



December 03, 2009

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

Re: Tronox Henderson
Work Order: 240965

Dear Mr. Hagar:

GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on November 12, 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,

Debbie Shaffer

for Edith Kent
Project Manager

Chain of Custody: 2027.001.01141
Enclosures

Tronox LLC
Tronox Henderson
SDG:240965

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Case Narrative

**CASE NARRATIVE
for
Tronox LLC
Tronox Henderson
SDG:240965**

December 03, 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 November 12, 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 are no additional comments concerning sample receipt.

Items of Note

There are no additional items of note concerning this SDG.

QC Issues

The following sample did not meet the Tronox QA program required detection limits for Alpha Spec Thorium due to limited sample volume and were counted for the maximum time: 240965002, the lab dup, and method blank.

Sample Identification

The laboratory received the following samples:

<u>Laboratory ID</u>	<u>Client ID</u>
240965001	M-122B
240965002	M-122BDISS

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.

Deatter Shaffer

for Edith Kent

Project Manager

Chain of Custody and Supporting Documentation

240905.1

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

COC No. 2027.001.01141
Page: 1 of 1
Cooler # _____ of _____
Collection Area: III

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	Standard 30 day	<input checked="" type="checkbox"/>	Rush	<input type="checkbox"/>	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
Address:	2040 Savage Road	Project #:	2027.001	Address:	PO Box 66	Standard 30 day	<input checked="" type="checkbox"/>	Rush	<input type="checkbox"/>	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
City:	Charleston, SC 29407	Site Address:	660 W. Lake Mead Drive	City/State:	Henderson, NV 89009	Phone #:	(849) 260-9283	Phone #:	(849) 260-9283	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
Lab P.M.:	Edith M. Kent	City:	Henderson	State:	NV	Reimbursement project?	<input checked="" type="checkbox"/>	Non-reimbursement project?	<input type="checkbox"/>	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
Phone/Fax:	(843) 666-8171	Site P.M. Name:	Derrick Willis	Send EDD to:	frank.hagar@ngem.com	Send EDD to:	frank.hagar@ngem.com	Send EDD to:	frank.hagar@ngem.com	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
Lab P.M. email:	emk@gel.com	Phone/Fax:	848-378-7004	CC Hardcopy report to:	PDF Electronic Version Only	CC Hardcopy report to:	see additional comments below	CC Hardcopy report to:	see additional comments below	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
Applicable Lab Quote #:		Site P.M. Email:	derrick.willis@ngem.com	Matrix Code:		Matrix Code:		Matrix Code:		Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	Sample Intact?	Temp in 00	
1	M-122B	WG	G	11/11/09	1335	1	N										
2	M-122B	WG	G			1	N										
3	M-122BDISS	WG	G			1	Y										
4	M-122BDISS	WG	G			1	Y										
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:
FULL DIGESTION SPECIFICATION
EMSL HASL 300* - DOE EMSL HASL 300 modified (alpha spectroscopy) Thorium (isotopic) and Uranium (isotopic)

All PDF reports and EDDs will be uploaded to:
Northgate Environmental Management, Inc.
FTP site address provided to labs
Notifications provided to:
cindy.arnold@ngem.com
frank.hagar@ngem.com

REQUISITIONED BY / AFFILIATION: Josh W Orls
DATE: 11/11/09 1500
ACCEPTED BY / AFFILIATION: Josh W Orls
DATE: 11/11/09 1500

SHIPPING METHOD: (mark as appropriate)
UPS COURIER FEDEX
US MAIL

PRINT Name of SAMPLER: Josh W Orls
SIGNATURE of SAMPLER: [Signature]
DATE Signed: 11/11/09 Time: 1430

Client: <u>KEPP/NORTHGATE</u>		SDG/ARCOC/Work Order: <u>240965-1.</u>	
Received By: <u>AK</u>		Date Received: <u>11-12-09</u>	
Suspected Hazard Information		Yes	No
COC/Samples marked as radioactive?			<input checked="" type="checkbox"/>
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"/>
Samples identified as Foreign Soil?			<input checked="" type="checkbox"/>
		*If Counts > x2 area background on samples not marked "radioactive", contact the Radiation Safety Group of further investigation.	
		Maximum Counts Observed*: <u>02-20</u>	
		Hazard Class Shipped: _____ UN#: _____	

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>17c</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 7981 3178 8698

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

Subject: SDG 240965 QC Issues - Alpha Spec Th

From: Heather Shaffer <Heather.Shaffer@gel.com>

Date: Thu, 03 Dec 2009 14:34:27 -0500

To: Cindy Arnold <Cindy.Arnold@ngem.com>, Derrick Willis <Derrick.Willis@ngem.com>

CC: Edie Kent <emk@gel.com>

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

Thorium Issues:

Samples 240965002, the lab dup, and the method blank do not meet the Tronox QA program Th-228 detection limits. The samples were analyzed with an appropriate aliquot for the method and matrix. Additionally, the samples were counted the maximum count time to achieve the lowest possible MDAs. The method blank does not meet the Th-232 detection limits due to keeping the blank aliquot consistent with the other sample aliquots.

- This will be noted in the case narrative.

--

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
Web: www.gel.com

Laboratory Certifications

List of current GEL Certifications as of 03 December 2009

State	Certification
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 (ENSR)
SDG 240965**

Method/Analysis Information

Product: Alphaspec Th, Liquid
Analytical Method: DOE EML HASL-300, Th-01-RC Modified
Analytical Batch Number: 925745

Sample ID	Client ID
240965001	M-122B
240965002	M-122BDISS
1201979236	Method Blank (MB)
1201979237	240965002(M-122BDISS) Sample Duplicate (DUP)
1201979238	240965002(M-122BDISS) Matrix Spike (MS)
1201979239	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 volume in this batch.

Designated QC

The following sample was used for QC: 240965002 (M-122BDISS).

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 763349 was generated due to RDL less than MDA. 1. Sample 240965002, the duplicate, 1201979237, and the blank, 1201979236, do not meet the required detection limit for Th228. 1. The blank, 1201979236, did not meet the detection limit due to keeping the blank volume consistent with the other sample aliquots. The samples were analyzed with an appropriate aliquot for the method and matrix. Additionally, the samples were counted 1000 minutes. Per GELs accredited methods and SOPs, further corrective action is not required. PM notified, reporting results.

Manual Integration

No manual integrations were performed on data in this batch.

Additional Comments

The aliquot for the Matrix Spike was reduced due to limited sample volume.

Qualifier information

Manual qualifiers were not required.

Method/Analysis Information

Product:	Alphaspec U, Liquid
Analytical Method:	DOE EML HASL-300, U-02-RC Modified
Analytical Batch Number:	925746

Sample ID	Client ID
240965001	M-122B
240965002	M-122BDISS
1201979240	Method Blank (MB)
1201979241	240965001(M-122B) Sample Duplicate (DUP)
1201979242	240965001(M-122B) Matrix Spike (MS)
1201979243	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# 18.

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: 240965001 (M-122B).

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

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. A nonconformance report (NCR) was not generated for this

SDG.

Manual Integration

No manual integrations were performed on data in this batch.

Additional Comments

The aliquot for the Matrix Spike was reduced due to limited sample volume.

Qualifier information

Manual qualifiers were not required.

Method/Analysis Information

Product: GFPC, Ra228, Liquid
Analytical Method: EPA 904.0/SW846 9320 Modified
Analytical Batch Number: 922916

Sample ID	Client ID
240965001	M-122B
240965002	M-122BDISS
1201972623	Method Blank (MB)
1201972624	240965002(M-122BDISS) Sample Duplicate (DUP)
1201972625	240965002(M-122BDISS) Matrix Spike (MS)
1201972626	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: 240965002 (M-122BDISS).

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 1201972625 (M-122BDISS) was recounted due to high recovery.

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. A nonconformance report (NCR) was not generated for this SDG.

Additional Comments

Additional comments were not required for this sample set.

Qualifier information

Manual qualifiers were not required.

Method/Analysis Information

Product:	Lucas Cell, Ra226, liquid
Analytical Method:	EPA 903.1 Modified
Analytical Batch Number:	923071

Sample ID	Client ID
240965001	M-122B
240965002	M-122BDISS
1201973135	Method Blank (MB)
1201973136	240965001(M-122B) Sample Duplicate (DUP)
1201973137	240965001(M-122B) Matrix Spike (MS)
1201973138	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# 13.

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: 240965001 (M-122B).

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 1201973137 (M-122B) was recounted due to high recovery.

Miscellaneous Information:

NCR Documentation

Nonconformance reports are generated to document any procedural anomalies that may deviate from referenced SOP or contractual documents. A nonconformance report (NCR) was not generated for this

SDG.

Additional Comments

Additional comments were not required for this sample set.

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: LD 12/2/09

COMPANY - WIDE NONCONFORMANCE REPORT

Mo.Day Yr. 30-NOV-09	Division: Radiochemistry	Quality Criteria: Specifications	Type: Process
Instrument Type: ALPHA SPECTROMETER	Test / Method: DOE EML HASL-300, Th-01-RC Modified	Matrix Type: Liquid	Client Code: KERR
Batch ID: 925745	Sample Numbers: See Below		
Potentially affected work order(s)(SDG):240965			
Application Issues: RDL less than MDA			
Specification and Requirements Nonconformance Description:		NRG Disposition:	
1. Sample 240965002, the duplicate, 1201979237, and the blank, 1201979236, do not meet the required detection limit for Th228.		1. The blank, 1201979236, did not meet the detection limit due to keeping the blank volume consistent with the other sample aliquots. The samples were analyzed with an appropriate aliquot for the method and matrix. Additionally, the samples were counted 1000 minutes. Per GELs accredited methods and SOPs, further corrective action is not required. PM notified, reporting results.	

Originator's Name:

Joseph Moulden 30-NOV-09

Data Validator/Group Leader:

Eric Brimstin 02-DEC-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: 240965 GEL Work Order: 240965

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.

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: December 2, 2009

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

Client Sample ID:	M-122B	Project:	KERRHenderson
Sample ID:	240965001	Client ID:	KERR003
Matrix:	WG		
Collect Date:	11-NOV-09 13:35		
Receive Date:	12-NOV-09		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Alpha Spec Analysis												
<i>Alphaspec Th, Liquid "As Received"</i>												
Thorium-228		0.179	+/-0.0409	0.0369	0.030	pCi/L		KXM	11/25/09	1304	925745	1
												4
Thorium-230		0.217	+/-0.0405	0.0182	0.030	pCi/L						
Thorium-232		0.141	+/-0.0329	0.0182	0.030	pCi/L						
<i>Alphaspec U, Liquid "As Received"</i>												
Uranium-233/234		44.0	+/-1.35	0.091	0.030	pCi/L		KXM	11/25/09	1603	925746	2
												4
Uranium-235/236		1.78	+/-0.304	0.0743	0.030	pCi/L						
Uranium-238		31.6	+/-1.15	0.0521	0.030	pCi/L						
Rad Gas Flow Proportional Counting												
<i>GFPC, Ra228, Liquid "As Received"</i>												
Radium-228		2.31	+/-1.36	2.00	3.00	pCi/L		MXS2	11/20/09	1901	922916	3
Rad Radium-226												
<i>Lucas Cell, Ra226, liquid "As Received"</i>												
Radium-226		1.45	+/-0.409	0.385	1.00	pCi/L		KSD1	11/24/09	1745	923071	4

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 Th, Liquid "As Received"			113	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Liquid "As Received"			88.1	(15%-125%)
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			81.1	(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: December 2, 2009

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

Client Sample ID: M-122BDISS
Sample ID: 240965002
Matrix: WG
Collect Date: 11-NOV-09 13:35
Receive Date: 12-NOV-09
Collector: Client

Project: KERRHenderson
Client ID: KERR003

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Alpha Spec Analysis												
<i>Alphaspec Th, Liquid "As Received"</i>												
Thorium-228	U	-0.00691	+/-0.0229	0.0481	0.030	pCi/L		KXM	11/25/09	1304	925745	1
												4
Thorium-230	U	0.00	+/-0.00938	0.0229	0.030	pCi/L						
Thorium-232	U	0.00718	+/-0.0105	0.0183	0.030	pCi/L						
<i>Alphaspec U, Liquid "As Received"</i>												
Uranium-233/234		43.1	+/-0.673	0.0394	0.030	pCi/L		KXM	11/25/09	1603	925746	2
												4
Uranium-235/236		1.68	+/-0.148	0.0101	0.030	pCi/L						
Uranium-238		30.0	+/-0.562	0.0262	0.030	pCi/L						
Rad Gas Flow Proportional Counting												
<i>GFPC, Ra228, Liquid "As Received"</i>												
Radium-228	U	1.07	+/-1.26	2.13	3.00	pCi/L		MXS2	11/20/09	1901	922916	3
Rad Radium-226												
<i>Lucas Cell, Ra226, liquid "As Received"</i>												
Radium-226		0.724	+/-0.314	0.378	1.00	pCi/L		KSD1	11/24/09	1745	923071	4

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 Th, Liquid "As Received"			92.2	(15%-125%)
Uranium-232 Tracer	Alphaspec U, Liquid "As Received"			82.7	(15%-125%)
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			78.3	(15%-125%)

QUALITY CONTROL DATA

GEL LABORATORIES LLC

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

QC Summary

Report Date: December 2, 2009

Page 1 of 3

Northgate Environmental Management, Inc.

1100 Quail St., Suite 102
Newport Beach, California

Contact: Mr. Frank Hagar

Workorder: 240965

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Alpha Spec											
Batch	925745										
QC1201979237	240965002	DUP									
Thorium-228		U	-0.00691	U	0.0172	pCi/L	0.00		N/A	KXM4	11/25/09 13:04
			+/-0.0229		+/-0.0199						
Thorium-230		U	0.00	U	0.00214	pCi/L	0.00		N/A		
			+/-0.00938		+/-0.0111						
Thorium-232		U	0.00718	U	-0.00214	pCi/L	0.00		N/A		
			+/-0.0105		+/-0.00593						
QC1201979239	LCS										
Thorium-228				U	-0.00857	pCi/L					11/25/09 13:05
					+/-0.0172						
Thorium-230	2.68				2.15	pCi/L		80.3	(75%-125%)		
					+/-0.131						
Thorium-232				U	0.00207	pCi/L			(75%-125%)		
					+/-0.0107						
QC1201979236	MB										
Thorium-228				U	0.00839	pCi/L					11/25/09 13:04
					+/-0.0213						
Thorium-230				U	-0.00213	pCi/L					
					+/-0.00722						
Thorium-232				U	-0.00851	pCi/L					
					+/-0.00932						
QC1201979238	240965002	MS									
Thorium-228		U	-0.00691	U	0.0537	pCi/L					11/25/09 13:05
			+/-0.0229		+/-0.0744						
Thorium-230	10.7	U	0.00		9.49	pCi/L		88.7	(75%-125%)		
			+/-0.00938		+/-0.569						
Thorium-232		U	0.00718	U	-0.00881	pCi/L			(75%-125%)		
			+/-0.0105		+/-0.0386						
Batch	925746										
QC1201979241	240965001	DUP									
Uranium-233/234			44.0		43.8	pCi/L	0.385		(0% - 20%)	KXM4	11/25/09 16:03
			+/-1.35		+/-1.25						
Uranium-235/236			1.78		1.84	pCi/L	3.56		(0% - 20%)		
			+/-0.304		+/-0.284						
Uranium-238			31.6		31.8	pCi/L	0.366		(0% - 20%)		
			+/-1.15		+/-1.06						
QC1201979243	LCS										
Uranium-233/234					2.98	pCi/L					11/25/09 16:03
					+/-0.180						
Uranium-235/236					0.153	pCi/L					
					+/-0.0472						
Uranium-238	3.15				3.13	pCi/L		99.5	(75%-125%)		

GEL LABORATORIES LLC

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

QC Summary

Workorder: 240965

Page 2 of 3

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Alpha Spec											
Batch	925746										
				+/-0.184							
QC1201979240 MB											
Uranium-233/234			U	0.0085	pCi/L				KXM4	11/25/09	16:03
				+/-0.0148							
Uranium-235/236			U	0.0071	pCi/L						
				+/-0.00984							
Uranium-238			U	0.0115	pCi/L						
				+/-0.0138							
QC1201979242 240965001 MS											
Uranium-233/234		44.0		54.0	pCi/L					11/25/09	16:03
		+/-1.35		+/-1.36							
Uranium-235/236		1.78		2.22	pCi/L						
		+/-0.304		+/-0.308							
Uranium-238	12.6	31.6		43.7	pCi/L		95.5	(75%-125%)			
		+/-1.15		+/-1.22							
Rad Gas Flow											
Batch	922916										
QC1201972624 240965002 DUP											
Radium-228		U	1.07	U	1.89	pCi/L	0.00		N/A MXS2	11/20/09	19:01
			+/-1.26		+/-1.34						
QC1201972626 LCS											
Radium-228	39.2			40.5	pCi/L		103	(75%-125%)		11/20/09	19:01
				+/-4.06							
QC1201972623 MB											
Radium-228			U	1.04	pCi/L					11/20/09	19:01
				+/-1.18							
QC1201972625 240965002 MS											
Radium-228	78.6	U	1.07	77.3	pCi/L		98.3	(75%-125%)		11/20/09	21:43
			+/-1.26	+/-9.52							
Rad Ra-226											
Batch	923071										
QC1201973136 240965001 DUP											
Radium-226				1.45	1.45	pCi/L	0.079	(0% - 100%)	KSD1	11/24/09	17:45
			+/-0.409	+/-0.390							
QC1201973138 LCS											
Radium-226	24.2			21.4	pCi/L		88.6	(75%-125%)		11/24/09	17:45
				+/-1.26							
QC1201973135 MB											
Radium-226			U	0.133	pCi/L					11/24/09	17:45
				+/-0.239							
QC1201973137 240965001 MS											
Radium-226	121		1.45	149	pCi/L		122	(75%-125%)		11/24/09	18:30
			+/-0.409	+/-8.91							

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

GEL LABORATORIES LLC

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

QC Summary

Workorder: 240965

Page 3 of 3

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
**		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									
^		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

THORIUM

Radiochemistry Batch Checklist, Rev 9

Batch# 925745 Product: Th Date: 11/30/09

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 763349
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.	✓		NCR 763349
Batch non-conformances second reviewed and disposition verified to be completed.	✓		NCR 763349
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: JapLM r - 11/30/09

Secondary Review Performed By: [Signature] 12/2/09

Thorium (Ac-227 Tracer) Que Sheet

Analyst: KXM4 First Client Due Date: 10-DEC-09 Internal Due Date: 29-NOV-09
 Tracer Isotope: Ac-227 Tracer Code: 0387-B-02 Expiration Date: 7-23-10 Vol: 0.1n1 Ac-227 Separation Date/Time: 11-24-09/109'03
 LCS Isotope: Th-230 LCS Code: A2796-5 Expiration Date: 4-13-10 Vol: 0.1n1
 Spike Isotope: Th-230 Spike Code: A2796-5 Expiration Date: 4-13-10 Vol: 0.1n1
 Prep Date: 11-23-09 Initials: KM Pipet ID: 2971058 Balance ID: 51204863

Witness: 11/23/09

Wet/Dry

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collection Date	Pos.	Label #	Aliquot (g) (D/W)	Th Det #
240965001-1	M-122B	SAMPLE		.03 pCi/L	GROUND WATER	KERR003	11-NOV-09	1	1	0.800	179
240965002-1	M-122BDISS	SAMPLE		.03 pCi/L	GROUND WATER	KERR003	11-NOV-09	2	2	0.800	181
1201979236-1	MB for batch 925745	MB		.03 pCi/L	GROUND WATER	QC ACCOUNT		3	3	0.800	180
1201979237-1	M-122BDISS(240965002DUP)	DUP		.03 pCi/L	GROUND WATER	QC ACCOUNT	11-NOV-09	4	4	0.800	182
1201979238-1	M-122BDISS(240965002MS)	MS		.03 pCi/L	GROUND WATER	QC ACCOUNT	11-NOV-09	5	5	0.200	183
1201979239-1	LCS for batch 925745	LCS		.03 pCi/L	GROUND WATER	QC ACCOUNT		6	6	0.800	184

23-NOV-09

Choose SOP Used GL-RAD-A-038

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

Solid Sample Dissolution by: LEACH-DIGESTION

Circle One

MA KK
 11-23-09
 Data Reviewed By: JapMLL 11/30/09

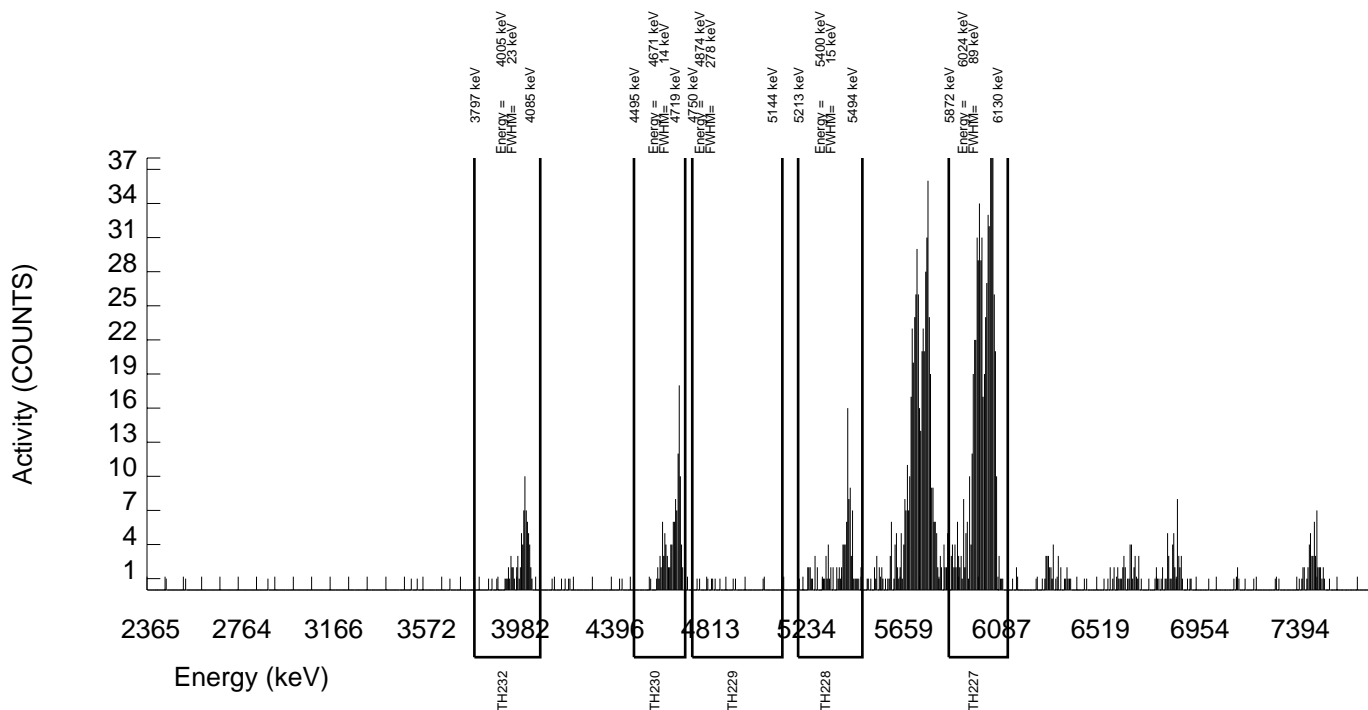
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925745 SAMPLE DATE : 11-NOV-2009 00:00:00 AC-227 SEPARATION : 24-NOV-2009 09:03:00		SAMPLE ID : S0240965001_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74437 AVERAGE %EFFICIENCY :26.2122 % YIELD : 112.914		COUNT DATE:25-NOV-2009 13:04:51 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 3.88213 dpm RESULTS : 4.38348 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B179.CNF;146 BKG DATE : 22-NOV-2009 EFF FILE : W179.CNF;46 CAL DATE : 24-NOV-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	632.000	624.000	8.000	2.8284	57.44000	2.19E+00	2.10E-01	5.66E-02	2.30E-02	1.74E-01
TH-228	5363.000	107.000	92.684	12.000	3.4641	99.94000	1.79E-01	4.20E-02	3.69E-02	1.56E-02	4.09E-02
TH229	4900.000	10.000	5.000	5.000	2.2361	99.52000	9.56E-03	1.45E-02	2.56E-02	9.94E-03	1.45E-02
TH-230	4625.000	116.000	114.000	2.000	1.4142	100.0000	2.17E-01	4.22E-02	1.82E-02	6.26E-03	4.05E-02
TH-232	3972.000	76.000	74.000	2.000	1.4142	100.0000	1.41E-01	3.38E-02	1.82E-02	6.26E-03	3.29E-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.



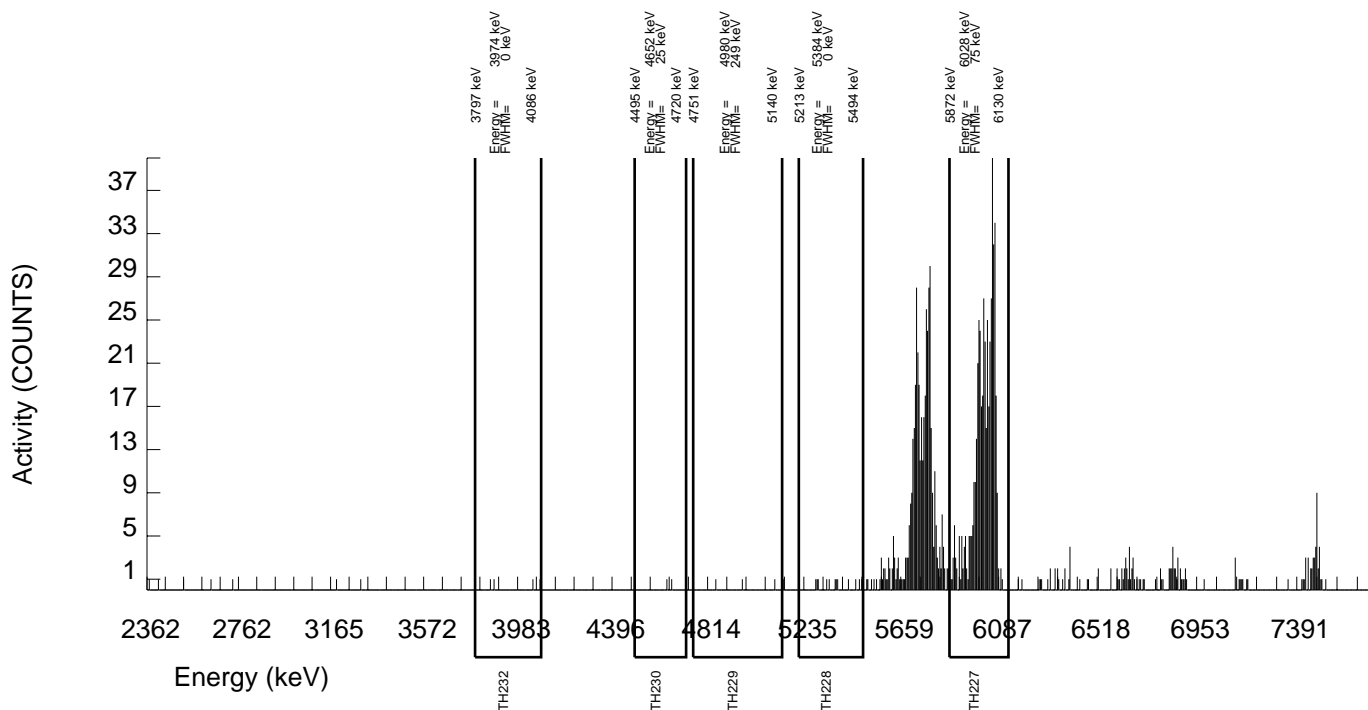
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925745 SAMPLE DATE : 11-NOV-2009 00:00:00 AC-227 SEPARATION : 24-NOV-2009 09:03:00		SAMPLE ID : S0240965002_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74439 AVERAGE %EFFICIENCY :25.5171 % YIELD : 92.197		COUNT DATE:25-NOV-2009 13:04:55 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 3.88213 dpm RESULTS : 3.57922 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B181.CNF;146 BKG DATE : 22-NOV-2009 EFF FILE : W181.CNF;46 CAL DATE : 24-NOV-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	499.000	496.000	3.000	1.7321	57.44000	2.19E+00	2.27E-01	4.87E-02	1.78E-02	1.94E-01
TH-228	5363.000	12.000	-2.841	13.000	3.6056	99.94000	-6.91E-03	2.29E-02	4.81E-02	2.04E-02	2.29E-02
TH229	4900.000	3.000	-2.000	5.000	2.2361	99.52000	-4.81E-03	1.33E-02	3.22E-02	1.25E-02	1.33E-02
TH-230	4625.000	2.000	0.000	2.000	1.4142	100.0000	0.00E+00	9.38E-03	2.29E-02	7.87E-03	9.38E-03
TH-232	3972.000	4.000	3.000	1.000	1.0000	100.0000	7.18E-03	1.05E-02	1.83E-02	5.57E-03	1.05E-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.



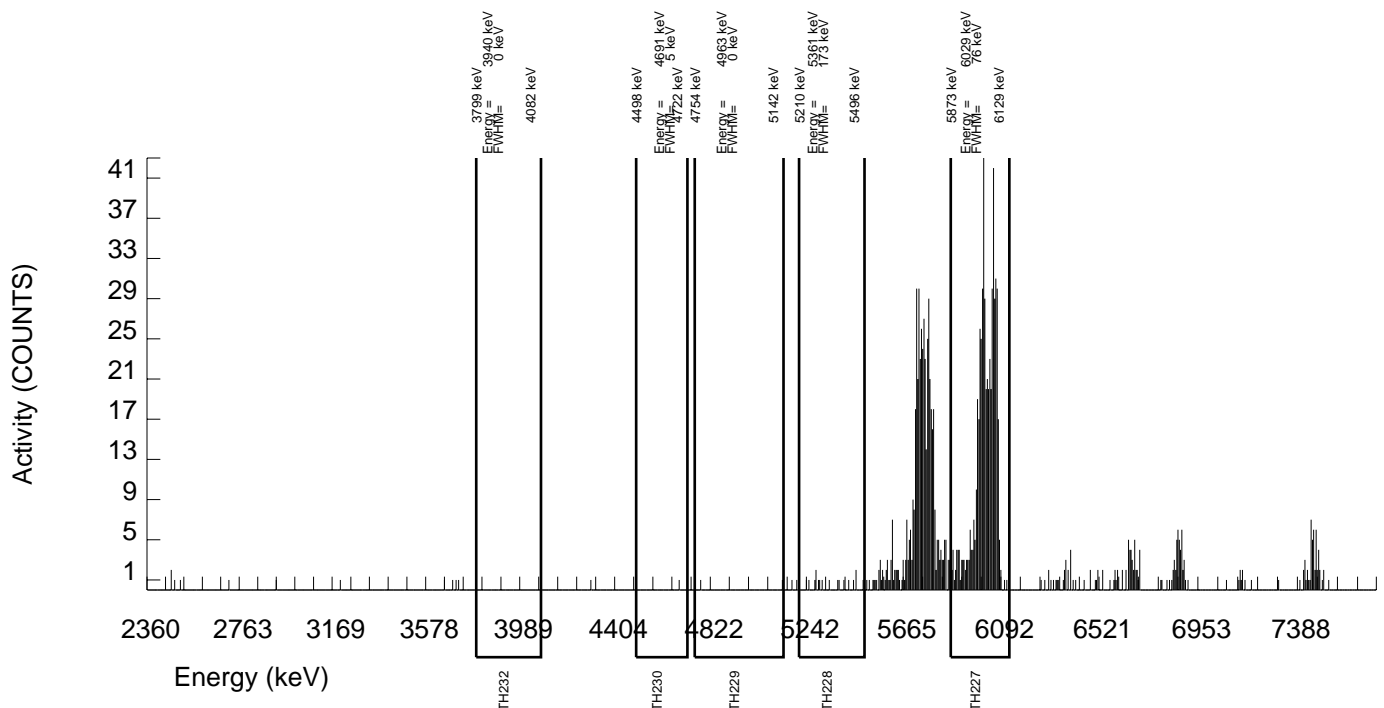
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925745 SAMPLE DATE : 23-NOV-2009 00:00:00 AC-227 SEPARATION : 24-NOV-2009 09:03:00		SAMPLE ID : S1201979236_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74438 AVERAGE %EFFICIENCY :25.2058 % YIELD : 105.003		COUNT DATE:25-NOV-2009 13:04:52 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 3.88213 dpm RESULTS : 4.07636 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B180.CNF;148 BKG DATE : 22-NOV-2009 EFF FILE : W180.CNF;46 CAL DATE : 24-NOV-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	564.000	558.000	6.000	2.4495	57.44000	2.19E+00	2.18E-01	5.64E-02	2.23E-02	1.83E-01
TH-228	5363.000	17.000	3.929	11.000	3.3166	99.94000	8.39E-03	2.13E-02	3.93E-02	1.65E-02	2.13E-02
TH229	4900.000	2.000	-4.000	6.000	2.4495	99.52000	-8.55E-03	1.19E-02	3.08E-02	1.22E-02	1.19E-02
TH-230	4625.000	1.000	-1.000	2.000	1.4142	100.0000	-2.13E-03	7.22E-03	2.04E-02	7.00E-03	7.22E-03
TH-232	3972.000	0.000	-4.000	4.000	2.0000	100.0000	-8.51E-03	9.32E-03	2.62E-02	9.90E-03	9.32E-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.



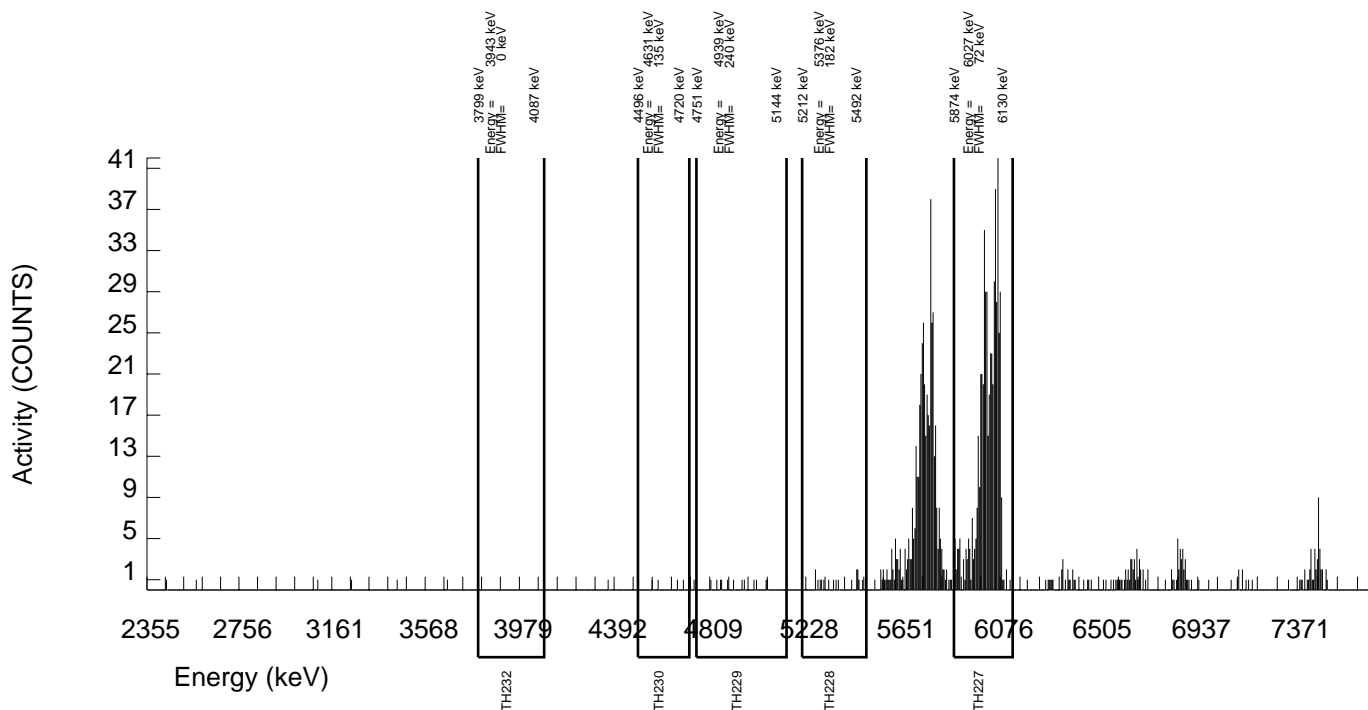
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925745 SAMPLE DATE : 11-NOV-2009 00:00:00 AC-227 SEPARATION : 24-NOV-2009 09:03:00		SAMPLE ID : S1201979237_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74440 AVERAGE %EFFICIENCY :25.6234 % YIELD : 102.737		COUNT DATE:25-NOV-2009 13:04:58 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 3.88213 dpm RESULTS : 3.98837 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B182.CNF;146 BKG DATE : 22-NOV-2009 EFF FILE : W182.CNF;46 CAL DATE : 24-NOV-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	558.000	555.000	3.000	1.7321	57.44000	2.19E+00	2.18E-01	4.36E-02	1.59E-02	1.83E-01
TH-228	5363.000	17.000	7.940	7.000	2.6458	99.94000	1.72E-02	2.00E-02	3.33E-02	1.34E-02	1.99E-02
TH229	4900.000	12.000	10.000	2.000	1.4142	99.52000	2.15E-02	1.58E-02	2.06E-02	7.07E-03	1.58E-02
TH-230	4625.000	4.000	1.000	3.000	1.7321	100.0000	2.14E-03	1.11E-02	2.37E-02	8.62E-03	1.11E-02
TH-232	3972.000	0.000	-1.000	1.000	1.0000	100.0000	-2.14E-03	5.93E-03	1.64E-02	4.98E-03	5.93E-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.



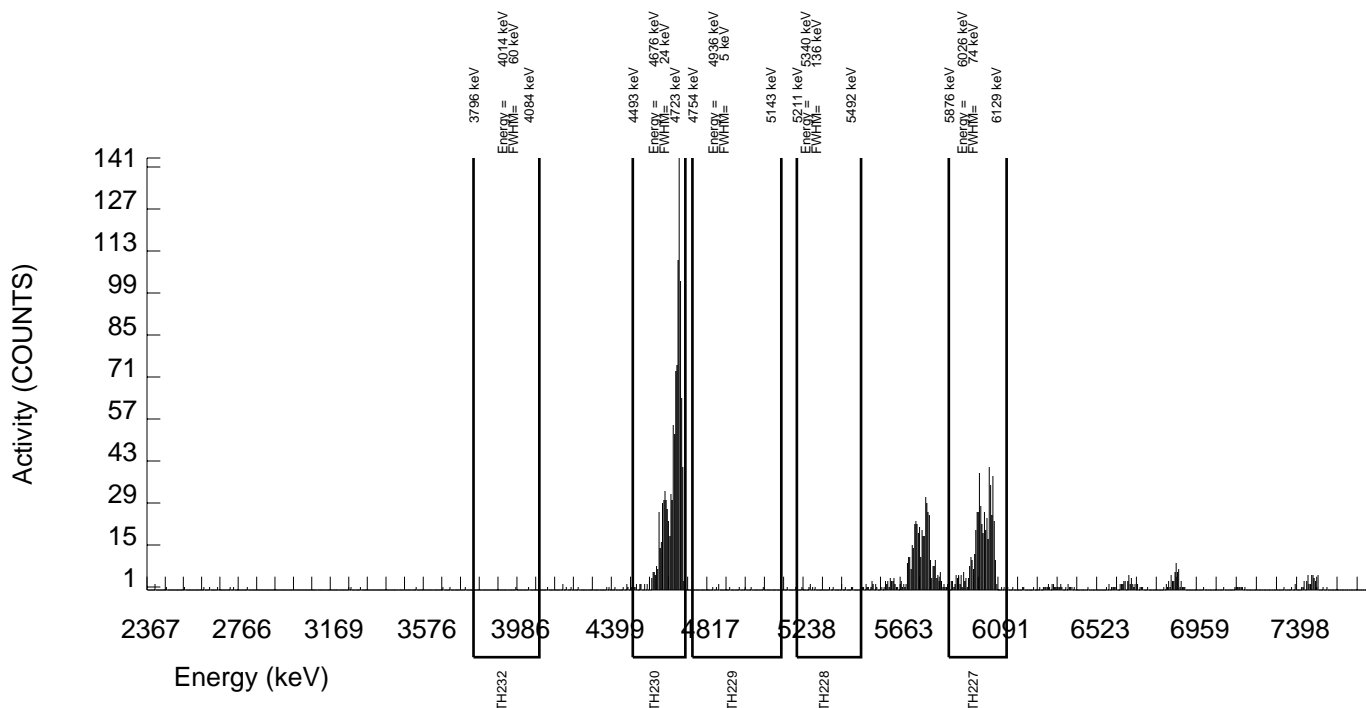
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925745 SAMPLE DATE : 11-NOV-2009 00:00:00 AC-227 SEPARATION : 24-NOV-2009 09:03:00		SAMPLE ID : S1201979238_TH SAMPLE QTY: 0.200 L	
DETECTOR NUMBER :74441 AVERAGE %EFFICIENCY :26.0548 % YIELD : 98.123		COUNT DATE:25-NOV-2009 13:05:00 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
MS/MSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 1.070E+01	LCS/LCSD ID : A2796-J ISOTOPE : TH-230 PCI/L : 1.070E+01	TRACER ID : 0387-B-102 ISOTOPE : AC-227 NOMINAL : 3.88213 dpm RESULTS : 3.80927 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B183.CNF;146 BKG DATE : 22-NOV-2009 EFF FILE : W183.CNF;46 CAL DATE : 24-NOV-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	545.000	539.000	6.000	2.4495	57.44000	8.74E+00	8.83E-01	2.34E-01	9.24E-02	7.46E-01
TH-228	5363.000	14.000	5.999	6.000	2.4495	99.94000	5.37E-02	7.44E-02	1.29E-01	5.10E-02	7.44E-02
TH229	4900.000	9.000	1.000	8.000	2.8284	99.52000	8.85E-03	7.15E-02	1.43E-01	5.82E-02	7.15E-02
TH-230	4625.000	1081.000	1077.000	4.000	2.0000	100.0000	9.49E+00	7.65E-01	1.08E-01	4.10E-02	5.69E-01
TH-232	3972.000	2.000	-1.000	3.000	1.7321	100.0000	-8.81E-03	3.86E-02	9.74E-02	3.55E-02	3.86E-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.



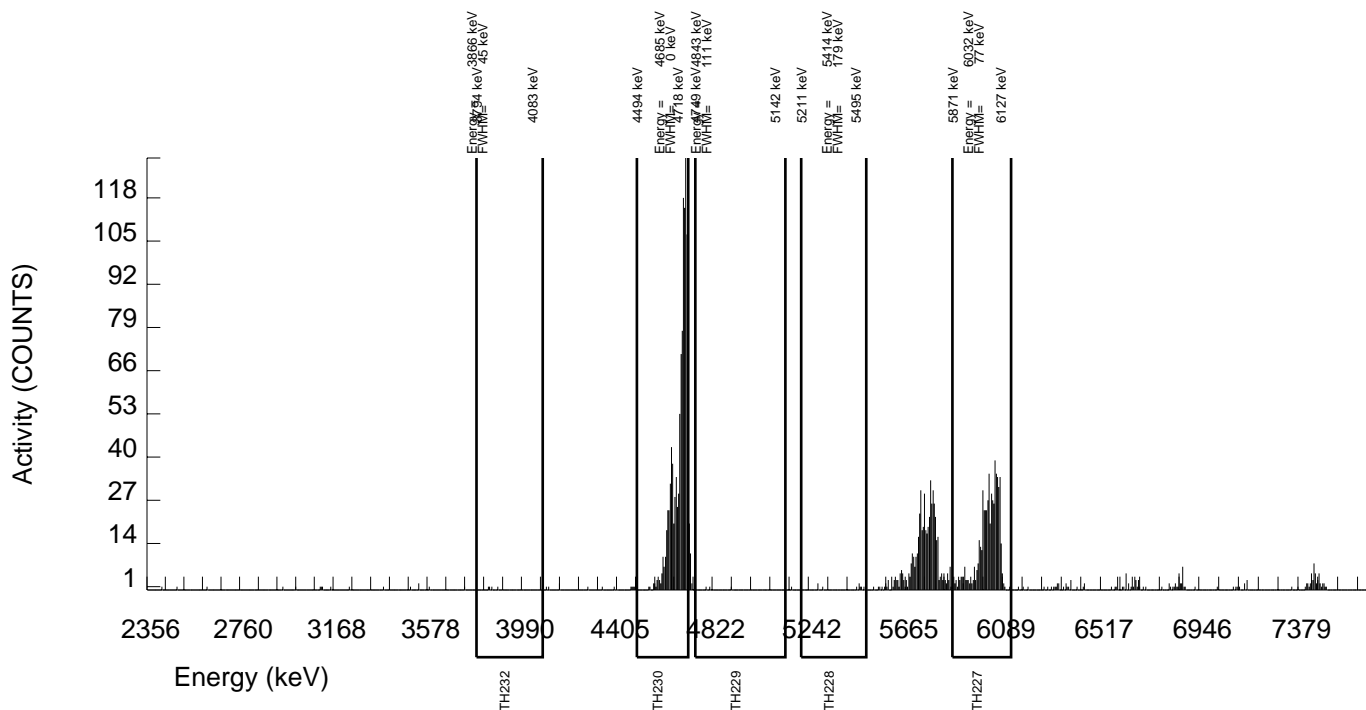
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925745 SAMPLE DATE : 23-NOV-2009 00:00:00 AC-227 SEPARATION : 24-NOV-2009 09:03:00		SAMPLE ID : S1201979239_TH SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74442 AVERAGE %EFFICIENCY :26.1103 % YIELD : 104.273		COUNT DATE:25-NOV-2009 13:05:03 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 3.88213 dpm RESULTS : 4.04800 dpm	LIB FILE : ENV_ALPHA_TH.N BKG FILE : B184.CNF;148 BKG DATE : 22-NOV-2009 EFF FILE : W184.CNF;46 CAL DATE : 24-NOV-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	583.000	574.000	9.000	3.0000	57.44000	2.19E+00	2.17E-01	6.46E-02	2.66E-02	1.82E-01
TH-228	5363.000	9.000	-4.131	11.000	3.3166	99.94000	-8.57E-03	1.72E-02	3.83E-02	1.60E-02	1.72E-02
TH229	4900.000	3.000	-1.000	4.000	2.0000	99.52000	-2.08E-03	1.08E-02	2.56E-02	9.67E-03	1.08E-02
TH-230	4625.000	1041.000	1039.000	2.000	1.4142	100.0000	2.15E+00	1.75E-01	1.98E-02	6.80E-03	1.31E-01
TH-232	3972.000	4.000	1.000	3.000	1.7321	100.0000	2.07E-03	1.07E-02	2.29E-02	8.33E-03	1.07E-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.



URANIUM

Radiochemistry Batch Checklist, Rev 9

Batch# 925746 Product: U Date: 11/30/09

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.	✓		
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 stasured.	✓		
QC data entered into QC database and batch is in REWV	✓		
Hit notification complete (if necessary)			N/A
Batch entered into Case Narrative.	✓		
Batch non-conformances completed, if applicable.			N/A
Batch non-conformances second reviewed and disposition verified to be completed.			N/A
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: Jap LML - 11/30/09

Secondary Review Performed By: [Signature] 12/2/09

Uranium Que Sheet

Internal Due Date: 29-NOV-09

First Client Due Date: 10-DEC-09

Analyst: KXM4

Batch #: 925746

Vol: 0.141

Expiration Date: 1-15-10

Tracer Code: 1283-E

Tracer Isotope: U-232

Vol: 0.141

Expiration Date: 4-16-10

LCS Code: 1163-G

LCS Isotope: U-238

Vol: 0.141

Expiration Date: 4-16-10

Spike Code: 1163-G

Spike Isotope: U-238

Balance ID: 51204663

Pipet ID: 2971058

Initials: YM

Prep Date: 11-13-09

Witness: ~~JK~~ 11/23/09

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collection Date	Pos.	Label #	Wet/Dry Aliquot (g) (U/D)	U Det #
240965001-1	M-122B	SAMPLE		.03 pCi/L	GROUND WATER	KERR003	11-NOV-09	1	1	0.800	147
240965002-1	M-122BDISS	SAMPLE		.03 pCi/L	GROUND WATER	KERR003	11-NOV-09	2	2	0.800	148
1201979240-1	MB for batch 925746	MB		.03 pCi/L	GROUND WATER	QC ACCOUNT		3	3	0.800	149
1201979241-1	M-122B(240965001DUP)	DUP		.03 pCi/L	GROUND WATER	QC ACCOUNT	11-NOV-09	4	4	0.800	150
1201979242-1	M-122B(240965001MS)	MS		.03 pCi/L	GROUND WATER	QC ACCOUNT	11-NOV-09	5	5	0.710	151
1201979243-1	LCS for batch 925746	LCS		.03 pCi/L	GROUND WATER	QC ACCOUNT		6	6	0.800	152

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 ^{NT}
 Circle One 11-23-09

Data Reviewed By: J. McL - 11/20/09

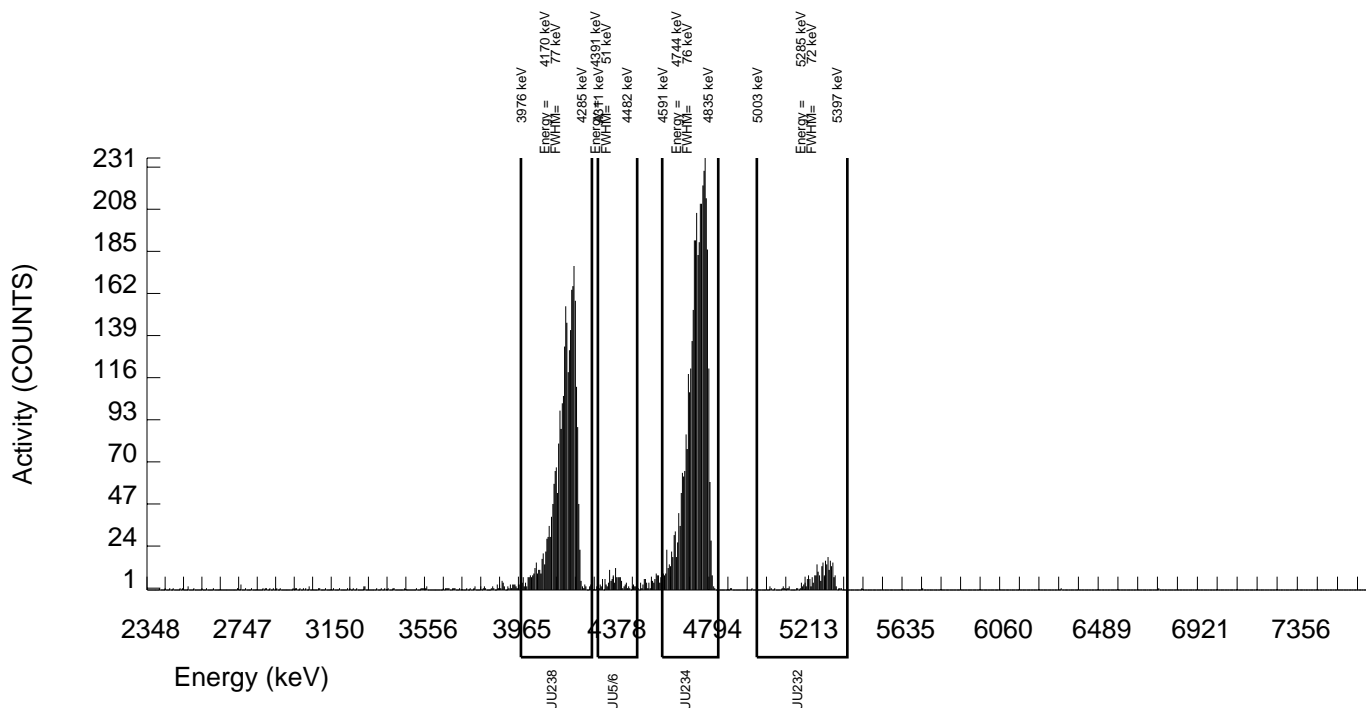
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925746 SAMPLE DATE : 11-NOV-2009 00:00:00		SAMPLE ID : S0240965001_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :75550 AVERAGE %EFFICIENCY :24.5119 % YIELD : 88.146		COUNT DATE:25-NOV-2009 16:03:14 ELAPSED LIVE TIME(SEC): 14400.00 ANALYST :KXM4	
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 : 5.24974 dpm RESULTS : 4.62744 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B147.CNF;371 BKG DATE : 22-NOV-2009 EFF FILE : W147.CNF;108 CAL DATE : 18-NOV-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	4051.000	4048.565	2.160	1.4697	100.0000	4.40E+01	7.80E+00	9.10E-02	2.92E-02	1.35E+00
U232	5302.100	275.000	272.120	2.880	1.6971	100.0000	2.96E+00	6.26E-01	1.00E-01	3.38E-02	3.54E-01
U-235	4391.000	133.000	132.520	0.480	0.6928	80.90000	1.78E+00	4.34E-01	7.43E-02	1.70E-02	3.04E-01
U-238	4184.730	2914.000	2913.760	0.240	0.4899	100.0000	3.16E+01	5.65E+00	5.21E-02	9.74E-03	1.15E+00

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



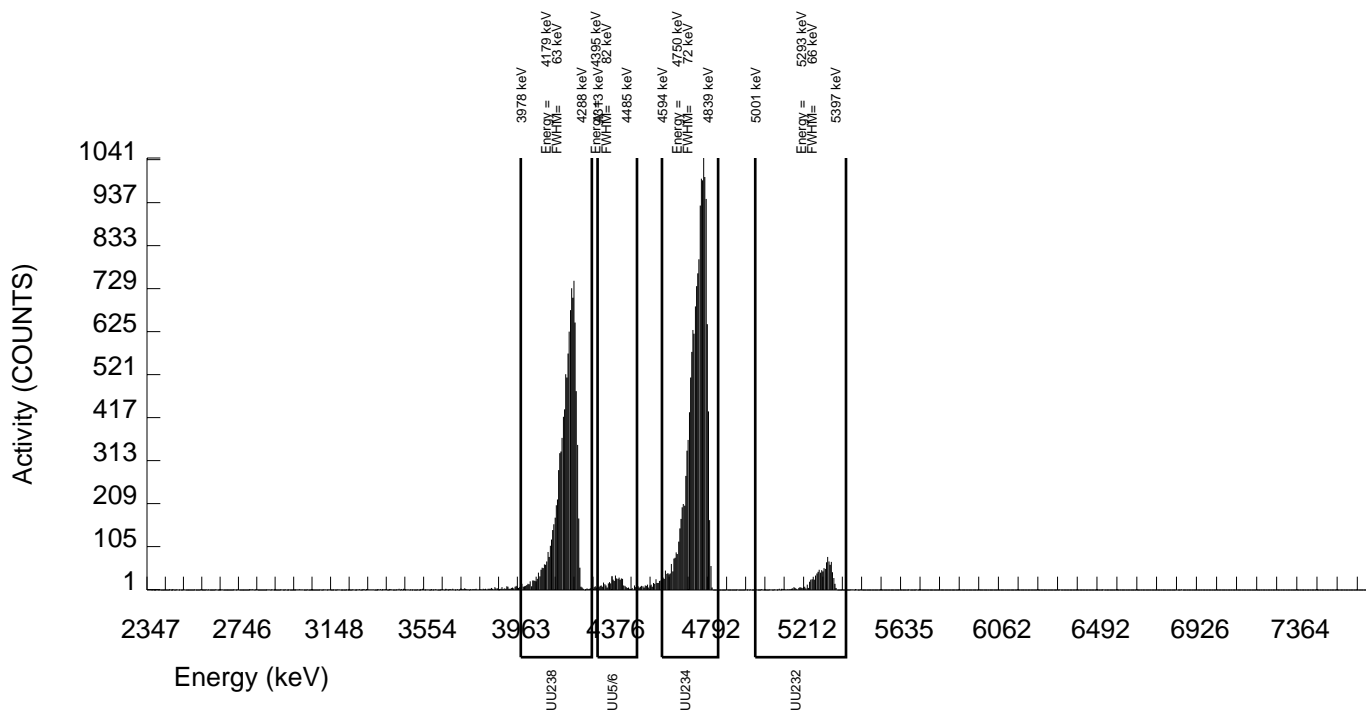
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925746 SAMPLE DATE : 11-NOV-2009 00:00:00		SAMPLE ID : S0240965002_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :74429 AVERAGE %EFFICIENCY :24.8842 % YIELD : 82.706		COUNT DATE:25-NOV-2009 16:03:16 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 5.24972 dpm RESULTS : 4.34182 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B148.CNF;370 BKG DATE : 22-NOV-2009 EFF FILE : W148.CNF;123 CAL DATE : 18-NOV-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	15744.000	15736.910	6.000	2.4495	100.0000	4.31E+01	5.98E+00	3.94E-02	1.56E-02	6.73E-01
U232	5302.100	1082.000	1080.000	2.000	1.4142	100.0000	2.96E+00	4.44E-01	2.62E-02	9.00E-03	1.77E-01
U-235	4391.000	498.000	498.000	0.000	0.0000	80.90000	1.68E+00	2.75E-01	1.01E-02	0.00E+00	1.48E-01
U-238	4184.730	10983.000	10981.000	2.000	1.4142	100.0000	3.00E+01	4.18E+00	2.62E-02	9.00E-03	5.62E-01

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



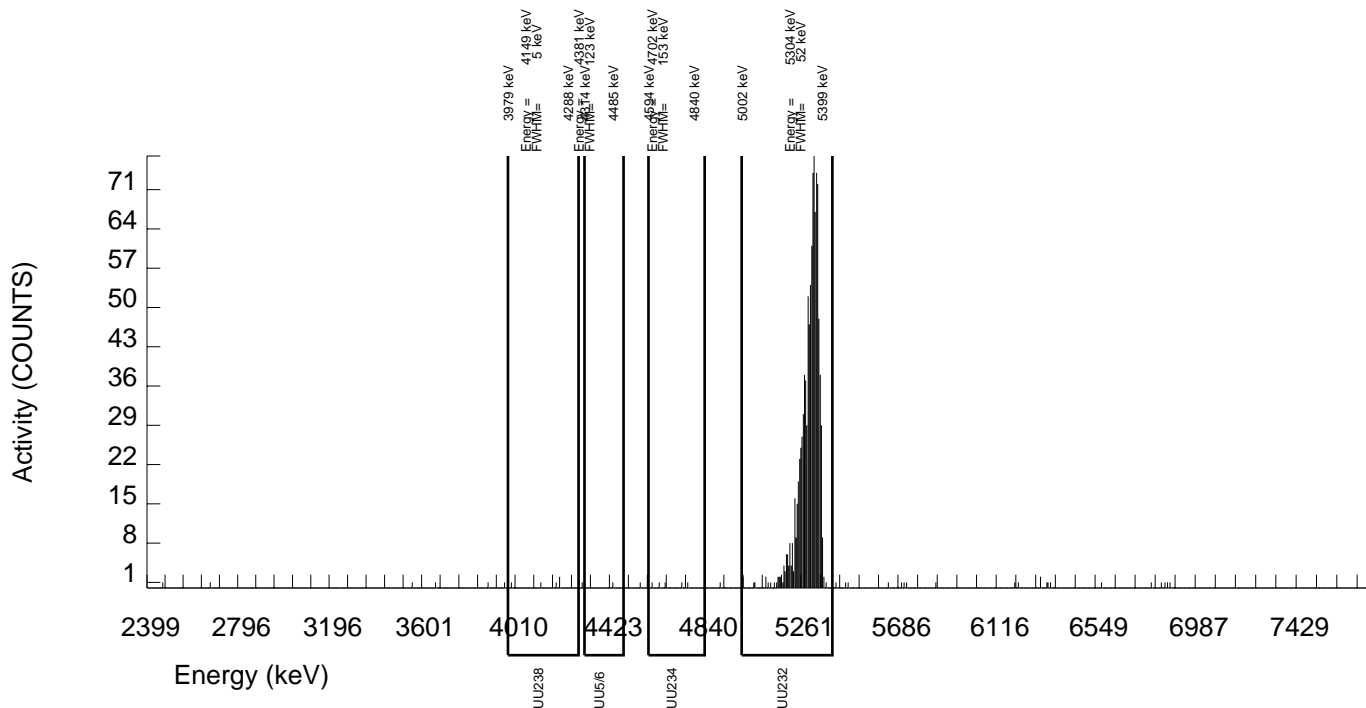
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925746 SAMPLE DATE : 23-NOV-2009 00:00:00		SAMPLE ID : S1201979240_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :33449 AVERAGE %EFFICIENCY :24.8326 % YIELD : 78.964		COUNT DATE:25-NOV-2009 16:03:19 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 5.24806 dpm RESULTS : 4.14408 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B149.CNF;374 BKG DATE : 22-NOV-2009 EFF FILE : W149.CNF;108 CAL DATE : 18-NOV-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	6.000	2.961	2.000	1.4142	100.0000	8.50E-03	1.49E-02	2.75E-02	9.45E-03	1.48E-02
U232	5302.100	1039.000	1029.000	10.000	3.1623	100.0000	2.95E+00	4.49E-01	5.09E-02	2.11E-02	1.82E-01
U-235	4391.000	2.000	2.000	0.000	0.0000	80.90000	7.10E-03	9.89E-03	1.06E-02	0.00E+00	9.84E-03
U-238	4184.730	5.000	4.000	1.000	1.0000	100.0000	1.15E-02	1.39E-02	2.20E-02	6.68E-03	1.38E-02

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



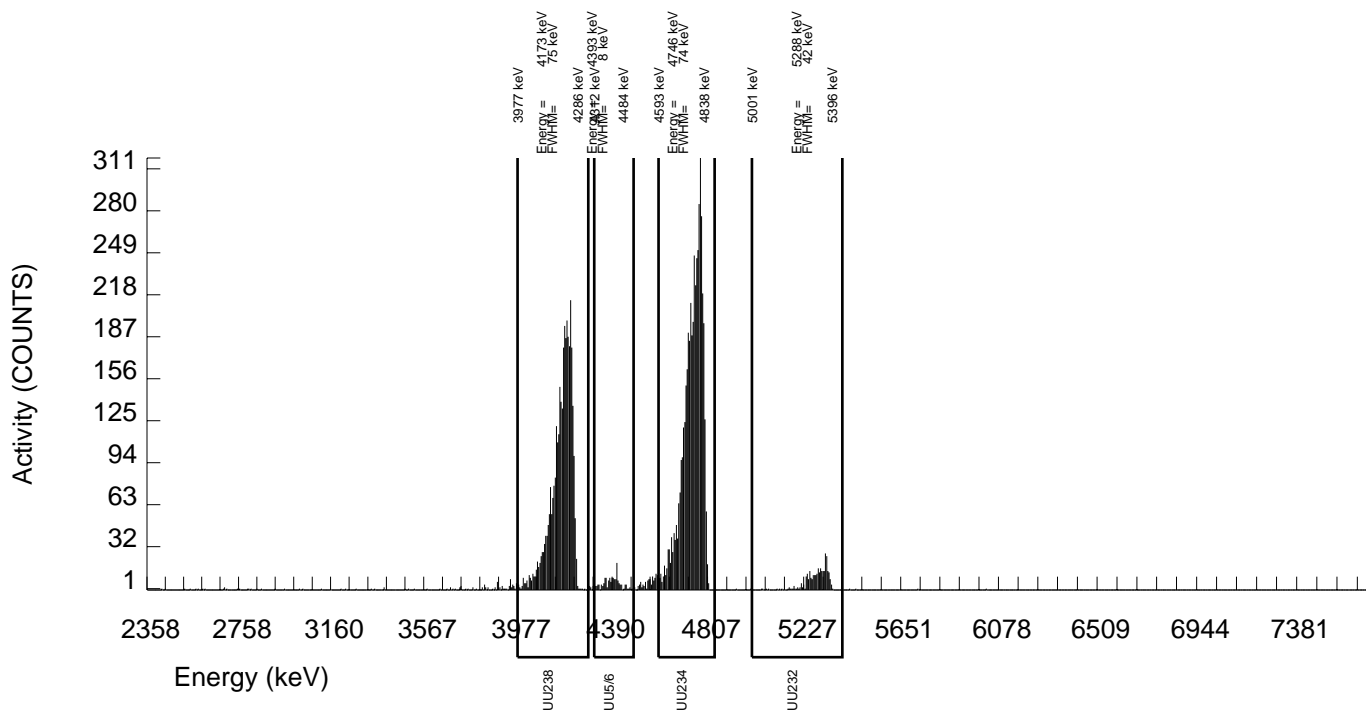
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925746 SAMPLE DATE : 11-NOV-2009 00:00:00		SAMPLE ID : S1201979241_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :75552 AVERAGE %EFFICIENCY :24.7216 % YIELD : 102.956		COUNT DATE:25-NOV-2009 16:03:21 ELAPSED LIVE TIME(SEC): 14400.00 ANALYST :KXM4	
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 : 5.24974 dpm RESULTS : 5.40492 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B150.CNF;375 BKG DATE : 22-NOV-2009 EFF FILE : W150.CNF;116 CAL DATE : 18-NOV-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	4752.000	4750.956	0.720	0.8485	100.0000	4.38E+01	7.37E+00	5.63E-02	1.43E-02	1.25E+00
U232	5302.100	322.000	320.560	1.440	1.2000	100.0000	2.96E+00	5.88E-01	6.82E-02	2.03E-02	3.24E-01
U-235	4391.000	162.000	161.760	0.240	0.4899	80.90000	1.84E+00	4.17E-01	5.46E-02	1.02E-02	2.84E-01
U-238	4184.730	3445.000	3445.000	0.000	0.0000	100.0000	3.18E+01	5.37E+00	2.77E-02	0.00E+00	1.06E+00

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



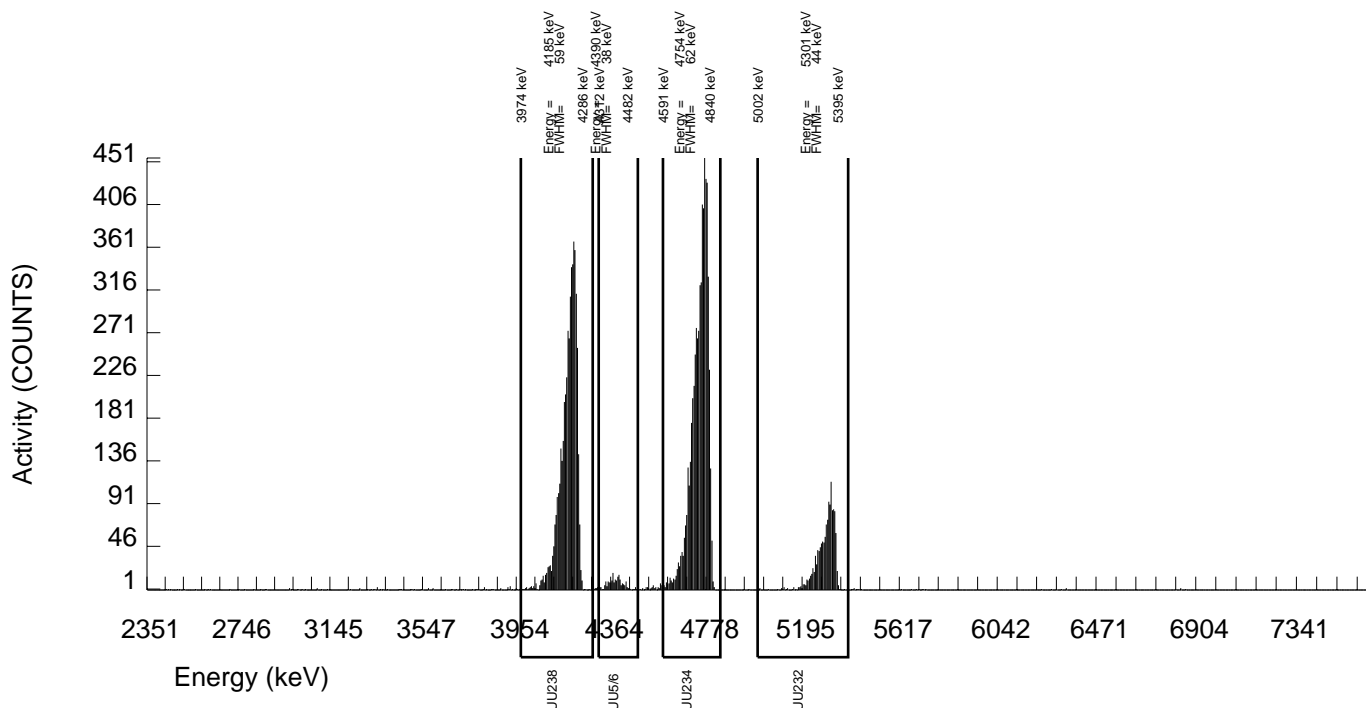
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925746 SAMPLE DATE : 11-NOV-2009 00:00:00		SAMPLE ID : S1201979242_UU SAMPLE QTY: 0.200 L	
DETECTOR NUMBER :75556 AVERAGE %EFFICIENCY :24.5337 % YIELD : 102.839		COUNT DATE:25-NOV-2009 16:03:24 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
MS/MSD ID : 1163-G ISOTOPE : U-238 PCI/L : 1.259E+01	LCS/LCSD ID : 1163-G ISOTOPE : U-238 PCI/L : 1.259E+01	TRACER ID : 1283-E ISOTOPE : U232 NOMINAL : 5.24972 dpm RESULTS : 5.39878 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B151.CNF;370 BKG DATE : 22-NOV-2009 EFF FILE : W151.CNF;114 CAL DATE : 18-NOV-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	6049.000	6045.664	2.000	1.4142	100.0000	5.40E+01	7.44E+00	8.55E-02	2.94E-02	1.36E+00
U232	5302.100	1330.000	1324.000	6.000	2.4495	100.0000	1.18E+01	1.73E+00	1.29E-01	5.09E-02	6.40E-01
U-235	4391.000	202.000	201.000	1.000	1.0000	80.90000	2.22E+00	4.31E-01	8.44E-02	2.57E-02	3.08E-01
U-238	4184.730	4893.000	4892.000	1.000	1.0000	100.0000	4.37E+01	6.05E+00	6.83E-02	2.08E-02	1.22E+00

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



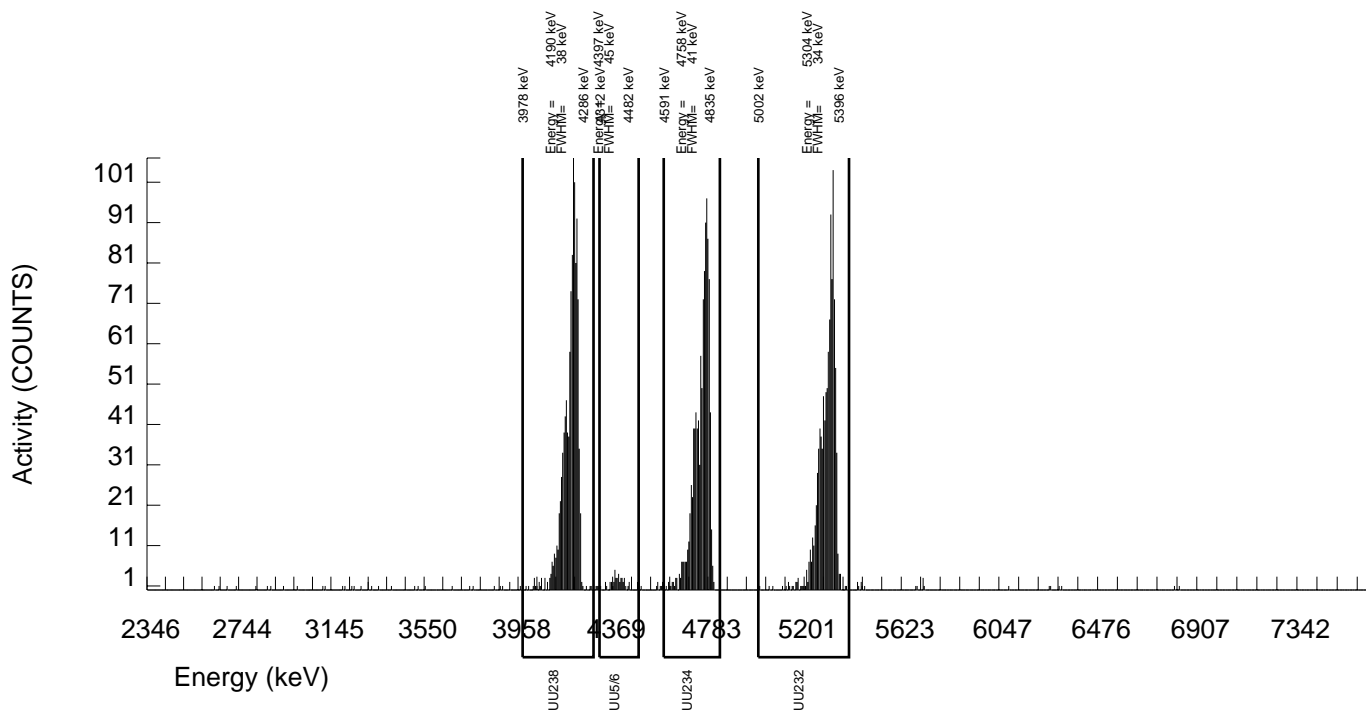
GEL Laboratories LLC
ALPHA SPECTROSCOPY REPORT

BATCH NUMBER: 925746 SAMPLE DATE : 23-NOV-2009 00:00:00		SAMPLE ID : S1201979243_UU SAMPLE QTY: 0.800 L	
DETECTOR NUMBER :76222 AVERAGE %EFFICIENCY :24.4246 % YIELD : 81.999		COUNT DATE:25-NOV-2009 16:03:26 ELAPSED LIVE TIME(SEC): 60000.00 ANALYST :KXM4	
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 : 5.24806 dpm RESULTS : 4.30337 dpm	LIB FILE : ENV_ALPHA_UU.N BKG FILE : B152.CNF;367 BKG DATE : 22-NOV-2009 EFF FILE : W152.CNF;101 CAL DATE : 18-NOV-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	1067.000	1060.939	5.000	2.2361	100.0000	2.98E+00	4.51E-01	3.77E-02	1.46E-02	1.80E-01
U232	5302.100	1060.000	1051.000	9.000	3.0000	100.0000	2.95E+00	4.47E-01	4.77E-02	1.96E-02	1.80E-01
U-235	4391.000	46.000	44.000	2.000	1.4142	80.90000	1.53E-01	5.17E-02	3.33E-02	1.14E-02	4.72E-02
U-238	4184.730	1115.000	1114.000	1.000	1.0000	100.0000	3.13E+00	4.71E-01	2.15E-02	6.54E-03	1.84E-01

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



RADIUM 228

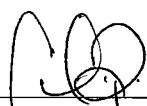
Radiochemistry Batch Checklist, Rev 9

Batch# 922916 Product: RA 228 Date: 11/21/09

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.	✓		
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)	✓		
Batch entered into Case Narrative.	✓		
Batch non-conformances completed, if applicable.			N/A
Batch non-conformances second reviewed and disposition verified to be completed.			N/A
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:  11/21/09

Secondary Review Performed By: 

Radium-228 Que Sheet

11/16/2009

Batch #: 922916 Analyst: MXS2 First Client Due Date: 12/10/2009 Internal Due Date: 11/29/2009
 Spike Isotope: Radium-228 Spike Code: 0503-B Expiration Date: 9-11-10
 LCS Isotope: Radium-228 LCS Code: 0503-B Expiration Date: 9-11-10
 Tracer Isotope: Barium-133 Tracer Code: 012-5 Expiration Date: 2-17-10
 Prep Date: 11-18-09 Initials: MS Pipet ID: 179 S419 Balance ID: 51204863
 Ac-228 Ingrow: 11-17-09 | 1010
 Ac-228 Separation Date/Time: 11-20-09 | 1645
 Witness: GE 11-18-09

Sample ID	Client Description	Type	Hazard Code	Min CRDL	Matrix	Client	Collect Date & Time	Pos. #	Vol (mL)	Det #	Ba Yield (%)	Gamma Det. #
240965001-1	M-122B	SAMPLE		3 pCi/L	GROUND WATI	KERR003	11-NOV-09 01:35 PM	1	200	7A	81.15	
240965002-1	M-122BDISS	SAMPLE		3 pCi/L	GROUND WATI	KERR003	11-NOV-09 01:35 PM	2	200	7B	78.29	
1201972623-1	MB for batch 922916	MB		3 pCi/L	GROUND WATI	QC ACCOUNT		3	200	9C	79.90	
1201972624-1	M-122BDISS(240965002DUP)	DUP		3 pCi/L	GROUND WATI	QC ACCOUNT	11-NOV-09 01:35 PM	4	200	7D	77.08	
1201972625-1	M-122BDISS(240965002MS)	MS		3 pCi/L	GROUND WATI	QC ACCOUNT	11-NOV-09 01:35 PM	5	100	8A 11B	78.98	
1201972626-1	LCS for batch 922916	LCS		3 pCi/L	GROUND WATI	QC ACCOUNT		6	200	8C	84.07	

11/20/09

stamped in error
 09/11/09
DO NOT REPORT

Data Reviewed By: [Signature] 11/21/09

Radium-228 Liquid

Filename : RA228.XLS
 File type : Excel
 Version # : 1.2.6
 Batch : 922916
 Analyst : MXS2
 Prep Date : 11/18/2009
 Ra-228 Abundance : 1
 Ra-228 Method Uncertainty : 0.1268
 Geometry: Cef. on 25mm Filter

Spike SN : 0503-B
 Spike Exp Date : 9/11/2010
 Spike Activity (dpm/ml): 174.18
 Spike Volume Added: 0.10
 LCS SN : 0503-B
 LCS Exp Date : 9/11/2010
 LCS Activity (dpm/ml): 174.18
 LCS Volume Added: 0.10
 Tracer SN : 0112-J
 Tracer Exp Date : 2/17/2010
 Tracer 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
 Parmname : Radium-228
 Required MDA : 3 pCi/L
 Half-life of Ra-228 : 5.75 years
 Half-life of Ac-228 : 6.15 hours

Pos.	Sample Characteristics		Sample Aliquot L	Sample Aliquot StDev. L	Sample Date/Time	Tracer Calculations		Tracer Concentration (cpm) (Ba-133 Ref.)	Tracer Count Uncertainty (cpm)	Tracer Ref. Count Uncertainty (cpm)	Tracer Concentration (cpm) (Ba-133 Samp.)	Tracer Count Uncertainty (cpm)	Tracer Aliquot (mL)	Tracer Aliquot StDev. (mL)
	Sample ID	Sample Aliquot L												
1	240965001.1	0.2000	1.6007E-05	11/11/2009 13:35	304.5	3.52%	247.1	3.96%	247.1	3.52%	247.1	3.96%	0.1	0.000701
2	240965002.1	0.2000	1.6007E-05	11/11/2009 13:35	304.5	3.52%	238.4	4.04%	238.4	3.52%	238.4	4.04%	0.1	0.000701
3	1201972623.1	0.2000	1.6007E-05	11/18/2009 0:00	304.5	3.52%	243.3	3.99%	243.3	3.52%	243.3	3.99%	0.1	0.000701
4	1201972624.1	0.2000	1.6007E-05	11/11/2009 13:35	304.5	3.52%	234.7	4.07%	234.7	3.52%	234.7	4.07%	0.1	0.000701
5	1201972625.1	0.1000	1.1370E-05	11/11/2009 13:35	304.5	3.52%	240.5	4.02%	240.5	3.52%	240.5	4.02%	0.1	0.000701
6	1201972626.1	0.2000	1.6007E-05	11/18/2009 0:00	304.5	3.52%	256.0	3.88%	256.0	3.52%	256.0	3.88%	0.1	0.000701

* - RPD changed to 0% due to :

Count raw Data		Calibration Data																
Pos.	Detector ID	Counting Time (min.)	Gross Counts		Beta cpm	Count Start Date/Time	Separation Date/Time	Ra-228 Decay	Ac-228 Decay	Ac-228 Count Correction	Calculated 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.)
			Alpha	Beta														
1	7A	70	10	57	0.814	11/20/2009 19:01	11/20/2009 16:45	0.987	0.775	1.067	81.15%	2.83%	PIC	7/2/2009	7/31/2010	0.6180	0.00816	500
2	7B	70	3	46	0.657	11/20/2009 19:01	11/20/2009 16:45	0.987	0.774	1.067	78.29%	2.86%	PIC	7/2/2009	7/31/2010	0.6280	0.00816	500
3	9C	70	3	42	0.600	11/20/2009 19:01	11/20/2009 16:45	0.989	0.774	1.067	79.90%	2.84%	PIC	7/2/2009	7/31/2010	0.6273	0.00816	500
4	7D	70	11	51	0.729	11/20/2009 19:01	11/20/2009 16:45	0.987	0.774	1.067	77.08%	2.87%	PIC	7/2/2009	7/31/2010	0.6257	0.00816	500
5	11B	60	10	304	5.067	11/20/2009 21:43	11/20/2009 16:45	0.987	0.571	1.057	78.98%	2.85%	PIC	7/2/2009	7/31/2010	0.6372	0.00816	500
6	8C	60	7	457	7.617	11/20/2009 19:01	11/20/2009 16:45	0.989	0.774	1.057	84.07%	2.80%	PIC	7/2/2009	7/31/2010	0.6339	0.00816	500

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

activity below MDA for 1201972624.1

Pos.	Decision Level		Critical Level	Required MDA	MDA	Sample Act. Conc.	Sample Act. Error	Net Count Rate	Net Count Rate Error	2 SIGMA Counting Uncertainty		2 SIGMA Total Prop. Uncertainty		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
	pCi/L	pCi/L								pCi/L	CPM	CPM	pCi/L						
1	1.2271	0.8663	0.9287	3	1.9987	2.3109	0.3020	0.3723	0.1119	1.3612	1.4834								
2	1.3154	0.9287	1.0712	3	2.1288	1.0712	0.6026	0.1691	0.1018	1.2636	1.2929								
3	1.2117	0.8555	1.0416	3	1.9767	1.0416	0.5789	0.1680	0.0971	1.1804	1.2100								
4	1.2679	0.8952	1.8894	3	2.0671	1.8894	0.3642	0.2926	0.1062	1.3443	1.4282								
5	3.4409	2.4293	77.2826	3	5.8906	77.2826	0.0695	4.6447	0.2920	9.5242	21.9038	240965002.1	0.0%					78.6269	98.3%
6	1.4923	1.0112	40.5203	3	2.3114	40.5203	0.0588	7.0107	0.3580	4.0555	11.1008	240965002.1						39.2300	103.3%

SampleID	Instr	Time (min.)	Alpha Counts	Beta Counts	Count Start Time	Count End Time	Machine
240965001	7A	70	10	57	11/20/2009 19:01	11/20/2009 20:11	PIC
240965002	7B	70	3	46	11/20/2009 19:01	11/20/2009 20:11	PIC
1201972623	9C	70	3	42	11/20/2009 19:01	11/20/2009 20:11	PIC
1201972624	7D	70	11	51	11/20/2009 19:01	11/20/2009 20:11	PIC
1201972625	11B	60	10	304	11/20/2009 21:43	11/20/2009 22:43	PIC
1201972626	8C	60	7	457	11/20/2009 19:01	11/20/2009 20:01	PIC

ASSAY 19-Nov-09 11:54:32

Protocol id 9 228_REC2
Time limit 180
Count limit 50000
Isotope Ba-133
Protocol date 9-Apr-07 10:02:22
Run id. 50

