213

10-19-70

1590

BHO--69-1

MASTER

NUMEC®

Nuclear Materials and Equipment Corporation

Apollo, Pennsylvania

REPRODUCTION OF THIS DOCUMENT IS UNLIMITED

a subsidiary of Atlantic Richfield Company

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Contract AT(30-1)69
Plant Instrumentation Program

Quarterly Progress Report
April-June 1970

LEGAL NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

NUCLEAR MATERIALS AND EQUIPMENT CORPORATION
Apollo, Pennsylvania

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

SUMMARY

Methods Standardization and Evaluation

Passive gamma-spectrometric measurements with NaI and Ge(Li) detectors as well as passive measurements of both total neutrons and coincident fission neutrons were studied to establish the sensitivities, interferences, and precision of the methods and to compare the effectiveness of these methods for plutonium-contaminated solid waste materials in 1.5-gallon packages and in 55-gallon steel drums, and for plutonium-bearing mixed-oxide fuel-fabrication scrap in small cans.

For the gamma measurements a study was made of the several methods that could be used with the existing equipment to subtract the Compton contribution from the "384 complex". Analysis of data from known standards showed that a subtraction of the environmental background and a horizontal estimation of the Compton contribution yields the best results.

A passive gamma assay technique for solid waste in drums was adapted from the previously demonstrated method for solid waste in packages. A single mixed-oxide pellet, containing 0.22 g of Pu-239, was found to be a lower limit to the sensitivity. A study of the effect of varying the location of a single standard package in a drum filled with dummy packages showed a deviation as high as 11.6% from the homogeneous distribution for a package at a top-edge location. A calibration coefficient of 1.122 (grams Pu-239) (seconds)/(net count) with a standard deviation of ± 0.023 was determined for the method. The operational precision for the drum method is $\pm 1.7\%$ (standard deviation).

The assays of seventeen drums of plant-generated waste fortuitously showed a better correlation with the NaI assays on the contained packages than with the Ge(Li) assays on the packages. This is because one or a few packages with matrix material vastly different from the rest of the packages in the drum could have individual attenuation correction factors significantly different than the integral factor measured on the drum. This single abnormal package would not proportionally affect the measured drum attenuation factor if this package contains a quantity of plutonium significantly different from

the average content of the other packages. It appears that the contents of the drum must be controlled as to matrix type, if the method is to claim reasonable accuracy.

The variation in sensitivity along the vertical axis of the first neutron well counter from Brookhaven National Laboratory was shown to contribute to a considerable uncertainty in the measurement of mixed-oxide scrap with varying heights of material and a standard container. Although the precision of the measurements was poor due to instrument difficulties, in a majority of the cases the 25 w/o PuO_2 standard mixed-oxide samples counted higher than the 100 w/o standard PuO_2 samples, suggesting the possibility of a bias for variable mixed-oxide compositions.

Operations Measurements

Gamma spectrometric measurements of plutonium-contaminated solid waste in 1.5-gallon cardboard packages were conducted according to procedures developed by NUMEC prior to this contract. Other measurements were made with both gamma and neutron systems, but because the methods were simultaneously under development, evaluation, and calibration these new techniques were not optimum.

The standard deviation of the differences between the results of the NaI single-channel-analyzer package method and the results of the Ge(Li) multichannel-analyzer method was $\pm 0.18\text{g Pu}$ for the 77% of the packages that contained less than a gram of Pu-239, and the mean difference [Ge(Li) minus NaI] was 0.07g Pu . For the 23% of the packages that contained more than one gram of Pu-239 the results were $\pm 0.68\text{g Pu}$ and 0.54g Pu , respectively. These results demonstrate that a significant bias exists between the two methods.

The preliminary gamma measurement of 160 drums of non-glovebox waste revealed several drums that contained multigram quantities of plutonium.

With little methods development, thirty containers of mixed-oxide scrap from the "high-240" ZPPR job were counted with the neutron-coincidence instrumentation because scrap recovery was imminent. Even with four of the eight BF_3 tubes removed from the detector, the instrument dead time was three times

the active time. The standard deviation of repetitive measurements ranged from 1.4 to 11.9% with no discernible correlation with either Pu-240 or total oxide weight. A calibration curve was developed using the analytical chemistry numbers for each of the containers, but the scatter in the data was equivalent to about fifty grams of Pu-240.

