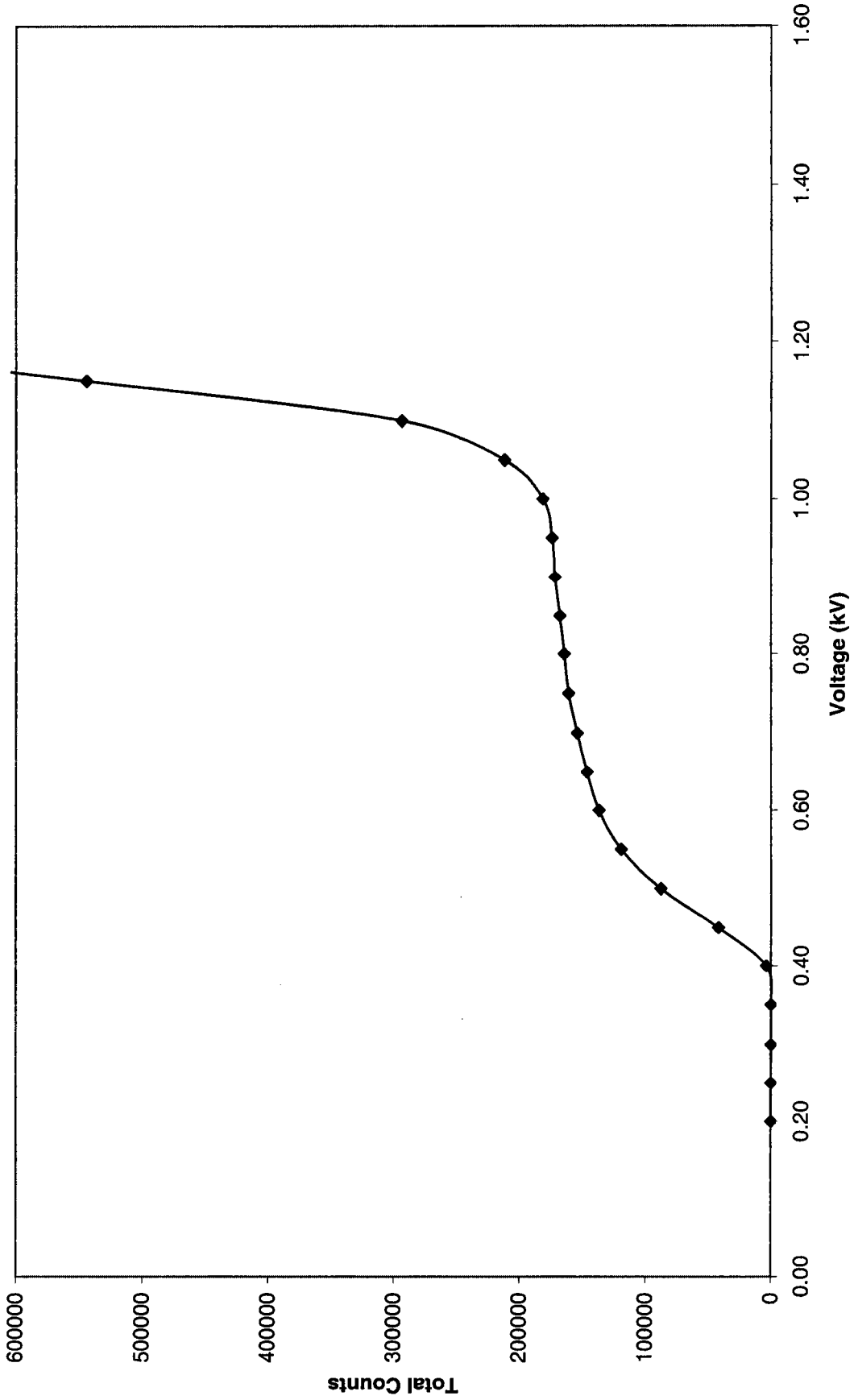
Voltage (kV)	Count Time (min)	Counts	Date/Time
0.20	1.00	0	9/15/09 12:13
0.25	1.00	0	9/15/09 12:14
0.30	1.00	0	9/15/09 12:15
0.35	1.00	0	9/15/09 12:16
0.40	1.00	3788	9/15/09 12:17
0.45	1.00	41827	9/15/09 12:18
0.50	1.00	87578	9/15/09 12:19
0.55	1.00	119153	9/15/09 12:20
0.60	1.00	136757	9/15/09 12:21
0.65	1.00	146242	9/15/09 12:22
0.70	1.00	154066	9/15/09 12:23
0.75	1.00	160997	9/15/09 12:24
0.80	1.00	164506	9/15/09 12:25
0.85	1.00	168023	9/15/09 12:26
0.90	1.00	171900	9/15/09 12:27
0.95	1.00	174082	9/15/09 12:28
1.00	1.00	181331	9/15/09 12:29
1.05	1.00	211928	9/15/09 12:30
1.10	1.00	293552	9/15/09 12:31
1.15	1.00	544079	9/15/09 12:32
1.20	1.00	827973	9/15/09 12:33
1.25	1.00	1214090	9/15/09 12:34

Detector set to operate at 0.70 kV

JK  
9/30/09

Ludlum Detector Voltage Curve

—◆— Voltage Curve Ludlum #7



JKG  
9/30/09

### DAILY CALIBRATION RANGE

Trial	Counts	Date	Time	Detector
1	154335	9/15/2009	13:30	7
2	153698	9/15/2009	13:31	7
3	153933	9/15/2009	13:32	7
4	154196	9/15/2009	13:33	7
5	154114	9/15/2009	13:34	7
6	153766	9/15/2009	13:35	7
7	154409	9/15/2009	13:36	7
8	154086	9/15/2009	13:37	7
9	153833	9/15/2009	13:38	7
10	153689	9/15/2009	13:39	7
11	148183	9/16/2009	10:25	7
12	148142	9/16/2009	10:35	7
13	148193	9/16/2009	10:36	7
14	147463	9/16/2009	10:37	7
15	147251	9/16/2009	10:39	7
16	146697	9/17/2009	4:25	7
17	146925	9/17/2009	5:45	7
18	147238	9/17/2009	6:00	7
19	147239	9/17/2009	6:15	7
20	146836	9/17/2009	6:30	7

STATISTICS	
Average	150711.30
St. Dev.	3407.47
+ 3 S.D.	160933.72
+ 2 S.D.	157526.25
Average	150711.30
- 2 S.D.	143896.35
- 3 S.D.	140488.88
<b>UPPER</b>	<b>160934</b>
<b>LOWER</b>	<b>140489</b>

*Handwritten:* 9/30/09

701	2.107	9/30/2009
702	2.033	9/30/2009
703	2.221	9/30/2009
704	2.235	9/30/2009
705	2.107	9/30/2009
706	2.142	9/30/2009
707	2.275	9/30/2009
708	2.188	9/30/2009
709	2.285	9/30/2009
710	2.409	9/30/2009
711	2.242	9/30/2009
712	2.069	9/30/2009

Handwritten signature and date: 9/30/09

# Ra-226 WATER

Batch : LCSVER  
 Date : 9/22/2009  
 Analyst : KSD1

Procedure Code : LUC26RAL

Parname : Radium-226

MDA : 1 pCi/L

Bkg Count Time: 30 min

Instrument Used : LUCAS CELL DETECTOR

Sample ID	Sample Vol L	Count Time min	Gross counts cts	Cell # num	Cell Const. num	BKG cpm	Ra-226 MDA pCi/L	Ra-226 RESULT pCi/L	Ra-226 ERROR pCi/L	COUNT DATE/TIME
VER 1	0.500	15	636	701	2.107	0.267	0.5512	24.6163	1.9283	9/30/2009 9:20
VER 2	0.500	15	625	702	2.033	0.267	0.5247	27.0835	2.1404	9/29/2009 16:10
VER 3	0.500	15	625	703	2.221	0.267	0.4811	24.8342	1.9627	9/29/2009 16:45
VER 4	0.500	15	587	704	2.235	0.267	0.4786	23.1944	1.8925	9/29/2009 17:15
VER 5	0.500	15	511	705	2.107	0.267	0.5081	21.4146	1.8751	9/29/2009 17:50
VER 6	0.500	15	580	706	2.142	0.267	0.4998	23.9310	1.9645	9/29/2009 18:25
VER 7	0.500	15	539	707	2.275	0.267	0.4643	20.6372	1.7586	9/29/2009 18:40
VER 8	0.500	15	525	708	2.188	0.267	0.4816	20.8572	1.8013	9/29/2009 19:00
VER 9	0.500	15	559	709	2.285	0.267	0.4615	21.2888	1.7807	9/29/2009 19:40
VER 10	0.500	15	694	710	2.409	0.267	0.4093	23.4767	1.7593	9/30/2009 9:50
VER 11	0.500	15	537	711	2.242	0.267	0.4690	20.7776	1.7739	9/29/2009 20:20
VER 12	0.500	15	552	712	2.069	0.267	0.5096	23.2132	1.9542	9/29/2009 21:10

Handwritten signature and date: 9/30/09

Sample ID	Det #	Run Date	Sample Type	Standard ID	NC	NC units	Recovery/RPD
701	7	9/29/2009 15:35	LCS	0638-F	24.05	pCi/L	102%
702	7	9/29/2009 16:10	LCS	0638-F	24.05	pCi/L	113%
703	7	9/29/2009 16:45	LCS	0638-F	24.05	pCi/L	103%
704	7	9/29/2009 17:15	LCS	0638-F	24.05	pCi/L	96%
705	7	9/29/2009 17:50	LCS	0638-F	24.05	pCi/L	89%
706	7	9/29/2009 18:25	LCS	0638-F	24.05	pCi/L	100%
707	7	9/29/2009 18:40	LCS	0638-F	24.05	pCi/L	86%
708	7	9/29/2009 19:00	LCS	0638-F	24.05	pCi/L	87%
709	7	9/29/2009 19:40	LCS	0638-F	24.05	pCi/L	89%
710	7	9/29/2009 20:00	LCS	0638-F	24.05	pCi/L	98%
711	7	9/29/2009 20:20	LCS	0638-F	24.05	pCi/L	86%
712	7	9/29/2009 21:10	LCS	0638-F	24.05	pCi/L	97%

DEGASSING DATE/TIME	DE-EMAN. DATE/TIME	DEGASS-DE-EM	dE-EM-COUNT	constant	constant	Net CPM	Ingrowth constant
9/22/2009 14:30	9/30/2009 6:00	183.50	3.33	0.7498	0.9751	42.1333	0.7318
9/22/2009 14:30	9/29/2009 10:00	163.50	6.17	0.7090	0.9545	41.4000	0.6774
9/22/2009 14:30	9/29/2009 10:15	163.75	6.50	0.7095	0.9521	41.4000	0.6762
9/22/2009 14:30	9/29/2009 10:30	164.00	6.75	0.7101	0.9503	38.8667	0.6755
9/22/2009 14:30	9/29/2009 10:50	164.33	7.00	0.7108	0.9485	33.8000	0.6749
9/22/2009 14:30	9/29/2009 11:15	164.75	7.17	0.7117	0.9473	38.4000	0.6749
9/22/2009 14:30	9/29/2009 12:45	166.25	5.92	0.7150	0.9563	35.6663	0.6844
9/22/2009 14:30	9/29/2009 13:10	166.67	5.83	0.7159	0.9569	34.7333	0.6857
9/22/2009 14:30	9/29/2009 13:35	167.08	6.08	0.7168	0.9551	37.0000	0.6852
9/22/2009 14:30	9/30/2009 6:30	184.00	3.33	0.7507	0.9751	46.0000	0.7328
9/22/2009 14:30	9/29/2009 14:20	167.83	6.00	0.7184	0.9557	35.5333	0.6872
9/22/2009 14:30	9/29/2009 14:40	168.17	6.50	0.7191	0.9521	36.5333	0.6853

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Re-226 Verification Sheet

VNS #7

count time: 15 min

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
<del>VN1</del>	<del>500</del>	<del>9/29/09 1430</del>	<del>9/29/09 1040</del>	<del>9/29/09 1535</del>	<del>701</del>	<del>7</del>	<del>8</del>	<del>488</del>
VN2	500	9/29/09 1430	9/29/09 1000	9/29/09 1610	702	7	8	685
VN3	500	9/29/09 1430	9/29/09 1015	9/29/09 1645	703	7	1	625
VN4	500	9/29/09 1430	9/29/09 1030	9/29/09 1715	704	7	3	587
VN5	500	9/29/09 1430	9/29/09 1050	9/29/09 1750	705	7	1	511
VN6	500	9/29/09 1430	9/29/09 1115	9/29/09 1825	706	7	6	580
VN7	500	9/29/09 1430	9/29/09 1145	9/29/09 1840	707	7	1	539
VN8	500	9/29/09 1430	9/29/09 1310	9/29/09 1900	708	7	6	525
VN9	500	9/29/09 1430	9/29/09 1335	9/29/09 1940	709	7	5	559
<del>VN10</del>	<del>500</del>	<del>9/29/09 1430</del>	<del>9/29/09 1400</del>	<del>9/29/09 2000</del>	<del>710</del>	<del>7</del>	<del>4</del>	<del>322</del>
VN11	500	9/29/09 1430	9/29/09 1420	9/29/09 2020	711	7	7	537
VN12	500	9/29/09 1430	9/29/09 1440	9/29/09 2110	712	7	3	552

419  
9/30/09

419  
9/30/09

419  
9/30/09

Ra-226 Verification Sheet

\* COUNT 15 min

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
VER 16	500	9/22/09 1430	9/30/09 600	9/30/09 0920	701	7	3	636
VER 17	500	9/22/09 1430	9/30/09 630	9/30/09 0950	710	7	8	694
/								

JH9 9/30/09

JH9 9/30/09

## General Engineering Laboratories Verification Source Preparation Sheet

Applicable SOP Number GL RAD-A-008 Isotope RA 226  
 Date Standards Prepared 7/31/09 Cocktail Type Used NA  
 Standard ID DL2814 Matrix of Vial/Planchett NA  
 Amount Used (g or ml) 0.1 Type of Scintillation Vial NA  
 Standard Activity (DPM/g or mL) 268.8845 Pipette ID Used 1429303  
 Reference Date 11/23/04 Balance ID Used 38080104  
 Expiration Date 7/17/10 Quenching Agent NA  
 Residue/Carrier Agent NA

	Standard Number	Quenching Vol (uL) Residue Volume (mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
1	VEN 1				
2	VEN 2				
3	VEN 3				
4	VEN 4				
5	VEN 5				
6	VEN 6				
7	VEN 7				
8	VEN 8				
9	VEN 9				
10	VEN 10				
11	VEN 11				
12	VEN 12				
13	VEN 16				
14	VEN 17				

~~/~~

9/30/09

Prepared By: Kelli & Deuce Date: 9/30/09  
 Reviewed By: Aggie & Jk Date: 9/30/09

**ANALYTICS**

1380 Seaboard Industrial Blvd.  
Atlanta, Georgia 30318 - U.S.A.

0638

Phone (404) 352-8677  
Fax (404) 352-2837

**CERTIFICATE OF CALIBRATION**  
**Standard Radionuclide Source**

67519-278

Ra-226 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated using a germanium gamma spectrometer system.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

Analytics maintains traceability to the National Institute of Standards and Technology through participation in a Measurements Assurance Program as described in USNRC Reg. Guide 4.15, Revision 1, February 1979.

ISOTOPE:	Ra-226
ACTIVITY (dps):	2.353 E4
HALF-LIFE:	1.600 E3 years
CALIBRATION DATE:	January 23, 2004 12:00 EST
RELATIVE EXPANDED UNCERTAINTY (k=2):	3.3%

Impurities:  $\gamma$ -impurities (other than decay products) <0.1%

5.01065 grams 0.1M HCl solution with 50  $\mu$ g/g Ba carrier.

P O NUMBER 3231RD, Item 5

SOURCE PREPARED BY:

M. D. Currie  
M. D. Currie, Radiochemist

Q A APPROVED:

MCW 1/26/04

## Standard Traceability Log Rad

**WARNING! Training must be completed!!**  
**Alphalims will be locked out if training is not completed within 1 week of assignment Contact**  
**Quality if additional time is needed to complete training**

Source Material Info		A Solution Material Info	
Parent Code:	0638	Isotope:	Radium-226
Prepared By:	Amanda Fehr	Prepared By:	Amanda Fehr
Carrier Conc:	0.1M HCl	Prep Date:	01/16/2006
Reference Date:	01/23/2004	Verification Date:	04/09/2009
Ampoule Mass (g):	5.01065 g	Expiration Date:	04/09/2010
Uncertainty:	+/- 3.3 %	Primary Code:	0638-A
LogBook No:	RC-S-037-037	Dilution(mL):	100 mL
		Mass of Parent(g):	4.8398 g
		Density(g/mL):	1.0266
		Balance ID:	38080204

### Calculations Converting parent activity to dpm/mL/dpm/g

$$(\text{Mass of parent(g)} * (\text{Parm Activity (dps)} * (\text{conversion dpm to dps}) * (\text{conversion dpm to dps}) / (\text{Ampoule Mass(g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)} * (\text{Parm Activity (dps)} * (\text{conversion dpm to dps}) / \text{Density} / (\text{Ampoule Mass (g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/g)}$$

$$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13636.6133 \text{ dpm/mL}$$

$$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (1.0266 \text{ g/mL}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13282.9676 \text{ dpm/g}$$

Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
01/17/2006	Amanda Fehr	2.1041	100	0638-B	279.0211 dpm/mL	01/17/2007	01/17/2008
07/17/2006	Mary Aders	2.1313	100	0638-C	282.6281 dpm/mL	07/26/2006	07/26/2007
03/28/2007	Daniel Roy	2.1025	100	0638-D	279.2744 dpm/ml	04/08/2007	04/08/2008
03/28/2007	Daniel Roy	45.468	250	0638-E	2415.7999 dpm/ml	04/09/2009	04/09/2010
12/18/2007	Daniel Roy	2.014	100	0638-F	267.519 dpm/ml	02/02/2009	02/02/2010
02/12/2008	Daniel Roy	.5004	100	0638-G	66.468 dpm/ml	03/02/2009	03/02/2010
07/23/2008	Daniel Roy	5.0607	250	0638-H	268.8845 dpm/ml	07/17/2009	07/17/2010

GEL Laboratories LLC  
Version 1.0 9/18/2000

VN 61260106

# Verification for Ra-226 Standard 0638-H

M. Aders 7/17/2009	<b>Isotope</b> 0638-H 0638-H 0638-H	<b>Value</b> 12.025 10.739 12.348	<b>Uncertainty</b> 1.2237 1.1752 1.2298
<b>Mean Value (Counting) =</b>	11.704	96.86	<b>Pass</b>
<b>Stdev =</b>	0.85081728		<b>Rule 3 (Pass/Fail)</b>
<b>Target =</b>	12.08		
<b>Lower Limit =</b>	10.00223211		
<b>Upper Limit =</b>	13.40550123		
<b>Rule 1 Pass/Fail</b>	<b>Pass</b>		
<b>Two sigma =</b>	1.701634559		
<b>10 % of Mean =</b>	1.170386667		
<b>Rule 2 (Pass/Fail)</b>	<b>Fail</b>		<b>*Exception taken due to full recovery of standard</b>

**Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements**

**Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.**

**Rule 3 = The determined mean value shall be within 5% of the certificate value.**

The analyst prepared three standard verification sources for Ra-226 source 0638-H by transferring portions of the degassed standard into tared glass liquid scintillation vials. 10 mL of DI Water and 10 mL of mineral oil were added to each vial and the vials were shaken. A Blank vial was prepared in a similar fashion using 10 mL of DI Water and 10 mL of mineral oil. The standard verification vials and Background source were dark adapted for two hours and counted on LSC Green using source standard verification. Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

Reference RAD SOP M-001

*Angela D. H. 7/30/09*  
*Henry J. Adams 7/20/09*  
*Nancy M. Hart 7/20/09*

# Radon-222 Liquid

Filename : RN222.XLS  
 File type : Excel  
 Version # : 1.2.4

Spike S/N : N/A  
 Spike Exp Date : N/A  
 Spike Activity (dpm/ml) : N/A  
 Spike Volume Added : N/A  
 Spike Date/Time : 7/17/2009 15:00

LCS S/N : 0638-H  
 LCS Exp Date : 7/23/2009  
 LCS Activity (dpm/ml) : 268.25  
 LCS Volume Added : 0.10

Batch : 886194  
 Analyst : MLA  
 Prep Date : 7/17/2009

Procedure Code : LSC99TCL  
 Parmname : Radon-222  
 Required MDA : 50  
 Half-life of Radon-222 : 3.823 days

Rn-222 Abundance : 1  
 Rn-222 Method Uncertainty : 0.0556  
 Geometry : 10ML MINERAL OIL/10ML SAMPLE

Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml

Sample Characteristics			Count raw Data			Background			Sample Decay	
Pos.	Sample ID	Sample Aliquot L	Sample Aliquot StDev. L	Rack Position #	Counting Time (min.)	Quench#	Gross cpm	Count Time (min.)	Count Start Date/Time	Sample Decay
1	1201883284.1	1.0000	2.0399E-05	22-2	15	50.3	43.73	15	7/20/2009 11:53	0.594
2	1201883285.1	1.0000	2.0399E-05	22-3	15	50	38.2	15	7/20/2009 12:09	0.592
3	1201883286.1	1.0000	2.0399E-05	22-4	15	49.1	45.4	15	7/20/2009 12:26	0.591



Calibration Data				Backgrounds				Correction Factors			Net Sample Activity for MS pCi/L	
Pos.	Counted on	Calibration Date	Calibration Due Date	Detector Efficiency (cpm/dpm)	Detector Efficiency Error (cpm/dpm)	Rack Position #	Count Start Date/Time	Spike Date/Time	Rn-222 Ingrowth	Rn-222 Count Correction	Net Sample Activity for MS pCi/L	
1	LSCGREEN	3/25/2009	3/31/2010	3.4365	0.00792	22-1	7/20/2009 11:36	7/17/2009 15:00	0.406	0.406	0.406	
2	LSCGREEN	3/25/2009	3/31/2010	3.4365	0.00792	22-1	7/20/2009 11:36	7/17/2009 15:00	0.408	0.408	0.408	
3	LSCGREEN	3/25/2009	3/31/2010	3.4365	0.00792	22-1	7/20/2009 11:36	7/17/2009 15:00	0.409	0.409	0.409	

- Notes:  
 1 - Results are decay corrected to Sample Date/Time  
 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date  
 3 - Spike Nominals are decay corrected to Sample Date/Time

Pos.	Decision Level pCi/L	Critical Level pCi/L	Required MDA pCi/L	MDA pCi/L	Sample Act. Conc. pCi/L	Sample Act. Error pCi/L	Net Count Rate CPM	Net Count Rate Error CPM	2 SIGMA		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
									Counting Uncertainty pCi/L	Total Prop. Uncertainty pCi/L						
1	0.8104	0.5722	50	1.2114	12.0246	0.0525	35.8600	1.8619	1.2237	1.8026		LCS			12.0832	99.5%
2	0.8078	0.5703	50	1.2075	10.7393	0.0564	32.1300	1.7939	1.1752	1.6669		LCS			12.0832	88.9%
3	0.8053	0.5685	50	1.2037	12.3477	0.0514	37.0600	1.8833	1.2298	1.8330		LCS			12.0832	102.2%

# Radon 222 Que Sheet

07/17/2009

Batch #: 886194      Analyst: MLA      First Client Due Date: \_\_\_\_\_      Internal Due Date: 07/22/2009  
 Spike Isotope: Radium-226      Spike Code: C03281      Expiration Date: 7/23/09      Vol: 0.1      Nom Conc: \_\_\_\_\_  
 LCS Isotope: Radium-226      LCS Code: \_\_\_\_\_      Expiration Date: \_\_\_\_\_      Vol: \_\_\_\_\_      Nom Conc: \_\_\_\_\_  
 Prep Date: 7/17/09      Pipet ID: 2971055      Initials: MLA      Witness: \_\_\_\_\_      Comments: \_\_\_\_\_

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collection Date	Label	Wet/Dry Sample Mass (g/mL)	LSC Rack #	Time Spike Added
1201883284-1	LCS for batch 886194	LCS	50	pCi/L	WATER	QC ACCOUNT	15-JUL-09 10:45 AM	1		22-2	
1201883285-1	LCS for batch 886194	LCS	50	pCi/L	WATER	QC ACCOUNT	15-JUL-09 10:45 AM	2		22-3	
1201883286-1	LCS for batch 886194	LCS	50	pCi/L	WATER	QC ACCOUNT	15-JUL-09 10:45 AM	3		22-4	

Bkg Rack #: 22-1

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Comments: \_\_\_\_\_      Data Reviewed By: \_\_\_\_\_

Instrument Used: LS6000 (Red) 7065155, LS6500 (Black) 7069123, LS6500 (Blue) 7067083, LS6500 (Green) 7067404  
 Wallac (Yellow) 4040127, Wallac (Pink) 2200082, Purple 7069123, Silver 7060656  
 GEL Laboratories LLC, Radiochemistry Division

ID: RIV-222

20 JUL 2009 11:46

USER: LA

COMMENT: GREEN

PRESET TIME : 15.00

DATA CALC :	CPM	H# :	YES	SAMPLE REPEATS :	1	PRINTER :	EDIT
COUNT BLANK :	NO	IC# :	NO	REPLICATES :	1	RS232 :	EDIT
T&D PHASE :	NO	ADC :	NO	CYCLE REPEATS :	1	DISK :	OFF
SCINTILLATOR :	LIQUID	LUMEX :	YES	LOW SAMPLE REJ :	0	RWM LIST :	OFF
LOW LEVEL :	YES	HALF LIFE CORRECTION DATE :					none

CHAN: 600.0 - 875.0 %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0

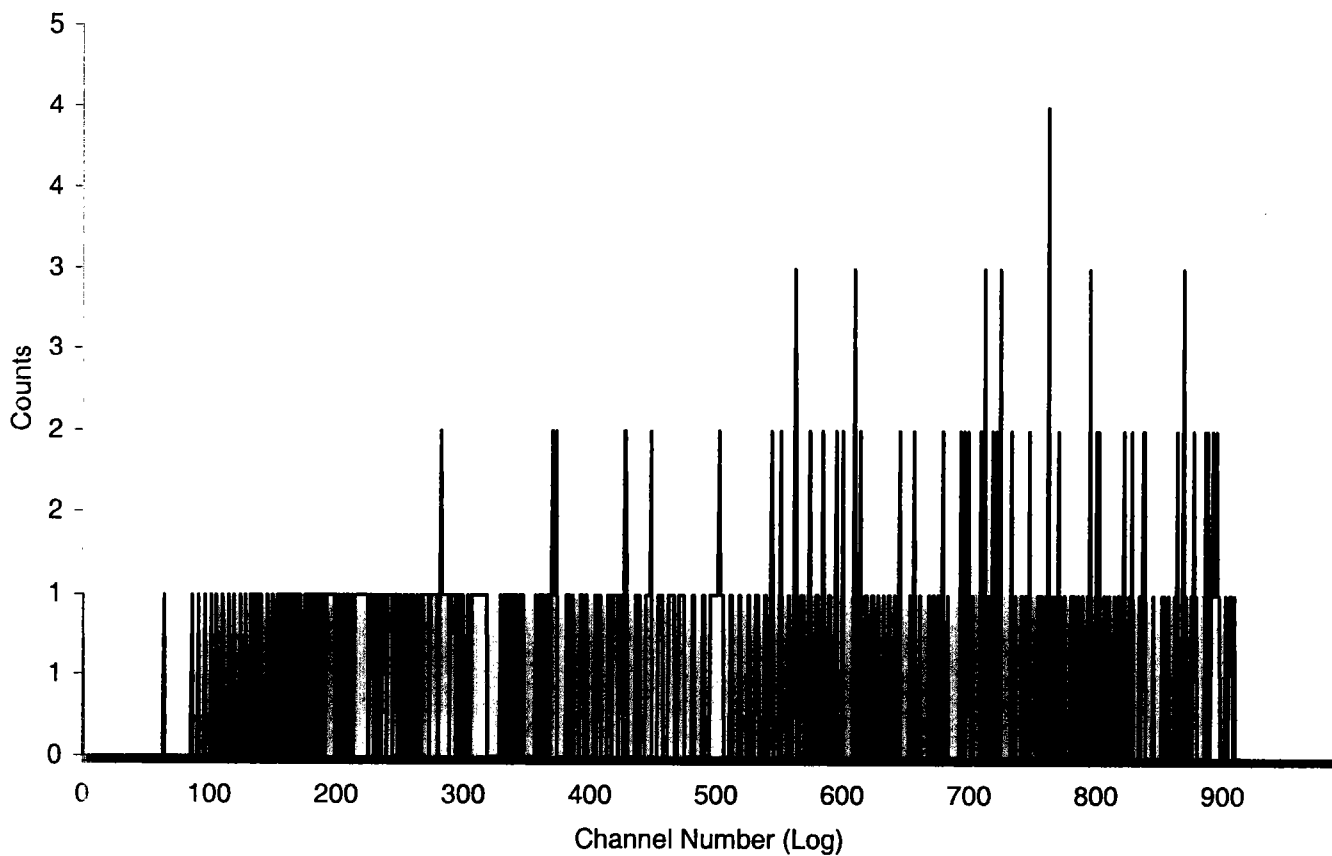
CHAN: 300.0 - 900.0 %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0

ALPHA-BETA DISCRIMINATION: NO

SAM NO	POS	TIME MIN	H#	WIND1		WIND2		LUMEX %	ELAPSED TIME
				CPM	%ERROR	CPM	%ERROR		
1	20-1	15.00	47.9	8.20	18.03	19.13	11.81	0.38	15.92
2	20-2	15.00	50.3	43.73	7.81	60.67	6.63	0.16	32.28
3	20-3	15.00	50.0	38.20	8.36	52.27	7.14	0.17	48.66
4	20-4	15.00	49.1	45.40	7.66	62.93	6.51	0.15	65.03

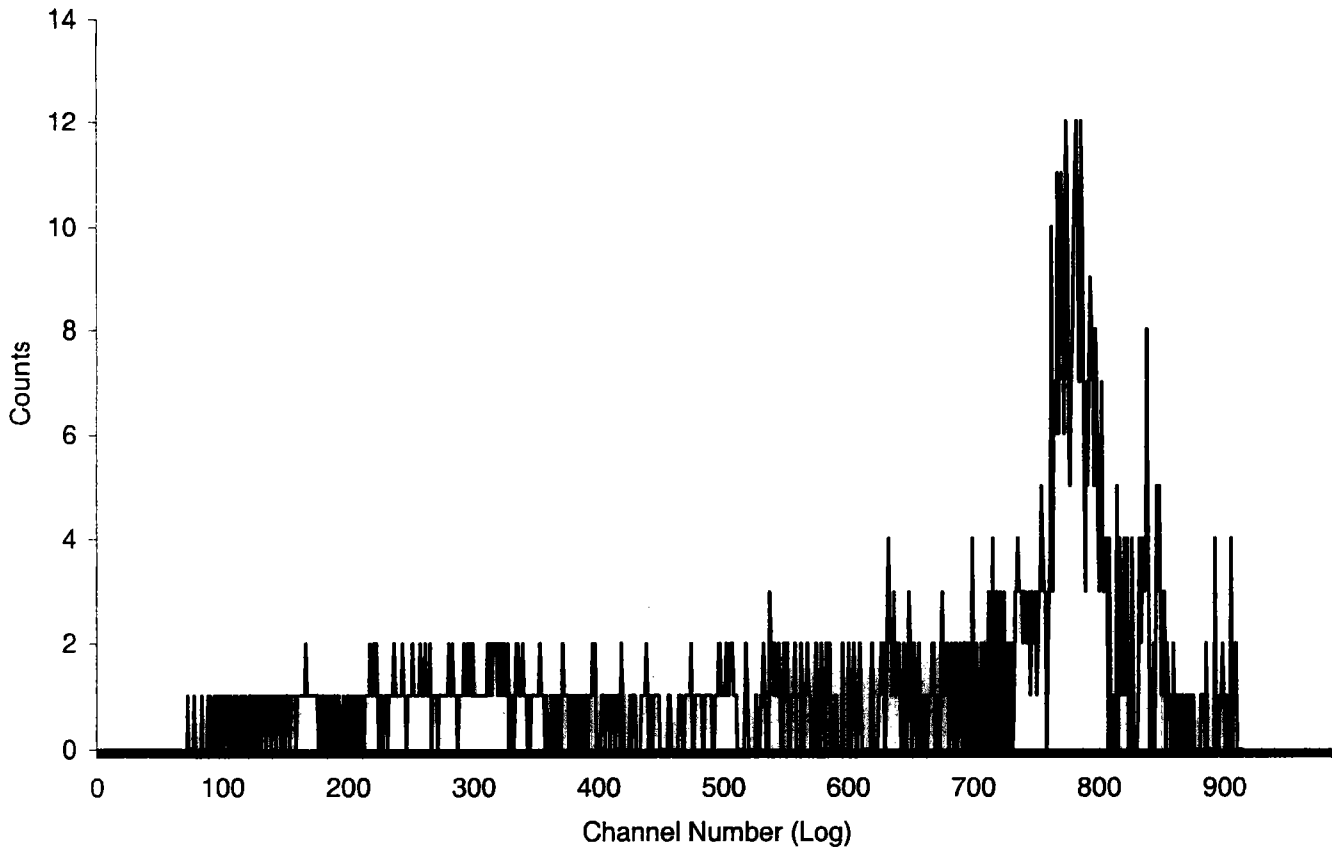
Sample Count Start Time:	20 Jul 2009 11:36:58		
Data Capture Date	20 Jul 2009 11:52:21		
User Filename	S16072022-1B.XLS		
	U16072022-1B.XLS		
Spectrum Type	Log Counts		
User Number	16		
User Id	RN-222		
User Comment	GREEN		
Isotope Name	14C		
Scintillator	LIQUID		
Sample, Rack-Pos, Time:	1	22-1	15.00
H#, Total Counts:	47.9	412	
Start, End, X-Axis:	0	990	Channel Number

SPECTRUM PLOT  
USER 16 - RN-222



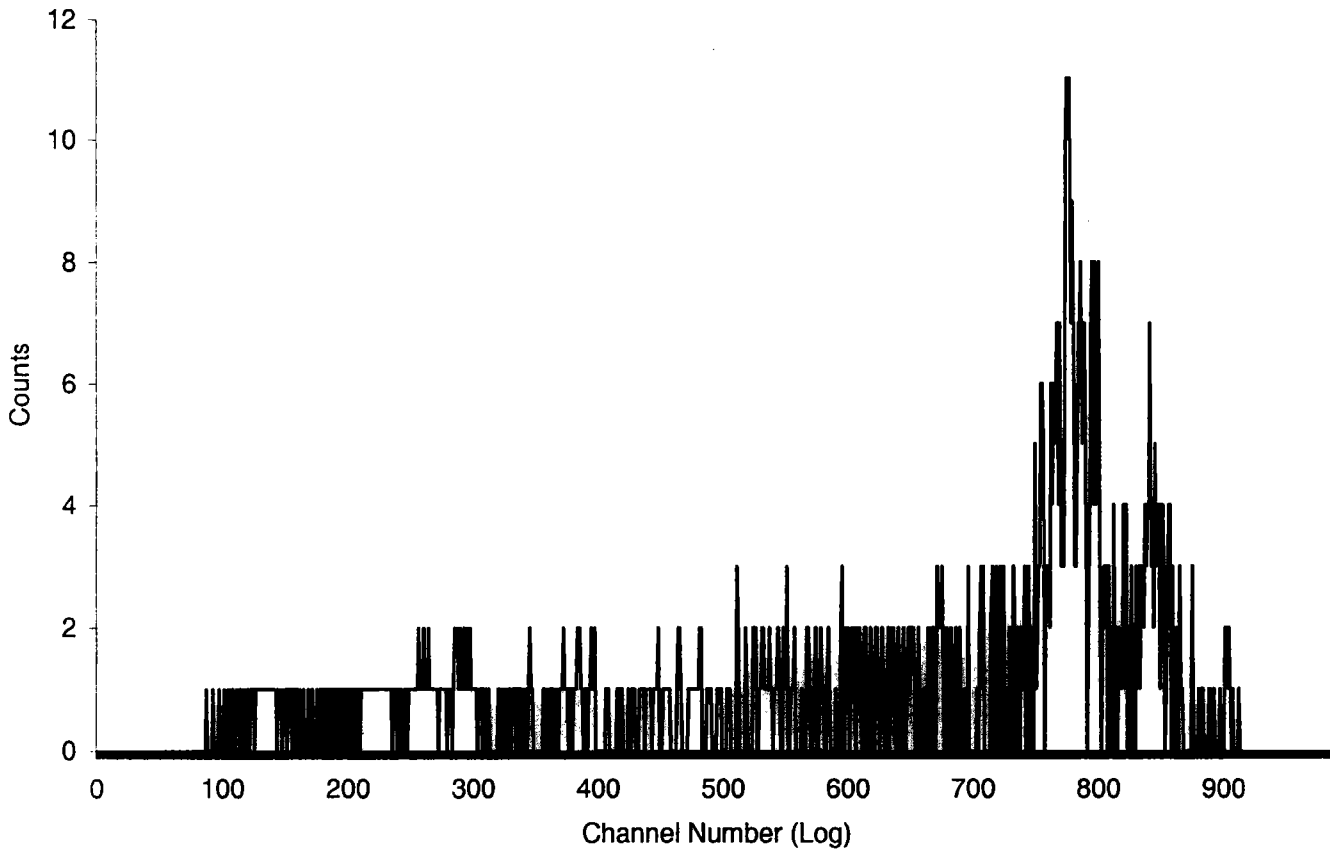
Sample Count Start Time: 20 Jul 2009 11:53:20  
Data Capture Date: 20 Jul 2009 12:08:43  
User Filename: S16072022-2B.XLS  
U16072022-1B.XLS  
Spectrum Type: Log Counts  
User Number: 16  
User Id: RN-222  
User Comment: GREEN  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 2 22-2 15.00  
H#, Total Counts: 50.3 1100  
Start, End, X-Axis: 0 990 Channel Number

SPECTRUM PLOT  
USER 16 - RN-222



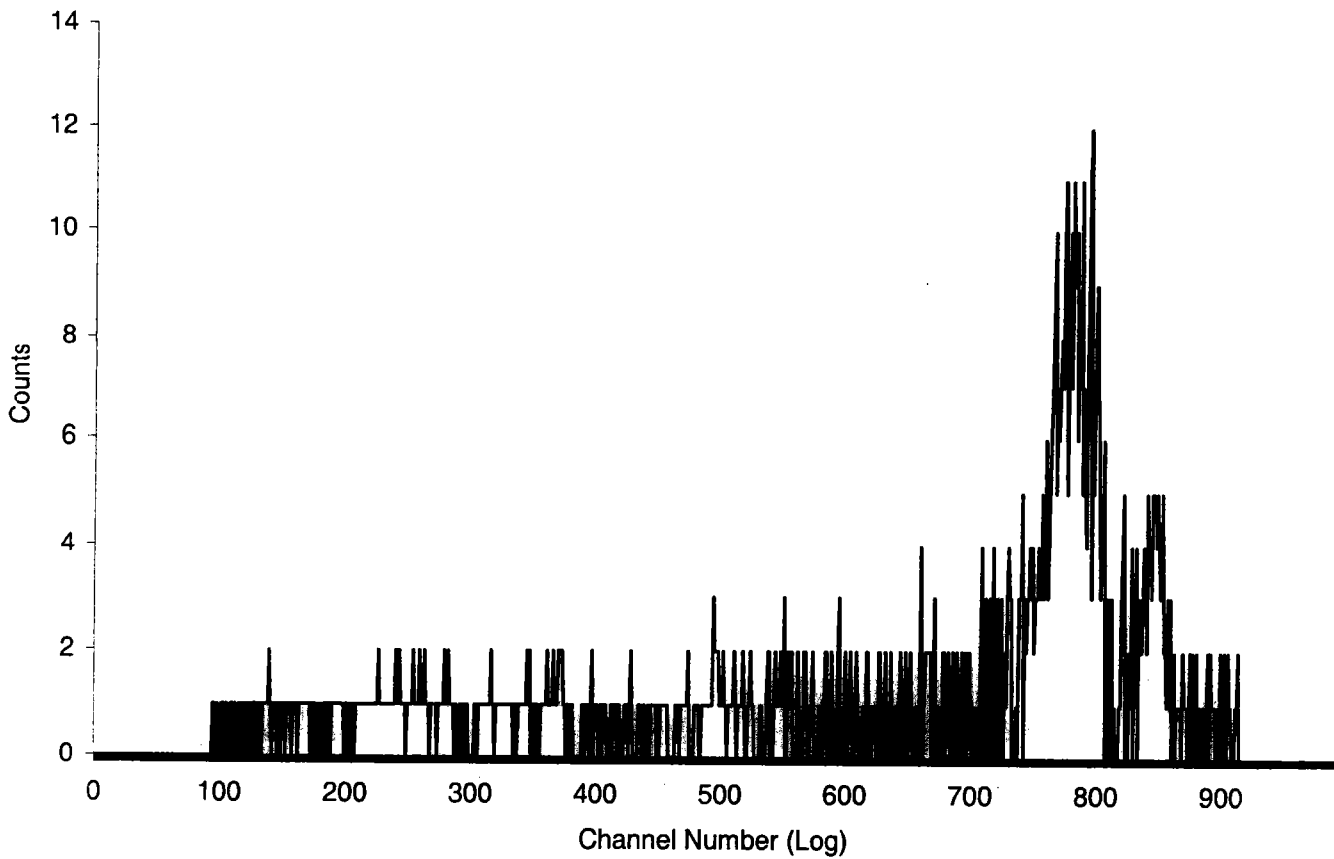
Sample Count Start Time:	20 Jul 2009 12:09:43		
Data Capture Date	20 Jul 2009 12:25:05		
User Filename	S16072022-3B.XLS		
	U16072022-1B.XLS		
Spectrum Type	Log Counts		
User Number	16		
User Id	RN-222		
User Comment	GREEN		
Isotope Name	14C		
Scintillator	LIQUID		
Sample, Rack-Pos, Time:	3	22-3	15.00
H#, Total Counts:	50.0	956	
Start, End, X-Axis:	0	990	Channel Number

SPECTRUM PLOT  
USER 16 - RN-222



Sample Count Start Time: 20 Jul 2009 12:26:05  
Data Capture Date: 20 Jul 2009 12:41:28  
User Filename: S16072022-4B.XLS  
U16072022-1B.XLS  
Spectrum Type: Log Counts  
User Number: 16  
User Id: RN-222  
User Comment: GREEN  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 4 22-4 15.00  
H#, Total Counts: 49.1 1123  
Start, End, X-Axis: 0 990 Channel Number

SPECTRUM PLOT  
USER 16 - RN-222





# **GAS FLOW PROPORTIONAL COUNTERS**

# General Engineering Laboratories

2040 Savage Road, Charleston, SC 29414  
(843)556-8171

## Gas Flow Proportional Counter Calibration Package

Method: Pa-228 (AC)

	YES	NO	Comments
1) Is all calibration standard information enclosed for: primary standard certificate? secondary standard(s) documentation? standard preparation information? standard < 1 Year old or verified?	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
2) Are the detector graphs included? beta absorption curves? beta plateau?			Average Efficiency
	<input checked="" type="checkbox"/>		
3) Is the raw count data included for: the plateau generation? the absorption curve generation? the calibration verification? the crosstalk calculations?	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
	<input checked="" type="checkbox"/>		
4) Are the calibration verification calculations included? are verification recoveries 100% +/- 25%	<input checked="" type="checkbox"/>		
5) Is the method Carrier Standardization included?			N/A

Prepared By: 

Date: 7/2/09

Reviewed By: 

Date: 7/2/09

Effective Date: 7/2/09

# Ra-228 Calibration PROTEAN Detectors

Detector #	Source #	Seperation date		Ac-228 decay (dec)	Spike Vol. Ra-228 (mL)	Std. Act. Ra-228 (dpm/mL)	Standard Nominal (dpm)	raw beta counts	ct. time (min)	Beta cpm	corrected* cpm	Ra-228 eff (cpm/dpm)	
		Seperation date	Count date										
1A	1	7/1/09 10:45	7/1/2009 13:36	0.7249	1.5	6363.2	9544.8	13564	3	4521.3	6237.434348	0.6535	
1A	2	7/1/09 10:45	7/1/2009 13:52	0.7032	1.5	6363.2	9544.8	12775	3	4258.3	6055.521583	0.6344	
1A	3	7/1/09 10:45	7/1/2009 13:48	0.7083	1.5	6363.2	9544.8	12750	3	4250.0	6000.085083	0.6286	
1A	4	7/1/09 10:45	7/1/2009 13:41	0.7170	1.5	6363.2	9544.8	12410	3	4136.7	5769.683602	0.6045	Average EFF 0.6303
1B	1	7/1/09 10:45	7/1/2009 13:41	0.7174	1.5	6363.2	9544.8	13292	3	4430.7	6176.07771	0.6471	
1B	2	7/1/09 10:45	7/1/2009 13:36	0.7246	1.5	6363.2	9544.8	13274	3	4424.7	6106.181463	0.6397	
1B	3	7/1/09 10:45	7/1/2009 13:52	0.7031	1.5	6363.2	9544.8	12699	3	4233.0	6020.43969	0.6308	Average EFF 0.6282
1B	4	7/1/09 10:45	7/1/2009 13:48	0.7082	1.5	6363.2	9544.8	12072	3	4024.0	5682.267909	0.5953	
1C	1	7/1/09 10:45	7/1/2009 13:48	0.7085	1.5	6363.2	9544.8	12813	3	4271.0	6028.410186	0.6316	
1C	2	7/1/09 10:45	7/1/2009 13:41	0.7172	1.5	6363.2	9544.8	12979	3	4326.3	6032.15531	0.6320	
1C	3	7/1/09 10:45	7/1/2009 13:36	0.7245	1.5	6363.2	9544.8	12755	3	4251.7	5868.722998	0.6149	Average EFF 0.6176
1C	4	7/1/09 10:45	7/1/2009 13:52	0.7030	1.5	6363.2	9544.8	11917	3	3972.3	5650.765354	0.5920	
1D	1	7/1/09 10:45	7/1/2009 13:52	0.7033	1.5	6363.2	9544.8	12473	3	4157.7	5911.258105	0.6193	
1D	2	7/1/09 10:45	7/1/2009 13:48	0.7084	1.5	6363.2	9544.8	12484	3	4161.3	5874.170562	0.6154	
1D	3	7/1/09 10:45	7/1/2009 13:41	0.7171	1.5	6363.2	9544.8	12289	3	4096.3	5712.363902	0.5985	Average EFF 0.6043
1D	4	7/1/09 10:45	7/1/2009 13:36	0.7243	1.5	6363.2	9544.8	12115	3	4038.3	5575.47435	0.5841	
2A	1	7/1/09 10:45	7/1/2009 13:57	0.6960	1.5	6363.2	9544.8	12499	3	4166.3	5986.085459	0.6272	
2A	2	7/1/09 10:45	7/1/2009 14:15	0.6728	1.5	6363.2	9544.8	12103	3	4034.3	5996.6905	0.6283	
2A	3	7/1/09 10:45	7/1/2009 14:09	0.6815	1.5	6363.2	9544.8	11968	3	3989.3	5854.110901	0.6133	Average EFF 0.6172
2A	4	7/1/09 10:45	7/1/2009 14:02	0.6899	1.5	6363.2	9544.8	11855	3	3951.7	5728.227222	0.6001	
2B	1	7/1/09 10:45	7/1/2009 14:02	0.6903	1.5	6363.2	9544.8	12471	3	4157.0	6022.266434	0.6309	
2B	2	7/1/09 10:45	7/1/2009 13:57	0.6958	1.5	6363.2	9544.8	12492	3	4164.0	5984.232843	0.6270	
2B	3	7/1/09 10:45	7/1/2009 14:15	0.6727	1.5	6363.2	9544.8	11892	3	3964.0	5892.884561	0.6174	Average EFF 0.6167
2B	4	7/1/09 10:45	7/1/2009 14:09	0.6814	1.5	6363.2	9544.8	11539	3	3846.3	5644.974311	0.5914	
2C	1	7/1/09 10:45	7/1/2009 14:08	0.6817	1.5	6363.2	9544.8	12050	3	4016.7	5892.005142	0.6173	
2C	2	7/1/09 10:45	7/1/2009 14:02	0.6901	1.5	6363.2	9544.8	11914	3	3971.3	5754.571355	0.6029	
2C	3	7/1/09 10:45	7/1/2009 13:58	0.6957	1.5	6363.2	9544.8	11994	3	3998.0	5746.92868	0.6021	Average EFF 0.5989
2C	4	7/1/09 10:45	7/1/2009 14:15	0.6726	1.5	6363.2	9544.8	10889	3	3629.7	5396.37168	0.5654	
2D	1	7/1/09 10:45	7/1/2009 14:15	0.6729	1.5	6363.2	9544.8	12010	3	4003.3	5949.493049	0.6233	
2D	2	7/1/09 10:45	7/1/2009 14:08	0.6816	1.5	6363.2	9544.8	12124	3	4041.3	5929.303014	0.6212	
2D	3	7/1/09 10:45	7/1/2009 14:02	0.6900	1.5	6363.2	9544.8	12168	3	4056.0	5878.360714	0.6159	Average EFF 0.6119
2D	4	7/1/09 10:45	7/1/2009 13:58	0.6954	1.5	6363.2	9544.8	11692	3	3897.3	5604.158523	0.5871	
3A	1	7/1/09 10:45	7/1/2009 14:19	0.6675	1.5	6363.2	9544.8	11194	3	3731.3	5589.748519	0.5856	
3A	2	7/1/09 10:45	7/1/2009 14:30	0.6482	1.5	6363.2	9544.8	14227	4	3556.8	5486.792678	0.5748	
3A	3	7/1/09 10:45	7/1/2009 14:35	0.6548	1.5	6363.2	9544.8	14180	4	3545.0	5414.108112	0.5672	Average EFF 0.5682
3A	4	7/1/09 10:45	7/1/2009 14:25	0.6608	1.5	6363.2	9544.8	13754	4	3438.5	5203.464549	0.5452	
3B	1	7/1/09 10:45	7/1/2009 14:25	0.6612	1.5	6363.2	9544.8	15370	4	3842.5	5811.010789	0.6088	
3B	2	7/1/09 10:45	7/1/2009 14:20	0.6673	1.5	6363.2	9544.8	11695	3	3898.3	5842.303251	0.6121	
3B	3	7/1/09 10:45	7/1/2009 14:35	0.6481	1.5	6363.2	9544.8	14905	4	3726.3	5749.171166	0.6023	Average EFF 0.5980
3B	4	7/1/09 10:45	7/1/2009 14:30	0.6547	1.5	6363.2	9544.8	14220	4	3555.0	5430.231301	0.5689	
3C	1	7/1/09 10:45	7/1/2009 14:29	0.6552	1.5	6363.2	9544.8	15644	4	3911.0	5969.527404	0.6254	
3C	2	7/1/09 10:45	7/1/2009 14:25	0.6611	1.5	6363.2	9544.8	15964	4	3991.0	6036.911214	0.6325	
3C	3	7/1/09 10:45	7/1/2009 14:20	0.6672	1.5	6363.2	9544.8	11701	3	3900.3	5846.033242	0.6125	Average EFF 0.6164
3C	4	7/1/09 10:45	7/1/2009 14:35	0.6480	1.5	6363.2	9544.8	14729	4	3682.3	5682.352456	0.5953	
3D	1	7/1/09 10:45	7/1/2009 14:35	0.6484	1.5	6363.2	9544.8	15152	4	3788.0	5842.430209	0.6121	
3D	2	7/1/09 10:45	7/1/2009 14:30	0.6550	1.5	6363.2	9544.8	15168	4	3792.0	5789.343603	0.6065	
3D	3	7/1/09 10:45	7/1/2009 14:25	0.6610	1.5	6363.2	9544.8	15295	4	3823.8	5785.011122	0.6061	Average EFF 0.5994
3D	4	7/1/09 10:45	7/1/2009 14:20	0.6670	1.5	6363.2	9544.8	10942	3	3647.3	5468.022172	0.5729	
4A	1	7/1/09 10:45	7/1/2009 14:40	0.6418	1.5	6363.2	9544.8	15298	4	3824.5	5959.288371	0.6243	
4A	2	7/1/09 10:45	7/1/2009 15:00	0.6187	1.5	6363.2	9544.8	14897	4	3724.3	6019.957238	0.6307	
4A	3	7/1/09 10:45	7/1/2009 14:53	0.6266	1.5	6363.2	9544.8	15050	4	3762.5	6005.095127	0.6291	Average EFF 0.6208
4A	4	7/1/09 10:45	7/1/2009 14:48	0.6325	1.5	6363.2	9544.8	14462	4	3615.5	5715.951787	0.5989	
4B	1	7/1/09 10:45	7/1/2009 14:48	0.6329	1.5	6363.2	9544.8	15335	4	3833.8	6057.768128	0.6347	
4B	2	7/1/09 10:45	7/1/2009 14:41	0.6416	1.5	6363.2	9544.8	15513	4	3878.3	6044.745331	0.6333	
4B	3	7/1/09 10:45	7/1/2009 15:00	0.6186	1.5	6363.2	9544.8	14521	4	3630.3	5868.58525	0.6148	Average EFF 0.6205
4B	4	7/1/09 10:45	7/1/2009 14:53	0.6265	1.5	6363.2	9544.8	14328	4	3582.0	5717.547589	0.5990	
4C	1	7/1/09 10:45	7/1/2009 14:53	0.6268	1.5	6363.2	9544.8	14733	4	3683.3	5876.583259	0.6157	
4C	2	7/1/09 10:45	7/1/2009 14:48	0.6327	1.5	6363.2	9544.8	14902	4	3725.5	5888.011911	0.6169	
4C	3	7/1/09 10:45	7/1/2009 14:41	0.6414	1.5	6363.2	9544.8	14856	4	3714.0	5790.010642	0.6066	Average EFF 0.6052
4C	4	7/1/09 10:45	7/1/2009 15:00	0.6185	1.5	6363.2	9544.8	13733	4	3433.3	5550.795964	0.5816	
4D	1	7/1/09 10:45	7/1/2009 15:00	0.6188	1.5	6363.2	9544.8	14167	4	3541.8	5723.884149	0.5997	
4D	2	7/1/09 10:45	7/1/2009 14:53	0.6267	1.5	6363.2	9544.8	14204	4	3551.0	5866.467573	0.5937	
4D	3	7/1/09 10:45	7/1/2009 14:48	0.6326	1.5	6363.2	9544.8	14131	4	3532.8	5584.07765	0.5850	Average EFF 0.5873
4D	4	7/1/09 10:45	7/1/2009 14:41	0.6413	1.5	6363.2	9544.8	13978	4	3494.5	5449.182717	0.5709	
5A	1	7/1/09 10:45	7/1/2009 15:06	0.6112	1.5	6363.2	9544.8	14870	4	3717.5	6082.165089	0.6372	
5A	2	7/1/09 10:45	7/1/2009 15:21	0.5943	1.5	6363.2	9544.8	14487	4	3621.8	6094.223373	0.6385	
5A	3	7/1/09 10:45	7/1/2009 15:17	0.5996	1.5	6363.2	9544.8	14259	4	3564.8	5945.170793	0.6229	Average EFF 0.6258
5A	4	7/1/09 10:45	7/1/2009 15:12	0.6047	1.5	6363.2	9544.8	13957	4	3489.3	5770.592799	0.6046	
5B	1	7/1/09 10:45	7/1/2009 15:12	0.6050	1.5	6363.2	9544.8	14869	4	3717.3	6144.005028	0.6437	
5B	2	7/1/09 10:45	7/1/2009 15:06	0.6111	1.5	6363.2	9544.8	14821	4	3705.3	6063.072791	0.6352	
5B	3	7/1/09 10:45	7/1/2009 15:21	0.5942	1.5	6363.2	9544.8	14289	4	3572.3	6011.872812	0.6299	Average EFF 0.6280
5B	4	7/1/09 10:45	7/1/2009 15:17	0.5995	1.5	6363.2	9544.8	13809	4	3452.3	5758.629577	0.6033	
5C	1	7/1/09 10:45	7/1/2009 15:17	0.5994	1.5	6363.2	9544.8	14676	4	3669.0	6120.953053	0.6413	
5C	2	7/1/09 10:45	7/1/2009 15:12	0.6049	1.5	6363.2	9544.8	15122	4	3780.5	6249.917577	0.6548	
5C	3	7/1/09 10:45	7/1/2009 15:07	0.6108	1.5	6363.2	9544.8	14958	4	3739.5	6121.8025	0.6414	Average EFF

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5C	4	7/1/09 10:45	7/1/2009 15:21	0.5941	1.5	6363.2	9544.8	13831	4	3457.8	5819.905873	0.6097	0.6368
5D	1	7/1/09 10:45	7/1/2009 15:21	0.5943	1.5	6363.2	9544.8	14321	4	3580.3	6024.014899	0.6311	
5D	2	7/1/09 10:45	7/1/2009 15:17	0.5993	1.5	6363.2	9544.8	14642	4	3680.5	6107.538025	0.6399	
5D	3	7/1/09 10:45	7/1/2009 15:12	0.6048	1.5	6363.2	9544.8	14443	4	3610.8	5970.409434	0.6255	Average EFF
5D	4	7/1/09 10:45	7/1/2009 15:07	0.6107	1.5	6363.2	9544.8	13954	4	3488.5	5711.973074	0.5984	0.6237
6A	1	7/1/09 10:45	7/1/2009 15:27	0.5885	1.5	6363.2	9544.8	14018	4	3504.5	5955.42076	0.6239	
6A	2	7/1/09 10:45	7/1/2009 15:40	0.5735	1.5	6363.2	9544.8	12283	3.5	3509.4	6118.819734	0.6411	
6A	3	7/1/09 10:45	7/1/2009 15:36	0.5779	1.5	6363.2	9544.8	12111	3.5	3460.3	5987.187856	0.6273	Average EFF
6A	4	7/1/09 10:45	7/1/2009 15:32	0.5826	1.5	6363.2	9544.8	11598	3.5	3313.7	5687.952648	0.5959	0.6221
6B	1	7/1/09 10:45	7/1/2009 15:32	0.5824	1.5	6363.2	9544.8	12151	3.5	3471.7	5961.398905	0.6246	
6B	2	7/1/09 10:45	7/1/2009 15:27	0.5885	1.5	6363.2	9544.8	14371	4	3592.8	6105.369624	0.6397	
6B	3	7/1/09 10:45	7/1/2009 15:40	0.5734	1.5	6363.2	9544.8	11705	3.5	3344.3	5831.983307	0.6110	Average EFF
6B	4	7/1/09 10:45	7/1/2009 15:36	0.5779	1.5	6363.2	9544.8	11388	3.5	3253.7	5630.295163	0.5899	0.6163
6C	1	7/1/09 10:45	7/1/2009 15:36	0.5778	1.5	6363.2	9544.8	12161	3.5	3474.6	6013.224586	0.6300	
6C	2	7/1/09 10:45	7/1/2009 15:32	0.5821	1.5	6363.2	9544.8	12083	3.5	3452.3	5930.638446	0.6213	
6C	3	7/1/09 10:45	7/1/2009 15:27	0.5883	1.5	6363.2	9544.8	13638	4	3409.5	5795.433731	0.6072	Average EFF
6C	4	7/1/09 10:45	7/1/2009 15:40	0.5733	1.5	6363.2	9544.8	11218	3.5	3205.1	5590.212659	0.5857	0.6111
6D	1	7/1/09 10:45	7/1/2009 15:40	0.5732	1.5	6363.2	9544.8	11987	3.5	3424.9	5974.547886	0.6259	
6D	2	7/1/09 10:45	7/1/2009 15:36	0.5777	1.5	6363.2	9544.8	12183	3.5	3480.9	6025.235519	0.6313	
6D	3	7/1/09 10:45	7/1/2009 15:32	0.5819	1.5	6363.2	9544.8	11882	3.5	3394.9	5833.810262	0.6112	Average EFF
6D	4	7/1/09 10:45	7/1/2009 15:27	0.5881	1.5	6363.2	9544.8	13018	4	3254.5	5533.899914	0.5798	0.6120
7A	1	7/1/09 10:45	7/1/2009 15:46	0.5673	1.5	6363.2	9544.8	12007	3.5	3430.6	6047.285606	0.6336	
7A	2	7/1/09 10:45	7/1/2009 16:00	0.5525	1.5	6363.2	9544.8	11655	3.5	3330.0	6027.30696	0.6315	
7A	3	7/1/09 10:45	7/1/2009 15:56	0.5569	1.5	6363.2	9544.8	11445	3.5	3270.0	5871.972756	0.6152	Average EFF
7A	4	7/1/09 10:45	7/1/2009 15:50	0.5627	1.5	6363.2	9544.8	11121	3.5	3177.4	5846.694018	0.5916	0.6180
7B	1	7/1/09 10:45	7/1/2009 15:51	0.5622	1.5	6363.2	9544.8	11988	3.5	3419.4	6082.664171	0.6373	
7B	2	7/1/09 10:45	7/1/2009 15:46	0.5673	1.5	6363.2	9544.8	12050	3.5	3442.9	6069.322745	0.6359	
7B	3	7/1/09 10:45	7/1/2009 16:00	0.5524	1.5	6363.2	9544.8	11675	3.5	3335.7	6038.785014	0.6327	Average EFF
7B	4	7/1/09 10:45	7/1/2009 15:56	0.5567	1.5	6363.2	9544.8	11271	3.5	3220.3	5784.331251	0.6060	0.6280
7C	1	7/1/09 10:45	7/1/2009 15:56	0.5566	1.5	6363.2	9544.8	11781	3.5	3366.0	6047.202464	0.6336	
7C	2	7/1/09 10:45	7/1/2009 15:51	0.5621	1.5	6363.2	9544.8	11760	3.5	3360.0	5978.073192	0.6263	
7C	3	7/1/09 10:45	7/1/2009 15:46	0.5670	1.5	6363.2	9544.8	11766	3.5	3361.7	5928.878357	0.6212	Average EFF
7C	4	7/1/09 10:45	7/1/2009 16:00	0.5523	1.5	6363.2	9544.8	10888	3.5	3110.9	5632.598965	0.5901	0.6178
7D	1	7/1/09 10:45	7/1/2009 16:00	0.5522	1.5	6363.2	9544.8	11805	3.5	3315.7	6004.271132	0.6291	
7D	2	7/1/09 10:45	7/1/2009 15:56	0.5565	1.5	6363.2	9544.8	11920	3.5	3405.7	6119.509991	0.6411	
7D	3	7/1/09 10:45	7/1/2009 15:51	0.5619	1.5	6363.2	9544.8	11933	3.5	3409.4	6067.346561	0.6357	Average EFF
7D	4	7/1/09 10:45	7/1/2009 15:46	0.5668	1.5	6363.2	9544.8	11305	3.5	3230.0	5698.366602	0.5970	0.6257
8A	1	7/1/09 10:45	7/1/2009 16:06	0.5466	1.5	6363.2	9544.8	11673	3.5	3335.1	6101.651756	0.6393	
8A	2	7/1/09 10:45	7/1/2009 16:19	0.5333	1.5	6363.2	9544.8	11172	3.5	3192.0	5985.379105	0.6271	
8A	3	7/1/09 10:45	7/1/2009 16:15	0.5377	1.5	6363.2	9544.8	11258	3.5	3216.6	5982.329368	0.6268	Average EFF
8A	4	7/1/09 10:45	7/1/2009 16:10	0.5424	1.5	6363.2	9544.8	10977	3.5	3136.3	5782.059146	0.6058	0.6247
8B	1	7/1/09 10:45	7/1/2009 16:10	0.5423	1.5	6363.2	9544.8	11583	3.5	3309.4	6102.412618	0.6393	
8B	2	7/1/09 10:45	7/1/2009 16:06	0.5466	1.5	6363.2	9544.8	11758	3.5	3359.4	6146.082528	0.6439	
8B	3	7/1/09 10:45	7/1/2009 16:19	0.5332	1.5	6363.2	9544.8	11499	3.5	3285.4	6161.727069	0.6456	Average EFF
8B	4	7/1/09 10:45	7/1/2009 16:15	0.5376	1.5	6363.2	9544.8	10844	3.5	3098.3	5763.600098	0.6038	0.6332
8C	1	7/1/09 10:45	7/1/2009 16:15	0.5375	1.5	6363.2	9544.8	11539	3.5	3296.9	6133.762218	0.6426	
8C	2	7/1/09 10:45	7/1/2009 16:10	0.5422	1.5	6363.2	9544.8	11774	3.5	3364.0	6204.011354	0.6500	
8C	3	7/1/09 10:45	7/1/2009 16:06	0.5465	1.5	6363.2	9544.8	11611	3.5	3317.4	6070.574762	0.6380	Average EFF
8C	4	7/1/09 10:45	7/1/2009 16:19	0.5331	1.5	6363.2	9544.8	10809	3.5	3088.3	5793.080291	0.6069	0.6339
8D	1	7/1/09 10:45	7/1/2009 16:19	0.5330	1.5	6363.2	9544.8	11301	3.5	3228.9	6057.336905	0.6346	
8D	2	7/1/09 10:45	7/1/2009 16:15	0.5374	1.5	6363.2	9544.8	11412	3.5	3260.6	6067.58377	0.6357	
8D	3	7/1/09 10:45	7/1/2009 16:10	0.5421	1.5	6363.2	9544.8	11660	3.5	3331.4	6145.674775	0.6439	Average EFF
8D	4	7/1/09 10:45	7/1/2009 16:06	0.5464	1.5	6363.2	9544.8	10918	3.5	3119.4	5709.327085	0.5982	0.6281
9A	1	7/1/09 10:45	7/1/2009 16:24	0.5280	1.5	6363.2	9544.8	11805	3.5	3315.7	6280.207813	0.6580	
9A	2	7/1/09 10:45	7/1/2009 16:42	0.5106	1.5	6363.2	9544.8	11281	3.5	3223.1	6313.016372	0.6614	
9A	3	7/1/09 10:45	7/1/2009 16:33	0.5196	1.5	6363.2	9544.8	11301	3.5	3228.9	6214.402502	0.6511	Average EFF
9A	4	7/1/09 10:45	7/1/2009 16:29	0.5236	1.5	6363.2	9544.8	10987	3.5	3139.1	5995.155865	0.6281	0.6496
9B	1	7/1/09 10:45	7/1/2009 16:29	0.5235	1.5	6363.2	9544.8	11151	3.5	3186.0	6085.406803	0.6376	
9B	2	7/1/09 10:45	7/1/2009 16:24	0.5280	1.5	6363.2	9544.8	11462	3.5	3274.9	6202.821366	0.6499	
9B	3	7/1/09 10:45	7/1/2009 16:42	0.5104	1.5	6363.2	9544.8	11004	3.5	3144.0	6180.125852	0.6454	Average EFF
9B	4	7/1/09 10:45	7/1/2009 16:33	0.5195	1.5	6363.2	9544.8	10581	3.5	3023.1	5819.569586	0.6097	0.6356
9C	1	7/1/09 10:45	7/1/2009 16:33	0.5194	1.5	6363.2	9544.8	11026	3.5	3150.3	6064.890483	0.6354	
9C	2	7/1/09 10:45	7/1/2009 16:29	0.5235	1.5	6363.2	9544.8	11281	3.5	3223.1	6157.122814	0.6451	
9C	3	7/1/09 10:45	7/1/2009 16:24	0.5279	1.5	6363.2	9544.8	11016	3.5	3147.4	5962.583098	0.6247	Average EFF
9C	4	7/1/09 10:45	7/1/2009 16:42	0.5103	1.5	6363.2	9544.8	10297	3.5	2942.0	5765.244836	0.6040	0.6273
9D	1	7/1/09 10:45	7/1/2009 16:38	0.5146	1.5	6363.2	9544.8	11135	3.5	3181.4	6182.4976	0.6477	
9D	2	7/1/09 10:45	7/1/2009 16:33	0.5193	1.5	6363.2	9544.8	11412	3.5	3260.6	6278.391381	0.6578	
9D	3	7/1/09 10:45	7/1/2009 16:29	0.5234	1.5	6363.2	9544.8	11340	3.5	3240.0	6190.682442	0.6486	Average EFF
9D	4	7/1/09 10:45	7/1/2009 16:24	0.5278	1.5	6363.2	9544.8	10912	3.5	3117.7	5907.401951	0.6189	0.6433
10A	1	7/1/09 10:45	7/1/2009 16:47	0.5057	1.5	6363.2	9544.8	10991	3.5	3140.3	6209.984837	0.6506	
10A	2	7/1/09 10:45	7/1/2009 17:12	0.4824	1.5	6363.2	9544.8	11959	4	2889.8	6198.168046	0.6494	
10A	3	7/1/09 10:45	7/1/2009 16:58	0.4958	1.5	6363.2	9544.8	10553	3.5	3015.1	6081.381423	0.6371	Average EFF
10A	4	7/1/09 10:45	7/1/2009 16:53	0.5003	1.5	6363.2	9544.8	10338	3.5	2953.7	5903.409852	0.6185	0.6389
10B	1	7/1/09 10:45	7/1/2009 17:03	0.4910	1.5	6363.2	9544.8	11110	4	2777.5	5856.748417	0.5927	
10B	2	7/1/09 10:45	7/1/2009 16:47	0.5057	1.5	6363.2	9544.8	10812	3.5	3089.1	6109.231533	0.6401	
10B	3	7/1/09 10:45	7/1/2009 17:12	0.4822	1.5	6363.2	9544.8	11422	4	2855.5	5921.333197	0.6204	Average EFF
10B	4	7/1/09 10:45	7/1/2009 16:58	0.4957	1.5	6363.2	9544.8	9967	3.5	2847.7	5744.946895	0.6019	0.6137
10C	1	7/1/09 10:45	7/1/2009 16:58	0.4956	1.5	6363.2	9544.8	10482	3.5	2994.9	6042.548531	0.6331	
10C	2	7/1/09 10:45	7/										

10D	3	7/1/09 10:45	7/1/2009 16:53	0.5000	1.5	6363.2	9544.8	10643	3.5	3040.9	6081.577364	0.6372	Average EFF
10D	4	7/1/09 10:45	7/1/2009 16:48	0.5053	1.5	6363.2	9544.8	10064	3.5	2875.4	5690.501596	0.5962	0.6320
11A	1	7/1/09 10:45	7/1/2009 11:56	0.8745	1.5	6363.2	9544.8	14773	3	4924.3	5631.22443	0.5900	
11A	2	7/1/09 10:45	7/1/2009 12:08	0.8547	1.5	6363.2	9544.8	14429	3	4809.7	5627.17636	0.5896	
11A	3	7/1/09 10:45	7/1/2009 12:04	0.8607	1.5	6363.2	9544.8	14454	3	4818.0	5597.851728	0.5865	Average EFF
11A	4	7/1/09 10:45	7/1/2009 12:00	0.8677	1.5	6363.2	9544.8	14013	3	4671.0	5383.193838	0.5640	0.5825
11B	1	7/1/09 10:45	7/1/2009 12:00	0.8681	1.5	6363.2	9544.8	16203	3	5401.0	6221.768068	0.6518	
11B	2	7/1/09 10:45	7/1/2009 11:56	0.8742	1.5	6363.2	9544.8	16106	3	5368.7	6141.073627	0.6434	
11B	3	7/1/09 10:45	7/1/2009 12:08	0.8545	1.5	6363.2	9544.8	15643	3	5214.3	6102.154531	0.6393	Average EFF
11B	4	7/1/09 10:45	7/1/2009 12:04	0.8606	1.5	6363.2	9544.8	15133	3	5044.3	5861.738123	0.6141	0.6372
11C	1	7/1/09 10:45	7/1/2009 12:04	0.8609	1.5	6363.2	9544.8	15637	3	5212.3	6054.305139	0.6343	
11C	2	7/1/09 10:45	7/1/2009 12:00	0.8680	1.5	6363.2	9544.8	15919	3	5308.3	6113.481467	0.6405	
11C	3	7/1/09 10:45	7/1/2009 11:56	0.8740	1.5	6363.2	9544.8	16452	3	5484.0	6274.376359	0.6574	Average EFF
11C	4	7/1/09 10:45	7/1/2009 12:08	0.8544	1.5	6363.2	9544.8	14887	3	4962.3	5808.157492	0.6085	0.6352
11D	1	7/1/09 10:45	7/1/2009 12:08	0.8548	1.5	6363.2	9544.8	15607	3	5202.3	6085.822645	0.6376	
11D	2	7/1/09 10:45	7/1/2009 12:04	0.8608	1.5	6363.2	9544.8	15944	3	5314.7	6174.138045	0.6469	
11D	3	7/1/09 10:45	7/1/2009 12:00	0.8679	1.5	6363.2	9544.8	16098	3	5366.0	6182.998937	0.6478	Average EFF
11D	4	7/1/09 10:45	7/1/2009 11:56	0.8738	1.5	6363.2	9544.8	15191	3	5063.7	5794.733717	0.6071	0.6348
12A	1	7/1/09 10:45	7/1/2009 12:15	0.8437	1.5	6363.2	9544.8	15450	3	5150.0	6104.026984	0.6395	
12A	2	7/1/09 10:45	7/1/2009 12:28	0.8234	1.5	6363.2	9544.8	15016	3	5005.3	6078.958269	0.6369	
12A	3	7/1/09 10:45	7/1/2009 12:24	0.8296	1.5	6363.2	9544.8	14984	3	4994.7	6020.558384	0.6308	Average EFF
12A	4	7/1/09 10:45	7/1/2009 12:20	0.8358	1.5	6363.2	9544.8	14530	3	4843.3	5794.58497	0.6071	0.6286
12B	1	7/1/09 10:45	7/1/2009 12:20	0.8362	1.5	6363.2	9544.8	15404	3	5134.7	6140.835636	0.6433	
12B	2	7/1/09 10:45	7/1/2009 12:15	0.8437	1.5	6363.2	9544.8	15607	3	5202.3	6166.05496	0.6460	
12B	3	7/1/09 10:45	7/1/2009 12:28	0.8232	1.5	6363.2	9544.8	15060	3	5020.0	6097.91718	0.6389	Average EFF
12B	4	7/1/09 10:45	7/1/2009 12:24	0.8295	1.5	6363.2	9544.8	14553	3	4851.0	5848.11587	0.6127	0.6352
12C	1	7/1/09 10:45	7/1/2009 12:24	0.8300	1.5	6363.2	9544.8	15183	3	5061.0	6097.649845	0.6388	
12C	2	7/1/09 10:45	7/1/2009 12:20	0.8361	1.5	6363.2	9544.8	15651	3	5217.0	6239.881493	0.6537	
12C	3	7/1/09 10:45	7/1/2009 12:15	0.8436	1.5	6363.2	9544.8	15216	3	5072.0	6012.519531	0.6299	Average EFF
12C	4	7/1/09 10:45	7/1/2009 12:28	0.8231	1.5	6363.2	9544.8	14117	3	4705.7	5716.805229	0.5989	0.6304
12D	1	7/1/09 10:45	7/1/2009 12:28	0.8235	1.5	6363.2	9544.8	15174	3	5058.0	6141.959419	0.6435	
12D	2	7/1/09 10:45	7/1/2009 12:24	0.8298	1.5	6363.2	9544.8	15137	3	5045.7	6080.699807	0.6371	
12D	3	7/1/09 10:45	7/1/2009 12:20	0.8359	1.5	6363.2	9544.8	15418	3	5139.3	6148.142699	0.6441	Average EFF
12D	4	7/1/09 10:45	7/1/2009 12:15	0.8434	1.5	6363.2	9544.8	14566	3	4855.3	5758.75774	0.6031	0.6320
13A	1	7/1/09 10:45	7/1/2009 12:33	0.8153	1.5	6363.2	9544.8	15230	3	5076.7	6226.552932	0.6524	
13A	2	7/1/09 10:45	7/1/2009 12:50	0.7902	1.5	6363.2	9544.8	14784	3	4928.0	6236.596242	0.6534	
13A	3	7/1/09 10:45	7/1/2009 12:41	0.8031	1.5	6363.2	9544.8	14851	3	4950.3	6164.384216	0.6458	Average EFF
13A	4	7/1/09 10:45	7/1/2009 12:37	0.8090	1.5	6363.2	9544.8	14183	3	4727.7	5843.553624	0.6122	0.6410
13B	1	7/1/09 10:45	7/1/2009 12:37	0.8094	1.5	6363.2	9544.8	15825	3	5208.3	6434.850276	0.6742	
13B	2	7/1/09 10:45	7/1/2009 12:33	0.8153	1.5	6363.2	9544.8	15450	3	5150.0	6316.496573	0.6618	
13B	3	7/1/09 10:45	7/1/2009 12:50	0.7901	1.5	6363.2	9544.8	14689	3	4896.3	6197.297391	0.6493	Average EFF
13B	4	7/1/09 10:45	7/1/2009 12:41	0.8029	1.5	6363.2	9544.8	14377	3	4792.3	5968.757323	0.6253	0.6526
13C	1	7/1/09 10:45	7/1/2009 12:41	0.8033	1.5	6363.2	9544.8	15426	3	5142.0	6401.251014	0.6707	
13C	2	7/1/09 10:45	7/1/2009 12:37	0.8093	1.5	6363.2	9544.8	15315	3	5105.0	6307.973396	0.6609	
13C	3	7/1/09 10:45	7/1/2009 12:33	0.8152	1.5	6363.2	9544.8	15288	3	5096.0	6251.048762	0.6549	Average EFF
13C	4	7/1/09 10:45	7/1/2009 12:50	0.7900	1.5	6363.2	9544.8	14222	3	4740.7	6001.209943	0.6287	0.6538
13D	1	7/1/09 10:45	7/1/2009 12:50	0.7903	1.5	6363.2	9544.8	14492	3	4830.7	6112.65055	0.6404	
13D	2	7/1/09 10:45	7/1/2009 12:46	0.7958	1.5	6363.2	9544.8	14858	3	4952.7	6223.19528	0.6520	
13D	3	7/1/09 10:45	7/1/2009 12:37	0.8082	1.5	6363.2	9544.8	14873	3	4957.7	6126.881339	0.6419	Average EFF
13D	4	7/1/09 10:45	7/1/2009 12:33	0.8151	1.5	6363.2	9544.8	14389	3	4796.3	5884.197712	0.6165	0.6377
14A	1	7/1/09 10:45	7/1/2009 12:54	0.7834	1.5	6363.2	9544.8	14463	3	4821.0	6153.596507	0.6447	
14A	2	7/1/09 10:45	7/1/2009 13:17	0.7507	1.5	6363.2	9544.8	14137	3	4712.3	6277.53373	0.6577	
14A	3	7/1/09 10:45	7/1/2009 13:13	0.7571	1.5	6363.2	9544.8	14022	3	4674.0	6173.627369	0.6468	Average EFF
14A	4	7/1/09 10:45	7/1/2009 13:02	0.7727	1.5	6363.2	9544.8	13451	3	4483.7	5802.830587	0.6080	0.6393
14B	1	7/1/09 10:45	7/1/2009 13:01	0.7730	1.5	6363.2	9544.8	14039	3	4679.7	6054.030301	0.6343	
14B	2	7/1/09 10:45	7/1/2009 12:54	0.7834	1.5	6363.2	9544.8	14398	3	4799.3	6126.324754	0.6418	
14B	3	7/1/09 10:45	7/1/2009 13:17	0.7505	1.5	6363.2	9544.8	13475	3	4491.7	5984.510182	0.6270	Average EFF
14B	4	7/1/09 10:45	7/1/2009 13:13	0.7569	1.5	6363.2	9544.8	13077	3	4359.0	5758.643863	0.6033	0.6266
14C	1	7/1/09 10:45	7/1/2009 13:12	0.7573	1.5	6363.2	9544.8	14116	3	4705.3	6213.281445	0.6510	
14C	2	7/1/09 10:45	7/1/2009 13:02	0.7729	1.5	6363.2	9544.8	14187	3	4729.0	6118.427365	0.6410	
14C	3	7/1/09 10:45	7/1/2009 12:55	0.7832	1.5	6363.2	9544.8	14409	3	4803.0	6132.734423	0.6425	Average EFF
14C	4	7/1/09 10:45	7/1/2009 13:17	0.7505	1.5	6363.2	9544.8	13229	3	4409.7	5875.993199	0.6156	0.6375
14D	1	7/1/09 10:45	7/1/2009 13:17	0.7508	1.5	6363.2	9544.8	13927	3	4642.3	6183.314452	0.6478	
14D	2	7/1/09 10:45	7/1/2009 13:12	0.7572	1.5	6363.2	9544.8	14089	3	4696.3	6202.348821	0.6498	
14D	3	7/1/09 10:45	7/1/2009 13:02	0.7728	1.5	6363.2	9544.8	13912	3	4637.3	6000.768164	0.6287	Average EFF
14D	4	7/1/09 10:45	7/1/2009 12:55	0.7830	1.5	6363.2	9544.8	13545	3	4515.0	5766.084113	0.6041	0.6326

\*Background is considered negligible

SampleID	Instr	Time (min.)	Alpha Counts	Beta Counts	Count Start Time	Count End Time
1 1A		3	126	13564	7/1/2009 13:36	7/1/2009 13:39
2 1A		3	136	12775	7/1/2009 13:52	7/1/2009 13:55
3 1A		3	135	12750	7/1/2009 13:48	7/1/2009 13:51
4 1A		3	142	12410	7/1/2009 13:41	7/1/2009 13:44
1 1B		3	115	13292	7/1/2009 13:41	7/1/2009 13:44
2 1B		3	136	13274	7/1/2009 13:36	7/1/2009 13:39
3 1B		3	131	12699	7/1/2009 13:52	7/1/2009 13:55
4 1B		3	129	12072	7/1/2009 13:48	7/1/2009 13:51
1 1C		3	207	12813	7/1/2009 13:48	7/1/2009 13:51
2 1C		3	221	12979	7/1/2009 13:41	7/1/2009 13:44
3 1C		3	189	12755	7/1/2009 13:36	7/1/2009 13:39
4 1C		3	179	11917	7/1/2009 13:52	7/1/2009 13:55
1 1D		3	558	12473	7/1/2009 13:52	7/1/2009 13:55
2 1D		3	582	12484	7/1/2009 13:48	7/1/2009 13:51
3 1D		3	632	12289	7/1/2009 13:41	7/1/2009 13:44
4 1D		3	568	12115	7/1/2009 13:36	7/1/2009 13:39
1 2A		3	424	12499	7/1/2009 13:57	7/1/2009 14:00
2 2A		3	449	12103	7/1/2009 14:15	7/1/2009 14:18
3 2A		3	419	11968	7/1/2009 14:09	7/1/2009 14:12
4 2A		3	417	11855	7/1/2009 14:02	7/1/2009 14:05
1 2B		3	42	12471	7/1/2009 14:02	7/1/2009 14:05
2 2B		3	39	12492	7/1/2009 13:57	7/1/2009 14:00
3 2B		3	54	11892	7/1/2009 14:15	7/1/2009 14:18
4 2B		3	69	11539	7/1/2009 14:09	7/1/2009 14:12
1 2C		3	504	12050	7/1/2009 14:08	7/1/2009 14:11
2 2C		3	527	11914	7/1/2009 14:02	7/1/2009 14:05
3 2C		3	496	11994	7/1/2009 13:58	7/1/2009 14:01
4 2C		3	499	10889	7/1/2009 14:15	7/1/2009 14:18
1 2D		3	543	12010	7/1/2009 14:15	7/1/2009 14:18
2 2D		3	508	12124	7/1/2009 14:08	7/1/2009 14:11
3 2D		3	542	12168	7/1/2009 14:02	7/1/2009 14:05
4 2D		3	544	11692	7/1/2009 13:58	7/1/2009 14:01
1 3A		3	1397	11194	7/1/2009 14:19	7/1/2009 14:22
2 3A		4	1809	14227	7/1/2009 14:35	7/1/2009 14:39
3 3A		4	1757	14180	7/1/2009 14:30	7/1/2009 14:34
4 3A		4	1725	13754	7/1/2009 14:25	7/1/2009 14:29
1 3B		4	914	15370	7/1/2009 14:25	7/1/2009 14:29
2 3B		3	731	11695	7/1/2009 14:20	7/1/2009 14:23
3 3B		4	960	14905	7/1/2009 14:35	7/1/2009 14:39
4 3B		4	922	14220	7/1/2009 14:30	7/1/2009 14:34
1 3C		4	671	15644	7/1/2009 14:29	7/1/2009 14:33
2 3C		4	722	15964	7/1/2009 14:25	7/1/2009 14:29
3 3C		3	558	11701	7/1/2009 14:20	7/1/2009 14:23
4 3C		4	647	14729	7/1/2009 14:35	7/1/2009 14:39
1 3D		4	651	15152	7/1/2009 14:35	7/1/2009 14:39
2 3D		4	722	15168	7/1/2009 14:30	7/1/2009 14:34
3 3D		4	684	15295	7/1/2009 14:25	7/1/2009 14:29
4 3D		3	466	10942	7/1/2009 14:20	7/1/2009 14:23
1 4A		4	412	15298	7/1/2009 14:40	7/1/2009 14:44
2 4A		4	407	14897	7/1/2009 15:00	7/1/2009 15:04
3 4A		4	389	15050	7/1/2009 14:53	7/1/2009 14:57

419  
7/2/09

4 4A	4	417	14462	7/1/2009 14:48	7/1/2009 14:52
1 4B	4	58	15335	7/1/2009 14:48	7/1/2009 14:52
2 4B	4	61	15513	7/1/2009 14:41	7/1/2009 14:45
3 4B	4	53	14521	7/1/2009 15:00	7/1/2009 15:04
4 4B	4	72	14328	7/1/2009 14:53	7/1/2009 14:57
1 4C	4	532	14733	7/1/2009 14:53	7/1/2009 14:57
2 4C	4	545	14902	7/1/2009 14:48	7/1/2009 14:52
3 4C	4	486	14856	7/1/2009 14:41	7/1/2009 14:45
4 4C	4	540	13733	7/1/2009 15:00	7/1/2009 15:04
1 4D	4	1158	14167	7/1/2009 15:00	7/1/2009 15:04
2 4D	4	1192	14204	7/1/2009 14:53	7/1/2009 14:57
3 4D	4	1136	14131	7/1/2009 14:48	7/1/2009 14:52
4 4D	4	1149	13978	7/1/2009 14:41	7/1/2009 14:45
1 5A	4	424	14870	7/1/2009 15:06	7/1/2009 15:10
2 5A	4	395	14487	7/1/2009 15:21	7/1/2009 15:25
3 5A	4	403	14259	7/1/2009 15:17	7/1/2009 15:21
4 5A	4	389	13957	7/1/2009 15:12	7/1/2009 15:16
1 5B	4	428	14869	7/1/2009 15:12	7/1/2009 15:16
2 5B	4	440	14821	7/1/2009 15:06	7/1/2009 15:10
3 5B	4	420	14289	7/1/2009 15:21	7/1/2009 15:25
4 5B	4	414	13809	7/1/2009 15:17	7/1/2009 15:21
1 5C	4	436	14676	7/1/2009 15:17	7/1/2009 15:21
2 5C	4	443	15122	7/1/2009 15:12	7/1/2009 15:16
3 5C	4	433	14958	7/1/2009 15:07	7/1/2009 15:11
4 5C	4	416	13831	7/1/2009 15:21	7/1/2009 15:25
1 5D	4	451	14321	7/1/2009 15:21	7/1/2009 15:25
2 5D	4	452	14642	7/1/2009 15:17	7/1/2009 15:21
3 5D	4	444	14443	7/1/2009 15:12	7/1/2009 15:16
4 5D	4	414	13954	7/1/2009 15:07	7/1/2009 15:11
1 6A	4	272	14018	7/1/2009 15:27	7/1/2009 15:31
2 6A	3.5	246	12283	7/1/2009 15:40	7/1/2009 15:44
3 6A	3.5	231	12111	7/1/2009 15:36	7/1/2009 15:40
4 6A	3.5	229	11598	7/1/2009 15:32	7/1/2009 15:35
1 6B	3.5	540	12151	7/1/2009 15:32	7/1/2009 15:36
2 6B	4	592	14371	7/1/2009 15:27	7/1/2009 15:31
3 6B	3.5	498	11705	7/1/2009 15:40	7/1/2009 15:44
4 6B	3.5	498	11388	7/1/2009 15:36	7/1/2009 15:40
1 6C	3.5	462	12161	7/1/2009 15:36	7/1/2009 15:40
2 6C	3.5	468	12083	7/1/2009 15:32	7/1/2009 15:36
3 6C	4	534	13638	7/1/2009 15:27	7/1/2009 15:31
4 6C	3.5	455	11218	7/1/2009 15:40	7/1/2009 15:44
1 6D	3.5	456	11987	7/1/2009 15:40	7/1/2009 15:44
2 6D	3.5	468	12183	7/1/2009 15:36	7/1/2009 15:40
3 6D	3.5	496	11882	7/1/2009 15:32	7/1/2009 15:36
4 6D	4	525	13018	7/1/2009 15:27	7/1/2009 15:31
1 7A	3.5	466	12007	7/1/2009 15:46	7/1/2009 15:50
2 7A	3.5	491	11655	7/1/2009 16:00	7/1/2009 16:04
3 7A	3.5	444	11445	7/1/2009 15:56	7/1/2009 15:59
4 7A	3.5	477	11121	7/1/2009 15:50	7/1/2009 15:54
1 7B	3.5	418	11968	7/1/2009 15:51	7/1/2009 15:54
2 7B	3.5	448	12050	7/1/2009 15:46	7/1/2009 15:50
3 7B	3.5	460	11675	7/1/2009 16:00	7/1/2009 16:04

4 7B	3.5	413	11271	7/1/2009 15:56	7/1/2009 16:00
1 7C	3.5	471	11781	7/1/2009 15:56	7/1/2009 16:00
2 7C	3.5	457	11760	7/1/2009 15:51	7/1/2009 15:54
3 7C	3.5	454	11766	7/1/2009 15:46	7/1/2009 15:50
4 7C	3.5	406	10888	7/1/2009 16:00	7/1/2009 16:04
1 7D	3.5	359	11605	7/1/2009 16:00	7/1/2009 16:04
2 7D	3.5	391	11920	7/1/2009 15:56	7/1/2009 16:00
3 7D	3.5	386	11933	7/1/2009 15:51	7/1/2009 15:55
4 7D	3.5	400	11305	7/1/2009 15:46	7/1/2009 15:50
1 8A	3.5	348	11673	7/1/2009 16:06	7/1/2009 16:09
2 8A	3.5	340	11172	7/1/2009 16:19	7/1/2009 16:22
3 8A	3.5	298	11258	7/1/2009 16:15	7/1/2009 16:18
4 8A	3.5	327	10977	7/1/2009 16:10	7/1/2009 16:13
1 8B	3.5	124	11583	7/1/2009 16:10	7/1/2009 16:13
2 8B	3.5	112	11758	7/1/2009 16:06	7/1/2009 16:09
3 8B	3.5	110	11499	7/1/2009 16:19	7/1/2009 16:23
4 8B	3.5	102	10844	7/1/2009 16:15	7/1/2009 16:18
1 8C	3.5	202	11539	7/1/2009 16:15	7/1/2009 16:18
2 8C	3.5	196	11774	7/1/2009 16:10	7/1/2009 16:14
3 8C	3.5	203	11611	7/1/2009 16:06	7/1/2009 16:09
4 8C	3.5	207	10809	7/1/2009 16:19	7/1/2009 16:23
1 8D	3.5	240	11301	7/1/2009 16:19	7/1/2009 16:23
2 8D	3.5	248	11412	7/1/2009 16:15	7/1/2009 16:18
3 8D	3.5	233	11660	7/1/2009 16:10	7/1/2009 16:14
4 8D	3.5	235	10918	7/1/2009 16:06	7/1/2009 16:10
1 9A	3.5	39	11605	7/1/2009 16:24	7/1/2009 16:28
2 9A	3.5	49	11281	7/1/2009 16:42	7/1/2009 16:46
3 9A	3.5	47	11301	7/1/2009 16:33	7/1/2009 16:36
4 9A	3.5	64	10987	7/1/2009 16:29	7/1/2009 16:32
1 9B	3.5	53	11151	7/1/2009 16:29	7/1/2009 16:32
2 9B	3.5	39	11462	7/1/2009 16:24	7/1/2009 16:28
3 9B	3.5	45	11004	7/1/2009 16:42	7/1/2009 16:46
4 9B	3.5	51	10581	7/1/2009 16:33	7/1/2009 16:36
1 9C	3.5	49	11026	7/1/2009 16:33	7/1/2009 16:36
2 9C	3.5	49	11281	7/1/2009 16:29	7/1/2009 16:32
3 9C	3.5	40	11016	7/1/2009 16:24	7/1/2009 16:28
4 9C	3.5	60	10297	7/1/2009 16:42	7/1/2009 16:46
1 9D	3.5	65	11135	7/1/2009 16:38	7/1/2009 16:41
2 9D	3.5	53	11412	7/1/2009 16:33	7/1/2009 16:37
3 9D	3.5	54	11340	7/1/2009 16:29	7/1/2009 16:32
4 9D	3.5	77	10912	7/1/2009 16:24	7/1/2009 16:28
1 10A	3.5	71	10991	7/1/2009 16:47	7/1/2009 16:51
2 10A	4	106	11959	7/1/2009 17:12	7/1/2009 17:16
3 10A	3.5	70	10553	7/1/2009 16:58	7/1/2009 17:01
4 10A	3.5	95	10338	7/1/2009 16:53	7/1/2009 16:56
1 10B	4	139	11110	7/1/2009 17:03	7/1/2009 17:07
2 10B	3.5	102	10812	7/1/2009 16:47	7/1/2009 16:51
3 10B	4	103	11422	7/1/2009 17:12	7/1/2009 17:16
4 10B	3.5	110	9967	7/1/2009 16:58	7/1/2009 17:01
1 10C	3.5	74	10482	7/1/2009 16:58	7/1/2009 17:01
2 10C	3.5	79	10535	7/1/2009 16:53	7/1/2009 16:57
3 10C	3.5	87	10723	7/1/2009 16:47	7/1/2009 16:51



4 10C	4	95	11066	7/1/2009 17:13	7/1/2009 17:17
1 10D	4	102	12021	7/1/2009 17:13	7/1/2009 17:17
2 10D	3.5	75	10614	7/1/2009 16:58	7/1/2009 17:01
3 10D	3.5	78	10643	7/1/2009 16:53	7/1/2009 16:57
4 10D	3.5	81	10064	7/1/2009 16:48	7/1/2009 16:51
1 11A	3	31	14773	7/1/2009 11:56	7/1/2009 11:59
2 11A	3	23	14429	7/1/2009 12:08	7/1/2009 12:11
3 11A	3	33	14454	7/1/2009 12:04	7/1/2009 12:07
4 11A	3	49	14013	7/1/2009 12:00	7/1/2009 12:03
1 11B	3	43	16203	7/1/2009 12:00	7/1/2009 12:03
2 11B	3	53	16106	7/1/2009 11:56	7/1/2009 11:59
3 11B	3	46	15643	7/1/2009 12:08	7/1/2009 12:11
4 11B	3	42	15133	7/1/2009 12:04	7/1/2009 12:07
1 11C	3	27	15637	7/1/2009 12:04	7/1/2009 12:07
2 11C	3	38	15919	7/1/2009 12:00	7/1/2009 12:03
3 11C	3	33	16452	7/1/2009 11:56	7/1/2009 11:59
4 11C	3	46	14887	7/1/2009 12:08	7/1/2009 12:11
1 11D	3	43	15607	7/1/2009 12:08	7/1/2009 12:11
2 11D	3	42	15944	7/1/2009 12:04	7/1/2009 12:07
3 11D	3	32	16098	7/1/2009 12:00	7/1/2009 12:03
4 11D	3	39	15191	7/1/2009 11:56	7/1/2009 11:59
1 12A	3	29	15450	7/1/2009 12:15	7/1/2009 12:18
2 12A	3	28	15016	7/1/2009 12:28	7/1/2009 12:31
3 12A	3	31	14984	7/1/2009 12:24	7/1/2009 12:27
4 12A	3	46	14530	7/1/2009 12:20	7/1/2009 12:23
1 12B	3	26	15404	7/1/2009 12:20	7/1/2009 12:23
2 12B	3	31	15607	7/1/2009 12:15	7/1/2009 12:18
3 12B	3	34	15060	7/1/2009 12:28	7/1/2009 12:31
4 12B	3	49	14553	7/1/2009 12:24	7/1/2009 12:27
1 12C	3	24	15183	7/1/2009 12:24	7/1/2009 12:27
2 12C	3	44	15651	7/1/2009 12:20	7/1/2009 12:23
3 12C	3	46	15216	7/1/2009 12:15	7/1/2009 12:18
4 12C	3	60	14117	7/1/2009 12:28	7/1/2009 12:31
1 12D	3	48	15174	7/1/2009 12:28	7/1/2009 12:31
2 12D	3	37	15137	7/1/2009 12:24	7/1/2009 12:27
3 12D	3	25	15418	7/1/2009 12:20	7/1/2009 12:23
4 12D	3	59	14566	7/1/2009 12:15	7/1/2009 12:18
1 13A	3	50	15230	7/1/2009 12:33	7/1/2009 12:36
2 13A	3	36	14784	7/1/2009 12:50	7/1/2009 12:53
3 13A	3	41	14851	7/1/2009 12:41	7/1/2009 12:44
4 13A	3	49	14183	7/1/2009 12:37	7/1/2009 12:40
1 13B	3	39	15625	7/1/2009 12:37	7/1/2009 12:40
2 13B	3	41	15450	7/1/2009 12:33	7/1/2009 12:36
3 13B	3	37	14689	7/1/2009 12:50	7/1/2009 12:53
4 13B	3	47	14377	7/1/2009 12:41	7/1/2009 12:44
1 13C	3	54	15426	7/1/2009 12:41	7/1/2009 12:44
2 13C	3	41	15315	7/1/2009 12:37	7/1/2009 12:40
3 13C	3	36	15288	7/1/2009 12:33	7/1/2009 12:36
4 13C	3	34	14222	7/1/2009 12:50	7/1/2009 12:53
1 13D	3	47	14492	7/1/2009 12:50	7/1/2009 12:53
2 13D	3	50	14858	7/1/2009 12:46	7/1/2009 12:49
3 13D	3	43	14873	7/1/2009 12:37	7/1/2009 12:40

4 13D	3	47	14389	7/1/2009 12:33	7/1/2009 12:36
1 14A	3	44	14463	7/1/2009 12:54	7/1/2009 12:57
2 14A	3	41	14137	7/1/2009 13:17	7/1/2009 13:20
3 14A	3	45	14022	7/1/2009 13:13	7/1/2009 13:16
4 14A	3	51	13451	7/1/2009 13:02	7/1/2009 13:05
1 14B	3	42	14039	7/1/2009 13:01	7/1/2009 13:04
2 14B	3	36	14398	7/1/2009 12:54	7/1/2009 12:57
3 14B	3	47	13475	7/1/2009 13:17	7/1/2009 13:20
4 14B	3	47	13077	7/1/2009 13:13	7/1/2009 13:16
1 14C	3	26	14116	7/1/2009 13:12	7/1/2009 13:15
2 14C	3	35	14187	7/1/2009 13:02	7/1/2009 13:05
3 14C	3	37	14409	7/1/2009 12:55	7/1/2009 12:58
4 14C	3	38	13229	7/1/2009 13:17	7/1/2009 13:20
1 14D	3	16	13927	7/1/2009 13:17	7/1/2009 13:20
2 14D	3	32	14089	7/1/2009 13:12	7/1/2009 13:15
3 14D	3	16	13912	7/1/2009 13:02	7/1/2009 13:05
4 14D	3	47	13545	7/1/2009 12:55	7/1/2009 12:58

# Radium-228 Liquid

Filename : RA228.LXS  
 File Type : Excel  
 Version # : 1.2.3  
  
 Batch : 595514  
 Analyst : AFI  
 Prep Date : 7/12/2009  
  
 Re-228 Abundance : 1  
 Re-228 Method Uncertainty : 0.0784  
 Calibration Date : 6/2/2008  
 Calibration Due Date : 6/30/2009  
  
 Spike S/N : N/A  
 Spike Exp Date : N/A  
 Spike Activity (dpm/ml) : N/A  
 Spike Volume Added : N/A  
  
 LCS S/N : 0503-B  
 LCS Exp Date : 9/13/2009  
 LCS Activity (dpm/ml) : 182.42  
 LCS Volume Added : 2.00  
  
 Tracer S/N : 0112-J  
 Tracer Exp Date : 2/17/2010  
 Tracer Volume Added : 0.10  
  
 Procedure Code : GF090SRL  
 Parname : Radium-228  
 Required MDA : 1 pCi/L  
 Half-life of Re-228 : 5.75 years  
 Half-life of Ac-228 : 6.13 hours  
 Batch counted on : PIC  
 BKG Count time : 500 min  
  
 Pipet, 0.1 ml Stdev : +/- 0.000701 ml  
 Pipet, 0.5 ml Stdev : +/- 0.002564 ml  
 Pipet, 1 ml Stdev : +/- 0.005480 ml

