CALORIMETRY EXCHANGE PROGRAM
ANNUAL DATA REPORT FOR
1988

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EG&G MOUND APPLIED TECHNOLOGIES

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MASTER

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The Calorimetry Exchange Program

The goals of the Calorimetry Sample Exchange Program are:

1. Discuss measurement differences
2. Review and improve analytical measurements and methods
3. Discuss new measurement capabilities
4. Provide data to DoE on measurement capabilities to evaluate shipper-receiver differences
5. Provide characterized or standard materials as necessary for exchange participants
6. Provide a measurement control program for plutonium analysis

A sample of PuO₂ powder is available at each participating site for NDA measurement, including either or both calorimetry and high-resolution gamma-ray spectroscopy, the elements which are typically combined to provide a calorimetric assay of plutonium. The facilities measure the sample as frequently and to the level of precision which they desire, and then submit the data to the Exchange for analysis. Statistical tests are used to evaluate the data and to determine if there are significant differences from accepted values for the exchange sample or from data previously reported by that facility. This information is presented, in the form of a quarterly report, intended for use by Exchange participants in measurement control programs, or to indicate when bias corrections may be appropriate. No attempt, however, has been made to standardize methods or frequency of data collection, calibration, or operating procedures. Direct comparisons between laboratories may, therefore, be misleading since data have not been collected to the same precision or for the same time periods.

A meeting of the participants of the Calorimetry Exchange is held annually at EG&G-Mound. The purposes of this meeting are to discuss measurement differences, problems, and new measurement capabilities, and to determine the additional activities needed to fulfill the goals of the Exchange.

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SUMMARY

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Data included in this report is a compilation of all exchange data received in 1988. Since a large number of data points were recorded, a change was made to the analysis methods to account for uncertainty in the accepted values. This is not done for the quarterly reports since uncertainty in the accepted values is generally much smaller than uncertainty in reported measurements. It is necessary, however, when working with the large data base used for this report. In addition, data listings are not included since they have already been provided in the quarterly reports for 1988.

LAWRENCE LIVERMORE

=====

No significant difference from the accepted values for the power measurement and P-effective were noted. A significant difference for 238 Pu (2.13%) was noted.

LOS ALAMOS

=====

Significant differences from the accepted values for power (0.11%), P-effective (0.16%), and 238 Pu (4.21%) were noted.

EG&G-MOUND

=====

No significant difference from the accepted value for the power measurement was noted. Significant differences from accepted values were noted for P-effective (0.25%), 238 Pu (12.60%), and 240 Pu (-0.49%).

WESTINGHOUSE HANFORD

=====

No significant differences from the accepted values for the power measurement was noted. Significant differences from accepted values were noted for P-effective (0.20%), 238 Pu (7.48%), 240 Pu (2.77%), and 241 Am (-4.40%).

ROCKY FLATS

=====

Chemical Standards Lab: No significant differences from the accepted values were noted. There was no power data submitted for the year.

Analytical Labs: No significant difference from the accepted value for P-effective was noted. A significant difference was observed for power (0.14%).

SAVANNAH RIVER

=====

No significant differences from the accepted values were noted for the power measurement and P-effective. Significant differences from the accepted values for 238 Pu (3.98%), 240 Pu (1.12%), and 241 Am (-2.54%) were noted.

SUMMARY TABLE

% DIFFERENCE FROM ACCEPTED VALUES FOR THE CALORIMETRY EXCHANGE SAMPLE

MEAS.	LIVERMORE	LOS ALAMOS	MOUND	HANFORD	ROCKY FLATS CSL	FLATS AL	SAVANNAH RIVER
=====	=====	=====	=====	=====	=====	=====	=====
POWER	0.12	0.11*	-0.02	-0.01	**	0.14*	-0.12
P-EFF	0.01	0.16*	0.25*	0.20*	0.12	-0.01	0.06
238/239 Pu	2.13*	4.21*	12.60*	7.48*	2.93	1.66	3.98*
240/239 Pu	-0.06	0.30	-0.49*	2.77*	0.64	-0.31	1.12*
241/239 Pu	-0.02	-0.62	0.35	0.31	0.01	-0.14	0.34
Am/239 Pu	-0.70	0.22	0.08	-4.40*	0.35	-0.16	-2.54*

* Difference is significant at the 95% confidence level.