RESULTS AND DISCUSSION

Methods Standardization and Evaluation

Programs to develop standard operating procedures; to establish sensitivities, interferences, and precision; and to compare the effectiveness of alternate measurement methods were conducted for plutonium-contaminated solid waste materials in 1.5-gallon packages and in 55-gallon steel drums and for plutonium-bearing mixed-oxide fuel-fabrication scrap in small cans. Passive gamma-spectrometric measurements with NaI and Ge(Li) detectors were studied as well as passive measurements of both total neutrons and the coincident fission neutrons.

Passive Gamma Measurements of Plutonium-Contaminated Solid Wastes (J. Kormuth, A. J. Dukat) - A study was made of the most accurate way with the existing equipment to subtract the Compton contribution from the "384" plutonium complex. Six different methods were investigated using a single set of data from known plutonium standards.

The memory of the 1024-channel analyzer was split into two halves. In one half was stored a previously measured environmental background. The other half was used for data acquisition. In this manner the environmental background was subtracted electronically from the data. The six methods were:

1. gross counts with no corrections,
2. gross counts minus environmental background,
3. gross counts minus background minus horizontal Compton correction,
4. gross counts minus horizontal Compton correction,
5. gross counts minus background minus sloped Compton correction, and
6. gross counts minus sloped Compton correction.

The horizontal Compton correction was calculated from the average counts per channel in the ten channels after the "384" complex; the sloped Compton correction was calculated from the geometric mean of ten-channel averages before and after the "384" complex.

The results of this study are shown in Figure 1. The calculated regression coefficients, which are a measure of the "goodness" of fit of the data, are

1. -0.8740, 2. -0.8740, 3. -0.9294, 4. -0.9113, 5. 0.9260, and 6. -0.8799, respectively, for the six data-treatment methods. From these results it appears that the third method -- gross counts minus background minus a horizontal Compton correction -- will yield the best results. Method number four had been used previously; method number three will be used until the equipment is interfaced to the computer and more sophisticated spectral-treatment techniques can be applied.

Using the results obtained by applying the third method the calibration constant a in the previously derived formula,

$$W = e^{-a} I_u \left[I_{k+s} / (I_{u+s} - I_u) \right] 0.563$$

was calculated to be 9.45482 ± 0.05455 . In the above formula, W is the weight of PuO_2 in the package in grams, I_u is the corrected activity of the unknown package, I_{k+s} is the corrected activity of the standard exterior source and the standard package that contains no PuO_2 and I_{u+s} is the corrected activity of the standard exterior source and the unknown package. After the equipment was moved from Fab 3 to Fab 9, another calibration was made, and the calibration constant was calculated to be 9.42975 ± 0.06088 . The equipment was moved from Fab 3 to Fab 9 to escape the high background of the former location.

The passive, gamma spectrometric measurement of plutonium-contaminated solid waste in steel drums was studied. The drum assay technique was adapted from previous work on the assay of waste in 1.5-gallon cardboard packages. A drum will hold 21 packages by placing on each of three layers a ring of six packages and one at the center.

Data were obtained on the variation of sensitivity to the location of Pu-239 in a drum. A single pellet containing 0.22 g of Pu-239 was counted at several positions in the drum. It was found that the pellet could be detected ($>$ twice the standard deviation of background) on the edges or at the center of the barrel but not at the bottom center. A three-bag PVC matrix of dummy packages was used for similar measurements with standard, known packages. The results are shown in Figure 2. The calibration data presented in Figure 3, were obtained with a detector-to-drum-center distance of 54 inches, which was the maximum distance that was physically practical.

Figure 2 - Variation in Sensitivity with Source Location
2 bag matrix data normalized to middle edge position

FIGURE 3

BARREL ASSAY CALIBRATION

(3-BAG MATRIX)

The curve for a middle center location was developed by a linear regression analysis of the 14 data points in the range of 0.1 to 6.8 g of Pu-239. The curves for material around the edge of the drum were obtained from measurements on a combination of four packages totaling 19 grams.

