UNITED STATES NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

IE Inspection Report No. 070-1193/75-10

Licensee: Kerr-McGee Nuclear Corporation
Kerr-McGee Building
Oklahoma City, Oklahoma

Cimarron Facility, Plutonium Plant
Cresent, Oklahoma 73028

License No. SNM-1174
Category: A
Priority: 1

Type of Licensee: Plutonium Fuel Fabrication

Type of Inspection: Special, Announced

Dates of Inspection: July 31 - August 1, 1975

Principal Inspector: C. C. Peck — 8/5/75 (Date)

Accompanying Inspector: W. J. McGonnagle — (Date)

Other Accompanying Personnel: None

Reviewed By: J. A. Hind, Chief
Materials and Plant
Protection Branch — 8/5/75 (Date)

Attachment:
(10 CFR 2.790 Information)

SUMMARY OF FINDINGS

Inspection Summary

Inspection on July 31 and August 1, 1975 (75-10): Fact-finding inspection to learn details of licensee's nondestructive assay (NDA) system for inventorying in-process plutonium. Information was obtained on quantities of plutonium found and their locations, measurement procedures and equipment, and limits of error assigned to the measurements. NDA system has been used on three bi-monthly inventories for the measurement of inaccessible plutonium, and program is considered to be in developmental phase.

Enforcement Items

None.

Licensee Action on Previously Identified Enforcement Items

No previously identified enforcement items.

Other Significant Items

A. Systems and Components

Not applicable.

B. Facility Items (Plans and Procedures)

Not applicable.

C. Managerial Items

None.

D. Noncompliance Identified and Corrected by Licensee

None.

E. Deviations

None.

F. Status of Previously Reported Unresolved Items

No previously reported unresolved items.

[redacted]

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Management Interview

Licensee representatives were advised that the data and detailed information obtained by the inspectors had resulted in an improved understanding of the NDA system. The inspectors had no further questions at the time. However, it was stated that there might be further questions concerning the licensee's application of NDA theory and data interpretation after additional study of the information obtained.

[redacted]

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REPORT DETAILS

Persons Contacted

R. Jamka, Manager, Administration and Accountability
R. Marshall, Analytical Supervisor
W. Severe, Mathematician
R. Adkisson, Supervisor, Safeguards and Security

Status of NDA Program

The licensee began the development of a nondestructive assay system for inventorying inaccessible plutonium in his process system in October 1974. Introduction of this type of measurement was prompted by a change in license conditions effective in July 1974 requiring that all plutonium on inventory be measured. Prior to this change, the licensee had been permitted to include a constant holdup quantity of 18.7 kilograms in his inventory to account for material inaccessible for measurement by conventional sampling and analytical techniques. The 18.7 kilogram amount was determined from a series of four material balances based on physical inventories conducted in early 1973. For the purpose of determining the holdup quantity, the MUF component of the material balance was considered to be equal to holdup. From the available material balance data, the licensee selected 18.7 kilograms as his "constant" holdup quantity, and used this as an inventory constant from July 1973 through January 1975.

Although the revised license conditions of July 1974 prescribed that all plutonium be measured, the licensee was not prepared to initiate a full-scale NDA measurement system at that time and was found to be in noncompliance shortly thereafter for continuing to assume the 18.7 kilograms of unmeasured holdup. The licensee contended that an NDA measurement system would require several months of experiment and development and that the large uncertainty associated with this type of measurement would make it impossible to meet the LEMUF limit of the license, which was 1.8 kilograms of plutonium. In January 1975, Licensing increased the permissible LEMUF limit to 5.0 kilograms. In subsequent bi-monthly inventories in March, May and July, plutonium measured by NDA has been officially a part of the total physical inventory.

Ostensibly the NDA program has been successful because the MUF component of the three material balances conducted since its inception has been less than LEMUF and LEMUF has been less than 5.0 kilograms. It was concluded by the inspectors, however, that the program is still evolving

[redacted]

and that the best evidence of the reliability of NDA quantities will be forthcoming at the conclusion of the FFTF program when the process will be subjected to a complete cleanout. Final material balances at that time should determine whether inaccessible plutonium that has been measured by NDA appears as product or whether there are significant MUF discrepancies.