** No data was reported for this measurement.

REPORTING LABORATORY

	CSL =====	LLL =====	LANL =====	EG&G =====	WHO =====	RFP =====	SRP =====
LAB MEAN (W)	.000000	.97711	.97698	.97566	.97581	.97724	.97476
STD DEV (W)	.000000	.00290	.00206	.00134	.00252	.00170	.00487
NO. OF RUNS	0	21	38	31	166	37	71

DIFFERENCE BETWEEN MEANS

=====

MEAN - ACCEPTED VALUE

(W)	0.00000	.0012	.0011	-.0002	-.0001	.0013	-.0011
(%)	0.00	.12	.11	-.02	-.01	.14	-.12

Z-TEST (DIFFERENCE BETWEEN MEANS) **

=====

With Acc. Val:	0.00	1.83	2.79*	-.79	-.31	3.92*	-1.88
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F-TEST (DIFFERENCE BETWEEN VARIANCES) ***

=====

VS. REPORTED:	---	.35	---	.12	1.04	.28	---
---------------	-----	-----	-----	-----	------	-----	-----

* Value is significant at the 95% confidence level

** The Z-test tests the hypothesis that the mean value is equal to the accepted value, taking into account the uncertainty in both the mean and the accepted values.

*** The F-test tests the hypothesis that the calculated uncertainty is equal to the reported uncertainty.

QUARTERLY MEANS FOR POWER DATA *

* DATA DECAYED TO 1/1/1989

RESULTS OF ANALYSIS OF P-EFF DATA

REPORTING LABORATORY

	CSL =====	LLL =====	LANL =====	EG&G =====	WHO =====	RFP =====	SRP =====
LAB MEAN (mW/G)	2.4528	2.4502	2.4538	2.4560	2.4548	2.4498	2.4515
STD DEV (mW/G)	.0142	.0026	.0088	.0051	.0150	.0139	.0109
NO. OF RUNS	24	38	40	31	64	98	69

DIFFERENCE BETWEEN MEANS

=====

MEAN - ACCEPTED VALUE

(mW/G)	.0028	.0002	.0038	.0060	.0048	-.0002	.0015
(%)	.12	.01	.16	.25	.20	-.01	.06

Z-TEST (DIFFERENCE BETWEEN MEANS) **

=====

With Acc. Val:	.97	.35	2.62*	5.74*	2.47*	-.15	1.07
----------------	-----	-----	-------	-------	-------	------	------

F-TEST (DIFFERENCE BETWEEN VARIANCES) ***

=====

VS. REPORTED:	1.15	1.52	.32	1.35	.94	.93	.66
---------------	------	------	-----	------	-----	-----	-----

* Value is significant at the 95% confidence level

** The Z-test tests the hypothesis that the mean value is equal to the accepted value, taking into account the uncertainty in both the mean and the accepted values.

*** The F-test tests the hypothesis that the calculated uncertainty is equal to the reported uncertainty.

QUARTERLY MEANS FOR P-EFF *

* DATA DECAYED TO 1/1/1989

RESULTS OF ANALYSIS OF 238/239 Pu DATA

REPORTING LABORATORY

	CSL =====	LLL =====	LANL =====	EG&G =====	WHO =====	RFP =====	SRP =====
LAB MEAN (ppm)	104	103	105	114	109	103	105
STD DEV (ppm)	22	3	11	9	13	22	10
NO. OF RUNS	24	38	40	31	64	98	69

DIFFERENCE BETWEEN MEANS

=====

MEAN - ACCEPTED VALUE

(ppm)	3	2	4	13	8	2	4
(%)	2.93	2.13	4.21	12.60	7.48	1.66	3.98

Z-TEST (DIFFERENCE BETWEEN MEANS) **

=====

With Acc. Val:	.68	2.67*	2.36*	7.29*	4.31*	.72	2.92*
----------------	-----	-------	-------	-------	-------	-----	-------

F-TEST (DIFFERENCE BETWEEN VARIANCES) ***

=====

VS. REPORTED:	1.30	1.52	.81	2.41*	1.02	1.00	.99
---------------	------	------	-----	-------	------	------	-----

* Value is significant at the 95% confidence level

** The Z-test tests the hypothesis that the mean value is equal to the accepted value, taking into account the uncertainty in both the mean and the accepted values.

*** The F-test tests the hypothesis that the calculated uncertainty is equal to the reported uncertainty.

QUARTERLY MEANS FOR 238/239 Pu *

LAB

* DATA DECAYED TO 1/1/1989

RESULTS OF ANALYSIS OF 240/239 Pu DATA

	REPORTING LABORATORY						
	CSL =====	LLL =====	LANL =====	EG&G =====	WHO =====	RFP =====	SRP =====
LAB MEAN (ppm)	62566	62132	62354	61866	63890	61972	62867
STD DEV (ppm)	2459	230	2177	565	2782	1750	1909
NO. OF RUNS	24	38	40	31	64	98	69

DIFFERENCE BETWEEN MEANS

=====

MEAN - ACCEPTED VALUE

(ppm)	398	-36	186	-302	1722	-196	699
(%)	.64	-.06	.30	-.49	2.77	-.31	1.12

Z-TEST (DIFFERENCE BETWEEN MEANS) **

=====

With Acc. Val:	.81	-.69	.54	-2.80*	4.96*	-1.08	3.00*
----------------	-----	------	-----	--------	-------	-------	-------

F-TEST (DIFFERENCE BETWEEN VARIANCES) ***

=====

VS. REPORTED:	1.02	.73	.52	.86	.95	.73	.54
---------------	------	-----	-----	-----	-----	-----	-----

* Value is significant at the 95% confidence level

** The Z-test tests the hypothesis that the mean value is equal to the accepted value, taking into account the uncertainty in both the mean and the accepted values.

