SEP 27 1994

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1	1	Cog.:Eng. Thomas Bratvold [signature] 9/13/94 X3-69	Byron Christiansen [signature] 9-14-94 L8-20	1	1
1	1	Cog.:Mgr. Mano Kaviani [signature] 9/13/94 X3-60	CENTRAL FILES L8-04	3	
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1		Safety: Larry Jordan [signature] 9/15/94 X5-53	Bob Ruben S0-06	3	
1	1	Robert Ford [signature] 9-14-94 L8-20			
1	1	Dave Ottley [signature] Sept 1, 94 L8-20			
~~1~~		~~Bob Ruben~~ 9/11/94 S0-06			

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Thomas Bratvold [signature] 9-14-94 Signature of EDT Originator Date	Mano Kaviani [signature] Authorized Representative for Receiving Organization Date 9/13/94	Mano Kaviani [signature] Cognizant/Project Engineer's Manager Date 9/13/94	Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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Document Number:	WHC-SD-SNF-LB-001, REV 0
Document Title:	RADON DISCRIMINATION FOR WORK PLACE AIR SAMPLES
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This document was reviewed following the procedures described in WHC-CM-3-4 and is:

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WHC Information Release Administration Specialist:

Kara Broz — 9/26/94

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SUPPORTING DOCUMENT

1. Total Pages 15

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6. Author

Name: Thomas Bratvold

Signature

Organization/Charge Code
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7. Abstract

This document identifies the process that K Basins Radiological Control will use to identify radon on grab air samples.

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RADON DISCRIMINATION FOR WORK PLACE AIR SAMPLES

July, 31 1994

183KE Health Physics Analytical Laboratory

K Basins Radiological Control
Westinghouse Hanford Company

1.0 Introduction

The relationship between work place air sampling, respiratory protection, and radon has been a sensitive topic for many years at K-Basins and throughout the Hanford Site. The fundamental roadblock has been the inability to efficiently assure radon is the sole airborne radioactive contaminant. There are valid methods available utilizing characteristic decay curves and alpha:beta ratios for radon daughter identification. The fundamental problem in using alpha:beta ratios and characteristic decay times arises when you want to remove a work area from respiratory protection. Even with the proper ratios and decay characteristics, the work place air sample may be above 10% alpha DAC for the isotope of concern. Therefore, one must accept a certain degree of risk when using decay/ratio techniques.

Gross alpha/beta measurement systems are designed solely to identify an incident particle as either an alpha or a beta and register a count accordingly. The tool of choice for radon identification, via decay daughters, is an instrument capable of identifying the energy of incident alpha particles and storing that information separately from detected alpha emissions of different energy. In simpler terms, the desired instrument is an alpha spectroscopy system. K Basins Radiological Control (KBRC) procured an EG&G ORTEC *OCTETE PC* alpha spectroscopy system to facilitate radon identification on work place air samples. The alpha spectrometer allows for the identification of any alpha emitting isotope based on characteristic alpha emission energies. With this new capability, KBRC will explicitly know whether or not there exists a true airborne concern. Based on historical air quality data, this new information venue will reduce the use of respirators substantially. Situations where an area remains "on mask" due solely to the presence of radon daughters on the grab air filter will finally be eliminated.

2.0 Scope

This document serves to introduce a new method for radon daughter detection at the 183KE Health Physics Analytical Laboratory (HPAL). A new work place air sampling analysis program will be described throughout this paper. There is no new technology being introduced, nor any unproven analytical process. Alpha Spectroscopy has been utilized for decades within the Hanford Site and across the globe. The program defined over the expanse of this document simply explains how K Basins Radiological Control will employ their alpha spectrometer. Eliminating the occurrence of respiratory protection, for naturally occurring contaminants in concentrations greater than 10% ^{239}Pu D.A.C. and less than the Radon D.A.C. defined in DOE 5480.11, is the end result of this program. This document does not include guidance for grab air sampling.