NDA Measurement Quantities

The NDA program has been an effort to measure all plutonium in the process (gloveboxes, pipes, operating equipment, and the process filtration system) after routine cleanout procedure have been completed prior to a bi-monthly inventory. The total NDA quantities measured have tended to increase from the first trial effort in October 1974 through May 1975, then there was a decrease in July 1975. The increase in totals in the earlier efforts is considered to have resulted from increased experience and knowledge of the locations where plutonium was most likely to be found. The decrease in the most recent inventory probably resulted from the fact that the overall plant inventory has been progressively decreasing and the inaccessible holdup quantity has also finally begun to decrease.

A summary table of plant and NDA totals appears below:

Inventory Date	Plant Total (g)	NDa Total (g)
October 1974	296,456	11,977
December 1974	281,064	11,771
January 1975	251,435	12,949
March 1975	243,641	20,045
May 1975	200,949	29,122
July 1975	137,270	24,338

Note: The NDA totals in the table are not included in the plant totals for October, December and January since NDA was in its experimental phase. The NDA totals for March, May, and July are included in the Plant totals.

The plutonium measured by NDA has been distributed among all areas or rooms of the plant. No particular area has been found to contain the most material consistently, but the area which has averaged the highest for the six inventories is Room 127. This is a scrap processing area containing about a dozen gloveboxes in which several operations such as the burning of combustibles, calcination of ash, dissolution, solution evaporation, and ion exchange separation take place. The manual handling of the heterogeneous assortment of materials probably leads to more spills and dust than in any other plant area.

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NDA measurements are made after the process has been cleaned up for inventory. Operations are not resumed in any area until the counting has been completed. No movement of material in adjacent areas that might affect the counting is permitted.

At each glovebox location where material is counted, the general procedure is to make two 30-second counts. The collimator is then covered by a lead shield and two 30-second background counts are made. Background counts are subtracted from the gross counts to give two corrected counts, which are converted to grams of plutonium (per square foot of area in the case of a glovebox measurement or simply grams of plutonium in the case of a pipe measurement). The formula is:

$$\text{g Pu/sq ft} = \frac{\text{(gross counts - background counts)}}{\text{transmission constant}} \times \text{calibration constant}$$

The transmission constant is a factor for the type of material through which the measurement is made. Some of the constants used are 0.96 for Plexiglas, 0.71 for stainless steel, 0.57 for lead glass, and 0.97 for a leaded glove. The constants are obtained from tables. The licensee has experimentally confirmed one or two of the more generally used constants. The calibration constant is the ratio of grams plutonium to counts as determined from standard measurements.

In determining the amount of plutonium in gloveboxes the following technique is used. The grams per square foot are determined at approximately two foot intervals along the length of the glovebox. These determinations are averaged and multiplied by the total surface area involved. Usually it is necessary to measure the plutonium on both horizontal and vertical surfaces of gloveboxes. Horizontal surfaces are measured by positioning the detector above or underneath the surface whichever is more convenient. Vertical surfaces are measured by holding the detector in a horizontal position. For convenience some measurements are made at an angle of 45°. Appropriate changes are made in the transmission constant in such instances. In pipe measurements counts are converted, using the proper calibrator factor, directly to grams of plutonium. In pipe measurements the grams of plutonium in a two foot length of pipe are determined. Similar determinations are made at other positions along the pipe. The weighted average is then multiplied by the length of the particular pipe.

It was noted that the amount of counting that has been done during the six NDA inventories has tended to increase. In the July inventory counts were made at 1131 box locations and 416 pipe locations. Assuming about three minutes to get the data at each location, it is estimated that box measurements required 57 hours of work, pipe measurements about 20 hours.

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The second highest NDA inventory area is the solvent extraction area. This area consists of three tall gloveboxes containing solvent extraction columns which extend from the basement to the ceiling of the first floor, approximately 25 feet. Most of the plutonium is within the equipment. Since March 1975 the columns have not been used. The room has been closed, the piping sealed off and the March plutonium inventory carried as a covarient item in the two subsequent inventories.