Pos.	Sample Characteristics			Count raw Data			Counting Time		Gross Counts		Beta		Detector Efficiency Error		Weekly Bkg Count		Separation Date/Time		Count Start Date/Time		Ra-228 Ac-228		Calculated Sample Recovery %		Results	
	Sample ID	Sample Aliquot	Sample Aliquot	Sample Date/Time	Detector ID	Detector Pos.	Alpha	Beta	Alpha	Beta	Beta cpm	Beta hours	Efficiency	Error	Count	Time (min.)	Date/Time	Date/Time	Decay	Count	Decay	Correction	Recovery %	Sample Recovery Error %	Pos.	Pos.
1	1201245712.1	1.0000	2.0399E-05	7/1/2009 0:00	1A	1	36	1980	132.000	0.6303	0.00600	500	7/2/2009 5:40	7/2/2009 8:39	1.000	0.713	1.014	100.83%	1.00%	1						
2	1201245713.1	1.0000	2.0399E-05	7/1/2009 0:00	1B	2	27	1959	130.600	0.6292	0.00409	500	7/2/2009 5:40	7/2/2009 8:40	1.000	0.712	1.014	108.20%	1.00%	2						
3	1201245714.1	1.0000	2.0399E-05	7/1/2009 0:00	1C	3	44	2108	140.533	0.6176	0.00344	500	7/2/2009 5:40	7/2/2009 8:40	1.000	0.712	1.014	114.22%	1.00%	3						
4	1201245715.1	1.0000	2.0399E-05	7/1/2009 0:00	1D	4	108	2265	151.000	0.6043	0.00511	500	7/2/2009 5:40	7/2/2009 8:40	1.000	0.712	1.014	120.58%	1.00%	4						
5	1201245716.1	1.0000	2.0399E-05	7/1/2009 0:00	2A	5	69	1858	122.533	0.6172	0.00349	500	7/2/2009 5:40	7/2/2009 8:40	1.000	0.712	1.014	105.84%	1.00%	5						
6	1201245717.1	1.0000	2.0399E-05	7/1/2009 0:00	2B	6	8	2053	136.867	0.6167	0.00383	500	7/2/2009 5:40	7/2/2009 8:40	1.000	0.712	1.014	102.70%	1.00%	6						
7	1201245718.1	1.0000	2.0399E-05	7/1/2009 0:00	2C	7	96	1982	132.133	0.5969	0.00575	500	7/2/2009 5:40	7/2/2009 8:40	1.000	0.711	1.014	112.82%	1.00%	7						
8	1201245719.1	1.0000	2.0399E-05	7/1/2009 0:00	2D	8	233	1645	109.667	0.5682	0.00643	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.675	1.014	111.91%	1.00%	8						
9	1201245720.1	1.0000	2.0399E-05	7/1/2009 0:00	3A	9	99	1821	121.400	0.5980	0.00655	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.675	1.014	114.22%	1.00%	9						
10	1201245721.1	1.0000	2.0399E-05	7/1/2009 0:00	3B	10	96	1942	129.467	0.6164	0.00535	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.675	1.014	114.22%	1.00%	10						
11	1201245722.1	1.0000	2.0399E-05	7/1/2009 0:00	3C	11	90	2076	138.400	0.5994	0.00464	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.675	1.014	105.84%	1.00%	11						
12	1201245723.1	1.0000	2.0399E-05	7/1/2009 0:00	3D	12	79	1877	125.133	0.6208	0.00744	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.675	1.014	102.70%	1.00%	12						
13	1201245724.1	1.0000	2.0399E-05	7/1/2009 0:00	4A	13	4A	1909	127.267	0.6205	0.00196	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.674	1.014	112.82%	1.00%	13						
14	1201245725.1	1.0000	2.0399E-05	7/1/2009 0:00	4B	14	4C	1974	131.600	0.6052	0.00426	500	7/2/2009 5:40	7/2/2009 8:08	1.000	0.684	1.014	111.91%	1.00%	14						
15	1201245726.1	1.0000	2.0399E-05	7/1/2009 0:00	4C	15	181	1880	125.333	0.5673	0.00816	500	7/2/2009 5:40	7/2/2009 8:26	1.000	0.654	1.014	100.83%	1.00%	15						
16	1201245727.1	1.0000	2.0399E-05	7/1/2009 0:00	4D	16	53	1818	121.200	0.6258	0.00816	500	7/2/2009 5:40	7/2/2009 8:26	1.000	0.651	1.014	108.20%	1.00%	16						
17	1201245728.1	1.0000	2.0399E-05	7/1/2009 0:00	5A	17	5A	1785	119.000	0.6280	0.00816	500	7/2/2009 5:40	7/2/2009 8:26	1.000	0.653	1.014	114.22%	1.00%	17						
18	1201245729.1	1.0000	2.0399E-05	7/1/2009 0:00	5B	18	59	2009	133.933	0.6368	0.00816	500	7/2/2009 5:40	7/2/2009 8:26	1.000	0.662	1.014	105.84%	1.00%	18						
19	1201245730.1	1.0000	2.0399E-05	7/1/2009 0:00	5C	19	43	2107	140.467	0.6237	0.00816	500	7/2/2009 5:40	7/2/2009 8:26	1.000	0.652	1.014	108.20%	1.00%	19						
20	1201245731.1	1.0000	2.0399E-05	7/1/2009 0:00	5D	20	5D	1800	120.000	0.6221	0.00816	500	7/2/2009 5:40	7/2/2009 8:27	1.000	0.651	1.014	112.82%	1.00%	20						
21	1201245732.1	1.0000	2.0399E-05	7/1/2009 0:00	6A	21	6A	1816	121.067	0.6163	0.00816	500	7/2/2009 5:40	7/2/2009 8:27	1.000	0.651	1.014	111.91%	1.00%	21						
22	1201245733.1	1.0000	2.0399E-05	7/1/2009 0:00	6B	22	6B	1867	128.667	0.6111	0.00816	500	7/2/2009 5:40	7/2/2009 8:27	1.000	0.651	1.014	108.20%	1.00%	22						
23	1201245734.1	1.0000	2.0399E-05	7/1/2009 0:00	6C	23	6C	1933	128.667	0.6111	0.00816	500	7/2/2009 5:40	7/2/2009 8:27	1.000	0.651	1.014	111.91%	1.00%	23						
24	1201245735.1	1.0000	2.0399E-05	7/1/2009 0:00	6D	24	6D	1826	121.733	0.6120	0.00816	500	7/2/2009 5:40	7/2/2009 8:27	1.000	0.651	1.014	108.20%	1.00%	24						
25	1201245736.1	1.0000	2.0399E-05	7/1/2009 0:00	7A	25	7A	1768	119.200	0.6332	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.626	1.014	100.83%	1.00%	25						
26	1201245737.1	1.0000	2.0399E-05	7/1/2009 0:00	7B	26	7B	1834	128.933	0.6178	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.627	1.014	114.22%	1.00%	26						
27	1201245738.1	1.0000	2.0399E-05	7/1/2009 0:00	7C	27	7C	1963	130.867	0.6257	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.626	1.014	105.84%	1.00%	27						
28	1201245739.1	1.0000	2.0399E-05	7/1/2009 0:00	7D	28	7D	1653	110.200	0.6247	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.626	1.014	102.70%	1.00%	28						
29	1201245740.1	1.0000	2.0399E-05	7/1/2009 0:00	8A	29	8A	1820	128.000	0.6339	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.626	1.014	111.91%	1.00%	29						
30	1201245741.1	1.0000	2.0399E-05	7/1/2009 0:00	8B	30	8B	1788	119.200	0.6332	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.626	1.014	108.20%	1.00%	30						
31	1201245742.1	1.0000	2.0399E-05	7/1/2009 0:00	8C	31	8C	1820	128.000	0.6281	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.626	1.014	111.91%	1.00%	31						
32	1201245743.1	1.0000	2.0399E-05	7/1/2009 0:00	8D	32	8D	1689	112.800	0.6496	0.00816	500	7/2/2009 5:40	7/2/2009 8:48	1.000	0.605	1.014	100.83%	1.00%	32						
33	1201490021.1	1.0000	2.0399E-05	7/1/2009 0:00	9A	33	9A	1706	113.733	0.6356	0.00816	500	7/2/2009 5:40	7/2/2009 10:06	1.000	0.605	1.014	108.20%	1.00%	33						
34	1201490022.1	1.0000	2.0399E-05	7/1/2009 0:00	9B	34	9B	1802	120.133	0.6273	0.00816	500	7/2/2009 5:40	7/2/2009 10:06	1.000	0.605	1.014	114.22%	1.00%	34						
35	1201490023.1	1.0000	2.0399E-05	7/1/2009 0:00	9C	35	9C	1945	128.667	0.6433	0.00816	500	7/2/2009 5:40	7/2/2009 10:06	1.000	0.604	1.014	105.84%	1.00%	35						
36	1201490024.1	1.0000	2.0399E-05	7/1/2009 0:00	9D	36	9D	1708	113.867	0.6389	0.00816	500	7/2/2009 5:40	7/2/2009 10:07	1.000	0.604	1.014	102.70%	1.00%	36						
37	1201490025.1	1.0000	2.0399E-05	7/1/2009 0:00	10A	37	10A	1743	116.200	0.6137	0.00816	500	7/2/2009 5:40	7/2/2009 10:07	1.000	0.604	1.014	108.20%	1.00%	37						
38	1201490026.1	1.0000	2.0399E-05	7/1/2009 0:00	10B	38	10B	1826	121.733	0.6250	0.00816	500	7/2/2009 5:40	7/2/2009 10:07	1.000	0.604	1.014	111.91%	1.00%	38						
39	1201490027.1	1.0000	2.0399E-05	7/1/2009 0:00	10C	39	10C	1769	117.933	0.6320	0.00816	500	7/2/2009 5:40	7/2/2009 10:22	1.000	0.587	1.014	100.83%	1.00%	39						
40	1201490028.1	1.0000	2.0399E-05	7/1/2009 0:00	10D	40	10D	2125	141.667	0.5825	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.819	1.014	108.20%	1.00%	40						
41	1201245737.1	1.0000	2.0399E-05	7/1/2009 0:00	11A	41	11A	2260	160.667	0.6372	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.819	1.014	114.22%	1.00%	41						
42	1201245738.1	1.0000	2.0399E-05	7/1/2009 0:00	11B	42	11B	2544	169.600	0.6352	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.819	1.014	105.84%	1.00%	42						
43	1201245739.1	1.0000	2.0399E-05	7/1/2009 0:00	11C	43	11C	2544	169.600	0.6352	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.819	1.014	114.22%	1.00%	43						
44	1201245740.1	1.0000	2.0399E-05	7/1/2009 0:00	11D	44	11D	2596	173.067	0.6348	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.818	1.014	105.84%	1.00%	44						
45	1201245741.1	1.0000	2.0399E-05	7/1/2009 0:00	12A	45	12A	2235	149.000	0.6286	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.818	1.014	102.70%	1.00%	45						
46	1201245742.1	1.0000	2.0399E-05	7/1/2009 0:00	12B	46	12B	2380	155.333	0.6352	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.818	1.014	112.82%	1.00%	46						
47	1201245743.1	1.0000	2.0399E-05	7/1/2009 0:00	12C	47	12C	2530	168.667	0.6304	0.00816	500	7/2/2009 5:40	7/2/2009 7:26	1.000	0.818	1.014	105.84%	1.00%	47						
48	1201245744.1	1.0000	2.0399E-05	7/1/2009 0:00	12D	48	12D	2463	164.2																	

Notes:

- 1 - Results are decay corrected to Sample Date/Time
- 2 - Reference date for Spike Activity (dpm/ml) is the batch Prep Date
- 3 - Spike Normalis are decay corrected to Sample Date/Time

\* indicates results calculated at 100% recovery

Decision Level	Critical Level	Required MDA	MDA	Sample Act. Conc.		Sample Error	Net Count Rate	Net Count Rate	Net Count Rate	2 SIGMA Counting		Total Prop. Uncertainty	Sample Type	Nominal pCi/L	Recovery
				pCi/L	Conc.					CPM	CPM				
0.3471	0.2451	1	0.6937	134.0279	0.0254	131.6880	2.9666	5.9178	21.6466	LCS	164.3409	81.6%			
0.3647	0.2575	1	0.7192	133.0399	0.0251	130.2580	2.9508	5.9071	21.4655	LCS	164.3409	81.0%			
0.5889	0.3790	1	0.9659	145.2921	0.0243	139.8173	3.0611	6.2347	23.3752	LCS	164.3409	88.4%			
0.4695	0.3314	1	0.8755	159.8828	0.0239	150.4760	3.1730	6.6057	25.6756	LCS	164.3409	97.3%			
0.4261	0.3008	1	0.8087	127.0000	0.0257	122.0833	2.8583	5.8279	20.5368	LCS	164.3409	77.3%			
0.7599	0.5395	1	1.2813	141.0616	0.0247	135.4387	3.0211	6.1673	22.7300	LCS	164.3409	85.8%			
0.3798	0.2681	1	0.7515	141.8559	0.0253	131.7993	2.9681	6.2613	22.9053	LCS	164.3409	86.3%			
0.4150	0.2830	1	0.8072	145.8182	0.0251	131.8887	2.9696	6.4352	23.5274	LCS	164.3409	88.7%			
0.6347	0.4481	1	1.1343	129.8854	0.0284	108.9047	2.7042	6.3116	21.1935	LCS	164.3409	78.9%			
0.9035	0.6379	1	1.5022	135.4510	0.0266	119.6900	2.8455	6.3115	21.9803	LCS	164.3409	82.4%			
0.6078	0.4291	1	1.0779	141.2594	0.0255	128.6447	2.9382	6.3235	22.8259	LCS	164.3409	86.0%			
0.5473	0.3864	1	0.9887	155.5960	0.0247	137.7700	3.0378	6.7244	25.0636	LCS	164.3409	94.7%			
0.6283	0.4436	1	1.1054	135.5336	0.0264	124.2433	2.8986	6.1761	21.9739	LCS	164.3409	83.3%			
0.9036	0.6378	1	1.4942	136.9155	0.0254	125.4287	2.9134	6.2333	22.1127	LCS	164.3409	88.8%			
0.7676	0.5419	1	1.3079	145.9826	0.0252	130.3400	2.9624	6.5032	23.5621	LCS	164.3409	90.0%			
0.7520	0.5309	1	1.3000	147.9661	0.0269	124.2633	2.8910	6.7471	24.0105	LCS	164.3409	82.1%			
0.4809	0.3395	1	0.9027	134.9611	0.0266	120.7040	2.8427	6.2312	21.9265	LCS	164.3409	80.0%			
0.8974	0.4924	1	1.2076	131.4742	0.0271	117.9500	2.8170	6.1544	21.3797	LCS	164.3409	89.0%			
0.6530	0.4610	1	1.1419	148.2299	0.0259	132.9873	2.9884	6.4406	23.6659	LCS	164.3409	95.2%			
0.7661	0.5409	1	1.3064	156.3706	0.0255	139.2187	3.0605	6.7377	25.2668	LCS	164.3409	81.7%			
0.6889	0.4871	1	1.1997	134.1863	0.0270	118.9960	2.8288	6.2523	21.8127	LCS	164.3409	83.4%			
0.6079	0.4292	1	1.0862	137.0396	0.0269	120.3027	2.8412	6.3436	22.2643	LCS	164.3409	88.8%			
0.9509	0.6713	1	1.5725	146.0056	0.0264	127.0307	2.9317	6.6044	23.6775	LCS	164.3409	88.0%			
0.4376	0.3090	1	0.8562	144.5849	0.0276	113.7227	2.7577	6.3803	21.8573	LCS	164.3409	89.8%			
0.4227	0.2984	1	0.8330	134.2390	0.0275	118.4887	2.8152	6.4094	22.3723	LCS	164.3409	92.4%			
0.4360	0.3079	1	0.8480	137.6373	0.0270	118.4887	2.8152	6.7858	24.6088	LCS	164.3409	92.6%			
0.3962	0.2797	1	0.7956	151.8935	0.0262	128.6313	2.9319	6.6518	23.4785	LCS	164.3409	77.8%			
0.4480	0.3163	1	0.8657	152.1131	0.0261	130.4707	2.9539	6.2072	20.8618	LCS	164.3409	82.2%			
0.6332	0.4470	1	1.1278	127.8251	0.0279	109.4120	2.7108	6.3699	21.9896	LCS	164.3409	89.2%			
0.9817	0.6931	1	1.6167	135.1471	0.0273	117.2540	2.8214	6.5922	23.7610	LCS	164.3409	86.1%			
0.5779	0.4080	1	1.0463	146.5864	0.0263	127.3240	2.9214	6.4441	23.0149	LCS	164.3409	79.4%			
0.8422	0.5946	1	1.4301	141.4935	0.0272	117.4880	2.8147	6.6441	23.1282	LCS	164.3409	81.4%			
0.4379	0.3091	1	0.8509	130.5505	0.0276	112.2200	2.7400	6.2478	21.2682	LCS	164.3409	81.4%			
0.7972	0.5629	1	1.3635	133.7974	0.0277	112.5273	2.7540	6.4182	21.9026	LCS	164.3409	87.8%			
0.4475	0.3159	1	0.8728	144.2924	0.0269	119.7633	2.8301	6.6832	23.4437	LCS	164.3409	91.8%			
0.8154	0.5757	1	1.3863	150.8313	0.0263	128.3747	2.9406	6.7718	24.4459	LCS	164.3409	81.8%			
0.4063	0.2868	1	0.8104	134.4151	0.0285	119.5507	2.7553	6.3927	21.8871	LCS	164.3409	82.2%			
1.9322	1.3641	1	2.9747	135.0540	0.0265	109.6040	2.7857	6.7277	22.0820	LCS	164.3409	89.4%			
0.4205	0.2969	1	0.8358	146.9063	0.0268	121.4093	2.8489	6.7565	23.8548	LCS	164.3409	86.1%			
0.4437	0.3182	1	0.8728	144.8386	0.0271	117.5853	2.8041	6.7699	23.5500	LCS	164.3409	88.1%			
0.3432	0.2423	1	0.6763	135.4546	0.0253	141.3227	3.0733	5.7736	21.8705	LCS	164.3409	80.1%			
0.3289	0.2322	1	0.6397	131.8931	0.0247	150.2887	3.1684	5.4434	21.2189	LCS	164.3409	80.1%			
0.2949	0.2082	1	0.5922	148.8038	0.0237	169.2880	3.3626	5.7929	23.8966	LCS	164.3409	90.5%			
0.3379	0.2385	1	0.6530	151.8473	0.0235	172.6707	3.3968	5.8549	24.3615	LCS	164.3409	92.4%			
0.4616	0.3400	1	0.8577	131.6889	0.0249	148.2120	3.2186	5.4891	21.2301	LCS	164.3409	80.1%			
0.7488	0.5287	1	1.2332	134.8566	0.0246	153.3873	3.2186	5.5483	21.7215	LCS	164.3409	82.1%			
0.4447	0.3140	1	0.8052	148.8317	0.0238	162.8880	3.3080	5.6232	23.8982	LCS	164.3409	90.8%			
0.6180	0.4363	1	1.0494	143.9479	0.0241	162.8880	3.3080	5.7315	23.1384	LCS	164.3409	87.6%			
0.3427	0.2420	1	0.6680	135.0873	0.0248	148.3533	3.1490	5.6202	21.7752	LCS	164.3409	82.2%			
0.5997	0.4234	1	1.0256	129.5009	0.0251	144.7940	3.1202	5.4697	20.8960	LCS	164.3409	78.9%			
0.6469	0.4602	1	1.0649	146.0021	0.0240	163.4967	3.3053	5.7852	23.4616	LCS	164.3409	88.8%			
0.3316	0.2341	1	0.6469	146.0021	0.0235	174.3747	3.4225	6.1425	25.6134	LCS	164.3409	97.2%			
0.6355	0.4487	1	1.0805	159.6717	0.0251	144.5507	3.1078	5.5650	21.3060	LCS	164.3409	80.4%			
0.3136	0.2214	1	0.6255	132.0625	0.0251	145.4707	3.1861	5.8215	22.7970	LCS	164.3409	82.5%			
1.4618	1.0321	1	2.2506	135.6135	0.0254	154.5427	3.1861	5.7718	21.9070	LCS	164.3409	86.2%			
0.3185	0.2249	1	0.6330	141.6298	0.0245	154.5427	3.2153	5.7718	21.9070	LCS	164.3409	86.2%			
0.3327	0.2349	1	0.6546	146.7439	0.0242	158.8520	3.2579	5.8988	23.6017	LCS	164.3409	89.3%			

Handwritten signature and date: 7/12/09

SampleID	Instr	Time (min.)	Alpha Counts	Beta Counts	Count Start Time	Count End Time	Machine
1	1A	15	36	1980	7/2/2009 8:39	7/2/2009 8:54	Protean
2	1B	15	27	1959	7/2/2009 8:40	7/2/2009 8:55	Protean
3	1C	15	44	2108	7/2/2009 8:40	7/2/2009 8:55	Protean
4	1D	15	108	2265	7/2/2009 8:40	7/2/2009 8:55	Protean
5	2A	15	69	1838	7/2/2009 8:40	7/2/2009 8:55	Protean
6	2B	15	8	2053	7/2/2009 8:40	7/2/2009 8:55	Protean
7	2C	15	96	1982	7/2/2009 8:40	7/2/2009 8:55	Protean
8	2D	15	93	1984	7/2/2009 9:08	7/2/2009 9:23	Protean
1	3A	15	233	1645	7/2/2009 9:08	7/2/2009 9:23	Protean
2	3B	15	99	1821	7/2/2009 9:08	7/2/2009 9:23	Protean
3	3C	15	96	1942	7/2/2009 9:08	7/2/2009 9:23	Protean
4	3D	15	90	2076	7/2/2009 9:08	7/2/2009 9:23	Protean
5	4A	15	79	1877	7/2/2009 9:08	7/2/2009 9:23	Protean
6	4B	15	13	1909	7/2/2009 9:08	7/2/2009 9:23	Protean
7	4C	15	97	1974	7/2/2009 9:09	7/2/2009 9:24	Protean
8	4D	15	181	1880	7/2/2009 9:25	7/2/2009 9:40	Protean
1	5A	15	53	1818	7/2/2009 9:26	7/2/2009 9:41	Protean
2	5B	15	59	1785	7/2/2009 9:26	7/2/2009 9:41	Protean
3	5C	15	43	2009	7/2/2009 9:26	7/2/2009 9:41	Protean
4	5D	15	59	2107	7/2/2009 9:26	7/2/2009 9:41	Protean
5	6A	15	35	1800	7/2/2009 9:27	7/2/2009 9:42	Protean
6	6B	15	71	1816	7/2/2009 9:27	7/2/2009 9:42	Protean
7	6C	15	81	1933	7/2/2009 9:27	7/2/2009 9:42	Protean
8	6D	15	81	1826	7/2/2009 9:47	7/2/2009 10:02	Protean
1	7A	15	75	1711	7/2/2009 9:48	7/2/2009 10:03	Protean
2	7B	15	59	1783	7/2/2009 9:48	7/2/2009 10:03	Protean
3	7C	15	74	1934	7/2/2009 9:48	7/2/2009 10:03	Protean
4	7D	15	83	1963	7/2/2009 9:48	7/2/2009 10:03	Protean
5	8A	15	49	1653	7/2/2009 9:48	7/2/2009 10:03	Protean
6	8B	15	20	1788	7/2/2009 9:48	7/2/2009 10:03	Protean
7	8C	15	34	1920	7/2/2009 9:48	7/2/2009 10:03	Protean
8	8D	15	45	1782	7/2/2009 10:07	7/2/2009 10:22	Protean
1	9A	15	17	1689	7/2/2009 10:06	7/2/2009 10:21	Protean
2	9B	15	13	1706	7/2/2009 10:06	7/2/2009 10:21	Protean
3	9C	15	13	1802	7/2/2009 10:06	7/2/2009 10:21	Protean
4	9D	15	15	1945	7/2/2009 10:06	7/2/2009 10:21	Protean
5	10A	15	10	1708	7/2/2009 10:07	7/2/2009 10:22	Protean
6	10B	15	19	1743	7/2/2009 10:07	7/2/2009 10:22	Protean
7	10C	15	15	1826	7/2/2009 10:07	7/2/2009 10:22	Protean
8	10D	15	14	1769	7/2/2009 10:22	7/2/2009 10:37	Protean
1	11A	15	19	2125	7/2/2009 7:26	7/2/2009 7:41	Protean
2	11B	15	22	2260	7/2/2009 7:26	7/2/2009 7:41	Protean
3	11C	15	13	2544	7/2/2009 7:26	7/2/2009 7:41	Protean
4	11D	15	14	2596	7/2/2009 7:26	7/2/2009 7:41	Protean
5	12A	15	17	2235	7/2/2009 7:26	7/2/2009 7:41	Protean
6	12B	15	10	2330	7/2/2009 7:26	7/2/2009 7:41	Protean
7	12C	15	16	2530	7/2/2009 7:26	7/2/2009 7:41	Protean
8	12D	15	10	2463	7/2/2009 7:26	7/2/2009 7:41	Protean
1	13A	15	11	2231	7/2/2009 7:49	7/2/2009 8:04	Protean
2	13B	15	13	2190	7/2/2009 7:49	7/2/2009 8:04	Protean
3	13C	15	11	2458	7/2/2009 7:49	7/2/2009 8:04	Protean

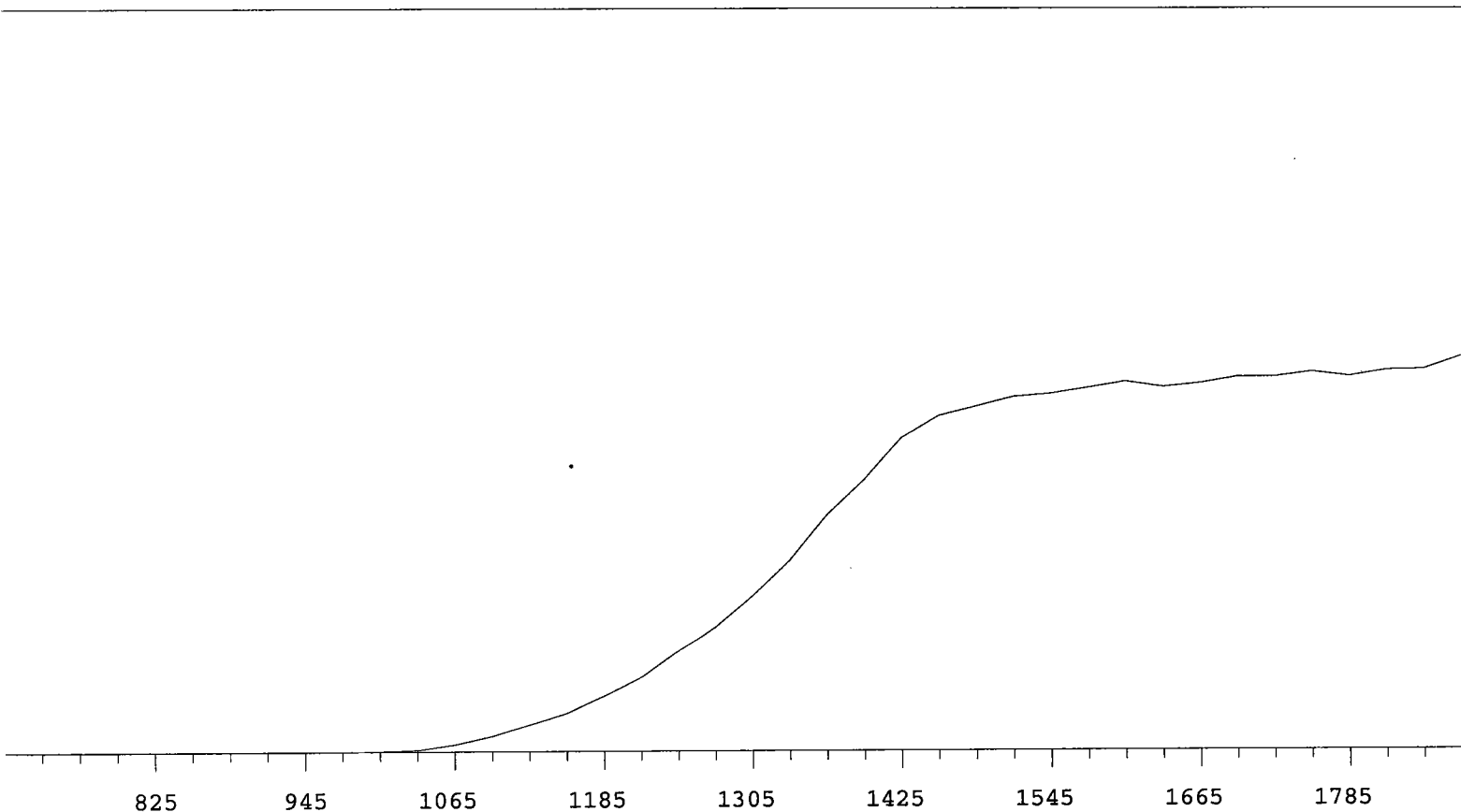
219  
7/2/09

4	13D	15	12	2635	7/2/2009 7:50	7/2/2009 8:05	Protean
5	14A	15	11	2173	7/2/2009 7:50	7/2/2009 8:05	Protean
6	14B	15	11	2281	7/2/2009 7:50	7/2/2009 8:05	Protean
7	14C	15	14	2323	7/2/2009 7:50	7/2/2009 8:05	Protean
8	14D	15	14	2388	7/2/2009 7:50	7/2/2009 8:05	Protean

Ra-228 Protean	Cal Date A0	7/2/2009 A1	Exp Date A2	7/31/2009 A3	A4
1A	6.30258E-01				
1B	6.28221E-01				
1C	6.17615E-01				
1D	6.04341E-01				
2A	6.17224E-01				
2B	6.16681E-01				
2C	5.96919E-01				
2D	6.11886E-01				
3A	5.68218E-01				
3B	5.98041E-01				
3C	6.16431E-01				
3D	5.99405E-01				
4A	6.20765E-01				
4B	6.20459E-01				
4C	6.05183E-01				
4D	5.87325E-01				
5A	6.25790E-01				
5B	6.28027E-01				
5C	6.36802E-01				
5D	6.23741E-01				
6A	6.22050E-01				
6B	6.16280E-01				
6C	6.11053E-01				
6D	6.12043E-01				
7A	6.17961E-01				
7B	6.27962E-01				
7C	6.17791E-01				
7D	6.25720E-01				
8A	6.24723E-01				
8B	6.33167E-01				
8C	6.33890E-01				
8D	6.28089E-01				
9A	6.496412E-01				
9B	6.356321E-01				
9C	6.273008E-01				
9D	6.432553E-01				
10A	6.389066E-01				
10B	6.137441E-01				
10C	6.249999E-01				
10D	6.319781E-01				
11A	5.82502E-01				
11B	6.37172E-01				
11C	6.35171E-01				
11D	6.34840E-01				
12A	6.28566E-01				
12B	6.35234E-01				
12C	6.30366E-01				
12D	6.31956E-01				
13A	6.40953E-01				

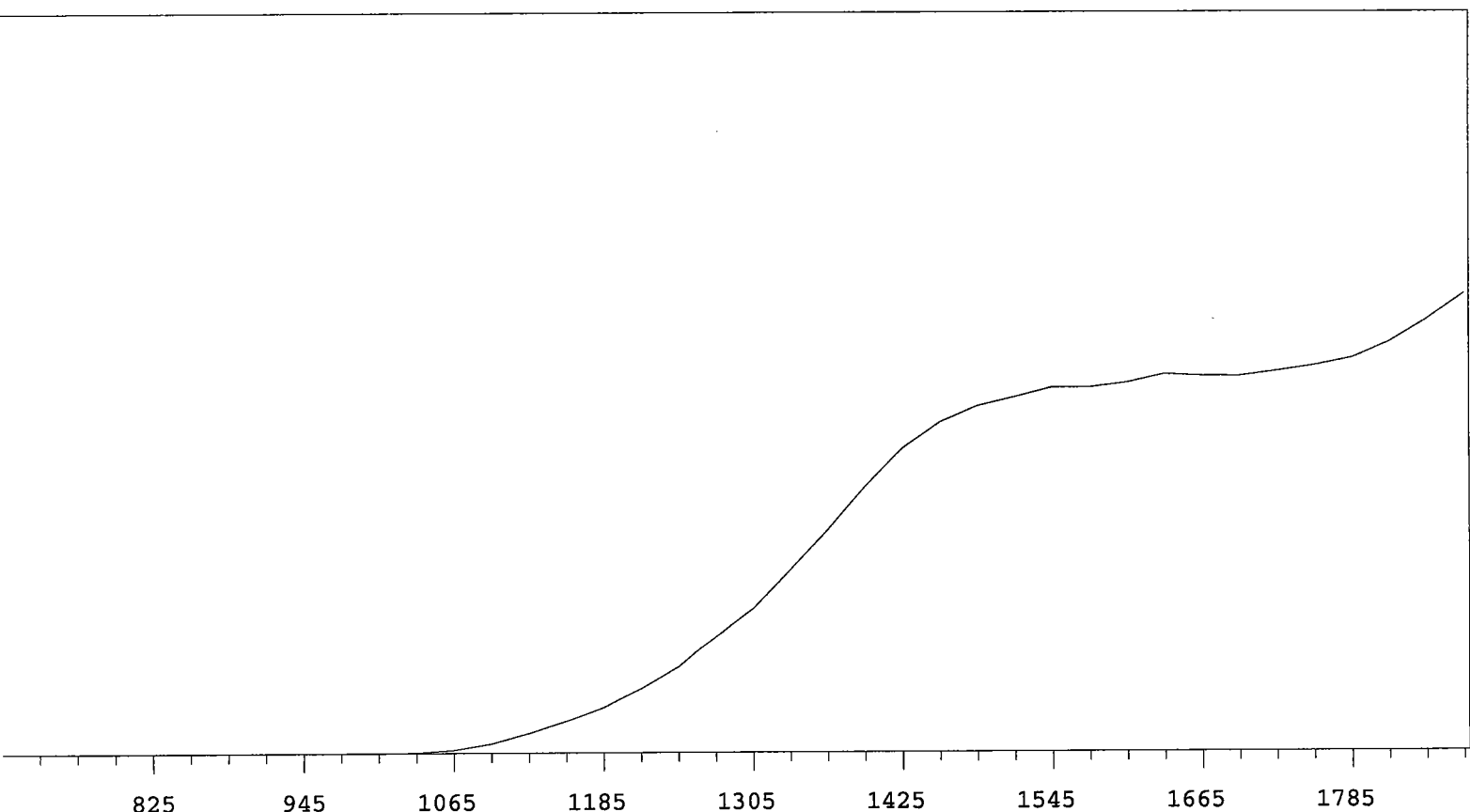
<b>13B</b>	6.52643E-01
<b>13C</b>	6.53798E-01
<b>13D</b>	6.37701E-01
<b>14A</b>	6.39290E-01
<b>14B</b>	6.26611E-01
<b>14C</b>	6.37531E-01
<b>14D</b>	6.32609E-01





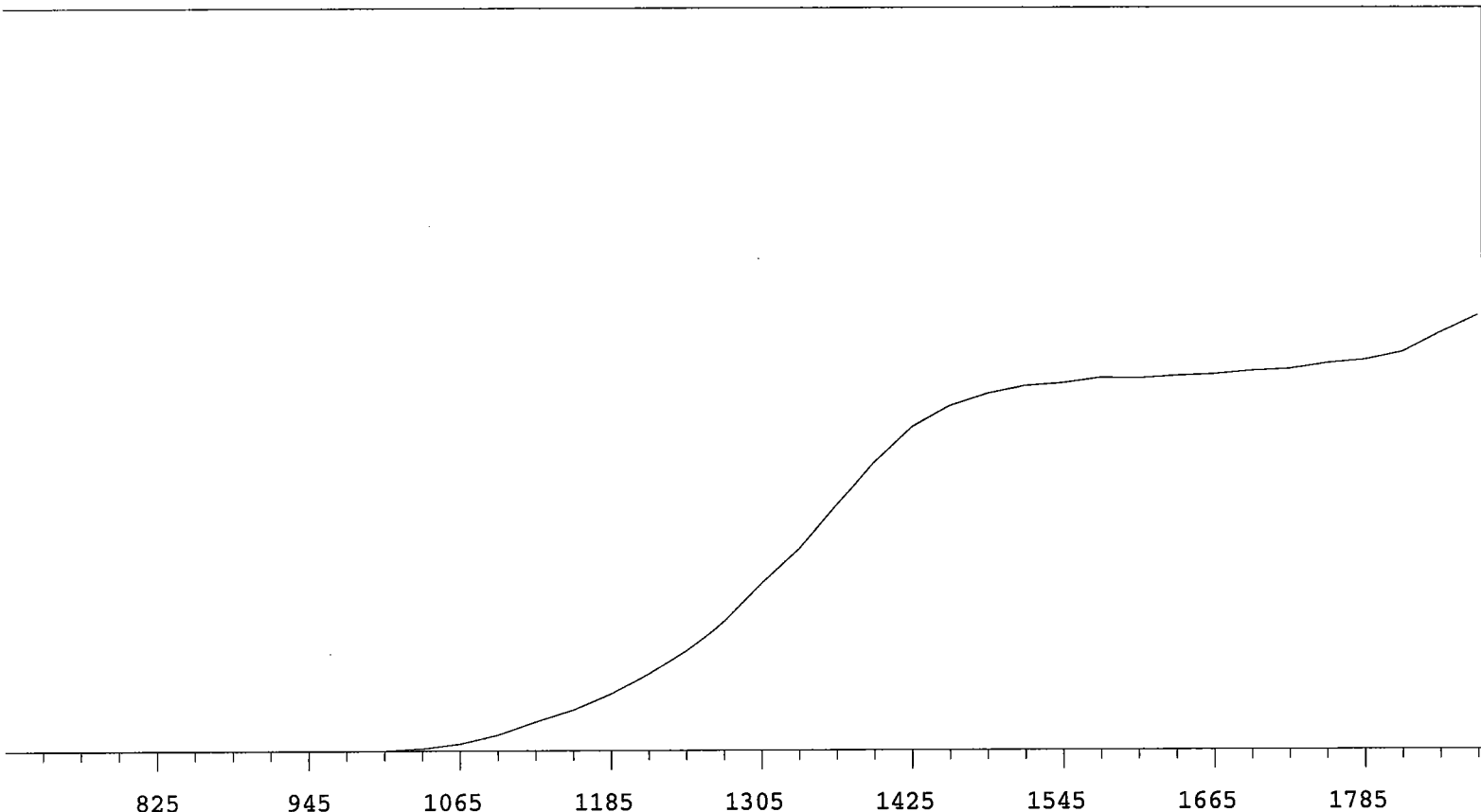
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	11640	+69.78
735	1		1335	14241	+62.88
765	0		1365	17534	+55.91
795	0	+0.00	1395	20127	+45.04
825	0	>100	1425	23254	+31.29
855	1	>100	1455	24902	+20.41
885	0	+55.56	1485	25605	+10.49
915	2	+66.67	1515	26310	+6.44
945	0	>100	1545	26535	+5.31
975	2	>100	1575	26953	+2.79
1005	42	>100	1605	27399	+1.83
1035	145	>100	1635	27000	+1.71
1065	544	>100	1665	27255	+1.62
1095	1136	>100	1695	27723	+3.14
1125	1967	>100	1725	27705	+1.56
1155	2845	>100	1755	28072	+1.15
1185	4078	>100	1785	27729	+1.43
1215	5483	+93.18	1815	28194	+3.24
1245	7400	+83.35	1845	28243	
1275	9328	+75.40	1875	29191	

Alpha Volts: 1575 Beta Volts: 1575

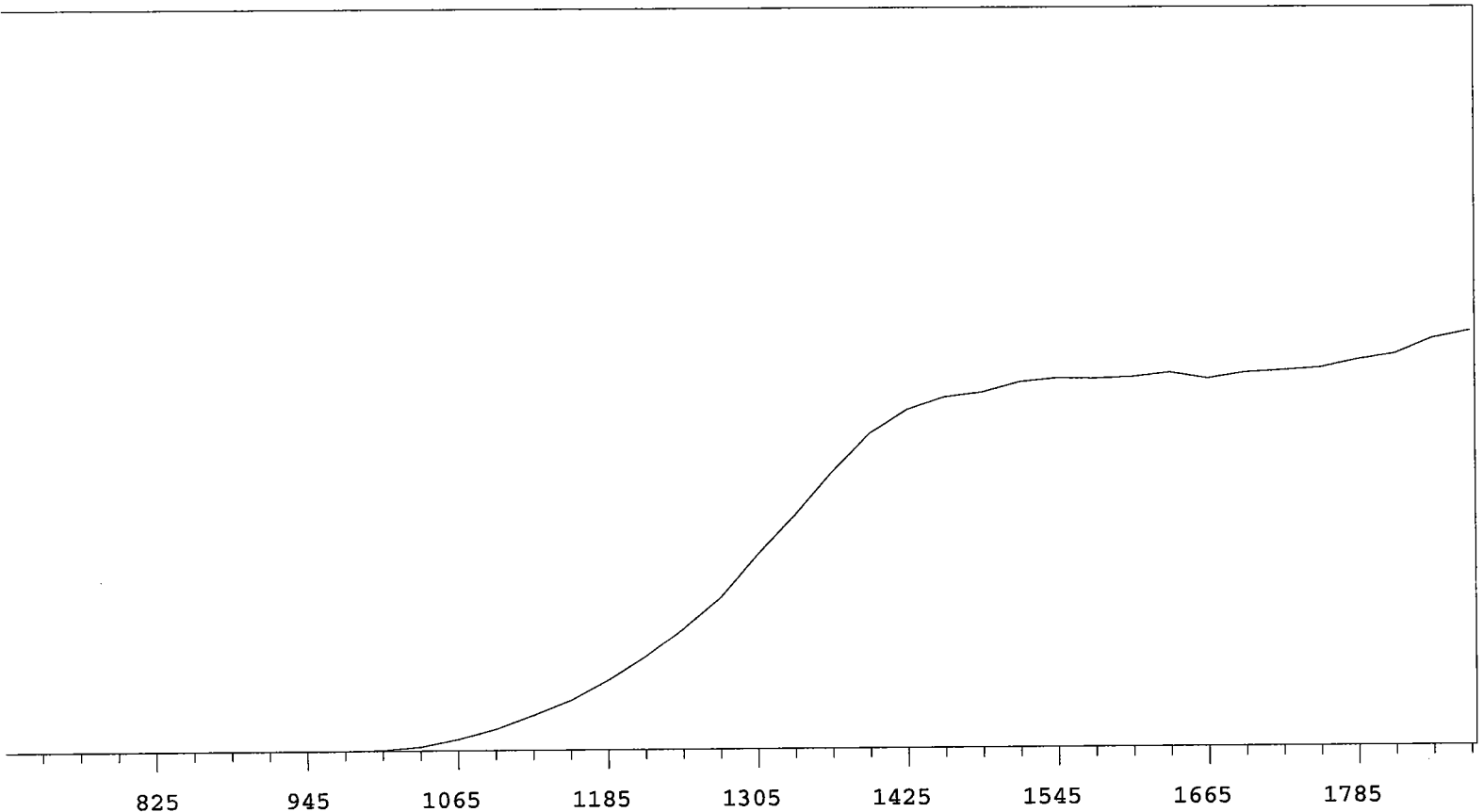


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	13188	+75.92
735	0		1335	16818	+67.60
765	0	+55.56	1365	20420	+59.86
795	1	+83.33	1395	24341	+47.85
825	1	+55.56	1425	27854	+35.51
855	0	>100	1455	30288	+23.26
885	1	+0.00	1485	31798	+14.54
915	0	+0.00	1515	32622	+8.32
945	1	>100	1545	33496	+5.11
975	0	>100	1575	33475	+4.43
1005	4	>100	1605	33903	+3.09
1035	56	>100	1635	34654	+2.46
1065	292	>100	1665	34485	+1.74
1095	890	>100	1695	34445	+1.84
1125	1841	>100	1725	34908	+3.91
1155	2936	>100	1755	35401	+6.80
1185	4179	>100	1785	36062	+10.27
1215	5837	>100	1815	37505	+14.30
1245	7821	+91.28	1845	39508	
1275	10638	+83.88	1875	41843	

Alpha Volts: 1575 Beta Volts: 1575



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	14817	+71.06
735	0		1335	17823	+63.34
765	1	+0.00	1365	21704	+53.63
795	0	>100	1395	25422	+42.55
825	1	-55.56	1425	28424	+29.21
855	1	+55.56	1455	30244	+18.11
885	0	>100	1485	31305	+10.10
915	1	>100	1515	31989	+6.07
945	0	>100	1545	32223	+3.43
975	4	>100	1575	32671	+2.15
1005	32	>100	1605	32621	+1.68
1035	206	>100	1635	32837	+1.52
1065	639	>100	1665	32961	+2.01
1095	1416	>100	1695	33249	+2.64
1125	2551	>100	1725	33409	+3.21
1155	3619	>100	1755	33931	+4.07
1185	5037	+98.68	1785	34234	+7.20
1215	6875	+91.19	1815	34909	+10.28
1245	8915	+85.53	1845	36660	
1275	11519	+77.28	1875	38205	

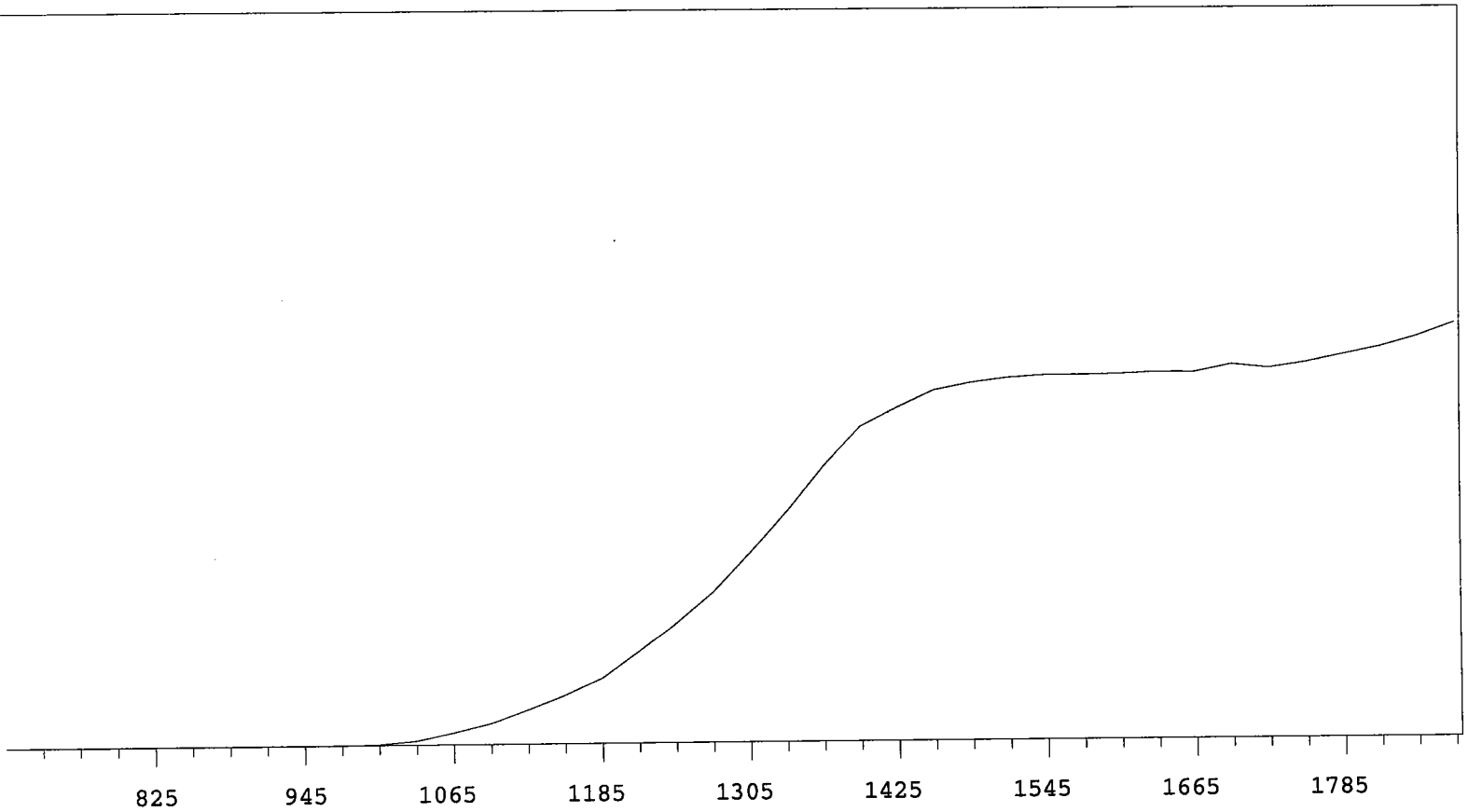


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	15202	+66.36
735	1		1335	18216	+57.86
765	0	+0.00	1365	21597	+45.58
795	1	+0.00	1395	24648	+32.96
825	0	+0.00	1425	26505	+19.92
855	1	>100	1455	27475	+11.42
885	0	>100	1485	27836	+7.08
915	0	>100	1515	28609	+4.51
945	0	>100	1545	28896	+2.93
975	8	>100	1575	28862	+1.66
1005	75	>100	1605	28969	+0.36
1035	303	>100	1635	29292	+0.80
1065	872	>100	1665	28836	+1.06
1095	1656	>100	1695	29279	+1.48
1125	2729	>100	1725	29439	+3.59
1155	3862	>100	1755	29642	+4.07
1185	5425	+98.19	1785	30243	+6.51
1215	7256	+88.82	1815	30699	+7.79
1245	9510	+81.89	1845	31876	
1275	11944	+74.07	1875	32444	

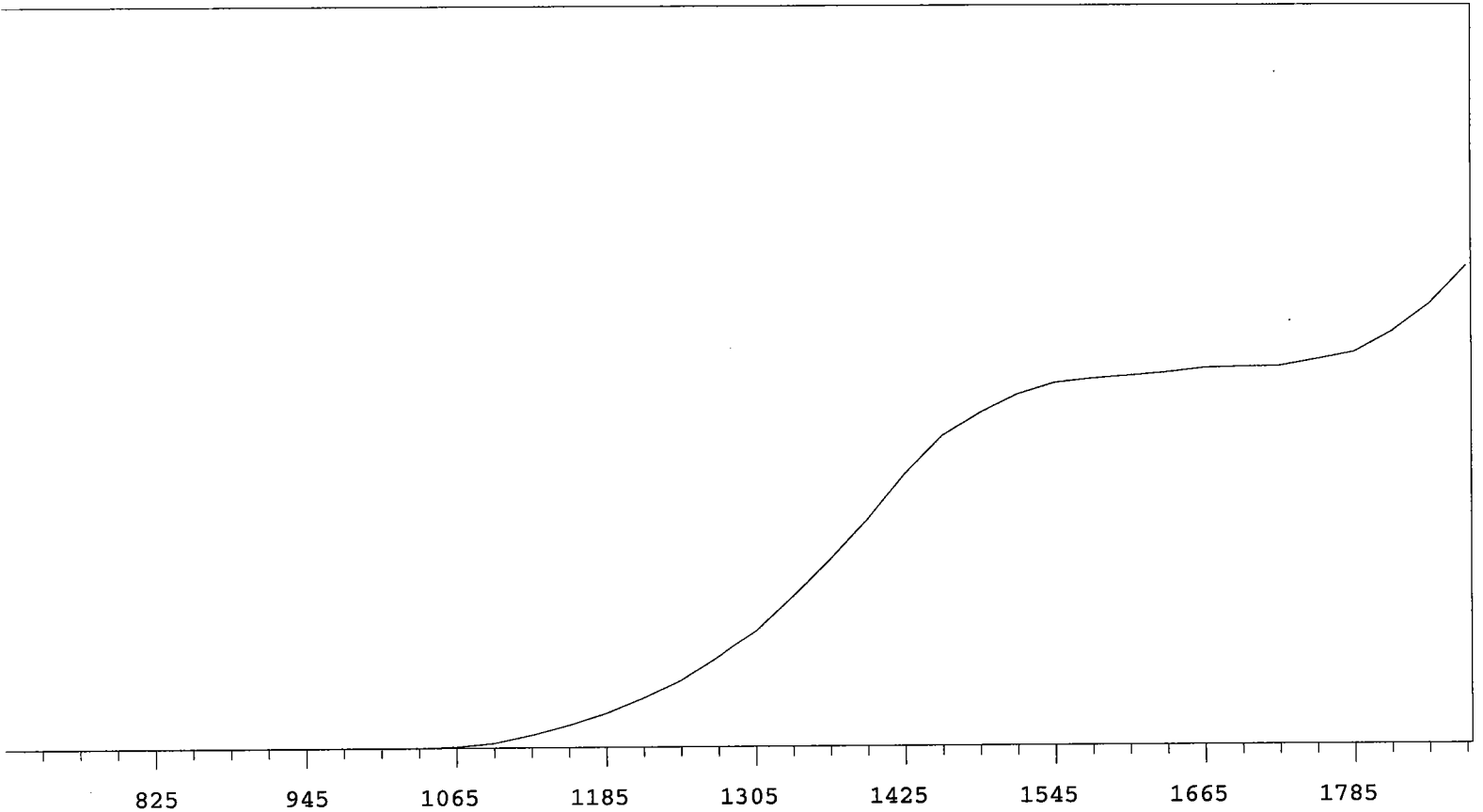
MPC 9600 Plateau  
Alpha Volts: 705

Instrument 2 MPC 9604 Detector A  
Beta Volts: 1575

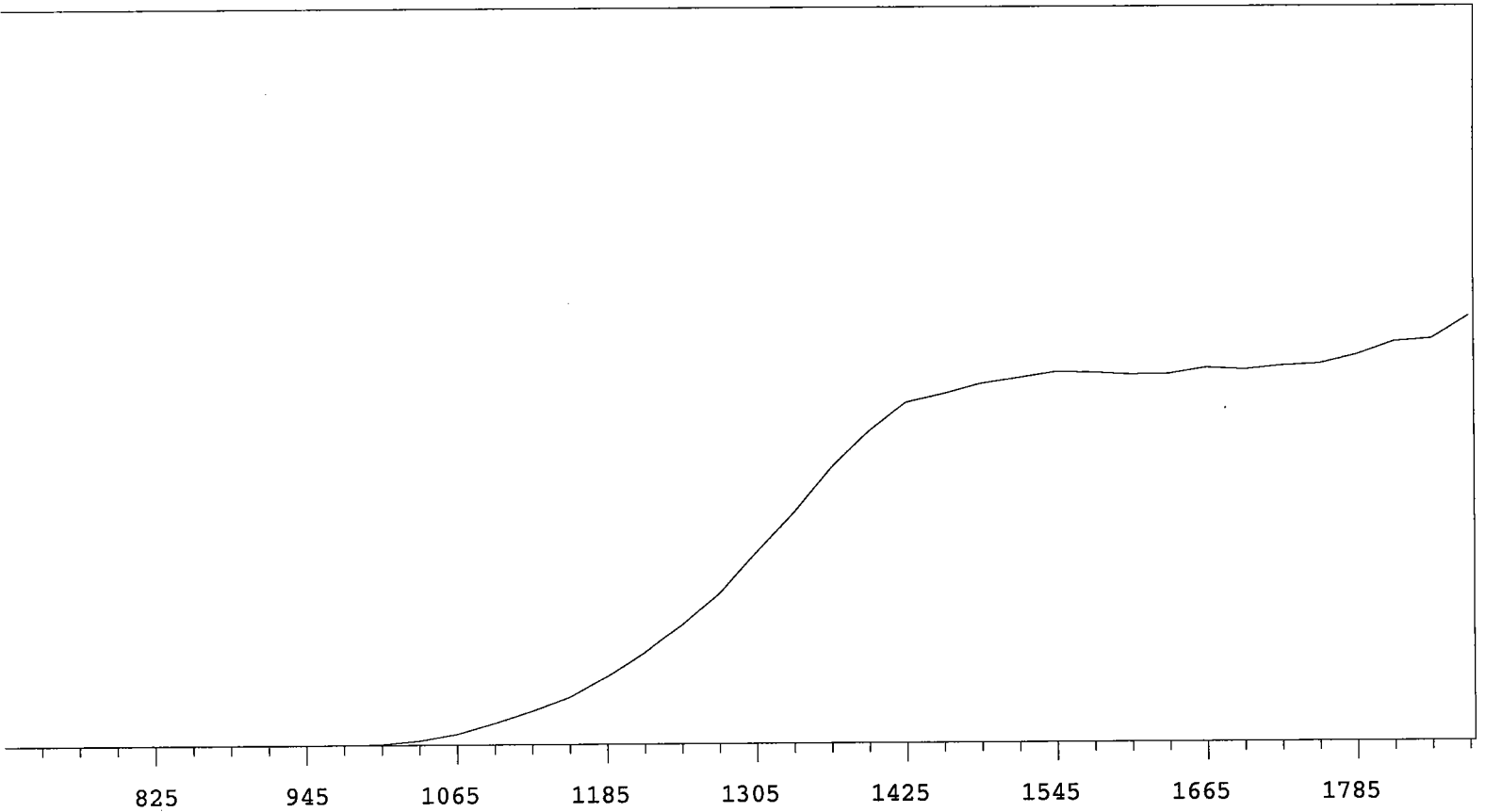
7/1/2009



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	19017	+67.45
735	1		1335	23157	+59.23
765	0	+83.33	1365	27625	+45.78
795	0	-83.33	1395	31465	+32.72
825	1	>100	1425	33352	+20.41
855	0	>100	1455	35084	+11.74
885	1	+100.00	1485	35819	+7.11
915	1	>100	1515	36292	+3.35
945	2	>100	1545	36527	+1.63
975	12	>100	1575	36540	+0.87
1005	91	>100	1605	36585	+0.48
1035	421	>100	1635	36742	+1.76
1065	1239	>100	1665	36691	+1.53
1095	2155	>100	1695	37461	+1.89
1125	3527	>100	1725	37073	+3.07
1155	4974	>100	1755	37603	+4.02
1185	6647	+97.44	1785	38346	+6.58
1215	9250	+89.00	1815	39111	+7.95
1245	12041	+82.15	1845	40115	
1275	15094	+73.81	1875	41409	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	12541	+83.18
735	1		1335	16192	+74.48
765	0		1365	20083	+67.17
795	0	>100	1395	24273	+58.43
825	0	>100	1425	29090	+46.86
855	0	>100	1455	33223	+34.56
885	0	>100	1485	35608	+22.67
915	0	>100	1515	37581	+13.63
945	1	>100	1545	38762	+8.18
975	2	>100	1575	39185	+4.42
1005	3	>100	1605	39484	+3.06
1035	14	>100	1635	39806	+2.61
1065	127	>100	1665	40264	+2.03
1095	500	>100	1695	40353	+2.32
1125	1332	>100	1725	40431	+3.28
1155	2373	>100	1755	41127	+7.09
1185	3614	>100	1785	41882	+12.40
1215	5227	>100	1815	44049	+18.52
1245	7060	+97.33	1845	46950	
1275	9574	+90.30	1875	51097	

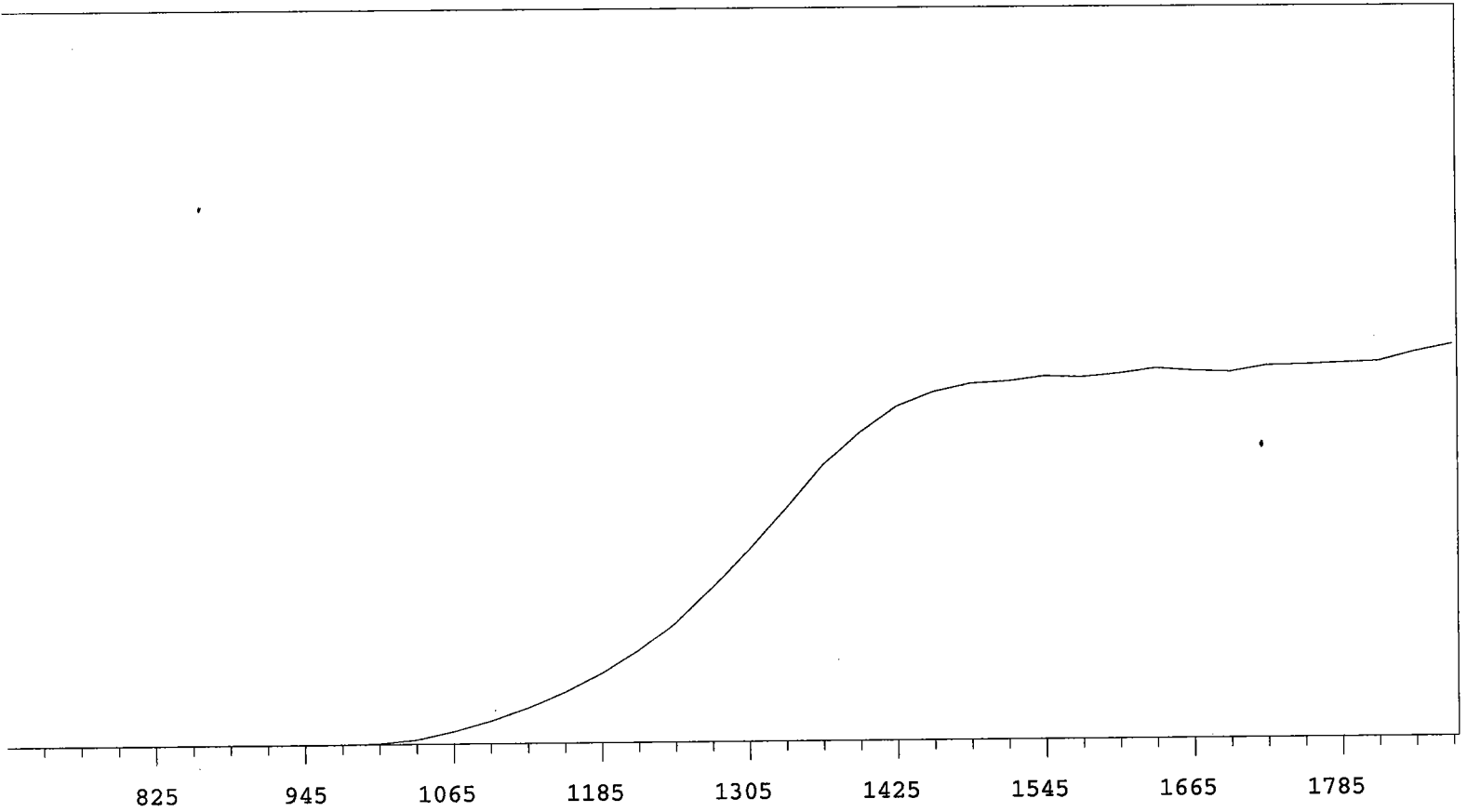


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18216	+67.74
735	0		1335	21995	+58.11
765	0		1365	26173	+46.11
795	0	>100	1395	29479	+32.75
825	0	>100	1425	32186	+20.62
855	0	>100	1455	33022	+12.13
885	0	>100	1485	33981	+7.22
915	1	>100	1515	34520	+4.95
945	0	>100	1545	35095	+2.07
975	17	>100	1575	35014	+0.38
1005	87	>100	1605	34812	+0.55
1035	438	>100	1635	34859	+1.11
1065	1055	>100	1665	35460	+1.94
1095	2114	>100	1695	35273	+1.95
1125	3282	>100	1725	35629	+2.73
1155	4625	>100	1755	35811	+5.77
1185	6554	+97.66	1785	36656	+6.44
1215	8743	+88.09	1815	37896	+9.21
1245	11345	+81.31	1845	38145	
1275	14261	+74.60	1875	40283	

MPC 9600 Plateau  
Alpha Volts: 705

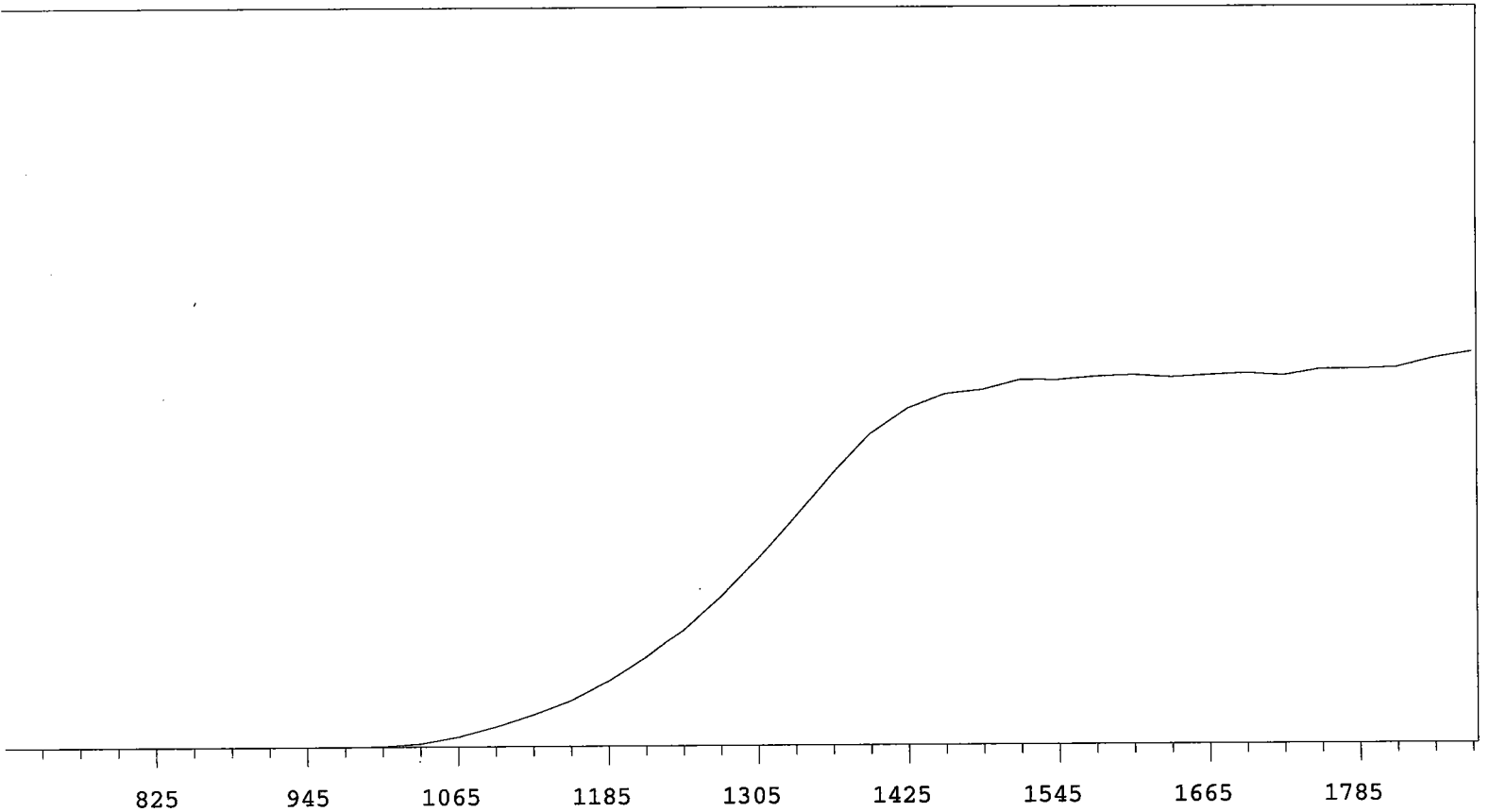
Instrument 2 MPC 9604 Detector D  
Beta Volts: 1575

7/1/2009

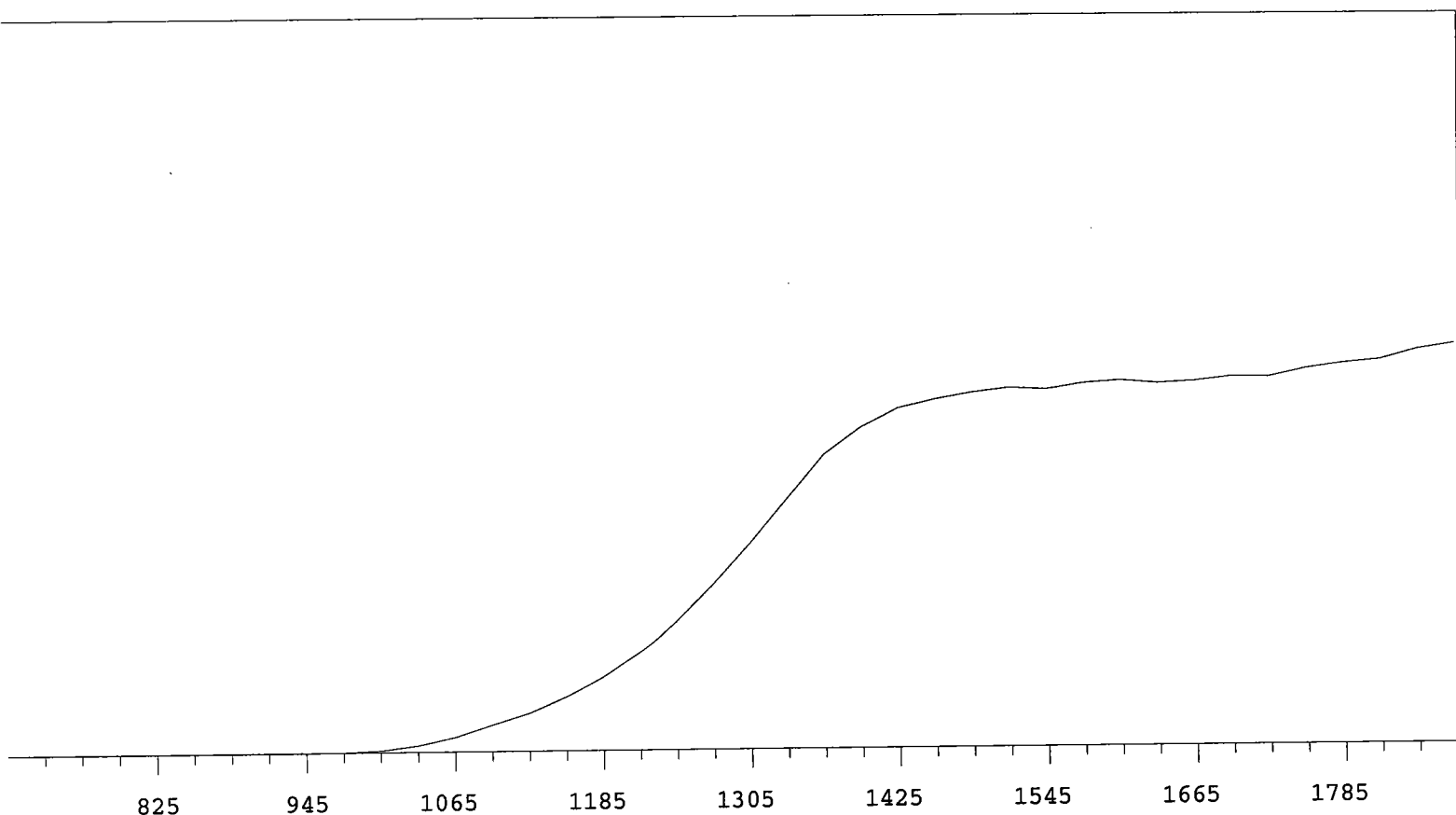


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18675	+65.94
735	0		1335	22620	+55.69
765	0	+83.33	1365	26869	+44.63
795	2	+55.56	1395	29957	+32.08
825	1	>100	1425	32494	+20.49
855	0	>100	1455	33836	+11.98
885	0	>100	1485	34627	+6.45
915	0	>100	1515	34849	+3.22
945	2	>100	1545	35298	+1.98
975	9	>100	1575	35180	+2.37
1005	89	>100	1605	35503	+1.57
1035	439	>100	1635	36006	+0.99
1065	1198	>100	1665	35722	+0.89
1095	2164	>100	1695	35597	+0.93
1125	3436	>100	1725	36188	+1.86
1155	4917	>100	1755	36272	+1.90
1185	6762	+96.59	1785	36389	+2.55
1215	9006	+89.14	1815	36529	+4.39
1245	11800	+81.34	1845	37459	
1275	15132	+73.59	1875	38170	

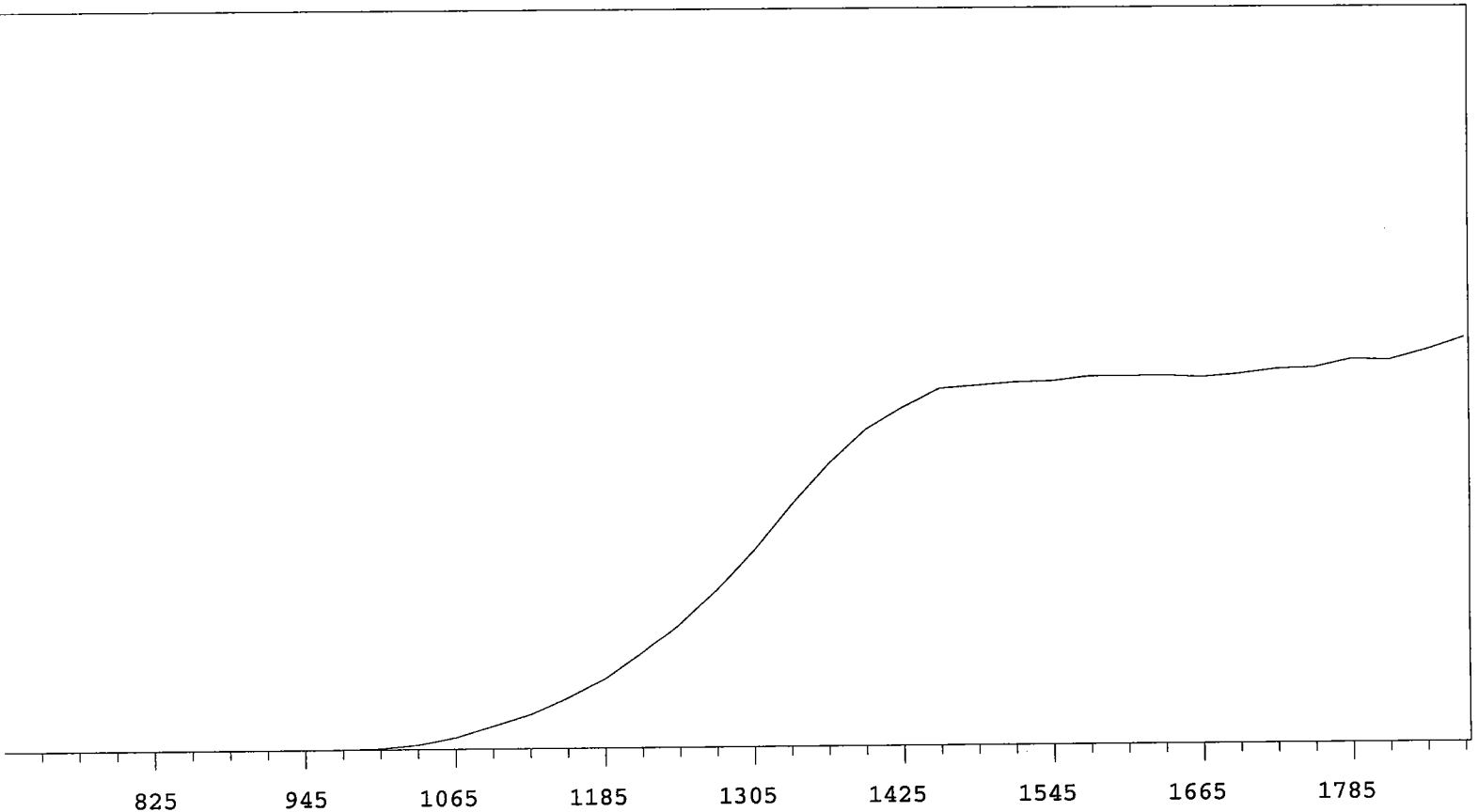




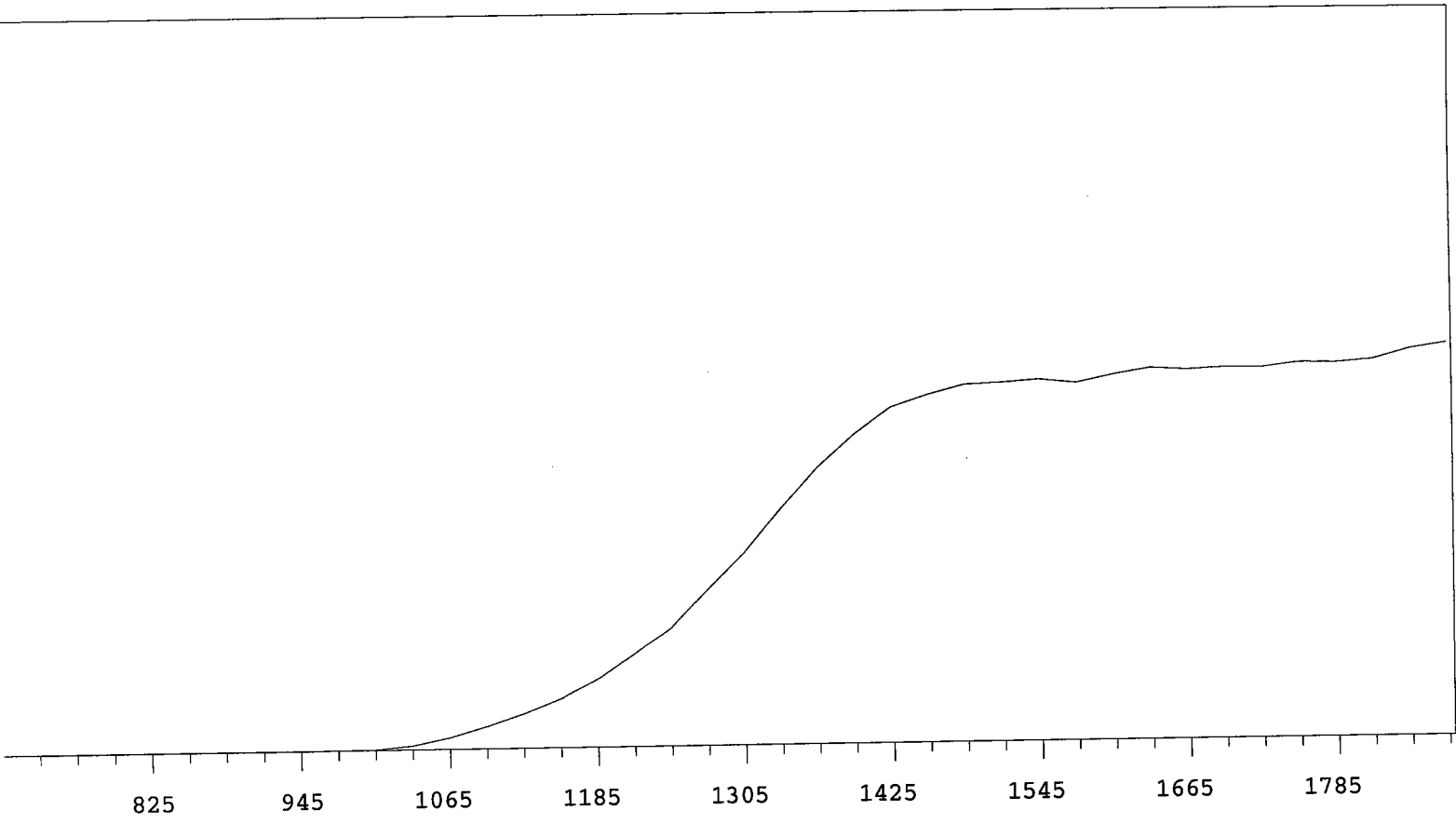
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	16654	+68.57
735	0		1335	20416	+59.26
765	0	+55.56	1365	24191	+47.28
795	1	>100	1395	27643	+34.04
825	1	+0.00	1425	29891	+21.08
855	1	>100	1455	31183	+12.30
885	0	>100	1485	31558	+6.67
915	0	>100	1515	32444	+4.05
945	0	>100	1545	32413	+2.90
975	9	>100	1575	32704	+0.81
1005	53	>100	1605	32837	+0.71
1035	302	>100	1635	32629	+0.49
1065	878	>100	1665	32797	+0.16
1095	1805	>100	1695	32964	+1.32
1125	2887	>100	1725	32746	+1.40
1155	4163	>100	1755	33308	+1.56
1185	5842	+99.81	1785	33318	+3.21
1215	7959	+90.90	1815	33456	+3.92
1245	10323	+83.03	1845	34283	
1275	13250	+75.91	1875	34815	



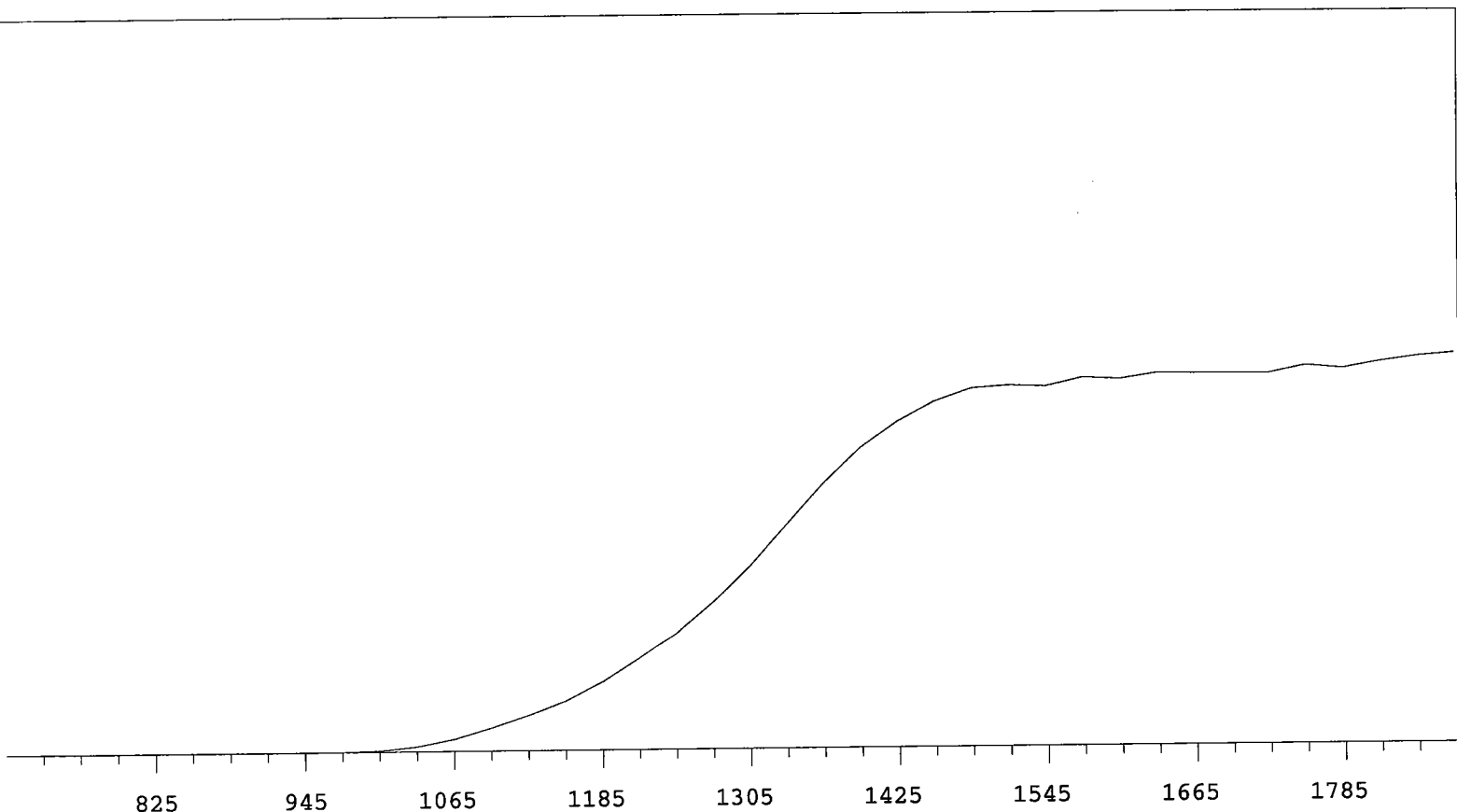
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	19810	+64.73
735	1		1335	23962	+52.62
765	0	-55.56	1365	28091	+39.27
795	0	>100	1395	30594	+25.61
825	1	>100	1425	32381	+14.86
855	3	+33.33	1455	33206	+8.91
885	0	+0.00	1485	33832	+4.41
915	1	>100	1515	34260	+3.01
945	2	>100	1545	34071	+2.33
975	29	>100	1575	34623	+1.34
1005	165	>100	1605	34848	+1.22
1035	613	>100	1635	34564	+0.89
1065	1394	>100	1665	34733	+1.01
1095	2558	>100	1695	35144	+2.76
1125	3702	>100	1725	35084	+3.66
1155	5222	>100	1755	35839	+3.97
1185	7161	+96.06	1785	36332	+5.39
1215	9507	+89.18	1815	36654	+5.35
1245	12552	+81.52	1845	37609	
1275	16030	+73.64	1875	38164	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	21412	+66.80
735	1		1335	26262	+56.32
765	1		1365	30679	+43.71
795	0	>100	1395	34466	+31.61
825	0	+0.00	1425	36949	+20.14
855	0	>100	1455	38998	+11.16
885	1	>100	1485	39313	+5.34
915	1	>100	1515	39625	+2.44
945	1	>100	1545	39751	+2.04
975	17	>100	1575	40227	+1.45
1005	122	>100	1605	40228	+0.56
1035	533	>100	1635	40255	+0.13
1065	1287	>100	1665	40075	+1.22
1095	2493	>100	1695	40384	+1.95
1125	3753	>100	1725	40900	+3.50
1155	5482	>100	1755	41028	+3.05
1185	7538	+99.39	1785	41899	+3.71
1215	10305	+90.31	1815	41767	+5.64
1245	13415	+82.57	1845	42852	
1275	17141	+75.13	1875	44132	



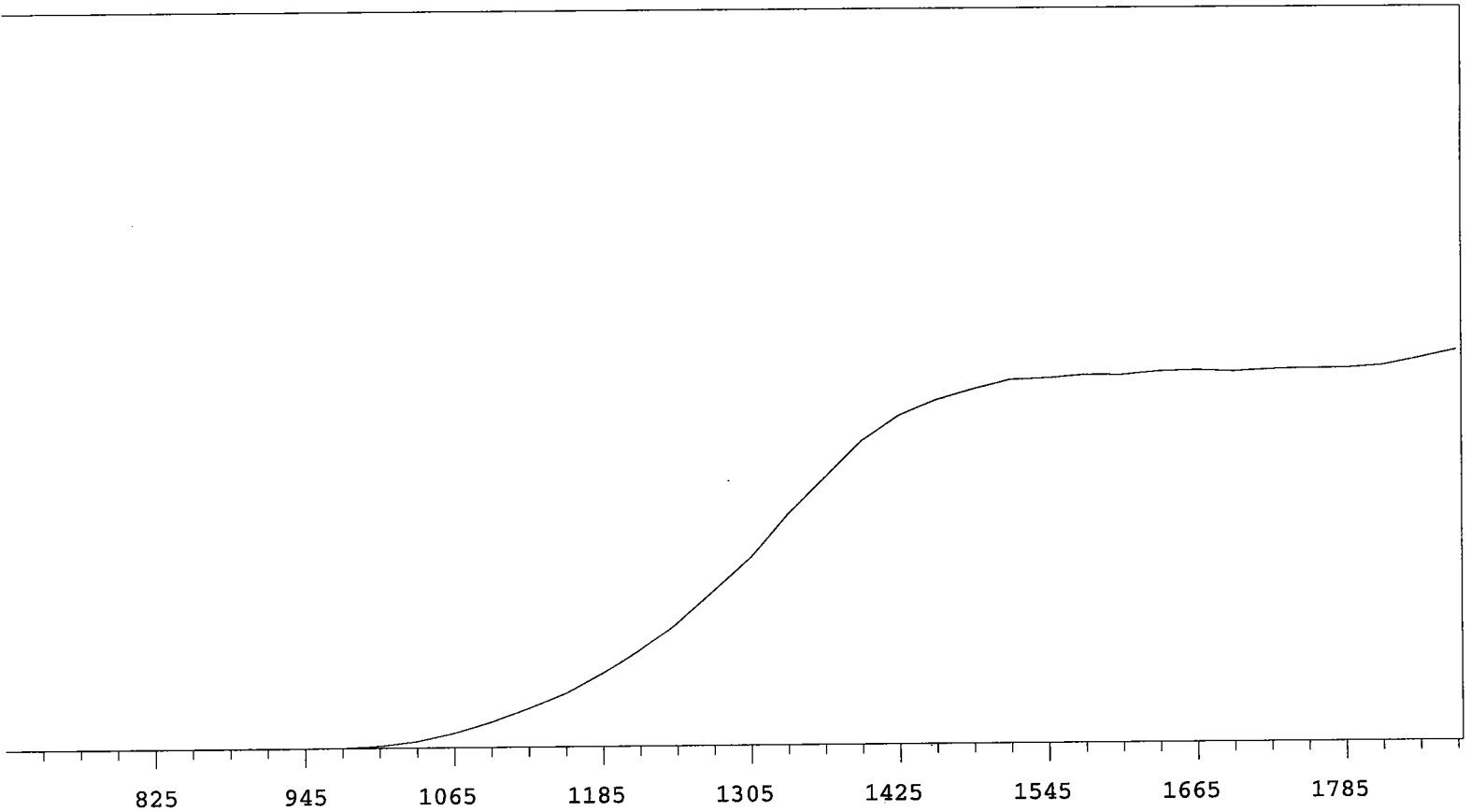
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	14171	+66.45
735	1		1335	17362	+54.90
765	0	+0.00	1365	20310	+43.83
795	1	>100	1395	22647	+30.82
825	0	+83.33	1425	24551	+20.19
855	0	-83.33	1455	25440	+11.69
885	1	>100	1485	26124	+5.90
915	0	>100	1515	26245	+2.21
945	1	>100	1545	26428	+1.39
975	12	>100	1575	26151	+2.69
1005	51	>100	1605	26721	+2.72
1035	298	>100	1635	27168	+2.80
1065	848	>100	1665	27007	+0.87
1095	1649	>100	1695	27135	+0.70
1125	2535	>100	1725	27089	+1.24
1155	3602	>100	1755	27414	+1.43
1185	5036	+98.31	1785	27373	+3.21
1215	6880	+91.37	1815	27581	+4.34
1245	8822	+82.29	1845	28332	
1275	11546	+74.61	1875	28750	



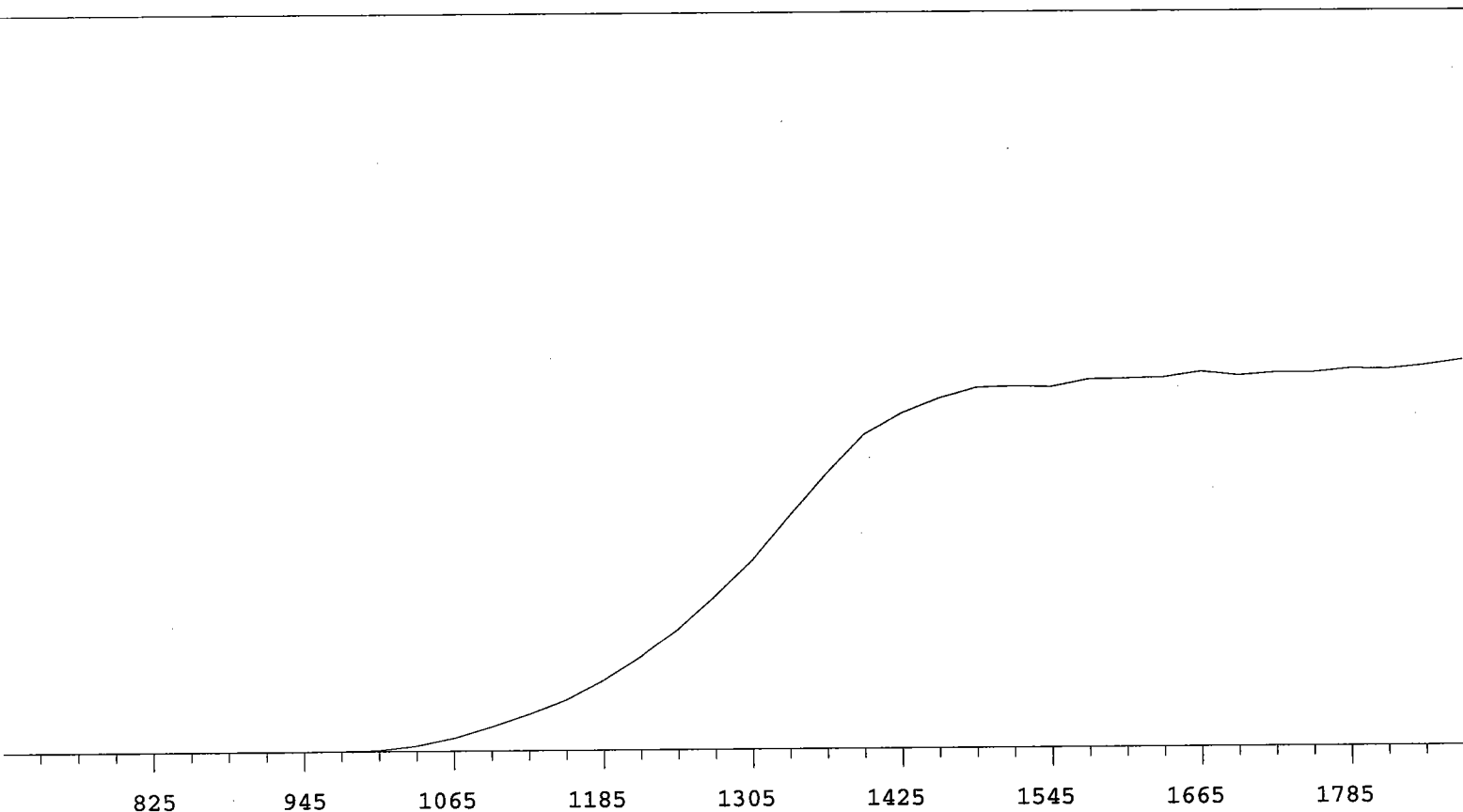
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16442	+66.24
735	0		1335	20146	+57.40
765	0		1365	23769	+46.40
795	0	>100	1395	26926	+34.68
825	2	+55.56	1425	29276	+24.40
855	1	>100	1455	31037	+15.28
885	0	-55.56	1485	32197	+7.91
915	3	>100	1515	32425	+4.33
945	0	>100	1545	32314	+2.14
975	16	>100	1575	33071	+2.66
1005	114	>100	1605	32918	+2.52
1035	451	>100	1635	33435	+1.02
1065	1100	>100	1665	33382	+0.73
1095	2068	>100	1695	33349	+1.07
1125	3189	>100	1725	33324	+1.28
1155	4386	>100	1755	34001	+2.26
1185	6094	+94.81	1785	33701	+3.08
1215	8184	+87.09	1815	34304	+2.97
1245	10489	+78.88	1845	34744	
1275	13273	+72.66	1875	35012	

MPC 9600 Plateau  
Alpha Volts: 705

Instrument 4 MPC 9604 Detector B 7/1/2009  
Beta Volts: 1575



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	15747	+62.38
735	1		1335	19230	+54.19
765	0	+0.00	1365	22255	+44.46
795	1	>100	1395	25299	+32.45
825	0	>100	1425	27370	+22.24
855	0	>100	1455	28625	+14.10
885	0	>100	1485	29467	+8.56
915	0	>100	1515	30213	+5.29
945	2	>100	1545	30326	+2.77
975	31	>100	1575	30564	+1.57
1005	176	>100	1605	30548	+1.52
1035	550	>100	1635	30820	+0.85
1065	1218	>100	1665	30898	+0.79
1095	2114	>100	1695	30779	+0.44
1125	3212	>100	1725	30934	+0.45
1155	4416	>100	1755	31008	+0.96
1185	6066	+92.28	1785	30991	+2.01
1215	7936	+85.60	1815	31196	+3.80
1245	10288	+76.79	1845	31781	
1275	13020	+70.59	1875	32406	

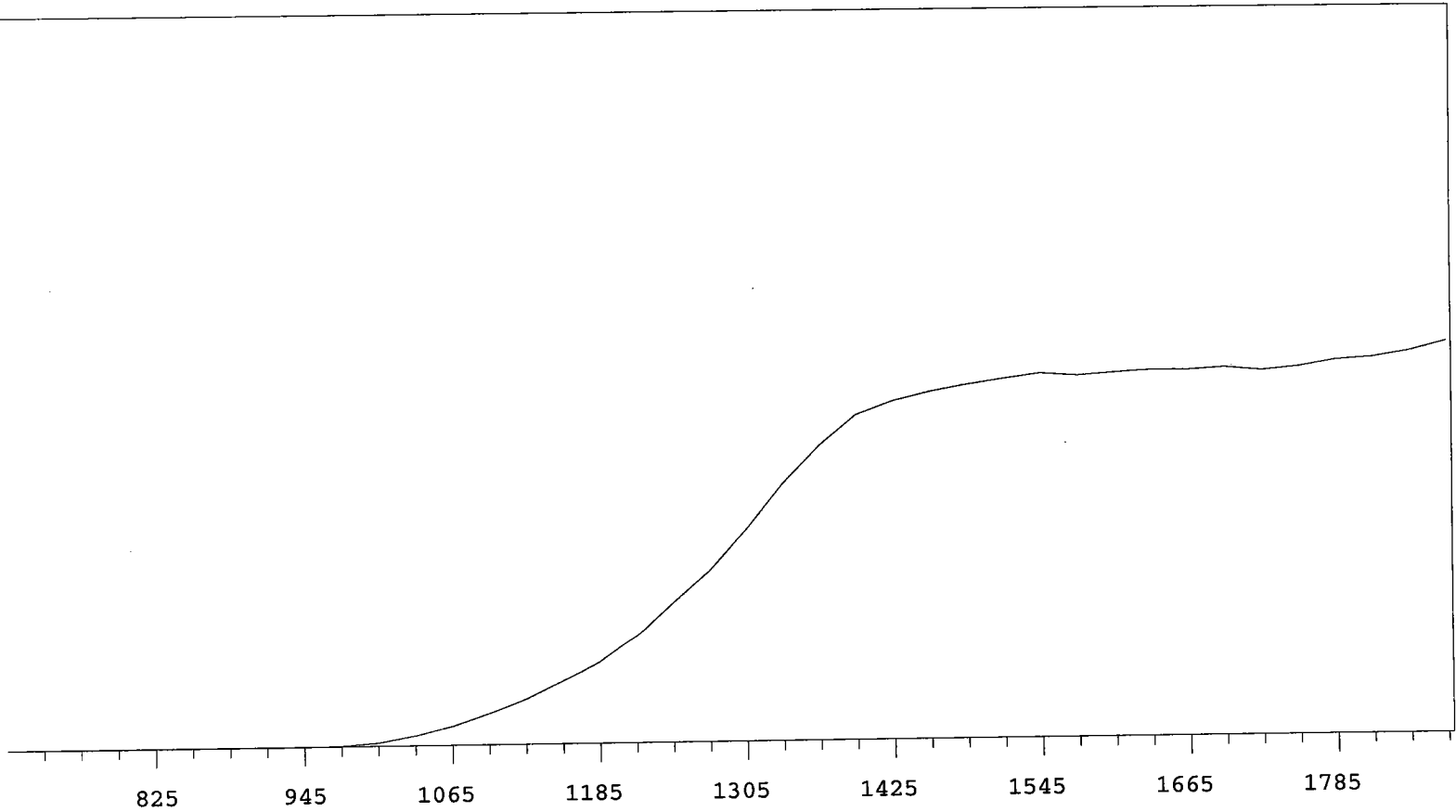


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	19796	+65.77
735	1		1335	24338	+57.55
765	0	+55.56	1365	28686	+45.86
795	2	+0.00	1395	32750	+32.27
825	0	-55.56	1425	34919	+20.83
855	1	>100	1455	36434	+11.45
885	0	>100	1485	37487	+5.80
915	0	>100	1515	37623	+3.32
945	2	>100	1545	37528	+2.07
975	24	>100	1575	38277	+2.12
1005	134	>100	1605	38338	+2.70
1035	558	>100	1635	38426	+1.12
1065	1361	>100	1665	39007	+1.06
1095	2511	>100	1695	38592	+0.64
1125	3762	>100	1725	38870	+0.63
1155	5246	>100	1755	38868	+1.30
1185	7268	+96.29	1785	39238	+1.45
1215	9733	+88.98	1815	39169	+2.34
1245	12701	+79.94	1845	39570	
1275	16176	+73.13	1875	40086	

MPC 9600 Plateau  
Alpha Volts: 705

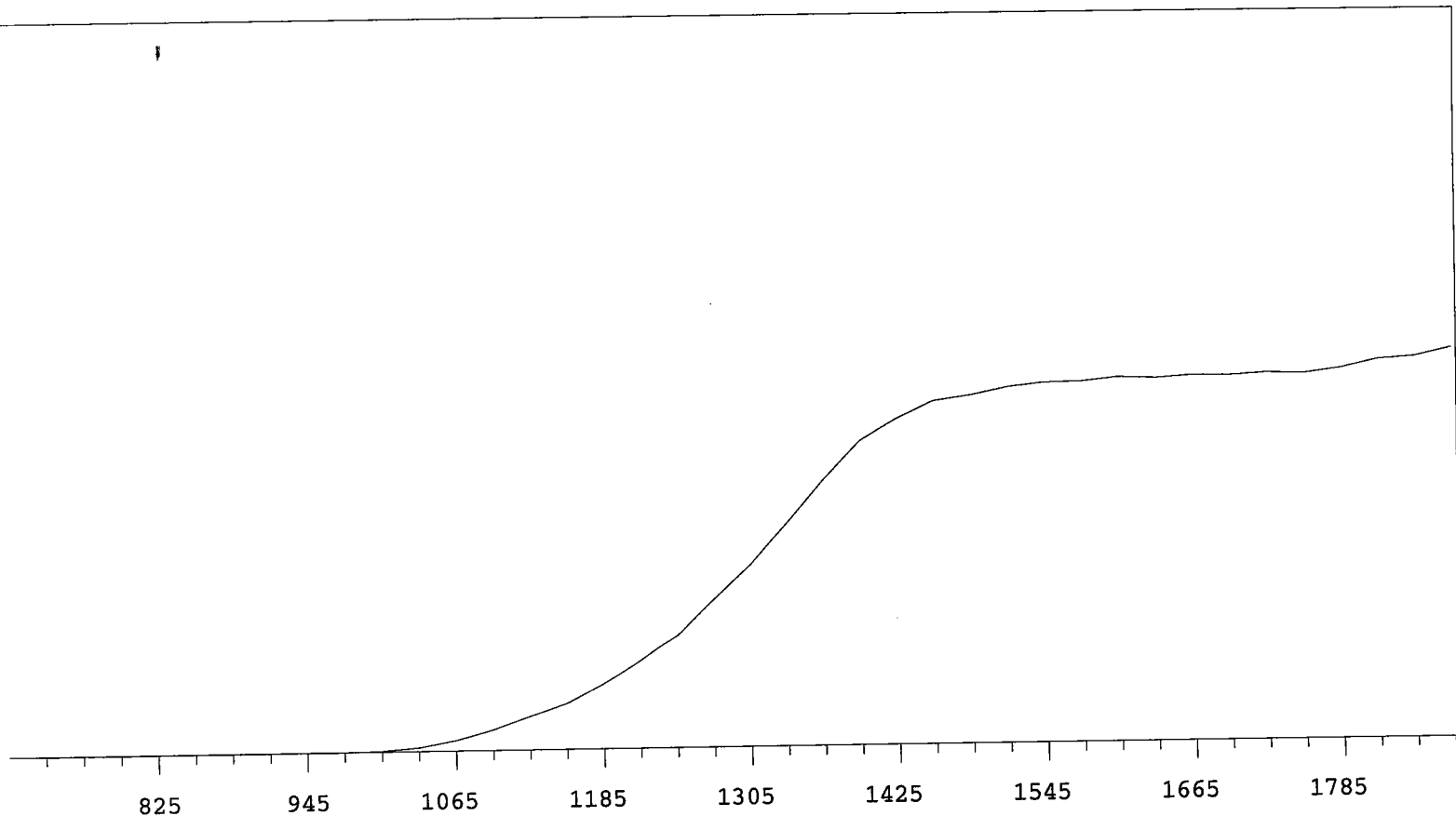
Instrument 4 MPC 9604 Detector D  
Beta Volts: 1575

7/1/2009



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18491	+61.09
735	0		1335	22444	+51.56
765	0	+0.00	1365	25756	+37.44
795	0	>100	1395	28379	+23.82
825	1	+83.33	1425	29517	+14.00
855	1	+55.56	1455	30309	+8.08
885	0	+0.00	1485	30874	+6.03
915	1	>100	1515	31345	+3.66
945	1	>100	1545	31782	+2.17
975	60	>100	1575	31567	+1.31
1005	297	>100	1605	31789	+0.78
1035	855	>100	1635	31963	+1.34
1065	1647	>100	1665	31956	+0.29
1095	2700	>100	1695	32123	+0.20
1125	3921	>100	1725	31850	+1.46
1155	5471	+96.54	1755	32114	+2.39
1185	7042	+90.21	1785	32665	+3.95
1215	9405	+82.23	1815	32876	+4.96
1245	12266	+76.33	1845	33399	
1275	14989	+69.38	1875	34206	