3.0 The Instrument

The EG&G ORTEC OCTETE PC is a Personal Computer-controlled integrated ALPHA SPECTROSCOPY workstation. It is intended for use with ion-implanted-silicon or silicon surface barrier charged-particle detectors. The OCTETE PC is a complete system comprising eight complete spectroscopy channels and the Multi Channel Analyzer (MCA) function in a single unit. Individual control of each spectrometer is via the MAESTRO MCA Emulator. Two DOS (MAESTRO II, ALPHAMAT) and a WINDOWS 3 (MAESTRO FOR WINDOWS 3) MCA Emulator software bundles are supplied with each OCTETE PC.

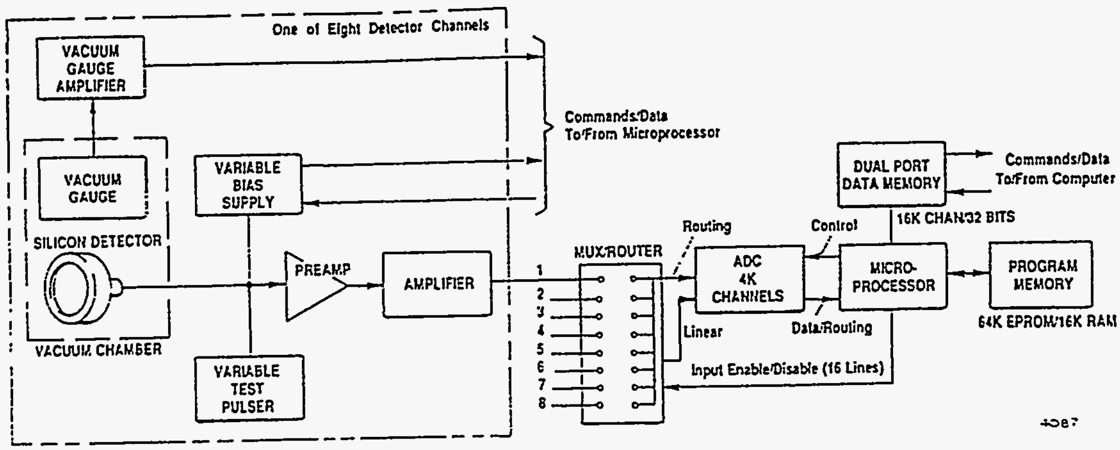
Each alpha spectroscopy channel includes a vacuum gauge, variable detector bias supply (positive or negative), preamplifier, shaping amplifier with adjustable gain, pulse stretcher and bias amplifier, test pulser generator with variable amplitude, and leakage current monitor. The design is modular for serviceability.

Each pulse generator is adjustable over a range representing 4 to 10 MeV; the bias supply is adjustable over the range from 0 to + 100 V. Each detector's bias voltage and leakage current may be read via the PC.

The MCA section of the OCTETE PC consists of an 8-input multiplexer, with individual control of start/stop/preset, and a successive-approximation ADC with a fixed conversion time per event of <15 μs and conversion gain range from 64 to 4096 channels. Individual conversion gains and individual digital offsets, with a one-channel resolution, are provided on each of the eight electronic channels. Distributed architecture allows up to 8 spectrometers (64 channels) to be controlled by a single PC. The block diagram of the OCTETE PC is shown in Diagram 1.

All eight vacuum chambers in each OCTETE PC are connected to an integral vacuum manifold with a single connector for attachment to an external vacuum pump. Each chamber has a manually operated pump/hold/vent valve, interlocked to the detector bias for that chamber. Individual pressure-gauge heads monitor the chamber pressures independently; pressure readout is via the PC.

Diagram 1:



4.0 Work Place Air Sample Analysis

Analytical operations for work place air samples received at the 183KE HPAL will include a combination of the following analysis as directed by the laboratory supervisor.

1. Upon receipt, log sample into "Sample Log Book" assigning it a unique sample identification number.

2. Count sample on the TENNELEC LB5100W in accordance with WHC-IP-0718 (APPENDIX I), Section 4.11A: Operation Of The Tennelec LB-5100-III-W α/β Counter.

3. Count Sample on the OCTETE PC in accordance with WHC-IP-0718 (APPENDIX I), Section 4.12A: Operation Of The Octete PC Alpha Spectroscopy System.

