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IN-1255
November 1968

QUARTERLY REPORT

MASTER

QUALITY CONTROL PROGRAM FOR COUNTING INSTRUMENTS AND
TECHNIQUES USED IN THE RADIO AND SPECIAL
ANALYSIS LABORATORY

January 1, to March 31, 1968

IDAHO NUCLEAR CORPORATION
NATIONAL REACTOR TESTING STATION
IDAHO FALLS, IDAHO

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U. S. ATOMIC ENERGY COMMISSION

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Issued: November 1968
Chemistry
TID-4500

QUARTERLY REPORT

QUALITY CONTROL PROGRAM FOR COUNTING INSTRUMENTS AND TECHNIQUES USED IN THE RADIO AND SPECIAL ANALYSIS LABORATORY

January 1, to March 31, 1968

J. W. Brothers, A. C. Hill, C. M. Wilcox, J. G. Scott

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ABSTRACT

This is the first quarterly report of the "Quality Control Program for Counting Instruments and Techniques Used in the Radio and Special Analysis Laboratory". Sources of Pu-239 and UX₂ were counted respectively with the gross-alpha and beta counters. Single nuclides including Cs-137 and I-131 were analyzed using the NaI(Tl) detection system. A mixed source of I-131, Te-I-132, Te-129, Cs-137, and Ru-103 was analyzed using the SHIFTY III computer program for calculation of the NaI(Tl) spectral data. A mixed source of Ce-Pr-144, Ru-106, Cs-137, and Zr-Nb-95 was analyzed by gamma nullification of NaI(Tl) spectral data using a ND-180, 512-channel analyzer.

SUMMARY

This is the first report of the "Quality Control Program for Counting Instruments and Techniques Used in the Radio and Special Analysis Laboratory". The purpose of the program is to provide insight into the control of counting instruments and provide a means for detailed investigations of any special problems encountered in the analysis of samples. To this end, standards have been prepared and analyzed with NaI(Tl) detection systems, gas-proportional beta counters, and alpha-scintillation counters, and the results have been statistically evaluated.

Instrument performance standards were counted with the alpha and beta counters, and the results indicate that the counters were within control for the period covered. A source of pure I-131 was analyzed using NaI(Tl) detection systems to reveal any discrepancies in calibrations. No discrepancies were found. A mixed source of Ce-Pr-144, Ru-106, Cs-137, and Zr-Nb-95 was analyzed by gamma-ray spectrometry using hand stripping techniques, and an inadequate standard spectrum of Ce-Pr-144 was revealed and replaced. A mixed source of I-131, Te-I-132, Te-129 Ru-103, and Cs-137 also was analyzed using the SHIFTY III computer program. It was found that the elapsed time at which samples of this type are counted is very important. The optimum time of counting depends upon the accuracy and number of nuclide activities required by the customer. If the short half-life nuclides are not allowed to decay, the gamma-spectra of the nuclide of interest may not be well defined, resulting in an erroneous and misleading activity value. If decay of the desired nuclide is extensive, the same problem arises; but now the values (usually high) have large decay corrections applied, and the error is increased.

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I. INTRODUCTION

The Special Analysis Group is responsible for counting radioactive samples for beta, alpha, and gamma radiations. The types of samples range from single nuclides mounted in a calibrated geometry system to complex mixtures of nuclides in various sample sizes and configurations.

In the past, some standards have been counted periodically to determine the performance of the instruments. As more complex instruments and techniques are incorporated, it is necessary to reduce the amount of labor in data reduction and at the same time, increase the reliability of the instruments and techniques. It is also desirable to inform both management and customers about the accuracy and precision of the analytical techniques. To accomplish this, a program has been initiated to analyze samples, make appropriate statistical evaluation of the counting results, and publish both results and statistical evaluations with discussion in the form of a quarterly report.

The type of standards to be analyzed will depend upon the requirements needed to evaluate problems and the complexity of analyses, present and future.

Results from the gross beta and alpha counters and some of the gamma-energy analyses may be obtained directly from the counting data by hand calculation. It is necessary to resort to computer calculations for more involved analyses.

The SHIFTY III Program written for the CDC-1604 computer is used to resolve and calculate activities from spectral data produced by NaI(Tl) systems.[1] Other unpublished programs in use include a program to calculate activities from data obtained by manually stripping mixed spectra with the Nuclear Data-512-channel analyzers and a program to calculate activities from spectral data produced by a Ge(Li) system.

The Ge(Li) system consists of a 12-cc Ge(Li) detector connected to an analyzer having a 4096-channel ADC and a 4096 channel memory. The resolution is 3.1-keV FWHM at 661.6 keV for the entire system. Input devices are magnetic tape, IBM typewriter, and a strip chart recorder.

Programs used to calculate results for a quality control standard will be noted in the discussion for each standard.

A program has been written for the CDC-1604 computer in Fortran-63 to tabulate the analytical results and calculate recovery and relative precision (APPENDIX A).

II. STANDARDS

1. Instrument Performance Standards

The performance standards consist of: a commercially purchased UX_2 source for gross beta counters (see Section III), a Pu-239 standard prepared by personnel in the Radio and Special Analysis Laboratory for alpha counters (see Section IV), and Cs-137 standards prepared from type RS-137 ASTM standard solution for NaI(Tl) systems (see Section V.1). The purpose of these standards is to verify the day-to-day stability of the counting systems. The standards are counted at least once each day the instruments are used.

2. Gamma Technique Standards

A source of 7×10^9 dpm I-131 (designated Gamma 2) was prepared by personnel in the Radio and Special Analysis Laboratory for the NaI(Tl) systems from a solution purchased from Oak Ridge National Laboratory. This standard is used to reveal any discrepancies in calibrations or hand calculations between the six standard geometries of the two NaI(Tl) systems (see Section V.2).

A mixed source, containing Ce-Pr-144, Ru-106, Cs-137, and a small amount of Zr-Nb-95 (designated Gamma 3) was also prepared by personnel in the Radio and Special Analysis Laboratory for the NaI(Tl) systems (see Section V.3). This source is typical of samples obtained from the Idaho Chemical Processing Plant (ICPP). Samples of this type are manually stripped using the ND-512 channel analyzer and standard tapes, as this technique provides rapid turn-around time.

A mixed source containing I-131, Te-I-132, and small amounts of Te-129, Ru-103 and Cs-137 (designated Gamma 4) was prepared from a fresh fission product sample by personnel in the Radio and Special Analysis Laboratory for the NaI(Tl) systems (see Section V.4). This source is typical of samples from the Contamination Decontamination Experiment (CDE). The purpose of the source is to obtain the reliability associated with the calculation of this type of sample by use of the SHIFTY III Program.

III. BETA COUNTING

Beta 11 (Tables I, II) is a commercially prepared UX_2 source used for daily control of the two gas-proportional beta counters designated A and B. The reference value of 2.285×10^4 cpm was obtained by averaging 44 counts on A and B instruments. The average recovery is high but well within control. These counters are operated by a large number of personnel. Under these circumstances the relative precision of better than 3% at the 95% C. I. is considered good.