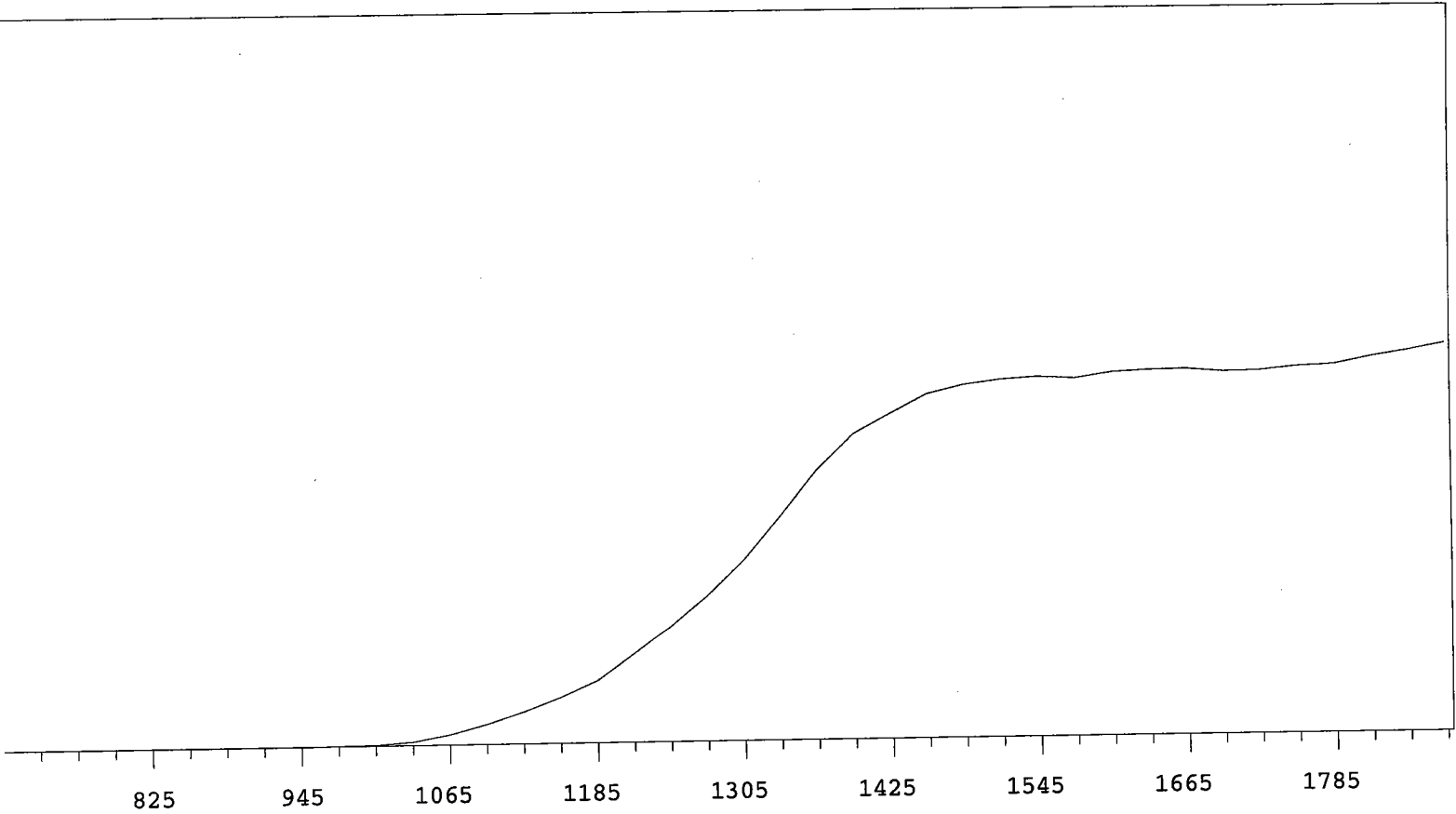


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	13974	+68.00
735	0		1335	17170	+58.62
765	1		1365	20456	+47.04
795	1	+83.33	1395	23332	+33.83
825	1	-83.33	1425	24996	+21.10
855	1	>100	1455	26290	+12.40
885	0	-55.56	1485	26683	+7.74
915	0	>100	1515	27270	+4.43
945	1	>100	1545	27590	+3.48
975	9	>100	1575	27635	+1.71
1005	76	>100	1605	27932	+1.20
1035	308	>100	1635	27807	+0.88
1065	814	>100	1665	28006	+0.62
1095	1600	>100	1695	27964	+0.63
1125	2598	>100	1725	28112	+0.98
1155	3596	>100	1755	28020	+2.84
1185	5065	+96.05	1785	28392	+3.76
1215	6773	+90.23	1815	29028	+5.17
1245	8717	+81.43	1845	29220	
1275	11391	+74.83	1875	29849	

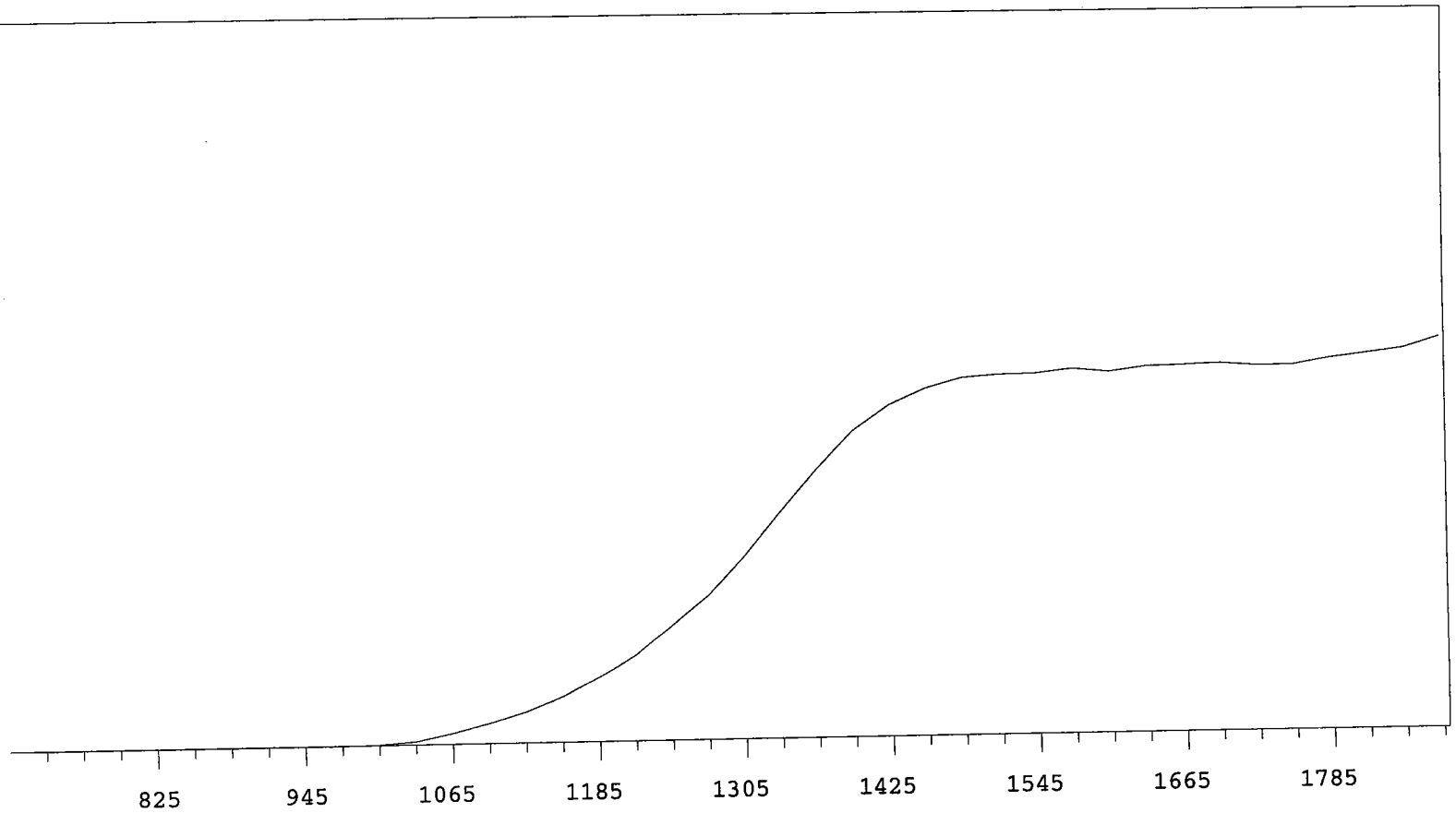
MPC 9600 Plateau  
 Alpha Volts: 705

Instrument 5 MPC 9604 Detector B  
 Beta Volts: 1575

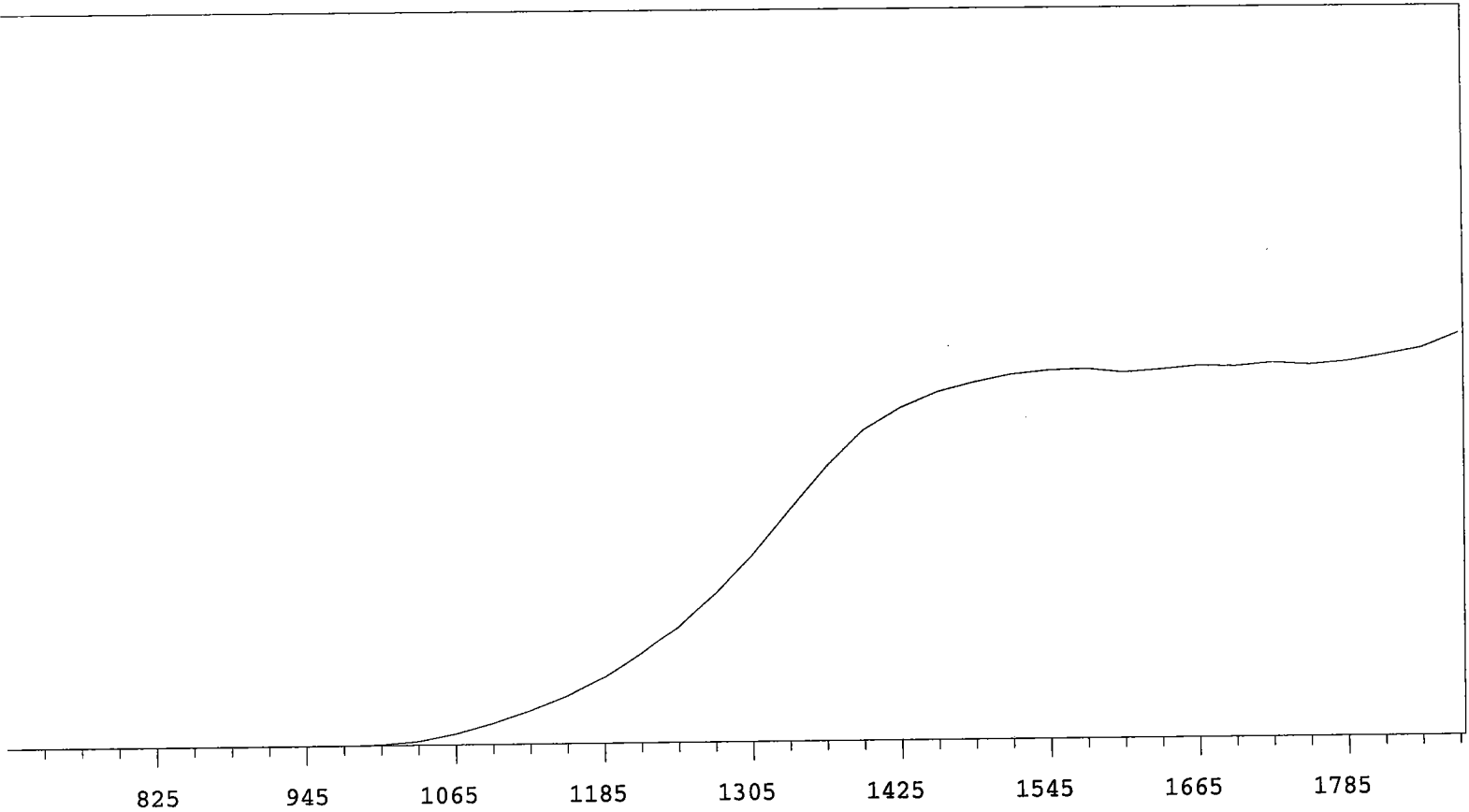
7/1/2009



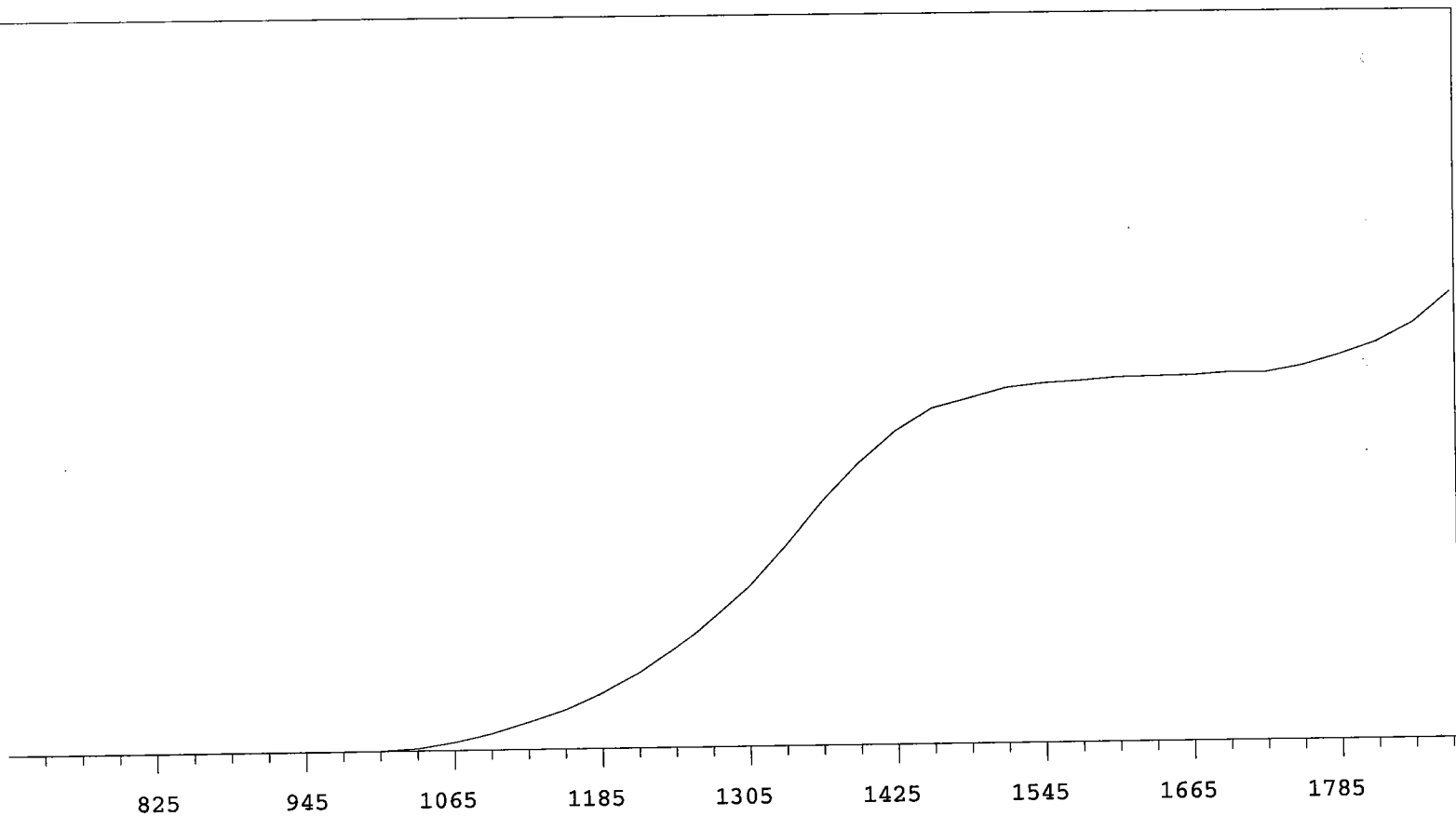
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17414	+68.46
735	0		1335	21540	+59.98
765	0		1365	25854	+46.75
795	0	>100	1395	29222	+33.38
825	1	>100	1425	31128	+21.52
855	1	+41.67	1455	32995	+13.26
885	2	-33.33	1485	33846	+8.09
915	0	>100	1515	34289	+3.25
945	1	>100	1545	34528	+2.00
975	17	>100	1575	34311	+1.78
1005	87	>100	1605	34866	+1.78
1035	336	>100	1635	35046	+1.14
1065	1010	>100	1665	35087	-0.26
1095	1955	>100	1695	34795	+0.11
1125	3124	>100	1725	34857	+0.93
1155	4486	>100	1755	35220	+2.81
1185	6017	>100	1785	35363	+3.98
1215	8507	+91.20	1815	36028	+4.79
1245	11148	+82.59	1845	36577	
1275	14003	+74.21	1875	37207	



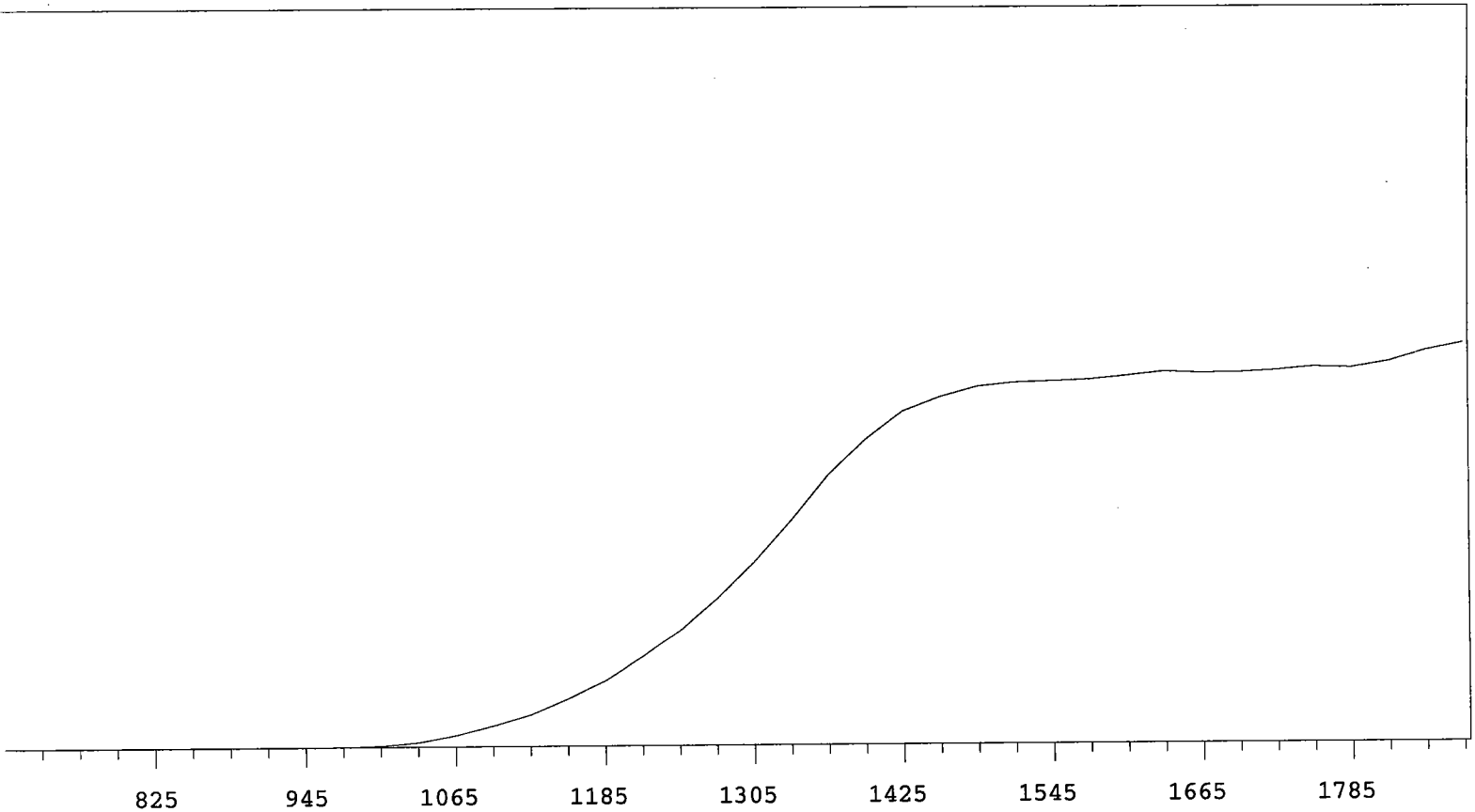
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17085	+68.24
735	0		1335	21135	+59.99
765	0		1365	25066	+47.39
795	0	>100	1395	28530	+33.93
825	0	>100	1425	30823	+22.30
855	1	>100	1455	32287	+12.93
885	0	>100	1485	33217	+6.71
915	1	>100	1515	33474	+3.57
945	2	>100	1545	33517	+1.17
975	7	>100	1575	33921	+1.13
1005	56	>100	1605	33584	+1.27
1035	305	>100	1635	34014	+1.12
1065	982	>100	1665	34116	+0.98
1095	1874	>100	1695	34225	-0.22
1125	2890	>100	1725	33980	+0.58
1155	4260	>100	1755	33971	+1.96
1185	6001	>100	1785	34541	+3.64
1215	8050	+91.54	1815	34954	+5.38
1245	10895	+82.98	1845	35375	
1275	13556	+76.26	1875	36384	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	15025	+68.87
735	0		1335	18640	+58.97
765	0		1365	22048	+45.84
795	0	>100	1395	24877	+32.08
825	0	>100	1425	26653	+20.83
855	0	>100	1455	27899	+13.08
885	0	>100	1485	28670	+8.43
915	0	>100	1515	29257	+5.13
945	0	>100	1545	29568	+2.06
975	6	>100	1575	29683	+0.52
1005	81	>100	1605	29362	+0.57
1035	318	>100	1635	29589	+0.80
1065	897	>100	1665	29870	+1.82
1095	1710	>100	1695	29783	+0.90
1125	2714	>100	1725	30077	+0.75
1155	3925	>100	1755	29889	+2.02
1185	5395	+97.31	1785	30152	+3.33
1215	7282	+88.49	1815	30656	+6.54
1245	9426	+81.36	1845	31211	
1275	12007	+75.65	1875	32389	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16217	+71.57
735	0		1335	20184	+63.76
765	0		1365	24605	+53.98
795	0	>100	1395	28528	+41.40
825	0	>100	1425	31675	+28.02
855	0	>100	1455	33899	+17.93
885	0	>100	1485	34826	+10.65
915	0	>100	1515	35815	+6.13
945	0	>100	1545	36225	+4.15
975	7	>100	1575	36456	+2.28
1005	31	>100	1605	36747	+1.47
1035	238	>100	1635	36801	+1.26
1065	810	>100	1665	36859	+0.85
1095	1637	>100	1695	37095	+1.85
1125	2743	>100	1725	37072	+4.01
1155	3932	>100	1755	37724	+6.65
1185	5579	>100	1785	38802	+10.33
1215	7602	+94.41	1815	40036	+14.71
1245	10078	+84.86	1845	41975	
1275	13091	+77.67	1875	45123	

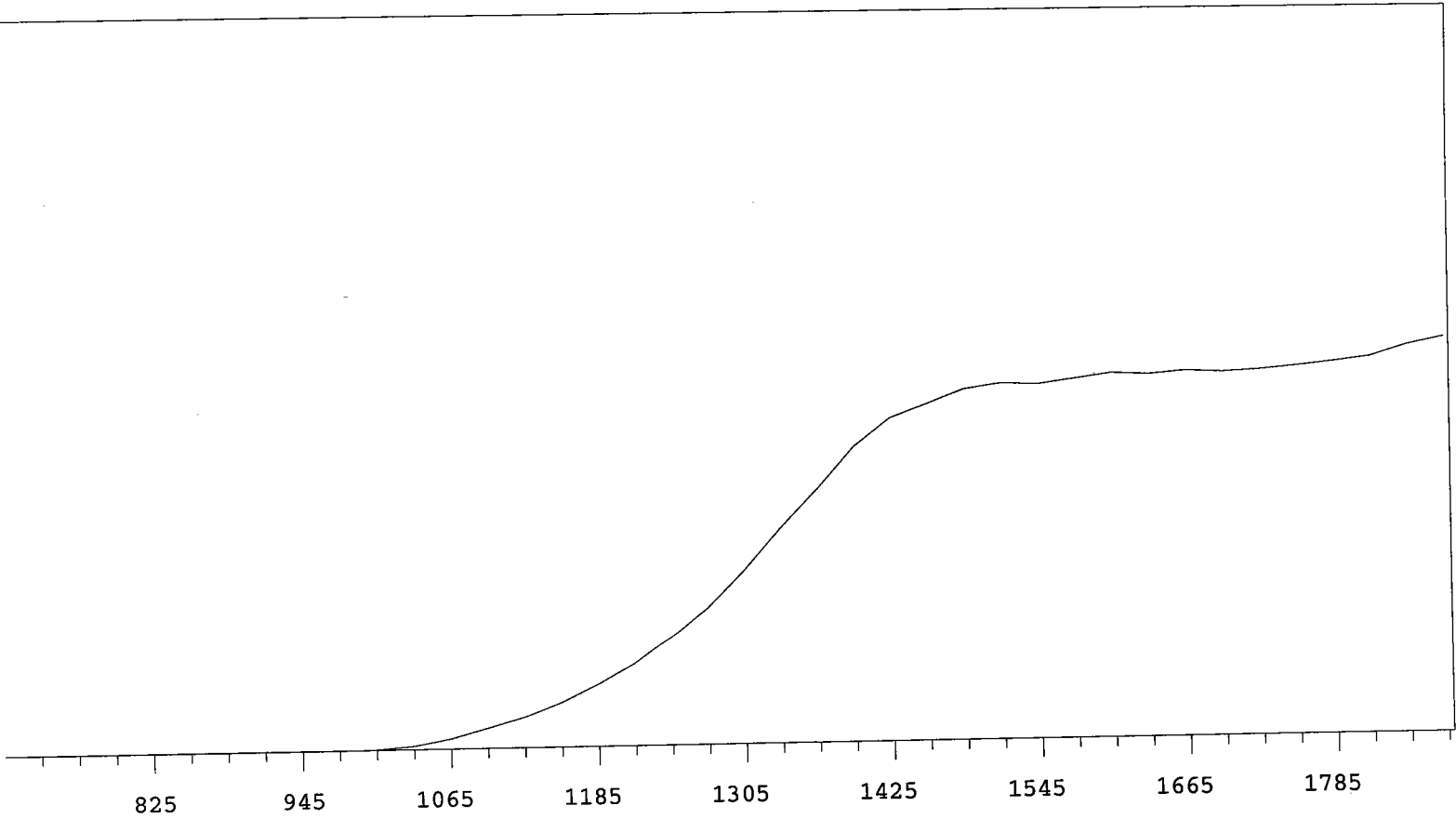


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	20094	+68.67
735	0		1335	24665	+59.40
765	0		1365	29591	+47.86
795	0	>100	1395	33376	+34.51
825	1	+83.33	1425	36440	+22.50
855	1	-83.33	1455	38024	+13.58
885	0	>100	1485	39187	+7.04
915	0	>100	1515	39608	+3.63
945	5	>100	1545	39722	+2.10
975	18	>100	1575	39894	+2.32
1005	125	>100	1605	40298	+2.09
1035	482	>100	1635	40711	+1.41
1065	1255	>100	1665	40574	+0.80
1095	2318	>100	1695	40608	+1.02
1125	3540	>100	1725	40839	+1.28
1155	5288	>100	1755	41201	+1.97
1185	7168	+98.51	1785	41065	+3.74
1215	9760	+88.48	1815	41711	+5.42
1245	12656	+81.52	1845	42917	
1275	16065	+74.58	1875	43699	

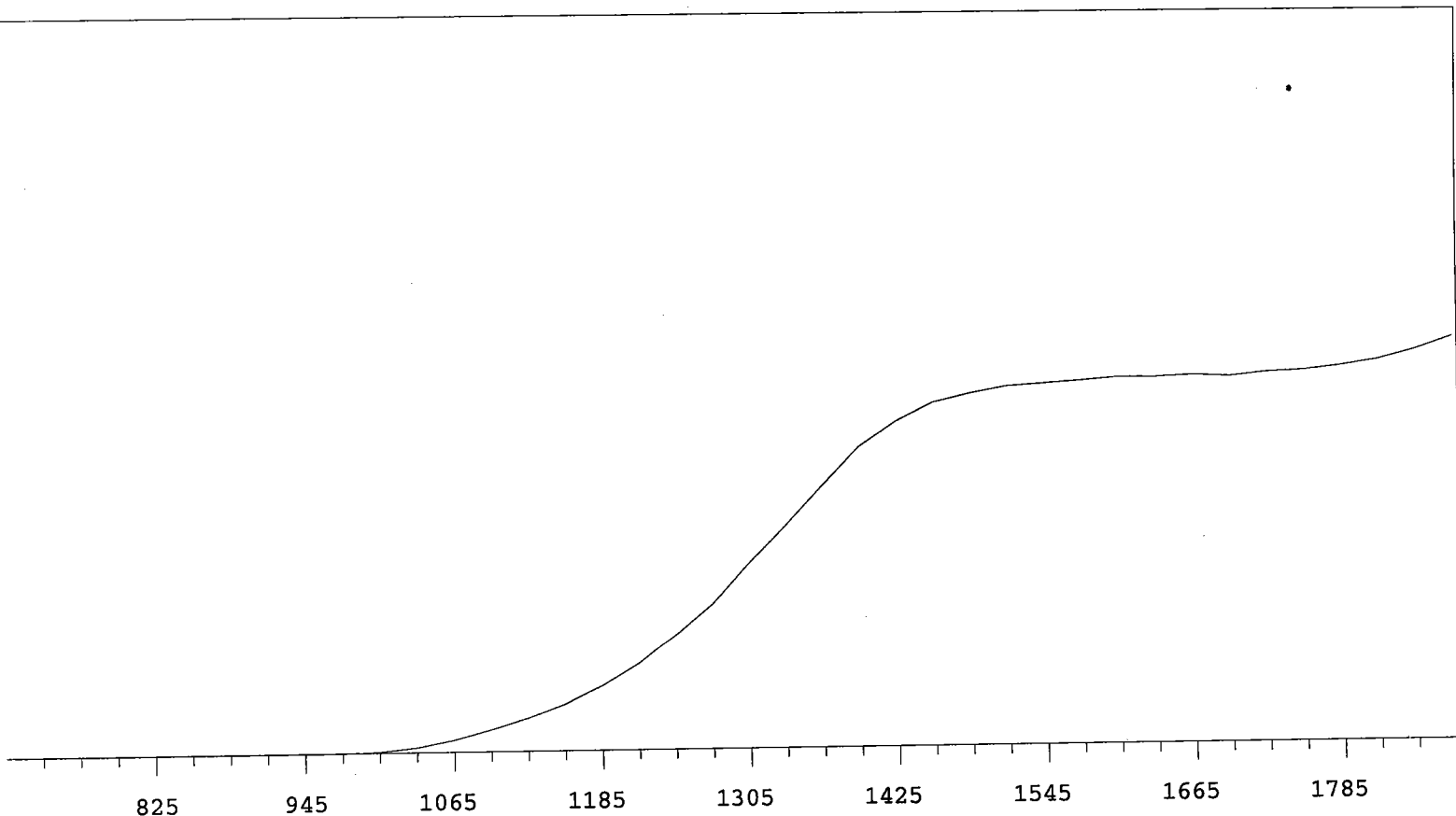
MPC 9600 Plateau  
 Alpha Volts: 705

Instrument 6 MPC 9604 Detector C  
 Beta Volts: 1575

7/1/2009



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17350	+67.80
735	0		1335	21371	+60.27
765	1	+0.00	1365	25084	+49.32
795	0	>100	1395	29177	+36.15
825	0	+0.00	1425	31927	+24.86
855	0	>100	1455	33217	+14.70
885	1	>100	1485	34545	+7.74
915	1	>100	1515	35097	+4.64
945	2	>100	1545	34927	+2.96
975	8	>100	1575	35439	+2.21
1005	70	>100	1605	35939	+2.41
1035	353	>100	1635	35763	+0.94
1065	990	>100	1665	36053	+0.35
1095	1956	>100	1695	35886	+1.15
1125	3024	>100	1725	36066	+1.77
1155	4400	>100	1755	36379	+3.03
1185	6173	+99.75	1785	36768	+4.80
1215	8230	+89.85	1815	37193	+6.14
1245	10904	+82.36	1845	38320	
1275	13747	+76.18	1875	39061	



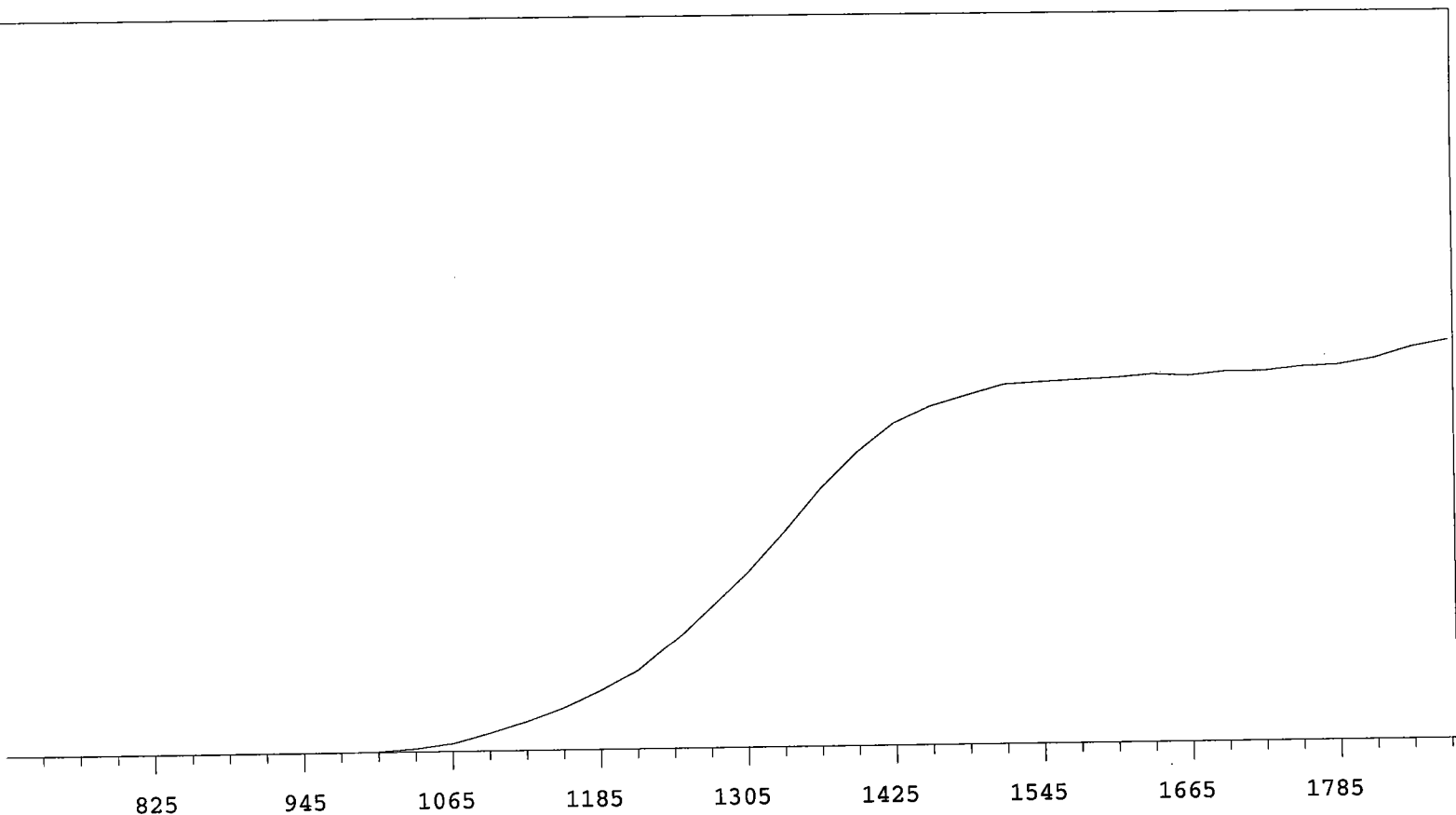
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17954	+65.82
735	0		1335	21482	+57.64
765	0		1365	25373	+45.78
795	1	+0.00	1395	29042	+34.80
825	0	>100	1425	31373	+23.29
855	0	+0.00	1455	33143	+14.25
885	0	>100	1485	34006	+8.49
915	1	>100	1515	34662	+4.71
945	0	>100	1545	34892	+3.14
975	14	>100	1575	35129	+1.86
1005	109	>100	1605	35411	+1.49
1035	481	>100	1635	35380	+0.62
1065	1177	>100	1665	35554	+0.65
1095	2133	>100	1695	35385	+1.18
1125	3243	>100	1725	35755	+1.89
1155	4554	>100	1755	35907	+3.26
1185	6285	+98.38	1785	36305	+4.62
1215	8468	+89.75	1815	36870	+6.98
1245	11266	+83.13	1845	37807	
1275	14088	+74.43	1875	39047	



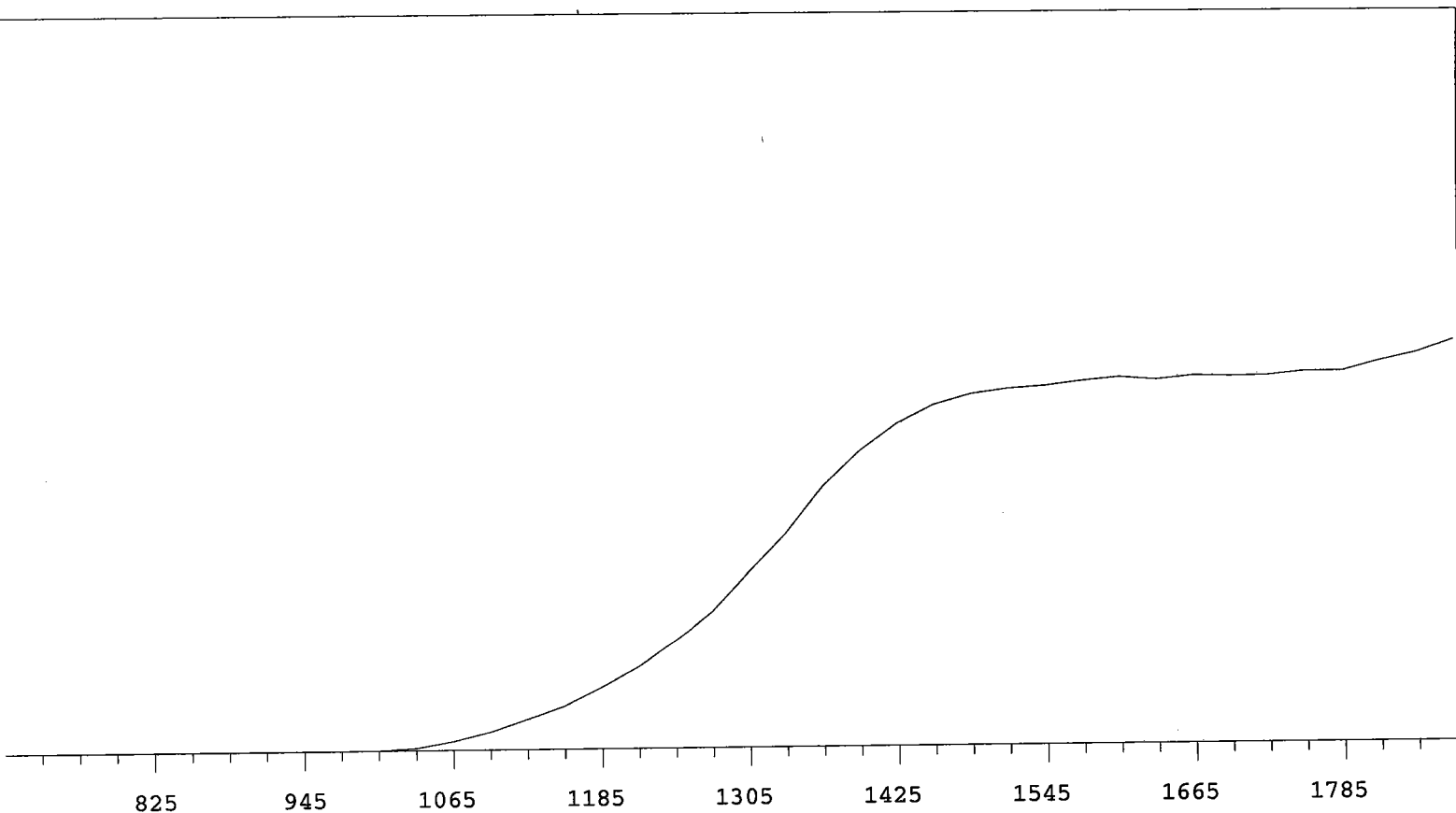
MPC 9600 Plateau  
Alpha Volts: 705

Instrument 7 MPC 9604 Detector A  
Beta Volts: 1575

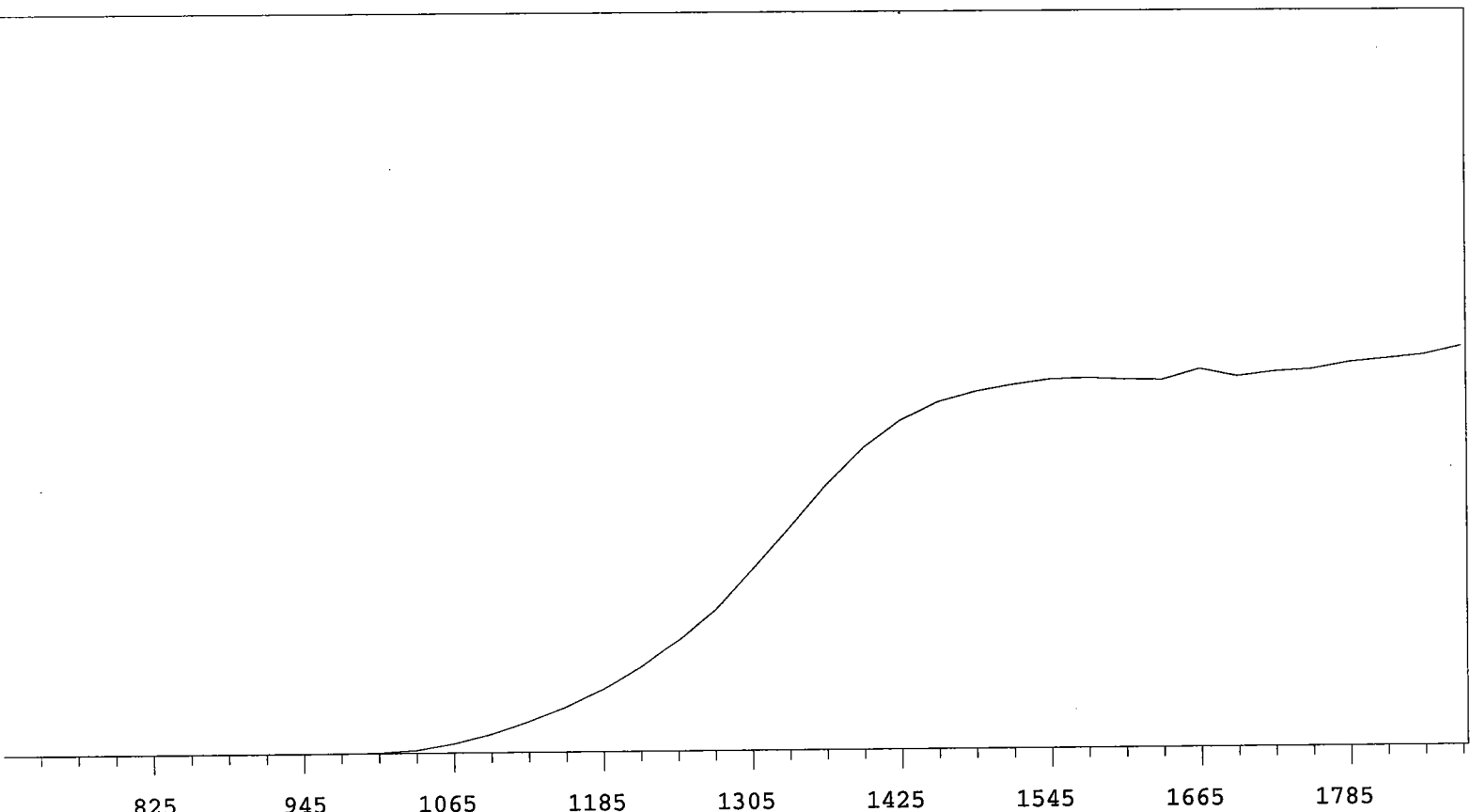
7/1/2009



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	13228	+70.36
735	0		1335	16271	+60.12
765	0		1365	19506	+49.19
795	0	>100	1395	22188	+36.46
825	1	+83.33	1425	24373	+24.43
855	1	-83.33	1455	25649	+15.99
885	0	-55.56	1485	26433	+9.58
915	0	>100	1515	27195	+5.74
945	1	>100	1545	27367	+3.24
975	3	>100	1575	27490	+1.86
1005	42	>100	1605	27608	+1.22
1035	242	>100	1635	27841	+1.33
1065	613	>100	1665	27695	+1.11
1095	1353	>100	1695	27999	+1.42
1125	2213	>100	1725	27992	+2.04
1155	3256	>100	1755	28289	+2.52
1185	4474	>100	1785	28408	+4.56
1215	5932	+94.10	1815	28863	+5.70
1245	8072	+87.32	1845	29664	
1275	10579	+79.61	1875	30148	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16978	+70.97
735	0		1335	20569	+61.39
765	0		1365	24989	+48.97
795	0	>100	1395	28389	+36.69
825	0	>100	1425	30977	+24.05
855	0	>100	1455	32727	+14.93
885	0	>100	1485	33697	+8.42
915	1	>100	1515	34195	+4.89
945	1	>100	1545	34437	+3.49
975	3	>100	1575	34850	+2.11
1005	34	>100	1605	35174	+1.62
1035	221	>100	1635	34923	+0.68
1065	825	>100	1665	35250	+0.35
1095	1709	>100	1695	35171	+1.24
1125	2873	>100	1725	35237	+1.02
1155	4078	>100	1755	35584	+2.79
1185	5858	>100	1785	35587	+4.59
1215	7809	+91.82	1815	36485	+6.74
1245	10336	+85.02	1845	37270	
1275	13215	+77.79	1875	38453	

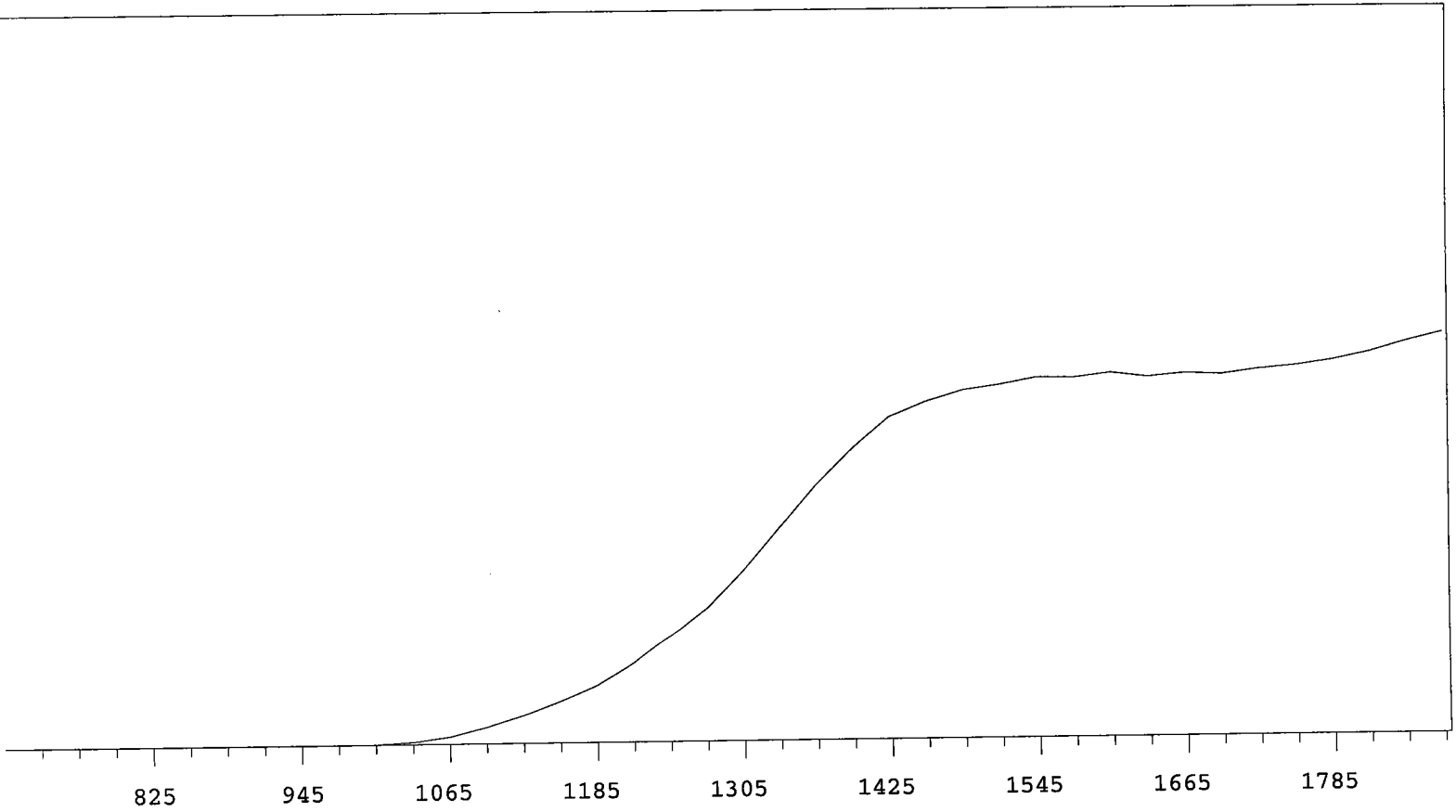


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16543	+70.03
735	0		1335	20257	+60.71
765	0		1365	24245	+48.17
795	0	>100	1395	27602	+35.50
825	0	>100	1425	30019	+23.48
855	0	>100	1455	31614	+14.53
885	0	>100	1485	32522	+8.91
915	0	>100	1515	33103	+5.28
945	0	>100	1545	33572	+2.60
975	4	>100	1575	33695	+0.70
1005	57	>100	1605	33525	+1.48
1035	277	>100	1635	33477	+0.99
1065	817	>100	1665	34432	+1.49
1095	1666	>100	1695	33745	+1.43
1125	2766	>100	1725	34149	+1.60
1155	4077	>100	1755	34350	+3.69
1185	5667	>100	1785	34955	+3.62
1215	7694	+91.50	1815	35251	+4.44
1245	10209	+84.83	1845	35592	
1275	12950	+77.50	1875	36382	

MPC 9600 Plateau  
 Alpha Volts: 705

Instrument 7 MPC 9604 Detector D  
 Beta Volts: 1575

7/1/2009

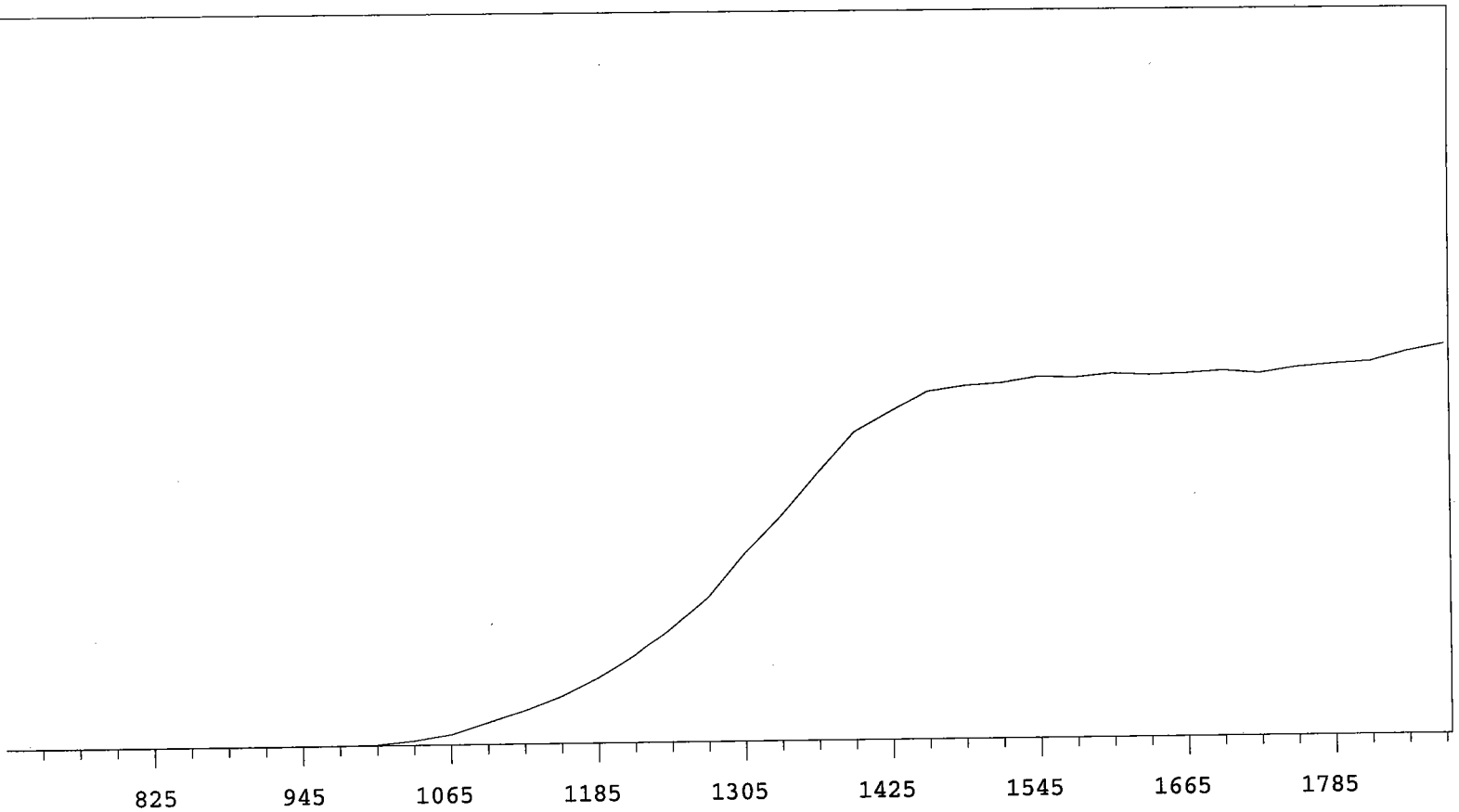


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	14016	+71.42
735	0		1335	17436	+62.21
765	0		1365	20814	+50.32
795	0	>100	1395	23760	+36.91
825	0	>100	1425	26302	+24.91
855	0	>100	1455	27519	+15.17
885	0	>100	1485	28410	+8.91
915	0	>100	1515	28843	+5.41
945	0	>100	1545	29396	+3.58
975	5	>100	1575	29357	+1.54
1005	29	>100	1605	29719	+0.51
1035	204	>100	1635	29358	+0.23
1065	609	>100	1665	29623	+0.57
1095	1354	>100	1695	29509	+2.12
1125	2316	>100	1725	29896	+2.84
1155	3418	>100	1755	30165	+4.42
1185	4654	>100	1785	30570	+5.65
1215	6455	+92.99	1815	31180	+6.95
1245	8669	+86.45	1845	31995	
1275	10931	+79.15	1875	32717	

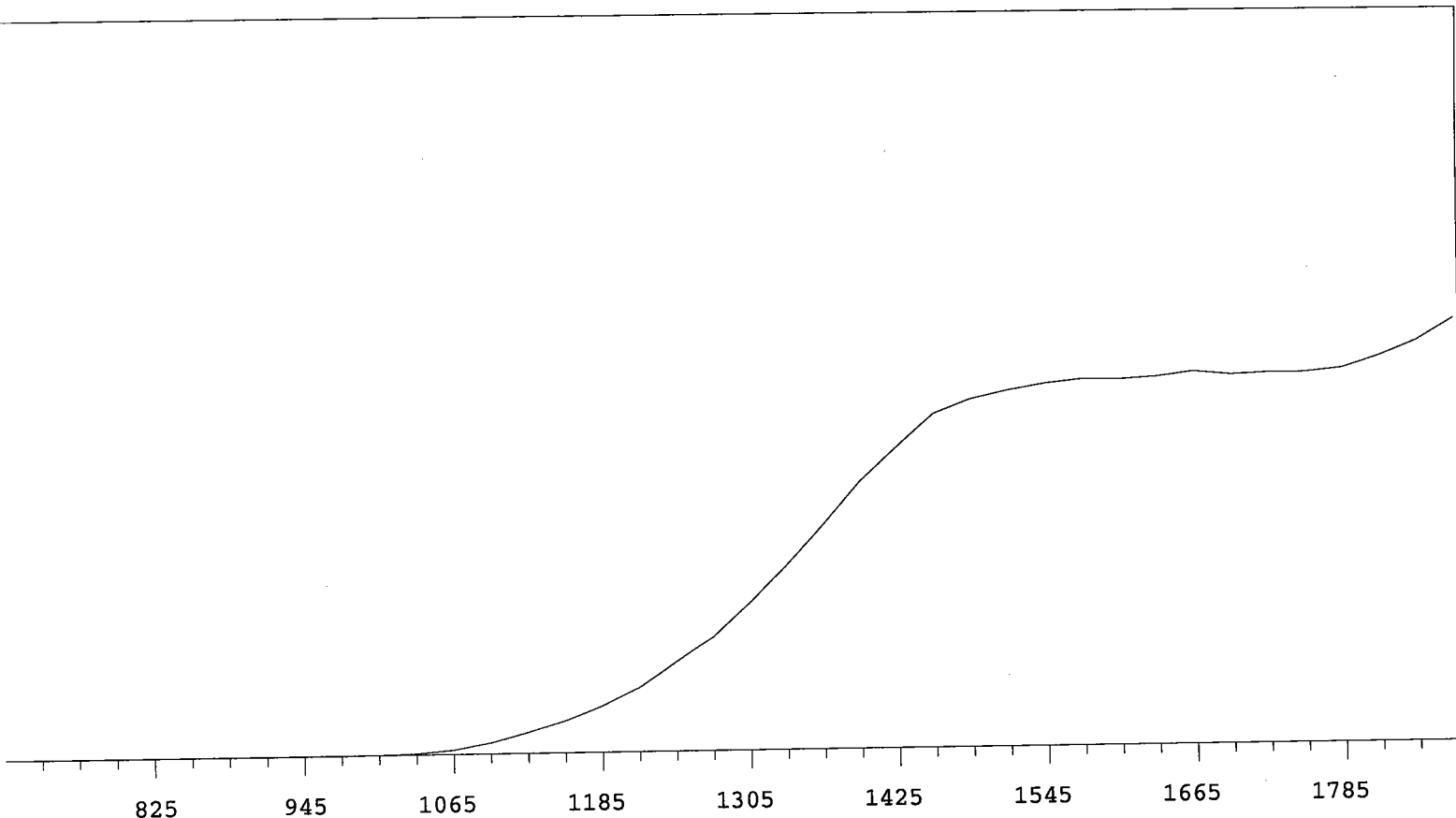
MPC 9600 Plateau  
Alpha Volts: 705

Instrument 8 MPC 9604 Detector A  
Beta Volts: 1575

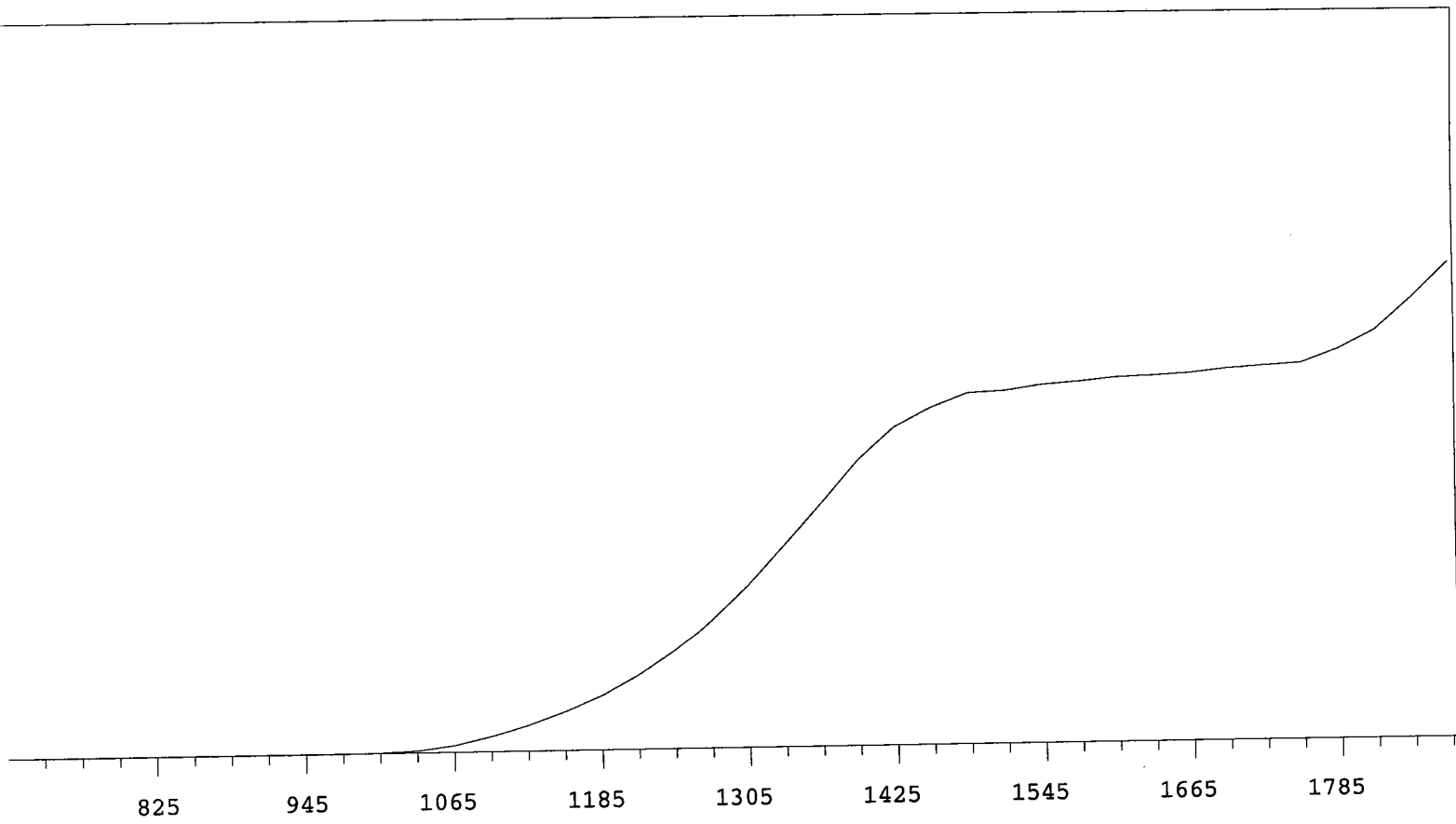
7/1/2009



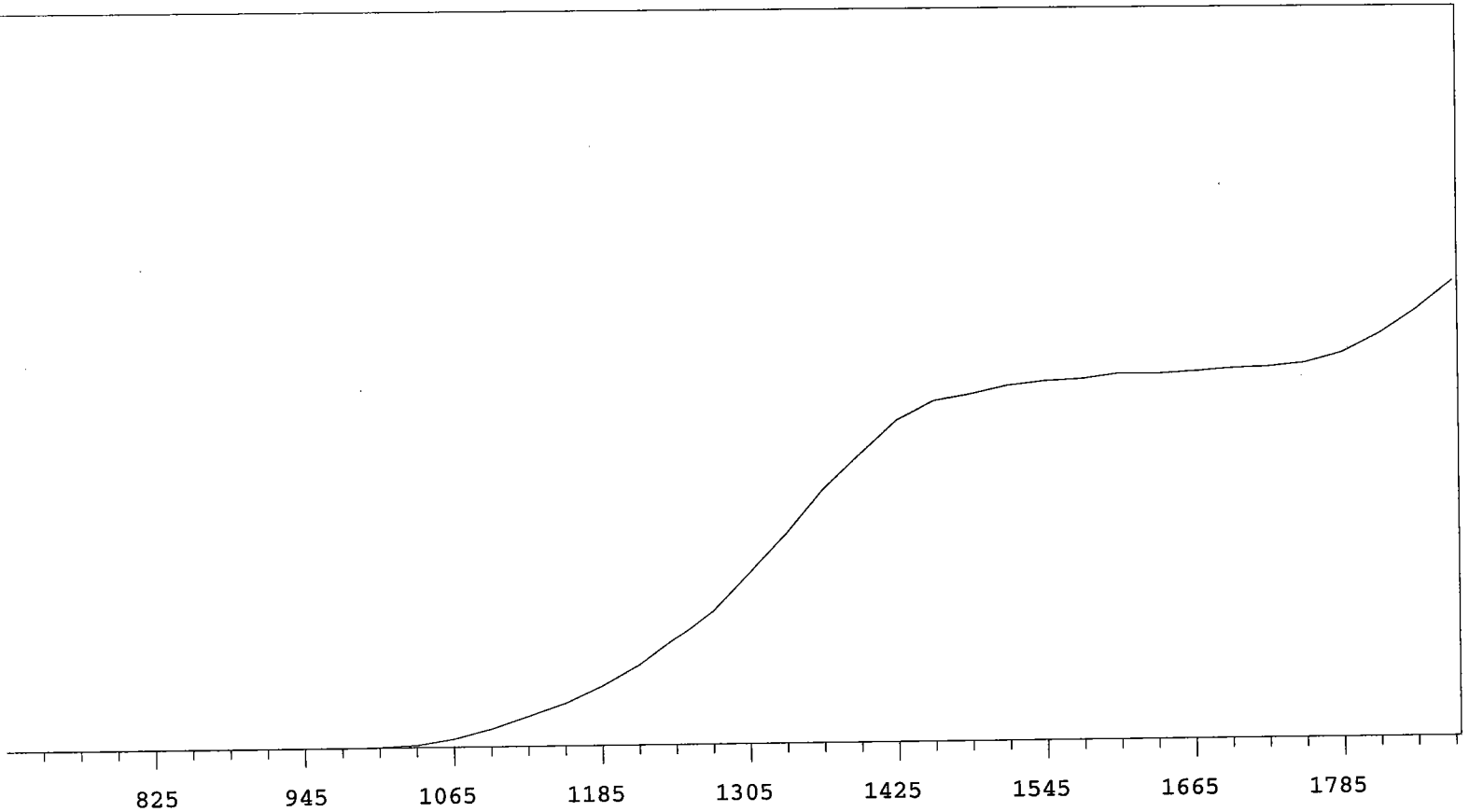
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	19482	+67.45
735	0		1335	23344	+59.35
765	0		1365	27793	+45.86
795	0	>100	1395	31916	+34.29
825	0	>100	1425	33979	+21.61
855	0	>100	1455	35993	+11.71
885	0	>100	1485	36530	+7.04
915	0	>100	1515	36796	+3.11
945	1	>100	1545	37393	+2.44
975	9	>100	1575	37279	+1.41
1005	96	>100	1605	37650	+0.49
1035	468	>100	1635	37458	+0.91
1065	1084	>100	1665	37579	+0.12
1095	2286	>100	1695	37828	+1.10
1125	3479	>100	1725	37535	+1.72
1155	4912	>100	1755	38104	+2.18
1185	6819	+98.23	1785	38416	+4.12
1215	9153	+89.05	1815	38633	+4.92
1245	12105	+83.21	1845	39649	
1275	15122	+75.24	1875	40366	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16337	+74.91
735	0		1335	20471	+68.07
765	0		1365	25012	+57.86
795	0	>100	1395	29694	+47.48
825	0	>100	1425	33409	+35.17
855	0	>100	1455	37013	+23.27
885	0	>100	1485	38629	+14.35
915	0	>100	1515	39529	+7.69
945	0	>100	1545	40284	+4.34
975	0	>100	1575	40711	+2.52
1005	20	>100	1605	40642	+1.97
1035	122	>100	1635	40879	+1.11
1065	511	>100	1665	41405	+0.98
1095	1263	>100	1695	41011	+0.30
1125	2390	>100	1725	41182	+0.41
1155	3641	>100	1755	41178	+3.28
1185	5246	>100	1785	41573	+6.47
1215	7212	+98.32	1815	42858	+10.82
1245	9897	+89.80	1845	44440	
1275	12742	+82.40	1875	46780	

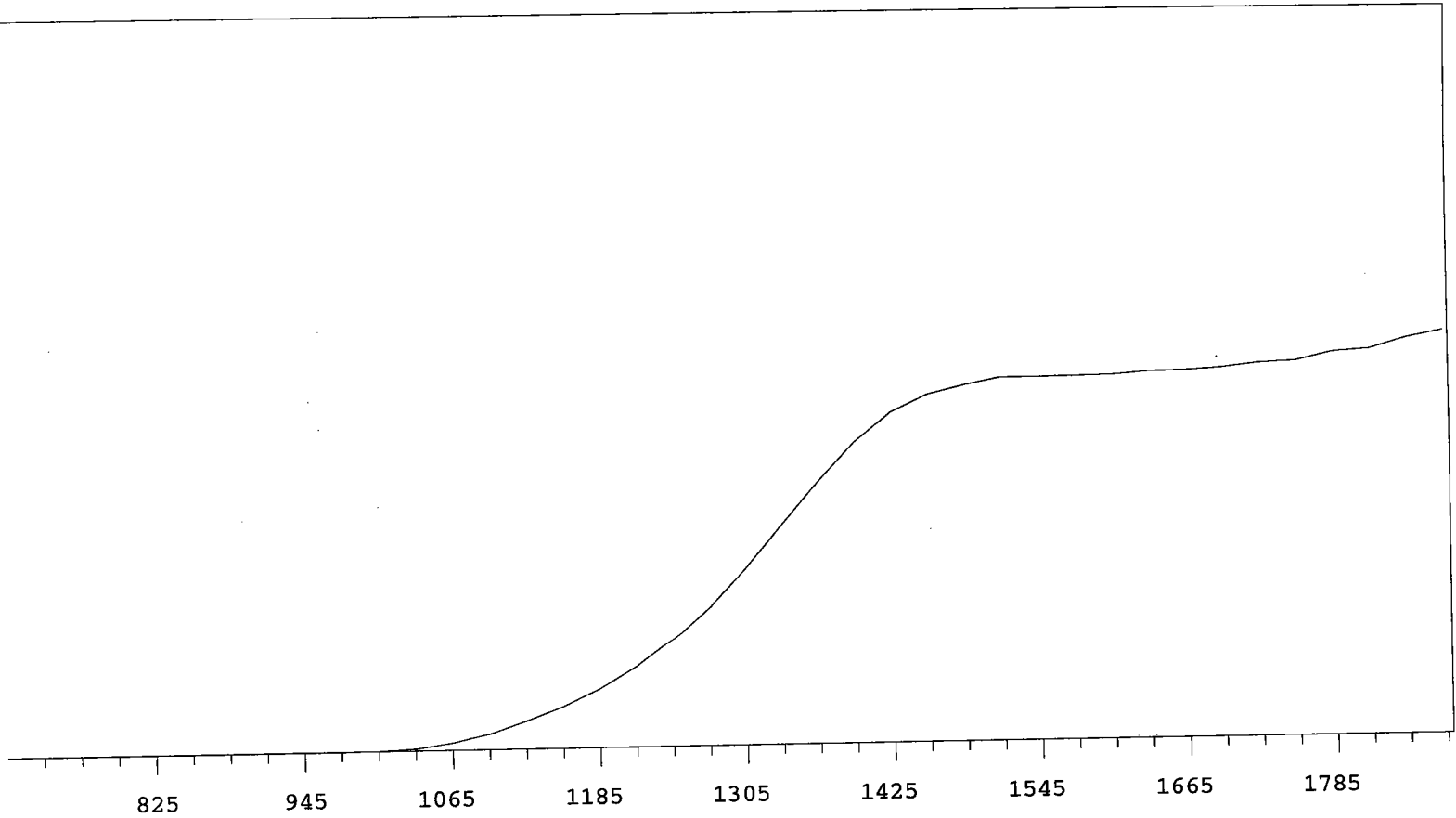


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16303	+72.82
735	0		1335	20309	+64.32
765	0		1365	24364	+53.82
795	0	>100	1395	28527	+40.95
825	0	>100	1425	31774	+28.74
855	0	>100	1455	33631	+16.87
885	0	>100	1485	35030	+9.25
915	0	>100	1515	35208	+5.21
945	0	>100	1545	35741	+3.27
975	4	>100	1575	36019	+2.95
1005	46	>100	1605	36373	+2.21
1035	202	>100	1635	36484	+2.27
1065	697	>100	1665	36713	+2.28
1095	1532	>100	1695	37093	+2.46
1125	2614	>100	1725	37325	+4.17
1155	3953	>100	1755	37543	+7.52
1185	5474	>100	1785	38833	+13.43
1215	7466	+93.09	1815	40656	+19.49
1245	9842	+86.73	1845	43753	
1275	12814	+80.29	1875	47246	

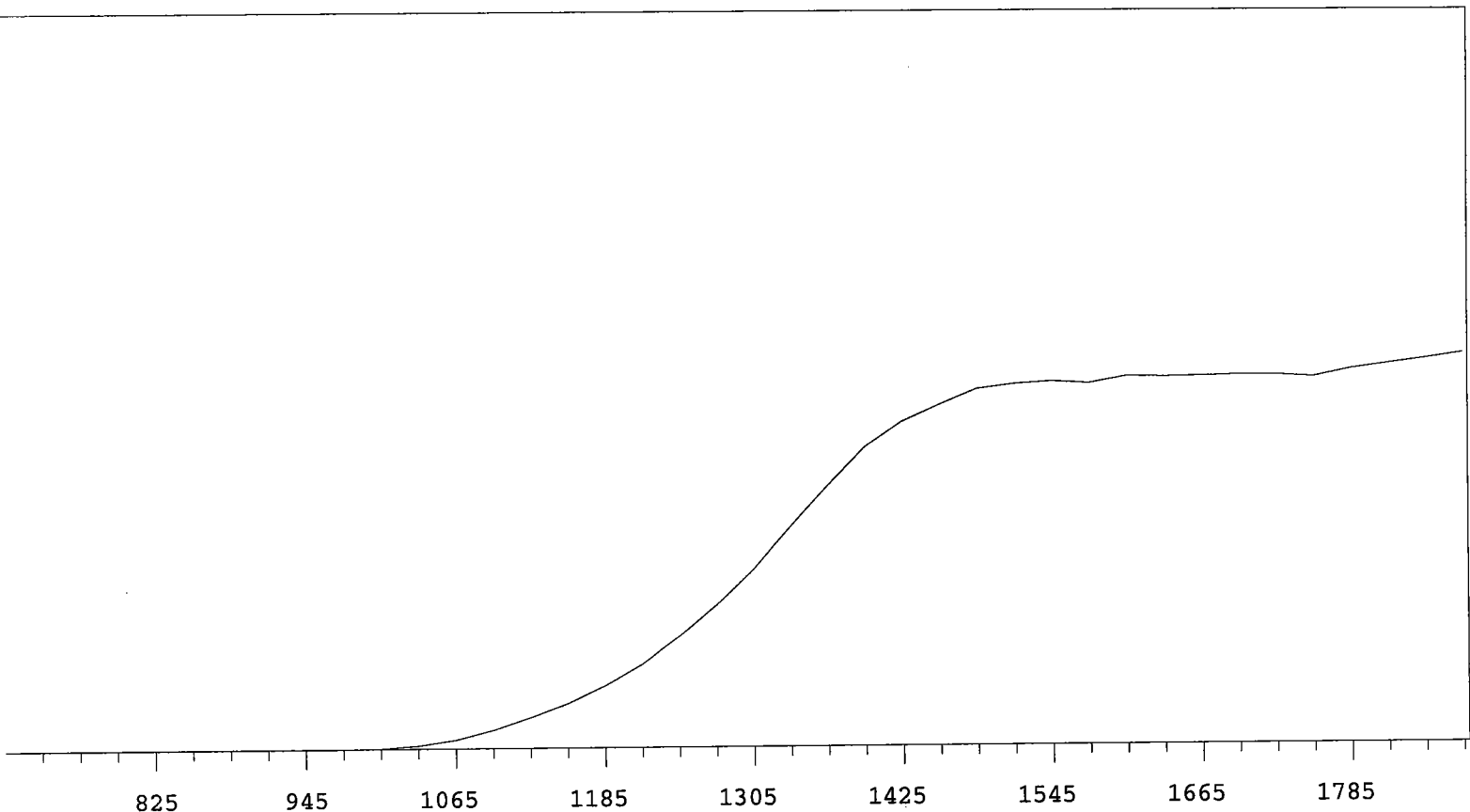


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16889	+70.18
735	0		1335	20600	+61.29
765	1	+0.00	1365	24824	+50.40
795	0	>100	1395	28208	+38.85
825	0	>100	1425	31539	+25.79
855	0	>100	1455	33391	+16.06
885	0	>100	1485	33991	+8.60
915	0	>100	1515	34782	+5.01
945	0	>100	1545	35201	+4.10
975	5	>100	1575	35380	+2.50
1005	47	>100	1605	35849	+1.87
1035	243	>100	1635	35784	+1.79
1065	792	>100	1665	36000	+1.43
1095	1744	>100	1695	36269	+2.10
1125	2933	>100	1725	36381	+3.46
1155	4123	>100	1755	36733	+6.86
1185	5780	>100	1785	37669	+11.78
1215	7791	+91.58	1815	39465	+16.64
1245	10478	+84.93	1845	41803	
1275	13118	+77.50	1875	44665	





VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16226	+71.71
735	0		1335	20083	+61.95
765	1	+0.00	1365	23913	+49.99
795	0	>100	1395	27526	+36.97
825	0	>100	1425	30193	+24.54
855	0	>100	1455	31747	+14.71
885	0	>100	1485	32544	+7.71
915	0	>100	1515	33198	+3.66
945	0	>100	1545	33188	+1.51
975	2	>100	1575	33227	+0.73
1005	33	>100	1605	33278	+1.04
1035	203	>100	1635	33518	+1.38
1065	668	>100	1665	33565	+1.95
1095	1403	>100	1695	33774	+1.99
1125	2545	>100	1725	34135	+3.30
1155	3800	>100	1755	34244	+3.67
1185	5363	>100	1785	35022	+4.84
1215	7355	+95.00	1815	35229	+5.93
1245	9807	+87.69	1845	36179	
1275	12700	+80.28	1875	36821	

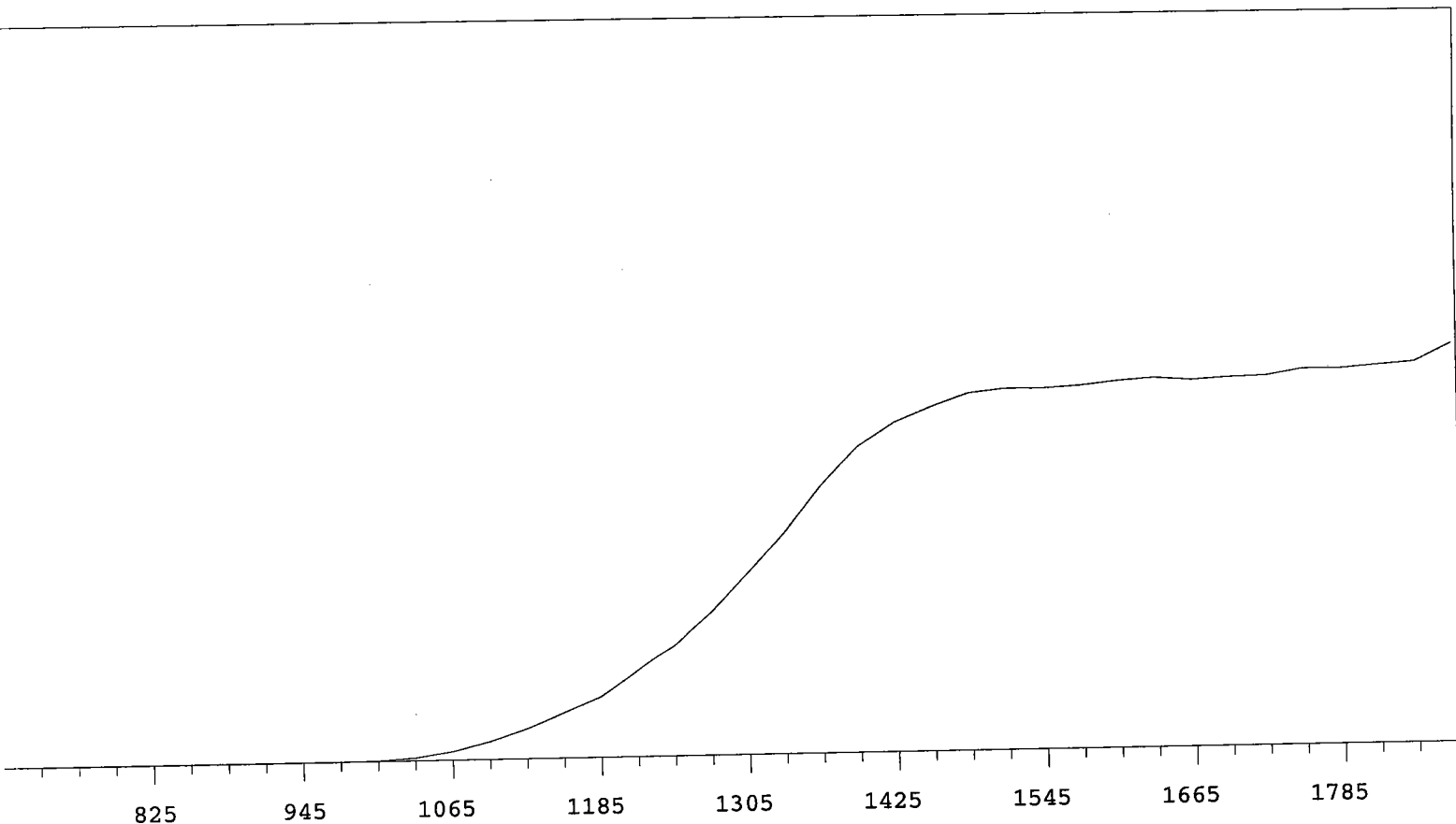


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16723	+68.78
735	0		1335	20749	+60.55
765	0		1365	24686	+48.78
795	0	>100	1395	28343	+35.24
825	0	>100	1425	30657	+24.31
855	0	>100	1455	32208	+15.22
885	0	>100	1485	33662	+9.32
915	0	>100	1515	34098	+4.47
945	0	>100	1545	34326	+2.17
975	4	>100	1575	34133	+1.60
1005	45	>100	1605	34758	+1.41
1035	300	>100	1635	34706	+1.35
1065	836	>100	1665	34769	+0.30
1095	1742	>100	1695	34830	-0.10
1125	2896	>100	1725	34850	+0.90
1155	4198	>100	1755	34613	+2.41
1185	5849	>100	1785	35351	+3.87
1215	7887	+92.20	1815	35849	+4.97
1245	10561	+83.55	1845	36285	
1275	13442	+76.62	1875	36814	

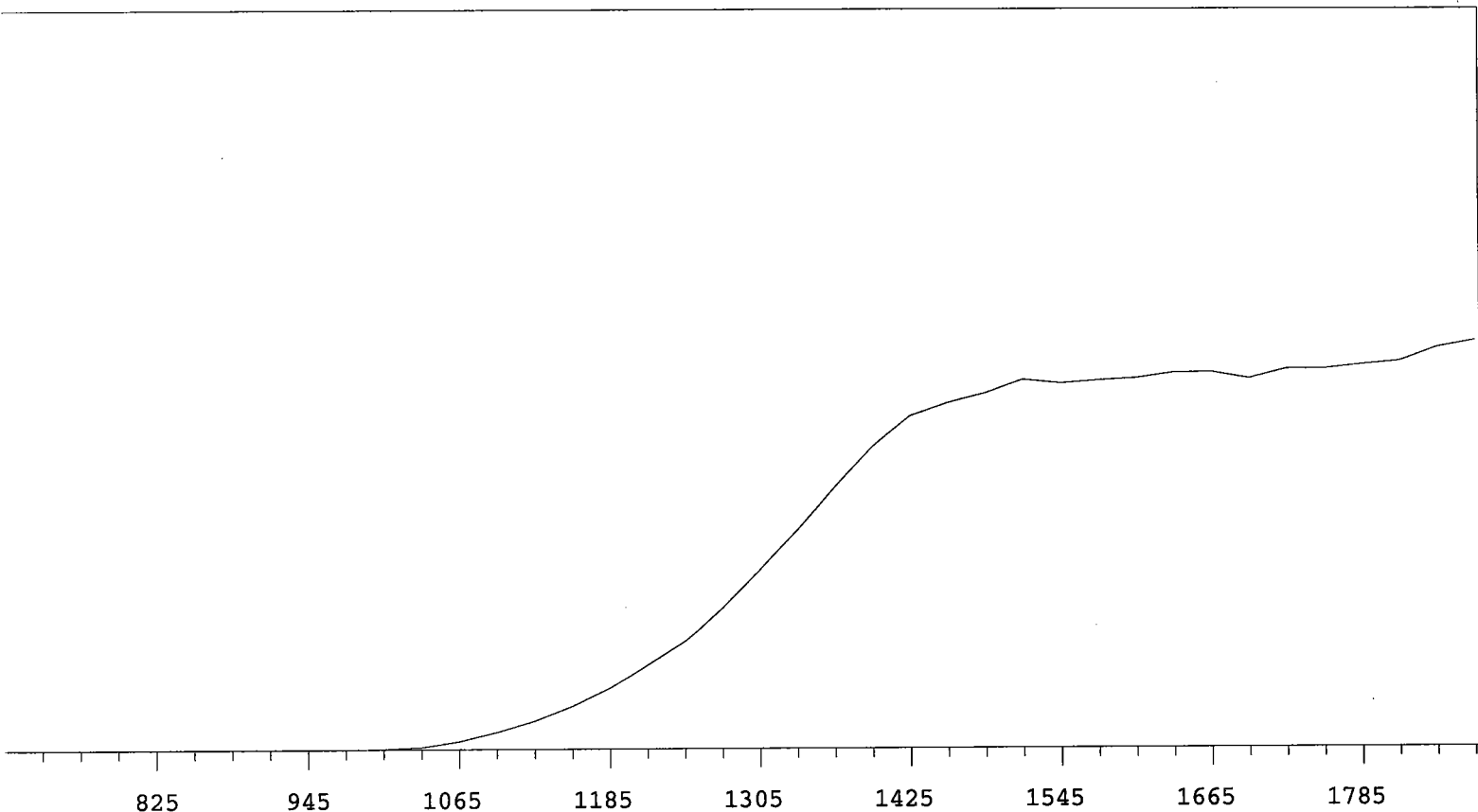
MPC 9600 Plateau  
Alpha Volts: 870

Instrument 9 MPC 9604 Detector C  
Beta Volts: 1530

7/1/2009



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	20192	+70.39
735	0		1335	24524	+60.97
765	0		1365	29650	+48.44
795	0	>100	1395	33904	+35.09
825	0	>100	1425	36549	+22.73
855	0	>100	1455	38217	+13.58
885	1	>100	1485	39628	+7.51
915	1	>100	1515	40035	+3.73
945	2	>100	1545	40020	+1.92
975	3	>100	1575	40236	+2.06
1005	64	>100	1605	40680	+1.62
1035	349	>100	1635	40953	+1.03
1065	970	>100	1665	40643	+0.43
1095	1982	>100	1695	40882	+1.41
1125	3328	>100	1725	40979	+2.18
1155	5012	>100	1755	41654	+2.20
1185	6669	>100	1785	41602	+2.27
1215	9448	+92.67	1815	41935	+4.50
1245	12293	+86.58	1845	42259	
1275	15917	+76.99	1875	44183	



VOLTS    COUNTS    %/100 Volts

VOLTS    COUNTS    %/100 Volts

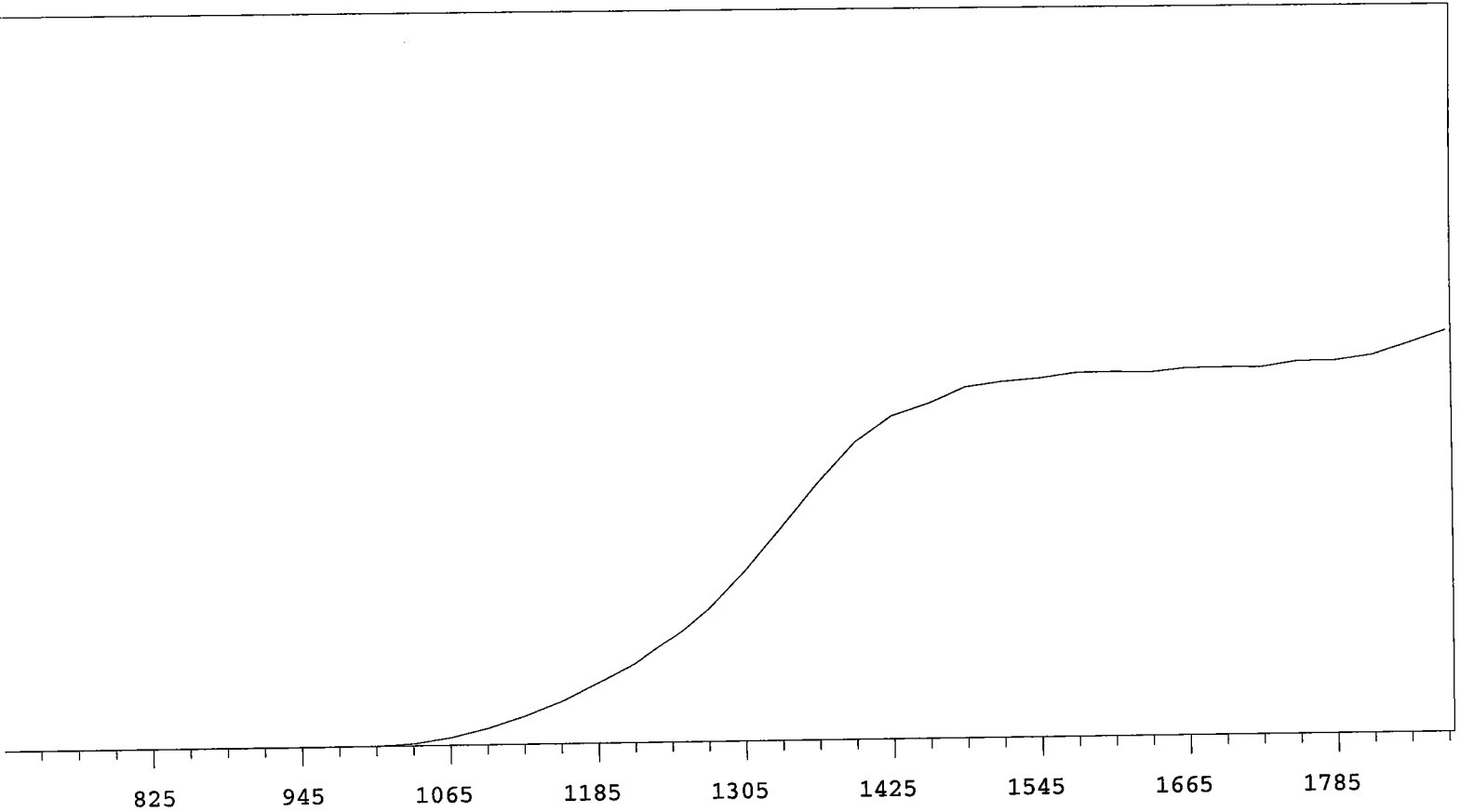
705	0	
735	0	
765	0	
795	0	>100
825	0	>100
855	0	>100
885	0	>100
915	1	>100
945	0	>100
975	5	>100
1005	35	>100
1035	186	>100
1065	618	>100
1095	1280	>100
1125	2141	>100
1155	3268	>100
1185	4659	>100
1215	6343	+90.68
1245	8064	+83.46
1275	10497	+77.03

1305	13319	+70.94
1335	16319	+61.35
1365	19577	+50.27
1395	22498	+36.85
1425	24782	+23.90
1455	25761	+15.37
1485	26486	+8.38
1515	27503	+5.11
1545	27223	+2.67
1575	27453	+1.71
1605	27604	+2.70
1635	28021	+0.78
1665	28059	+1.05
1695	27548	+0.90
1725	28280	+2.16
1755	28290	+3.51
1785	28600	+4.46
1815	28879	+6.35
1845	29913	
1875	30417	

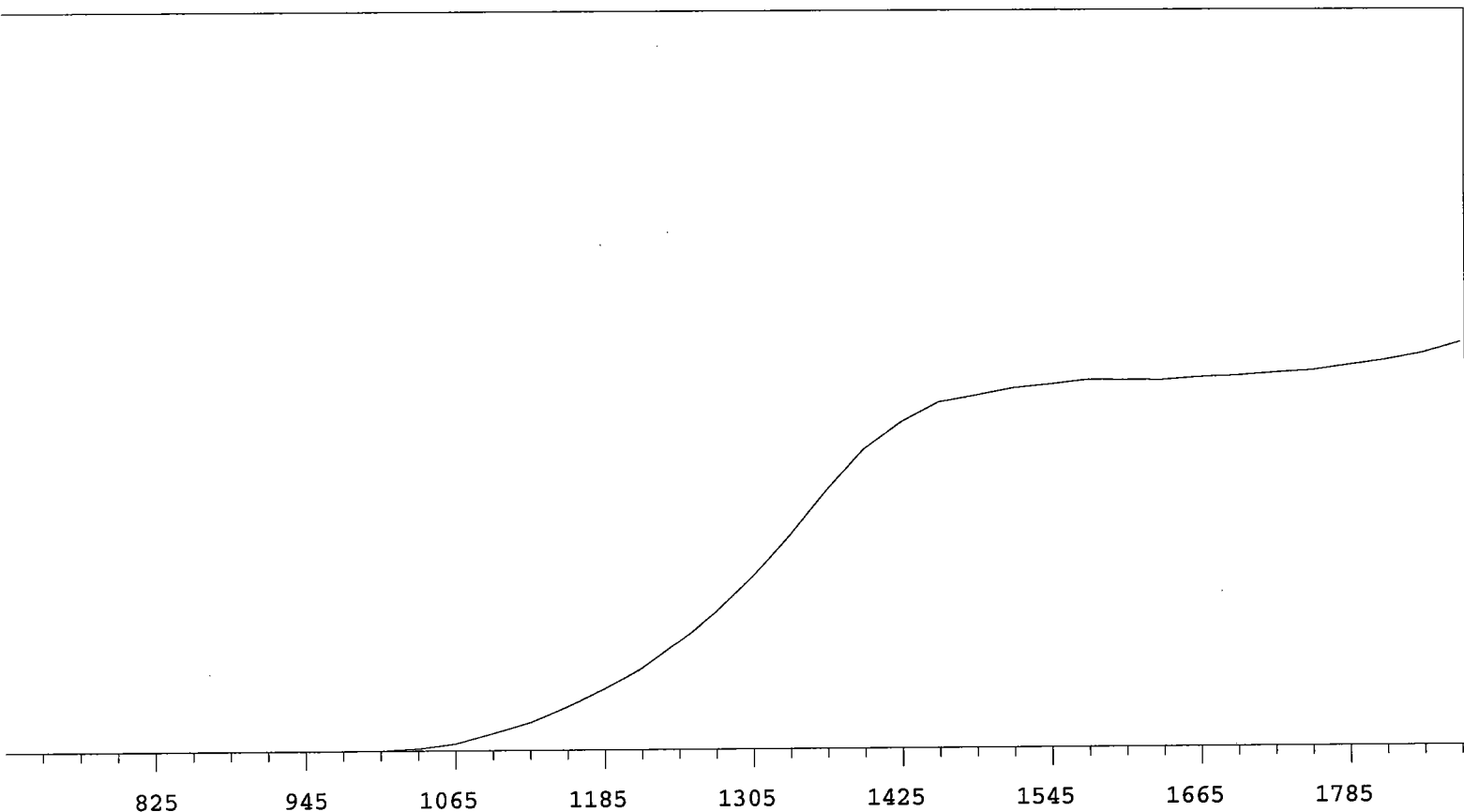
MPC 9600 Plateau  
Alpha Volts: 870

Instrument 10 MPC 9604 Detector A  
Beta Volts: 1552

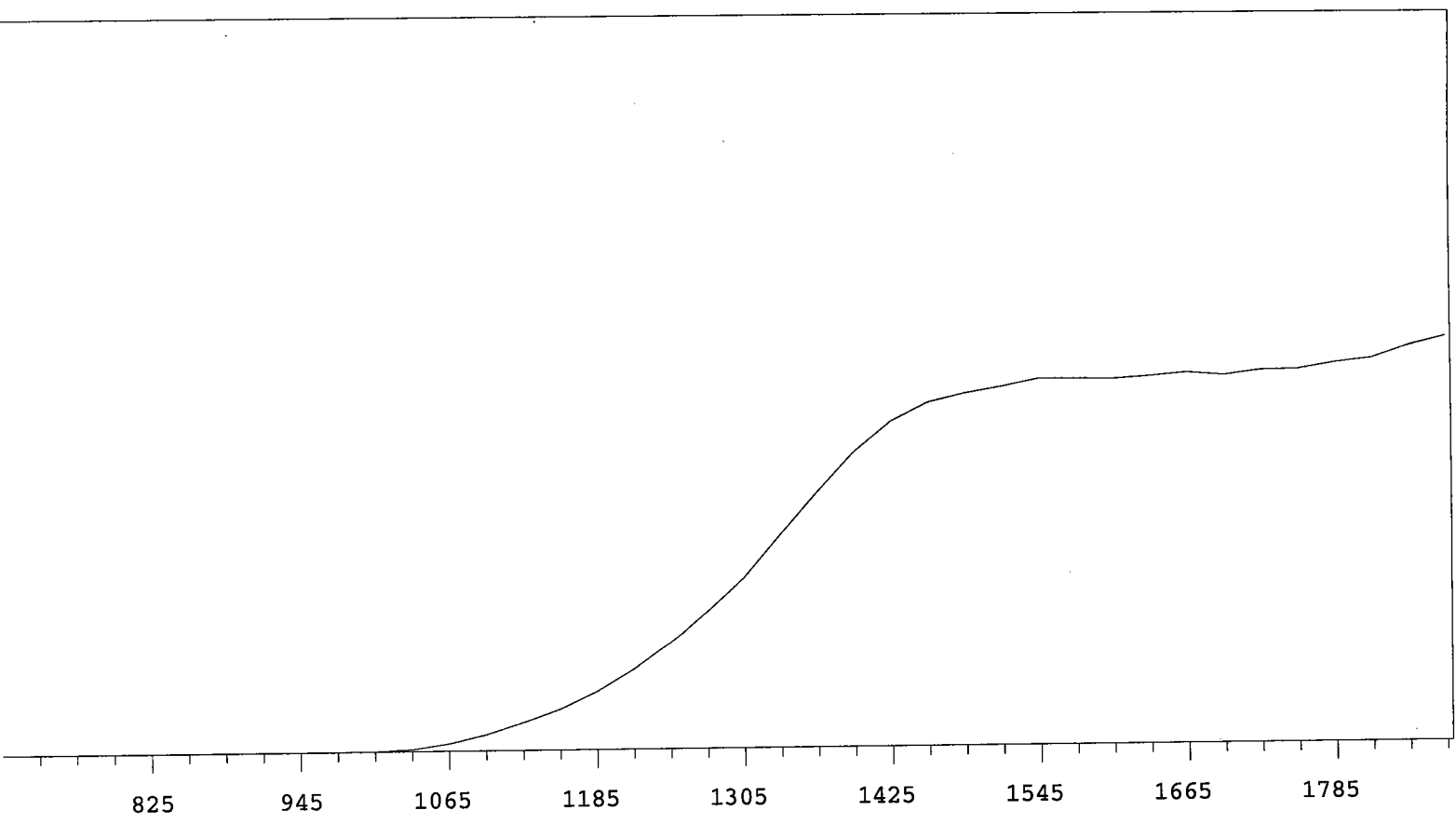
7/1/2009



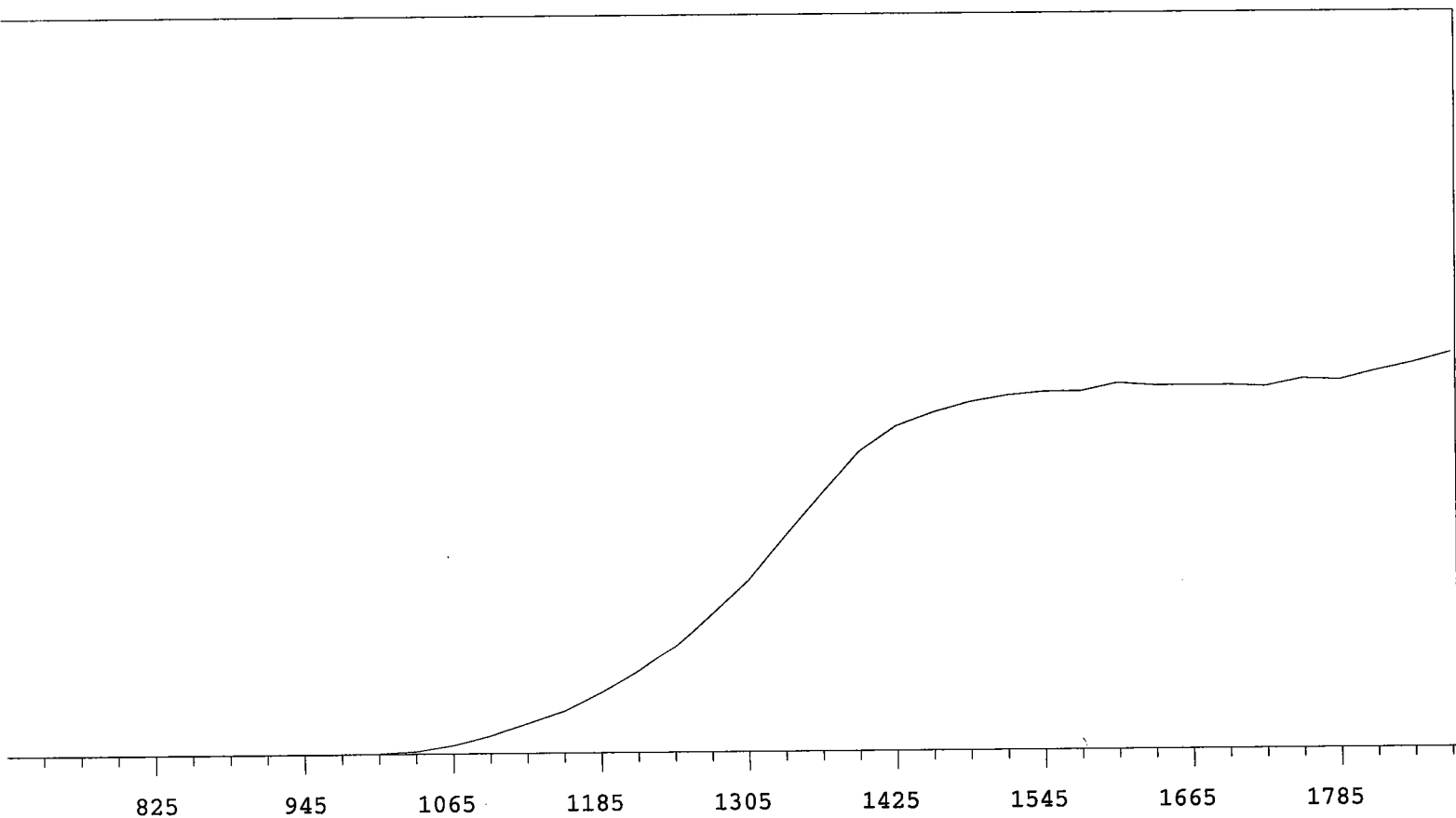
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16076	+72.76
735	1		1335	19985	+63.85
765	0		1365	24102	+50.95
795	0	>100	1395	27819	+36.01
825	0	>100	1425	30228	+23.86
855	0	>100	1455	31343	+14.40
885	0	>100	1485	32811	+8.77
915	0	>100	1515	33243	+6.10
945	0	>100	1545	33518	+3.25
975	1	>100	1575	34010	+1.98
1005	37	>100	1605	34061	+1.59
1035	198	>100	1635	33973	+0.97
1065	687	>100	1665	34346	+0.93
1095	1491	>100	1695	34366	+1.72
1125	2580	>100	1725	34341	+1.54
1155	3920	>100	1755	34860	+2.47
1185	5588	>100	1785	34897	+4.50
1215	7384	+91.32	1815	35377	+6.60
1245	9794	+84.81	1845	36458	
1275	12572	+79.73	1875	37630	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	14469	+71.08
735	0		1335	17904	+63.07
765	0		1365	21677	+51.20
795	0	>100	1395	25027	+38.06
825	0	>100	1425	27237	+24.55
855	0	>100	1455	28914	+14.61
885	0	>100	1485	29480	+8.48
915	0	>100	1515	30075	+5.06
945	1	>100	1545	30374	+3.42
975	7	>100	1575	30738	+1.68
1005	28	>100	1605	30703	+1.08
1035	190	>100	1635	30679	+0.77
1065	597	>100	1665	30902	+1.46
1095	1474	>100	1695	30992	+1.89
1125	2383	>100	1725	31224	+2.40
1155	3680	>100	1755	31397	+3.27
1185	5131	>100	1785	31826	+4.13
1215	6808	+89.95	1815	32236	+5.59
1245	8990	+83.03	1845	32782	
1275	11493	+77.30	1875	33632	