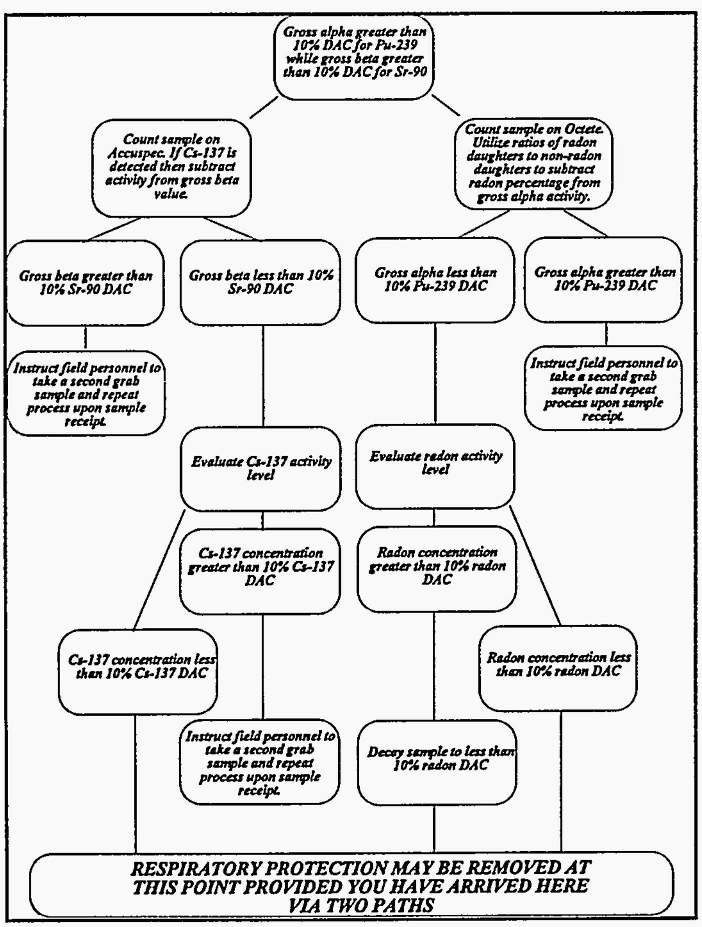
4. Count Sample on the ACCUSPEC gamma spectroscopy system in accordance with WHC-IP-0718 (APPENDIX I), Section 4.13A: Operation Of The Canberra Accuspec Gamma Spectroscopy System.

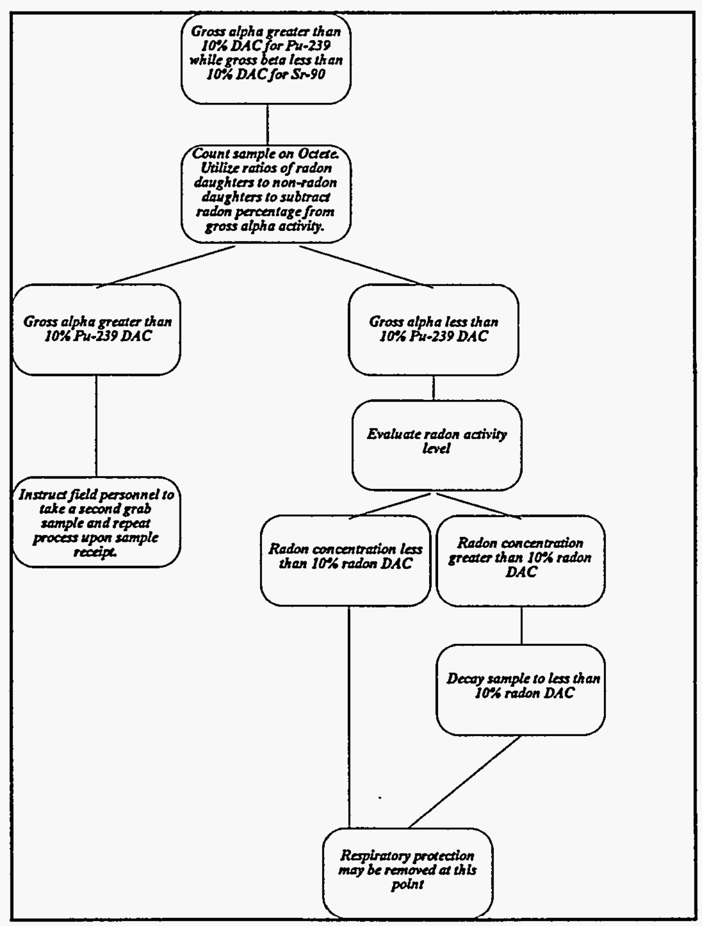
Upon completion of sample analysis, forward all data to the laboratory supervisor.