POS	RACK	BATCH	TIME	COUNTS	CPM	ERROR	% RECOVERY	COUNT TIME
1	72	1	180	1005	304.5	3.52		11:54:34
2	72	2	180	833	247.1	3.96	81.15	11:57:46
3	72	3	180	806	238.4	4.04	78.29	12:00:57
4	72	4	180	821	243.3	3.99	79.90	12:04:09
5	72	5	180	795	234.7	4.07	77.08	12:07:20
6	66	6	180	813	240.5	4.02	78.98	12:10:44
7	66	7	180	859	256	3.88	84.07	12:13:56

END OF ASSAY

RADIUM 226

Radiochemistry Batch Checklist, Rev 9

Batch# 923071 Product: Ra 224 Date: 11/25/09

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.	✓		
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.			N/A
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 stasured.	✓		
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
Batch non-conformances second reviewed and disposition verified to be completed.			N/A
Aliquot Correction completed if required.			N/A
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:

[Signature] 11/25/09

Secondary Review Performed By:

[Signature] 12/2/09

KECK

Radium-226 Que Sheet

16-NOV-09

GEL Laboratories, Radiochemistry Division

51 Batch #: 923071 Analyst: KSD1 First Client Due Date: 12/10/2009 Internal Due Date: 11/29/2009
 51 Spike Isotope: Radium-226 Spike Code: 0084 Expiration Date: 01/28/10 Vol: 0.1 End Initial/Degas Date/Time: 11/18/09 1000
 0 LCS Isotope: Radium-226 LCS Code: 0084 Expiration Date: 01/28/10 Vol: 0.1 End LN De-em Date: 11/21/09
 351 Bkg Count Time: 30 (Min) Sample Count Time: 30 (Min) Start Count Date: 11/24/09 Witness: JRS 11/18/09
 51 Pipet ID: 1118M Balance ID: SN04803 Initials: LD

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
240965001-1	M-122B	SAMPLE		GROUND WA11	pCi/L	KERR003	1	500	1435	1745	101	1	8	69
240965002-1	M-122BDISS	SAMPLE		GROUND WA11	pCi/L	KERR003	2	500	1435	1745	101	2	8	39
1201973135-1	MB for batch 923071	MB		GROUND WA11	pCi/L	QC ACCOUNT	3	500	1435	1745	300	3	8	13
1201973136-1	M-122B(240965001DUP)	DUP		GROUND WA11	pCi/L	QC ACCOUNT	4	500	1435	1745	400	4	8	74
1201973137-1	M-122B(240965001MS)	MS		GROUND WA11	pCi/L	QC ACCOUNT	5	100	1435	1745	501	5	4	179
1201973138-1	LCS for batch 923071	LCS		GROUND WA11	pCi/L	QC ACCOUNT	6	500	1435	1745	601	6	6	1133

Dailies ✓

Comments: _____

Data Reviewed By: [Signature] 11/25/09
Page 1 of 1

Radium-226 Liquid

Filename : RA226.XLS
 File type : Excel
 Version # : 1.2.5

Spike S/N : 0638-I
 Spike Exp Date : 9/28/2010
 Spike Activity (dpm/ml): 268.44
 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 : 923071
 Analyst : KSD1
 Prep Date : 11/18/2009
 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: 3.8235 days
 Batch counted on : LUCAS CELL DETECTOR
 BKG Count time : 30 min

Pos.	Sample Characteristics		Sample Aliquot L	Sample Aliquot StDev. L	Sample Date/Time	Count Raw Data			Weekly Background				
	Sample ID	Sample Aliquot L				Cell Number	Counting Time (min.)	Gross Counts	Gross CPM	Counts	CPM	Count Time (min.)	Detector Efficiency (cpm/dpm)
1	240965001.1	0.5000	2.0256E-05	2.0256E-05	11/11/2009 13:35	101	30	69	2.300	8	0.267	30	1.9560
2	240965002.1	0.5000	2.0256E-05	2.0256E-05	11/11/2009 13:35	201	30	39	1.300	8	0.267	30	1.9930
3	1201973135.1	0.5000	2.0256E-05	2.0256E-05	11/18/2009 0:00	306	30	13	0.433	8	0.267	30	1.7470
4	1201973136.1	0.5000	2.0256E-05	2.0256E-05	11/11/2009 13:35	402	30	74	2.467	8	0.267	30	2.1180
5	1201973137.1	0.1000	1.1370E-05	1.1370E-05	11/11/2009 13:35	507	30	1086	36.200	4	0.133	30	1.7010
6	1201973138.1	0.5000	2.0256E-05	2.0256E-05	11/18/2009 0:00	607	30	1133	37.767	6	0.200	30	2.4500

Detector Efficiency Error (cpm/dpm)	Cell Calibration Date	Cell Calibration Due Date	De-Gas Date/Time	Rn-222 Ingrow		Count Start Date/Time	De-Gas to Ingrowth	Rn-222 Corrections		Ra-226 Decay
				End Date/Time	Date/Time			Ingrowth to Count	During Count	
0.05303	8/31/2009	8/31/2010	11/18/2009 16:00	11/24/2009 14:35	11/24/2009 17:45	11/24/2009 17:45	0.659	0.976	1.002	1.000
0.07722	12/19/2008	12/19/2009	11/18/2009 16:00	11/24/2009 14:35	11/24/2009 17:45	11/24/2009 17:45	0.659	0.976	1.002	1.000
0.06082	2/4/2009	2/4/2010	11/18/2009 16:00	11/24/2009 14:35	11/24/2009 17:45	11/24/2009 17:45	0.659	0.976	1.002	1.000
0.12371	3/2/2009	3/2/2010	11/18/2009 16:00	11/24/2009 14:35	11/24/2009 17:45	11/24/2009 17:45	0.659	0.976	1.002	1.000
0.14377	3/25/2009	3/25/2010	11/18/2009 16:00	11/24/2009 14:35	11/24/2009 18:30	11/24/2009 18:30	0.659	0.971	1.002	1.000
0.06605	8/4/2009	8/4/2010	11/18/2009 16:00	11/24/2009 14:35	11/24/2009 17:45	11/24/2009 17:45	0.659	0.976	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

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		2 SIGMA		Sample QC	Sample Type	RPD	RER	Nominal pCi/L	Recovery
									Counting Uncertainty pCi/L	Total Prop. Uncertainty pCi/L	Counting Uncertainty pCi/L	Total Prop. Uncertainty pCi/L						
1	0.2218	0.1566	1	0.3846	1.4519	0.1533	2.0333	0.2925	0.4094	0.5085	0.3571		SAMPLE					
2	0.2177	0.1537	1	0.3775	0.7242	0.2342	1.0333	0.2285	0.3139	0.3571	0.2411		SAMPLE					
3	0.2484	0.1754	1	0.4307	0.1332	0.9185	0.1667	0.1528	0.2394	0.2411	0.2411		MB					
4	0.2049	0.1446	1	0.3552	1.4508	0.1847	2.2000	0.3018	0.3901	0.5866	0.5866	240965001.1	DUP	0.1%			120.9177	122.0%
5	0.9070	0.6404	1	1.6936	148.9152	0.1470	36.0667	1.1005	8.9060	50.5772	50.5772	240965001.1	MS				24.1834	88.6%
6	0.1534	0.1083	1	0.2736	21.4161	0.0725	37.5667	1.1250	1.2570	4.9107	4.9107		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 3/2/03

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



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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 (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 ⁻¹ at 22.8 °C [b]*		
Solution mass	Approximately 5.15 g		
Chemical Properties:			
Solution composition	Chemical Formula	Concentration (mol·L ⁻¹)	Mass Fraction (g·g ⁻¹)
	H ₂ O	54	0.94
	HNO ₃	1.0	0.06
	HCl	<0.001	<4 × 10 ⁻⁵
	²⁴⁴ Cm +3	5 × 10 ⁻¹¹	1 × 10 ⁻¹¹
Radiological Properties:			
Radionuclide	Curium-244		
Reference time	1230 EST, 1 February 1996 [c]		
Massic activity of the solution [d]	37.06 Bq·g ⁻¹ 24.12 Bq·g ⁻¹		
Relative expanded uncertainty (k=2)	0.68% [e] [f]		
Alpha-particle-emitting daughters	Plutonium-240: (0.22 ± 0.11) Bq·g ⁻¹ [b] [c]		
Alpha-particle-emitting impurities	Curium-243: (0.005 ± 0.004) Bq·g ⁻¹ [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		

37.06 x 2 2004
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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 λ (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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0493



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 ⁽¹⁾ *
Solution mass	Approximately 5 grams
Solution composition	Neptunium-237 in 2 mol·L ⁻¹ nitric acid
Reference time	March 1992
Radioactivity concentration	97.0 Bq·g ⁻¹
Overall uncertainty	1.28 percent ⁽²⁾
Photon-emitting impurities	None detected ⁽³⁾
Alpha-particle-emitting impurities	None detected ⁽⁴⁾
Half life	(2.14 ± 0.11) × 10 ⁶ years ⁽⁵⁾
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 ± 0.5 mm
wall thickness	0.60 ± 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

Instrument : CHAMBER 147

Detector : 75550
Standard ID : AESS-030
Standard Reference Date : 15-FEB-2008 09:06:52
Calibration Analysis Date/Time : 18-NOV-2009 08:16:08
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 18-NOV-2009 13:43:19

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.800
CM-244	4320A	28-FEB-2010	5795.020	5795.143

Energy Calibration Zero : 2342.758
Energy Calibration Slope : 4.974234
Energy Calibration Quadratic : 2.5187916E-04
Energy Calibration Range : 2348 to 7700 KeV

The Energy Calibration : $energy = 2342.758 + (4.974234 * Channel) + (2.5187916E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 15-NOV-2009 17:16:28
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2988.625	3302.025	2.000000	0.6000000	70.71068	95.00000
NP-237	4434.897	4903.298	14.00000	4.200000	26.72612	95.00000
CM-244	5534.180	5884.256	5.000000	1.500000	44.72136	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 18-NOV-2009 13:43:19
Average Efficiency : 0.2451187
Average Efficiency Error : 7.1902573E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	198.9792	28-FEB-2010	2988.625	3302.025	14282.00	0.2431632	1.2328269E-02	48.34250
NP-237	166.3758	28-FEB-2010	4434.897	4903.298	12254.00	0.2454244	1.2470047E-02	57.47663
CM-244	157.1856	28-FEB-2010	5534.180	5884.256	10884.00	0.2468401	1.2566833E-02	47.78167

Instrument : CHAMBER 148

Detector : 74429
Standard ID : AESS-036
Standard Reference Date : 18-FEB-2008 11:28:15
Calibration Analysis Date/Time : 18-NOV-2009 08:16:12
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 18-NOV-2009 13:43:37

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.134
NP-237	4341	28-FEB-2010	4768.800	4768.799
CM-244	4320A	28-FEB-2010	5795.020	5795.021

Energy Calibration Zero : 2342.267
Energy Calibration Slope : 4.959772
Energy Calibration Quadratic : 2.7652038E-04
Energy Calibration Range : 2347 to 7711 KeV

The Energy Calibration : $energy = 2342.267 + (4.959772 * Channel) + (2.7652038E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 15-NOV-2009 17:16:33
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2991.710	3299.671	3.000000	0.9000000	57.73503	95.00000
NP-237	4432.630	4901.757	17.00000	5.100000	24.25356	95.00000
CM-244	5534.227	5885.479	11.00000	3.300000	30.15113	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 18-NOV-2009 13:43:37
Average Efficiency : 0.2488421
Average Efficiency Error : 6.8639922E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	201.3204	28-FEB-2010	2991.710	3299.671	14736.00	0.2479510	1.0662264E-02	49.91240
NP-237	167.4312	28-FEB-2010	4432.630	4901.757	12530.00	0.2493544	1.2665348E-02	49.84171
CM-244	156.4188	28-FEB-2010	5534.227	5885.479	10957.00	0.2495920	1.2705517E-02	53.03390

Instrument : CHAMBER 149

Detector : 33449
Standard ID : AESS-037
Standard Reference Date : 18-FEB-2008 15:31:47
Calibration Analysis Date/Time : 18-NOV-2009 08:16:16
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 18-NOV-2009 13:43:50

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.207
NP-237	4341	28-FEB-2010	4768.800	4768.800
CM-244	4320A	28-FEB-2010	5795.020	5795.020

Energy Calibration Zero : 2394.373
Energy Calibration Slope : 4.928394
Energy Calibration Quadratic : 3.2330301E-04
Energy Calibration Range : 2399 to 7780 KeV

The Energy Calibration : $energy = 2394.373 + (4.928394 * Channel) + (3.2330301E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 15-NOV-2009 17:16:38
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2990.436	3302.050	4.000000	1.200000	50.00000	95.00000
NP-237	4433.023	4902.650	6.000000	1.800000	40.82483	95.00000
CM-244	5531.642	5884.441	6.000000	1.800000	40.82483	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 18-NOV-2009 13:43:50
Average Efficiency : 0.2483255
Average Efficiency Error : 6.8516782E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	197.7372	28-FEB-2010	2990.436	3302.050	14366.00	0.2460991	1.0587637E-02	68.92946
NP-237	167.1294	28-FEB-2010	4433.023	4902.650	12626.00	0.2517851	1.2787181E-02	66.29462
CM-244	154.7664	28-FEB-2010	5531.642	5884.441	10776.00	0.2481186	1.2634184E-02	65.00041

Instrument : CHAMBER 150

Detector : 75552
Standard ID : AESS-043
Standard Reference Date : 19-FEB-2008 00:32:27
Calibration Analysis Date/Time : 18-NOV-2009 08:16:20
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 18-NOV-2009 13:44:03

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.870
CM-244	4320A	28-FEB-2010	5795.020	5795.095

Energy Calibration Zero : 2353.210
Energy Calibration Slope : 4.970113
Energy Calibration Quadratic : 2.7265481E-04
Energy Calibration Range : 2358 to 7729 KeV

The Energy Calibration : $energy = 2353.210 + (4.970113 * Channel) + (2.7265481E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 15-NOV-2009 17:16:43
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2988.812	3302.301	1.000000	0.3000000	100.0000	95.00000
NP-237	4436.790	4906.431	6.000000	1.800000	40.82483	95.00000
CM-244	5534.181	5885.674	5.000000	1.500000	44.72136	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 18-NOV-2009 13:44:03
Average Efficiency : 0.2472161
Average Efficiency Error : 6.8205683E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	197.7708	28-FEB-2010	2988.812	3302.301	14459.00	0.2476633	1.0653616E-02	51.90544
NP-237	168.7422	28-FEB-2010	4436.790	4906.431	12530.00	0.2474881	1.2570423E-02	58.37593
CM-244	156.3252	28-FEB-2010	5534.181	5885.674	10806.00	0.2463256	1.2542248E-02	51.11081

Instrument : CHAMBER 151

Detector : 75556
Standard ID : AESS-038
Standard Reference Date : 18-FEB-2008 15:31:47
Calibration Analysis Date/Time : 18-NOV-2009 08:16:24
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 18-NOV-2009 13:44:18

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.800
CM-244	4320A	28-FEB-2010	5795.020	5795.021

Energy Calibration Zero : 2346.500
Energy Calibration Slope : 4.910573
Energy Calibration Quadratic : 2.9834322E-04
Energy Calibration Range : 2351 to 7688 KeV

The Energy Calibration : $energy = 2346.500 + (4.910573 * Channel) + (2.9834322E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 15-NOV-2009 17:16:48
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2989.916	3300.328	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4435.770	4902.424	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
CM-244	5532.149	5887.482	4.000000	1.200000	50.00000	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 18-NOV-2009 13:44:18
Average Efficiency : 0.2453373
Average Efficiency Error : 6.7687407E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	200.1408	28-FEB-2010	2989.916	3300.328	14345.00	0.2428084	1.0446316E-02	54.48222
NP-237	170.0886	28-FEB-2010	4435.770	4902.424	12621.00	0.2473418	1.2561537E-02	57.49018
CM-244	157.7460	28-FEB-2010	5532.149	5887.482	10933.00	0.2469928	1.2573596E-02	57.42320

Instrument : CHAMBER 152

Detector : 76222
Standard ID : AESS-044
Standard Reference Date : 19-FEB-2008 00:32:27
Calibration Analysis Date/Time : 18-NOV-2009 08:16:28
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 18-NOV-2009 13:44:34

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.799
CM-244	4320A	28-FEB-2010	5795.020	5795.021

Energy Calibration Zero : 2341.313
Energy Calibration Slope : 4.950351
Energy Calibration Quadratic : 2.6349045E-04
Energy Calibration Range : 2346 to 7687 KeV

The Energy Calibration : $energy = 2341.313 + (4.950351 * Channel) + (2.6349045E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 15-NOV-2009 17:16:53
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2989.311	3301.494	1.000000	0.3000000	100.0000	95.00000
NP-237	4435.919	4903.221	1.000000	0.3000000	100.0000	95.00000
CM-244	5532.929	5882.503	8.000000	2.400000	35.35534	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 18-NOV-2009 13:44:34
Average Efficiency : 0.2442460
Average Efficiency Error : 6.7417030E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	194.4510	28-FEB-2010	2989.311	3301.494	14186.00	0.2471355	1.0634735E-02	48.77798
NP-237	166.6248	28-FEB-2010	4435.919	4903.221	12052.00	0.2410947	1.2253158E-02	55.60851
CM-244	155.8290	28-FEB-2010	5532.929	5882.503	10651.00	0.2435444	1.2403901E-02	54.29796

Instrument : CHAMBER 179

Detector : 74437
Standard ID : AESS-016
Standard Reference Date : 14-FEB-2008 17:45:04
Calibration Analysis Date/Time : 24-NOV-2009 06:34:52
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 24-NOV-2009 12:00:19

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3182.758
NP-237	4341	28-FEB-2010	4768.800	4768.758
CM-244	4320A	28-FEB-2010	5795.020	5794.964

Energy Calibration Zero : 2359.823
Energy Calibration Slope : 4.962562
Energy Calibration Quadratic : 2.8667317E-04
Energy Calibration Range : 2365 to 7742 KeV

The Energy Calibration : $energy = 2359.823 + (4.962562 * Channel) + (2.8667317E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 22-NOV-2009 17:54:43
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2989.657	3297.847	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4437.466	4902.275	6.000000	1.800000	40.82483	95.00000
CM-244	5530.857	5882.983	52.00000	15.60000	13.86751	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 24-NOV-2009 12:00:19
Average Efficiency : 0.2621220
Average Efficiency Error : 7.2112521E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	204.0534	28-FEB-2010	2989.657	3297.847	15729.00	0.2611946	1.1218747E-02	46.48048
NP-237	199.3962	28-FEB-2010	4437.466	4902.275	15975.00	0.2670262	1.3517470E-02	58.20499
CM-244	198.6402	28-FEB-2010	5530.857	5882.983	14423.00	0.2587720	1.3117243E-02	51.81855

Instrument : CHAMBER 180

Detector : 74438
Standard ID : AESS-022
Standard Reference Date : 14-FEB-2008 21:55:55
Calibration Analysis Date/Time : 24-NOV-2009 06:34:56
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 24-NOV-2009 12:00:39

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.799
CM-244	4320A	28-FEB-2010	5795.020	5794.768

Energy Calibration Zero : 2355.312
Energy Calibration Slope : 5.017449
Energy Calibration Quadratic : 2.2851254E-04
Energy Calibration Range : 2360 to 7733 KeV

The Energy Calibration : $energy = 2355.312 + (5.017449 * Channel) + (2.2851254E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 22-NOV-2009 17:54:48
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2991.138	3301.566	0.0000000E+00	0.0000000E+00	0.0000000E+00	95.00000
NP-237	4435.267	4905.429	12.00000	3.600000	28.86751	95.00000
CM-244	5532.771	5883.499	37.00000	11.10000	16.43990	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 24-NOV-2009 12:00:39
Average Efficiency : 0.2520576
Average Efficiency Error : 6.9372137E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	209.6724	28-FEB-2010	2991.138	3301.566	15174.00	0.2452244	1.0539439E-02	48.07873
NP-237	206.8830	28-FEB-2010	4435.267	4905.429	16066.00	0.2588001	1.3100182E-02	59.82827
CM-244	203.0208	28-FEB-2010	5532.771	5883.499	14567.00	0.2557934	1.2964397E-02	52.37422

Instrument : CHAMBER 181

Detector : 74439
Standard ID : AESS-017
Standard Reference Date : 14-FEB-2008 17:45:04
Calibration Analysis Date/Time : 24-NOV-2009 06:35:01
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 24-NOV-2009 12:00:53

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3182.789
NP-237	4341	28-FEB-2010	4768.800	4768.697
CM-244	4320A	28-FEB-2010	5795.020	5794.857

Energy Calibration Zero : 2357.138
Energy Calibration Slope : 4.976092
Energy Calibration Quadratic : 2.7283657E-04
Energy Calibration Range : 2362 to 7739 KeV

The Energy Calibration : $energy = 2357.138 + (4.976092 * Channel) + (2.7283657E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 22-NOV-2009 17:54:53
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2988.457	3302.286	1.000000	0.3000000	100.0000	95.00000
NP-237	4432.801	4902.896	7.000000	2.100000	37.79645	95.00000
CM-244	5531.253	5883.084	25.00000	7.500000	20.00000	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 24-NOV-2009 12:00:53
Average Efficiency : 0.2551712
Average Efficiency Error : 7.0191962E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	210.0798	28-FEB-2010	2988.457	3302.286	15717.00	0.2535035	1.0888553E-02	49.39798
NP-237	208.5846	28-FEB-2010	4432.801	4902.896	16261.00	0.2598292	1.3150321E-02	56.53638
CM-244	205.5828	28-FEB-2010	5531.253	5883.084	14589.00	0.2530546	1.2825227E-02	54.20430

Instrument : CHAMBER 182

Detector : 74440
Standard ID : AESS-023
Standard Reference Date : 14-FEB-2008 21:55:55
Calibration Analysis Date/Time : 24-NOV-2009 06:35:06
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 24-NOV-2009 12:01:17

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3182.719
NP-237	4341	28-FEB-2010	4768.800	4768.509
CM-244	4320A	28-FEB-2010	5795.020	5795.020

Energy Calibration Zero : 2350.135
Energy Calibration Slope : 4.996904
Energy Calibration Quadratic : 2.3739120E-04
Energy Calibration Range : 2355 to 7716 KeV

The Energy Calibration : $energy = 2350.135 + (4.996904 * Channel) + (2.3739120E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 22-NOV-2009 17:55:01
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2988.571	3297.943	3.000000	0.9000000	57.73503	95.00000
NP-237	4433.580	4902.701	5.000000	1.500000	44.72136	95.00000
CM-244	5534.178	5884.404	23.00000	6.900000	20.85144	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 24-NOV-2009 12:01:17
Average Efficiency : 0.2562340
Average Efficiency Error : 7.0501021E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	207.4764	28-FEB-2010	2988.571	3297.943	15397.00	0.2514522	1.0804323E-02	46.96736
NP-237	207.4998	28-FEB-2010	4433.580	4902.701	16130.00	0.2590927	1.3114315E-02	55.56799
CM-244	199.8804	28-FEB-2010	5534.178	5884.404	14600.00	0.2604762	1.3201220E-02	47.59259

Instrument : CHAMBER 183

Detector : 74441
Standard ID : AESS-018
Standard Reference Date : 14-FEB-2008 17:45:04
Calibration Analysis Date/Time : 24-NOV-2009 06:35:10
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 24-NOV-2009 12:01:31

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.800
CM-244	4320A	28-FEB-2010	5795.020	5795.020

Energy Calibration Zero : 2362.221
Energy Calibration Slope : 4.965884
Energy Calibration Quadratic : 2.8538101E-04
Energy Calibration Range : 2367 to 7747 KeV

The Energy Calibration : $energy = 2362.221 + (4.965884 * Channel) + (2.8538101E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 22-NOV-2009 17:55:09
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2992.453	3300.821	2.000000	0.6000000	70.71068	95.00000
NP-237	4435.808	4906.007	11.00000	3.300000	30.15113	95.00000
CM-244	5534.813	5887.047	56.00000	16.80000	13.36306	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 24-NOV-2009 12:01:31
Average Efficiency : 0.2605479
Average Efficiency Error : 7.1674278E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	202.1856	28-FEB-2010	2992.453	3300.821	15516.00	0.2600277	1.1171286E-02	50.59949
NP-237	208.8990	28-FEB-2010	4435.808	4906.007	16241.00	0.2590997	1.3113623E-02	54.50348
CM-244	198.1458	28-FEB-2010	5534.813	5887.047	14611.00	0.2627811	1.3318177E-02	50.45325

Instrument : CHAMBER 184

Detector : 74442
Standard ID : AESS-024
Standard Reference Date : 14-FEB-2008 21:55:55
Calibration Analysis Date/Time : 24-NOV-2009 06:35:14
Calibration Count Time : 300.0000 min.

Subsection 1: Energy Calibration

Energy/Channel Equation
 $energy = Cal_Zero + (e1 * C) + (e2 * C^2)$

where : Cal_Zero = Energy Calibration Zero
e1 = Energy Calibration Slope
e2 = Energy Calibration Quadratic
C = Channel

Energy Calibration Date/Time : 24-NOV-2009 12:02:02

Cal. Isotopes	Source Id	Expiration Date	Standard Energy (KeV)	Actual Energy (KeV)
GD-148	6445-278	28-FEB-2010	3183.000	3183.000
NP-237	4341	28-FEB-2010	4768.800	4768.799
CM-244	4320A	28-FEB-2010	5795.020	5795.021

Energy Calibration Zero : 2350.469
Energy Calibration Slope : 5.046060
Energy Calibration Quadratic : 1.9380735E-04
Energy Calibration Range : 2356 to 7721 KeV

The Energy Calibration : $energy = 2350.469 + (5.046060 * Channel) + (1.9380735E-04 * Channel^2)$

Subsection 2: Background Calibration

Background Analysis Date/Time : 22-NOV-2009 17:55:14
Background Count Time : 60000.00 sec.

Cal. Isotopes	Start Energy (KeV)	End Energy (KeV)	Counts in 1000 min	Counts during Cal	% Error	% Confidence
GD-148	2989.350	3300.860	4.000000	1.200000	50.00000	95.00000
NP-237	4436.320	4906.233	5.000000	1.500000	44.72136	95.00000
CM-244	5532.384	5887.337	42.00000	12.60000	15.43033	95.00000

Subsection 3: Efficiency Calibration

Efficiency Calibration Date/Time : 24-NOV-2009 12:02:02
Average Efficiency : 0.2611030
Average Efficiency Error : 7.1840268E-03
% Confidence : 95.00000

Cal. Isotopes	DPM	Exp. Date	Start Engy (KeV)	End Engy (KeV)	Counts	EFF.	EFF Err	Resolution
GD-148	203.5218	28-FEB-2010	2989.350	3300.860	15331.00	0.2552293	1.0967464E-02	45.68402
NP-237	205.6662	28-FEB-2010	4436.320	4906.233	16340.00	0.2648062	1.3401426E-02	55.40918
CM-244	198.3060	28-FEB-2010	5532.384	5887.337	14811.00	0.2662378	1.3490811E-02	50.23361

GAS FLOW PROPORTIONAL COUNTERS


General Engineering Laboratories

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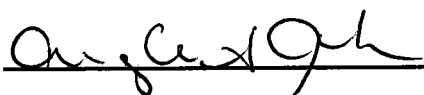
Gas Flow Proportional Counter Calibration Package

Method: Ra-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 #	Separation date	Count date	Ac-228 decay (dec)	Spike Vol. Ra-228 (mL)	Std. Act. Ra-228 dpm/mL	Standard Nominal	raw beta counts	ct. time (min)	Beta cpm	corrected* cpm	Ra-228 eff (cpm/dpm)	Separation time	
													Decay Corrected	Volume corrected
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	Average EFF	
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	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	
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	0.6282	
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	
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	0.6176	
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	
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	0.6043	
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	
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	0.6172	
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	
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	0.6167	
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	
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	0.5969	
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	
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	0.6119	
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	
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	0.5682	
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	
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	0.5980	
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	
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	0.6164	
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	
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	0.5994	
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	
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	0.6208	
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	
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	0.6205	
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	5790.010842	0.6066	Average EFF	
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	0.6052	
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	5666.467573	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	
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	0.5873	
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	
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	0.6258	
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	
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	0.6280	
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	6105.389624	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	6047.285806	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	5698.36602	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	6133.782218	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	6145.874775	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	7/1										

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	15625	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

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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

July 7/2/09

Notes:

- 1 - Results are decay corrected to Sample Date/Time
- 2 - Reference date for Spike Activity (dpm/fm) 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	2 SIGMA Counting		Total Prop. Uncertainty	Sample Type	Nominal pCi/L	Recovery
				pCi/L	Conc.				pCi/L	CPM				
0.3471	0.2451	1	0.6937	134.0279	0.0254	131.6880	2.9666	5.9178	21.6466	164.3409	LCS	164.3409	81.6%	
0.3647	0.2575	1	0.7192	133.0399	0.0251	130.2580	2.9508	5.9071	21.4655	164.3409	LCS	164.3409	81.0%	
0.5889	0.3790	1	0.9659	145.2921	0.0243	139.8173	3.0611	6.2347	23.3752	164.3409	LCS	164.3409	88.4%	
0.4695	0.3314	1	0.8755	159.8828	0.0239	150.4760	3.1730	6.6057	25.6756	164.3409	LCS	164.3409	87.3%	
0.4261	0.3008	1	0.8097	127.0000	0.0257	122.0633	2.8583	5.8279	20.5368	164.3409	LCS	164.3409	77.3%	
0.7599	0.5395	1	1.2813	141.0616	0.0247	135.4387	3.0211	6.1673	22.7300	164.3409	LCS	164.3409	85.8%	
0.3798	0.2681	1	0.7515	141.8559	0.0253	131.7993	2.9681	6.2613	22.9053	164.3409	LCS	164.3409	86.3%	
0.4150	0.2830	1	0.8072	145.8182	0.0251	131.8887	2.9696	6.4352	23.5274	164.3409	LCS	164.3409	88.7%	
0.6347	0.4481	1	1.1343	129.8854	0.0284	108.9047	2.7042	6.3116	21.1935	164.3409	LCS	164.3409	78.9%	
0.9035	0.6379	1	1.5022	135.4510	0.0266	119.6900	2.8455	6.3115	21.9803	164.3409	LCS	164.3409	82.4%	
0.6078	0.4291	1	1.0779	141.2594	0.0255	128.6447	2.9382	6.3235	22.8259	164.3409	LCS	164.3409	86.0%	
0.5473	0.3864	1	0.9987	155.5960	0.0247	137.7700	3.0378	6.7244	25.0636	164.3409	LCS	164.3409	94.7%	
0.6283	0.4436	1	1.1054	135.5336	0.0264	124.2433	2.8986	6.1761	21.9739	164.3409	LCS	164.3409	83.3%	
0.9036	0.6379	1	1.4942	136.9155	0.0254	125.4287	2.9134	6.2333	22.1127	164.3409	LCS	164.3409	88.8%	
0.7676	0.5419	1	1.3079	145.9826	0.0252	130.3400	2.9624	6.5032	23.5621	164.3409	LCS	164.3409	90.0%	
0.7520	0.5309	1	1.3000	147.9661	0.0266	124.2633	2.8910	6.7471	24.0105	164.3409	LCS	164.3409	82.1%	
0.4809	0.3395	1	0.9027	134.9911	0.0269	120.7040	2.8427	6.1544	21.3797	164.3409	LCS	164.3409	80.0%	
0.8974	0.4924	1	1.2076	131.4742	0.0271	117.9500	2.8170	6.4406	23.6659	164.3409	LCS	164.3409	89.0%	
0.6530	0.4610	1	1.1419	148.2299	0.0259	132.9873	2.9894	6.7377	25.2668	164.3409	LCS	164.3409	95.2%	
0.7661	0.5409	1	1.3064	156.3706	0.0255	139.2187	3.0605	6.7377	25.2668	164.3409	LCS	164.3409	81.7%	
0.6899	0.4871	1	1.1997	134.1863	0.0270	118.9960	2.8288	6.2523	21.8127	164.3409	LCS	164.3409	83.4%	
0.6079	0.4292	1	1.0862	137.0396	0.0269	120.3027	2.8412	6.3436	22.2643	164.3409	LCS	164.3409	88.8%	
0.9509	0.6713	1	1.5725	146.0056	0.0264	127.0307	2.9317	6.6044	23.6775	164.3409	LCS	164.3409	88.0%	
0.4376	0.3090	1	0.8562	144.5849	0.0276	113.7227	2.7577	6.3903	21.8573	164.3409	LCS	164.3409	88.0%	
0.4227	0.2984	1	0.8330	134.2390	0.0275	118.4887	2.8152	6.4094	22.3723	164.3409	LCS	164.3409	92.4%	
0.4360	0.3079	1	0.8480	137.6373	0.0270	118.4887	2.8152	6.7858	24.6068	164.3409	LCS	164.3409	92.6%	
0.3962	0.2797	1	0.7956	151.8935	0.0262	128.6313	2.9319	6.6518	23.4785	164.3409	LCS	164.3409	77.8%	
0.4480	0.3091	1	0.8657	152.1131	0.0261	130.4707	2.9539	6.7489	24.6318	164.3409	LCS	164.3409	82.2%	
0.6932	0.4470	1	1.1278	127.8251	0.0279	109.4120	2.7108	6.2072	20.8618	164.3409	LCS	164.3409	89.2%	
0.8917	0.6931	1	1.6167	135.1471	0.0273	117.2540	2.8197	6.3699	21.9896	164.3409	LCS	164.3409	86.1%	
0.5779	0.4080	1	1.0463	146.5864	0.0263	127.3240	2.8214	6.5922	23.7610	164.3409	LCS	164.3409	86.1%	
0.8422	0.5946	1	1.4301	141.4935	0.0272	117.4880	2.8147	6.6441	23.0149	164.3409	LCS	164.3409	79.4%	
0.4379	0.3091	1	0.8509	130.5505	0.0276	112.2200	2.7400	6.2478	21.2682	164.3409	LCS	164.3409	81.4%	
0.7972	0.5629	1	1.3635	133.7974	0.0277	112.5273	2.7540	6.4182	21.9026	164.3409	LCS	164.3409	87.8%	
0.4475	0.3159	1	0.8728	144.2924	0.0269	119.7633	2.8301	6.6832	23.4437	164.3409	LCS	164.3409	91.8%	
0.8154	0.5757	1	1.3863	150.8313	0.0263	128.3747	2.9406	6.7718	24.4459	164.3409	LCS	164.3409	81.8%	
0.4063	0.2868	1	0.8104	134.4151	0.0285	118.5507	2.7553	6.3927	21.8871	164.3409	LCS	164.3409	82.2%	
0.4205	0.2969	1	0.8358	146.9063	0.0268	121.4093	2.8489	6.7565	23.8548	164.3409	LCS	164.3409	89.4%	
0.4437	0.3182	1	0.8728	144.8386	0.0271	117.5853	2.8041	6.7699	23.5500	164.3409	LCS	164.3409	86.1%	
0.3432	0.2423	1	0.6763	135.4546	0.0253	141.3227	3.0733	5.7736	21.8705	164.3409	LCS	164.3409	82.4%	
0.3289	0.2322	1	0.6397	131.8931	0.0247	150.2887	3.1684	5.4434	21.2189	164.3409	LCS	164.3409	80.1%	
0.2949	0.2082	1	0.5922	148.3038	0.0237	169.2980	3.3626	5.7929	23.8966	164.3409	LCS	164.3409	92.4%	
0.3379	0.2385	1	0.6530	151.8473	0.0235	172.6707	3.3968	6.8549	24.3615	164.3409	LCS	164.3409	80.1%	
0.4616	0.3400	1	0.8577	131.6889	0.0249	148.2120	3.2186	5.4891	21.2301	164.3409	LCS	164.3409	82.1%	
0.7498	0.5287	1	1.2332	134.8566	0.0246	153.3873	3.3053	5.8282	23.8982	164.3409	LCS	164.3409	90.6%	
0.4447	0.3140	1	0.8052	148.8317	0.0238	162.8880	3.3080	5.7315	23.1384	164.3409	LCS	164.3409	87.8%	
0.6180	0.4363	1	1.0494	143.9479	0.0241	162.8880	3.3080	5.6202	21.7752	164.3409	LCS	164.3409	82.2%	
0.3427	0.2420	1	0.6680	135.0873	0.0248	148.3533	3.1202	5.4697	20.8960	164.3409	LCS	164.3409	78.9%	
0.5997	0.4234	1	1.0256	129.5009	0.0251	144.7940	3.0053	5.7852	23.4616	164.3409	LCS	164.3409	88.8%	
0.3316	0.2341	1	0.6469	146.0021	0.0240	163.4967	3.3053	5.4225	25.6134	164.3409	LCS	164.3409	97.2%	
0.6355	0.4487	1	1.0805	159.6717	0.0235	174.3747	3.4225	6.1425	26.6194	164.3409	LCS	164.3409	80.4%	
0.3136	0.2214	1	0.6255	132.0625	0.0251	144.5507	3.1078	5.5650	21.3060	164.3409	LCS	164.3409	82.5%	
1.4618	1.0321	1	2.2506	135.6135	0.0254	145.4707	3.1861	5.8215	22.7970	164.3409	LCS	164.3409	86.2%	
0.3185	0.2249	1	0.6330	141.6298	0.0245	154.5427	3.2133	5.7718	21.9070	164.3409	LCS	164.3409	86.2%	
0.3327	0.2349	1	0.6546	146.7439	0.0242	158.8520	3.2579	5.8988	23.6017	164.3409	LCS	164.3409	89.3%	

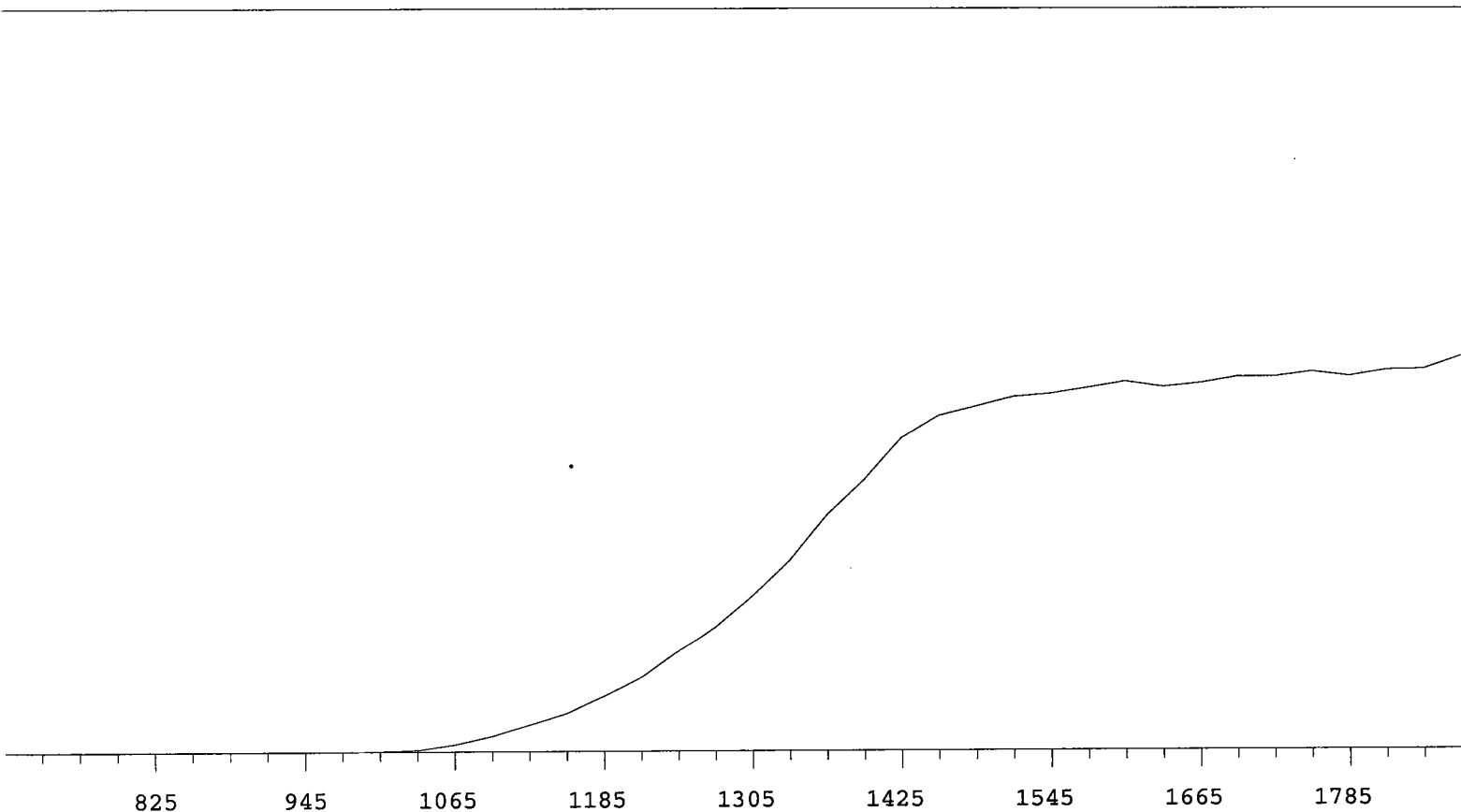
SampleID	Instr	Time (min.)	Alpha Counts	Beta Counts	Count Start Time	Count End Time	Machine
1	1A	15	36	1980	7/2/2009 8:39	7/2/2009 8:54	Protean
2	1B	15	27	1959	7/2/2009 8:40	7/2/2009 8:55	Protean
3	1C	15	44	2108	7/2/2009 8:40	7/2/2009 8:55	Protean
4	1D	15	108	2265	7/2/2009 8:40	7/2/2009 8:55	Protean
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

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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

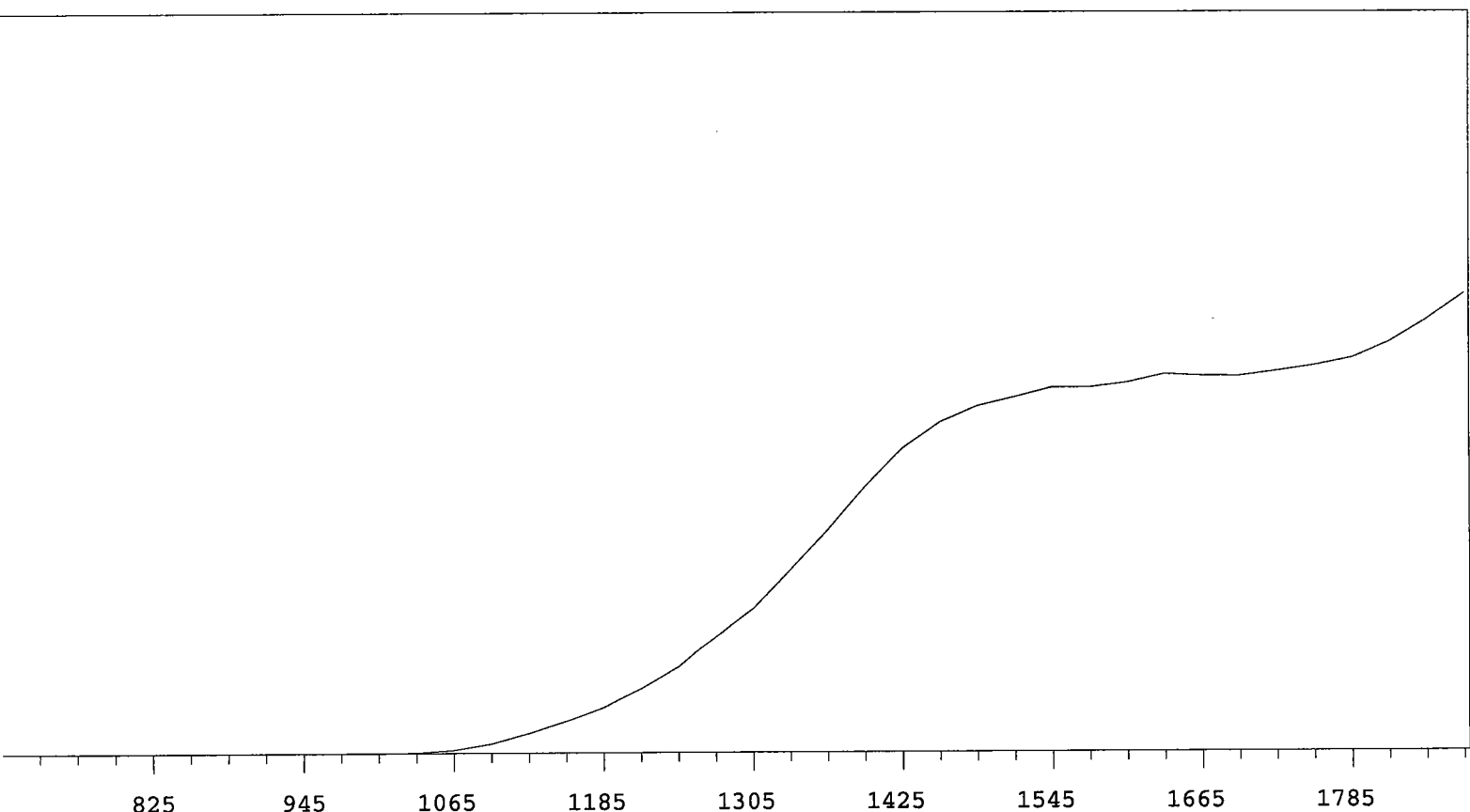
Ra-228 Protean	Cal Date A0	7/2/2009 A1	Exp Date A2	7/31/2009 A3	A4
1A	6.30258E-01				
1B	6.28221E-01				
1C	6.17615E-01				
1D	6.04341E-01				
2A	6.17224E-01				
2B	6.16681E-01				
2C	5.96919E-01				
2D	6.11886E-01				
3A	5.68218E-01				
3B	5.98041E-01				
3C	6.16431E-01				
3D	5.99405E-01				
4A	6.20765E-01				
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				

13B	6.52643E-01
13C	6.53798E-01
13D	6.37701E-01
14A	6.39290E-01
14B	6.26611E-01
14C	6.37531E-01
14D	6.32609E-01



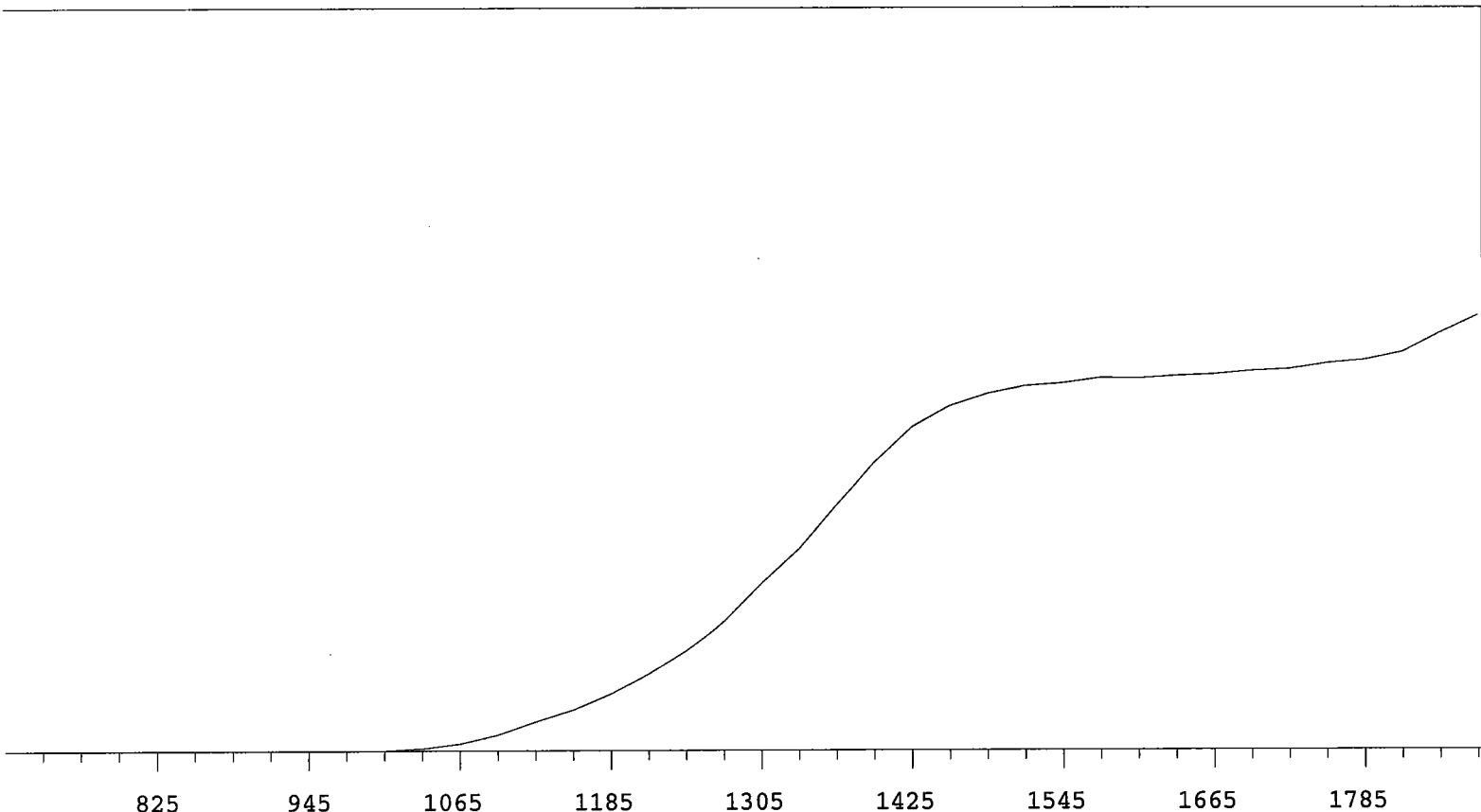
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	11640	+69.78
735	1		1335	14241	+62.88
765	0		1365	17534	+55.91
795	0	+0.00	1395	20127	+45.04
825	0	>100	1425	23254	+31.29
855	1	>100	1455	24902	+20.41
885	0	+55.56	1485	25605	+10.49
915	2	+66.67	1515	26310	+6.44
945	0	>100	1545	26535	+5.31
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

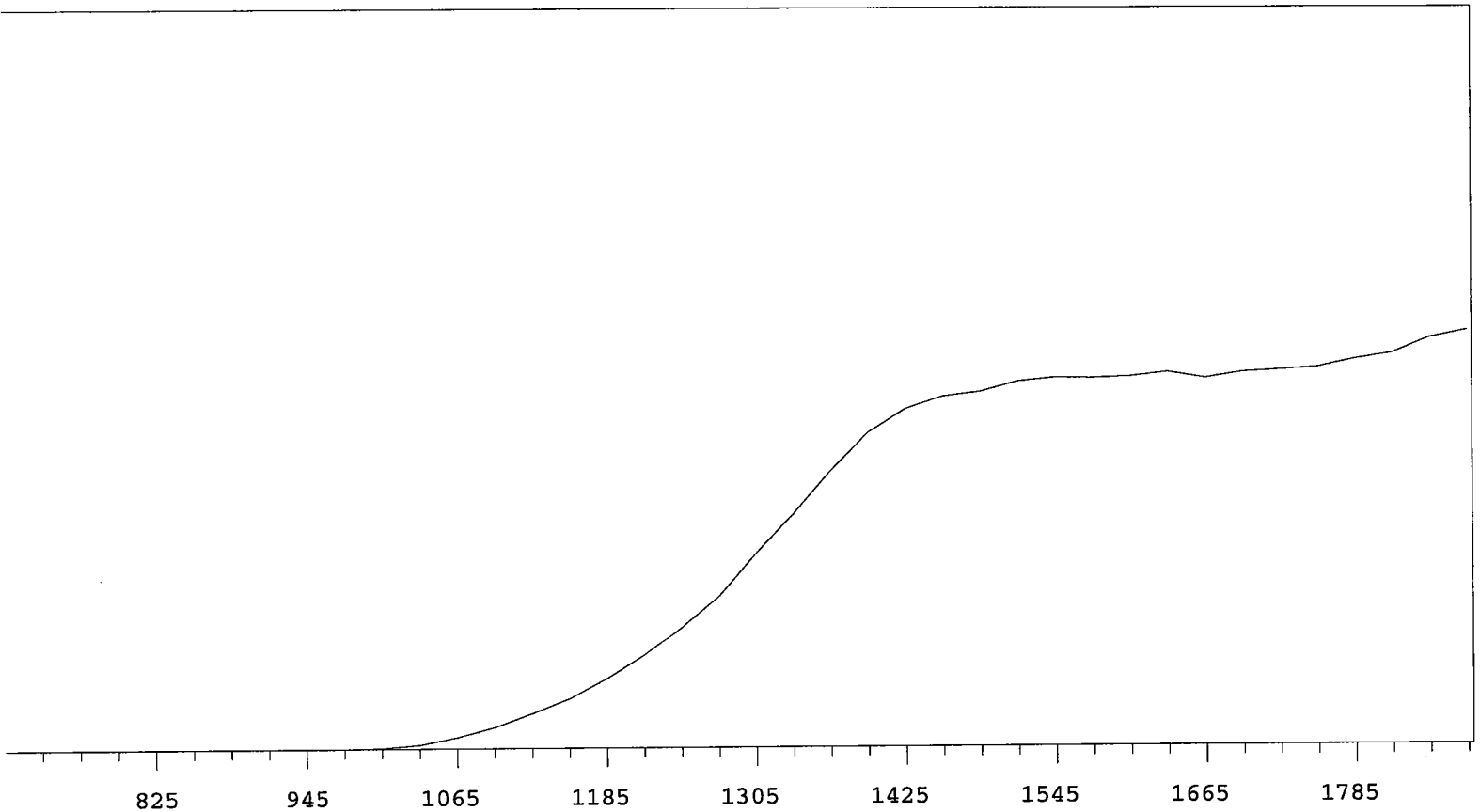


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	13188	+75.92
735	0		1335	16818	+67.60
765	0	+55.56	1365	20420	+59.86
795	1	+83.33	1395	24341	+47.85
825	1	+55.56	1425	27854	+35.51
855	0	>100	1455	30288	+23.26
885	1	+0.00	1485	31798	+14.54
915	0	+0.00	1515	32622	+8.32
945	1	>100	1545	33496	+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



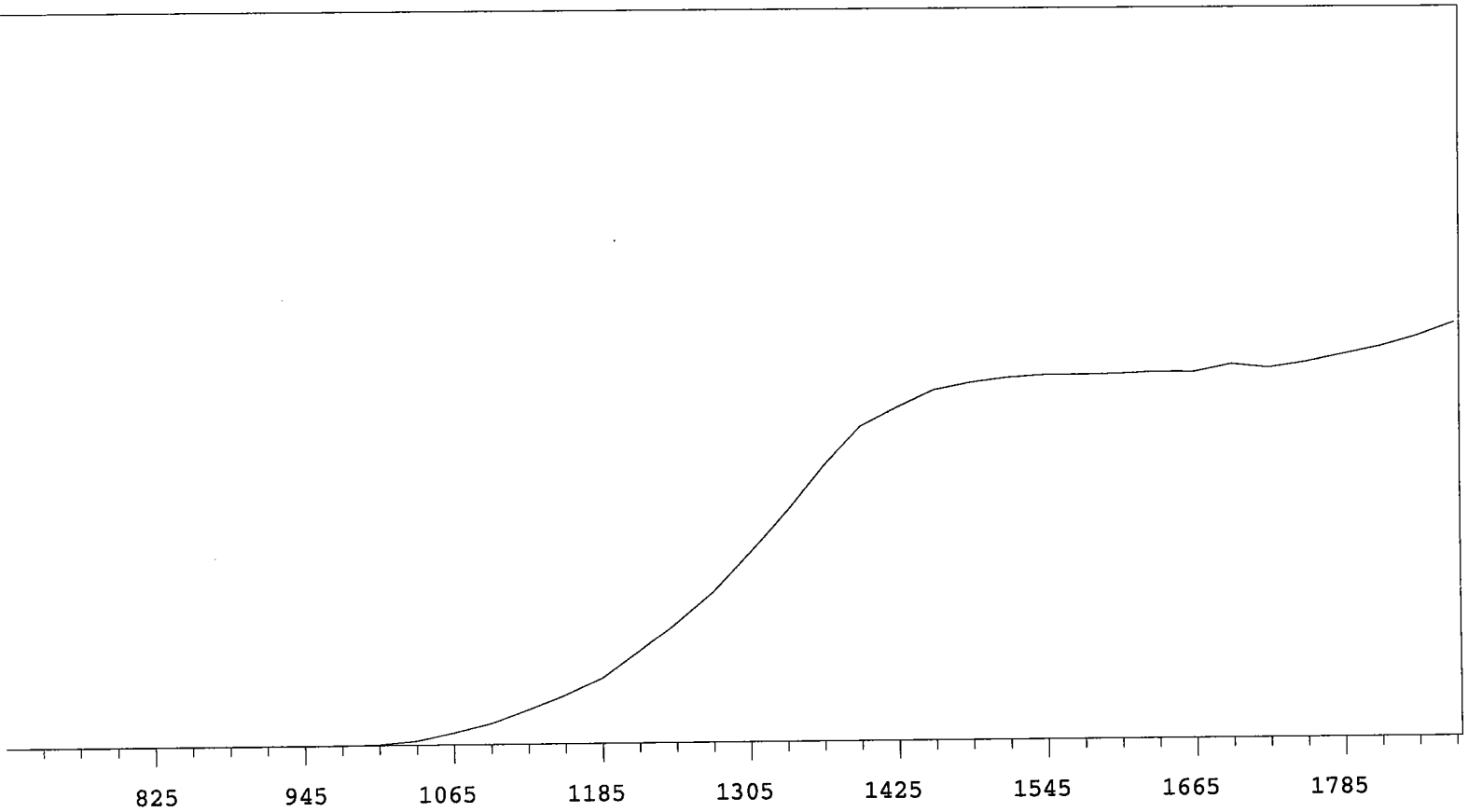
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	14817	+71.06
735	0		1335	17823	+63.34
765	1	+0.00	1365	21704	+53.63
795	0	>100	1395	25422	+42.55
825	1	-55.56	1425	28424	+29.21
855	1	+55.56	1455	30244	+18.11
885	0	>100	1485	31305	+10.10
915	1	>100	1515	31989	+6.07
945	0	>100	1545	32223	+3.43
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	



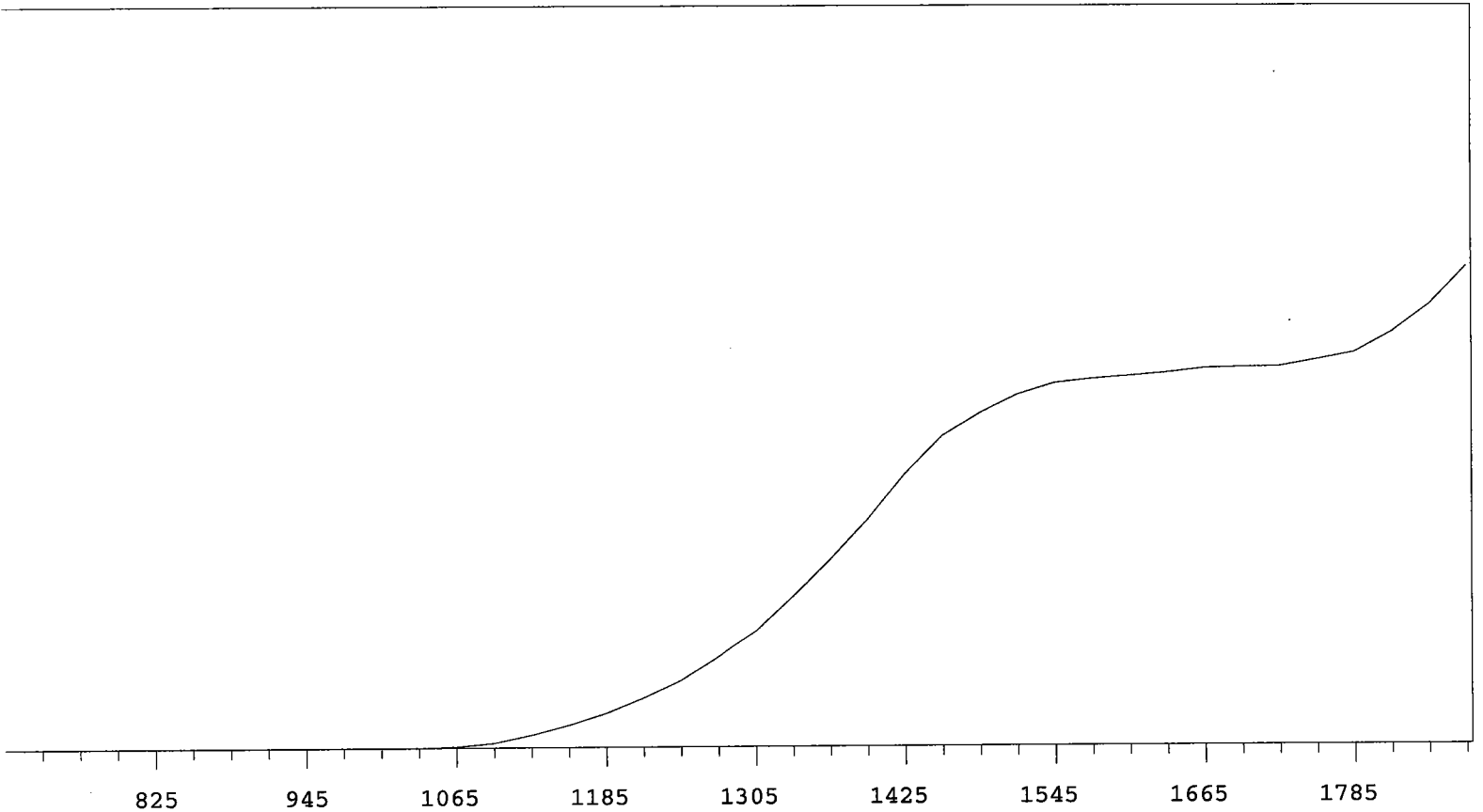
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	15202	+66.36
735	1		1335	18216	+57.86
765	0	+0.00	1365	21597	+45.58
795	1	+0.00	1395	24648	+32.96
825	0	+0.00	1425	26505	+19.92
855	1	>100	1455	27475	+11.42
885	0	>100	1485	27836	+7.08
915	0	>100	1515	28609	+4.51
945	0	>100	1545	28896	+2.93
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

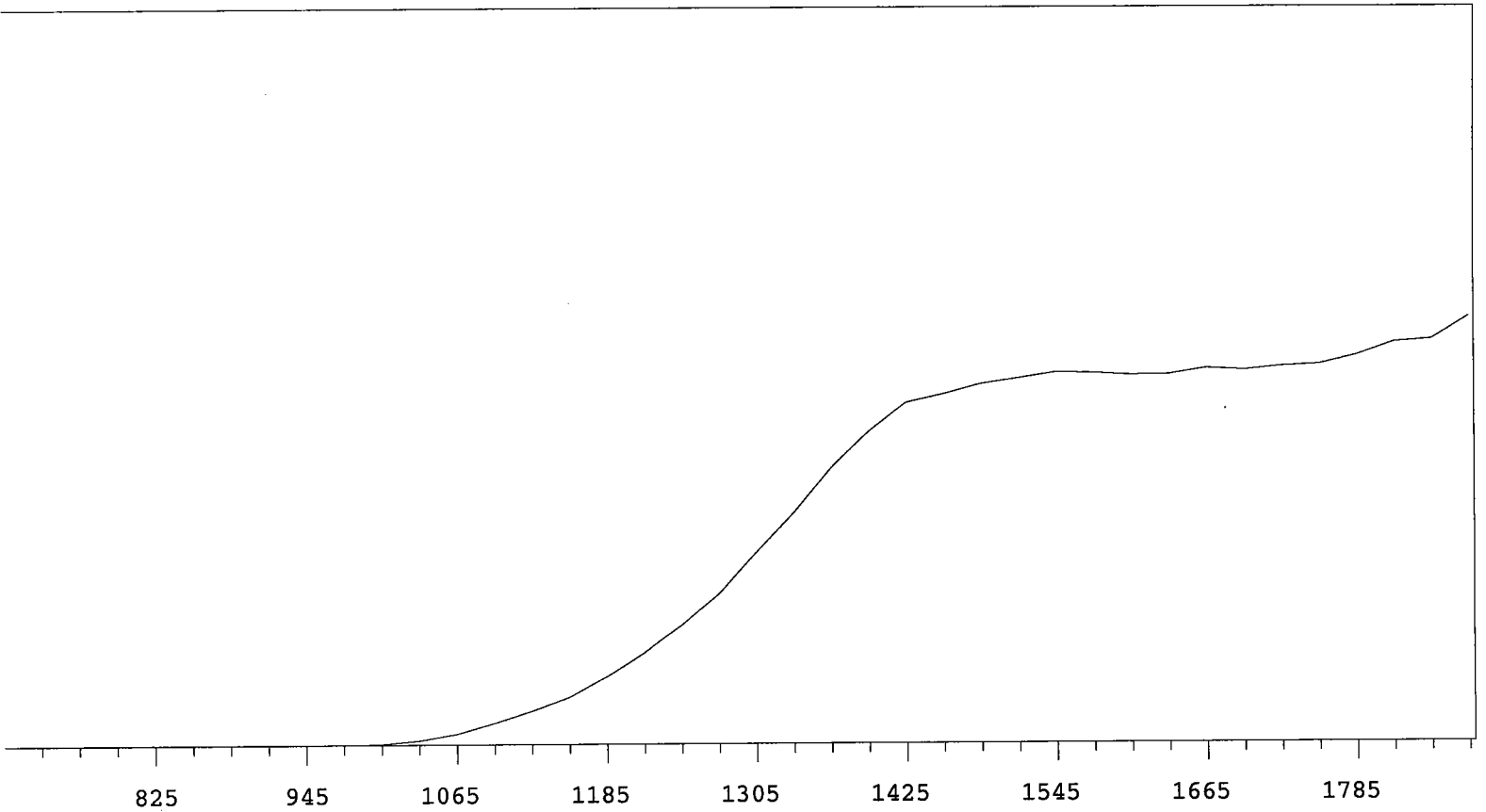
Instrument 2 MPC 9604 Detector A 7/1/2009
Beta Volts: 1575



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	

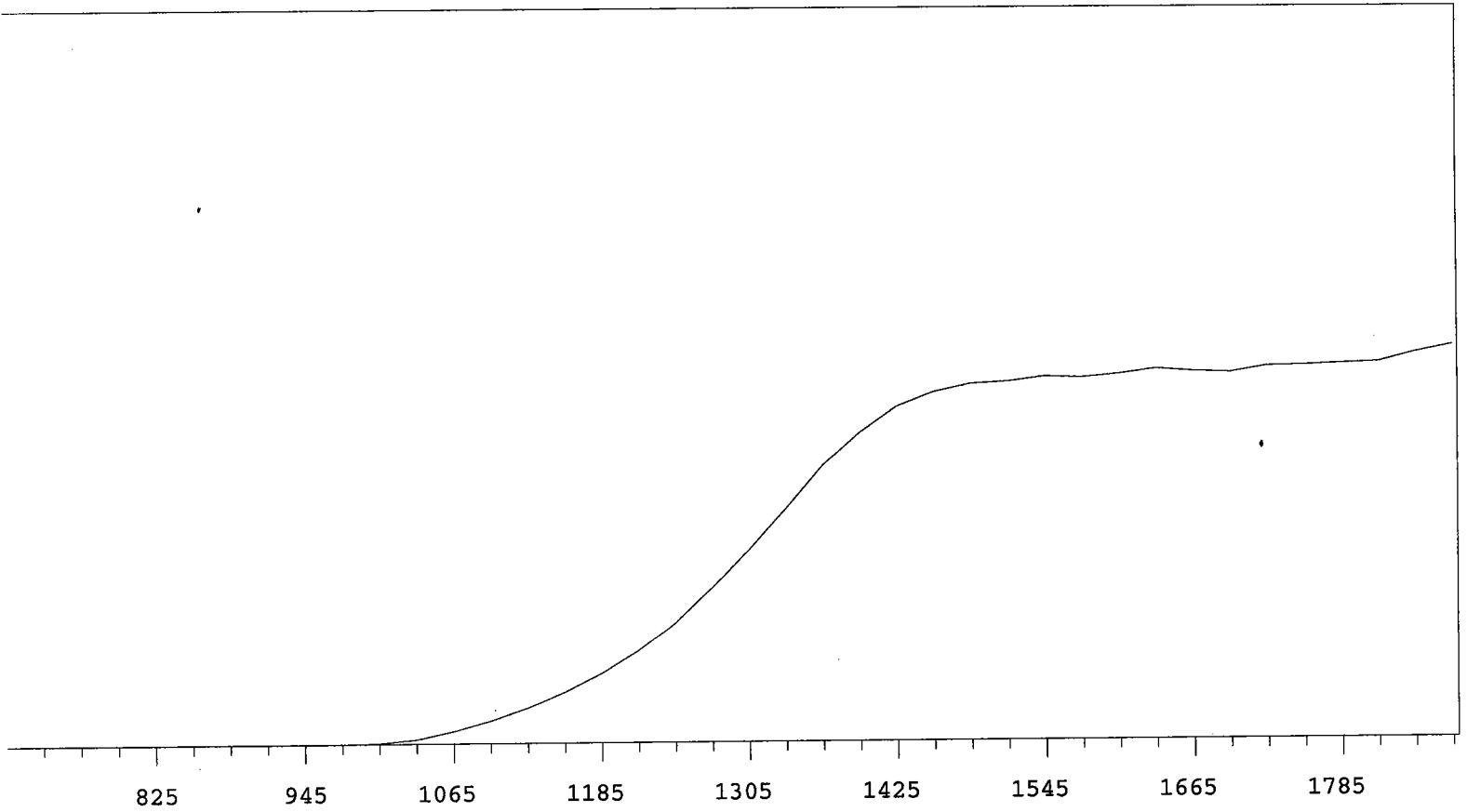


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18216	+67.74
735	0		1335	21995	+58.11
765	0		1365	26173	+46.11
795	0	>100	1395	29479	+32.75
825	0	>100	1425	32186	+20.62
855	0	>100	1455	33022	+12.13
885	0	>100	1485	33981	+7.22
915	1	>100	1515	34520	+4.95
945	0	>100	1545	35095	+2.07
975	17	>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	

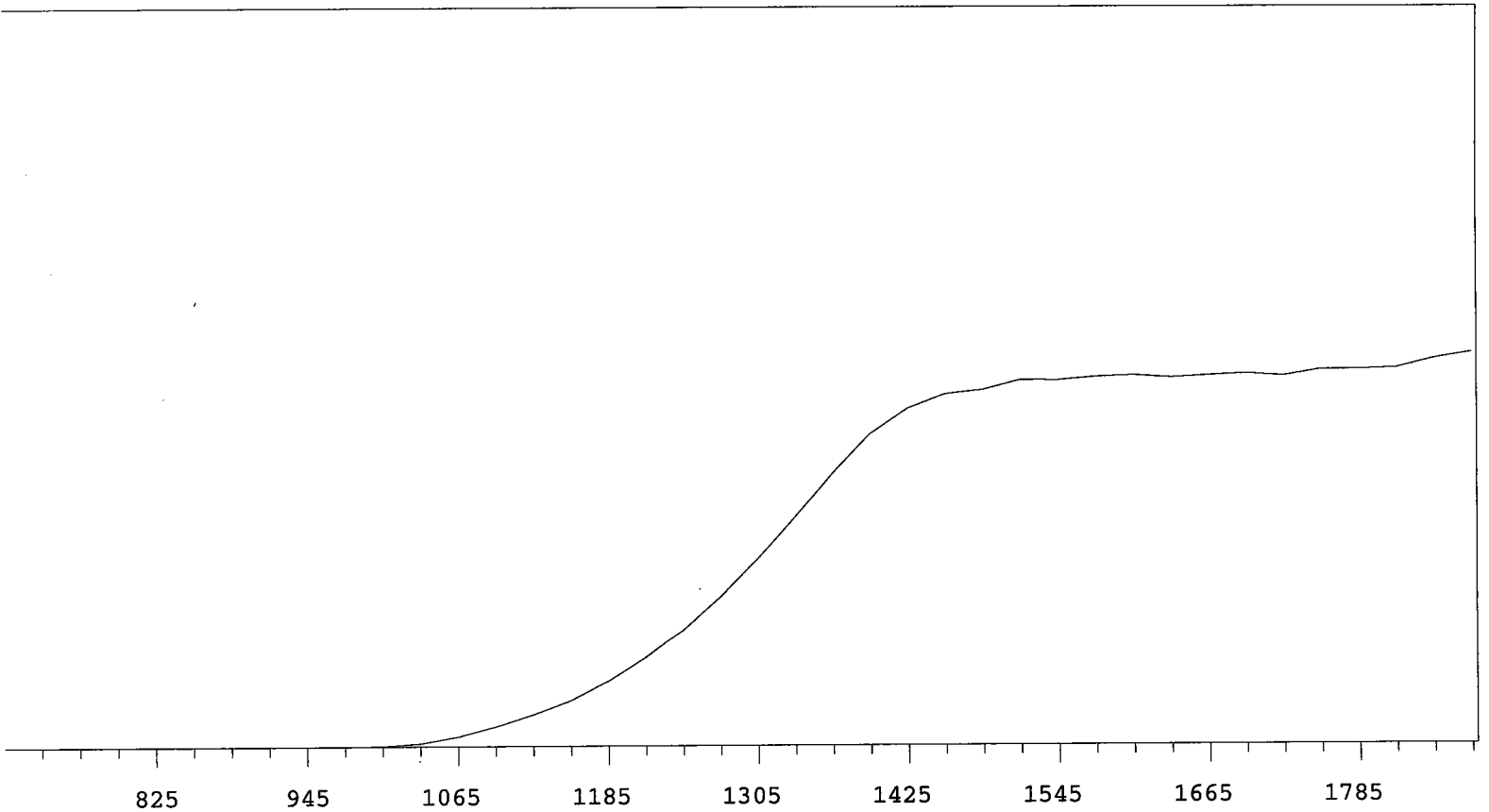
MPC 9600 Plateau
Alpha Volts: 705

Instrument 2 MPC 9604 Detector D
Beta Volts: 1575

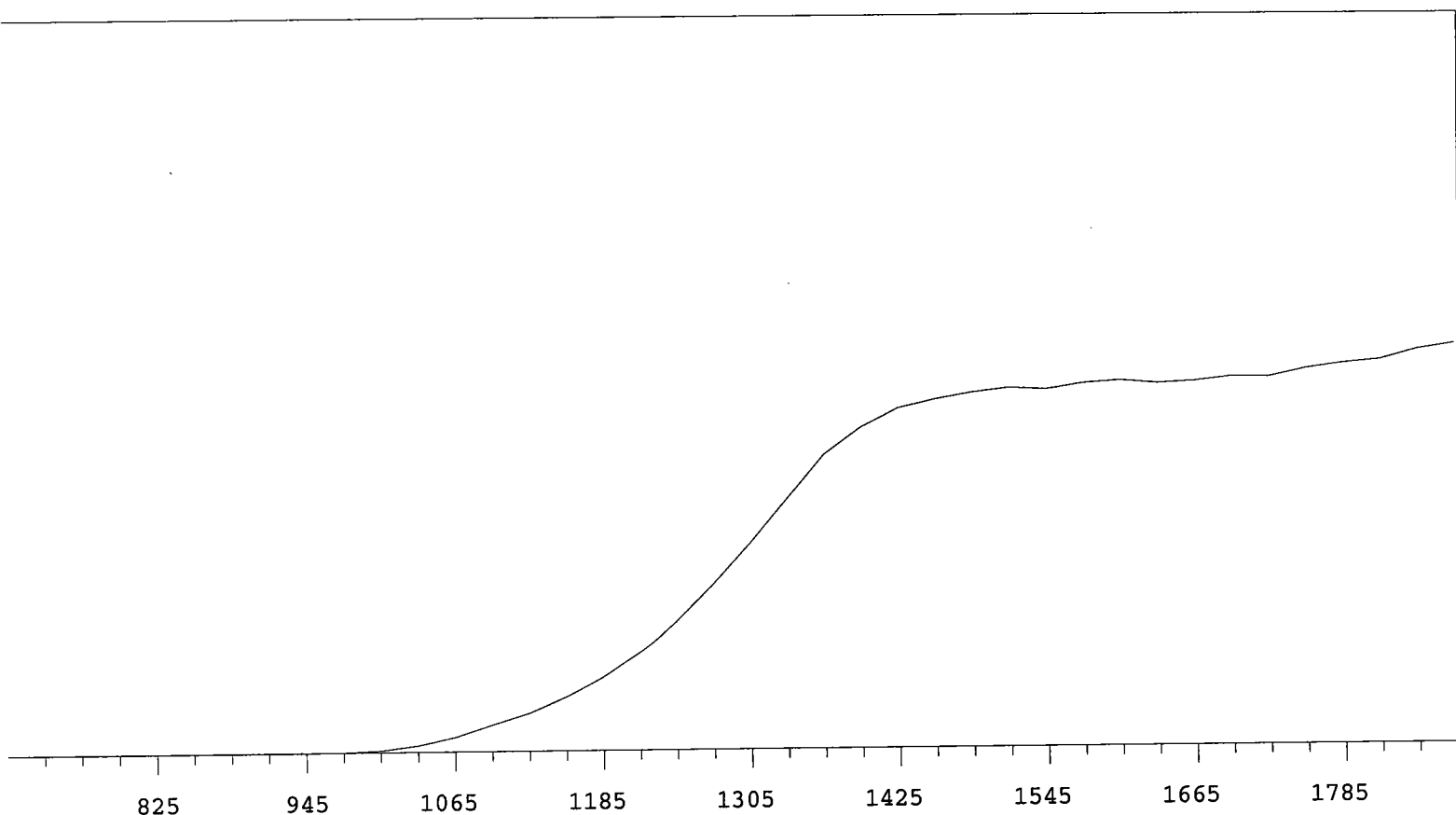
7/1/2009



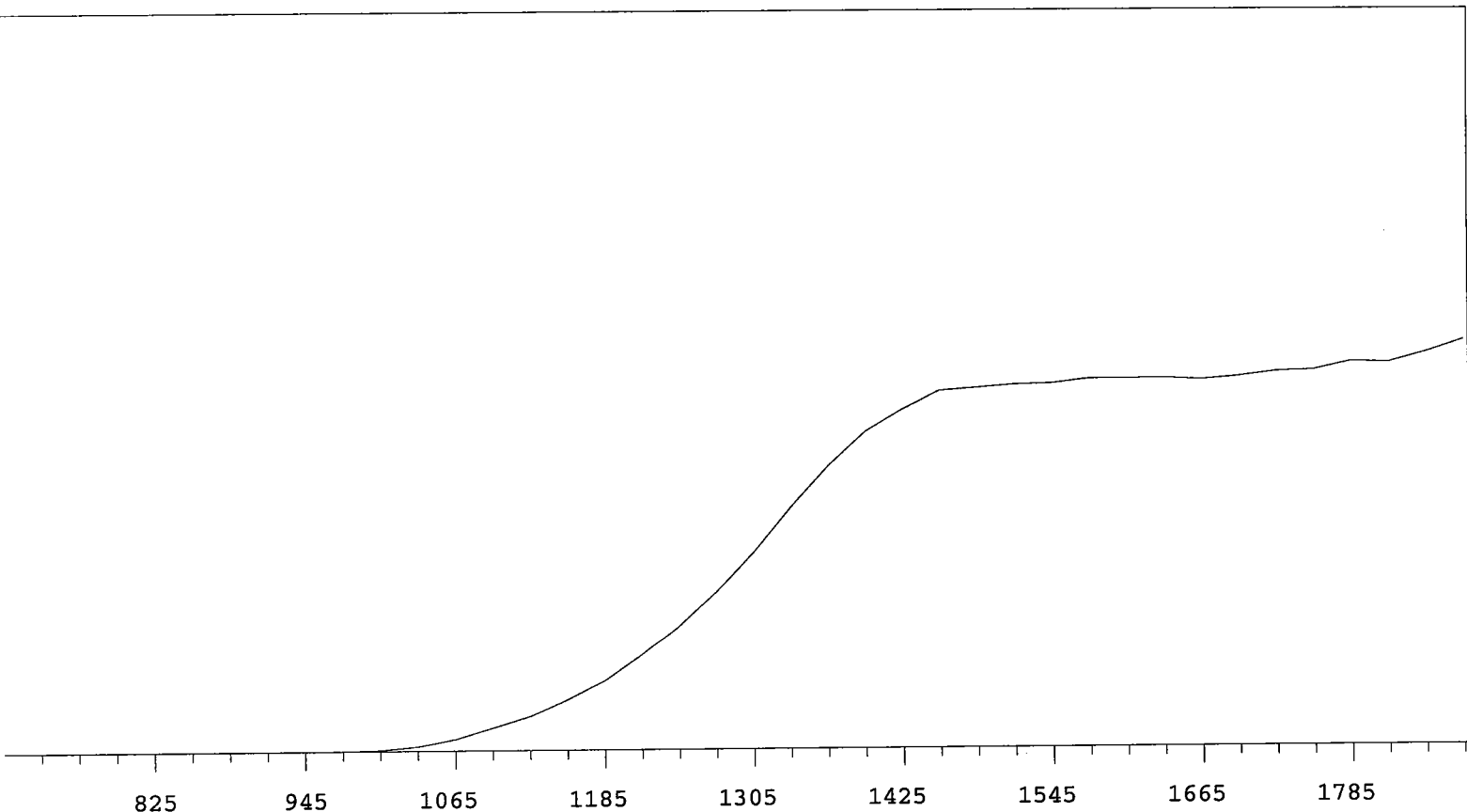
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18675	+65.94
735	0		1335	22620	+55.69
765	0	+83.33	1365	26869	+44.63
795	2	+55.56	1395	29957	+32.08
825	1	>100	1425	32494	+20.49
855	0	>100	1455	33836	+11.98
885	0	>100	1485	34627	+6.45
915	0	>100	1515	34849	+3.22
945	2	>100	1545	35298	+1.98
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	