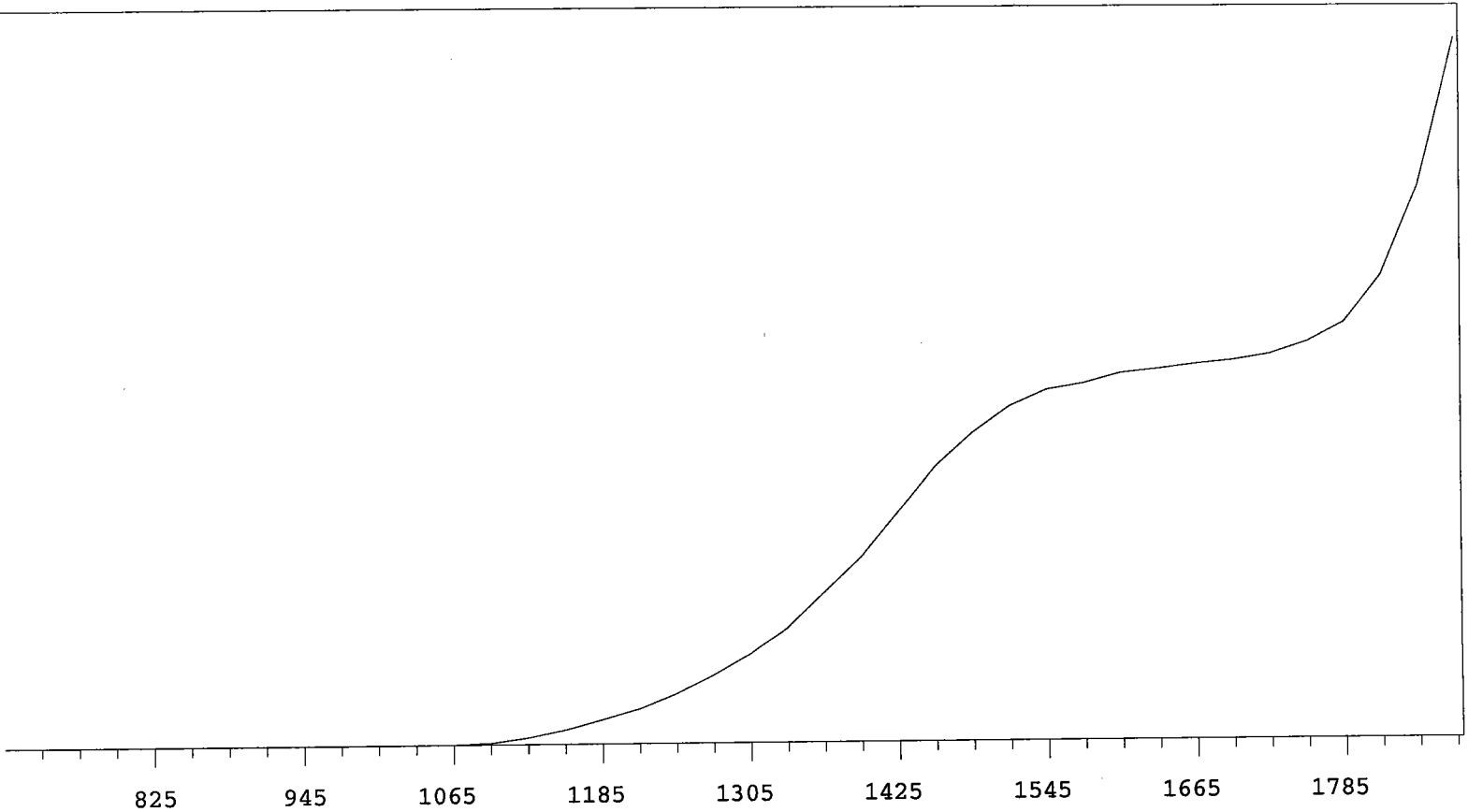
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18051	+71.16
735	0		1335	22586	+62.34
765	0		1365	26973	+51.47
795	0	>100	1395	31137	+38.24
825	0	>100	1425	34321	+25.70
855	0	>100	1455	36267	+15.37
885	1	>100	1485	37197	+9.21
915	0	>100	1515	37851	+5.38
945	2	>100	1545	38622	+3.00
975	2	>100	1575	38600	+1.55
1005	36	>100	1605	38538	+1.03
1035	220	>100	1635	38786	+0.91
1065	780	>100	1665	39129	+1.38
1095	1712	>100	1695	38832	+1.20
1125	2926	>100	1725	39323	+2.00
1155	4297	>100	1755	39390	+3.35
1185	6097	>100	1785	40031	+4.86
1215	8397	+95.11	1815	40466	+6.64
1245	11155	+85.84	1845	41713	
1275	14430	+78.79	1875	42620	



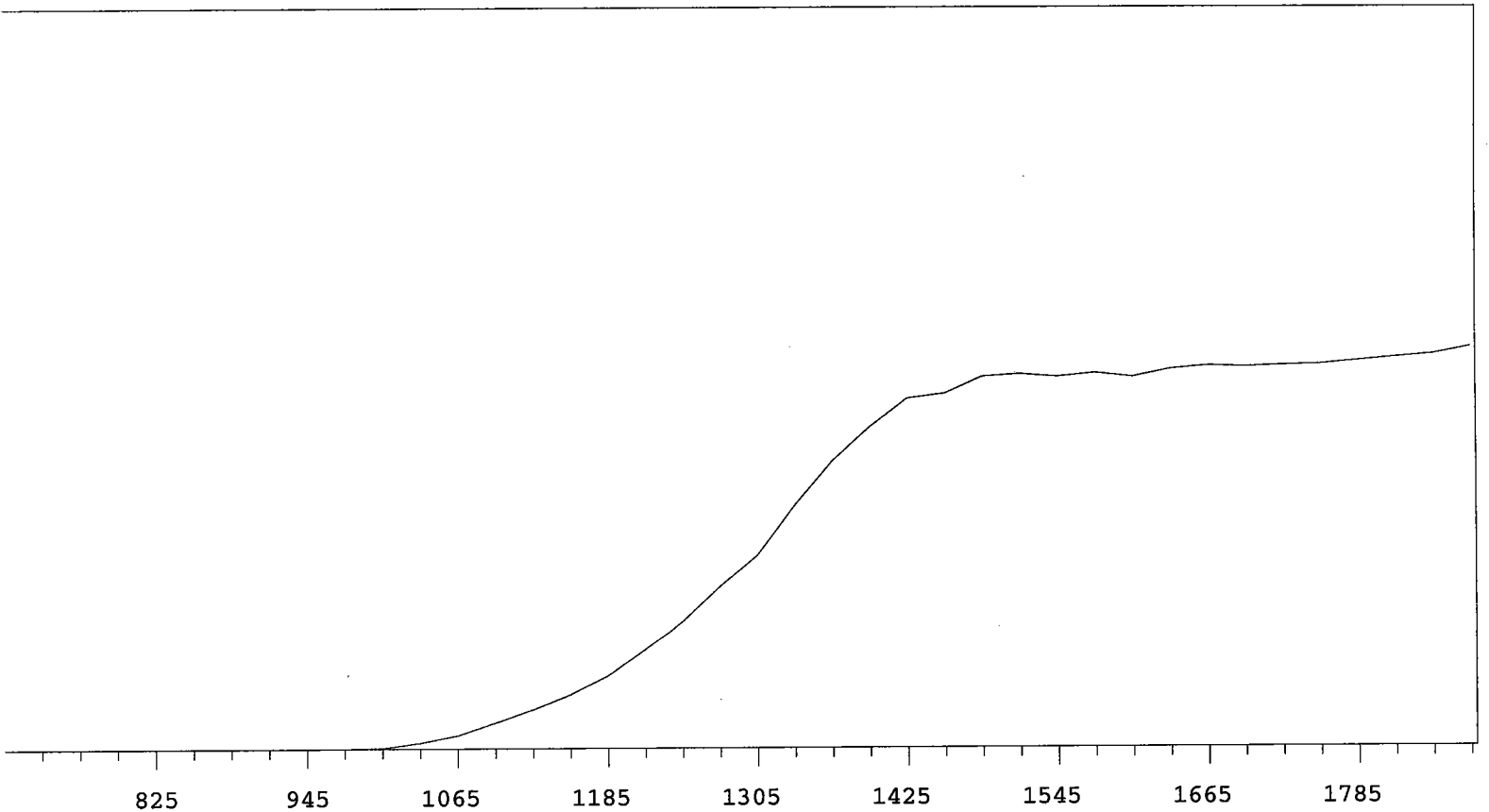
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	15430	+69.87
735	0		1335	19258	+61.49
765	0		1365	23018	+50.06
795	0	>100	1395	26562	+35.34
825	0	>100	1425	28750	+22.67
855	0	>100	1455	29911	+13.20
885	0	>100	1485	30798	+8.01
915	0	>100	1515	31375	+4.83
945	0	>100	1545	31684	+3.74
975	3	>100	1575	31721	+2.38
1005	49	>100	1605	32398	+1.44
1035	244	>100	1635	32154	+0.64
1065	764	>100	1665	32157	-0.77
1095	1584	>100	1695	32152	+0.99
1125	2677	>100	1725	32029	+1.41
1155	3763	>100	1755	32699	+3.00
1185	5395	>100	1785	32566	+4.71
1215	7350	+93.71	1815	33351	+5.92
1245	9655	+83.52	1845	34031	
1275	12504	+76.82	1875	34941	



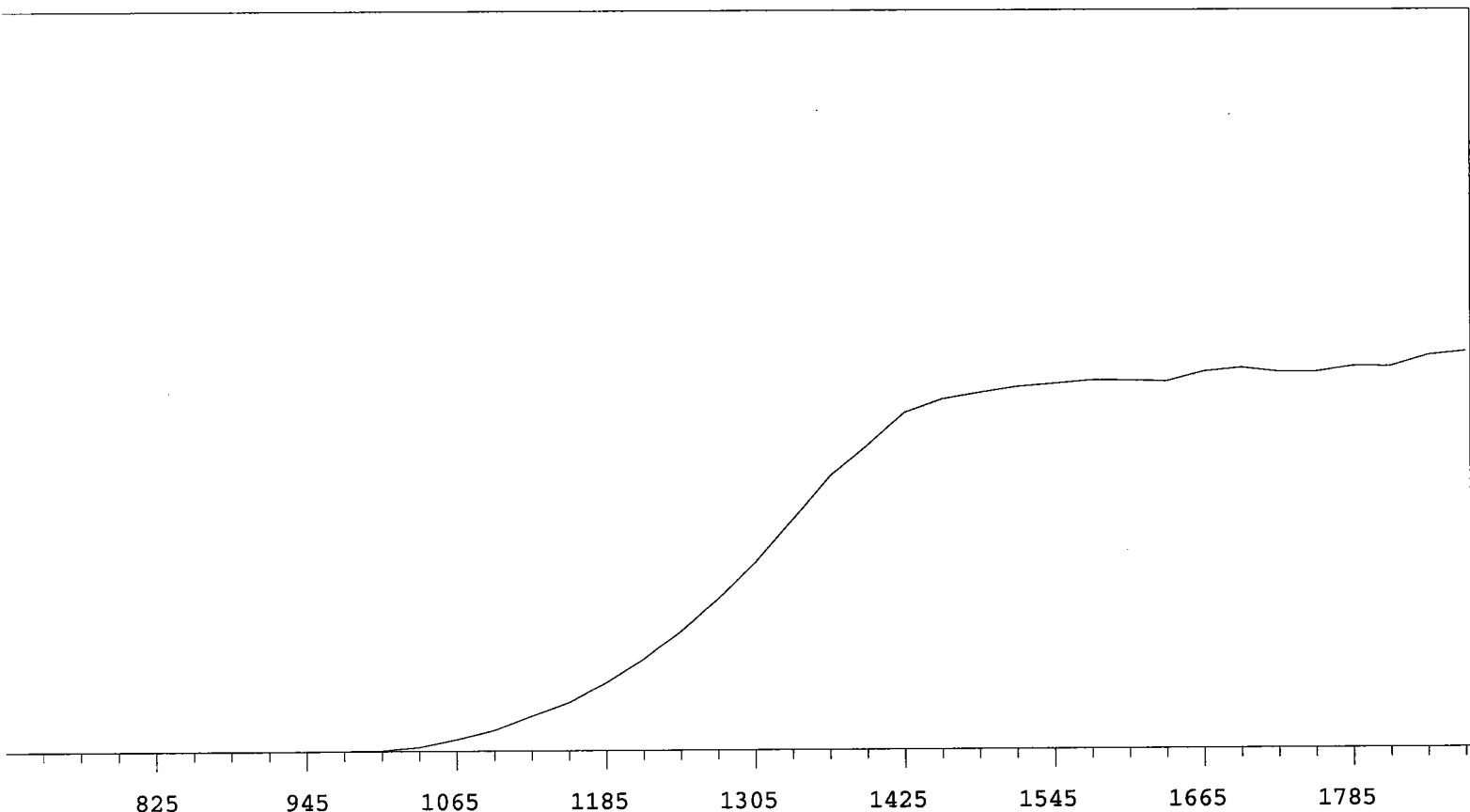
Alpha Volts: 1515 Beta Volts: 1515



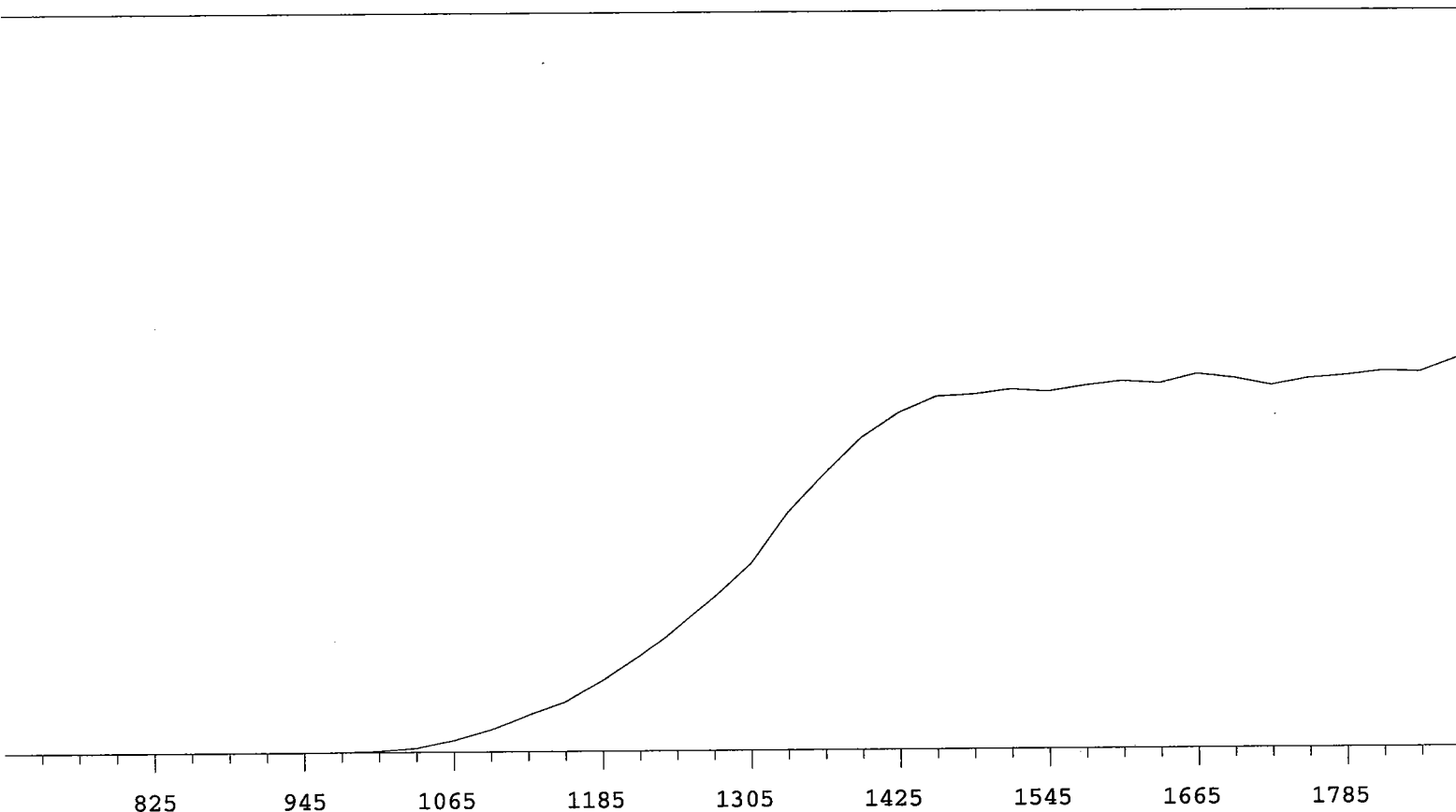
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	3225	+87.64
735	1		1335	4189	+80.15
765	0		1365	5428	+75.12
795	0	>100	1395	6662	+68.60
825	0	>100	1425	8241	+58.14
855	0	>100	1455	9857	+46.65
885	0	>100	1485	11018	+33.24
915	0	>100	1515	11953	+21.01
945	1	+0.00	1545	12538	+13.57
975	0	>100	1575	12760	+8.35
1005	0	>100	1605	13114	+5.84
1035	2	>100	1635	13258	+4.78
1065	9	>100	1665	13430	+3.99
1095	61	>100	1695	13551	+5.46
1125	248	>100	1725	13771	+8.65
1155	528	>100	1755	14204	+16.44
1185	882	>100	1785	14916	+30.03
1215	1270	>100	1815	16579	+48.74
1245	1786	>100	1845	19717	
1275	2478	+93.67	1875	25029	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	8947	+65.63
735	0		1335	11238	+56.58
765	0		1365	13246	+46.66
795	0	>100	1395	14838	+30.69
825	0	>100	1425	16166	+20.11
855	0	>100	1455	16396	+11.95
885	0	>100	1485	17161	+5.61
915	1	>100	1515	17274	+3.59
945	0	>100	1545	17144	-0.00
975	11	>100	1575	17323	+0.80
1005	47	>100	1605	17136	+2.21
1035	280	>100	1635	17484	+1.94
1065	610	>100	1665	17638	+2.16
1095	1192	>100	1695	17580	+0.85
1125	1789	>100	1725	17655	+1.05
1155	2466	>100	1755	17700	+1.98
1185	3337	+94.91	1785	17857	+2.38
1215	4526	+88.85	1815	18006	+3.36
1245	5885	+78.40	1845	18140	
1275	7518	+72.09	1875	18468	



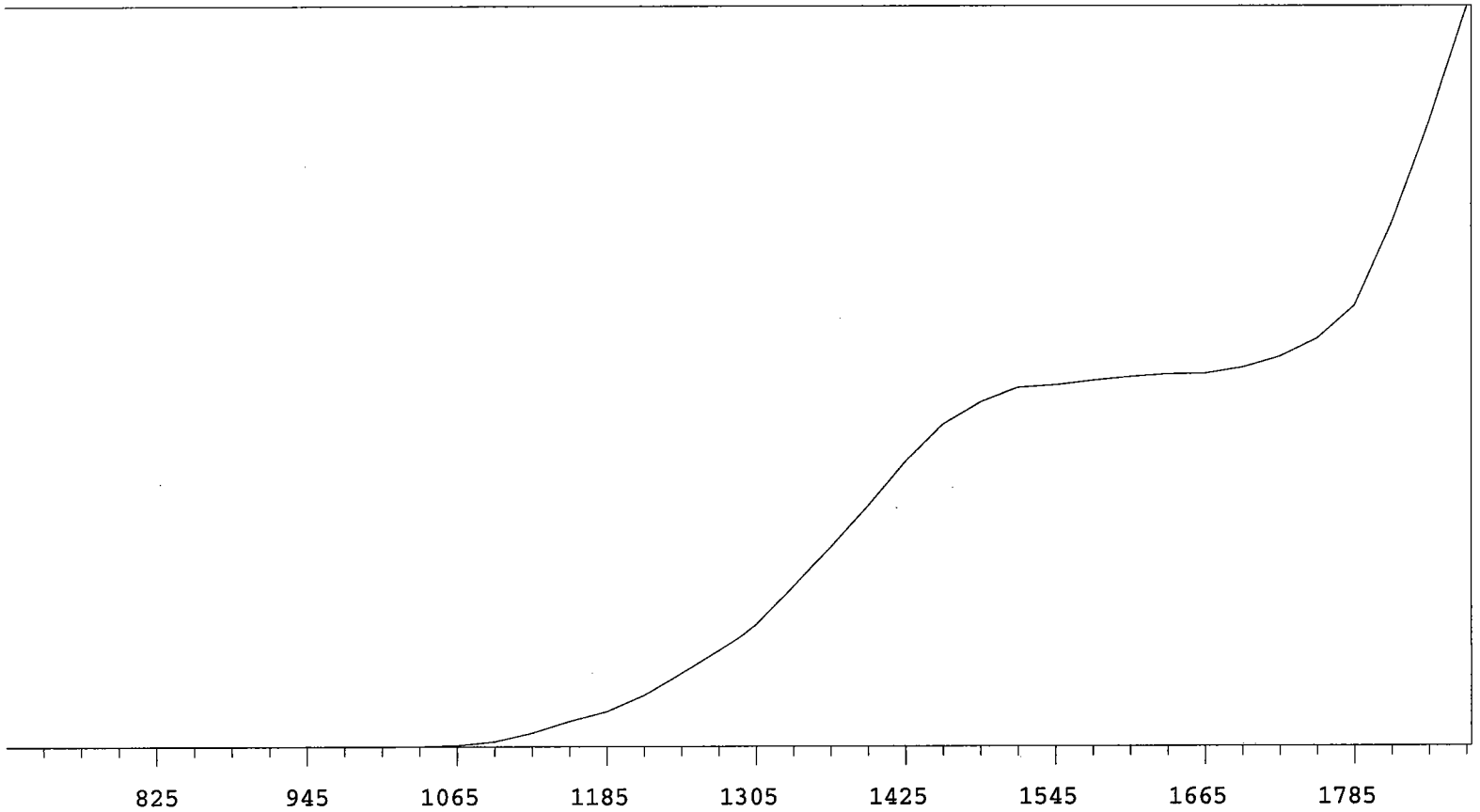
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	8636	+66.44
735	0		1335	10593	+56.56
765	0	+0.00	1365	12582	+46.23
795	0	>100	1395	13957	+33.45
825	1	+0.00	1425	15443	+21.49
855	0	>100	1455	16048	+13.14
885	0	+0.00	1485	16331	+6.45
915	0	>100	1515	16603	+4.19
945	1	>100	1545	16736	+2.73
975	7	>100	1575	16884	+1.11
1005	46	>100	1605	16875	+1.91
1035	191	>100	1635	16813	+2.86
1065	540	>100	1665	17257	+2.60
1095	957	>100	1695	17425	+1.58
1125	1597	>100	1725	17238	+0.49
1155	2217	>100	1755	17230	+0.63
1185	3154	+98.74	1785	17482	+3.27
1215	4239	+89.75	1815	17468	+4.46
1245	5550	+79.98	1845	17977	
1275	6980	+73.12	1875	18163	



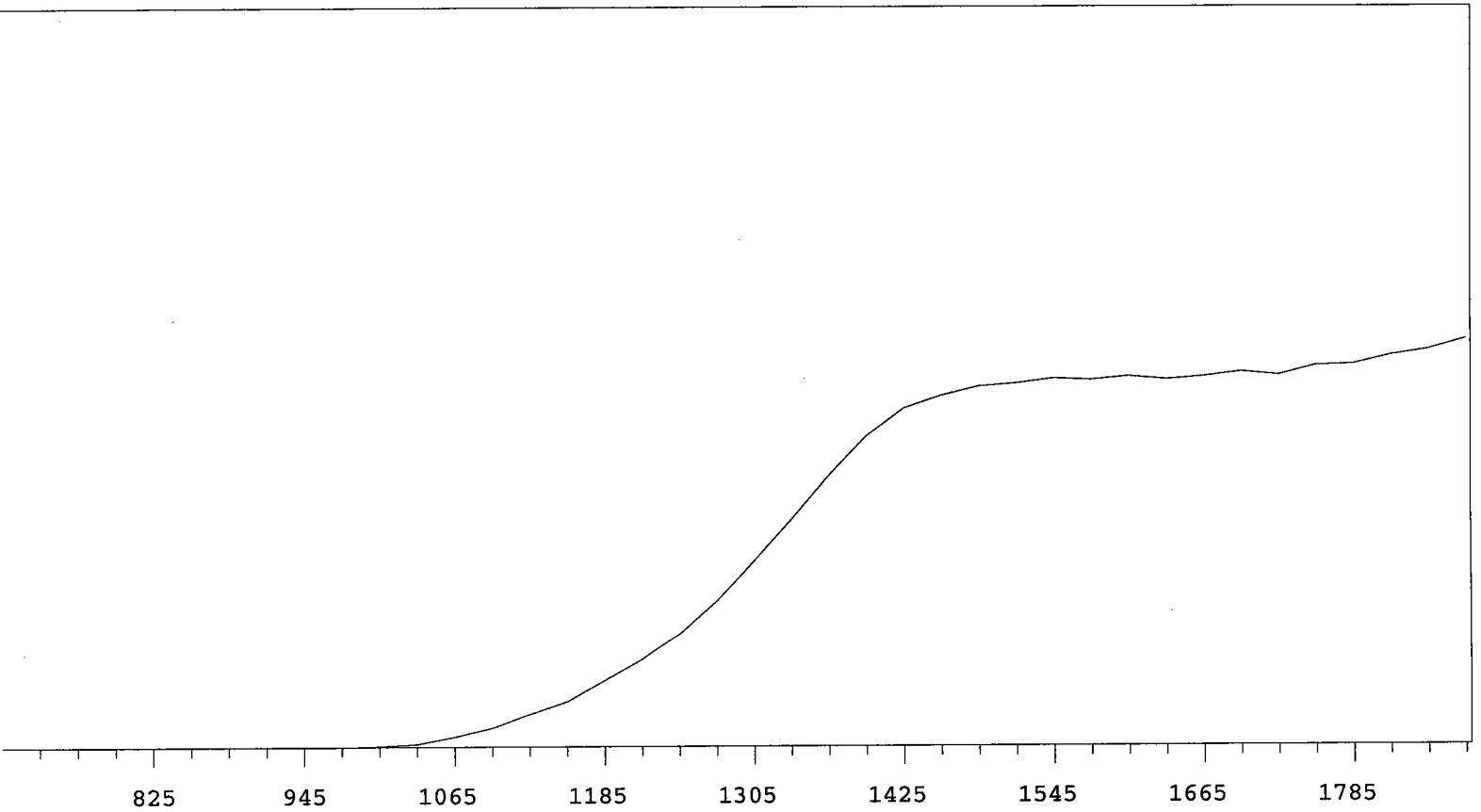
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	7679	+65.97
735	0		1335	9737	+57.57
765	0		1365	11301	+45.87
795	0	>100	1395	12767	+31.71
825	0	>100	1425	13767	+19.90
855	1	+83.33	1455	14399	+10.72
885	1	+55.56	1485	14467	+4.38
915	0	>100	1515	14671	+2.12
945	1	>100	1545	14576	+2.61
975	9	>100	1575	14808	+1.80
1005	60	>100	1605	14974	+3.15
1035	173	>100	1635	14872	+1.76
1065	480	>100	1665	15248	-0.41
1095	911	>100	1695	15067	-0.27
1125	1508	>100	1725	14784	-0.43
1155	2024	>100	1755	15044	+2.01
1185	2872	+97.38	1785	15163	+2.82
1215	3858	+89.30	1815	15333	+3.61
1245	5070	+78.02	1845	15278	
1275	6322	+73.30	1875	15817	

Alpha Volts: 705

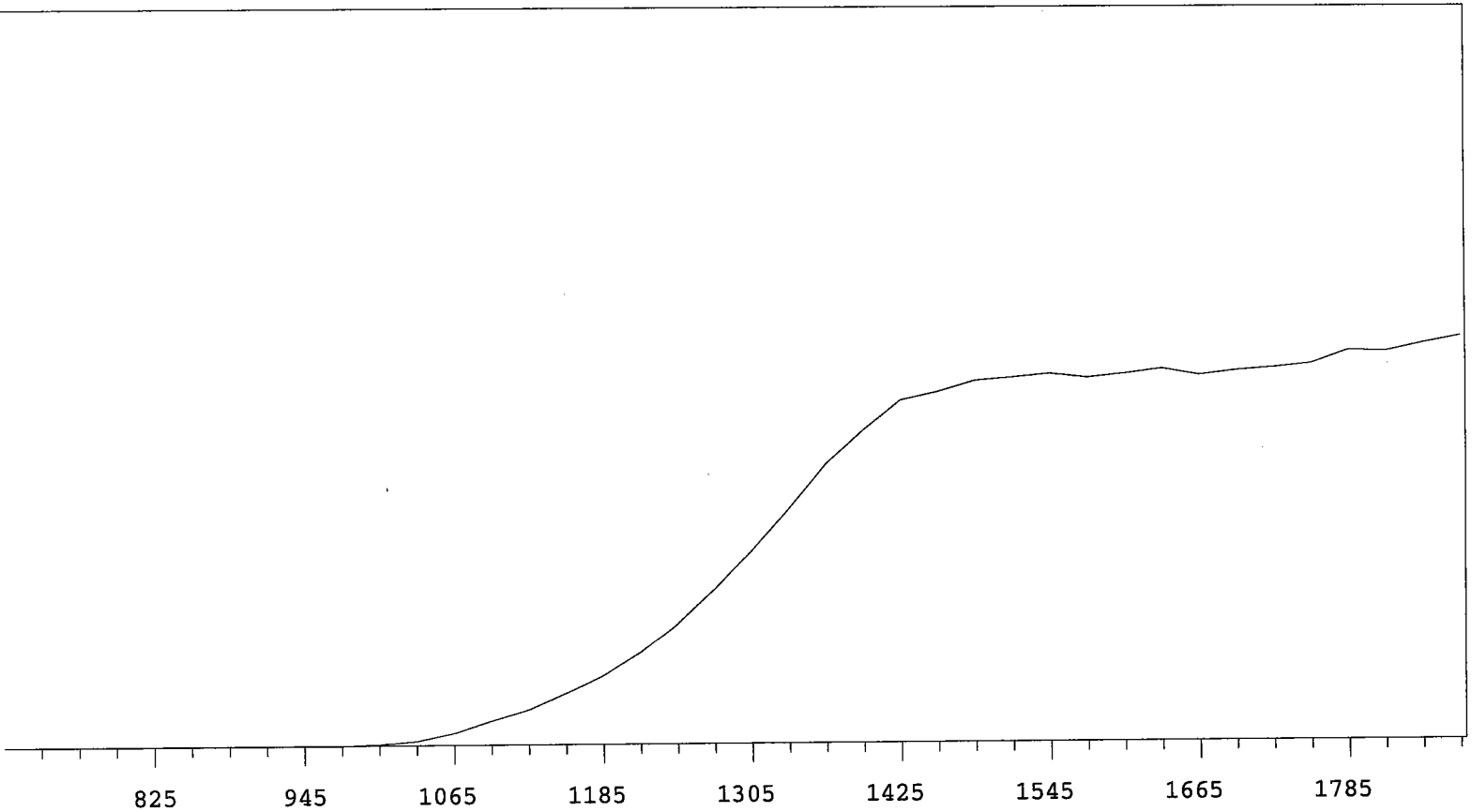
Beta Volts: 1515



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	6302	+80.03
735	1		1335	8191	+73.78
765	0		1365	10140	+66.18
795	0	>100	1395	12247	+55.83
825	0	>100	1425	14468	+43.92
855	0	>100	1455	16303	+31.28
885	0	>100	1485	17411	+18.64
915	0	>100	1515	18150	+9.87
945	0	>100	1545	18275	+5.30
975	1	>100	1575	18496	+3.16
1005	3	>100	1605	18685	+2.66
1035	17	>100	1635	18820	+2.63
1065	84	>100	1665	18855	+4.16
1095	267	>100	1695	19152	+7.70
1125	709	>100	1725	19706	+13.90
1155	1299	>100	1755	20640	+26.51
1185	1813	>100	1785	22308	+40.92
1215	2638	>100	1815	26460	+51.46
1245	3777	+96.47	1845	31616	
1275	4915	+87.98	1875	37348	



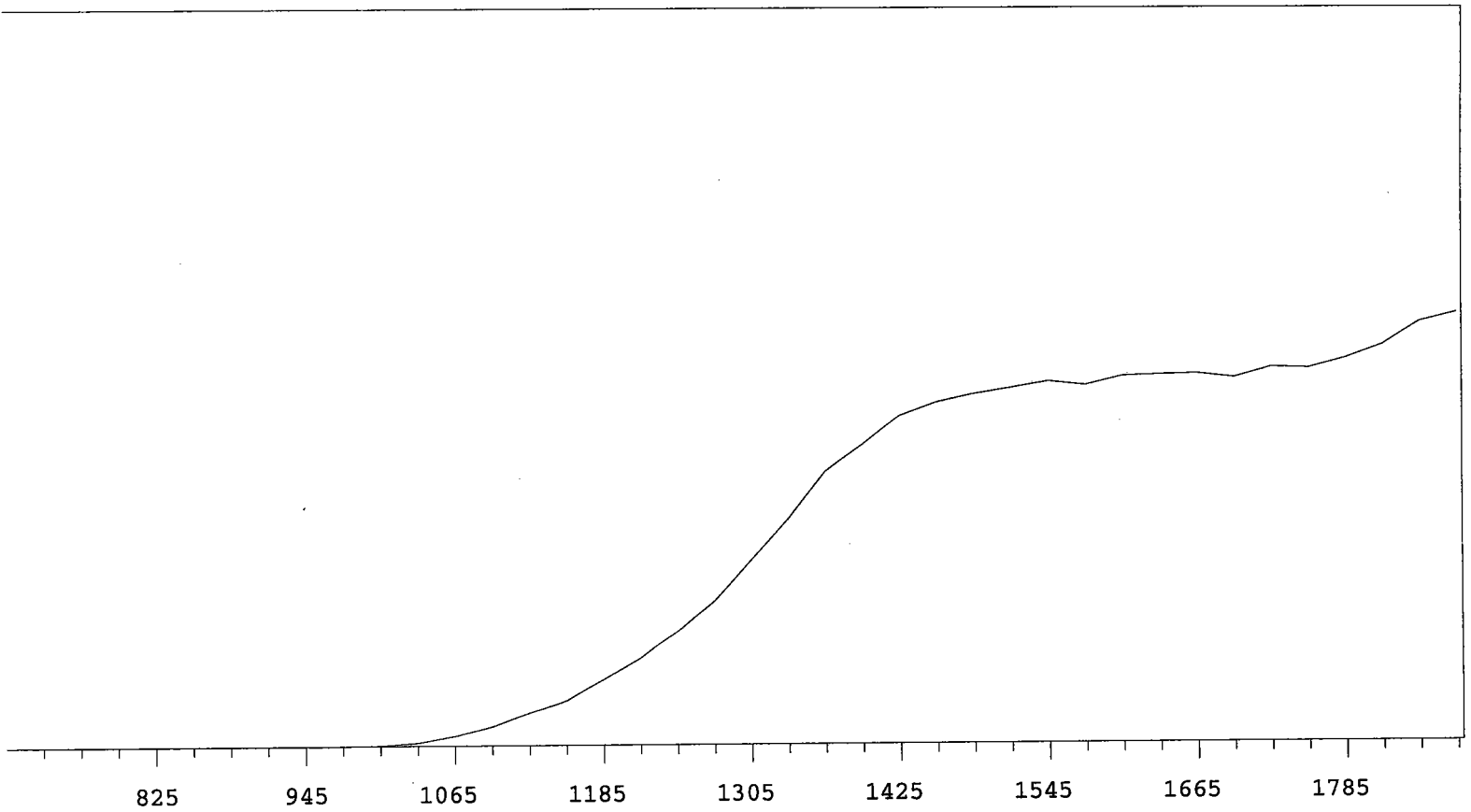
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	10207	+70.42
735	0		1335	12473	+60.75
765	0		1365	14900	+48.87
795	0	>100	1395	17101	+35.36
825	0	>100	1425	18643	+22.53
855	1	+83.33	1455	19350	+12.34
885	1	-83.33	1485	19848	+6.68
915	0	-55.56	1515	20014	+3.51
945	0	>100	1545	20278	+2.03
975	1	>100	1575	20186	+0.80
1005	43	>100	1605	20375	+0.32
1035	165	>100	1635	20209	+1.36
1065	557	>100	1665	20364	+0.83
1095	1055	>100	1695	20607	+2.43
1125	1775	>100	1725	20429	+2.51
1155	2470	>100	1755	20924	+3.64
1185	3617	+98.46	1785	20984	+5.11
1215	4757	+90.95	1815	21470	+5.63
1245	6186	+83.59	1845	21773	
1275	8021	+77.85	1875	22346	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	9543	+67.01
735	0		1335	11617	+56.47
765	0		1365	13791	+45.47
795	0	>100	1395	15387	+31.66
825	0	>100	1425	16819	+20.02
855	0	>100	1455	17210	+11.63
885	1	+0.00	1485	17742	+6.05
915	0	>100	1515	17892	+3.04
945	0	>100	1545	18070	+1.09
975	7	>100	1575	17856	+1.43
1005	52	>100	1605	18054	+0.42
1035	214	>100	1635	18287	+1.06
1065	590	>100	1665	17969	+0.78
1095	1201	>100	1695	18187	+1.48
1125	1759	>100	1725	18317	+4.89
1155	2569	>100	1755	18518	+4.76
1185	3440	+95.13	1785	19156	+5.18
1215	4583	+87.74	1815	19100	+5.18
1245	5985	+81.67	1845	19496	
1275	7682	+74.54	1875	19842	

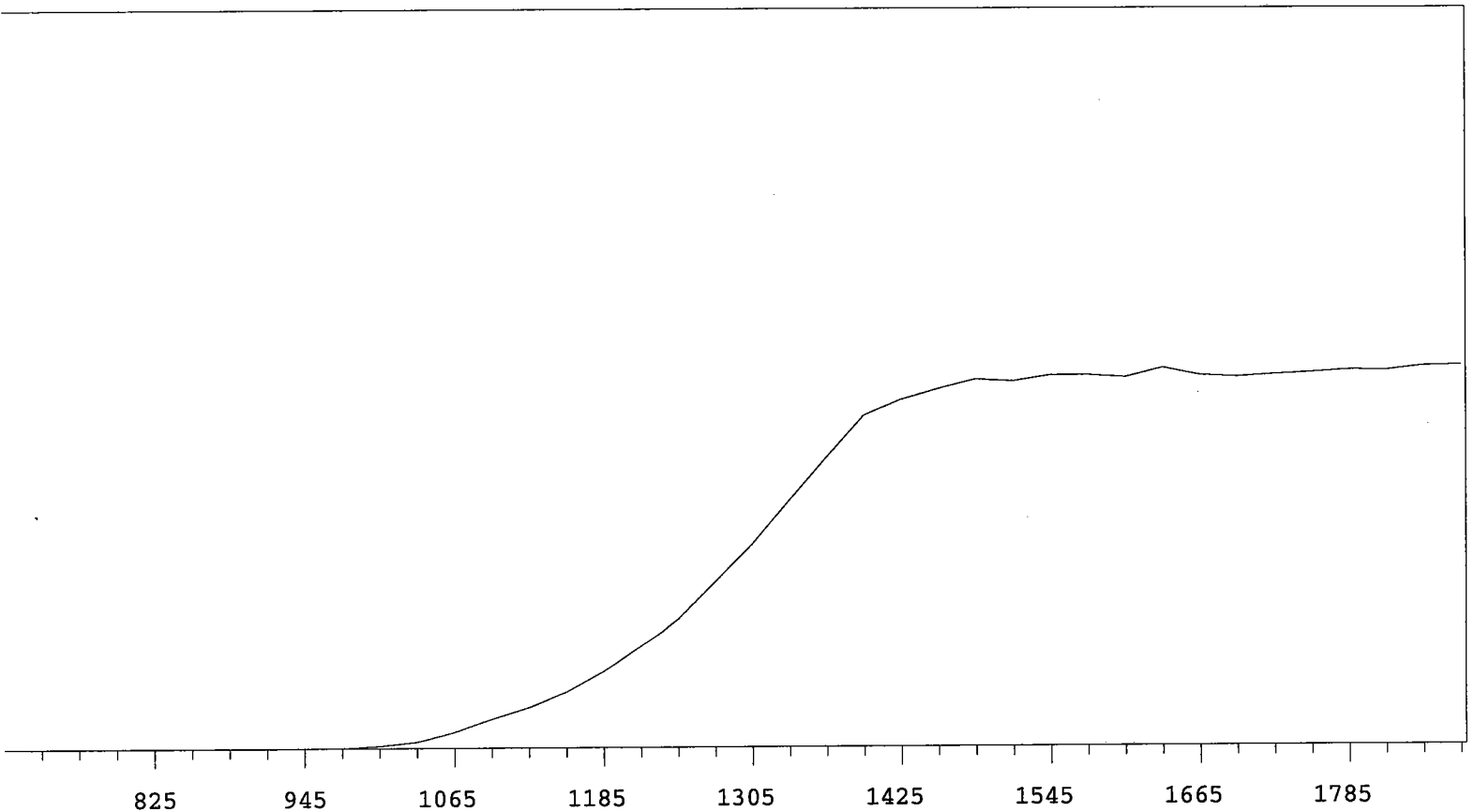
Alpha Volts: 705

Beta Volts: 1515

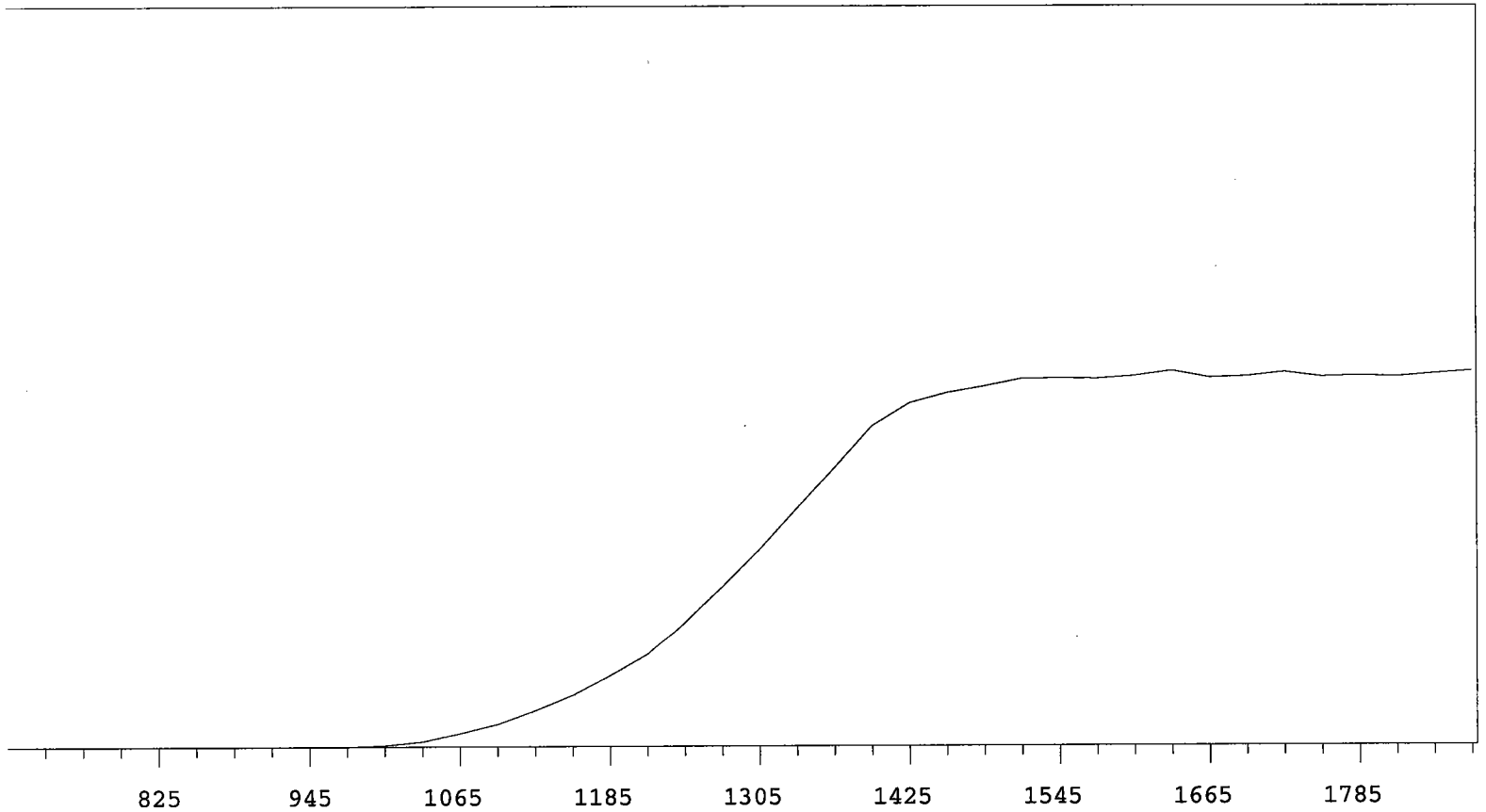


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	9144	+69.92
735	0		1335	11120	+58.43
765	0		1365	13399	+45.40
795	0	>100	1395	14711	+32.57
825	0	>100	1425	16134	+20.69
855	0	>100	1455	16805	+13.46
885	0	>100	1485	17209	+7.90
915	0	>100	1515	17500	+4.31
945	0	>100	1545	17812	+3.48
975	4	>100	1575	17629	+2.80
1005	26	>100	1605	18066	+2.23
1035	169	>100	1635	18122	+1.44
1065	483	>100	1665	18166	+1.20
1095	955	>100	1695	17967	+1.60
1125	1639	>100	1725	18469	+3.41
1155	2233	>100	1755	18409	+6.35
1185	3262	+98.61	1785	18884	+9.47
1215	4306	+89.77	1815	19535	+11.98
1245	5662	+82.36	1845	20630	
1275	7113	+76.36	1875	21076	

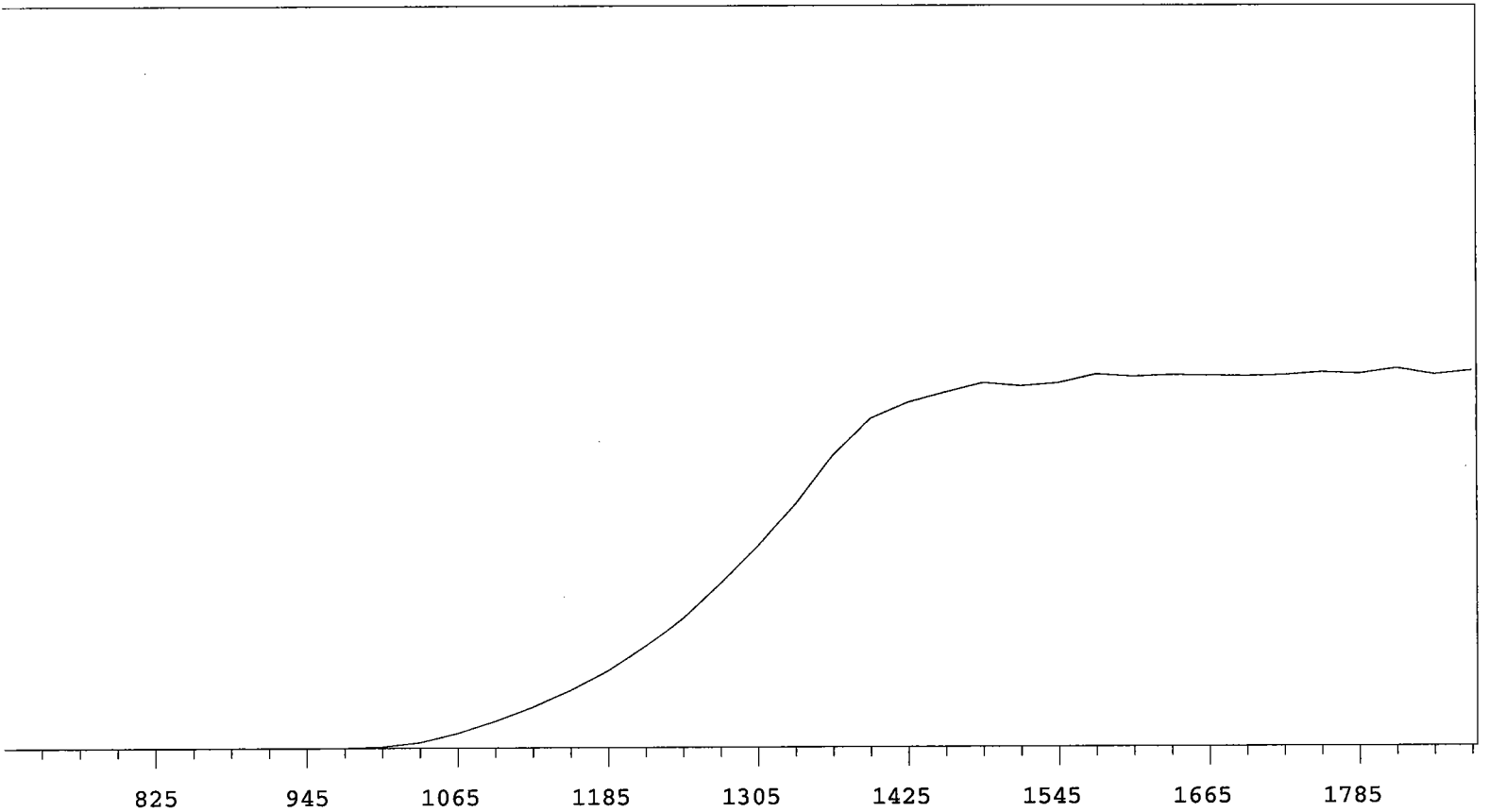




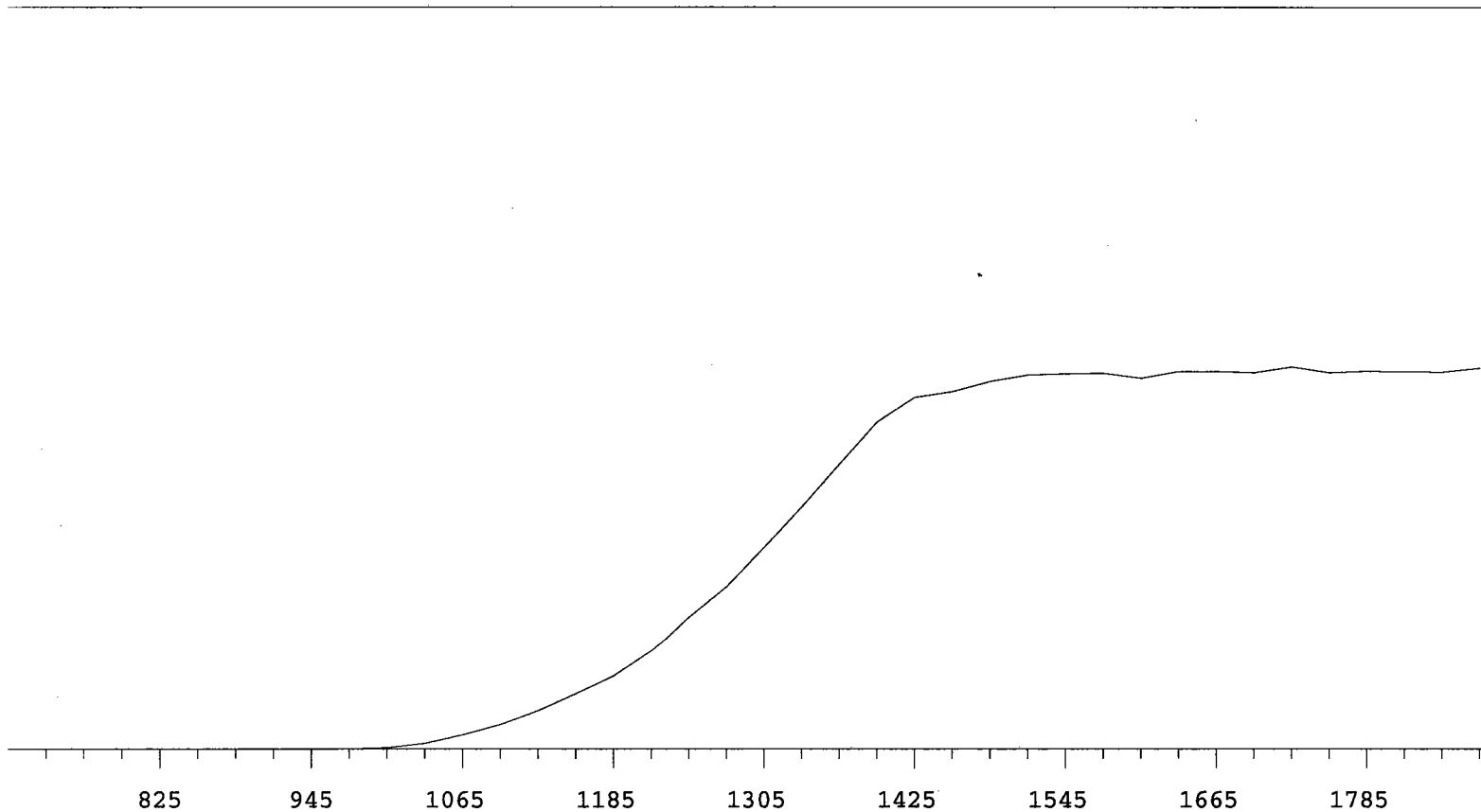
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	9209	+64.55
735	1		1335	11200	+55.94
765	0	+55.56	1365	13123	+43.27
795	2	>100	1395	14957	+29.04
825	0	+0.00	1425	15658	+17.41
855	0	>100	1455	16123	+8.01
885	1	>100	1485	16530	+4.92
915	0	>100	1515	16437	+2.71
945	1	>100	1545	16704	+0.83
975	14	>100	1575	16707	+2.14
1005	104	>100	1605	16602	+0.55
1035	281	>100	1635	17024	-0.28
1065	720	>100	1665	16684	-0.42
1095	1302	>100	1695	16597	-0.85
1125	1834	>100	1725	16711	+1.27
1155	2544	>100	1755	16796	+1.51
1185	3485	+92.28	1785	16903	+1.57
1215	4624	+85.50	1815	16880	+1.46
1245	5878	+77.82	1845	17066	
1275	7515	+71.49	1875	17085	



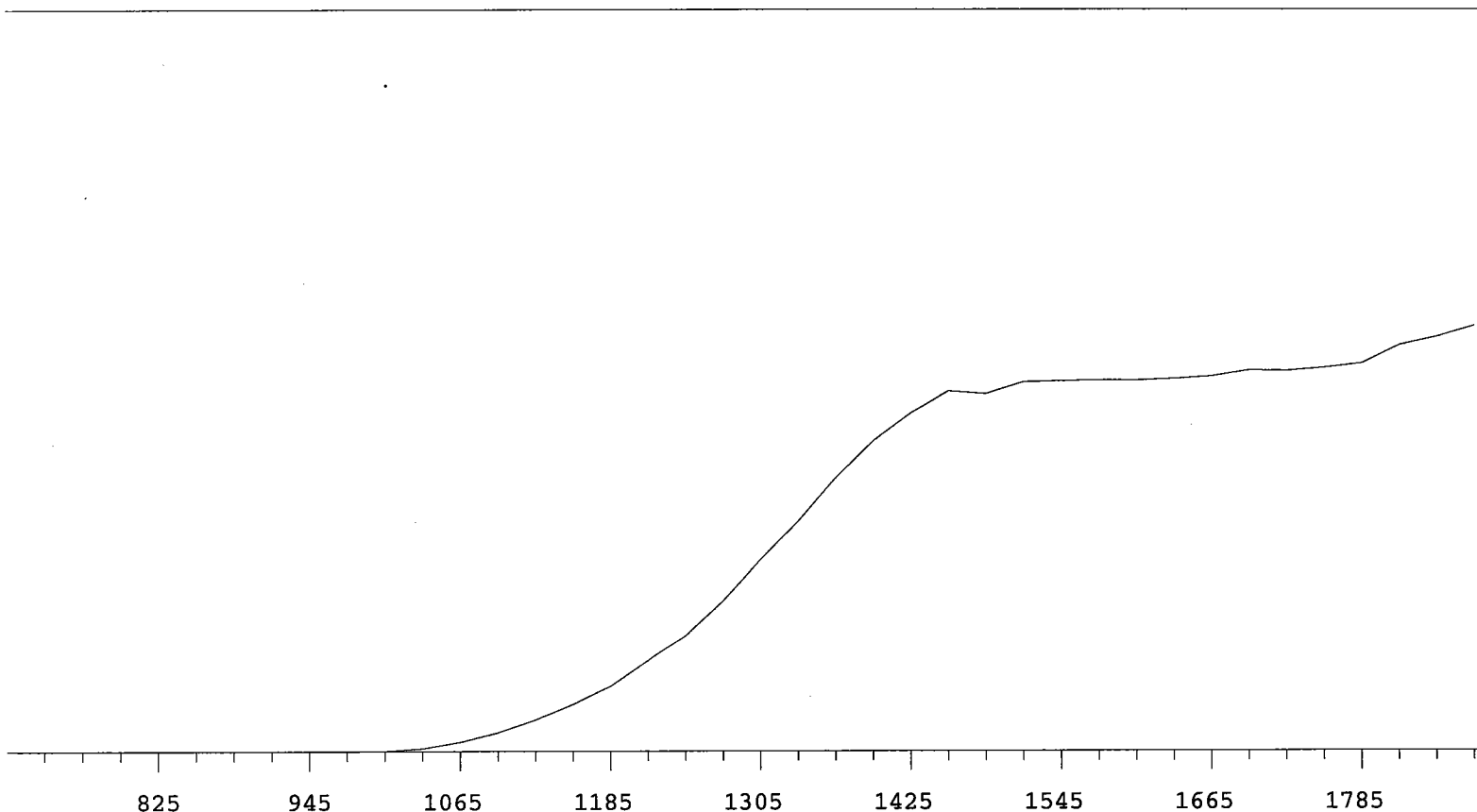
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	9666	+64.39
735	0		1335	11722	+55.91
765	0		1365	13680	+44.91
795	0	>100	1395	15677	+31.56
825	0	>100	1425	16786	+19.46
855	0	>100	1455	17283	+10.57
885	0	>100	1485	17608	+5.95
915	1	>100	1515	17972	+3.32
945	0	>100	1545	18006	+1.84
975	4	>100	1575	17970	+1.58
1005	70	>100	1605	18104	+0.74
1035	257	>100	1635	18351	+0.24
1065	648	>100	1665	18016	+0.16
1095	1116	>100	1695	18080	-0.63
1125	1784	>100	1725	18283	+0.29
1155	2560	>100	1755	18047	-0.47
1185	3531	+96.11	1785	18110	-0.32
1215	4568	+89.22	1815	18040	+1.17
1245	6137	+81.65	1845	18200	
1275	7855	+74.42	1875	18320	



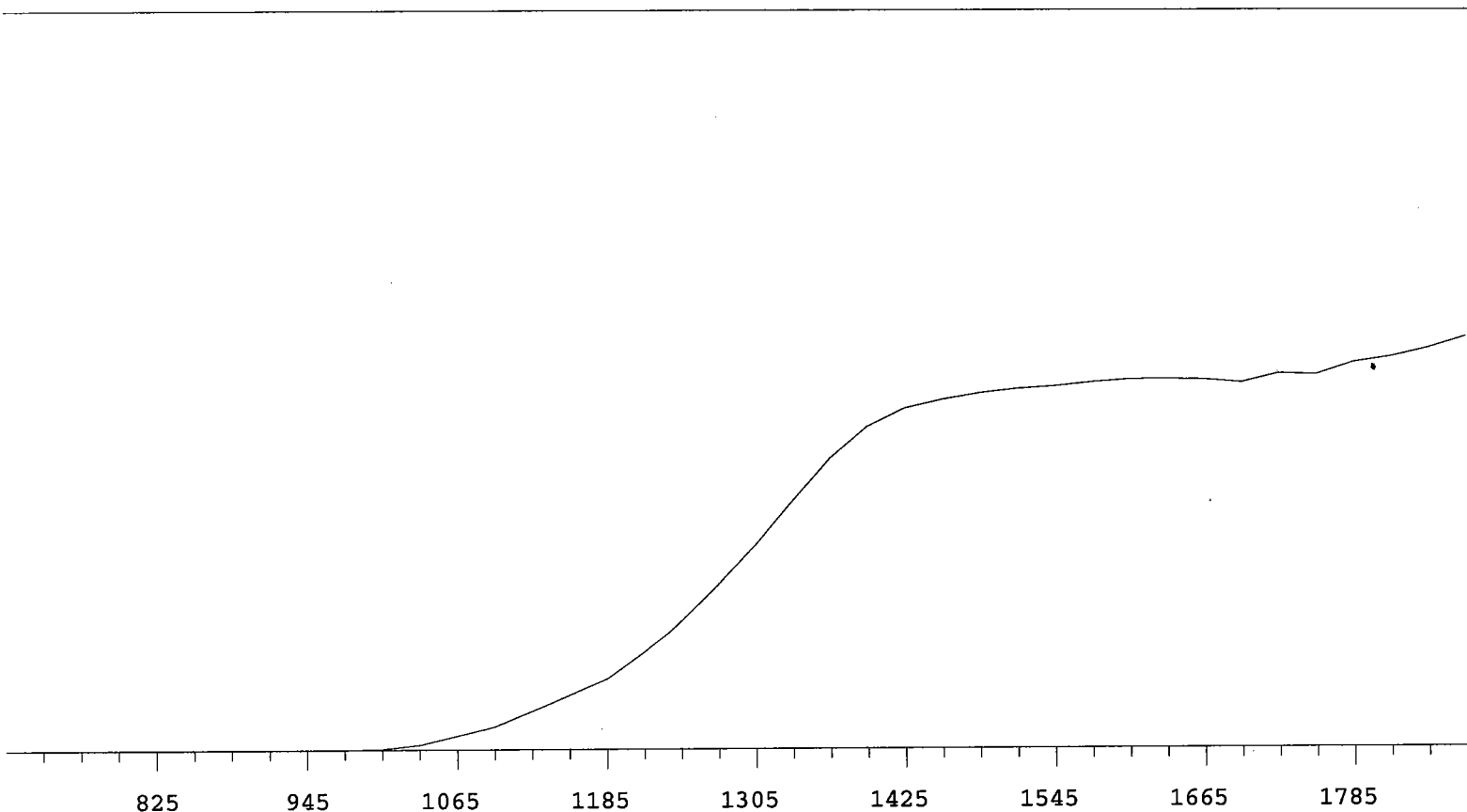
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	11573	+64.95
735	0		1335	13929	+56.47
765	0		1365	16726	+43.82
795	0	>100	1395	18834	+29.38
825	0	>100	1425	19743	+16.84
855	0	>100	1455	20314	+7.95
885	0	>100	1485	20860	+4.16
915	0	>100	1515	20670	+3.23
945	0	>100	1545	20844	+2.09
975	9	>100	1575	21330	+2.48
1005	93	>100	1605	21188	+1.16
1035	325	>100	1635	21280	-0.32
1065	834	>100	1665	21237	+0.08
1095	1525	>100	1695	21202	+0.42
1125	2318	>100	1725	21254	+0.60
1155	3233	>100	1755	21406	+1.41
1185	4357	+92.07	1785	21326	+0.42
1215	5755	+85.64	1815	21619	+0.16
1245	7438	+78.35	1845	21282	
1275	9463	+70.89	1875	21478	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	7524	+61.93
735	0		1335	9002	+55.36
765	0		1365	10542	+44.70
795	0	>100	1395	12064	+31.21
825	0	>100	1425	12981	+19.20
855	0	>100	1455	13192	+10.41
885	0	>100	1485	13570	+5.93
915	0	>100	1515	13820	+4.08
945	0	>100	1545	13866	+0.75
975	9	>100	1575	13880	+0.21
1005	58	>100	1605	13695	+0.59
1035	228	>100	1635	13950	+0.77
1065	544	>100	1665	13954	+1.92
1095	936	>100	1695	13911	+0.19
1125	1468	>100	1725	14116	+0.02
1155	2110	>100	1755	13908	-0.24
1185	2770	+94.71	1785	13960	-0.81
1215	3670	+85.91	1815	13939	+0.71
1245	4937	+79.46	1845	13931	
1275	6066	+70.79	1875	14071	



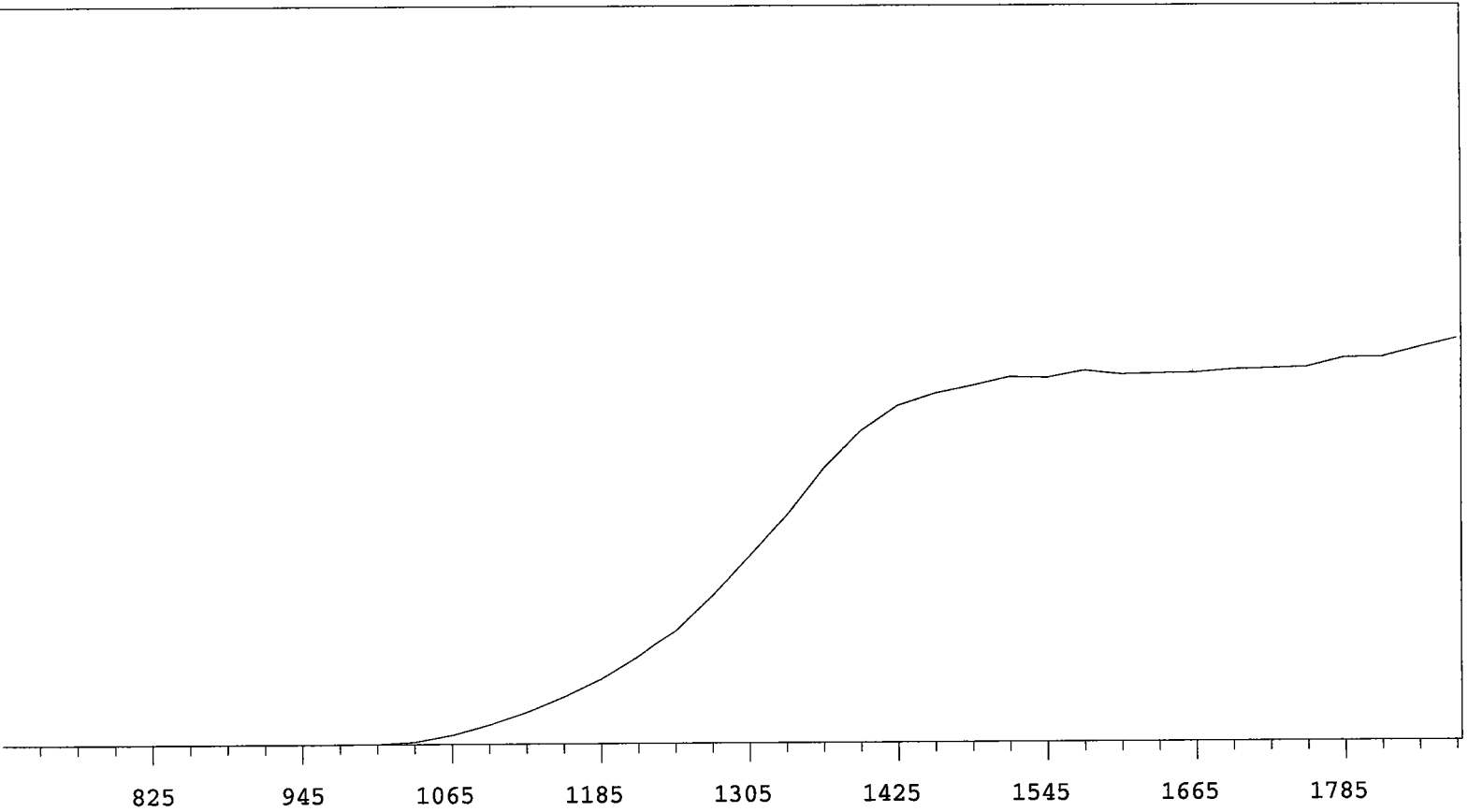
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	8778	+67.49
735	0		1335	10502	+57.68
765	0		1365	12516	+46.36
795	0	>100	1395	14215	+35.88
825	0	>100	1425	15472	+22.01
855	0	>100	1455	16469	+12.99
885	1	+0.00	1485	16342	+6.70
915	0	>100	1515	16874	+3.07
945	0	>100	1545	16918	+2.53
975	0	>100	1575	16950	+0.58
1005	18	>100	1605	16943	+0.95
1035	137	>100	1635	17008	+2.13
1065	430	>100	1665	17130	+2.45
1095	865	>100	1695	17403	+2.43
1125	1444	>100	1725	17377	+2.43
1155	2151	>100	1755	17515	+4.88
1185	2981	>100	1785	17710	+7.54
1215	4168	+92.14	1815	18533	+9.04
1245	5377	+84.73	1845	18905	
1275	6924	+74.92	1875	19415	



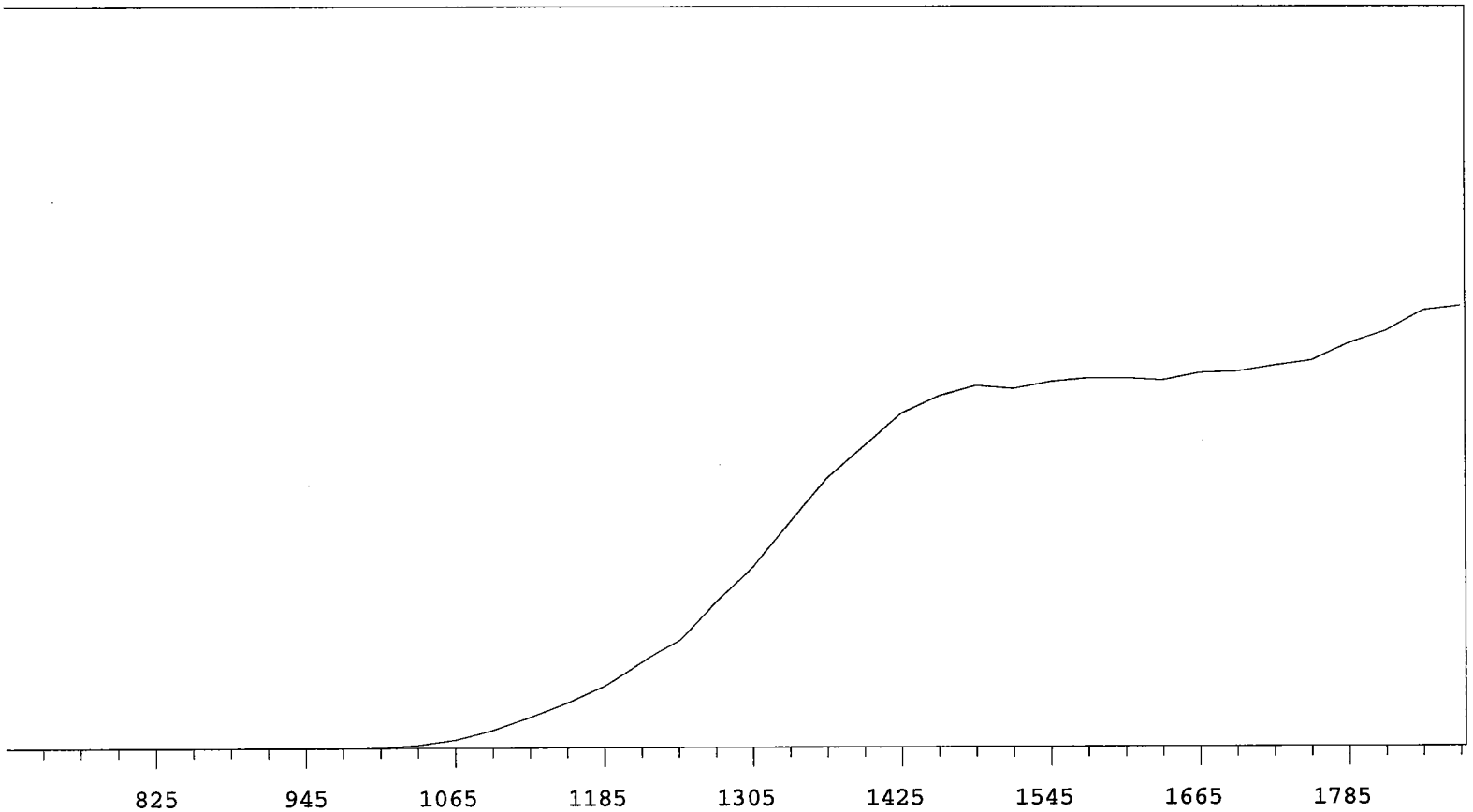
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	8797	+65.44
735	0		1335	10726	+54.47
765	0		1365	12570	+41.11
795	0	>100	1395	13917	+26.79
825	0	>100	1425	14687	+15.44
855	1	+0.00	1455	15048	+8.47
885	0	>100	1485	15318	+5.00
915	0	>100	1515	15494	+3.76
945	0	>100	1545	15606	+3.04
975	3	>100	1575	15776	+2.35
1005	40	>100	1605	15889	+1.44
1035	210	>100	1635	15907	-0.16
1065	590	>100	1665	15881	+0.64
1095	983	>100	1695	15741	+1.21
1125	1645	>100	1725	16124	+3.63
1155	2342	>100	1755	16076	+5.41
1185	3045	+96.43	1785	16588	+5.79
1215	4201	+90.42	1815	16830	+7.53
1245	5579	+83.64	1845	17185	
1275	7121	+74.44	1875	17682	

Alpha Volts: 705

Beta Volts: 1515



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	10118	+69.76
735	0		1335	12269	+59.65
765	0		1365	14810	+47.35
795	0	>100	1395	16773	+33.46
825	0	>100	1425	18104	+20.13
855	0	>100	1455	18720	+11.98
885	1	+0.00	1485	19122	+6.50
915	0	>100	1515	19580	+4.77
945	0	>100	1545	19527	+2.48
975	2	>100	1575	19902	+0.81
1005	21	>100	1605	19690	+0.53
1035	132	>100	1635	19739	+0.23
1065	491	>100	1665	19765	+1.29
1095	1036	>100	1695	19932	+1.40
1125	1698	>100	1725	19976	+2.72
1155	2517	>100	1755	20051	+2.92
1185	3468	>100	1785	20523	+4.26
1215	4721	+91.83	1815	20542	+5.57
1245	6175	+85.13	1845	21035	
1275	8025	+76.82	1875	21528	



VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	8095	+71.16
735	0		1335	10052	+58.38
765	0		1365	11990	+47.92
795	0	>100	1395	13400	+35.01
825	0	>100	1425	14808	+23.58
855	0	>100	1455	15554	+13.45
885	0	>100	1485	15987	+6.39
915	0	>100	1515	15861	+3.45
945	0	>100	1545	16156	+2.18
975	1	>100	1575	16297	+1.72
1005	14	>100	1605	16297	+1.33
1035	130	>100	1635	16208	+1.62
1065	363	>100	1665	16526	+2.92
1095	785	>100	1695	16581	+3.94
1125	1357	>100	1725	16832	+5.91
1155	1996	>100	1755	17039	+8.68
1185	2735	+99.45	1785	17800	+11.53
1215	3785	+94.20	1815	18351	+11.46
1245	4857	+86.43	1845	19265	
1275	6571	+78.80	1875	19468	



# CERTIFICATE OF CALIBRATION

## Standard Radionuclide Source

66002-278

Ra-228 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated using a germanium gamma spectrometer system.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Ra-228
ACTIVITY (dps):	2.367 E4
HALF-LIFE:	5.75 years
CALIBRATION DATE:	April 23, 2003 12:00 EST
TOTAL UNCERTAINTY*:	2.4%

\*95% Confidence Level

Impurities:  $\gamma$ -impurities (other than decay products) <0.1%,  
Ra-226 <0.1%

5.31628 grams 4M HCl solution with 100  $\mu$ g/g Ba carrier.

P O NUMBER 3219 RD, Item 1

SOURCE PREPARED BY:

M. Taskaeva  
M. Taskaeva, Radiochemist

Q A APPROVED:

JM. Muty 4-23-03



# Standard Traceability Log Rad

Source Material Info		A Solution Material Info	
Parent Code:	0553-A	Isotope:	Radium-228 SPIKE
Prepared By:	Lonnie Morris	Prepared By:	Lonnie Morris
Carrier Conc:	0.5M HCl	Prep Date:	04/25/2003
Reference Date:	04/23/2003	Verification Date:	04/27/2005
Ampoule Mass (g):	5.0235 g	Expiration Date:	04/27/2006
Uncertainty:	+/-	Primary Code:	0553-B
LogBook No:	RC-S-035-068	Dilution(mL):	1000 mL
		Mass of Parent(g):	30.535 g
		Density(g/mL):	
		Balance ID:	

### Calculations Converting parent activity to dpm/mL|dpm/g

$(\text{Mass of parent(g)}) * (\text{Parent Activity (dpm/mL)}) * (\text{conversion dpm to dpm}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$
$(\text{Mass of parent(g)}) * (\text{Parent Activity (dpm/mL)}) * (\text{conversion dpm to dpm}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$
$(30.535 \text{ g}) * (13419.8626 \text{ dpm/mL}) * (1 \text{ dpm/dpm}) / (1000 \text{ mL}) = 409.7755 \text{ dpm/mL}$
$(30.535 \text{ g}) * (13419.8626 \text{ dpm/mL}) * (1 \text{ dpm/dpm}) / (\text{g/mL}) / (1000 \text{ mL}) = \text{dpm/g}$

### Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date

GEL Laboratories LLC  
Version 1.0 9/18/2000

# CERTIFICATE OF CALIBRATION

## Standard Radionuclide Source

64673-278

Ra-228 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated using a germanium gamma spectrometer system.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Ra-228
ACTIVITY (dps):	1.939 E4
HALF-LIFE:	5.75 years
CALIBRATION DATE:	October 1, 2002 12:00 EST
TOTAL UNCERTAINTY*:	3.6%
SYSTEMATIC:	3.4%
RANDOM:	1.1%

\*99% Confidence Level

Impurities:  $\gamma$ -impurities <0.1%

5.02617 grams 0.1M HCl solution with 110  $\mu\text{g/g}$  Ba carrier.

P O NUMBER 3208RD, Item 2

SOURCE PREPARED BY: M. Taskaeva  
M. Taskaeva, Radiochemist

Q A APPROVED:

M. M. Ty 10202



# Standard Traceability Log Rad

Source Material Info		A Solution Material Info	
Parent Code:	0503	Isotope:	Radium-228
Prepared By:	Angela Johnson	Prepared By:	Angela Johnson
Carrier Conc:	0.1 M HCL	Prep Date:	02/20/2003
Reference Date:	10/01/2002	Verification Date:	04/09/2004
Ampoule Mass (g):	5.02617 g	Expiration Date:	04/09/2005
Uncertainty:	+/- 3.6 %	Primary Code:	0503-A
LogBook No:	RC S 035 018	Dilution(mL):	100 mL
		Mass of Parent(g):	4.4737 g
		Density(g/mL):	0.9992
		Balance ID:	

### Calculations Converting parent activity to dpm/mL/dpm/g

$(\text{Mass of parent(g)}) * (\text{Parm Activity (dps)}) * (\text{conversion dpm to dps}) / (\text{Ampoule Mass(g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/mL)}$
$(\text{Mass of parent(g)}) * (\text{Parm Activity (dps)}) * (\text{conversion dpm to dps}) / \text{Density} / (\text{Ampoule Mass (g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/g)}$
$(4.4737 \text{ g}) * (19390 \text{ dps}) * (60 \text{ dpm/dps}) / (5.02617 \text{ g} * 100 \text{ mL}) = 10355.2060 \text{ dpm/mL}$
$(4.4737 \text{ g}) * (19390 \text{ dps}) * (60 \text{ dpm/dps}) / (0.9992 \text{ g/mL}) / (5.02617 \text{ g} * 100 \text{ mL}) = 10363.0820 \text{ dpm/g}$

### Secondary Standards

Prep Date	Preparer	Mass Primary	Dilution (mL)	Code	Conc dpm/mL	Verification Date	Expiration Date
04/02/2003	Lonnie Morris	39.71	1000	0503-B	411.518 dpm/mL	09/13/2008	09/13/2009

GEL Laboratories LLC  
Version 1.0 9/18/2000

## Verification for Ra-228 Standard 0503-B

D. Roy 9/13/2008	Isotope	Detector CPM	BKG CPM	NET CPM	Detector Eff. Mass. Used (mL)	Standard Source DPM/mL
	0503-B	1962.0000	45.6000	1916.4000	9.263763	1.0000 206.8705773
	0503-B	1983.2000	45.6000	1937.6000	9.263763	1.0000 209.1590642
	0503-B	1927.0000	45.6000	1881.4000	9.263763	1.0000 203.092415

Mean Value (Counting) = 206.3740189 dpm/mL      102.890426      Pass  
 Stdev = 3.063655617 dpm/mL      0.01484516      Rule 3 (Pass/Fail)

Certificate Value = 200.596 dpm/mL  
 Lower Limit = 200.2467076 dpm/mL  
 Upper Limit = 212.5013301 dpm/mL  
 Rule 1 Pass/Fail Pass  
 Two sigma = 6.127311233  
 10 % of Mean = 20.63740189  
 Rule 2 (Pass/Fail) Pass

### Verification Rules

- Rule 1 = The certificate value (NOT including any uncertainty) shall lie within the 95% confidence interval determined from the mean and two sigma standard deviation of the three measurements
- Rule 2 = The two sigma value used for the 95% confidence interval shall not exceed 10% of the mean value of the three verification measurements.
- Rule 3 = The determined mean value shall be within 10% of the certificate value.

The analyst prepared three standard verification sources for Ra-228 source 0503-B by transferring portions of the standard into glass liquid scintillation vials. Ten mL of Ready Gel liquid scintillation cocktail was added to each vial and the vials were shaken to mix. A Blank vial was prepared in a similar fashion using 1 mL of DI water and 10 mL of Ready Gel cocktail. The standard verification vials and Background source were dark adapted for two hours and counted on LSC Gold for Ra-228 source standard verification. The Ra-228 efficiency calibration which was used for verification calculations was performed on 9/13/08 using source 0683-A (Ra-228). Calibration data is recorded in this logbook under Ra-228 0683-A. Each verification source calculation was performed as follows:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

Reference RAD SOP M-001

*David D. Perry* 9/16/08  
*Angela Johnson* 9/17/08

5/19/16  
28

16 SEP 2008 16:24

**ID: TOTAL ACTIVITY**

USER:11 COMMENT:GOLD

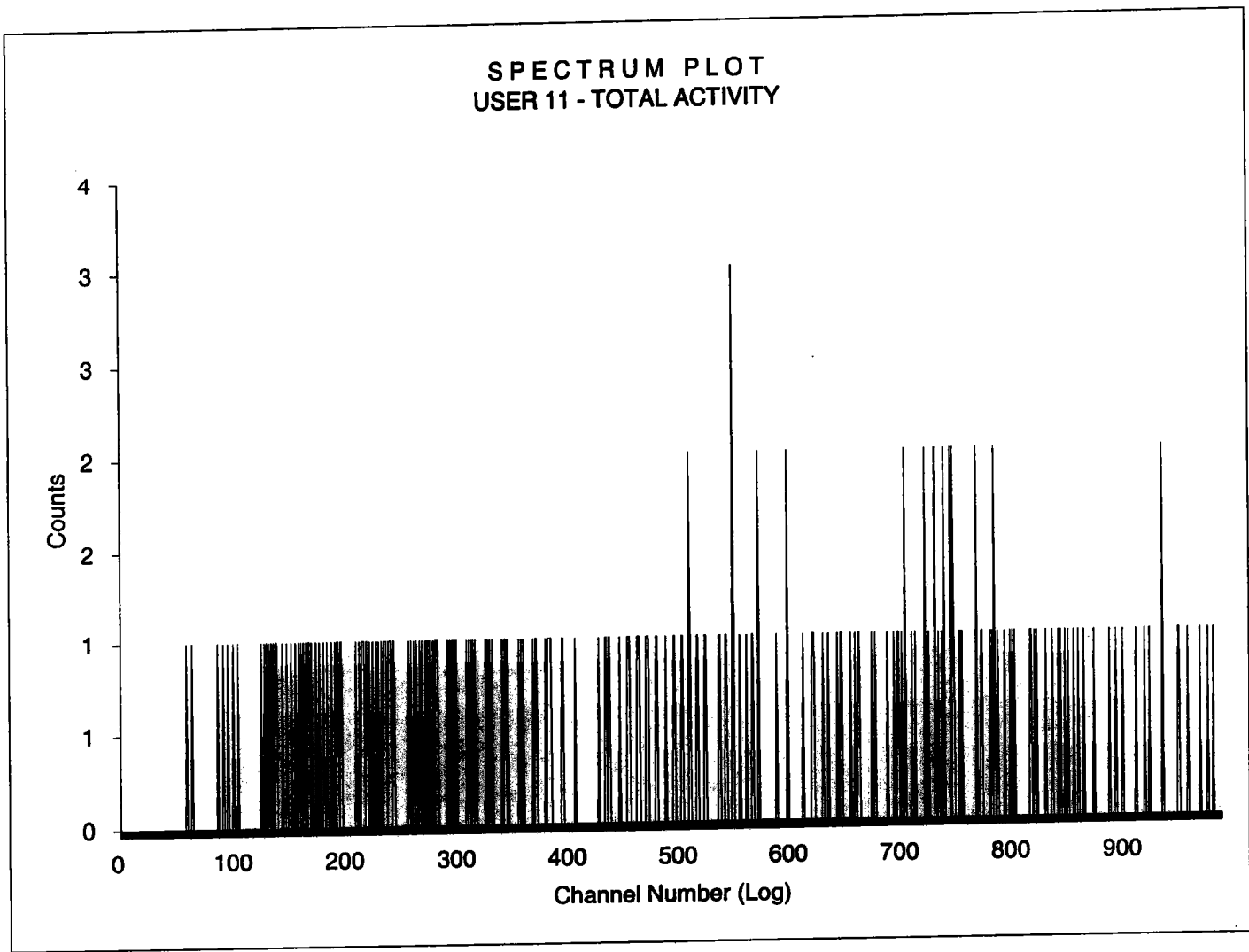
PRESET TIME : 5.00  
 DATA CALC : CPM H# :YES SAMPLE REPEATS: 1 PRINTER : STD  
 COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 :EDIT  
 TWO PHASE : NO AQC : NO CYCLE REPEATS : 1 DISK : OFF  
 SCINTILLATOR: LIQUID LUMEX:YES LOW SAMPLE REJ: 0  
 LOW LEVEL : NO HALF LIFE CORRECTION DATE: none

CHAN: 0.0 - 990.0 %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0  
 CHAN: 0.0 - 1000.0 %ERROR: 2.00 FACTOR: 1.000000 BKG. SUB: 0

SAM NO	POS	TIME MIN	H#	WIND1		WIND2		LUMEX %	ELAPSED TIME
				CPM	%ERROR	CPM	%ERROR		
1	11-1	5.00	98.2	50.40	12.60	54.00	12.17	0.41	5.55
2	11-2	1.30	99.3	7802.31	1.99	7803.08	1.99	0.00	7.81
3	11-3	1.30	100.4	7782.31	1.99	7786.15	1.99	0.00	10.14
4	11-4	1.35	99.2	7581.48	1.98	7585.19	1.98	0.01	12.51
5	11-5	5.00	97.9	45.60	13.25	47.20	13.02	0.43	18.61
6	11-6	5.00	110.7	1962.00	2.02	1964.80	2.02	0.01	24.65
7	11-7	5.00	110.8	1983.20	2.01	1984.80	2.01	0.01	30.75
8	11-8	5.00	110.7	1927.00	2.04	1927.80	2.04	0.02	36.85

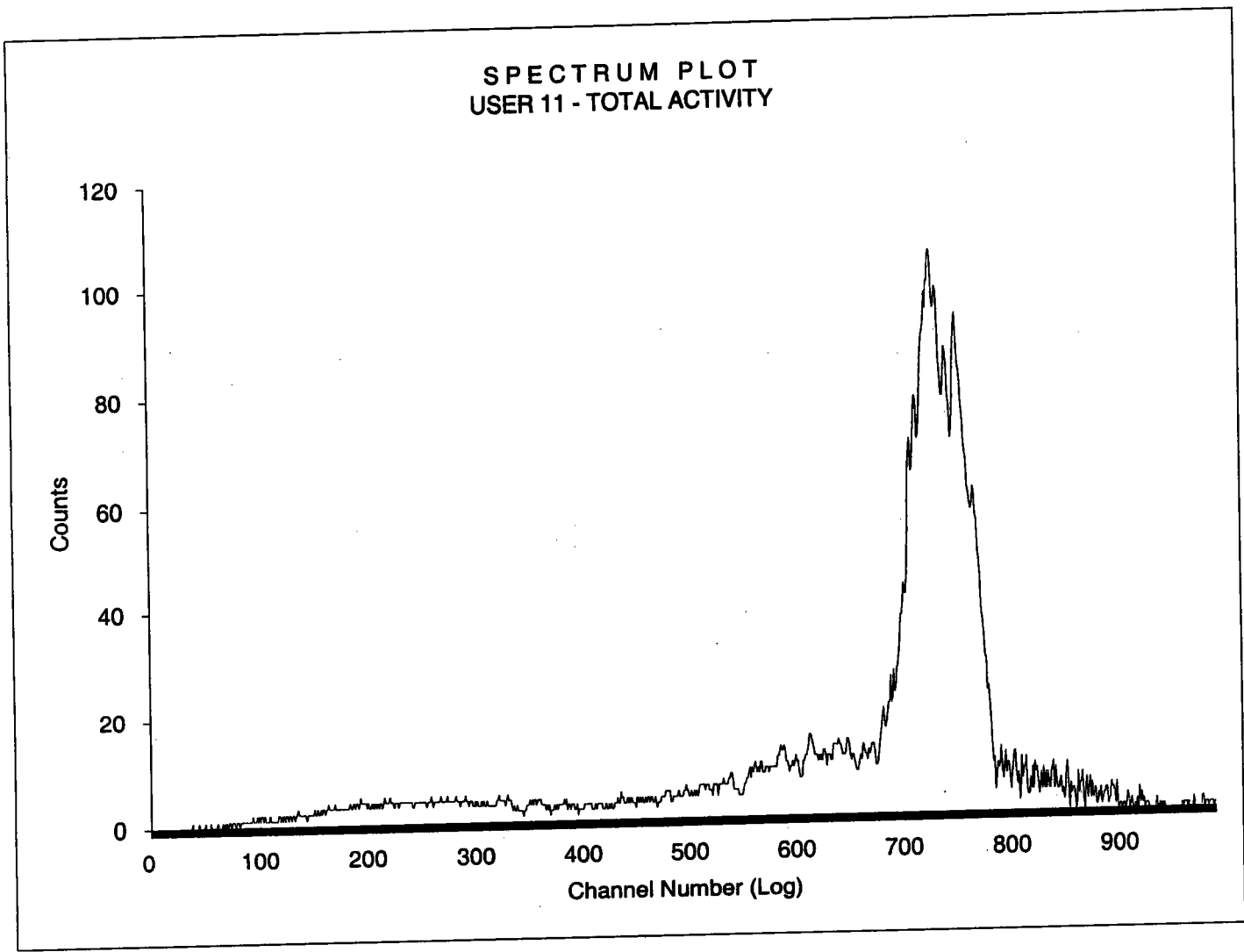
8/16/08  
228

Sample Count Start Time: 16 Sep 2008 16:46:59  
Data Capture Date: 9/16/2008 16:52:01  
User Filename: S11091611-5A.WK1  
U11091611-1A.WK1  
Spectrum Type: Log Counts  
User Number: 11  
User Id: TOTAL ACTIVITY  
User Comment: GOLD  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 5 11-5 5.00  
H#, Total Counts: 97.9 69  
Start, End, X-Axis: 0 990 Channel Number



50/9/16  
25

Sample Count Start Time: 16 Sep 2008 16:53:01  
Data Capture Date: 9/16/2008 16:58:06  
User Filename: S11091611-6A.WK1  
U11091611-1A.WK1  
Spectrum Type: Log Counts  
User Number: 11  
User Id: TOTAL ACTIVITY  
User Comment: GOLD  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 6 11-6 5.00  
H#, Total Counts: 110.7 7666  
Start, End, X-Axis: 0 990 Channel Number

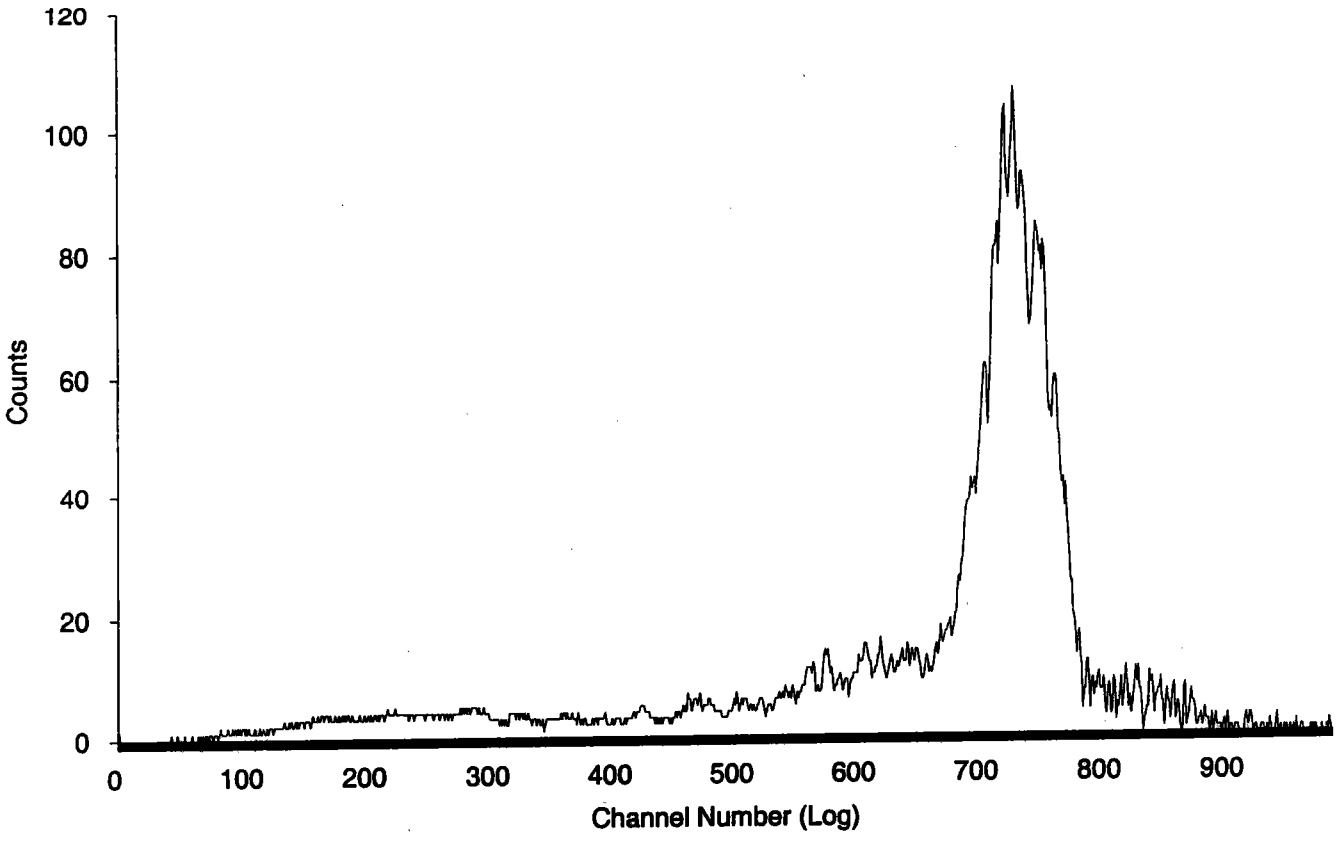




8/16/08  
SJS

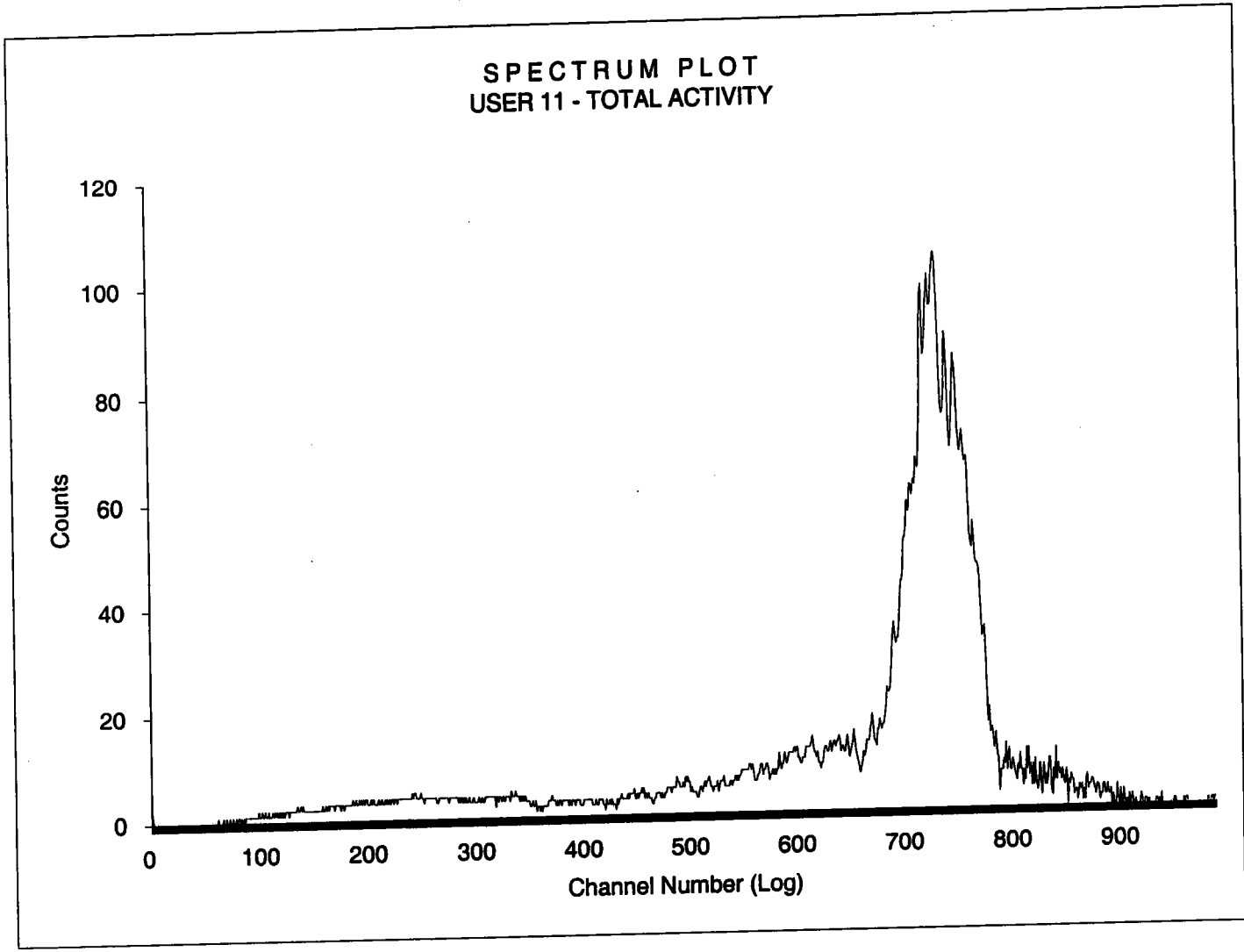
Sample Count Start Time: 16 Sep 2008 16:59:07  
Data Capture Date: 9/16/2008 17:04:12  
User Filename: S11091611-7A.WK1  
U11091611-1A.WK1  
Spectrum Type: Log Counts  
User Number: 11  
User Id: TOTAL ACTIVITY  
User Comment: GOLD  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 7 11-7 5.00  
H#, Total Counts: 110.8 7726  
Start, End, X-Axis: 0 990 Channel Number

SPECTRUM PLOT  
USER 11 - TOTAL ACTIVITY



9/16/08  
11-8

Sample Count Start Time: 16 Sep 2008 17:05:13  
Data Capture Date: 9/16/2008 17:10:18  
User Filename: S11091611-8A.WK1  
U11091611-1A.WK1  
Spectrum Type: Log Counts  
User Number: 11  
User Id: TOTAL ACTIVITY  
User Comment: GOLD  
Isotope Name: 14C  
Scintillator: LIQUID  
Sample, Rack-Pos, Time: 8 11-8 5.00  
H#, Total Counts: 110.7 7557  
Start, End, X-Axis: 0 990 Channel Number



# Radium-228 Que Sheet

SR 6/30/09

Batch #: 881540      Analyst: DXM2      Internal Due Date: 07/03/2009  
 Spike Isotope: Radium-228      Spike Code: NA      Ac-228 Ingrow: 2025 6/30/09  
 LCS Isotope: Radium-228      LCS Code: 0503-B      Expiration Date: 9/13/09  
 Tracer Isotope: Barium-133      Tracer Code: 0112-2      Expiration Date: 2/17/10  
 Prep Date: 6/30/09      Initials: JRS      Pipet ID: 1734212      Balance ID: NA  
 Ac-228 Separation Date/Time: 7-2-09 0540      Witness: JRS 6/30/09

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collect Date & Time	Pos. #	Vol (mL)	Det #	Ba Yield (%)	Gamma Det. #
1201872112-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	1	20		100.83	↑
1201872113-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	2	20		108.20	
1201872114-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	3	20		114.22	
1201872115-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	4	20		120.58	WZAL
1201872116-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	5	20		105.84	
1201872117-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	6	20		102.70	
1201872118-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	7	20		112.82	
1201872119-1	LCS for batch 881540	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT	16-JUN-09 03:56 PM	8	20		111.91	↓

JRS 7/2/09

SLC 7/2/09

Data Reviewed By:

Comments:

ASSAY 30-Jun-09 19:32:06

Protocol id 8 228\_REC  
Time limit 180  
Count limit 50000  
Isotope Ba-133  
Protocol date 9-Apr-07 10:03:07  
Run id. 54