IV. ALPHA COUNTING

Alpha 12 (Table III) is a Pu-239 source used for control of the alpha-scintillation counter. The reference value was obtained by averaging three counts. This instrument is operated by a large number of personnel. The results indicate that this instrument was within control.

V. NaI(Tl) GAMMA-RAY SPECTROMETRY

1. Gamma 1

Gamma 1 (Tables IV, V) is a Cs-137 source used for daily control of the two 3- x 3-in. NaI(Tl) detectors and counting systems. The reference values for each instrument were obtained by counting the source on the 10-cm shelf for each system. The precision is better than 1.5% at 95% C. I. for both systems. The difference between the two systems was due to errors in the analyzer timing. One minute time intervals were checked for both instruments with a stop watch yielding 61.2 and 57.4 sec for A and B instruments respectively, a 3% difference. The clocks were changed to eliminate the difference by adjusting the timing oscillators.

2. Gamma 2

Gamma 2 (Tables VI through XI) is an I-131 source. The purpose of this check is to reveal calibration discrepancies between geometries and instruments for the nuclide I-131. The reference value was calculated from an average of three analyses 200-cm from the detector.

The source was counted 28 times in 52 days. Data were obtained on the 200-, 100-, and 50-cm shelves. All calculations were performed by hand integrating the 0.364-MeV photopeak, applying an efficiency and branching ratio factor, and calculating a decay correction to a common time using a half-life value of 8.05 days. The precision is better than 3% at the 95% C. I., and this is considered excellent in relation to the uncertainty of the half-life and the change in geometries (Table VI). The results for the two separate counting systems (Tables VII, VIII) indicate good agreement between the two systems. The results for separate geometries (Tables IX, X, XI) also indicate good agreement. This source will be analyzed periodically until data are obtained for geometries closer to the detector.

3. Gamma 3

Gamma 3 (Tables XII, XIII, XIV) is a mixed source of Ce-Pr-144, Ru-106, Cs-137, and Zr-Nb-95. The purpose of this analysis is to evaluate the precision at which the mixed spectrum representing an ICPP process sample can be resolved by gamma nullification with the Nuclear Data 512-channel analyzers. The reference values for the four isotopes present were obtained by averaging the results from the last three spectra of the set. The spectra were stripped with standard tapes of known distintegration rate and activities were calculated to a common time. Midway through the quarter, erratic results indicated that the Ce-Pr-144 standard stripping tape for A instrument was not adequate for stripping

purposes and a new standard tape was obtained. The high value of Ce-144 on February 27, 1968 cannot be accounted for. For these reasons, Tables XIII and XIV indicate that the precision for B instrument is better than A instrument. The poor precision for Zr-Nb-95 results is due to the extremely low levels of Zr-Nb-95 in relation to the other nuclides present in the standard. Considering the degree of interference between photo peaks of this source and the activity levels present, the precision is good. The source will be analyzed again during the second quarter.

4. Gamma 4

Gamma 4 (Table XV) is a mixed source of I-131, Te-I-132, and lesser activities of Te-129, Ru-103, and Cs-137. The purpose of this analysis is to evaluate the precision that can be obtained for this type of sample using the SHIFTY III Computer analysis of NaI(Tl) spectra. This program uses the least squares fitting technique with a library of standards[1]. This sample is typical of the type of sample encountered in the CDE in support of the Loss-of-Fluid Tests (LOFT). The reference values for the five isotopes present were obtained by gamma analysis of the I-131 from a standard solution and the other nuclides from a tellurium separation of fresh fission products.

The analyses spanned a period of 44 days. As the nuclides decayed, the source was counted closer to the detector. The 50-, 20-, 10-, and 3-cm shelves were used. As might be expected, from the results of Gamma 2, the precision for I-131 is good. The results for Te-I-132 were good for a period of about 15 days and then became increasingly biased high due to large decay corrections and the spectral interferences of the longer-lived nuclides. At the same time the analysis of Te-I-132 became difficult, the Te-129 results become meaningful. The Te-129 result of 1.04×10^4 dps on March 19, 1968 was from the only analysis performed on the 3-cm shelf and leaves the standard spectrum for this geometry in doubt. The Ru-103 results become meaningful near the end of the counting period. The Cs-137 activity was too low to determine precisely; therefore, results were reported as less than 200 dps. The source was analyzed on a 12-cc coaxial Ge(Li) detection system. No quantitative analysis was performed, but photopeaks from all five of the nuclides were visible.

VI. CONCLUSIONS

The performance standards for the gross alpha and beta counters indicate the instruments were within control during the first quarter. These sources will be used again during the second quarter.

The precisions for the NaI(Tl) systems using the Cs-137 source were acceptable. A standard activity value for this source will be obtained by mass spectrometry for the determination of the accuracy of the results. ✓

The I-131 source (Gamma 2) was analyzed at three geometries; 200-, 100-, and 50-cm during the first quarter with excellent results. The same source will be analyzed periodically during the second quarter to provide information at the remaining geometries: 20, 10, and 3 cm.

The mixed source of Ce-Pr-144, Ru-106, Cs-137, and Zr-Nb-95 (Gamma 3) revealed an inadequate standard tape of Ce-Pr-144 for the A instrument and the tape was replaced. The poor precision was expected because of the spectral interference and the activity levels present. The source is being counted again during the second quarter, but will be calculated by the SHIFTY III program in addition to the hand stripping technique.

The mixed source of I-131, Te-I-132, Te-129, Ru-103, and Cs-137 revealed the extreme limitations upon calculation of activities imposed by the half-lives of these nuclides. At some future date, it would be desirable to repeat this type of standard taking more counts over a longer period of time.

The only new standard to be added to the program for the second quarter will be a source of initially pure Zr-95. The purpose of this standard is to evaluate discrepancies in the branching ratios for the 0.724- and 0.757-MeV gamma rays of Zr-95 by use of the 12-cc (Ge(Li) system. Preliminary analyses show a discrepancy between experimental values of the branching ratio and those found in the literature.

VII. REFERENCE

1. R. Helmer, R. Heath, L. Schmittroth, G. Jayne, and L. Wagner, "Analysis of Gamma-Ray Spectra From NaI(Tl) and Ge(Li) Sepectrometers". Computer Programs. Nuclear Instruments and Methods, 47 (1967) pp. 317-319.

APPENDIX A

TABLES

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Table Ia.