*** The F-test tests the hypothesis that the calculated uncertainty is equal to the reported uncertainty.

QUARTERLY MEANS FOR $^{240/239} \text{Pu}$ *

LAB

* DATA DECAYED TO 1/1/1989

RESULTS OF ANALYSIS OF 241/239 Pu DATA

REPORTING LABORATORY

	CSL =====	LLL =====	LANL =====	EG&G =====	WHO =====	RFP =====	SRP =====
LAB MEAN (ppm)	2470	2470	2455	2479	2478	2466	2478
STD DEV (ppm)	20	7	41	6	14	25	18
NO. OF RUNS	24	38	40	31	64	98	69

DIFFERENCE BETWEEN MEANS

=====

MEAN - ACCEPTED VALUE

(ppm)	0	-0	-15	9	8	-4	8
(%)	.01	-.02	-.62	.35	.31	-.14	.34

Z-TEST (DIFFERENCE BETWEEN MEANS) **

=====

With Acc. Val:	.01	-.04	-1.19	.77	.68	-.31	.74
----------------	-----	------	-------	-----	-----	------	-----

F-TEST (DIFFERENCE BETWEEN VARIANCES) ***

=====

VS. REPORTED:	.59	.86	18.84*	.75	.85	.73	4.18*
---------------	-----	-----	--------	-----	-----	-----	-------

* Value is significant at the 95% confidence level

** The Z-test tests the hypothesis that the mean value is equal to the accepted value, taking into account the uncertainty in both the mean and the accepted values.

*** The F-test tests the hypothesis that the calculated uncertainty is equal to the reported uncertainty.

QUARTERLY MEANS FOR 241/239 Pu *

* DATA DECAYED TO 1/1/1989

RESULTS OF ANALYSIS OF Am/239 Pu DATA

	REPORTING LABORATORY						
	CSL	LLL	LANL	EG&G	WHO	RFP	SRP
	=====	=====	=====	=====	=====	=====	=====
LAB MEAN (ppm)	1515	1499	1513	1511	1443	1507	1471
STD DEV (ppm)	22	7	46	5	36	21	47
NO. OF RUNS	24	38	40	31	64	98	69

DIFFERENCE BETWEEN MEANS =====

MEAN - ACCEPTED VALUE							
(ppm)	5	-11	3	1	-66	-2	-38
(%)	.35	-.70	.22	.08	-4.40	-.16	-2.54

Z-TEST (DIFFERENCE BETWEEN MEANS) ** =====

With Acc. Val:	.46	-1.00	.26	.11	-5.79*	-.23	-3.20*
----------------	-----	-------	-----	-----	--------	------	--------

F-TEST (DIFFERENCE BETWEEN VARIANCES) *** =====

VS. REPORTED:	.08	.55	.88	.38	.94	.86	1.37
---------------	-----	-----	-----	-----	-----	-----	------

* Value is significant at the 95% confidence level

** The Z-test tests the hypothesis that the mean value is equal to the accepted value, taking into account the uncertainty in both the mean and the accepted values.

*** The F-test tests the hypothesis that the calculated uncertainty is equal to the reported uncertainty.

QUARTERLY MEANS FOR Am/239 Pu *

* DATA DECAYED TO 1/1/1989

CALORIMETRY EXCHANGE SAMPLE ON 1/1/1989

=====

ISOTOPE =====	PPM ISOTOPE / 239 Pu =====	% ISOTOPE / Pu =====	% UNCERTAINTY * =====
238 Pu	101.0	0.00944	0.6
239 Pu	1,000,000.	93.8676	0.003
240 Pu	62,168.	5.8600	0.06
241 Pu	2,470.3	0.2338	0.57
242 Pu	306.4	0.0291	5.0
241 Am	1,509.7	0.1429	0.4

Power = 0.9759 Watts +/- 0.02 %

P-effective = 2.450 mW/G +/- 0.02 %

- * Uncertainties shown for Pu isotopes are one standard deviation, as found using the data reported by four labs which made the reference measurement on the sample in 1982.

CONSTANTS

=====

ISOTOPE =====	DECAY FACTOR =====	POWER =====
238 Pu	2.163 E-5	0.56757
239 Pu	7.868 E-8	1.9288 E-3
240 Pu	2.892 E-7	7.0824 E-3
241 Pu	1.323 E-4	0.3412 E-2
242 Pu	5.043 E-9	0.1159 E-3
241 Am	4.377 E-6	0.11420

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