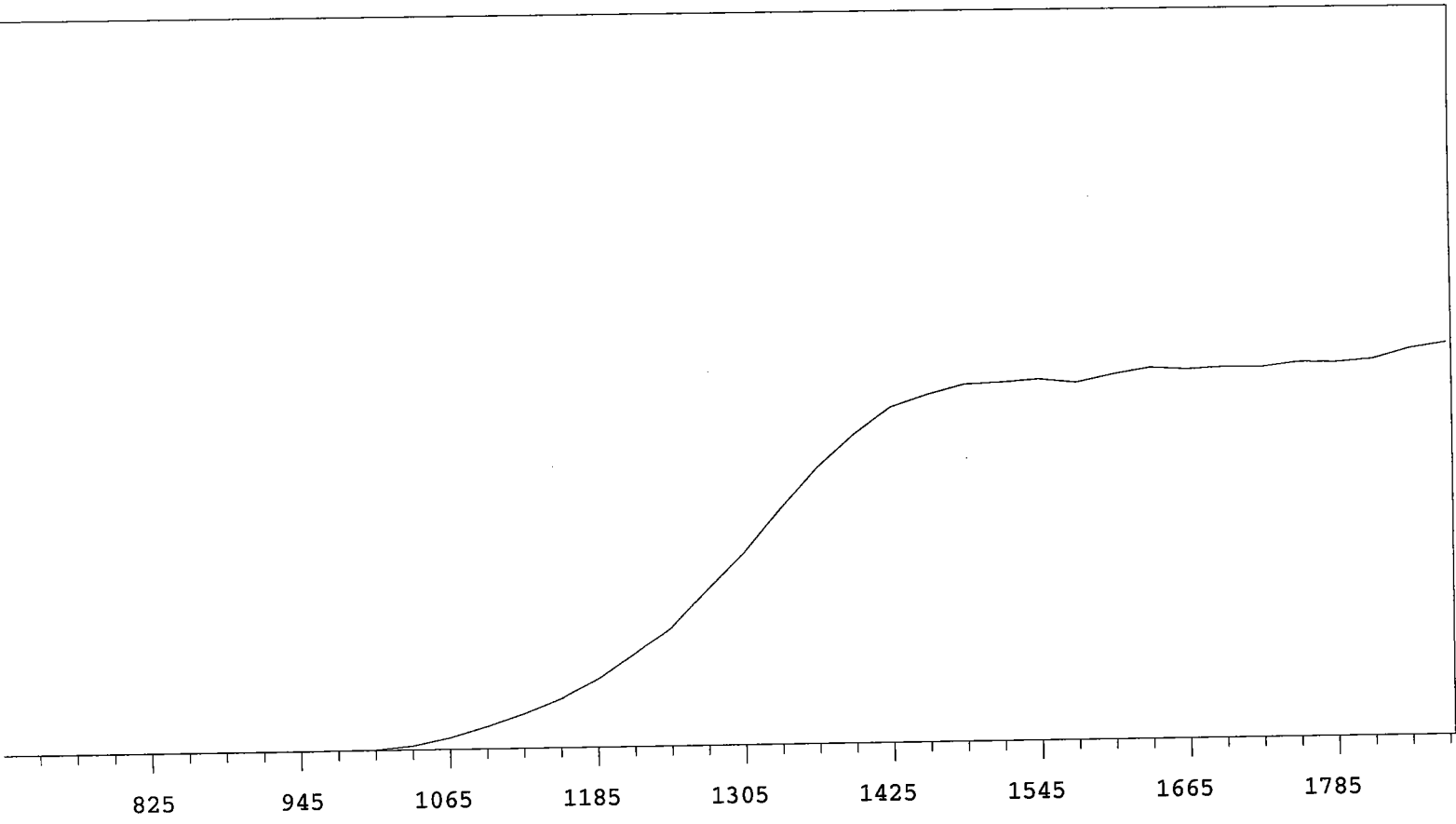
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	16654	+68.57
735	0		1335	20416	+59.26
765	0	+55.56	1365	24191	+47.28
795	1	>100	1395	27643	+34.04
825	1	+0.00	1425	29891	+21.08
855	1	>100	1455	31183	+12.30
885	0	>100	1485	31558	+6.67
915	0	>100	1515	32444	+4.05
945	0	>100	1545	32413	+2.90
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	



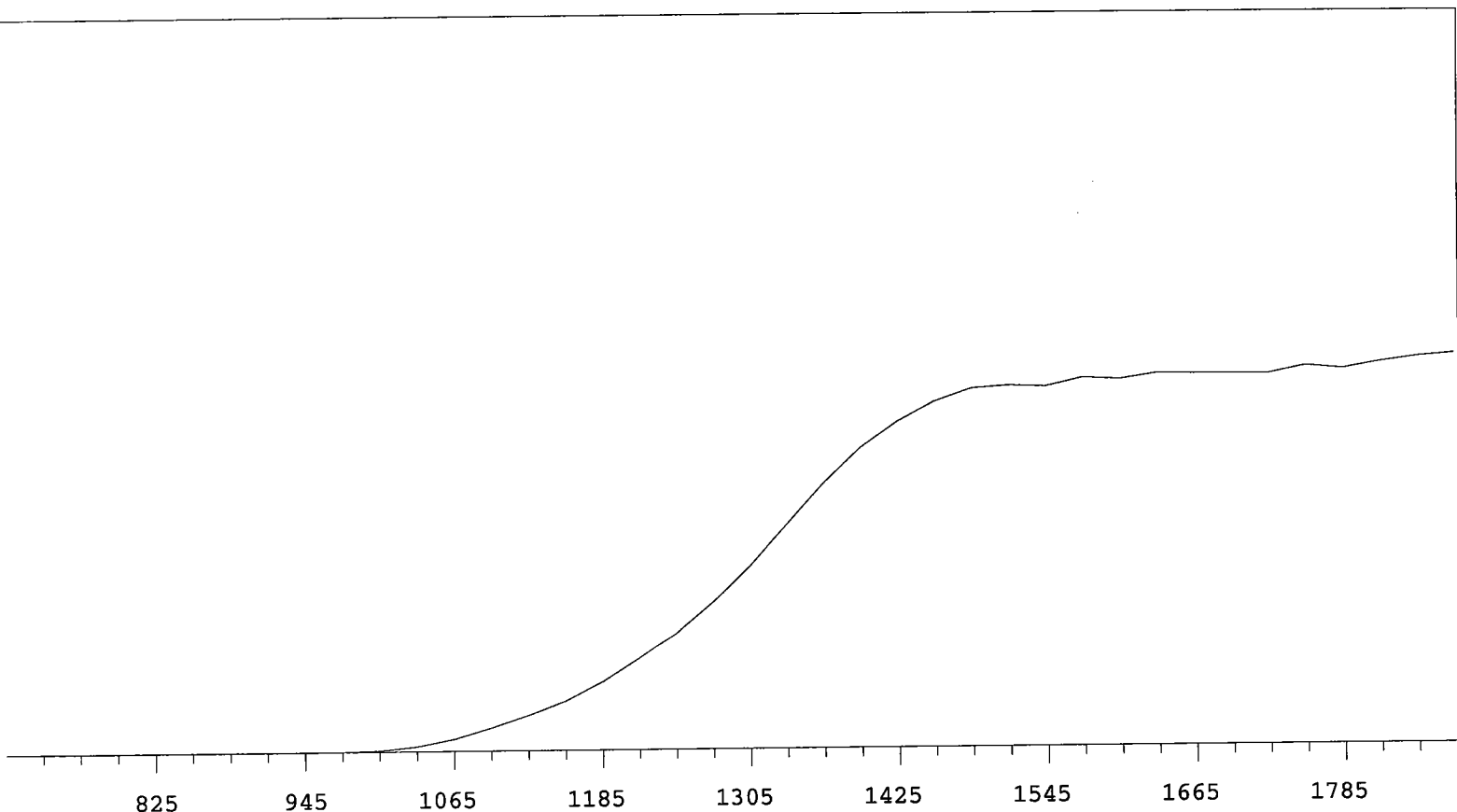
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	19810	+64.73
735	1		1335	23962	+52.62
765	0	-55.56	1365	28091	+39.27
795	0	>100	1395	30594	+25.61
825	1	>100	1425	32381	+14.86
855	3	+33.33	1455	33206	+8.91
885	0	+0.00	1485	33832	+4.41
915	1	>100	1515	34260	+3.01
945	2	>100	1545	34071	+2.33
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	



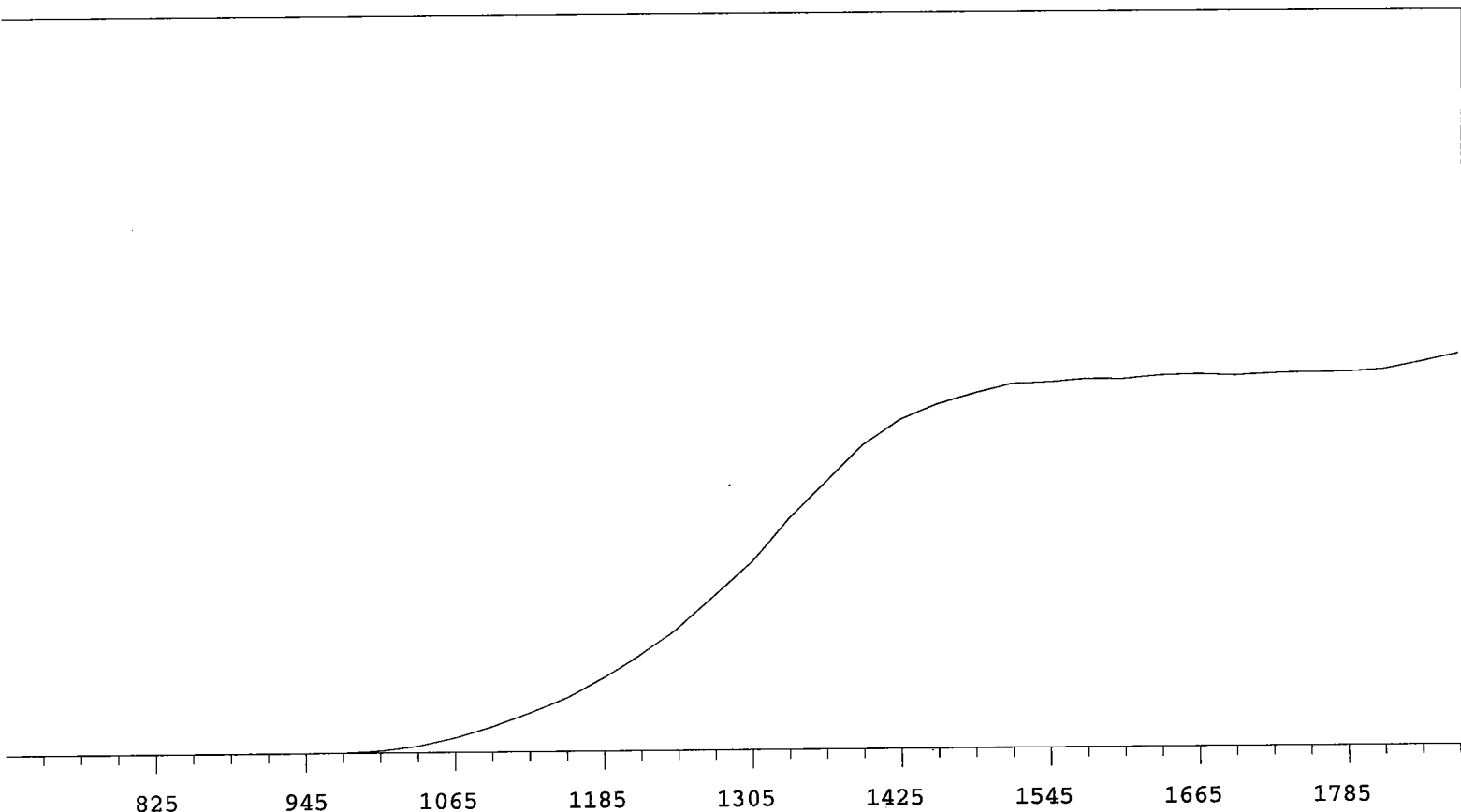
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	21412	+66.80
735	1		1335	26262	+56.32
765	1		1365	30679	+43.71
795	0	>100	1395	34466	+31.61
825	0	+0.00	1425	36949	+20.14
855	0	>100	1455	38998	+11.16
885	1	>100	1485	39313	+5.34
915	1	>100	1515	39625	+2.44
945	1	>100	1545	39751	+2.04
975	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	



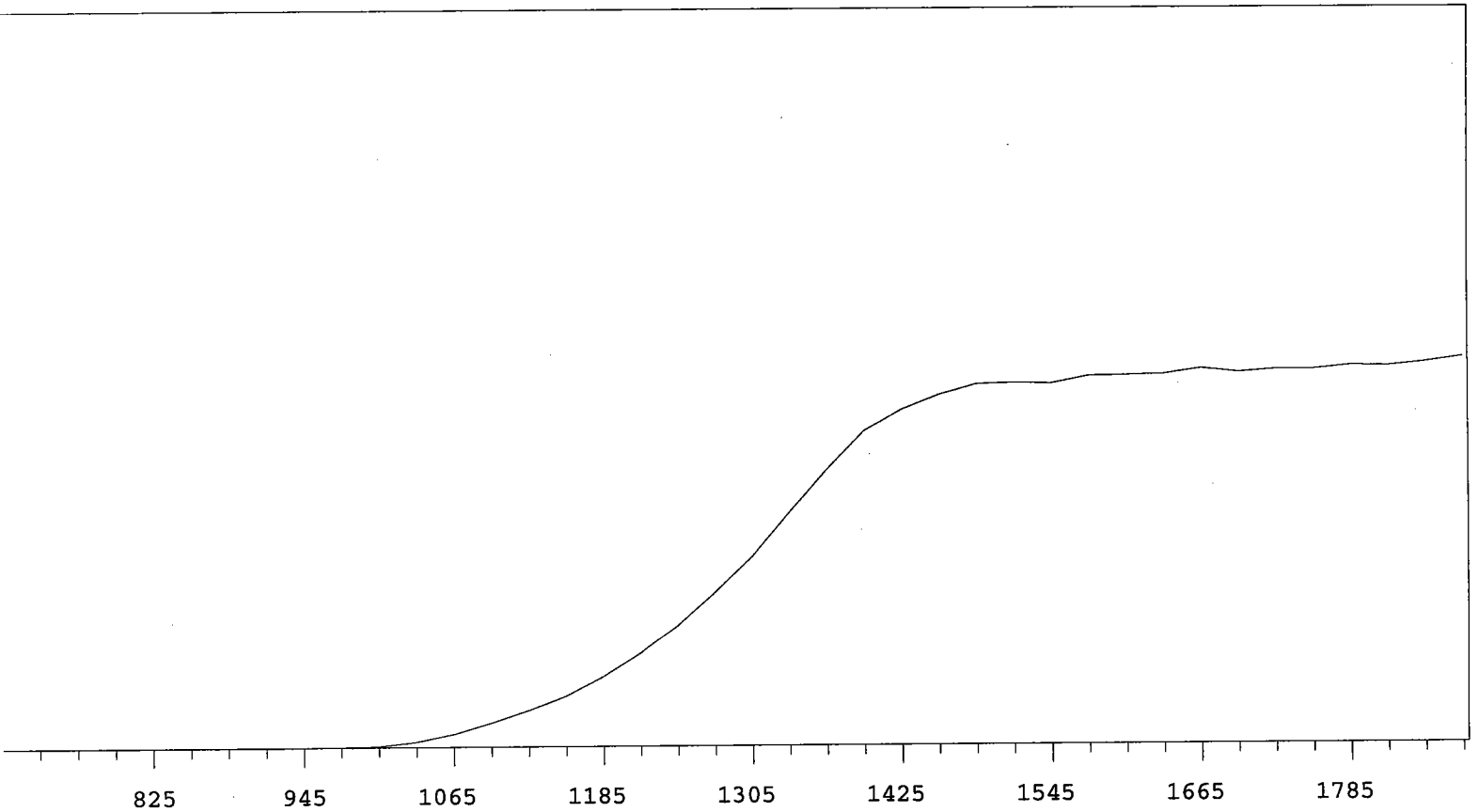
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	14171	+66.45
735	1		1335	17362	+54.90
765	0	+0.00	1365	20310	+43.83
795	1	>100	1395	22647	+30.82
825	0	+83.33	1425	24551	+20.19
855	0	-83.33	1455	25440	+11.69
885	1	>100	1485	26124	+5.90
915	0	>100	1515	26245	+2.21
945	1	>100	1545	26428	+1.39
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	



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	

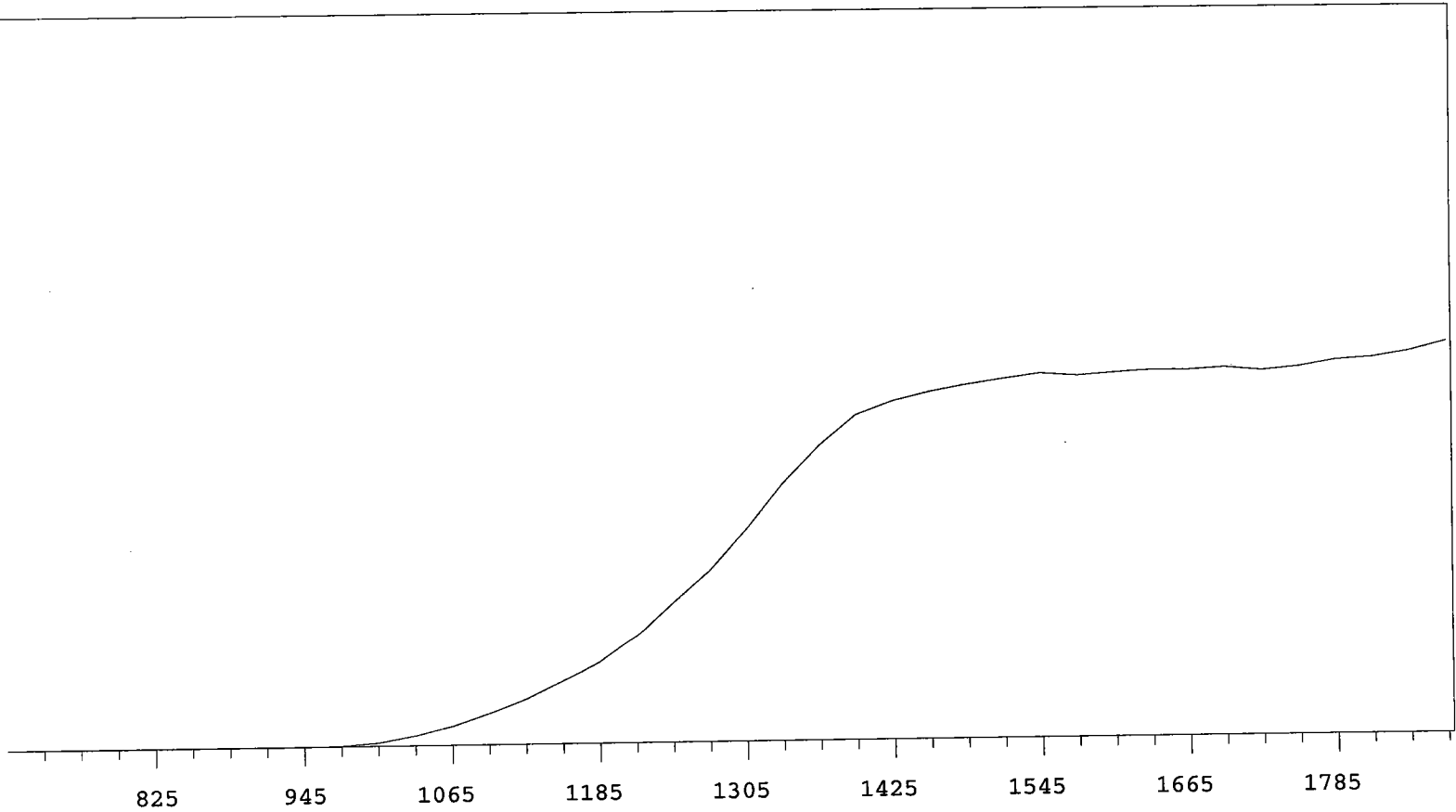


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	19796	+65.77
735	1		1335	24338	+57.55
765	0	+55.56	1365	28686	+45.86
795	2	+0.00	1395	32750	+32.27
825	0	-55.56	1425	34919	+20.83
855	1	>100	1455	36434	+11.45
885	0	>100	1485	37487	+5.80
915	0	>100	1515	37623	+3.32
945	2	>100	1545	37528	+2.07
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	

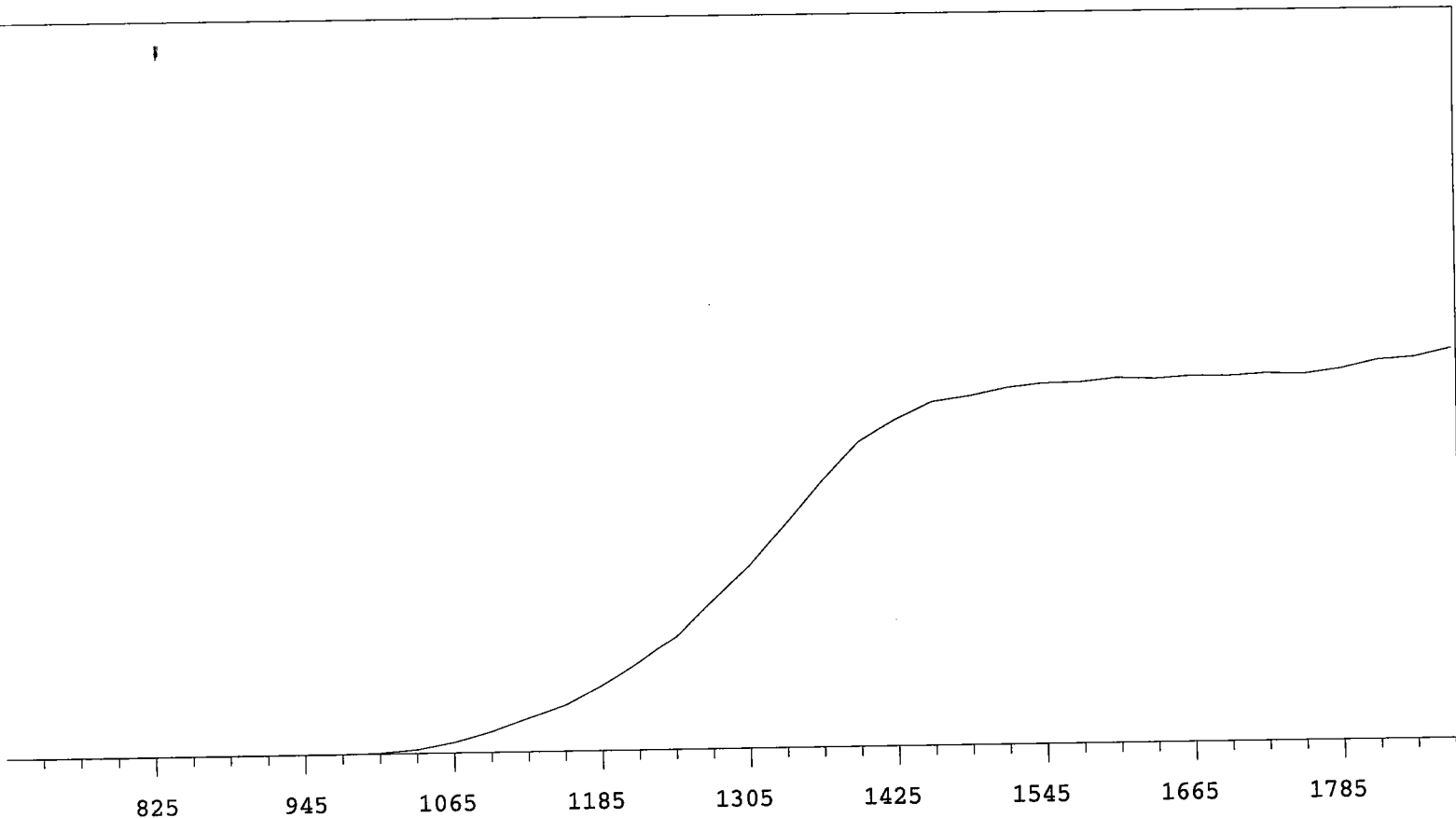
MPC 9600 Plateau
Alpha Volts: 705

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	

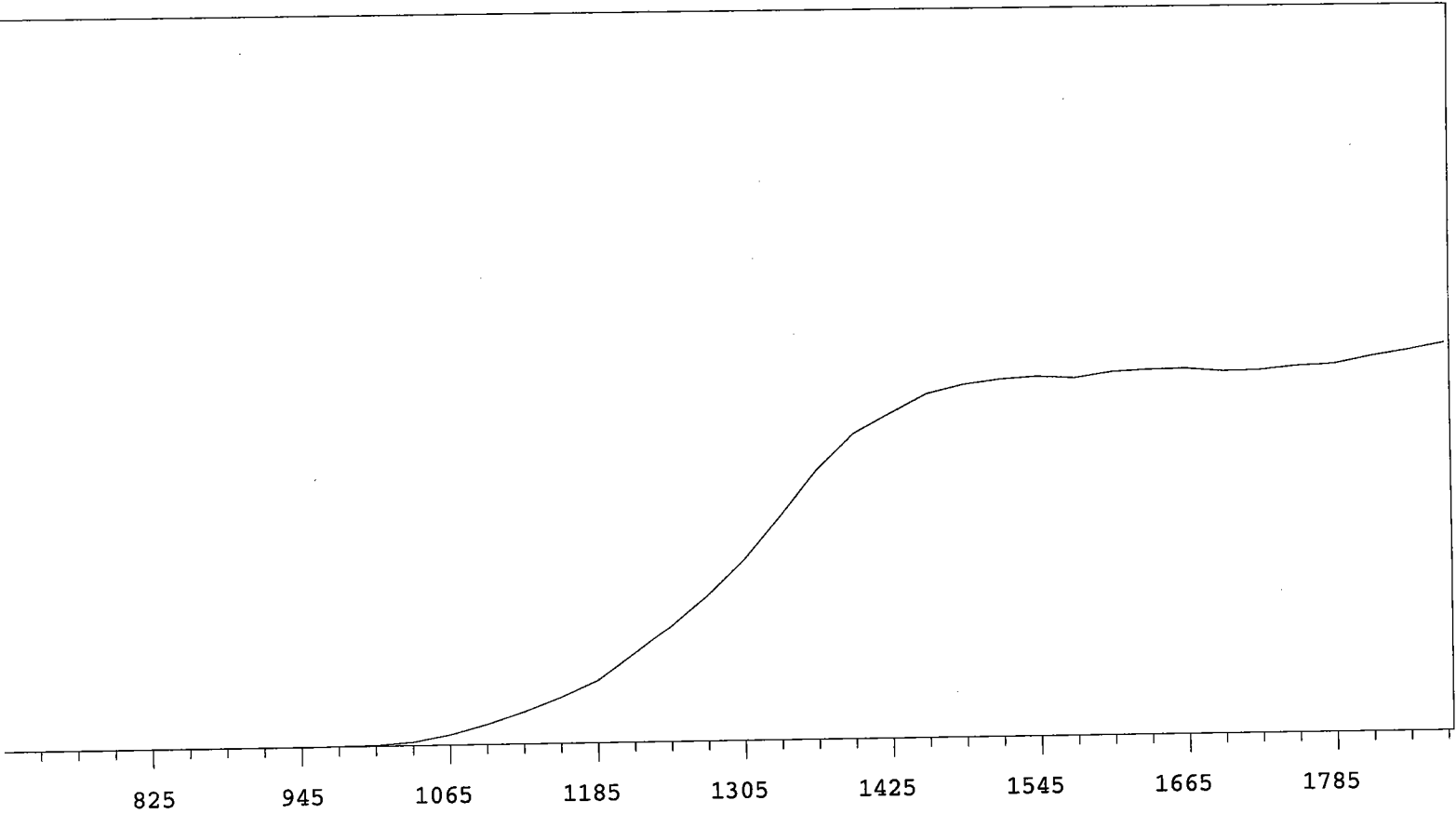


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	13974	+68.00
735	0		1335	17170	+58.62
765	1		1365	20456	+47.04
795	1	+83.33	1395	23332	+33.83
825	1	-83.33	1425	24996	+21.10
855	1	>100	1455	26290	+12.40
885	0	-55.56	1485	26683	+7.74
915	0	>100	1515	27270	+4.43
945	1	>100	1545	27590	+3.48
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

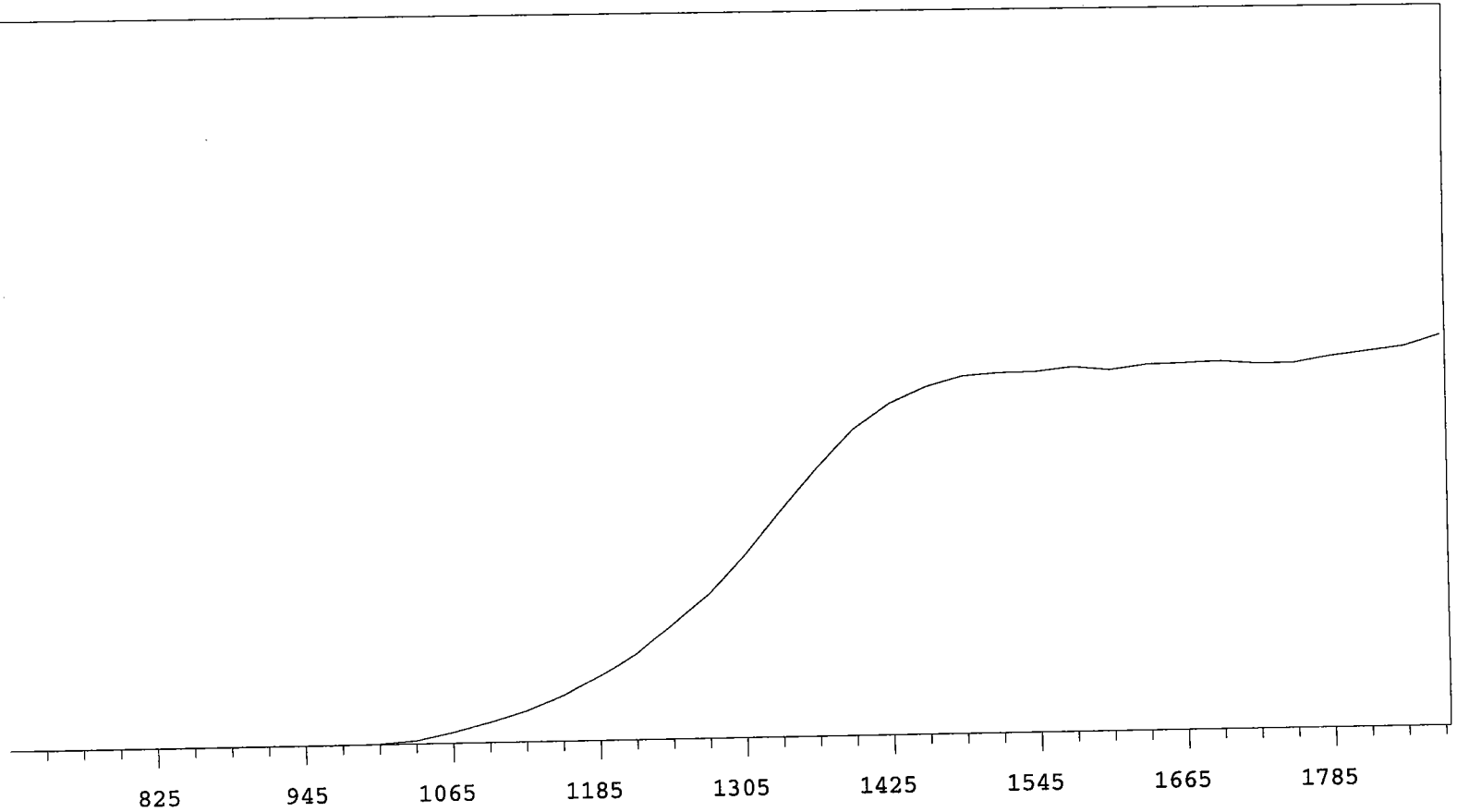


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17414	+68.46
735	0		1335	21540	+59.98
765	0		1365	25854	+46.75
795	0	>100	1395	29222	+33.38
825	1	>100	1425	31128	+21.52
855	1	+41.67	1455	32995	+13.26
885	2	-33.33	1485	33846	+8.09
915	0	>100	1515	34289	+3.25
945	1	>100	1545	34528	+2.00
975	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	

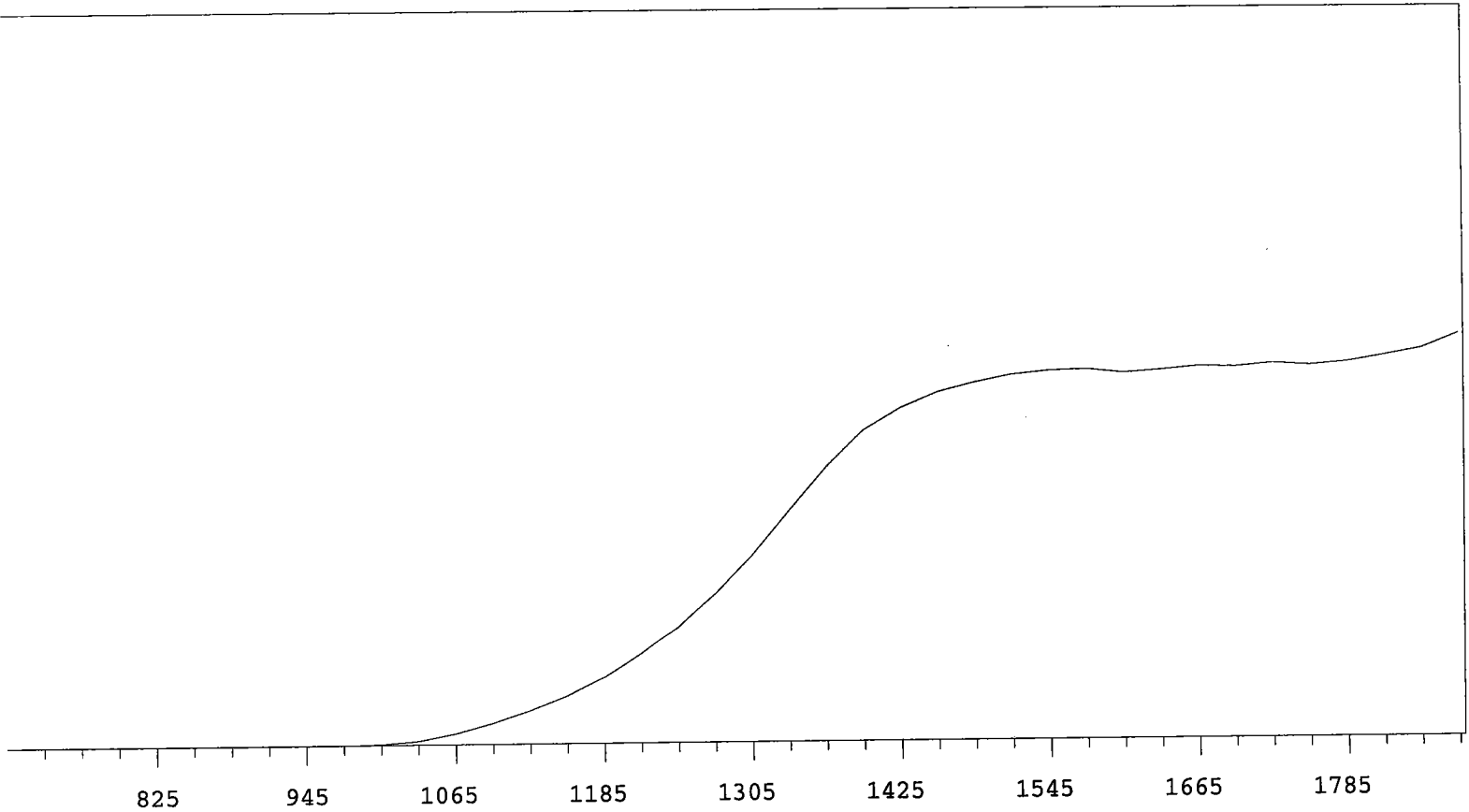
MPC 9600 Plateau
Alpha Volts: 705

Instrument 5 MPC 9604 Detector C
Beta Volts: 1575

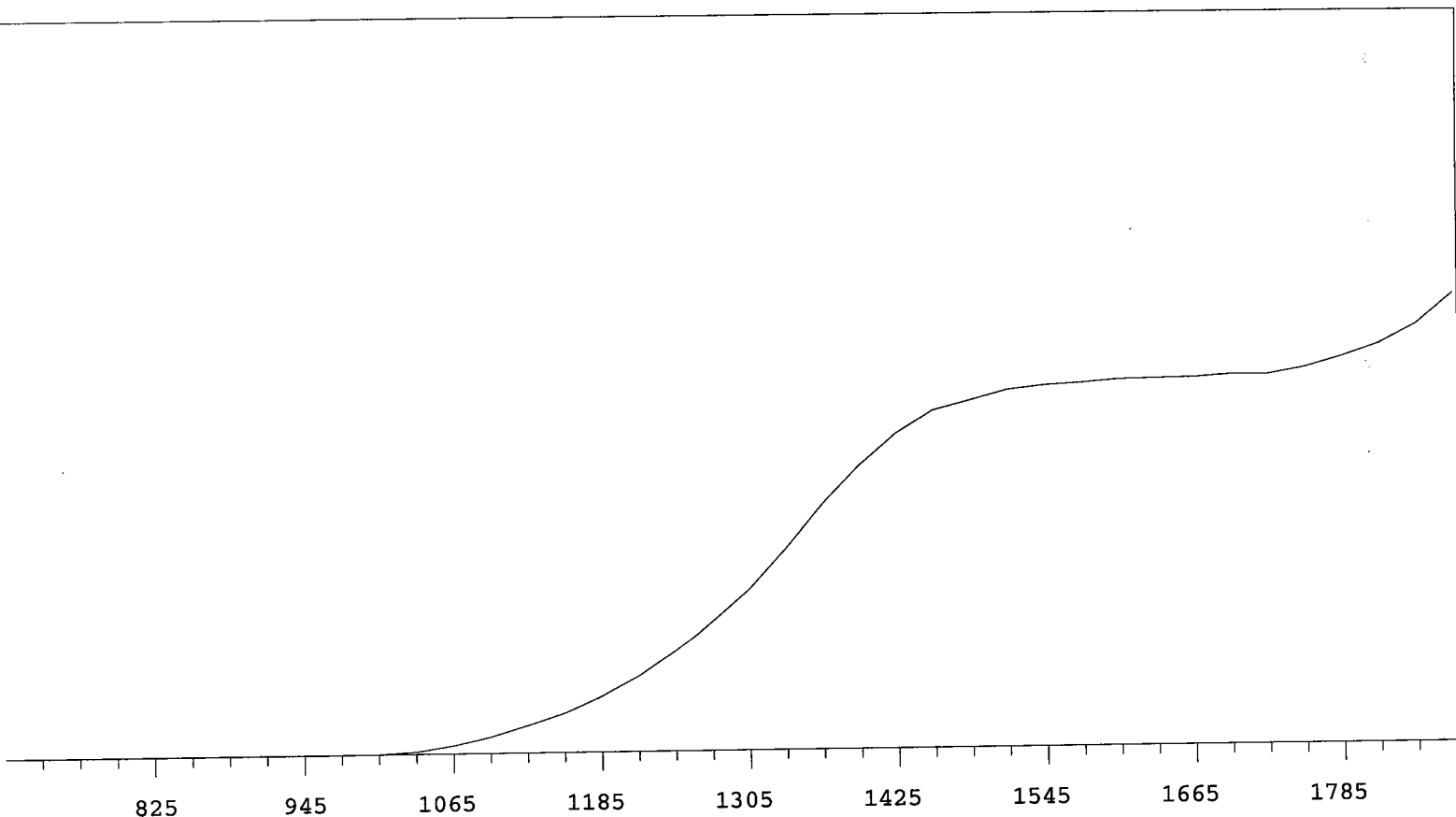
7/1/2009



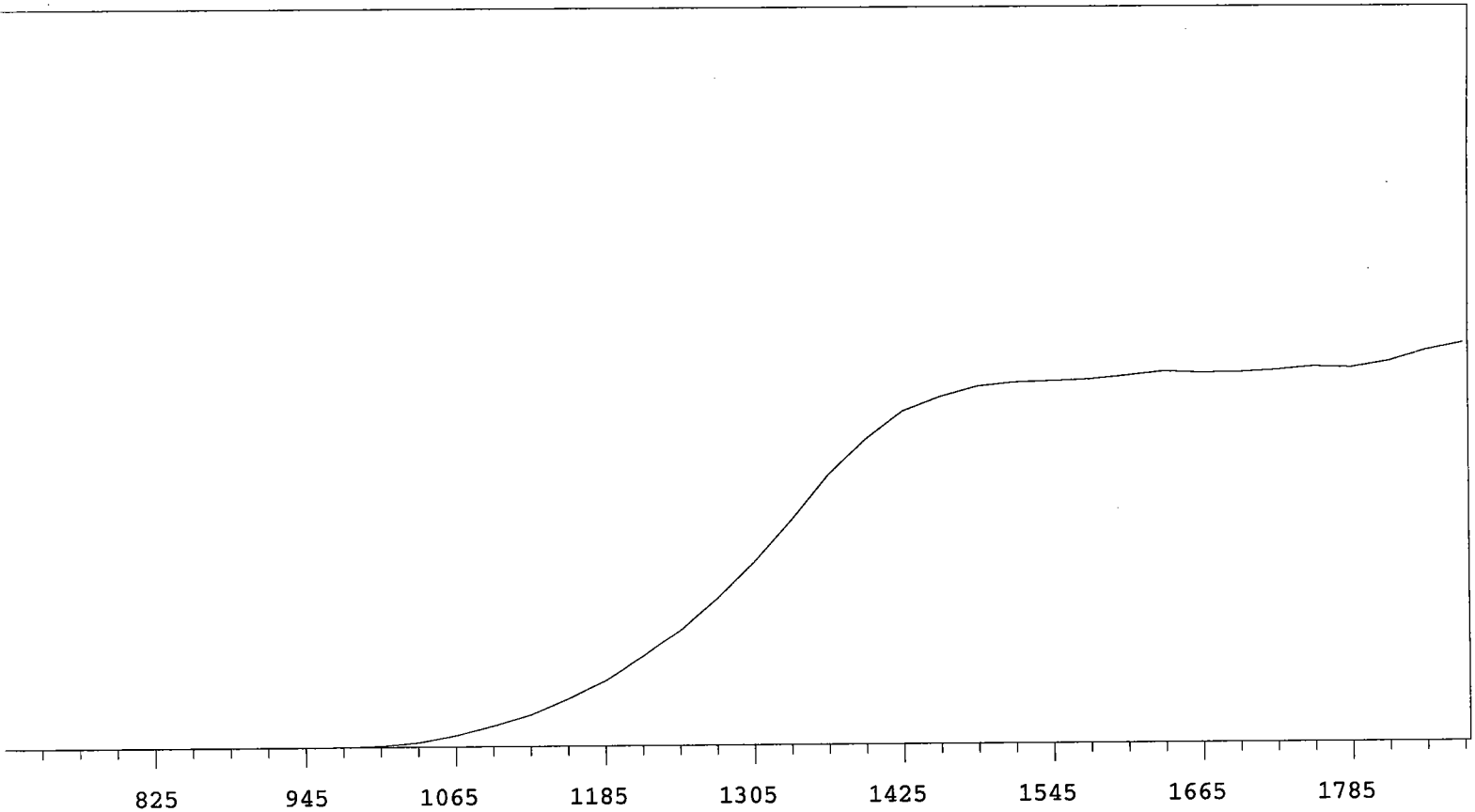
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17085	+68.24
735	0		1335	21135	+59.99
765	0		1365	25066	+47.39
795	0	>100	1395	28530	+33.93
825	0	>100	1425	30823	+22.30
855	1	>100	1455	32287	+12.93
885	0	>100	1485	33217	+6.71
915	1	>100	1515	33474	+3.57
945	2	>100	1545	33517	+1.17
975	7	>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	

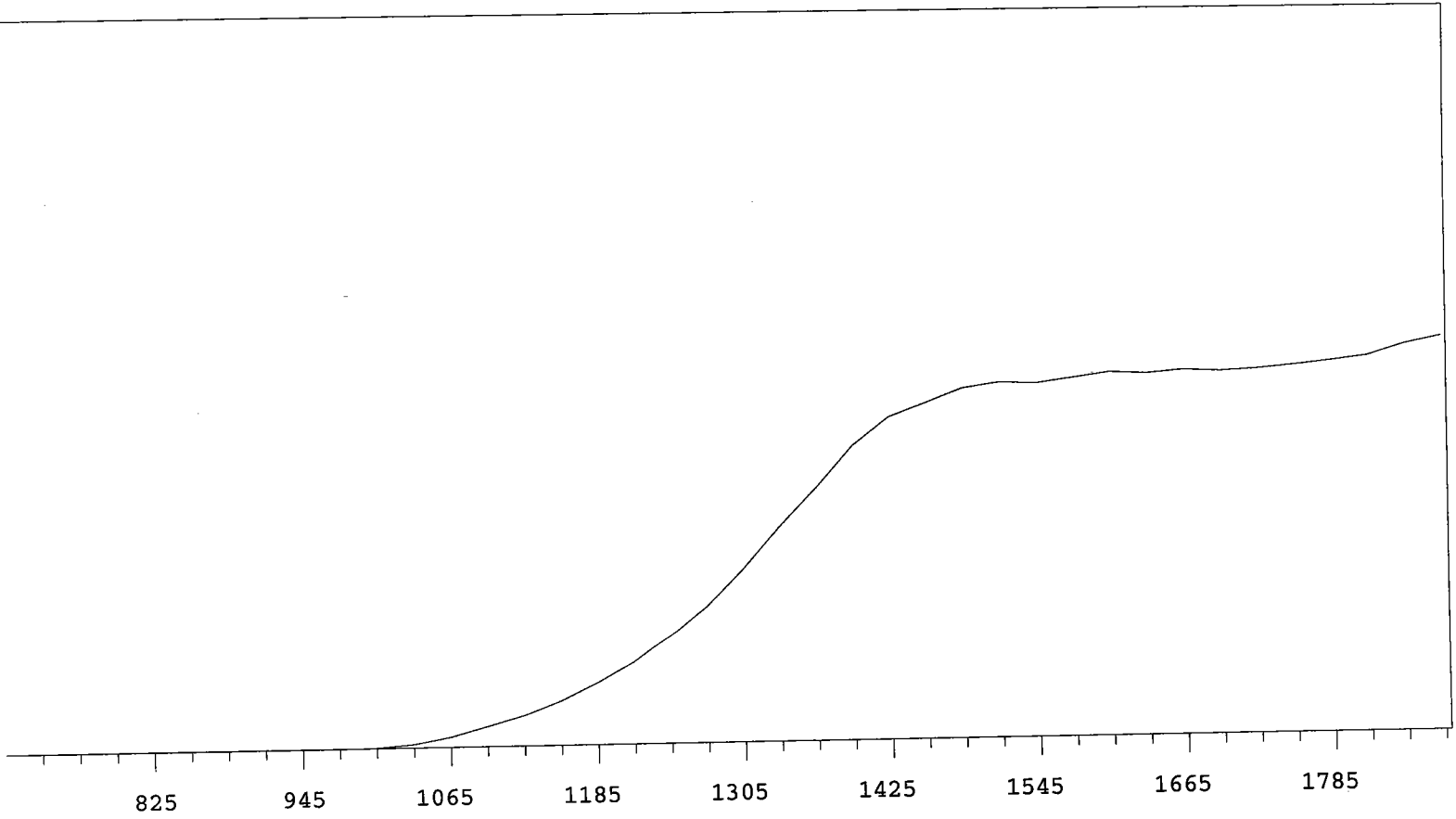


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	20094	+68.67
735	0		1335	24665	+59.40
765	0		1365	29591	+47.86
795	0	>100	1395	33376	+34.51
825	1	+83.33	1425	36440	+22.50
855	1	-83.33	1455	38024	+13.58
885	0	>100	1485	39187	+7.04
915	0	>100	1515	39608	+3.63
945	5	>100	1545	39722	+2.10
975	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	

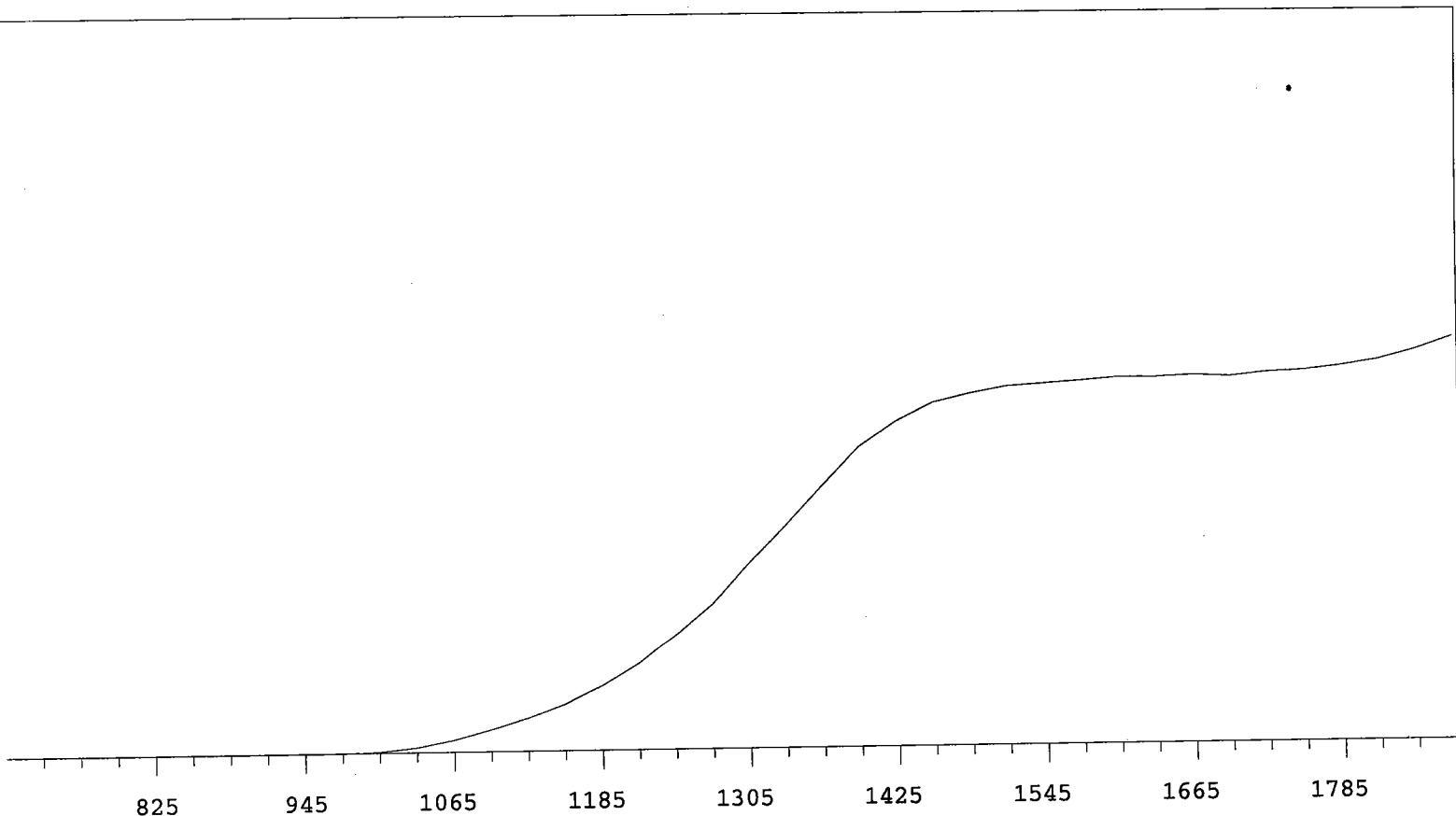
MPC 9600 Plateau
 Alpha Volts: 705

Instrument 6 MPC 9604 Detector C
 Beta Volts: 1575

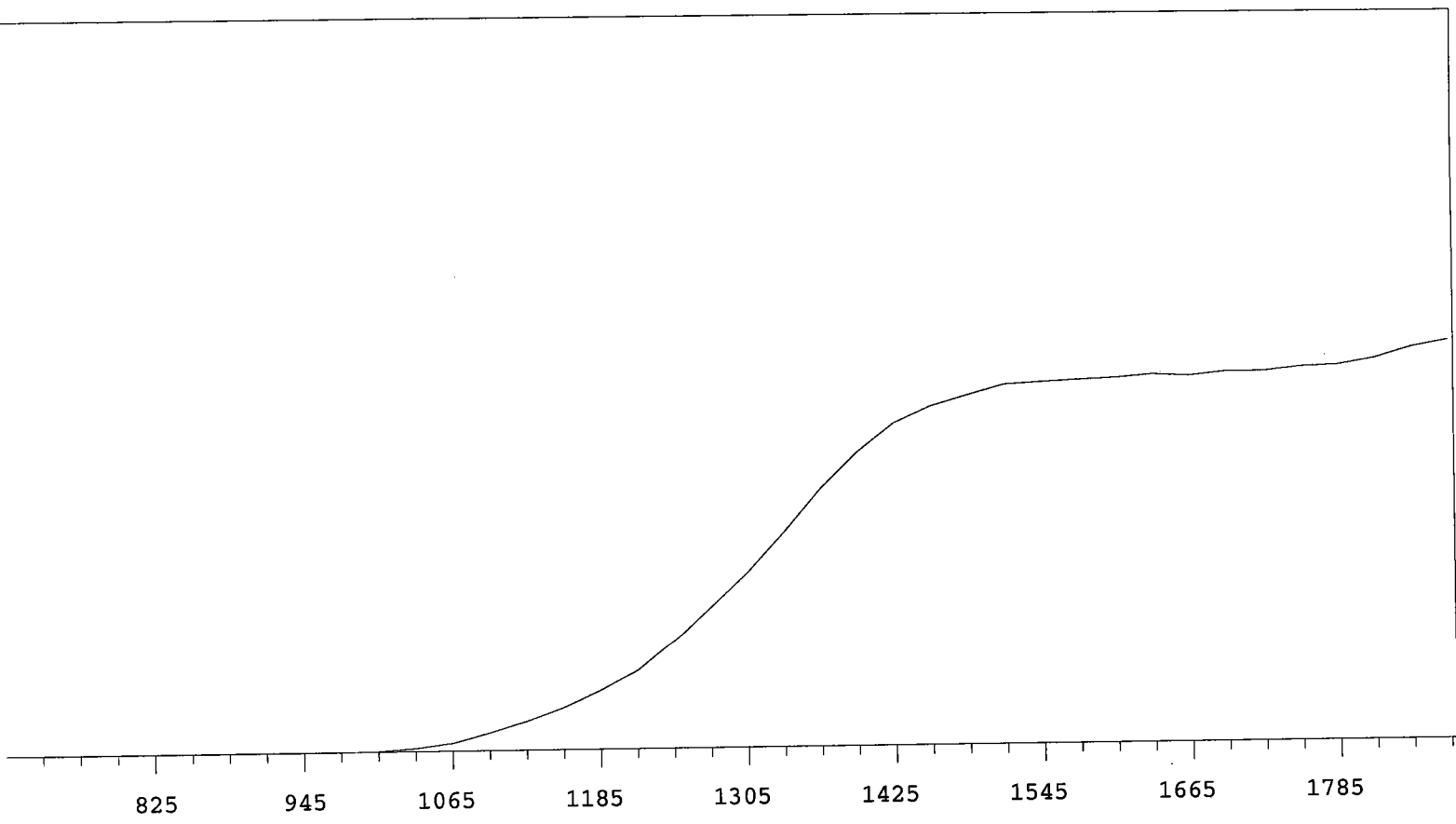
7/1/2009



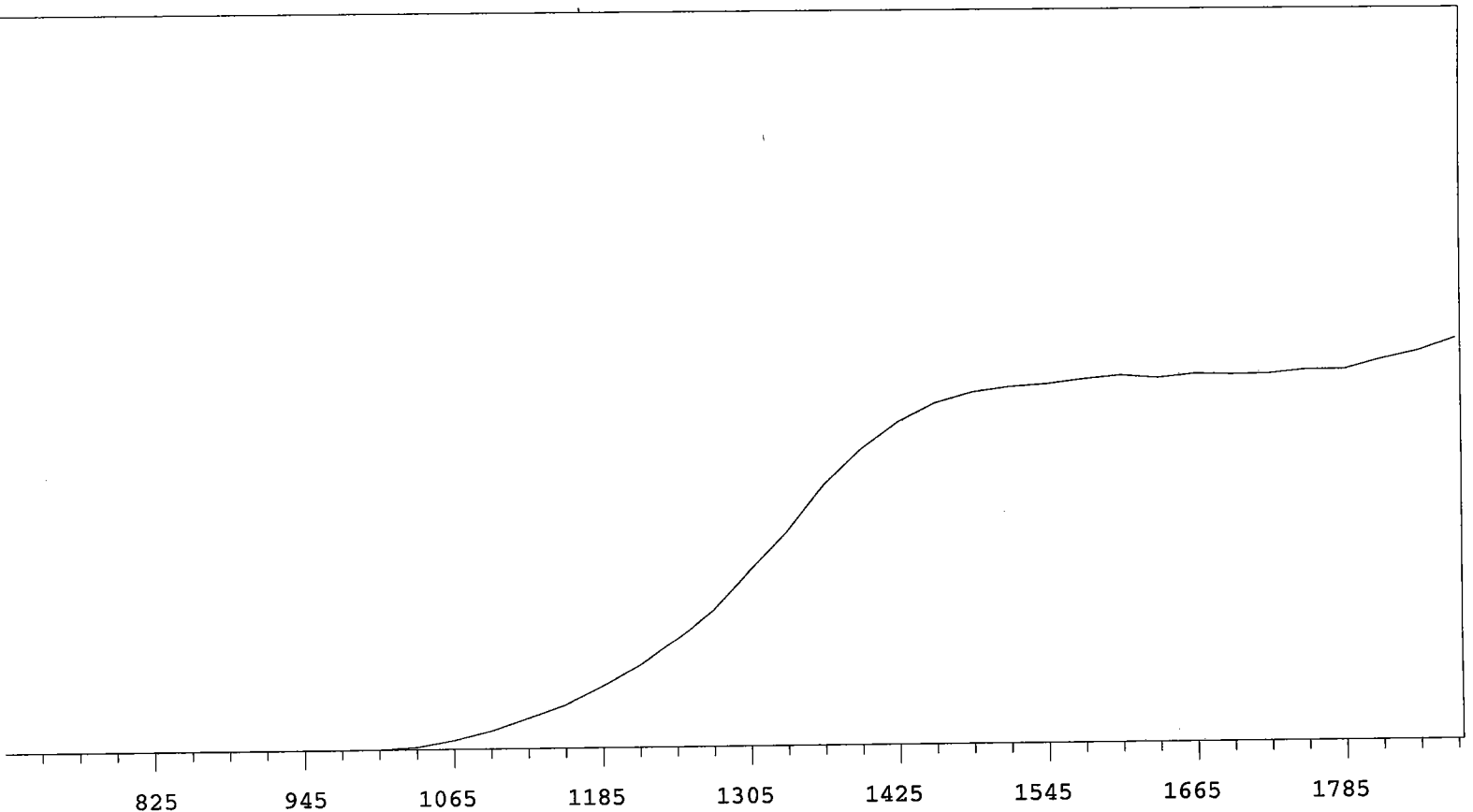
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17350	+67.80
735	0		1335	21371	+60.27
765	1	+0.00	1365	25084	+49.32
795	0	>100	1395	29177	+36.15
825	0	+0.00	1425	31927	+24.86
855	0	>100	1455	33217	+14.70
885	1	>100	1485	34545	+7.74
915	1	>100	1515	35097	+4.64
945	2	>100	1545	34927	+2.96
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	



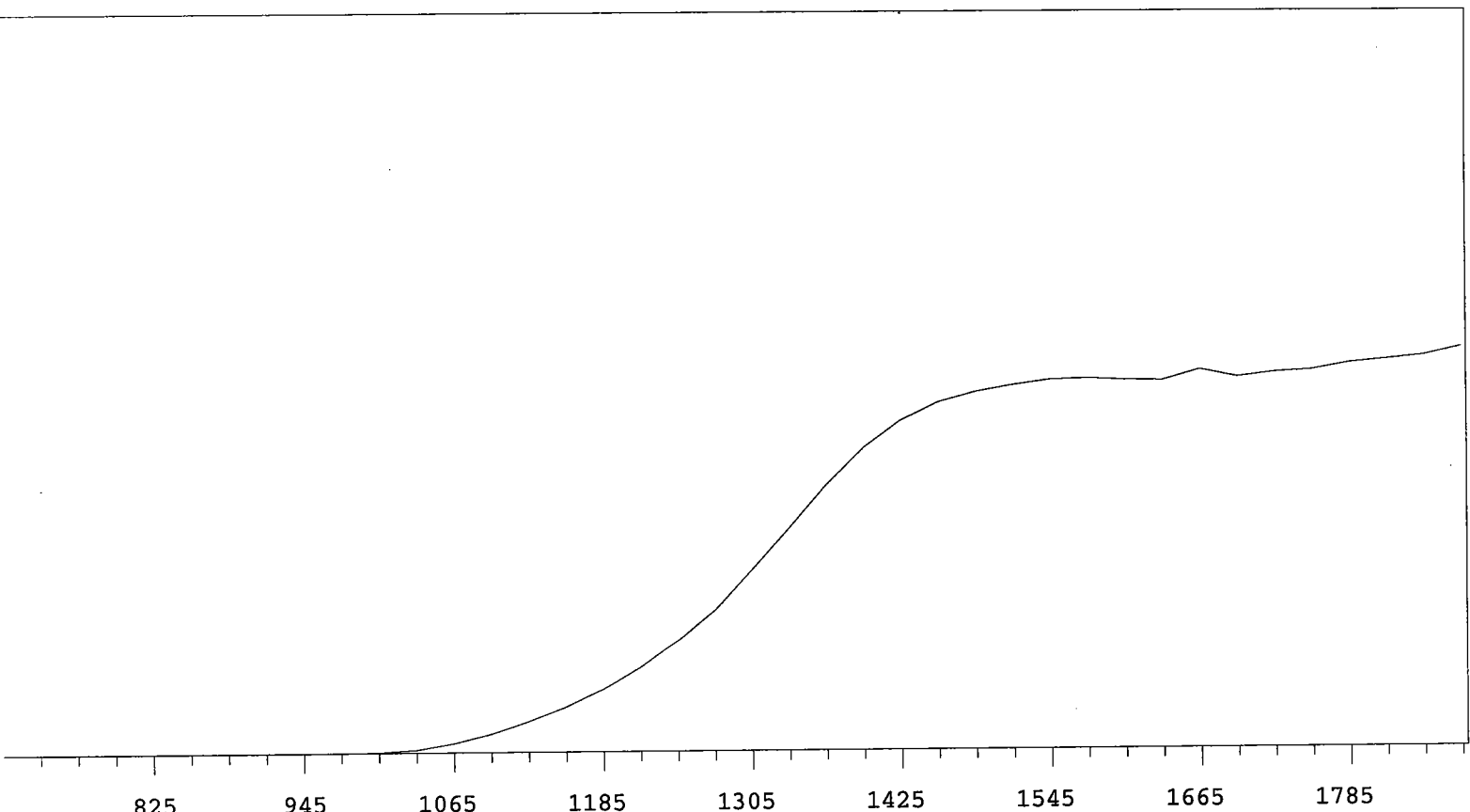
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	17954	+65.82
735	0		1335	21482	+57.64
765	0		1365	25373	+45.78
795	1	+0.00	1395	29042	+34.80
825	0	>100	1425	31373	+23.29
855	0	+0.00	1455	33143	+14.25
885	0	>100	1485	34006	+8.49
915	1	>100	1515	34662	+4.71
945	0	>100	1545	34892	+3.14
975	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	



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	

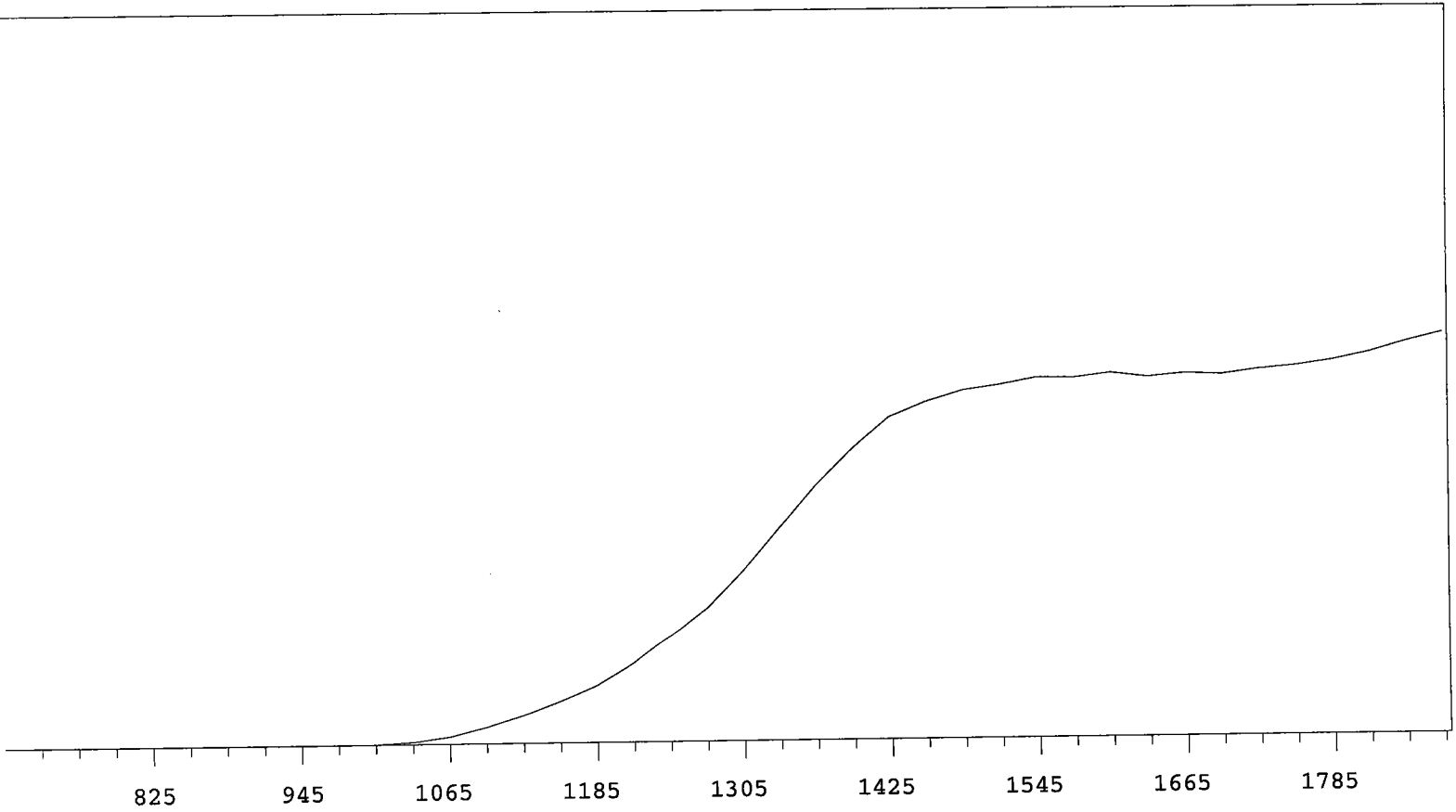


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16543	+70.03
735	0		1335	20257	+60.71
765	0		1365	24245	+48.17
795	0	>100	1395	27602	+35.50
825	0	>100	1425	30019	+23.48
855	0	>100	1455	31614	+14.53
885	0	>100	1485	32522	+8.91
915	0	>100	1515	33103	+5.28
945	0	>100	1545	33572	+2.60
975	4	>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

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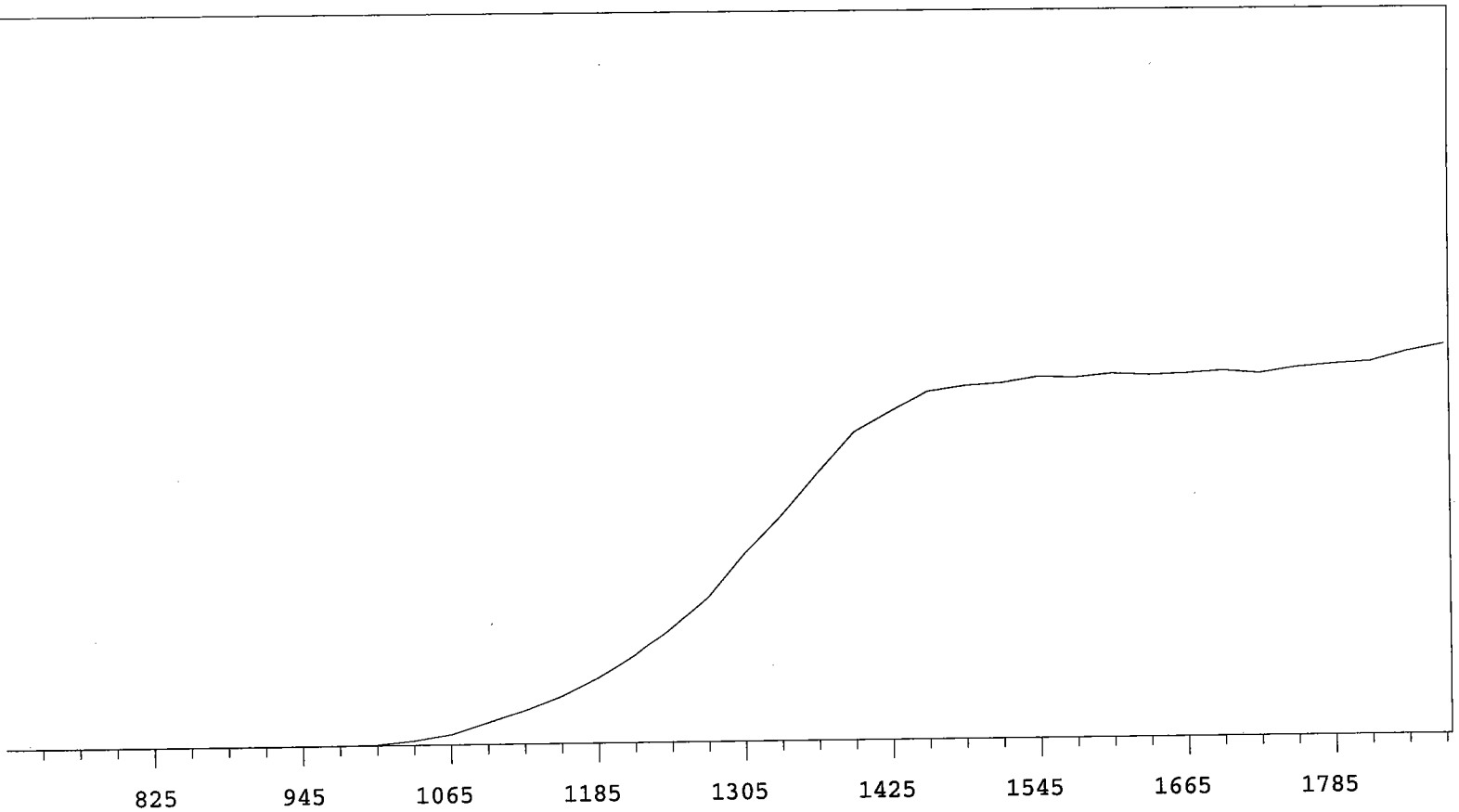


VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	14016	+71.42
735	0		1335	17436	+62.21
765	0		1365	20814	+50.32
795	0	>100	1395	23760	+36.91
825	0	>100	1425	26302	+24.91
855	0	>100	1455	27519	+15.17
885	0	>100	1485	28410	+8.91
915	0	>100	1515	28843	+5.41
945	0	>100	1545	29396	+3.58
975	5	>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	

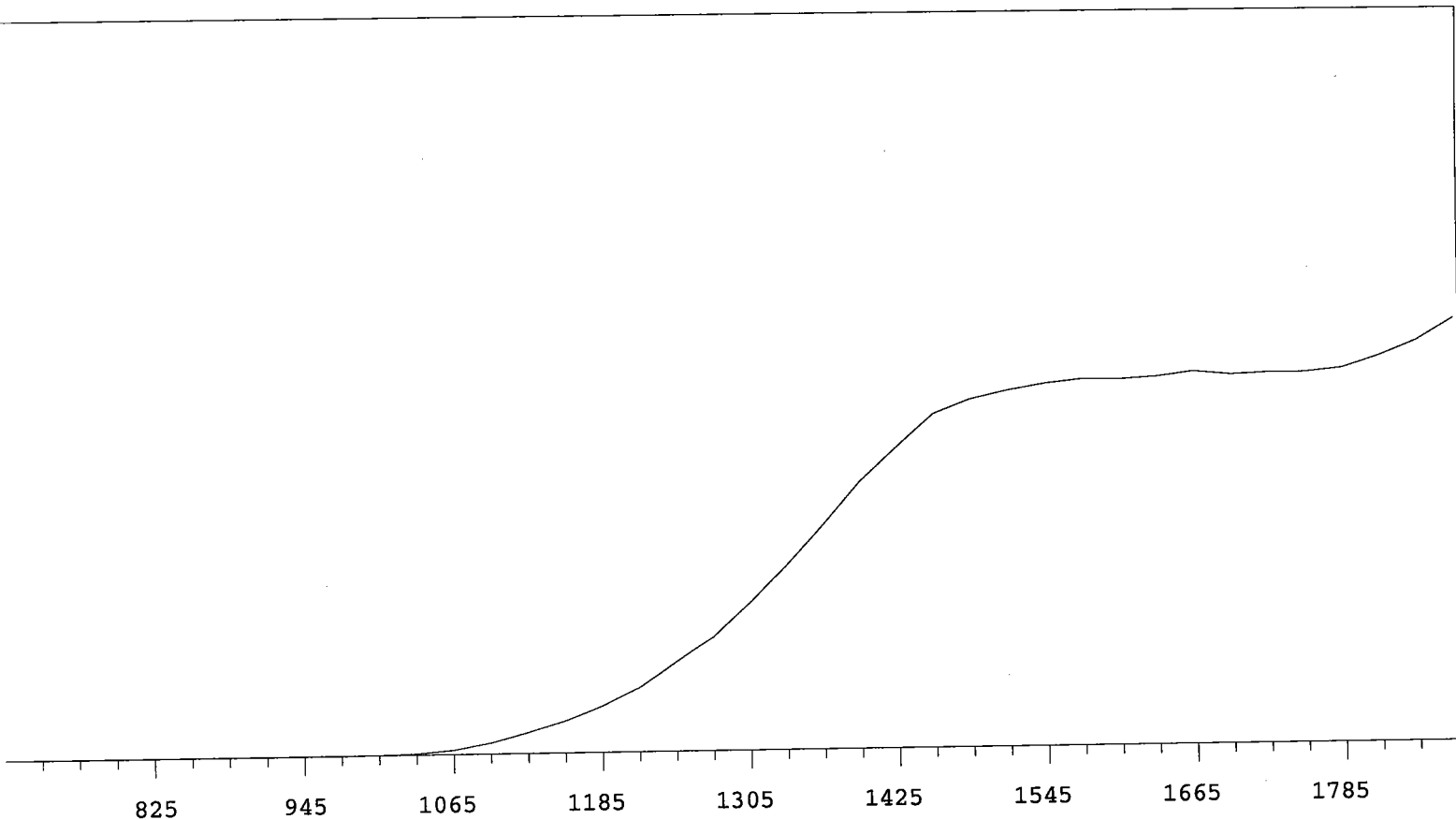
MPC 9600 Plateau
Alpha Volts: 705

Instrument 8 MPC 9604 Detector A
Beta Volts: 1575

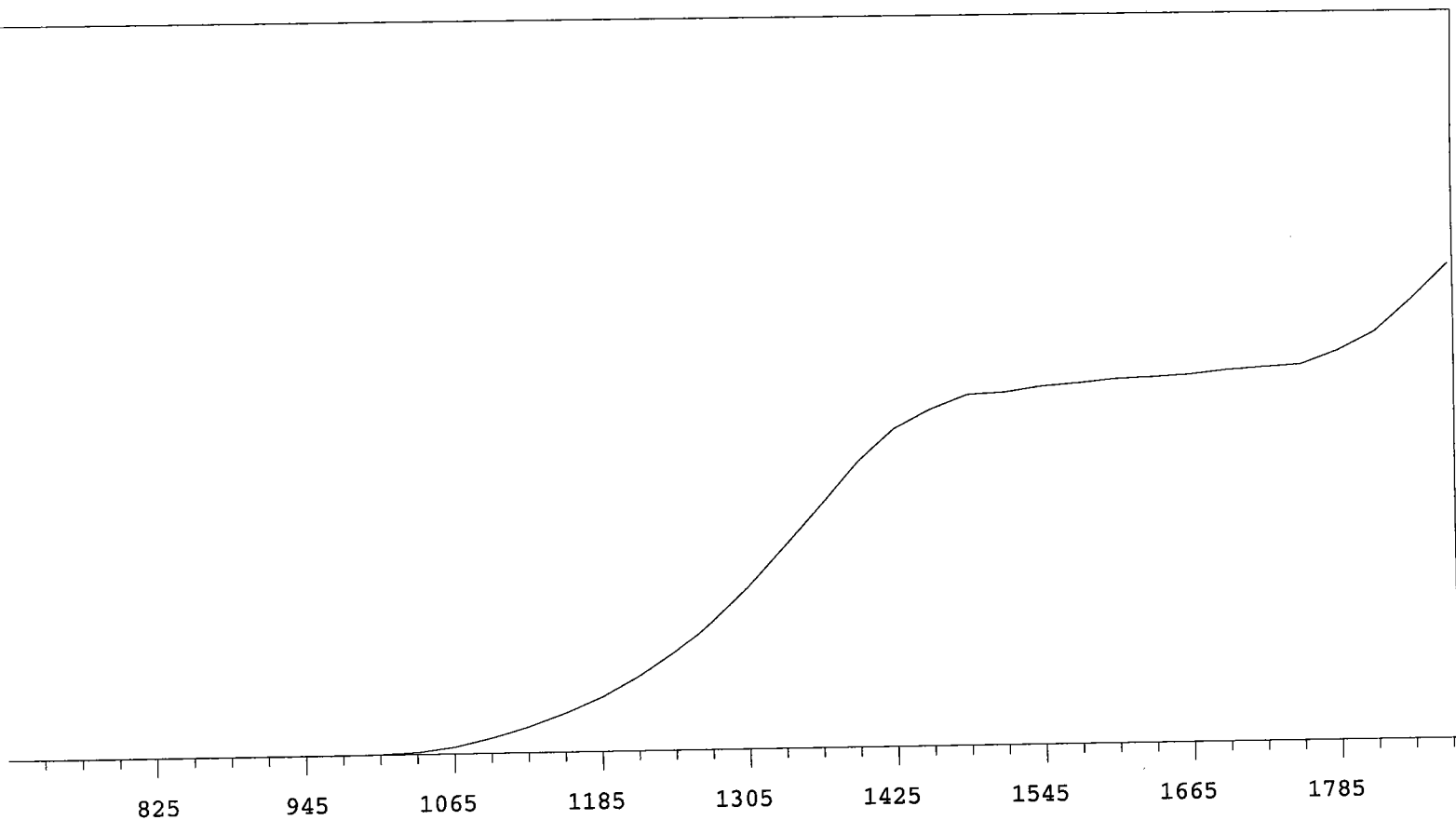
7/1/2009



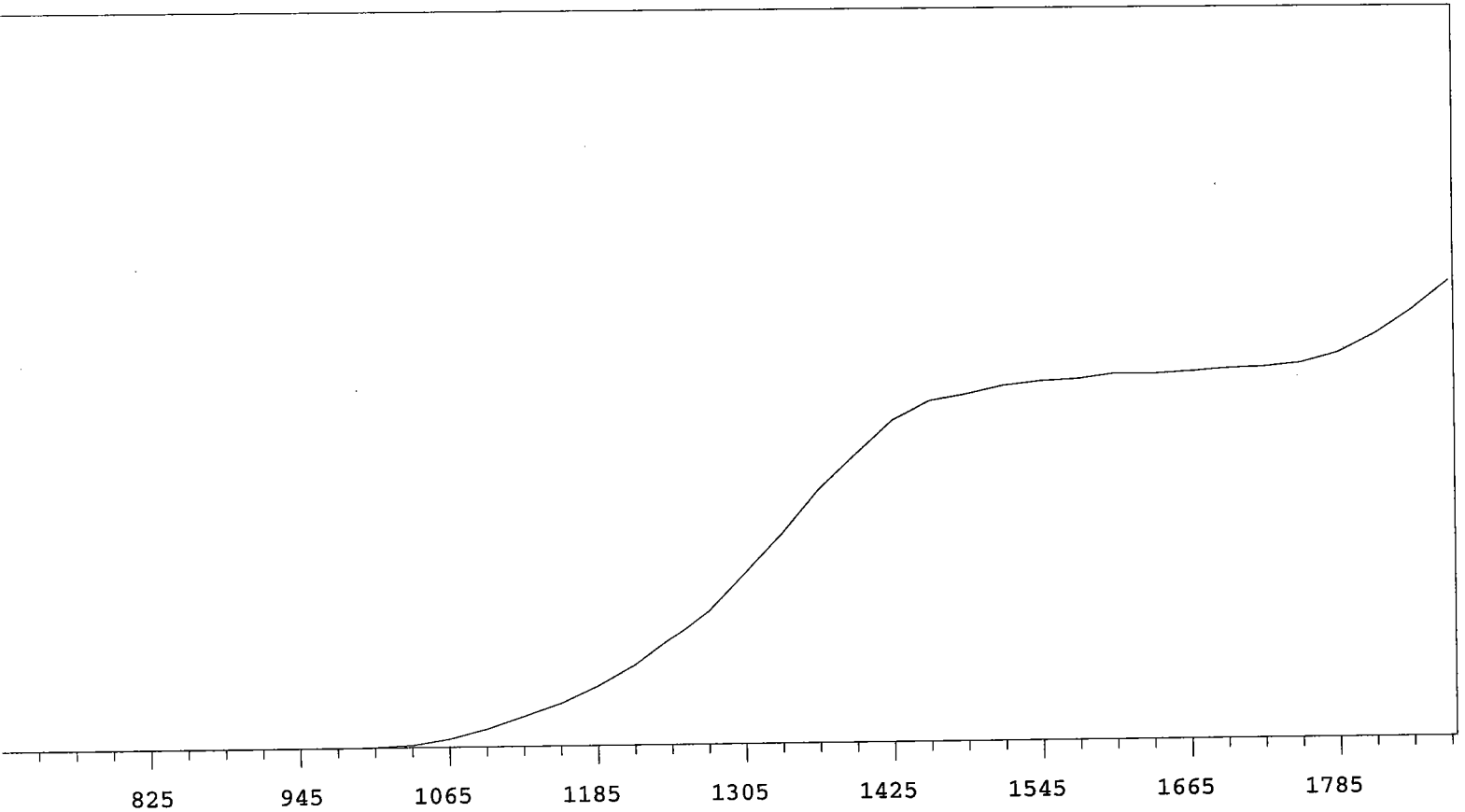
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	19482	+67.45
735	0		1335	23344	+59.35
765	0		1365	27793	+45.86
795	0	>100	1395	31916	+34.29
825	0	>100	1425	33979	+21.61
855	0	>100	1455	35993	+11.71
885	0	>100	1485	36530	+7.04
915	0	>100	1515	36796	+3.11
945	1	>100	1545	37393	+2.44
975	9	>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	