POS	RACK	BATCH	TIME	COUNTS	CPM	ERROR	% RECOVERY	COUNT	TIME
1	97	1	180	779	229.3	4.13			19:32:13
2	97	2	180	785	231.2	4.11	100.83		19:35:24
3	97	3	180	835	248.1	3.95	108.20		19:38:35
4	97	4	180	877	261.9	3.83	114.22		19:41:47
5	97	5	180	921	276.5	3.71	120.58		19:44:58
6	72	6	180	819	242.7	4	105.84		19:48:17
7	72	7	180	798	235.5	4.07	102.70		19:51:28
8	72	8	180	867	258.7	3.85	112.82		19:54:40
9	72	9	180	861	256.6	3.87	111.91		19:57:51

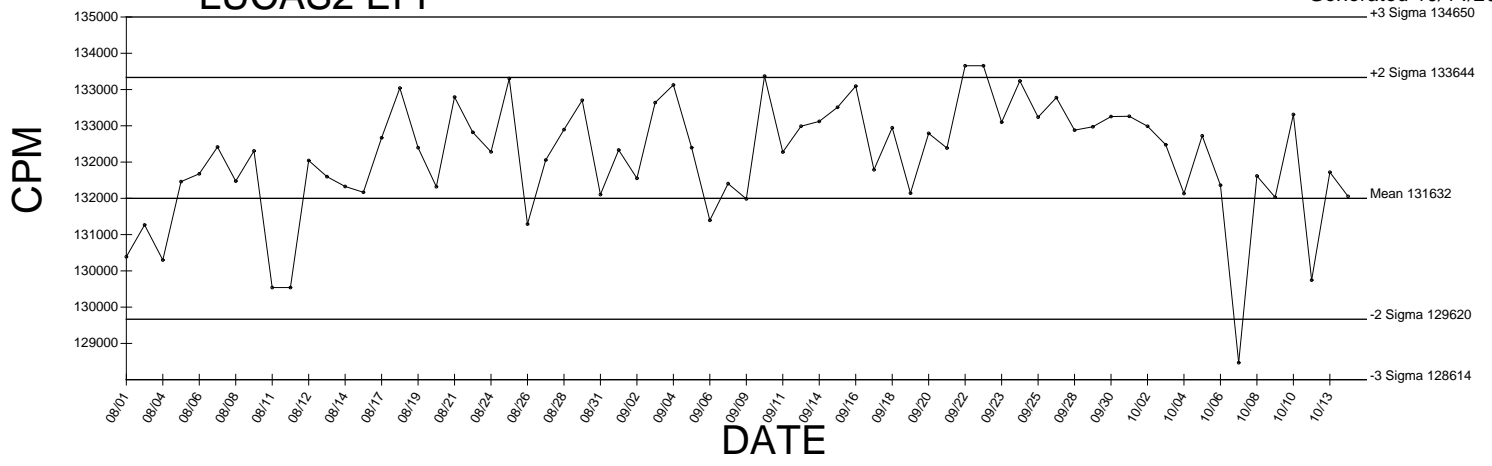
END OF ASSAY

*[Handwritten signature]*  
7/2/09

# BACKGROUND AND EFFICIENCY DATA

# LUCAS2 EFF

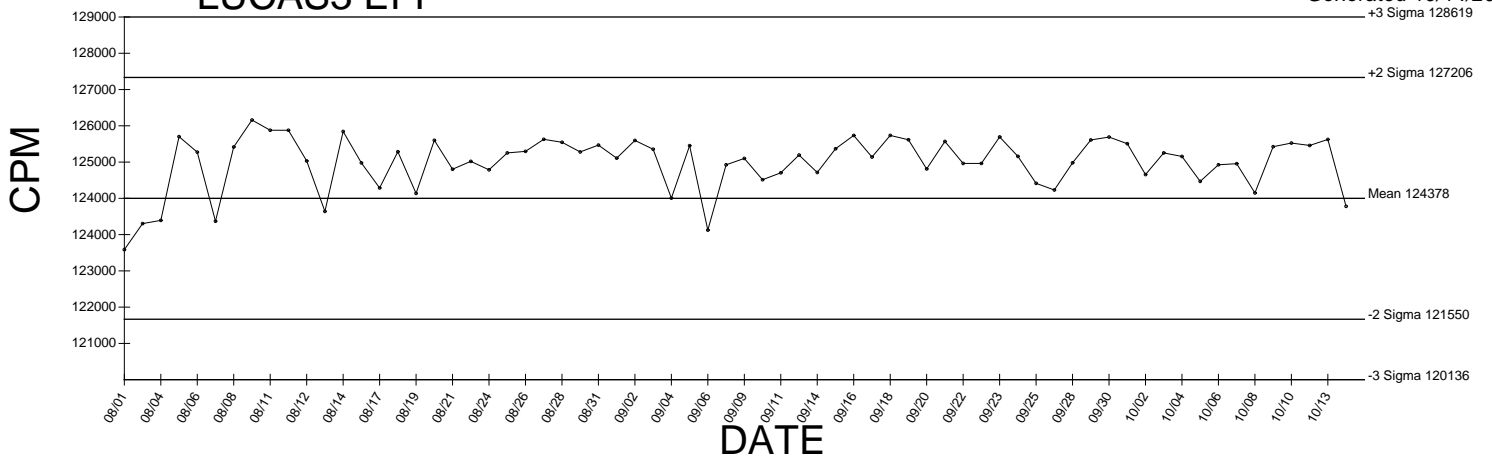
Generated 10/14/2009



● Denotes Outlier

# LUCAS3 EFF

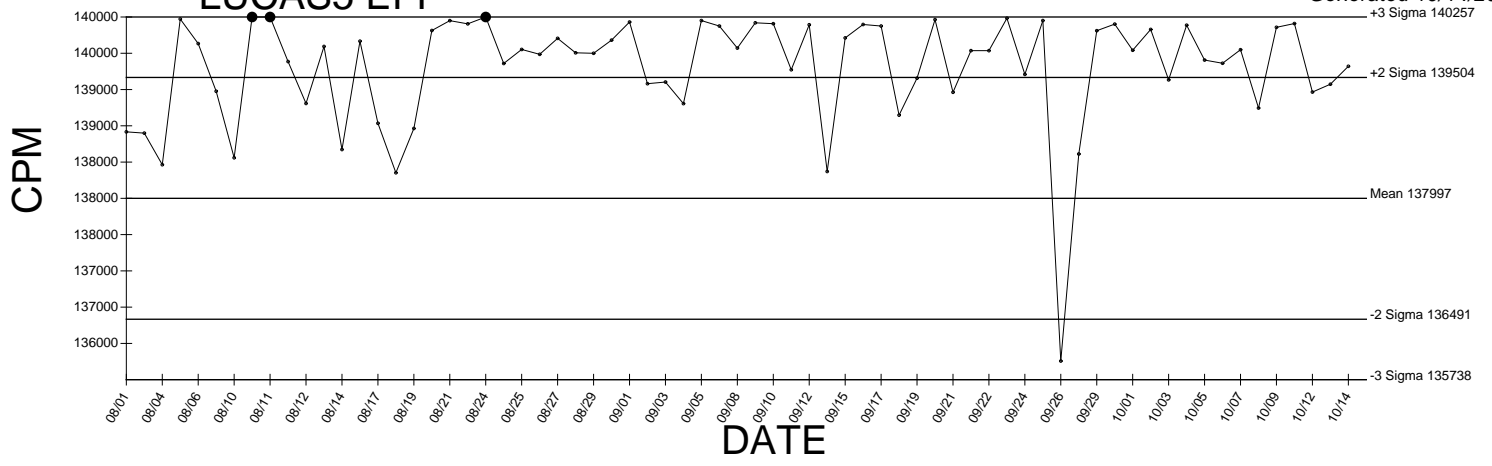
Generated 10/14/2009



● Denotes Outlier

# LUCAS5 EFF

Generated 10/14/2009

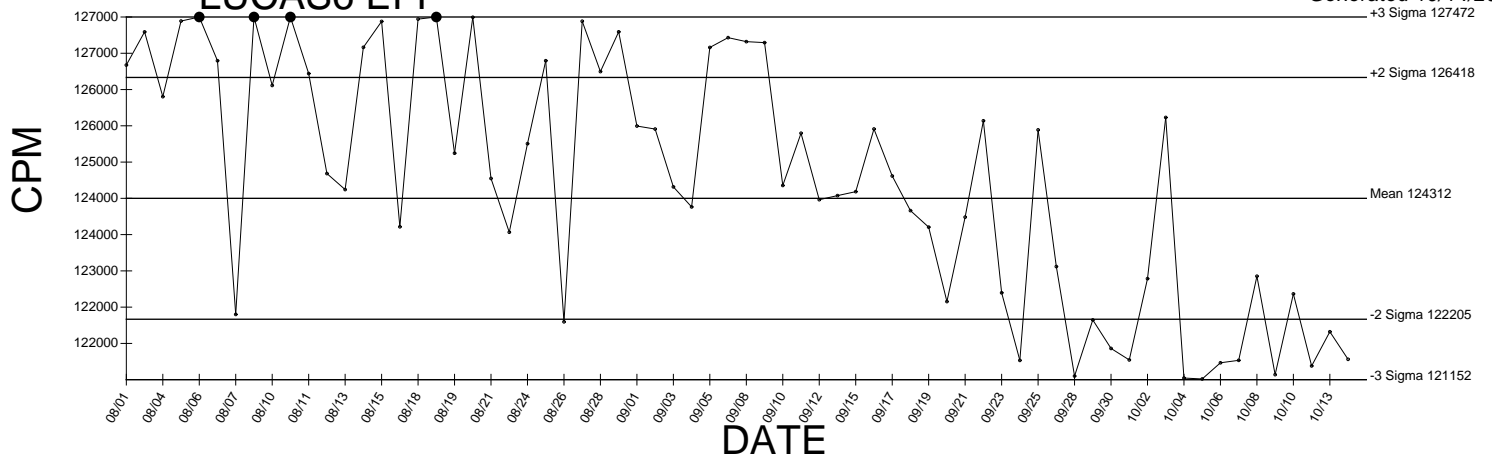


● Denotes Outlier



# LUCAS6 EFF

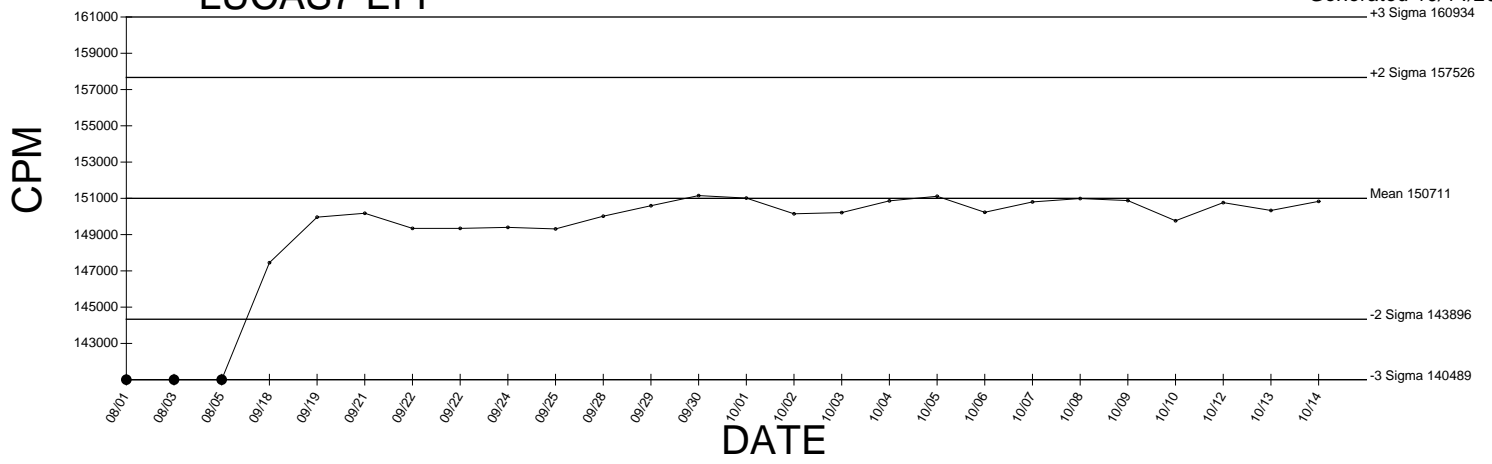
Generated 10/14/2009



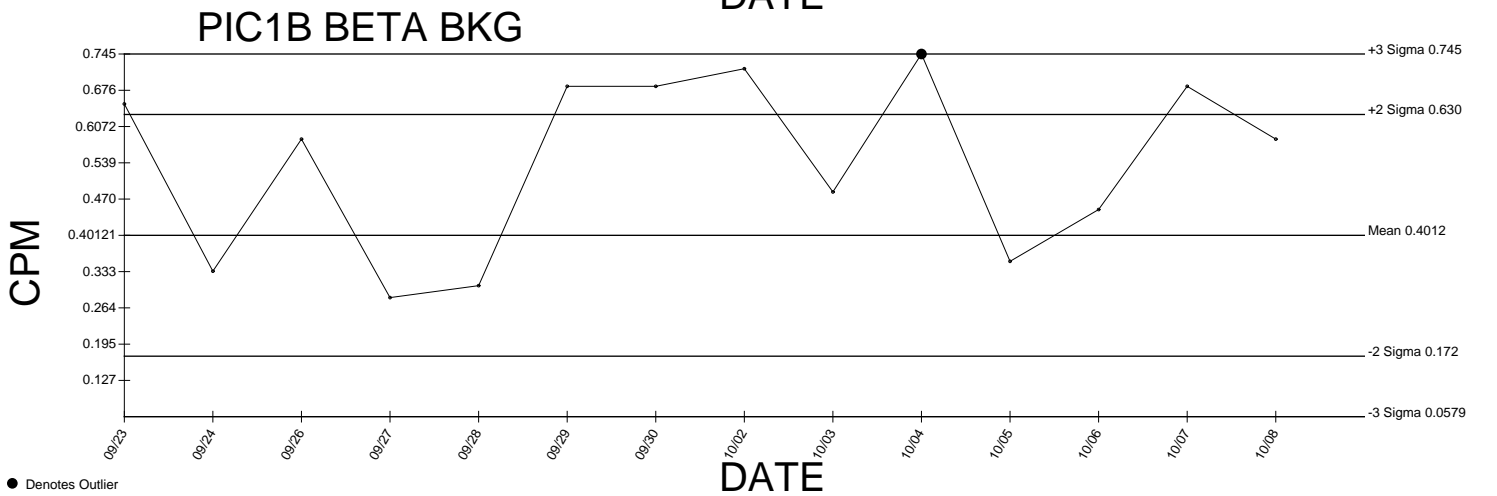
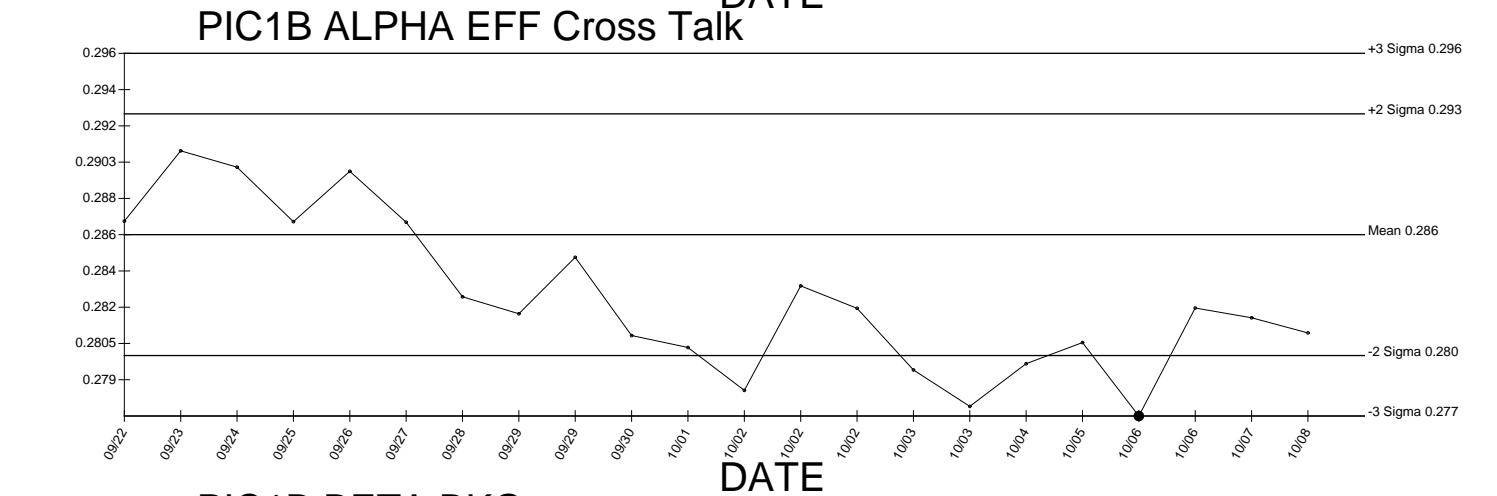
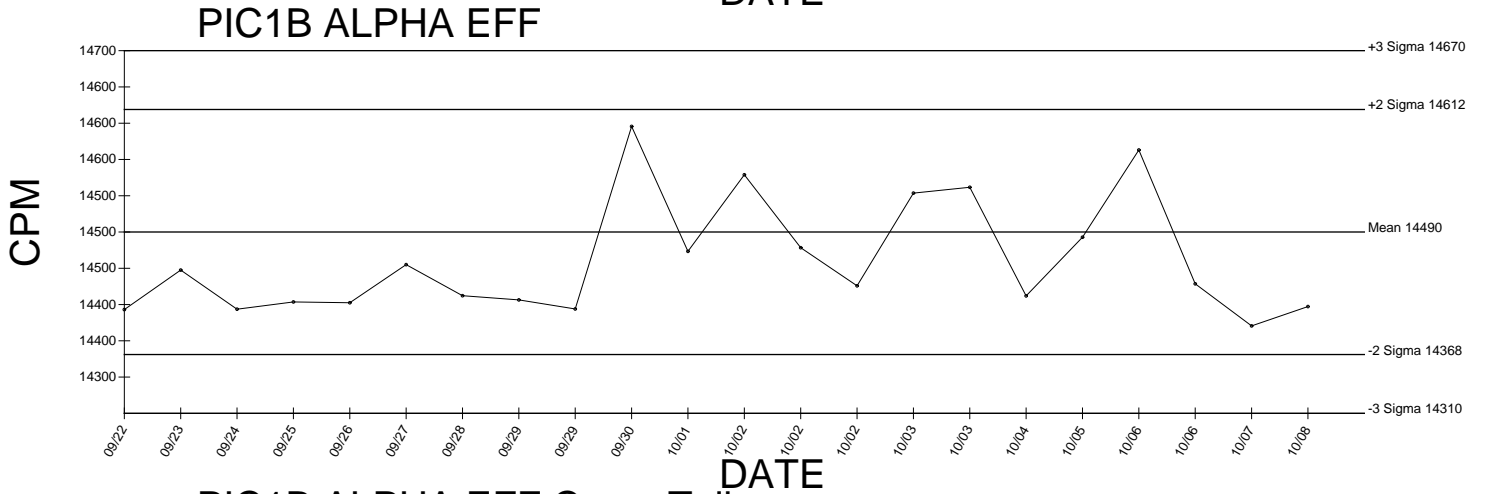
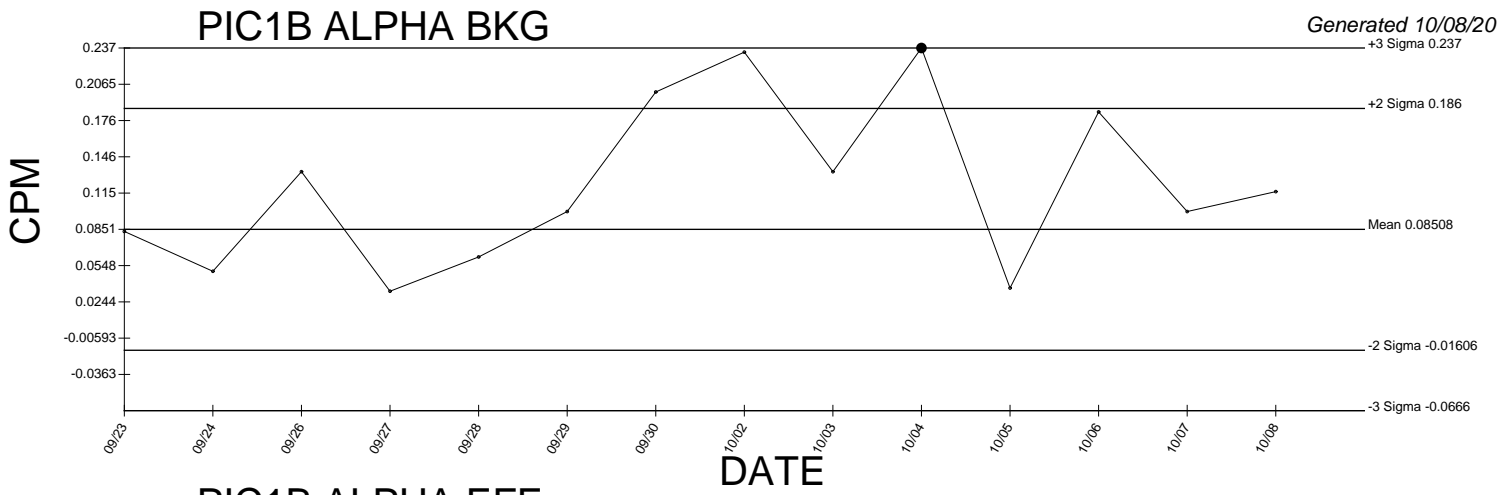
● Denotes Outlier

# LUCAS7 EFF

Generated 10/14/2009



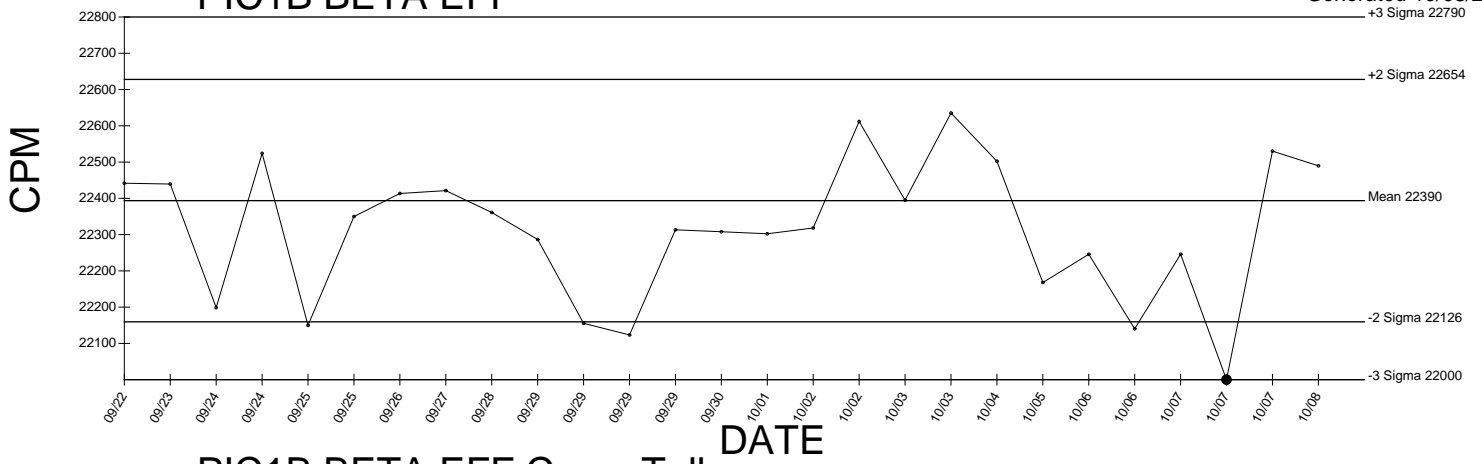
● Denotes Outlier



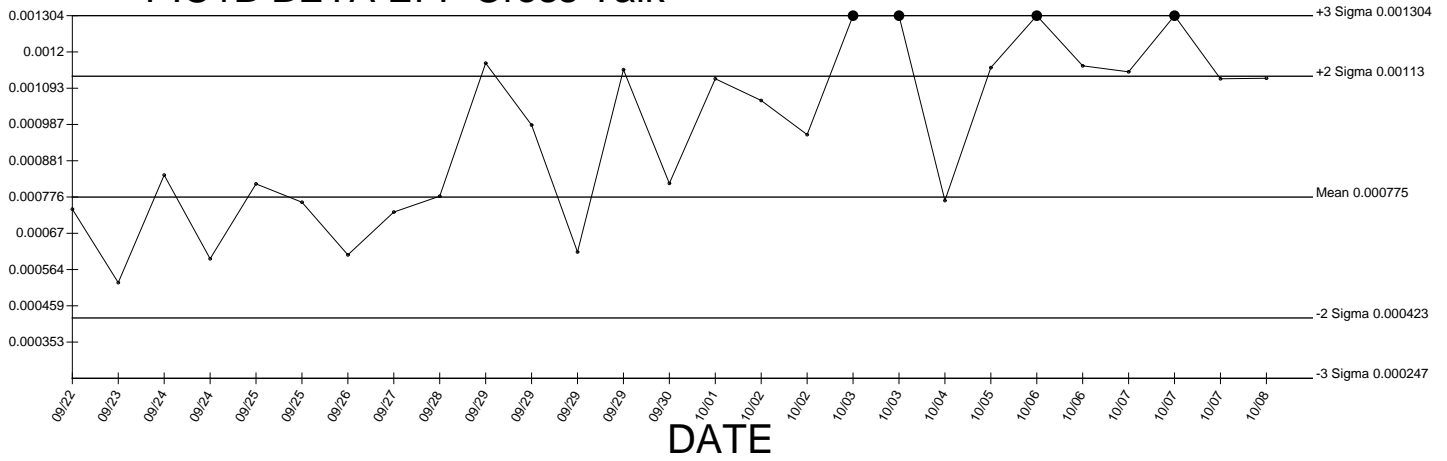
● Denotes Outlier

# PIC1B BETA EFF

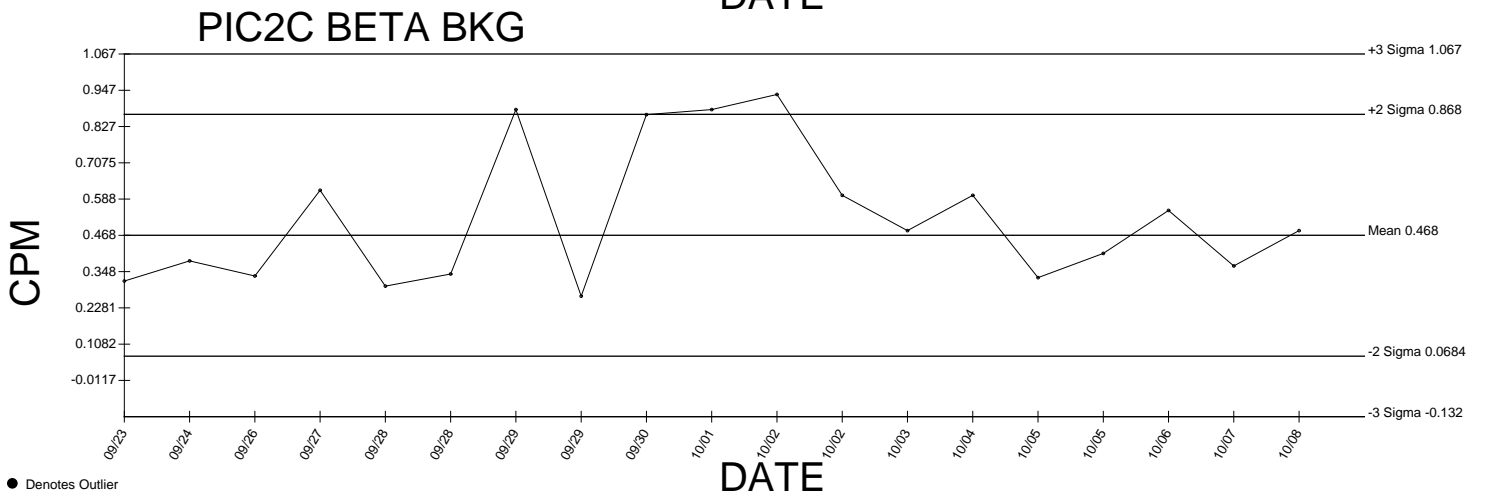
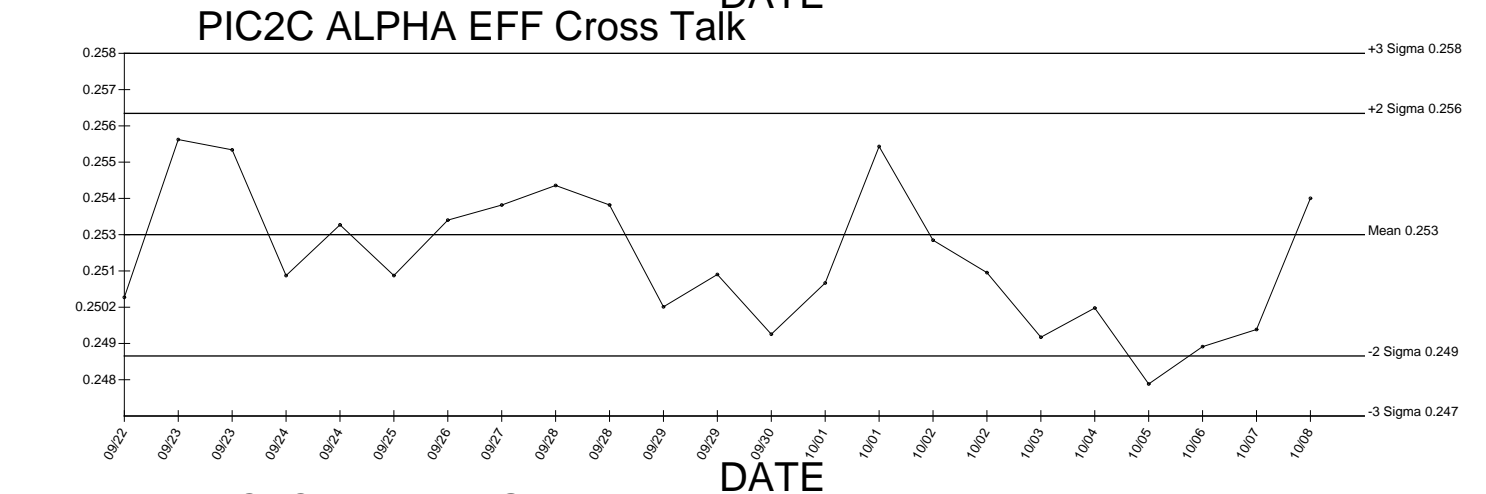
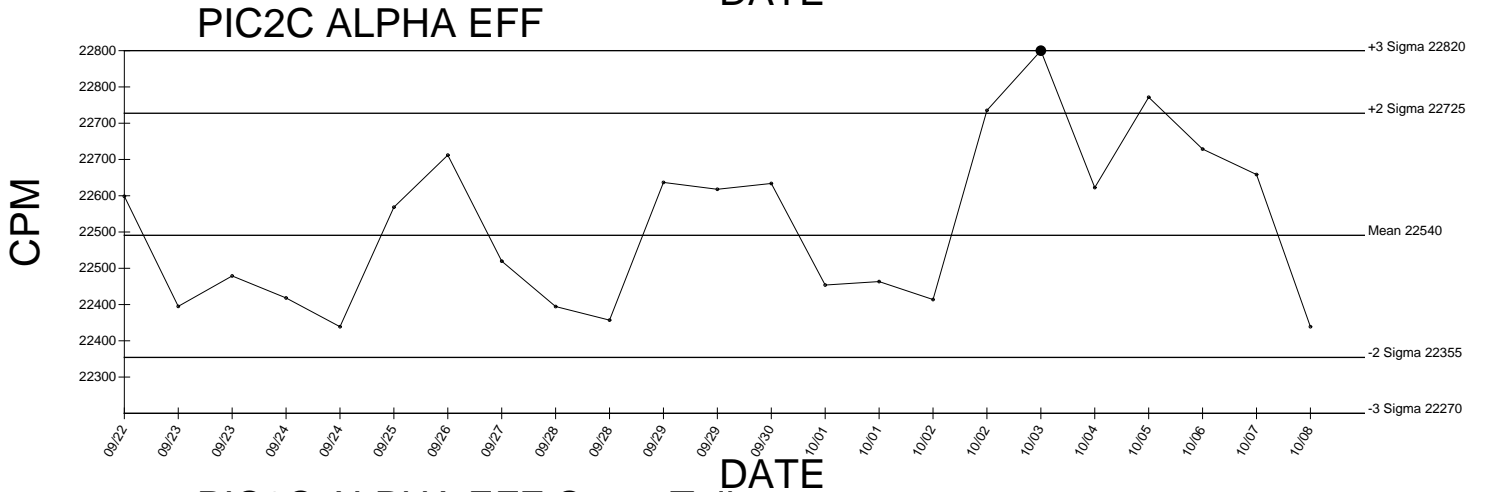
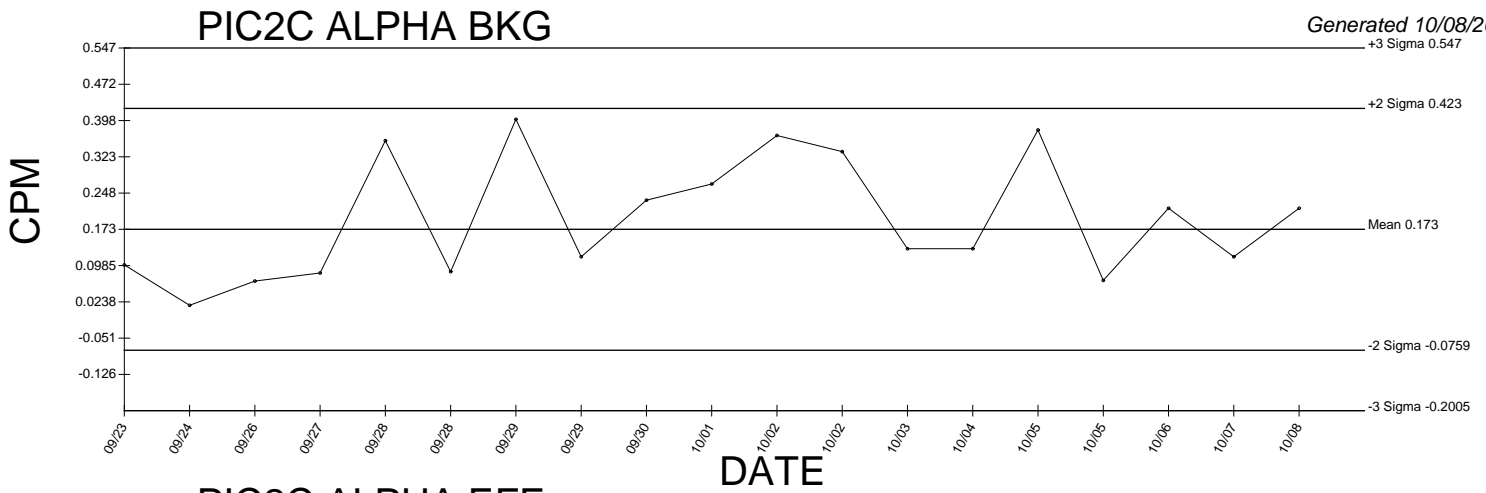
Generated 10/08/2009



# PIC1B BETA EFF Cross Talk



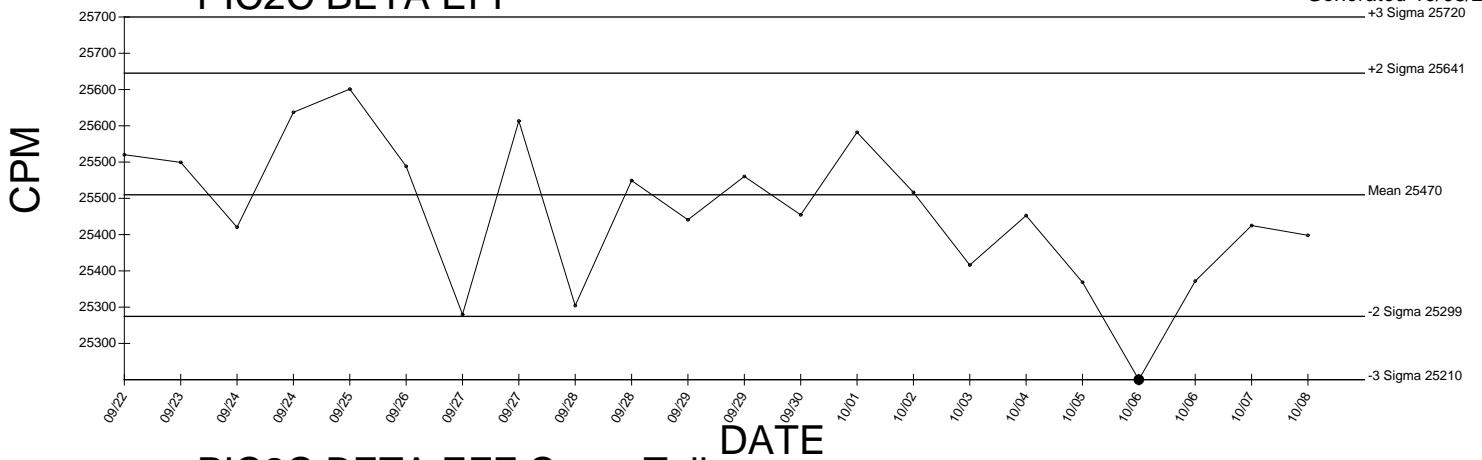
● Denotes Outlier



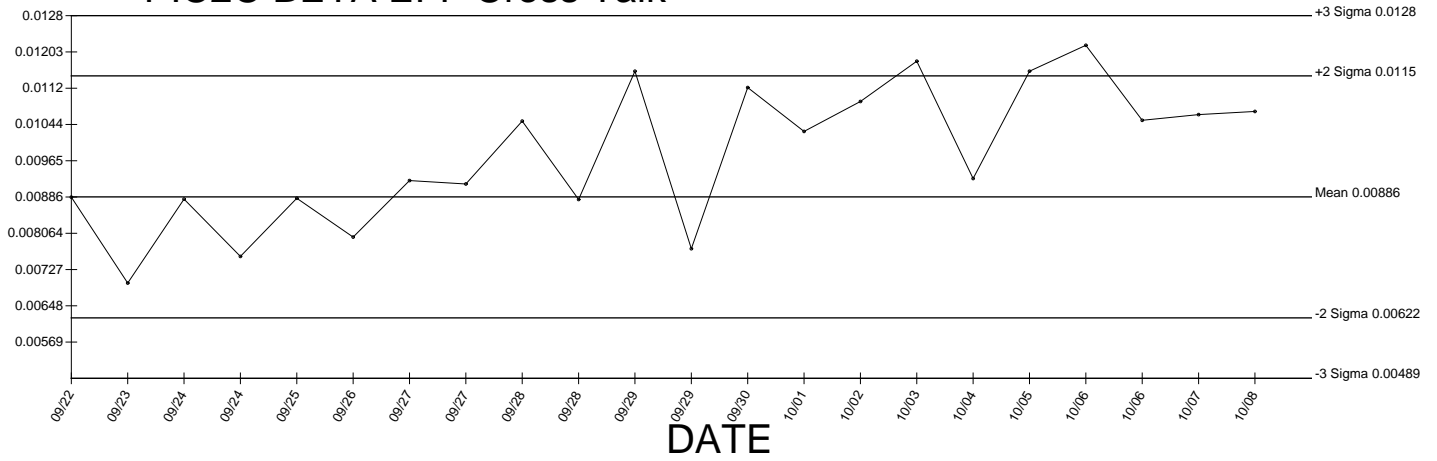
● Denotes Outlier

# PIC2C BETA EFF

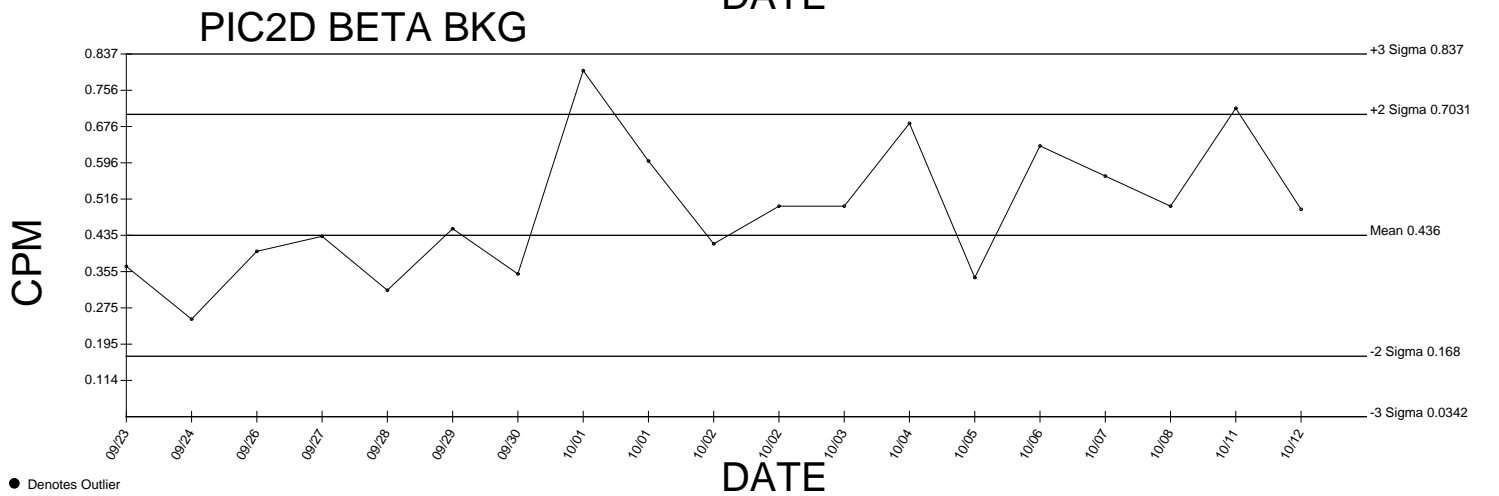
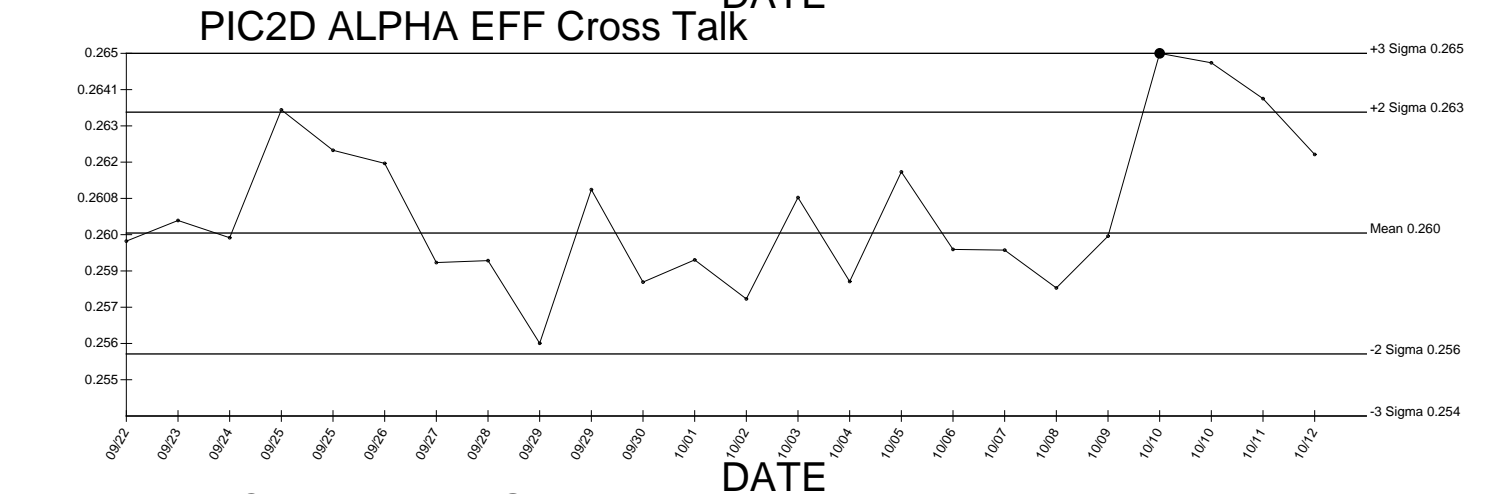
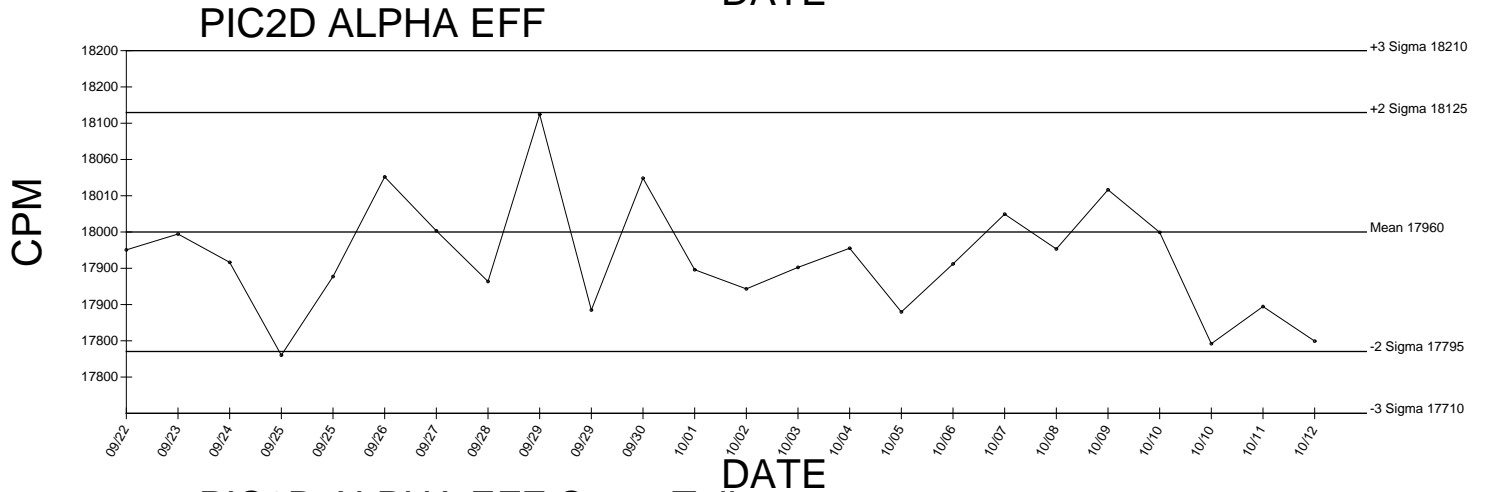
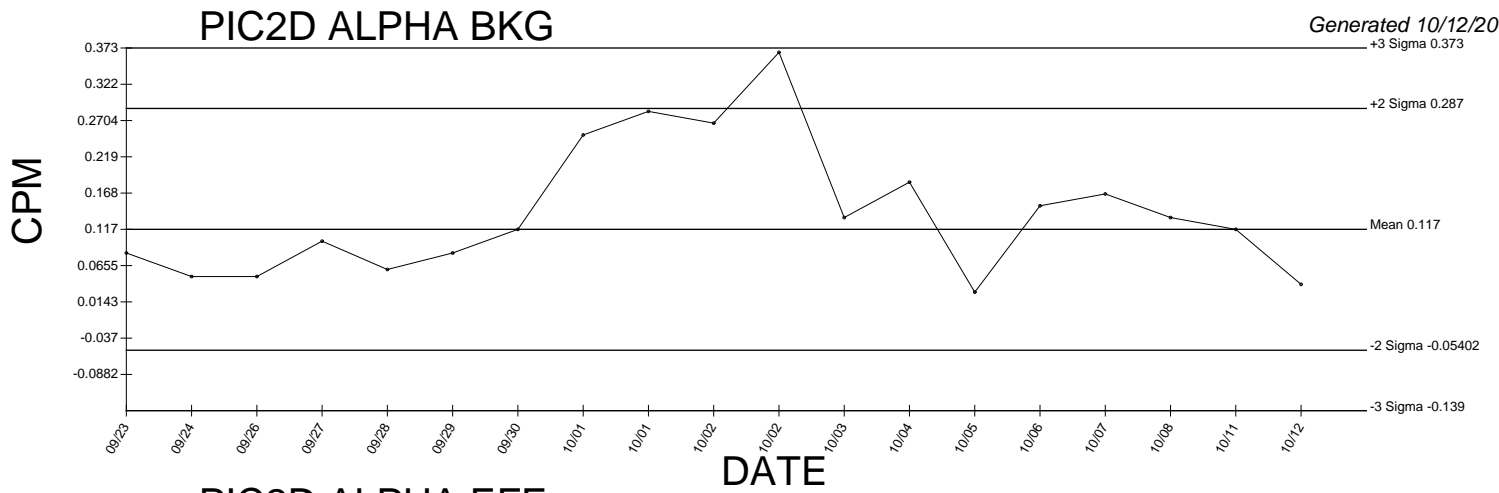
Generated 10/08/2009



# PIC2C BETA EFF Cross Talk



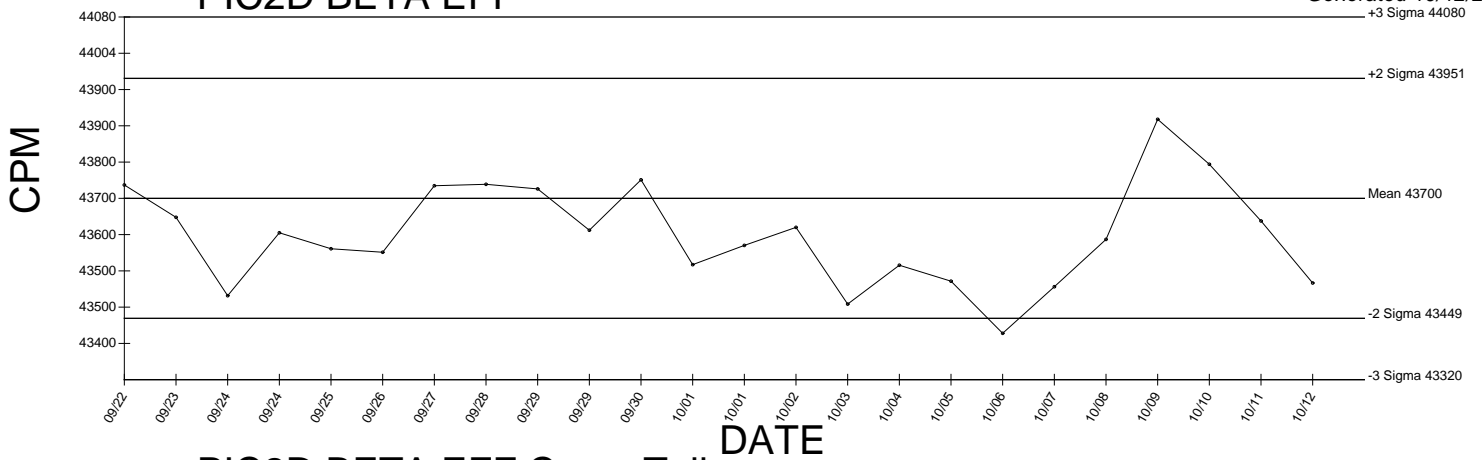
● Denotes Outlier



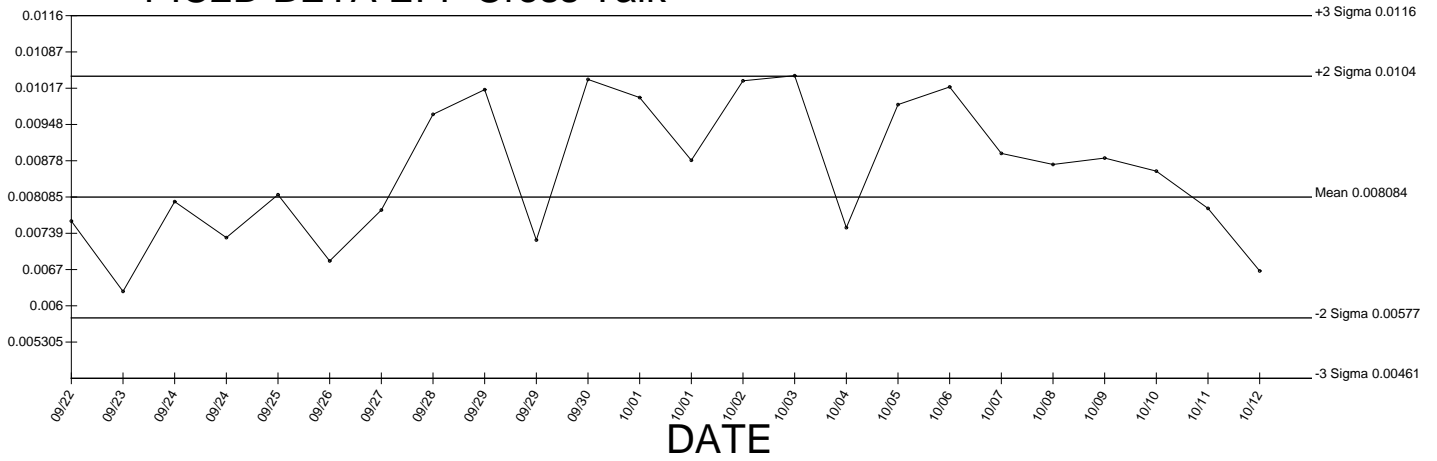
● Denotes Outlier

# PIC2D BETA EFF

Generated 10/12/2009



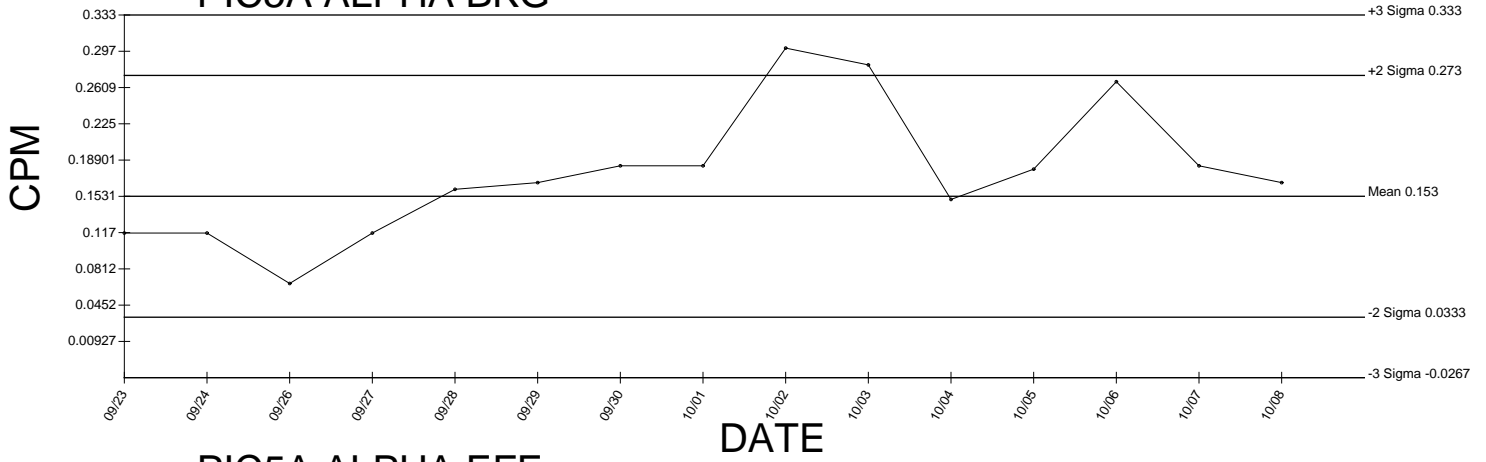
# PIC2D BETA EFF Cross Talk



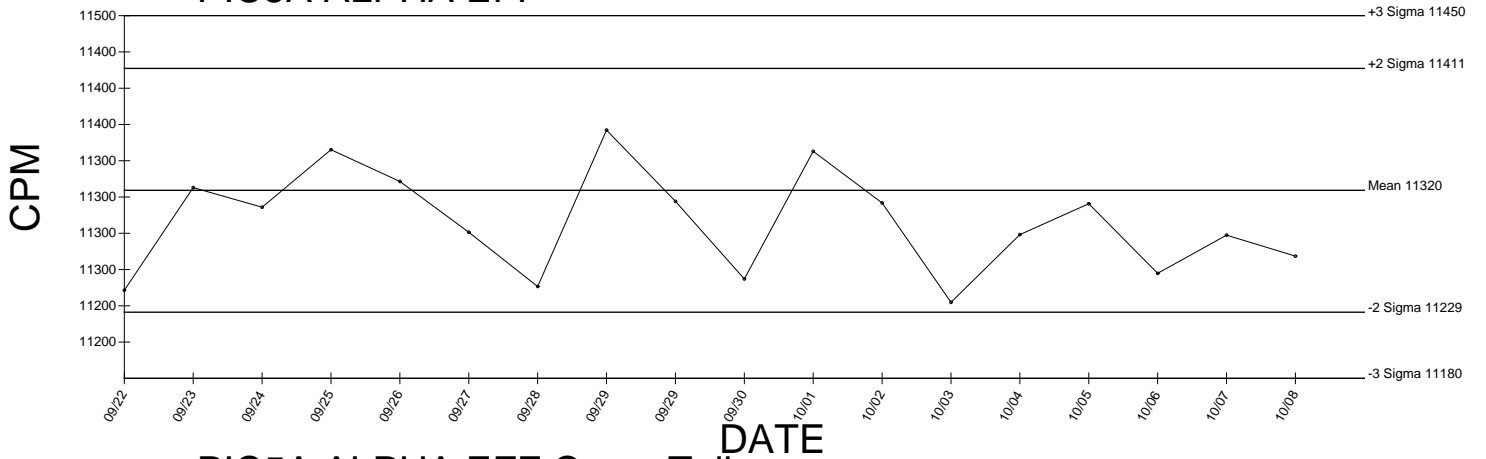
● Denotes Outlier



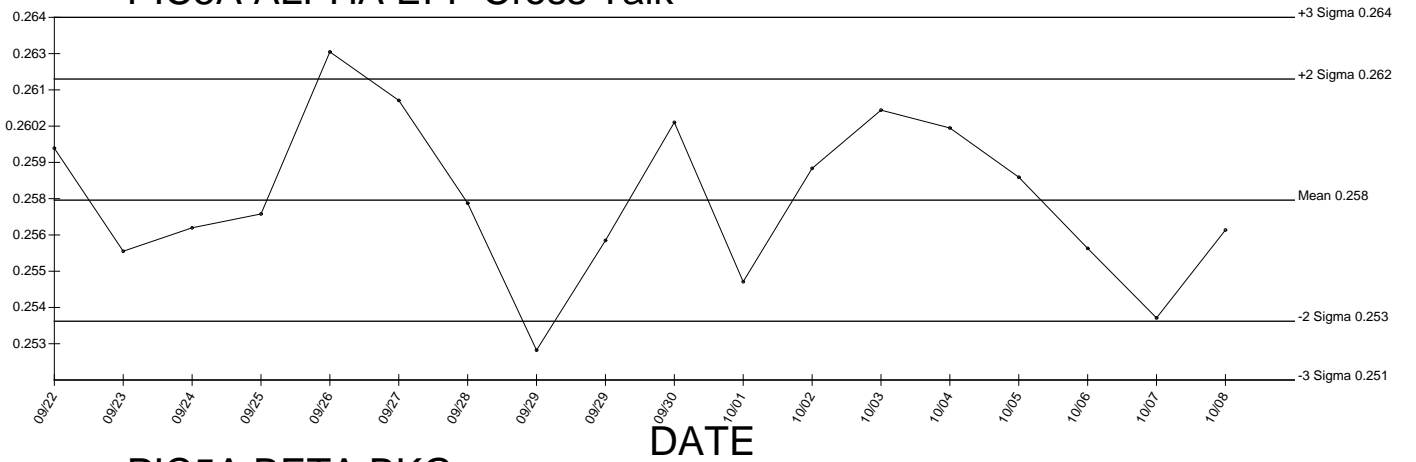
### PIC5A ALPHA BKG



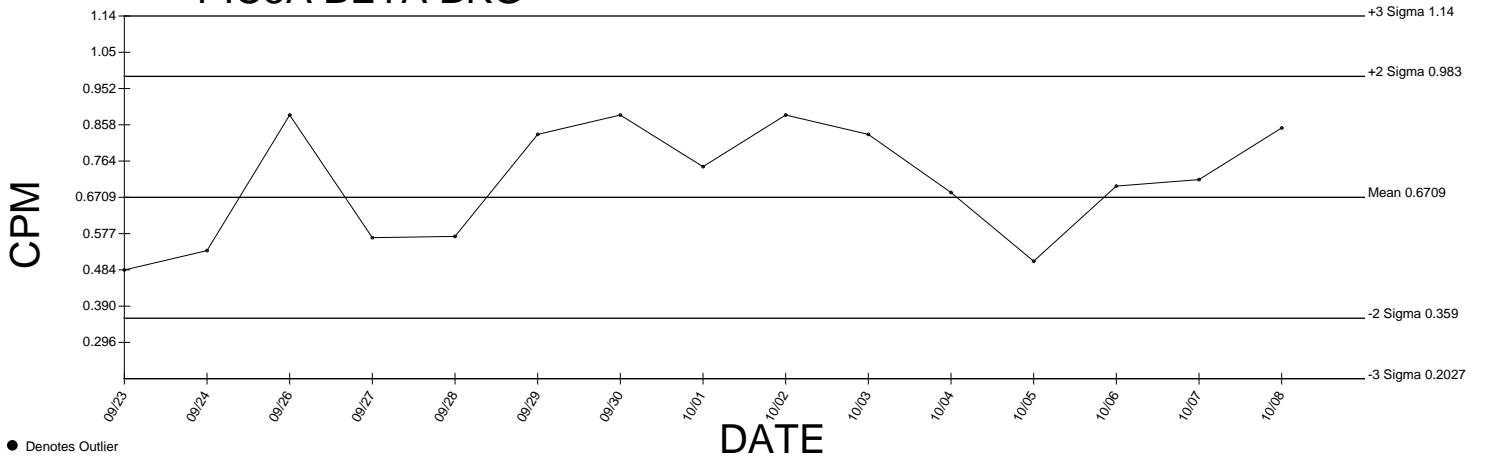
### PIC5A ALPHA EFF



### PIC5A ALPHA EFF Cross Talk



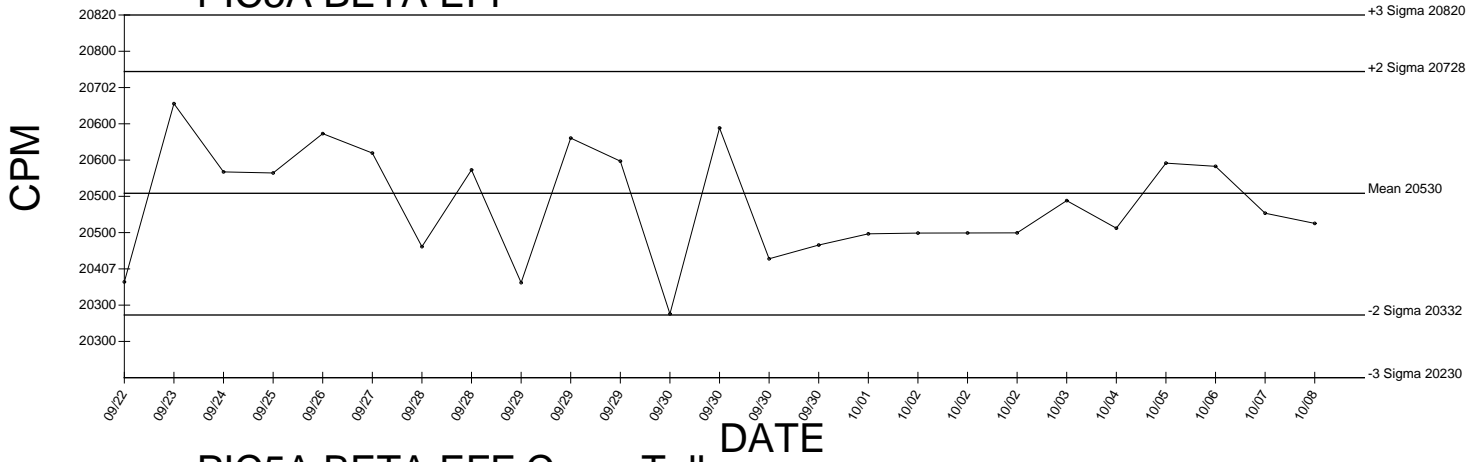
### PIC5A BETA BKG



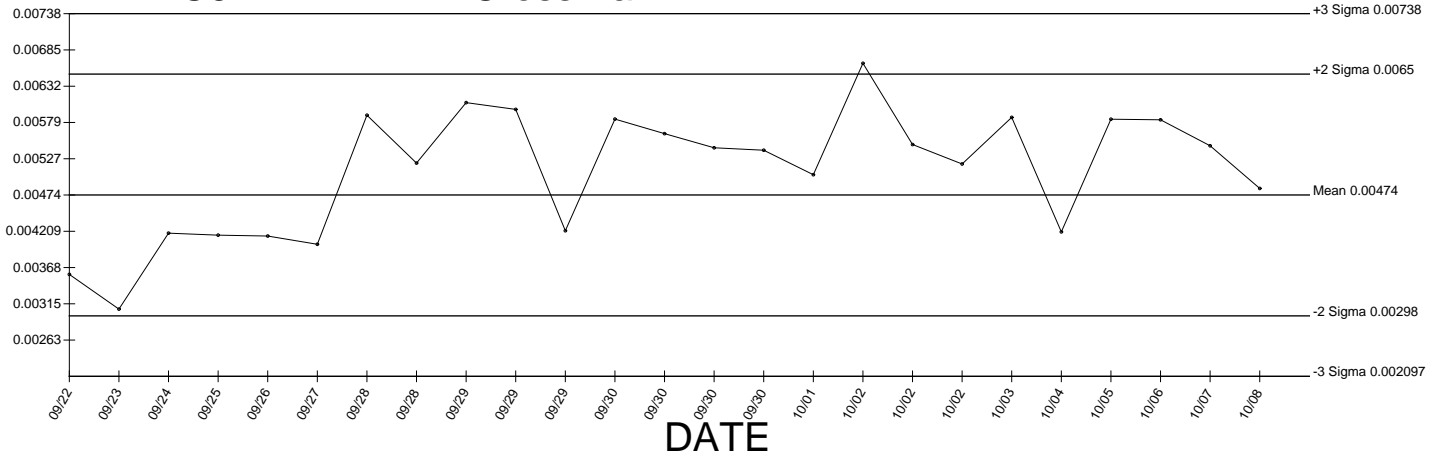
● Denotes Outlier

# PIC5A BETA EFF

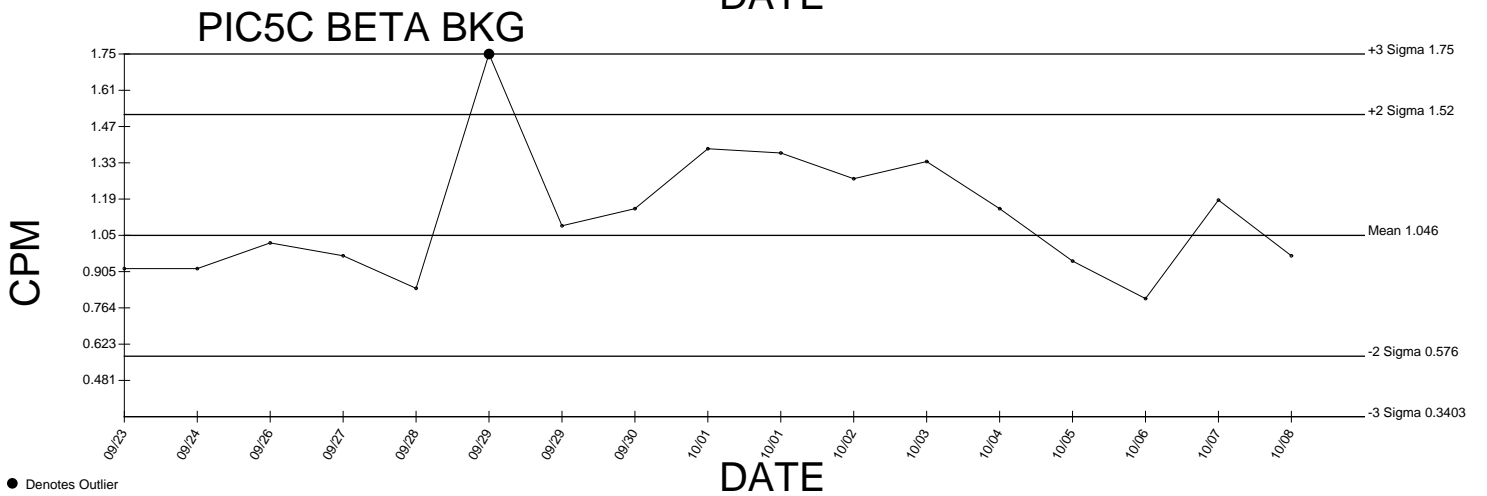
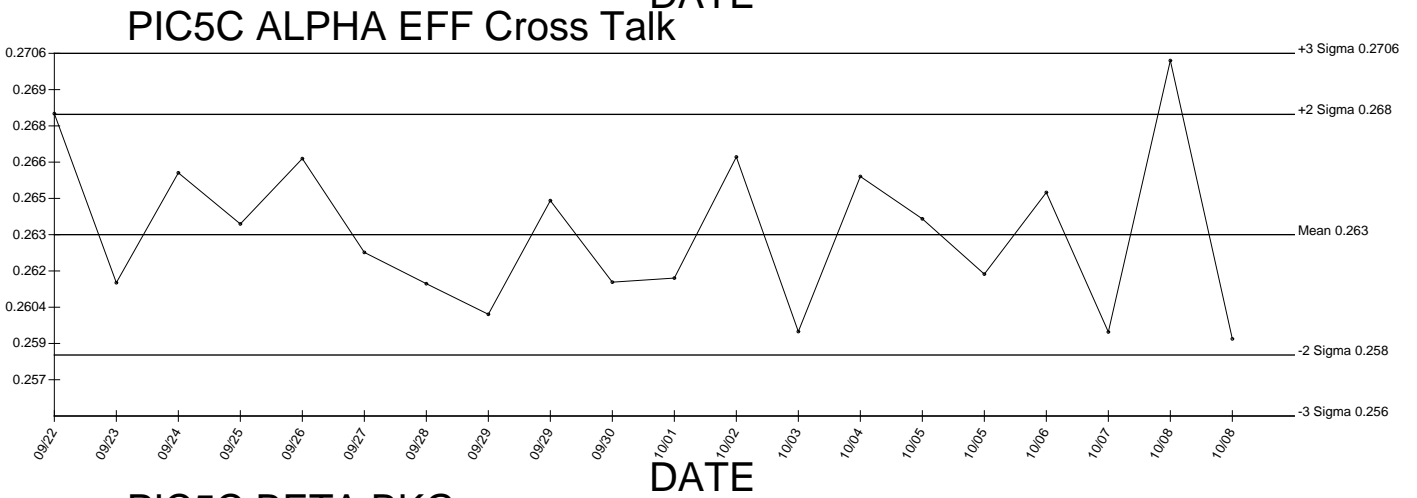
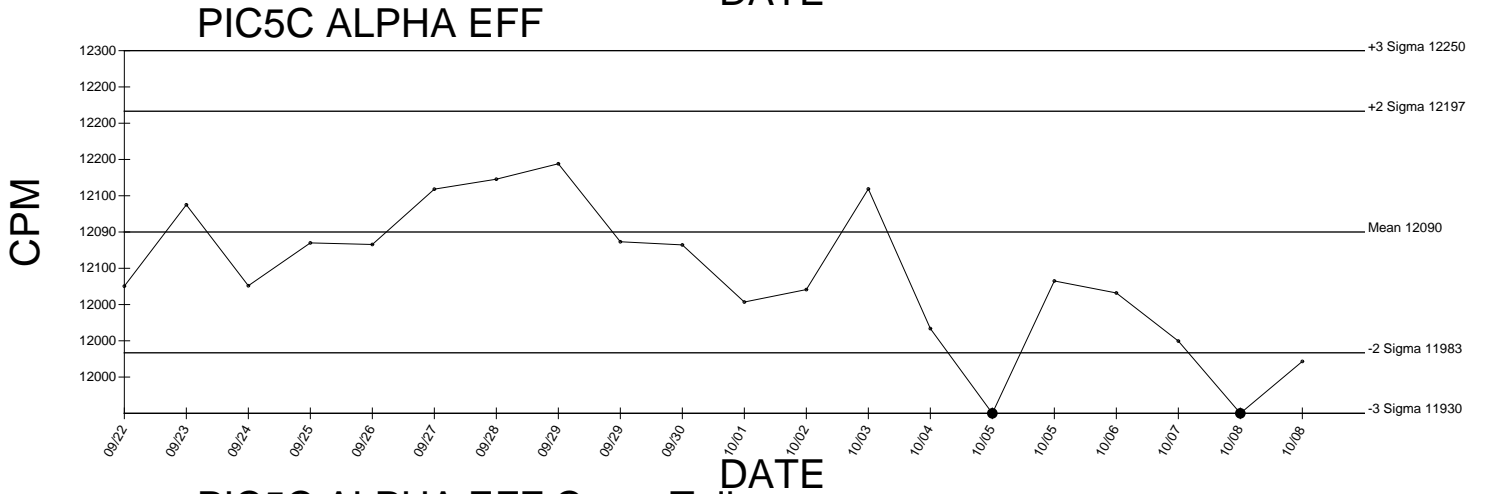
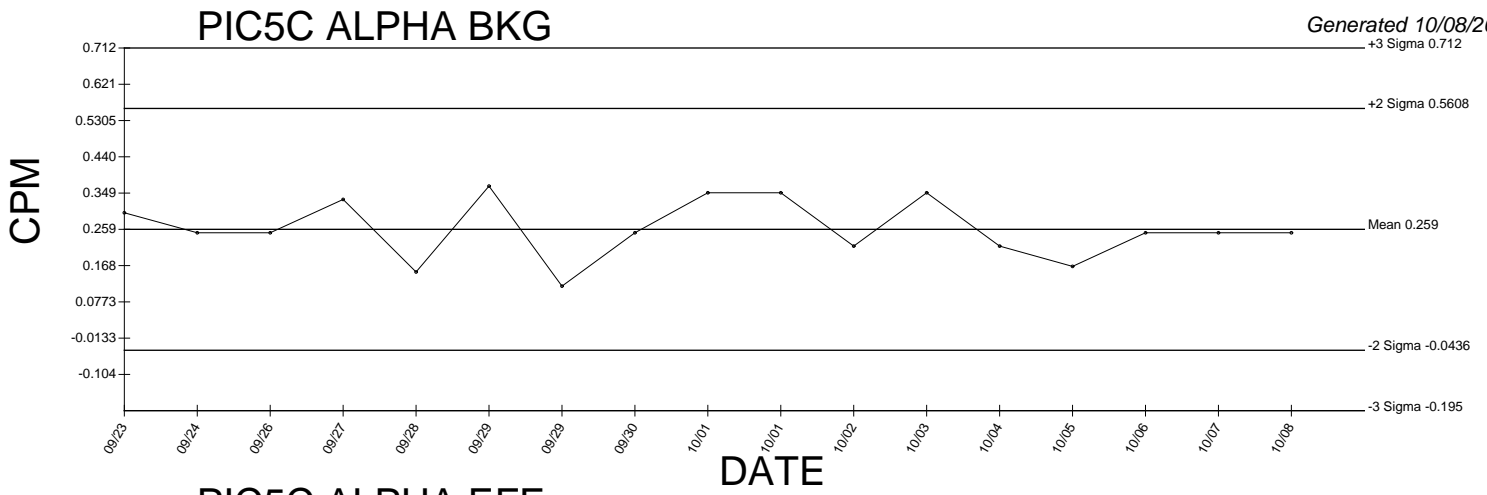
Generated 10/08/2009



# PIC5A BETA EFF Cross Talk



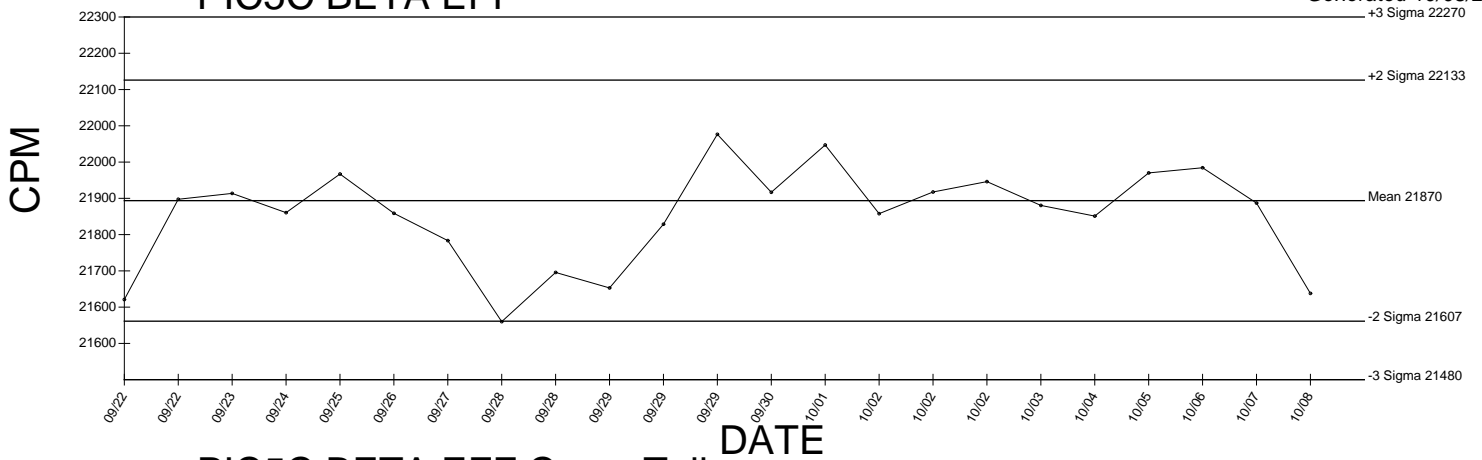
● Denotes Outlier



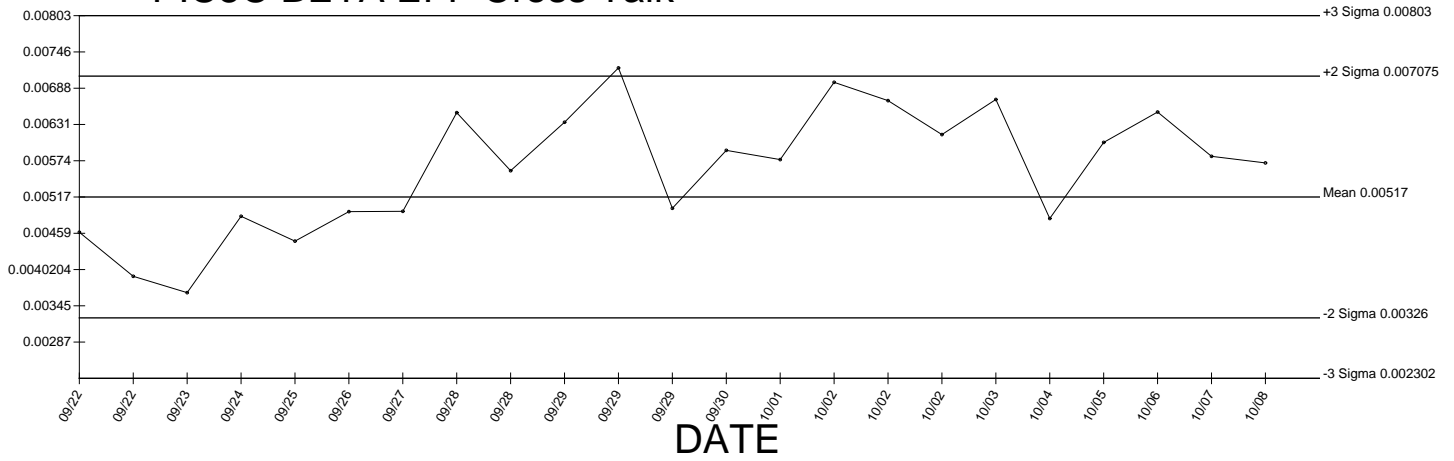
● Denotes Outlier

# PIC5C BETA EFF

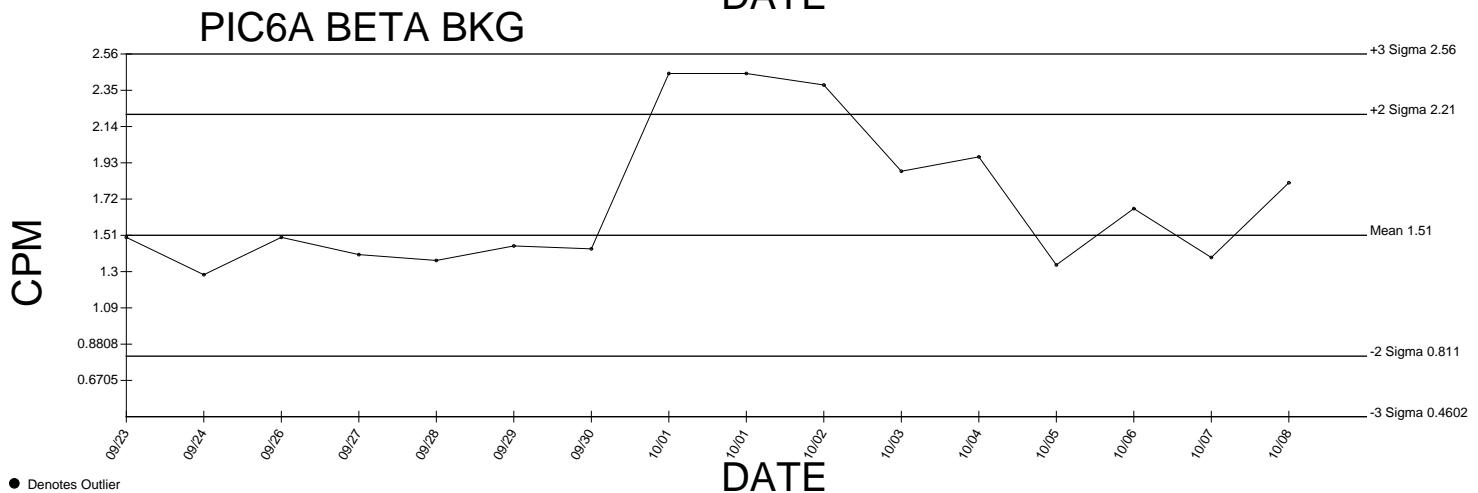
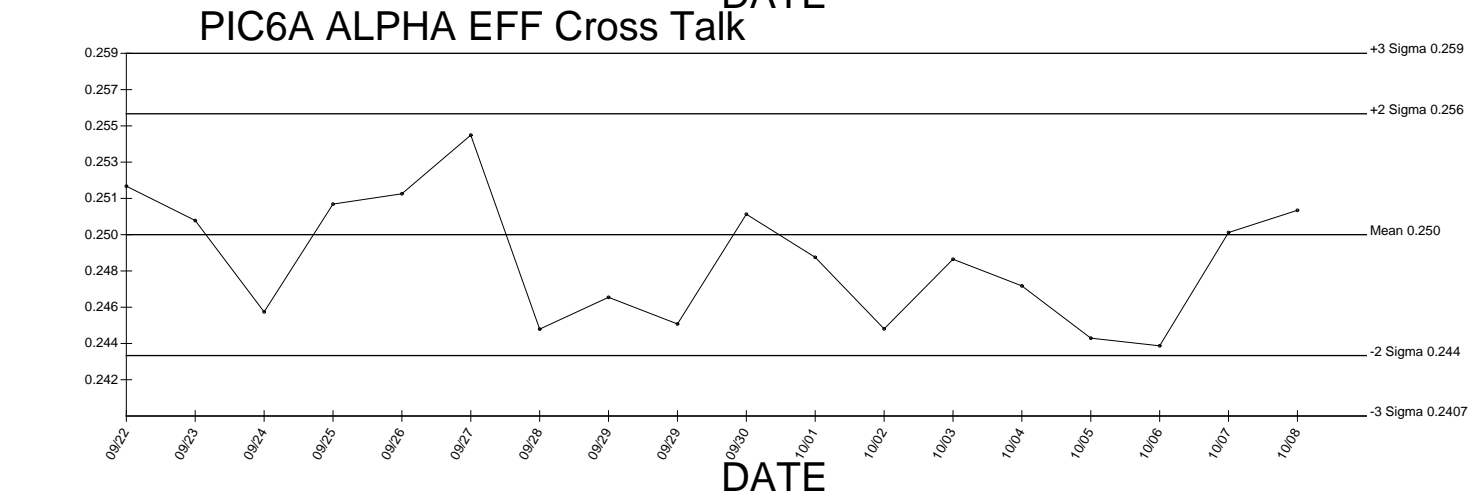
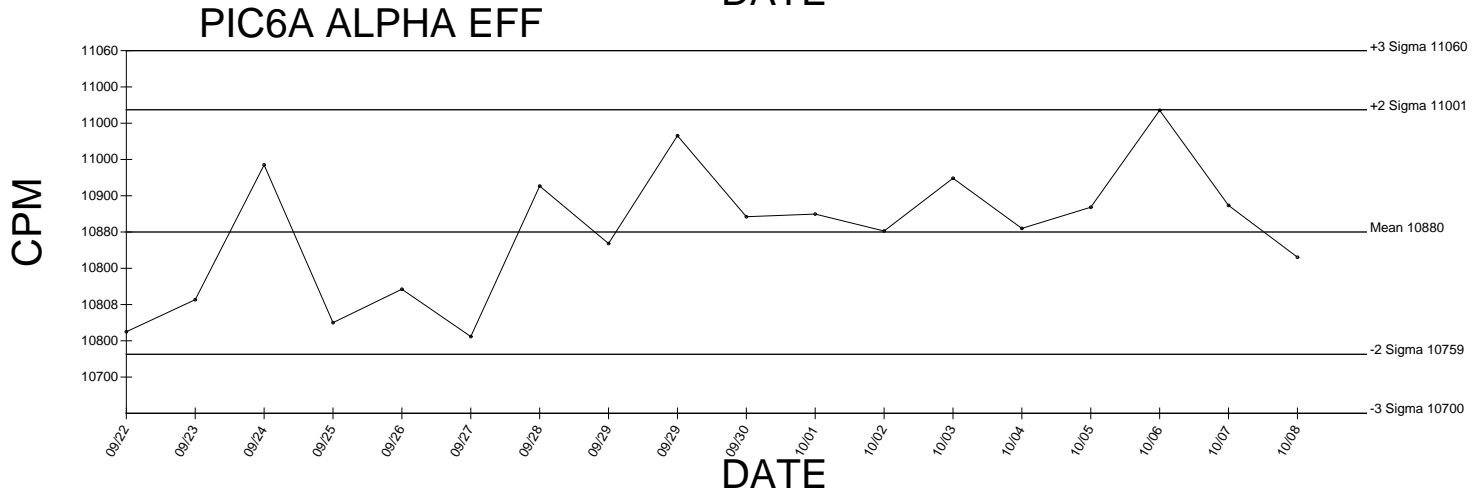
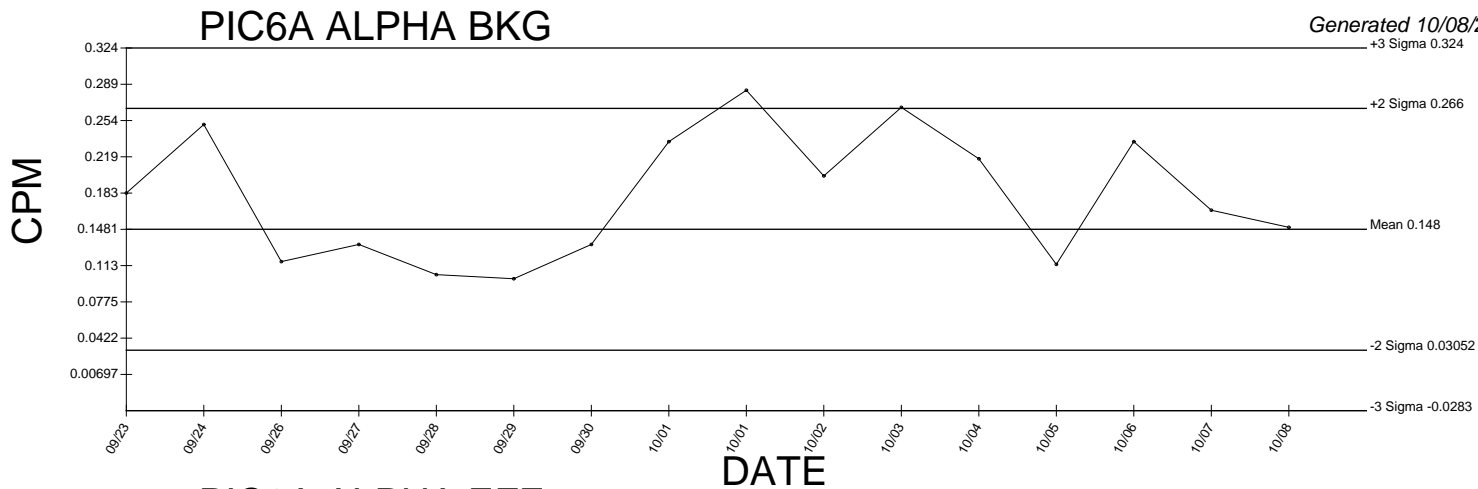
Generated 10/08/2009



# PIC5C BETA EFF Cross Talk



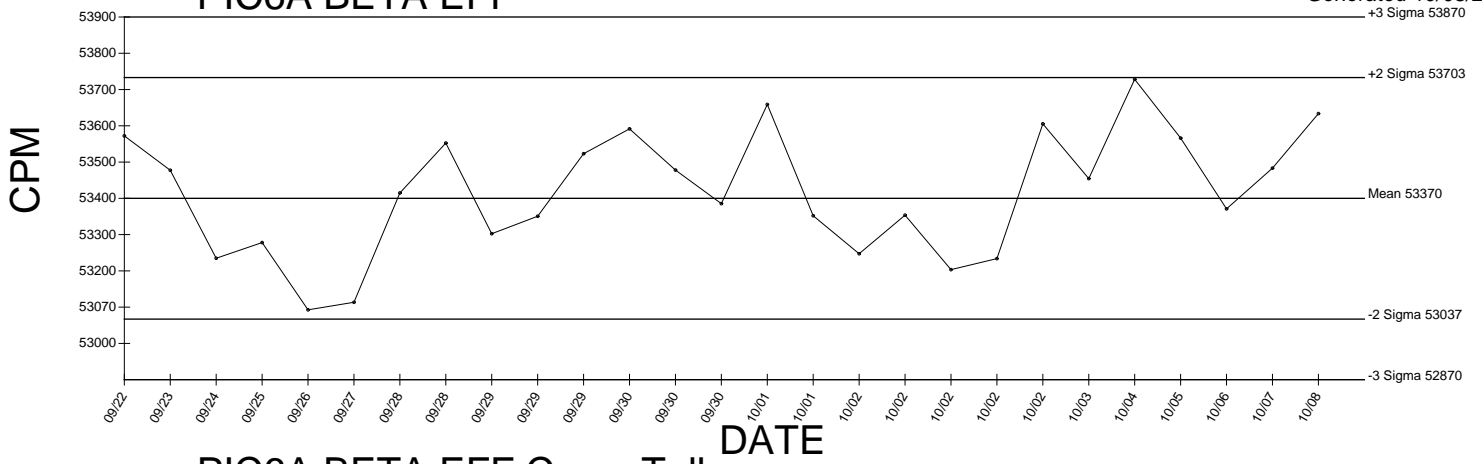
● Denotes Outlier



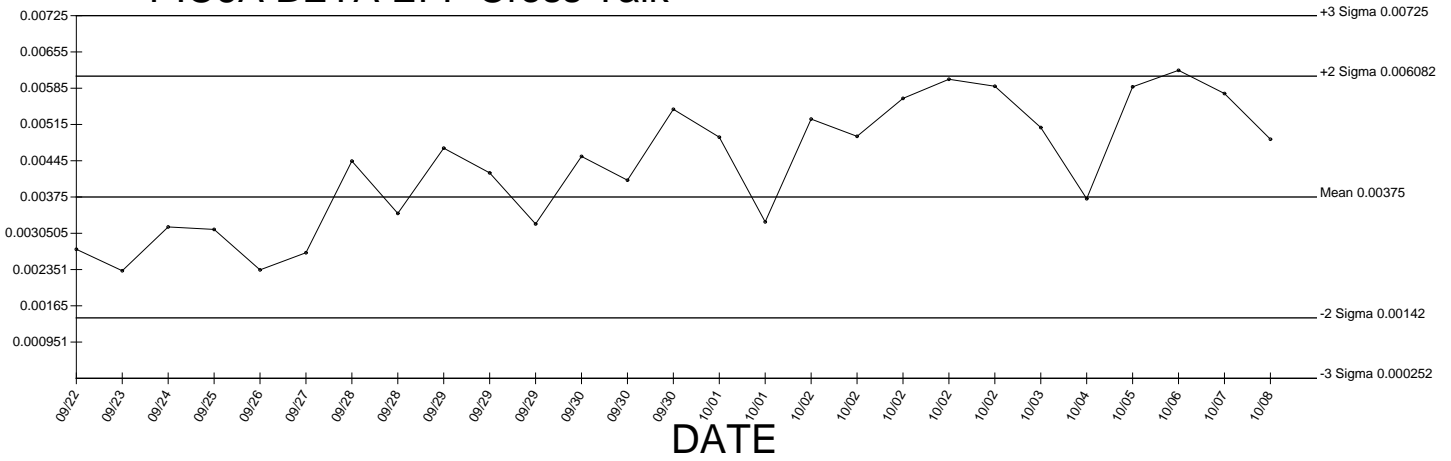
● Denotes Outlier

# PIC6A BETA EFF

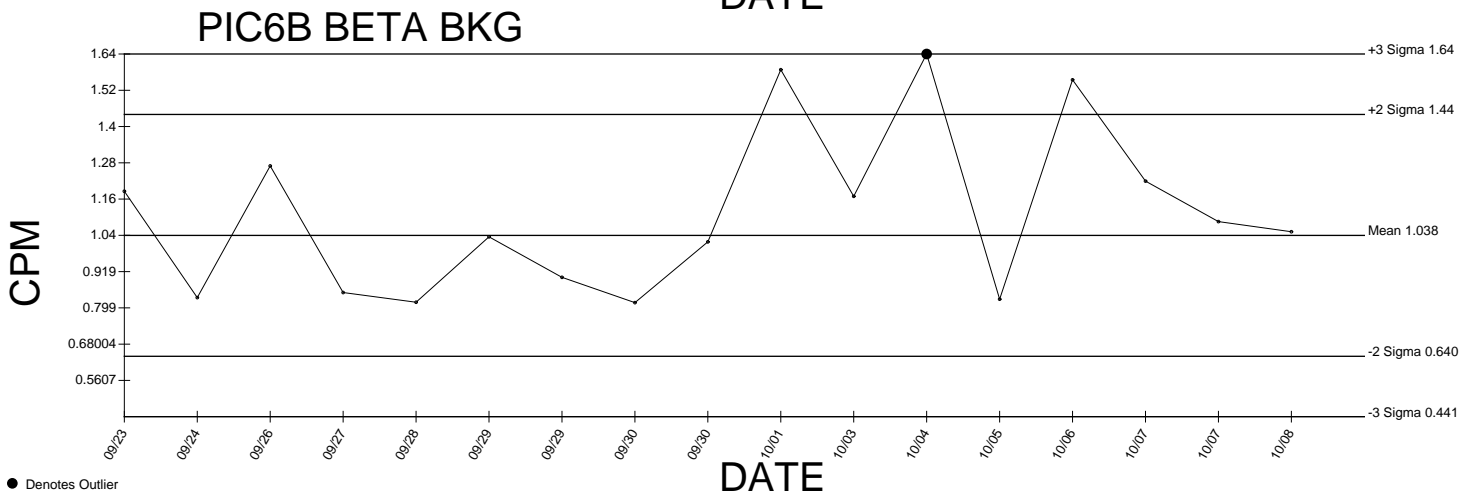
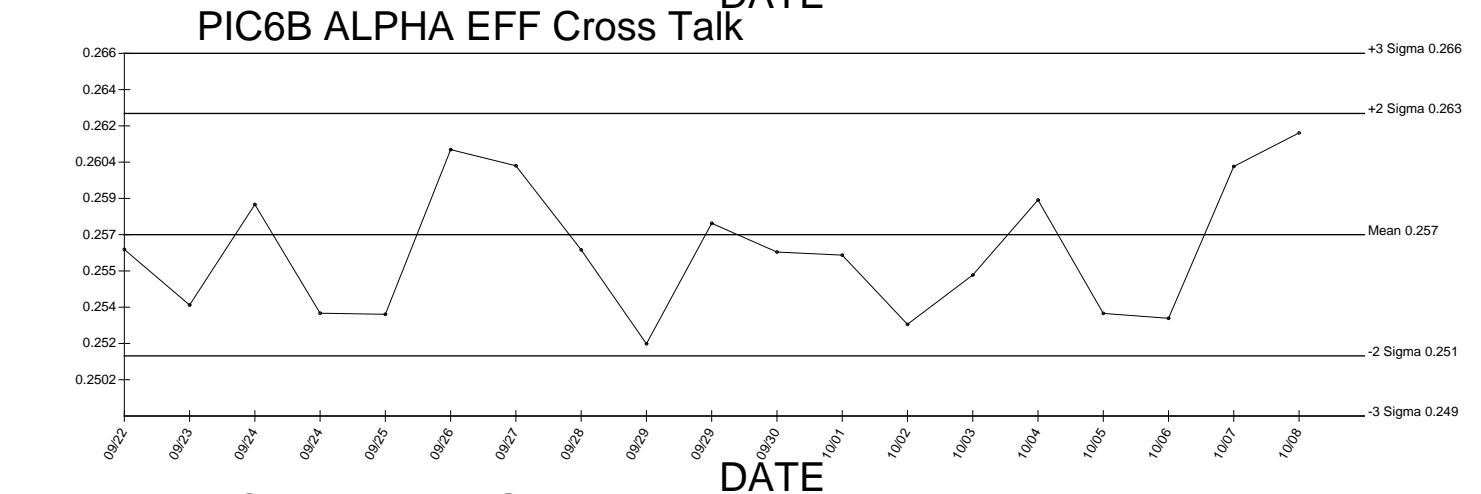
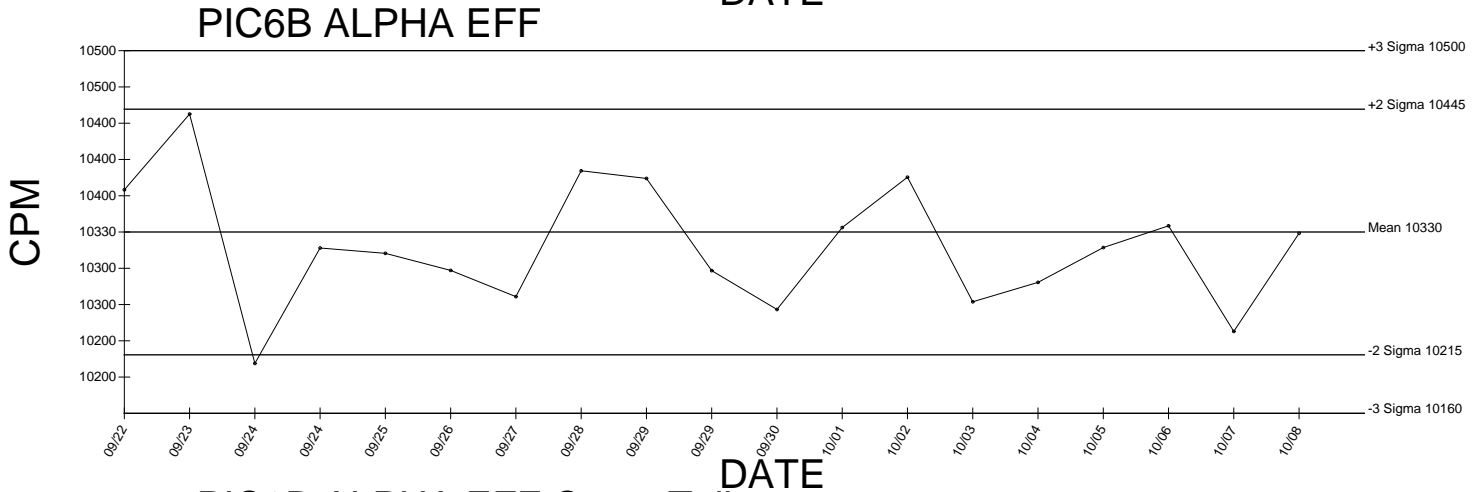
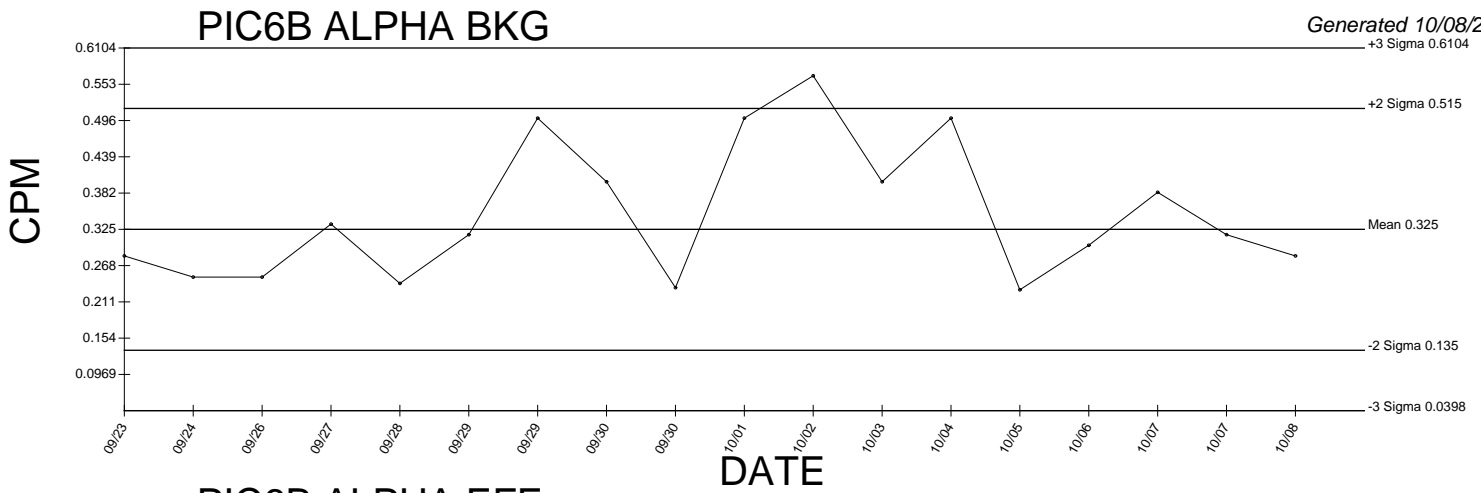
Generated 10/08/2009