Rooms 128 and 124 rank next in NDA plutonium. Room 128 contains the ceramic processing gloveboxes in which plutonium is converted from the nitrate to the dry oxide powder. The upper portion of the tall glovebox containing the nitrate blending and weigh tanks is also in this room and has been found to contain significant amounts of plutonium. Room 124 is the pellet fabrication area. As much as several hundred grams of plutonium has been found consistently in each of the several pieces of operating equipment in the glovebox train. The presses, blender, grinder and furnace, although all emptied to the extent that they could be without dismantling, all consistently more than 100 grams by NDA.

Rooms B01 and B02 have been found to contain relatively smaller quantities of plutonium. These are areas containing liquid processing equipment. B02 contains the lower portions of the nitrate blend tanks and some boxes housing pumps. B01 contains boxes in which scrap liquids are filtered.

Process piping has been found to contain less plutonium than any of the individual rooms or areas. The totals for all piping have been about 1500 grams for each of the last three inventories.

Attachment A is a listing of average plutonium quantities found in each area with sub-listings of amounts found in the major pieces of equipment within those areas.

Measurement Procedures

After calibration of the two measurement systems against standards (summarized in a later section) to establish the relationship between counts and grams of plutonium, the process material is measured. Two electronics systems are used for NDA work, a SAM II (Scintillation Amplitude Monitor) made by Eberline, and a Ludlum system. Each is coupled to a collimated sodium iodine detector. The Ludlum is an older instrument and does not appear to be a stable as the SAM II. Because of the more modern circuitry, the counting rate with the SAM II can be higher than that of the Ludlum without losses due to pulse pile-up and dead time. For these reasons the SAM II is used for counting of material in gloveboxes which contain the larger quantities while the Ludlum's use is restricted to piping.

[redacted]

It was also observed that quantities of plutonium measured have increased generally as the amount of counting has increased. This is attributed to increased experience. As knowledge has been acquired on where plutonium is most likely to be found, more emphasis and increased counting effort has been expended in these areas. The licensee stated that there was no likelihood that a saturation point had been reached in counting which would lead to overlapping counting and the measurement of some plutonium twice. He estimated that even at the current level of counting effort, only about 20% of the total surface area and piping are being measured.

Attachment B is a completed data sheet which illustrates the calculation of the grams of plutonium in a particular glovebox.

Calibration Standards

Standards that have been used to establish the relationship of between counts and grams of plutonium are of two types, one for box measurements the other for pipes.

The standards for box measurements, the more critical of the two, are flat plastic packets about one square foot in area. They were made by mixing a weighed quantity (about two grams) of plutonium from current production with a matrix material within a glovebox, then inserting the mixture into a heavy PVC-type plastic bag. The packet standards used on the first five inventories contained a matrix of Kemwipe material impregnated with plutonium nitrate. Because of the possibility of deterioration of these standards, they were replaced with similar size packets containing a liquid paint resin mixed with plutonium oxide. The new standards were used in the July inventory.

The standards for pipes consist of one foot sections of pipe of appropriate diameters containing two grams of plutonium. The plutonium was deposited on Kemwipe matrix material which was then rolled up and inserted into the pipe so that distribution would be uniform. The first standards made contained plutonium in the nitrate form but these have been replaced by the oxide for because of the potential leakage hazard.

Calibration work is accomplished in a laboratory area that is as far removed as possible from background interferences. The measurement equipment has been recalibrated to establish new calibration constants prior to each inventory. Packet standards are counted singly and also grouped with two or four packets laid one over another to establish a constant. The calibration constant established in this way for use in the July inventory was 3.80×10^{-3} grams per count for a half minute counting period. Pipe standards are similarly counted to determine a constant. The basic pipe constant for the July inventory was 2.07×10^{-3} counts per gram for a twelve second counting period.

[redacted]

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In counting packet standards and in actual plant measurements, the detector is usually positioned about thirty inches from the source. Exact distance is not critical because the area measured increases as the square of the distance, so that the ratio of area to distance is always constant.

