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CALORIMETRY EXCHANGE PROGRAM

ANNUAL DATA REPORT

FOR 1991

EG&G MOUND APPLIED TECHNOLOGIES

P.O. BOX 3000

MIAMISBURG, OHIO 45343-3000

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CALORIMETRY EXCHANGE PROGRAM

ANNUAL DATA REPORT

FOR 1991

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The Calorimetry Sample 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 Applied Technologies. 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.

NOTE: The next Calorimetry Exchange Program Annual Meeting is scheduled for April 28 - 29, 1993 at EG&G Mound Applied Technologies.

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SUMMARY TABLE

% DIFFERENCE FROM ACCEPTED VALUES FOR THE CALORIMETRY EXCHANGE SAMPLE

	LIVERMORE	LOS ALAMOS	MOUND	HANFORD	ROCKY FLATS		SAVANNAH RIVER
					CSL	AL	
POWER	0.19	0.06	-0.09	-0.10	**	0.12	**
P-EFF	-0.20	-0.05	0.08	0.09	**	0.03	**
238/239 Pu	0.73	5.57	5.83	2.15	**	4.46	**
240/239 Pu	-0.27	-0.24	-0.35	1.11	**	0.03	**
241/239 Pu	-0.55	0.18	-0.21	-0.25	**	0.34	**
Am/239 Pu	-1.65	-0.95	-0.09	-0.99	**	-0.30	**
% 238 Pu	0.74	5.56	5.85	2.09	**	4.47	**
% 239 Pu	0.42	0.40	0.03	-0.06	**	0.01	**
% 240 Pu	-0.25	-0.26	-0.32	1.05	**	-0.81	**
% 241 Pu	-0.54	0.17	-0.19	-0.31	**	-0.90	**
% 241 Am	-1.64	-0.96	-0.06	-1.05	**	-1.54	**

**** No data was reported for this measurement.**

RESULTS OF ANALYSIS OF POWER DATA

REPORTING LABORATORY

	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (mW)	***	1.868	0.596	-0.841	-1.029	1.194	***
Std. Dev. (mW)	***	13.395	2.144	1.734	2.252	1.624	***
Unc. in Mean (mW)	***	0.902	0.284	0.233	0.250	0.777	***
Mean Error (%)	***	0.19%	0.06%	-0.09%	-0.10%	0.12%	***
Std. Dev. (%)	***	1.36%	0.22%	0.18%	0.23%	0.16%	***
Unc. in Mean (%)	***	0.09%	0.03%	0.02%	0.03%	0.08%	***
Number of Data Points	0	29	48	35	80	49	0

LAWRENCE LIVERMORE NATIONAL LABORATORY CALORIMETER DATA 1991

LOS ALAMOS NATIONAL LABORATORY
CALORIMETER DATA 1991

*EG&G MOUND
CALORIMETER DATA 1991*

WESTINGHOUSE HANFORD CALORIMETER DATA 1991

EG&G ROCKY FLATS – ANALYTICAL LAB. CALORIMETER DATA 1991

RESULTS OF ANALYSIS OF P-EFFECTIVE DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (mW/g)	****	-0.0049	-0.0012	0.0020	0.0022	0.0008	****
Std. Dev. (mW/g)	****	0.0023	0.0070	0.0044	0.0038	0.0081	****
Unc. in Mean (mW/g)	****	0.0004	0.0015	0.0006	0.0002	0.0012	****
Mean Error (%)	****	-0.20%	-0.05%	0.08%	0.09%	0.03%	****
Std. Dev. (%)	****	0.09%	0.28%	0.18%	0.15%	0.33%	****
Unc. in Mean (%)	****	0.01%	0.06%	0.02%	0.01%	0.05%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
P-EFFECTIVE DATA 1991

LOS ALAMOS NATIONAL LABORATORY
P-EFFECTIVE DATA 1991

EG&G MOUND P-EFFECTIVE 1991

*WESTINGHOUSE HANFORD
P-EFFECTIVE DATA 1991*

EG&G ROCKY FLAITS - ANALYTICAL LAB.
P-EFFECTIVE DATA 1991

RESULTS OF ANALYSIS OF 238-Pu/239-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (ppm)	****	1	6	6	2	4	****
Std. Dev. (ppm)	****	2.68	9.62	5.57	4.85	15.21	****
Unc. in Mean (ppm)	****	0.45	1.20	0.68	0.33	1.92	****
Mean Error (%)	****	0.73%	5.57%	5.83%	2.15%	4.46%	****
Std. Dev. (%)	****	2.70%	9.73%	5.62%	4.89%	15.39%	****
Unc. in Mean (%)	****	0.45%	1.16%	0.65%	0.33%	1.96%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
238-PU/239-PU 1991