The curve for the combined top and bottom edges was determined by counting two packages of 6.8 grams each with one package in each position. The curve labeled homogeneous distribution was calculated from the other data assuming an equal quantity of Pu-239 in all 21 packages in the barrel.

The background level in Feb 9 was established for both Ge(Li) systems. The package-counting operates with a background of 890 counts per 1000 seconds in the "384 complex" region of the Pu-239 spectrum. Repetitive measurements of the background gave a standard deviation of 27 counts per 1000 seconds. The drum counting system has a background of 1220 counts per 1000 seconds and a standard deviation of 44 counts per 1000 seconds.

Background variations were also studied while drums were being moved in the area and with 2.2 kgs. of plutonium in the nearby shipping and receiving area. No change in background was observed in either case. Also, background determinations made with both instruments operating simultaneously showed no discernible correlation.

A small noise component in the instrument output from the drum counting system was found to be proportional to the total incident radiation. The contribution to the standard deviation from radiation statistics should be approximated by the square root of the gross counts. Data from a drum with 22 grams of plutonium shows $(\text{gross counts})^{1/2} = 131$, while the standard deviation from repetitive measurements 205. A crude estimate of precision is therefore, $\sigma = 1.5 (\text{net counts})^{1/2}$.

A calibration coefficient, e^{-a} in the equation above, for the 55-gallon drum gamma-counting system for plutonium-contaminated solid waste was determined for a matrix of two PVC bags in each 1.5-gallon carton in the drum. A measurement of the attenuating effect of the matrix in any unknown

drum permits the use of this coefficient for any matrix. Varying numbers of synthetically prepared, "known" standard packages were placed randomly in the drum along with dummy packages. An average coefficient of 1.122 (grams Pu-239) (Seconds)/(net count) with a standard deviation of ± 0.023 was obtained.

Using a measured matrix-attenuation correction and this calibration coefficient, seventeen drums of real plant packaged waste were assayed with the Ge(Li) drum scanning system. Each package in these drums was previously assayed by both the plant NaI assay technique and by the Ge(Li) procedure for packages. The data are presented in Table I. The sum of the NaI package data for each drum appears to correlate better with the results of the drum measurement than does the sum of the Ge(Li) package data; but, this may be a fortuitous result. The NaI technique does not utilize a measured attenuation correction as does the Ge(Li) method. An empirical correction based upon package weight is applied, but small heavy objects in the packages have been shown to introduce a bias. The Ge(Li) drum assay procedure does utilize an experimentally calibrated attenuation correction; but one or a few packages with matrices vastly different from the rest of the packages in the drum could have individual correction factors significantly different than the integral factor measured for the drum.

A self-attenuation measurement is made on the drum by comparing the intensity of the radiation from a plutonium source array shining through a dummy barrel (filled with packages each containing two PVC bags but no plutonium) with the intensity from the same source shining through the unknown barrel. A single package with an abnormal material would not proportionally affect this attenuation correction if a large fraction of the total plutonium contents of the barrel is in this single package. To illustrate the effect of an abnormal package, one standard, plutonium-containing package was substituted in the drum of dummy packages. The substituted package was also assayed on the Ge(Li) package assay system to determine a self-attenuation factor for the single package. Table II compares the self-attenuation correction factors for several individual substituted packages with the equivalent factors measured on the drum containing the individual packages. Only in the case of the glass jars is the drum self-attenuation correction factor significantly different

Table I - Barrel Assay

Drum	Grams Plutonium-239		
	Barrel Scan	Sum of Packages	
	Ge(Li)	Ge(Li)	NaI
3689	12.269	28.379	10.49
3292	3.629	5.428	3.89
3693	9.052	13.950	11.76
3695	38.201 36.061	44.194	45.94
3698	8.806	8.024	10.18
3702	2.963	3.129	2.94
3704	60.420 59.884	67.04	51.01
3705	5.091 5.088	5.958	5.00
3707	1.297	1.200	1.12
3708	1.256	1.153	1.21
3709	11.282	10.772	11.04
3712	8.308	8.800	7.45
3717	1.383	1.543	1.38
3718	1.897 1.905	2.170	1.88
3722	10.675 10.402	13.565	9.04
3723	15.388 15.823	18.450	15.66
3724	2.368	2.882	2.08
3728	1.295	2.086	1.28
3731	3.347	5.671	2.66
3732	3.087	3.988	1.89
3734	34.533	49.549	21.53
3735	5.190	7.482	2.23
3736	8.122	12.322	5.40
3760	35.868	40.975	17.55
3761	2.804	3.140	1.15
3762	6.516	8.275	3.43
3764	3.227	5.171	1.28

than unity, but the radiation from the single package is being attenuated on its way out of that package as indicated by the package self-attenuation correction factor. Therefore, the drum self-attenuation factor will not correct for abnormal packages in the drum. It appears that the contents of the drum will have to be controlled as to matrix type, if the method is to claim reasonable accuracy.