Limits of Error

The licensee has developed a statistical system for determining the limits of error associated with the plutonium measured by NDA. Since the March inventory when NDA quantities officially became part of the inventory, the LE for NDA has been the major portion of the overall LE. The table below shows the LE's associated with NDA as well as the overall LEMUF for the plant for the three inventories in which NDA has been used.

Inventory	NDA Total (g)	LE (NDA)	LEMUF
March	20,045	2,719	2,779
May	29,122	2,774	3,578
July	24,333	2,660	2,742

The system presently used for calculating systematic and random errors associated with NDA is set forth in a report prepared in March 1975. The experiments performed and the equations used to convert the experimental data to errors are described. The report is presented as Attachment C.

Sources of systematic error considered in the report are those associated with the various calibration curves, the gamma spectra error which is an allowance for the interference of the ^{237}U daughter of ^{241}Pu, and the errors due to counting geometry. The sum of all these systematic errors has been only a small portion of the total LE for NDA measurements. Attachment D which itemizes the NDA errors for the May-July inventory period illustrates this point.

NDA random errors constitute a much larger portion of the total LE for NDA than do the systematic errors. The random errors are calculated from the replicate measurement data accumulated during the NDA inventory. This is possible since each measurement is made in duplicate. Attachment D indicates that random errors, particularly those associated with the sampling method, constitute the major part of both the LE for NDA and the LE for the July inventory.

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Bias Corrections

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Conclusions

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in an attempt to a

The licensee has considered many of the theoretical causes of inaccuracy in determining the limits of error and bias. However, all the measurements and the calculated limits of error must be based on standards and simulated conditions stated that the licensee can only hope are representative of the plutonium that he is measuring in the plant. There could be wide differences between laboratory and plant conditions. There is no assurance that standards consisting to weighed amounts of plutonium in plastic packets and sections of pipe can represent all the material in the plant. The plutonium in the plant exists in many different physical and chemical forms and geometries. The gamma ray response will vary extensively because of differences in self-absorption and geometry among the various forms. In most instances it is not possible to know just what form the plutonium being counted is in. When measuring a pipe, for example, there is no certainty as to whether the plutonium inside the pipe is solid, liquid, in pockets, or in a continuous stream, or what the depth of the stream might be. Similarly it is not possible to know much about the distribution or form of the plutonium in a glovebox or piece of equipment. An attempt to make up standards to represent all the possible situations would not be feasible.

In addition to the foregoing general comments on the problems of relating laboratory date to plant conditions, there appear to be some specific measures that could be taken by the licensee that might improve his results. These are:

1. A self-absorption (or self-attenuation) correction should be developed. For the packet-type specimens used for calibration, the measured count rate can be expressed as follows:

$$\text{Measured count rate} = KN(1-CN)$$

where K = counts/g of Pu per unit time
N = number grams of Pu
C = attenuation constant per gram

Using data that the licensee recently established for two packet type samples, values for K and C can be calculated. The data:

1365 counts/min for a 1.936 gram standard
4089 counts/min for a 7.744 gram standard

From the data the following table can be prepared:

Grams Pu	Measured Counts/Min	Unattenuated Counts/Min
1.936	1365	1479
3.872	2514	2958
5.808	3416	4487
7.744	4082	5916

The curve of measured counts vs unattenuated counts plotted from the above table, could be used to correct each plant measurement. Theoretically it appears that such a correction should be made.

The effect of the correction would be to increase the amount of plutonium measured by NDA by 10-20%. From a practical standpoint this is in the wrong direction because the quantity of plutonium currently being found by NDA appears to be too high, although this in only a guess.

2. The use of two sets of standards primary and secondary, both prepared in the same way might be useful. Use of the primary standards would be confined to the laboratory for the purpose of instrument calibration. The secondary standards would be for in-plant use for instrument checking, background studies, and measuring attenuation constants. They would be useful, in other words, in translating laboratory measurements into plant measurements.