Standards Report - Beta 11 3 A

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE BETA 11. 3 A

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
UX2	10968	2.274E 04	2.285E 04	99.545
UX2	11068	2.276E 04	2.285E 04	99.628
UX2	11168	2.280E 04	2.285E 04	99.790
UX2	11268	2.278E 04	2.285E 04	99.729
UX2	11568	2.288E 04	2.285E 04	100.127
UX2	11668	2.267E 04	2.285E 04	99.230
UX2	11768	2.286E 04	2.285E 04	100.057
UX2	11968	2.288E 04	2.285E 04	100.149
UX2	12268	2.312E 04	2.285E 04	101.199
UX2	12368	2.300E 04	2.285E 04	100.692
UX2	12468	2.291E 04	2.285E 04	100.293
UX2	12568	2.291E 04	2.285E 04	100.293
UX2	12668	2.309E 04	2.285E 04	101.046
UX2	12968	2.292E 04	2.285E 04	100.311
UX2	13068	2.300E 04	2.285E 04	100.665
UX2	13168	2.316E 04	2.285E 04	101.374
UX2	20168	2.294E 04	2.285E 04	100.416
UX2	20168	2.296E 04	2.285E 04	100.486
UX2	20668	2.299E 04	2.285E 04	100.648
UX2	20768	2.298E 04	2.285E 04	100.600
UX2	21268	2.297E 04	2.285E 04	100.552
UX2	21368	2.299E 04	2.285E 04	100.648
UX2	21468	2.299E 04	2.285E 04	100.613
UX2	21568	2.278E 04	2.285E 04	99.711
UX2	21668	2.291E 04	2.285E 04	100.258
UX2	21768	2.320E 04	2.285E 04	101.536
UX2	22068	2.311E 04	2.285E 04	101.147
UX2	22168	2.315E 04	2.285E 04	101.348
UX2	22368	2.321E 04	2.285E 04	101.589
UX2	22668	2.293E 04	2.285E 04	100.376
UX2	22768	2.299E 04	2.285E 04	100.626
UX2	22868	2.301E 04	2.285E 04	100.731
UX2	22968	2.304E 04	2.285E 04	100.849
UX2	30168	2.295E 04	2.285E 04	100.460
UX2	30468	2.303E 04	2.285E 04	100.788
UX2	30568	2.330E 04	2.285E 04	101.970
UX2	30668	2.302E 04	2.285E 04	100.744
UX2	30868	2.290E 04	2.285E 04	100.219
UX2	31168	2.294E 04	2.285E 04	100.420
UX2	31268	2.306E 04	2.285E 04	100.924

(*) COUNTS / MINUTE

Table Ia (Continued)

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE REF A 11 3 A

ISOTOPE	DATE	OBSERVED VALUE (*)	REFERENCE VALUE (*)	PERCENT RECOVERY
.....				
U2	31368	2.300E 04	2.285E 04	100.687
U2	31468	2.301E 04	2.285E 04	100.696
U2	31568	2.284E 04	2.285E 04	99.969
U2	31868	2.337E 04	2.285E 04	102.294
U2	31968	2.291E 04	2.285E 04	100.276
U2	32068	2.308E 04	2.285E 04	101.029
U2	32268	2.299E 04	2.285E 04	100.630
U2	32568	2.307E 04	2.285E 04	100.972
U2	32668	2.328E 04	2.285E 04	101.904
U2	32868	2.320E 04	2.285E 04	101.545
U2	32968	2.327E 04	2.285E 04	101.843

(*) COUNTS / MINUTE

.....

Table Ib.

Standards Summary - Beta: 11 3 A

STANDARDS SUMMARY FOR FIRST QUARTER, 1968:

CODE BETA 11: 3 A 51 DETERMINATIONS:

ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	...OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
UX2:	2,285E 04	2,300E 04	100.659	.652	1.303	.182

(8) COUNTS / MINUTE

.....

Table IIa.
Standards Report - Beta 11 3 B

STANDARDS REPORT FOR: FIRST QUARTER, 1968

CODE BETA 11 3 B

ISOTOPE	DATE	(*)	(*)	PERCENT
		OBSERVED VALUE	REFERENCE VALUE	
.....				
UX2	10868	2.264E 04	2.285E 04	99.115
UX2	11668	2.279E 04	2.285E 04	99.764
UX2	11768	2.292E 04	2.285E 04	100.315
UX2	11968	2.275E 04	2.285E 04	99.562
UX2	12268	2.238E 04	2.285E 04	97.933
UX2	12468	2.170E 04	2.285E 04	94.983
UX2	12668	2.272E 04	2.285E 04	99.462
UX2	12968	2.301E 04	2.285E 04	100.709
UX2	13068	2.279E 04	2.285E 04	99.742
UX2	20868	2.326E 04	2.285E 04	101.799
UX2	21268	2.304E 04	2.285E 04	100.862
UX2	21368	2.318E 04	2.285E 04	101.479
UX2	21468	2.312E 04	2.285E 04	101.208
UX2	21568	2.308E 04	2.285E 04	101.002
UX2	21968	2.335E 04	2.285E 04	102.197
UX2	22068	2.329E 04	2.285E 04	101.957
UX2	22668	2.316E 04	2.285E 04	101.379
UX2	22868	2.309E 04	2.285E 04	101.081
UX2	22968	2.326E 04	2.285E 04	101.825
UX2	30168	2.330E 04	2.285E 04	101.992
UX2	30468	2.320E 04	2.285E 04	101.550
UX2	30568	2.334E 04	2.285E 04	102.140
UX2	30668	2.296E 04	2.285E 04	100.486
UX2	30768	2.284E 04	2.285E 04	99.982
UX2	30868	2.276E 04	2.285E 04	99.624
UX2	31168	2.288E 04	2.235E 04	100.149
UX2	31268	2.289E 04	2.235E 04	100.201
UX2	31368	2.311E 04	2.235E 04	101.142
UX2	31468	2.302E 04	2.235E 04	100.744
UX2	31868	2.309E 04	2.235E 04	101.072
UX2	31968	2.303E 04	2.235E 04	100.819
UX2	32068	2.282E 04	2.235E 04	99.891
UX2	32268	2.289E 04	2.235E 04	100.175
UX2	32668	2.282E 04	2.285E 04	99.873
UX2	32668	2.297E 04	2.285E 04	100.530
UX2	32968	2.281E 04	2.285E 04	99.842

(*) COUNTS / MINUTE

.....

Table Iib.

Standards Summary - Beta 11 3 B

STANDARDS SUMMARY FOR FIRST QUARTER, 1968

CODE BETA 11 3 B 36 DETERMINATIONS

ISOTOPE	(*)	(*)	PERCENT AVERAGE RECOVERY	...SINGLE	OBSERVATION...	...MEAN....
	REFERENCE VALUE	AVERAGE OBSERVED VALUE		PERCENT STANDARD DEVIATION	PERCENT PRECISION AT .95 C.I.	PERCENT PRECISION AT .95 C.I.
.....						
UX2	2,285E 04	2,295E 04	100.461	1,340	2,706	,451

(*) COUNTS / MINUTE
.....