LOS ALAMOS NATIONAL LABORATORY
238-PU/239-PU 1991

EG&G MOUND
238-PU/239-PU 1991

*WESTINGHOUSE HANFORD
238-PU/239-PU 1991*

EG&G ROCKY FLATS - ANALYTICAL LAB.
238-PU/239-PU 1991

RESULTS OF ANALYSIS OF 240-Pu/239-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	
Mean Error (ppm)	****	-166	-152	-215	690	16	****
Std. Dev. (ppm)	****	315.32	1335.53	726.22	432.93	1195.22	****
Unc. in Mean (ppm)	****	40.64	193.24	90.67	28.91	157.77	****
Mean Error (%)	****	-0.27%	-0.24%	-0.35%	1.11%	0.03%	****
Std. Dev. (%)	****	0.51%	2.15%	1.17%	0.70%	1.92%	****
Unc. in Mean (%)	****	0.07%	0.31%	0.15%	0.05%	0.25%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
240-PU/239-PU 1991

LOS ALAMOS NATIONAL LABORATORY
240-PU/239-PU 1991

EG&G MOUND
240-PU/239-PU 1991

WESTINGHOUSE HANFORD
240-PU/239-PU 1991

EG&G ROCKY FLATS - ANALYTICAL LAB.
240-PU/239-PU 1991

RESULTS OF ANALYSIS OF 241-Pu/239-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (ppm)	****	-12	4	-5	-5	7	****
Std. Dev. (ppm)	****	12.60	6.55	7.88	7.76	15.20	****
Unc. in Mean (ppm)	****	1.02	0.42	1.28	0.69	2.65	****
Mean Error (%)	****	-0.55%	0.18%	-0.21%	-0.25%	0.34%	****
Std. Dev. (%)	****	0.57%	0.30%	0.36%	0.35%	0.71%	****
Unc. in Mean (%)	****	0.05%	0.02%	0.06%	0.03%	0.12%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
241-PU/239-PU 1991

LOS ALAMOS NATIONAL LABORATORY
241-PU/239-PU 1991

EG&G MOUND
241-PU/239-PU 1991

WESTINGHOUSE HANFORD
241-PU/239-PU 1991

EG&C ROCKY FLAITS - ANALYTICAL LAB.
241-PU/239-PU 1991

RESULTS OF ANALYSIS OF 241-Am/239-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (ppm)	****	-30	-17	-2	-18	-6	****
Std. Dev. (ppm)	****	3.65	17.38	7.11	8.24	23.81	****
Unc. in Mean (ppm)	****	0.96	2.39	1.30	0.61	2.00	****
Mean Error (%)	****	-1.65%	-0.95%	-0.09%	-0.99%	-0.30%	****
Std. Dev. (%)	****	0.21%	0.97%	0.40%	0.47%	1.31%	****
Unc. in Mean (%)	****	0.05%	0.13%	0.07%	0.03%	0.11%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
241-AM/239-PU 1991

LOS ALAMOS NATIONAL LABORATORY
241-AM/239-PU 1991

EG&G MOUND
241-AM/239-PU 1991

WESTINGHOUSE HANFORD
241-AM/239-PU 1991

EG&G ROCKY FLATS - ANALYTICAL LAB.
241-AM/239-PU 1991

RESULTS OF ANALYSIS OF PERCENT 238-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	
Mean Error (weight %)	****	0.0001%	0.0005%	0.0005%	0.0002%	0.0004%	****
Std. Dev. (weight %)	****	0.0003%	0.0009%	0.0005%	0.0005%	0.0014%	****
Unc. in Mean (weight %)	****	0.0000%	0.0001%	0.0001%	0.0000%	0.0002%	****
Mean Error (%)	****	0.74%	5.56%	5.85%	2.09%	4.47%	****
Std. Dev. (%)	****	2.70%	9.70%	5.61%	4.87%	15.41%	****
Unc. in Mean (%)	****	0.45%	1.16%	0.67%	0.32%	1.97%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
 PERCENT 238-Pu 1991

LOS ALAMOS NATIONAL LABORATORY
PERCENT 238-PU 1991

EG&G MOUND PERCENT 238--PU 1991

*WESTINGHOUSE HANFORD
PERCENT 238-Pu 1991*

EG&G ROCKY FLATS - ANALYTICAL LAB.
PERCENT 238-PU 1991

RESULTS OF ANALYSIS OF PERCENT 239-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (weight %)	****	0.3965%	0.3709%	0.0266%	-0.0563%	0.0053%	****
Std. Dev. (weight %)	****	0.0770%	0.1719%	0.0650%	0.0389%	0.1053%	****
Unc. in Mean (weight %)	****	0.0036%	0.0177%	0.0104%	0.0026%	0.0179%	****
Mean Error (%)	****	0.42%	0.40%	0.03%	-0.06%	0.01%	****
Std. Dev. (%)	****	0.08%	0.18%	0.07%	0.04%	0.11%	****
Unc. in Mean (%)	****	0.00%	0.02%	0.01%	0.00%	0.02%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
PERCENT 239-Pu 1991

