

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-96SR18500 with the U. S. Department of Energy.

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.

This report has been reproduced directly from the best available copy.

**Available for sale to the public, in paper, from: U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161,
phone: (800) 553-6847,
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/help/index.asp>**

**Available electronically at <http://www.osti.gov/bridge>
Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from: U.S. Department of Energy, Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831-0062,
phone: (865)576-8401,
fax: (865)576-5728
email: reports@adonis.osti.gov**

Active Well Neutron Coincidence Assays for U-235 Content in HB-Line Desicooler Repackage Campaign at the Savannah River Site

R. A. Dewberry, V. R. Casella, D. M. Smith and S. R. Salaymeh
Savannah River National Laboratory
Aiken, SC 29808
USA

J. L. Shaffer
Savannah River Site
Aiken, SC 29808
USA

Abstract

At HB-Line of the Savannah River Site, 4.3 kg of U-235 have been repackaged from FB-Line Desicooler material into a cement matrix in individual one-gallon paint cans for disposition as solid waste. The 4.3 kg of U-235 material were packaged into 172 paint cans with U-235 contents ranging from 8.9 g up to 32 g. Prior to transfer to the Solid Waste Facilities, verification measurements of selected cans were performed to assure valid control of the solid waste. The HB-Line-DOE Sampling Plan designated confirmatory assays, and a total of 67 paint cans were assayed to verify the contents. The Analytical Development Section of the Savannah River National Laboratory selected an active well coincidence neutron counter as the best instrument available to accomplish the assays. The instrument was set up at-line in the thermal excitation mode, and three standard samples that contained 8.9-, 28.5-, and 32.4-g of U-235 were counted for twenty hours of acquisition time each. A linear calibration based on the observed doubles rates was installed in the instrument. Subsequent verification measurements were performed on the selected samples using fifteen one-minute active acquisitions. Of the 67 samples assayed, 53 verification measurements were within the limits $\pm 32\%$ prescribed by the sample plan. Eleven samples had results that were biased low by as much as 95%, and three samples had results that were biased high and outside of the prescribed range. Because of the extremely variable nature of the cement matrix these results were not unexpected. From the observed data we were able to use the singles rates to develop a correction factor that we could apply to the doubles rates of the eleven negatively biased results that brought each verification measurement back into the prescribed range. The three samples that had large positive biases in the verification measurements were observed in the passive acquisition mode to confirm contributions from trans-uranium species. This paper will describe the calibrations, verification measurements, applied corrections, and diagnostic tests that were involved in completing the prescribed assays.

INTRODUCTION

At the Savannah River Site, the HB-Line facility was to dissolve FB-Line Desicooler material (HEU oxides) in a scrap recovery program to provide additional uranium feedstock for the HEU Blend Down Project. Because of a minor exothermic event early in the campaign, DOE-SR/Nuclear Materials Program gave concurrence to dispose of 4.3 kg of HEU Desicooler material by disposal to solid waste instead of completing the dissolution campaign. HB-Line Operations decided to mix the material with Portland cement and de-ionized water to create a waste form that meets the Attractiveness Level E criterion for "SNM micro-encapsulated in refractory compounds or in solid-dilution".¹ To meet these requirements the material was repackaged into 172 one-gallon paint cans. Each paint can would contain approximately 3 kg of cement waste and 8 – 40 g of U-235.

Edited to here 5/13

The DOE-SR approval directed that the discard campaign use the FB-Line accountability shippers values and that HB-Line Facility and the Savannah River Material Protection and Accountability group provide verification measurements of the solid waste product. At the time of planning, the HB-Line facility was not able to provide the required verification measurements with any available assay equipment. The Analytical Development Section (ADS) of the Savannah River National Laboratory (SRNL) recommended use of the ADS active well coincidence counter to provide the required measurements. The ADS active well neutron counter (AWCC) is described in reference 2.