Table IIIa

Standards Report - Alpha 12 OC

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE ALPHA 12 OC

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
PU-239	10368	8.321E 03	8.157E 03	102.011
PU-239	10568	8.194E 03	8.157E 03	100.454
PU-239	10868	8.229E 03	8.157E 03	100.883
PU-239	11068	8.131E 03	8.157E 03	99.681
PU-239	13068	8.291E 03	8.157E 03	101.643
PU-239	20268	8.098E 03	8.157E 03	99.277
PU-239	20868	8.133E 03	8.157E 03	99.706
PU-239	20968	8.144E 03	8.157E 03	99.841
PU-239	21268	8.249E 03	8.157E 03	101.128
PU-239	21668	8.095E 03	8.157E 03	99.240
PU-239	30168	8.019E 03	8.157E 03	98.308
PU-239	30568	8.063E 03	8.157E 03	98.848
PU-239	30568	8.078E 03	8.157E 03	99.032
PU-239	30668	8.154E 03	8.157E 03	99.963
PU-239	31968	8.039E 03	8.157E 03	98.553
PU-239	32868	8.041E 03	8.157E 03	98.578

(*) COUNTS / MINUTE

Table IIIh.

Standards Summary - Alpha 12 OC

STANDARDS SUMMARY FOR FIRST QUARTER, 1968

CODE ALPHA 12 OC 16 DETERMINATIONS:

ISOTOPE	REFERENCE VALUE	(*)	(*)	...SINGLE OBSERVATION...		...MEAN...
		AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	PERCENT STANDARD DEVIATION	PERCENT PRECISION AT .95 C.I.	PERCENT PRECISION AT .95 C.I.
.....						
PU-239	8.157E 03	8.142E 03	99.821	1.127	2.400	.600

(*) COUNTS / MINUTE
.....

Table IVa.

Standards Report - Gamma 1 10 A

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 1 10.A

ISOTOPE	DATE	OBSERVED VALUE (*)	REFERENCE VALUE (*)	PERCENT RECOVERY
CS-137	12968	4.715E 06	4.764E 06	98.971
CS-137	20268	4.775E 06	4.764E 06	100.231
CS-137	20568	4.802E 06	4.764E 06	100.793
CS-137	20668	4.779E 06	4.764E 06	100.315
CS-137	20768	4.732E 06	4.764E 06	99.323
CS-137	20868	4.823E 06	4.764E 06	101.233
CS-137	20968	4.763E 06	4.764E 06	99.979
CS-137	21268	4.735E 06	4.764E 06	99.391
CS-137	21368	4.720E 06	4.764E 06	99.075
CS-137	21468	4.763E 06	4.764E 06	99.979
CS-137	21668	4.730E 06	4.764E 06	99.285
CS-137	21968	4.749E 06	4.764E 06	99.685
CS-137	22168	4.741E 06	4.764E 06	99.517
CS-137	22668	4.748E 06	4.764E 06	99.654
CS-137	22768	4.770E 06	4.764E 06	100.126
CS-137	22868	4.772E 06	4.764E 06	100.158
CS-137	22968	4.710E 06	4.764E 06	98.856
CS-137	30468	4.765E 06	4.764E 06	100.021
CS-137	30568	4.737E 06	4.764E 06	99.435
CS-137	30668	4.696E 06	4.764E 06	98.575
CS-137	31168	4.785E 06	4.764E 06	100.441
CS-137	31268	4.782E 06	4.764E 06	100.378
CS-137	31368	4.769E 06	4.764E 06	100.105
CS-137	31568	4.799E 06	4.764E 06	100.735
CS-137	31868	4.784E 06	4.764E 06	100.420
CS-137	31968	4.830E 06	4.764E 06	101.385
CS-137	32068	4.715E 06	4.764E 06	98.971
CS-137	32168	4.780E 06	4.764E 06	100.356
CS-137	32268	4.777E 06	4.764E 06	100.273
CS-137	32568	4.749E 06	4.764E 06	99.685
CS-137	32668	4.795E 06	4.764E 06	100.651
CS-137	32768	4.735E 06	4.764E 06	99.391
CS-137	32868	4.728E 06	4.764E 06	99.244
CS-137	32968	4.757E 06	4.764E 06	99.853

(*) D_{CS} / MIN

Table IVb.

Standards Summary - Gamma 1 10 A

STANDARDS SUMMARY FOR FIRST QUARTER, 1968:

CODE GAMMA 1.10 A 34 DETERMINATIONS:

ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
CS-137	4,764E-06	4,759E-06	99.898	.675	1.364	.234

(*)...DIS / MIN.....

Table Va.

Standards Report - Gamma 1 10 B

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 1 10 B

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
CS-137	12568	4.635E 06	4.629E 06	100.130
CS-137	12668	4.610E 06	4.629E 06	99.560
CS-137	12968	4.641E 06	4.629E 06	100.259
CS-137	12968	4.610E 06	4.629E 06	99.560
CS-137	13068	4.653E 06	4.629E 06	100.516
CS-137	13168	4.590E 06	4.529E 06	99.157
CS-137	20168	4.606E 06	4.529E 06	99.503
CS-137	20268	4.627E 06	4.529E 06	99.957
CS-137	20568	4.604E 06	4.529E 06	99.460
CS-137	20668	4.705E 06	4.529E 06	101.642
CS-137	20768	4.609E 06	4.529E 06	99.568
CS-137	20968	4.616E 06	4.529E 06	99.719
CS-137	21268	4.684E 06	4.529E 06	101.188
CS-137	21368	4.622E 06	4.529E 06	99.849
CS-137	21468	4.646E 06	4.529E 06	100.367
CS-137	21668	4.596E 06	4.529E 06	99.287
CS-137	21968	4.587E 06	4.529E 06	99.093
CS-137	22068	4.631E 06	4.529E 06	100.043
CS-137	22668	4.595E 06	4.529E 06	99.266
CS-137	22768	4.624E 06	4.629E 06	99.892
CS-137	22868	4.593E 06	4.629E 06	99.222
CS-137	22968	4.605E 06	4.629E 06	99.482
CS-137	30468	4.587E 06	4.629E 06	99.093
CS-137	30568	4.577E 06	4.629E 06	98.877
CS-137	30668	4.620E 06	4.629E 06	99.805
CS-137	30768	4.665E 06	4.629E 06	100.773
CS-137	30868	4.615E 06	4.629E 06	99.693
CS-137	31168	4.646E 06	4.629E 06	100.367
CS-137	31268	4.573E 06	4.629E 06	98.790
CS-137	31368	4.652E 06	4.629E 06	100.497
CS-137	31468	4.620E 06	4.629E 06	99.806
CS-137	31568	4.651E 06	4.629E 06	100.475
CS-137	31868	4.611E 06	4.629E 06	99.611
CS-137	31968	4.575E 06	4.629E 06	98.833
CS-137	32068	4.639E 06	4.629E 06	100.216
CS-137	32168	4.631E 06	4.629E 06	100.043
CS-137	32268	4.609E 06	4.629E 06	99.568

(*) DIS / MIN

Table Yh.

Standards Summary - Gamma 10 B

STANDARDS SUMMARY FOR FIRST QUARTER, 1968.