Table II - Matrix Absorption Correction Factors

<u>Matrix</u>	<u>Package Weight (grams)</u>	<u>Measured Self-Attenuation Correction Factor</u>	
		<u>Package</u>	<u>Drum</u>
1/2 PVC bag	630	0.891	1.000
cardboard	800	0.879	.991
1 PVC bag	940	0.937	.996
2 PVC bags	1300	1.000	.996
Nyo gloves	1690	1.030	1.000
latex gloves	1840	1.161	1.001
glass jars	2830	1.161	1.014

The precision of the barrel-assay technique with an attenuation correction was estimated from duplicate measurements of six drums taken on five separate days over a two-week period. According to Youden*, an estimate of the standard deviation can be obtained from the average relative differences between duplicate determination by multiplying this average by 0.886. The results of the six duplicate measurements are presented in Table III.

A portion of this uncertainty is due to the natural variation in nuclear decay. This contribution to the standard deviation may be estimated by the square root of the gross gamma counts recorded by the instrument; this calculation led to the calculated difference presented in Table III. In terms of two standard deviations the operational precision for the method should be approximately 3.4%.

W. J. Youden, "Statistics in Chemical Analysis", in "Meite's Handbook of Analytical Chemistry", 1st Edition, McGraw Hill, New York (1963), page 14-1.

Table III - Precision of Barrel Assay

<u>Drum</u>	<u>Pu(239) Found (grams)</u>	<u>Relative Difference (%)</u>	<u>Calculated Difference (%)</u>
3695	36.20 38.06	5.0	0.6
3704	60.42 59.84	0.9	0.5
3705	5.09 5.09	0.0	1.6
3718	11.90 11.90	0.0	0.4
3722	10.68 10.40	2.7	1.0
3723	15.39 15.82	2.8	1.0
	Average	1.9	0.8
	Estimated σ	1.7	0.7

Neutron Measurements of Oxide Scrap (J. Gonser, J. Vaughn) A single lot of mixed oxide (1.9 Kg) from AEC Contract 15176 (LMFBR) was retained, blended, and calcined. The material contains 25 w/o PuO_2 and 11.5% Pu-240. It will be chemically and isotopically analyzed and will be used to prepare standard containers of scrap with known but varying amounts of plutonium, uranium, and impurities.

A sensitivity plateau curve for the first neutron well counter obtained from Brookhaven National Laboratory, was taken using a two-inch-by-four-inch PNC plate as a source. The best operating voltage for the counter was determined to be 2100 volts. The source was placed in a horizontal position on the bottom of the well, counted, raised five centimeters, and counted again. This was repeated along the total height of the well. Thus, the variation in sensitivity occurs at 15 cm from the bottom of the well. The sensitivity curve is shown in Figure 4.

Standards were prepared containing known Pu-240 compositions. Two series were compared with two different matrices, one with w/o PuO_2 -75 w/o UO_2 , the other

FIGURE 4

with 100 w/o PuO_2 . By varying the total quantity of material the 25 w/o standards contained 25, 40, 50, and 78 grams Pu-240 and the 100 w/o standards contained 5, 10, 20, 35, and 50 grams of Pu-240. Each standard was counted at 12 different positions in the well to determine the effects of vertical placement. These data are seen in Figure 5 and show that the broad maximum in sensitivity in the range of 5 to 11 inches is about as was expected from the previous calibration study.