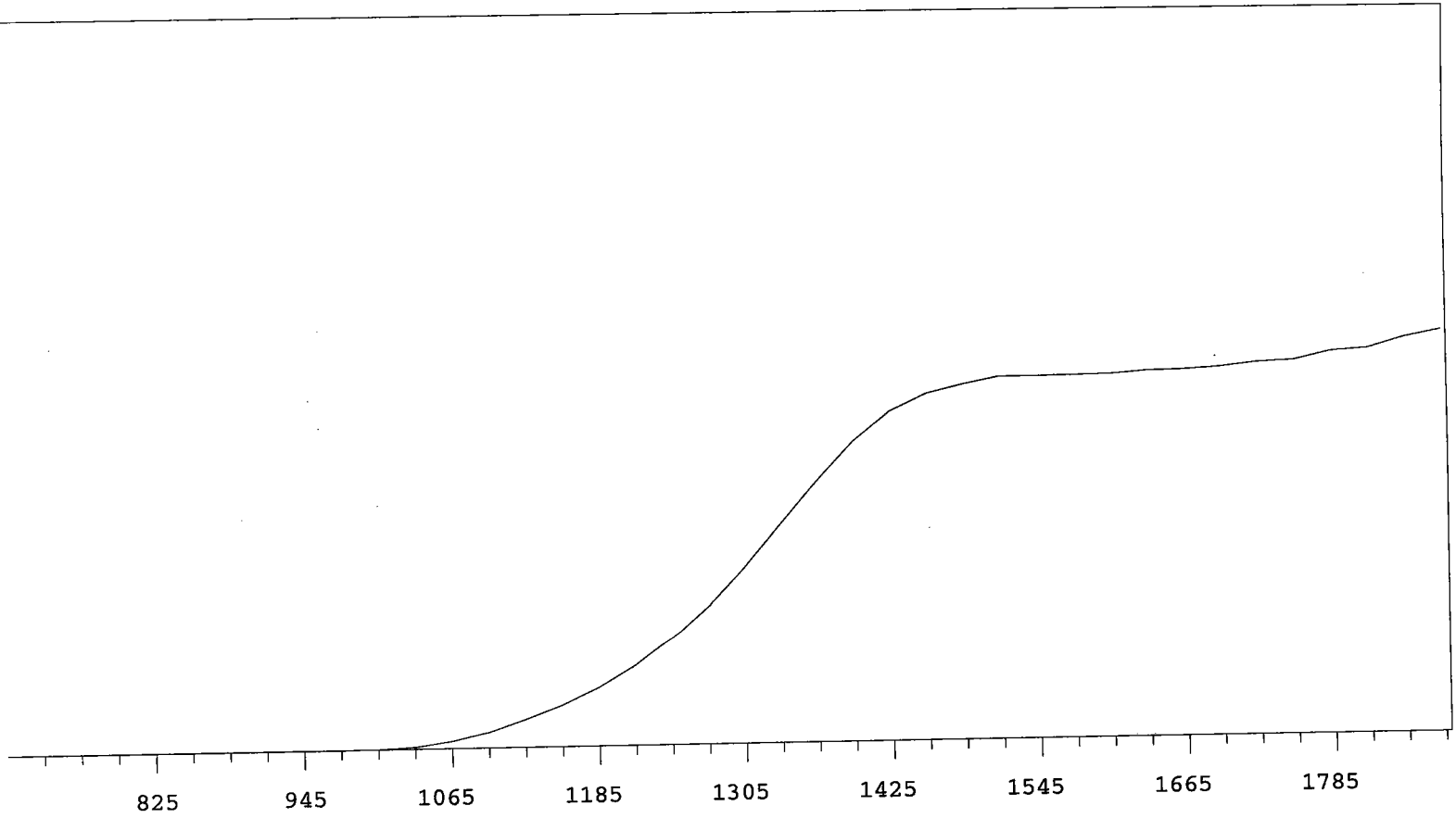
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16337	+74.91
735	0		1335	20471	+68.07
765	0		1365	25012	+57.86
795	0	>100	1395	29694	+47.48
825	0	>100	1425	33409	+35.17
855	0	>100	1455	37013	+23.27
885	0	>100	1485	38629	+14.35
915	0	>100	1515	39529	+7.69
945	0	>100	1545	40284	+4.34
975	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	



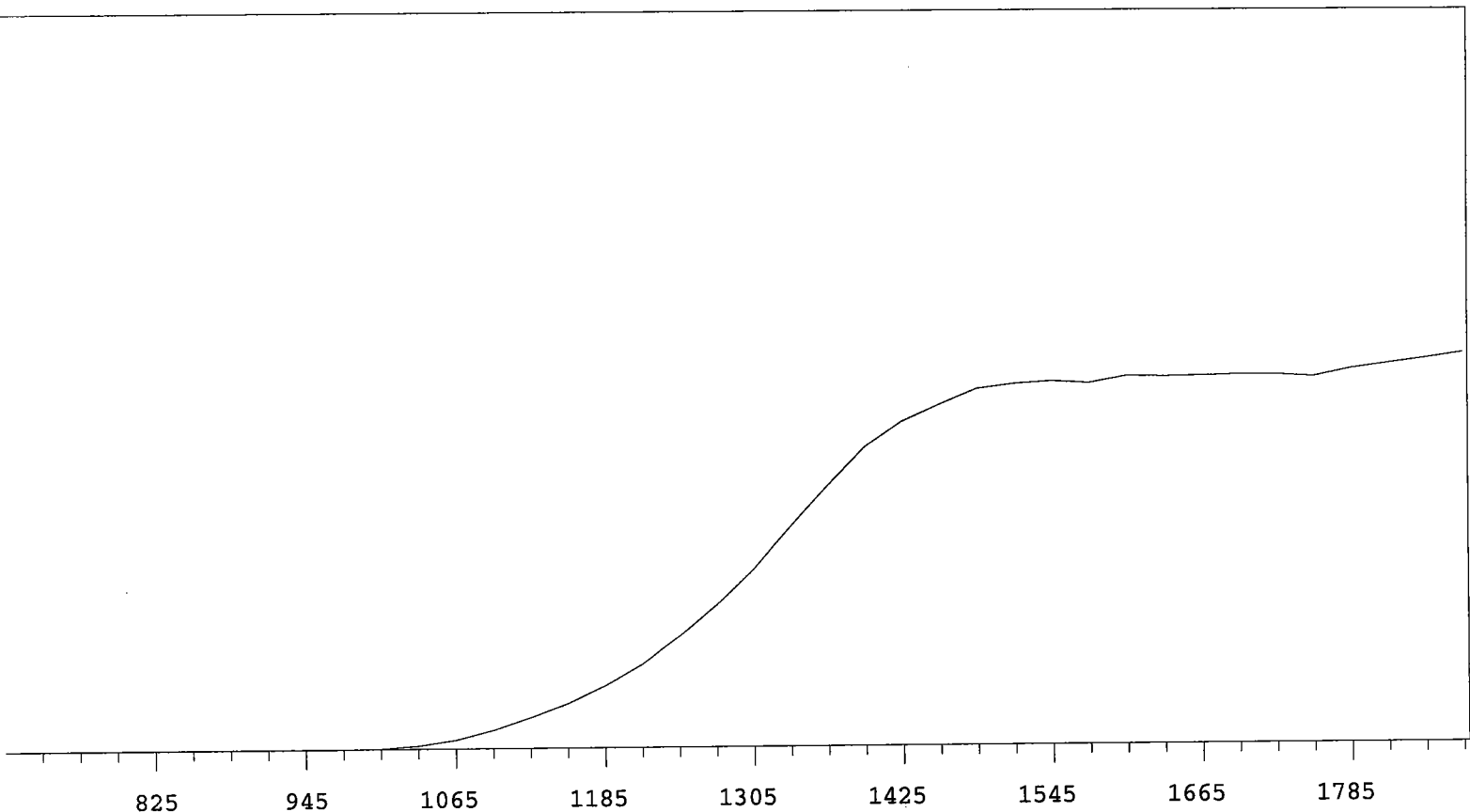
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16303	+72.82
735	0		1335	20309	+64.32
765	0		1365	24364	+53.82
795	0	>100	1395	28527	+40.95
825	0	>100	1425	31774	+28.74
855	0	>100	1455	33631	+16.87
885	0	>100	1485	35030	+9.25
915	0	>100	1515	35208	+5.21
945	0	>100	1545	35741	+3.27
975	4	>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	



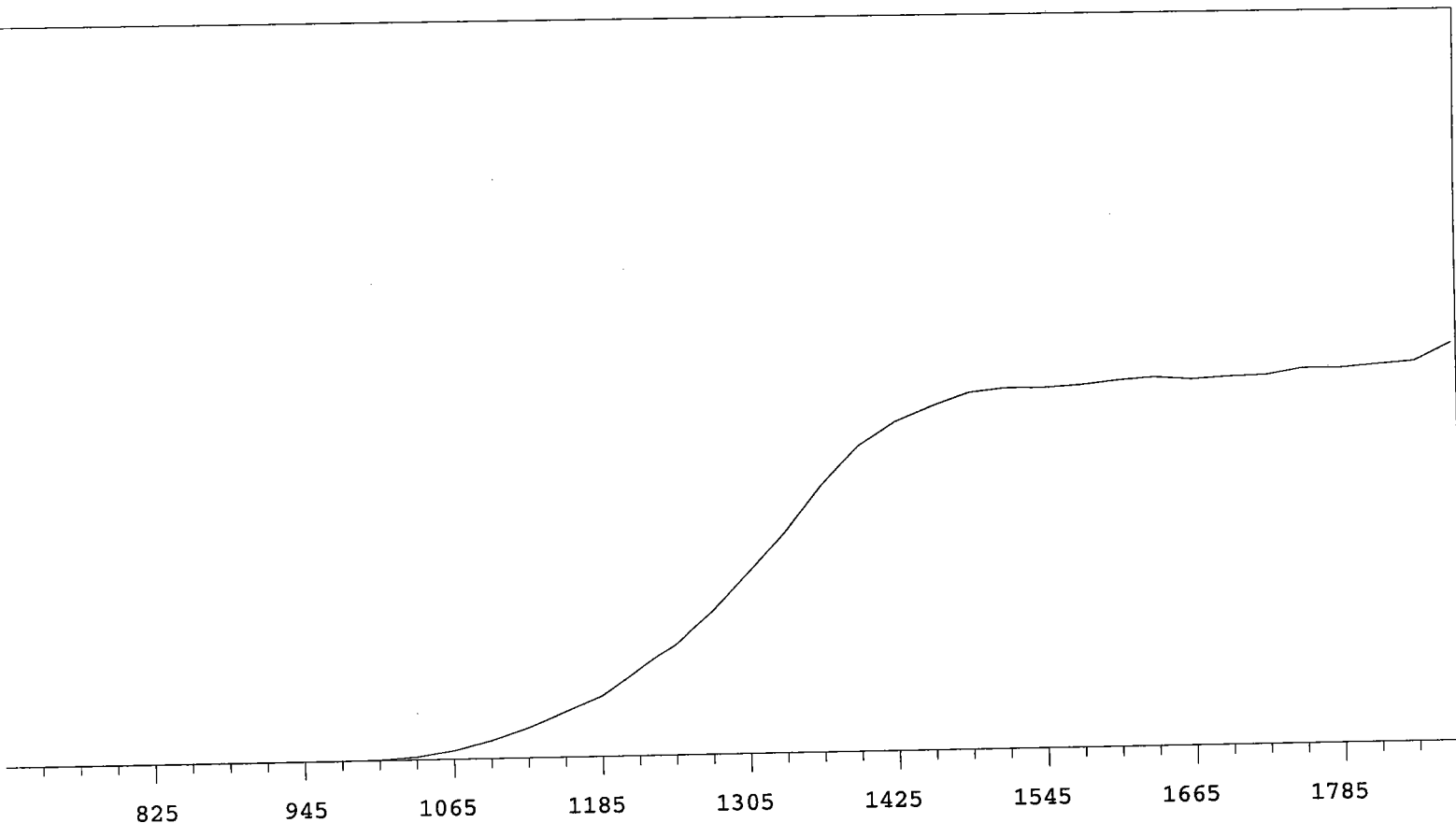
VOLTS	COUNTS	%/100 Volts
705	0	
735	0	
765	0	
795	0	>100
825	0	>100
855	0	>100
885	0	>100
915	0	>100
945	0	>100
975	4	>100
1005	45	>100
1035	300	>100
1065	836	>100
1095	1742	>100
1125	2896	>100
1155	4198	>100
1185	5849	>100
1215	7887	+92.20
1245	10561	+83.55
1275	13442	+76.62

VOLTS	COUNTS	%/100 Volts
1305	16723	+68.78
1335	20749	+60.55
1365	24686	+48.78
1395	28343	+35.24
1425	30657	+24.31
1455	32208	+15.22
1485	33662	+9.32
1515	34098	+4.47
1545	34326	+2.17
1575	34133	+1.60
1605	34758	+1.41
1635	34706	+1.35
1665	34769	+0.30
1695	34830	-0.10
1725	34850	+0.90
1755	34613	+2.41
1785	35351	+3.87
1815	35849	+4.97
1845	36285	
1875	36814	

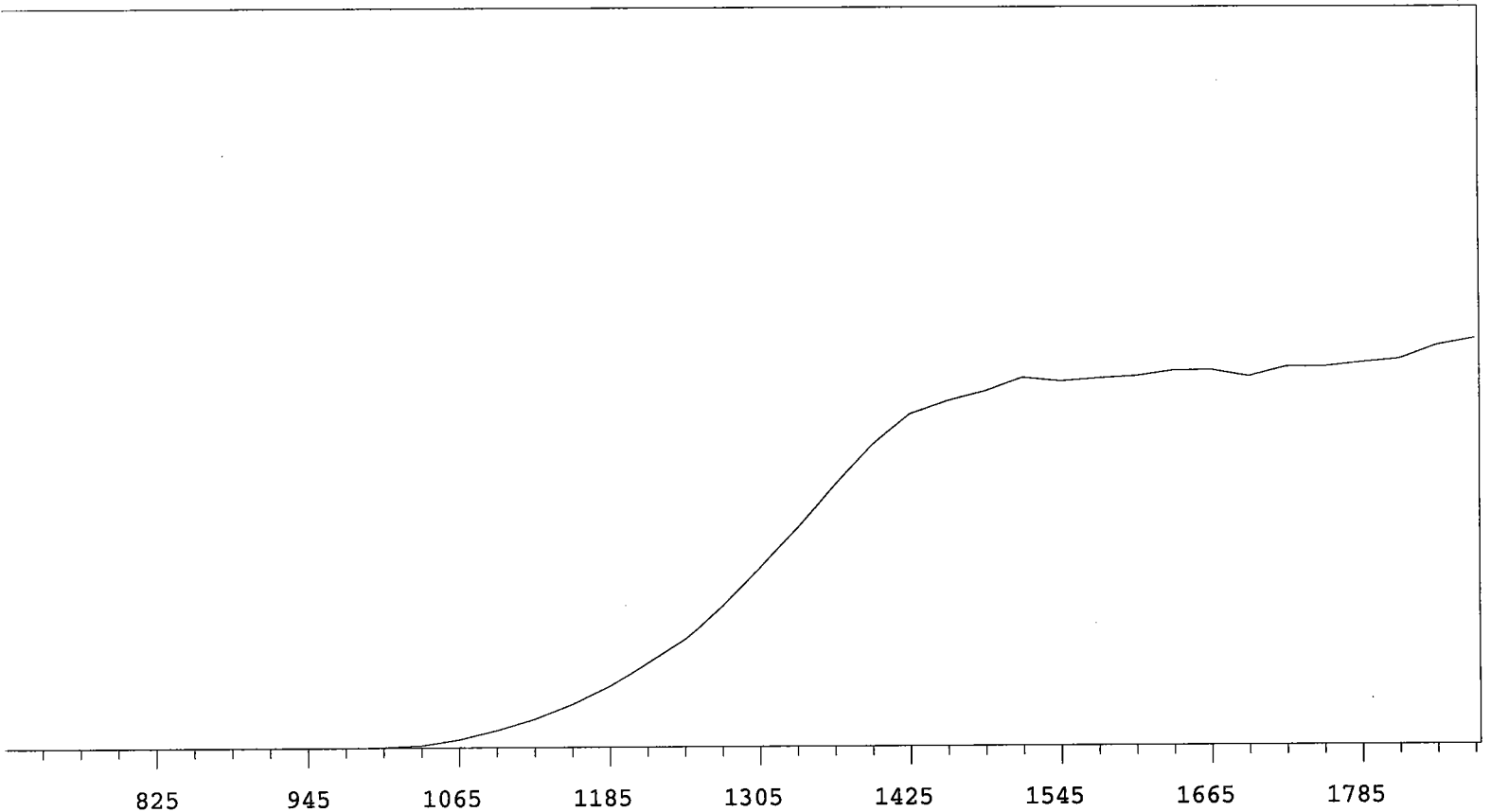
MPC 9600 Plateau
Alpha Volts: 870

Instrument 9 MPC 9604 Detector C
Beta Volts: 1530

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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	



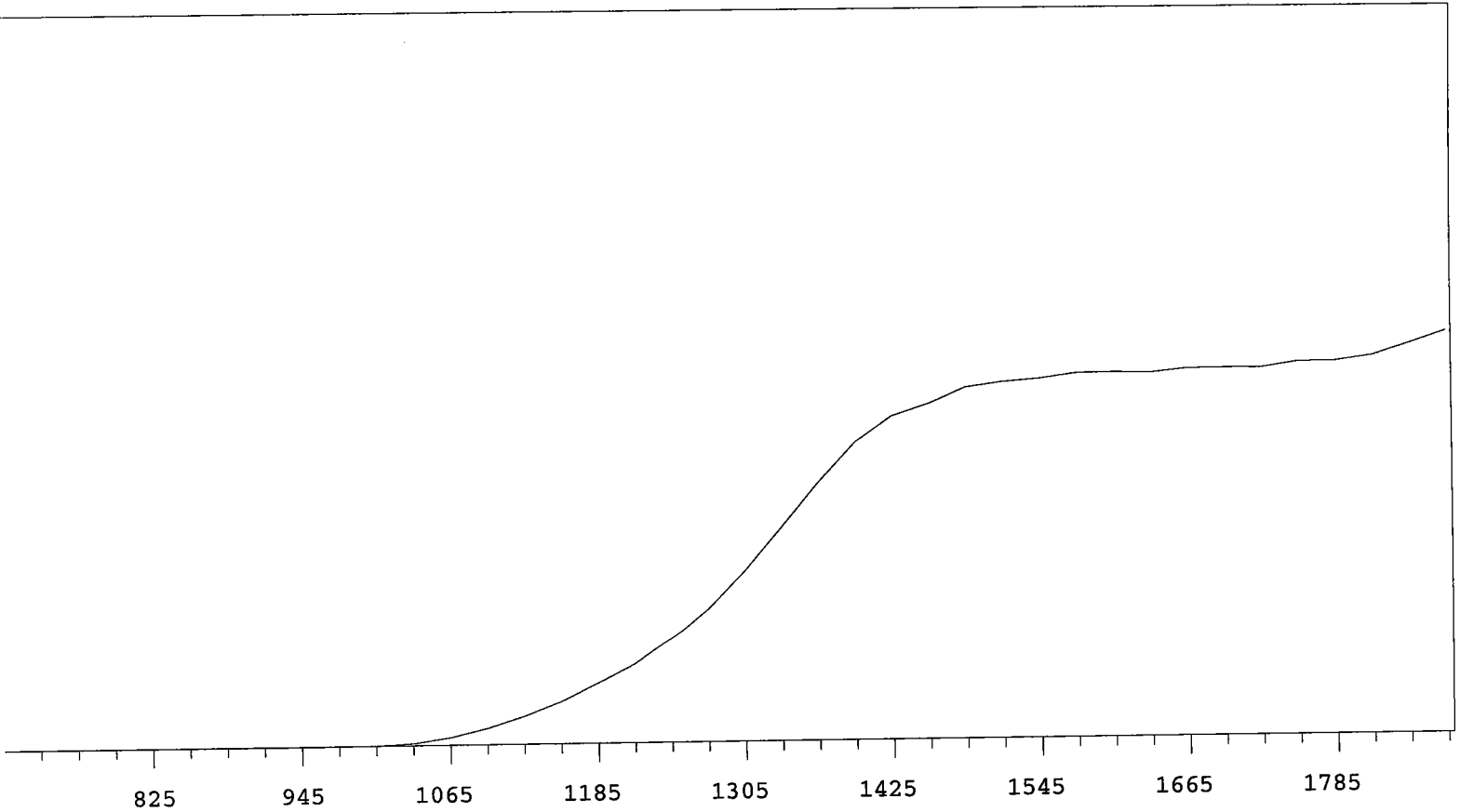
VOLTS	COUNTS	%/100 Volts
705	0	
735	0	
765	0	
795	0	>100
825	0	>100
855	0	>100
885	0	>100
915	1	>100
945	0	>100
975	5	>100
1005	35	>100
1035	186	>100
1065	618	>100
1095	1280	>100
1125	2141	>100
1155	3268	>100
1185	4659	>100
1215	6343	+90.68
1245	8064	+83.46
1275	10497	+77.03
1305	13319	+70.94
1335	16319	+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	

VOLTS	COUNTS	%/100 Volts
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	

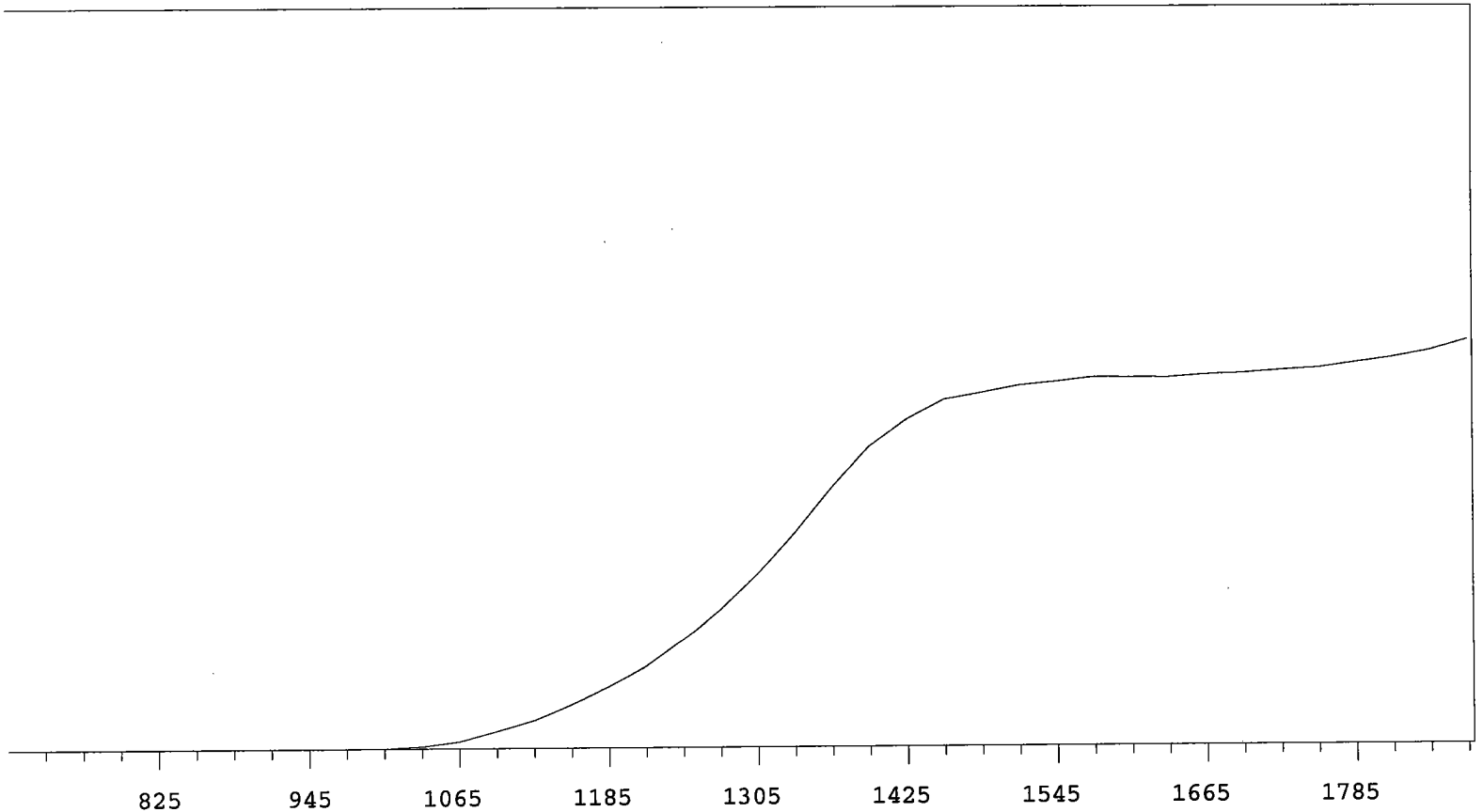
MPC 9600 Plateau
Alpha Volts: 870

Instrument 10 MPC 9604 Detector A
Beta Volts: 1552

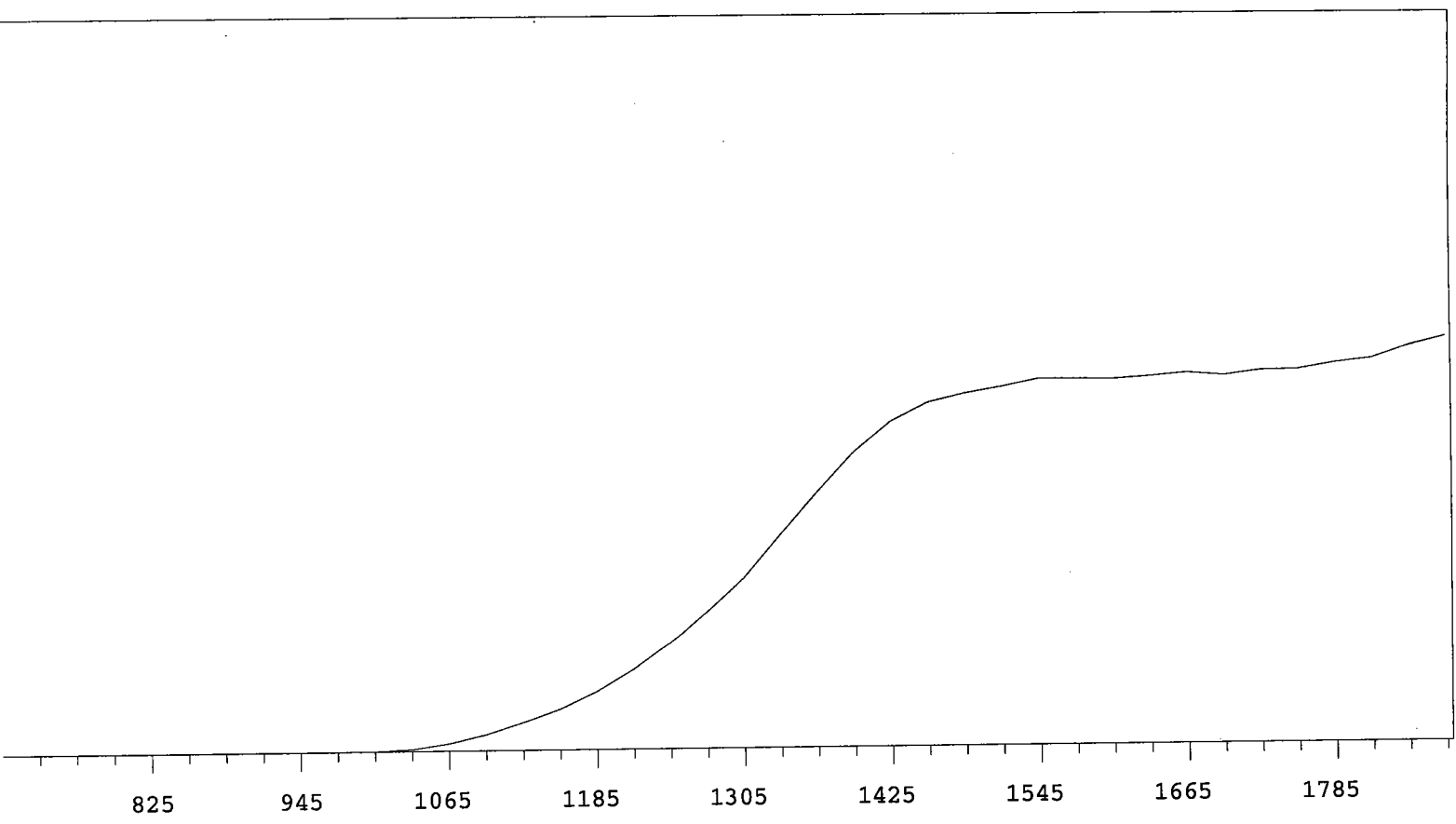
7/1/2009



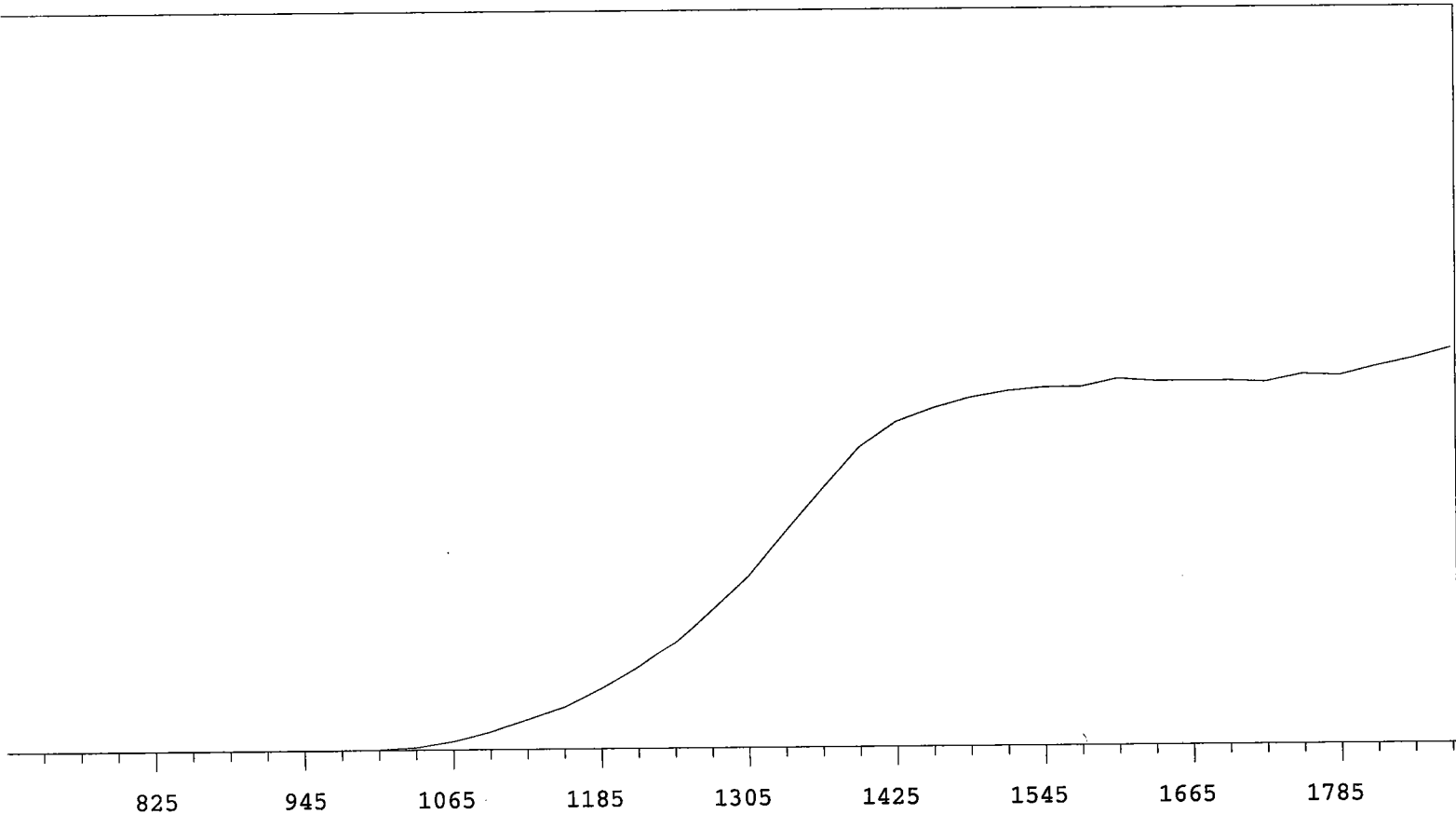
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	16076	+72.76
735	1		1335	19985	+63.85
765	0		1365	24102	+50.95
795	0	>100	1395	27819	+36.01
825	0	>100	1425	30228	+23.86
855	0	>100	1455	31343	+14.40
885	0	>100	1485	32811	+8.77
915	0	>100	1515	33243	+6.10
945	0	>100	1545	33518	+3.25
975	1	>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	



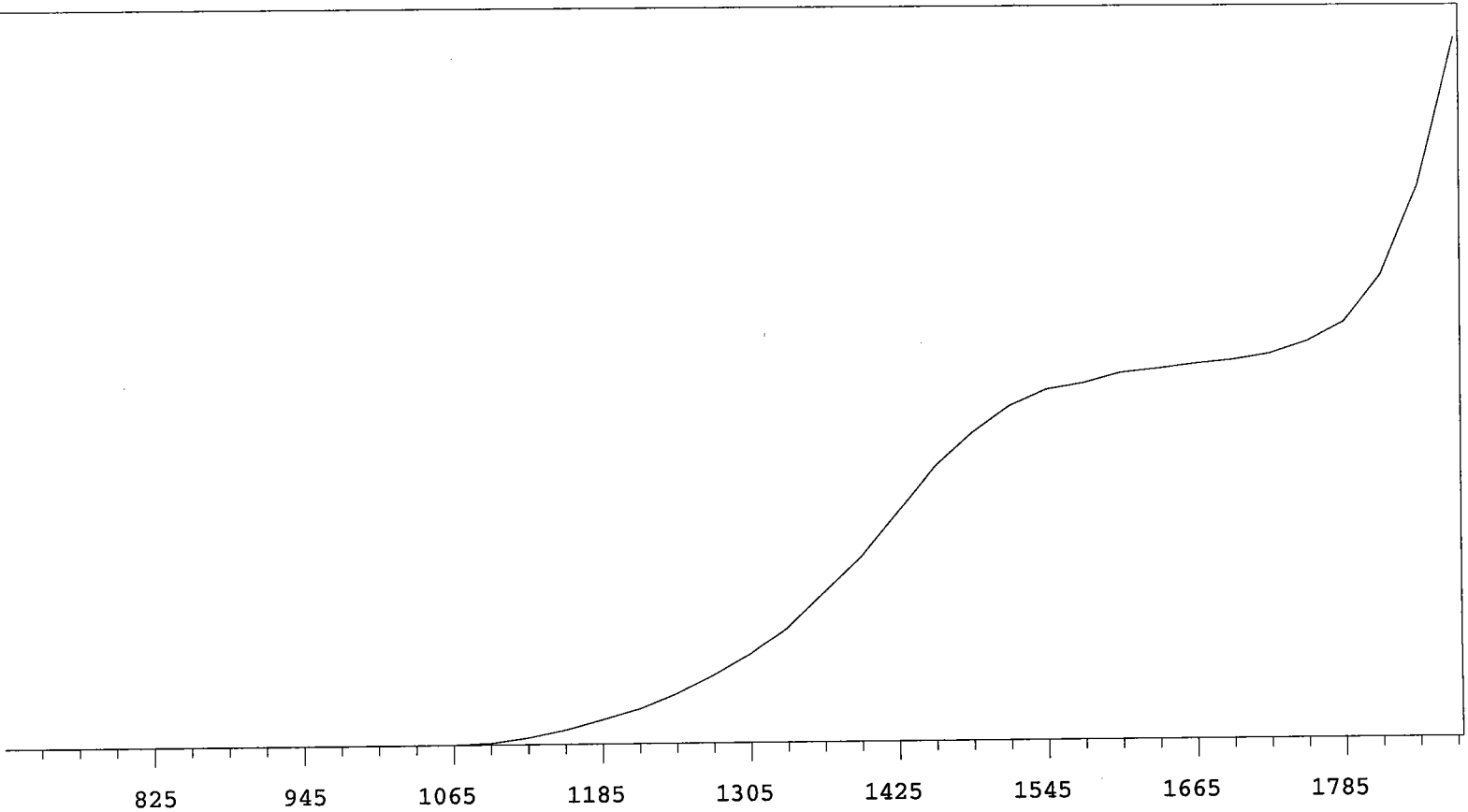
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	14469	+71.08
735	0		1335	17904	+63.07
765	0		1365	21677	+51.20
795	0	>100	1395	25027	+38.06
825	0	>100	1425	27237	+24.55
855	0	>100	1455	28914	+14.61
885	0	>100	1485	29480	+8.48
915	0	>100	1515	30075	+5.06
945	1	>100	1545	30374	+3.42
975	7	>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	



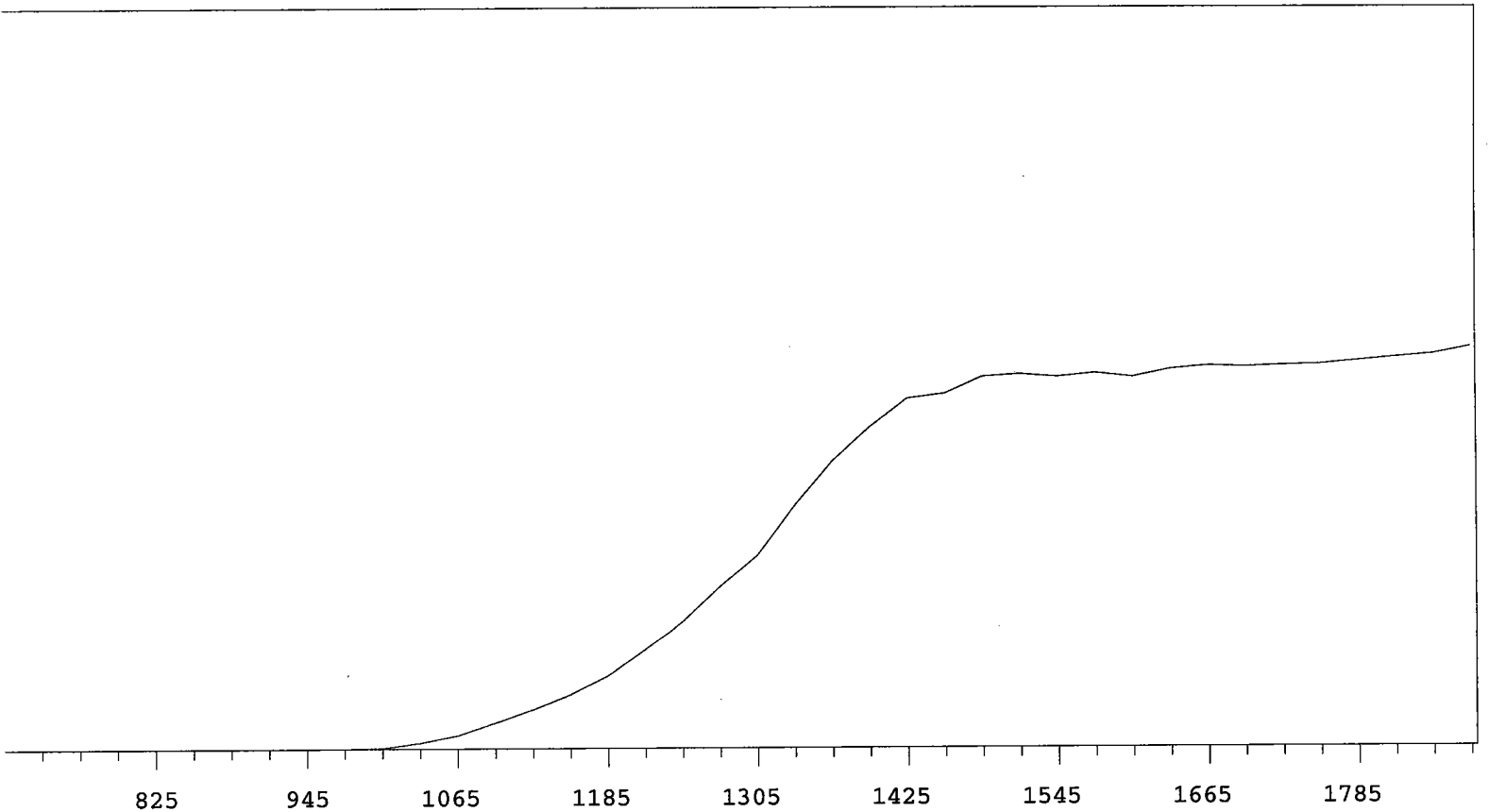
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	18051	+71.16
735	0		1335	22586	+62.34
765	0		1365	26973	+51.47
795	0	>100	1395	31137	+38.24
825	0	>100	1425	34321	+25.70
855	0	>100	1455	36267	+15.37
885	1	>100	1485	37197	+9.21
915	0	>100	1515	37851	+5.38
945	2	>100	1545	38622	+3.00
975	2	>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	



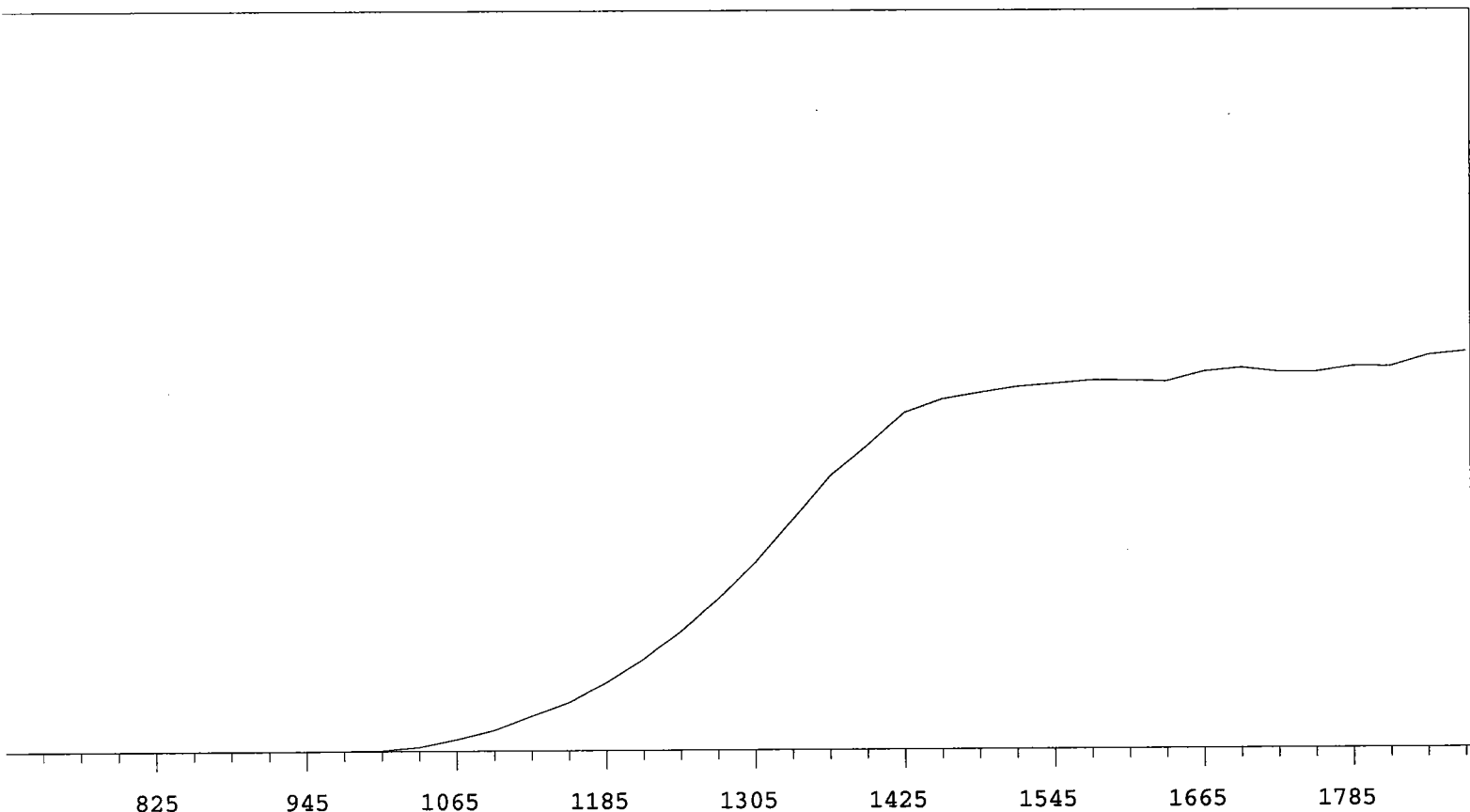
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	15430	+69.87
735	0		1335	19258	+61.49
765	0		1365	23018	+50.06
795	0	>100	1395	26562	+35.34
825	0	>100	1425	28750	+22.67
855	0	>100	1455	29911	+13.20
885	0	>100	1485	30798	+8.01
915	0	>100	1515	31375	+4.83
945	0	>100	1545	31684	+3.74
975	3	>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	



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
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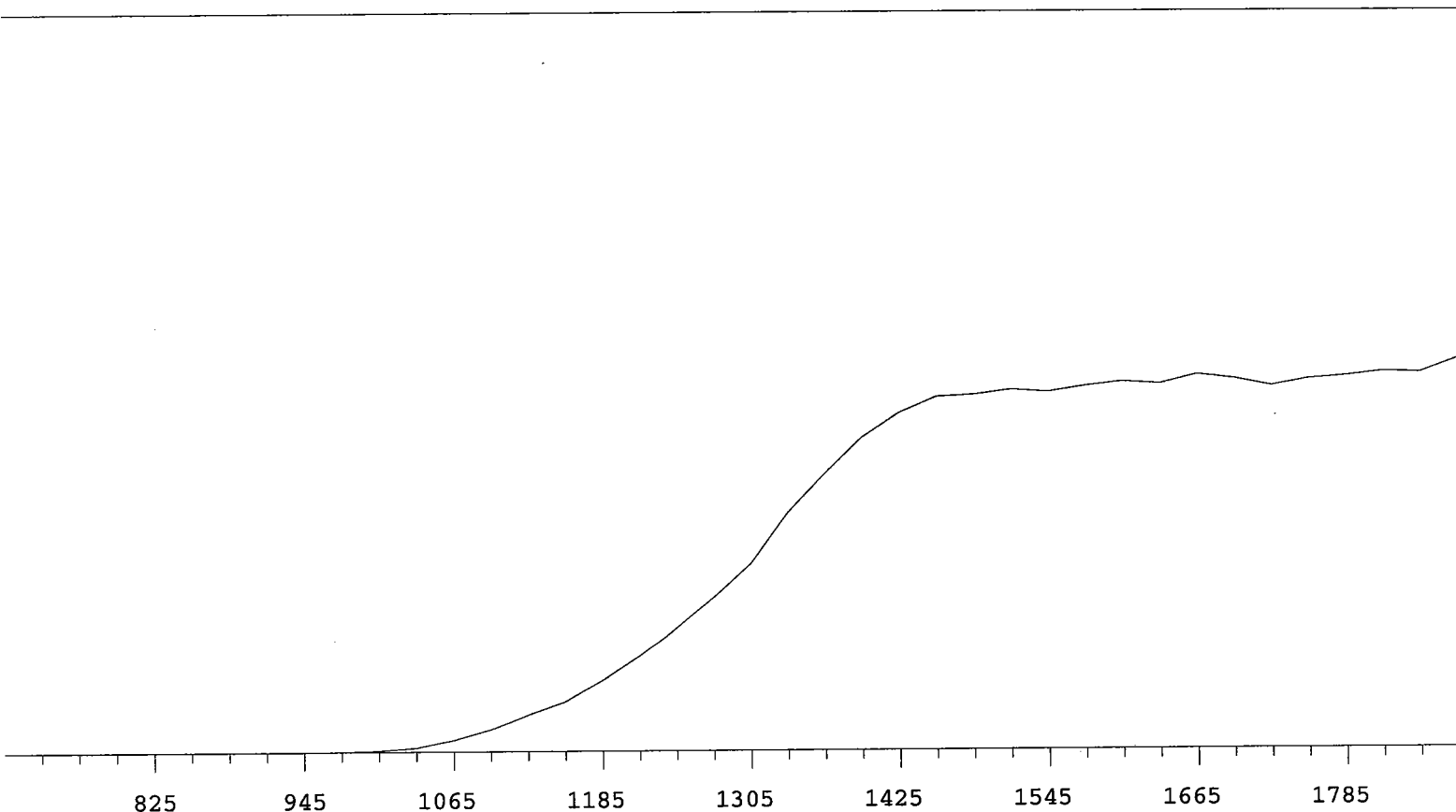
VOLTS	COUNTS	%/100 Volts
-------	--------	-------------

705	1	
735	0	
765	0	+0.00
795	0	>100
825	1	+0.00
855	0	>100
885	0	+0.00
915	0	>100
945	1	>100
975	7	>100
1005	46	>100
1035	191	>100
1065	540	>100
1095	957	>100
1125	1597	>100
1155	2217	>100
1185	3154	+98.74
1215	4239	+89.75
1245	5550	+79.98
1275	6980	+73.12

1305	8636	+66.44
1335	10593	+56.56
1365	12582	+46.23
1395	13957	+33.45
1425	15443	+21.49
1455	16048	+13.14
1485	16331	+6.45
1515	16603	+4.19
1545	16736	+2.73
1575	16884	+1.11
1605	16875	+1.91
1635	16813	+2.86
1665	17257	+2.60
1695	17425	+1.58
1725	17238	+0.49
1755	17230	+0.63
1785	17482	+3.27
1815	17468	+4.46
1845	17977	
1875	18163	

Alpha Volts: 1515

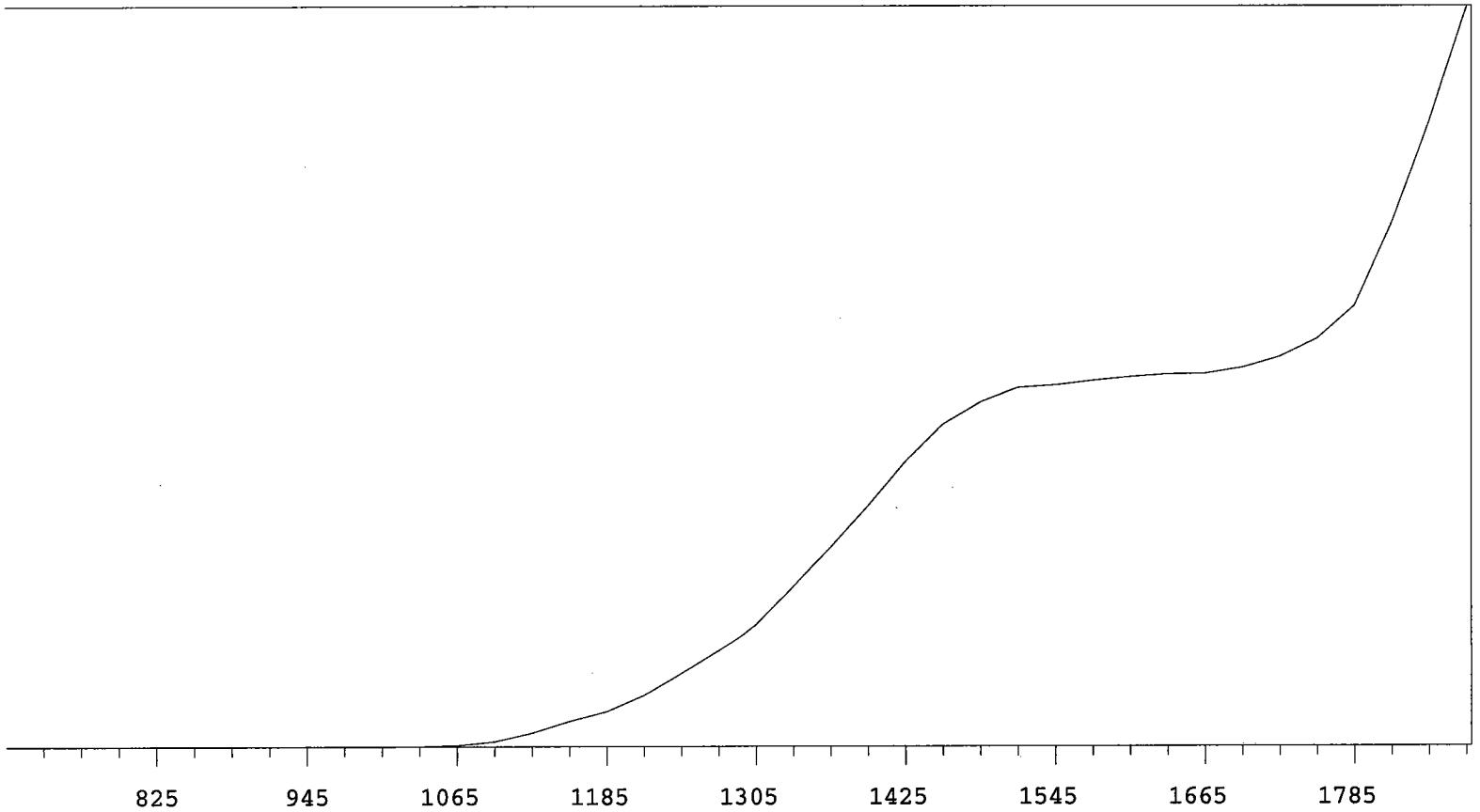
Beta Volts: 1515



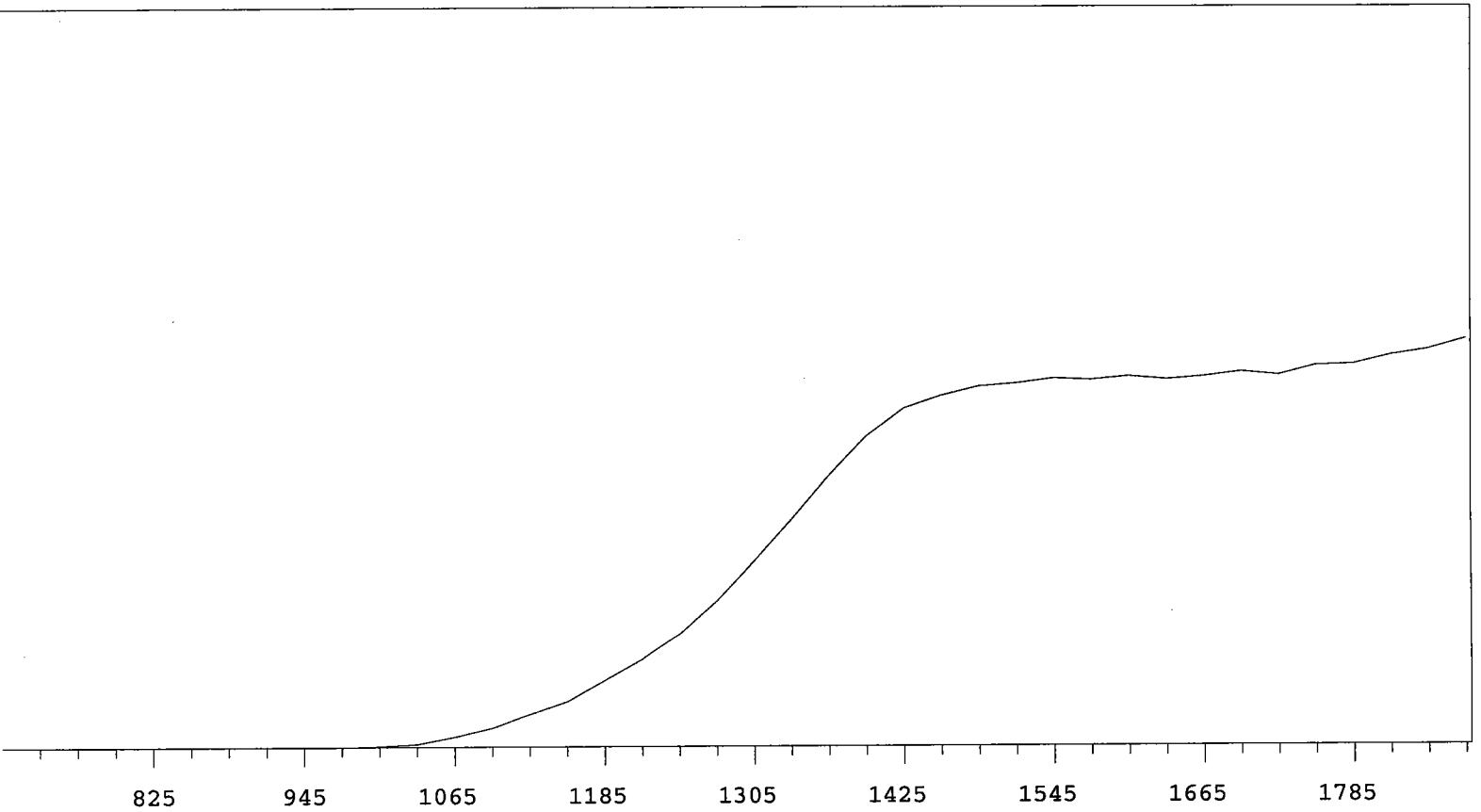
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	7679	+65.97
735	0		1335	9737	+57.57
765	0		1365	11301	+45.87
795	0	>100	1395	12767	+31.71
825	0	>100	1425	13767	+19.90
855	1	+83.33	1455	14399	+10.72
885	1	+55.56	1485	14467	+4.38
915	0	>100	1515	14671	+2.12
945	1	>100	1545	14576	+2.61
975	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

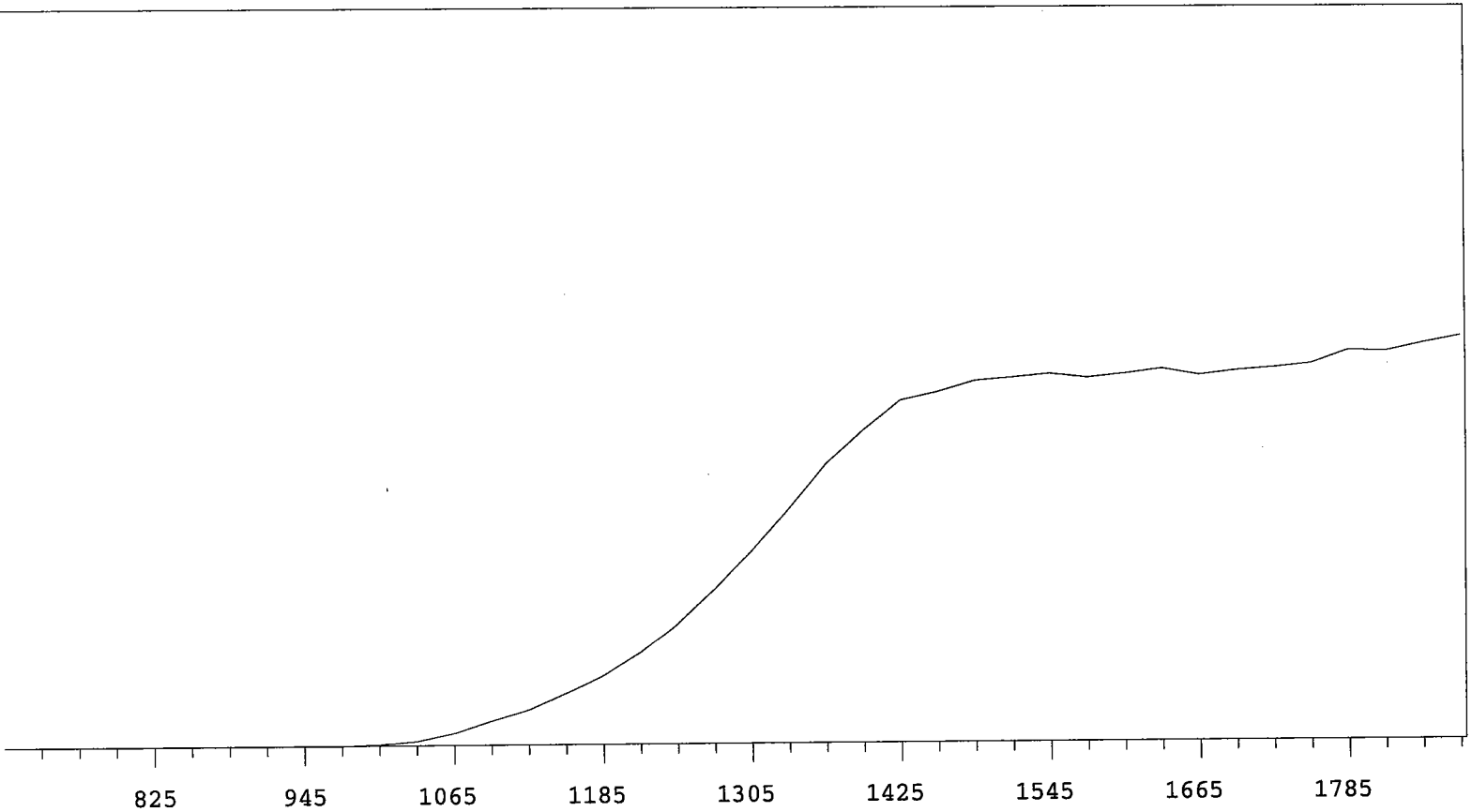
Beta Volts: 1515



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	



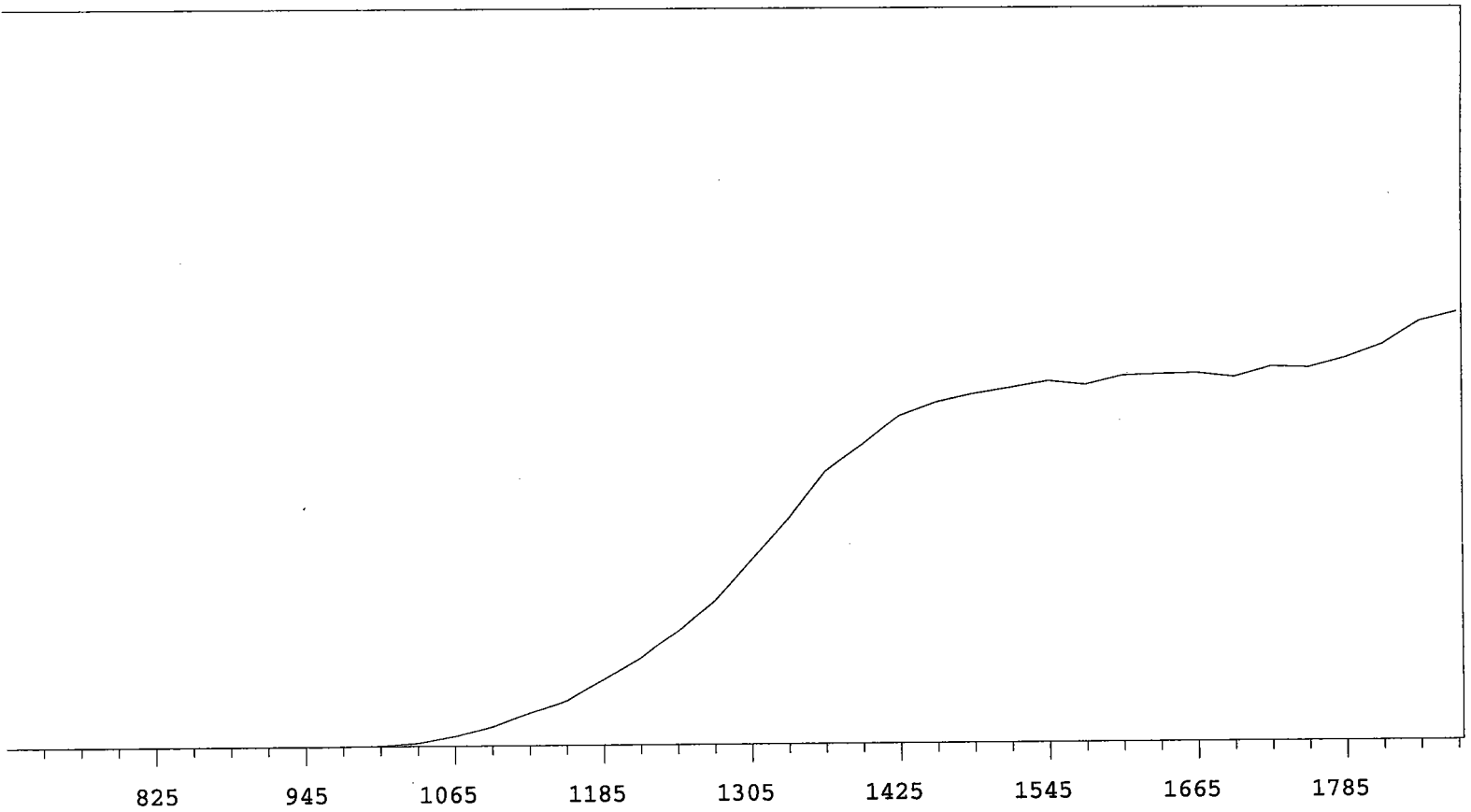
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	10207	+70.42
735	0		1335	12473	+60.75
765	0		1365	14900	+48.87
795	0	>100	1395	17101	+35.36
825	0	>100	1425	18643	+22.53
855	1	+83.33	1455	19350	+12.34
885	1	-83.33	1485	19848	+6.68
915	0	-55.56	1515	20014	+3.51
945	0	>100	1545	20278	+2.03
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	



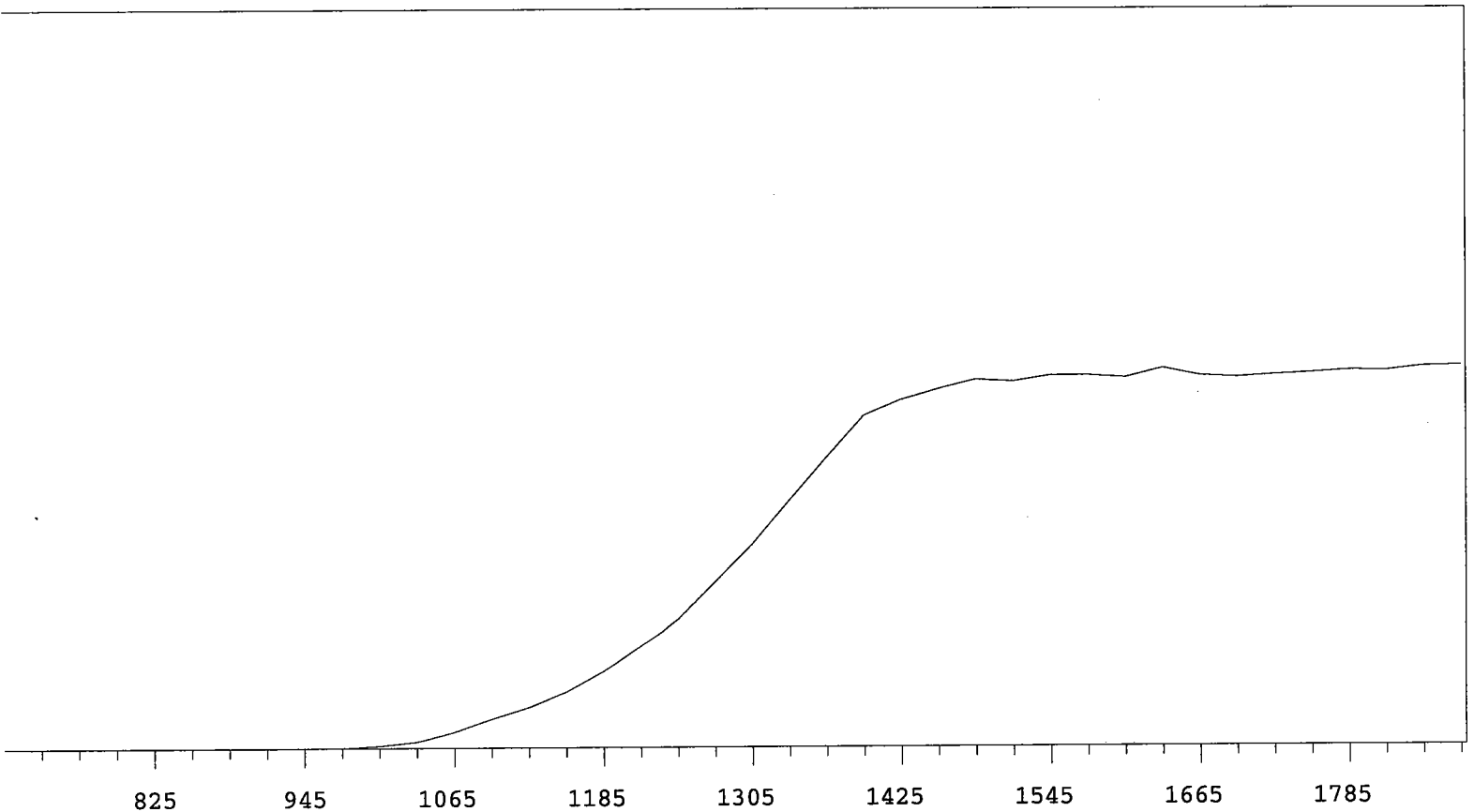
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	9543	+67.01
735	0		1335	11617	+56.47
765	0		1365	13791	+45.47
795	0	>100	1395	15387	+31.66
825	0	>100	1425	16819	+20.02
855	0	>100	1455	17210	+11.63
885	1	+0.00	1485	17742	+6.05
915	0	>100	1515	17892	+3.04
945	0	>100	1545	18070	+1.09
975	7	>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

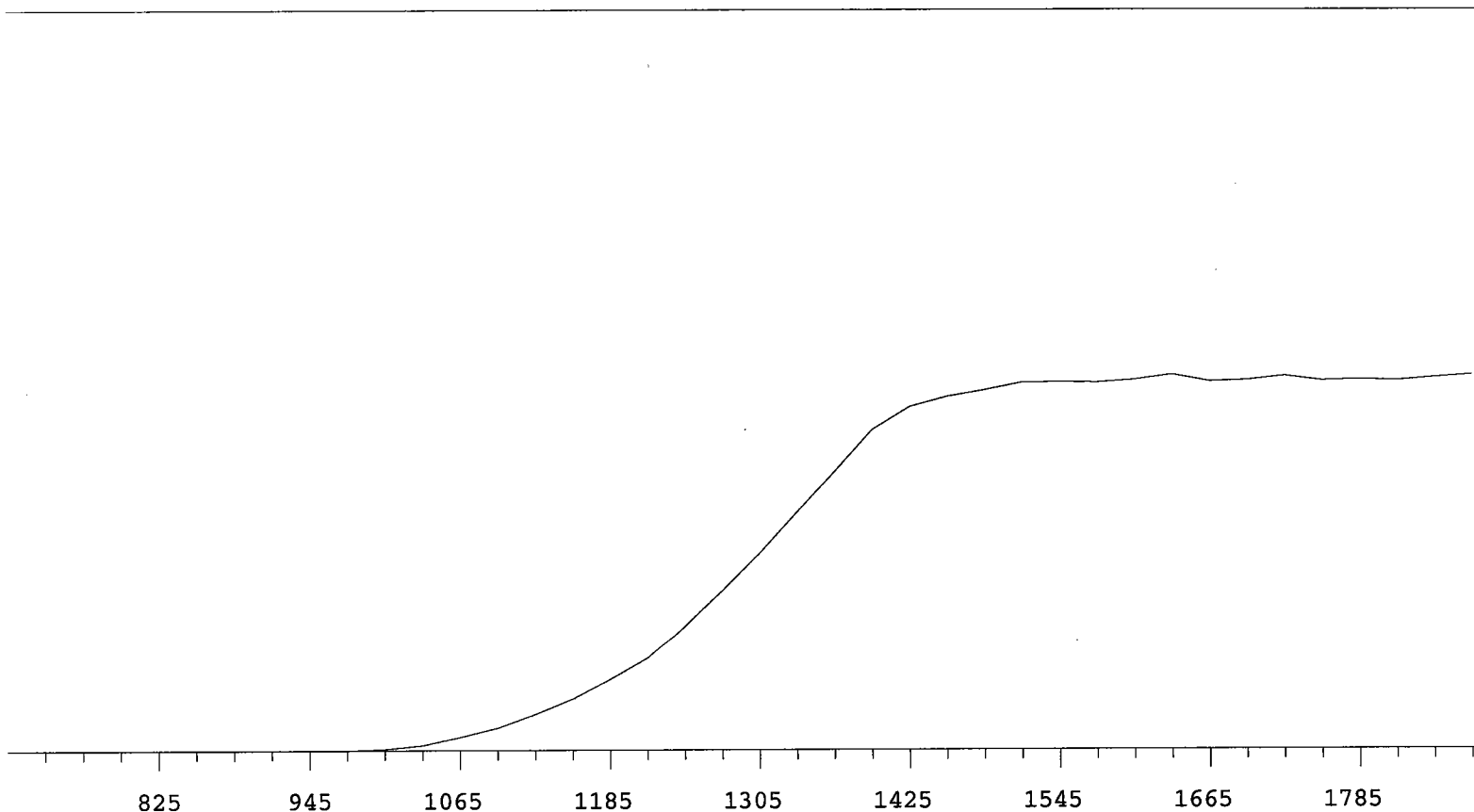
Beta Volts: 1515



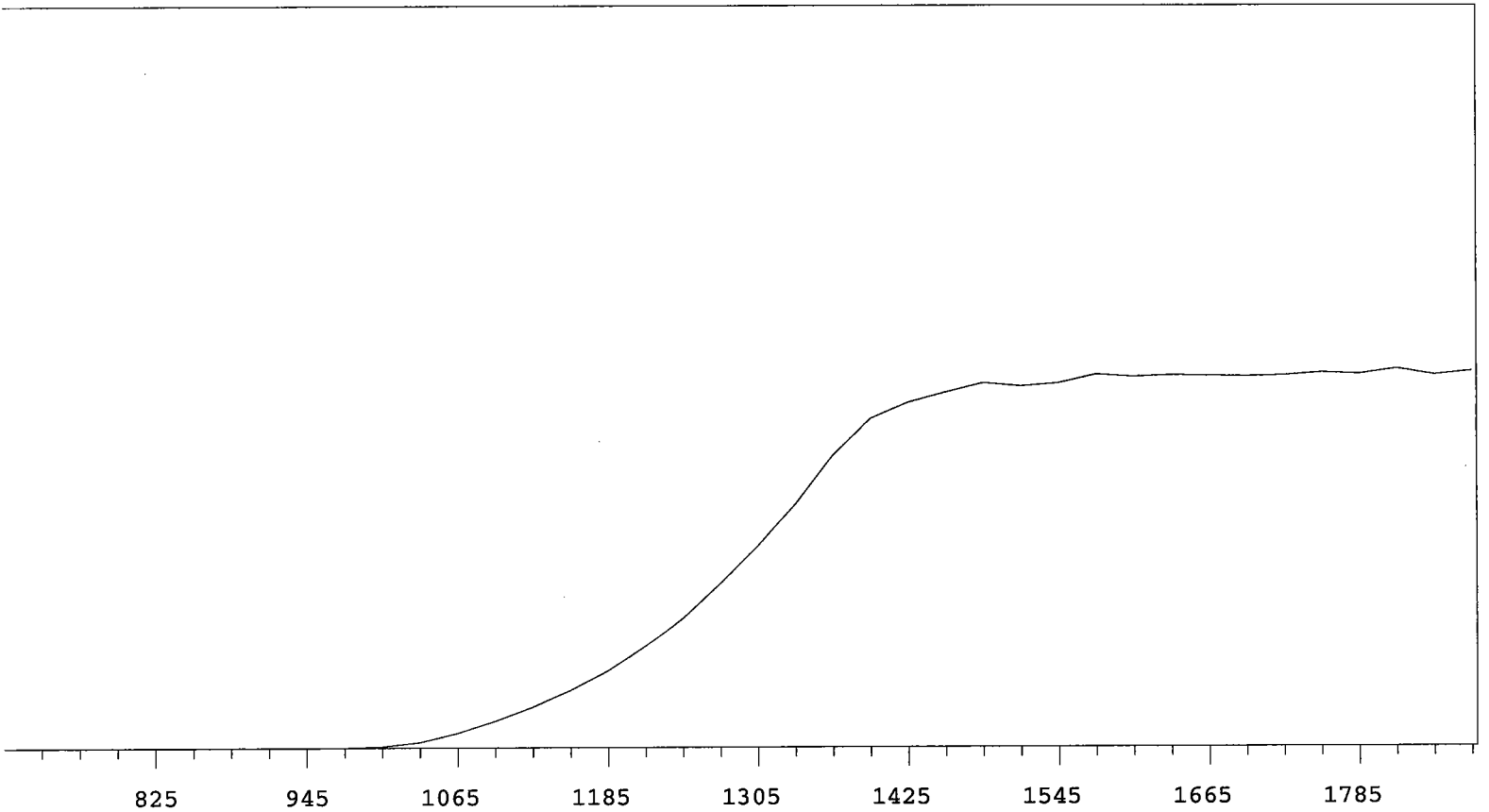
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	9144	+69.92
735	0		1335	11120	+58.43
765	0		1365	13399	+45.40
795	0	>100	1395	14711	+32.57
825	0	>100	1425	16134	+20.69
855	0	>100	1455	16805	+13.46
885	0	>100	1485	17209	+7.90
915	0	>100	1515	17500	+4.31
945	0	>100	1545	17812	+3.48
975	4	>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	



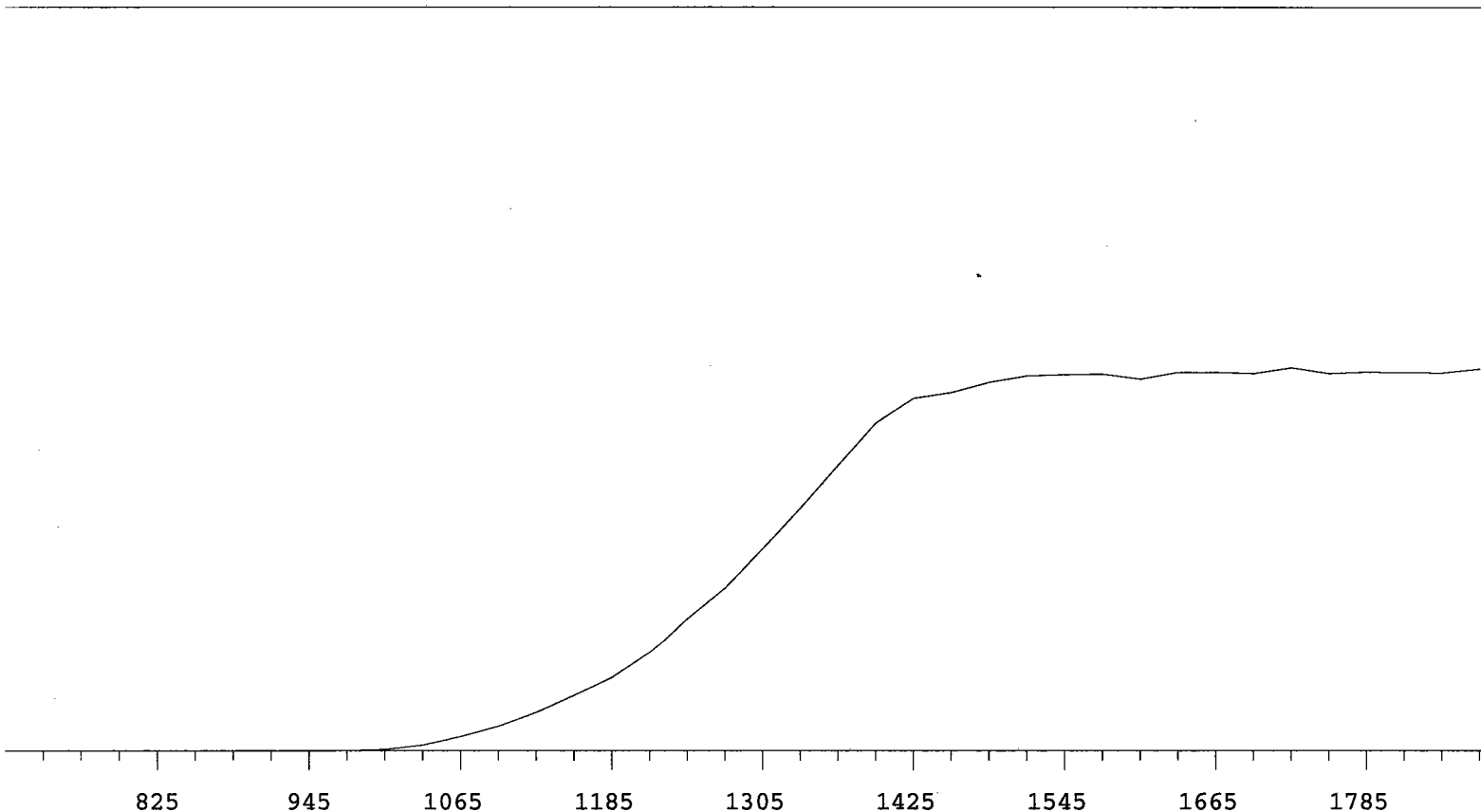
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	9666	+64.39
735	0		1335	11722	+55.91
765	0		1365	13680	+44.91
795	0	>100	1395	15677	+31.56
825	0	>100	1425	16786	+19.46
855	0	>100	1455	17283	+10.57
885	0	>100	1485	17608	+5.95
915	1	>100	1515	17972	+3.32
945	0	>100	1545	18006	+1.84
975	4	>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	



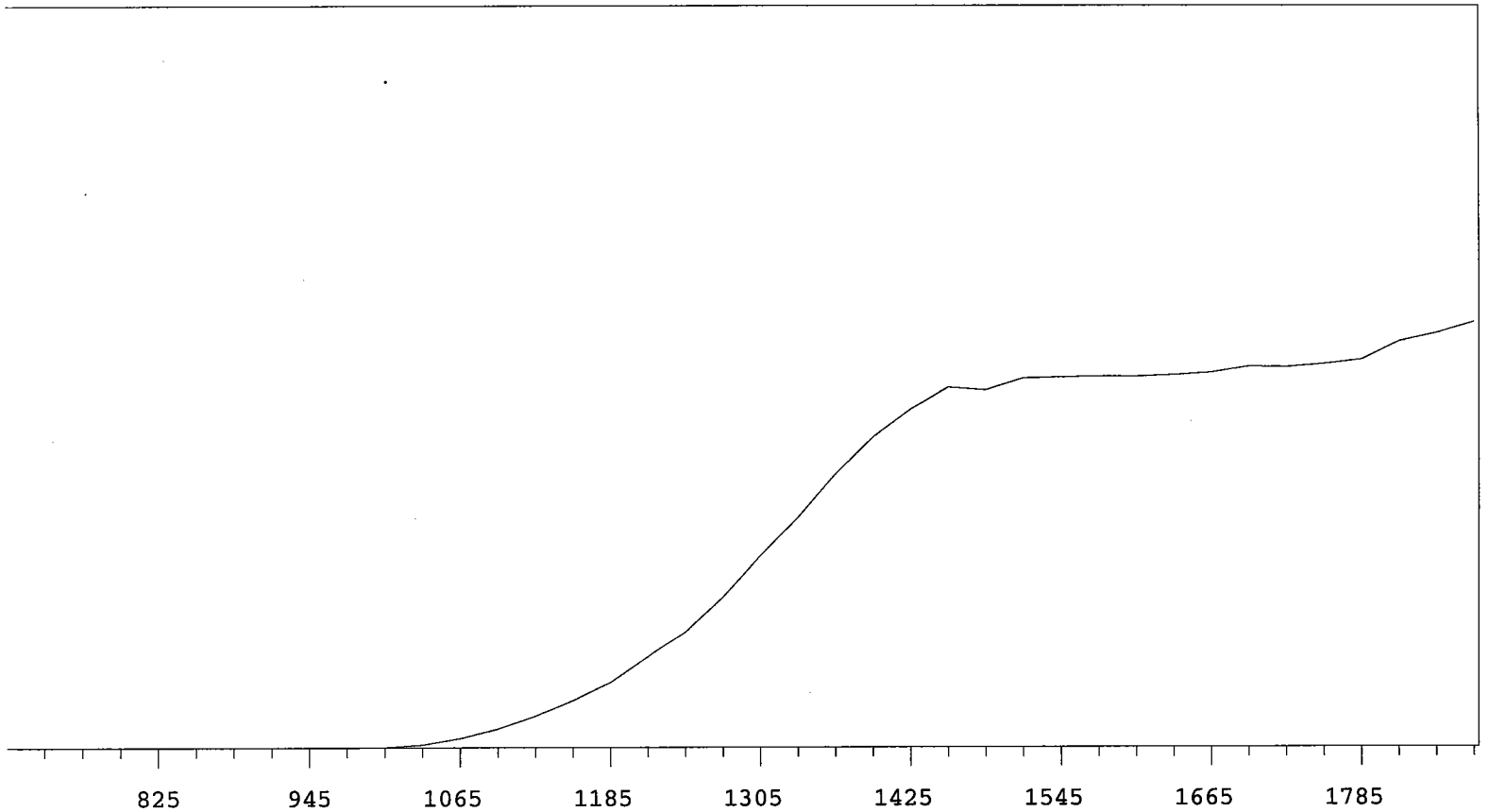
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	11573	+64.95
735	0		1335	13929	+56.47
765	0		1365	16726	+43.82
795	0	>100	1395	18834	+29.38
825	0	>100	1425	19743	+16.84
855	0	>100	1455	20314	+7.95
885	0	>100	1485	20860	+4.16
915	0	>100	1515	20670	+3.23
945	0	>100	1545	20844	+2.09
975	9	>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	

Alpha Volts: 705

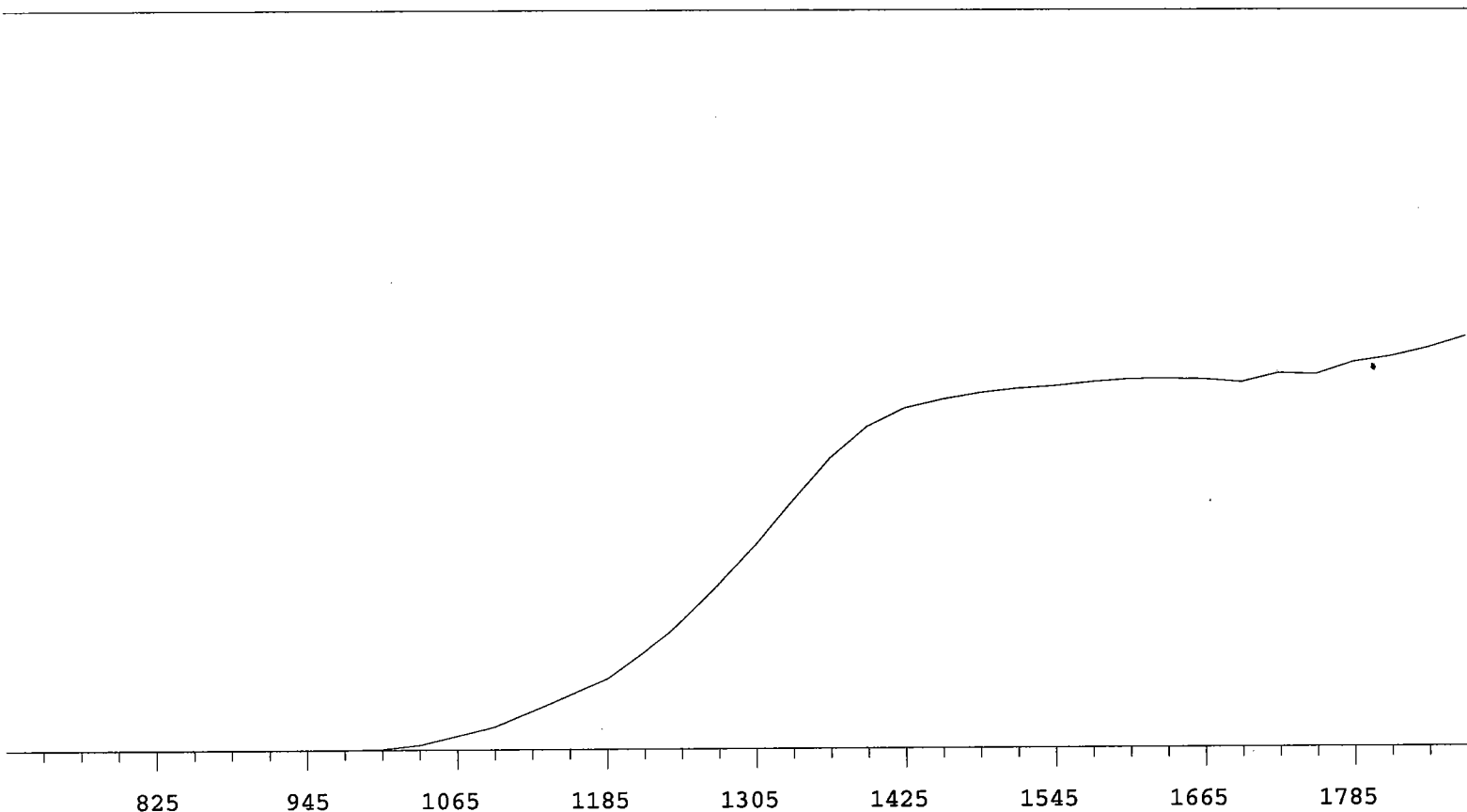
Beta Volts: 1515



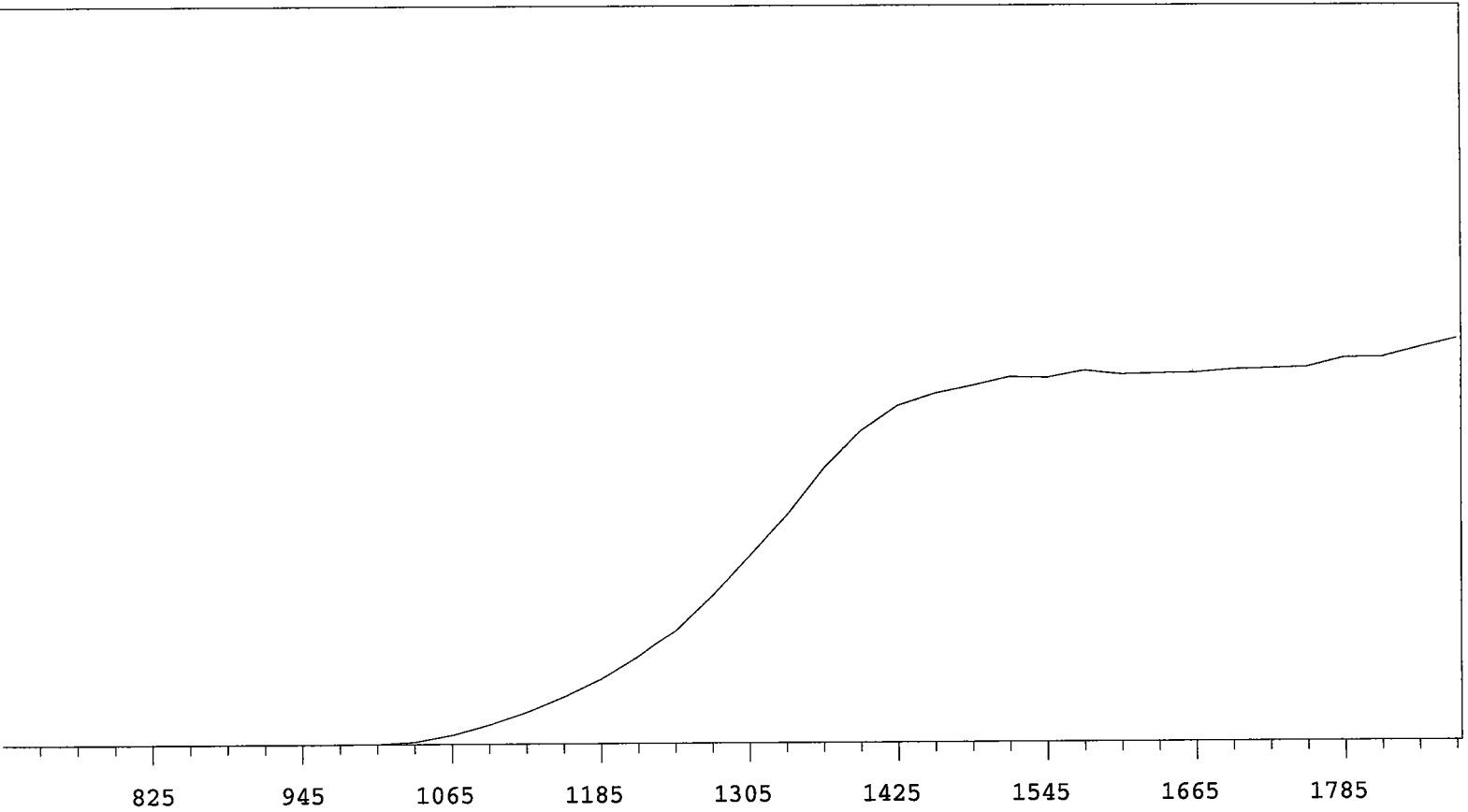
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	1		1305	7524	+61.93
735	0		1335	9002	+55.36
765	0		1365	10542	+44.70
795	0	>100	1395	12064	+31.21
825	0	>100	1425	12981	+19.20
855	0	>100	1455	13192	+10.41
885	0	>100	1485	13570	+5.93
915	0	>100	1515	13820	+4.08
945	0	>100	1545	13866	+0.75
975	9	>100	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	



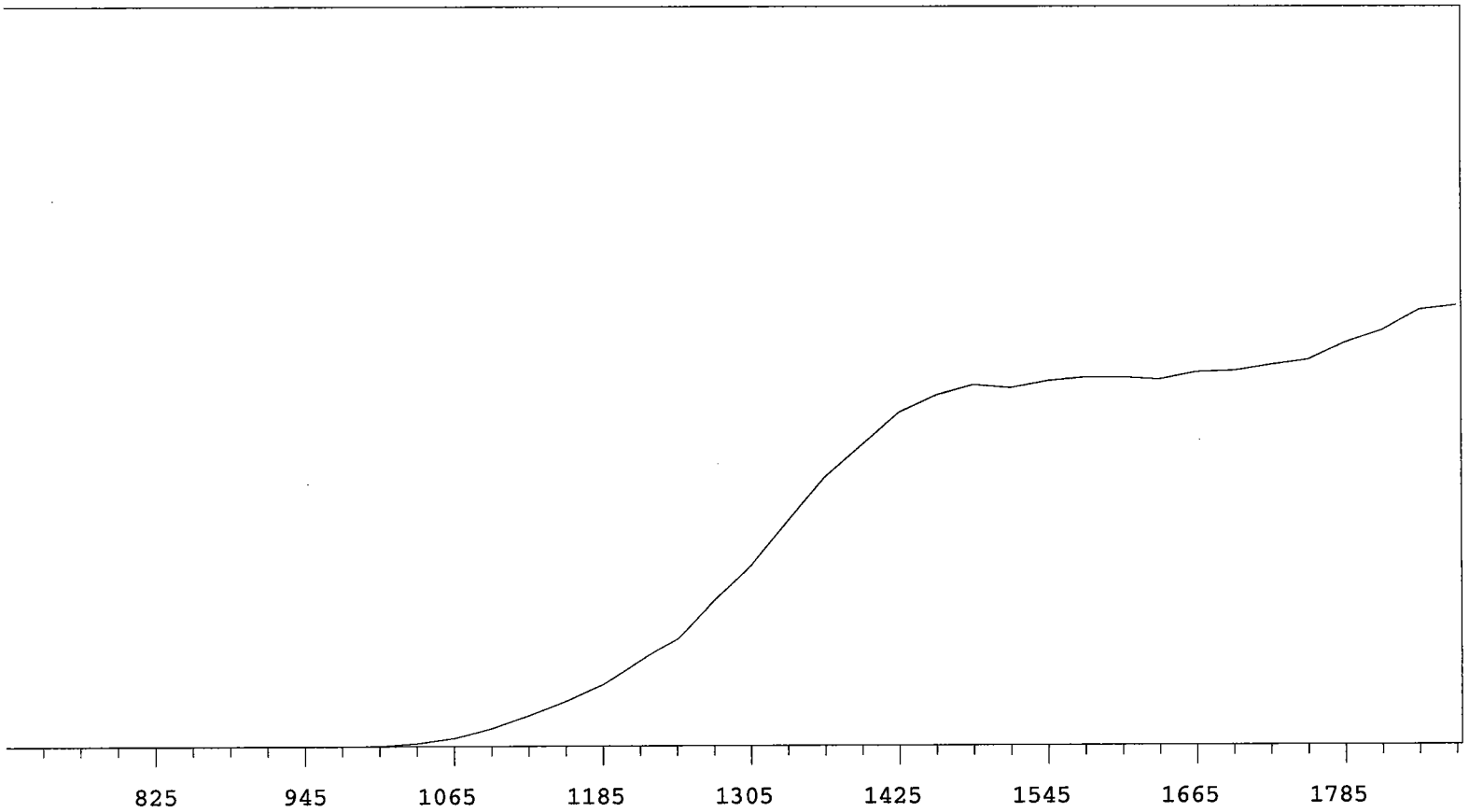
VOLTS	COUNTS	%/100 Volts	VOLTS	COUNTS	%/100 Volts
705	0		1305	8797	+65.44
735	0		1335	10726	+54.47
765	0		1365	12570	+41.11
795	0	>100	1395	13917	+26.79
825	0	>100	1425	14687	+15.44
855	1	+0.00	1455	15048	+8.47
885	0	>100	1485	15318	+5.00
915	0	>100	1515	15494	+3.76
945	0	>100	1545	15606	+3.04
975	3	>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	



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	

Alpha Volts: 705

Beta Volts: 1515



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: γ -impurities (other than decay products) <0.1%,
Ra-226 <0.1%

5.31628 grams 4M HCl solution with 100 μ g/g Ba carrier.