CODE GAMMA 1 10 B 37 DETERMINATIONS:

ISOTOPE	REFERENCE VALUE (*)	AVERAGE OBSERVED VALUE (*)	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	...OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
CS-137	4.629E-06	4.621E-06	99.817	.638	1.289	.212

(*) DIS / MIN

Table VIIa.

Standards Report - Gamma 2 ALL

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 2 ALL

ISOTOPE	DATE	OBSERVED VALUE (*)	REFERENCE VALUE (*)	PERCENT RECOVERY
I-131	12668	7.096E 09	7.190E 09	98.693
I-131	12968	7.274E 09	7.190E 09	101.168
I-131	13168	7.199E 09	7.190E 09	100.125
I-131	20268	7.313E 09	7.190E 09	101.711
I-131	20568	7.143E 09	7.190E 09	99.346
I-131	20768	7.274E 09	7.190E 09	101.168
I-131	20968	7.121E 09	7.190E 09	99.040
I-131	21268	7.235E 09	7.190E 09	100.626
I-131	21468	7.185E 09	7.190E 09	99.930
I-131	21668	7.352E 09	7.190E 09	102.253
I-131	21968	7.104E 09	7.190E 09	98.804
I-131	22168	7.274E 09	7.190E 09	101.168
I-131	22668	7.326E 09	7.190E 09	101.892
I-131	22668	7.328E 09	7.190E 09	101.919
I-131	22868	7.128E 09	7.190E 09	99.138
I-131	30468	7.145E 09	7.190E 09	99.374
I-131	30468	7.228E 09	7.190E 09	100.529
I-131	30668	7.424E 09	7.190E 09	103.255
I-131	30868	7.235E 09	7.190E 09	100.626
I-131	31168	7.267E 09	7.190E 09	101.071
I-131	31368	7.109E 09	7.190E 09	98.873
I-131	31568	7.209E 09	7.190E 09	100.264
I-131	31868	7.208E 09	7.190E 09	100.250
I-131	32068	7.250E 09	7.190E 09	100.834
I-131	32268	7.042E 09	7.190E 09	97.942
I-131	32668	7.112E 09	7.190E 09	98.915
I-131	32868	7.183E 09	7.190E 09	99.903
I-131	32968	7.221E 09	7.190E 09	100.431

(*) DIS / MIN

Table VIb

Standards Summary - Gamma '2 ALL

STANDARDS SUMMARY FOR FIRST QUARTER, 1968

		CODE GAMMA '2 ALL		28 DETERMINATIONS:		
ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	...OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
						
I-131	7.190E 09	7.214E 09	100.330	1.254	2.571	.486

(*) DIS / MIN

.....

Table VIIa.

Standards Report - Gamma 2 A

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE: GAMMA 2 A

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
I-131	12968	7.274E 09	7.190E 09	101.168
I-131	20268	7.313E 09	7.190E 09	101.711
I-131	21268	7.235E 09	7.190E 09	100.626
I-131	21668	7.352E 09	7.190E 09	102.253
I-131	22168	7.274E 09	7.190E 09	101.168
I-131	22668	7.328E 09	7.190E 09	101.919
I-131	30468	7.228E 09	7.190E 09	100.529
I-131	30668	7.424E 09	7.190E 09	103.255
I-131	31568	7.209E 09	7.190E 09	100.264
I-131	31168	7.267E 09	7.190E 09	101.071
I-131	32068	7.250E 09	7.190E 09	100.834
I-131	32668	7.112E 09	7.190E 09	98.915
I-131	32968	7.221E 09	7.190E 09	100.431

(*) DIS / MIN

Table YIib.

Standards Summary - Gamma 2 B

STANDARDS SUMMARY FOR FIRST QUARTER, 1968.

CODE GAMMA 2 A 13 DETERMINATIONS:

ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
I-131	7.190E 09	7.268E 09	101.088	1.063	2.318	.643

(*) DIS / MIN

Table VIIa.

Standards Report - Gamma 2 B

STANDARDS REPORT FOR FIRST QUARTER, 1958

CODE: GAMMA 2 B

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
I-131	12668	7.096E 09	7.190E 09	98.693
I-131	13168	7.199E 09	7.190E 09	100.125
I-131	20568	7.143E 09	7.190E 09	99.346
I-131	20768	7.274E 09	7.190E 09	101.168
I-131	20968	7.121E 09	7.190E 09	99.040
I-131	21468	7.185E 09	7.190E 09	99.930
I-131	21968	7.104E 09	7.190E 09	98.804
I-131	22668	7.326E 09	7.190E 09	101.892
I-131	22868	7.128E 09	7.190E 09	99.138
I-131	30468	7.145E 09	7.190E 09	99.374
I-131	30868	7.235E 09	7.190E 09	100.626
I-131	31368	7.109E 09	7.190E 09	98.873
I-131	31868	7.208E 09	7.190E 09	100.250
I-131	32268	7.042E 09	7.190E 09	97.942
I-131	32868	7.183E 09	7.190E 09	99.903

(*) DIS / MIN

.....

Table VIIIb.

Standards Summary - Gamma 2 B

STANDARDS SUMMARY FOR FIRST QUARTER, 1968.

CODE: GAMMA 2 B 15 DETERMINATIONS:

ISOTOPE	REFERENCE VALUE (*)	AVERAGE OBSERVED VALUE (*)	PERCENT AVERAGE RECOVERY	SINGLE PERCENT STANDARD DEVIATION	OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
I-131	7.190E 09	7.167E 09	99.674	1.034	2.222	.574

(*)...DIS / MIN.....

Table IXa.

Standards Report - Gamma 2 200

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 2 200

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
I-131	12668	7.096E 09	7.190E 09	98.693
I-131	12968	7.274E 09	7.190E 09	101.168
I-131	13168	7.199E 09	7.190E 09	100.125
I-131	20268	7.313E 09	7.190E 09	101.711
I-131	20568	7.143E 09	7.190E 09	99.346
I-131	20768	7.274E 09	7.190E 09	101.168
I-131	20968	7.121E 09	7.190E 09	99.040
I-131	21268	7.235E 09	7.190E 09	100.626
I-131	21468	7.185E 09	7.190E 09	99.930
I-131	21668	7.352E 09	7.190E 09	102.253
I-131	21968	7.104E 09	7.190E 09	98.804
I-131	22168	7.274E 09	7.190E 09	101.168
I-131	22668	7.326E 09	7.190E 09	101.892
I-131	22668	7.328E 09	7.190E 09	101.919
I-131	22868	7.128E 09	7.190E 09	99.138

(*) DIS / MIN

Table IXb.

Standards Summary - Gamma 2 200

STANDARDS SUMMARY FOR FIRST QUARTER, 1968:

		CODE: GAMMA 2 200	15 DETERMINATIONS:			
ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE	OBSERVATION...	...MEAN...
				PERCENT STANDARD DEVIATION	PERCENT PRECISION AT .95 C.I.	PERCENT PRECISION AT .95 C.I.
.....						
I-131	7.190E 09	7.223E 09	100.465	1.247	2.680	.692

(*) DIS / MIN

Table Xa.