# PIC6A BETA EFF Cross Talk



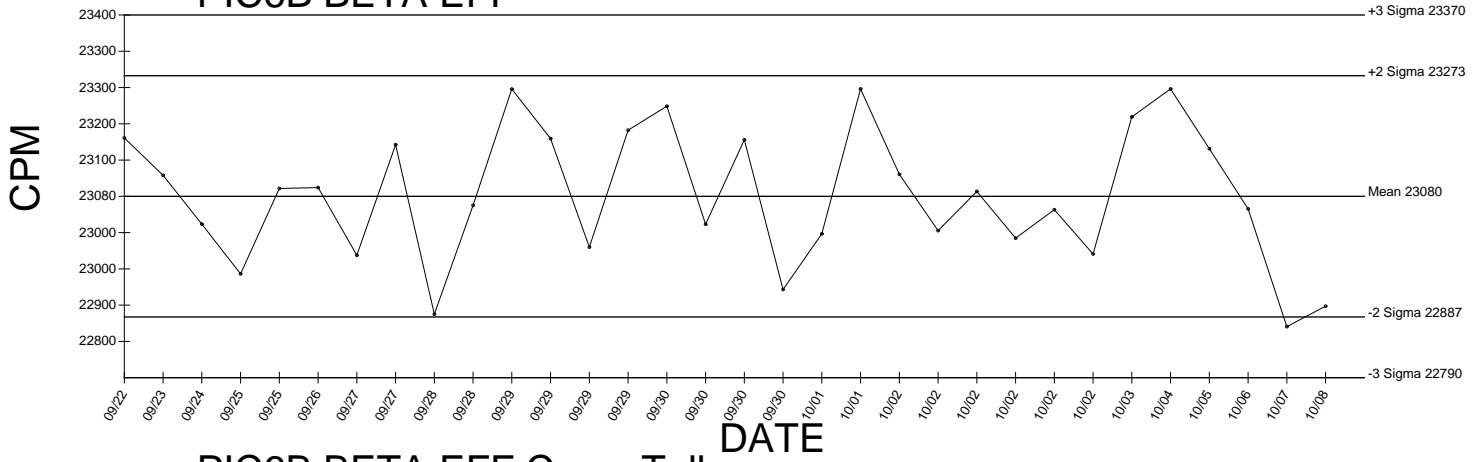
● Denotes Outlier



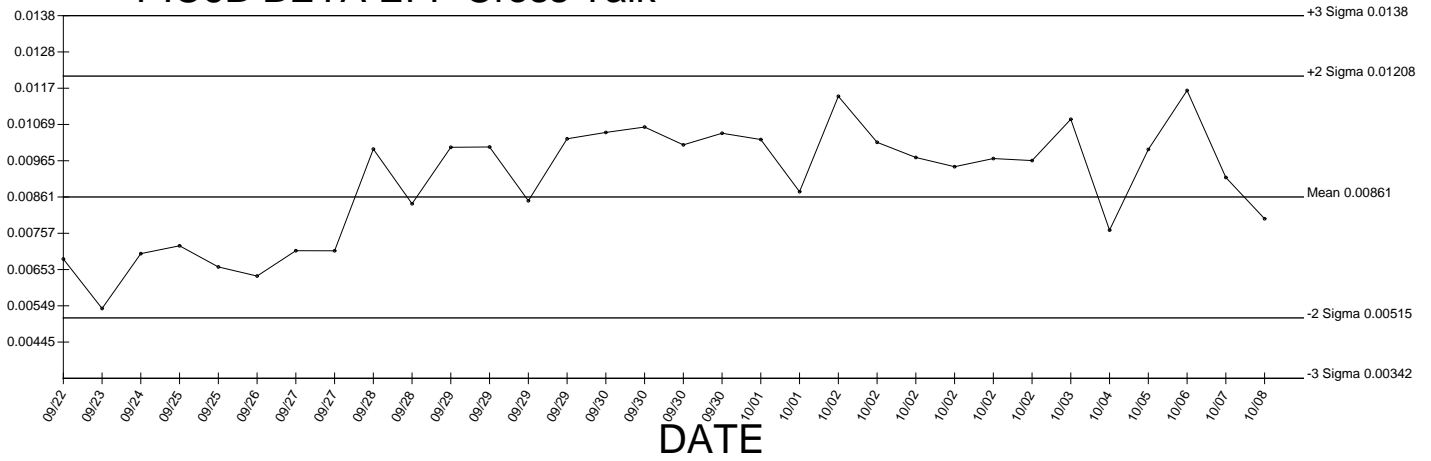
● Denotes Outlier

# PIC6B BETA EFF

Generated 10/08/2009

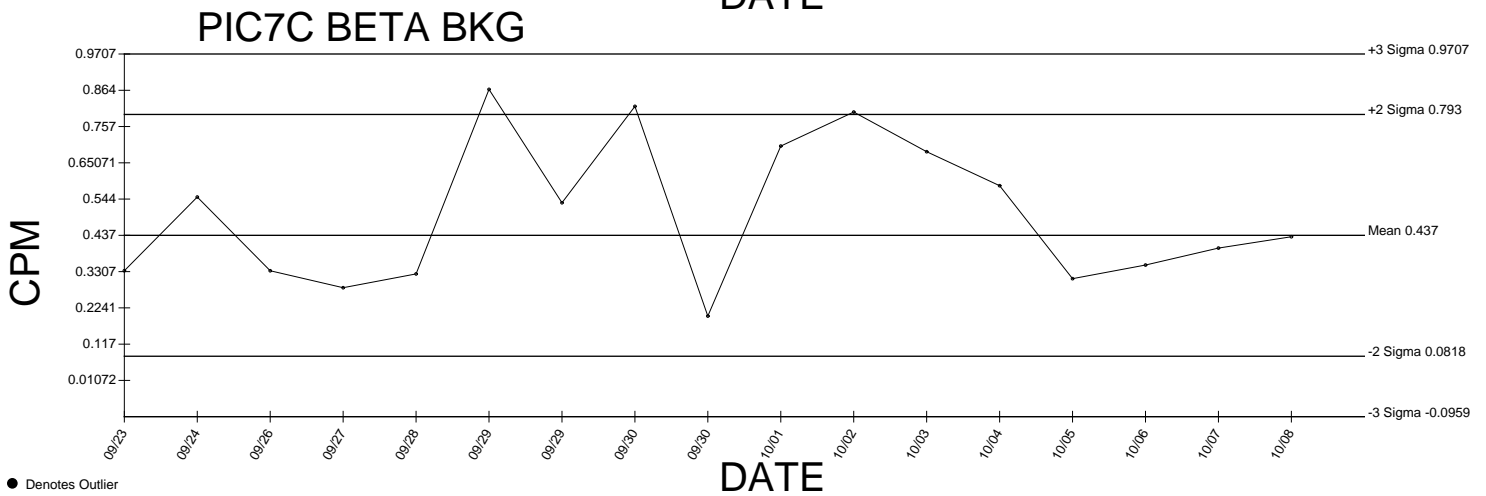
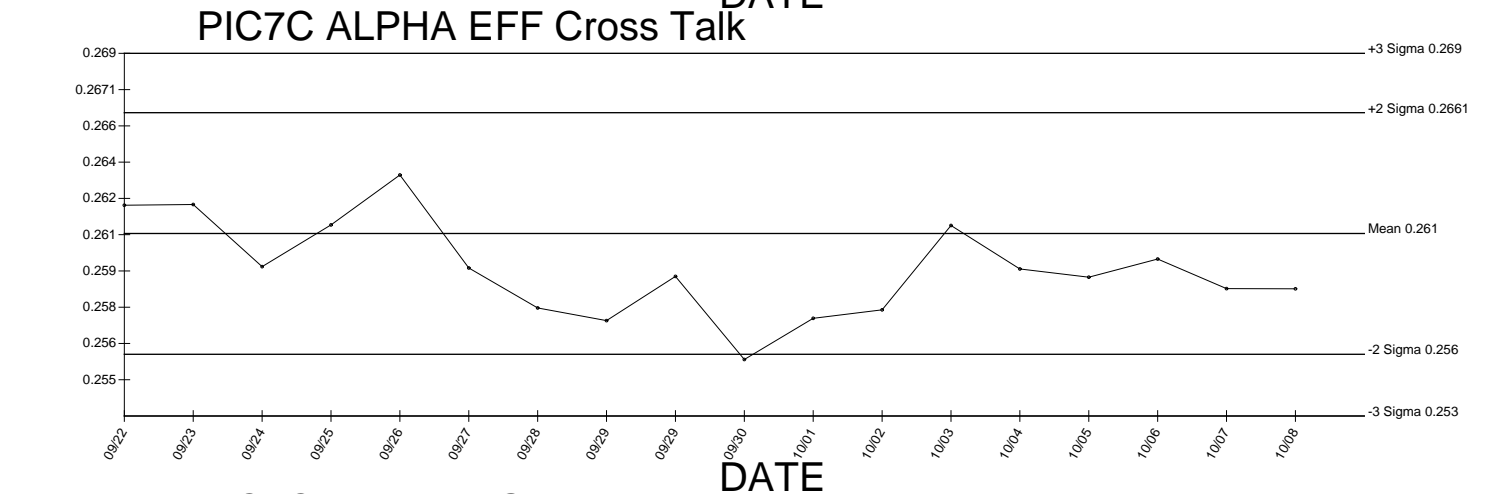
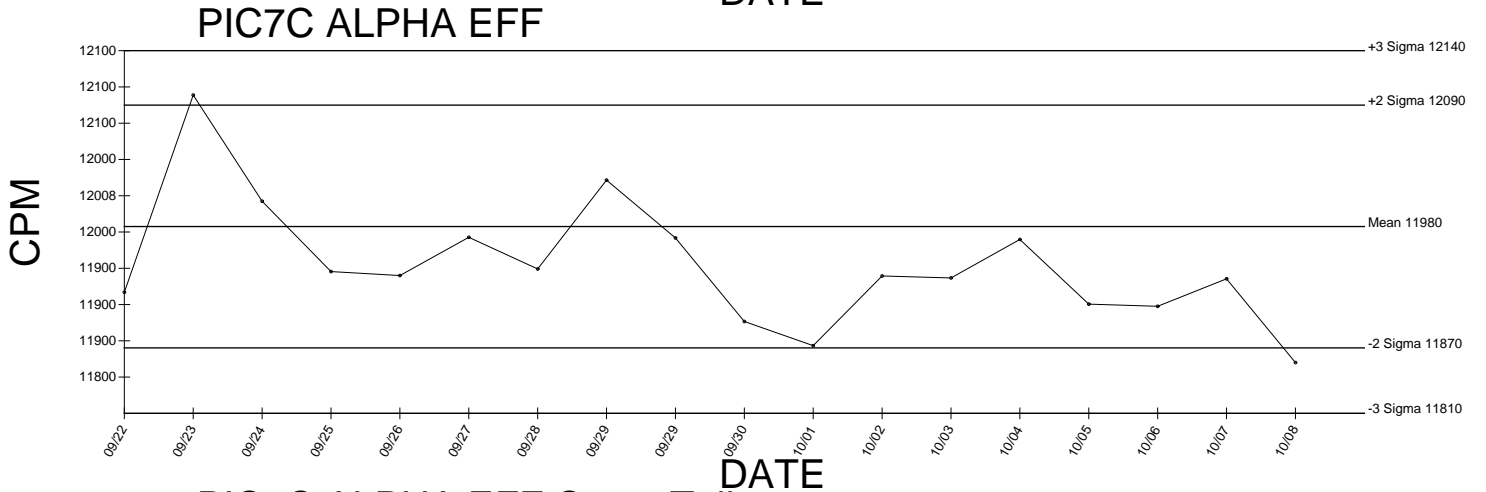
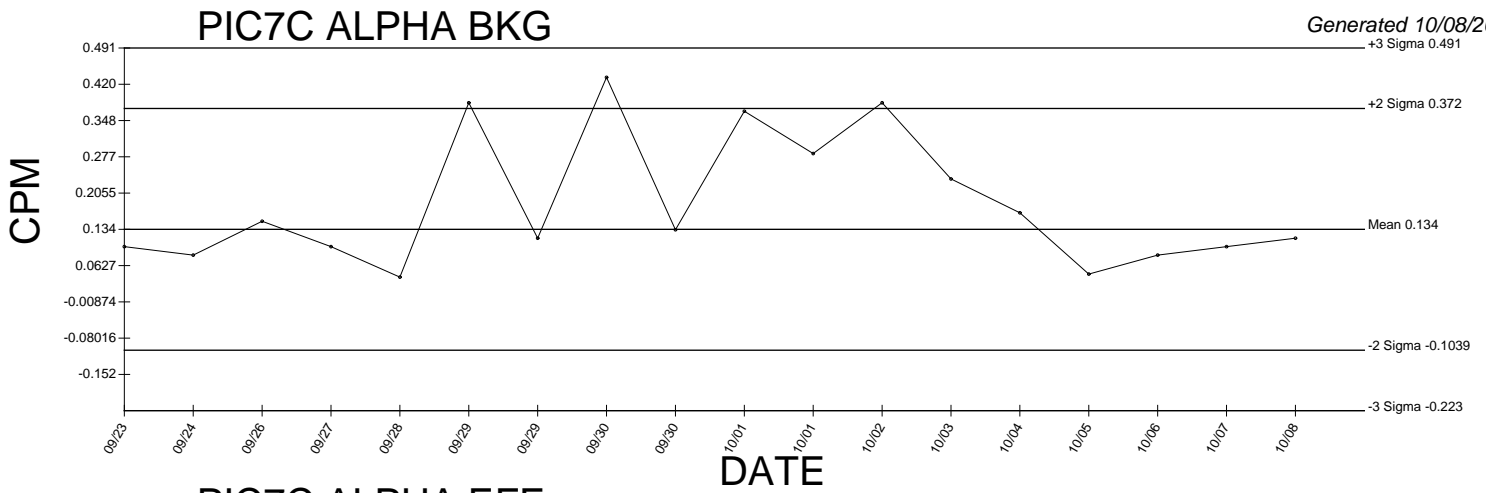


# PIC6B BETA EFF Cross Talk



● Denotes Outlier

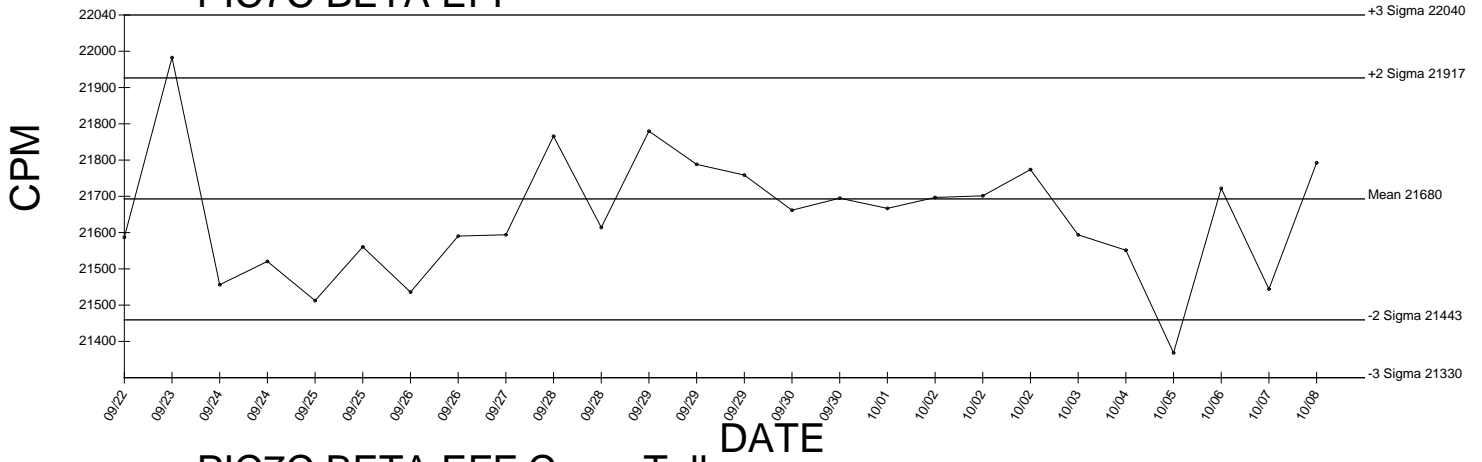




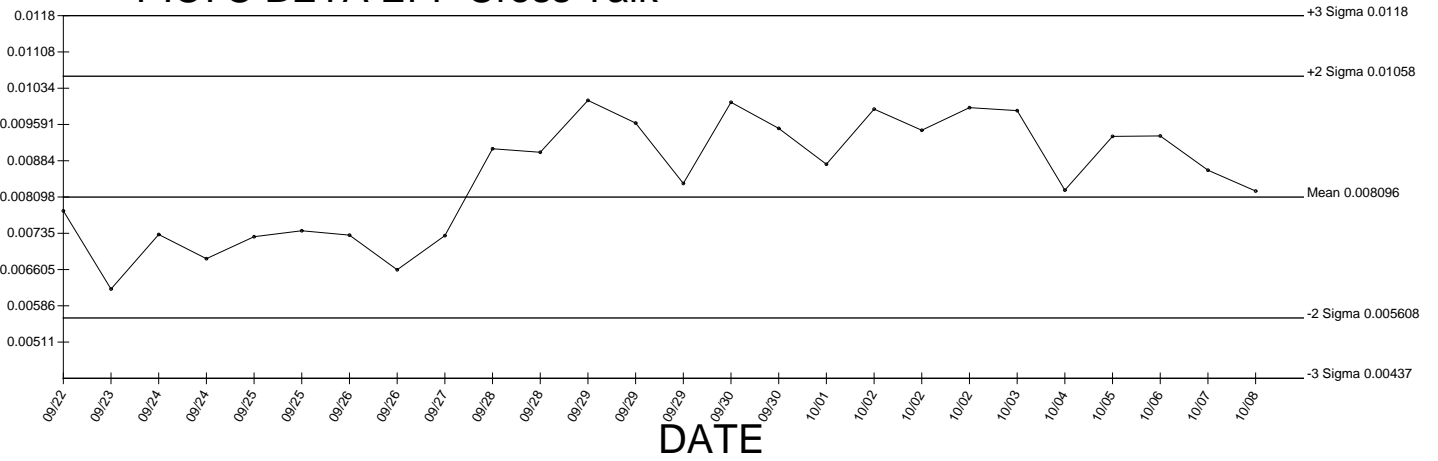
● Denotes Outlier

# PIC7C BETA EFF

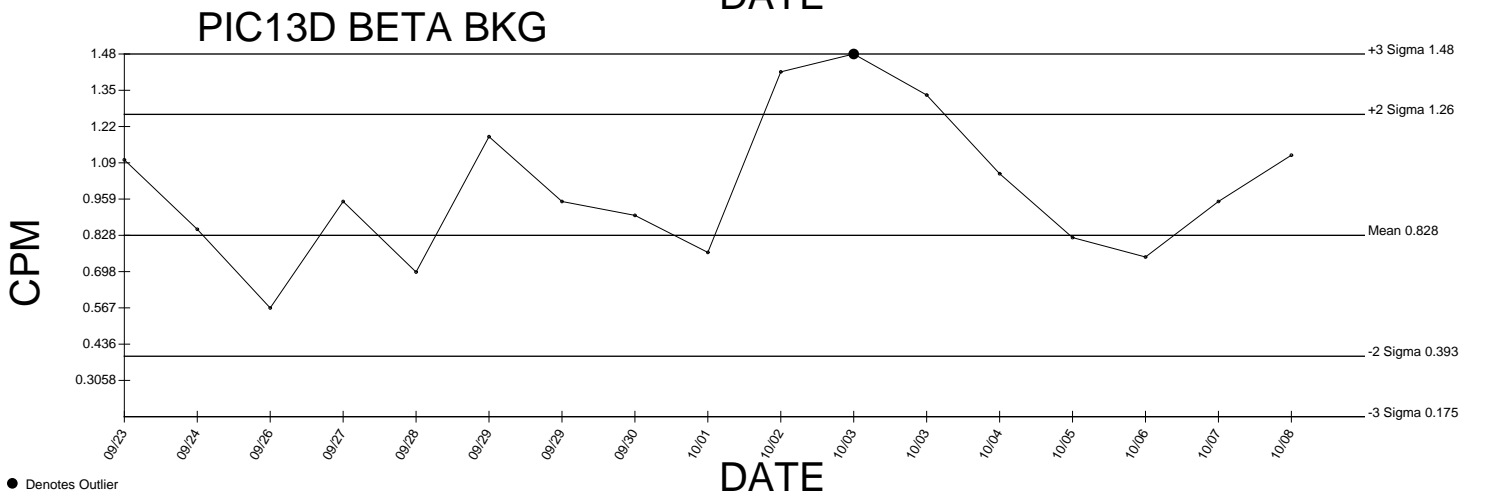
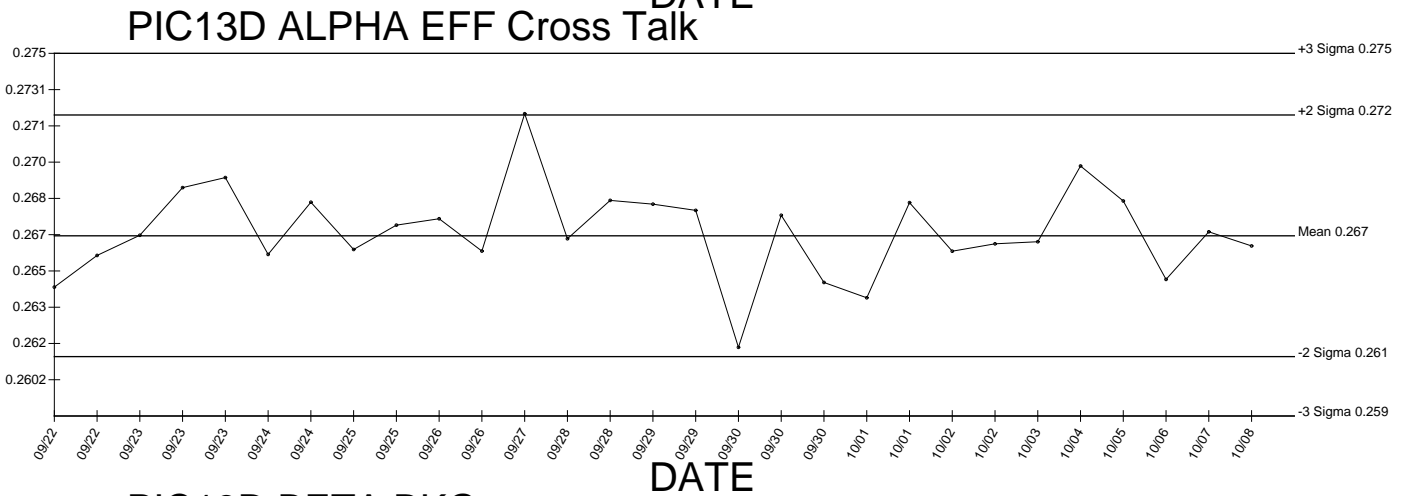
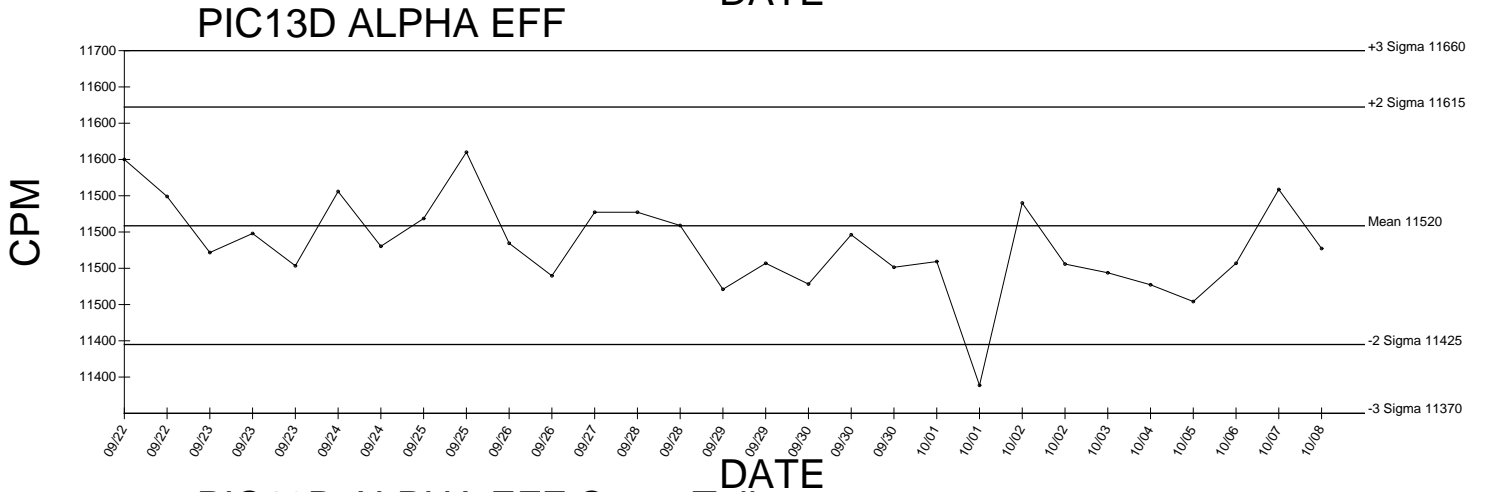
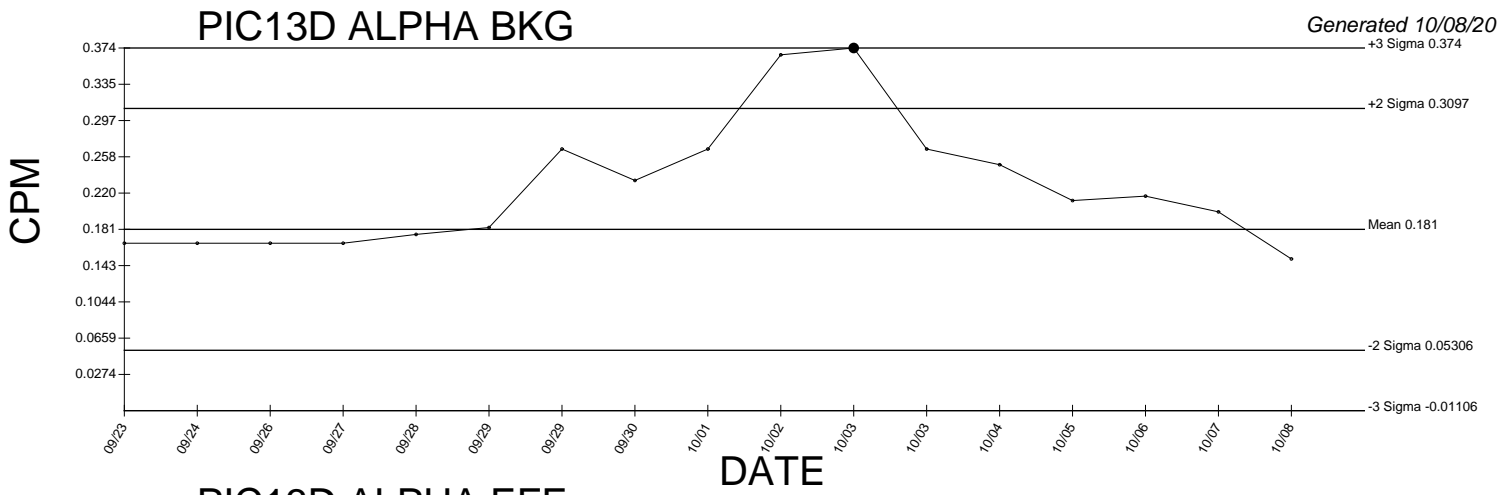
Generated 10/08/2009



# PIC7C BETA EFF Cross Talk



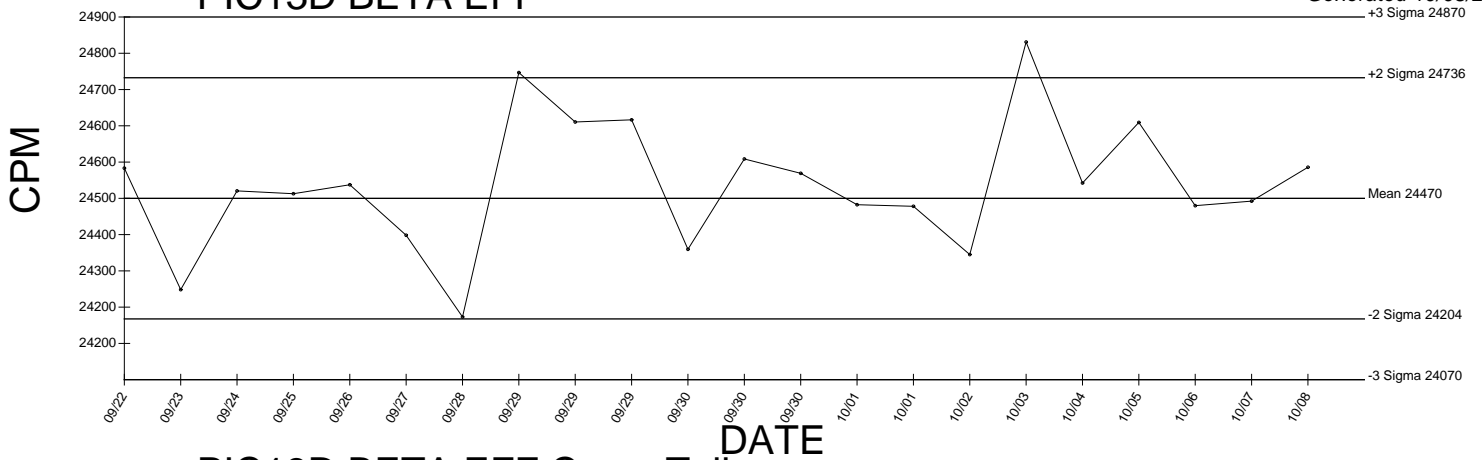
● Denotes Outlier



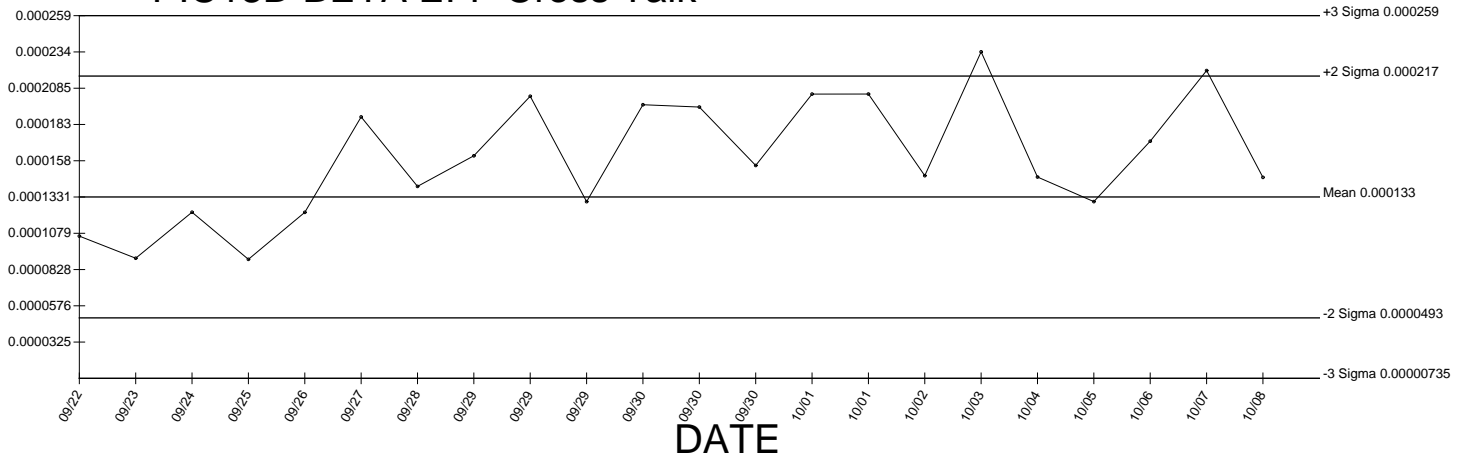
● Denotes Outlier

# PIC13D BETA EFF

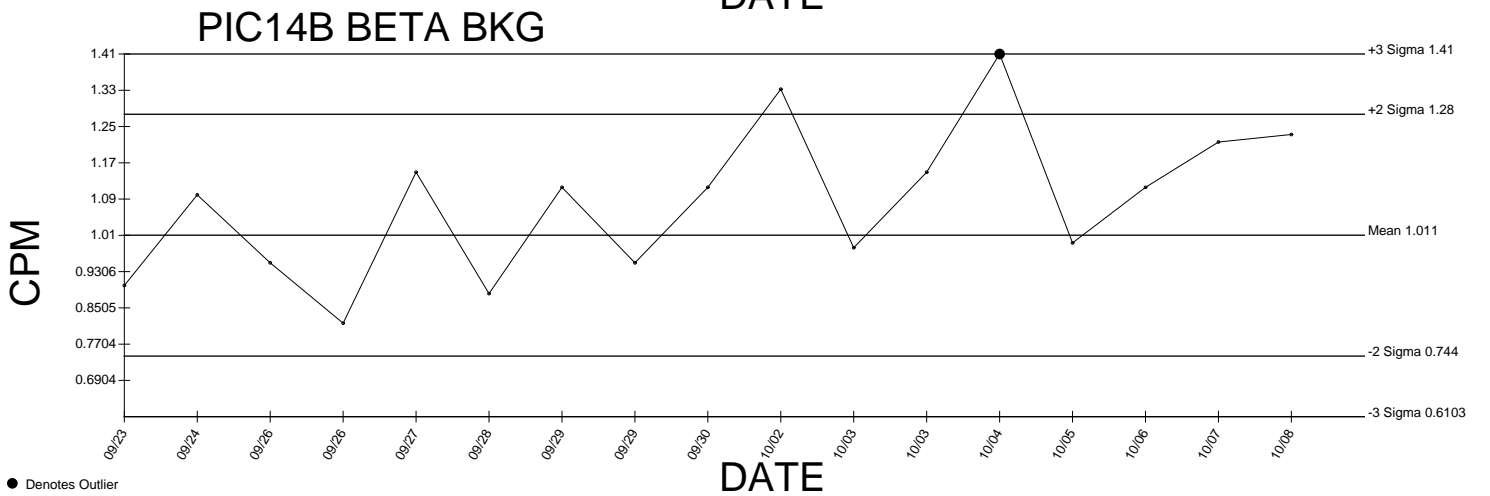
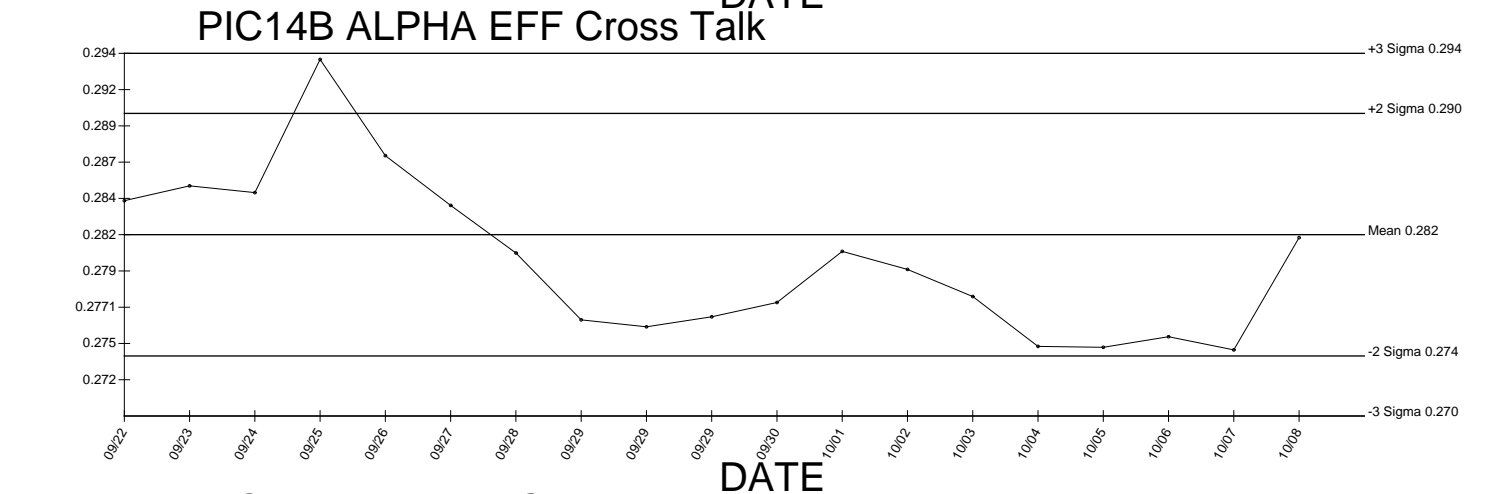
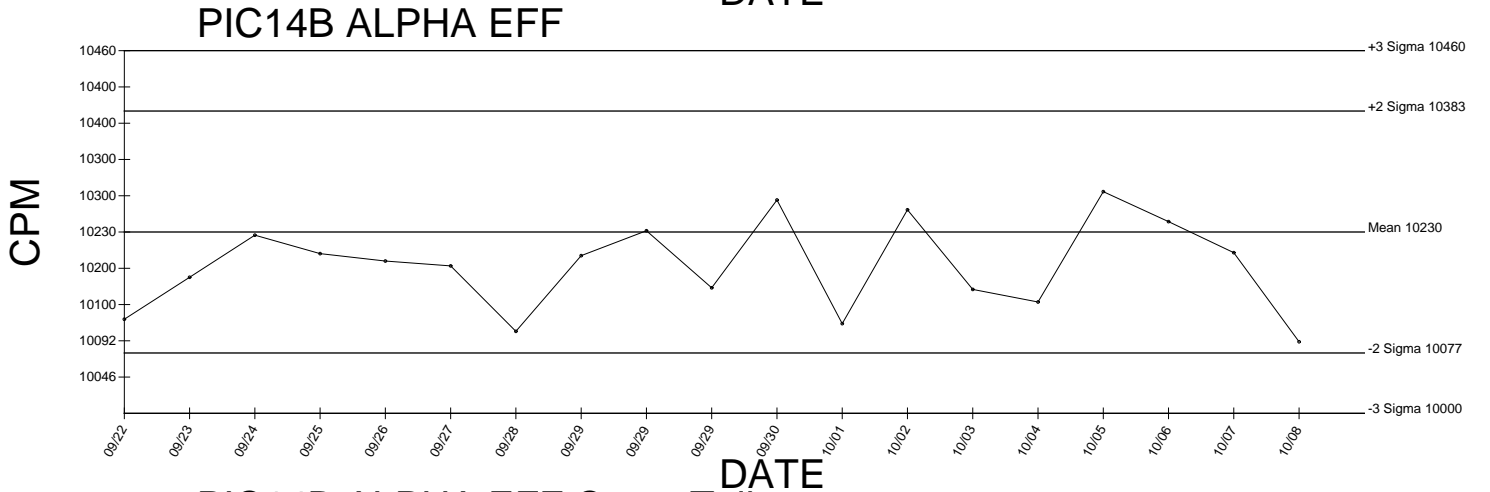
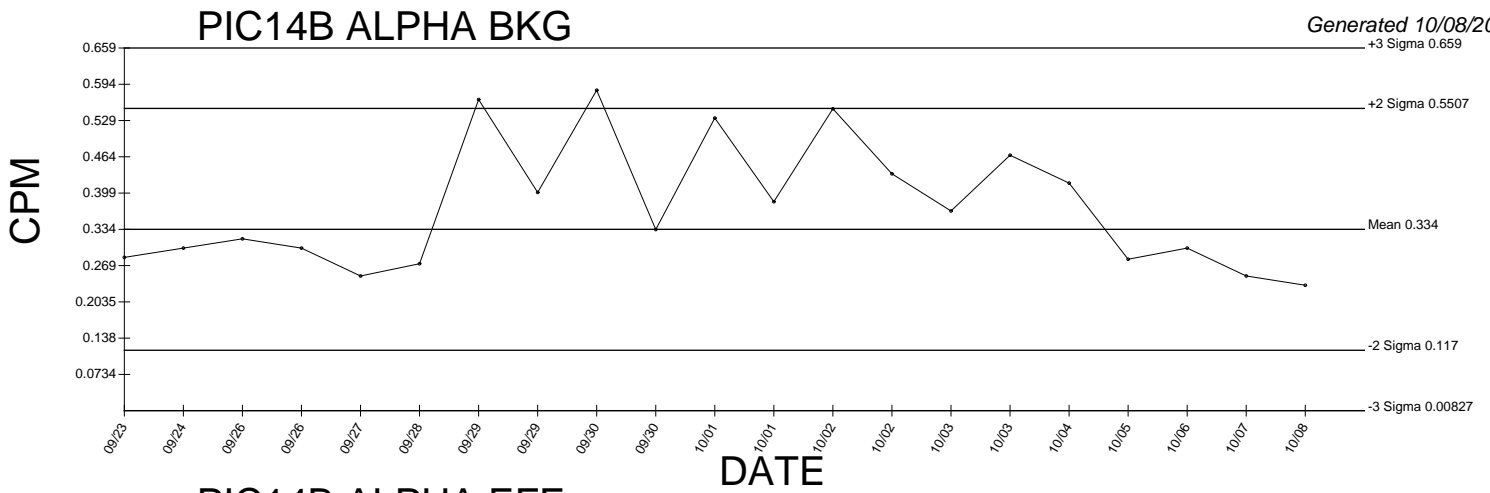
Generated 10/08/2009



# PIC13D BETA EFF Cross Talk

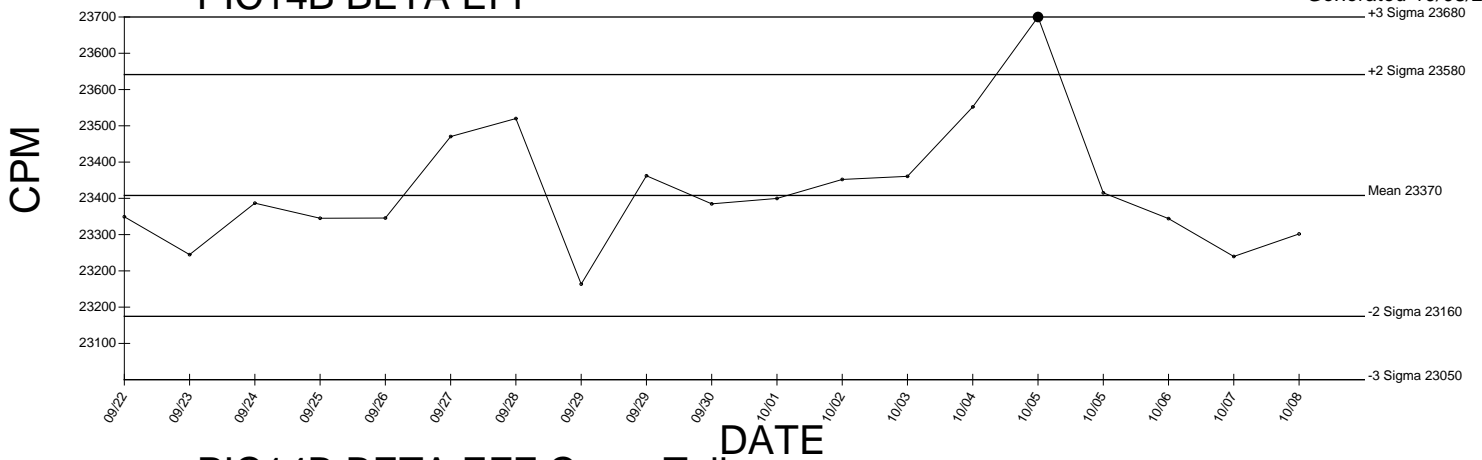


● Denotes Outlier

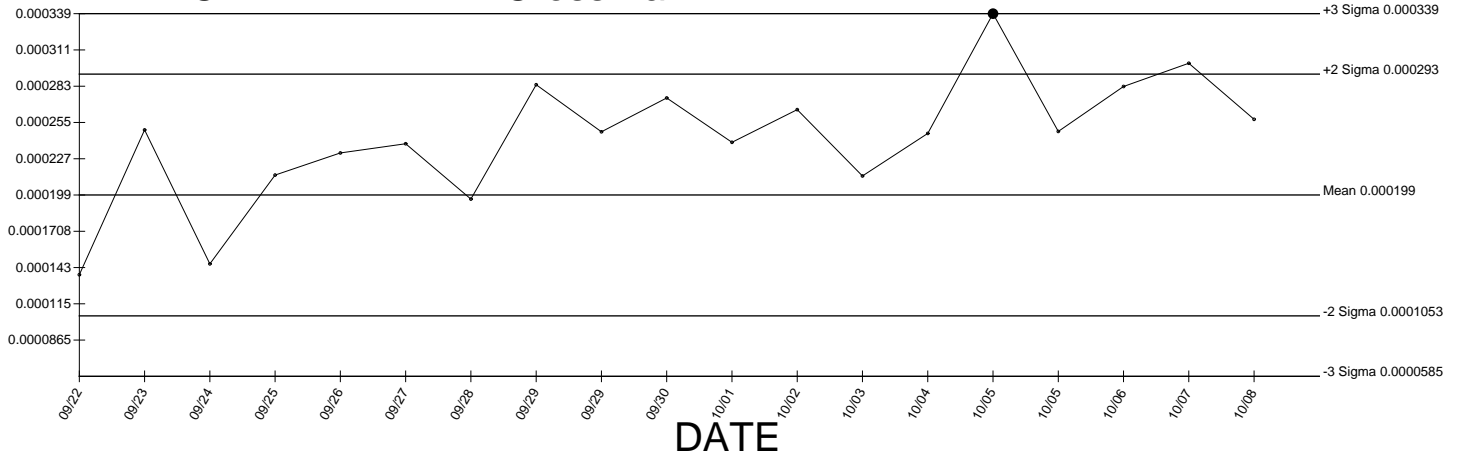


# PIC14B BETA EFF

Generated 10/08/2009

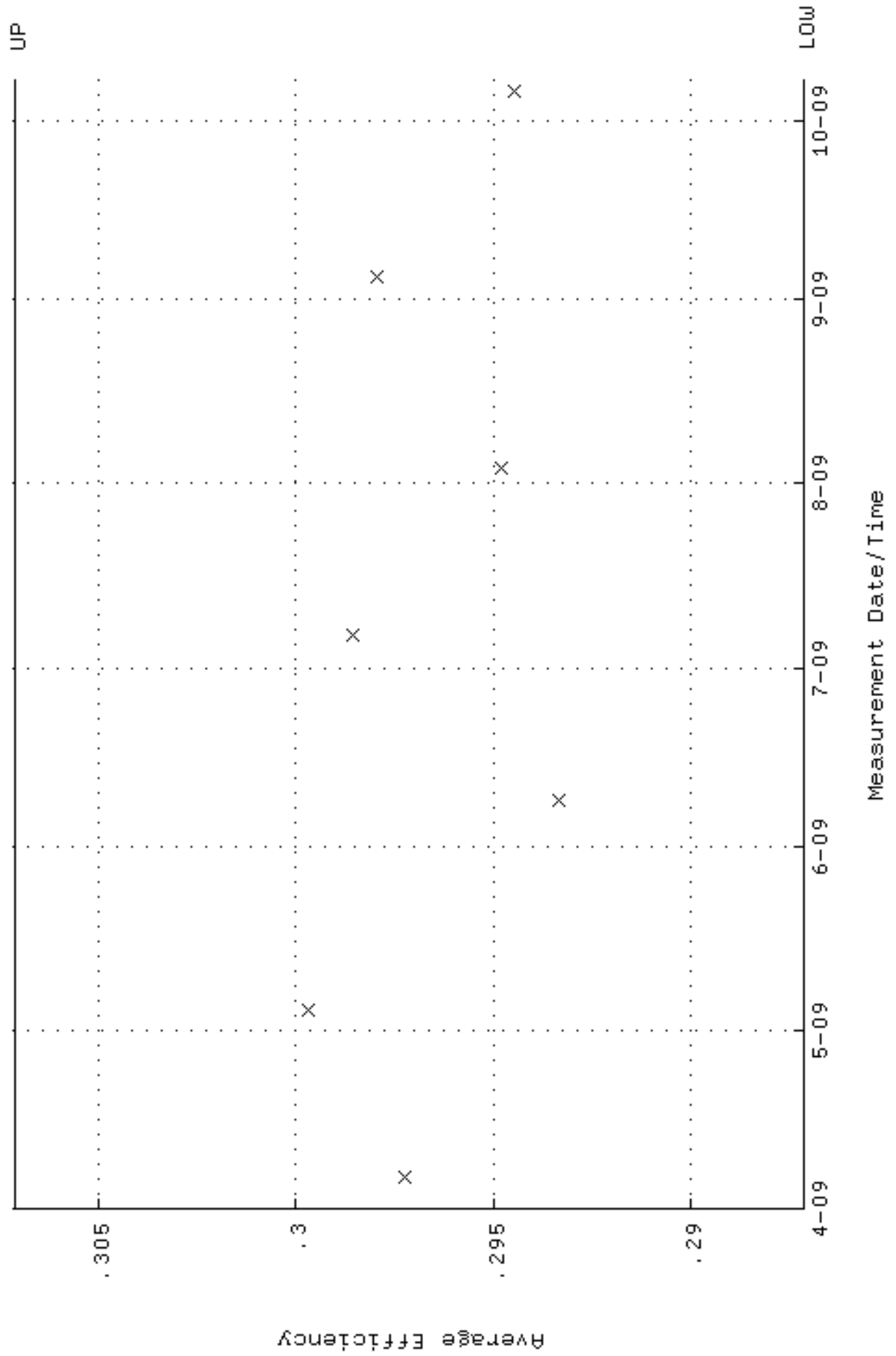


# PIC14B BETA EFF Cross Talk

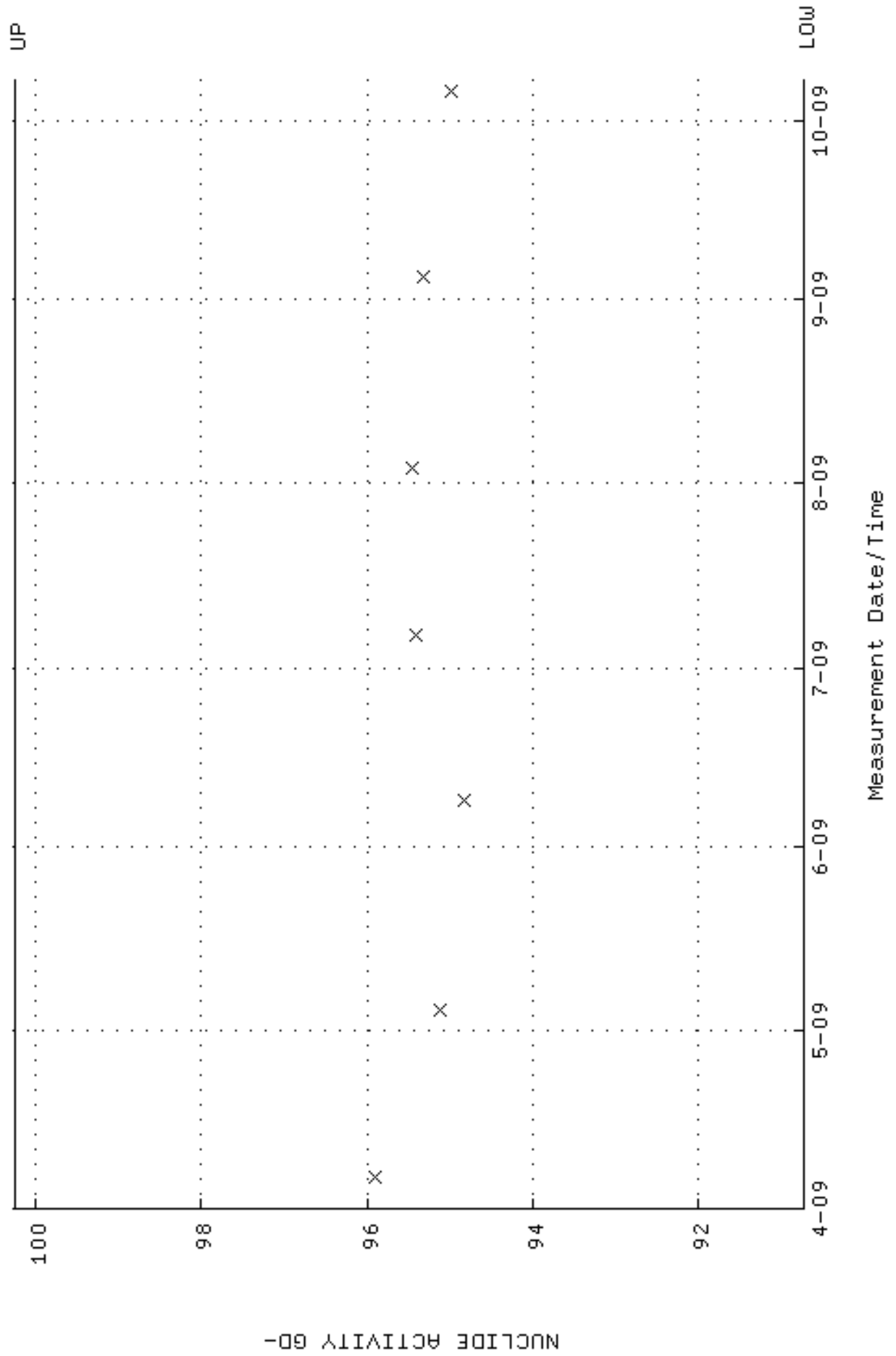


● Denotes Outlier

QA filename : DKA100:[ENV\_ALPHA.QA.W]W011.QAF;4  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:01 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.287129 through 0.307129

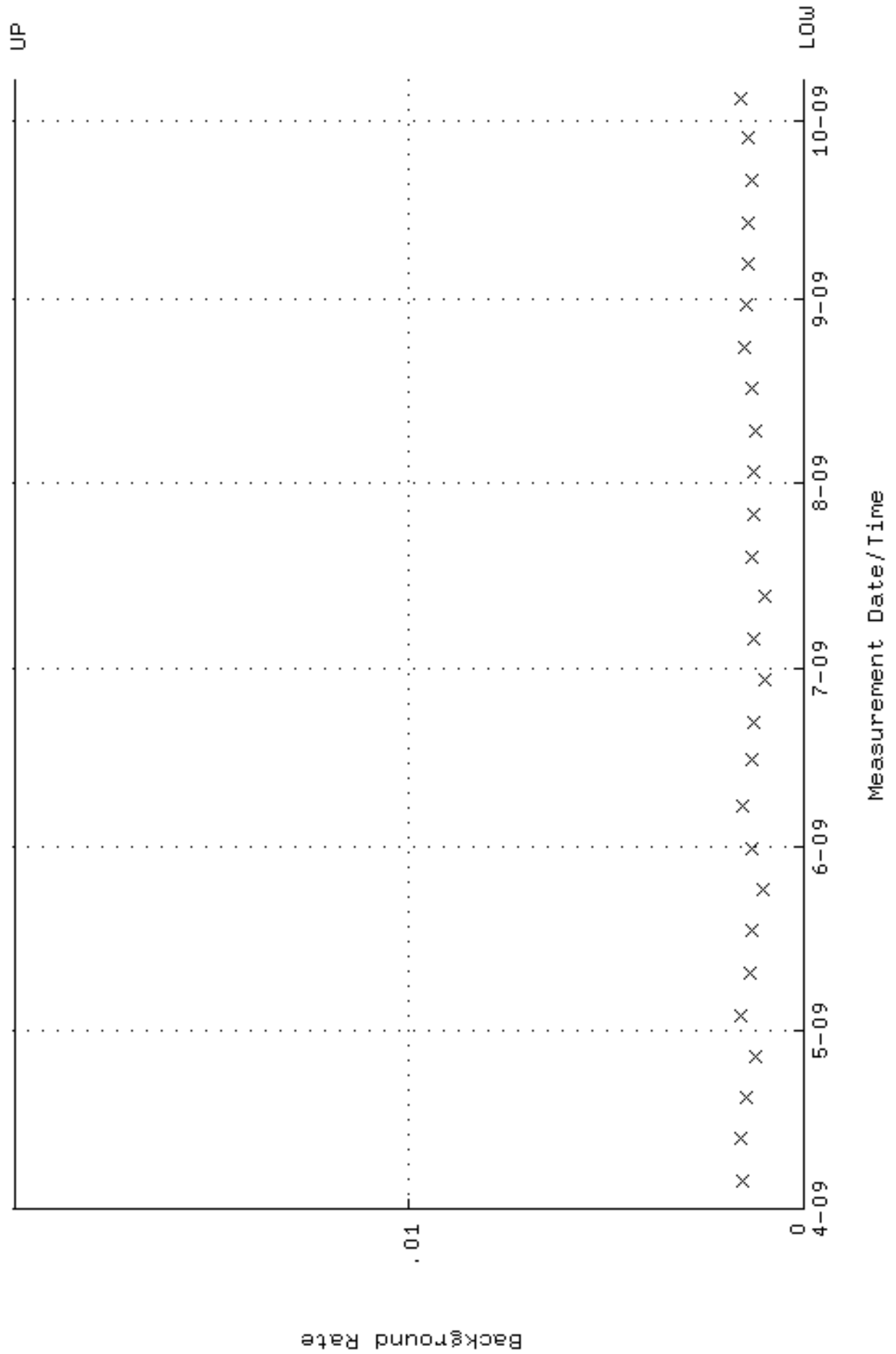


QA filename : DKA100:[ENV\_ALPHA.QA.W]W011.QAF;4  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:01 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 90.7092 through 100.258

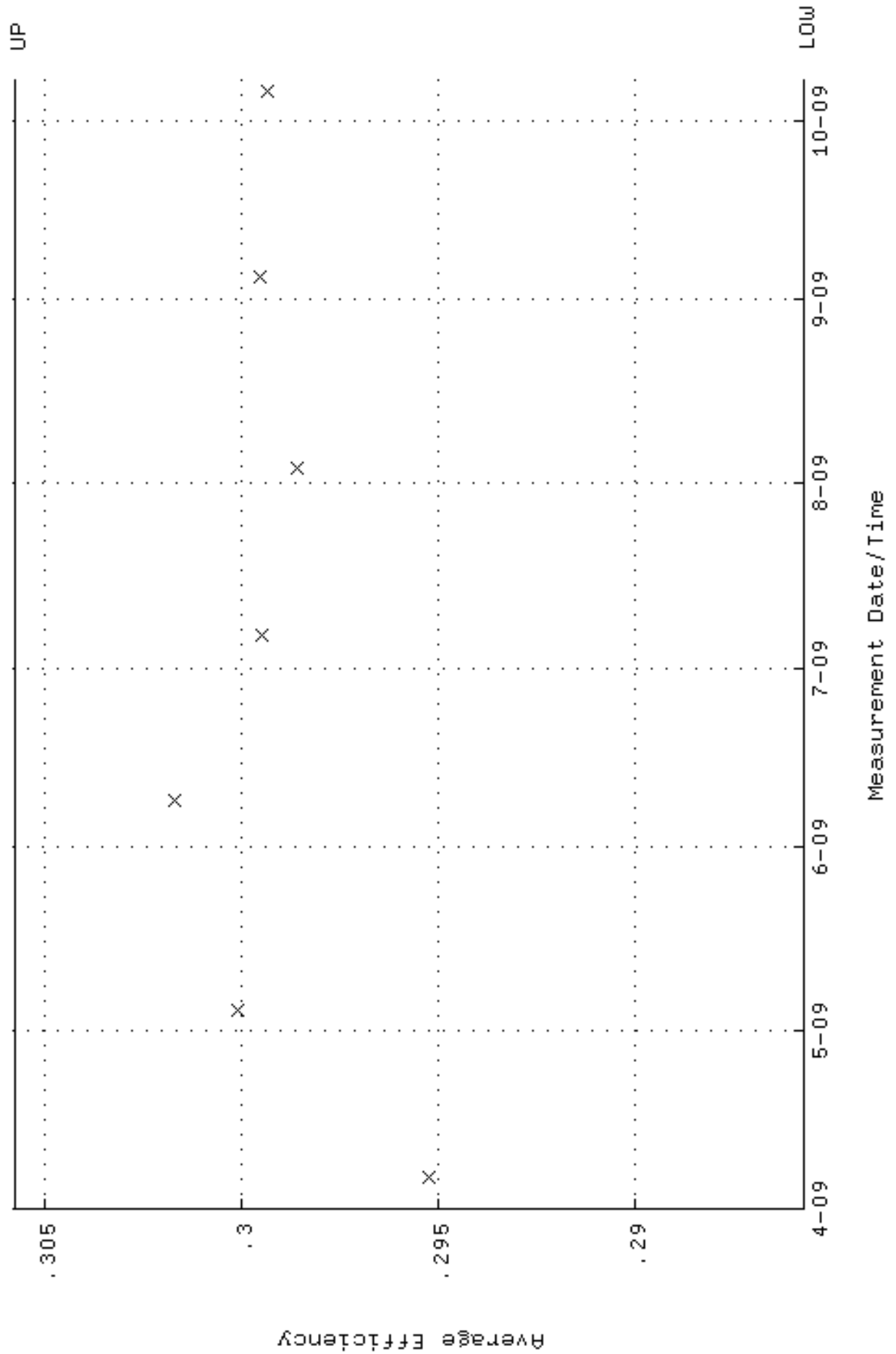




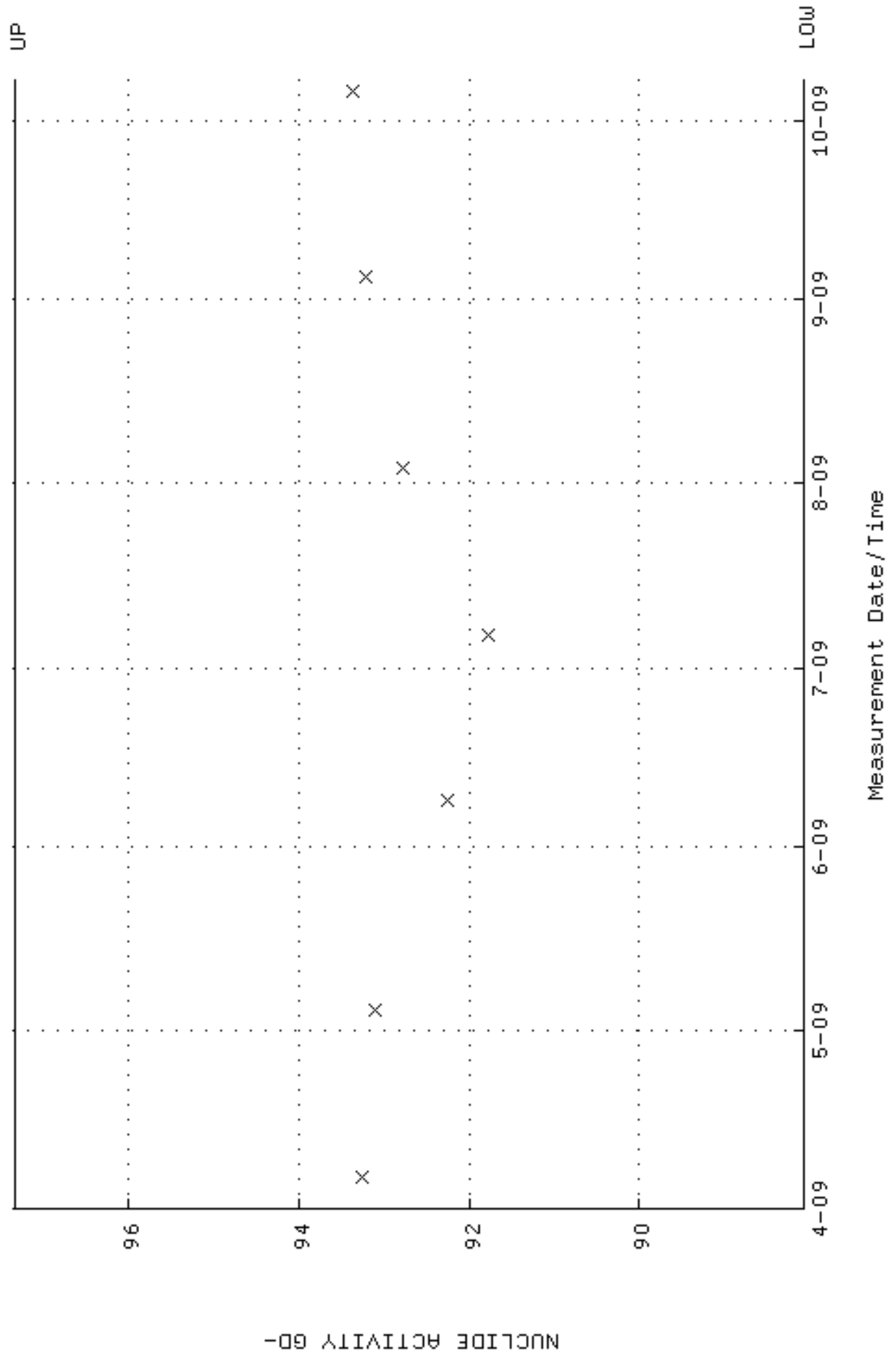
QA filename : DKA100:[ENV\_ALPHA.QA.B]B011.QAF;2  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



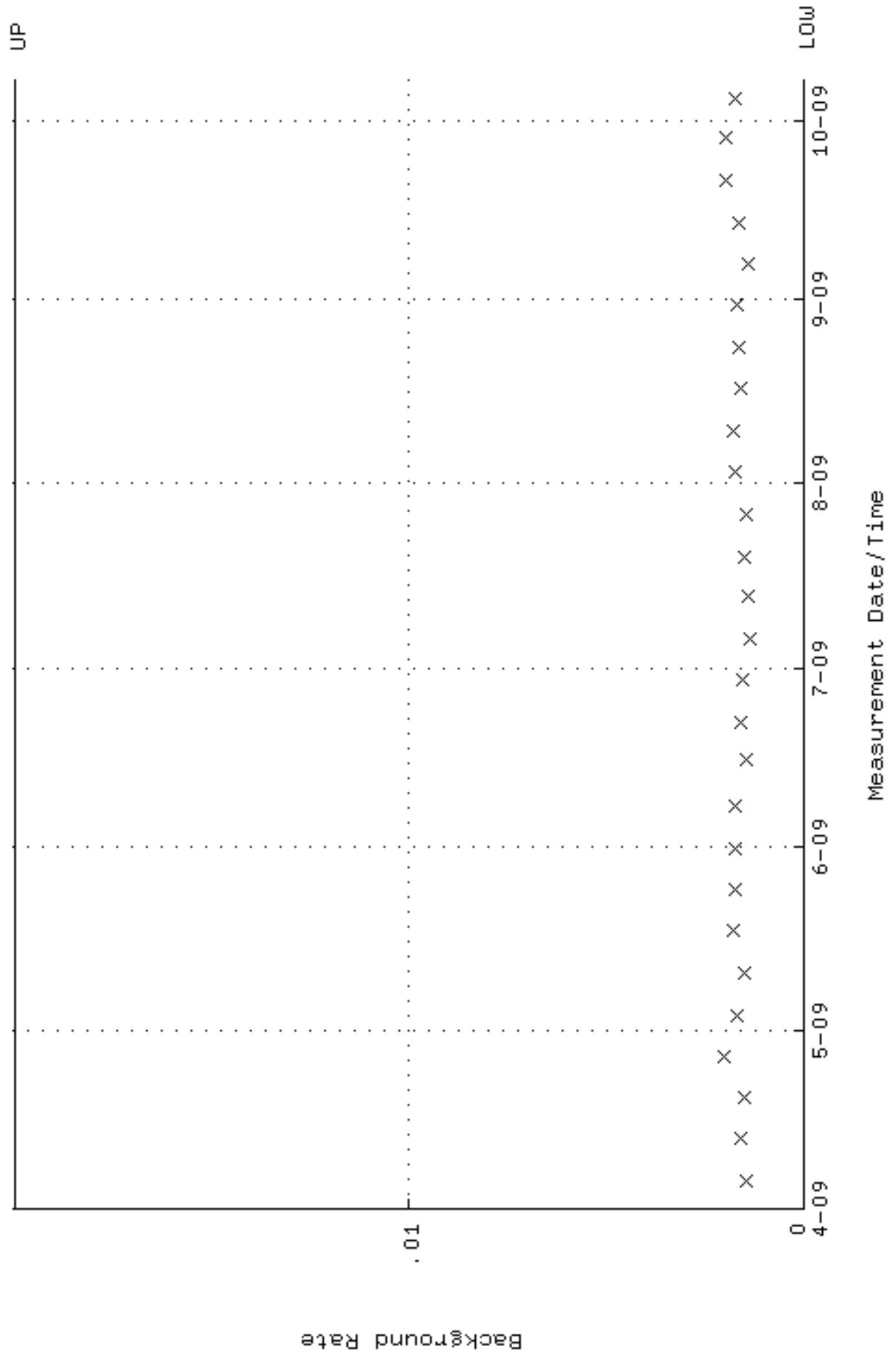
QA filename : DKA100:[ENV\_ALPHA.QA.W]W012.QAF;4  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:01 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.285730 through 0.305730



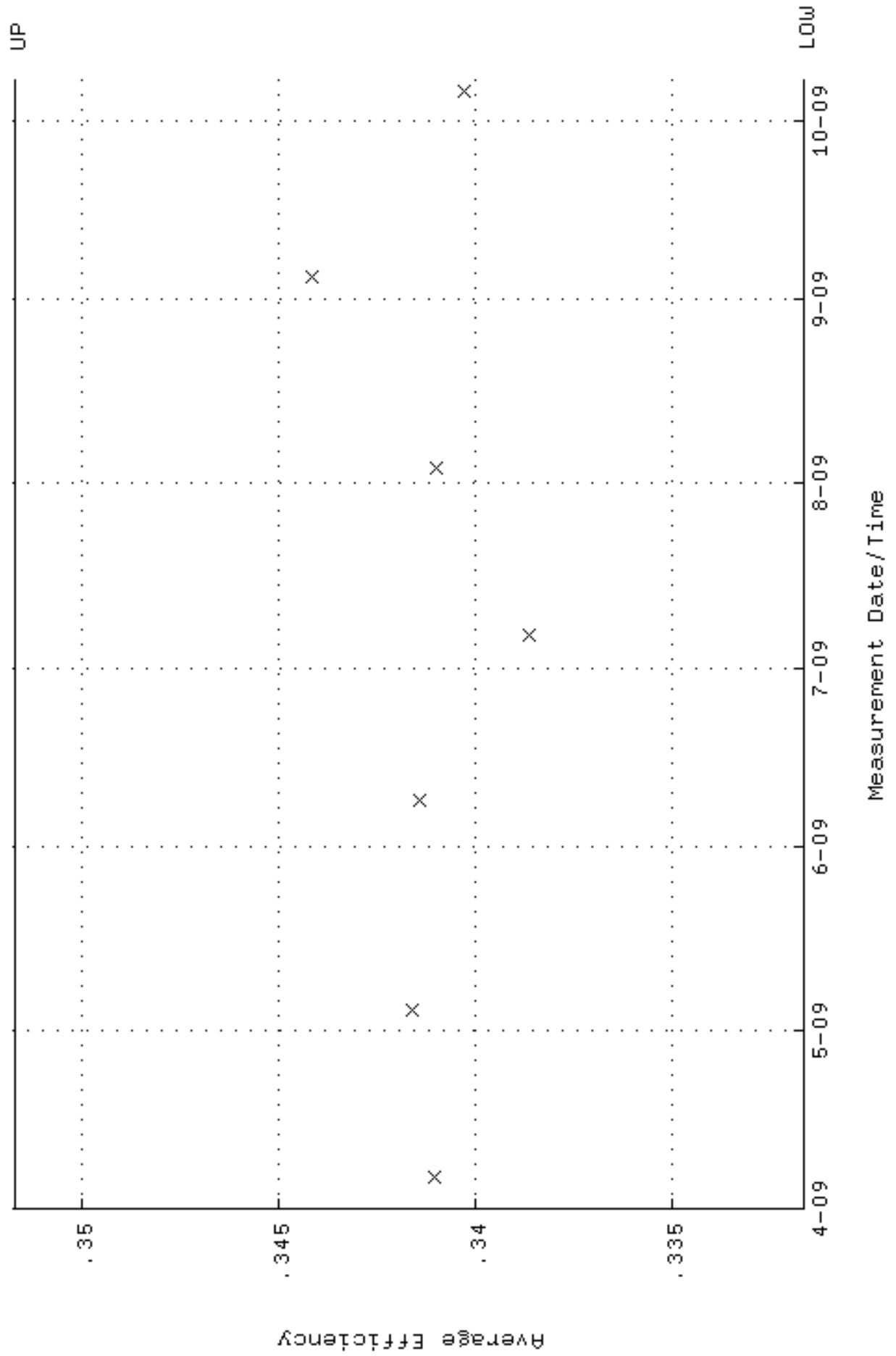
QA filename : DKA100:[ENV\_ALPHA.QA.W]w012.QAF;4  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:01 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 88.0678 through 97.3382



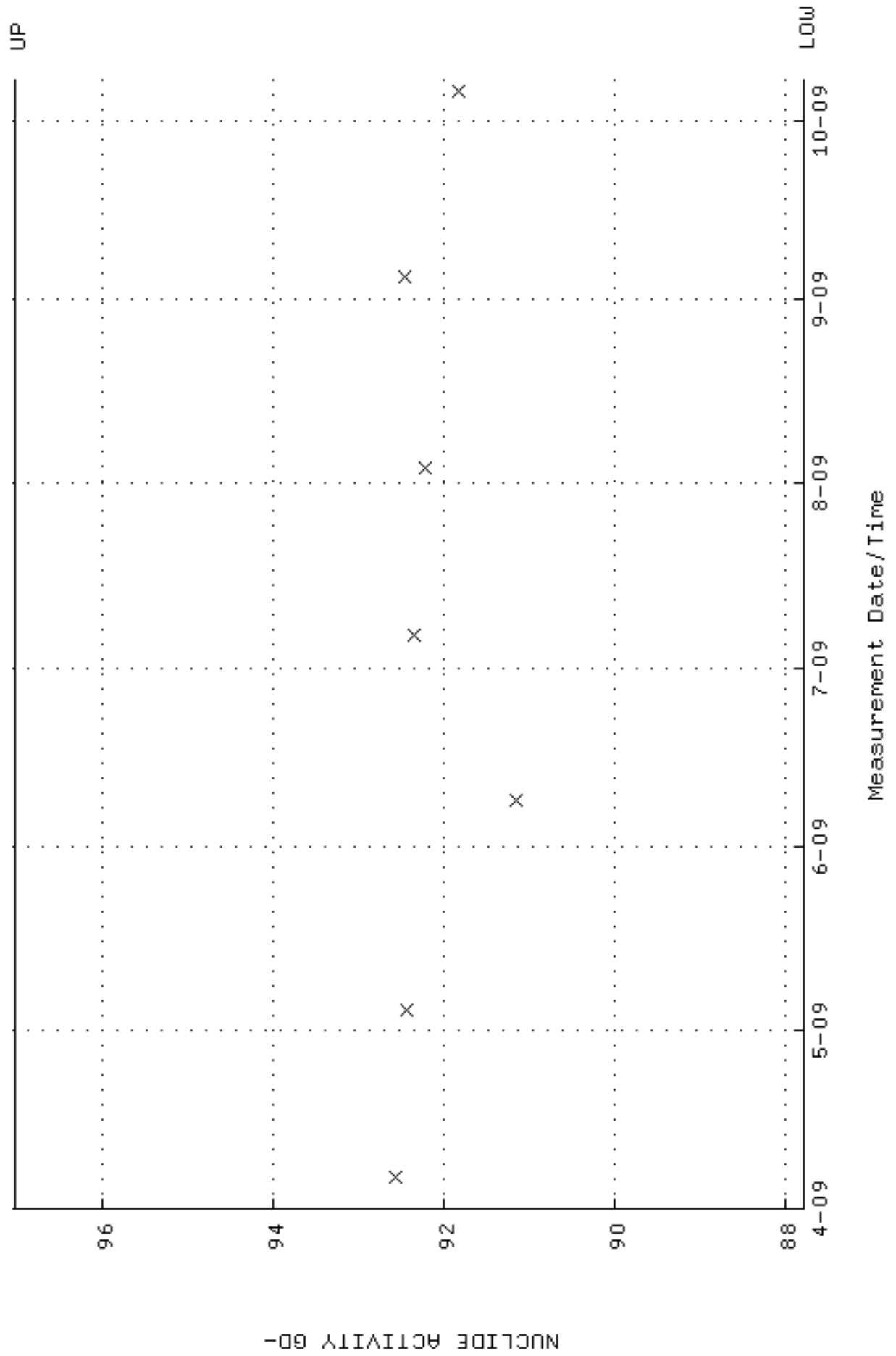
QA filename : DKA100:[ENV\_ALPHA.QA.B]B012.QAF;2  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



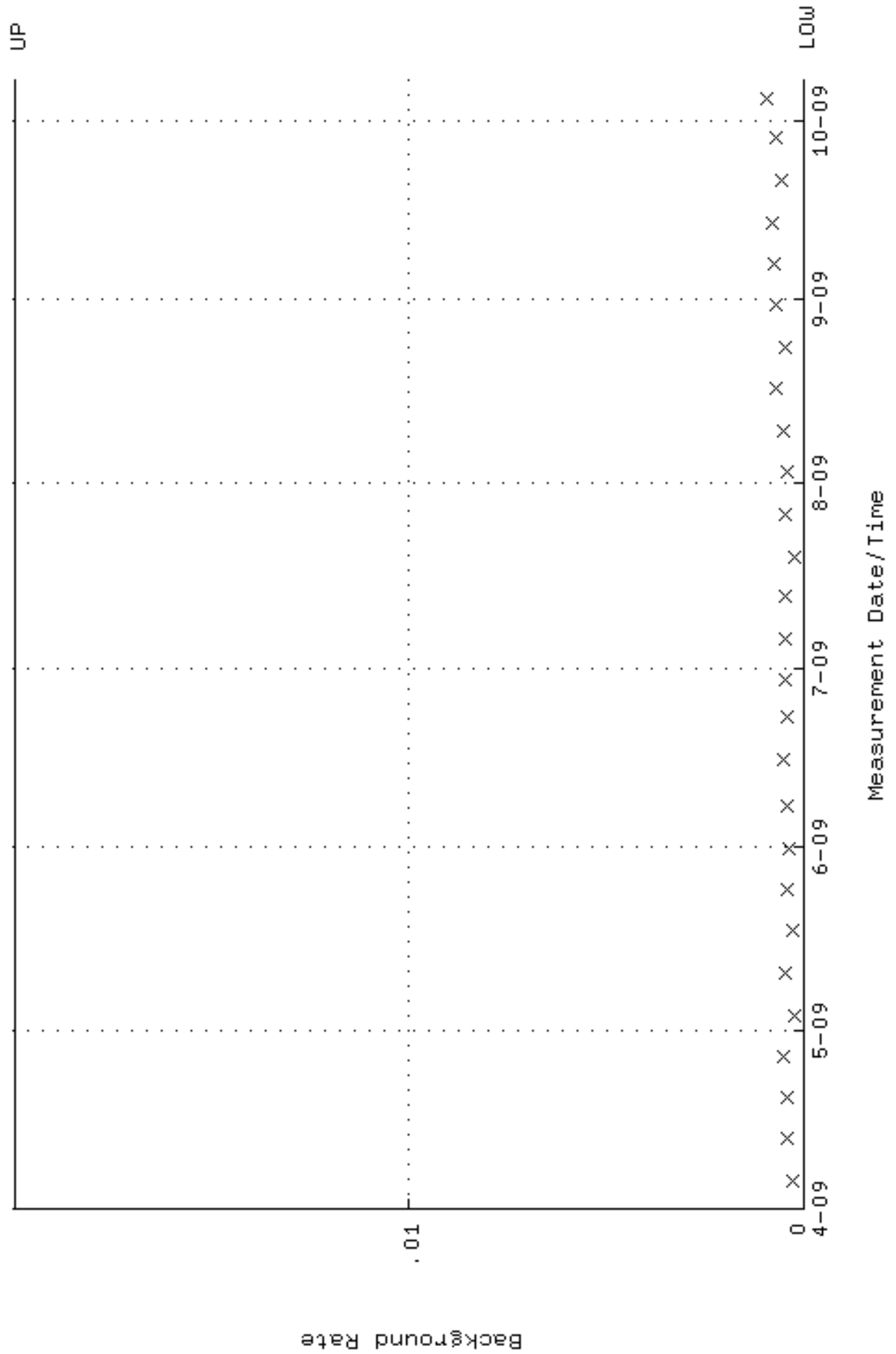
QA filename : DKA100:[ENV\_ALPHA.QA.W]W013.QAF;2  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.331676 through 0.351676



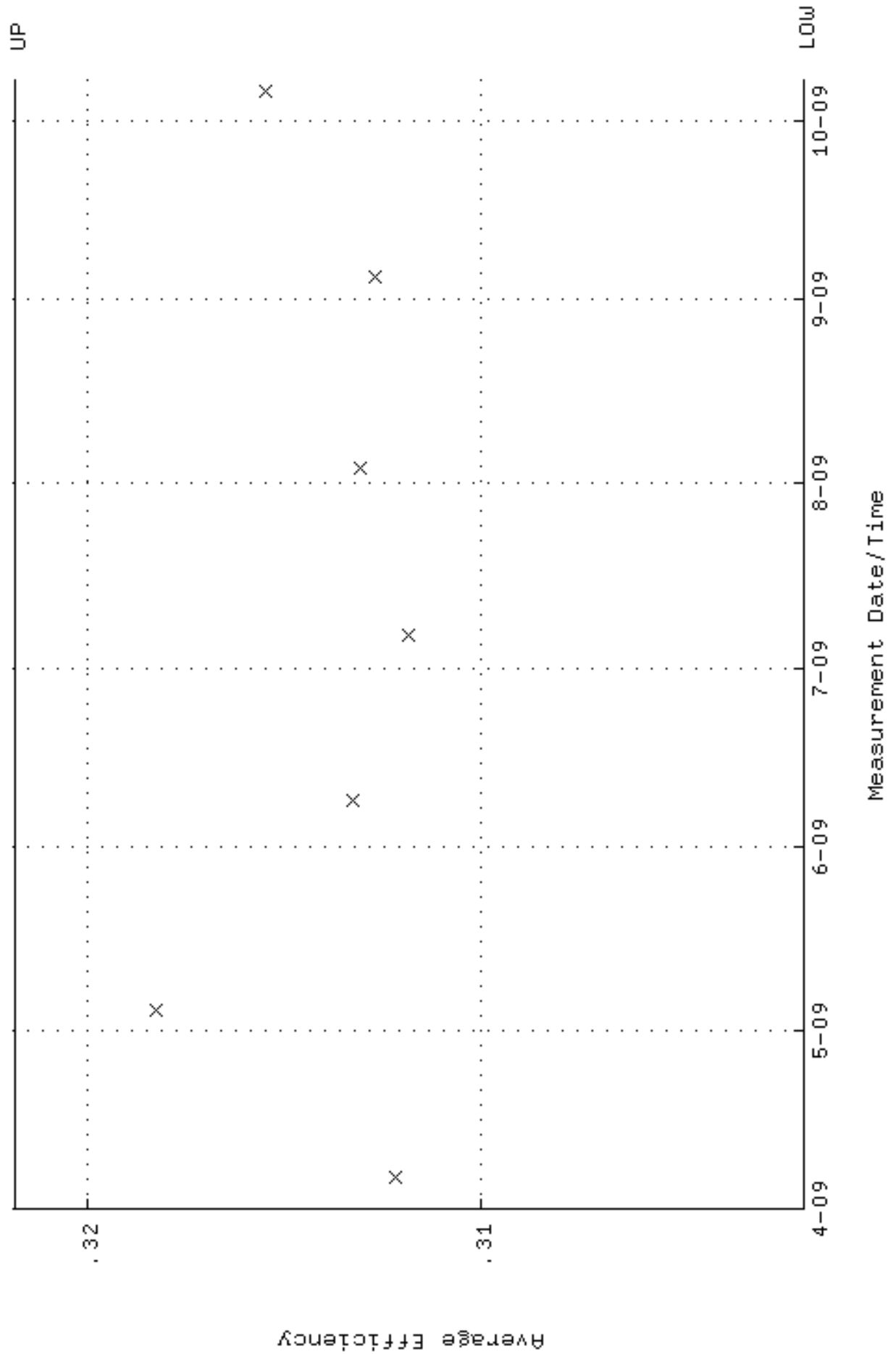
QA filename : DKA100:[ENV\_ALPHA.QA.W]W013.QAF;2  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 87.7736 through 97.0130



QA filename : DKA100:[ENV\_ALPHA.QA.B]B013.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02

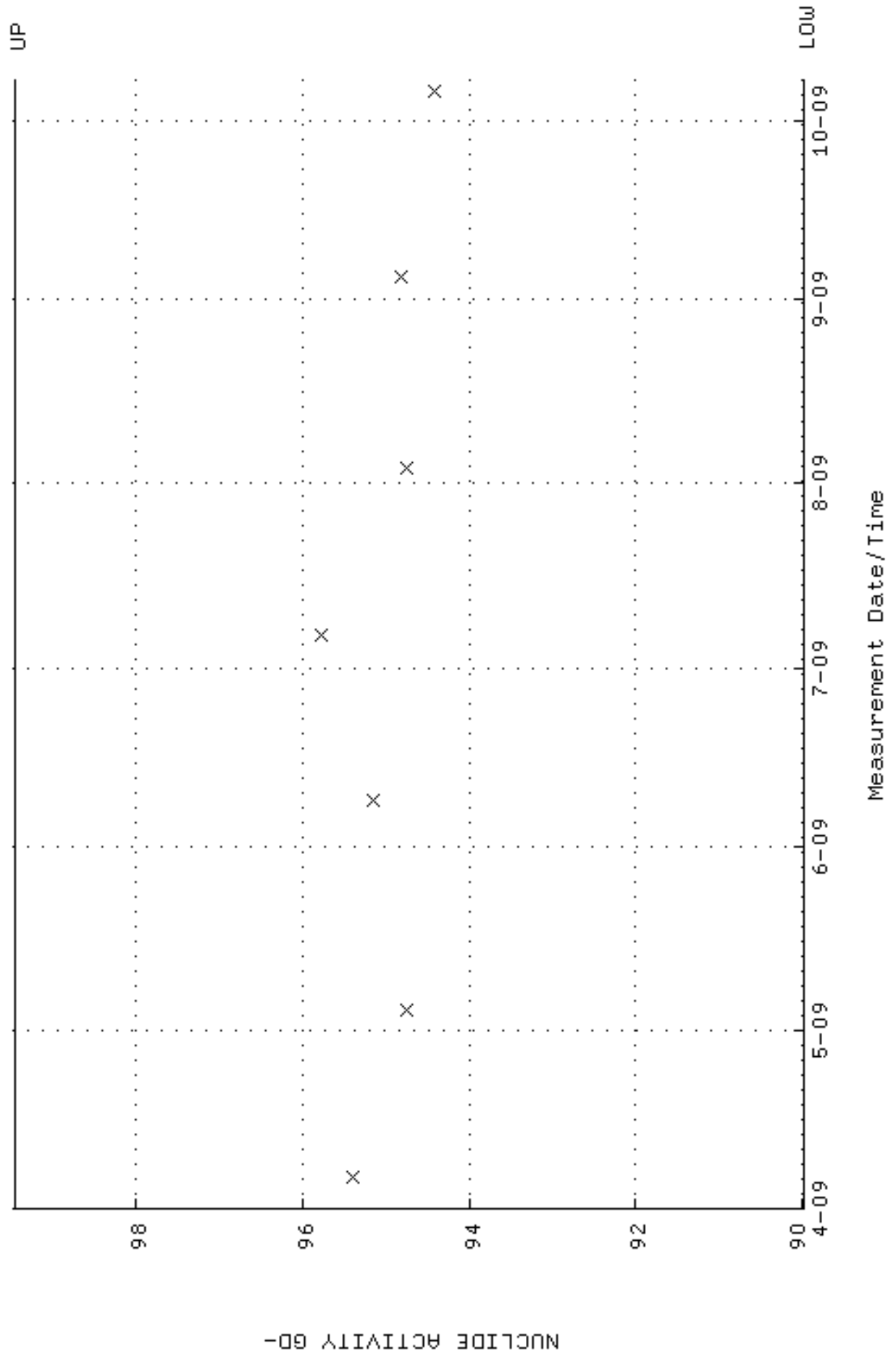


QA filename : DKA100:[ENV\_ALPHA.QA.W]W014.QAF;4  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.301834 through 0.321834

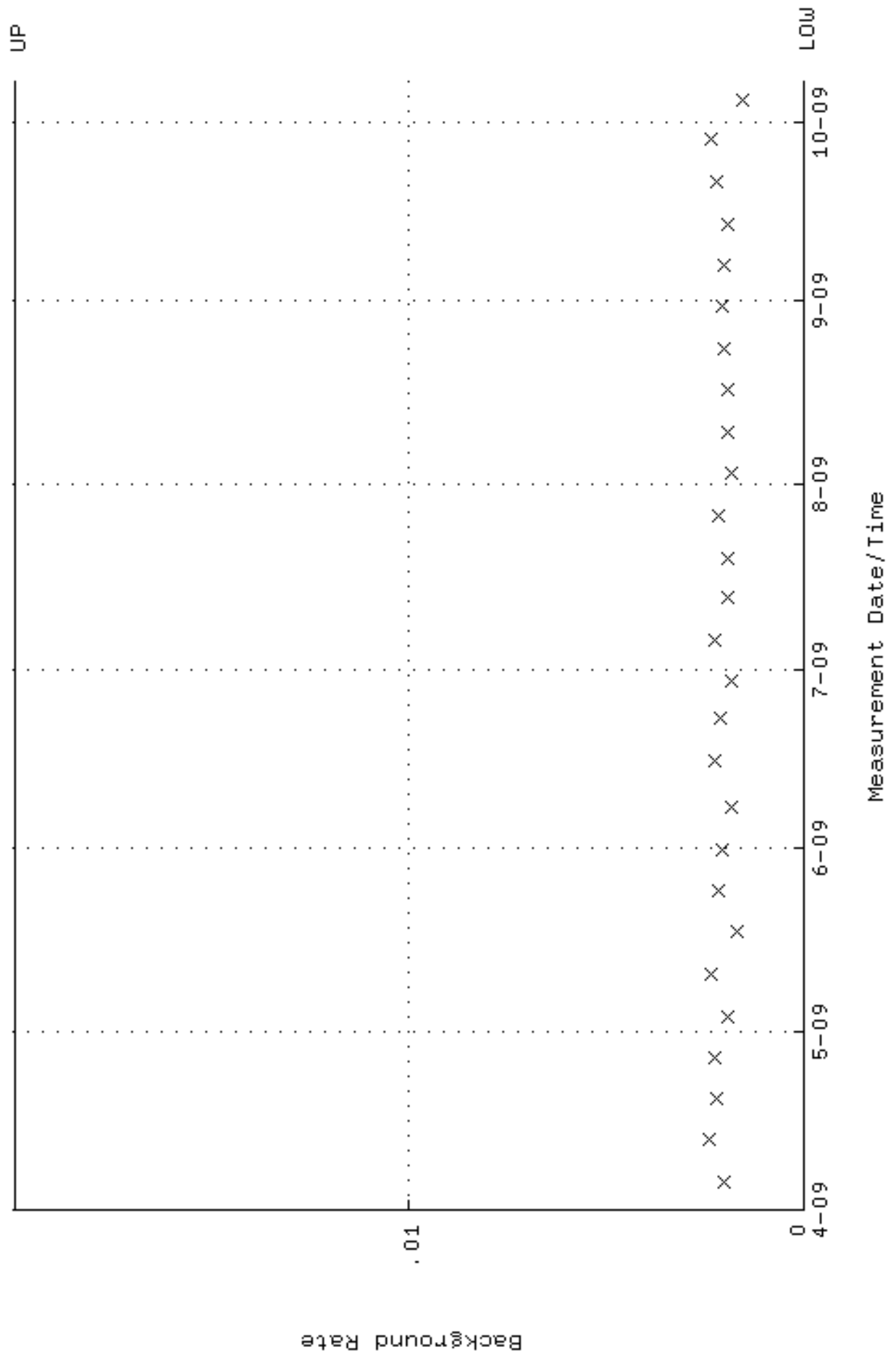




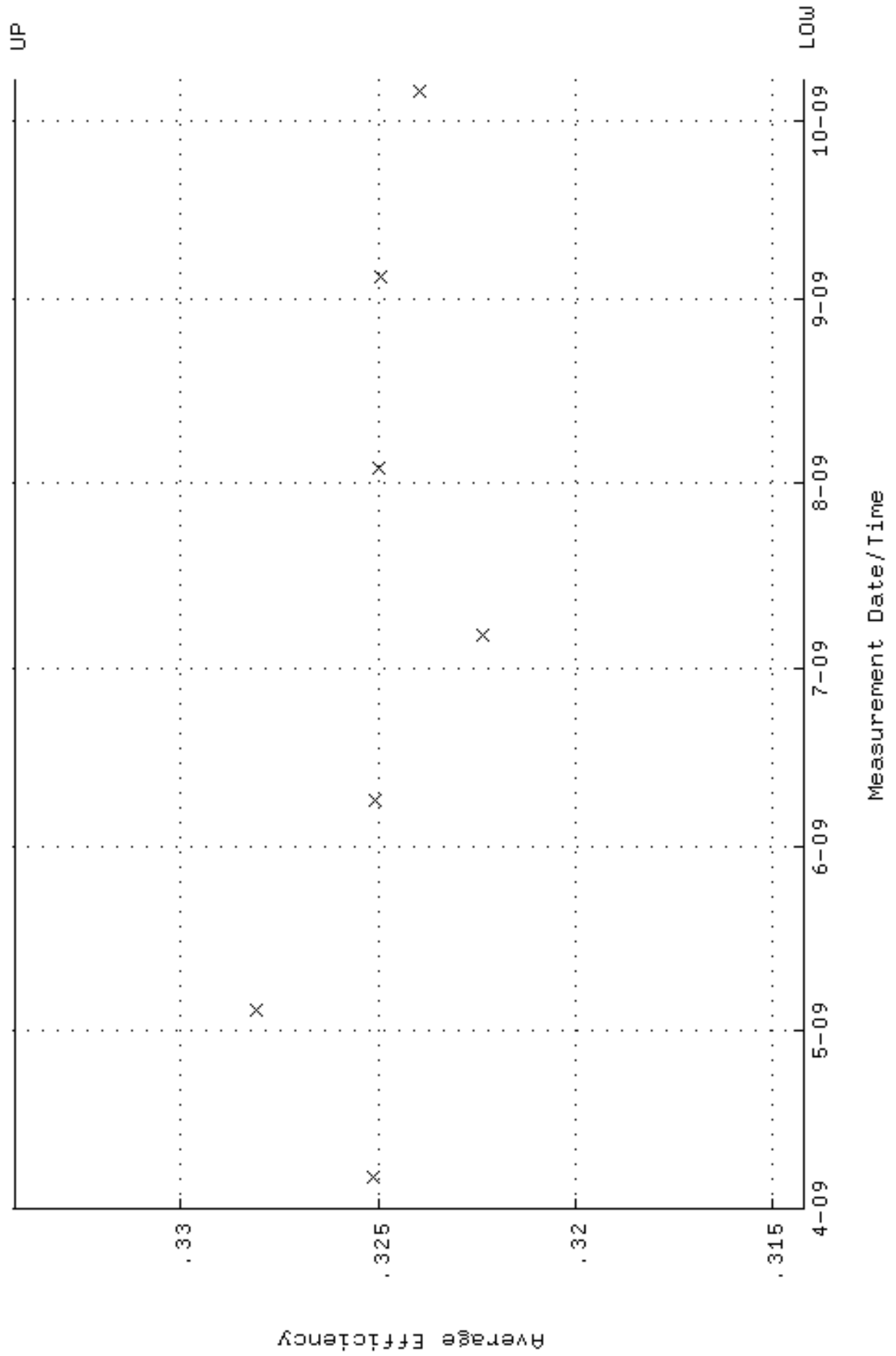
QA filename : DKA100:[ENV\_ALPHA.QA.W]W014.QAF;4  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 89.9790 through 99.4504



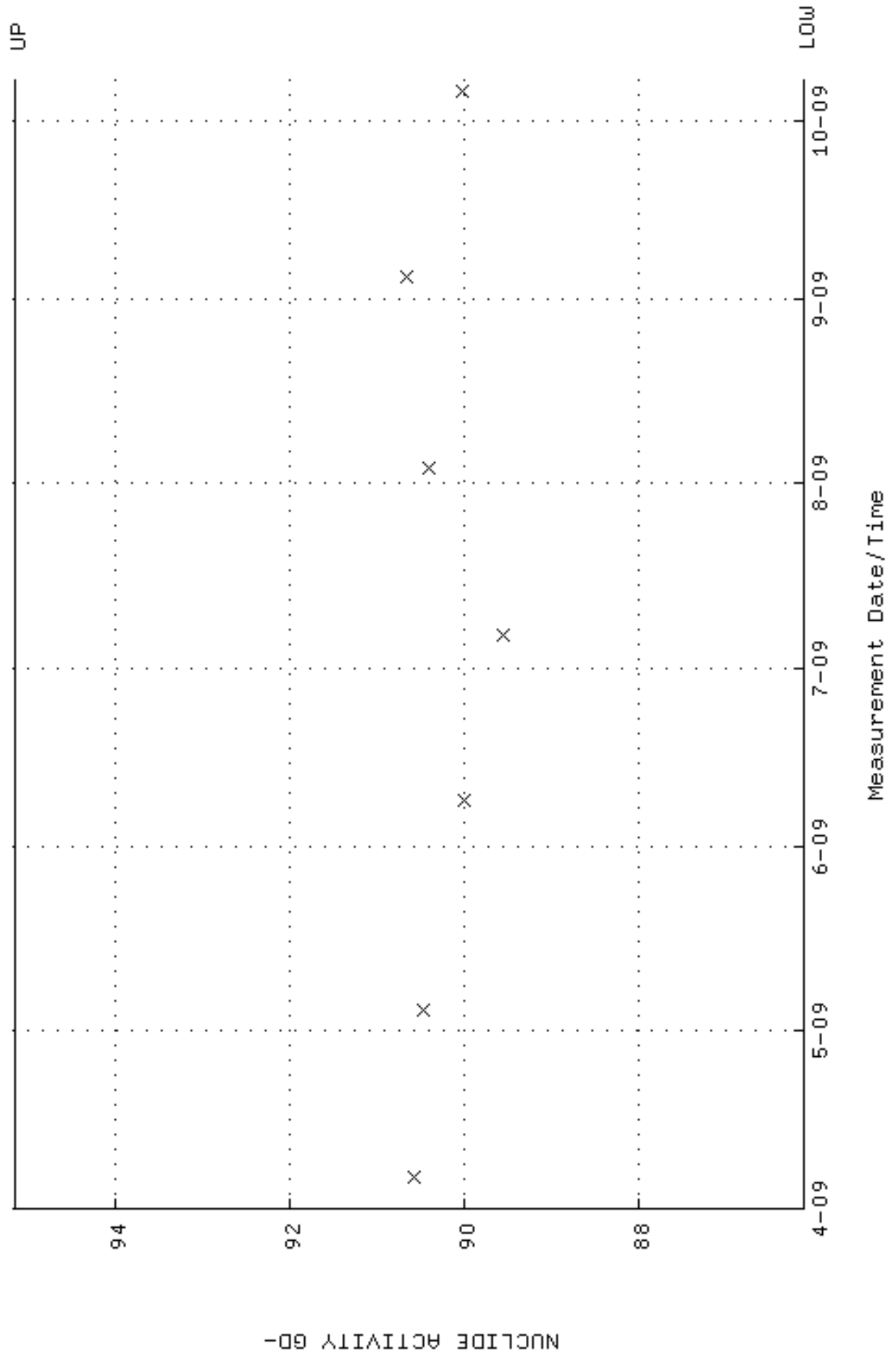
QA filename : DKA100:[ENV\_ALPHA.QA.B]B014.QAF;2  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



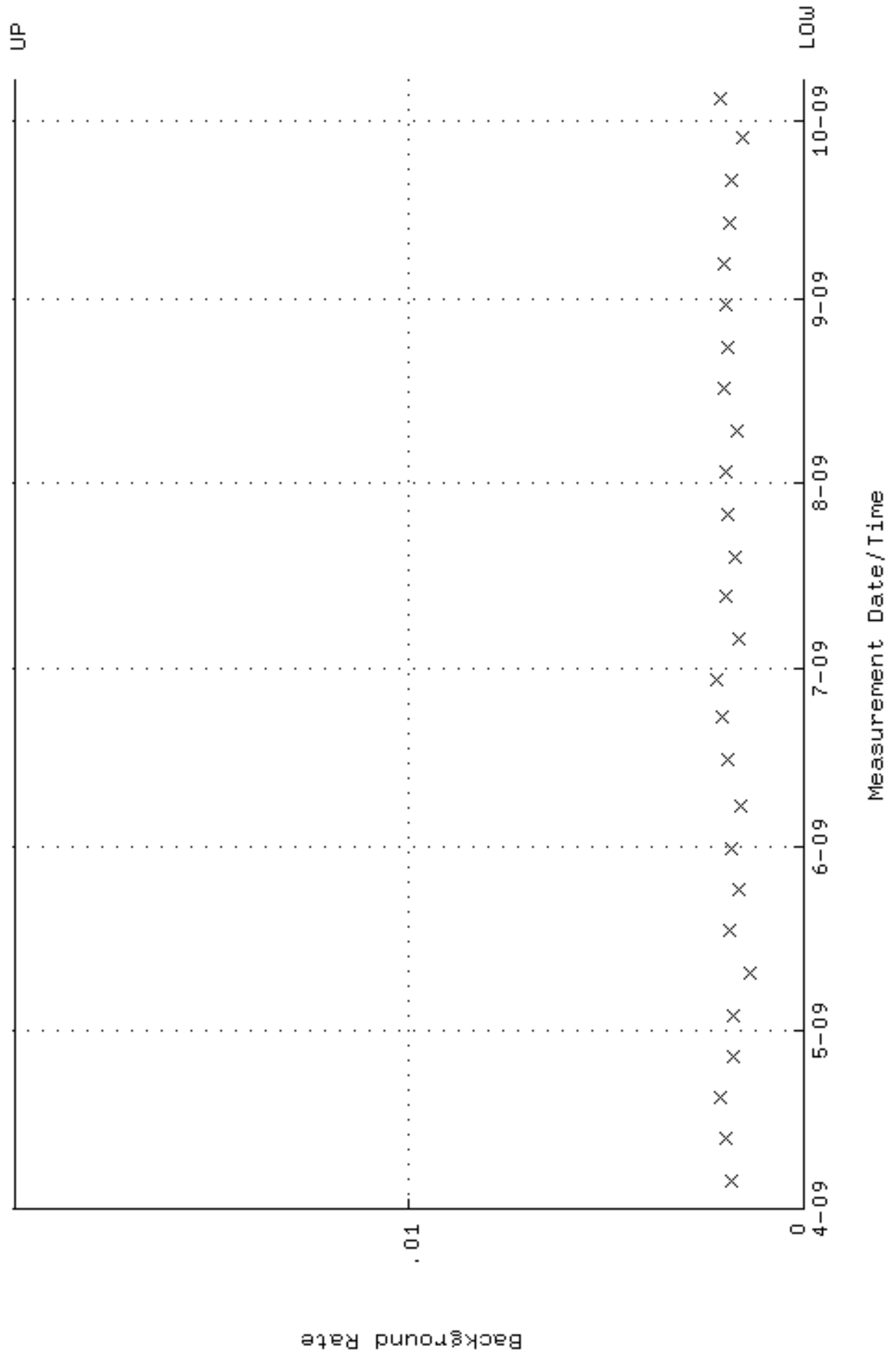
QA filename : DKA100:[ENV\_ALPHA.QA.W]W015.QAF;3  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.314211 through 0.334211