Attachments:
Attachment A through D

Room 127 - Scrap Area

Box 23, 24 - Sc

Box 25 - Dissol

Box 31A - Ion E

Box 31B and C -

Box 32

Box 33

Filters and Duc

Miscellaneous

Room 127 T

Basement - Solvent E

Room 128 - Ceramic /

Box 10 - Powder

Box 10 - Calcir

Box 5 - pH Adj

Box 5, 6 - Filt

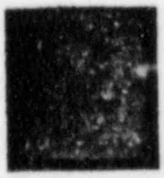
Box 3 - Nitrat

Box 4 (Top) - I

Powder Carts (

Miscellaneous

Room 128



	6 mos. Av	Range (I
Room 124 - Pellet Fabrication		
Box 11B - Press and Blender	444	108 -
Box 11A - Calciner and Slugger	380	191 -
Box 12 Conveyor	57	15 -
Box 14 Furnace Outlets	568	60 -
Box 15 - Grinder Inspection	1034	136 -
Filters and Ducts	444	224 -
Miscellaneous	122	50 -
Room 124 Total	3049	1097 -
Room B01 - Liquid Scrap Recovery		
Box 40 - Aqueous Recovery	367	47 - 9
Box 39 - Low Fu Disolution	358	45 - 7
Box 1A - Pump Hood	99	49 - 14
Miscellaneous	255	100 - 35
Room B01 Total	1079	387 - 23
Room B02 - Nitrate Blend and Weigh		
Box 4 - Nitrate Blend (Low Portion)	1118	293 - 216
Box 1 - Pump Box	270	90 - 620
Miscellaneous	286	100 - 350
Room B02 Total	1674	741 - 2776

[redacted]

	6 mos. Av	Range (Low and High)
Piping - All Areas		
B01	155	115 - 184
B02	1284	762 - 1636
B01 to B02	130	79 - 199
B01 to B127	154	27 - 218
B01 to B128	276	61 - 378
B01 to B128	124	26 - 221
Miscellaneous	56	25 - 75
Piping Total	2179	1439 - 3557

Room No. 121

Instrument Sam II

Technician Initials [illegible]

A = 0.96 D = 0.57

Item & Position		Transmission	Gross Count	Bkg. Count	Net Count	Corrected Count	GPu	
Box 11A T-7	1	B	2842	2149	693	976	3.71	2.7
27 Ft² [2.3]			2669	2346	323	455	1.77	
(84 g Pu)	2	A	2532	1914	618	644	2.45	2.
			2582	1761	821	855	3.25	
	3	A	2861	1871	990	1031	3.92	4
			2822	1789	1033	1076	4.09	
	4	A	2848	2110	738	821	3.11	2
			2809	2145	664	692	2.63	
	X						3.11	4
Box 11A S-7	1	D	1208	1053	155	272	1.03	1.46
238 Ft² [2.9]			1311	1029	282	495	1.88	
(595 g Pu)	2	D	1060	867	193	339	1.29	1.18
			1084	924	160	281	1.07	
	3	D	968	833	135	237	0.90	0.86
			985	864	121	212	0.81	
	4	D	1315	858	457	802	3.05	3.22
			1306	797	509	893	3.39	
	5	D	1777	930	847	1486	5.65	5.
			1847	957	890	1561	5.93	
	X						Av. 2.	

[redacted]

CALCULATIONS FOR ERROR STATEMENT

NDA INVENTORY 3/75

A. Systematic Error

1. Calibration Curves

Calibration curves representing various measurements were prepared by counting standards. The systematic error (variance) for each curve was calculated as follows:

$$s^2_{yx} = \frac{1}{n-1}\left(\Sigma y^2 - \frac{(\Sigma xy)^2}{\Sigma x^2}\right) \Sigma x^2 \qquad 1$$

Where: s^2_{yx} = Variance of y about x
n = Number of different calibration points
y = gPu or gPu/unit for each standard
x = Counts/unit time

This equation represents that variance of y about x for the equation:

$$y = bx.$$

If the uncertainty of the content of the standards is known to be significant relative to $S_{y\cdot x}$ and if more than one calibration curve is prepared for a given type of measurement, then the contributing errors are pooled and the systematic variance calculated using:

$$Sc^2 = \frac{\Sigma(n-1)S^2_{y\cdot x}}{m(\Sigma n - k)} + So^2 \qquad 2$$

Where: Sc^2 = Systematic variance
Σn = Total number of calibration points for all curves.
k = Number of calibration curves.
$S_{y\cdot x}$ = Relative standard deviation for a calibration curve.
So = Relative standard deviation for standards.
m = Number of counts taken per calibration point

Systematic errors for calibration curves used for the 3/75 NDA Inventory are listed on page 6.