P O NUMBER 3219 RD, Item 1

SOURCE PREPARED BY:

M. Taskaeva
M. Taskaeva, Radiochemist

Q A APPROVED:

J.M. 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: γ -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. Mty 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		Standard	
Isotope	Detector CPM	NET CPM	Detector Eff Mass. Used (mL)
0503-B	1962.0000	1916.4000	1.0000
0503-B	1983.2000	1937.6000	1.0000
0503-B	1927.0000	1881.4000	1.0000
			Source DPM/mL
			206.8705773
			209.1590642
			203.092415
			206.3740189

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:

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. J. J. 9/16/08

Angela Johnson 9/17/08

5/19/16

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
28

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:

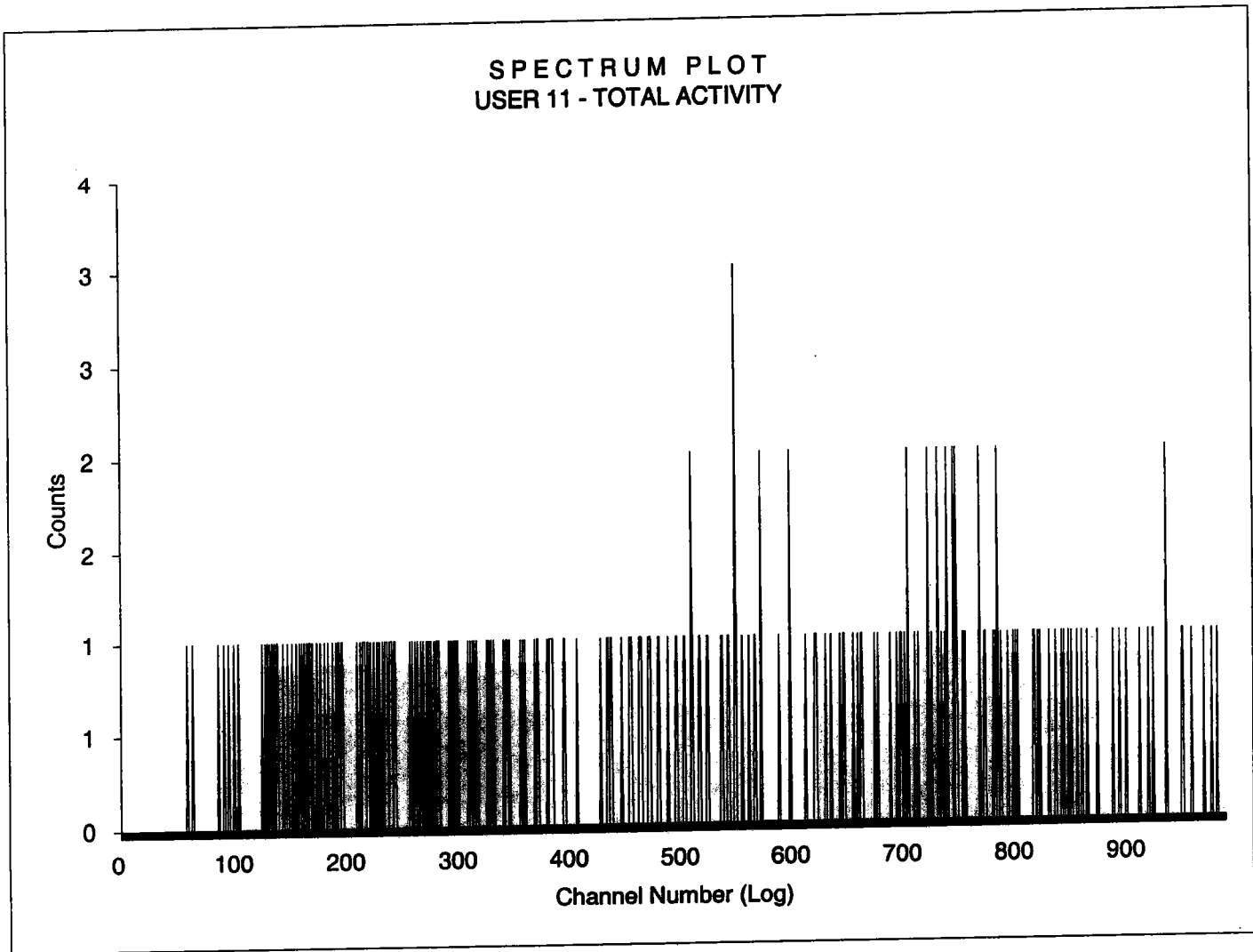
5 11-5 5.00

H#, Total Counts:

97.9 69

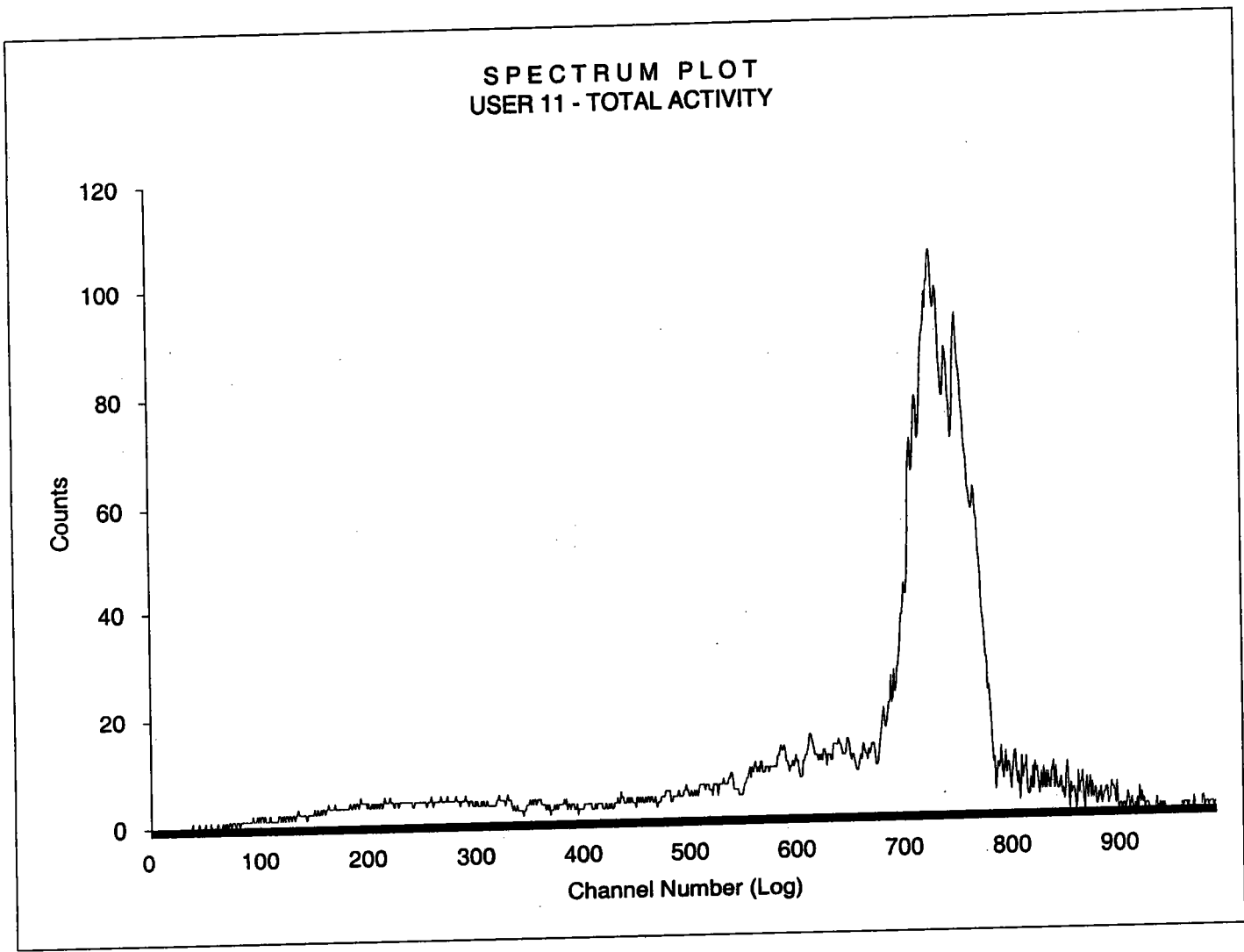
Start, End, X-Axis:

0 990 Channel Number



50/9/16
25

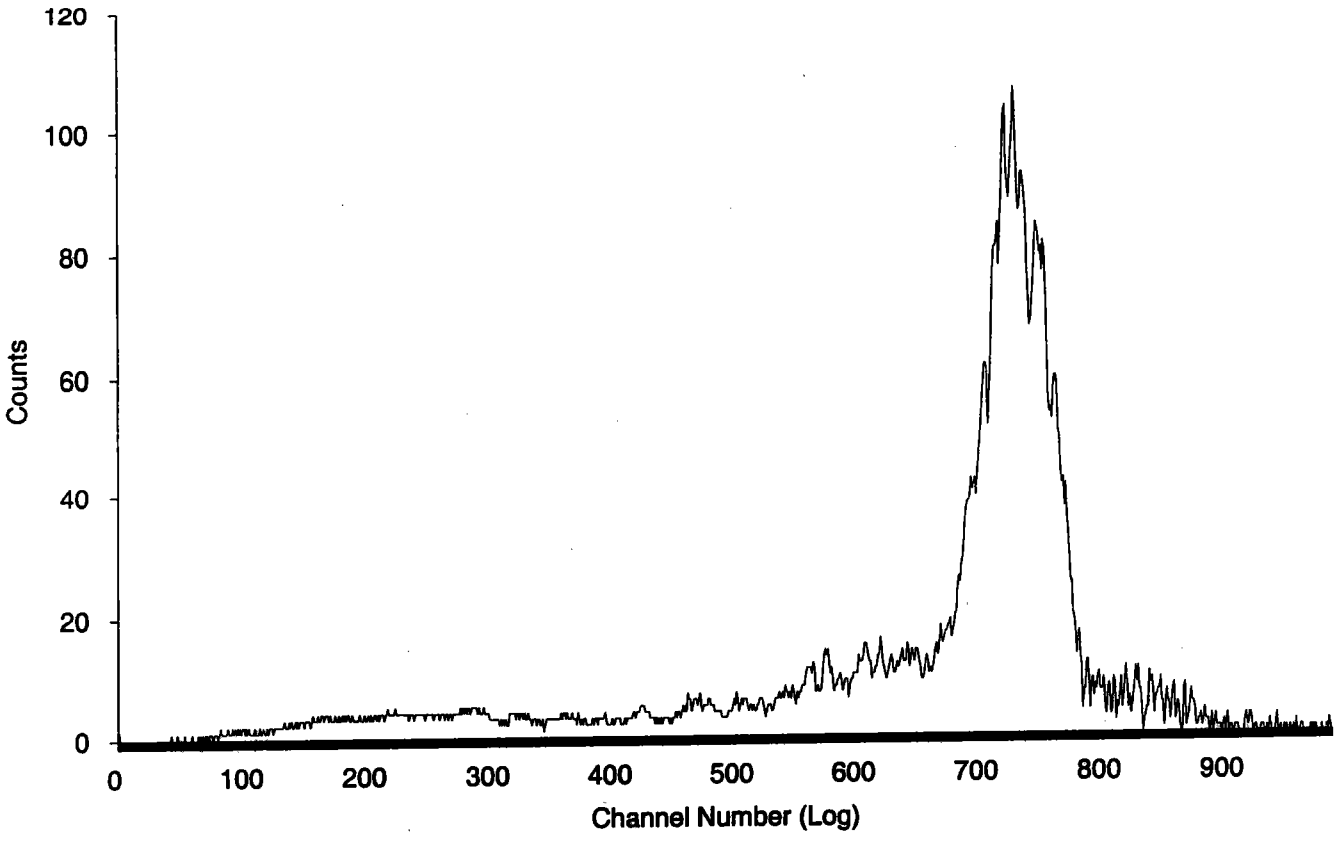
Sample Count Start Time: 16 Sep 2008 16:53:01
Data Capture Date: 9/16/2008 16:58:06
User Filename: S11091611-6A.WK1
U11091611-1A.WK1
Spectrum Type: Log Counts
User Number: 11
User Id: TOTAL ACTIVITY
User Comment: GOLD
Isotope Name: 14C
Scintillator: LIQUID
Sample, Rack-Pos, Time: 6 11-6 5.00
H#, Total Counts: 110.7 7666
Start, End, X-Axis: 0 990 Channel Number



80916
9/16/08
LJS

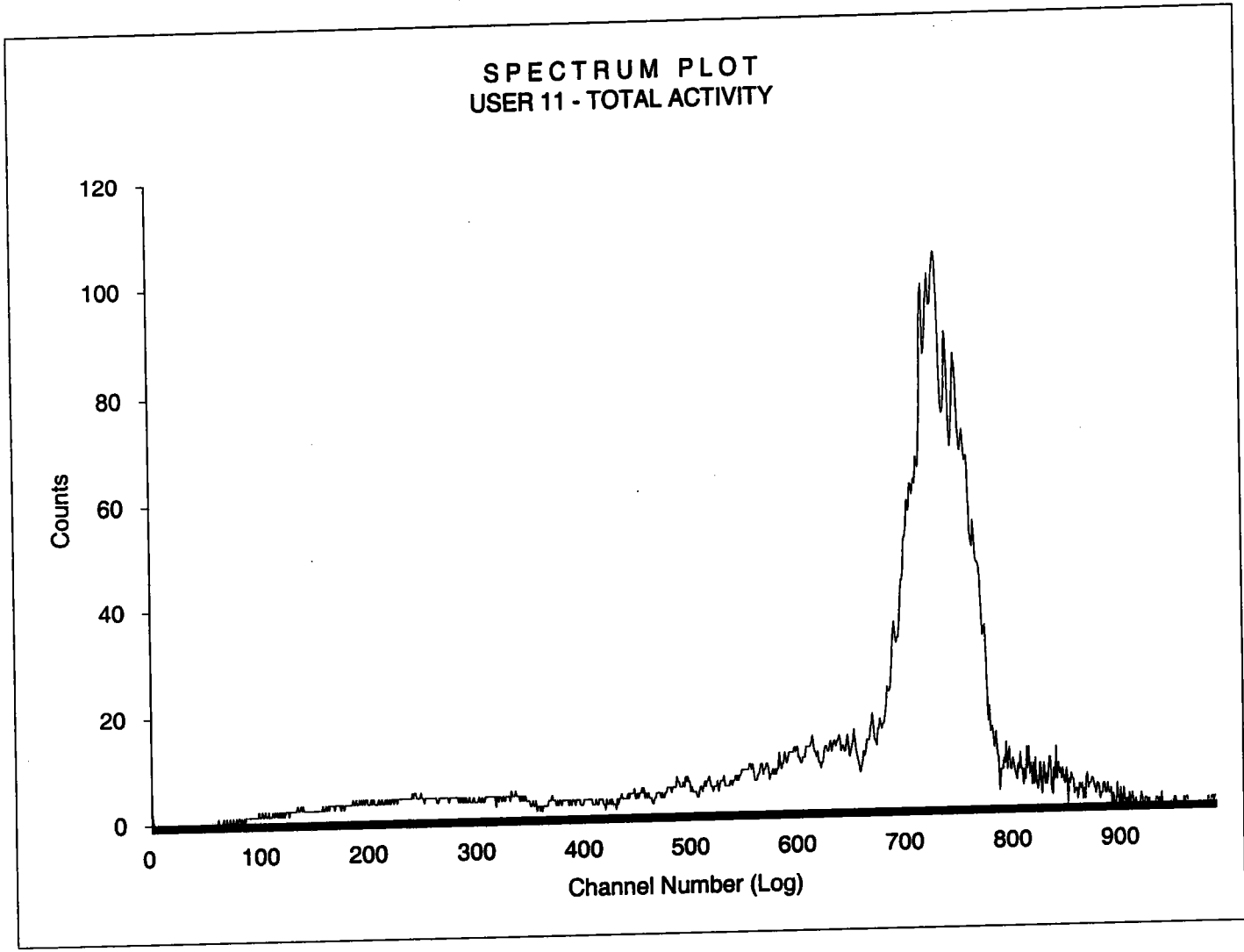
Sample Count Start Time: 16 Sep 2008 16:59:07
Data Capture Date: 9/16/2008 17:04:12
User Filename: S11091611-7A.WK1
U11091611-1A.WK1
Spectrum Type: Log Counts
User Number: 11
User Id: TOTAL ACTIVITY
User Comment: GOLD
Isotope Name: 14C
Scintillator: LIQUID
Sample, Rack-Pos, Time: 7 11-7 5.00
H#, Total 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

JRS 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

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 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 S. Dume

Date: 8/31/09

Reviewed By: Angela J. G.

Date: 8/31/09

Effective Date: 8/31/09

Ra-226 Cell Constants

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	Bkg Counts cpm	total counts	count time min	Known activity dpm	t1 (days)		t2 (days)		t3 (days)		Decay from Std Ref Date to count
										end-degas to flush	to flush	end-flush to count	to count	Std Ref Date to count		
101	1.846	cal 7	8/27/2009 16:35	8/27/2009 13:30	8/21/2009 11:30		4479	15	298.60	6.08333	0.12847	0.12847	3544	0.9958		
101	1.960	cal 9	8/24/2009 14:20	8/24/2009 9:30	8/18/2009 13:40		4581	15	305.40	5.82639	0.20139	0.20139	3541	0.9958		
101	2.060	cal 1	8/21/2009 15:00	8/21/2009 9:30	8/18/2009 13:40		2945	15	196.33	2.82639	0.22917	0.22917	3538	0.9958		
102	1.862	cal 5	8/27/2009 15:50	8/27/2009 12:40	8/21/2009 10:50		4510	15	300.67	6.07639	0.13194	0.13194	3544	0.9958		
102	1.850	cal 10	8/24/2009 14:45	8/24/2009 9:55	8/18/2009 13:40		4330	15	288.67	5.84375	0.20139	0.20139	3541	0.9958		
102	1.853	cal 2	8/21/2009 15:20	8/21/2009 9:50	8/18/2009 13:40		2659	15	177.27	2.84028	0.22917	0.22917	3538	0.9958		

104	2.073	Average	1.972	cal 1	8/27/2009 14:25	8/27/2009 9:35	8/24/2009 11:00		3070	15	204.67	2.94097	0.20139	3544	0.9958
104	1.855	Stdev	0.110	cal 11	8/24/2009 15:15	8/24/2009 10:15	8/18/2009 13:40		4343	15	289.53	5.85764	0.20833	3541	0.9958
104	1.987	cal 3		8/21/2009 15:50	8/21/2009 10:10	8/18/2009 13:40		2858	15	190.53	2.85417	0.23611	3538	0.9958	

106	1.985	Average	1.836	cal 2	8/27/2009 14:55	8/27/2009 10:00	8/24/2009 11:20		2940	15	196.00	2.94444	0.20466	3544	0.9958
106	1.738	Stdev	0.131	cal 12	8/24/2009 15:35	8/24/2009 10:40	8/18/2009 13:40		4078	15	271.87	5.87500	0.20466	3541	0.9958
106	1.786	cal 4		8/21/2009 16:30	8/21/2009 10:30	8/18/2009 13:40		2572	15	171.47	2.86806	0.25000	3538	0.9958	
107	2.025	Average	1.981	cal 8	8/27/2009 16:55	8/27/2009 13:50	8/21/2009 11:55		4910	15	327.33	6.07986	0.12847	3544	0.9958
107	2.054	Stdev	0.102	cal 1	8/24/2009 15:55	8/24/2009 11:00	8/21/2009 10:50		3090	15	206.00	3.00694	0.20466	3541	0.9958
107	1.864	cal 5		8/21/2009 16:45	8/21/2009 10:50	8/18/2009 13:40		2696	15	179.73	2.88194	0.24653	3538	0.9958	
108	1.906	Average	1.946	cal 6	8/27/2009 16:05	8/27/2009 13:05	8/21/2009 11:15		4623	15	308.20	6.07639	0.12500	3544	0.9958
108	1.975	Stdev	0.036	cal 2	8/24/2009 16:25	8/24/2009 11:20	8/21/2009 10:50		2978	15	198.53	3.02083	0.21181	3541	0.9958
108	1.957	cal 6		8/21/2009 17:00	8/21/2009 11:15	8/18/2009 13:40		2846	15	189.73	2.89931	0.23958	3538	0.9958	

111	2.162	Average	2.024	cal 3	8/27/2009 15:12	8/27/2009 10:20	8/24/2009 12:25		3177	15	211.80	2.91319	0.20278	3544	0.9958
111	2.051	Stdev	0.153	cal 3	8/24/2009 17:00	8/24/2009 12:25	8/21/2009 10:50		3139	15	209.27	3.06597	0.19097	3541	0.9958
111	1.859	cal 7		8/21/2009 17:15	8/21/2009 11:30	8/18/2009 13:40		2712	15	180.80	2.90972	0.23958	3538	0.9958	
112	1.962	Average	1.931	cal 4	8/27/2009 15:30	8/27/2009 10:50	8/24/2009 12:40		2895	15	193.00	2.92361	0.19444	3544	0.9958
112	1.967	Stdev	0.059	cal 4	8/24/2009 17:15	8/24/2009 12:40	8/21/2009 10:50		3019	15	201.27	3.07639	0.19097	3541	0.9958
112	1.863	cal 8		8/21/2009 17:35	8/21/2009 11:55	8/18/2009 13:40		2731	15	182.07	2.92708	0.23611	3538	0.9958	

EffErr 0.053028 <- Put in Machines.xls (Lucas Cell Tab)

8/13/09

VW 8/13/109

Ra-226 Calibration Sheet

Standard ID: 0119-H

Volume Added (mL): 0.1

Expiration Date: 8/1/10

$\frac{219}{8/13/09} = 900$
 $\frac{219}{8/13/09}$
 $\frac{219}{8/13/09}$
 * count time 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	8/18/09 1340	8/21/09 0930	1500 1410 8/21/09 1430	101	1	3142 4050 #8/21/09
Cal 2	500	8/18/09 1340	8/21/09 0950	1500 1425 8/21/09 1305	102	1	2778 #8/21/09
Cal 3	500	8/18/09 1340	8/21/09 1010	1550 8/21/09 1445	104	1	2182 #8/21/09
Cal 4	500	8/18/09 1340	8/21/09 1030	8/21/09 1630	106	1	2572 #8/21/09
Cal 5	500	8/18/09 1340	8/21/09 1050	8/21/09 1645	107	1	2696
Cal 6	500	8/18/09 1340	8/21/09 1115	8/21/09 1700	108	1	2846
Cal 7	500	8/18/09 1340	8/21/09 1130	8/21/09 1715	111	1	2712
Cal 8	500	8/18/09 1340	8/21/09 1155	8/21/09 1735	112	1	2731
Cal 9							
Cal 10							
Cal 11							
Cal 12							

2945
#8/21/09
2659
2858

WSP/BSM

8/13/09

8/28/09

General Engineering Laboratories Verification Source Preparation Sheet

Applicable SOP Number GL-RAD-A-008 Isotope RA-226
 Date Standards Prepared 4/5/05 Cocktail Type Used NA
 Standard ID 0799-H Matrix of Vial/Planchett NA
 Amount Used (g or ml) 0.1 NA
 Standard Activity (DPM/g or ml) 2483.233 Type of Scintillation Vial NA
 Reference Date 12/15/99 Pipette ID Used 1429303
 Expiration Date 8/1/10 Balance ID Used 38080204
 Residue/Carrier Agent D-IMHDI 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				
	100502105				

Prepared By: Kelli Dorego Date 8/31/09
 Reviewed By: Angela J Gh Date 8/31/09

Rev 1 RLM 9/10/97

ee'd

8-21-00

Nycomed Amersham plc
Amersham Laboratories

0299



CALIBRATION
No. 0140



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

Date of issue

17th December 1999

VO 8131105

Nycomed

GEL 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

$(\text{Mass of parent(g)}) * (\text{Parent Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$
$(\text{Mass of parent(g)}) * (\text{Parent Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$
$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$
$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$

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

WJ 8/26/05

Voltage Curve Ludlum #1

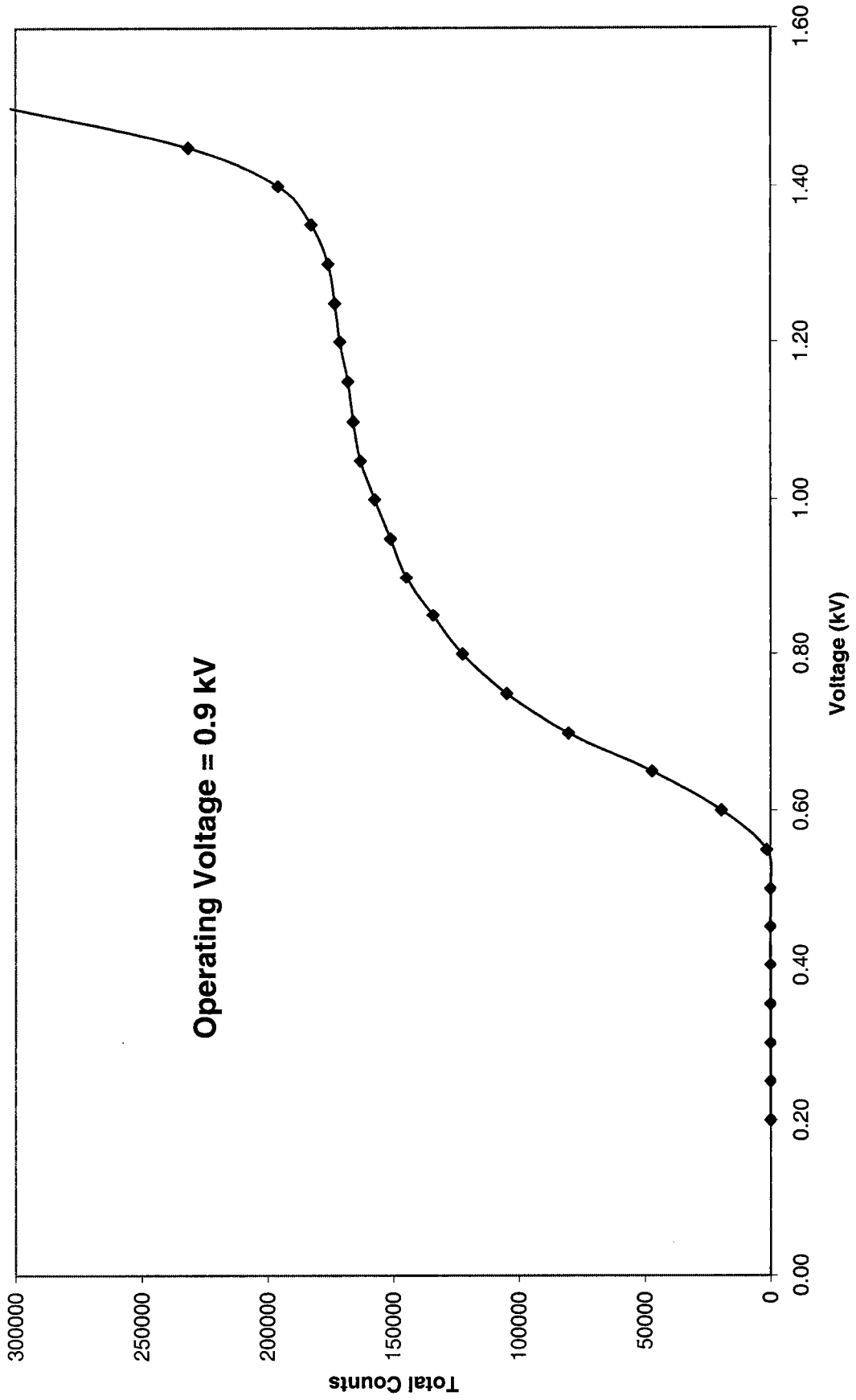
Voltage (kV)	Count Time (min)	Counts	Date/Time
0.20	1.00	0	8/21/09 13:20
0.25	1.00	0	8/21/09 13:21
0.30	1.00	0	8/21/09 13:22
0.35	1.00	0	8/21/09 13:23
0.40	1.00	0	8/21/09 13:24
0.45	1.00	0	8/21/09 13:25
0.50	1.00	0	8/21/09 13:26
0.55	1.00	1534	8/21/09 13:27
0.60	1.00	19637	8/21/09 13:28
0.65	1.00	47206	8/21/09 13:29
0.70	1.00	80410	8/21/09 13:30
0.75	1.00	104945	8/21/09 13:31
0.80	1.00	122514	8/21/09 13:32
0.85	1.00	134160	8/21/09 13:33
0.90	1.00	144753	8/21/09 13:34
0.95	1.00	151057	8/21/09 13:35
1.00	1.00	157429	8/21/09 13:36
1.05	1.00	163110	8/21/09 13:37
1.10	1.00	166034	8/21/09 13:38
1.15	1.00	168121	8/21/09 13:39
1.20	1.00	171347	8/21/09 13:40
1.25	1.00	173388	8/21/09 13:41
1.30	1.00	175958	8/21/09 13:42
1.35	1.00	182719	8/21/09 13:43
1.40	1.00	195871	8/21/09 13:44
1.45	1.00	231584	8/21/09 13:45
1.50	1.00	303021	8/21/09 13:46
1.55	1.00	387838	8/21/09 13:47

Detector set to operate at 0.90 kV

Handwritten signature
8/31/09

Ludlum Detector Voltage Curve

—◆— Voltage Curve Ludlum #1



8/13/09

Control Limits for Lucas Cell Counter #1

Analyst: KSD1
Date: 8/31/2009

Count #	Detector #1
1	138383
2	138269
3	141307
4	140521
5	132825
6	135924
7	139231
8	138298
9	135342
10	138056
11	138123
12	139159
13	138410
14	138251
15	138438
16	138080
17	137814
18	137961
19	137248
20	137477

Average = 137955.9
Std. Dev. = 1775.5

+3 S. D. = 143282.4266
+2 S. D. = 141506.901
Mean = 137955.9
-2 S. D. = 134404.799
-3 S. D. = 132629.2734

Control Limits **8/31/2009** * Operating Voltage changed to 0.9 kV
Detector #1
Upper Limit **143282**
Lower Limit **132629**

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8/31/09

	Eff	Cal Date
101	1.956	8/31/2009
102	1.855	8/31/2009
104	1.972	8/31/2009
106	1.836	8/31/2009
107	1.981	8/31/2009
108	1.946	8/31/2009
111	2.024	8/31/2009
112	1.931	8/31/2009

Lucas	Ra-226	
Oldest Cal	01/23/2008	
Detector	Eff Error	Cal Date
1	0.0530	8/31/2009
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

Ra-226 WATER

Batch : LCSVER
 Date : 8/20/2008
 Analyst : KSD1
 Bkg Count Time: 30 min
 Procedure Code : LUC26RAL
 Parmname : Radium-226
 MDA : 1 pCi/L
 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 2	0.500	30	689	101	1.956	0.267	0.5907	25.3156	1.9236	8/31/2009 14:35
Ver 6	0.500	30	697	102	1.855	0.133	0.4721	27.1986	2.0367	8/31/2009 15:05
Ver 2	0.500	30	656	104	1.972	0.267	0.6303	25.7021	2.0032	8/28/2009 14:00
Ver 4	0.500	30	638	106	1.836	0.267	0.6304	24.9919	1.9762	8/31/2009 15:40
Ver 7	0.500	30	629	107	1.981	0.267	0.6257	24.4533	1.9479	8/28/2009 17:50
Ver 5	0.500	30	693	108	1.946	0.267	0.5959	25.6861	1.9459	8/31/2009 16:15
Ver 3	0.500	30	672	111	2.024	0.267	0.6129	25.6096	1.9713	8/28/2009 14:35
Ver 4	0.500	30	631	112	1.931	0.267	0.6411	25.1365	1.9990	8/28/2009 15:10

JLQ
8/31/09

Sample ID	Sample Dup	Det #	Run Date	Sample Type	Standard ID	NC	NC units	Recovery/RPD
Ver 2		1	8/31/2009 14:35	LCS	0638-H	24.17	pCi/L	105%
Ver 3		1	8/31/2009 15:05	LCS	0638-H	24.17	pCi/L	113%
Ver 2		1	8/28/2009 14:00	LCS	0638-H	24.17	pCi/L	106%
Ver 4		1	8/31/2009 15:40	LCS	0638-H	24.17	pCi/L	103%
Ver 7		1	8/28/2009 17:50	LCS	0638-H	24.17	pCi/L	101%
Ver 8		1	8/31/2009 16:15	LCS	0638-H	24.17	pCi/L	106%
Ver 3		1	8/28/2009 14:35	LCS	0638-H	24.17	pCi/L	106%
Ver 4		1	8/28/2009 15:10	LCS	0638-H	24.17	pCi/L	104%

DEGASSING DATE/TIME	DE-EMAN. DATE/TIME	DEGASS-DE-EM	dE-EM-COUNT	constant	constant	constant	Net CPM	Ingrowth constant
8/28/2009 10:20	8/31/2009 11:10	72.83	3.42	0.4230	0.9745	1.0019	22.7000	0.4130
8/28/2009 10:40	8/31/2009 11:30	72.83	3.58	0.4230	0.9733	1.0019	23.1000	0.4125
8/25/2009 16:00	8/28/2009 10:20	66.33	3.67	0.3940	0.9727	1.0019	21.6000	0.3839
8/28/2009 11:00	8/31/2009 11:55	72.92	3.75	0.4234	0.9721	1.0019	21.0000	0.4123
8/25/2009 16:00	8/28/2009 12:00	68.00	5.83	0.4015	0.9569	1.0019	20.7000	0.3850
8/28/2009 11:20	8/31/2009 12:15	72.92	4.00	0.4234	0.9703	1.0019	22.8333	0.4115
8/25/2009 16:00	8/28/2009 10:40	66.67	3.92	0.3955	0.9709	1.0019	22.1333	0.3847
8/25/2009 16:00	8/28/2009 11:00	67.00	4.17	0.3970	0.9690	1.0019	20.7667	0.3854

Handwritten signature and date: 8/31/09

ANALYTICS

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 · U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

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: γ -impurities (other than decay products) <0.1%

5.01065 grams 0.1M HCl solution with 50 μ g/g Ba carrier.

P O NUMBER 3231RD, Item 5

SOURCE PREPARED BY:

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

Q A APPROVED:

ACUM 1/26/04

W 8731105

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

$(\text{Mass of parent(g)} * (\text{Parent Activity (dps)}) * (\text{conversion dpm to dps}) / (\text{Ampoule Mass(g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/mL)}$
$(\text{Mass of parent(g)} * (\text{Parent Activity (dps)}) * (\text{conversion dpm to dps}) / \text{Density} / (\text{Ampoule Mass (g)} * (\text{Dilution Vol})) = \text{Parent Activity (dpm/g)}$
$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) * (5.01065 \text{ g} * 100 \text{ mL}) = 13636.6133 \text{ dpm/mL}$
$(4.8398 \text{ g}) * (23530 \text{ dps}) * (60 \text{ dpm/dps}) / (1.0266 \text{ g/mL}) / (5.01065 \text{ g} * 100 \text{ mL}) = 13282.9676 \text{ dpm/g}$

W 8/28/09

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

W 8/31/09

Verification for Ra-226 Standard 0638-H

D. Roy 7/23/2008	Isotope	Value	Uncertainty
	0638-H	11.852	1.1079
	0638-H	12.092	1.1141
	0638-H	12.372	1.1216
Mean Value (Counting) =	12.106	100.13	Pass
Stdev =	0.260353631		Rule 3 (Pass/Fail)
Target =	12.09		
Lower Limit =	11.5848594		
Upper Limit =	12.62627393		
Rule 1 Pass/Fail	Pass		
Two sigma =	0.520707263		
10 % of Mean =	1.210556667		
Rule 2 (Pass/Fail)	Pass		

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 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

David D. Roy 8/14/08
Ver. L. Jones 8/14/08

VAD 8/20/08

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 secondard 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	0.43056	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	7856	30	255.20	243.02	4.04167	0.21875	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

NU 12/19/08

NU 12/19/08

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 104.944421 Pass
 Stdev = 10.63610098 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:

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

M. V. T. 12/19/08
 W. V. 11/19/08
 Nancy E. Johnson 4/19/08
 Daniel D. King 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 ok 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: Kelli S. Deroso Date: 12/19/08
 Reviewed By: Mary G. Johnson Date: 12/19/08

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: $\pm 1.3\%$

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	0.500	30	593	208	2.283	0.267	0.5132	16.9552	1.4723	11/20/2008 16:40
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

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12/19/08

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

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12/18/08

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12/19/08
W
12/18/08

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
VCV 1	500	1110108 1535	1111108 1020	1111108 1510	201	2	8	1014
2	500	11110108 1535	1111108 1045	1111108 1545	202	2	8	1054
3	500	11110108 1535	1111108 1110	1111108 1020	205	2	8	937
4	500	11110108 1535	1111108 1145	1111108 2050	208	2	8	786
5	500	11110108 1535	1111108 1150	1111108 2120	209	2	8	1200
6	500	11110108 1535	1111108 1200	1111108 2155	211	2	8	1067
7	500	11110108 1535	1111108 1845	1111108 1330	701	1	8	982
8	500	11110108 1535	1111108 0900	1111108 1405	708	1	8	1191
9	500	11110108 1535	1111108 0900	1111108 1435	705	1	8	1121
10								
11								
12								
VCV 3	500	1111108 1110	11110108 1145	11110108 1040	208	2	8	533

VCV
12/18/08

VCV
12/18/08
VCV
11/21/08

VCV 12/19/08

VCV 12/19/08
VCV 12/18/08

VCV
12/18/08

VCV
12/18/08

VCV
12/18/08

VCV
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:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

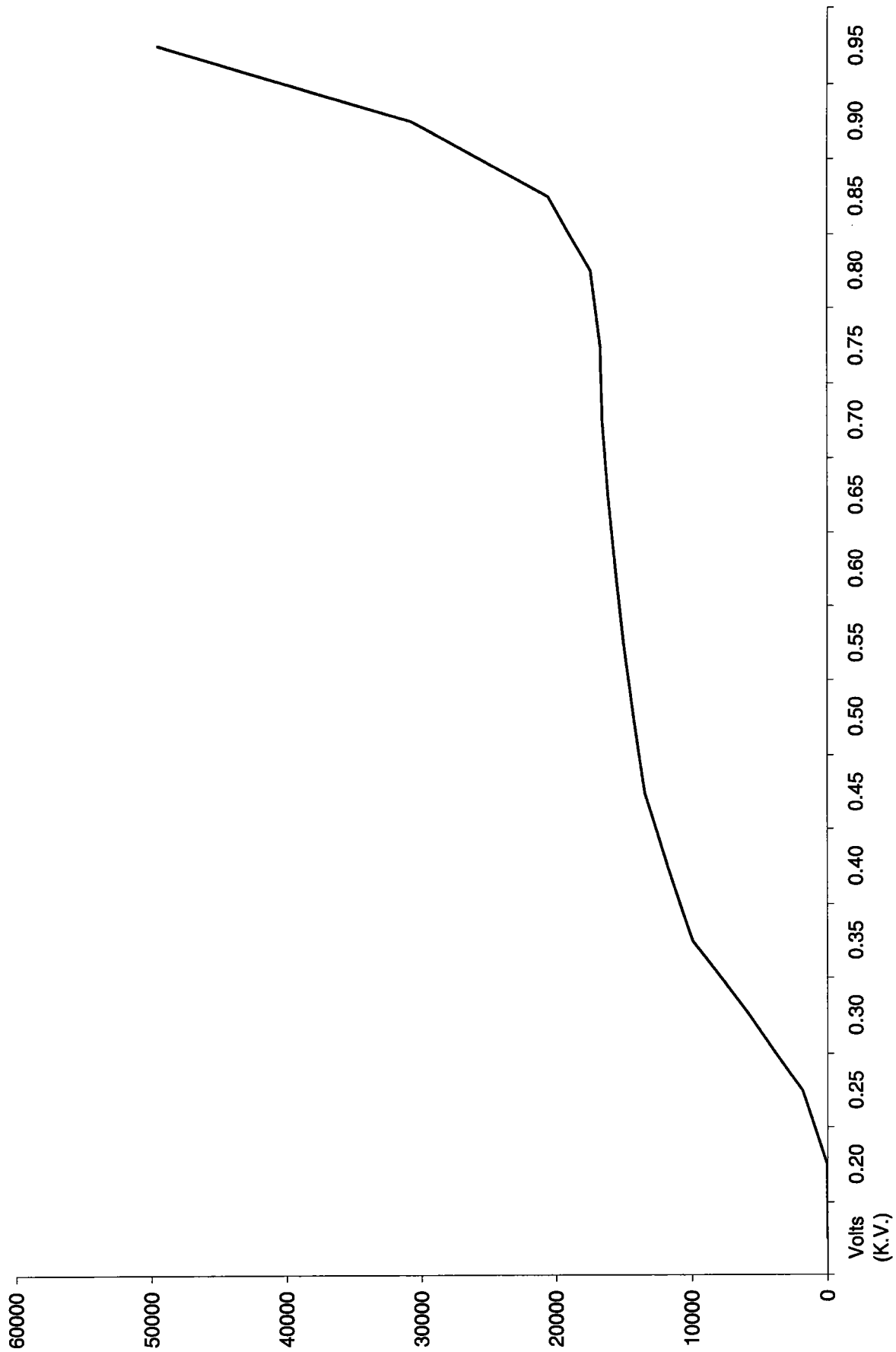
where:

- 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*

12/19/2008 10:48 AM

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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	4.20139	0.88194	3331	0.9961

K0 213109

Verification for Ra-226 Standard 0299-G

4/2/2008
D. Roy

Isotope
0299-G N1
0299-G N2
0299-G N3

Detector CPM
2536.9600
2520.2500
2532.5000

BKG CPM
52.4000
52.4000
52.4000

NET CPM
2484.5600
2467.8500
2480.1000

Detector Eff
1.917186
1.917186
1.917186

Mass. Used (G)
0.5057
0.5056
0.5042

Source DPM/G
2562.667649
2545.935781
2565.677715

Average =
2558.093715

Mean Value (Counting) =
10.63610098

Standard Dev =
104.944421

Rule 3 (Pass/Fail)
0.00415782

Pass

2437.6
2536.821513
2579.365917

dpm/mL
dpm/mL
dpm/mL

Certificate Value =
Lower Limit =
Upper Limit =

Rule 1 Pass/Fail
Two sigma =
10 % of Mean =

Rule 2 (Pass/Fail)

*exception taken due to full recovery of standard

Fail
21.27220197
255.8093715

dpm/mL
dpm/mL

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
LSC Gold
Ra-226
0024



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

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$$

$$(\text{Mass of parent(g)}) * (\text{Parm Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$$

$$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$$

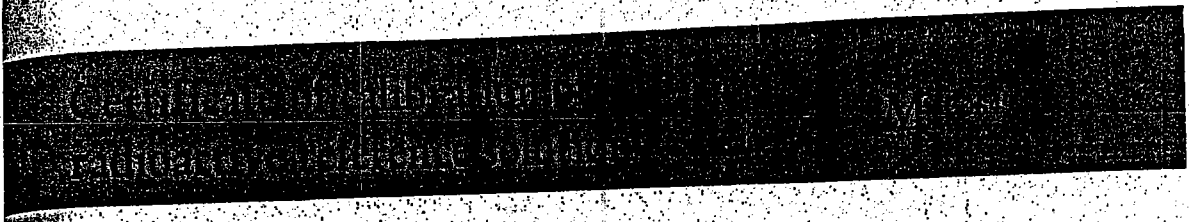
Secondary Standards

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

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.

Chemical Carrier free in 0.5M HCL
position

Remarks 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

601112
 CW

Handwritten signature

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 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

5/11/12
 071
 LEWA 2141.04

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
Mean Value (Counting) =	23.953	99.60	Pass
Stdev =	1.010781096		Rule 3 (Pass/Fail)
Target =	24.05		
Lower Limit =	21.93100448		
Upper Limit =	25.97412886		
Rule 1 Pass/Fail	Pass		
Two sigma =	2.021562191		
10 % of Mean =	2.395256667		
Rule 2 (Pass/Fail)	Pass		

- 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 24109
[Signature] 2/2/09
 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 ^{2/11/09} 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 H₂O

	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				

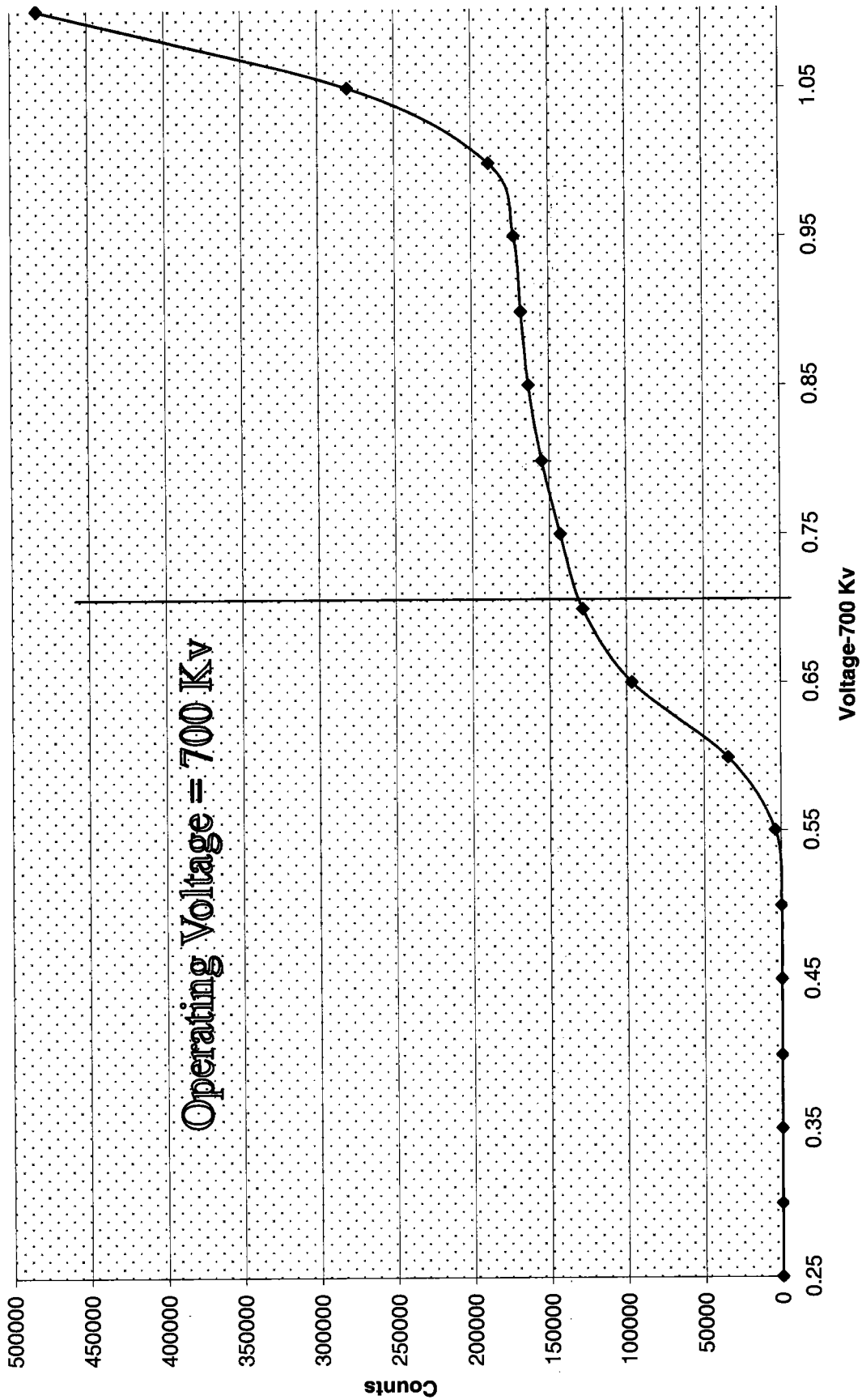
Prepared By: Kelli Brunell Date 2/13/09
 Reviewed By: [Signature] Date 2/14/09

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

LLA 2/4/09
 LW
 2/3/09

Ludlum 3 Voltage Curve



KO 213109

LCM
2/11/09

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

	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 Dorrel

Date: 2/28/09

Reviewed By: Angela Johnson

Date: 3/2/09

Effective Date: 3/2/09

Ra-226 Cell Constants

Standard Reference date: 12/15/1999
standard ID: 0.299-G
Volume added (mL): 0.1
Standard Reference Activity (DPM/mL): 2446.35

Lucas cell #	Call 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
401	1.689	Average	2/23/2009 16:15	2/23/2009 10:30	2/20/2009 17:25	0.267	4580	30	152.67	243.66	2.71181	0.23958	3359	0.9960
401	1.585	Stdev	2/27/2009 13:15	2/27/2009 9:00	2/23/2009 16:05	0.267	5474	30	182.47	243.66	3.70486	0.17708	3363	0.9960
401	1.448		2/25/2009 14:40	2/25/2009 7:55	2/20/2009 17:25	0.267	5677	30	189.23	243.66	4.60417	0.28125	3361	0.9960
402	2.133	Average	2/23/2009 16:55	2/23/2009 11:05	2/20/2009 17:25	0.267	5817	30	193.90	243.66	2.73611	0.24306	3359	0.9960
402	2.173	Stdev	2/27/2009 14:10	2/27/2009 9:30	2/23/2009 16:05	0.267	7507	30	250.23	243.66	3.72569	0.19444	3363	0.9960
402	2.048		2/25/2009 15:25	2/25/2009 8:15	2/20/2009 17:25	0.267	8017	30	267.23	243.66	4.61806	0.29861	3361	0.9960
403	1.475	Average	2/23/2009 18:30	2/23/2009 11:30	2/20/2009 17:25	0.267	4011	30	133.70	243.66	2.75347	0.29167	3359	0.9960
403	1.495	Stdev	2/27/2009 14:50	2/27/2009 10:00	2/23/2009 16:05	0.267	5182	30	172.73	243.66	3.74853	0.20139	3363	0.9960
403	1.419		2/25/2009 15:55	2/25/2009 8:35	2/20/2009 17:25	0.267	5582	30	185.40	243.66	4.63194	0.30556	3361	0.9960
404	1.792	Average	2/23/2009 19:05	2/23/2009 13:10	2/20/2009 17:25	0.267	5005	30	166.83	243.66	2.82292	0.24653	3359	0.9960
404	2.142	Stdev	2/27/2009 15:25	2/27/2009 10:30	2/23/2009 16:05	0.267	7443	30	248.10	243.66	3.76736	0.20486	3363	0.9960
404	1.859		2/25/2009 20:20	2/25/2009 8:55	2/20/2009 17:25	0.267	7075	30	235.83	243.66	4.64583	0.47569	3361	0.9960
405	2.066	Average	3/2/2009 13:40	3/2/2009 10:30	2/25/2009 14:00	0.267	8602	30	286.73	243.66	4.85417	0.13194	3366	0.9960
405	1.899	Stdev	2/27/2009 16:00	2/27/2009 10:55	2/23/2009 16:05	0.267	6612	30	220.40	243.66	3.78472	0.21181	3363	0.9960
405	1.745		2/25/2009 20:55	2/25/2009 10:10	2/20/2009 17:25	0.267	6721	30	224.03	243.66	4.69792	0.44792	3361	0.9960
409	1.805	Average	2/24/2009 0:30	2/23/2009 15:20	2/20/2009 17:25	0.267	5039	30	167.97	243.66	2.91319	0.38194	3359	0.9960
409	2.153	Stdev	2/3/2009 21:10	2/3/2009 15:00	1/30/2009 10:50	0.267	7949	30	264.97	243.67	4.17361	0.25694	3339	0.9960
409	2.149		2/27/2009 16:35	2/27/2009 11:30	2/23/2009 16:05	0.267	7516	30	250.53	243.66	3.80903	0.21181	3363	0.9960
410	1.869	Average	2/26/2009 8:50	2/25/2009 13:05	2/20/2009 17:25	0.267	6838	30	227.93	243.66	4.31944	0.82292	3361	0.9960
410	1.965	Stdev	2/4/2009 8:30	2/3/2009 15:30	1/30/2009 10:50	0.267	6708	30	223.60	243.67	4.19444	0.70853	3339	0.9960
410	1.824		2/24/2009 8:00	2/23/2009 15:40	2/20/2009 17:25	0.267	4840	30	161.33	243.66	2.92708	0.68056	3359	0.9960
411	1.824	Average	2/24/2009 8:40	2/23/2009 15:55	2/20/2009 17:25	0.267	4839	30	161.30	243.66	2.93750	0.69792	3359	0.9960
411	1.911	Stdev	2/27/2009 17:45	2/27/2009 12:20	2/23/2009 16:05	0.267	6357	30	211.90	243.66	3.84375	0.22569	3363	0.9960
411	1.836		2/26/2009 9:30	2/25/2009 13:40	2/20/2009 17:25	0.267	6734	30	224.47	243.66	4.84375	0.82639	3361	0.9960
412	1.947	Average	2/26/2009 10:15	2/25/2009 14:05	2/20/2009 17:25	0.267	7137	30	237.90	243.66	4.86111	0.84028	3361	0.9960
412	2.131	Stdev	2/27/2009 18:20	2/27/2009 12:45	2/23/2009 16:05	0.267	7495	30	249.83	243.66	3.86111	0.23264	3363	0.9960
412	1.822		2/24/2009 9:40	2/23/2009 16:10	2/20/2009 17:25	0.267	4818	30	160.60	243.66	2.94792	0.72917	3359	0.9960

EffErr 0.123705 <- Put in Machines.xls (Lucas Cell Tab)

Angela J. ... 3/2/09
Miki Davel 3/2/09

401	1.574	3/2/2009
402	2.118	3/2/2009
403	1.463	3/2/2009
404	1.931	3/2/2009
405	1.903	3/2/2009
409	2.036	3/2/2009
410	1.886	3/2/2009
411	1.824	3/2/2009
412	1.967	3/2/2009

General Engineering Laboratories Verification Source Preparation Sheet

Applicable SOP Number GLRAD-A-008 Isotope Pu-239
 Date Standards Prepared 4/15/09 Cocktail Type Used NA
 Standard ID 02996 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 4/15/09 Pipette ID Used 1429303
 Expiration Date 4/15/09 Balance ID Used 3604026
 Residue/Carrier Agent 0.5M HCl Quenching Agent NA

	Standard Number	Quenching Vol (uL) Residue Volume(mL)	Initial Wt. (g)	Final Wt. (g)	Net Wt. (mg)
3	CA13				
43	CA143				
7	CA17				
42	CA142				
13	CA143				
44	CA144				
30	CA130				
48	CA148				
36	CA136				
35	CA135				
38	CA138				
15	CA115				
14	CA114				
46	CA146				
47	CA147				

W 3/2/09

Prepared By: Kell Deneo Date: 3/2/09
 Reviewed By: Angie J. Ghera Date: 3/2/09

Rev 1 RLM 9/10/97

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:	

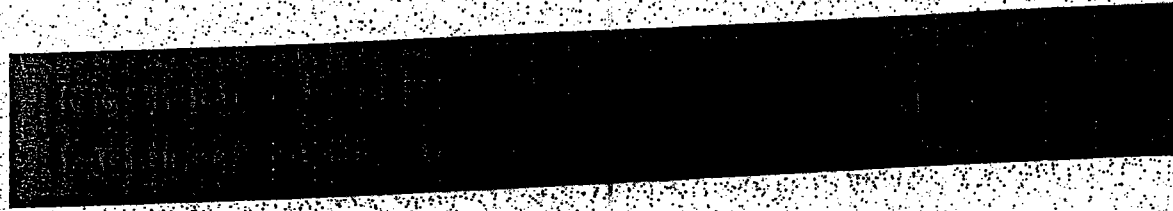
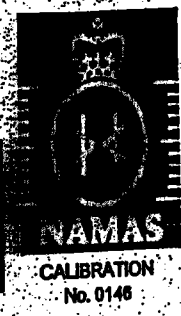
Calculations Converting parent activity to dpm/mL|dpm/g

$(\text{Mass of parent(g)}) * (\text{Parent Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / (\text{Dilution Vol}) = \text{Parent Activity (dpm/mL)}$
$(\text{Mass of parent(g)}) * (\text{Parent Activity (kBq/g)}) * (\text{conversion dpm to kBq}) / \text{Density (g/mL)} / (\text{Dilution Vol}) = \text{Parent Activity (dpm/g)}$
$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (100 \text{ mL}) = 122414.2500 \text{ dpm/mL}$
$(4.6634 \text{ g}) * (43.75 \text{ kBq/g}) * (60000 \text{ dpm/kBq}) / (1.0012 \text{ g/mL}) / (100 \text{ mL}) = 122273.3377 \text{ dpm/g}$

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	04/02/2008	04/02/2009

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 $\nu_{eff} = \infty$ 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

Date of issue 17th December 1999

Nycomed Amersham
Via 31/05

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 **Pass**
 Stdev = 10.63610098 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 *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:

$$\text{Source dpm/g} = (A - B)/(C)(D)$$

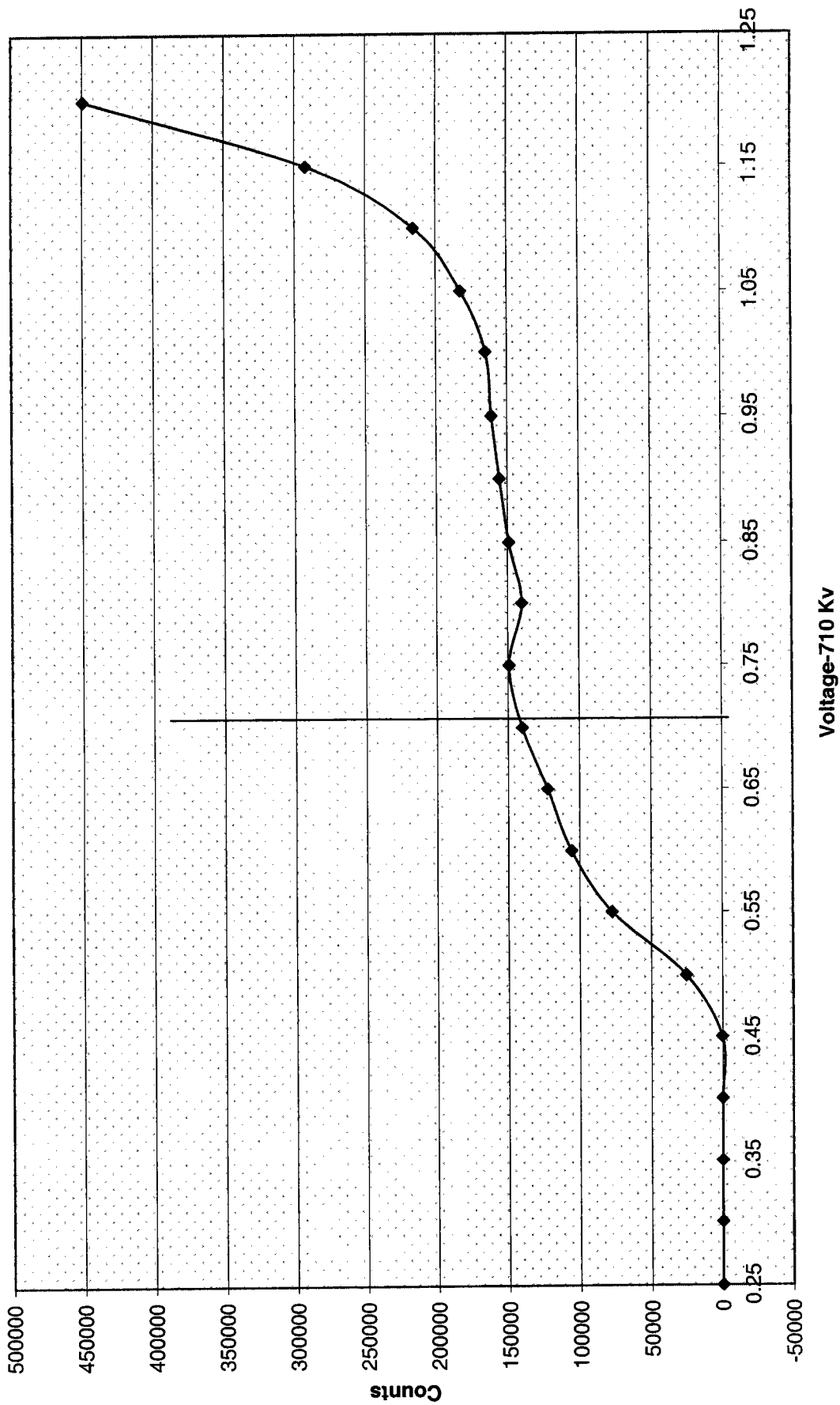
where:

- A = Ver. source cpm,
- B = BKG cpm,
- C = System efficiency, (cpm/dpm), and
- D = mass used for standard verification.

RAD.SOP.M-001

Henry St. Johnson 4/19/08
David Dwyer 4/10/08
WJN

Ludlum 4 Voltage Curve



10/3/04

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 second 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"/>		
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	7282	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	0.25784	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	0.35784	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	3/12/2009 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	3/10/2009 14:00	8653	30	288.43	243.03	7.00000	0.95833	3382	0.9960

ERR 0.143768 <- Put in Machines.xls (Lucas Cell Tab) *Backgrounds are not significant enough to be considered in calculations. ANSI N42.25-1997 (B.2).

Calibration
Ra-226 Verification-Sheet
3/14/09

Cal # 5

no 3124109
3119109

3/19/09

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	3/2/09 0815	3/6/09 0750	501	5	8	5281
Cal 14	500	2/25/09 1400	2/27/09 0845	3/6/09 0840	502	5	1	4200
		2/25/09 1400	3/2/09		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

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
Cal 15	500	3/5/09 1400	3/10/09 1345	3/11/09 1155	503	5	8	7352
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
Cal 18	500	3/5/09 1400	3/10/09 1527	3/11/09 1410	507	5	4	6315
Cal 19	500	3/5/09 1400	3/10/09 1550	3/11/09 1455	508	5	4	6443
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
3/19/09

LD 3124109

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Background CPM	Total Counts
Cal 42	500	3/6/09 1525	3/12/09 1110	3/12/09 1330	501	5	8	10210
Cal 19	500	3/6/09 1525	3/12/09 1035 1045 1055	3/12/09 1470	502	5	8	8243
Cal 44	500	3/6/09 1525	3/12/09 1000	3/12/09 1450	503	5	2	7214
Cal 40	500	3/6/09 1525	3/12/09 1035	3/12/09 1535	504	5	0	4202
Cal 7	500	3/6/09 1525	3/12/09 1050	3/12/09 1701	505	5	5	9884
Cal 13	500	3/6/09 1525	3/12/09 1115	3/12/09 1740	506	5	8	8554
Cal 43	500	3/6/09 1525	3/12/09 1135	3/12/09 1830	507	5	6	7535
Cal 2	500	3/6/09 1525 1403/12/09	3/12/09 1200	3/12/09 2045	508	5	0	6680
Cal 6	500	3/6/09 1525	3/12/09 1235	3/12/09 2120	509	5	8	8049
Cal 35	500	3/6/09 1525	3/12/09 1250	3/12/09 2155	510	5	1	6589
Cal 37	500	3/6/09 1525	3/12/09 1310	3/12/09 2240	511	5	8	9068
Cal 38	500	3/6/09 1525	3/12/09 1330	3/12/09 2315	512	5	5	9322

3/19/09

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
Cal 30	500	3/12/09 1210	3/12/09 1600	3/19/09 2200	509	5	7942

3/12/09

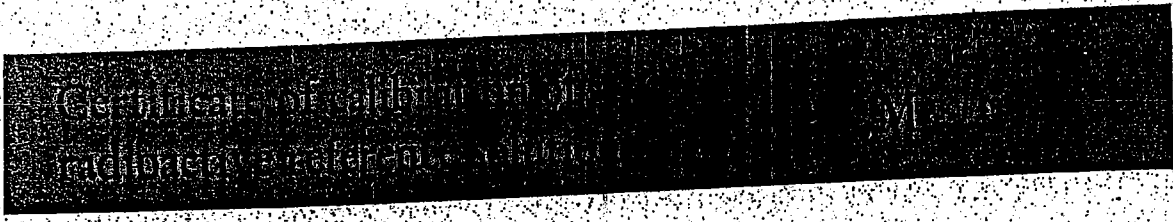
3/12/09

3/12/09

8-21-00

Nycomed Amersham plc
Amersham Laboratories

0299



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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.