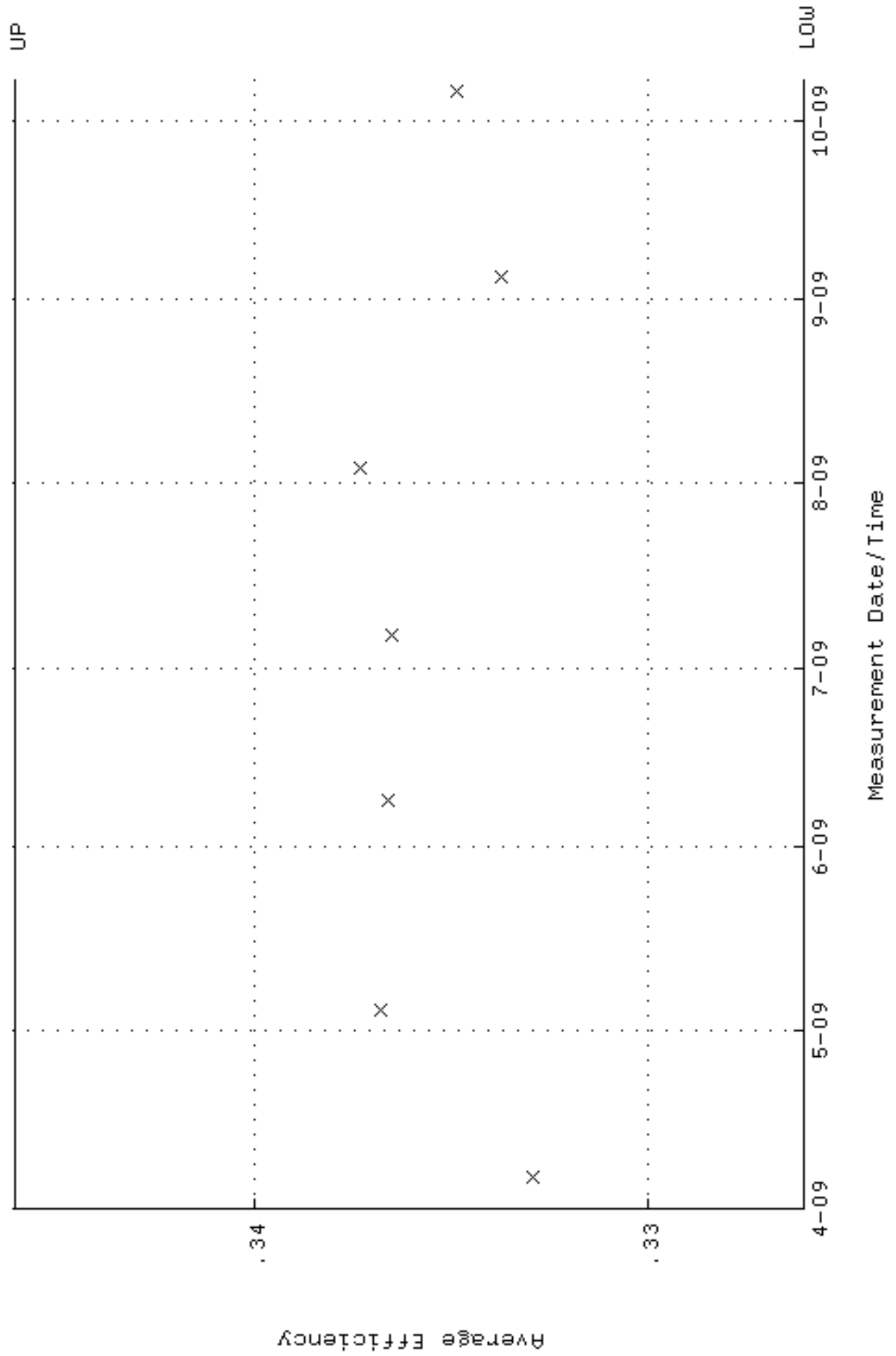
QA filename : DKA100:[ENV\_ALPHA.QA.W]W015.QAF;3  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 86.0931 through 95.1555



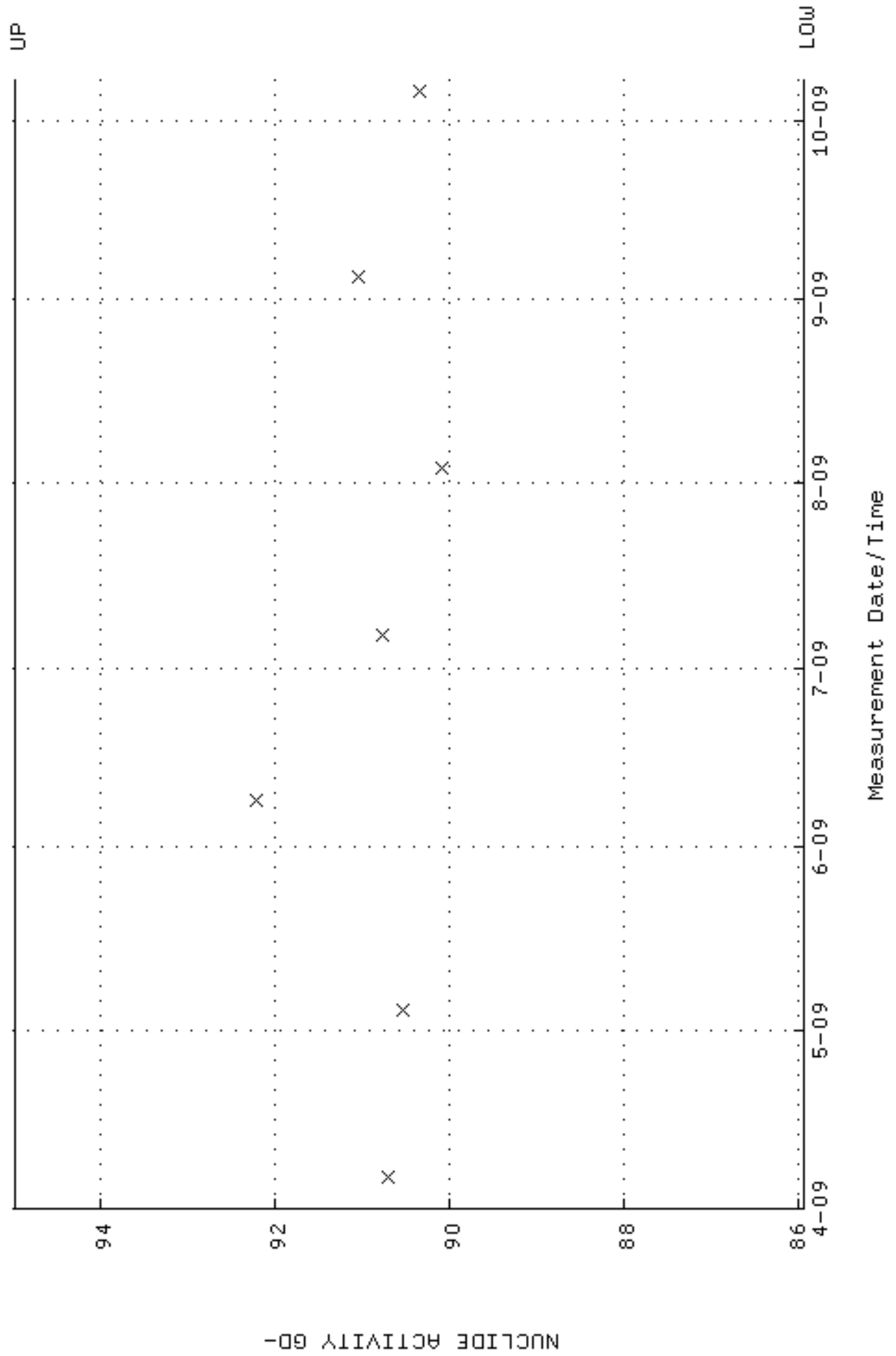
QA filename : DKA100:[ENV\_ALPHA.QA.B]B015.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



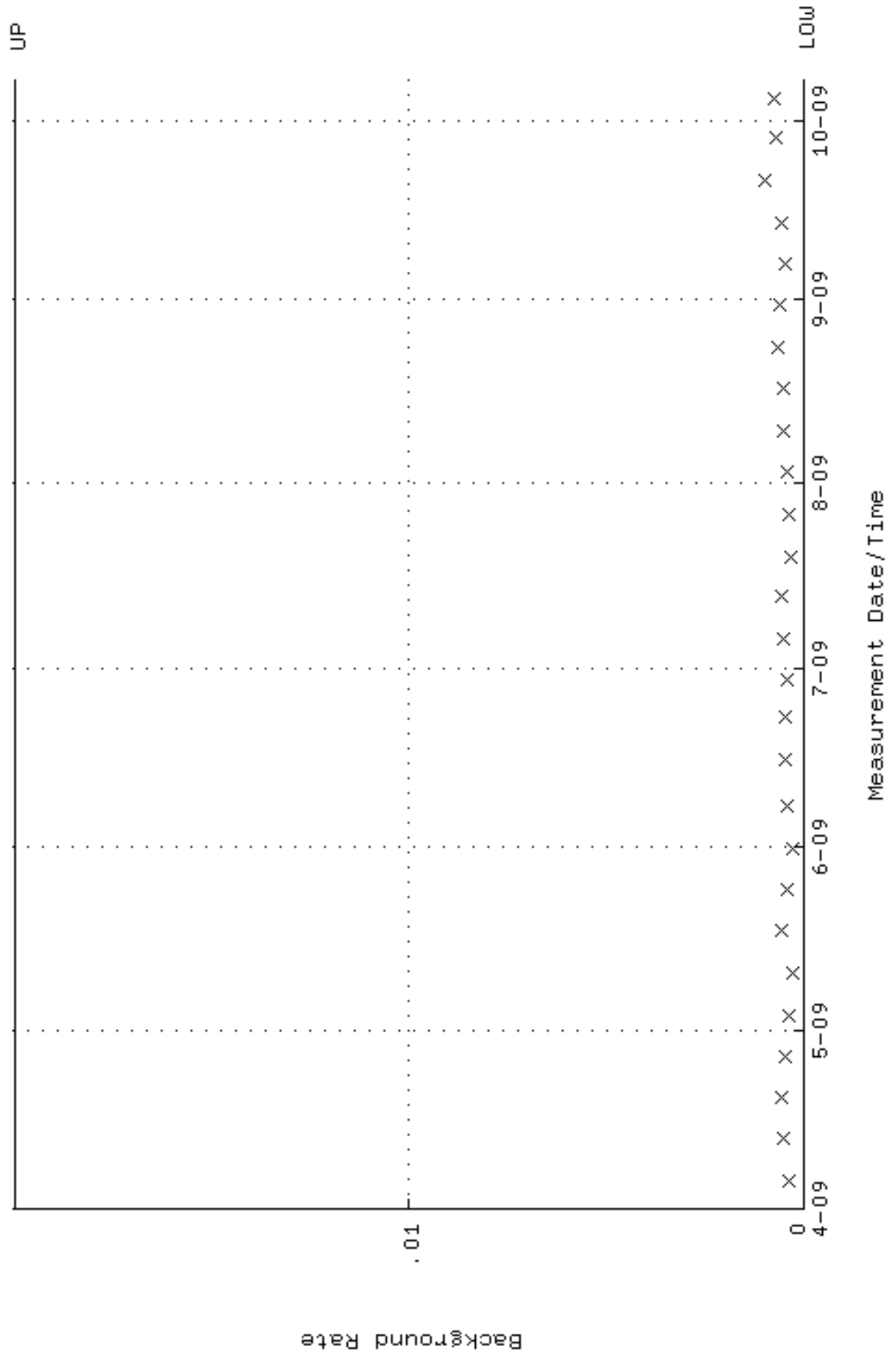
QA filename : DKA100:[ENV\_ALPHA.QA.W]W016.QAF;3  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.326058 through 0.346058



QA filename : DKA100:[ENV\_ALPHA.QA.W]W016.QAF;3  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 85.9280 through 94.9730

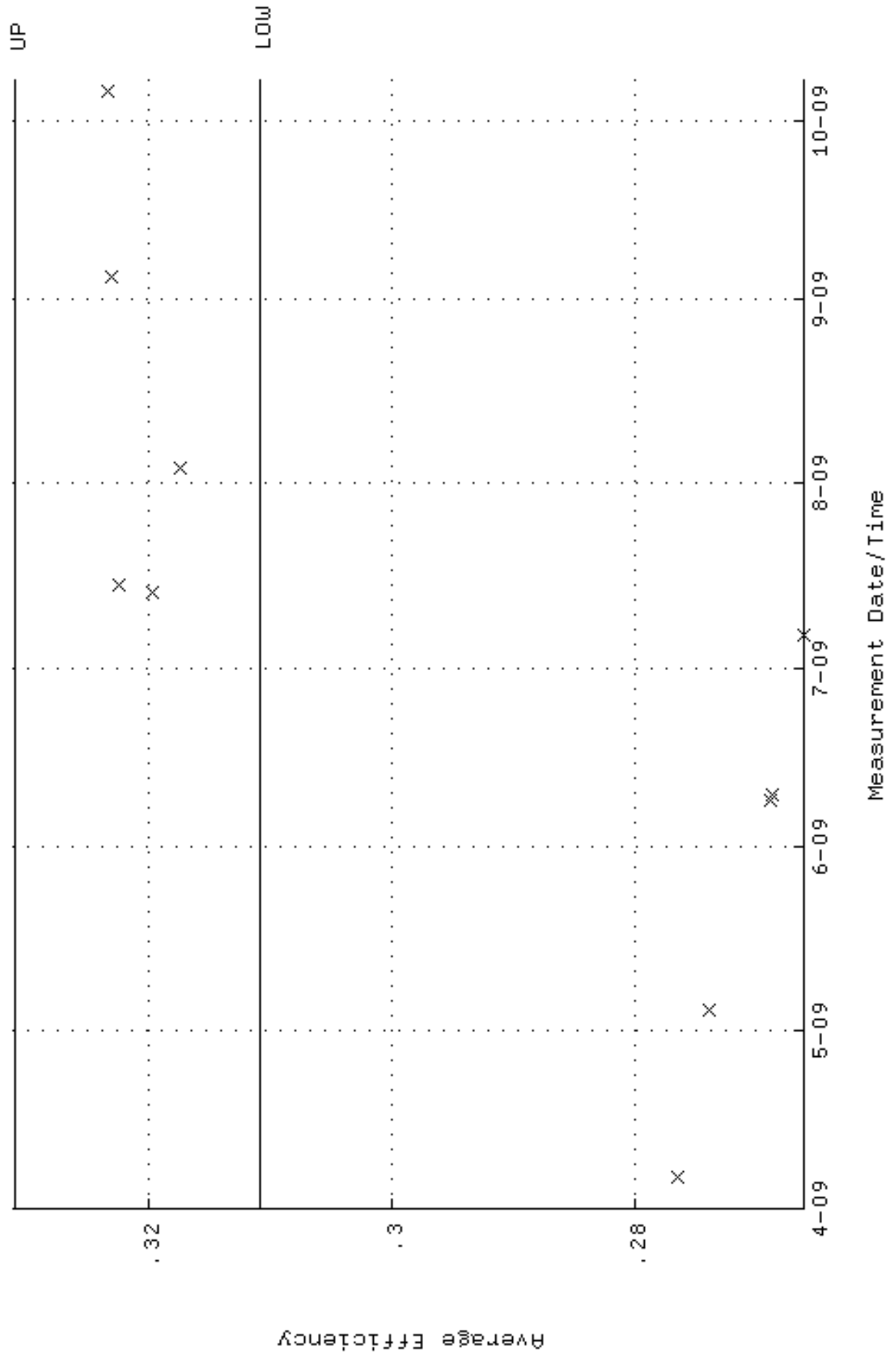


QA filename : DKA100:[ENV\_ALPHA.QA.B]B016.QAF;2  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02

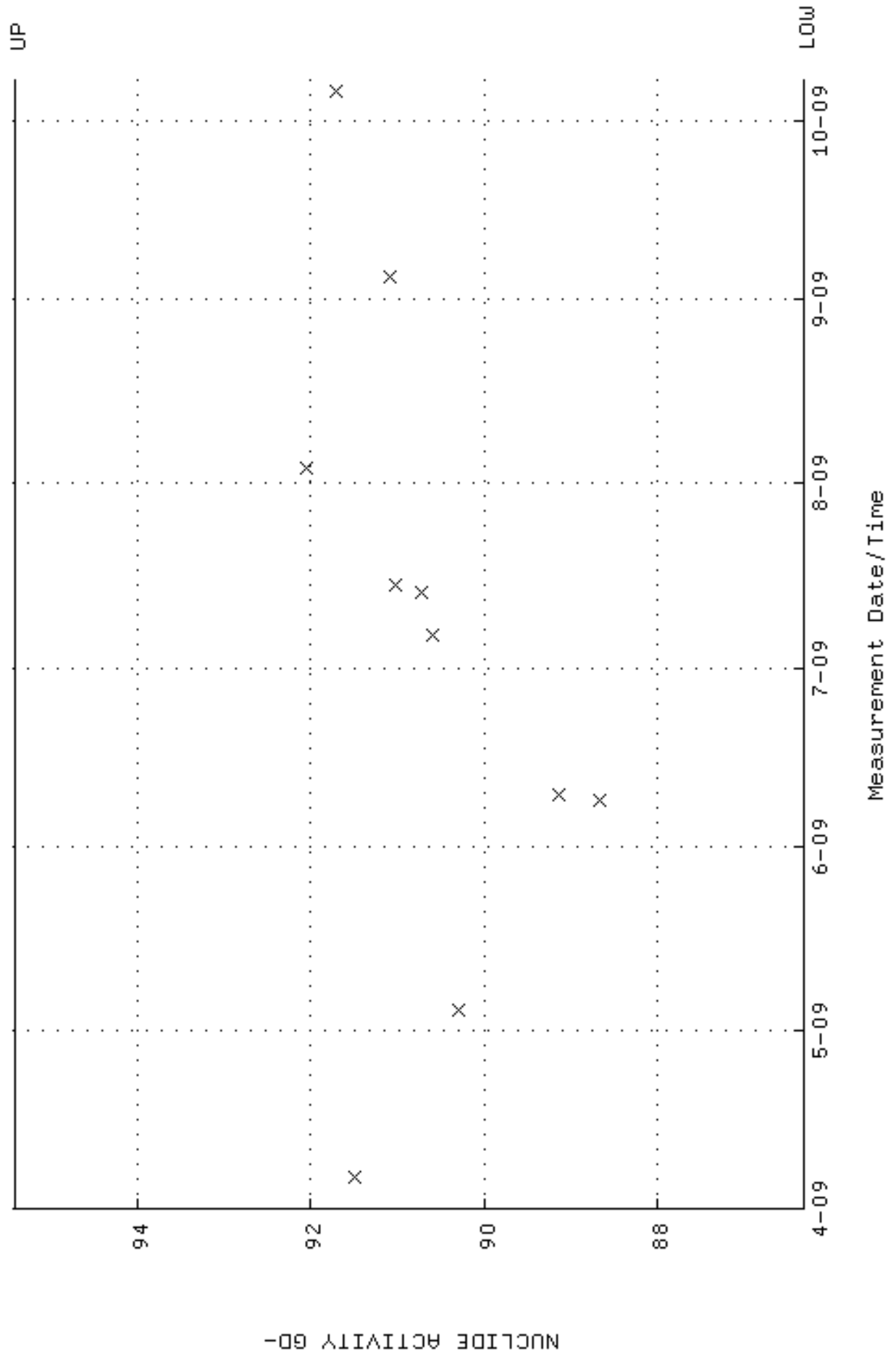




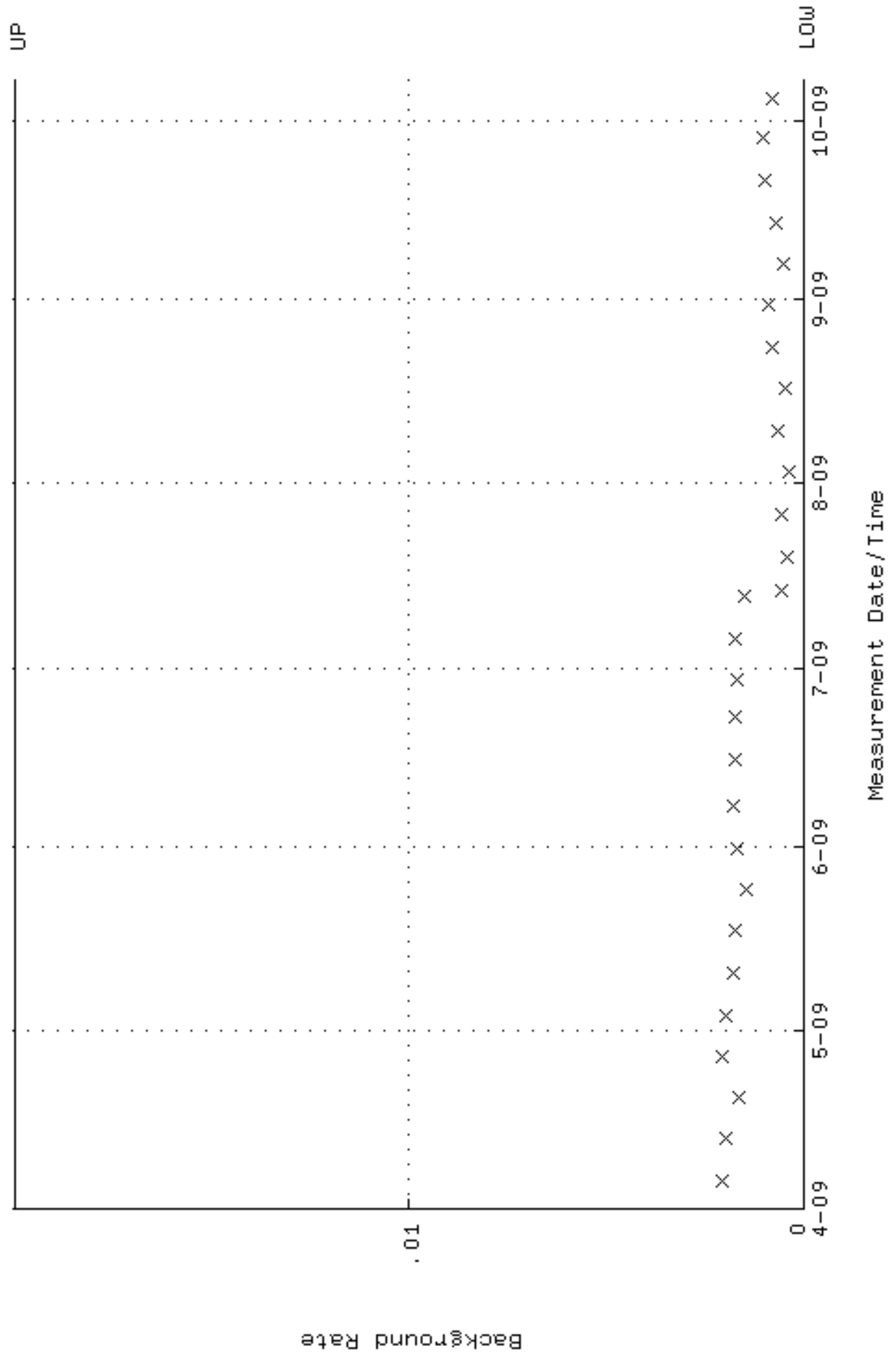
QA filename : DKA100:[ENV\_ALPHA.QA.W]W018.QAF;3  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.310950 through 0.330950



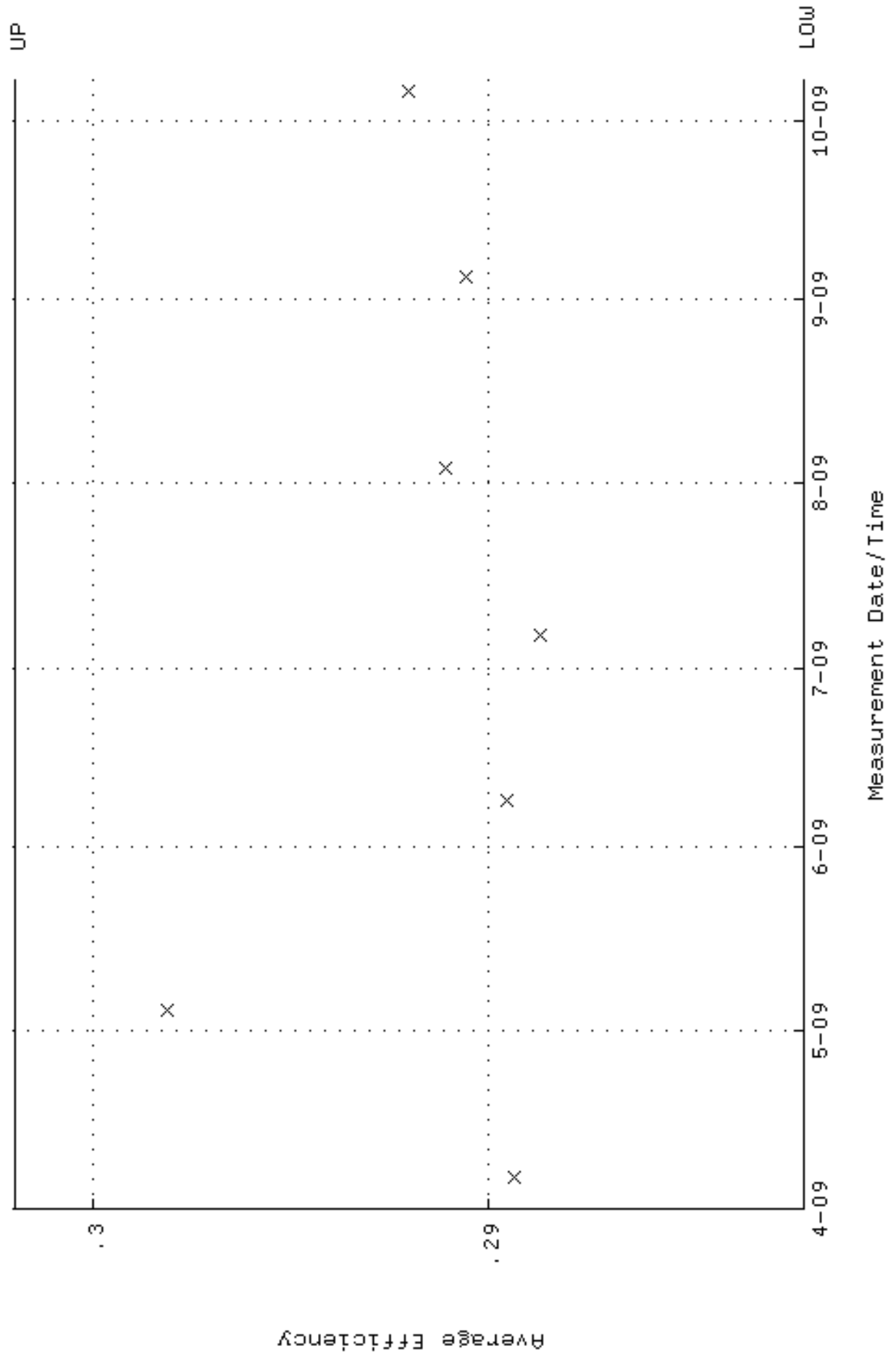
QA filename : DKA100:[ENV\_ALPHA.QA.W]W018.QAF;3  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:02 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 86.3167 through 95.4027



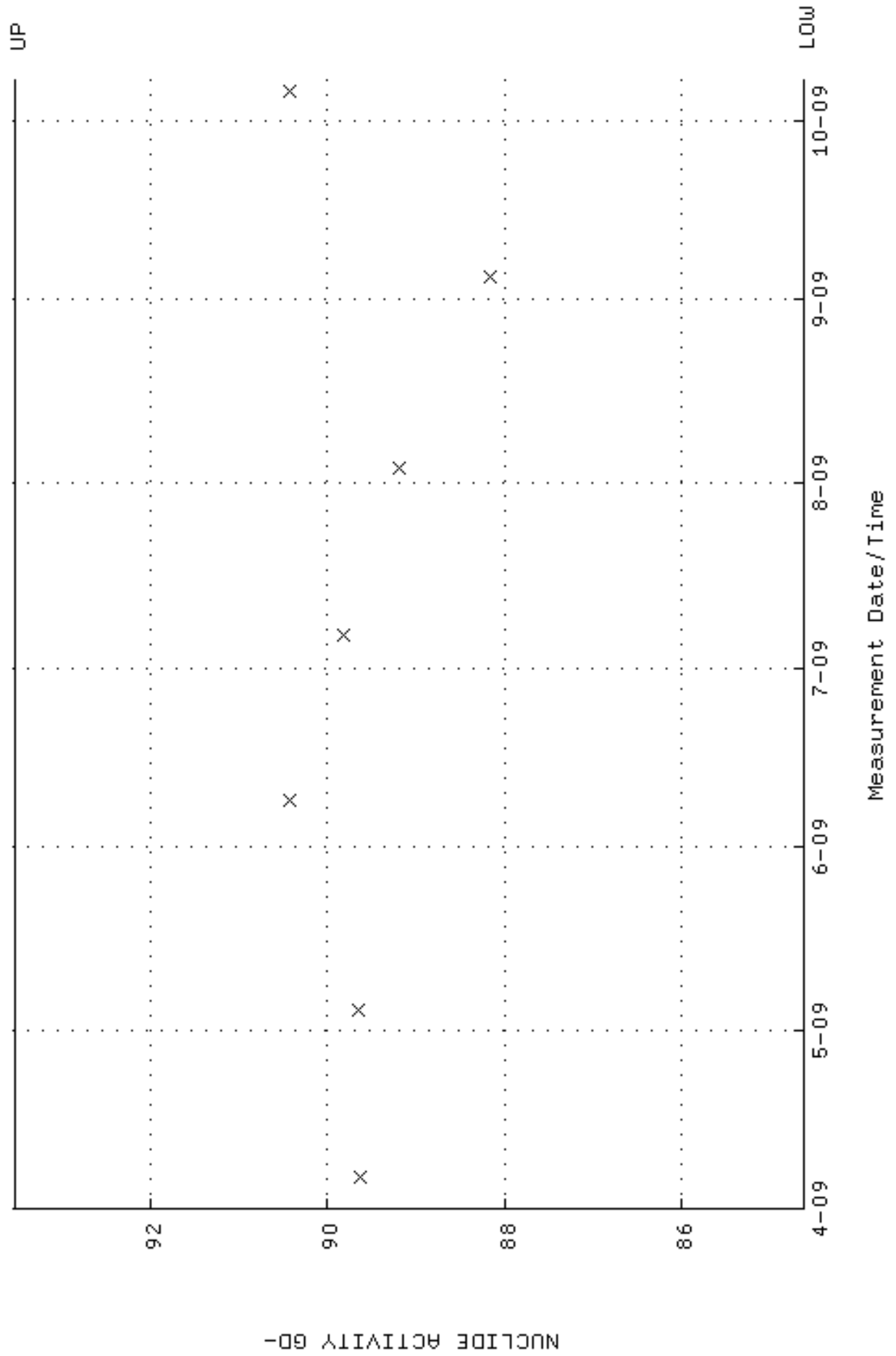
QA filename : DKA100:[ENV\_ALPHA.QA.B]B018.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:09 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



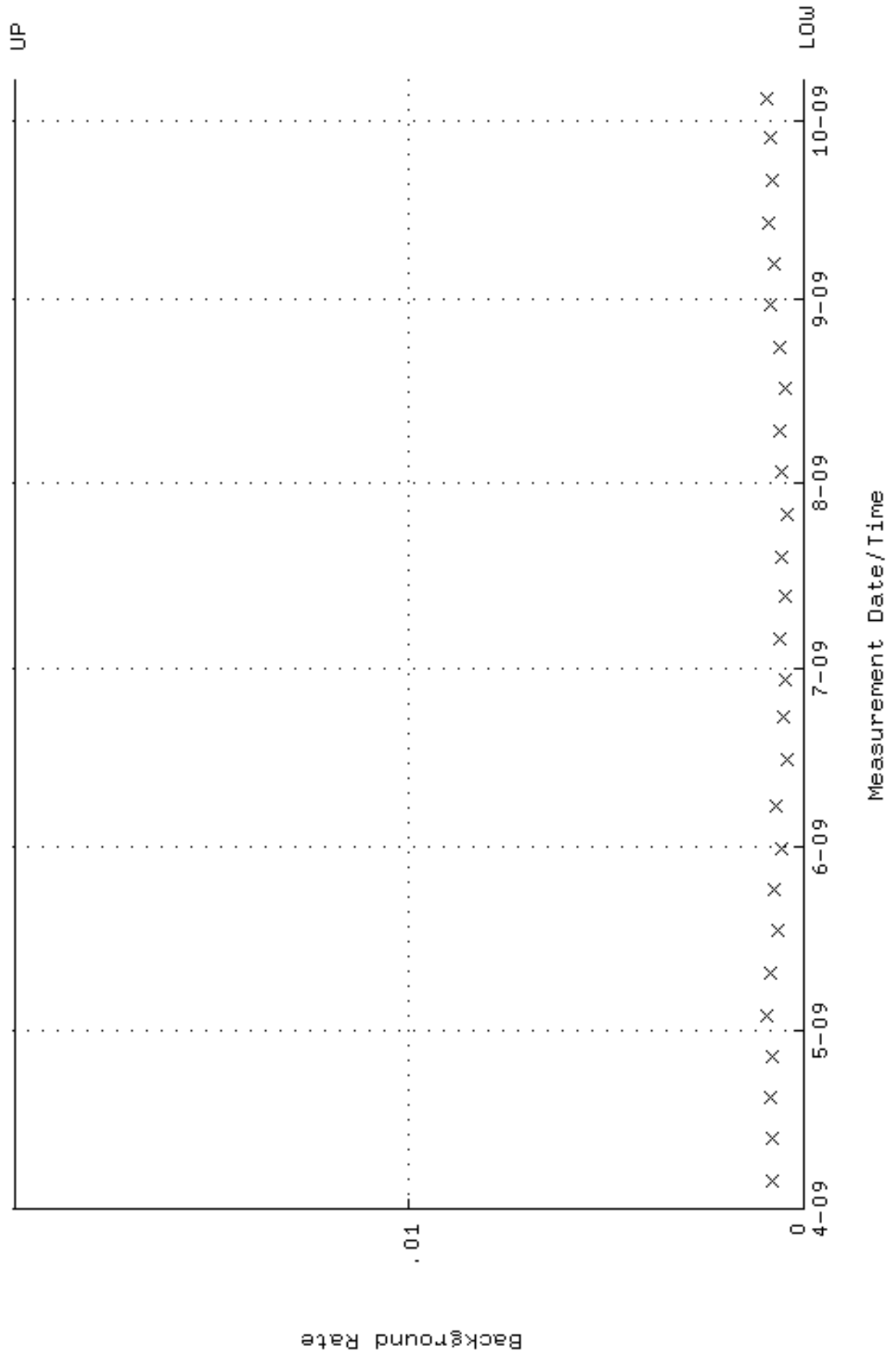
QA filename : DKA100:[ENV\_ALPHA.QA.W]W019.QAF;3  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:03 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.281988 through 0.301988



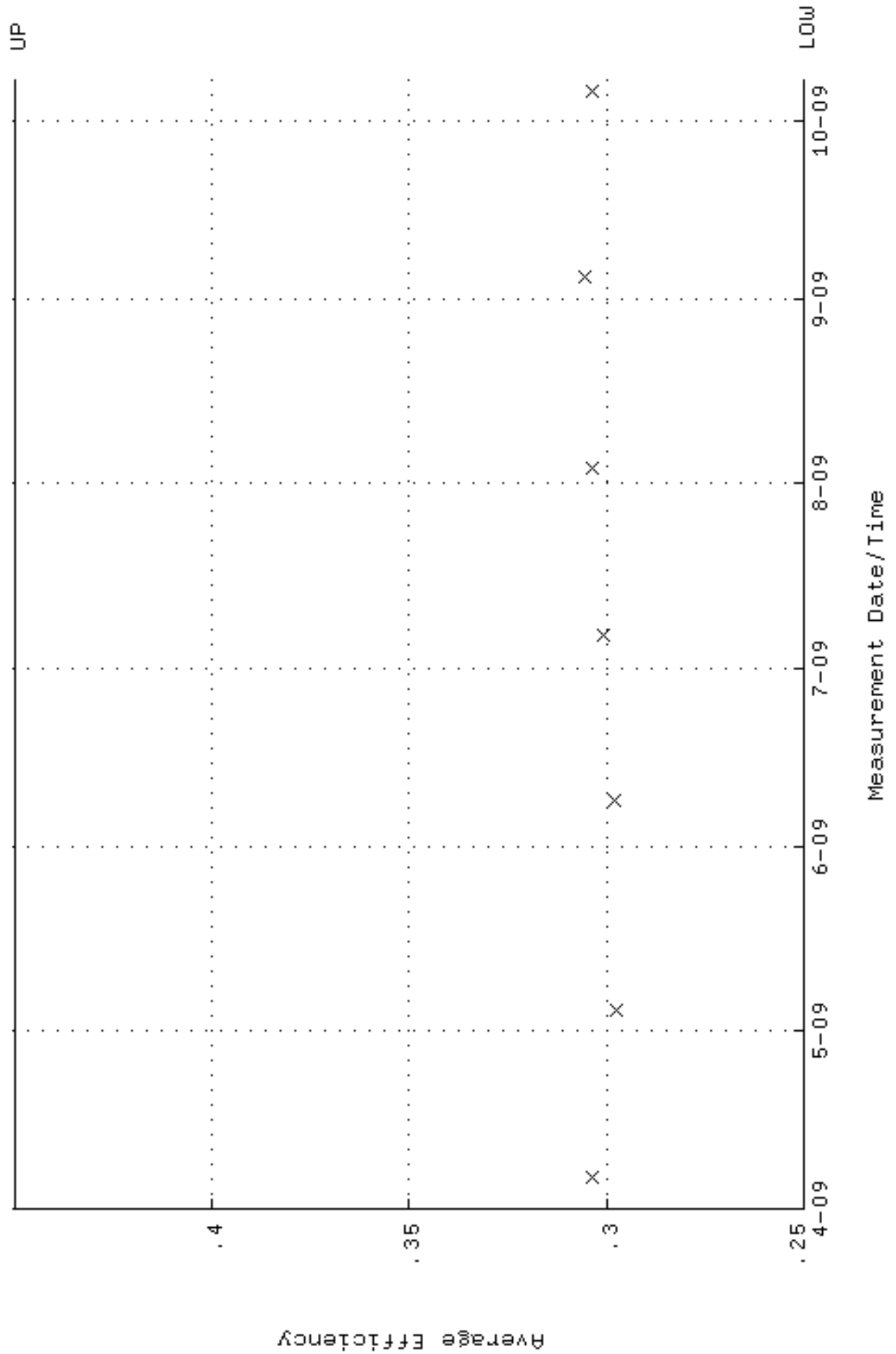
QA filename : DKA100:[ENV\_ALPHA.QA.W]w019.QAF;3  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:03 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 84.6167 through 93.5237



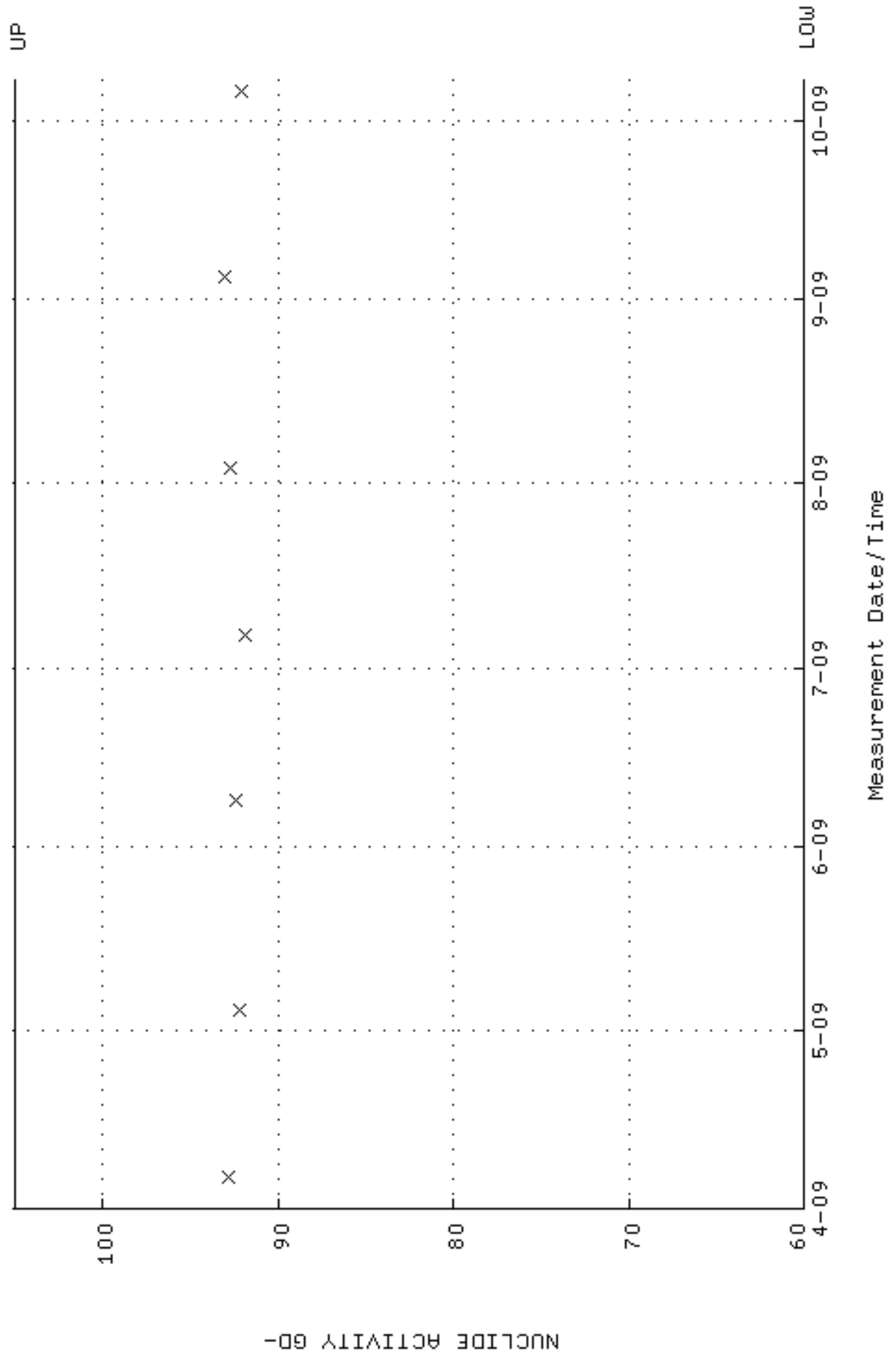
QA filename : DKA100:[ENV\_ALPHA.QA.B]B019.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:10 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



QA filename : DKA100:[ENV\_ALPHA.QA.W]W021.QAF;4  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:03 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.250000 through 0.450000

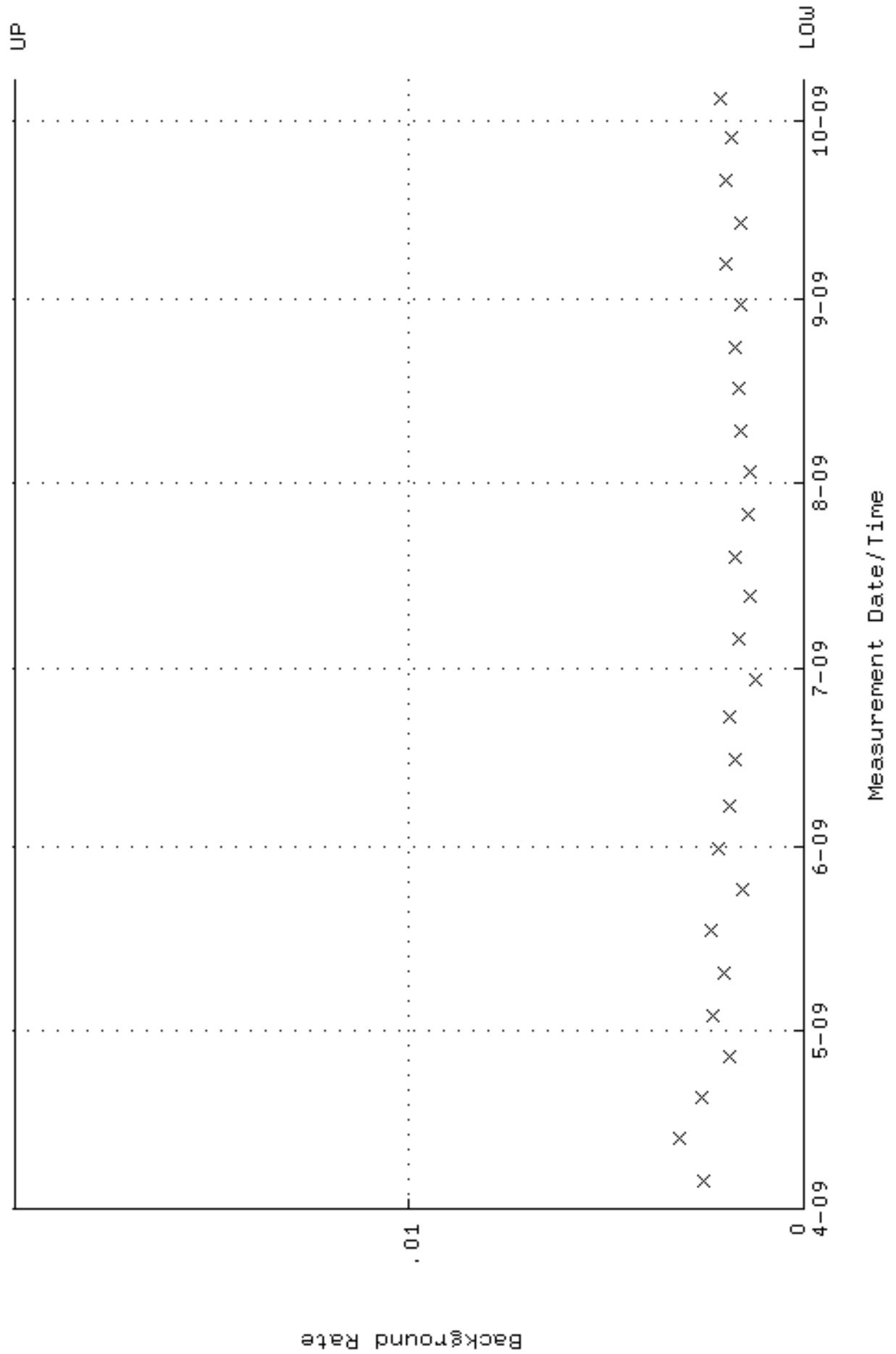


QA filename : DKA100:[ENV\_ALPHA.QA.W]W021.QAF;4  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:03 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 60.0000 through 105.0000

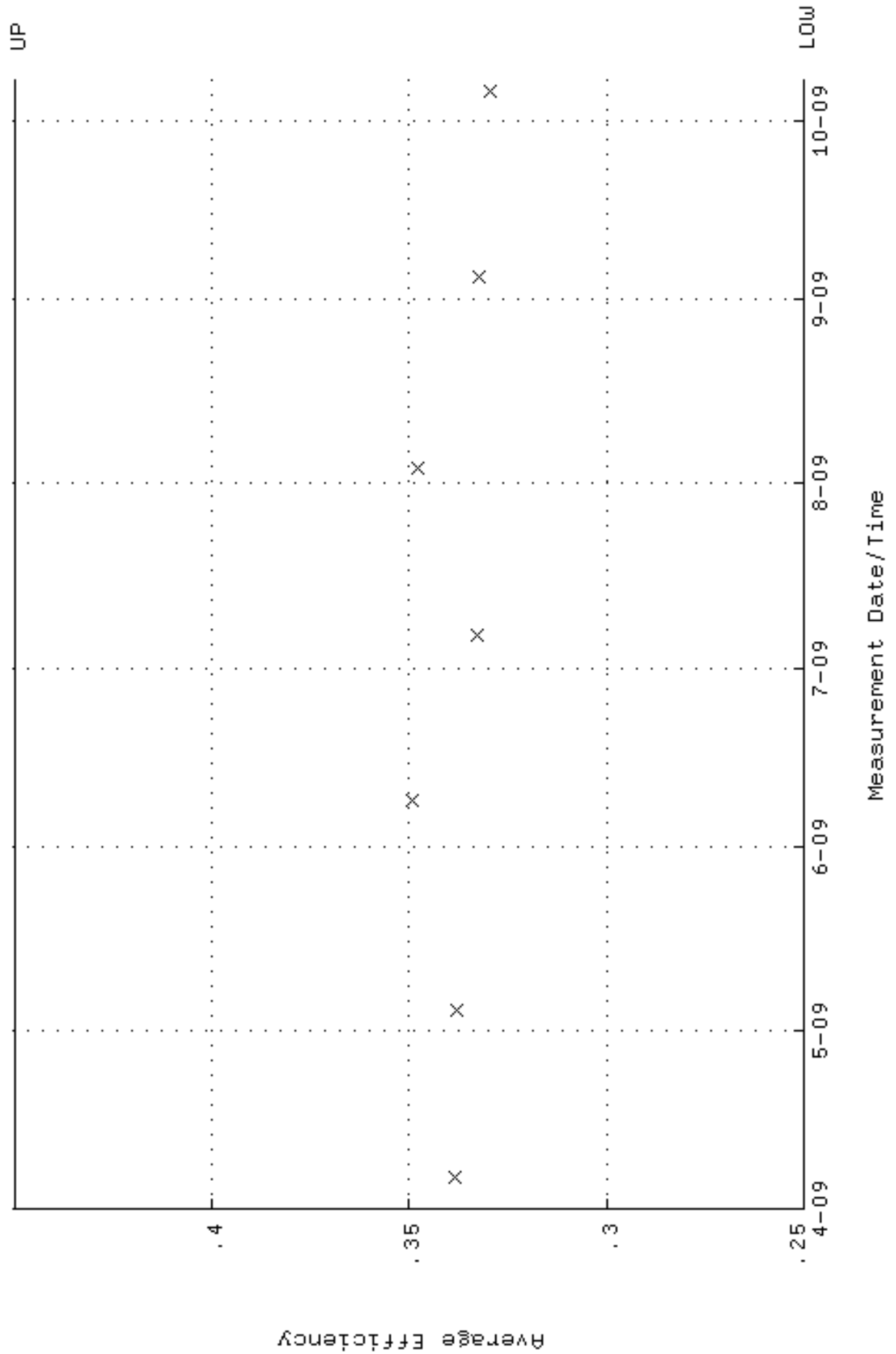




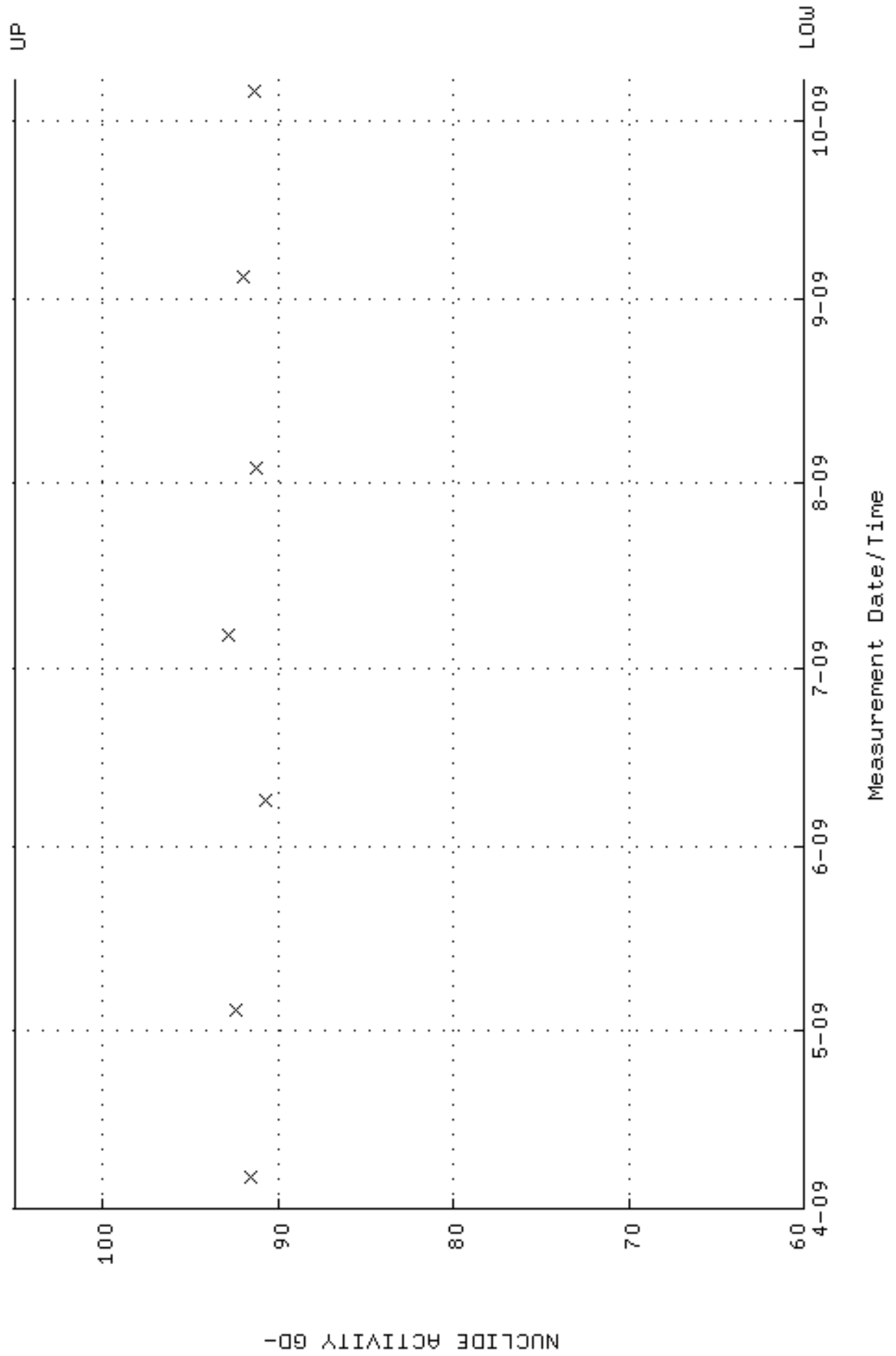
QA filename : DKA100:[ENV\_ALPHA.QA.B]B021.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:10 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



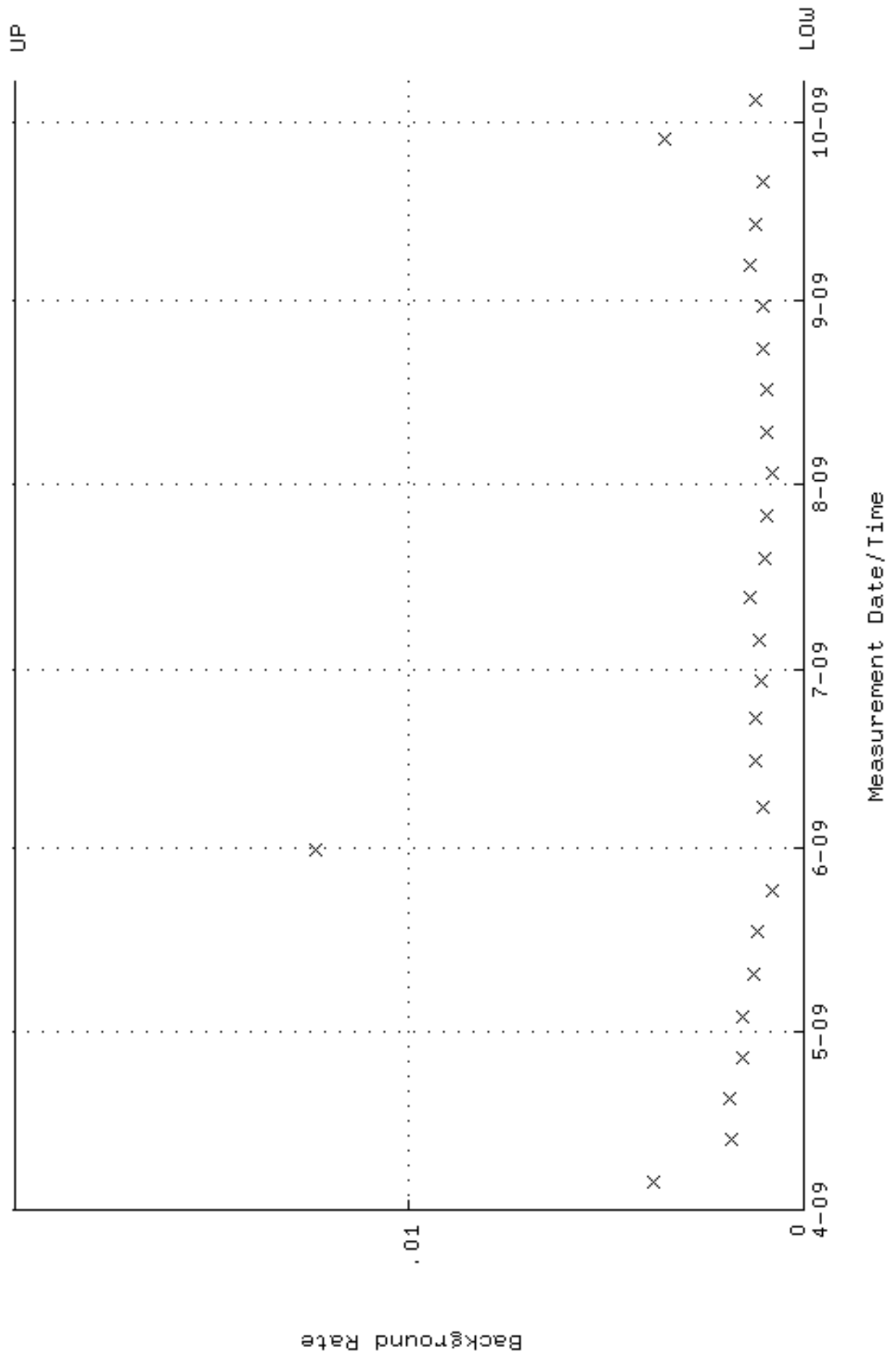
QA filename : DKA100:[ENV\_ALPHA.QA.W]W023.QAF;3  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:03 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.250000 through 0.450000



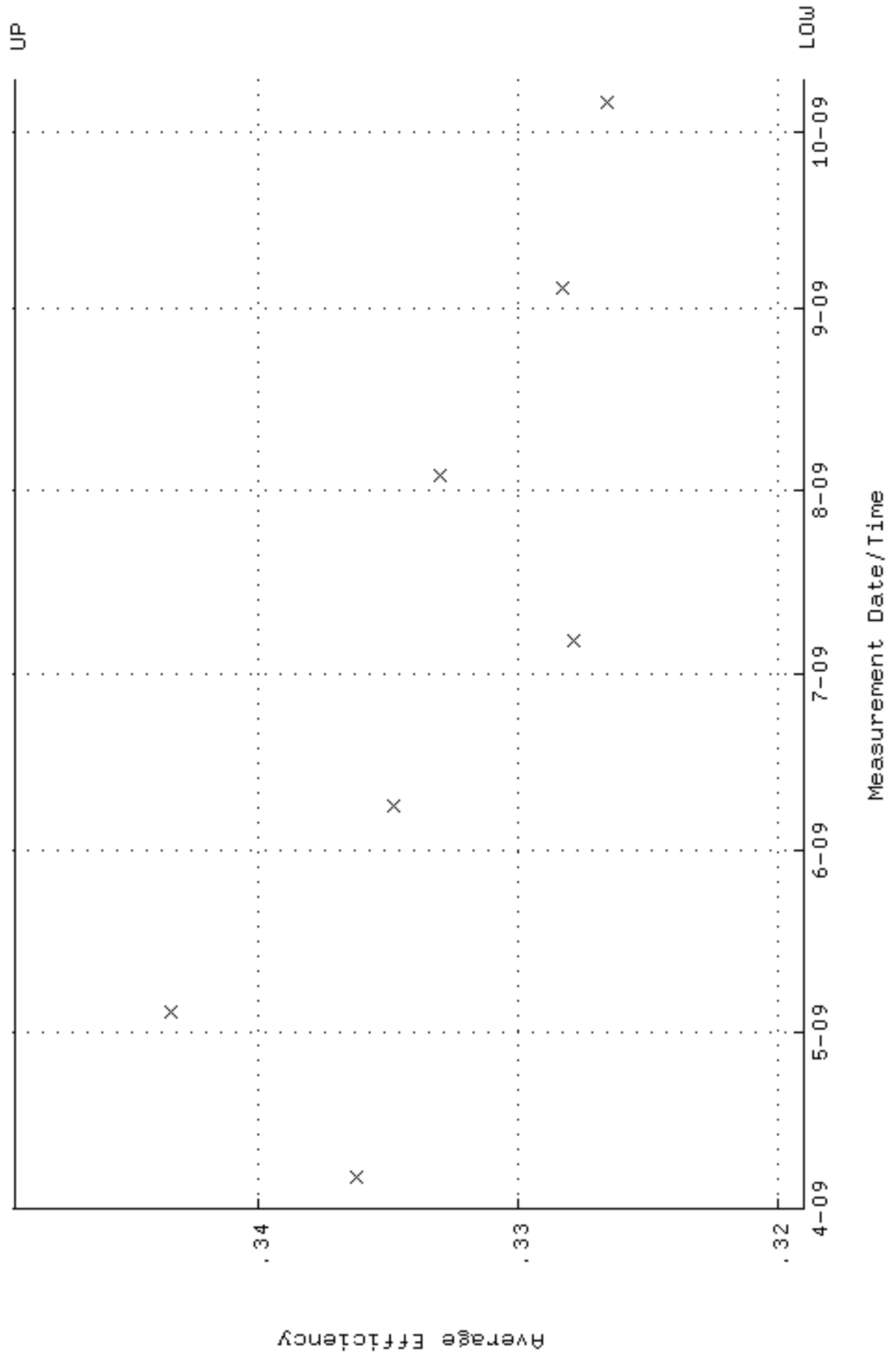
QA filename : DKA100:[ENV\_ALPHA.QA.W]W023.QAF;3  
Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
Start/End Dates : 6-APR-2009 08:44:03 through 7-OCT-2009 12:00:00  
Lower/Upper Lmts: 60.0000 through 105.0000



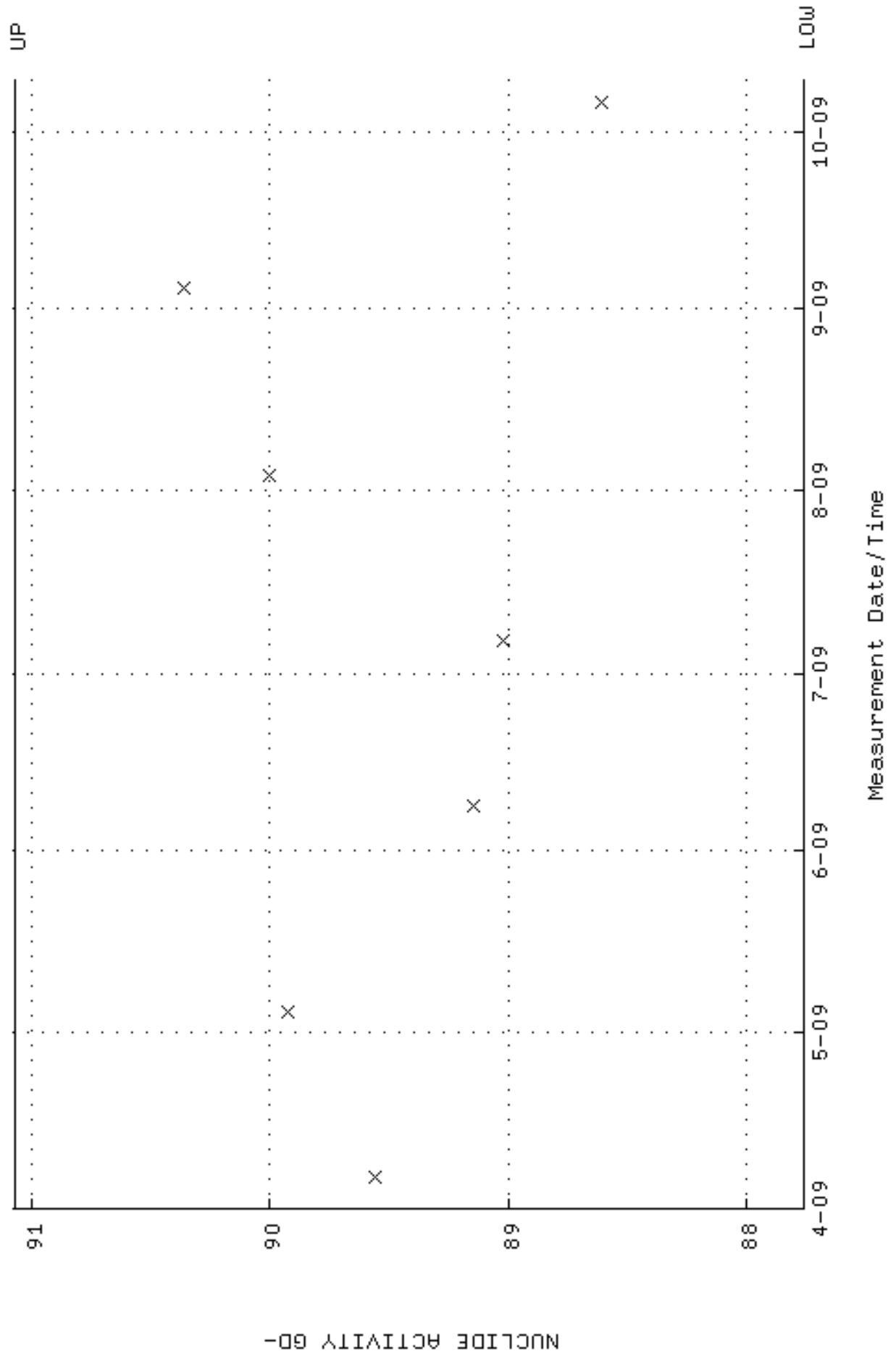
QA filename : DKA100:[ENV\_ALPHA.QA.B]B023.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:10 through 7-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02



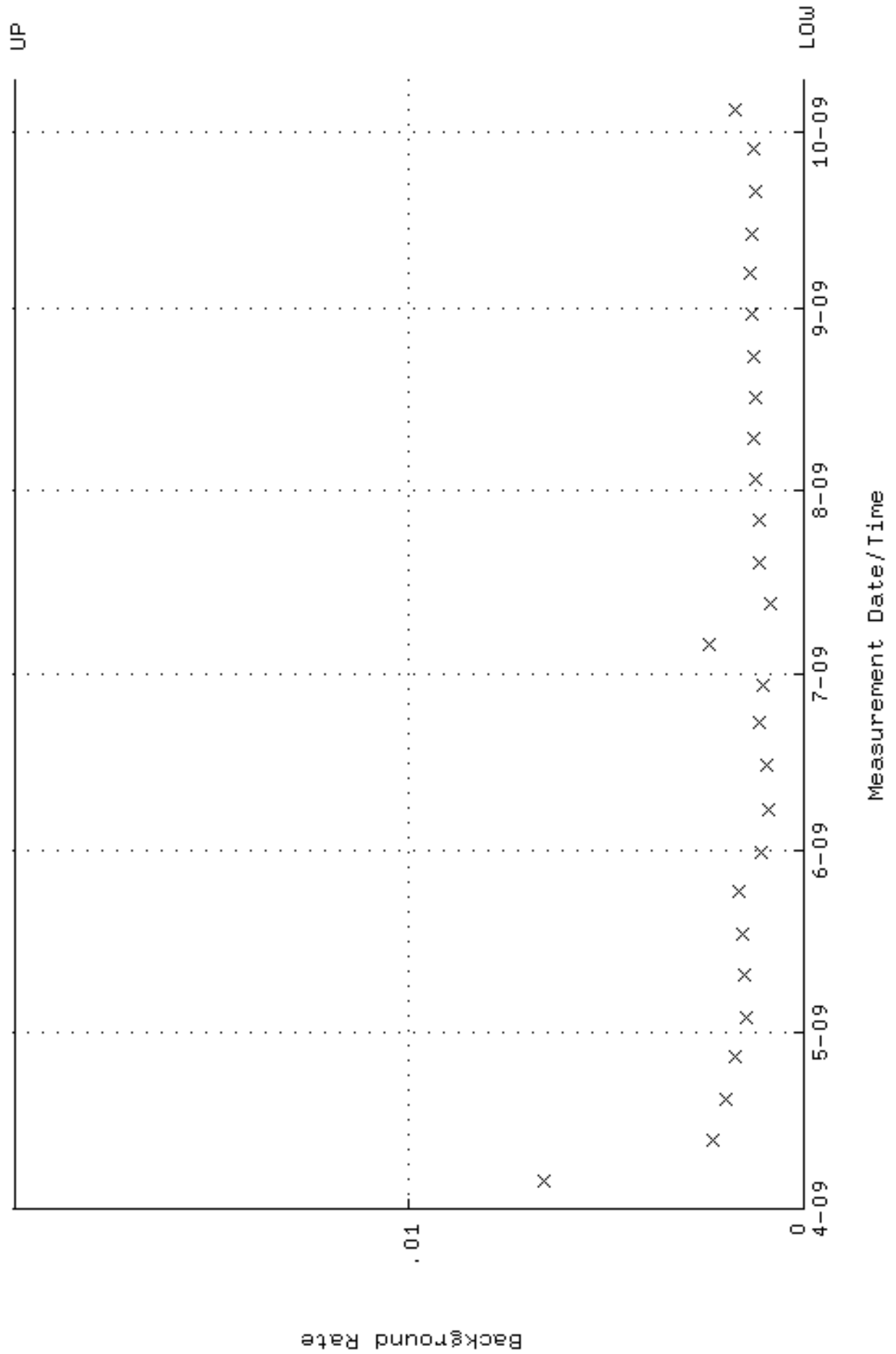
QA filename : DKA100:[ENV\_ALPHA.QA.W]W024.QAF;2  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 6-APR-2009 08:44:03 through 9-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.319004 through 0.349372



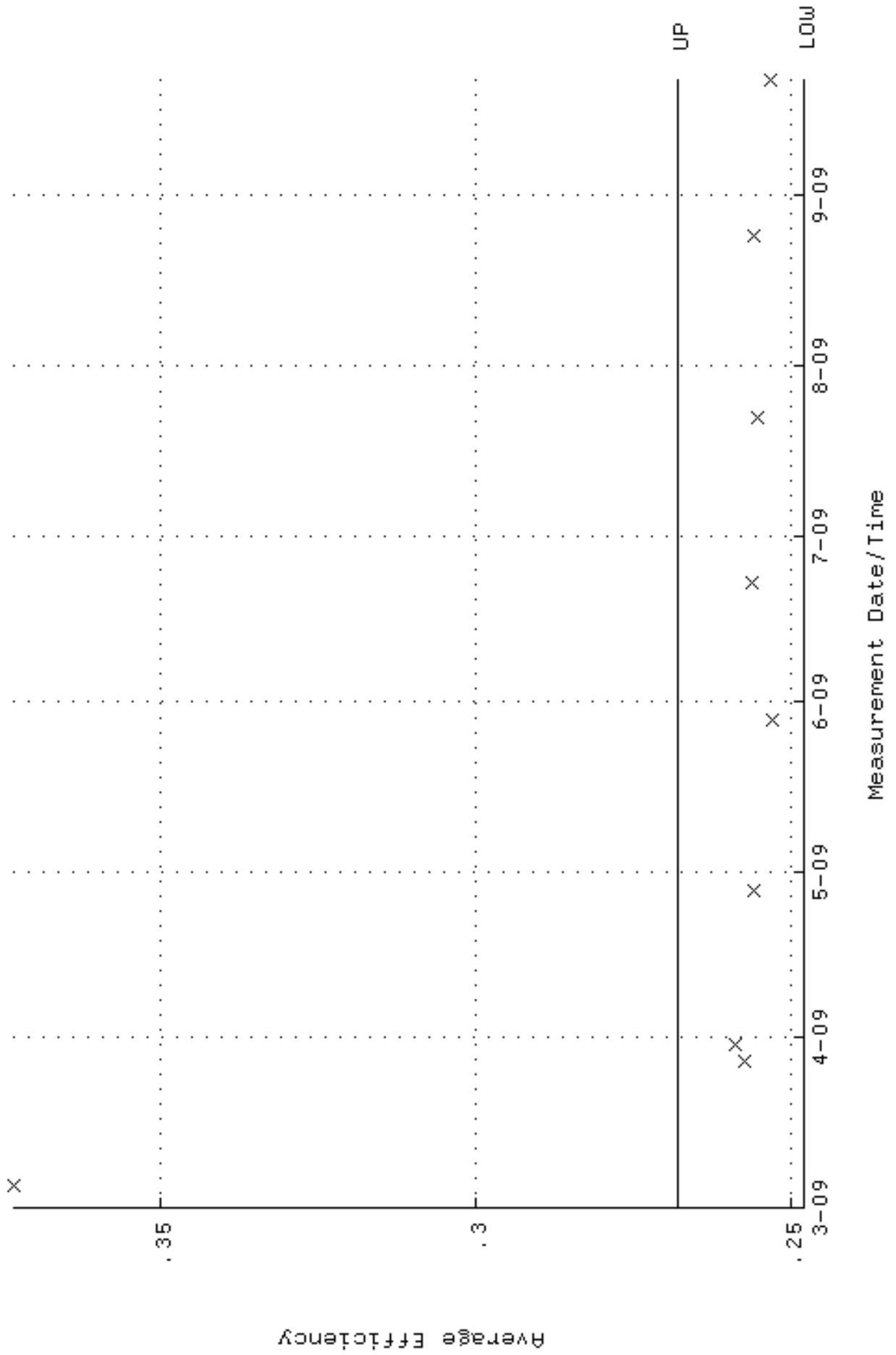
QA filename : DKA100:[ENV\_ALPHA.QA.W]W024.QAF;2  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 6-APR-2009 08:44:03 through 9-OCT-2009 12:00:00  
 Lower/Upper Lmts: 87.7616 through 91.0672



QA filename : DKA100:[ENV\_ALPHA.QA.B]B024.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 5-APR-2009 15:33:10 through 9-OCT-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 2.000000E-02

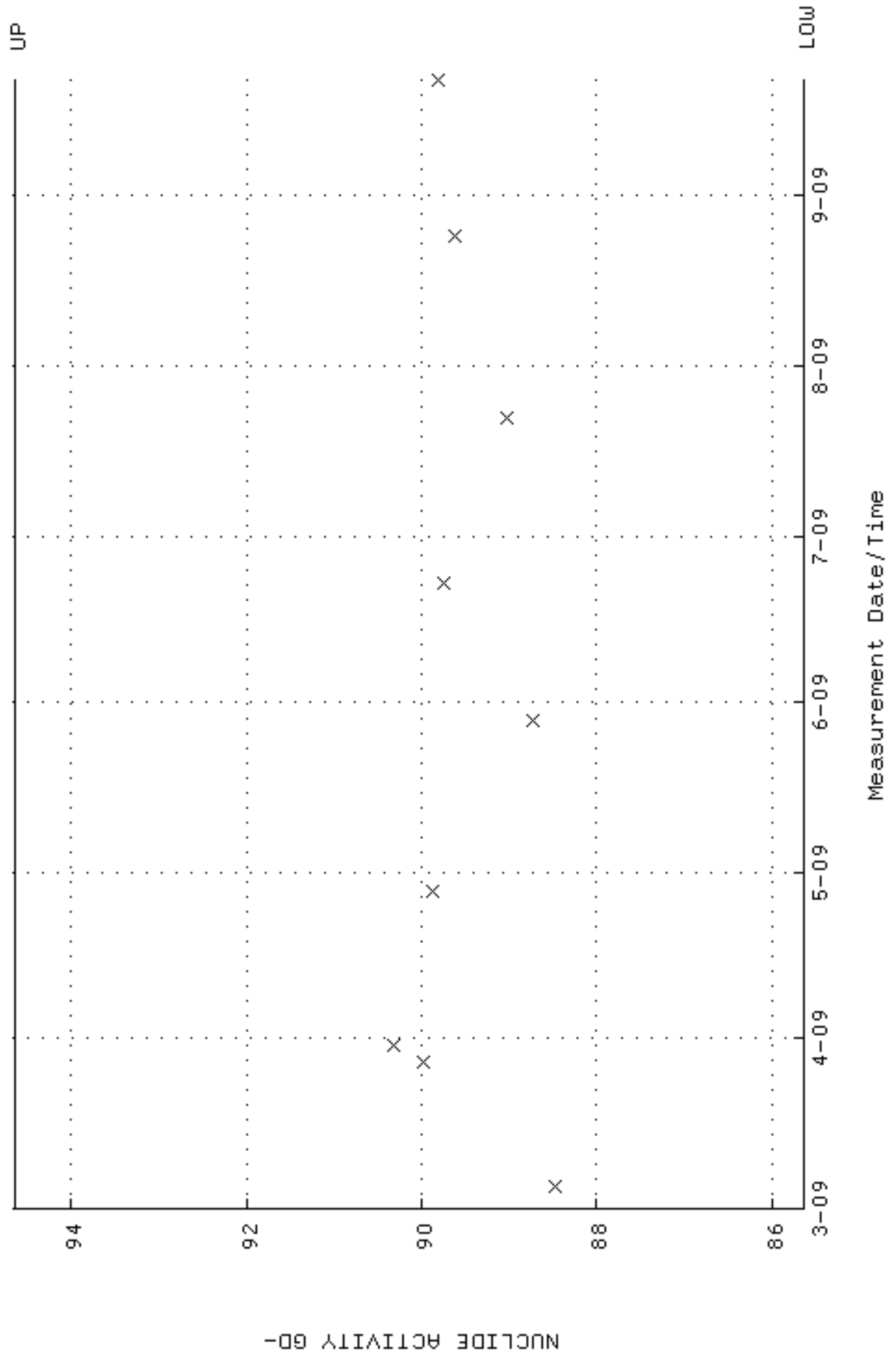


QA filename : DKA100:[ENV\_ALPHA.QA.W]W174.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:38:33 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.248038 through 0.268038

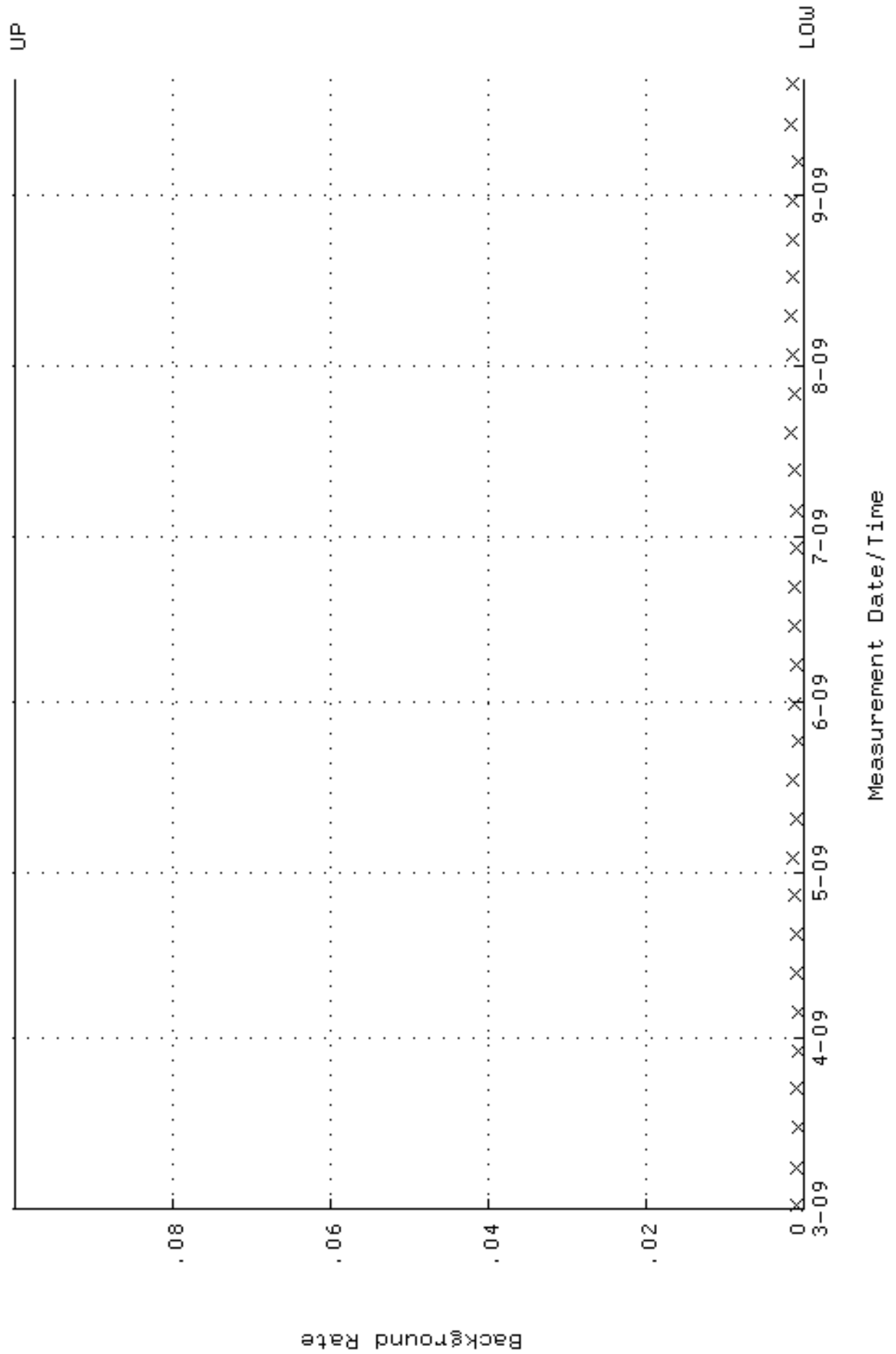




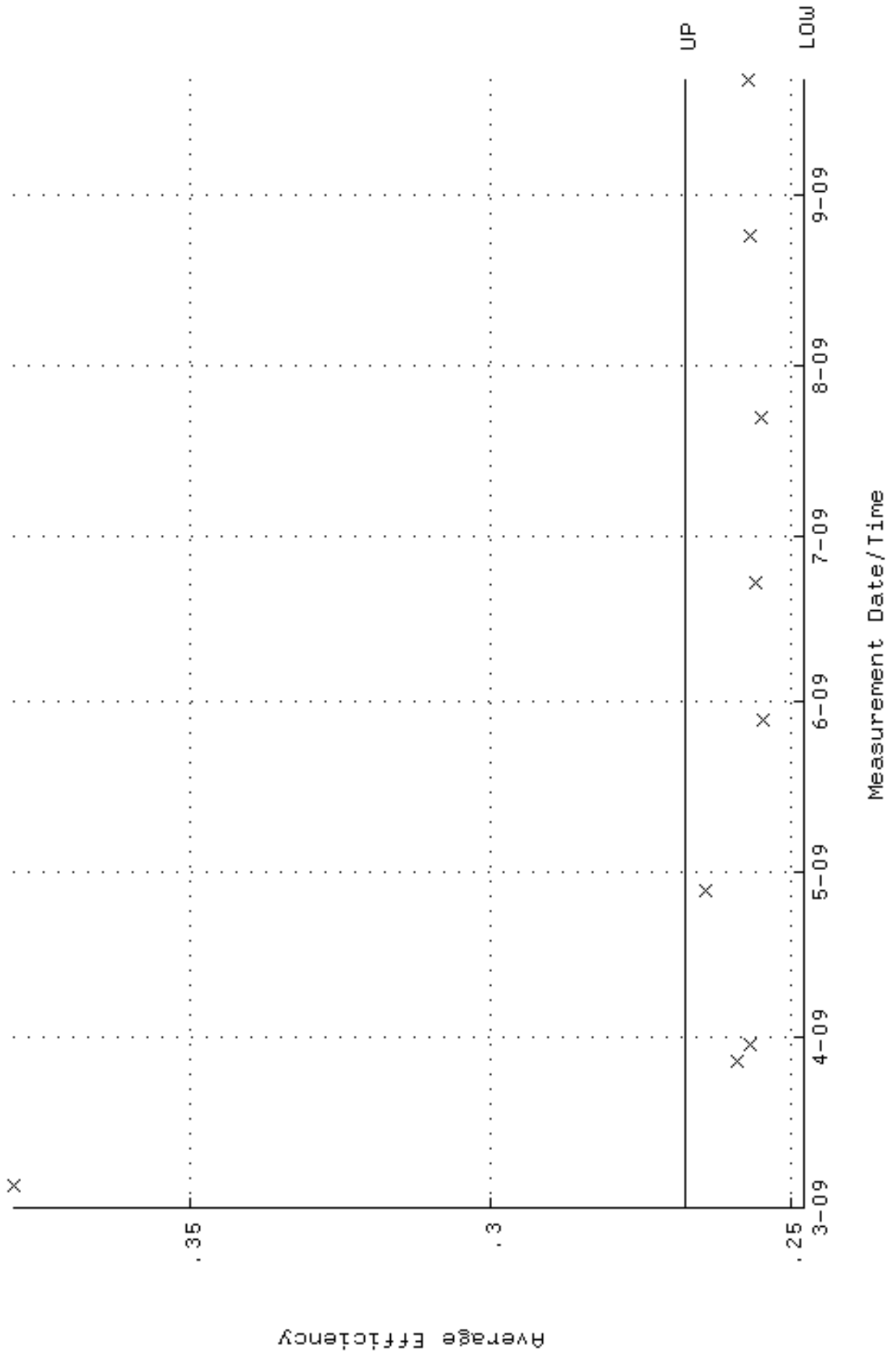
QA filename : DKA100:[ENV\_ALPHA.QA.W]W174.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:38:33 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 85.6304 through 94.6442



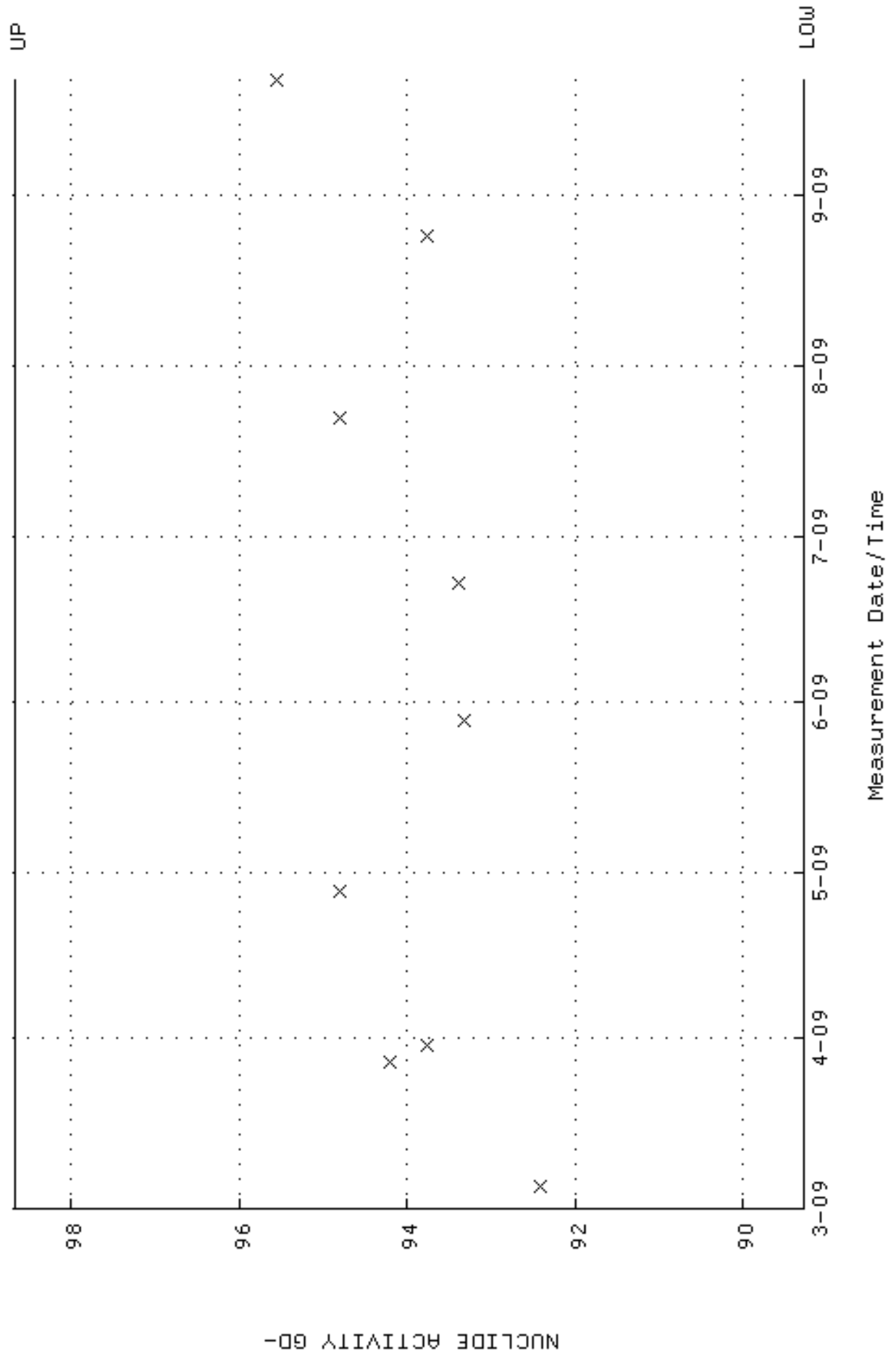
QA filename : DKA100:[ENV\_ALPHA.QA.B]B174.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:21:50 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



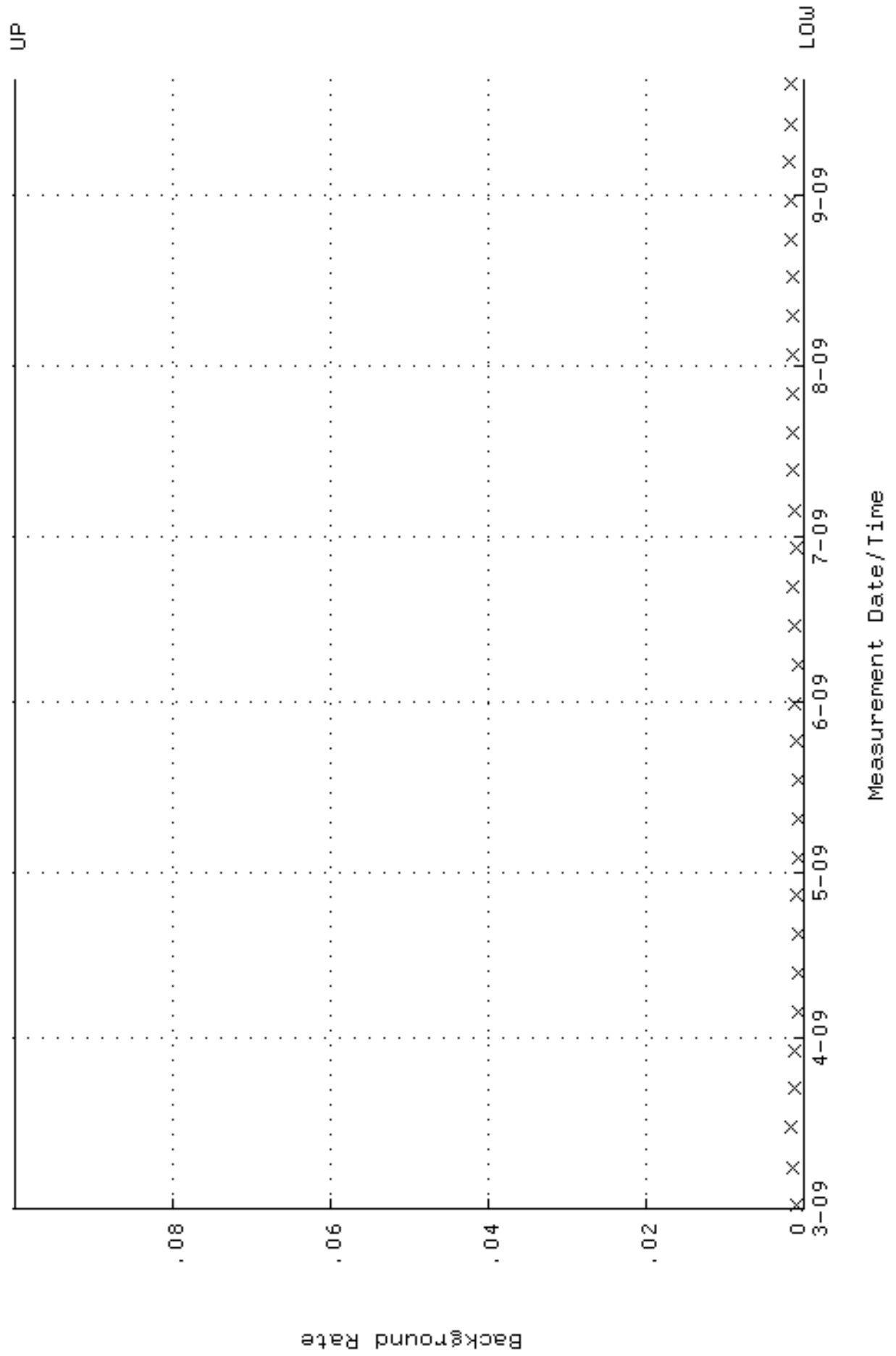
QA filename : DKA100:[ENV\_ALPHA.QA.W]W181.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:03 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.247722 through 0.267722



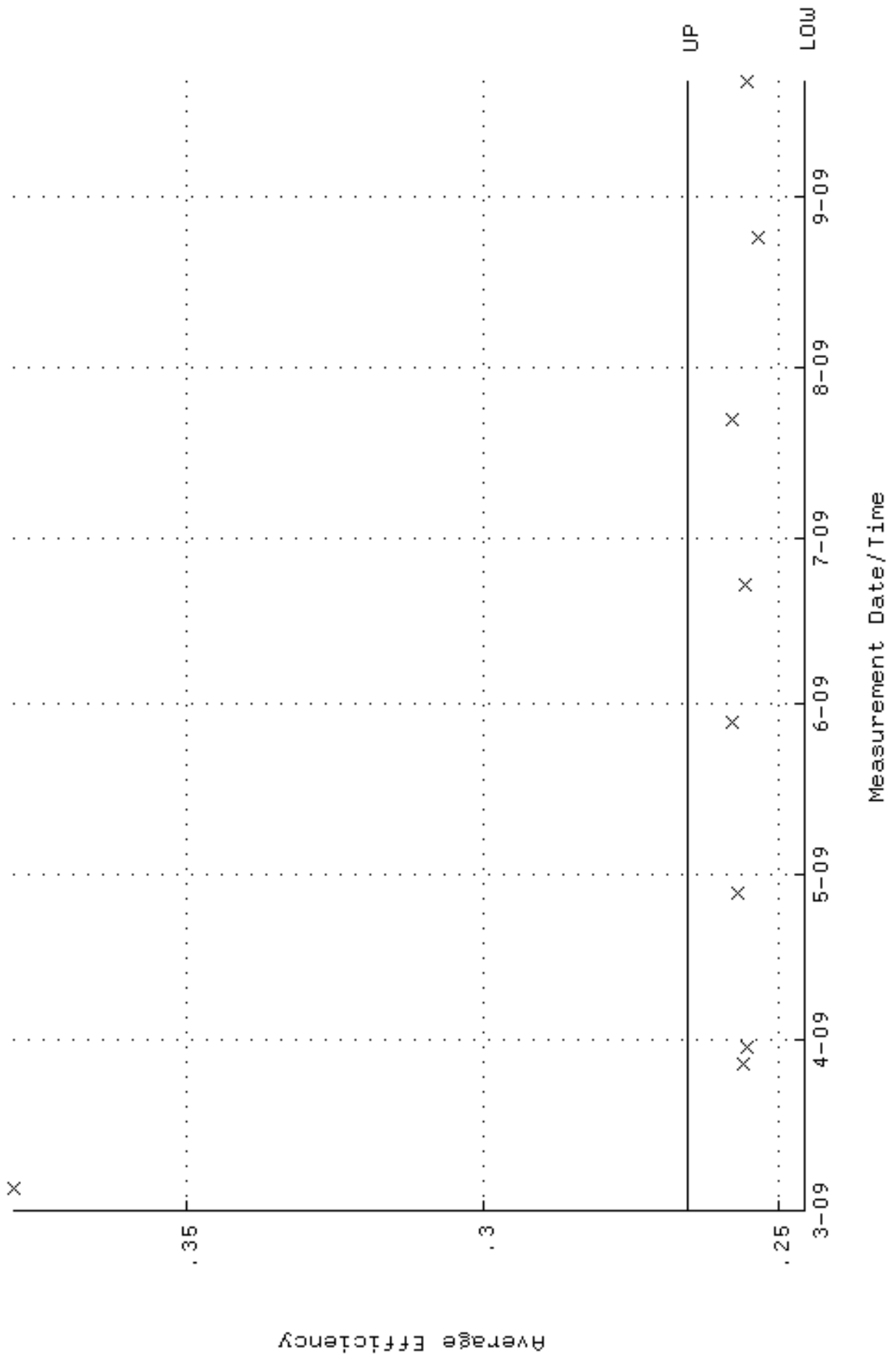
QA filename : DKA100:[ENV\_ALPHA.QA.W]w181.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:03 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 89.2737 through 98.6709



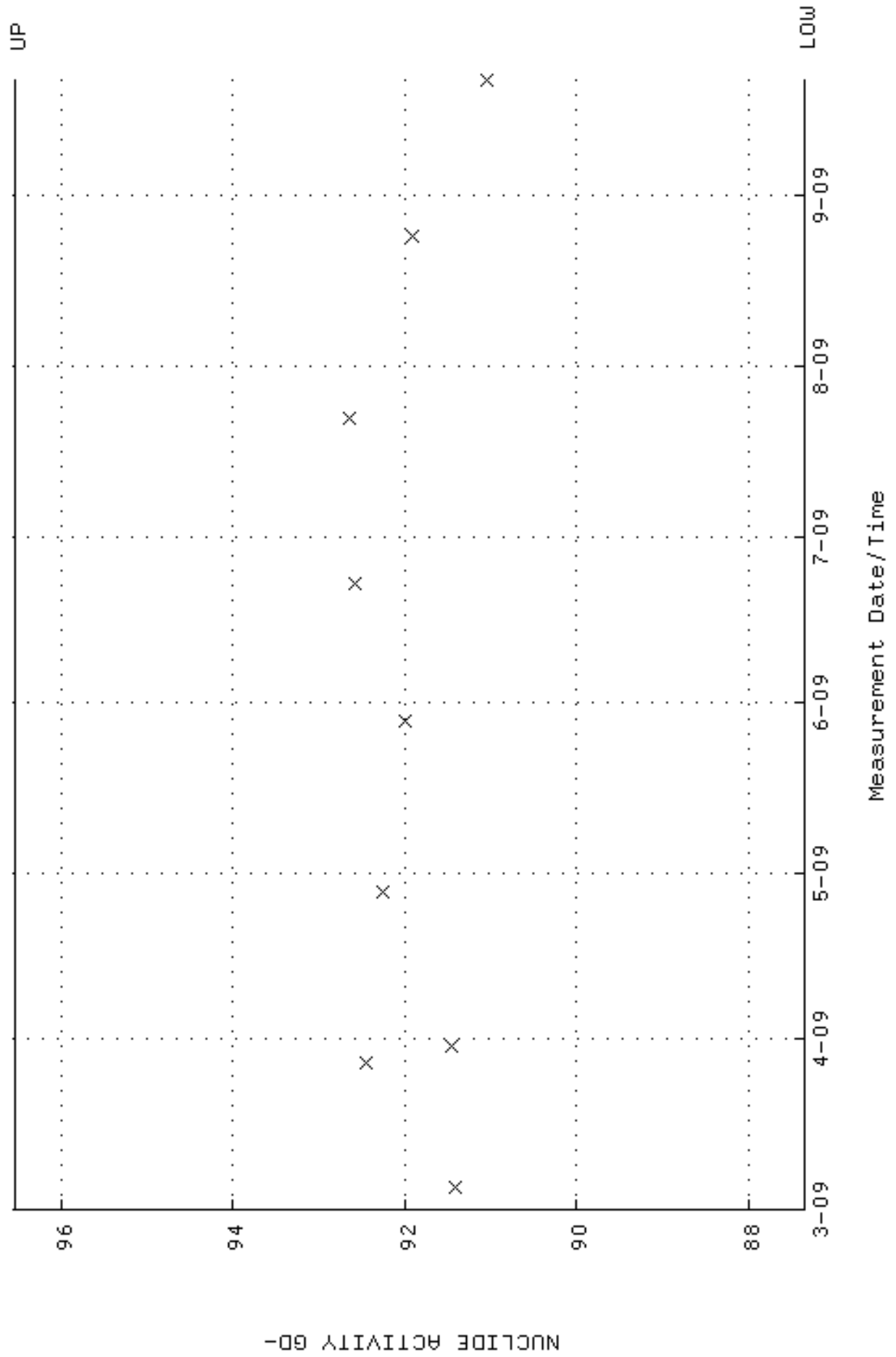
QA filename : DKA100:[ENV\_ALPHA.QA.B]B181.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:17 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



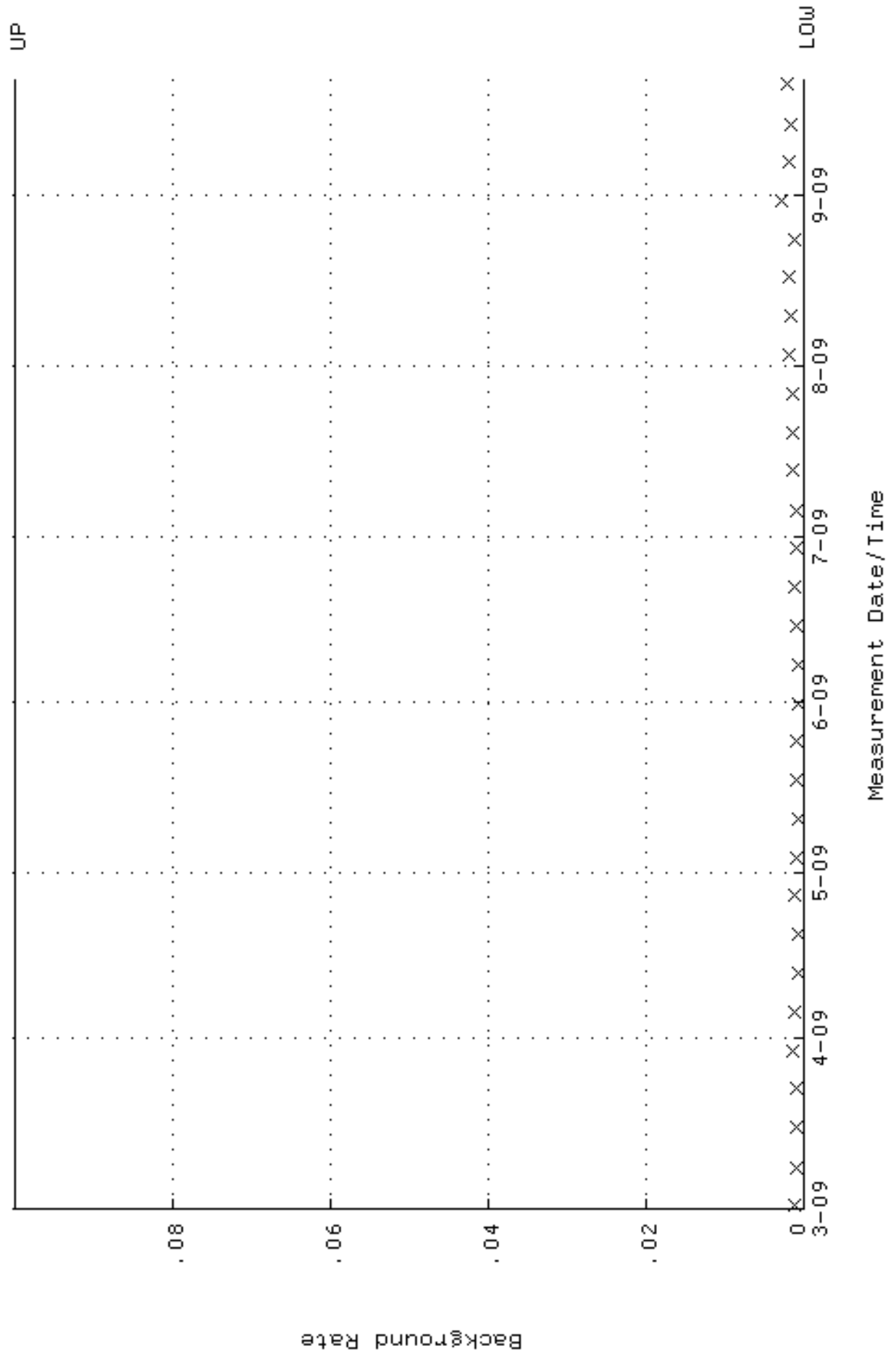
QA filename : DKA100:[ENV\_ALPHA.QA.W]W182.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:07 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.245707 through 0.265707