In the majority of the cases, the 25 w/o PuO_2 standard samples counted higher than the 100 w/o standard PuO_2 samples. There appears to be a bias when UO_2 is introduced into the sample, but additional studies with varying PuO_2 - UO_2 compositions are still in progress. Known amounts of depleted UO_2 will be added to the 100 w/o PuO_2 standards in order to establish the size of the apparent bias of mixed-oxide matrices. A new neutron measurement system is being obtained from BNL, and it is hoped that the statistical variation of the counting rate will be greatly improved.

Figure 5

OPERATIONS MEASUREMENTS

Measurements of plant-generated waste and scrap were made from the onset of the contract. Gamma spectrometric measurements of plutonium-contaminated solid waste in 1.5-gallon cardboard packages were conducted according to procedures developed by NUMEC prior to the contract. Other plant measurements were made with both gamma and neutron systems, but because the methods were simultaneously under development, evaluation, and calibration these new techniques were not optimum.

Passive Gamma Measurements of Plutonium-Contaminated Solid Wastes

(J. F. Gettings) -- Plant-generated contaminated solid wastes in 1.5 gallon packages were assayed by NUMEC procedures* with both the NaI and Ge(Li) systems. The NaI technique has been used by NUMEC for several years; a single-channel analyzer, set on a portion of the "384 complex", provides a passive measurement that is compared to standard, synthetically prepared packages, containing known quantities of plutonium. More recently the NaI method has included the addition to the measured activity of a correction, proportional to total package weight, that was determined by comparing results from the NaI method with results from the Ge(Li) method. The multichannel-analyzer, Ge(Li) method includes a self-attenuation correction measured with an external plutonium source.

A procedure was written to provide a uniform flow of packages that are transferred from one testing operation to another. The packages were counted with the NaI detector and single channel analyzer and then with the Ge(Li) detector and multichannel analyzer. The packages were accumulated in a drum, and then all the packages in the drum were counted using a Ge(Li) detector and a multichannel analyzer.

Approximately 350 packages were counted using both methods, of which 270 were found to contain less than a gram of plutonium. The standard deviation of the differences between the two methods was ± 0.18 grams of plutonium per packages for packages containing less than a gram, and the mean difference [Ge(Li) minus NaI] was 0.07 grams. With the packages containing more than a gram of plutonium, the standard deviation of the difference was ± 0.68 grams and the mean difference was 0.54 grams. These results demonstrate a significant bias exists between the two methods. The much more detailed effort with reducing systematic errors in the Ge(Li) method would support the premise that the inaccuracy lies with the NaI technique.

The gamma scanning of non-glovebox solid waste in 55-gallon steel drums

Standard procedures are documented in the Appendix to this report.

was initiated. Although the technique for barrels was still under development, these preliminary measurements identified those few barrel of the accumulated non-glovebox waste that contain sufficient plutonium to warrant their retention for quantitative measurements once the method is finalized, and for possible recovery of the contained plutonium. Only those barrels in which no plutonium could be detected were buried. Approximately 160 drums of non-glovebox waste were measured. No attenuation correction was applied to the measurements, and a crude calibration constant was derived using standard packages of known, plutonium-contaminated PVC.

Non-glovebox waste has previously not been measured by NUMEC, and its plutonium content has been assumed to be zero. Because several drums were found which contained multigram quantities of plutonium, it is evident that operations procedures have been violated; the drums containing plutonium will be remeasured with the refined drum assay procedures during the next quarter.

Neutron-Coincidence Measurements (J. Conser, J. Vaughn) Although very little of the method development program had been completed, approximately 30 containers of mixed oxide scrap from the "high 240" ZPPR job were counted with the neutron-coincidence instrumentation because scrap recovery was imminent. By chemical analyses the Pu-240 content of the material ranged from 95 grams to 267 grams. Extremely high gross counting rates ($\sim 10^7$ /minute) made it necessary to remove four of the eight BF_3 tubes from the detector. While the counting rate was reduced to about 3×10^6 , the dead time remained three times the active time. Repetitive measurements of the coincident counting rate (8 to 20×10^3 counts/minute) of several individual containers gave standard deviations of 1.4 to 11.9% with no discernible correlation with either weight of Pu-240 or weight of total oxide. A plot of the measured coincident rates and the gross rate against weight of Pu-240 did show a linear relationship, but the scatter in the data was equivalent to about 50 grams of Pu-240.