We had extensive experience using the active well instrument in the fast neutron excitation mode to perform U-AI verifications in the SRS K-Area material storage facility and at Argonne West National Laboratory.³ For those measurements we had demonstrated the capability to assay for U-235 content in the range 100 g – 1300 g with count times of 10 minutes to one hour. Our recommendation to the HB-Line Operations personnel was that the Aquila active well counter could satisfactorily perform the verification measurements at line with count times of several hours. DOE-SR directed the facility to perform the measurements and adopted a sample plan to perform verification measurements on 67 of the solid waste product cans.^{1,4} The verification measurements would validate the EU contents of all 172 waste cans based on comparison with the shipping data provided by FB-Line for the Desicooler material.⁴ These discussions and decisions took place over the course two weeks in mid-September 2003.

EXPERIMENTAL

ADS delivered the active well counter to the HB-Line Facility in late September, and the facility nuclear material accountability group managed the difficult transfer of the special nuclear material Am(Li) activation sources to their designated custodian in a matter of days. We set up the instrument for calibration at-line in the contaminated processing room where the waste items were being prepared, and the supporting electronics package (computer and software) was placed in the clean airlock just outside the processing room for ease of use by facility operations personnel.⁵ We next obtained the neutron detection rate with one of the activation sources placed in the center of the chamber well to observe the fast neutron efficiency in the identical manner that was demonstrated by Cowgill and Lu in reference 2. Using this technique we observed excellent agreement with their singles efficiency of 25% as shown in the printed output of Table 1. Table 1 also shows a list of the instrumental operating parameters.

Table 1. Example INCC 5.02 Hardcopy Output

INCC 5.02

```
Facility: HB-LINE
Detector type: HE-3
Detector id: kcc-51-dev
Electronics id: psr
Measurement date: 03.09.27 11:13:59
Results file name: 39JJ0222.RTS
Inspection number:
Item id: 176 Fast
Material type: U
Active comment: Passive fast acquisition of 176 source in chamber well.
Pre-delay: 4.50
Gate length: 64.00
2nd gate length: 64.00
High voltage: 1680
Die away time: 52.3600
Efficiency: 0.2500
Coefficient A deadtime: 0.8930
Coefficient B deadtime: 0.2010
Coefficient C deadtime: 0.0000
Active singles background: 15338.491 +- 15.091
Active doubles background: -0.091 +- 0.055
Active triples background: 0.003 +- 0.005
```

We then placed the activation source inside of a one-gallon paint can in which we had hardened 3 kg of cement. In this sample paint can we had fashioned a “pit” such that the Am(Li) source could sit in the approximate center of the can and would be surrounded on five sides by the cement matrix. The purpose of this measurement was to observe how the cement matrix affects the measured fast neutron efficiency. The results of this measurement and of similar measurements in the thermal mode are listed at the end of this report Table 2.

From Table 2 we observe a singles efficiency of 25% in the fast mode and of 28% in the thermal mode. We note approximately equal losses in efficiency from matrix moderation and absorption. We concluded the thermal mode of activation and analyses would give us superior precision. At this point we had no knowledge of the accuracy obtainable in the thermal mode, but we decided to proceed with calibration in the thermal mode. If that proved an unsatisfactory pathway, we could re-insert the Cd lining of the instrument and calibrate in the fast mode.

Table 2. Measured Fast and Thermal Singles Rates for Activation Source 176 as Described in Experimental.

Acquisition Number	Singles Rate (cps)	Efficiency	Moderator/Absorption Loss
39JJ0222.RTS	15338 +/- 15	0.251	0
39JJ0348.RTS	12921 +/- 12	0.211	15.80%
39JJ1838.RTS	17028 +/- 14	0.278	0
39JJ1405.RTS	14111 +/- 13	0.231	17.10%

CALIBRATION AND VERIFICATION MEASUREMENTS

To obtain an efficiency calibration we selected three samples that spanned the range of expected U masses that we could designate as working standards.¹ The items selected were WD6-04, WD6-05, and WD6-06 which had known working U-235 masses of 32.35 g, 28.28 g, and 8.57 g. These items were run first through the HB-Line discard process and were packaged into one-gallon paint cans with approximately 3 kg of cement. Each of these calibration runs was obtained using twenty 900-second acquisitions. The measured singles, doubles, and triples rates are shown in Table 3, and the linear calibration curve we obtained is shown in Figure 1.