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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



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:

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
 41912
 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 _____

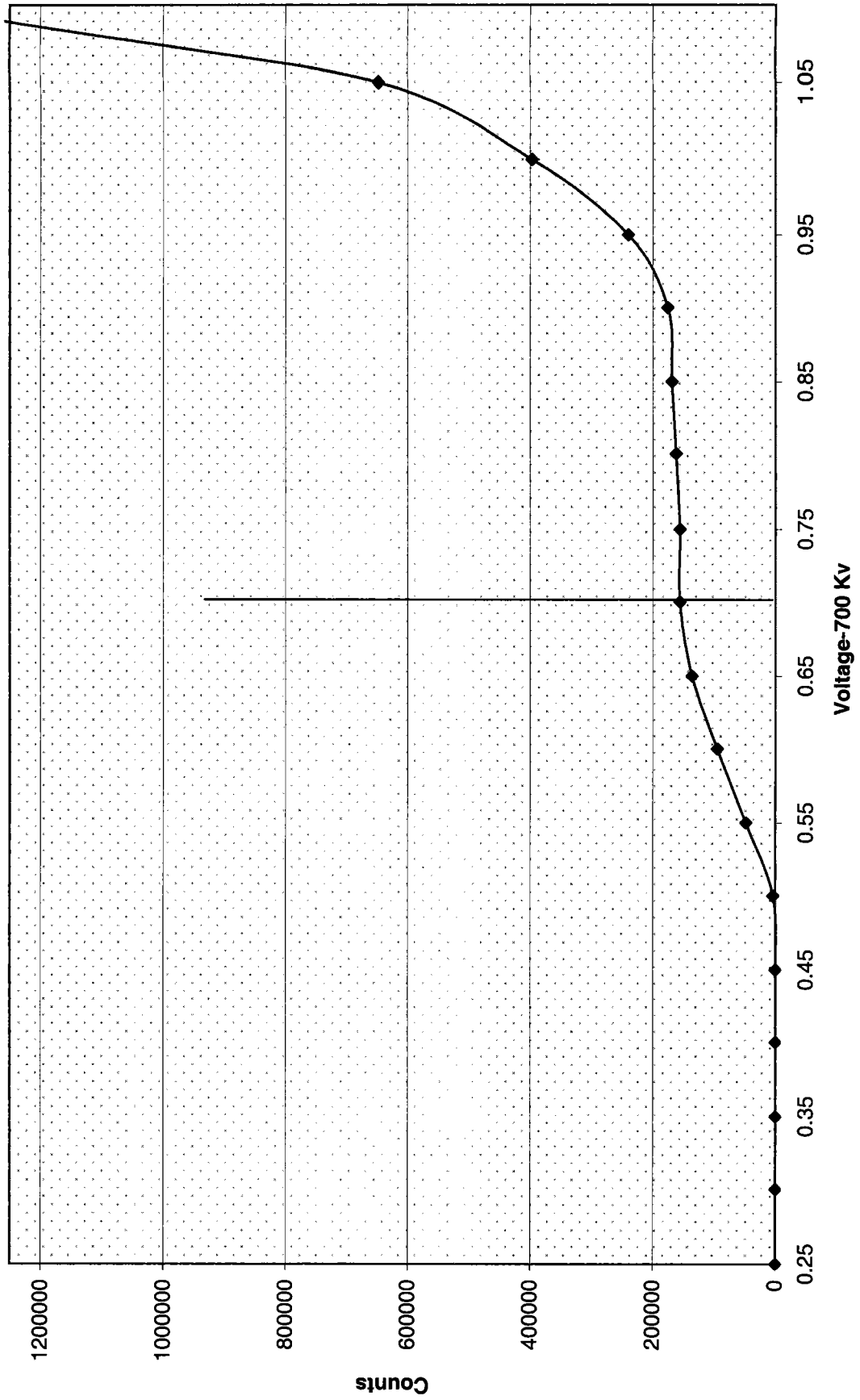
Rev 1 RLM 9/10/97

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
VUX 1	500	3/16/09 1530	3/16/09 0945	3/16/09 1510	501	5	8	766
VUX 2	500	3/13/09 1530	3/16/09 1010	3/16/09 1925	502	5	85 <small>140 3124109</small>	537
VUX 3	500	3/13/09 1530	3/16/09 1030	3/16/09 2020	503	5	8	518
VUX 4	500	3/13/09 1530	3/16/09 1100	3/16/09 2115	504	5	8	577
VUX 5	500	3/13/09 1530	3/16/09 1125	3/16/09 2200	505	5	8 <small>140 3124109</small>	680
VUX 6	500	3/13/09 1530	3/16/09 1155	3/16/09 2230	506	5	8	707
VUX 7	500	3/13/09 1530	3/16/09 1320	3/16/09 2300	507	5	8	488
VUX 8	500	3/13/09 1530	3/16/09 1350	3/16/09 2330	508	5	8 <small>140 3124109</small>	544
VUX 9	500	3/13/09 1530	3/16/09 1410	3/17/09 0445	509	5	8	640
VUX 10	500	3/13/09 1530	3/16/09 1415	3/17/09 0500 <small>0545</small>	510	5	8 <small>140 3124109</small>	432
VUX 11	500	3/13/09 1530	3/16/09 1445	3/17/09 0535 <small>0585</small>	511	5	8	577
VUX 12	500	3/13/09 1530	3/16/09 1500	3/17/09 0610	512	5	8	723

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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	Isotope	Value	Uncertainty
	0638-F #1	24.629	1.7426
	0638-F #2	24.438	1.7557
	0638-F #3	22.791	1.6808
Mean Value (Counting) =	23.953	99.60	Pass
Stdev =	1.010781096		Rule 3 (Pass/Fail)
Target =	24.05		
Lower Limit =	21.93100448		
Upper Limit =	25.97412886		
Rule 1 Pass/Fail	Pass		
Two sigma =	2.021562191		
10 % of Mean =	2.395256667		
Rule 2 (Pass/Fail)	Pass		

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

.. 01 - 1: 2/2/09

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

Lucas	Ra-226	
Oldest Cal	01/23/2008	
Detector	Eff Error	Cal Date
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: Angela Gh... Date 8/4/09

Rev 1 RLM 9/10/97

10/8/05

Ra-226 Calibration Sheet

Standard ID: ~~0299-G~~ 0299-G
 Volume Added (mL): 0.1 J19 8/4/09

Expiration Date: ~~4/4/10~~ J19 8/4/09

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 5	500	5/22/09 1045	5/24/09 0950	5/29/09 14:45	601	6	10735
Cal 6	500	5/22/09 1045	5/24/09 1015	5/29/09 15:20	602	6	10133
Cal 7	500	5/22/09 12:00	5/24/09 1045	5/29/09 15:55	604	6	10451
Cal 8	500	5/22/09 1250	5/24/09 1105	5/29/09 17:15 17:20	605	6	10587
Cal 9	500	5/24/09 0930	5/24/09 1310	5/29/09 17:45	606	6	7816
Cal 10	500	5/26/09 0955	5/26/09 1325	5/29/09 19:00	607	6	7832
Cal 11	500	5/26/09 1000	5/26/09 1345	5/29/09 19:40	609	6	7261
Cal 12	500	5/26/09 1050	5/26/09 1400	5/29/09 20:20	611	6	7510
					608	6	

W 8/16/09
 J19
 8/4/09

Ra-226 Calibration Sheet

Standard ID: ~~0299-6~~ 0299-6
 Volume Added (mL): 0.1 ~~1126110~~ 1126110
 Expiration Date: ~~1126110~~ 1126110

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
Cal 2	500	5/19/09 1400	5/22/09 0945	5/22/09 1325	602	6	6358
Cal 3	500	5/19/09 1400	5/22/09 1010	5/22/09 1420	604	6	4600
Cal 4	500	5/19/09 1400	5/22/09 1045	5/22/09 1625	605	6	6318
Cal 5	500	5/19/09 1400	5/22/09 1115	5/22/09 1700	606	6	6494
Cal 6	500	5/19/09 1400	5/22/09 1140	5/22/09 1735	607	6	6428
Cal 7	500	5/19/09 1400	5/22/09 1200	5/22/09 1920	609	6	6473
Cal 8	500	5/19/09 1400	5/22/09 1250	5/22/09 2035	611	6	6455
Cal 9							
Cal 10							
Cal 11							
Cal 12							

100 814109
 100 814109
 100 814109
 100 814109
 100 814109
 6162-100 814109

1126110

219
 814109
 100 816109

Ra-226 Calibration Sheet

Standard ID: ~~10386~~ 0299-G
 Volume Added (mL): 0.1 419 814109
 Expiration Date: ~~11/26/10~~ 419 514109

Sample ID	Volume (mL)	End Degas Date/Time	End De-em Date/Time	Start Count Date/Time	Cell #	Det #	Total Counts
Cal 9	500	5/19/09 1400	5/26/09 1430	5/26/09 1330	601	6	10883
Cal 10	500	5/19/09 1400	5/26/09 1455	5/26/09 1405	602	6	11033
Cal 11	500	5/19/09 1400	5/26/09 1020	5/26/09 1545	604	6	10372
Cal 12	500	5/19/09 1400	5/26/09 1050	5/26/09 1615	605	6	10474
Cal 1	500	5/22/09 1200	5/26/09 1725	5/26/09 1645	606	6	8557
Cal 2	500	5/22/09 1200	5/26/09 1750	5/26/09 1715	607	6	8527
Cal 3	500	5/22/09 1200	5/26/09 1310	5/26/09 1920	609	6	8261
Cal 4	500	5/22/09 1200	5/26/09 1325	5/26/09 2200	611	6	8010
				608			

419 814109
 419 814109

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

17th December 1999

Nycomed
Amersham

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
Mean Value (Counting) =	240.057	98.52	Pass
Stdev =	18.30744475		Rule 3 (Pass/Fail)
Target =	243.67		
Lower Limit =	203.4417772		
Upper Limit =	276.6715562		
Rule 1 Pass/Fail	Pass		
Two sigma =	36.6148895		
10 % of Mean =	24.00566667		
Rule 2 (Pass/Fail)	Fail	*exception taken due to full recovery of standard	

- 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

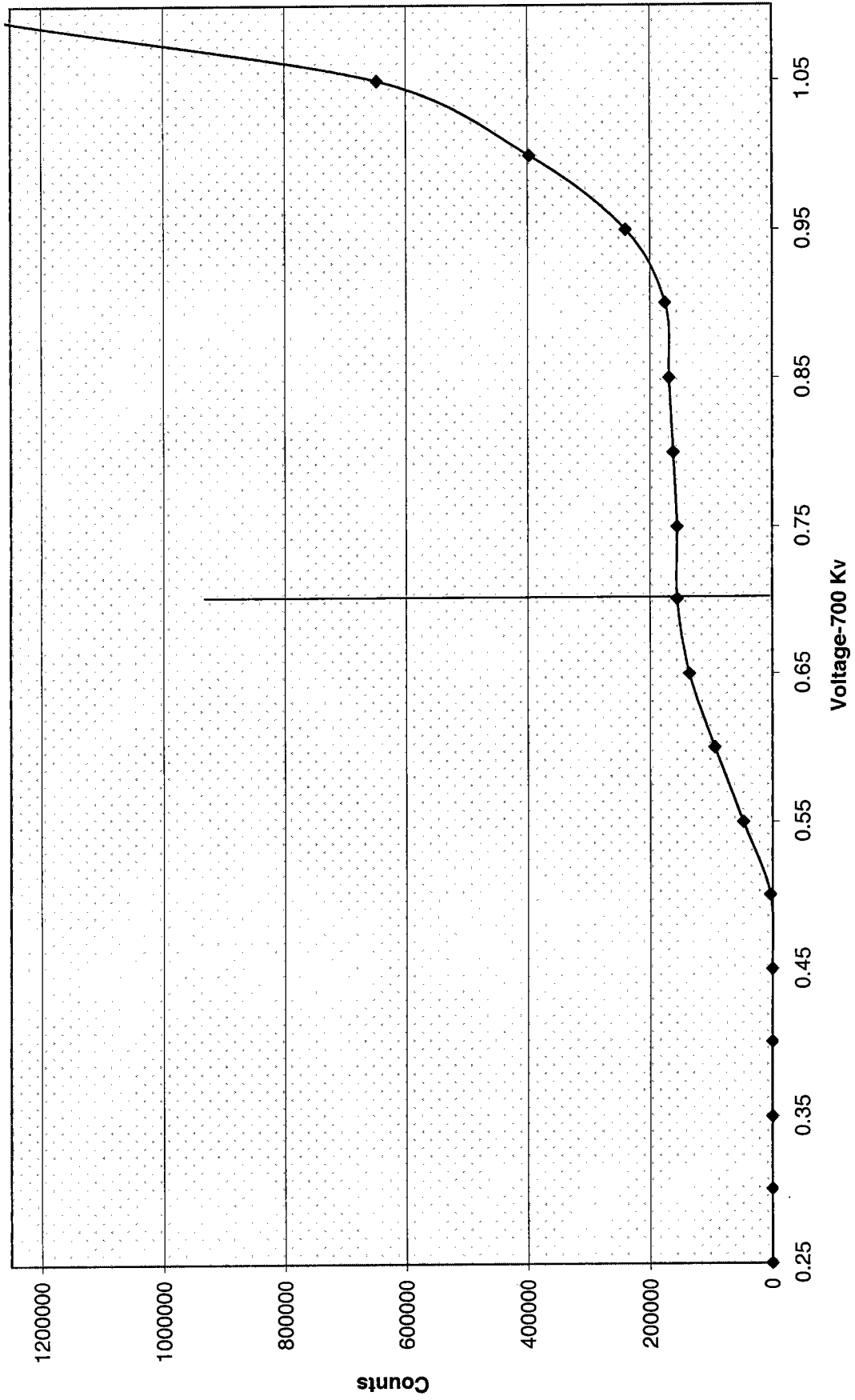
Lucas cell #	Cell constant	Standard Source	Date/Time of count	Date/Time flushed to cell	Date/Time end of degas	bkg cpm	total counts	count time min	cpm	Known activity dpm	t1 (days) end-degas to flush	t2 (days) end-flush to count	t3 (days) Std Ref Date to count	Decay from Std Ref Date to count
301	2.021	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 3_08

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

M 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: 28/6/09 and 10/8/09

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
 11/18/10/16

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: γ -impurities (other than decay products) <0.1%

5.01065 grams 0.1M HCl solution with 50 $\mu\text{g/g}$ Ba carrier.

P O NUMBER 3231RD, Item 5

SOURCE PREPARED BY:

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

Q A APPROVED:

RCUW 1/26/04

WD 8/4/09
2C-S-037-037a

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

W084116

GEL Laboratories LLC
Version 1.0 9/18/2000

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
Mean Value (Counting) =	23.953	99.60	Pass
Stdev =	1.010781096		Rule 3 (Pass/Fail)
Target =	24.05		
Lower Limit =	21.93100448		
Upper Limit =	25.97412886		
Rule 1 Pass/Fail	Pass		
Two sigma =	2.021562191		
10 % of Mean =	2.395256667		
Rule 2 (Pass/Fail)	Pass		

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

Page 288 of 351

Analyst: KSDI

First Client Due Date:

Internal Due Date: 02/07/2009

Batch #: 838839
Spike Isotope: Radium-226
LCS Isotope: Radium-226

Expiration Date: 12/27/08
Expiration Date: 12/27/08

Nom Conc:
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	1/26/09 13:10	1/26/09 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	1/26/09 13:10	1/26/09 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	1/26/09 13:10	1/26/09 19:05	305	3	9	743

Comments:

Instrument ID: LUCAS-5028, LUCAS-13617, LUCAS-9089, LUCAS-162753, LUCAS-132286, LUCAS-178055

Data Reviewed By:

W. S. Lewis

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 ID	Sample Aliquot L	Sample Aliquot StDev. L	Sample Date/Time	Count Raw Data			Weekly Background			Detector Efficiency (cpm/dpm)	
				Cell Number	Counting Time (min.)	Gross Counts	Gross CPM	Counts	CPM		Count Time (min.)
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

UNSM/05

Detector Efficiency Error (cpm/dpm)	Cell Calibration Date	Cell Calibration Due Date	De-Gas Date/Time	Rn-222 Ingrow End Date/Time	Count Start Date/Time	De-Gas to Ingrowth	Rn-222 Corrections Ingrowth to Count	During Count	Ra-226 Decay
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
04/21/09

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

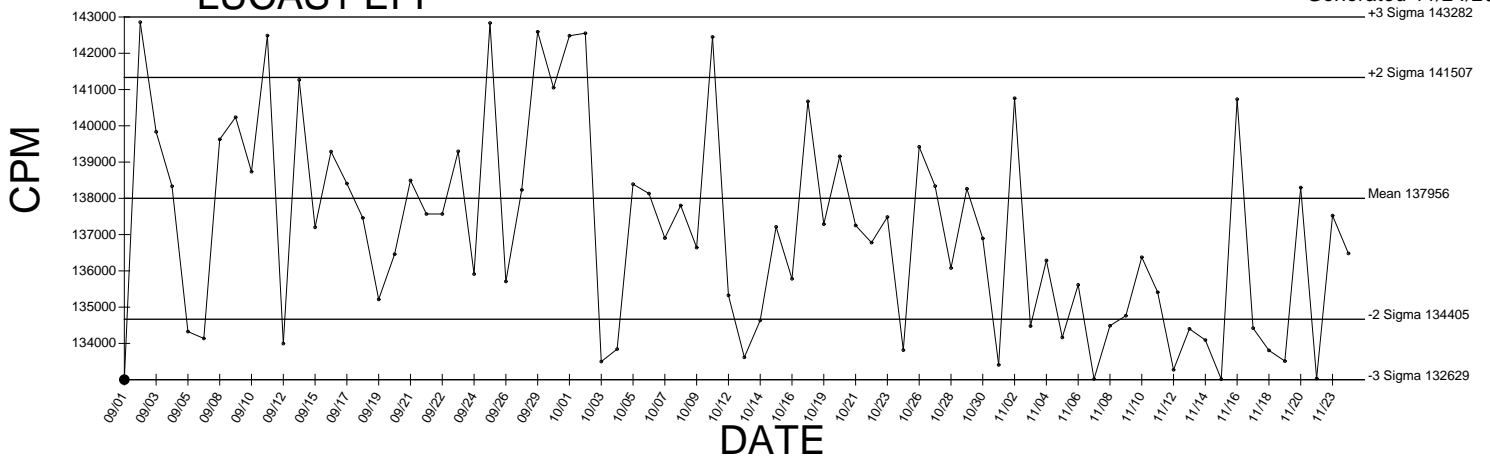
Results		MDA	Sample Act.	Sample Act.	Net Count	Net Count	Net Count	2 SIGMA	2 SIGMA	Sample	Sample	RER	Recovery
Decision	Critical	pCi/L	Conc.	Error	Rate	Rate	Rate	Counting	Total Prop.	QC	Type	RPD	Recovery
Level	Level	pCi/L	pCi/L	pCi/L	CPM	CPM	CPM	Uncertainty	Uncertainty				
pCi/L	pCi/L							pCi/L	pCi/L				pCi/L
0.2932	0.2070	0.5083	24.6287	0.0707	26.1000	0.9422	0.9422	1.7426	5.5940		LCS		102.4%
0.2997	0.2116	0.5196	24.4384	0.0710	25.3333	0.9286	0.9286	1.7557	5.5591		LCS		101.6%
0.2942	0.2077	0.5101	22.7906	0.0715	24.0667	0.9055	0.9055	1.6808	5.1982		LCS		94.8%

11/28/10
(15)

BACKGROUND AND EFFICIENCY DATA

LUCAS1 EFF

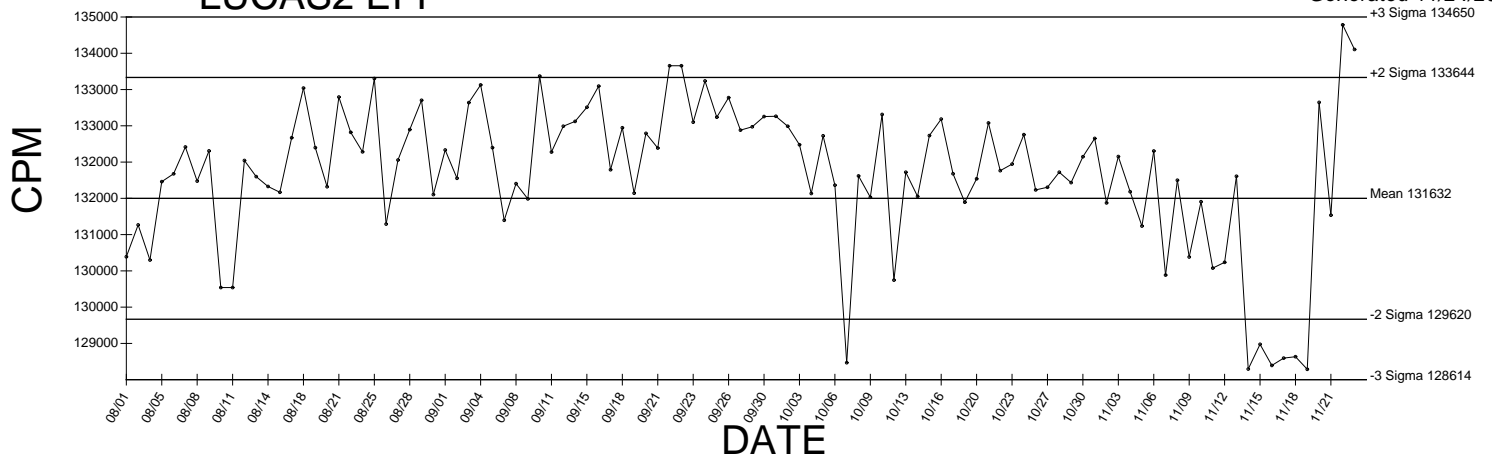
Generated 11/24/2009



● Denotes Outlier

LUCAS2 EFF

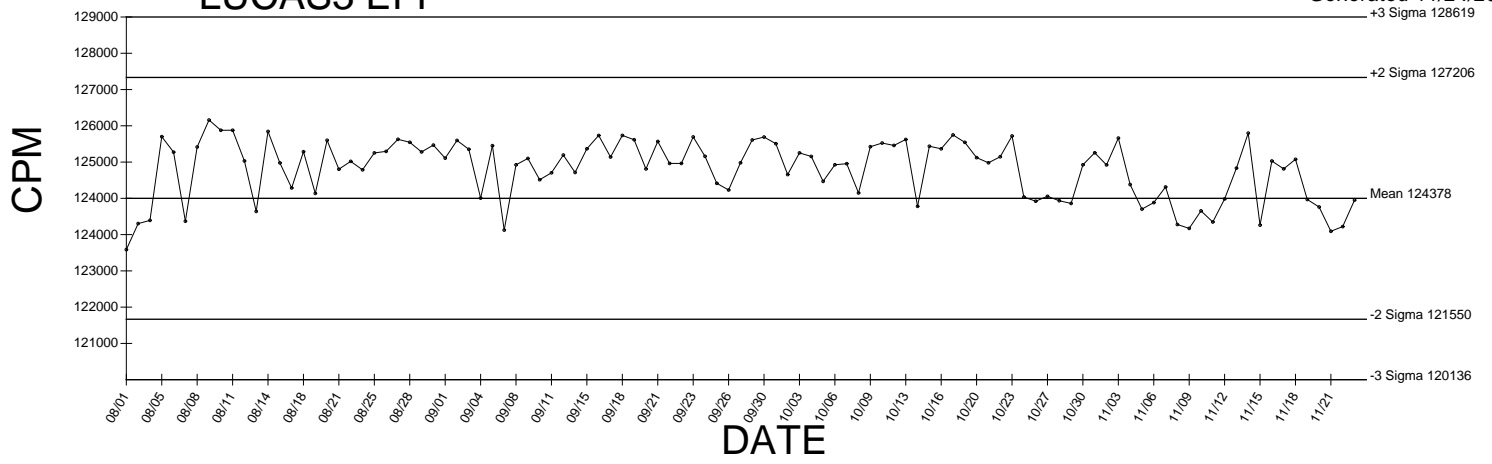
Generated 11/24/2009



● Denotes Outlier

LUCAS3 EFF

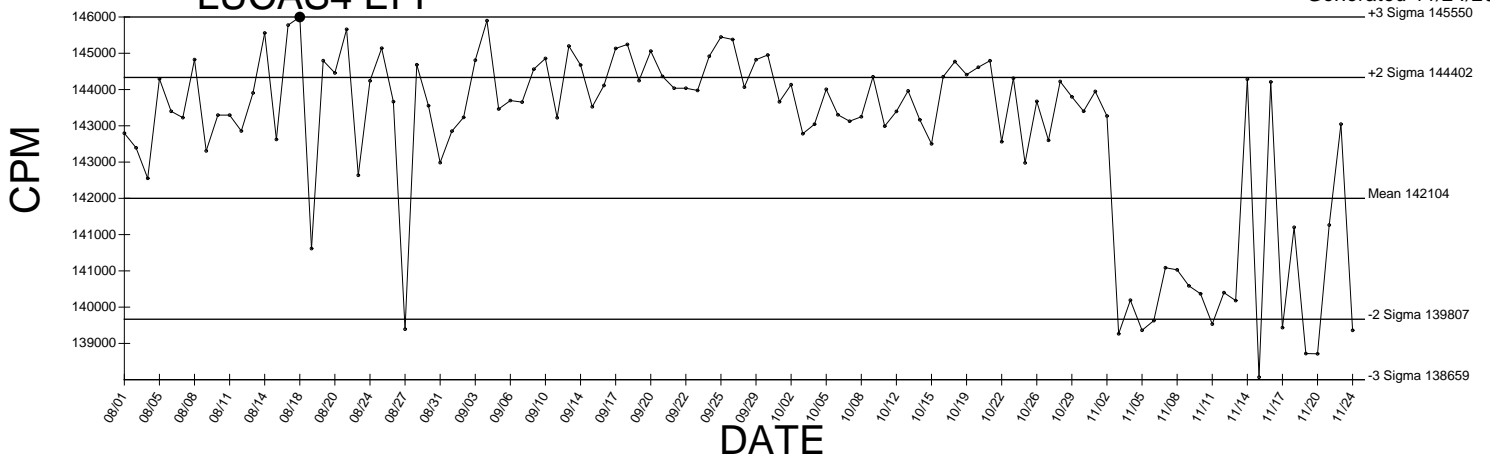
Generated 11/24/2009



● Denotes Outlier

LUCAS4 EFF

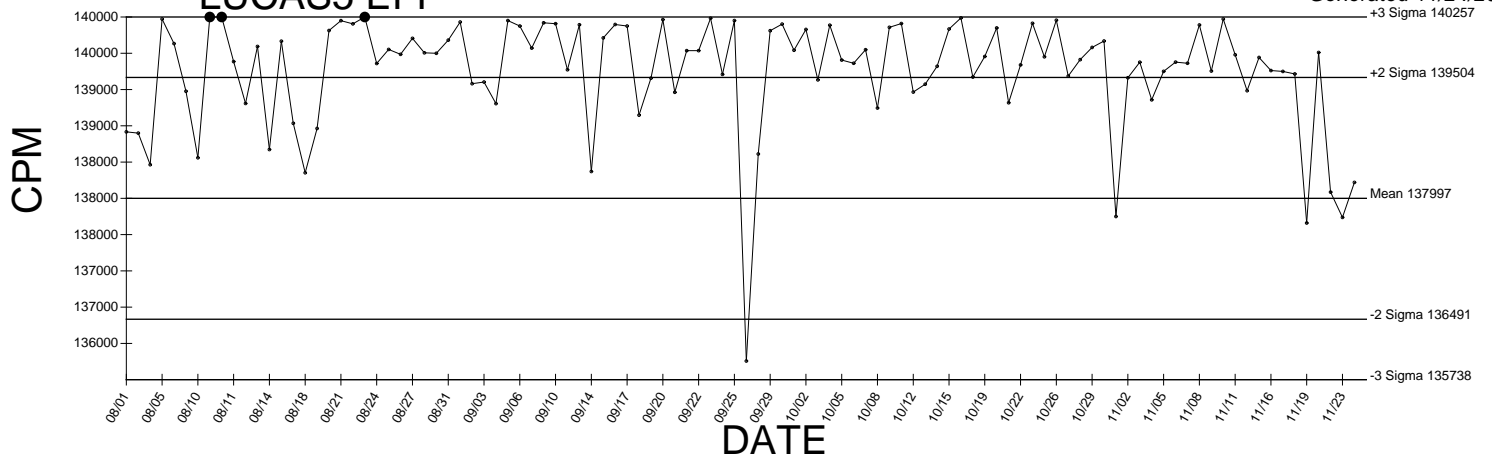
Generated 11/24/2009



● Denotes Outlier

LUCAS5 EFF

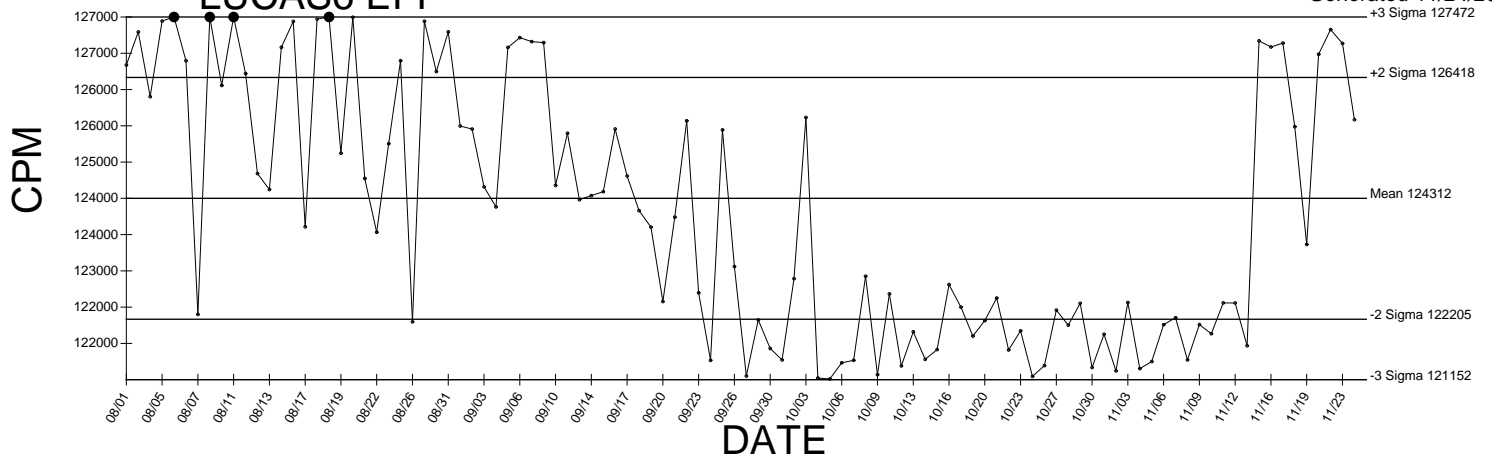
Generated 11/24/2009



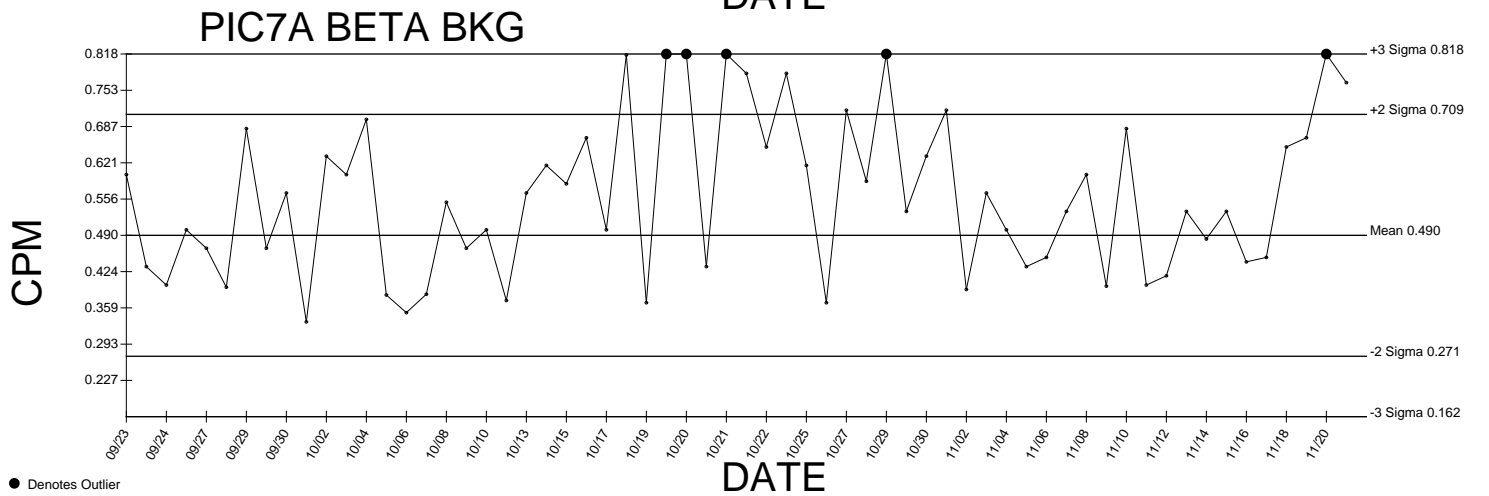
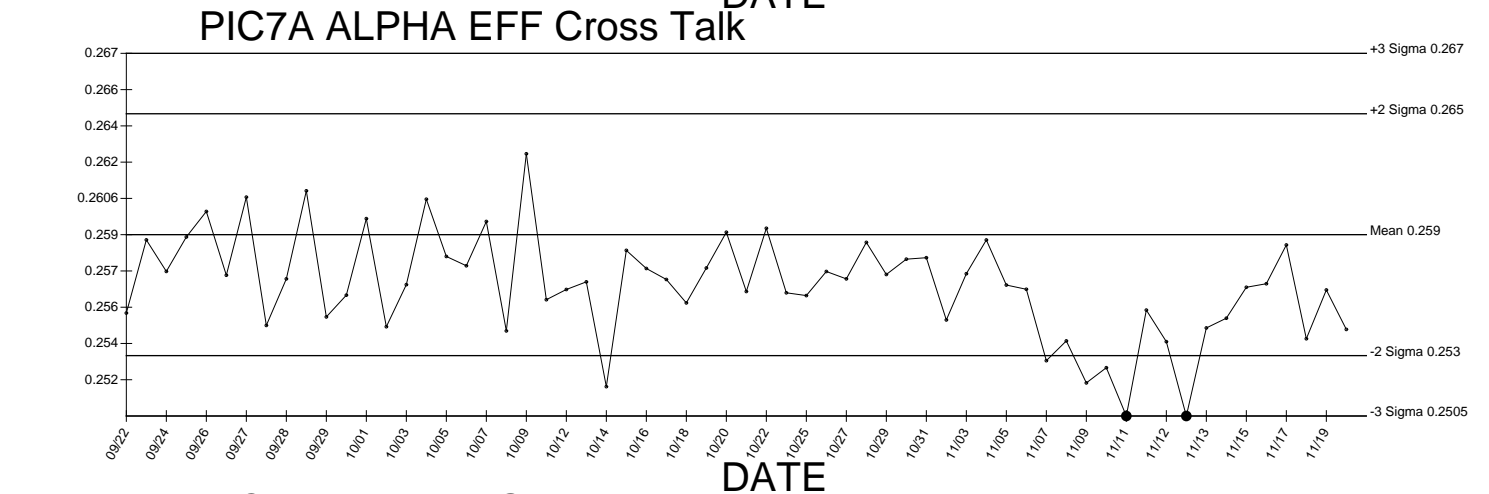
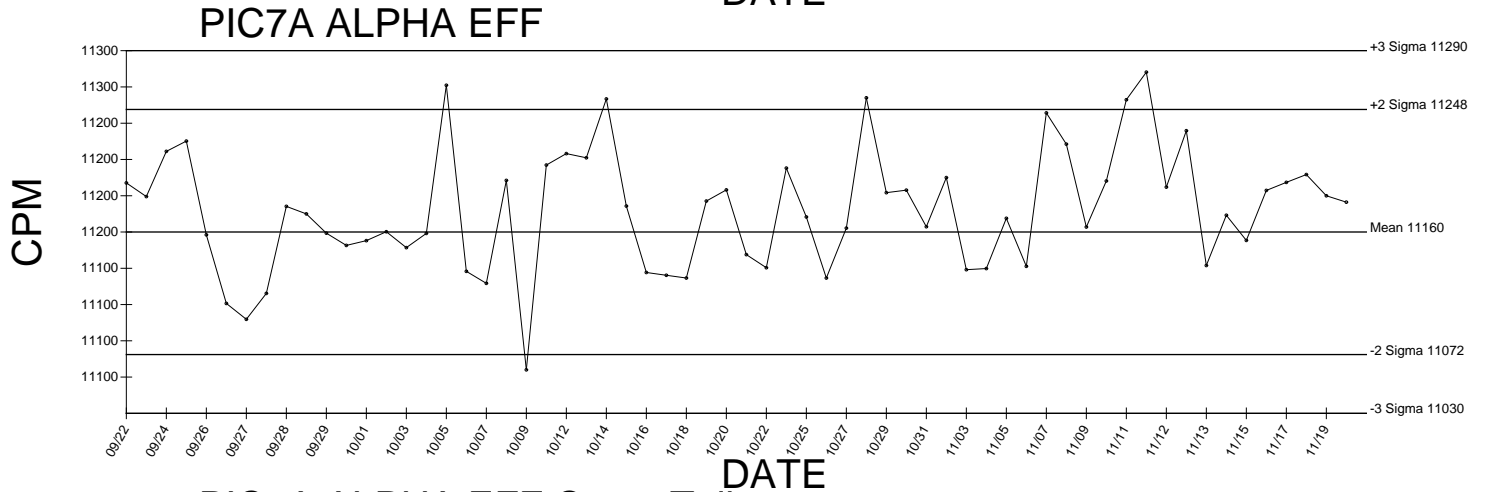
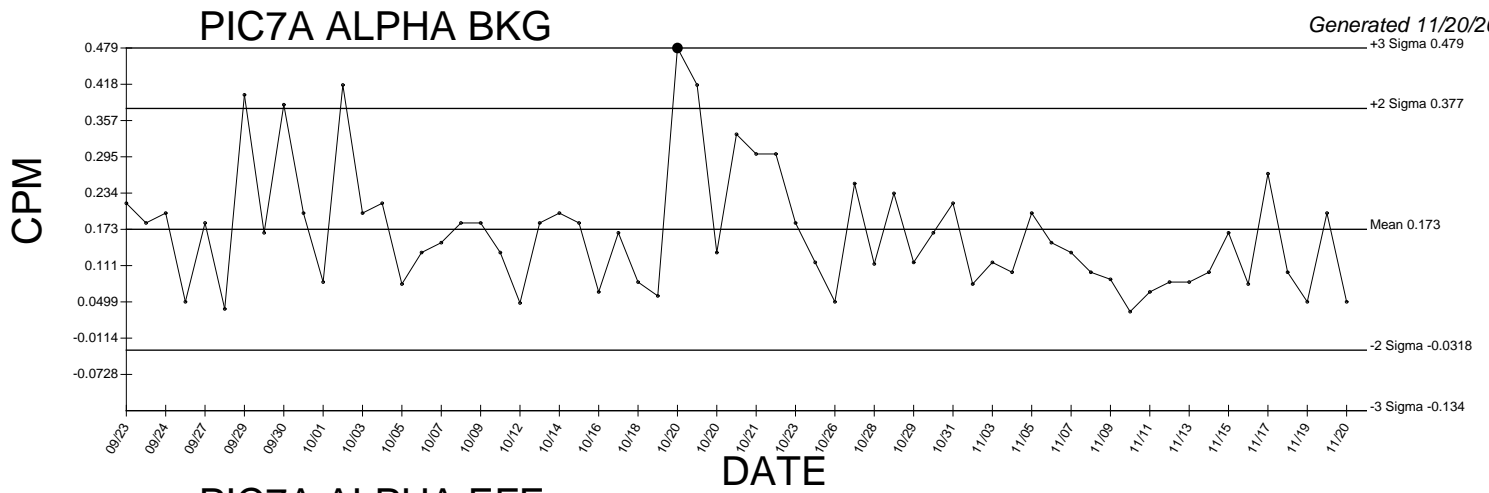
● Denotes Outlier

LUCAS6 EFF

Generated 11/24/2009



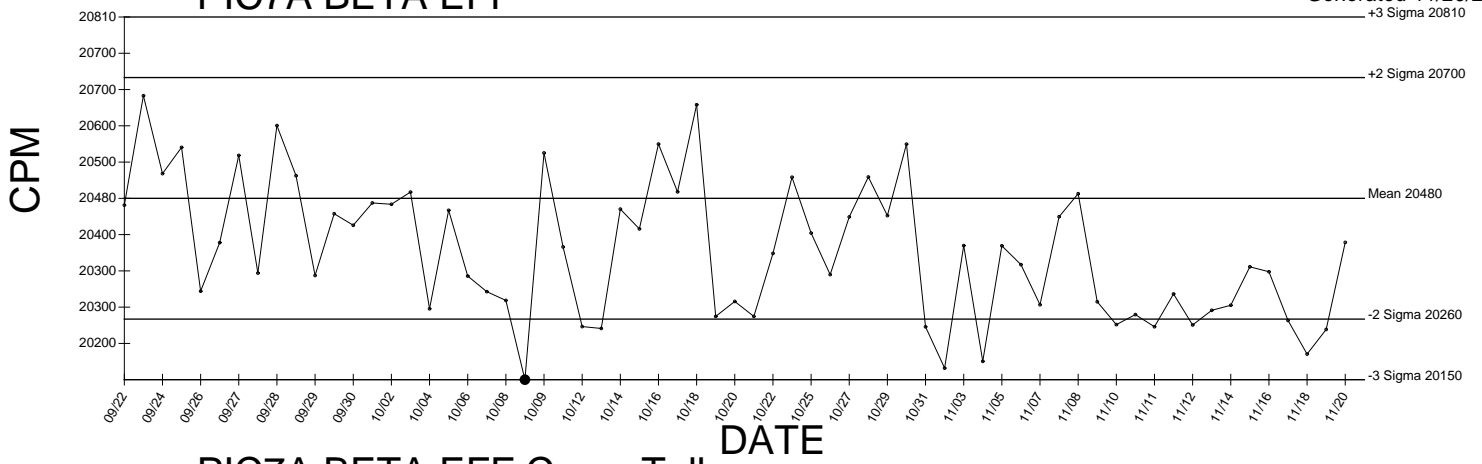
● Denotes Outlier



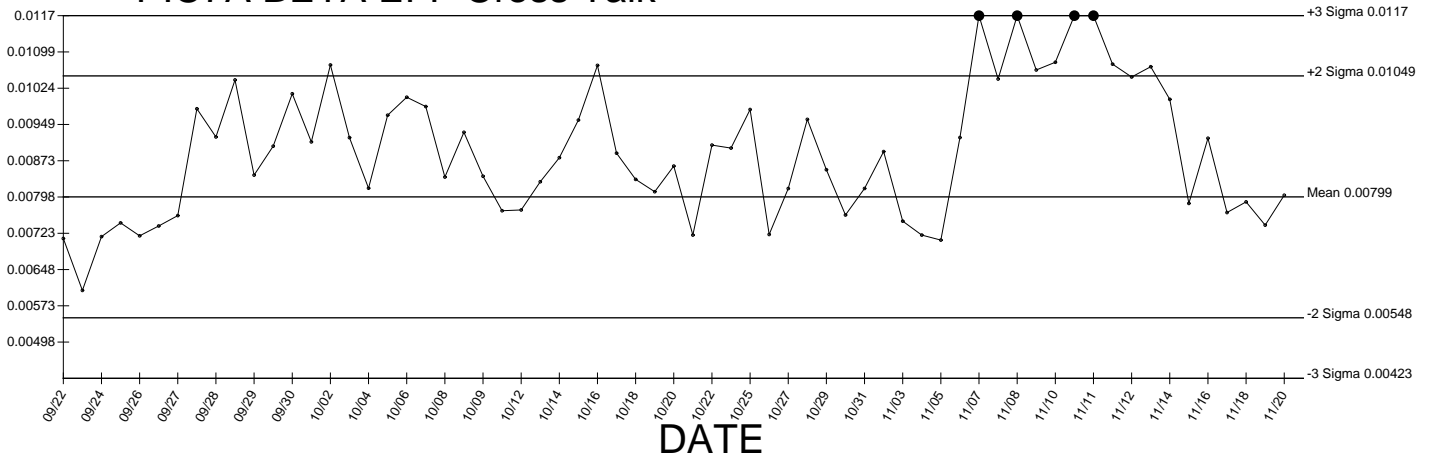
● Denotes Outlier

PIC7A BETA EFF

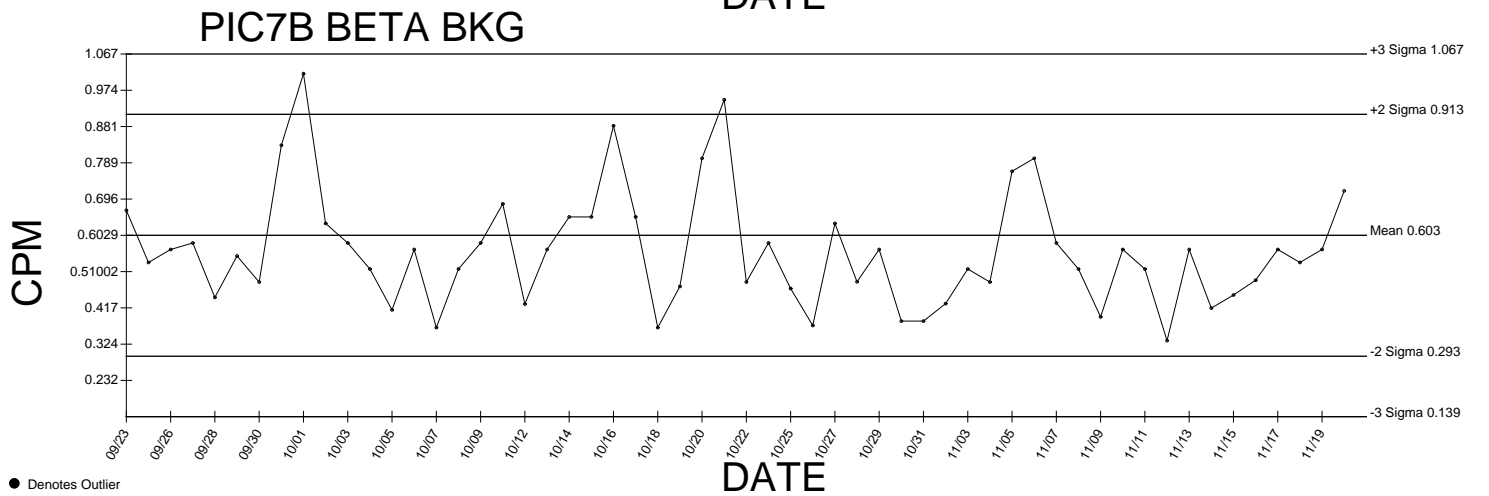
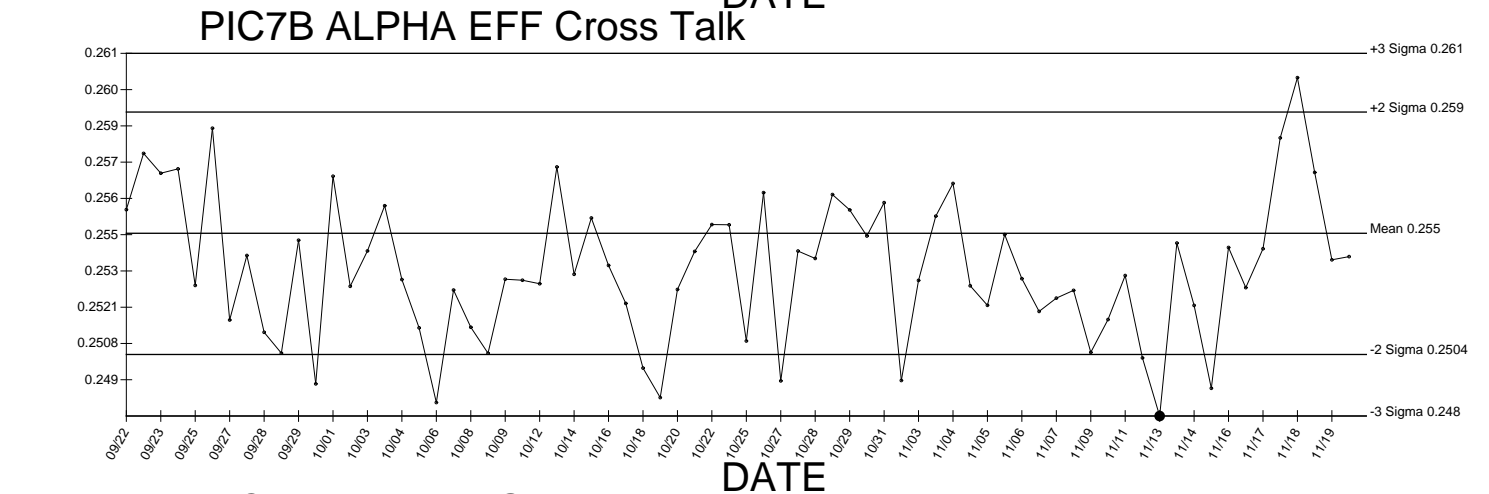
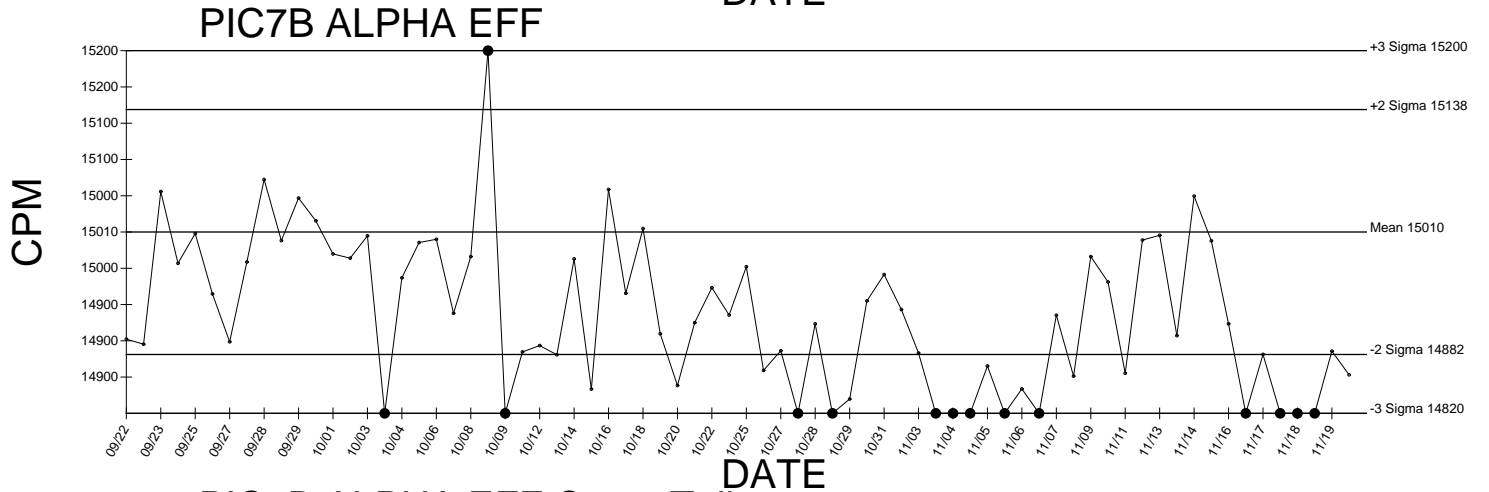
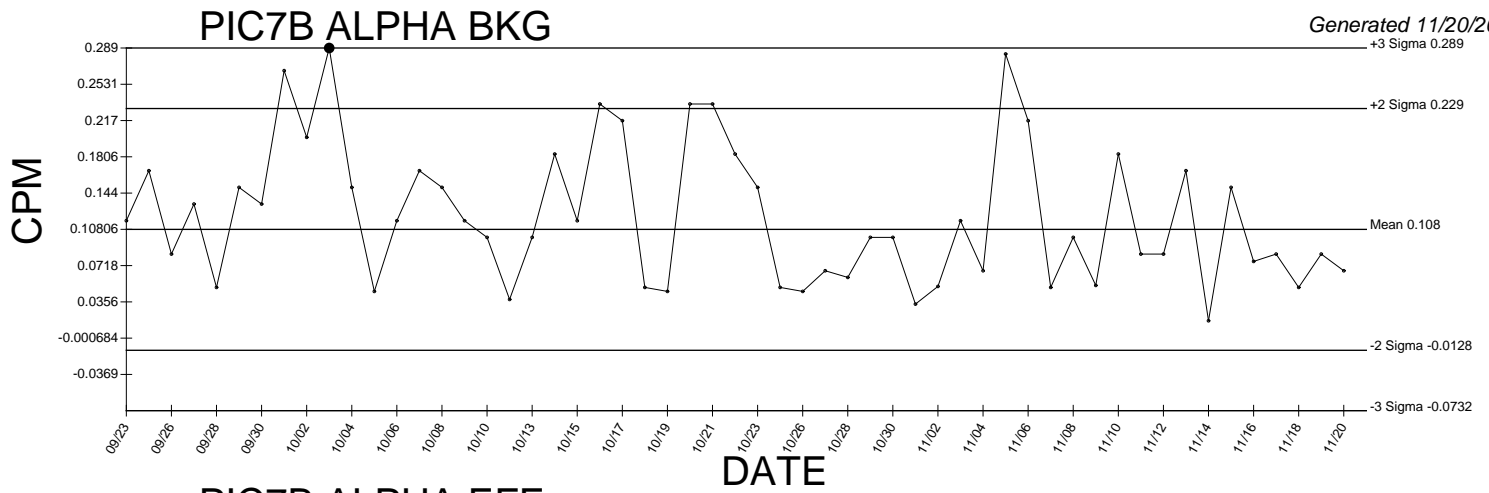
Generated 11/20/2009



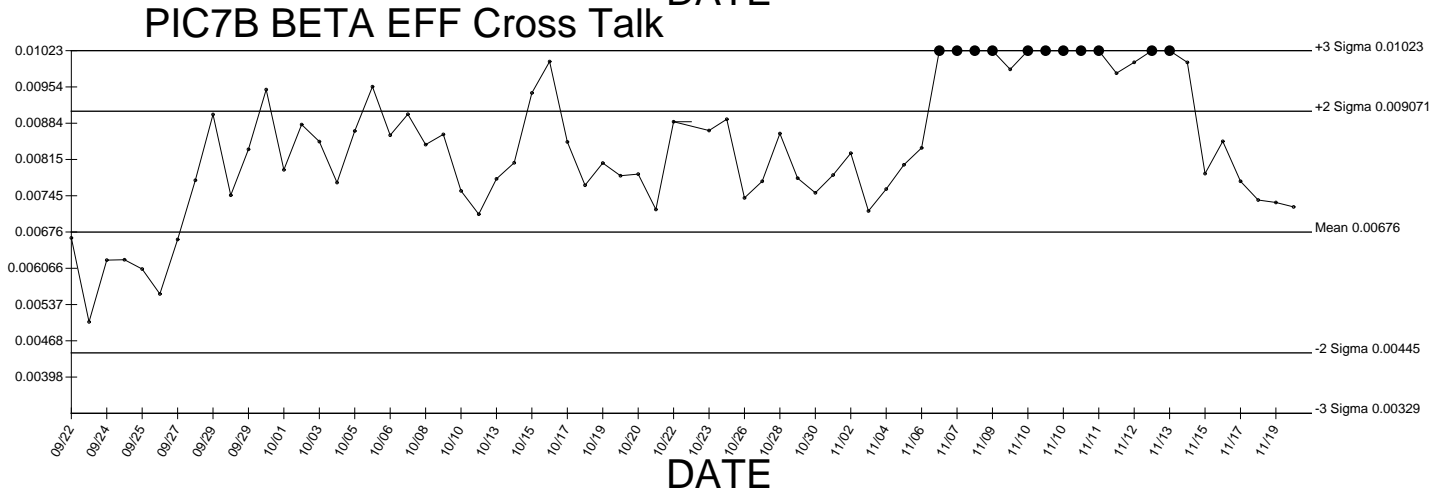
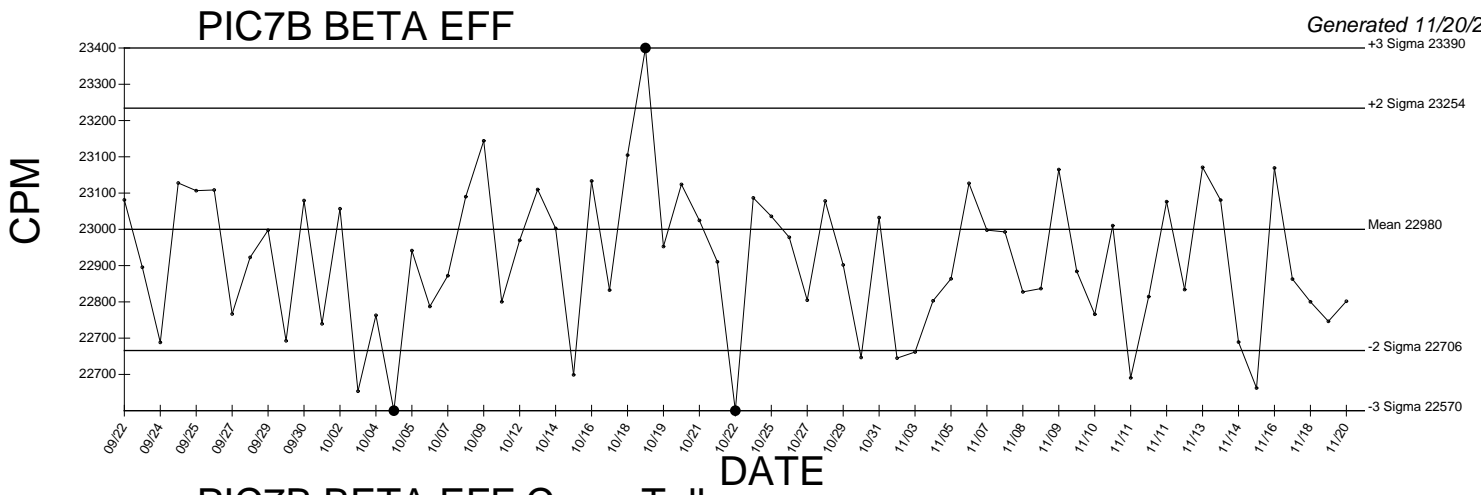
PIC7A BETA EFF Cross Talk



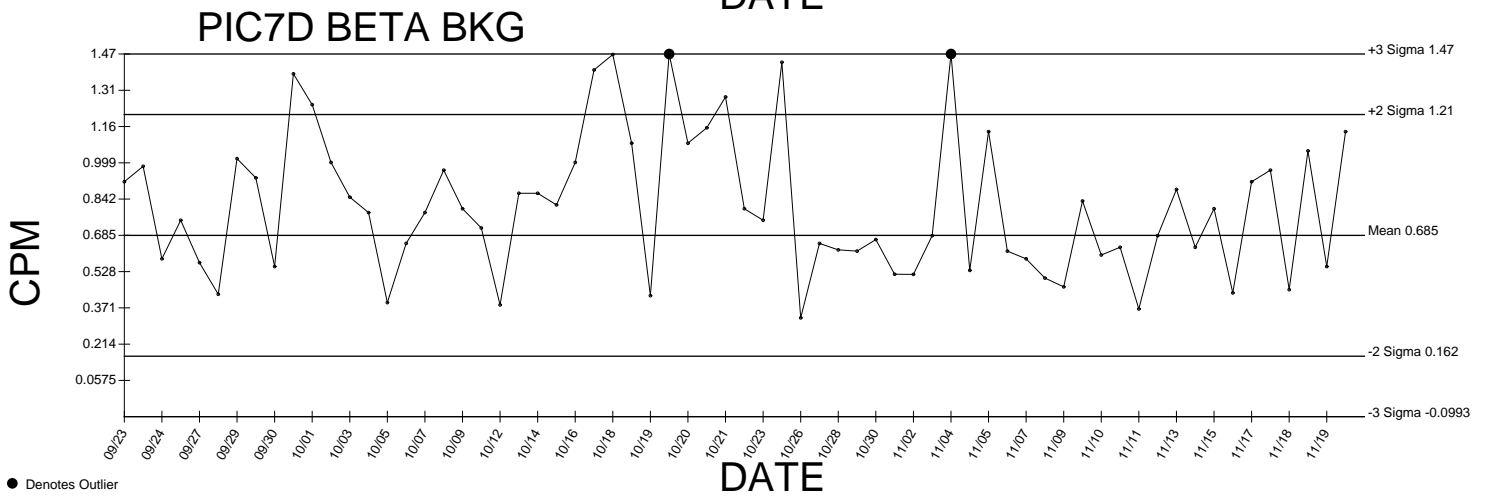
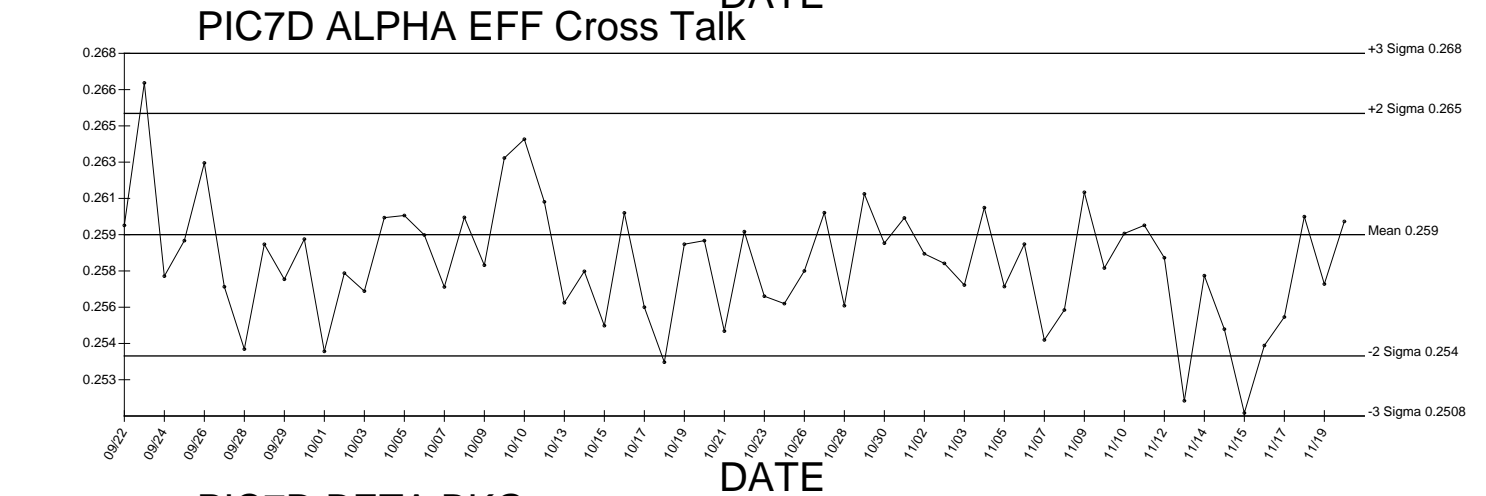
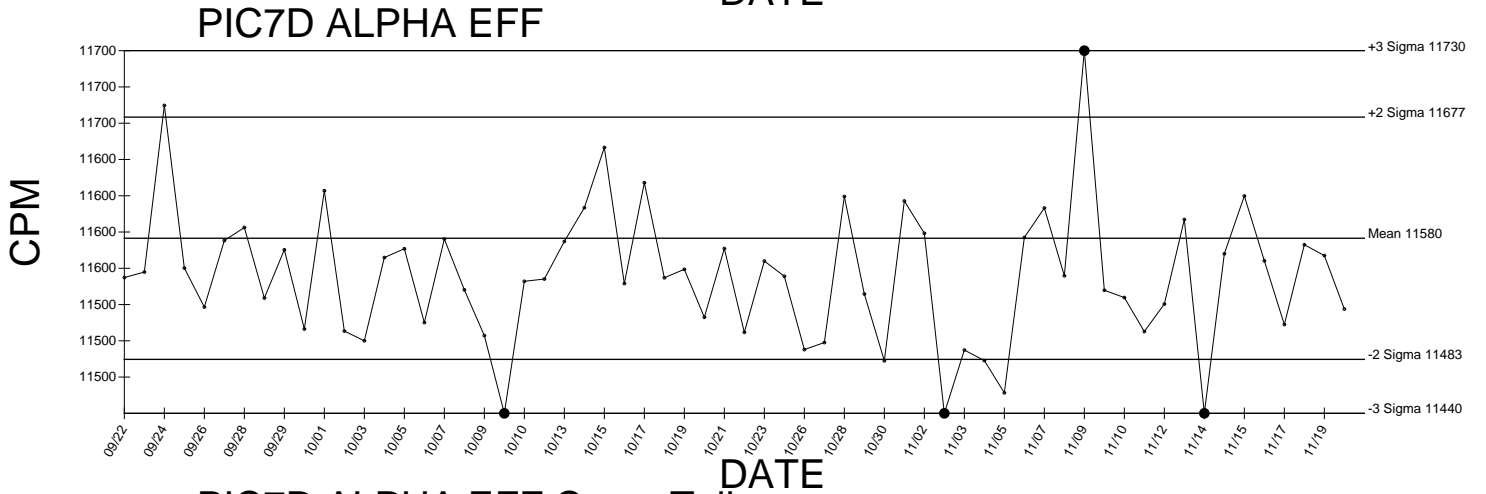
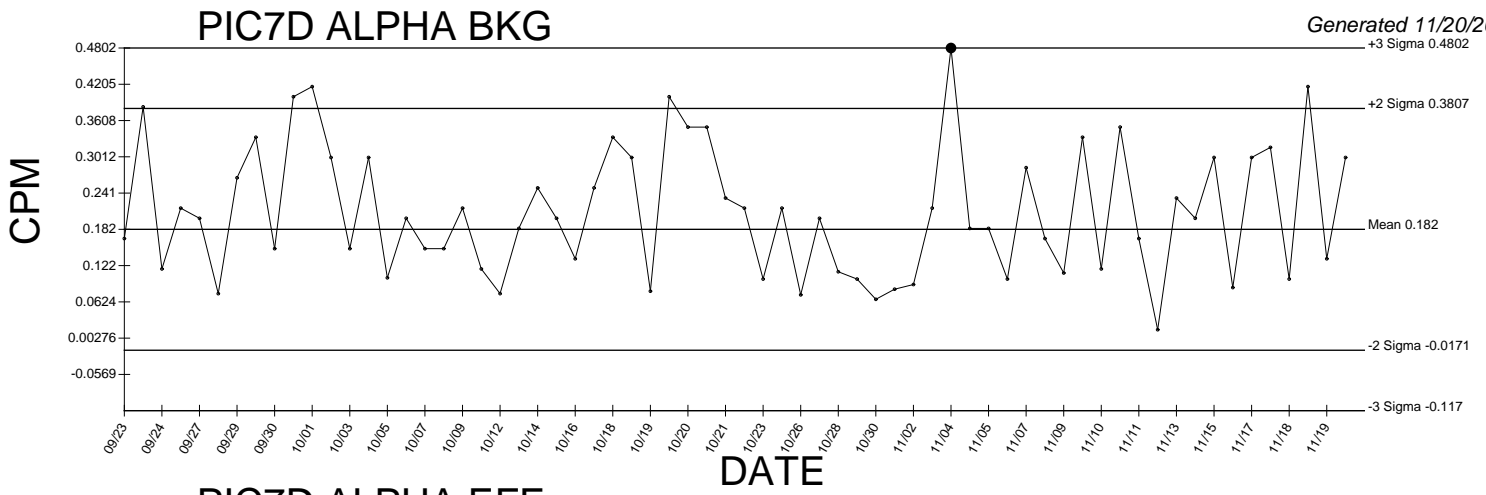
● Denotes Outlier



● Denotes Outlier



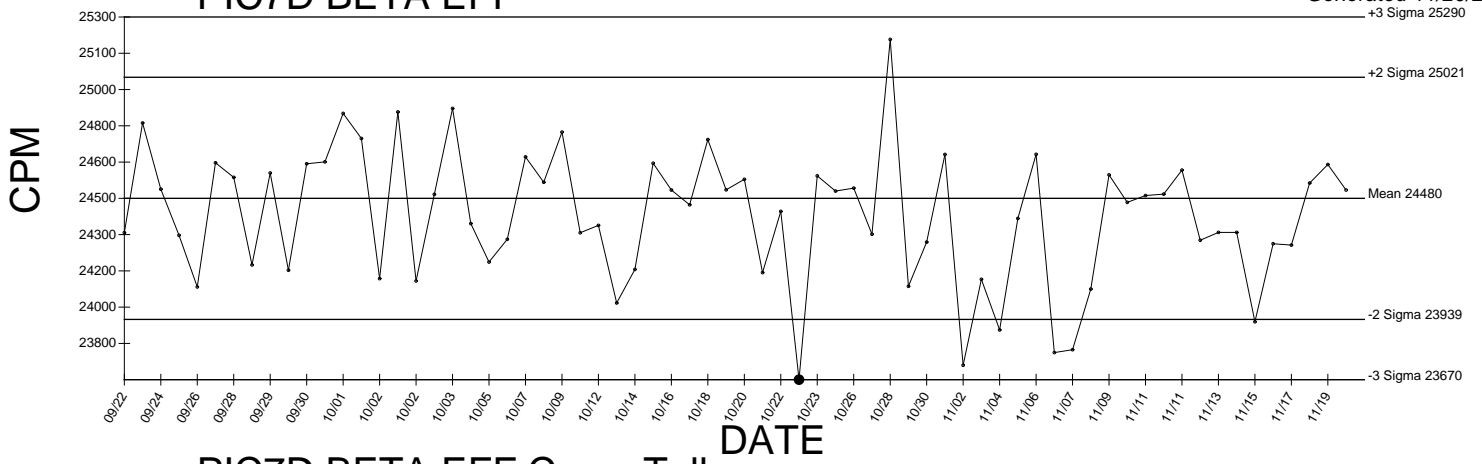
● Denotes Outlier



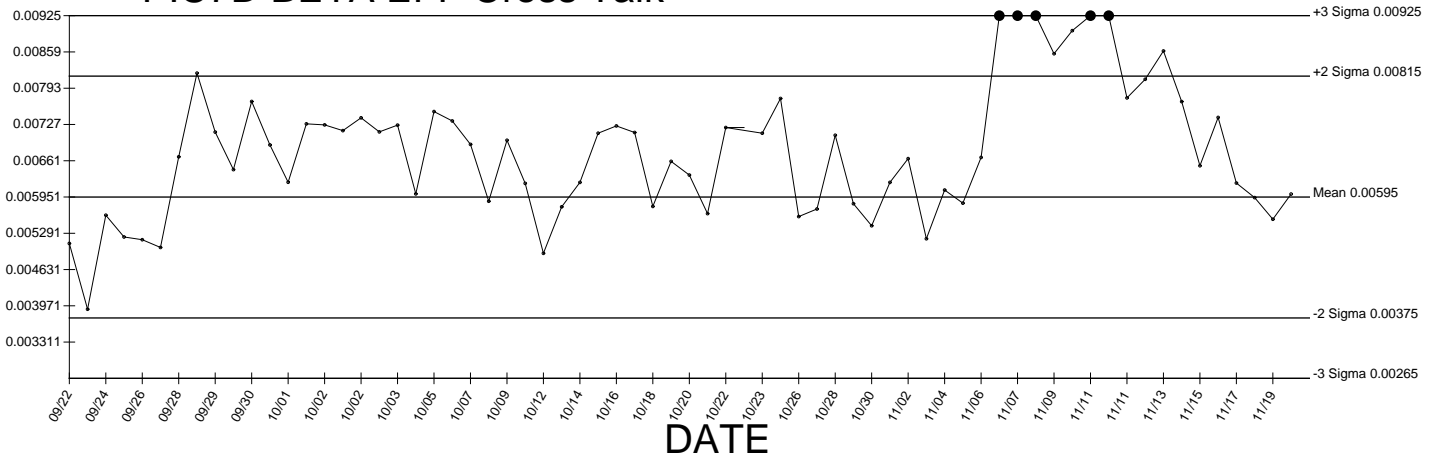
● Denotes Outlier

PIC7D BETA EFF

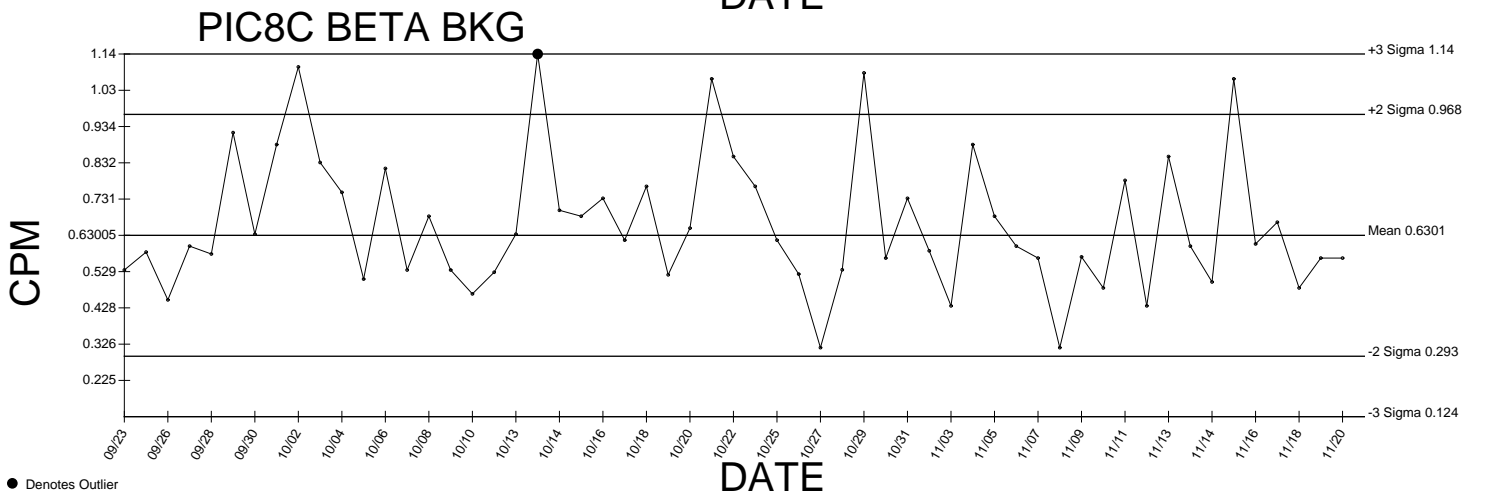
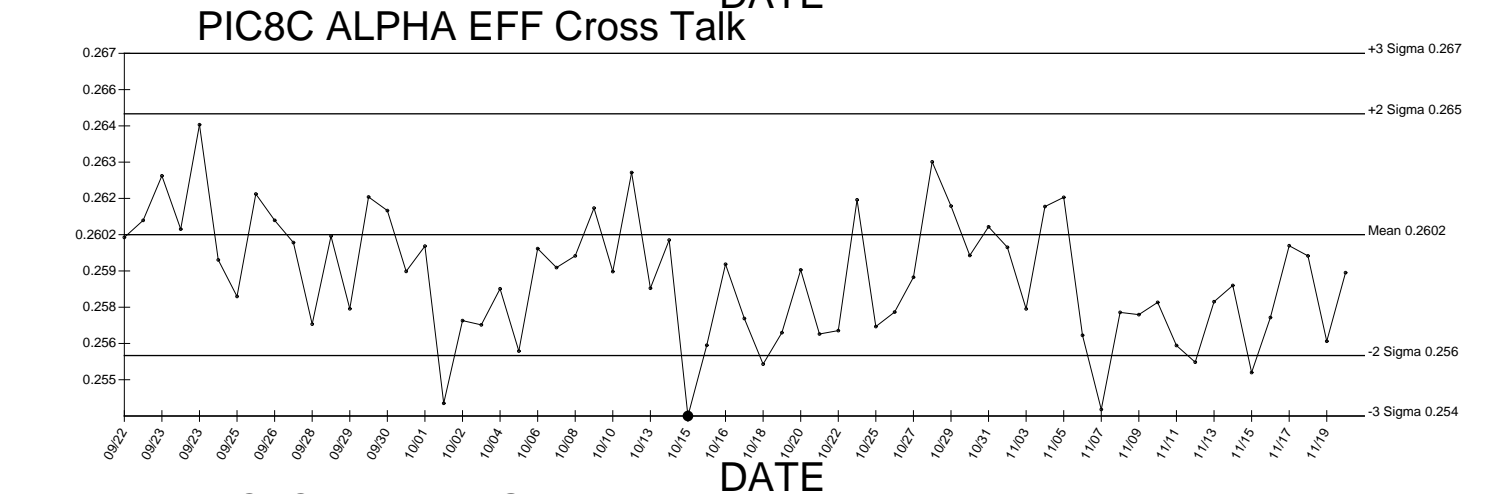
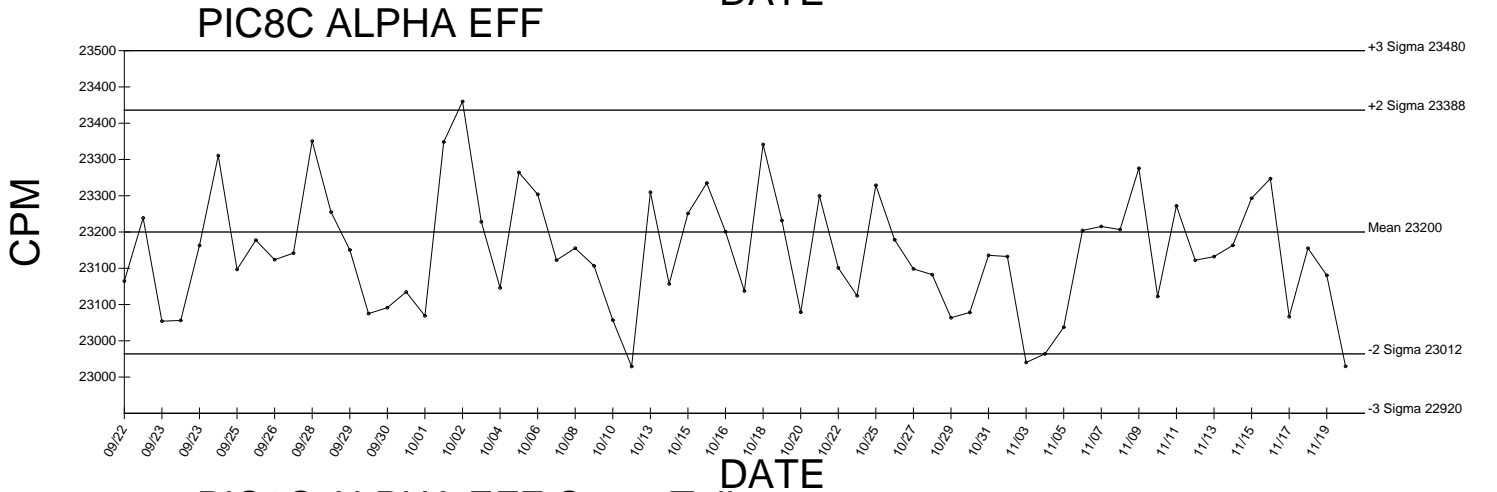
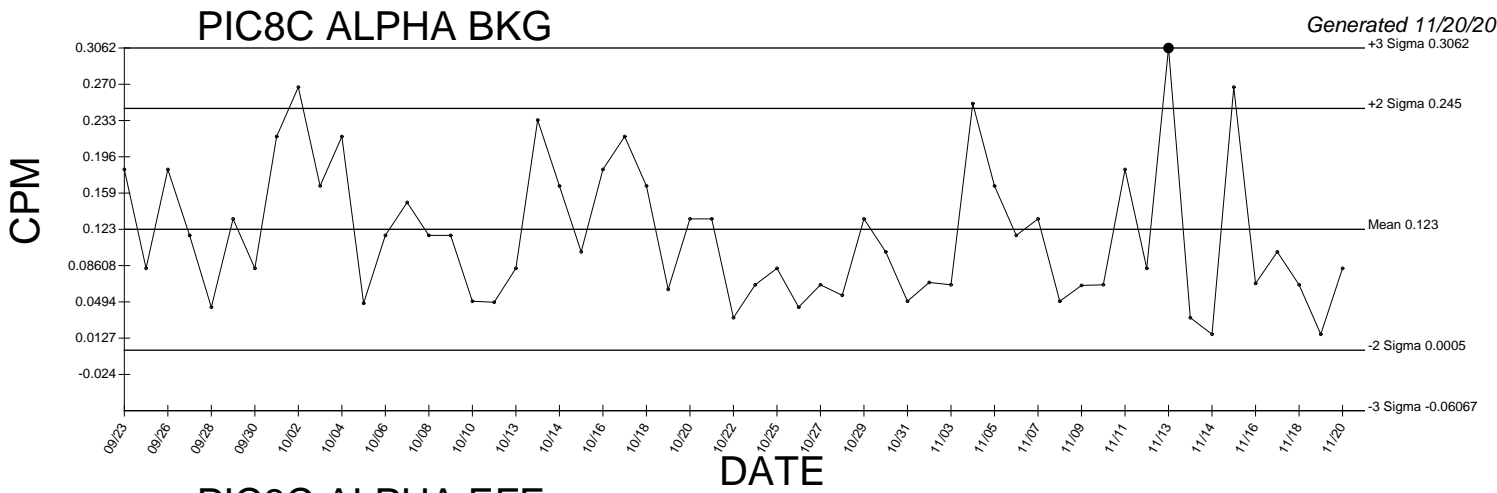
Generated 11/20/2009



PIC7D BETA EFF Cross Talk



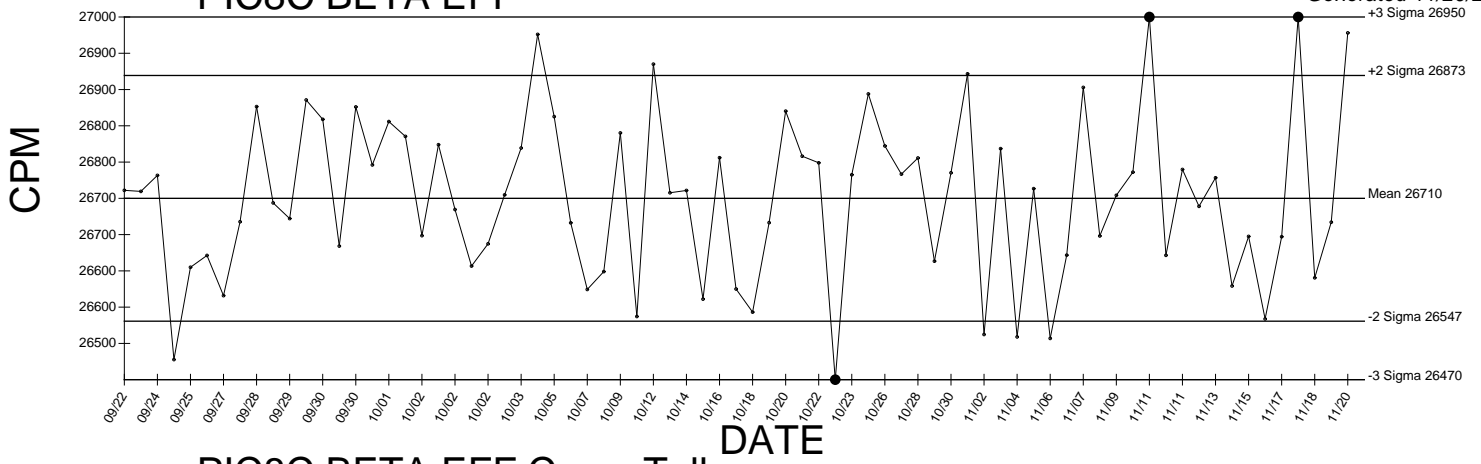
● Denotes Outlier



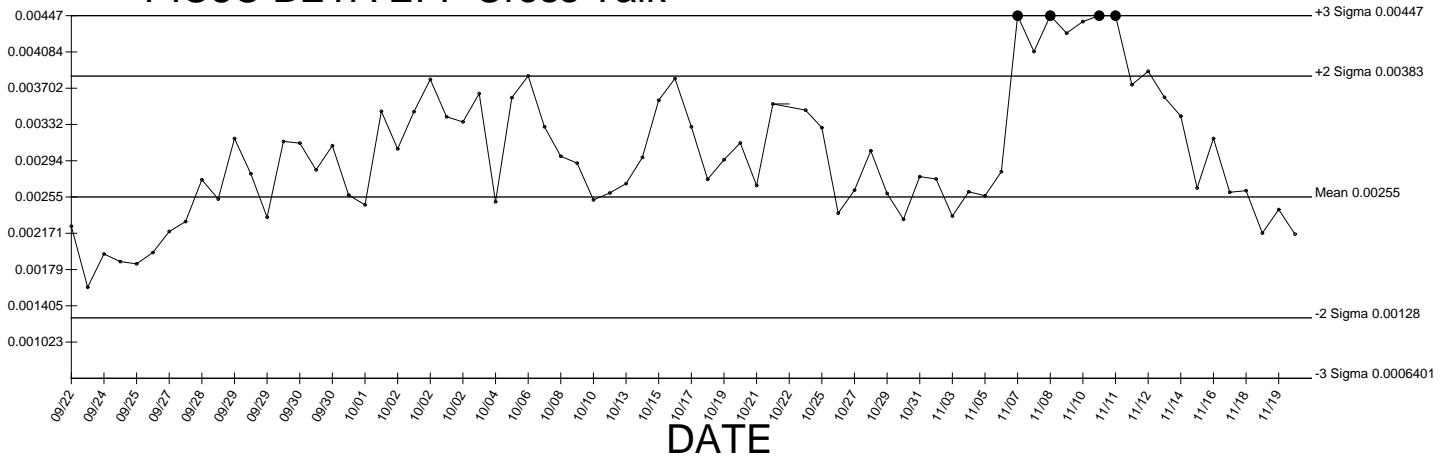
● Denotes Outlier

PIC8C BETA EFF

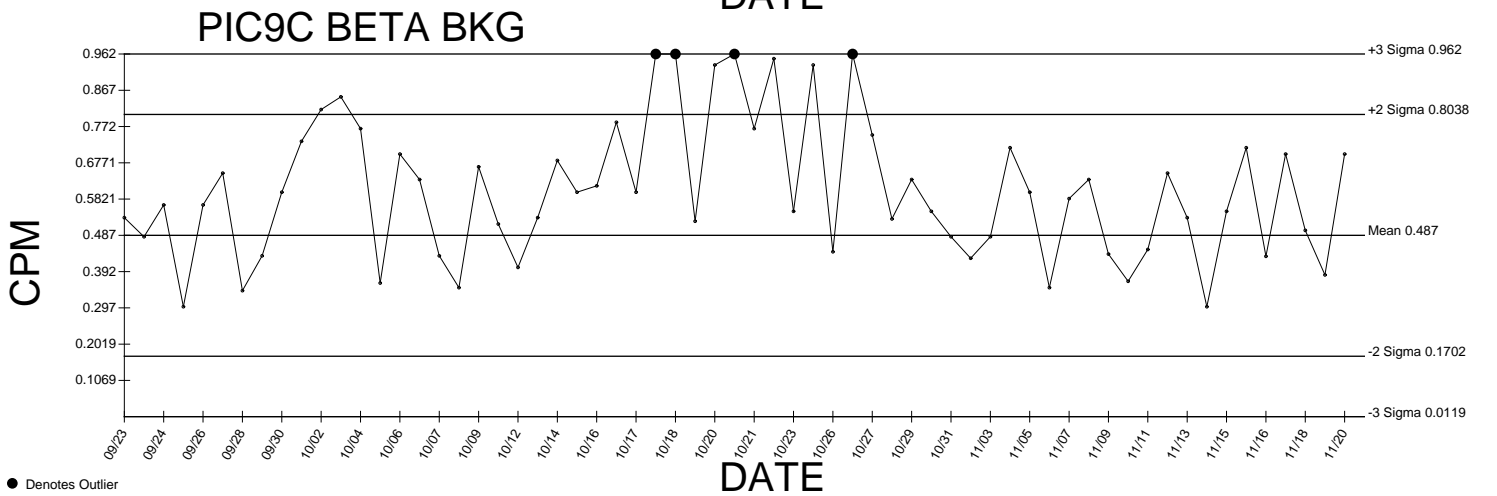
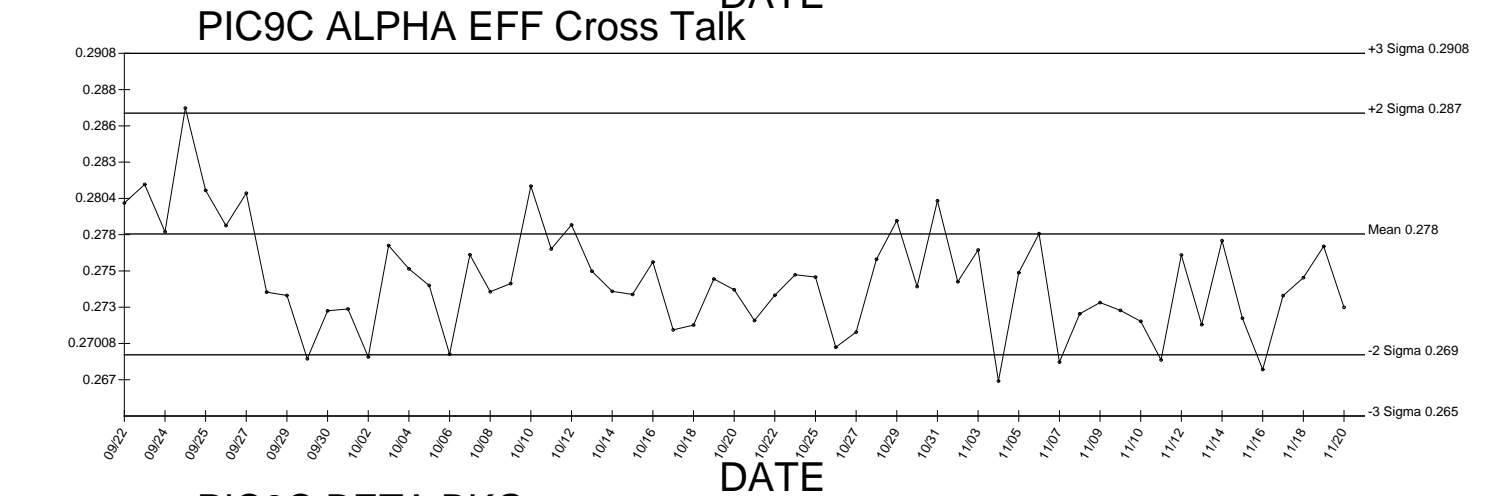
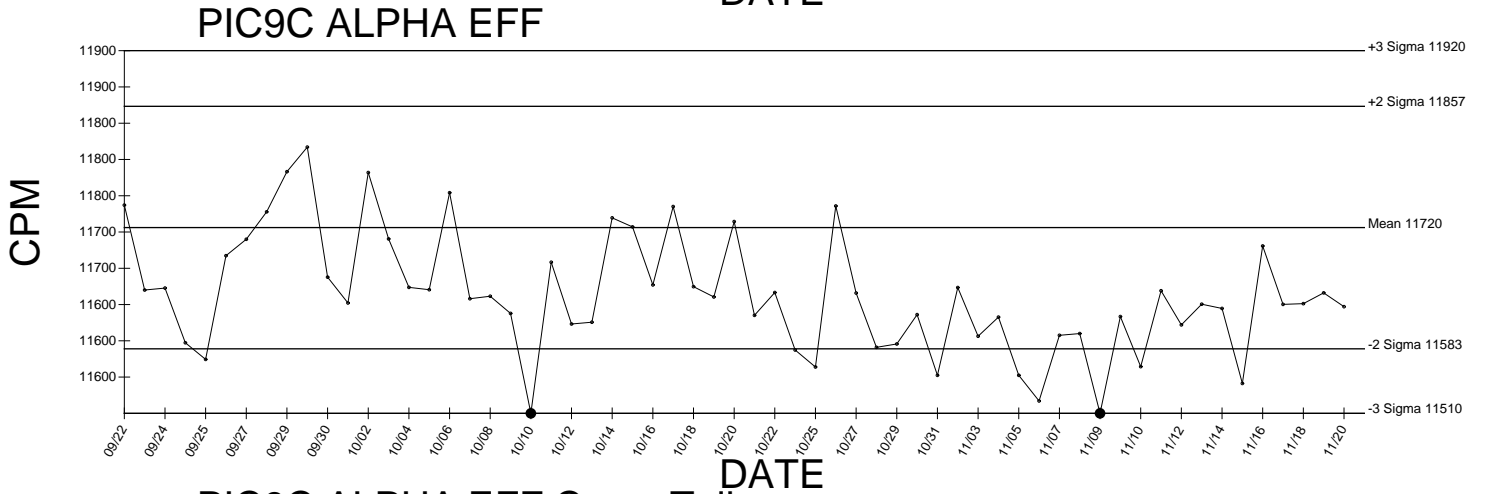
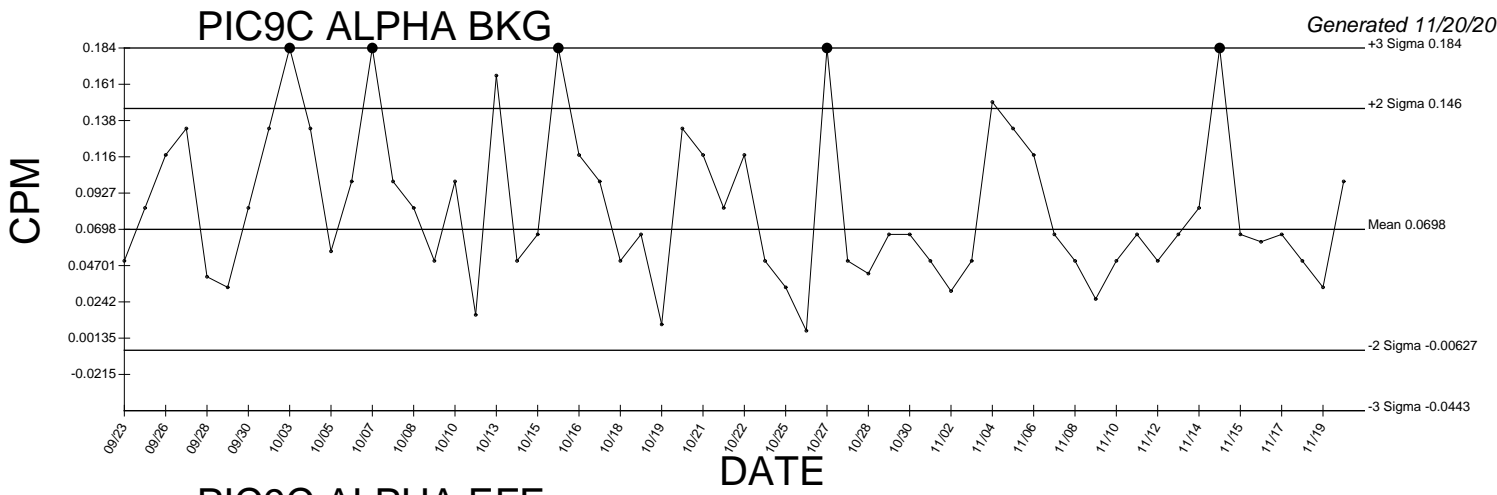
Generated 11/20/2009