FORECAST

Methods Standardization and Evaluation

When the new neutron-coincidence detector and instrumentation is provided by BNL, development and evaluation of methods for the assay of oxide scrap will continue.

The new detector will accommodate a standard, 1.5-gallon solid-waste carton; the synthetic knowns that were prepared by NUMEC prior to this contract for the gamma-assay development will be used to evaluate the utility of neutron measurements for the assay of plutonium-contaminated solid waste.

Concomitant with the study of neutron measurements on scrap will be the evaluation of passive gamma measurements with container geometries appropriate to provide sensitivity to all the plutonium in heterogeneous mixtures.

A demonstration and evaluation program will be outlined and measurements will commence on the gamma assay of plutonium hold-up and hide-out in the various types of process equipment associated with the Plutonium Scrap Recovery Facility. The gamma assay of plutonium in process air filters and in medium-level waste solutions in 55-gallon drums destined for burial will be studied.

Operations Measurements

Solid waste in packages will be measured by the NaI-gamma, the Ge(Li)-gamma, and the neutron-coincidence techniques to provide a comparison of the methods. Measurements of drummed solid waste will also continue by the Ge(Li) technique.

Mixed-oxide scrap from the PNC fuel-plate fabrication job and from miscellaneous leased material will be processed in the Plutonium Scrap Recovery Facility during the next quarter. This material will be assayed by neutron coincidence (and by gamma spectrometry should the method prove feasible) using the new BNL equipment.

APPENDIX

STANDARD OPERATING PROCEDURES NONDESTRUCTIVE ASSAY

OPERATION OF MULTICHANNEL ANALYZER FOR WASTE ASSAY

1.0 Set up of Analyzer

- 1.1 Turn the mode switch on the master control panel to the display position, and depress erase buttons.
- 1.2 Adjust intensity and focus on oscilloscope as required.
- 1.3 Take background count by placing the memory group switch in the 1,2 position on the master control panel, and count for 1000 seconds for the drum and 200 seconds for the package, in all cases.
- 1.4 After count is completed print the data out by:
 - 1.4.1 Turn teletype on to line.
 - 1.4.2 Turn tape on by depressing "on" button.
 - 1.4.3 Punch in on the teletype the following:
 - 1.4.3.1 The background or sample identification;
 - 1.4.3.2 The date
 - 1.4.3.3 Depress "Here Is" button on teletype once.
 - 1.4.4 Turn the mode switch on the master control panel to read in/out position. (Spectrum reads out)
 - 1.4.4.1 Depress "Here Is" button on teletype twice
 - 1.4.5 Turn teletype punch to off position.
 - 1.4.6 Place the mode switch on the master control panel to the display position.
 - 1.4.7 Place the compute-select switch on the data-reduce-intergrate panel to the totalize position.

- 1.4.8 Set the start channel three channels to the left to the peak channel of the 375-KEV gamma of Pu^{239} , and the stop at end of 451-KEV peak. (The start and stop settings can change due to instrument drift.)
- 1.4.9 Depress last channel switch down, and hold while pushing the erase buttons on the master control panel simultaneously.
- 1.4.10 Press compute start button (once) on the data-reduce-integrate panel.
- 1.4.11 Print out the totalized channels by depressing and holding the last channel switch while turning the mode switch to read in/out position.
- 1.4.12 For the Compton correction measurement, return to step 1.4.9 after setting start-channel switch at the end of the 451-KEV peak and the stop channel switch 20 channels after the start-channel switch; continue to 1.4.11.

2.0 Set up analyzer for waste assay.

- 2.1 Place the memory group on the master control panel in the 3,4 position.
- 2.2 Return to step 1.4 and continue to step 1.4.12.

3.0 Stripping background from assay spectrum.

- 3.1 Place the add-subtract switch on the master control panel in the subtract position.
- 3.2 Set the set start and stop channels as selected in 1.4.8.
- 3.3 Place the group-select transfer/compare switch in the 1,2 position.
- 3.4 Place the compute select switch on the strip position.
- 3.5 Depress momentarily the channel-one erase button on the data-reduce-integrate panel.
- 3.6 Press the compute-start button.
- 3.7 Place the add-subtract switch in the add position.