Standards Report - Gamma 2 100

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE: GAMMA 2 100

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
I-131	30468	7.228E 09	7.190E 09	100.529
I-131	30468	7.145E 09	7.190E 09	99.374
I-131	30668	7.424E 09	7.190E 09	103.255
I-131	30868	7.235E 09	7.190E 09	100.626
I-131	31168	7.267E 09	7.190E 09	101.071
I-131	31368	7.109E 09	7.190E 09	98.873
I-131	31568	7.209E 09	7.190E 09	100.264

(*) DIS / MIN

Table Xb.

Standards Summary - Gamma 2 100

STANDARDS SUMMARY FOR FIRST QUARTER, 1968.

CODE: GAMMA 2 100 7 DETERMINATIONS:

ISOTOPE	REFERENCE VALUE (*)	AVERAGE OBSERVED VALUE (*)	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	...OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
I-131	7.190E 09	7.231E 09	100.570	1.406	3.445	1.302

(*) DIS / MIN

.....

Table XIa.

Standards Report - Gamma 2 50

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 2 50

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
I-131	31868	7.208E 09	7.190E 09	100.250
I-131	32068	7.250E 09	7.190E 09	100.834
I-131	32268	7.042E 09	7.190E 09	97.942
I-131	32668	7.112E 09	7.190E 09	98.915
I-131	32868	7.183E 09	7.190E 09	99.903
I-131	32968	7.221E 09	7.190E 09	100.431

(*) DIS / MIN

Table XIb.

Standards Summary - Gamma 2 50

STANDARDS SUMMARY FOR: FIRST QUARTER, 1968.

CODE GAMMA 2 50

6 DETERMINATIONS:

ISOTOPE	REFERENCE VALUE (*)	AVERAGE OBSERVED VALUE (*)	PERCENT AVERAGE RECOVERY	SINGLE OBSERVATION.... PERCENT STANDARD DEVIATION	PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
I-131	7.190E-09	7.159E-09	99.713	1.084	2.785	1.137

(*) DIS / MIN

Table XIIa.

Standards Report - Gamma 3 10

STANDARDS REPORT FOR: FIRST QUARTER, 1968

CODE: GAMMA 3: 10

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
ZRN3-95	12568	2.611E 05	2.687E 05	97.172
ZRN3-95	20168	2.807E 05	2.687E 05	104.466
ZRN3-95	20868	2.642E 05	2.687E 05	98.325
ZRN3-95	21368	2.788E 05	2.687E 05	103.759
ZRN3-95	22768	3.236E 05	2.687E 05	120.432
ZRN3-95	30868	2.747E 05	2.687E 05	102.233
ZRN3-95	31268	2.872E 05	2.687E 05	106.885
ZRN3-95	32168	3.101E 05	2.687E 05	115.408
ZRN3-95	32668	3.271E 05	2.687E 05	121.734
CE-144	12568	3.507E 06	3.755E 06	93.395
CE-144	20168	3.565E 06	3.755E 06	94.940
CE-144	20868	4.192E 06	3.755E 06	111.638
CE-144	21368	3.811E 06	3.755E 06	101.491
CE-144	22768	5.586E 06	3.755E 06	148.762
CE-144	30868	3.891E 06	3.755E 06	103.622
CE-144	31268	3.796E 06	3.755E 06	101.092
CE-144	32168	3.995E 06	3.755E 06	106.391
CE-144	32668	3.868E 06	3.755E 06	103.009
RU-106	12568	3.962E 06	3.907E 06	101.408
RU-106	20168	3.818E 06	3.907E 06	97.722
RU-106	20868	3.942E 06	3.907E 06	100.896
RU-106	21368	3.980E 06	3.907E 06	101.868
RU-106	22768	3.990E 06	3.907E 06	102.124
RU-106	30868	3.773E 06	3.907E 06	96.570
RU-106	31268	3.803E 06	3.907E 06	97.338
RU-106	32168	3.761E 06	3.907E 06	96.263
RU-106	32668	4.105E 06	3.907E 06	105.068
CS-137	12568	2.039E 06	2.068E 06	98.598
CS-137	20168	2.073E 06	2.068E 06	100.242
CS-137	20868	2.093E 06	2.068E 06	101.209
CS-137	21368	2.093E 06	2.068E 06	101.209
CS-137	22768	2.095E 06	2.068E 06	101.306
CS-137	30868	2.078E 06	2.068E 06	100.484
CS-137	31268	2.045E 06	2.068E 06	98.888

(*) DIS / MIN

(Table XIa. Continued)

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE: GAMMA 3 10

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
CS-137	32168	2.098E 06	2.068E 06	101.451
CS-137	32668	2.099E 06	2.068E 06	101.499

(*) DIS / MIN

.....

Table XIIb.

Standards Summary - Gamma 3 10

STANDARDS SUMMARY FOR FIRST QUARTER, 1968:

CODE GAMMA 3.10		9 DETERMINATIONS:				
ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
ZRNB-95	2.687E 05	2.897E 05	107.824	9.176	21.197	7.066
CE-144	3.755E 06	4.023E 06	107.149	16.541	38.210	12.737
RU-106	3.907E 06	3.904E 06	99.918	3.050	7.045	2.348
CS-137	2.068E 06	2.079E 06	100.543	1.108	2.560	.853

(*) DIS, MIN

.....

Table XIIIa.

Standards Report - 3 10 A

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 3 10 A

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
ZRNB-95	20868	2.642E 05	2.687E 05	98.325
ZRNB-95	21368	2.788E 05	2.687E 05	103.759
ZRNB-95	22768	3.236E 05	2.687E 05	120.432
ZRNB-95	32168	3.101E 05	2.687E 05	115.408
ZRNB-95	32668	3.271E 05	2.687E 05	121.734
CE-144	20868	4.192E 06	3.755E 06	111.638
CE-144	21368	3.811E 06	3.755E 06	101.491
CE-144	22768	5.586E 06	3.755E 06	148.762
CE-144	32168	3.995E 06	3.755E 06	106.391
CE-144	32668	3.868E 06	3.755E 06	103.009
RU-106	20868	3.942E 06	3.907E 06	100.896
RU-106	21368	3.980E 06	3.907E 06	101.868
RU-106	22768	3.990E 06	3.907E 06	102.124
RU-106	32168	3.761E 06	3.907E 06	96.263
RU-106	32668	4.105E 06	3.907E 06	105.068
CS-137	20868	2.093E 06	2.068E 06	101.209
CS-137	21368	2.093E 06	2.068E 06	101.209
CS-137	22768	2.095E 06	2.068E 06	101.306
CS-137	32168	2.098E 06	2.068E 06	101.451
CS-137	32668	2.099E 06	2.068E 06	101.499

(*) DIS / MIN

.....

Table XIIIf.

Standards Summary - 3 10 A

STANDARDS SUMMARY FOR FIRST QUARTER, 1968.