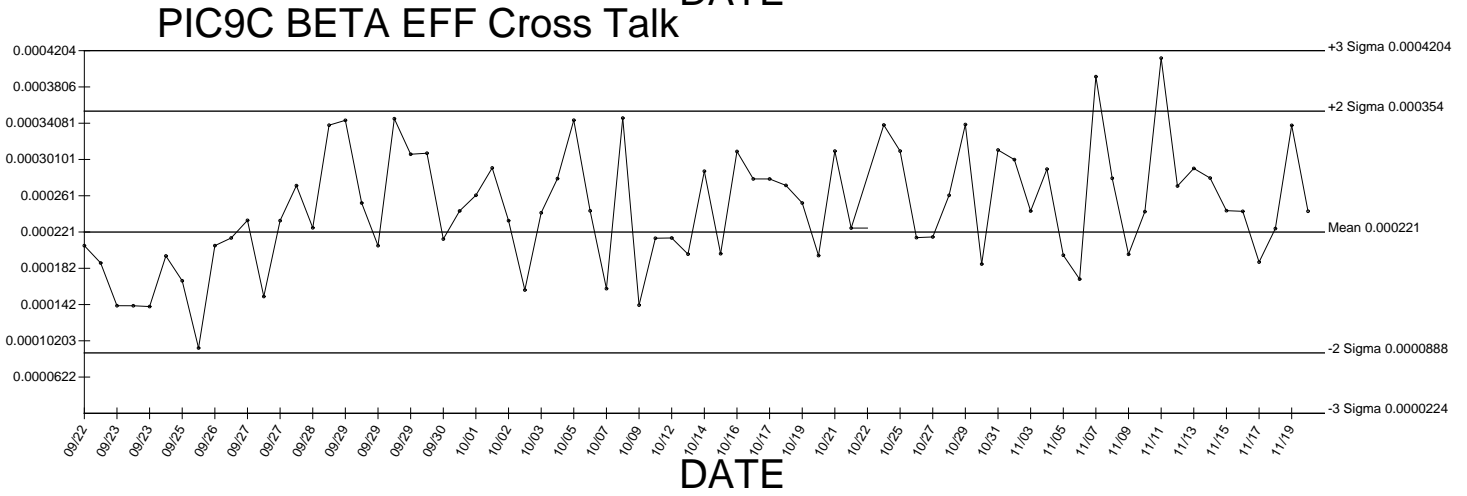
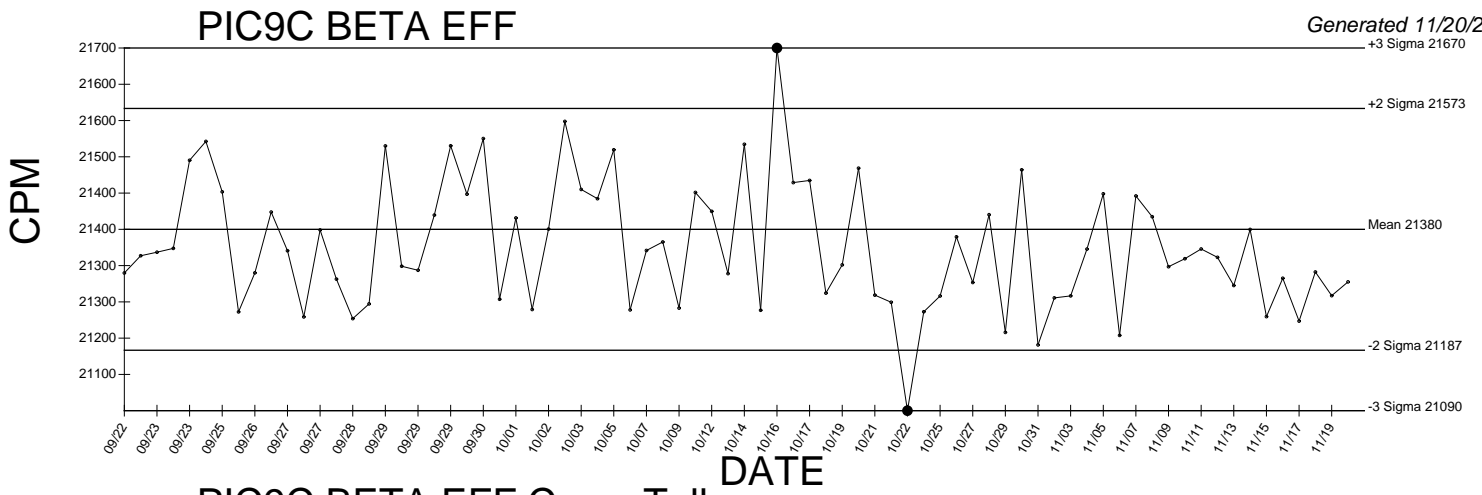
PIC8C BETA EFF Cross Talk



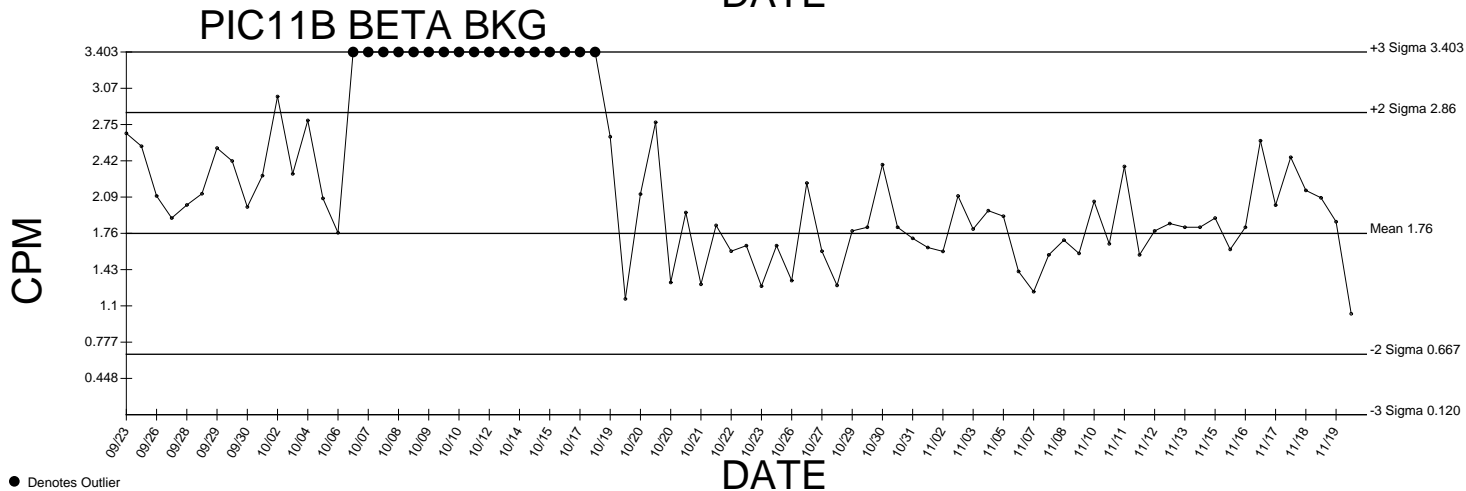
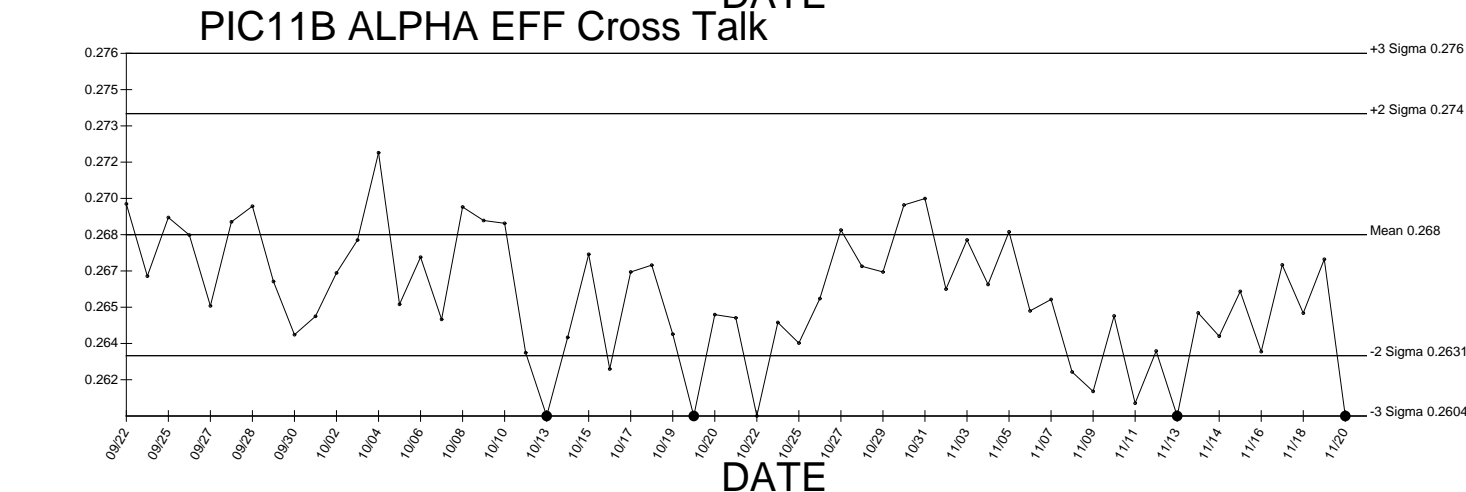
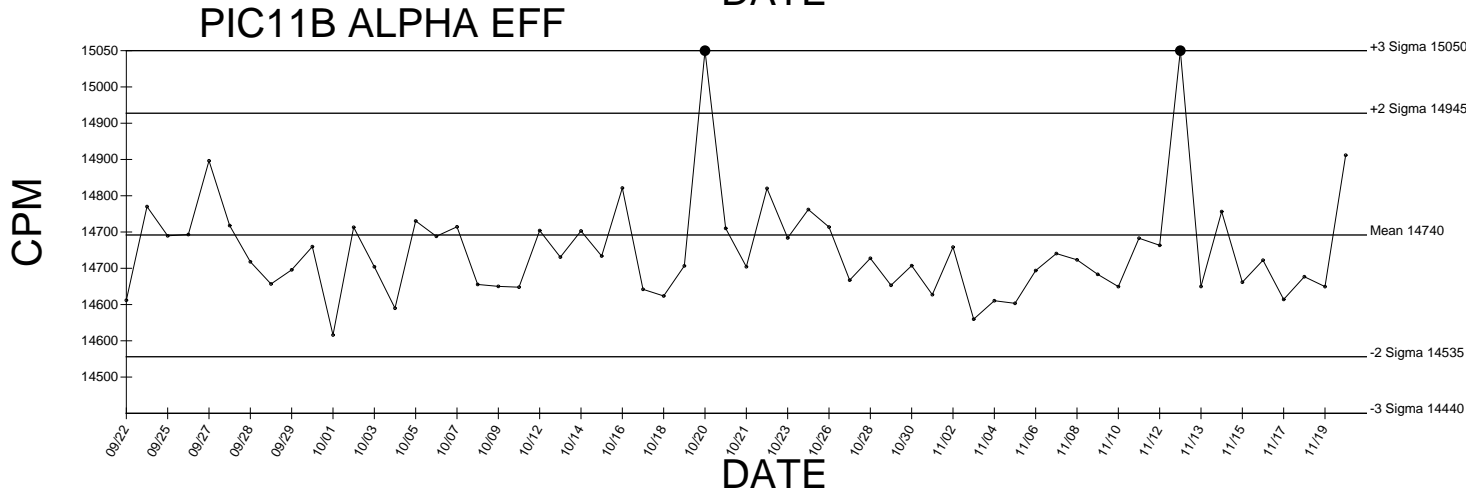
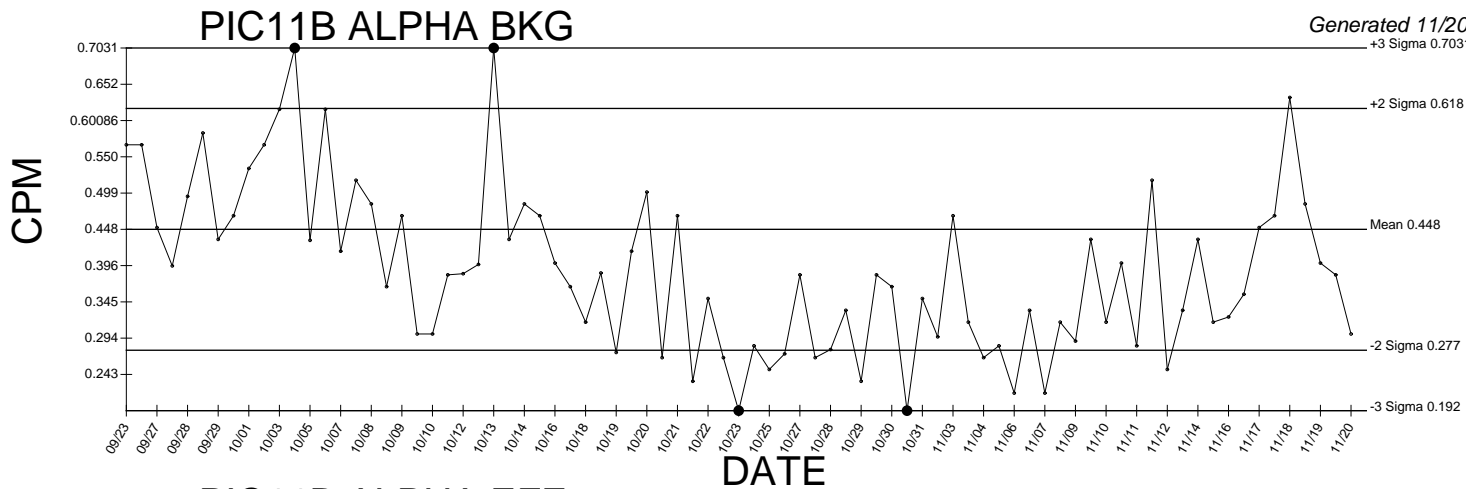
● Denotes Outlier



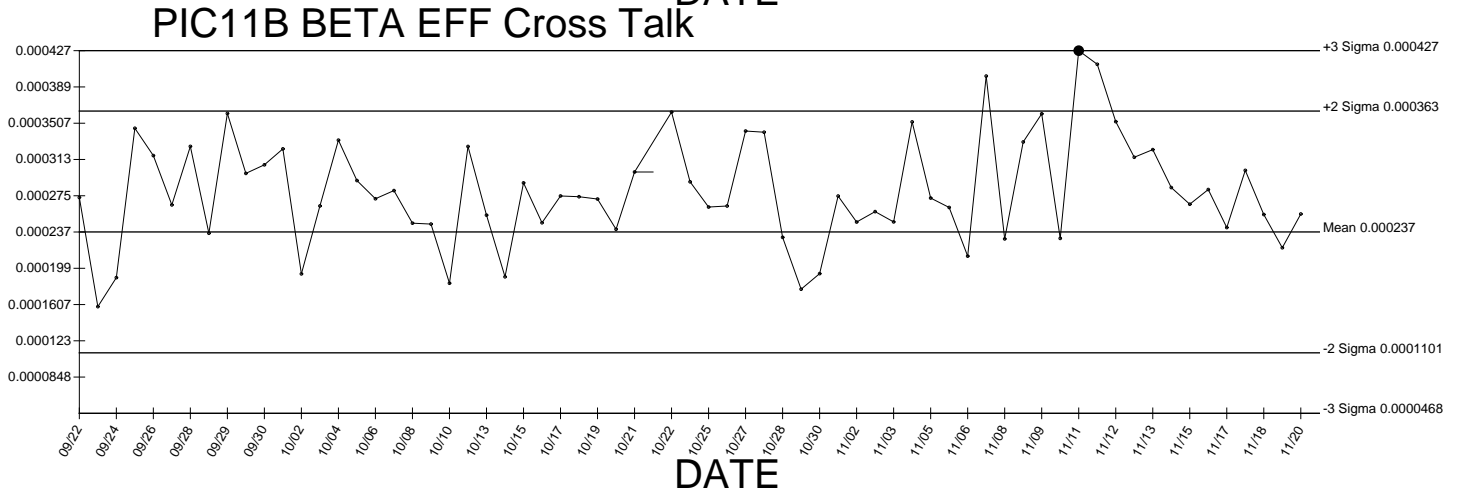
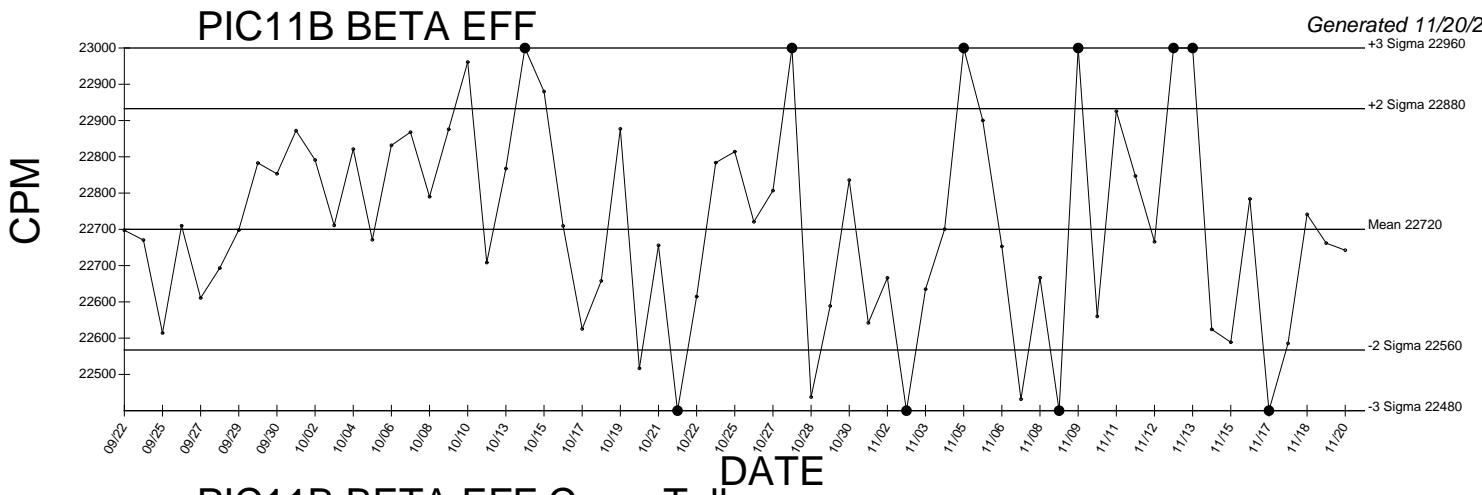
● Denotes Outlier



● Denotes Outlier

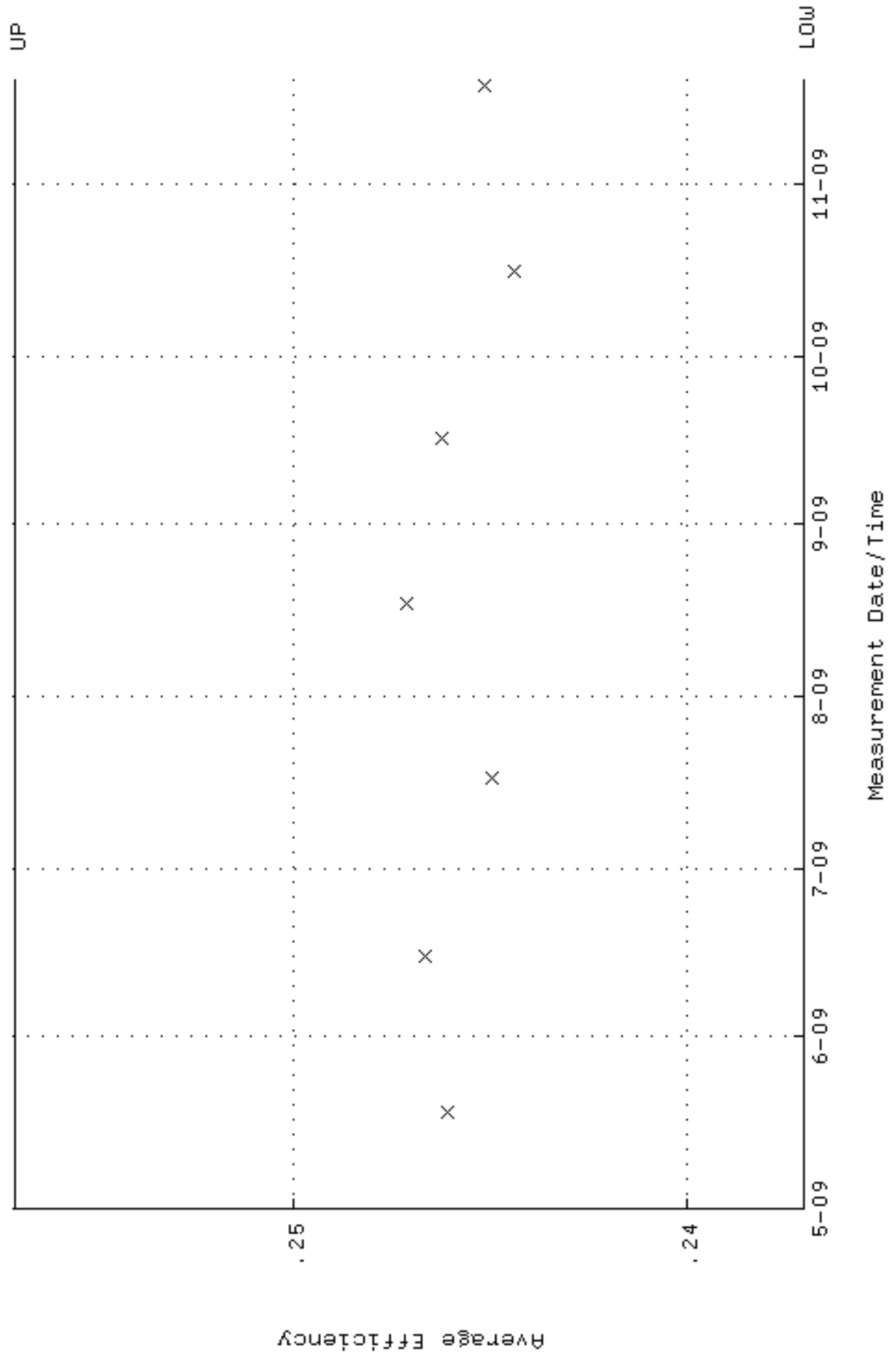


● Denotes Outlier

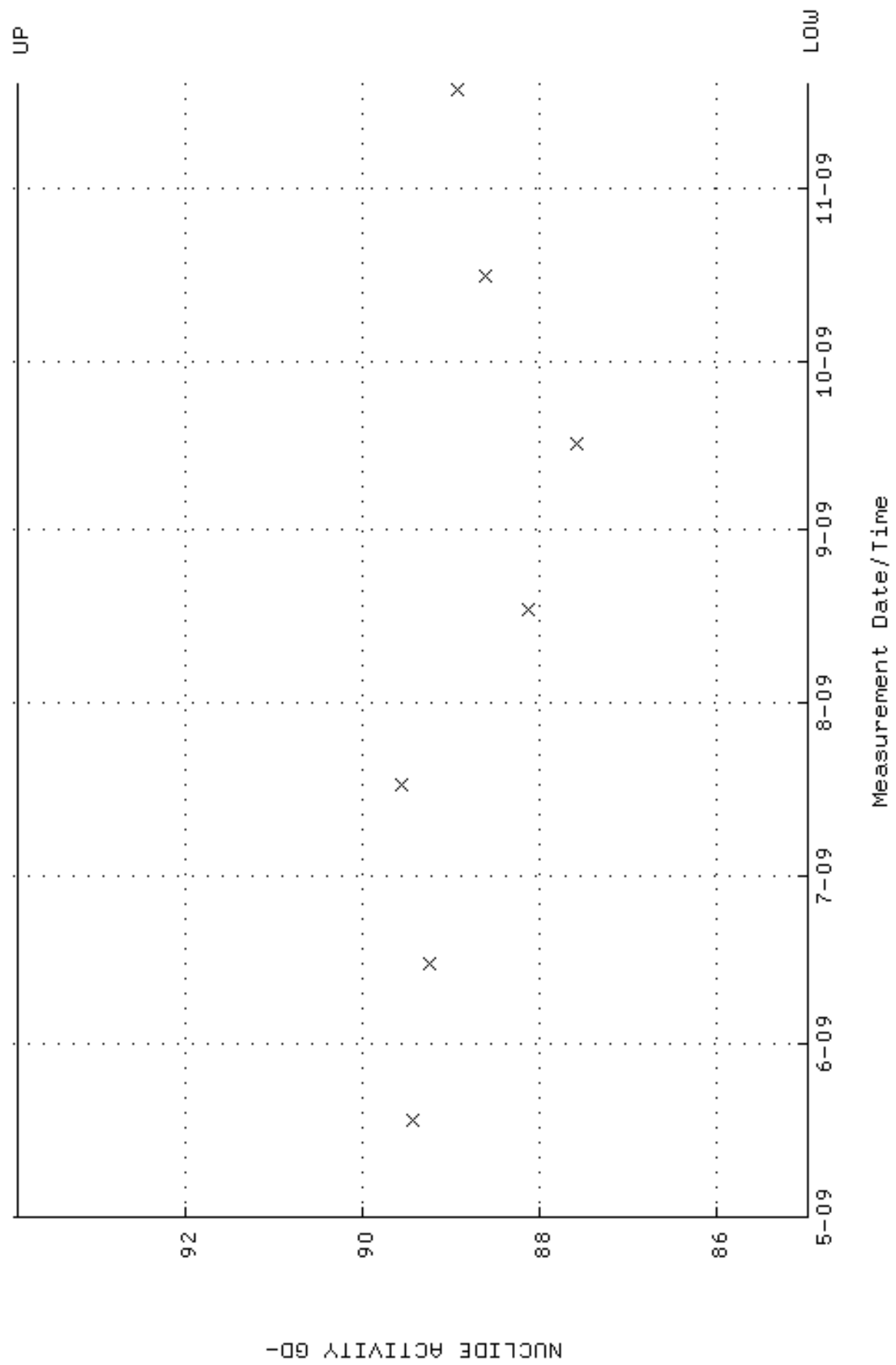


● Denotes Outlier

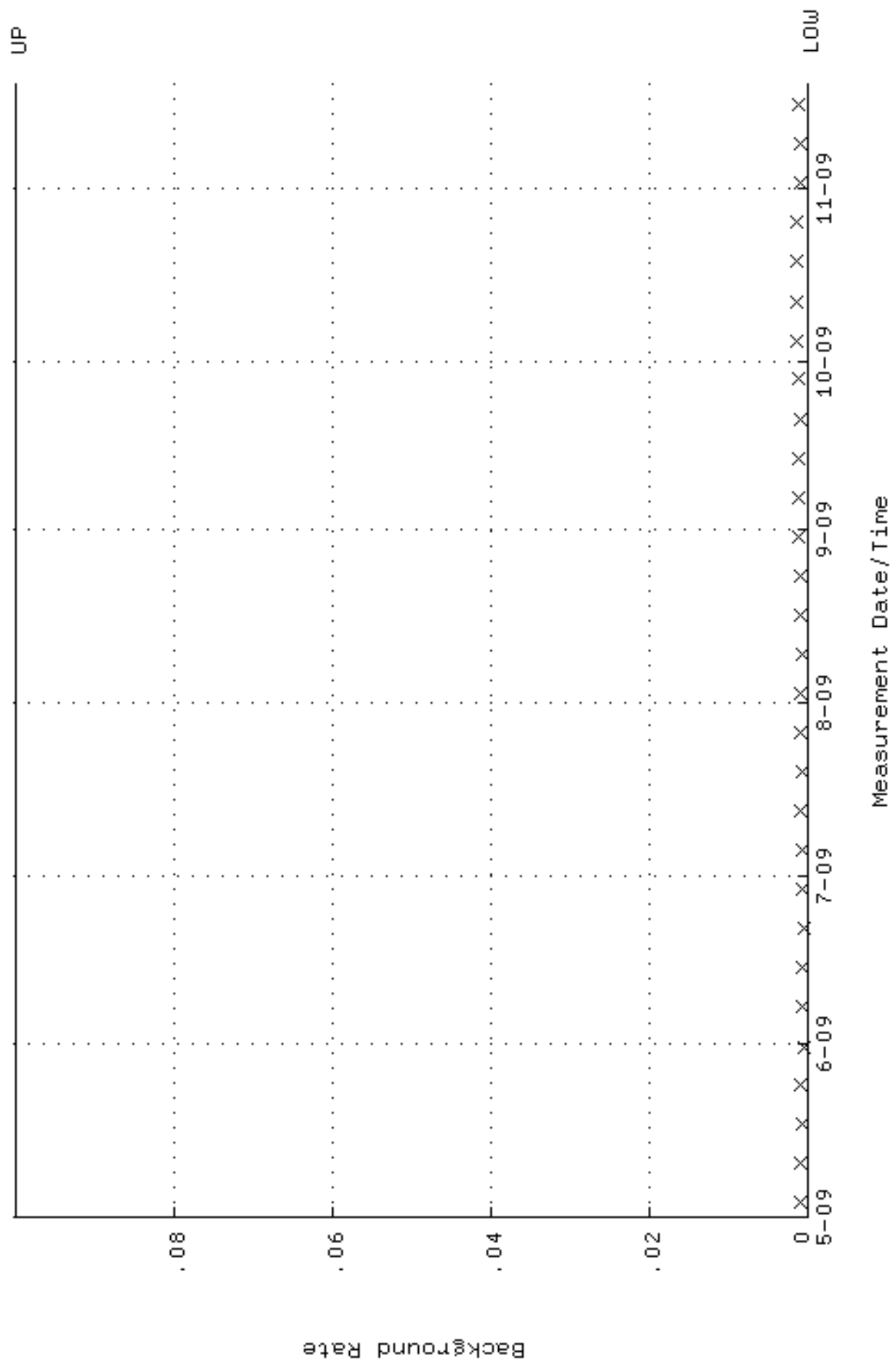
QA filename : DKA100:[ENV_ALPHA.QA.W]W147.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 18-MAY-2009 09:47:26 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.237046 through 0.257046



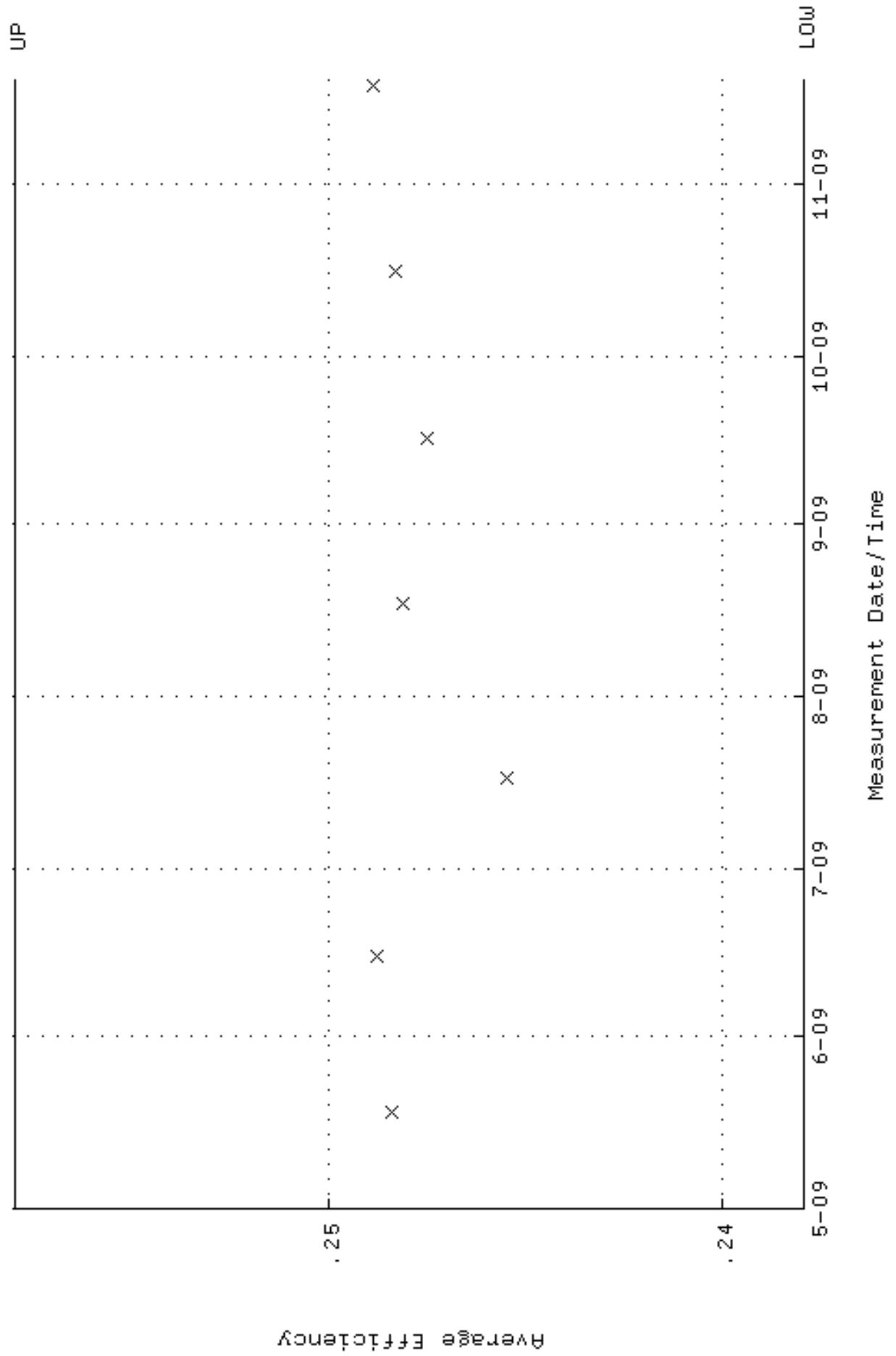
QA filename : DKA100:[ENV_ALPHA.QA.W]W147.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 18-MAY-2009 09:47:26 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 84.9777 through 93.9227



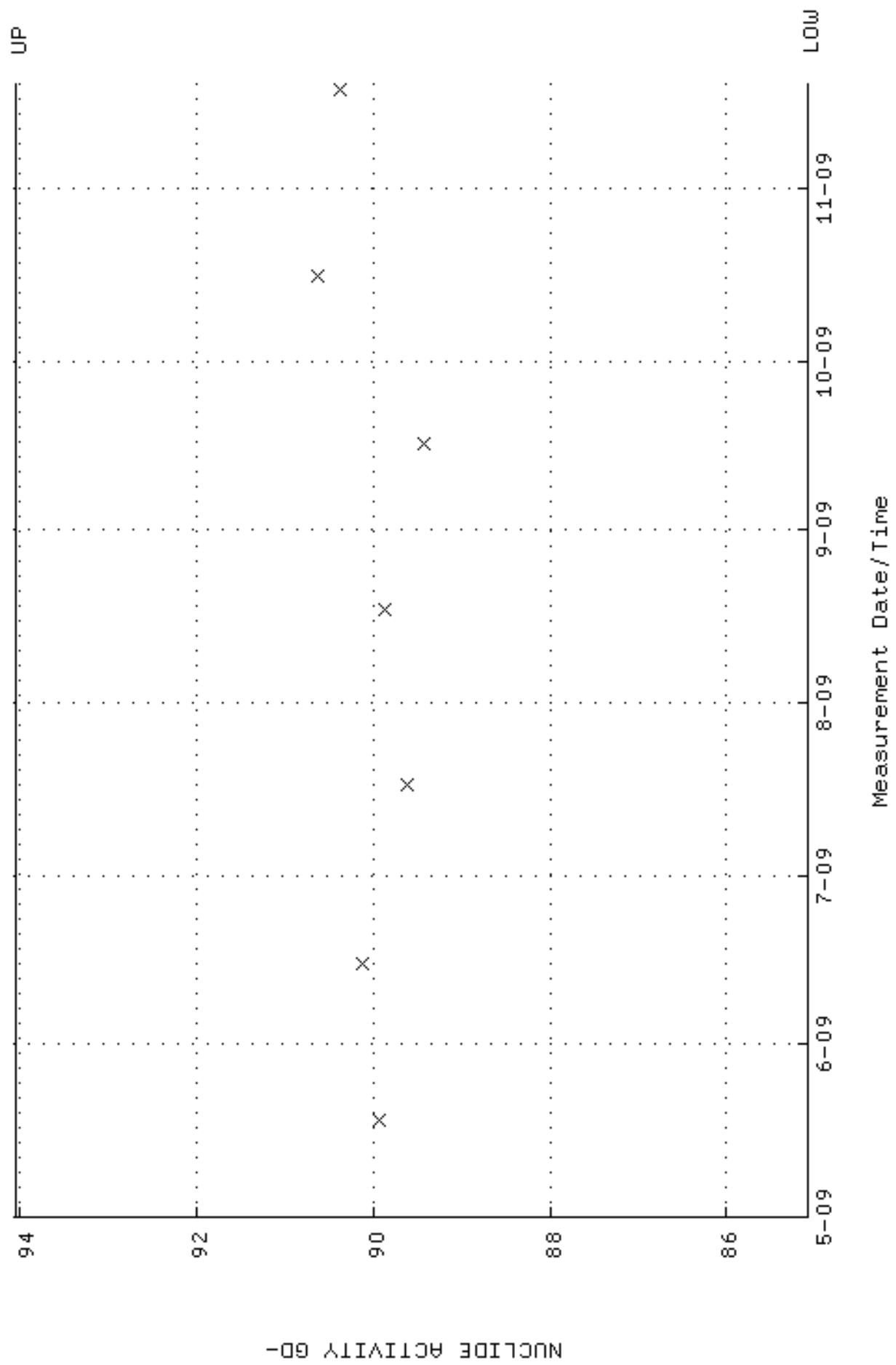
QA filename : DKA100:[ENV_ALPHA.QA.B]B147.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:52:23 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



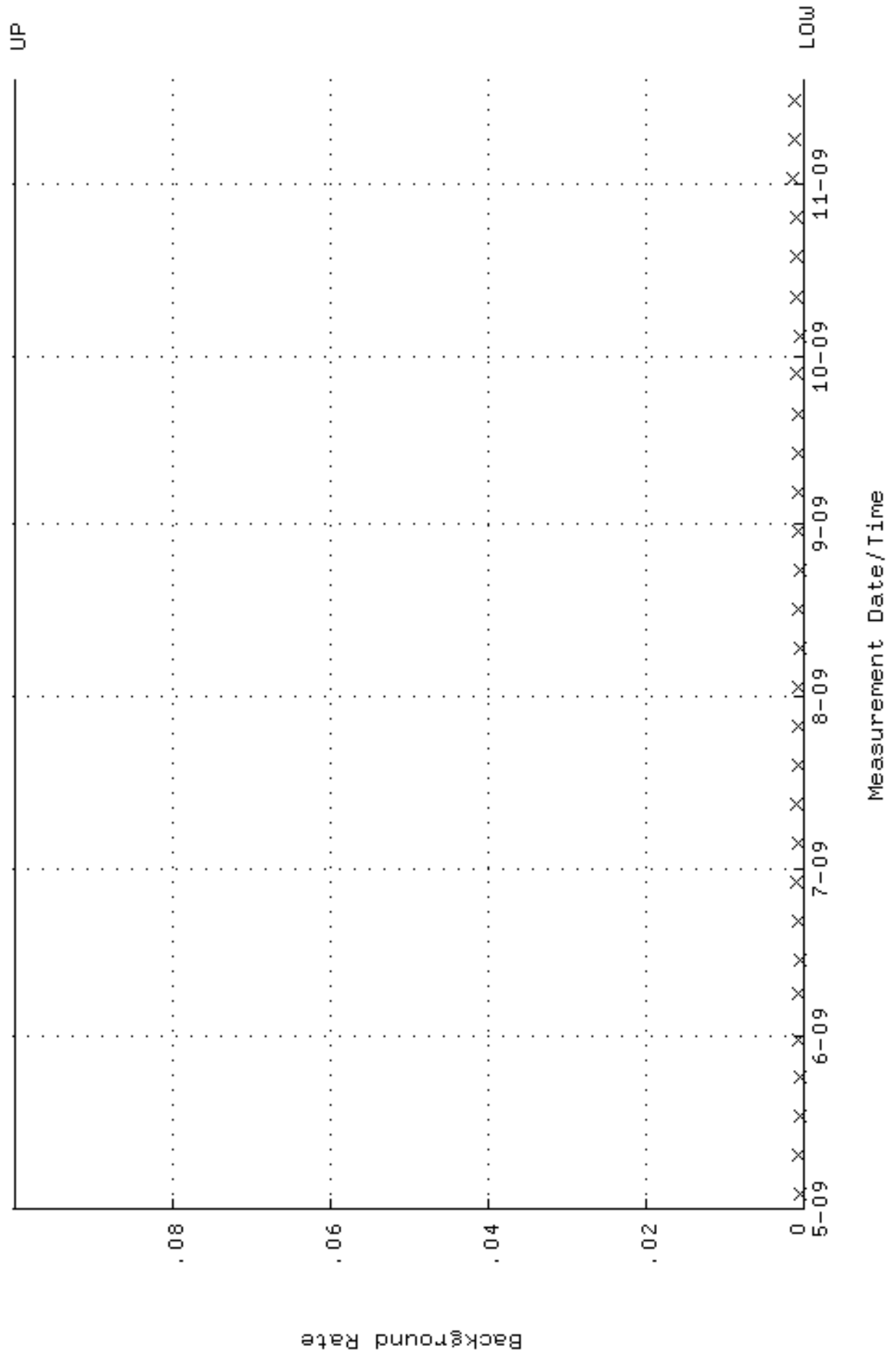
QA filename : DKA100:[ENV_ALPHA.QA.W]W148.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 18-MAY-2009 09:47:30 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.237934 through 0.257934



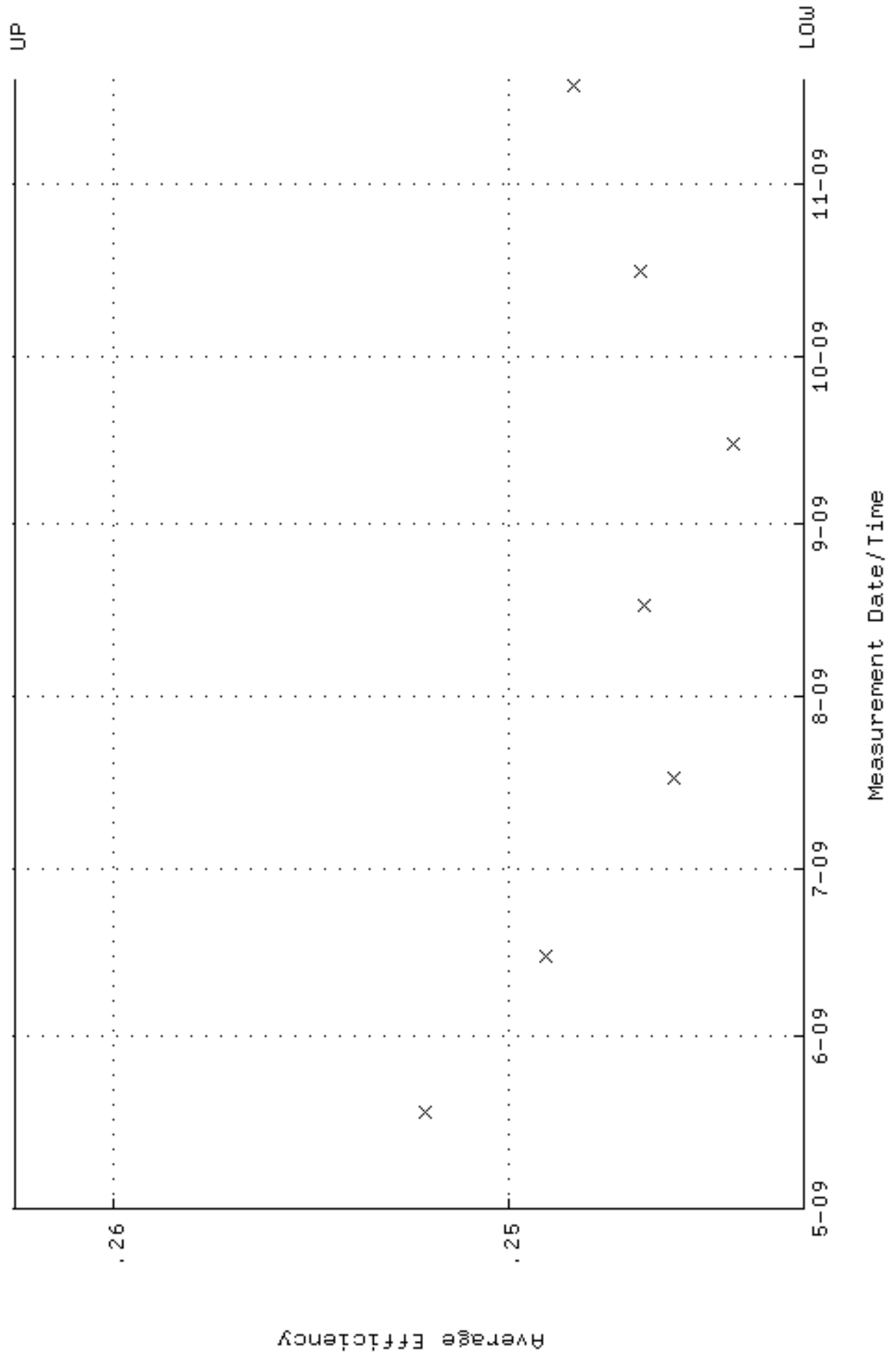
QA filename : DKA100:[ENV_ALPHA.QA.W]W148.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 18-MAY-2009 09:47:30 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 85.0831 through 94.0393



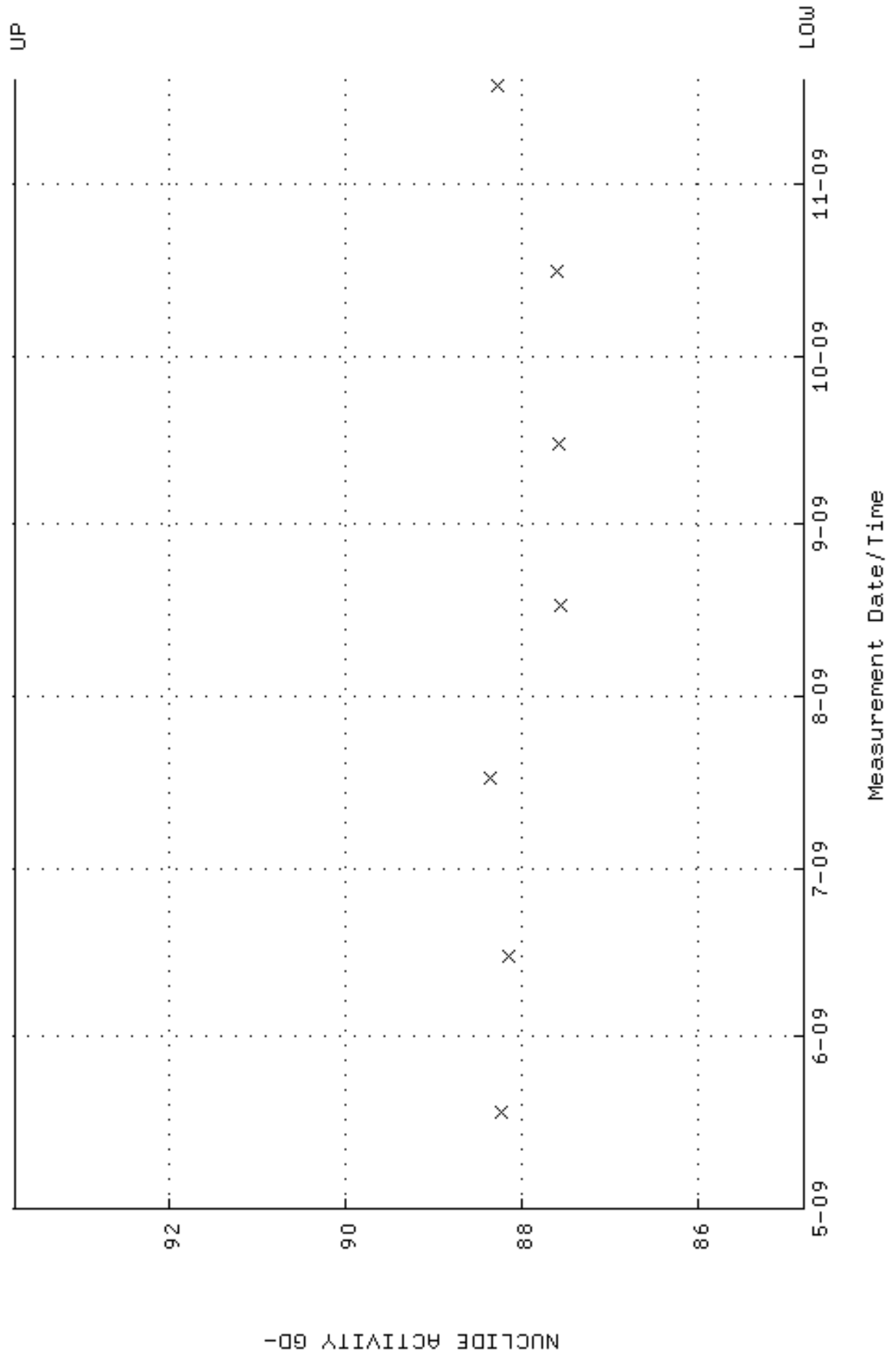
QA filename : DKA100:[ENV_ALPHA.QA.B]B148.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:52:27 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



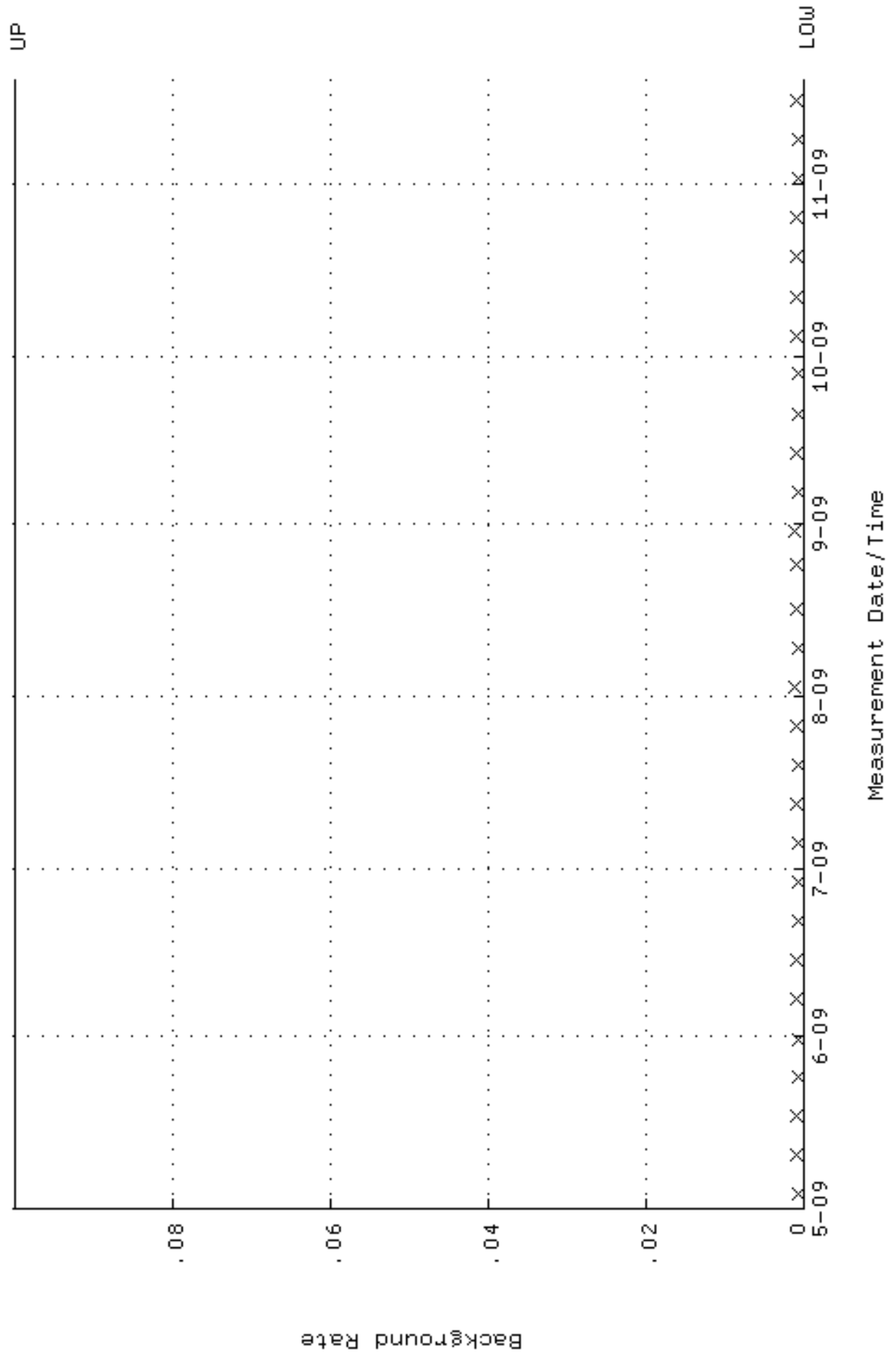
QA filename : DKA100:[ENV_ALPHA.QA.W]W149.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 18-MAY-2009 09:47:34 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.242495 through 0.262495



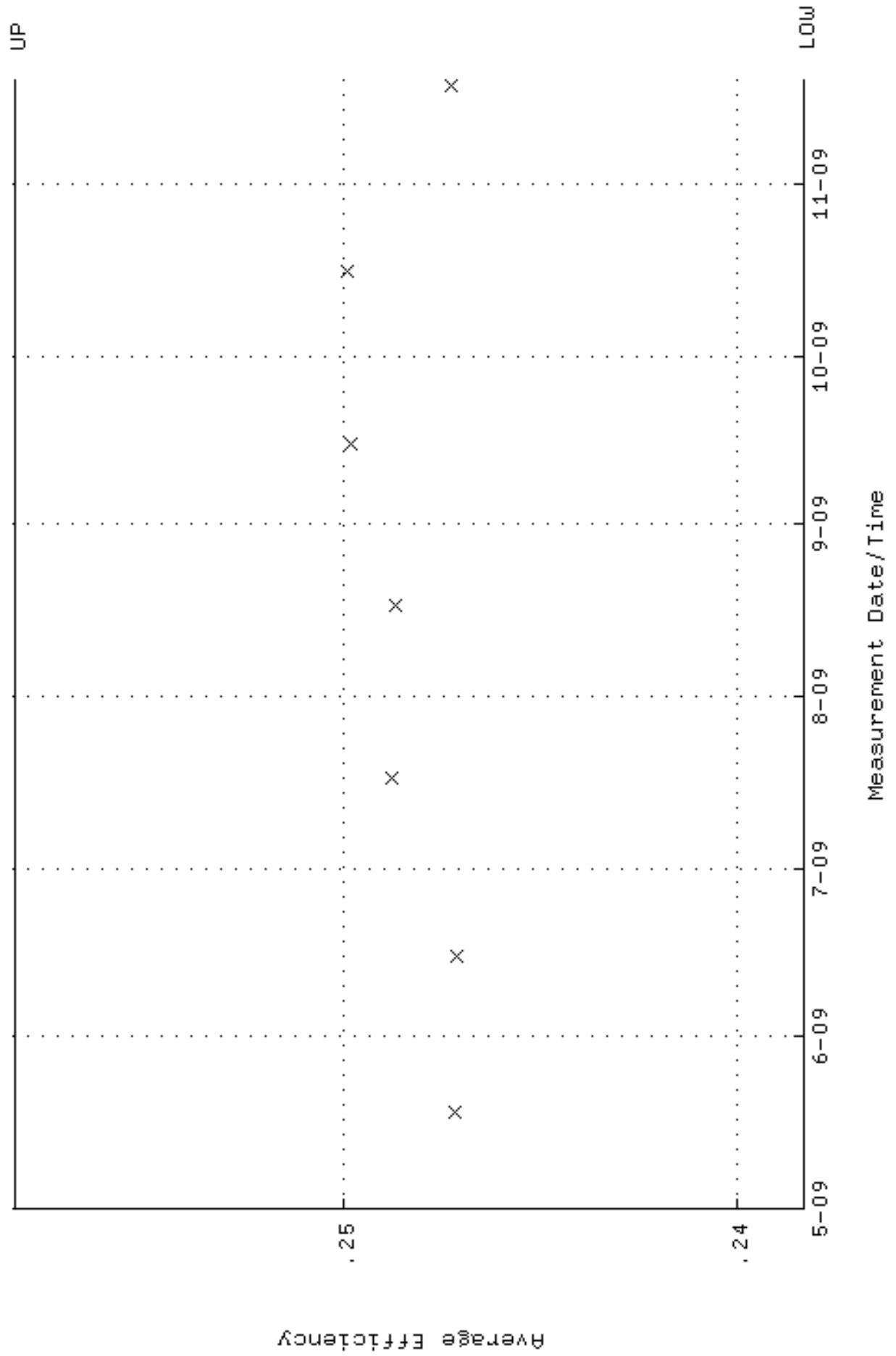
QA filename : DKA100:[ENV_ALPHA.QA.W]W149.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 18-MAY-2009 09:47:34 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 84.8126 through 93.7402



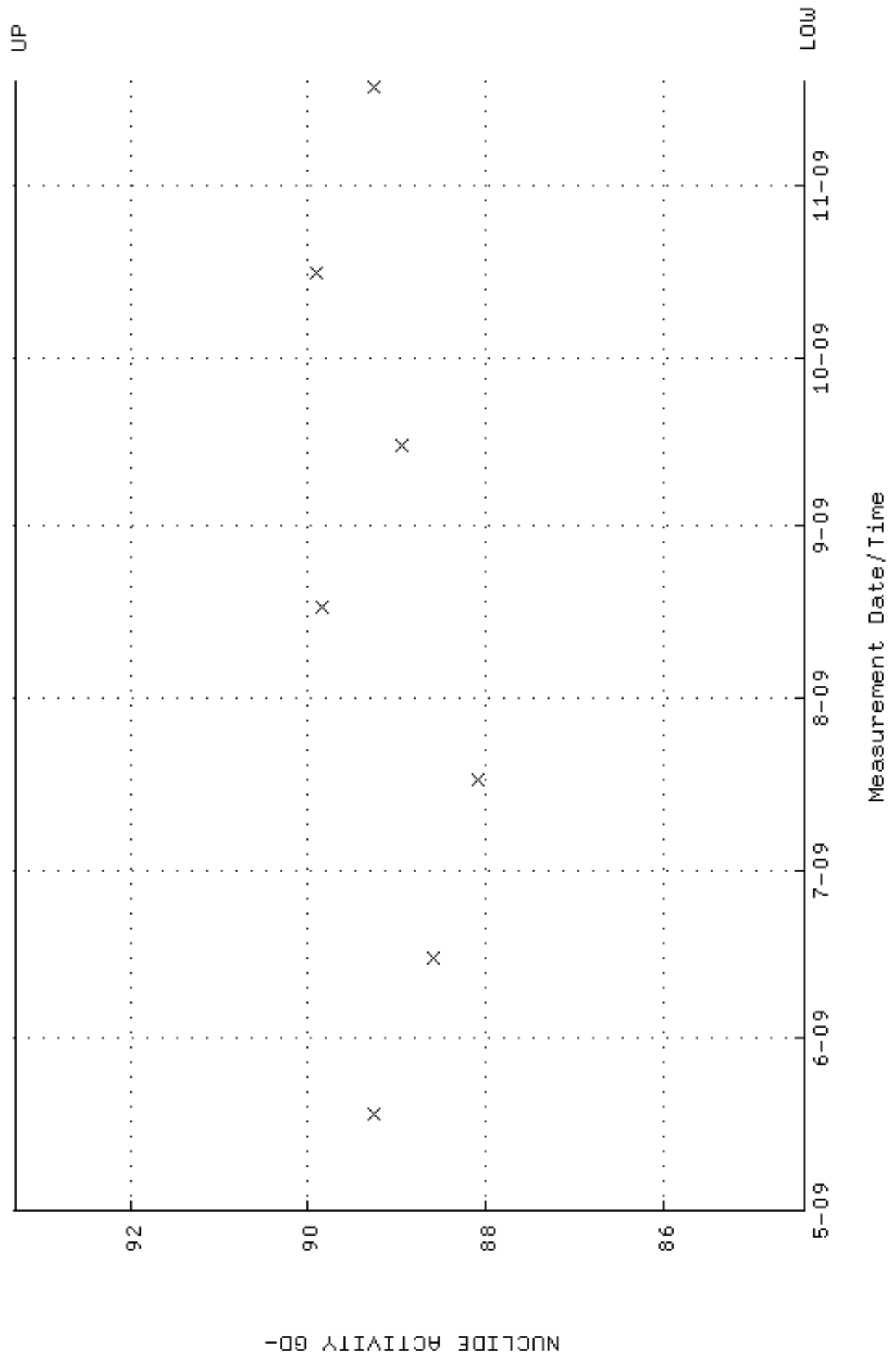
QA filename : DKA100:[ENV_ALPHA.QA.B]B149.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:52:31 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



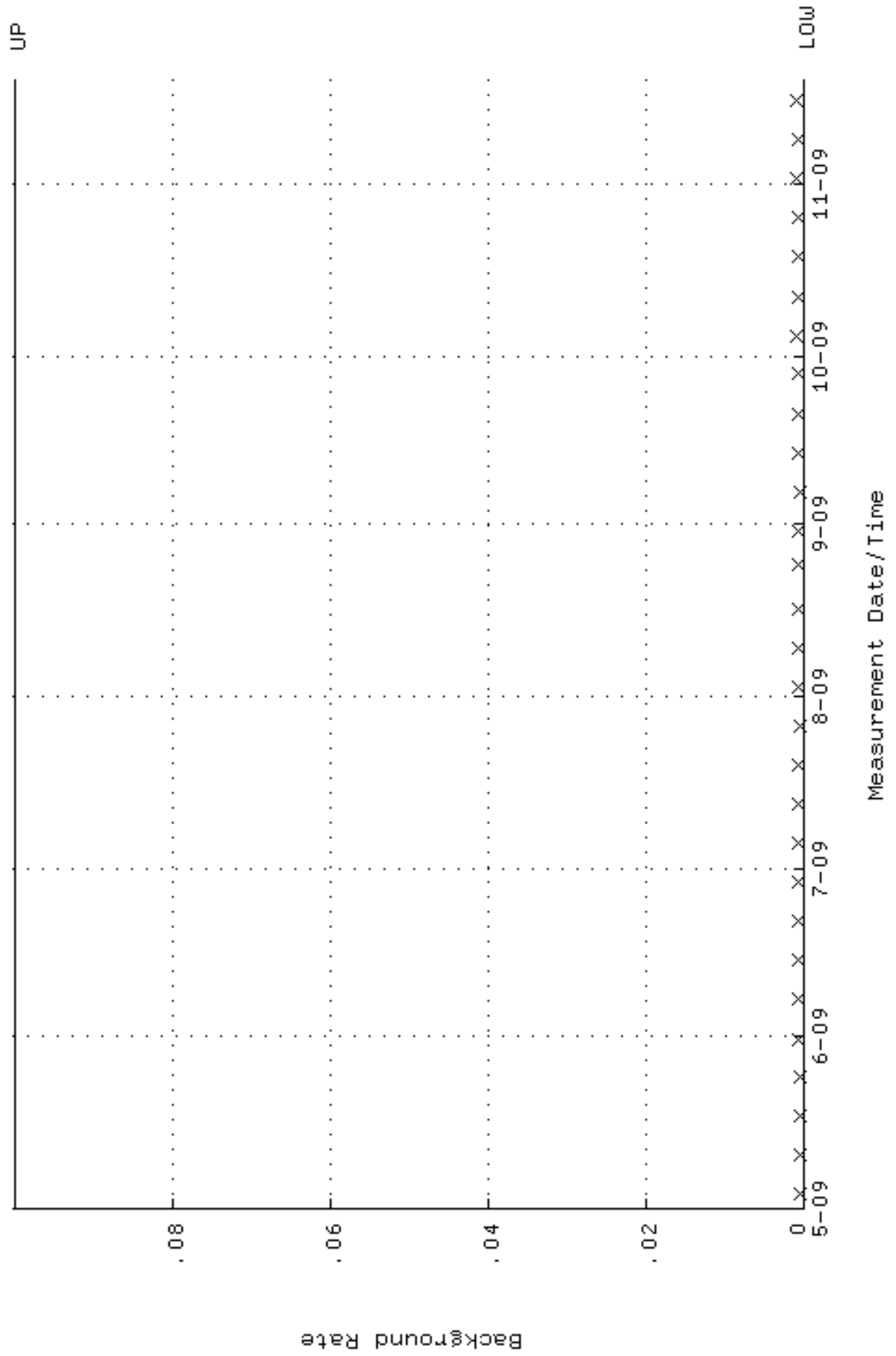
QA filename : DKA100:[ENV_ALPHA.QA.W]W150.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 18-MAY-2009 09:47:39 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.238314 through 0.258314



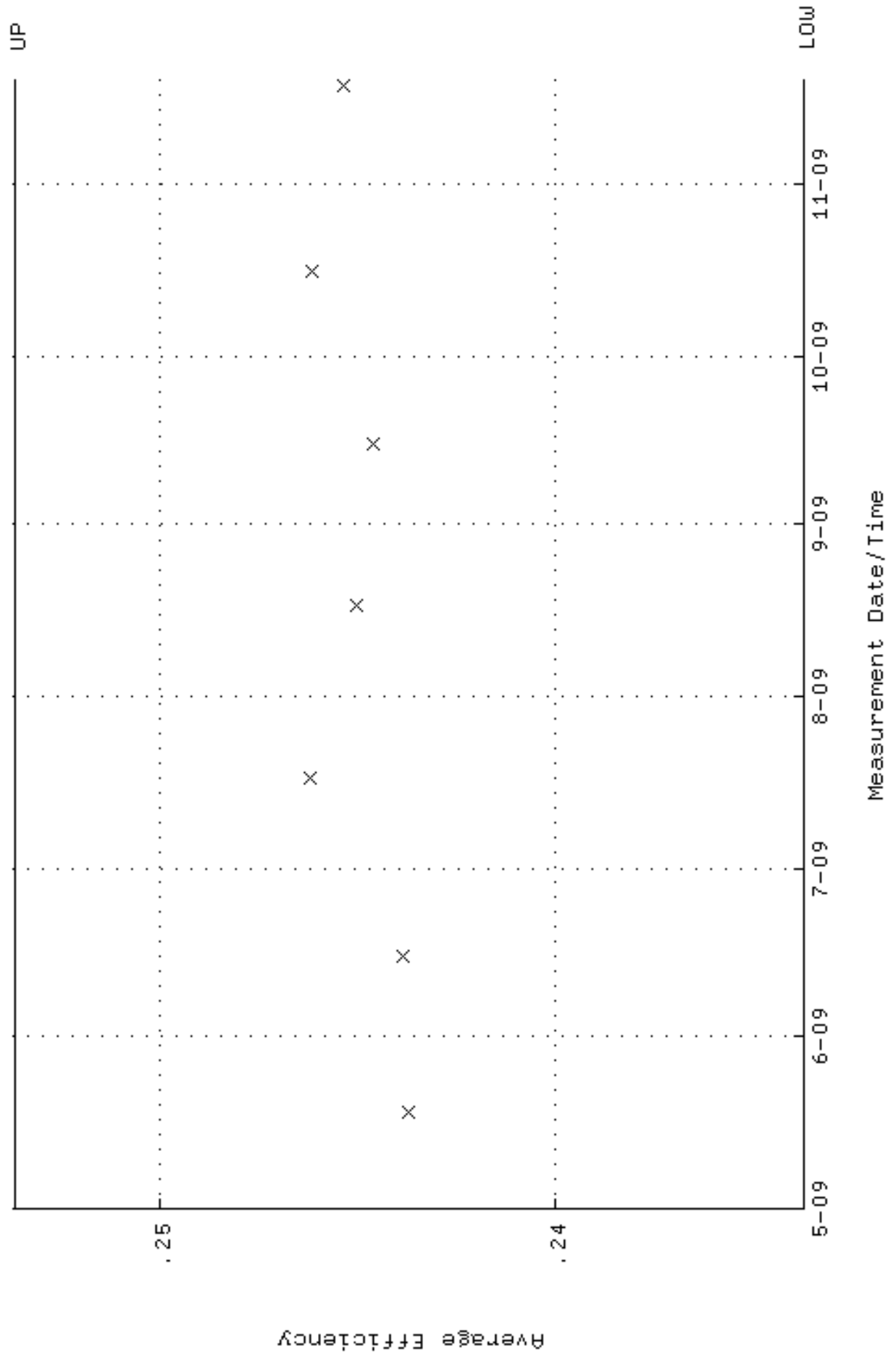
QA filename : DKA100:[ENV_ALPHA.QA.W]W150.QAF;1
Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
Start/End Dates : 18-MAY-2009 09:47:39 through 19-NOV-2009 12:00:00
Lower/Upper Lmts: 84.4039 through 93.2885



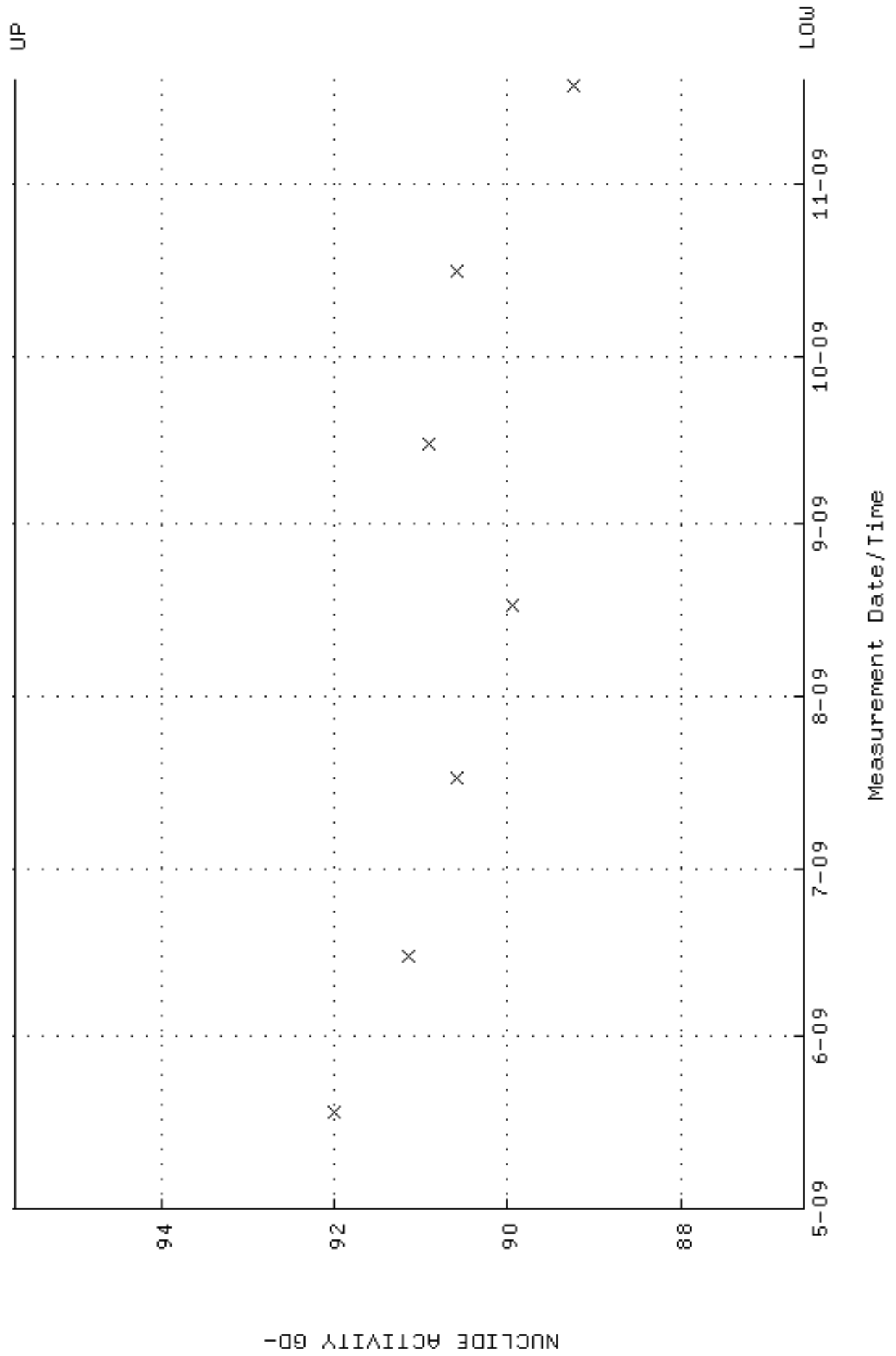
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 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:52:35 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



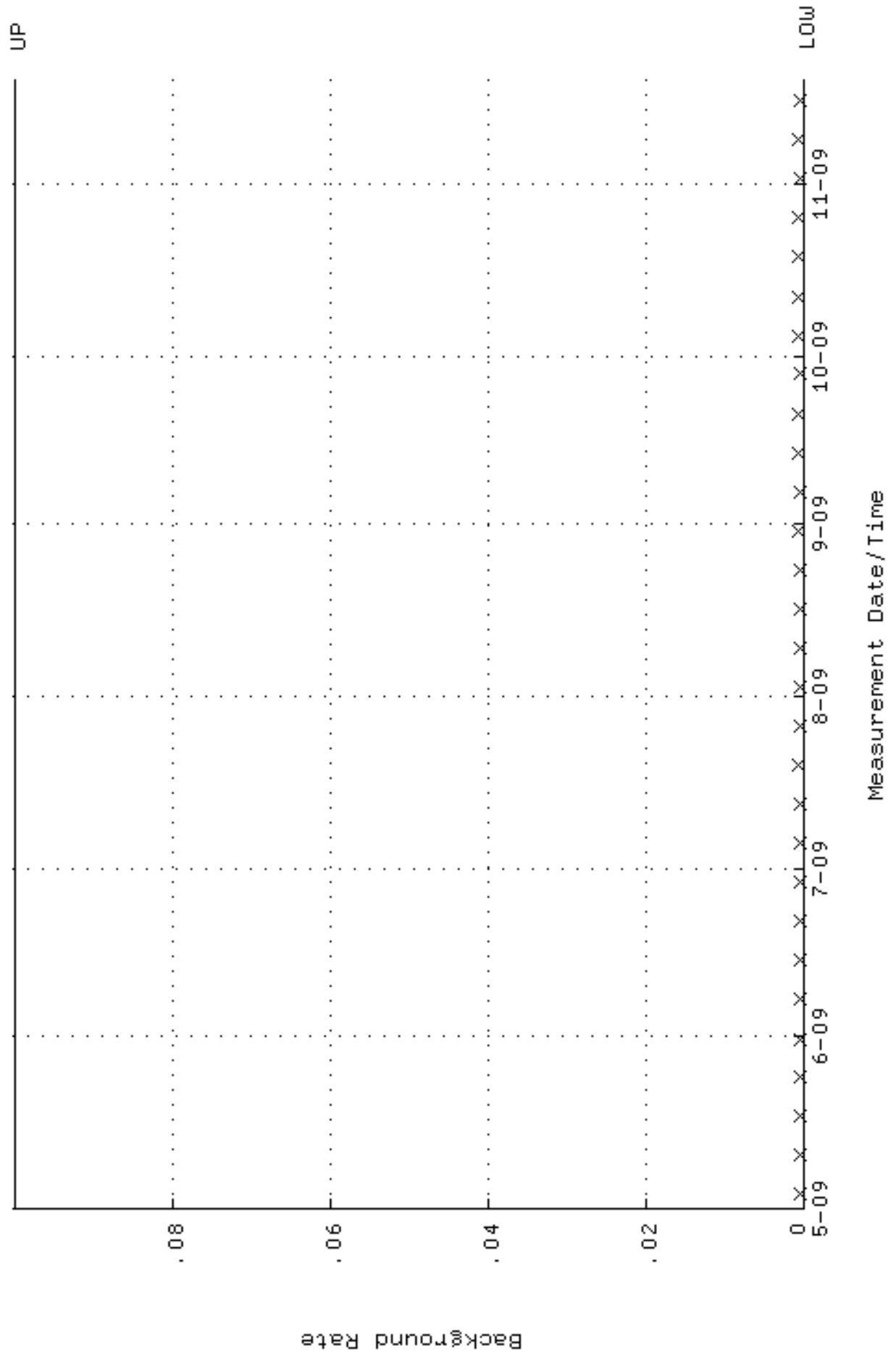
QA filename : DKA100:[ENV_ALPHA.QA.W]W151.QAF;1
Parameter Name : AVRGEFF (Average Efficiency)
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Lower/Upper Lmts: 0.233693 through 0.253693



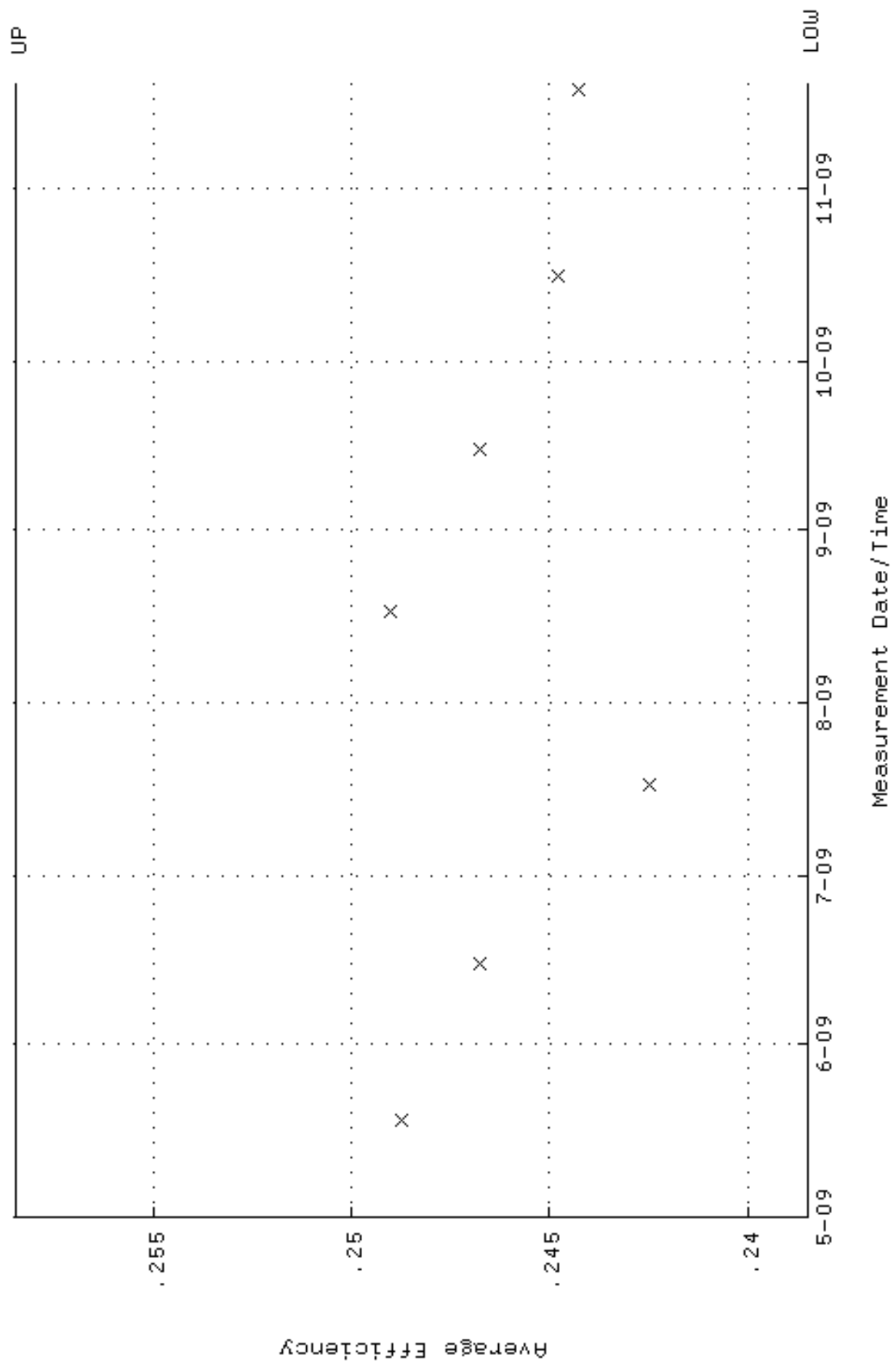
QA filename : DKA100:[ENV_ALPHA.QA.W]W151.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 18-MAY-2009 09:47:43 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 86.5749 through 95.6881