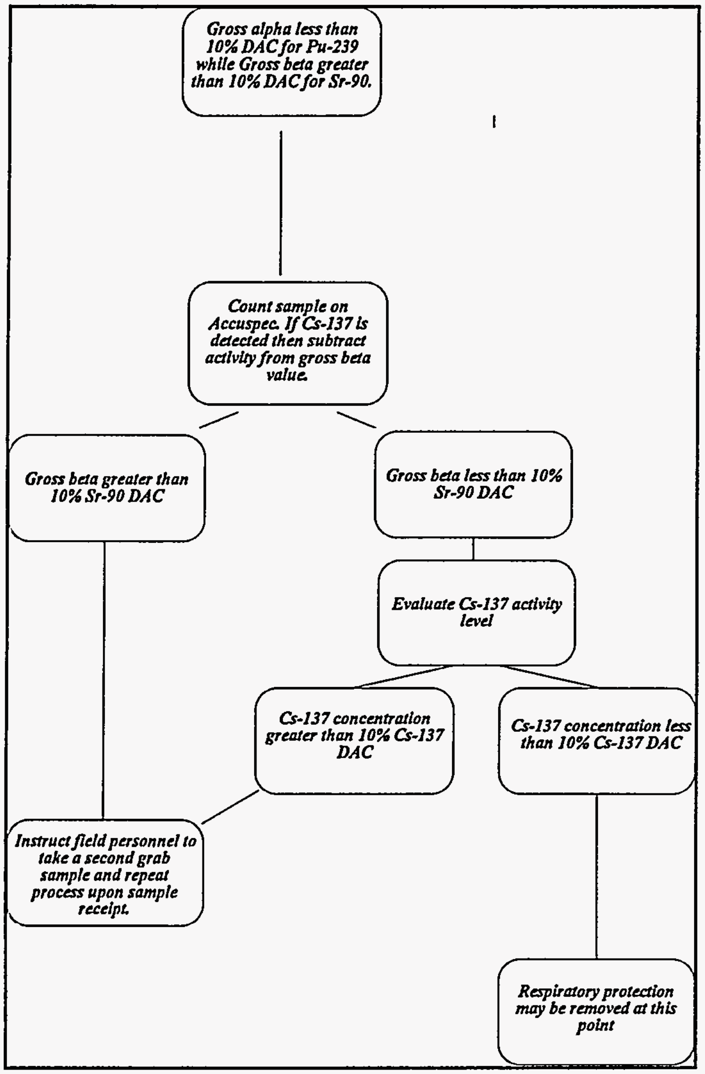
5.0 <u>Work Place Air Sample Data Analysis/Reporting</u>

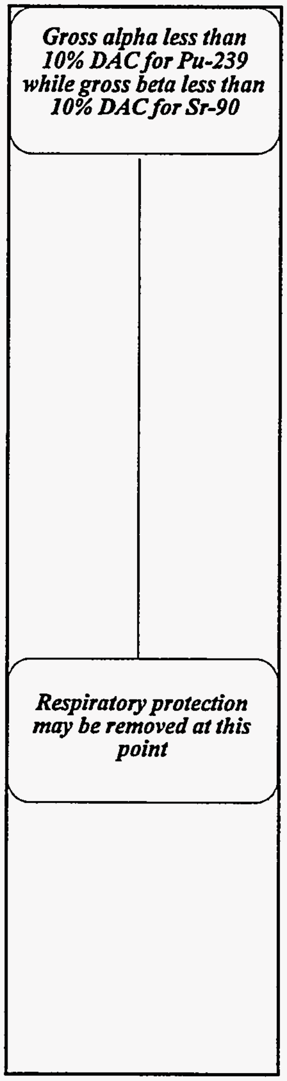
The Laboratory supervisor will review the collected data. The individual holding the Laboratory supervisor position must be authorized by both Health Physics and Radiological Engineering to review, validate, and report spectral data.