Table 3. Measured rates in the three calibration acquisitions with the working standards.

Item	Acquisition	Declared U	Singles	Doubles	Triples
WD6-04	39JK5235.CAL	32.35	295.0±0.6	110.4±0.5	10.5±0.3
WD6-05	39KJ5053.CAL	28.28	343.3±0.6	102.6±0.5	9.3±0.3
WD6-06	39LJ1712.CAL	8.57	121.1±0.6	50.7±0.4	4.5±0.2

Using the linear calibration curve of Figure 1, we then ran each of the working standards in a verification measurement that treated each as an independent sample. Based on the verification results for the larger two working standards (WD6-04 and WD6-05) Site MC&A defined the 95% limits of acceptance as ±32%. That is, any verification measurement whose assay value fell within ±32% of the declared value would be accepted as an approved verification measurement.^{6,7}

With the approval of reference 6, HB-Line operators conducted all of the verification measurements of all 67 items designated by the sample plan. The results of the measurements are plotted in Figure 2, where the blue line is the calibration line, and the yellow squares are the verification points. The reader can note the good agreement with declared mass for most of the measurements. The measurements for items WD6-04 and WD6-05 fell right on the declared masses, and the measurement for item WD6-06 is denoted by the point in Figure 2 at approximately (declared mass, doubles rate) = (8.6, 45). Given the matrix of 3 kg of cement that can have variable mass, variable moisture content, and variable moderation, the agreement for the 67 measurements was extremely good.

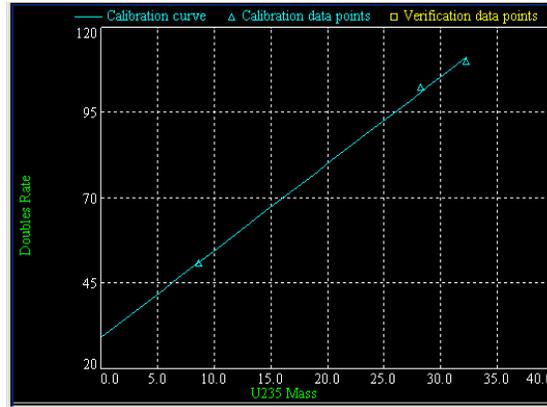


Figure 1. Calibration of doubles rate versus U-235 mass.

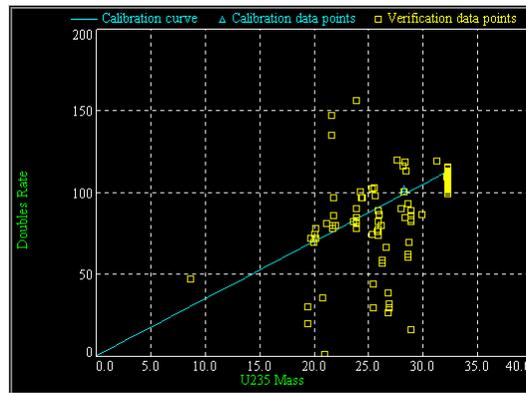


Figure 2. All Verification Measurements.

CALCULATIONS AND DISCUSSION

Of the 67 verification measurements, fourteen had results based solely on the observed doubles rates that lay outside of the $\pm 32\%$ limits designated by the sampling plan. Eleven of the fourteen had results biased low, and three had results biased high. Since the designated $\pm 32\%$ limits were set based on $2\text{-}\sigma$ counting statistics, it seemed clear that these “outliers” did not represent random statistical scatter, but rather indicated a nuclear physics phenomenon. Instrument problems were eliminated as likely causes by daily QC checks with working standard WD6-04 and after each observed outlier.