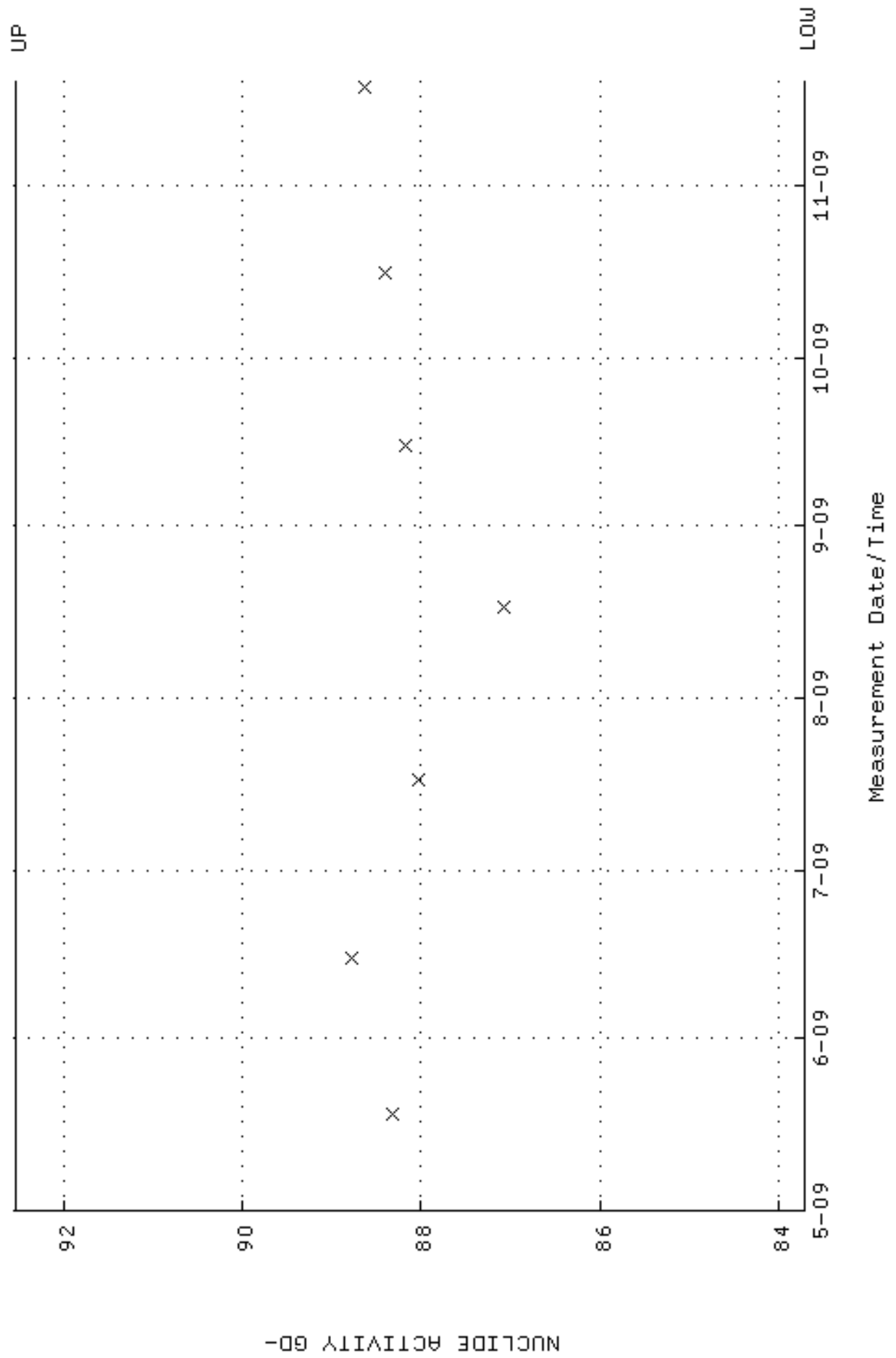
QA filename : DKA100:[ENV_ALPHA.QA.B]B151.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:52:39 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



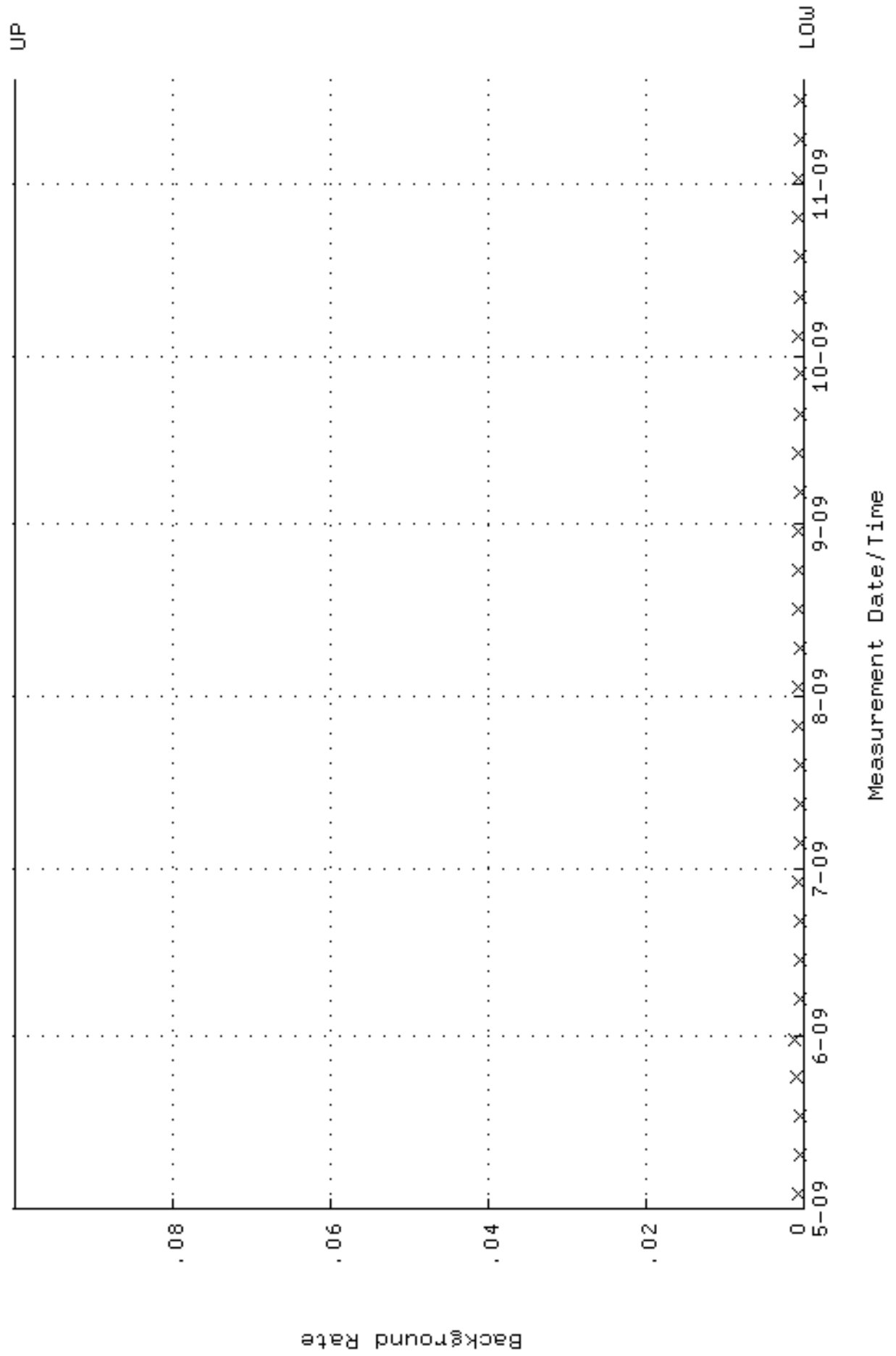
QA filename : DKA100:[ENV_ALPHA.QA.W]W152.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 18-MAY-2009 09:47:48 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.238479 through 0.258479



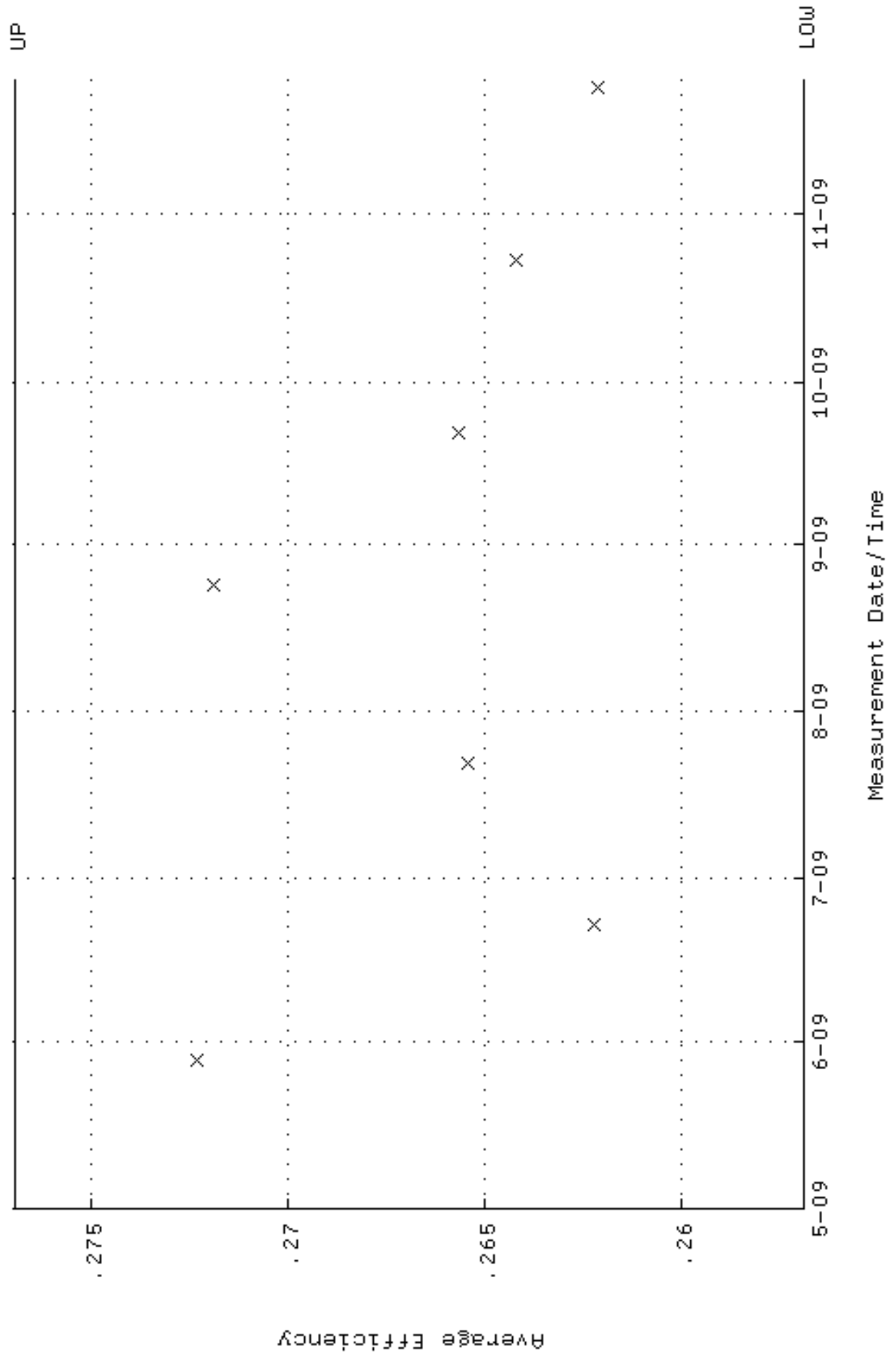
QA filename : DKA100:[ENV_ALPHA.QA.W]w152.QAF;1
Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
Start/End Dates : 18-MAY-2009 09:47:48 through 19-NOV-2009 12:00:00
Lower/Upper Lmts: 83.7180 through 92.5304



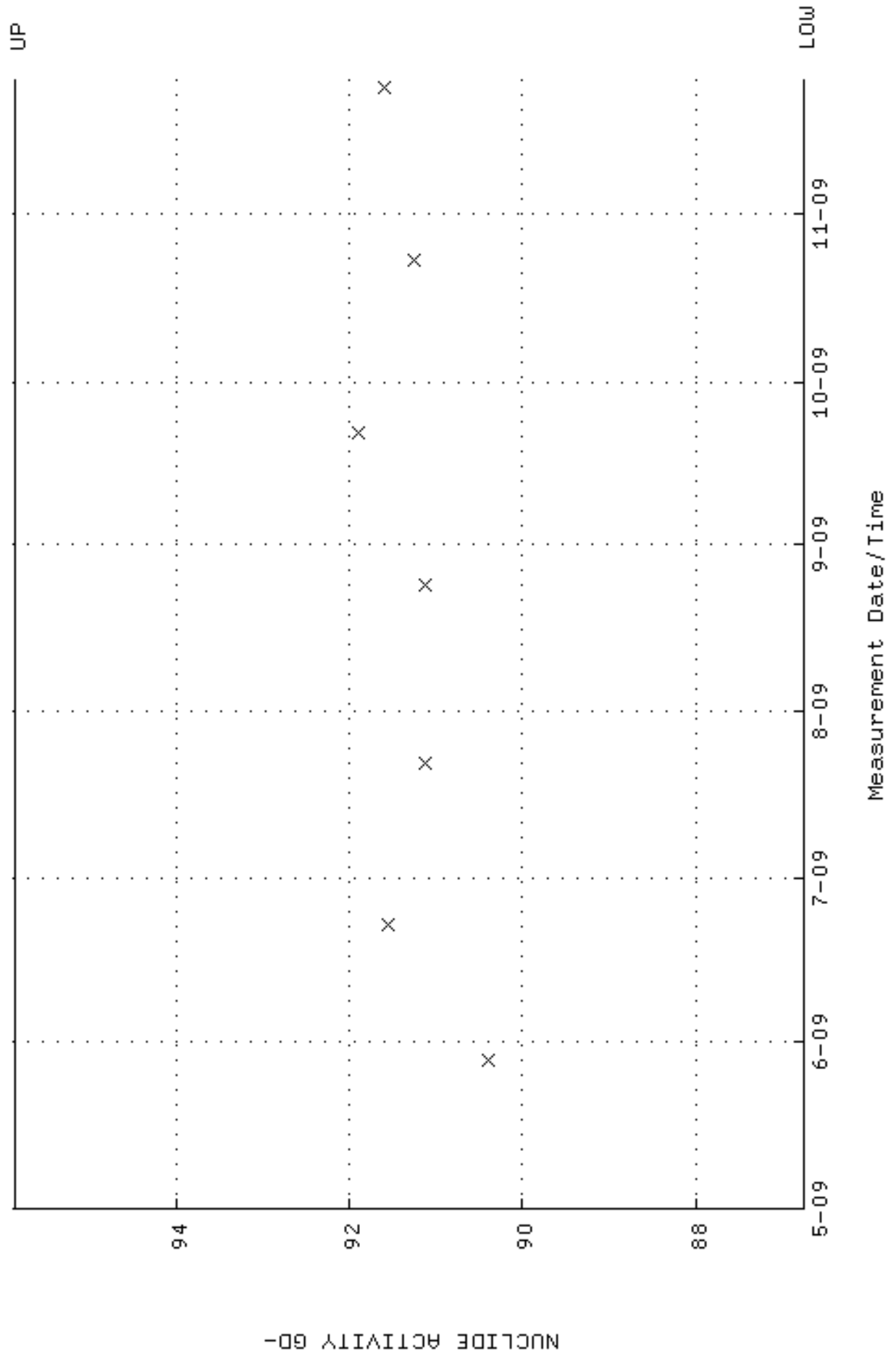
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 Start/End Dates : 3-MAY-2009 13:52:43 through 19-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



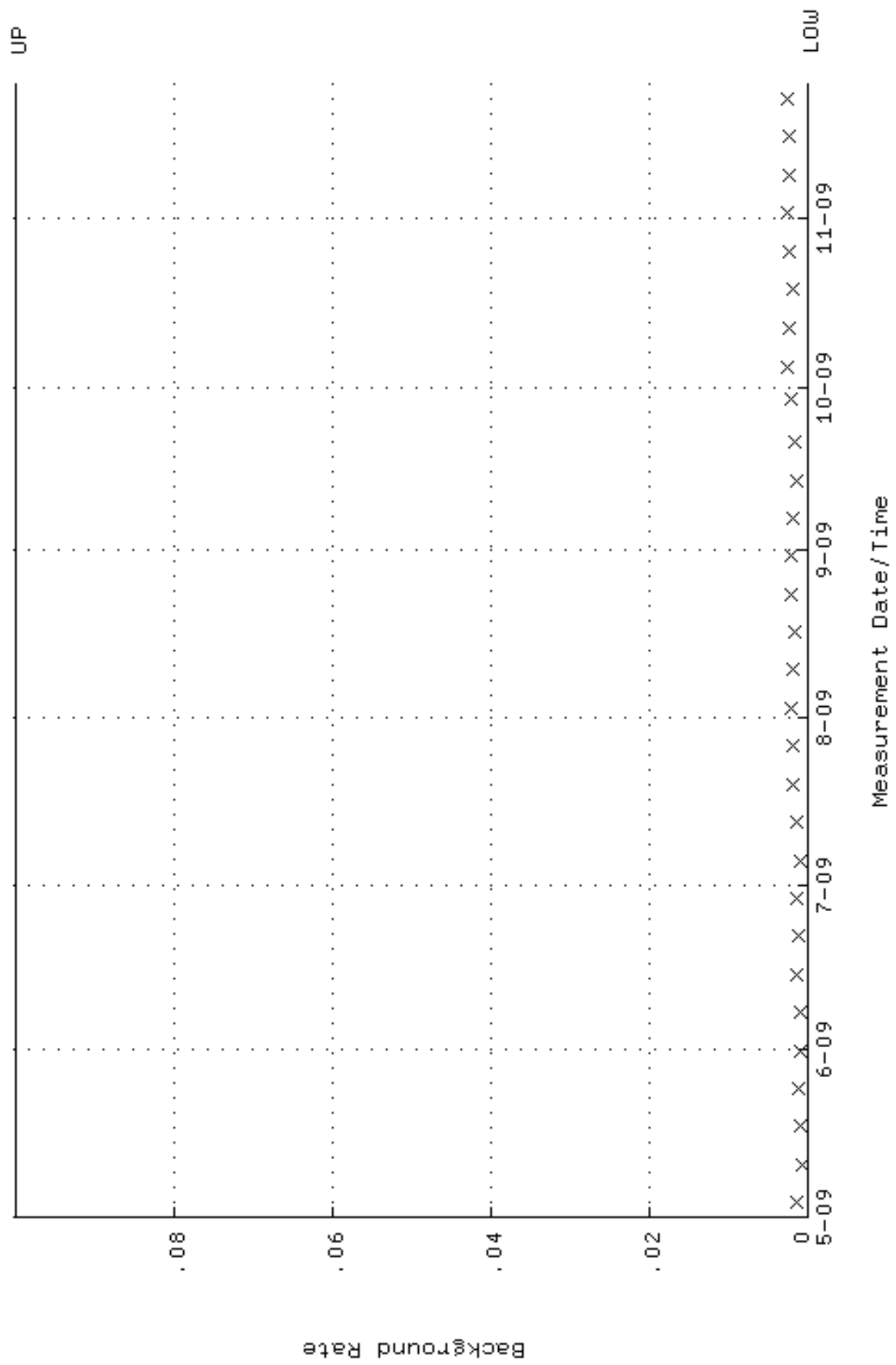
QA filename : DKA100:[ENV_ALPHA.QA.W]W179.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 28-MAY-2009 14:00:41 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.256911 through 0.276911



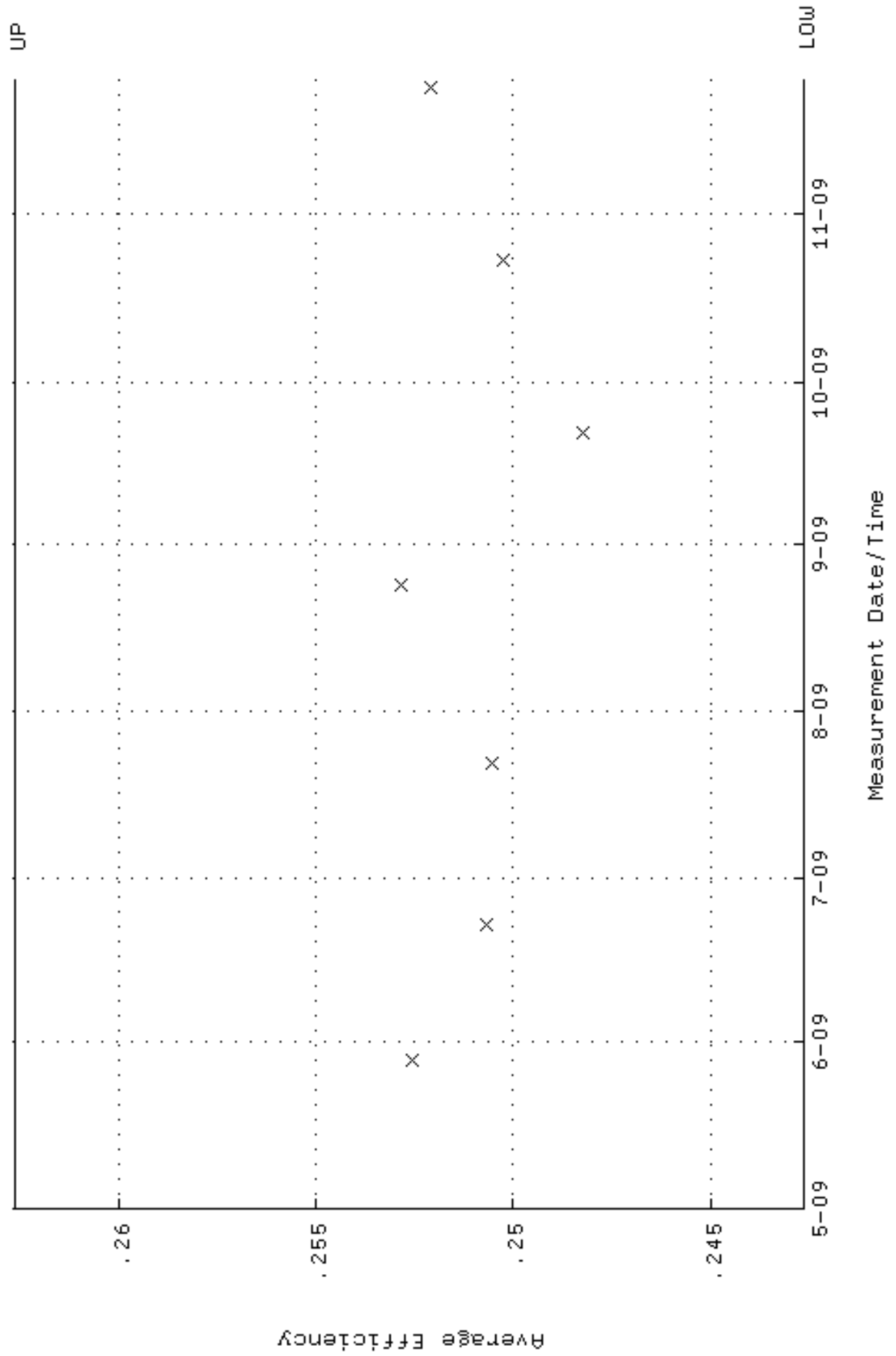
QA filename : DKA100:[ENV_ALPHA.QA.W]w179.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 28-MAY-2009 14:00:41 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 86.7434 through 95.8742



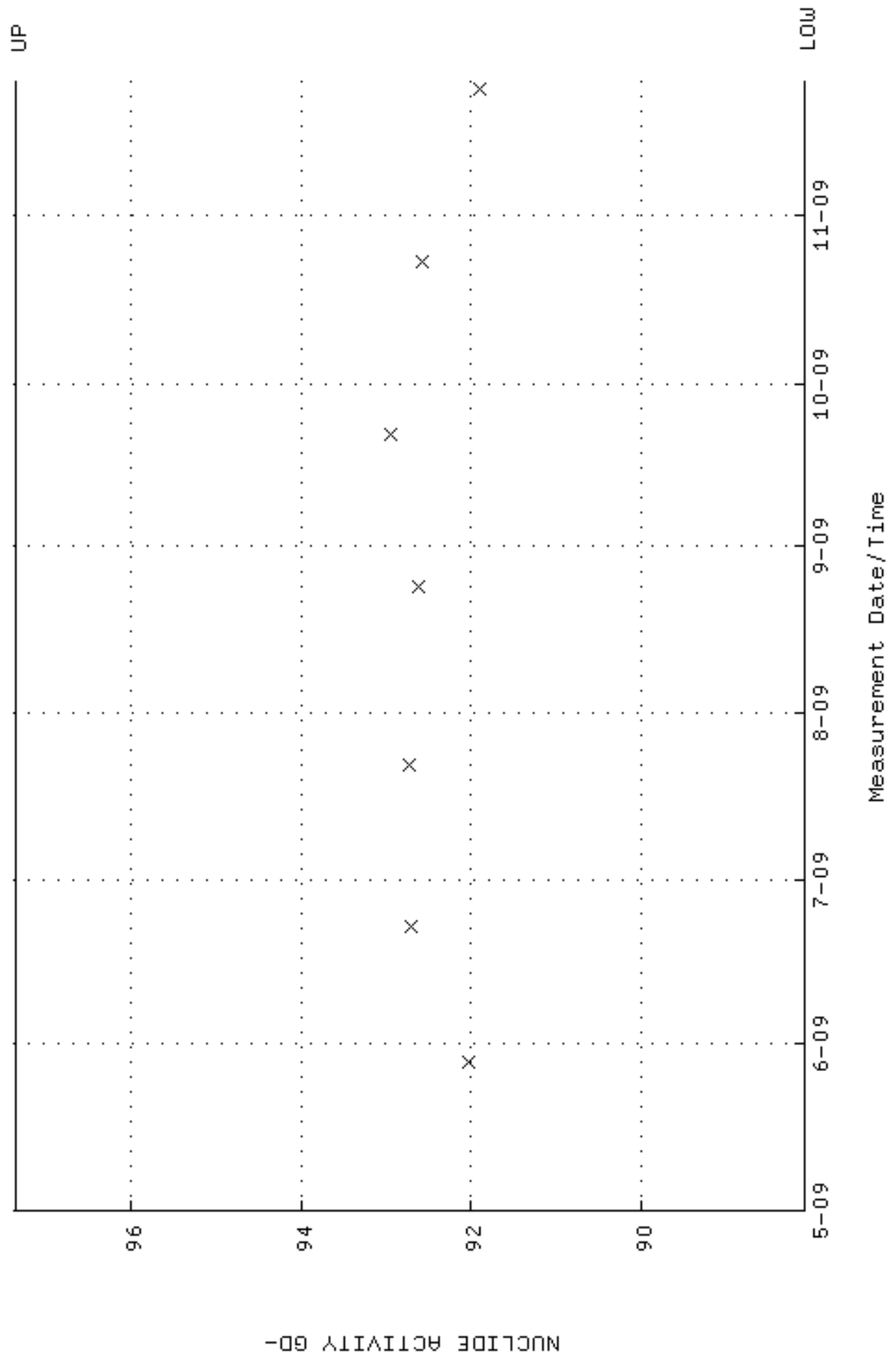
QA filename : DKA100:[ENV_ALPHA.QA.B]B179.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:54:24 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



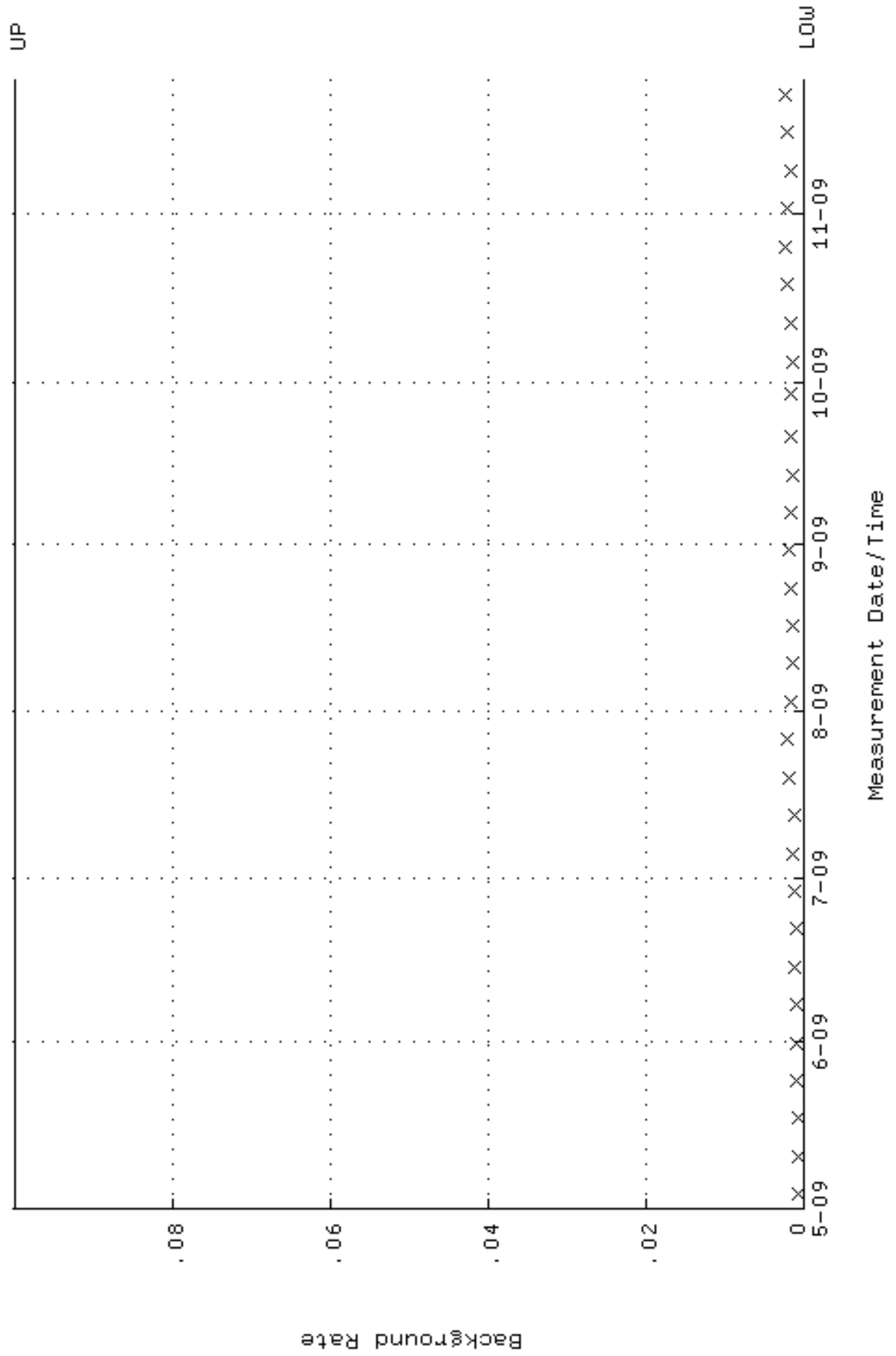
QA filename : DKA100:[ENV_ALPHA.QA.W]W180.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 28-MAY-2009 14:00:45 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.242633 through 0.262633



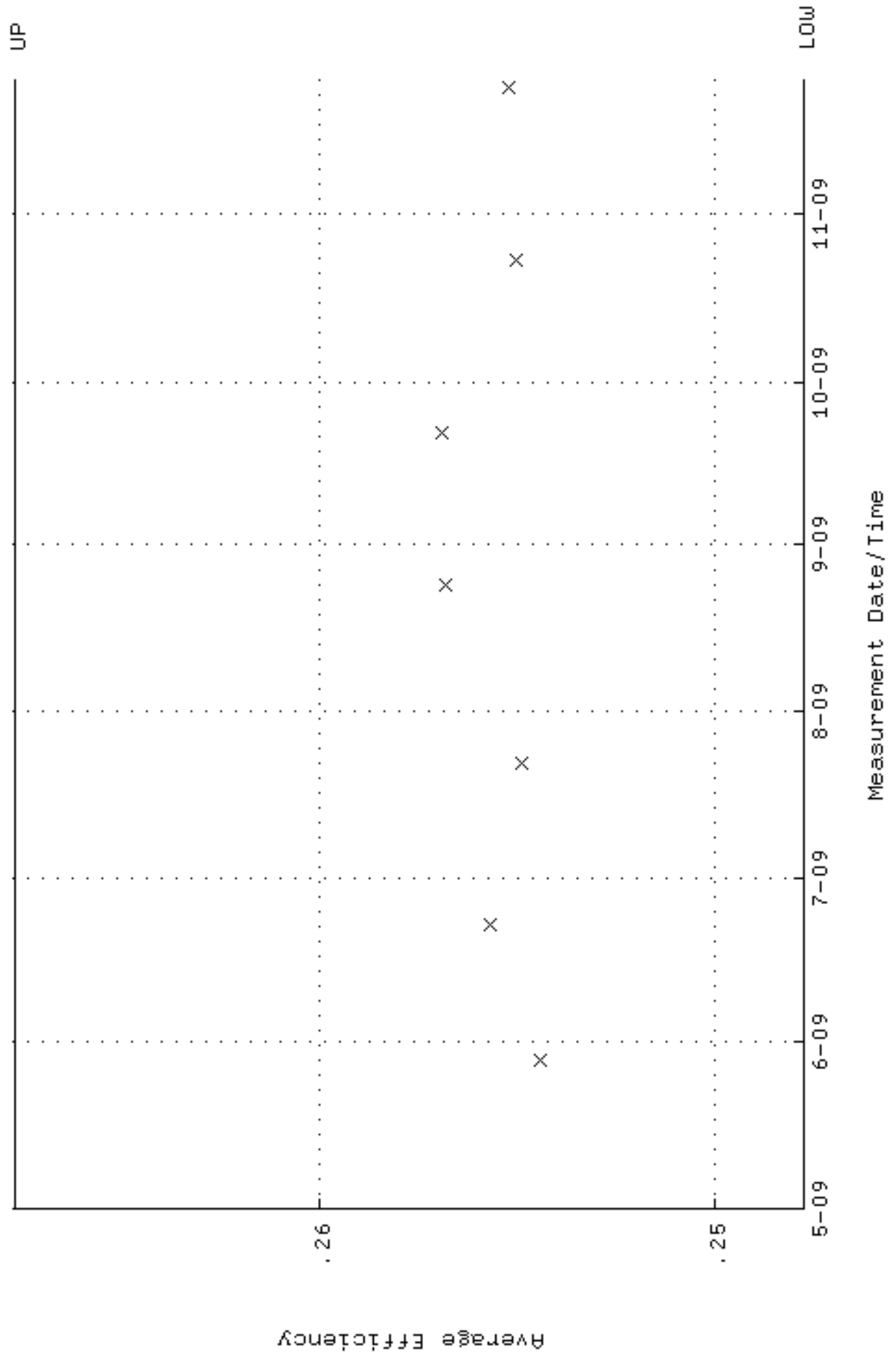
QA filename : DKA100:[ENV_ALPHA.QA.W]W180.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 28-MAY-2009 14:00:45 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 88.0803 through 97.3519



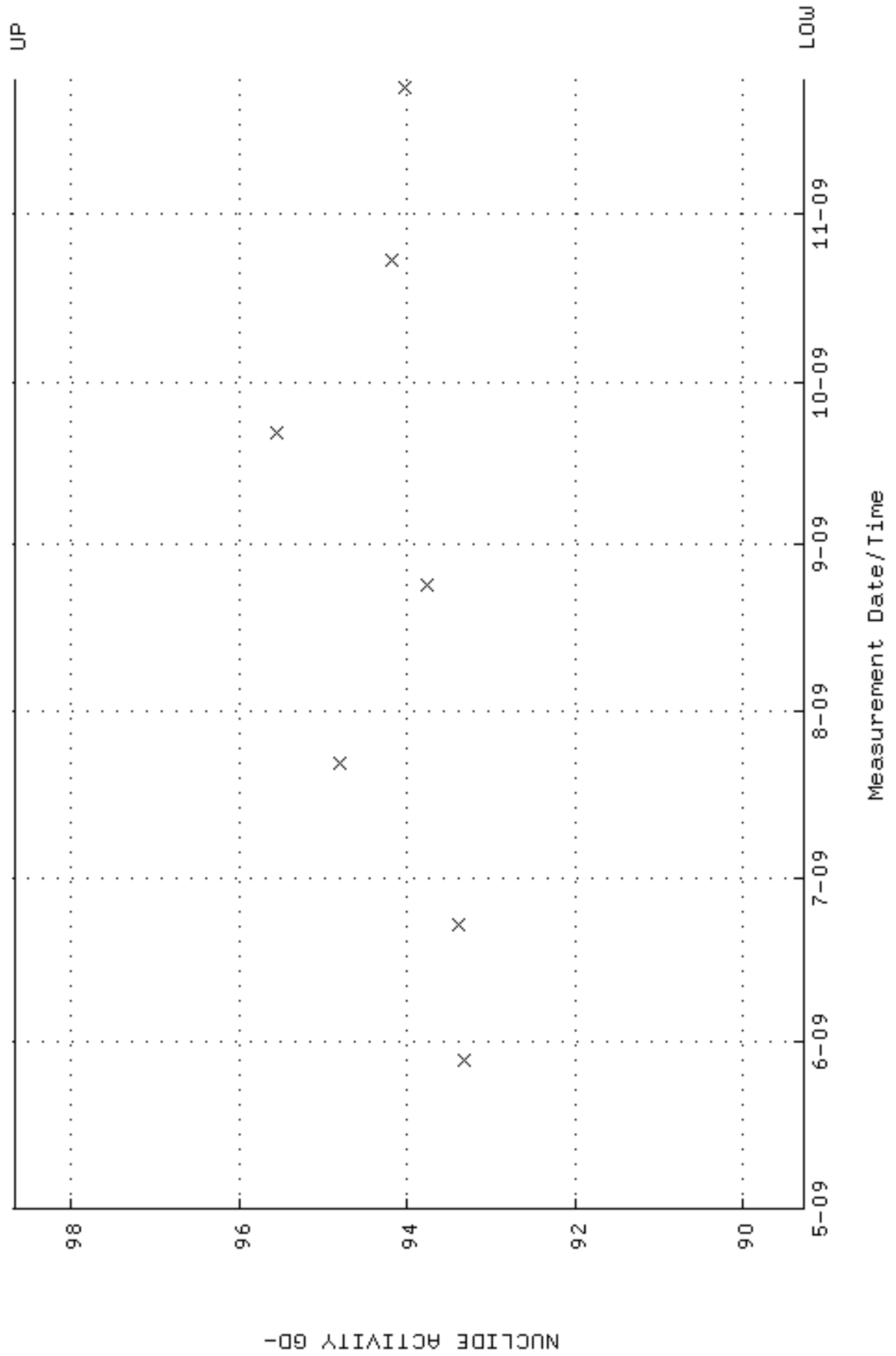
QA filename : DKA100:[ENV_ALPHA.QA.B]B180.QAF;1
 Parameter Name : BACKRATE (Background Rate)
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 Lower/Upper Lmts: 0.000000E+00 through 0.100000



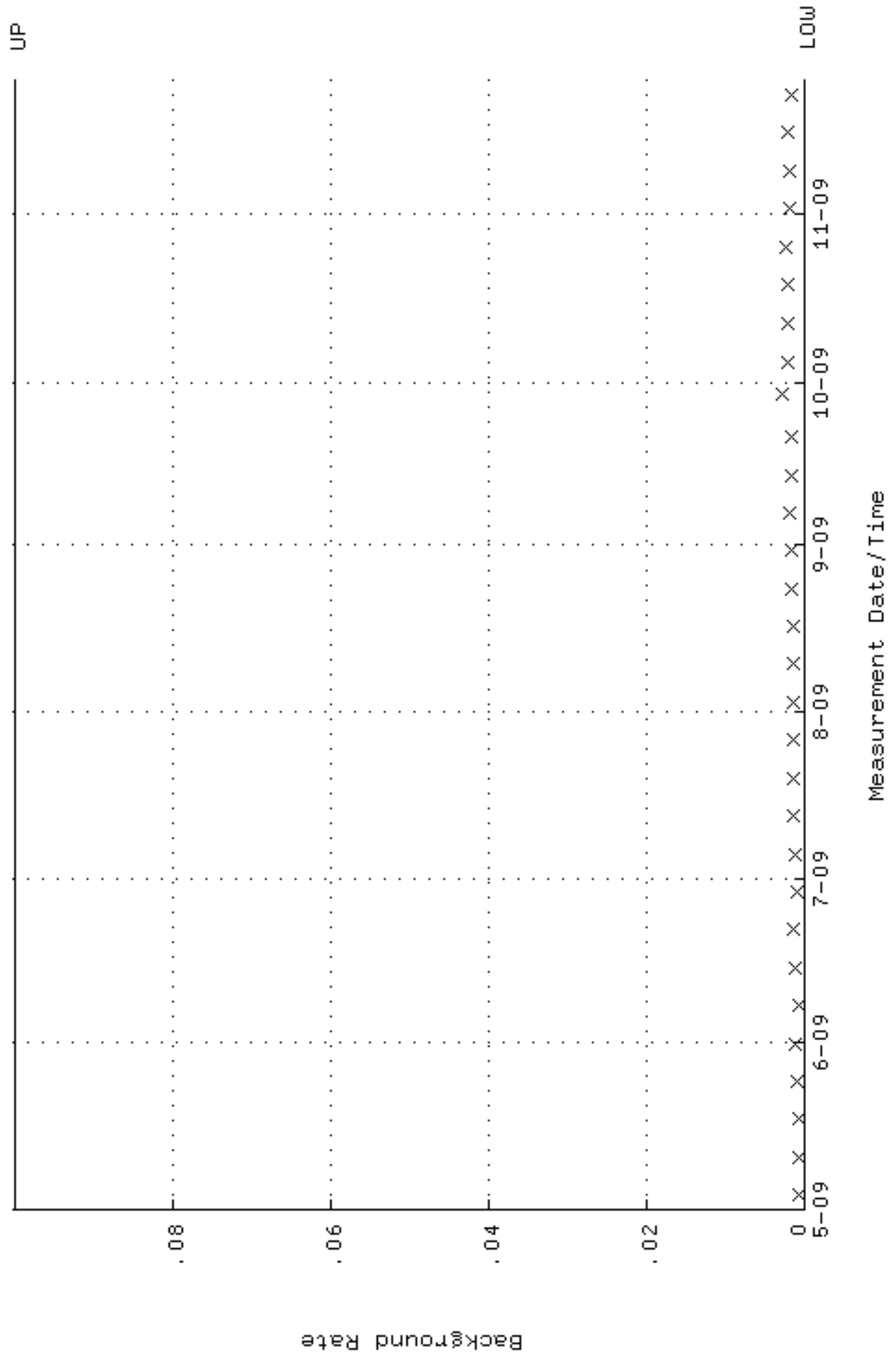
QA filename : DKA100:[ENV_ALPHA.QA.W]W181.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 28-MAY-2009 14:00:49 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.247722 through 0.267722



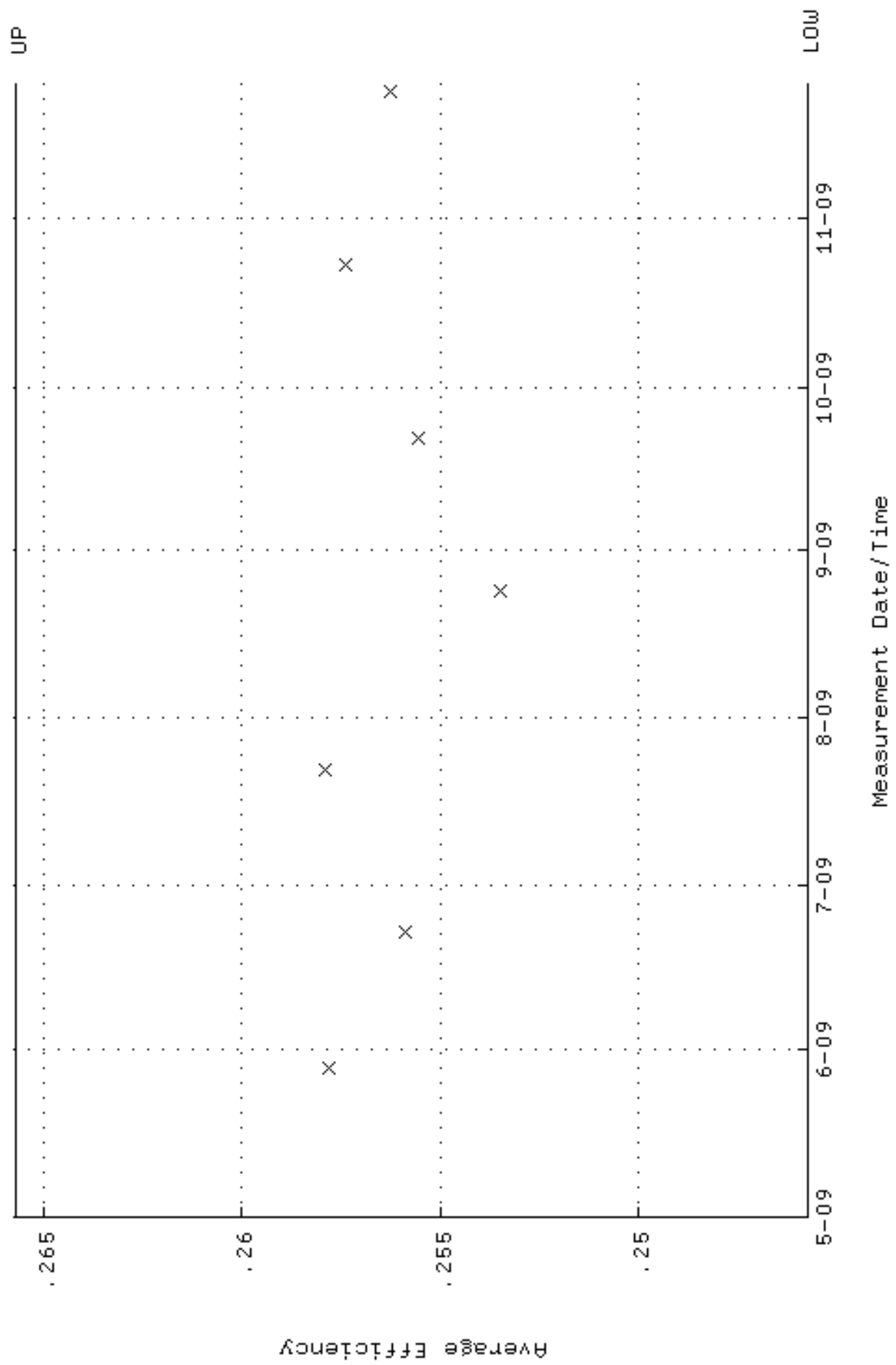
QA filename : DKA100:[ENV_ALPHA.QA.W]w181.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 28-MAY-2009 14:00:49 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 89.2737 through 98.6709



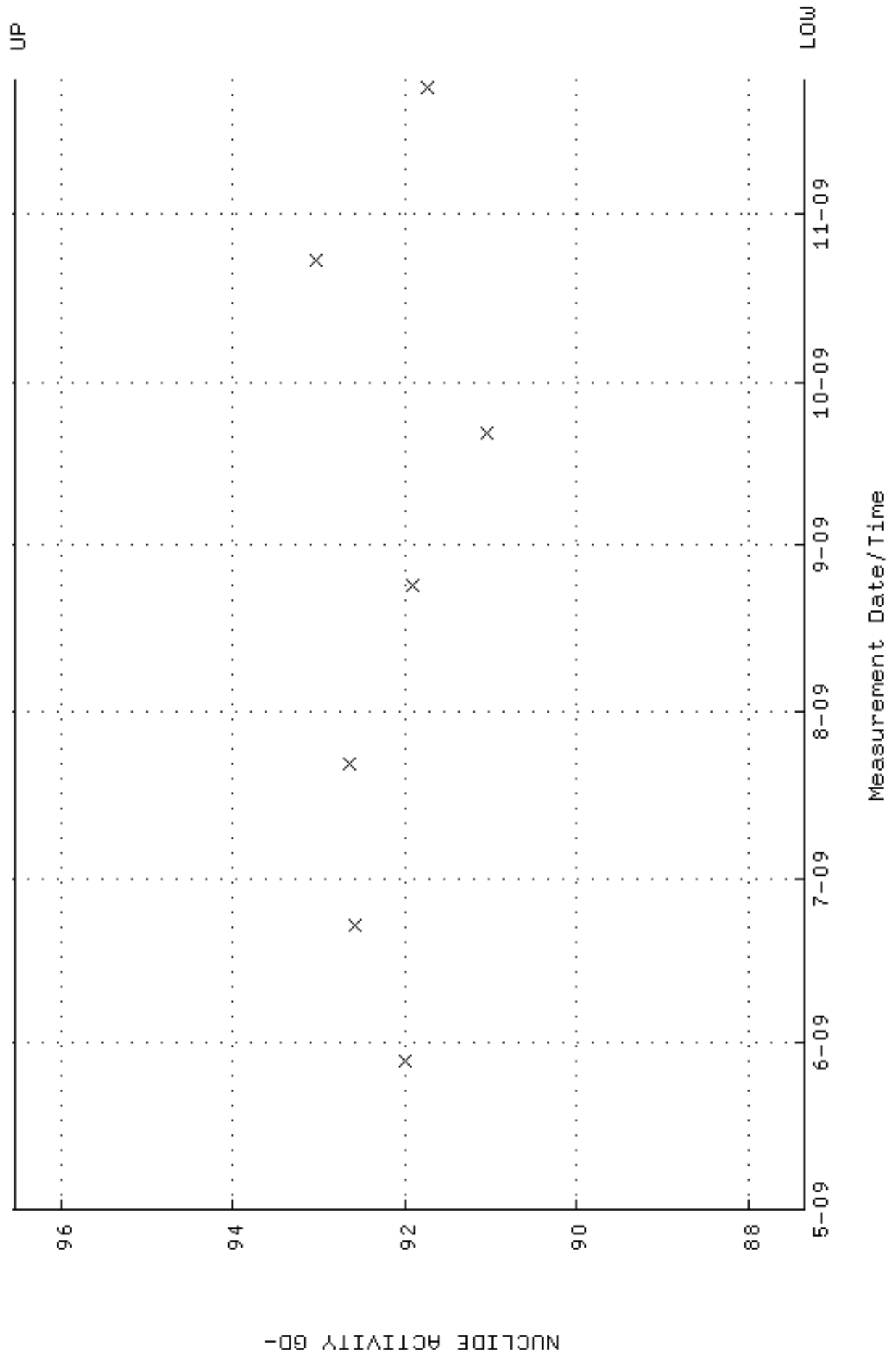
QA filename : DKA100:[ENV_ALPHA.QA.B]B181.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:54:31 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



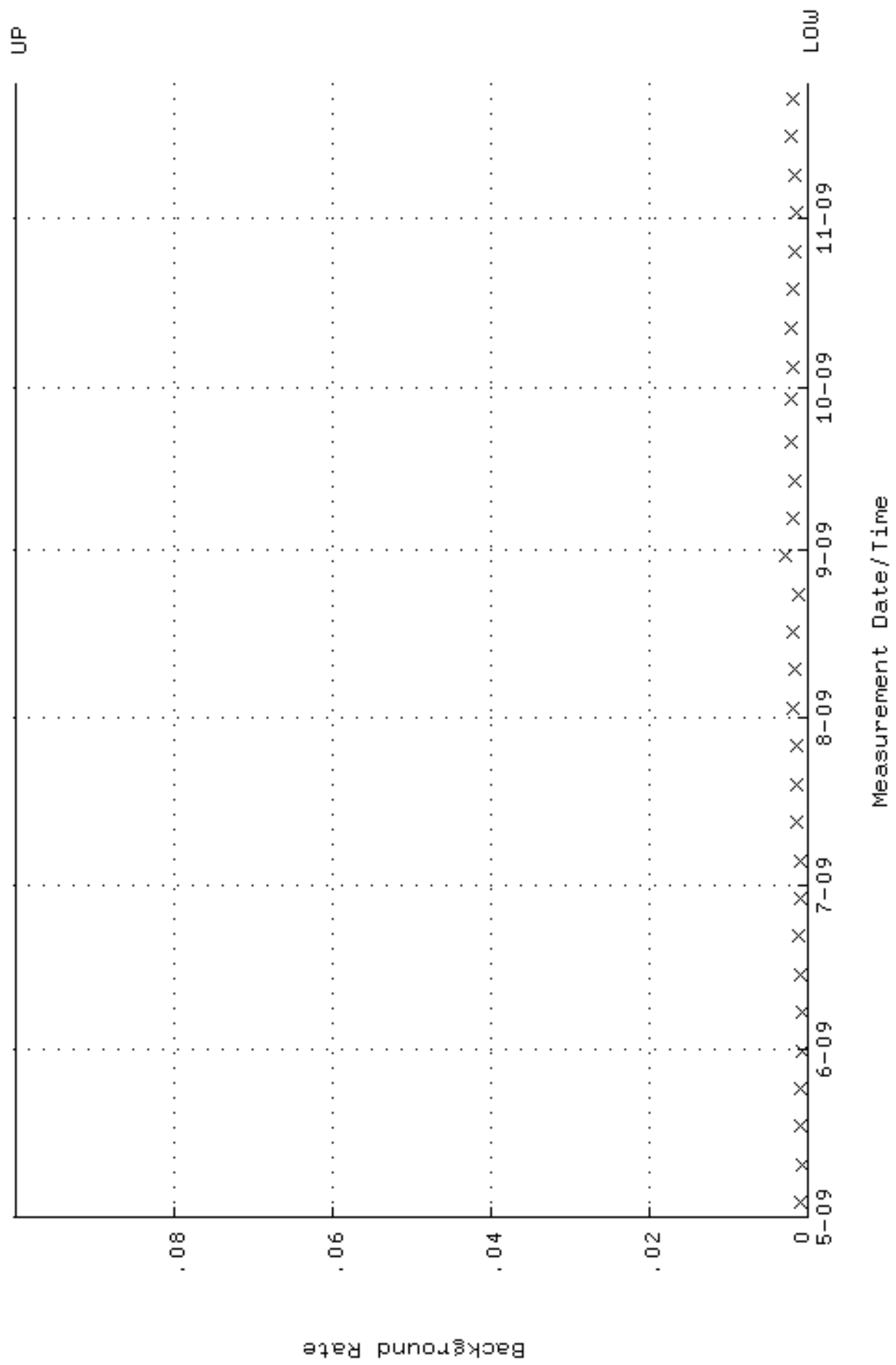
QA filename : DKA100:[ENV_ALPHA.QA.W]W182.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 28-MAY-2009 14:00:53 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.245707 through 0.265707



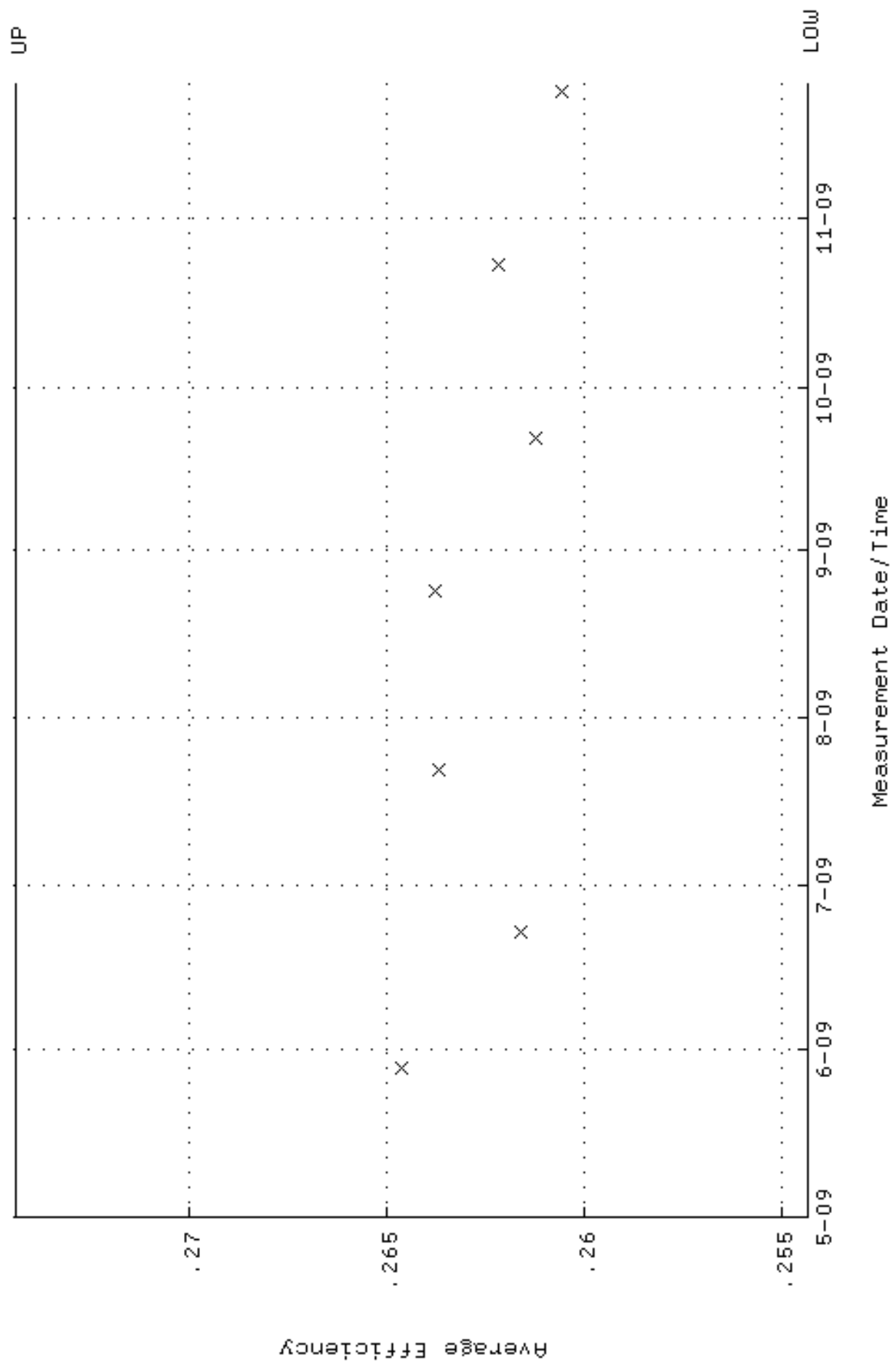
QA filename : DKA100:[ENV_ALPHA.QA.W]w182.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 28-MAY-2009 14:00:53 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 87.3454 through 96.5396



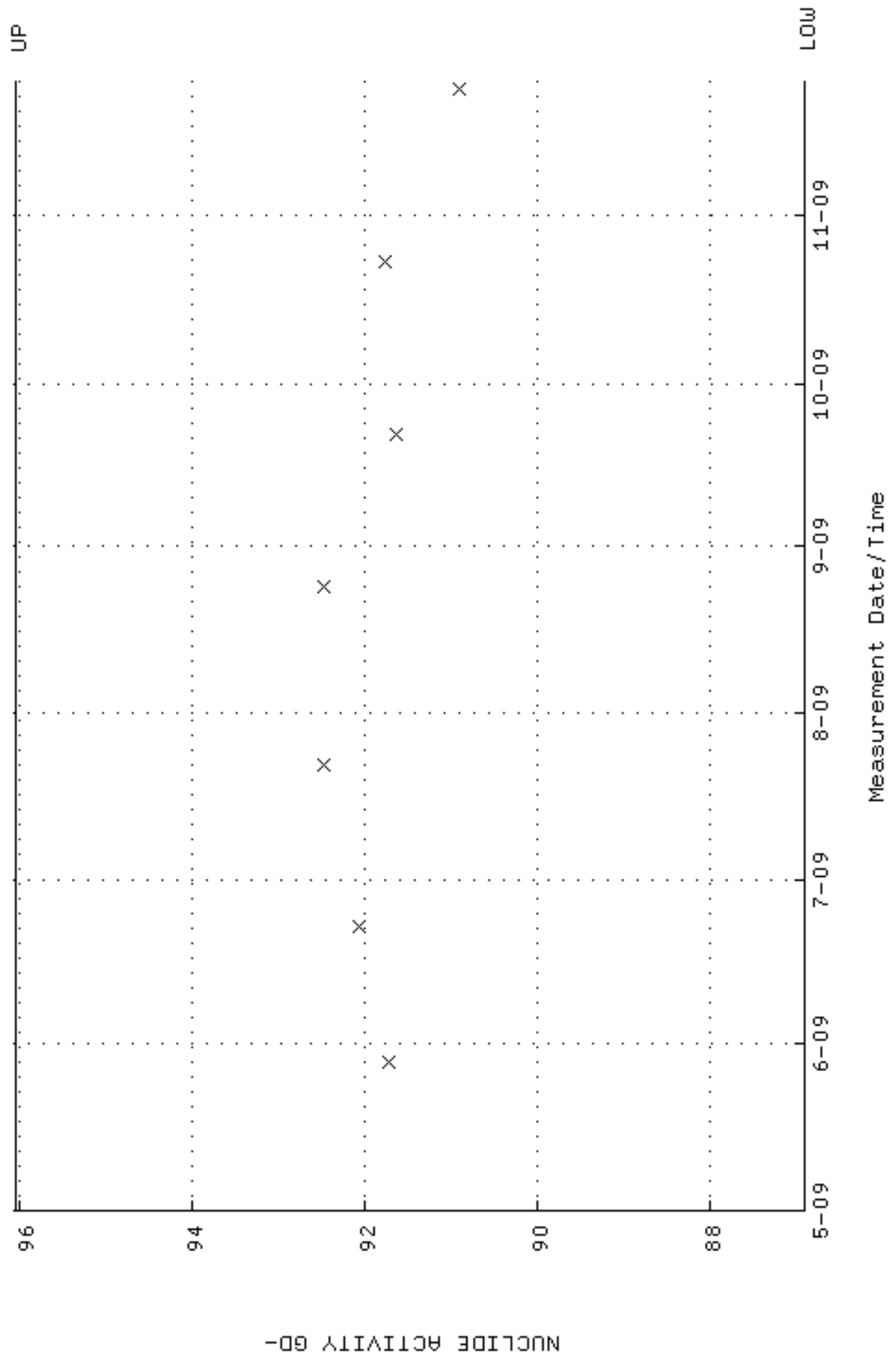
QA filename : DKA100:[ENV_ALPHA.QA.B]B182.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:54:35 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



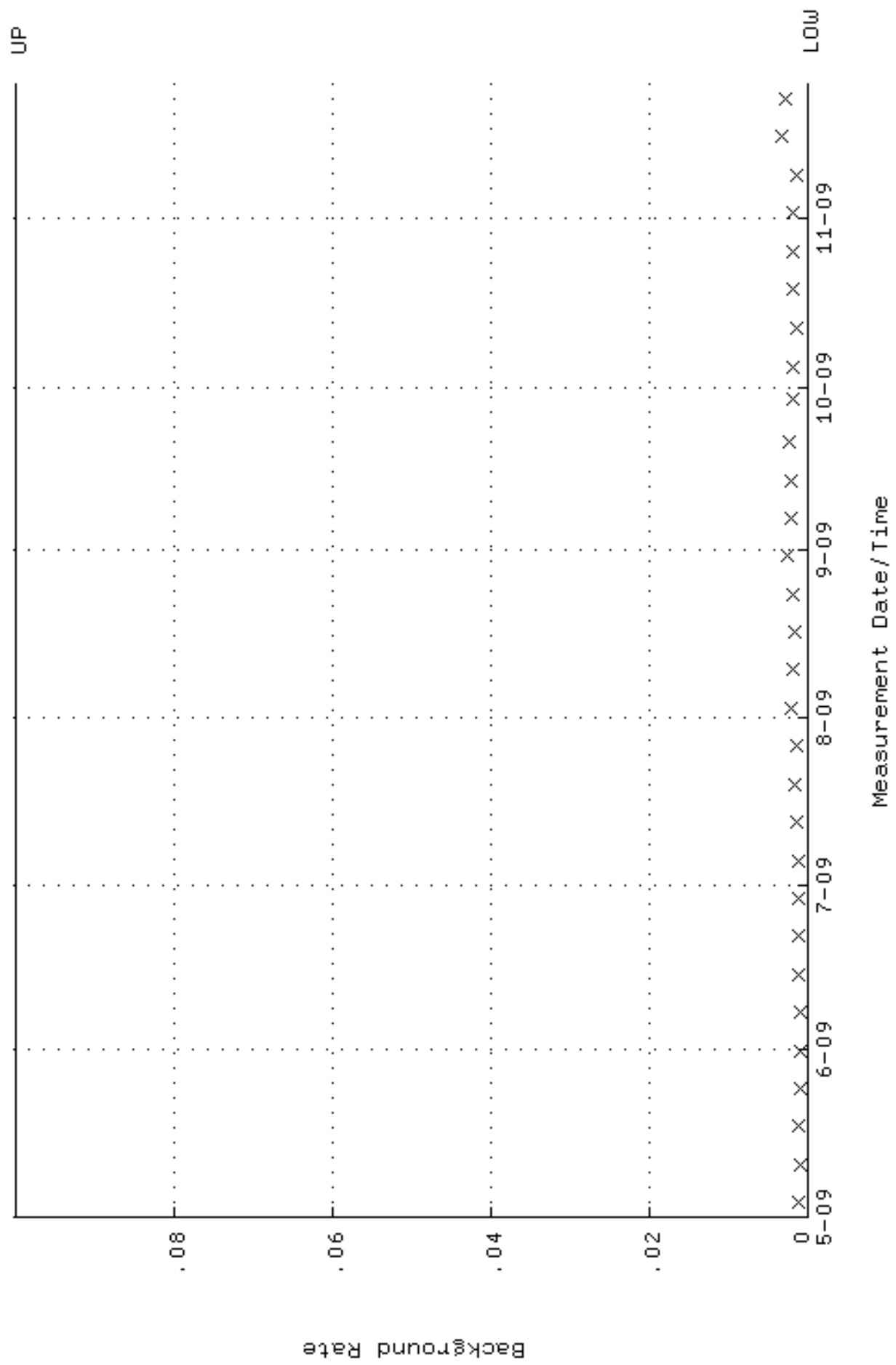
QA filename : DKA100:[ENV_ALPHA.QA.W]W183.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 28-MAY-2009 14:00:57 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.254364 through 0.274364



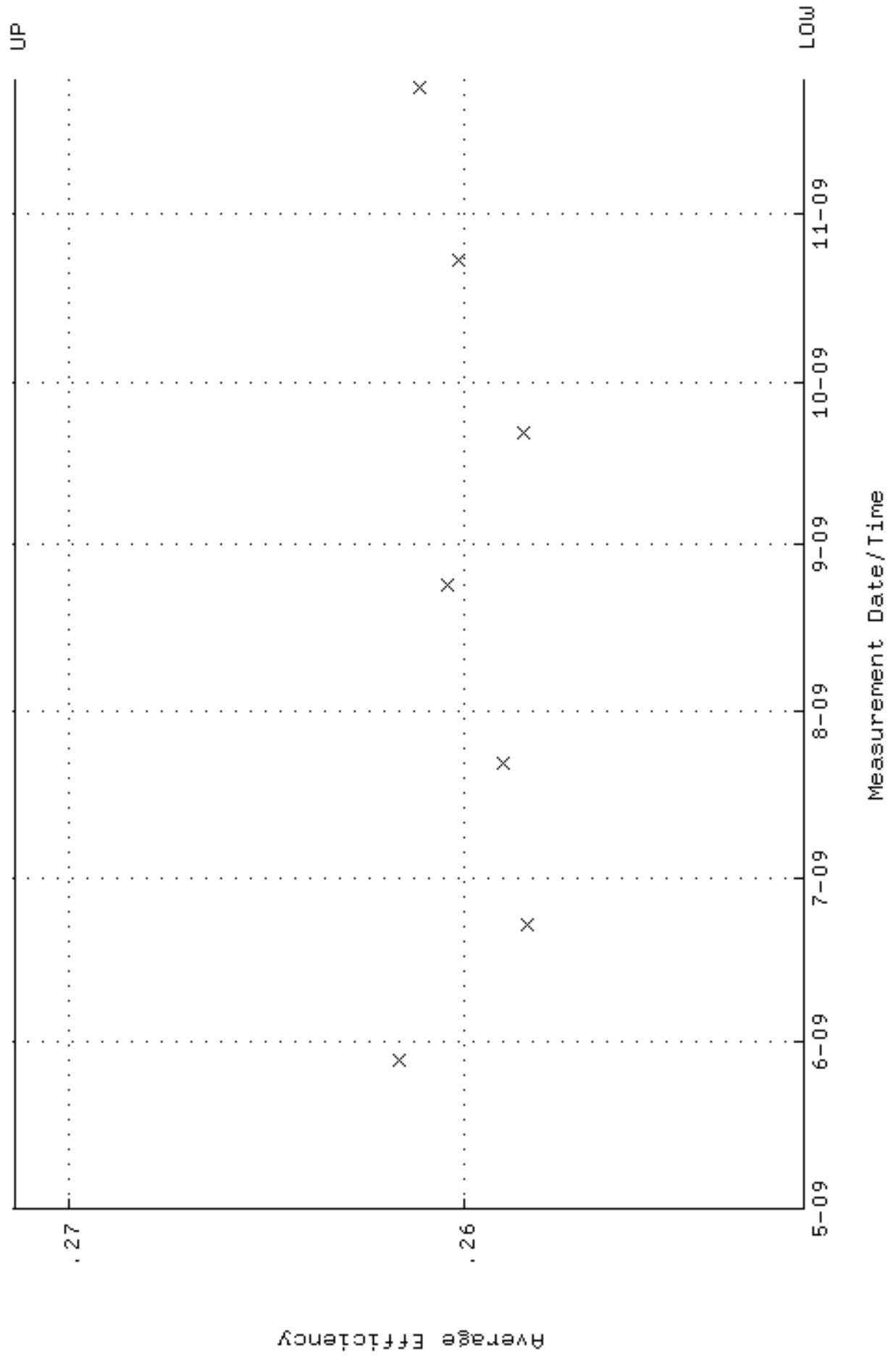
QA filename : DKA100:[ENV_ALPHA.QA.W]W183.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 28-MAY-2009 14:00:57 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 86.8927 through 96.0393



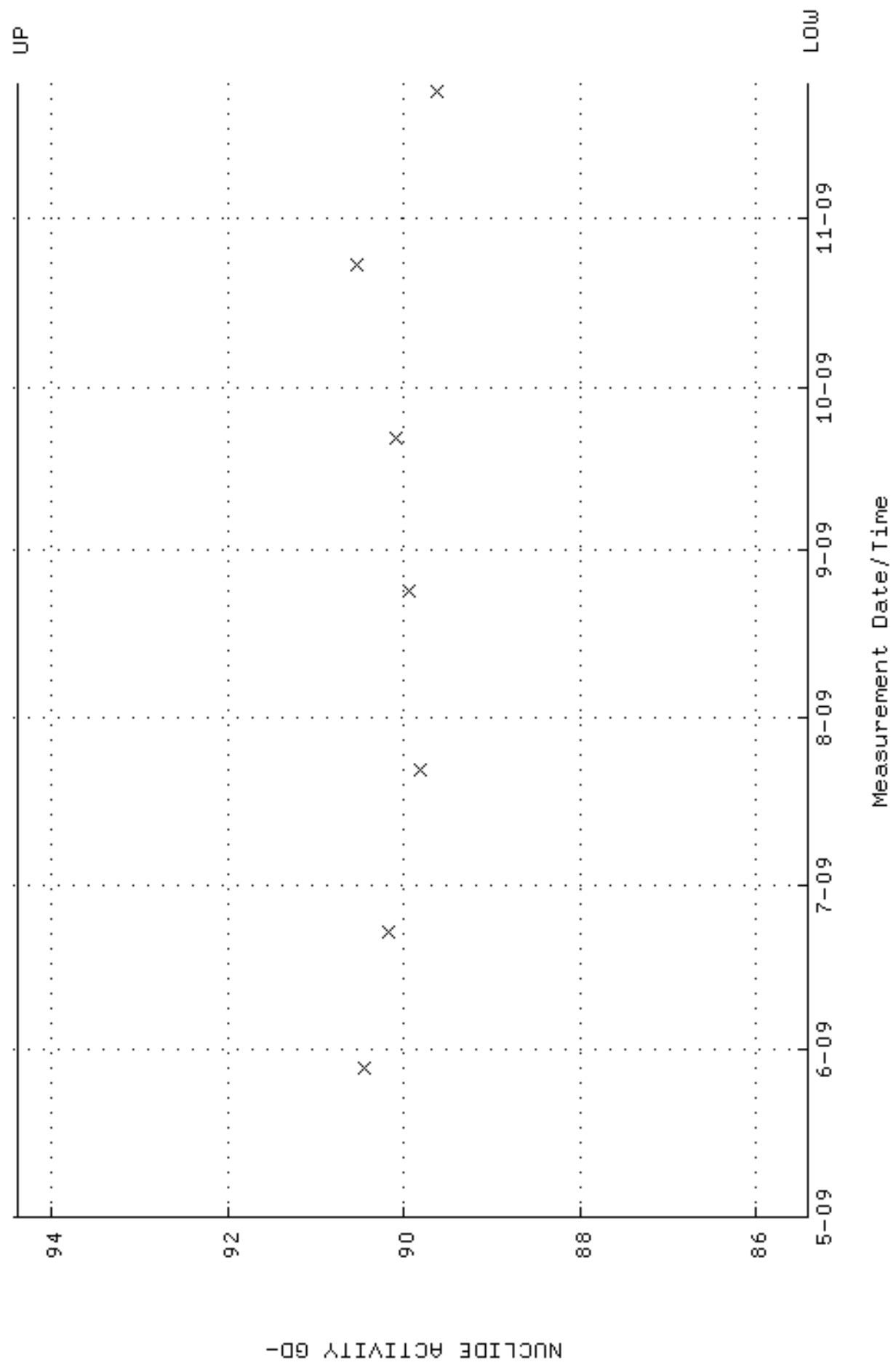
QA filename : DKA100:[ENV_ALPHA.QA.B]B183.QAF;1
 Parameter Name : BACKRATE (Background Rate)
 Start/End Dates : 3-MAY-2009 13:54:39 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



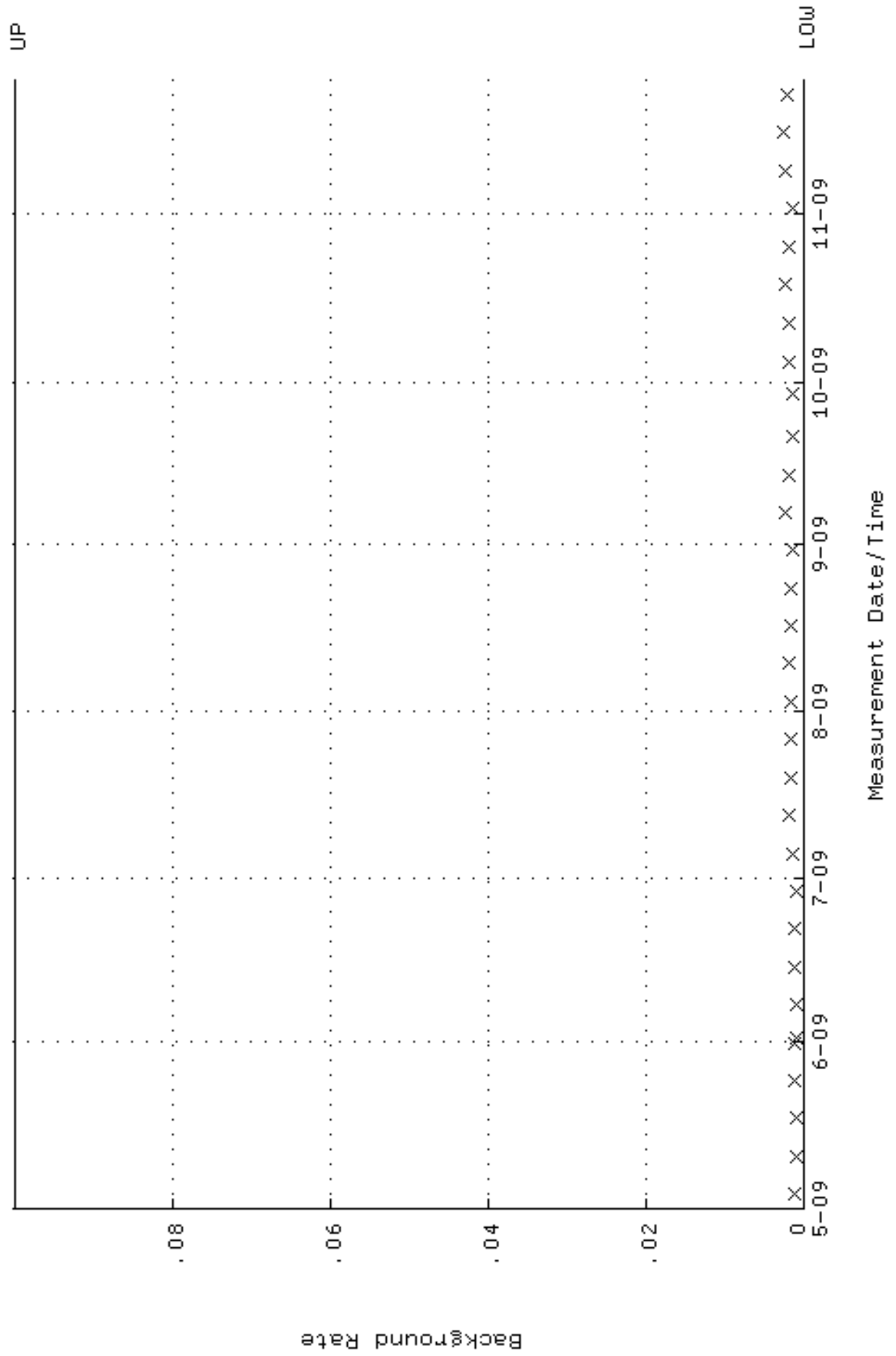
QA filename : DKA100:[ENV_ALPHA.QA.W]W184.QAF;1
 Parameter Name : AVRGEFF (Average Efficiency)
 Start/End Dates : 28-MAY-2009 14:01:01 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.251367 through 0.271367



QA filename : DKA100:[ENV_ALPHA.QA.W]w184.QAF;1
 Parameter Name : NLAIVITY-GD148 (NUCLIDE ACTIVITY GD-148)
 Start/End Dates : 28-MAY-2009 14:01:01 through 25-NOV-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 : 3-MAY-2009 13:54:43 through 25-NOV-2009 12:00:00
 Lower/Upper Lmts: 0.000000E+00 through 0.100000



RUNLOGS

Instrument Run Log

Instrument Type: GFPC

Batch ID:922916

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
240965001	SAMPLE	MXS2	PIC7A	20-NOV-09 19:01	DONE	CeF on 25mm Filter	02-JUL-09 00:00
240965002	SAMPLE	MXS2	PIC7B	20-NOV-09 19:01	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201972623	MB	MXS2	PIC9C	20-NOV-09 19:01	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201972624	DUP	MXS2	PIC7D	20-NOV-09 19:01	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201972626	LCS	MXS2	PIC8C	20-NOV-09 19:01	DONE	CeF on 25mm Filter	02-JUL-09 00:00
1201972625	MS	MXS2	PIC11B	20-NOV-09 21:43	DONE	CeF on 25mm Filter	02-JUL-09 00:00

Instrument Run Log

Instrument Type: LUCAS CELL DETECTOR

Batch ID: 923071

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
240965001	SAMPLE	KSD1	LUCAS1	24-NOV-09 17:45	DONE	Lucas Cell	31-AUG-09 00:00
240965002	SAMPLE	KSD1	LUCAS2	24-NOV-09 17:45	DONE	Lucas Cell	19-DEC-08 00:00
1201973135	MB	KSD1	LUCAS3	24-NOV-09 17:45	DONE	Lucas Cell	04-FEB-09 00:00
1201973136	DUP	KSD1	LUCAS4	24-NOV-09 17:45	DONE	Lucas Cell	02-MAR-09 00:00
1201973138	LCS	KSD1	LUCAS6	24-NOV-09 17:45	DONE	Lucas Cell	04-AUG-09 00:00
1201973137	MS	KSD1	LUCAS5	24-NOV-09 18:30	DONE	Lucas Cell	25-MAR-09 00:00

Instrument Run Log

Instrument Type: ALPHA SPECTROMETER

Batch ID: 925745

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
240965001	SAMPLE	KXM4	1179	25-NOV-09 13:04	DONE		
1201979236	MB	KXM4	1180	25-NOV-09 13:04	DONE		
240965002	SAMPLE	KXM4	1181	25-NOV-09 13:04	DONE		
1201979237	DUP	KXM4	1182	25-NOV-09 13:04	DONE		
1201979238	MS	KXM4	1183	25-NOV-09 13:05	DONE		
1201979239	LCS	KXM4	1184	25-NOV-09 13:05	DONE		

Instrument Run Log

Instrument Type: ALPHA SPECTROMETER

Batch ID: 925746

Sample ID	Sample Type	Analyst	Instrument	Run Date	Status	Geometry	Calibration Date
240965001	SAMPLE	KXM4	1147	25-NOV-09 16:03	DONE		
240965002	SAMPLE	KXM4	1148	25-NOV-09 16:03	DONE		
1201979240	MB	KXM4	1149	25-NOV-09 16:03	DONE		
1201979241	DUP	KXM4	1150	25-NOV-09 16:03	DONE		
1201979242	MS	KXM4	1151	25-NOV-09 16:03	DONE		
1201979243	LCS	KXM4	1152	25-NOV-09 16:03	DONE		