From all collected data, the Laboratory supervisor will determine the radon contribution to airborne activity. The radon percentage contribution, determined via alpha spectroscopy, will be subtracted from gross alpha/beta measurements. Radionuclides of concern are identified in WHC-SD-NR-RPT-005. The most conservative DAC values belong to Pu-239 (alpha) and Sr-90 (beta). These two isotopes are therefore defined as isotopes of concern. If radon subtracted values are less than these, one is assured that there is no airborne danger. The following are key issues: Radon concentrations less than 10% radon DAC. Subtracted gross beta concentrations less than 10% DAC for the beta emitting isotope of concern. Subtracted gross alpha concentrations less than 10% DAC for the alpha emitting isotope of concern. If all the above issues are true then the work place may be removed from respiratory protection. Logic diagrams for obtainment of this information follow for the four possible scenarios.









The alpha spectrometer is a fundamental instrument in these processes. Six figures follow. Each is a spectra obtained from the alpha spectroscopy system and illuminates the information supplied from this instrument. The following page gives a brief description of each figure.

Figure 1 shows a typical alpha spectrum used for calibration of chambers using a three to eight MeV energy range. Source S-3429 effectively spans this range allowing for dependable calibration parameters. This energy range incorporates the alpha energies resulting from radon daughters and allows for identification of radon in the workplace air. Typically this energy range will be utilized for a grab air samples initial count on the alpha spectrometer..

Figure 2 shows a typical alpha spectrum used for calibration of chambers using a four to six and one-half MeV energy range. Source 91PU4702304 effectively spans this range allowing for dependable calibration parameters. This energy range focuses on our alpha energy region of concern. This range is most useful in assuring that isotopes of concern are not present in the workplace air. Typically this energy range will be utilized when suspicion of isotopic contamination of concern is revealed on the broader three to eight MeV range..

Figure 3 documents that isotopic contamination is readily identifiable on samples counted in chambers preset with three to eight MeV ranges. Air samples that record counts in the four to six and one-half MeV region, on their first analysis, will typically be counted a second time within a chamber preset to this energy range.

Figure 4 documents that radon daughters are easily identifiable on samples counted in chambers preset to narrower energy windows. This information is useful when tracing the attenuated peak tail of the 6 MeV radon daughter alpha.

Figure 5 shows the presence of radon daughters and the lack of isotopic contamination of concern within the four to six and one-half MeV window. This air sample was drawn in the 183KE basement, an area free of contamination potential. This sample and the sample in figure 6 were taken at the same location during the same time interval. Comparison of Figures 5 and 6 displays the different spectra resulting from differing energy ranges.

Figure 6 identifies radon daughter contamination and the lack of isotopic contamination of concern. The full range of this spectra when compared to figure 5 displays the utility of the three to eight MeV range for identification of all radon daughter alpha emissions.

6.0 Conclusion

The attached figures display the information offered to the laboratory supervisor from the Octete alpha spectrometer. This information, when analyzed in conjunction with gross alpha/beta and possibly gamma spectroscopy analysis, will empower K Basins Radiological Control with true airborne data. This combination of analysis techniques yields a comprehensive understanding of airborne activity. This method eliminates risks associated with utilization of decay curves and alpha:beta ratios for Radon identification while offering a more efficient method than the decay technique. This method will yield in one hour what could take the decay technique one week.

7.0 Figures

1. Th-230 Calibration source with decay daughters. Source ID: S-3429 (3 to 8 MeV Range).

2. Plutonium-239 Calibration source with Plutonium-241* impurity. Source ID: 91PU4702304 (4 to 6.5 MeV Range). *: Pu-241 is Beta active.

3. Plutonium-239 Calibration source with Plutonium-241* impurity. Source ID: 91PU4702304 (3 to 8 MeV Range). *: Pu-241 is Beta active.