Because the items were being measured in a cement matrix with possibly varying moisture content, it was not unreasonable to expect matrix effects to significantly affect the measured neutron singles and doubles rates. Varying moisture content would change the neutron moderation, which can influence our detector counting efficiency. Impurities in the sample or cement matrix can absorb neutrons. This effect could cause a significant negative bias in the measured doubles rate. For pure HEU samples a positive bias in the neutron singles rate from (α, n) events was not likely, however the existence of trace transuranic impurities with possible accompanying fluorides would cause significant positive biases in both the observed neutron singles and doubles rates. Since all of the samples came from FB-Line, Pu metal and PuF_4 impurities seemed reasonable. PuF_4 would be especially likely to boost the observed singles rates from (α, n) events, and Pu content in any form would boost the observed doubles rates from spontaneous fission of Pu-240 and from neutron activation by Pu-239(n,fission).

Negatively Biased Outliers

The eleven samples with negatively biased assay values are listed in Table 4 and can be easily seen in the lowest portion of Figure 2. Note in Table 4 that for each of the samples we observed a negative singles rate in the verification acquisition. The INCC code automatically subtracts the stored active singles background that is composed predominantly from the activation sources. In the HB-Line at-line acquisitions we also had a passive singles rate of 805 cps. A negative singles rate was a strong indication to us that the cement matrix for these eleven samples was absorbing neutrons. Thus all of the observed singles, doubles, and triples rates for the samples in Table 4 are negatively biased, yielding the negative bias in the assay value.

Table 4. Evaluation of AWCC Outliers for HB-Line Dessicooler Campaign.

Sample	U-235 (g)	Singles	Doubles	Assay Value (g)	Expected Singles	Expected Doubles	Matrix Absorbed Singles
STD	32.35	300	108	30.89	341	112	
STD	28.58	343	103	29.45	302	99	
191-1	26.88	-484	30	8.46	284	93	768
192-2	26.86	-483	27	7.60	283	93	766
192-3	26.84	-495	39	11.10	283	93	778
192-4	26.84	-589	26	7.50	283	93	872
192-5	20.96	-658	0.35	0.101	221	73	879
192-6	20.80	-347	35	10.16	220	72	567
192-7	19.44	-450	30	8.52	205	67	655
192-8	19.37	-478	20	5.65	204	67	682
193-3	26.25	-158	58	16.25	277	91	435
194-4	28.61	-239	61	17.28	302	99	541
195-4	25.44	-597	44	12.67	268	88	865

Another possibility was that for these samples the matrix was over- or under-moderating compared to the working standards. In that case the instrument die-away time could be slightly or significantly changed, thus throwing the instrument out of calibration for these samples.

The change in the sample's singles rate also impacts the accidental doubles rate. The accidental doubles rate is accurately calculated by the INCC software for each acquisition by

$$\text{Accidentals} = S^2 \times \text{gate width}, \quad (1)$$

where S is the measured singles rate, and the coincidence gate width is 64µsec. For a typical sample singles rate of 10000 cps, the accidental doubles rate would be 6400 cps. Clearly these accidentals dominate the reals, and it is important to accurately calculate the accidental doubles based on an accurate singles rate. While in the condition of enhanced matrix absorption the observed singles rate is still accurately measured by the detection system, the stored background doubles rate is based on an accidental doubles rate that is reflective of a higher singles rate. Therefore, with additional matrix absorption of the Am(Li) activation neutrons, the reduced singles rates makes the stored background doubles the wrong function to subtract from the (sample observed doubles – sample accidental doubles). The subtracted active doubles background becomes inaccurate under the condition of enhanced matrix absorption. Therefore matrix absorption of neutrons has a significant two-fold effect on the measured doubles rate.

For the case of verification measurements on samples that contain U-235 fissile material only, all of the neutrons in the system come from the activation sources or from U-235(n,fission). That is, no matter what low-Z impurities are present in the sample, there are no (α,n) neutrons because the uranium α-decay half-lives are all too long. After accurate active background subtraction, all of the neutrons in the system are (n,fission) neutrons, and theoretically each of the observed singles, doubles, and triples rates is a good

measure of the U-235 content. Therefore the observed singles rate is also a very good predictor of U-235 content. Note that the observed singles rate/doubles rate for the standards in Table 3 is (2.80 ± 0.49) . This value is simply represented by the instrument efficiency.