QA filename : DKA100:[ENV\_ALPHA.QA.W]w182.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:07 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 87.3454 through 96.5396

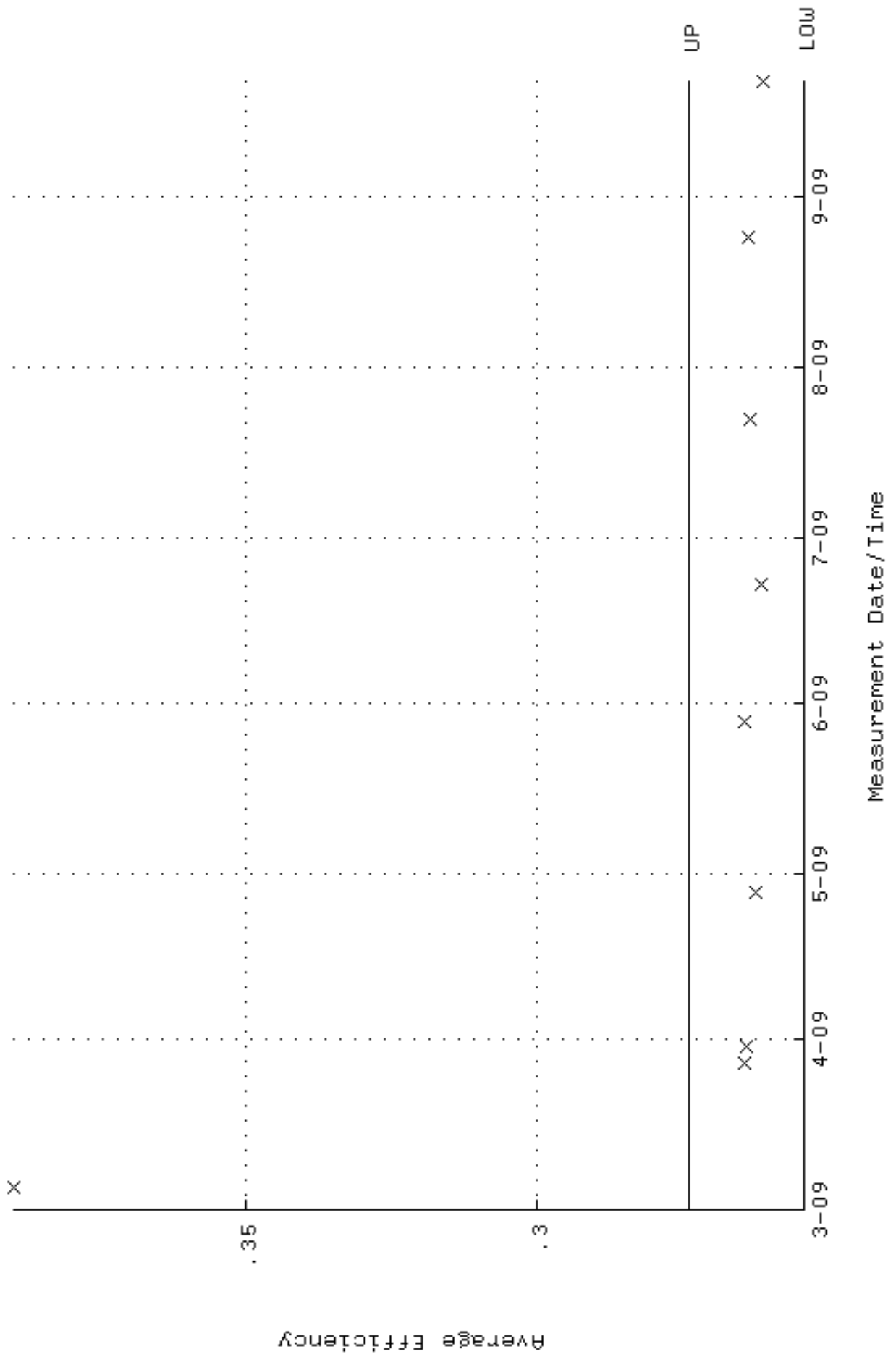


QA filename : DKA100:[ENV\_ALPHA.QA.B]B182.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:20 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000

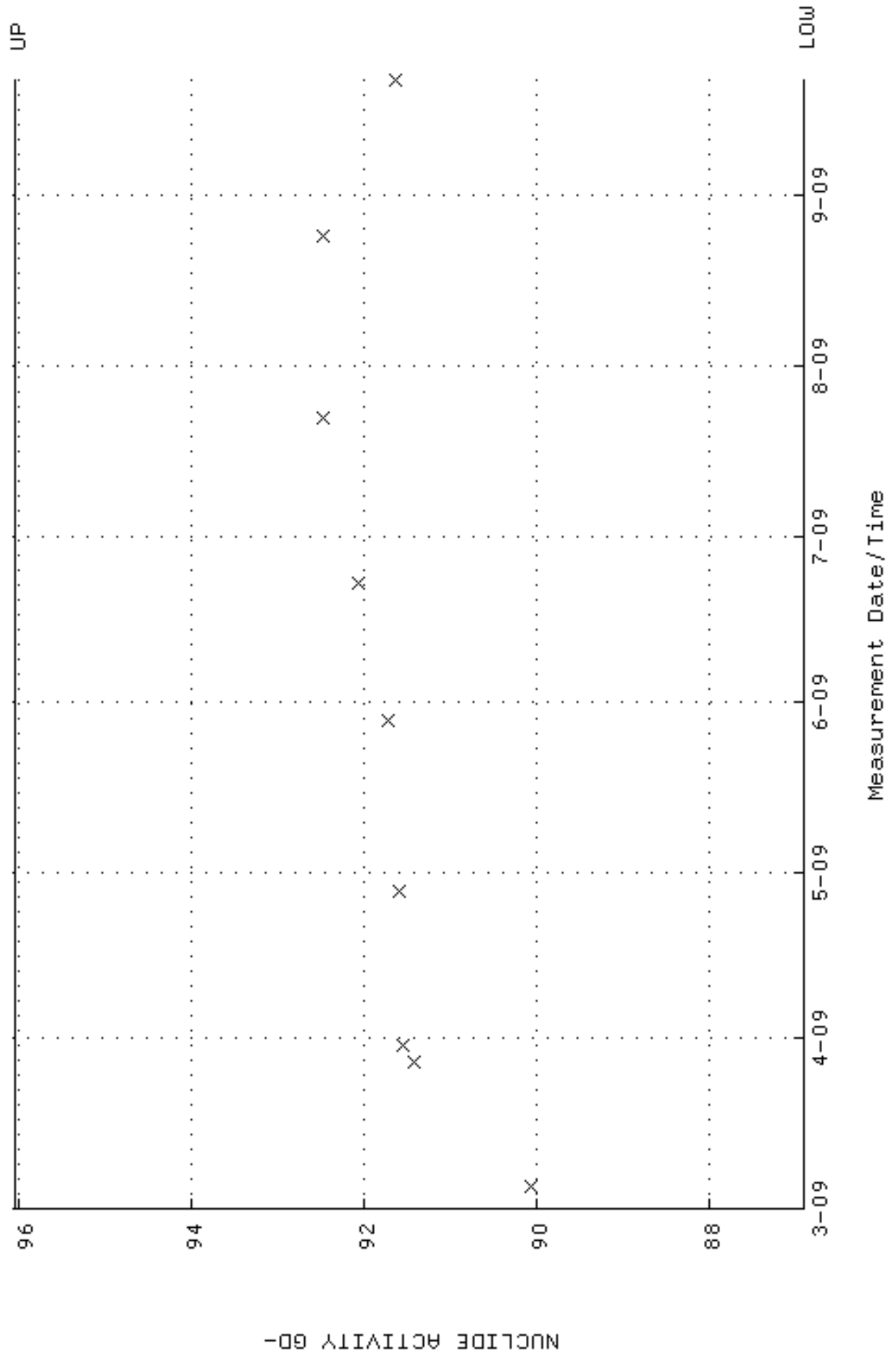




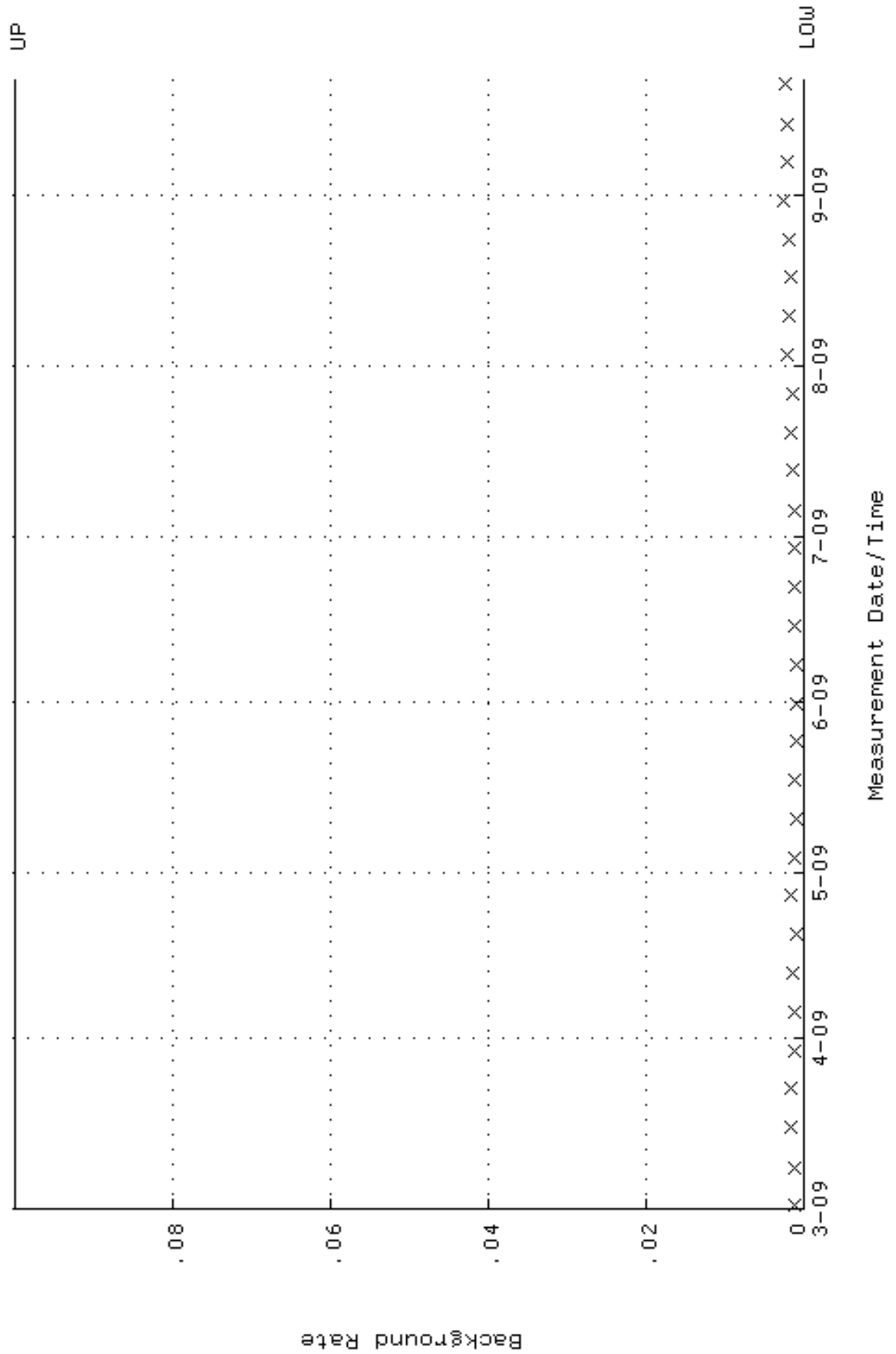
QA filename : DKA100:[ENV\_ALPHA.QA.W]W183.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:11 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.254364 through 0.274364



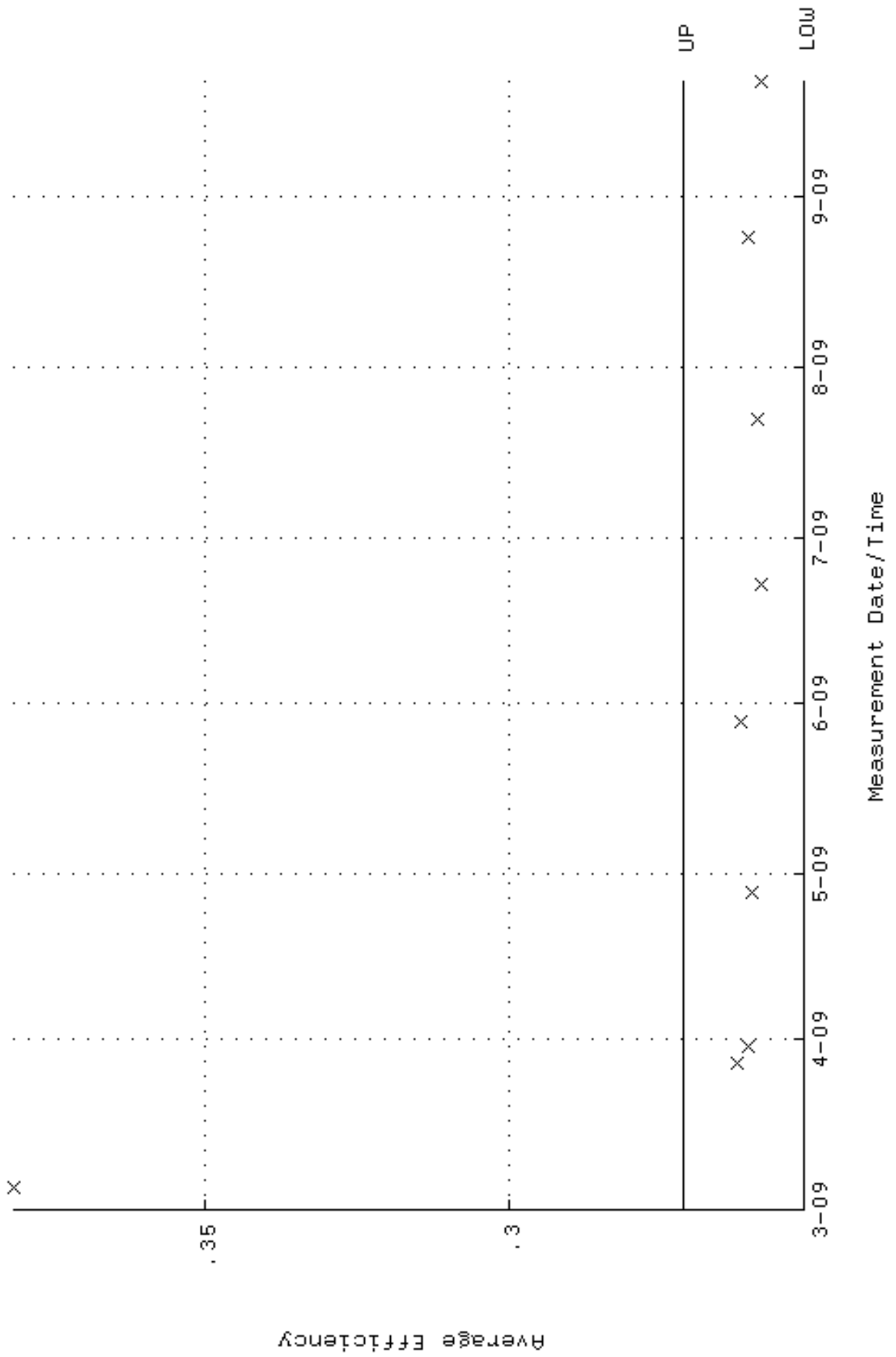
QA filename : DKA100:[ENV\_ALPHA.QA.W]W183.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:11 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 86.8927 through 96.0393



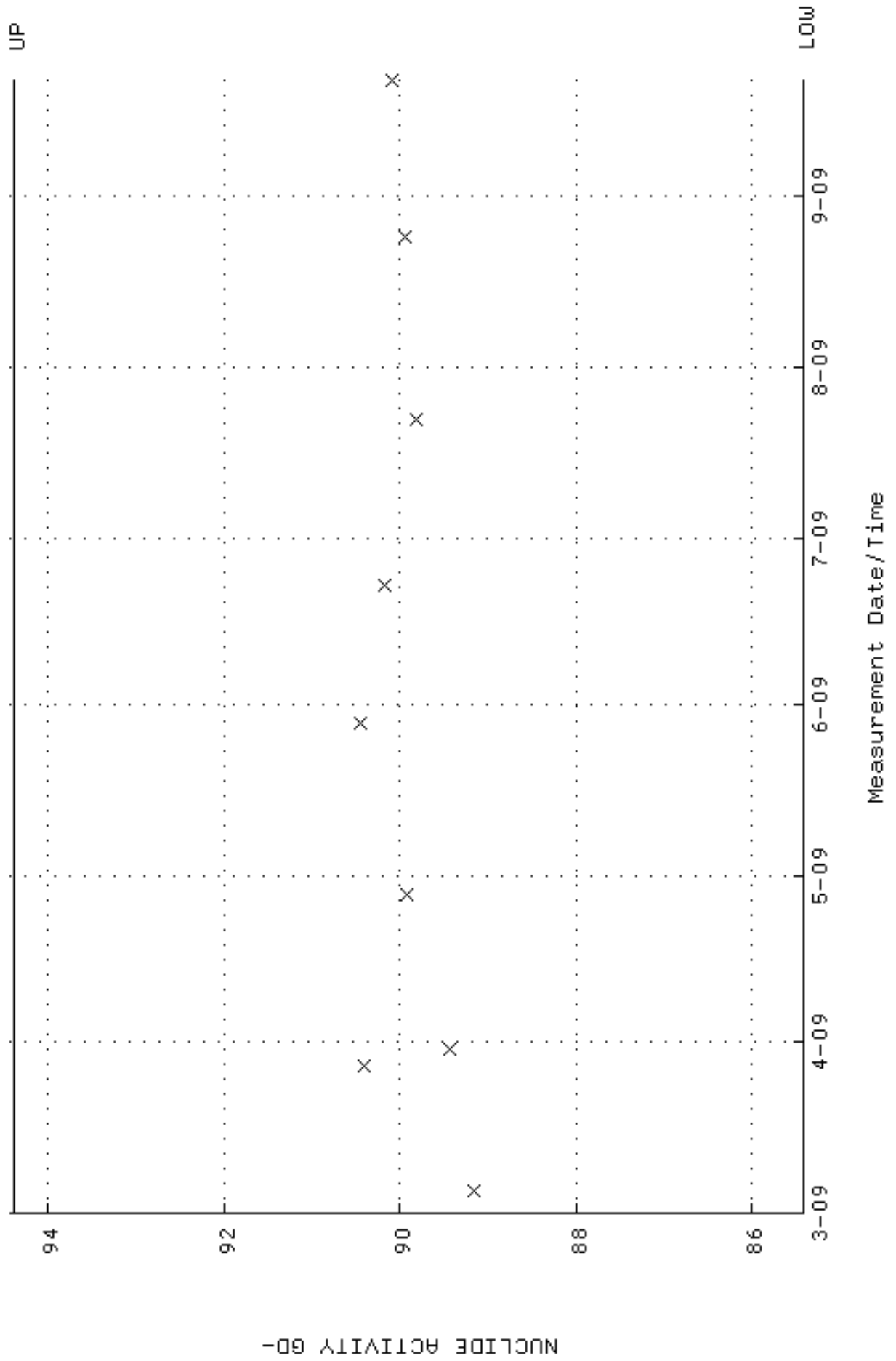
QA filename : DKA100:[ENV\_ALPHA.QA.B]B183.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:24 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



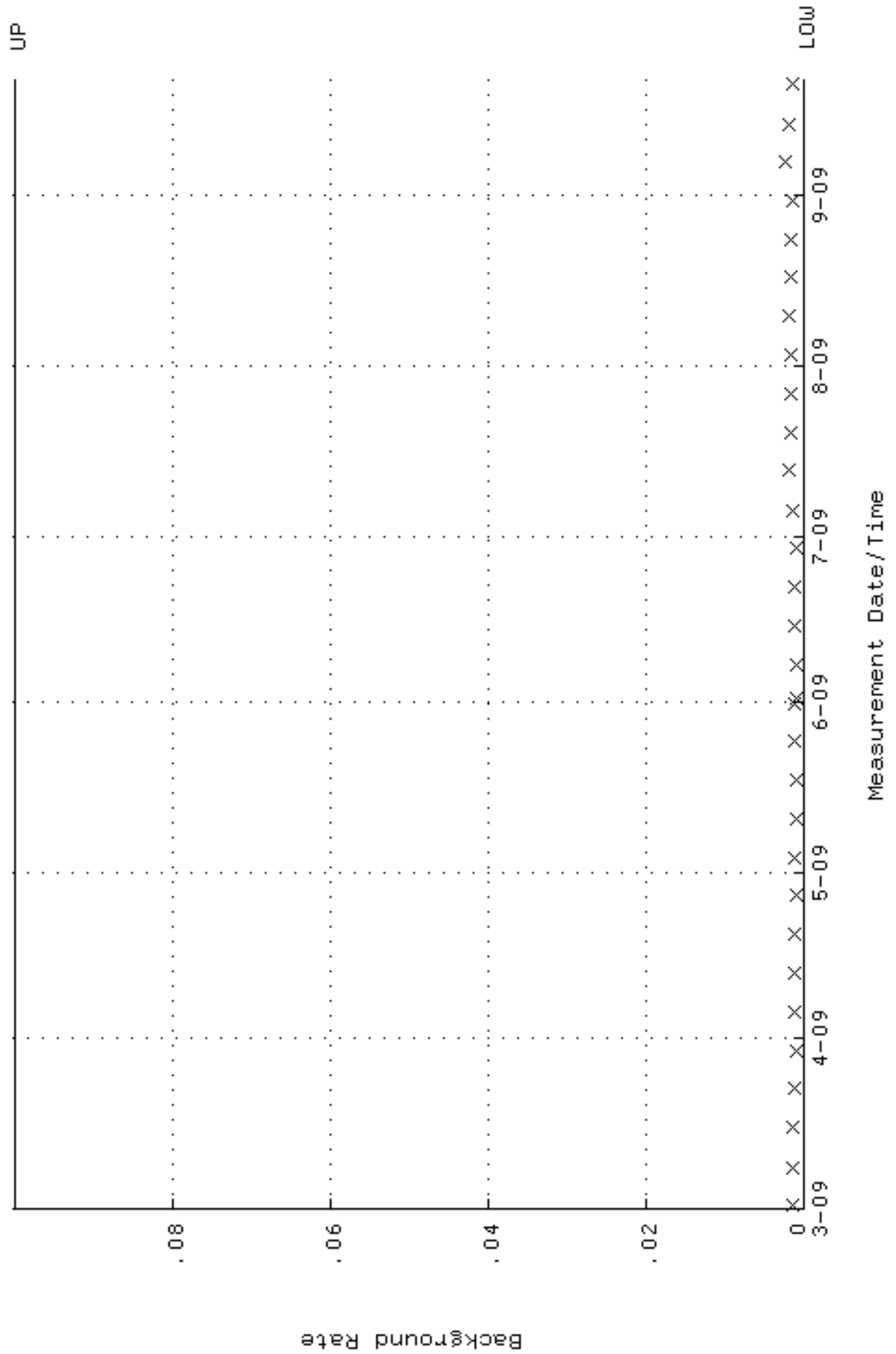
QA filename : DKA100:[ENV\_ALPHA.QA.W]W184.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:15 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.251367 through 0.271367



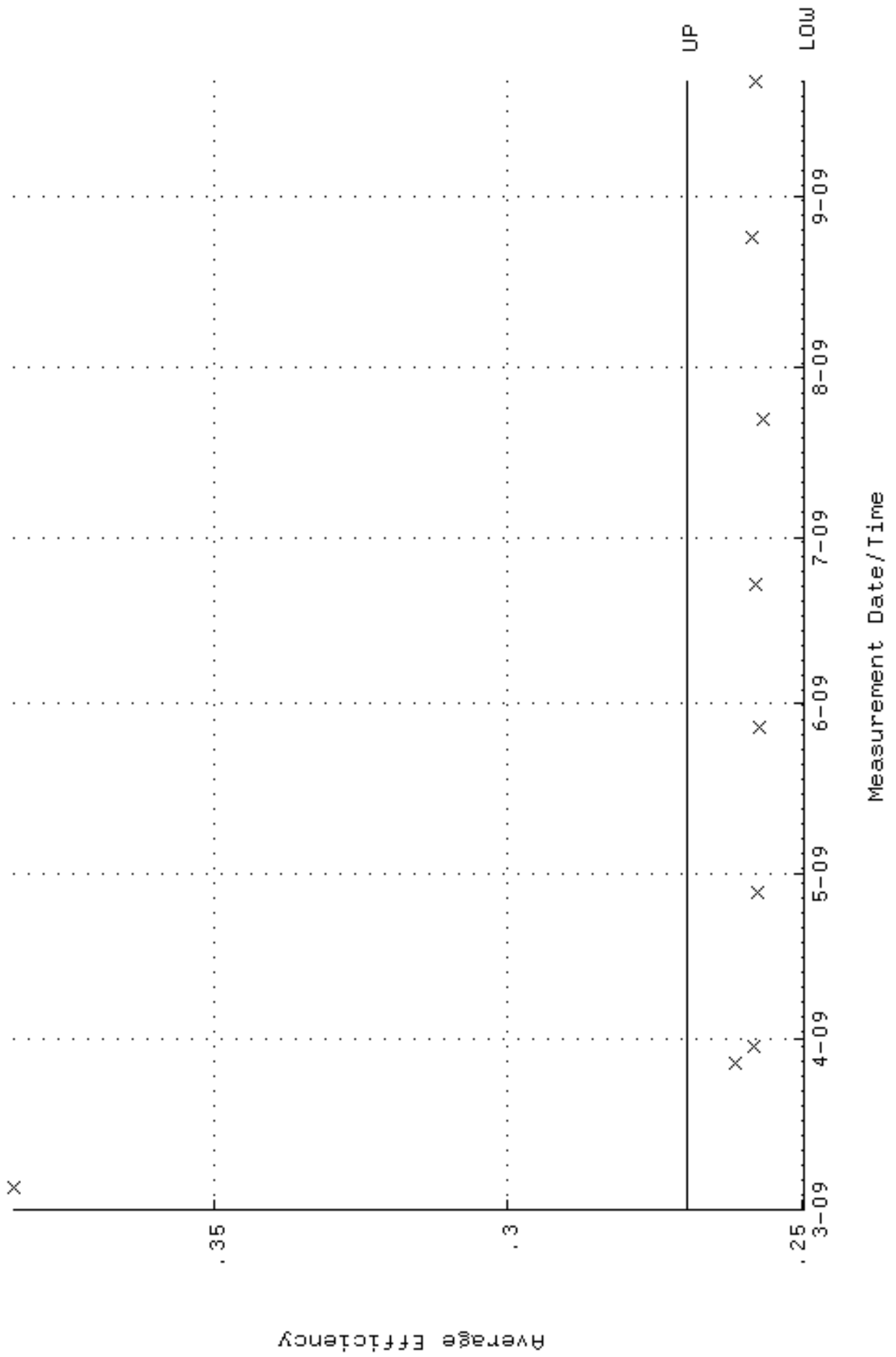
QA filename : DKA100:[ENV\_ALPHA.QA.W]w184.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:15 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 85.4139 through 94.4049



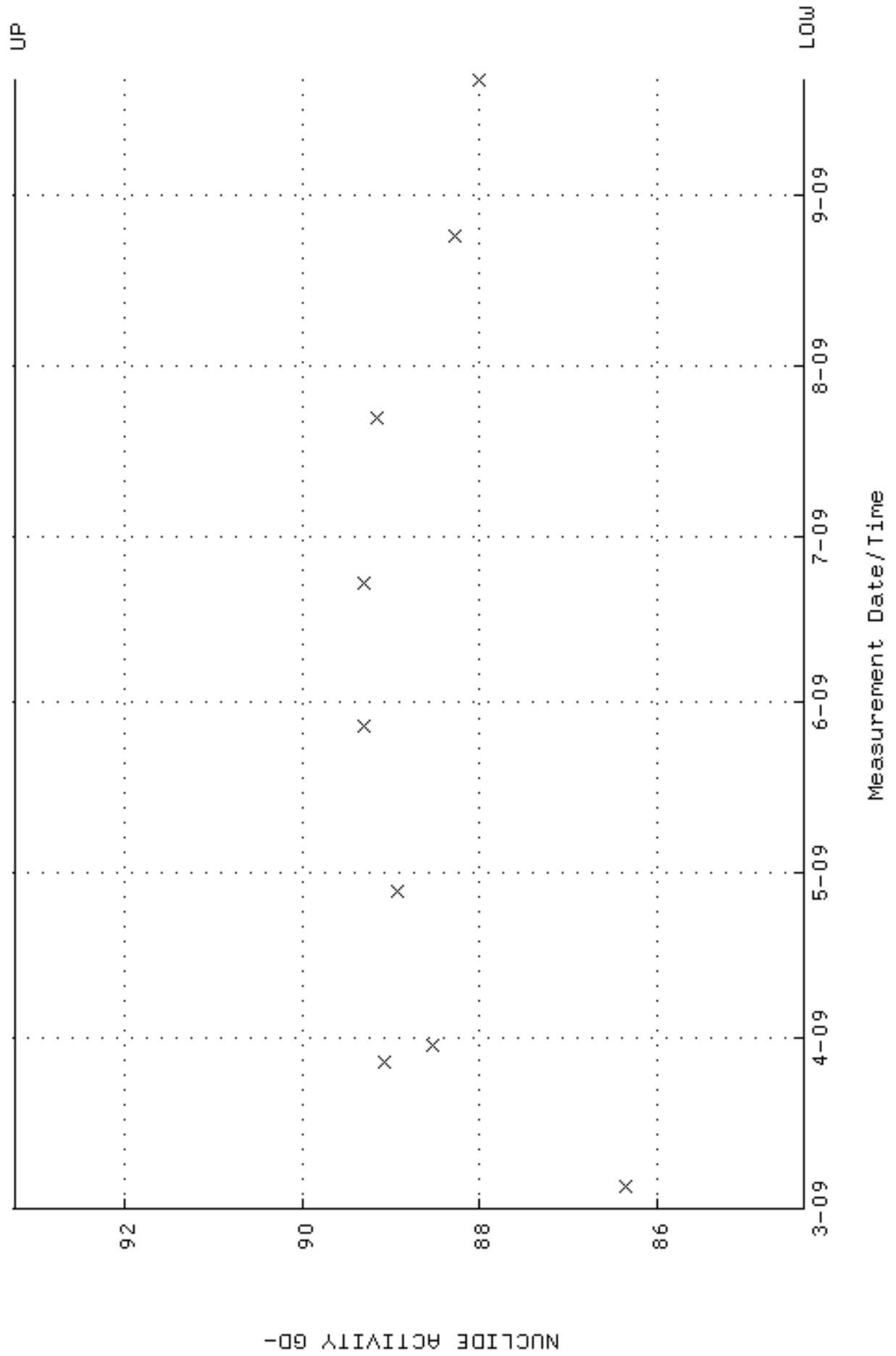
QA filename : DKA100:[ENV\_ALPHA.QA.B]B184.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:28 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



QA filename : DKA100:[ENV\_ALPHA.QA.W]W185.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:19 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.249628 through 0.269628

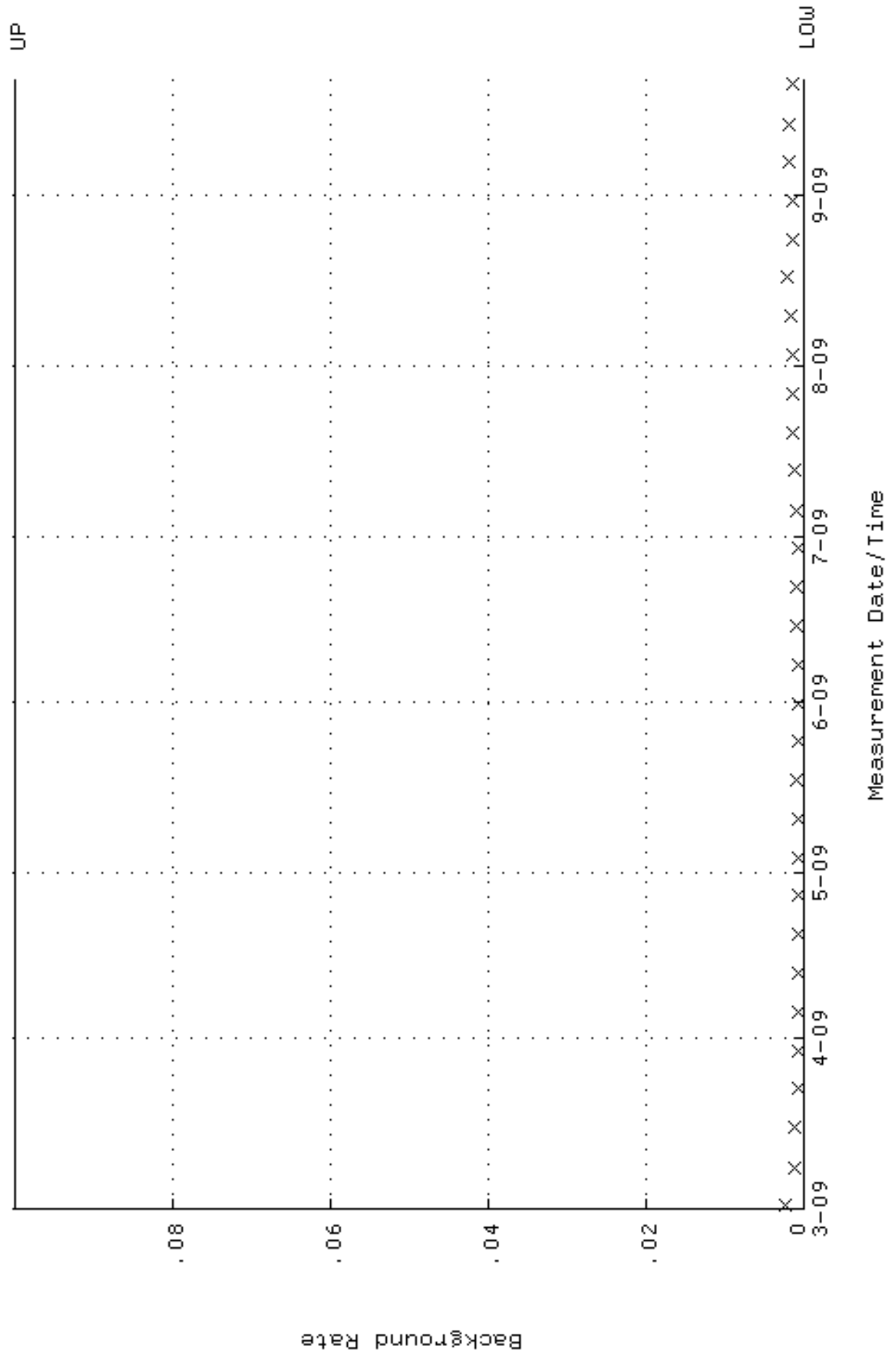


QA filename : DKA100:[ENV\_ALPHA.QA.W]w185.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:19 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 84.3502 through 93.2292

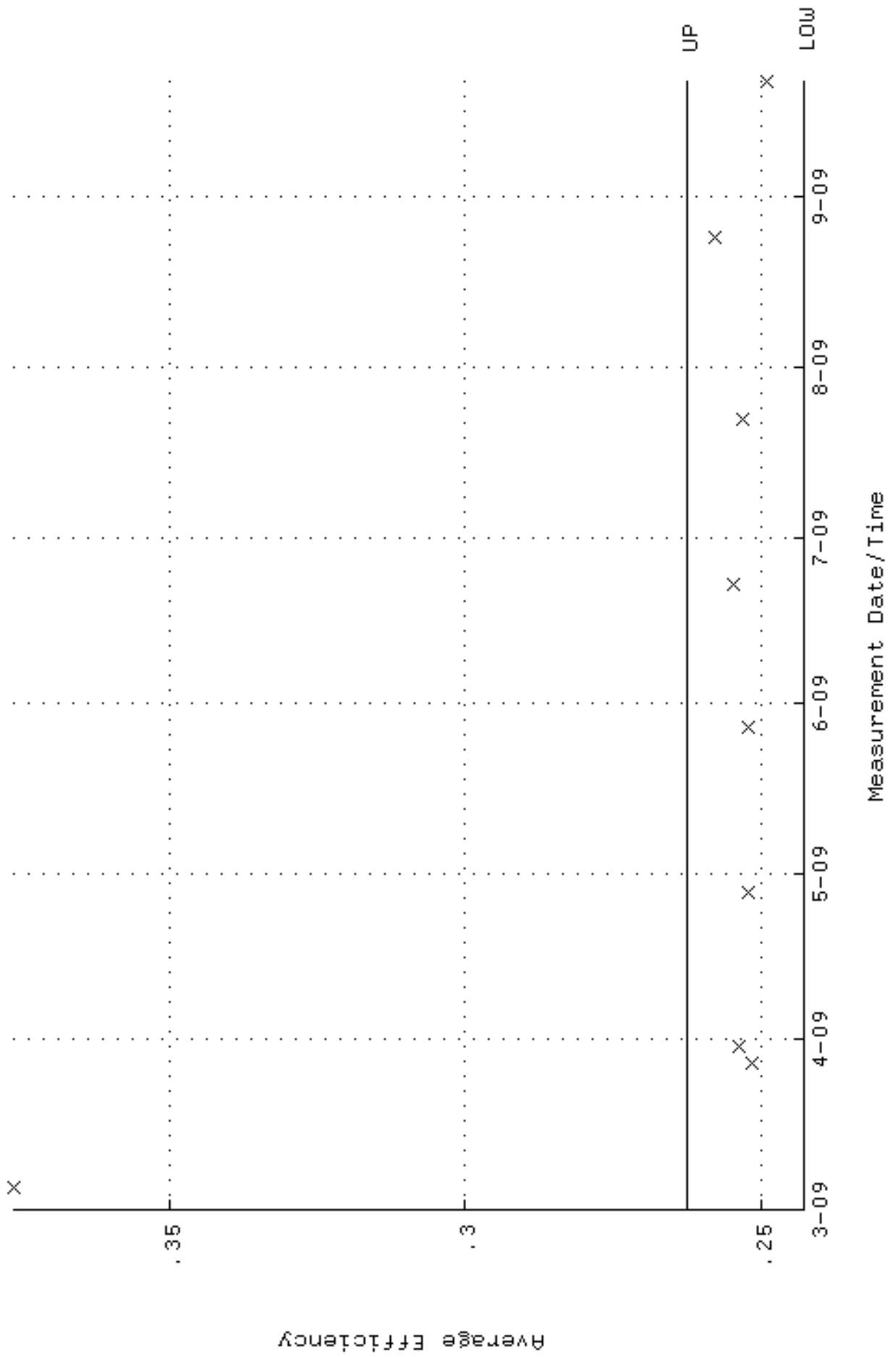




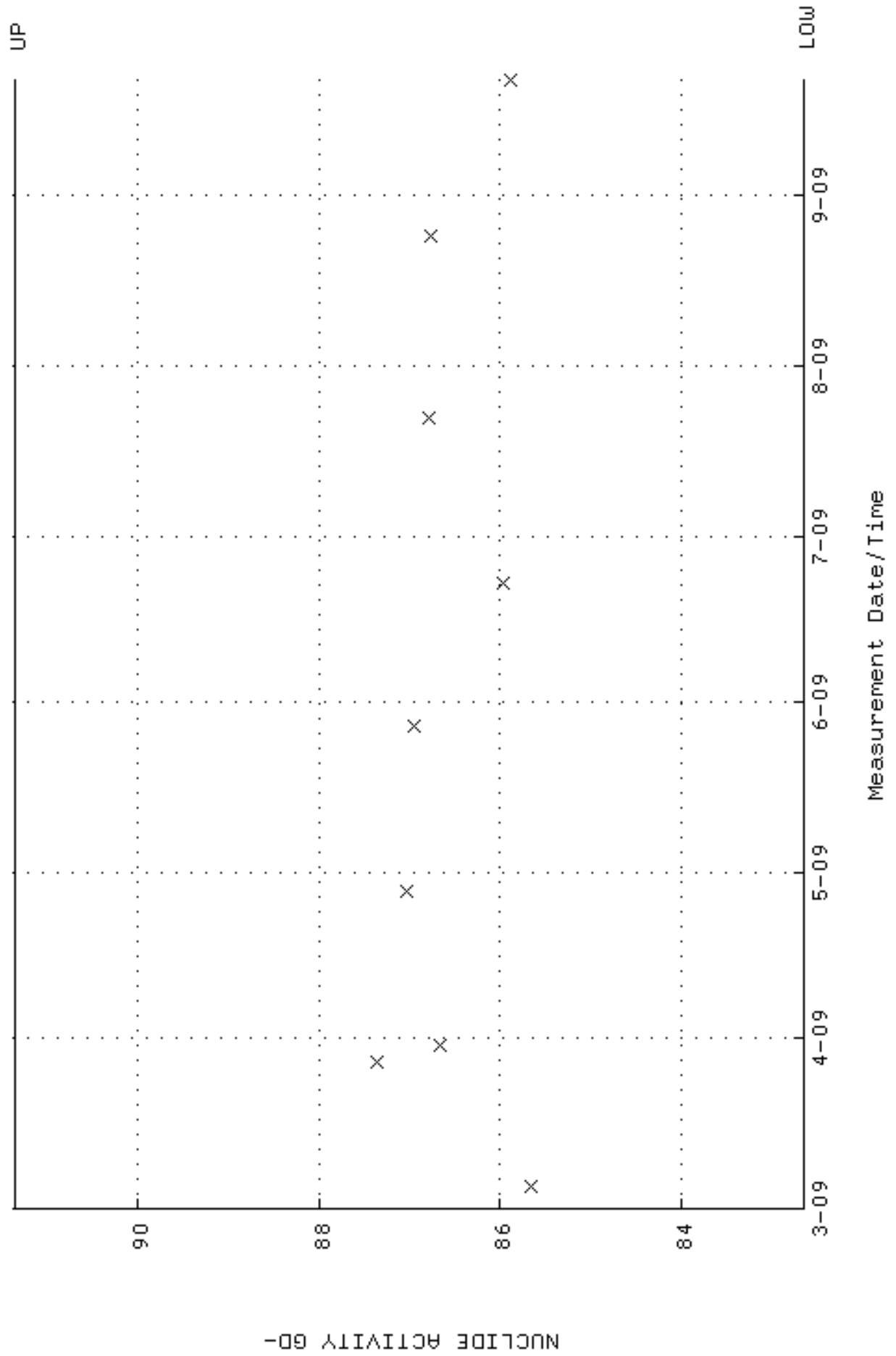
QA filename : DKA100:[ENV\_ALPHA.QA.B]B185.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:31 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



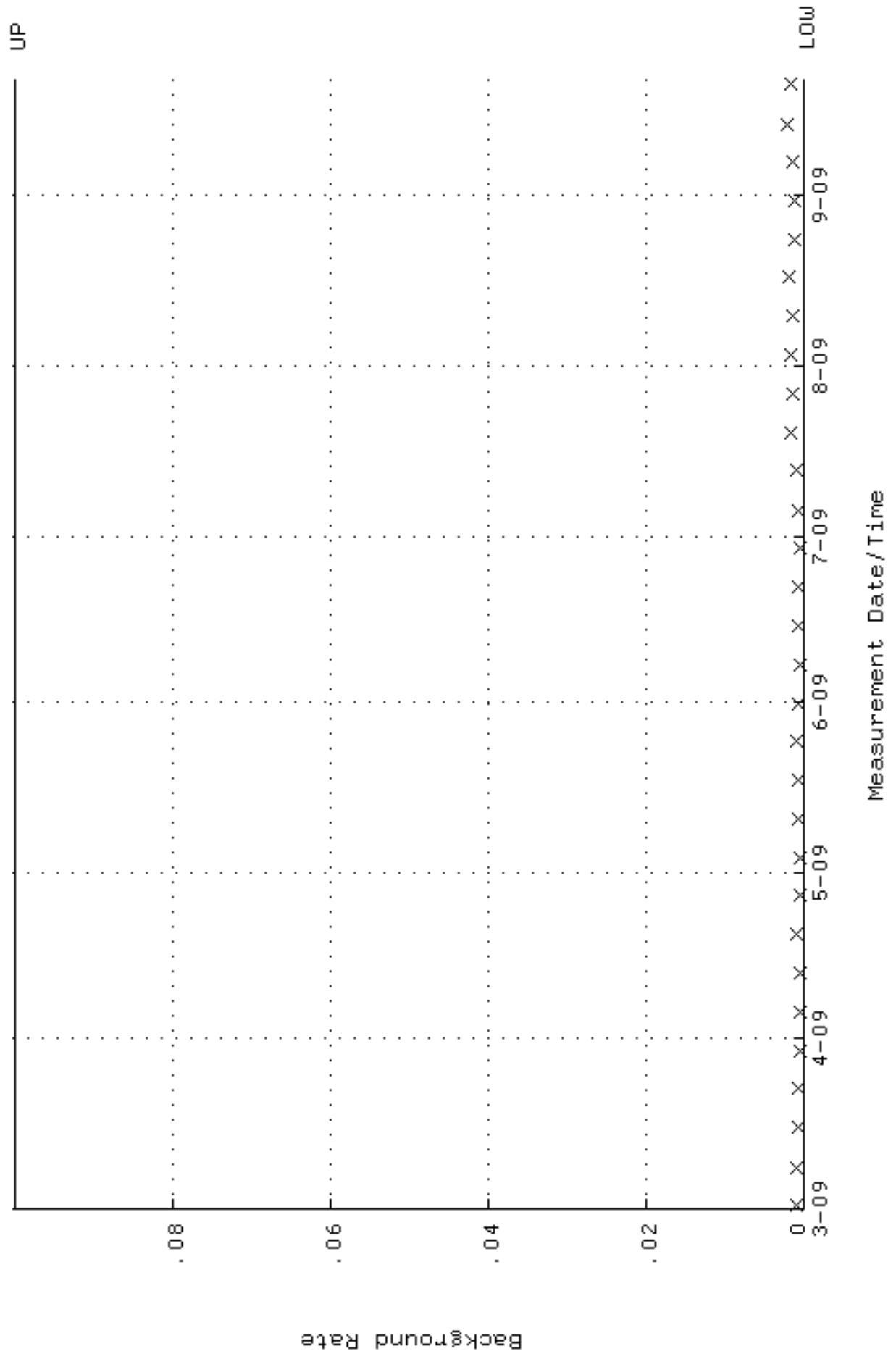
QA filename : DKA100:[ENV\_ALPHA.QA.W]W186.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:23 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.242649 through 0.262649



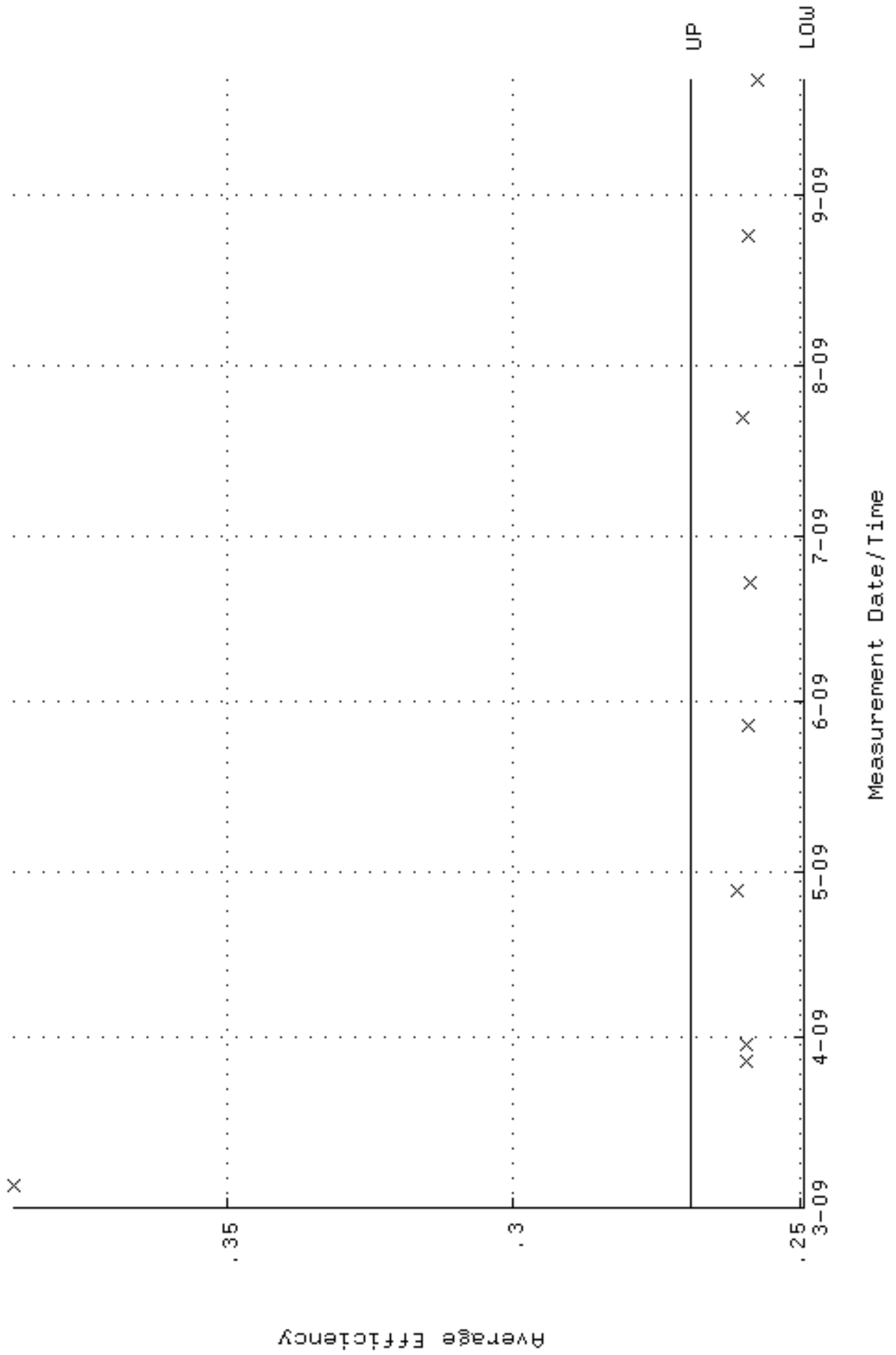
QA filename : DKA100:[ENV\_ALPHA.QA.W]W186.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:23 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 82.6495 through 91.3495



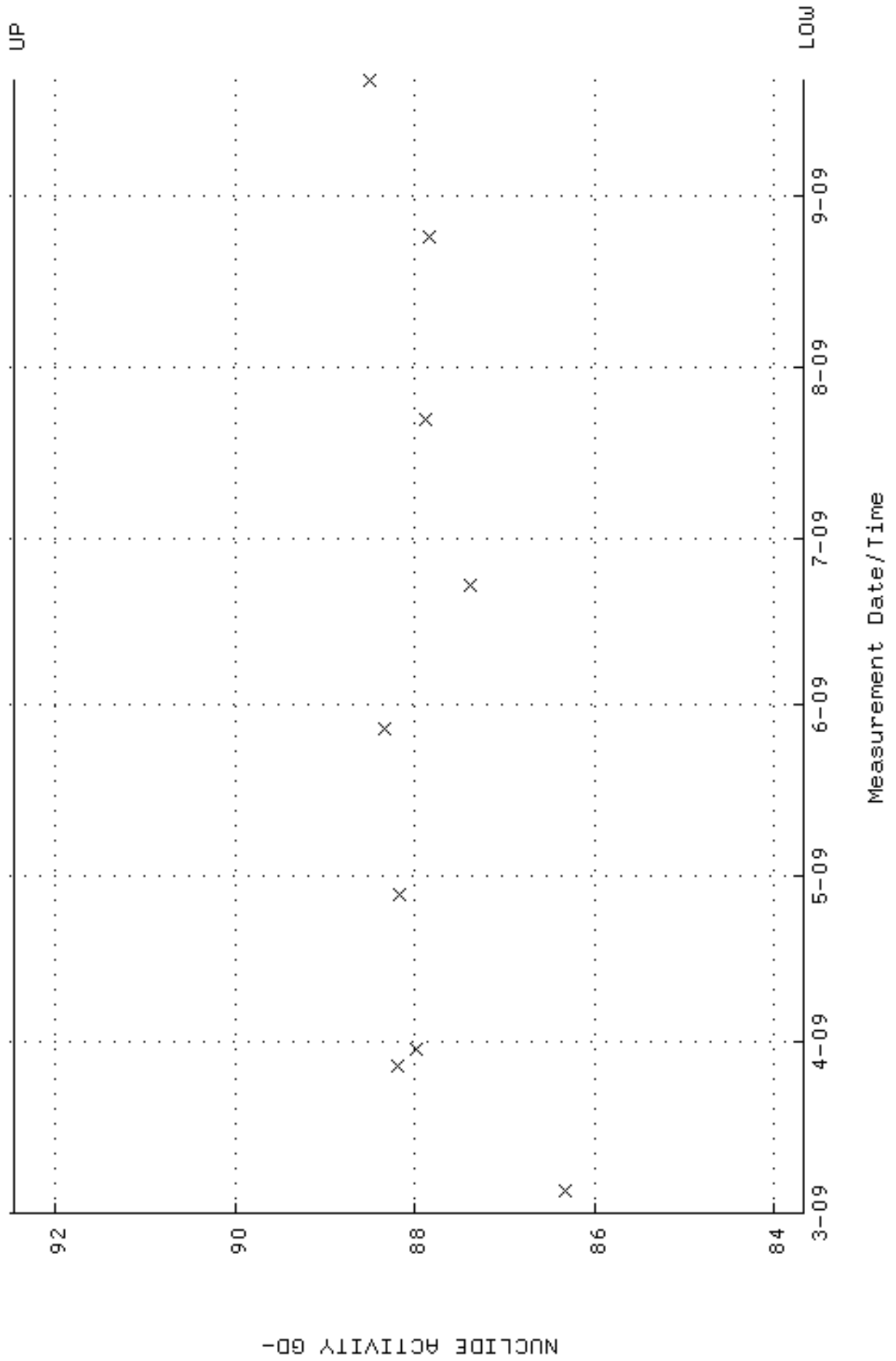
QA filename : DKA100:[ENV\_ALPHA.QA.B]B186.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:35 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



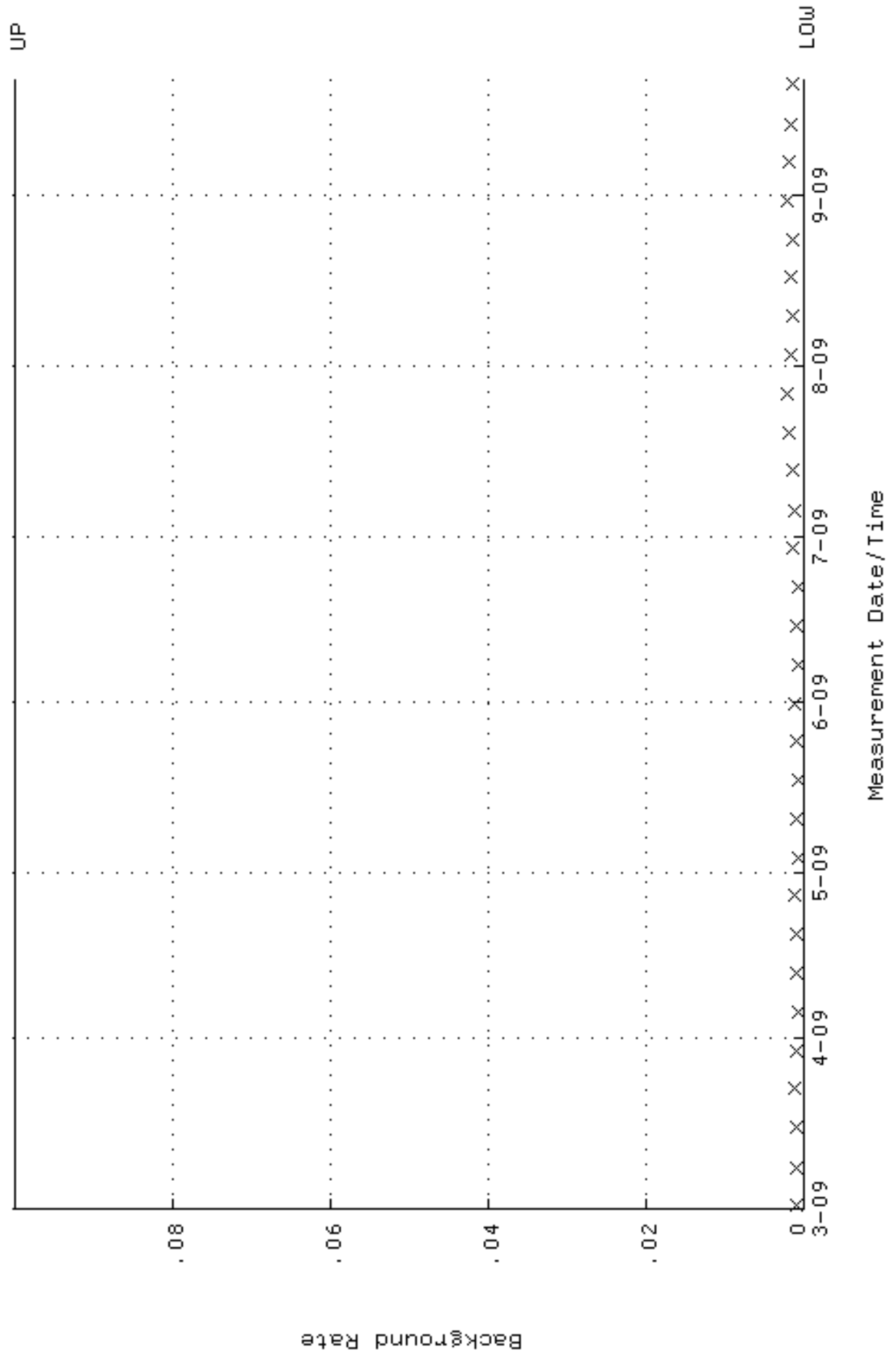
QA filename : DKA100:[ENV\_ALPHA.QA.W]W188.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:30 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.249341 through 0.269341



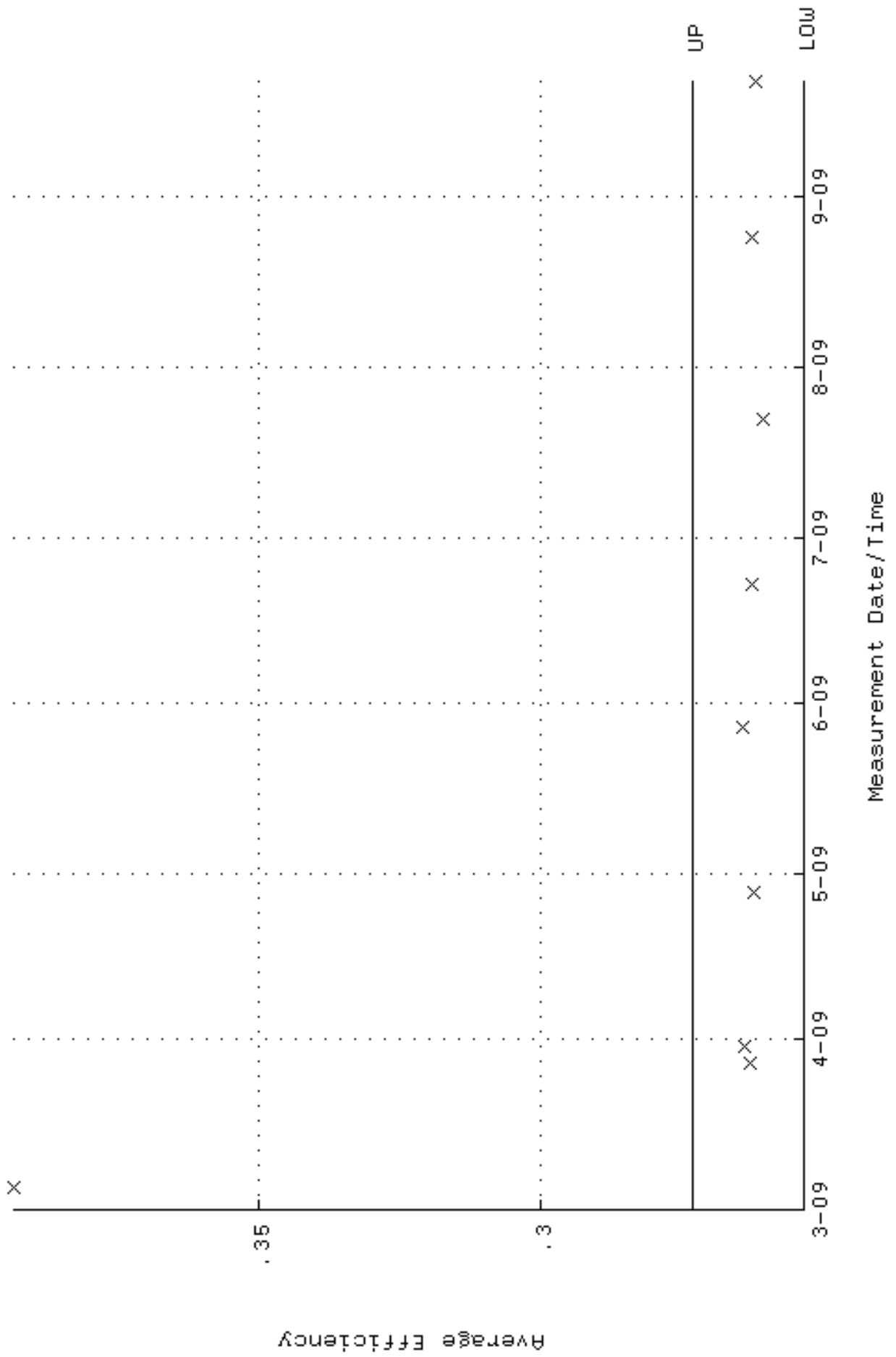
QA filename : DKA100:[ENV\_ALPHA.QA.W]w188.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:30 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 83.6747 through 92.4825



QA filename : DKA100:[ENV\_ALPHA.QA.B]B188.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:42 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000

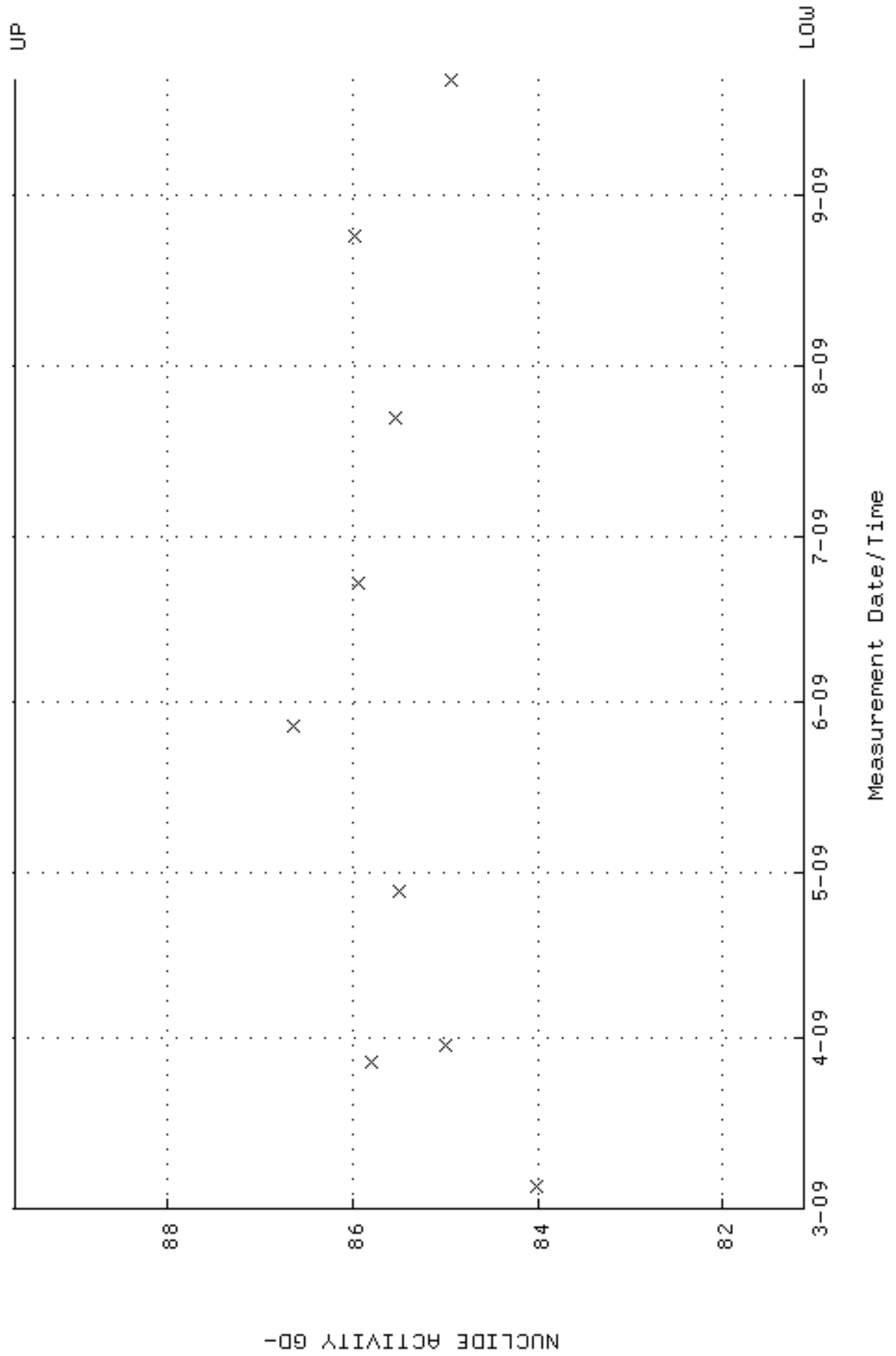


QA filename : DKA100:[ENV\_ALPHA.QA.W]W190.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:38 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.253504 through 0.273504

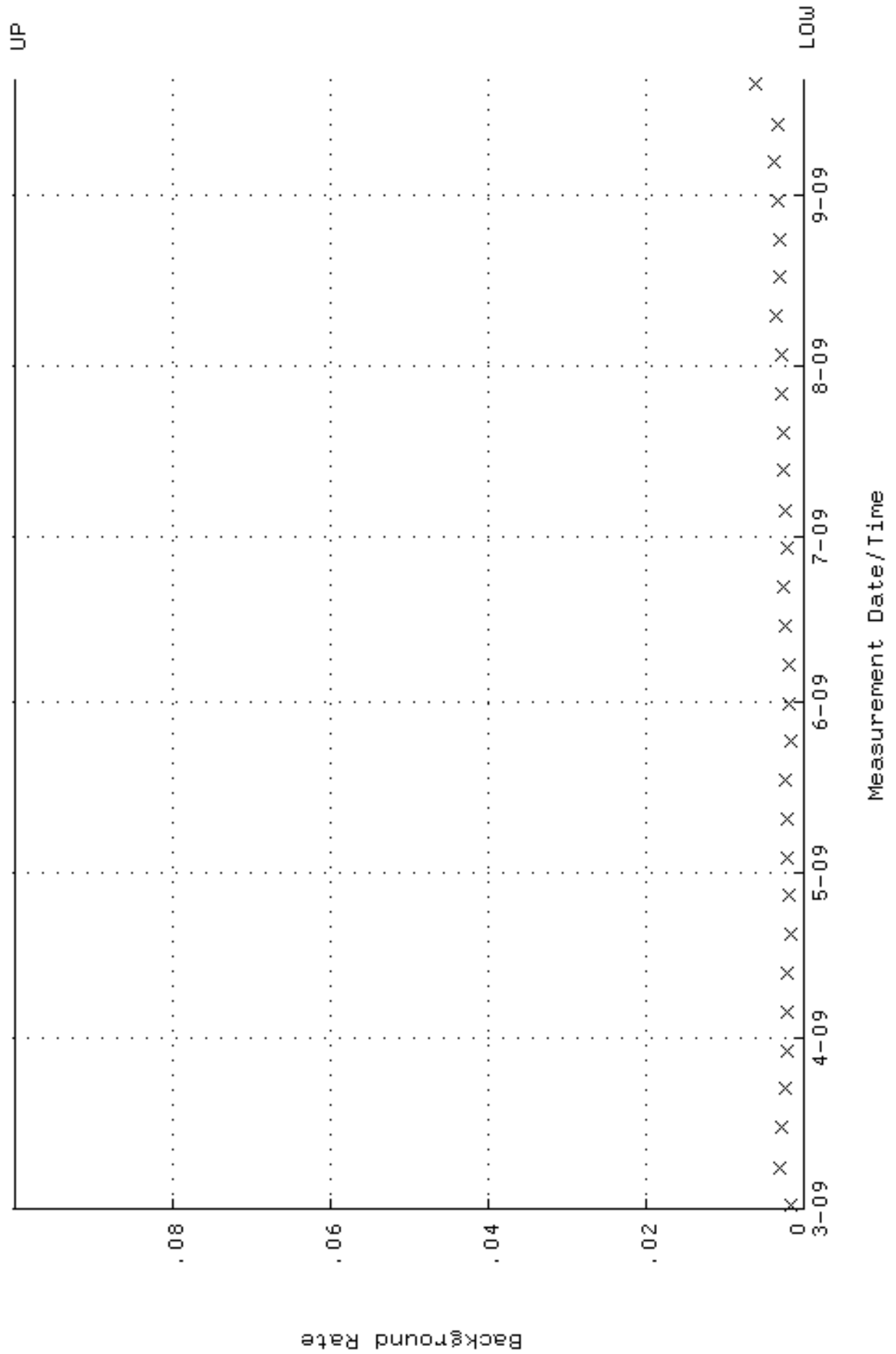




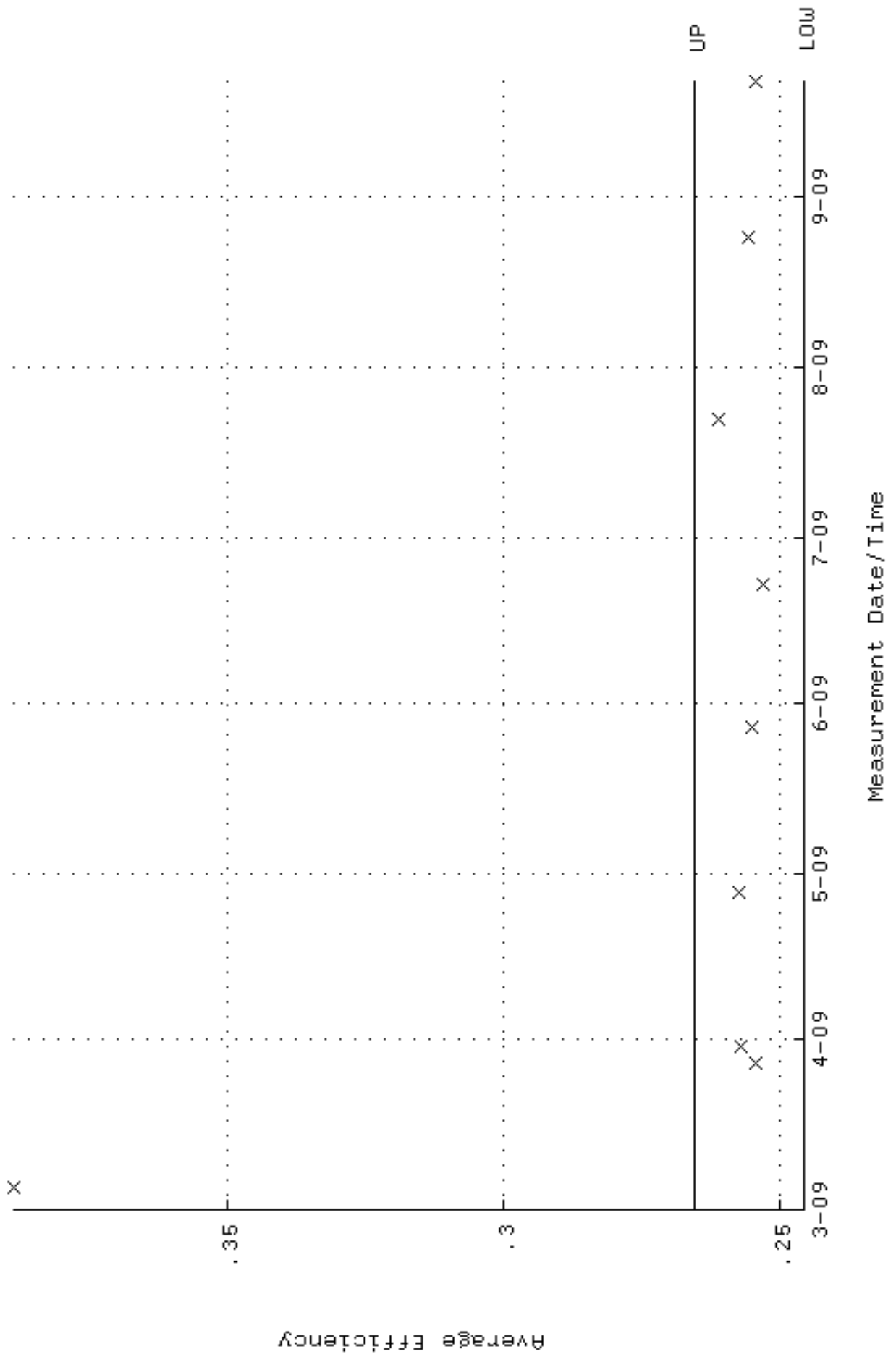
QA filename : DKA100:[ENV\_ALPHA.QA.W]W190.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:38 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 81.1176 through 89.6562



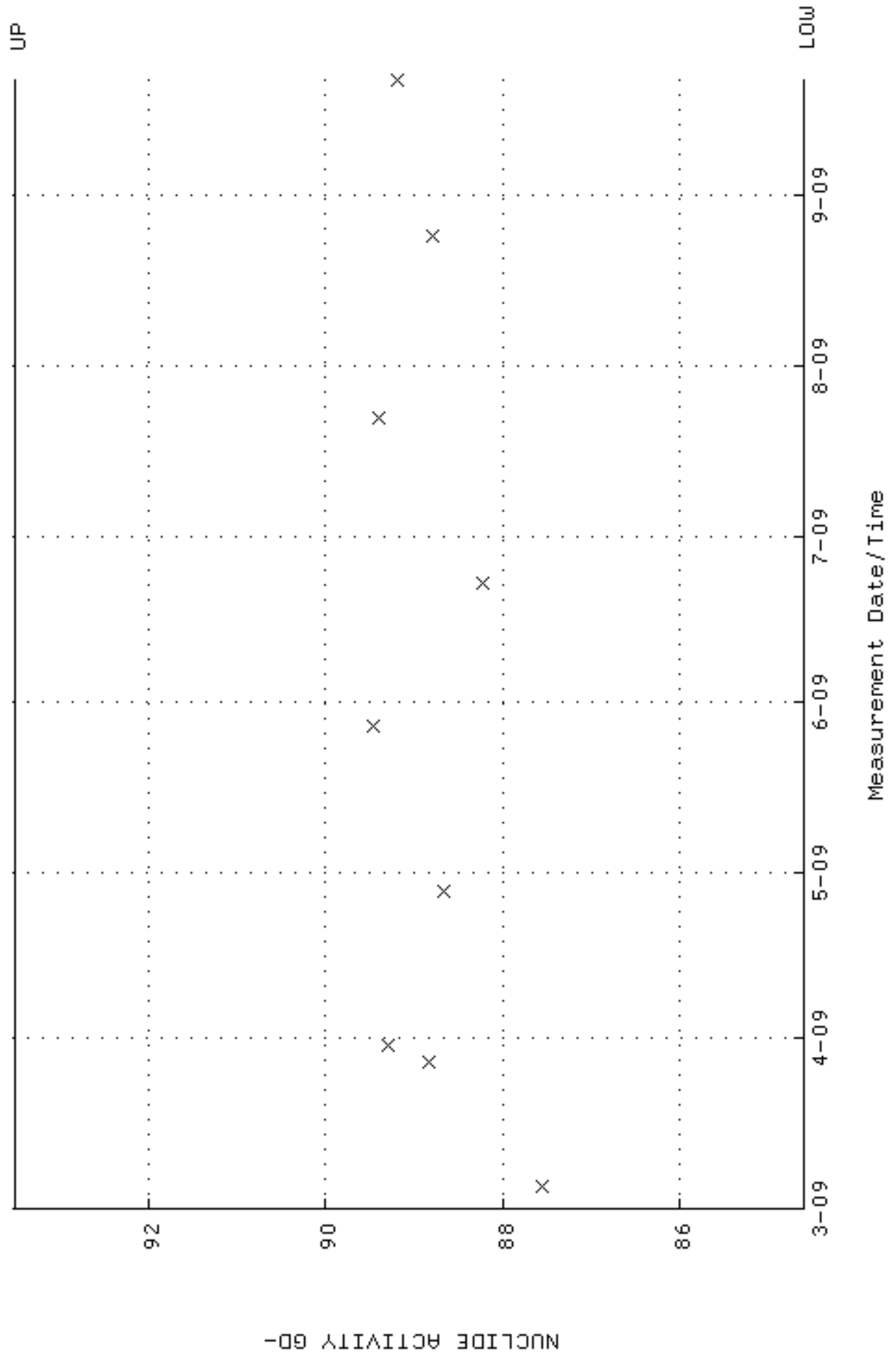
QA filename : DKA100:[ENV\_ALPHA.QA.B]B190.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:50 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



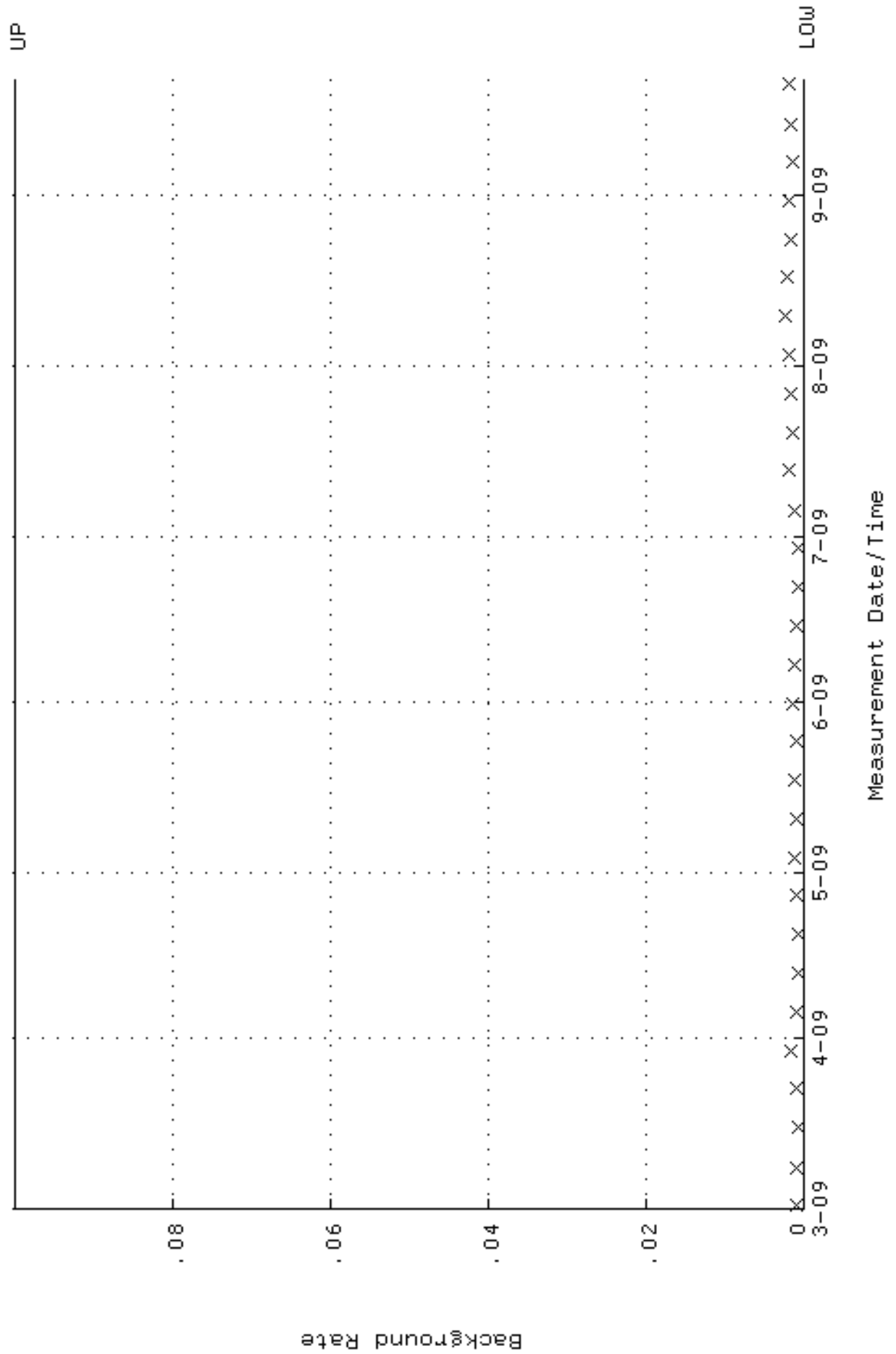
QA filename : DKA100:[ENV\_ALPHA.QA.W]W192.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 4-MAR-2009 22:39:46 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.245663 through 0.265663



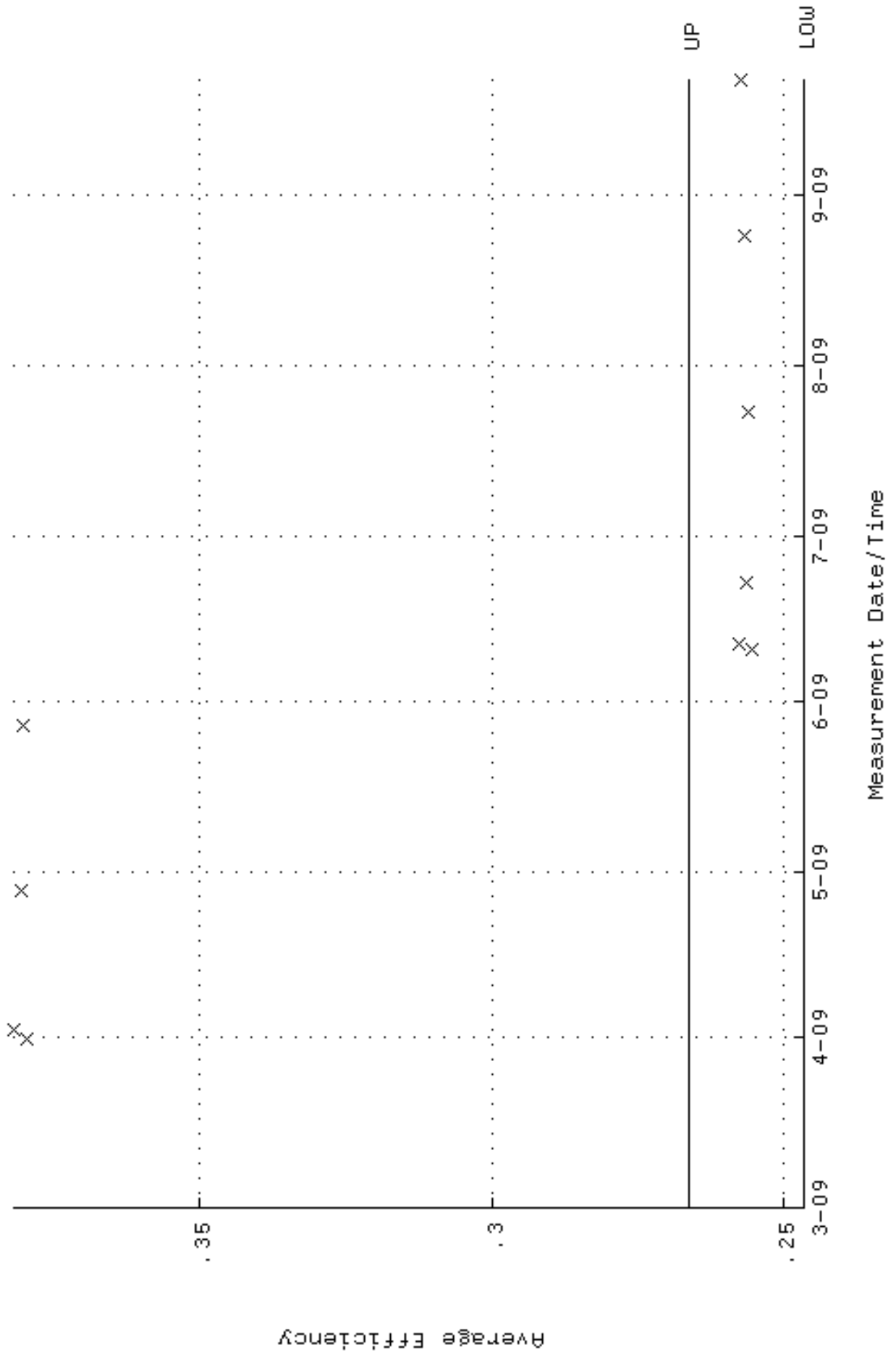
QA filename : DKA100:[ENV\_ALPHA.QA.W]W192.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 4-MAR-2009 22:39:46 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 84.6037 through 93.5093



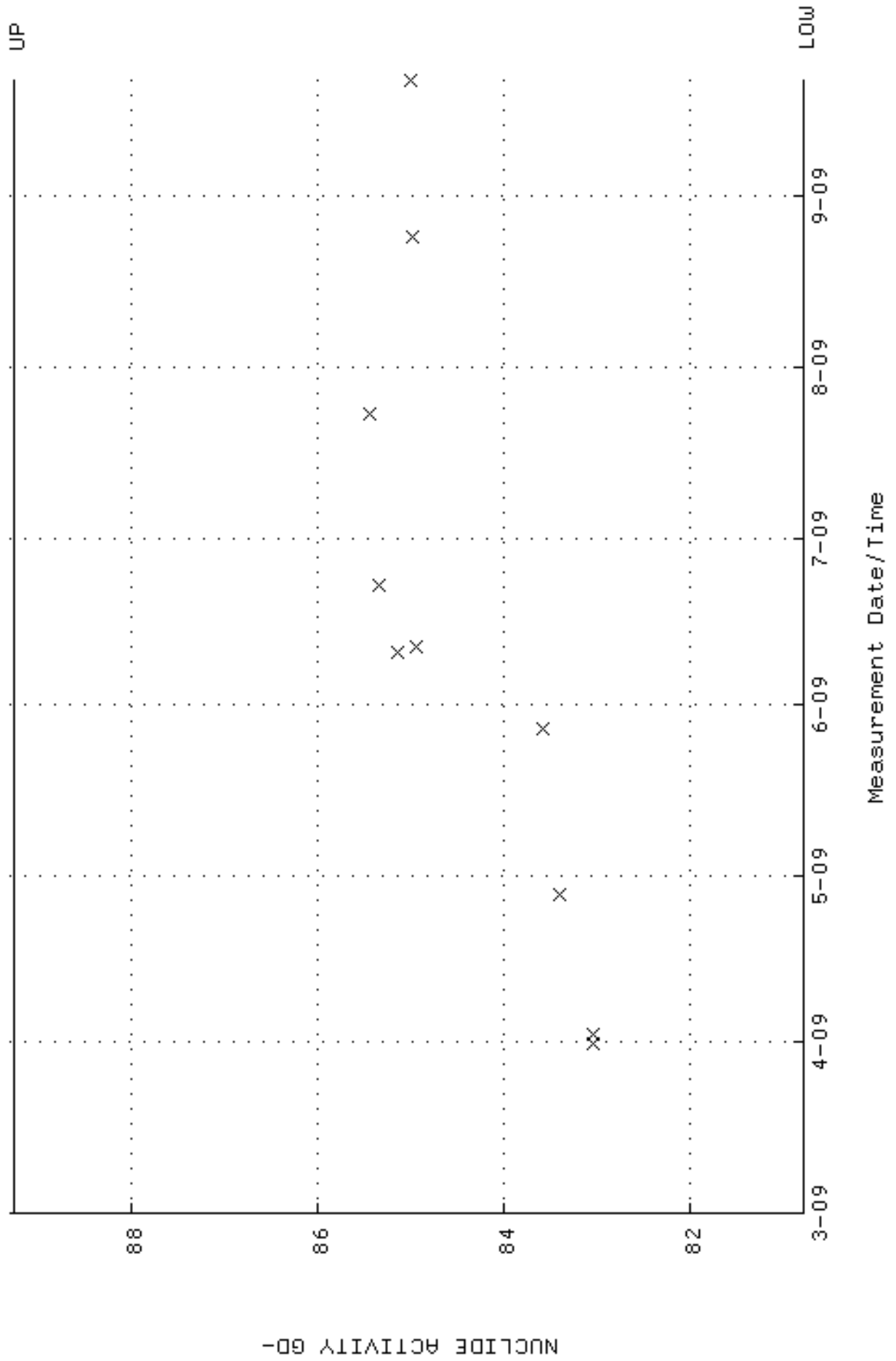
QA filename : DKA100:[ENV\_ALPHA.QA.B]B192.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-MAR-2009 17:22:57 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



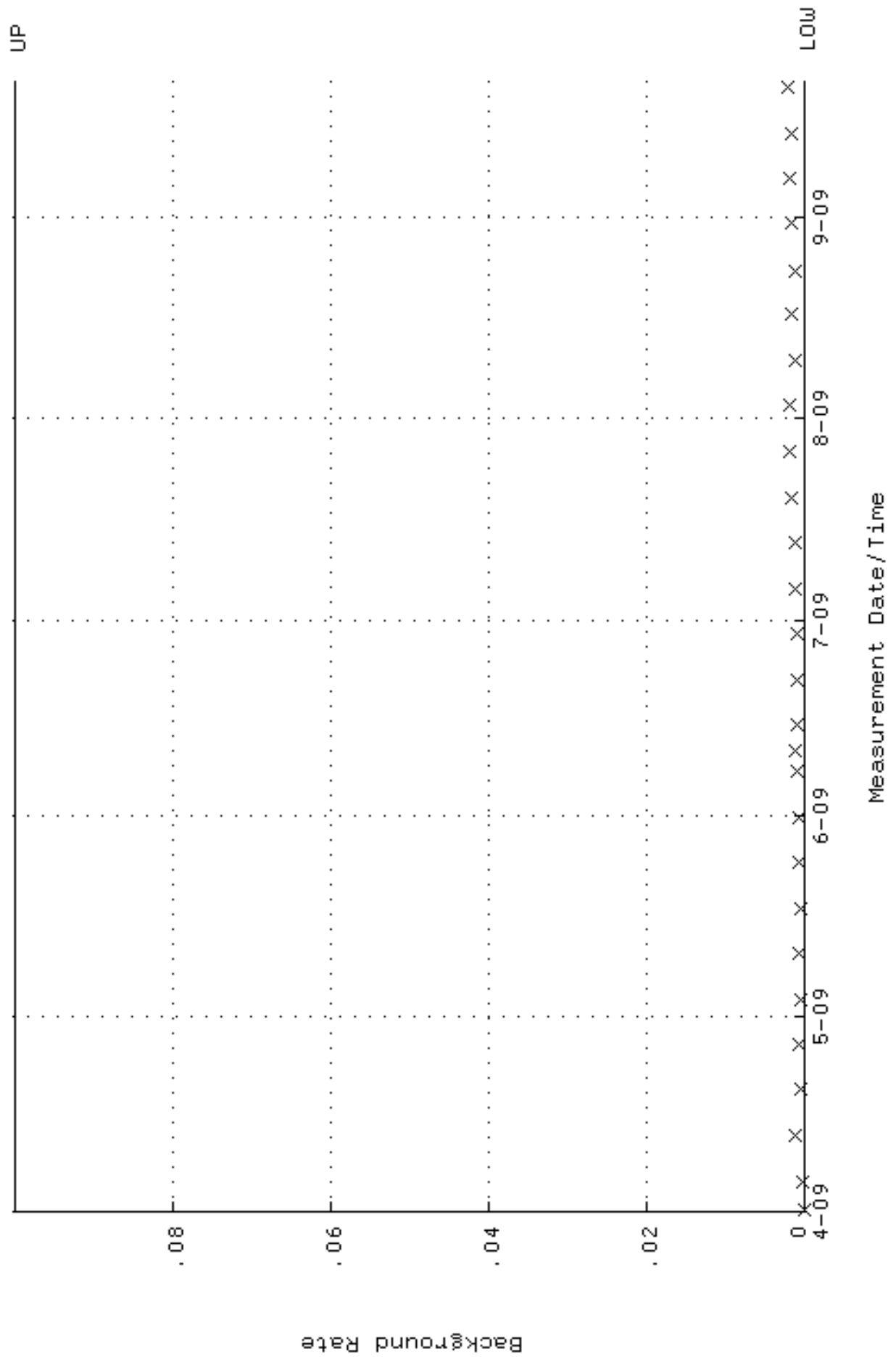
QA filename : DKA100:[ENV\_ALPHA.QA.W]W207.QAF;1  
 Parameter Name : AVRGEFF (Average Efficiency)  
 Start/End Dates : 31-MAR-2009 15:10:38 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.246432 through 0.266432



QA filename : DKA100:[ENV\_ALPHA.QA.W]w207.QAF;1  
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)  
 Start/End Dates : 31-MAR-2009 15:10:38 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 80.7759 through 89.2787



QA filename : DKA100:[ENV\_ALPHA.QA.B]B207.QAF;1  
 Parameter Name : BACKRATE (Background Rate)  
 Start/End Dates : 1-APR-2009 08:03:11 through 21-SEP-2009 12:00:00  
 Lower/Upper Lmts: 0.000000E+00 through 0.100000





# RUNLOGS

# Instrument Run Log

Instrument Type: GFPC

Batch ID: 906803

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
235941001	SAMPLE	JXC5	PIC1A	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235941002	SAMPLE	JXC5	PIC1B	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235941003	SAMPLE	JXC5	PIC1C	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235941004	SAMPLE	JXC5	PIC1D	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235941005	SAMPLE	JXC5	PIC2A	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235945001	SAMPLE	JXC5	PIC2C	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201933967	MB	JXC5	PIC5A	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201933969	DUP	JXC5	PIC5C	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201933970	MS	JXC5	PIC5D	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201933971	MS	JXC5	PIC6A	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201933972	LCS	JXC5	PIC6B	08-OCT-09 11:36	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235945002	SAMPLE	JXC5	PIC13D	08-OCT-09 13:55	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235945003	SAMPLE	JXC5	PIC14B	08-OCT-09 13:55	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235945004	SAMPLE	JXC5	PIC1B	08-OCT-09 14:24	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235945005	SAMPLE	JXC5	PIC2C	08-OCT-09 14:24	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201929716	TB	JXC5	PIC7A	08-OCT-09 14:25	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201929717	TB	JXC5	PIC7C	08-OCT-09 14:25	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201933968	DUP	JXC5	PIC10A	08-OCT-09 14:25	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235941006	SAMPLE	JXC5	PIC2A	12-OCT-09 18:03	DONE	CeF on 25mm Filter	02-JUL-09 00:00
235945006	SAMPLE	JXC5	PIC2D	12-OCT-09 18:04	DONE	CeF on 25mm Filter	02-JUL-09 00:00

# Instrument Run Log

Instrument Type: ALPHA SPECTROMETER

Batch ID: 906826

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
235941001	SAMPLE	MXA1	1185	08-OCT-09 21:15	DUSE		
235941002	SAMPLE	MXA1	1186	08-OCT-09 21:15	DUSE		
235941003	SAMPLE	MXA1	1187	08-OCT-09 21:15	DUSE		
235941004	SAMPLE	MXA1	1188	08-OCT-09 21:15	DUSE		
235941005	SAMPLE	MXA1	1189	08-OCT-09 21:15	DUSE		
235941006	SAMPLE	MXA1	1190	08-OCT-09 21:15	DUSE		
235945001	SAMPLE	MXA1	1191	08-OCT-09 21:16	DUSE		
235945002	SAMPLE	MXA1	1192	08-OCT-09 21:16	DUSE		
235945003	SAMPLE	MXA1	1193	08-OCT-09 21:16	DUSE		
235945004	SAMPLE	MXA1	1194	08-OCT-09 21:16	DUSE		
235945005	SAMPLE	MXA1	1195	08-OCT-09 21:16	DUSE		
235945006	SAMPLE	MXA1	1196	08-OCT-09 21:16	DUSE		
1201929716	TB	MXA1	1197	08-OCT-09 21:16	DUSE		
1201929717	TB	MXA1	1198	08-OCT-09 21:16	DUSE		
1201934058	MB	MXA1	1199	08-OCT-09 21:16	DUSE		
1201934059	DUP	MXA1	1200	08-OCT-09 21:16	DUSE		
1201934060	DUP	MXA1	1201	08-OCT-09 21:16	DUSE		
1201934061	MS	MXA1	1202	08-OCT-09 21:16	DUSE		
1201934062	MS	MXA1	1203	08-OCT-09 21:16	DUSE		
1201934063	LCS	MXA1	1204	08-OCT-09 21:16	DUSE		
1201934058	MB	MXA1	1207	12-OCT-09 11:42	DONE		
1201934063	LCS	MXA1	1174	12-OCT-09 17:09	DONE		
235941001	SAMPLE	MXA1	1175	12-OCT-09 17:09	DONE		
235941002	SAMPLE	MXA1	1176	12-OCT-09 17:09	DONE		
235941003	SAMPLE	MXA1	1177	12-OCT-09 17:09	DONE		
235941004	SAMPLE	MXA1	1178	12-OCT-09 17:09	DONE		
235941005	SAMPLE	MXA1	1179	12-OCT-09 17:09	DONE		
235941006	SAMPLE	MXA1	1180	12-OCT-09 17:09	DONE		
235945001	SAMPLE	MXA1	1181	12-OCT-09 17:09	DONE		
235945002	SAMPLE	MXA1	1182	12-OCT-09 17:09	DONE		
235945003	SAMPLE	MXA1	1183	12-OCT-09 17:09	DONE		
235945004	SAMPLE	MXA1	1184	12-OCT-09 17:09	DONE		
235945005	SAMPLE	MXA1	1185	12-OCT-09 17:09	DONE		
235945006	SAMPLE	MXA1	1186	12-OCT-09 17:09	DONE		
1201929717	TB	MXA1	1188	12-OCT-09 17:09	DONE		
1201934059	DUP	MXA1	1189	12-OCT-09 17:10	DONE		
1201934060	DUP	MXA1	1190	12-OCT-09 17:10	DONE		
1201934061	MS	MXA1	1191	12-OCT-09 17:10	DONE		
1201934062	MS	MXA1	1192	12-OCT-09 17:10	DONE		
1201929716	TB	MXA1	1189	14-OCT-09 19:09	DONE		

# Instrument Run Log

Instrument Type: ALPHA SPECTROMETER

Batch ID: 906828

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
235941001	SAMPLE	MXA1	1159	08-OCT-09 21:15	DONE		
235941002	SAMPLE	MXA1	1160	08-OCT-09 21:15	DONE		
235941003	SAMPLE	MXA1	1007	08-OCT-09 21:17	DONE		
235941004	SAMPLE	MXA1	1008	08-OCT-09 21:17	DONE		
235941005	SAMPLE	MXA1	1009	08-OCT-09 21:17	DONE		
235941006	SAMPLE	MXA1	1010	08-OCT-09 21:17	DONE		
235945001	SAMPLE	MXA1	1011	08-OCT-09 21:17	DONE		
235945002	SAMPLE	MXA1	1012	08-OCT-09 21:17	DONE		
235945003	SAMPLE	MXA1	1013	08-OCT-09 21:17	DONE		
235945004	SAMPLE	MXA1	1014	08-OCT-09 21:17	DONE		
235945005	SAMPLE	MXA1	1015	08-OCT-09 21:17	DONE		
235945006	SAMPLE	MXA1	1016	08-OCT-09 21:17	DONE		
1201929716	TB	MXA1	1017	08-OCT-09 21:17	DONE		
1201929717	TB	MXA1	1018	08-OCT-09 21:17	DONE		
1201934075	MB	MXA1	1019	08-OCT-09 21:17	DONE		
1201934076	DUP	MXA1	1020	08-OCT-09 21:17	DONE		
1201934077	DUP	MXA1	1021	08-OCT-09 21:17	DONE		
1201934078	MS	MXA1	1022	08-OCT-09 21:17	DONE		
1201934079	MS	MXA1	1023	08-OCT-09 21:17	DONE		
1201934080	LCS	MXA1	1024	08-OCT-09 21:17	DONE		

# Instrument Run Log

Instrument Type: LUCAS CELL DETECTOR

Batch ID: 907303

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
235945001	SAMPLE	KSD1	LUCAS6	14-OCT-09 08:45	DONE	Lucas Cell	04-AUG-09 00:00
235945002	SAMPLE	KSD1	LUCAS7	14-OCT-09 08:45	DONE	Lucas Cell	30-SEP-09 00:00
235945003	SAMPLE	KSD1	LUCAS2	14-OCT-09 09:15	DONE	Lucas Cell	19-DEC-08 00:00
235945004	SAMPLE	KSD1	LUCAS3	14-OCT-09 09:15	DONE	Lucas Cell	04-FEB-09 00:00
235945005	SAMPLE	KSD1	LUCAS5	14-OCT-09 09:15	DONE	Lucas Cell	25-MAR-09 00:00
235945006	SAMPLE	KSD1	LUCAS6	14-OCT-09 09:15	DONE	Lucas Cell	04-AUG-09 00:00
1201929717	TB	KSD1	LUCAS7	14-OCT-09 09:15	DONE	Lucas Cell	30-SEP-09 00:00
1201935051	MB	KSD1	LUCAS2	14-OCT-09 09:55	DONE	Lucas Cell	19-DEC-08 00:00
1201935052	DUP	KSD1	LUCAS3	14-OCT-09 09:55	DONE	Lucas Cell	04-FEB-09 00:00
1201935053	MS	KSD1	LUCAS5	14-OCT-09 09:55	DONE	Lucas Cell	25-MAR-09 00:00
1201935054	LCS	KSD1	LUCAS7	14-OCT-09 12:25	DONE	Lucas Cell	30-SEP-09 00:00