2. Gamma Spectra

The gamma interference of concern is that of U^{237} which has a significant peak at 330 Kev. A series of production samples assumed to represent materials inventoried were scanned with a Ge-Li detector and the peak areas representing the 330, 345, 375, 393 and 414 Kev peaks, determined. The ratio of total peak area to 414 peak area was calculated for the standards.

[redacted]

ATTACHMENT C

From this ratio, a theoretical total peak area was calculated for each sample. The ratio of actual total peak area to theoretical total peak area represents a gamma counting error caused by U^{237} interference. For each sample type, a standard deviation was calculated on the ratios as follows:

$$si = \sqrt{\frac{n\Sigma x^2 - (\Sigma x)^2}{n(n-1)}} \qquad 3$$

Where: s_i = standard deviation for a sample type
n = number of samples of a given type
x = total gamma ratio as explained in the test.

A relative standard deviation, Si^2 was calculated for each sample type and combined with a counting statistics error as follows:

$$Ssi = \sqrt{\frac{Si^2}{n} + So^2} \qquad 4$$

Where: Ssi = systematic relative standard deviation for material type a
S_j = relative standard deviation for material type i from gamma peak areas
S_o = relative standard deviation representing standard source counting error.

The Pu 'found' by NDA Inventory was divided into the material catagories represented by the gamma scanned samples. See page 6 for the systematic error calculated for each material type from gamma counts.

3. Counting Geometry

Counting geometry errors were calculated for both measuring techniques. The two techniques are discussed separately.

a. Summing Technique

An experiment was conducted in glovebox 21 wherein known quantities of Pu were symetrically dispersed along the length of the glovebox floor. The material was measured using the summing technique by counting the box at six locations. Variation in the amount of Pu 'found' from location to location was ascribed to a counting geometry error. A relative standard deviation was calculated using equation 3.

[redacted]

ATTACHMENT C (cont)

The relative standard deviation was determined at two different loadings of Pu in Box 21 and equation 2 used to pool the RSD's obtained.

Page 6 lists the RSD for the counting geometry summing technique as well as the amount of Pu measured via this technique and its respective error.

b. Sampling Technique

Since the sampling technique involves counting glovebox surfaces at a variety of distances, an experiment was conducted to determine the effect of distance on the sampling technique calibration. The relative standard deviation on the calibration data was calculated via equation 3. The systematic relative standard deviation was then calculated using equation 4.

Page 6 lists the sampling technique geometric error.

B. Random Error

1. Gloveboxes

a. Summing Method

The summing method involves counting the entire area of interest. If the surface is counted in sections, the gPu found per section are summed together.

Equation 3 is used to calculate the standard deviation associated with a glovebox. For these gloveboxes wherein insufficient data exists to calculate an RSD, a pooled RSD is used to estimate each boxes RSD. The pooled RSD is calculated as follows:

$$Sp^2 = \frac{(n_1-1)Si^2+(n_2-1)S_2{}^2+\cdots(n_{\ell}-1)S_{\ell}{}^2}{(n_1+n_2\ldots n_{\ell}) - k} \qquad 5$$

Where: Sp = pooled RSD
n_i = number of different measurements taken on ith item
S_i = RSD on ith item
k = number of different items.

[redacted]

ATTACHMENT C (cont'd)

The error as gPu from all gloveboxes measured by the summing method is calculated as follows assuming measurement from box to box as independent of each other:

$$Sc^2 = \left[\Sigma \frac{Ei^2 Si^2}{mi}\right] + \left[Er^2 + Es^2 + \ldots Ez^2\right]\frac{Sp^2}{m} \qquad 6$$

Where: S_c = random error for all boxes measured by the summing technique
E_i = gPu in i^{th} glovebox
S_i = RSD for i^{th} glovebox
m = number replicate counts per different measuring site.
Sp = pooled RSD
Er..Ez = gPu in gloveboxes without sufficient data for Si calculation for each box.