Recall our instrument efficiency is 0.278. If we assume all of the neutrons in the instrument (after active background subtraction) are fission neutrons that come in at least pairs, then after detection of an authentic fission neutron, the chance of detecting one of its partners is only 27.8%. Thus for every single fission neutron the system detects we will fail to detect a partner fission neutron 72.2% of the time, and we will successfully detect a partner fission neutron 27.8% of the time. This yields a singles/doubles ratio of 2.60, which is approximately what we observe. Refining that calculation to matrix efficiency of 23.1% yields a predicted singles/doubles ratio of 3.33. For the two standards WD6-04 and WD6-05 shown in Table 4, the measured singles to doubles rate is (3.05 ± 0.39) . We use that value instead of (2.80 ± 0.49) for the calculations of Table 5 that we describe below.

We believe we can use the observed negative singles rate to determine the number of singles absorbed by the sample matrix and from there gain a good estimation of the number of doubles absorbed. We perform that iterative calculation in the spreadsheet of Table 5 for the samples of Table 4. Taking the first item (191-1), if column two represents the correct mass (26.88 g), then using our calibration curve we would expect to measure 93 doubles/sec in the verification acquisition. Since we observed only 30, we calculate that we are missing approximately 63 doubles. Using the expected singles to doubles ratio of 3.05, we expected to observe 284 singles above the active background. Thus we determine $(-484 - 284) = 768$ missing or absorbed singles.

We then calculate a ratio of absorbed singles to absorbed doubles, which is $768/63 = 12.2$ for item 191-1. Doing this for each of the eleven items, we observe an overall ratio of absorbed singles to absorbed doubles of (13.8 ± 2.4) . We then apply that ratio in two iterations to correct the measured doubles rate to that obtained in column 12. From there we recalculate the assay mass using the corrected doubles rate. Note for each of the eleven items this yields a corrected assay value that is within the prescribed $\pm 32\%$.⁸ These corrected assay values were accepted as authentic verification measurements for the eleven samples.⁹

We make one further observation regarding the absorbed singles and doubles. Recall above that for an efficiency of 23.1% and with all neutrons being fission neutrons, we expect and observe a singles to doubles ratio of 3.33. Matrix absorption being a random process, we would expect eleven times ($=3.33^2$) as many singles absorbed as doubles. (This reasoning is analogous to the calculation of accidental doubles from observed singles.) From the observed ratio of absorbed singles and doubles, we can recalculate the detection efficiency that accounts for matrix absorption in the samples of Table 4.

$$Eff = \frac{1}{1 + \sqrt{Ratio}} = \frac{1}{1 + \sqrt{13.8 \pm 2.4}} = 0.21 \pm 0.02. \quad (2)$$

Now compare our active background of 9973 cps, which represents an efficiency of 0.231. Crudely comparing, we then predict that the (710 ± 147) average singles absorbed represents a loss of $(1.6 \pm 0.3)\%$ in detection efficiency. With increased matrix absorption we have an observed efficiency of about $0.231 - (0.016 \pm 0.003) = (0.215 \pm 0.003)$, in excellent agreement with equation (2).

Positively Biased Outliers

The three samples with positively biased assay values are listed in Table 6, where the declared masses and verification results are listed in the first two columns of rows 1 – 3. For samples with significant positive biases in the assay values we suspected Pu components in the sample. In the list of 172 pails, 57 pails were projected to have non-zero Pu components that totaled to 10 grams Pu and 9.7 g Pu-239.¹ We recommended that the three cans listed in Table 6 be counted in the passive neutron coincidence mode. Since the uranium components would yield no spontaneous fission and no (α, n) neutrons, any observed passive singles above the passive background of 805 cps and any observed passive doubles would be definitive indications of transuranic species in the sample.

The results of the measured active and passive acquisitions are listed in Table 6. Note all three samples have non-zero values in the passive singles, doubles, and triples rates. The very large passive singles rates of 2382 and 2890 cps in samples MC02-182-2 and MC02-182-1 is a good indicator of a Pu-238(α ,n) component in each of them. The large passive doubles rates demonstrate a Pu-240 spontaneous fission component. The passive doubles contribute directly to the measured active doubles rates and indicate the presence of Pu-239.