CODE GAMMA 3 10 A 5 DETERMINATIONS:

ISOTOPE	(*)	(*)	PERCENT AVERAGE RECOVERY	...SINGLE	OBSERVATION...	...MEAN...
	REFERENCE VALUE	AVERAGE OBSERVED VALUE		PERCENT STANDARD DEVIATION	PERCENT PRECISION AT .95 C.I.	PERCENT PRECISION AT .95 C.I.
.....						
ZRNB-95	2,687E 05	3,008E 05	111,932	10,397	28,902	12,926
CE-144	3,755E 06	4,290E 06	114,258	19,677	54,703	24,464
RU-106	3,907E 06	3,956E 06	101,244	3,190	8,870	3,967
CS-137	2,068E 06	2,096E 06	101,335	,135	,375	,168

(*) DIS / MIN

Table XIVA.

Standards Report - 3 10 B

STANDARDS REPORT FOR FIRST QUARTER, 1968.

CODE GAMMA 3 10 B

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
ZRNB-95	12568	2.611E 05	2.687E 05	97.172
ZRNB-95	20168	2.807E 05	2.687E 05	104.466
ZRNB-95	30868	2.747E 05	2.687E 05	102.233
ZRNB-95	31268	2.872E 05	2.687E 05	106.885
CE-144	12568	3.507E 06	3.755E 06	93.395
CE-144	20168	3.565E 06	3.755E 06	94.940
CE-144	30868	3.891E 06	3.755E 06	103.622
CE-144	31268	3.796E 06	3.755E 06	101.092
RU-106	12568	3.962E 06	3.907E 06	101.408
RU-106	20168	3.818E 06	3.907E 06	97.722
RU-106	30868	3.773E 06	3.907E 06	96.570
RU-106	31268	3.803E 06	3.907E 06	97.338
CS-137	12568	2.039E 06	2.068E 06	98.598
CS-137	20168	2.073E 06	2.068E 06	100.242
CS-137	30868	2.078E 06	2.068E 06	100.484
CS-137	31268	2.045E 06	2.068E 06	98.888

(*) DIS / MIN

.....

Table XIVb.

Standards Summary - 3 10 B

STANDARDS SUMMARY FOR FIRST QUARTER, 1968.

CODE GAMMA 3 10 B 4 DETERMINATIONS:

ISOTOPE	(*) REFERENCE VALUE	(*) AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	...OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
2RNB-95	2.687E-05	2.759E-05	102.689	4.140	13.165	6.582
CE-144	3.755E-06	3.690E-06	98.262	4.880	15.520	7.760
RU-106	3.907E-06	3.832E-06	98.260	2.153	6.846	3.423
CS-137	2.068E-06	2.059E-06	99.553	.948	3.014	1.507

(*) DIS / MIN

Table XVa.

Standards Report - 4 ALL

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 4 ALL

ISOTOPE	DATE	(*) OBSERVED VALUE	(*) REFERENCE VALUE	PERCENT RECOVERY
.....				
I-131	12468	9.470E 05	9.500E 05	99.684
I-131	20168	9.210E 05	9.500E 05	96.947
I-131	20668	9.480E 05	9.500E 05	99.789
I-131	21668	9.930E 05	9.500E 05	104.526
I-131	22068	1.020E 06	9.500E 05	107.368
I-131	22968	1.020E 06	9.500E 05	107.368
I-131	30568	1.010E 06	9.500E 05	106.316
I-131	31968	9.220E 05	9.500E 05	97.053
TE-132	12468	9.360E 05	9.000E 05	104.000
TE-132	20168	8.560E 05	9.000E 05	95.111
TE-132	20668	9.150E 05	9.000E 05	101.667
TE-132	21668	1.110E 06	9.000E 05	123.333
TE-132	22068	1.480E 06	9.000E 05	164.444
TE-132	22968	2.980E 06	9.000E 05	331.111
TE-132	30568	6.040E 06	9.000E 05	671.111
TE-132	31968	6.340E 07	9.000E 05	7044.444
TE-129	12468	5.430E 03	5.000E 03	108.600
TE-129	20168	6.870E 03	5.000E 03	137.400
TE-129	20668	7.130E 03	5.000E 03	142.600
TE-129	21668	4.790E 03	5.000E 03	95.800
TE-129	22068	4.790E 03	5.000E 03	95.800
TE-129	22968	4.820E 03	5.000E 03	96.400
TE-129	30568	4.740E 03	5.000E 03	94.800
TE-129	31968	1.040E 04	5.000E 03	208.000
RU-103	12468	0	2.000E 03	0
RU-103	20168	0	2.000E 03	0
RU-103	20668	0	2.000E 03	0
RU-103	21668	1.660E 03	2.000E 03	83.000
RU-103	22068	1.340E 03	2.000E 03	67.000
RU-103	22968	1.720E 03	2.000E 03	86.000
RU-103	30568	1.930E 03	2.000E 03	96.500
RU-103	31968	2.070E 03	2.000E 03	103.500

(*) DIS / SEC

[Table XVa. Continued.]

STANDARDS REPORT FOR FIRST QUARTER, 1968

CODE GAMMA 4 ALL

ISOTOPE	DATE	(*)	(*)	PERCENT RECOVERY
		OBSERVED VALUE	REFERENCE VALUE	
.....				
CS-137	12468	5.820E 03	3.230E 03	181.875
CS-137	20168	0	3.230E 03	0
CS-137	20668	0	3.230E 03	0
CS-137	21668	7.850E 01	3.230E 03	2.453
CS-137	22068	0	3.230E 03	0
CS-137	22968	3.100E 01	3.230E 03	2.531
CS-137	30568	2.150E 01	3.230E 03	.672
CS-137	31968	2.840E 01	3.230E 03	.887

(*) DIS / SEC

.....

Table Xyb.

Standards Summary - 4 ALL

STANDARDS SUMMARY FOR FIRST QUARTER, 1968:

ISOTOPE	(*)		CODE GAMMA 4 ALL 8 DETERMINATIONS			
	REFERENCE VALUE	AVERAGE OBSERVED VALUE	PERCENT AVERAGE RECOVERY	...SINGLE PERCENT STANDARD DEVIATION	OBSERVATION... PERCENT PRECISION AT .95 C.I.	...MEAN... PERCENT PRECISION AT .95 C.I.
.....						
I-131	9,500E-05	9,726E-05	102,382	4,500	10,665	3,770
TE-132	9,000E-05	9,715E-06	1079,403	2418,258	5731,271	2026,310
TE-129	5,000E-03	6,121E-03	122,425	39,648	93,966	33,222
RU-103	2,000E-03	1,090E-03	54,500	46,347	109,843	38,835
CS-137	3,200E-03	7,537E-02	23,552	63,980	151,634	53,611