4. Th-230 Calibration source with decay daughters. Source ID: S-3429 (4 to 6.5 MeV Range).

5. Typical Radon Spectrum Obtained In 183KE Basement. (4 to 6.5 MeV Range).

6. Typical Radon Spectrum Obtained in 183KE Basement (3 to 8 MeV Range).

FIGURE 1

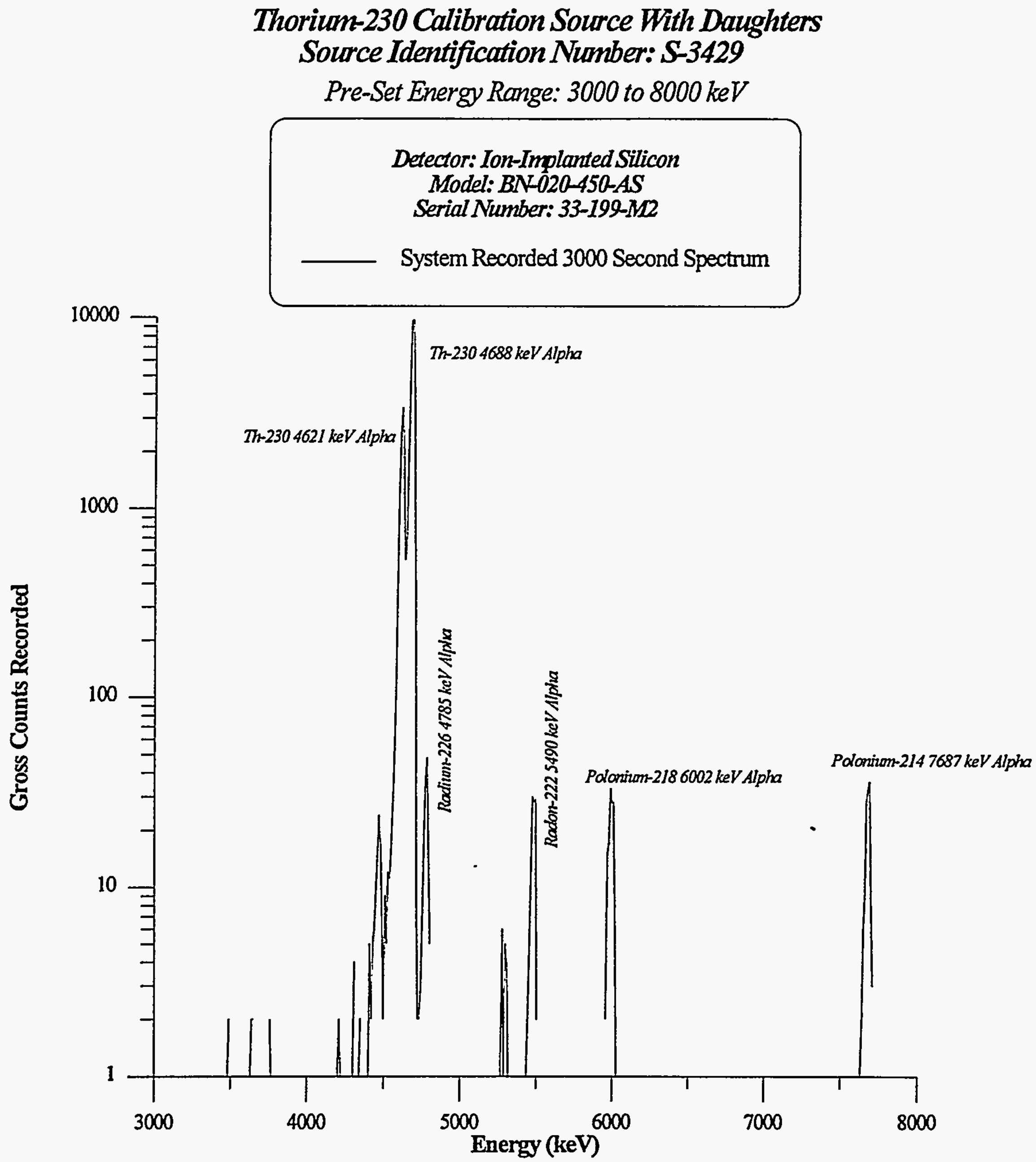

Thorium-230 Calibration Source With Daughters
Source Identification Number: S-3429
Pre-Set Energy Range: 3000 to 8000 keV
Detector: Ion-Implanted Silicon
Model: BN-020-450-AS
Serial Number: 33-199-M2
System Recorded 3000 Second Spectrum
Th-230 4688 keV Alpha
Th-230 4621 keV Alpha
Radium-226 4785 keV Alpha
Radon-222 5490 keV Alpha
Polonium-218 6002 keV Alpha
Polonium-214 7687 keV Alpha
Gross Counts Recorded
10000
1000
100
10
1
3000
4000
5000
6000
7000
8000
Energy (keV)