Pu-239 would be activated just like U-235 to yield fission neutrons from Pu-239(n,f). Since the cross section and multiplicity for Pu-239(n,f) are larger than for U-235(n,f), we expect this component of the active doubles rate to be significantly larger per gram of Pu-239 present than per gram of U-235 present. In addition there is crosstalk. The 2382, 30, and 2890 passive singles/sec represent an additional component of activation neutrons that themselves contribute to the Pu-239(n,f) and U-235(n,f) reactions. *And* the additional neutrons from the Pu-239(n,f) reactions contribute to further activation of the U-235 present. Thus the U-Pu crosstalk has two factors that boost the activation rates.

From spontaneous fission, Pu-239 activation, Pu passive activation of U-235, Pu-239(n,f) activation of U-235, and U-235(n,f) activation of Pu-239, it is clear that it is not a simple matter to subtract the measured passive doubles rate from the active doubles rate to obtain a net U-235(n,f) activation rate. The calculation quickly diverges with the introduction of Pu into the sample. We are not able to estimate the Pu content or the net U-235 content from the measured activation doubles rates. However for small Pu contamination in samples of bulk U-235, it should be possible to develop an algorithm to make this correction.¹⁰

Our analysis of the passive acquisitions satisfied us that there are transuranic impurities present in the three samples of Table 6. These conclusions were reported and described in reference 11, and were accepted by the customer in reference 12.

Conclusion

The Analytical Development Section of SRTC teamed with the HB-Line Facility and Operations and with Savannah River Material Protection and Accountability to repackage and assay 4.3 kg of U-235 from the FB-Line Desicooler Campaign into a cement matrix suitable for disposal as solid waste. The U-235 was repackaged into 172 one-gallon paint cans, and 67 were designated for verification measurements to demonstrate good accountability and control of the special nuclear material. The entire repackage campaign from conception to completion required less than two months and represents an excellent example of teamwork, good conduct of operations, and strong technical performance.

Upon conception of the repackage campaign there was no accepted method to perform MC&A verification measurements of the U-235. NDA experts from the ADS recommended the use of active well neutron coincidence measurements using the existing Aquila instrument. The instrument was moved to the facility to perform the efficiency calibrations and verification measurements at-line. Efficiency calibration in the thermal neutron activation mode demonstrated the capability to assay in the mass region 8 – 35 g U-235 with twenty 900-second acquisitions.

The verification measurements on the 67 samples designated by the DOE sample plan were performed at-line by non-technical personnel trained especially to perform the acquisitions. Only fourteen of the 67 measurements yielded verification results outside of the required $\pm 32\%$ agreement with declared mass. Matrix neutron absorption corrections brought all eleven of the negatively biased results into compliance with the accepted mass. For the three samples with positively biased results we were able to use passive counts of the neutron singles, doubles, and triples rates to demonstrate contributions from transuranic species. From the passive counts the positively biased exceptions were cleared from the original designation of out of compliance. The Department of Energy granted approval to accept all of the verification measurements and to close out the repackage campaign.