(*) DIS / SEC

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APPENDIX B

STATISTICAL PROGRAM FOR CDC-1604

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PROGRAM JBAHCW
TYPE INTEGER D,DR
DIMENSION T(34),DR(200),ID(200),S(18,200),R(18,200),SD(18),AV(18)
DIMENSION P(18),SDM(18),PM(18),IG(200),R(200)
DIMENSION REC(18),RR(18,200)
DATA (T= 12,71 ,

```

```

1      4.3 ,
1      3.18 ,
1      2.78 ,
1      2.57 ,
1      2.45 ,
1      2.37 ,
1      2.31 ,
1      2.26 ,
1      2.23 ,
1      2.2 ,
1      2.18 ,
1      2.16 ,
1      2.15 ,
1      2.13 ,
1      2.12 ,
1      2.11 ,
1      2.10 ,
1      2.09 ,
1      2.09 ,
1      2.08 ,
1      2.07 ,
1      2.07 ,
1      2.06 ,
1      2.06 ,
1      2.06 ,
1      2.05 ,
1      2.05 ,
1      2.04 ,
1      2.04 ,
1      2.02 ,
1      2 ,
1      1.98 ,
1      1.96

```

```

10  LC=2
    READ 20, NRESULTS,N,Q,Y,UNITS1,UNITS2
20  FORMAT (2I10,A6,3X,A4,2A8)
    IF (N) 23,999
23  IF (N.GT.121)24,25
24  L=34
    GO TO 32
25  IF (N.GT.61)26,27
26  L=33
    GO TO 32
27  IF (N.GT.41)28,29
28  L=32
    GO TO 32
29  IF (N.GT.31)30,31
30  L=31
    GO TO 32
31  L=N-1

```



```

32 DO 40 J=1,N
   DO 40 I=1,NRESULTS
     READ 33,SIG,CODE,NOCODE,D,DR(J),IG(J),B(J),
1     ID(I),S(I,J),SE,R(I,J),RE
33 FORMAT (A1,A5,I3,2I6,A3,A1,1X,A7,F5.4,F2.0,F5.4,F2.0)
   R(I,J)=R(I,J)*10,**RE
   S(I,J)=S(I,J)*10,**SE
40 RR(I,J)=R(I,J)/S(I,J)
   Z=N
   DO 50 I=1,NRESULTS
     SUMR=0.
     SUMR2=0.
     SUMDIF=0.
     PRINT 41
41 FORMAT(1H0)
     LC=LC-2
     DO 46 J=1,N
       IF (I.EQ.1.AND.J.EQ.1)42,80
80 IF (LC)44,85
85 PRINT 41
     PRINT 38,UNITS1,UNITS2
38 FORMAT(1H ,15X,60(1H.),// ,15X,4H(*) ,2A8)
42 PRINT 39
39 FORMAT(1H1)
     PRINT 43,Q,Y,CODE,NOCODE,IG(N),B(N)
43 FORMAT (1H0,23X,21HSTANDARDS REPORT FOR ,A6,10H QUARTER, ,A4 //
1     35X,5HCODE ,A5,I3,2X,A3,A1//
2     46X,3H(*),10X,3H(*)/
3     18X,7HISOTOPE,4X,4HDATE,6X,8HOBERVED,4X,9HREFERENCE,3X,7HPE
4RCENT / 29X,3X ,8X,5HVALUE,8X,5HVALUE,5X,8HRECOVERY /
5     18X, 7(1H.),3X,6(1H.),5X,9(1H.),3X,9(1H.),3X,8(1H.),/)
     LC=40
44 SUMR=SUMR+RR(I,J)
     SUMR2=SUMR2+RR(I,J)*RR(I,J)
     DIF=RR(I,J)*100.
     SUMDIF=SUMDIF+DIF
     PRINT 45, ID(I),DR(J),R(I,J),S(I,J),DIF,IG(J),B(J)
45 FORMAT(1H ,17X,A7,I9,E14,3,E12,3,F10,3,30X,2X,A3,A1)
     LC=LC-1
46 CONTINUE
     SD(I)=SQRTF((SUMR2+SUMR*SUMR/Z)/(Z-1))*100.
     AV(I)=SUMR/Z*S(I,N)
     REC(I)=SUMDIF/Z
     P(I)=T(L)*SD(I)
     SDM(I)=SD(I)/SQRTF(Z)
50 PM(I)=SDM(I)*T(L)
     IF (LC)51,53
51 DO 52 JL=1,LC
52 PRINT 54
54 FORMAT(1H )
53 PRINT 41
     PRINT 38, UNITS1,UNITS2
     LC=0
     DO 70 I=1,NRESULTS
       IF (I.EQ.1)65,61
61 IF (LC)63,91

```

```

91  PRINT 41
    PRINT 38,UNITS1,UNITS2
65  PRINT 39
    PRINT 41
    PRINT 62,0,Y,CODE,NOCODE,IG(N),B(N),N
62  FORMAT(1H0,35X,22HSTANDARDS SUMMARY FOR ,A6,10H QUARTER, ,A4 //
1    37X,5HCODE ,A5,I3,A5,A1,I5,15H DETERMINATIONS //
2    30X,3H(*),9X,3H(*),18X,39H...SINGLE OBSERVATION,... ...MEA
4N.... / 12X,32HISOTOPE REFERENCE AVERAGE,6X,7HPERCENT,6X,
5    7HPERCENT, 9X,7HPERCENT,7X,7HPERCENT/
5    24X,5HVALUE,7X,8HOBERVED,6X,7HAVERAGE,6X,8HSTANDARD,7X,
6    9HPRECISION,5X,9HPRECISION /
8    37X,5HVALUE,8X,8HRECOVERY,5X,9HDEVIATION,5X,25HAT ,95 C.I.
9AT ,95 C.I. / 12X 7(1H.),3X,9(1H.),5X,9(1H.),5X,8(1H.),5X,9(1H.),
1    5X,11(1H.),3X,11(1H.) /)
    LC=20
63  PRINT 64,ID(I),S(I,N),AV(I),REC(I),SD(I),P(I),PM(I)
64  FORMAT(1H0,11X,A7,E12.3,E14.3,F12.3,3F14.3)
70  LC=LC-2
    IF(LC)71,74
71  DO 72 I=1,LC
72  PRINT 54
74  PRINT 41
    PRINT 38,UNITS1,UNITS2
    GO TO 10
999 RETURN
    END

```

PROGRAM

JBAHCW

060768

		IDENT	JBAHCW
RANGE	FWA - LWA+1		
	00000 27644		
ENTRY POINTS	27170	JBAHCW	
EXTERNAL SYMBOLS			
	00001 Q2007111		
	00002 Q1Q10010		
	00003 SQRTF		
	00004 Q8QINGIN		
	00005 Q8QENGIN		
	00006 Q8QGINTY		
	00007 Q8QINGOT		
	00010 Q8QENGOT		
	00011 Q8QGOTTY		
	00012 Q8QENTRY		
NO DOUBLY DEFINED			
NO UNDEFINED SYMBOLS			
NO ASSEMBLY ERRORS			
NULLS		.24	.26
	IF00001,	.85	.46
	.91	.70	.72