The random error for glovebox summing technique is listed on page 6 .

b. Sampling Method

The sampling method involves measuring representative sites in a glovebox, calculating a gPu/unit area, and multiplying average gPu/unit area times box area to determine Pu holdup.

Equation 3 is used to calculate the RSD for each glovebox from the sampling method measurements. When insufficient measurements have been made to calculate an RSD, a pooled RSD is applied as calculated from Equation 5.

Equation 7 is then used to calculate the error associated with all gloveboxes measured via the sampling method:

$$Sc^2 = \left[\Sigma \frac{Ei^2 Si^2}{nim}\right] + \left[Er^2 + Es^2 \ldots Ez^2\right]\frac{Sp^2}{m} \qquad 7$$

Where: all symbols retain the same meaning as in equation 6 but n_i = number of different measurements taken on the i^{th} glovebox.

See page 6 for the random error for gloveboxes measured via the sampling technique.

ATTACHMENT C. (cont)

[redacted]

c. Ductwork and Pipes

Errors associated with Pu measurement in ductwork and pipes were calculated using the sampling method equations of the prior section (b). See page 6 for these errors expressed as gPu.

R.S. Harshall
4/9/75

[redacted]

ATTACHMENT C. (CONT.)

[illegible] MBA INVENTORY

I. SYSTEMATIC ERRORS

CATEGORY	CHANGE g Pu 3/75-7/75	CHANGE g Pu 5/75-7/75	RSD	ERROR g Pu 3/75-7/75	ERROR g Pu 5/75-7/75
A. CALIBRATION					
1. Glovebox Sampling	3808	4390	0.0040	15	18
2. Glovebox Summing	316	137	0.0156	5	2
3. Filters	199	62	0.0125	2	1
4. Ducts	70	226	0.0082	1	2
5. Tanks	376	69	0.0174	7	1
6. Pipes	62	38	0.0102	1	0
B. GAMMA SPECTRA					
1. Scrap	7760	5920	0.0089	69	53
2. Blend	5422	12701	0.0256	139	325
3. IX Effluent	1748	1997	0.0113	20	23
C. GEOMETRY					
1. Glovebox Sampling	3808	4390	0.0121	46	53
2. Glovebox Summing	316	137	0.0192	6	3
3. Filters	199	62	0.0046	1	0
4. Ducts	70	226	0.0014	0	0
5. Tanks	376	69	0.0333	13	2
6. Pipes	62	38	0.0169	1	1

II. RANDOM ERRORS

CATEGORY	ERROR g Pu 7/75	ERROR g Pu 5/75	ERROR g Pu 3/75		
A. SAMPLING	794	1027	751	1093	1298
B. SUMMING	134	160	233	269	209
PROPAGATED ERROR				1138	1357
LE				2230	2660

[redacted]

ATTACHMENT D

JULY 1975 INVENTORY BIAS

CATEGORY	BIAS RATIO	DID READ g Pu	SHOULD READ g Pu	CHANGE g Pu
Glovebox Sampling	1.075	15540	16706	+ 1166
Glovebox Summing	1.027	952	978	+ 26
Filters	1.121	627	703	+ 76
Ducts	1.000	198	198	0
Tanks	1.000	542	542	0
Pipes	0.984	1498	1474	- 24
Gamma, IXE	1.012	5620	5687	+ 67
Gamma, Scrap	1.050	13737	14424	+ 687
Total				+ 1998

[redacted]

ATTACHMENT D (CONT:)

NDA INVENTORY
JULY 1975

ITEM INVENTORIED	GRAMS Pu FOUND
R. 128	4296
R. B02	1743
R. 124	4915
R. 127	4496
R. B01	2300
SX	4981*
Piping	1498
Maintenance + R. 123	109
TOTAL	24,338

* Covarient from March, 1975 Inventory

ATTACHMENT D (cont...)

[redacted]