3.8 Return the compute-select switch to the totalize position.

3.9 Repeat steps 1.4.9 through 1.4.12.

4.0 Shut down of Multichannel Analyzer.

4.1 Turn intensity down on the oscilloscope,

4.2 Turn the mode switch on the master control panel to the stop position.

5.0 Handling of Spectral Data

If any sample, whether, drum, package or filter, counts less than 500 counts after stripping, the content is considered less than 1 gram of Pu. When the sample counts more than 500 counts, the sample will be counted with the attenuation source. Then the attenuation source will be counted and the grams of Pu will be calculated.

6.0 Calculations

A. Drums

$$W = cI_u \quad \begin{array}{|c|} \hline I_k \\ \hline I_s - I_u \\ \hline \end{array} \quad b$$

where,

W = weight of Pu-239 (grams);

I_u = net integrated activity (counts/1000 sec.) from the measured container;

I_k = net integrated activity (counts/1000 sec.) from the standard source through a reference dummy container;

I_s = net integrated activity (counts/1000 sec.) from the standard source and from the measured container;

c = calibration constant (1000 sec./gram-count), which is 1.1672;

b = geometry factor 0.796.

B. B. Packages.

$$W = cI_u \quad b$$

I_k
$I_s - I_u$

where,

W = weight of Pu-239 (grams);

I_u = net integrated activity (counts/200 sec.) from the measured container;

I_k = net integrated activity (counts/200 sec.) from the standard source through a reference dummy container;

I_s = net integrated activity (counts/200 sec.) from the standard source and from the measured container;

c = calibration constant (200 sec./gram-count), which is 0.04322

b = geometry factor 0.563.

PROCEDURE FOR NaI GAMMA COUNTING OF PU WASTE

A. Calibration:

The instrument will be calibrated each shift or immediately before counting scrap. Count the Pu Standards.

The instrument setting will be as follows:

Threshold	-	380 kev
Window	-	120 kev
High Voltage	-	935
Course Gain	-	1/4
Fine Gain	-	0.7

If the calibration shifts greater than five percent, calibrate spectrometer at 662 Kev. with a Cesium source and recalibrate using the Pu standards.

Calculation:

$$\frac{\text{Count/Minute}}{\text{Weight of Pu Standard (Gm.)}} = \frac{\text{Count/Minute}}{\text{Pu (Gm.)}}$$

B. Procedure:

1. Determine background count for two minutes.
2. Place package on the turntable and rotate.
3. Count package for two minutes.
4. Subtract background count from package count.
5. Calculation:

$$\frac{\text{Count of Unknown}}{3,685} \times \text{Wt. Correction Factor} * = \text{Pu(Gm.)}$$

* Correction Factor is Table I

TABLE I

CORRECTION FACTOR FOR PACKAGE WEIGHT

<u>Package Weight</u> <u>(g)</u>	<u>Correction Factor</u> <u>(-)</u>	<u>Package Weight</u> <u>(g)</u>	<u>Correction Factor</u> <u>(-)</u>
0 - 150	1.01	2051 - 2150	1.23
151 - 250	1.02	2151 - 2250	1.24
251 - 350	1.03	2251 - 2350	1.25
351 - 450	1.04	2351 - 2450	1.26
451 - 550	1.05	2451 - 2550	1.27
551 - 650	1.06	2551 - 2650	1.28
651 - 750	1.08	2651 - 2750	1.29
751 - 850	1.09	2751 - 2850	1.31
851 - 950	1.10	2851 - 2950	1.32
951 - 1050	1.11	2951 - 3050	1.33
1051 - 1150	1.12	3051 - 3150	1.34
1151 - 1250	1.13	3151 - 3250	1.35
1251 - 1350	1.14	3251 - 3350	1.36
1351 - 1450	1.15	3351 - 3450	1.37
1451 - 1550	1.16	3451 - 3550	1.39
1551 - 1650	1.17	3551 - 3650	1.40
1651 - 1750	1.18	3651 - 3750	1.41
1751 - 1850	1.20	3751 - 3850	1.42
1851 - 1950	1.21	3851 - 3950	1.43
1951 - 2050	1.22	3951 - 4050	1.44

NUMEC®

nuclear materials and equipment corporation

a subsidiary of Atlantic Richfield Company

apollo, pennsylvania 15613

cable NUMEC

telephone 412-842-0111