References

1. Mindi Adams to Jane Terrell, "Discard of HB-line Waste Above Approved U-235 Discard Limits", SEO-MCA-2003-00274, September 2003.
2. Melvyn Cowgill and Ming-Shih Lu, "Testing and Calibration of the BNL Aquila Active Well Coincidence Counter", Department of Advanced Technology, Brookhaven National Laboratory, June 1997.
3. R. A. Dewberry and S. R. Salaymeh, "Efficiency Calibration and Testing of a Commercial Active Well Coincidence Neutron Counter to Inventory U-AI Reactor Fuel and Target Elements at the Savannah River", WSRC-MS-2000-00913, Presented at the 42nd annual conference of the Institute of Nuclear Material Management, July 2000.
4. Mindi Adams, "HB-Line Mixed Scrap Processing Verification Measurement Sampling Plan", September 2003.
5. B. Harker and M. Krick, INCC 5.02 software, USDOE Office of Safeguards and Security, (1997).
6. Mindi Adams to Jane Terrell "Request for Approval of the Combined Limits of Error for the SRTC Active Well Counter in HBL Measuring Highly Enriched Uranium", SEO-MCA-2003-0339.
7. C. D. Harvel to D. M. Smith, "Comparison LEOs for the HB-Line Active Well Coincidence Counter, SEO-MCA-2003-00334, September 2003.
8. V. R. Casella and R. A. Dewberry, "Re: Data Evaluation for AWCC U-235 Measurement Outliers", SRT-ADS-2003-0702, October 2003.
9. Mindi Adams to Jane Terrell, "Request for Approval to Accept HBL Desicooler Verification Measurements (U)", SEO-MCA-2003-00375, October 2003.
10. R. A. Dewberry, "Improved measurement of HEU in the presence of plutonium", OSS User Need, January 2004.
11. R. A. Dewberry and V. R. Casella, "Passive/Active Neutron Counts of Positive Bias Outliers in Desicooler Measurements", SRT-ADS-2003-0752, November 2003.
12. Mindi Adams to Jane Terrell, "Request for Approval to Accept HBL Desicooler Verification Measurements (U)", SEO-MCA-2003-0388, November 2003.

Table 5. Evaluation of AWCC negatively biased outliers for HB-Line Desicooler campaign.

Sample	U-235 (g)	Meas. Singles	Meas. Doubled	Expected Singles	Expected Doubles	Matrix Abs Singles	Matrix Abs Doubles	Ratio of Abs S to Abs D	Doubles @ zero Singles	Doubles Iteration 1	Doubles Iteration 2	U-235 (g) Calc	Calc/ Declared	
STD	32.35	300	108	341	112									
STD	28.58	343	103	302	99									
191-1	26.88	-484	30	284	93	768	63	12.2	65	79	83	23.9	0.89	
192-2	26.86	-483	27	283	93	766	66	11.6	62	76	79	22.7	0.85	
192-3	26.84	-495	39	283	93	778	54	14.4	75	91	95	27.5	1.02	
192-4	26.84	-589	26	283	93	872	67	13.0	69	84	87	25.2	0.94	
192-5	20.96	-658	0.35	221	73	879	72	12.2	48	59	61	17.6	0.84	
192-6	20.80	-347	35	220	72	567	37	15.3	60	73	76	22.1	1.06	
192-7	19.44	-450	30	205	67	655	37	17.6	63	76	79	23.0	1.18	
192-8	19.37	-478	20	204	67	682	47	14.5	55	67	69	20.0	1.03	
193-3	26.25	-158	58	277	91	435	33	13.2	69	85	88	25.5	0.97	
194-4	28.61	-239	61	302	99	541	38	14.2	78	96	99	28.7	1.00	
195-4	25.44	-597	44	268	88	865	44	19.6	87	106	111	32.0	1.26	
								Ave =	13.8					
								STDEV=	2.4					

Table 6. Results of Passive and Active Acquisitions on the Three Samples With Positively Biased Assay Results.

Meas. U-235	Declared U-235	Sample	Acquisition Number	Active/passive	Count time (s)	Singles (cps)	Doubles (cps)	Triples (cps)
90.4	28.6	MC02-182-2	39TK2613.VER	active	900	2368.6±3.9	314.7±5.0	28.5±3.1
42.4	21.6	MC02-172-2	39UC5519.VER	active	900	292.0±3.4	147.6±3.9	11.9±2.2
104.9	28.6	MC02-182-1	39SW4757.VER	active	900	3156.7±4.0	365.4±5.4	36.0±3.4
		MC02-182-2	3AOD2536.RTS	passive	18000	2381.8±0.5	147.5±0.3	15.3±0.1
		MC02-172-2	3AOK1313.RTS	passive	18000	28.9±0.2	1.06±0.08	0.101±0.012
		MC02-182-1	3ANW0036.RTS	passive	18000	2889.9±0.5	183.4±0.4	19.2±0.2