LOS ALAMOS NATIONAL LABORATORY
PERCENT 239-PU 1991

EG&G MOUND
PERCENT 239-Pu 1991

WESTINGHOUSE HANFORD
PERCENT 239-PU 1991

EG&G ROCKY FLATS - ANALYTICAL LAB.
PERCENT 239-Pu 1991

RESULTS OF ANALYSIS OF PERCENT 240-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (weight %)	****	-0.0147%	-0.0153%	-0.0186%	0.0614%	-0.0472%	****
Std. Dev. (weight %)	****	0.0280%	0.1213%	0.0644%	0.0385%	0.1051%	****
Unc. in Mean (weight %)	****	0.0036%	0.0172%	0.0117%	0.0026%	0.0202%	****
Mean Error (%)	****	-0.25%	-0.26%	-0.32%	1.05%	-0.81%	****
Std. Dev. (%)	****	0.48%	2.07%	1.10%	0.66%	1.79%	****
Unc. in Mean (%)	****	0.06%	0.30%	0.20%	0.04%	0.35%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
PERCENT 240-PU 1991

LOS ALAMOS NATIONAL LABORATORY
PERCENT 240-PU 1991

EG&G MOUND PERCENT 240-PU 1991

WESTINGHOUSE HANFORD
PERCENT 240-PU 1991

EG&G ROCKY FLAITS - ANALYTICAL LAB.
PERCENT 240-PU 1991

RESULTS OF ANALYSIS OF PERCENT 241-Pu DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (weight %)	****	-0.0011%	0.0004%	-0.0004%	-0.0006%	-0.0018%	****
Std. Dev. (weight %)	****	0.0012%	0.0006%	0.0007%	0.0007%	0.0015%	****
Unc. in Mean (weight %)	****	0.0001%	0.0001%	0.0003%	0.0001%	0.0004%	****
Mean Error (%)	****	-0.54%	0.17%	-0.19%	-0.31%	-0.90%	****
Std. Dev. (%)	****	0.55%	0.30%	0.35%	0.35%	0.72%	****
Unc. in Mean (%)	****	0.05%	0.03%	0.15%	0.03%	0.20%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
PERCENT 241-PU 1991

LOS ALAMOS NATIONAL LABORATORY
PERCENT 241-PU 1991

EG&G MOUND
PERCENT 241-Pu 1991

WESTINGHOUSE HANFORD
PERCENT 241-PU 1991

EG&G ROCKY FLATS - ANALYTICAL LAB.
PERCENT 241-Pu 1991

RESULTS OF ANALYSIS OF PERCENT 241-Am DATA

	REPORTING LABORATORY						
	CSL	LLNL	LANL	MOUND	WHO	RFP	SRS
Mean Error (weight %)	****	-0.0028%	-0.0016%	-0.0001%	-0.0018%	-0.0027%	****
Std. Dev. (weight %)	****	0.0003%	0.0016%	0.0007%	0.0008%	0.0023%	****
Unc. in Mean (weight %)	****	0.0001%	0.0002%	0.0003%	0.0001%	0.0004%	****
Mean Error (%)	****	-1.64%	-0.96%	-0.06%	-1.05%	-1.54%	****
Std. Dev. (%)	****	0.20%	0.96%	0.42%	0.46%	1.34%	****
Unc. in Mean (%)	****	0.05%	0.14%	0.16%	0.03%	0.26%	****
Number of Data Points	0	30	42	74	115	54	0

LAWRENCE LIVERMORE NATIONAL LABORATORY
PERCENT 241-AM 1991

LOS ALAMOS NATIONAL LABORATORY
PERCENT 241-AM 1991

EG&G MOUND PERCENT 241-AM 1991

*WESTINGHOUSE HANFORD
PERCENT 241-AM 1991*

EG&G ROCKY FLATS - ANALYTICAL LAB.
PERCENT 241-AM 1991

CALORIMETRY EXCHANGE SAMPLE ON 01/01/89

Isotope	PPM Isotope / 239-Pu	% Isotope / Pu	% Uncertainty *
238-Pu	101	0.00944	0.6
239-Pu	1,000,000	93.8676	0.003
240-Pu	62,168	5.8600	0.06
241-Pu	2471	0.2338	0.57
242-Pu	306	0.0291	5.0
241-Am	1509	0.1429	0.4

Power = 0.9759 Watts +/- 0.07%

P-effective = 2.450 mW/g +/- 0.05%

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

CONSTANTS

Isotope	Decay Constant (day)**	Specific Power (W/g)
238-Pu	2.1630E-05	0.56757
239-Pu	7.8684E-08	1.9288E-03
240-Pu	2.8912E-07	7.0824E-03
241-Pu	1.3227E-04	3.4120E-03
242-Pu	5.0432E-09	1.1590E-04
241-Am	4.3768E-06	0.11420

** Reference: ANSI 15.22-1987 (Plutonium Bearing Solids - Calibration Techniques for Calorimetric Assay), page 22 (Table 4)

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