FIGURE 2

Plutonium-239 Calibration Source With Plutonium-241 Impurity
Source Identification Number: 91PU4702304

Pre-Set Energy Range: 4000 to 6500 keV

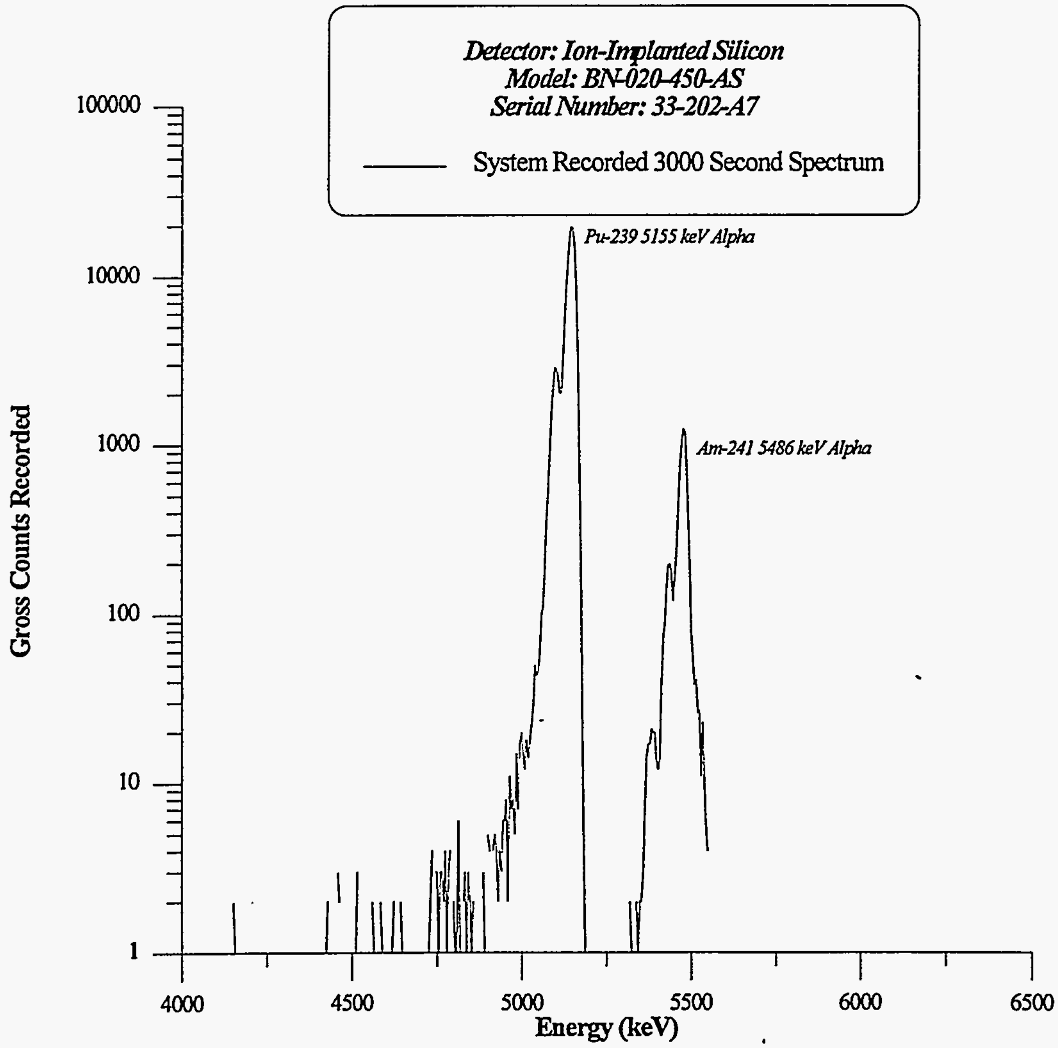


FIGURE 3

Plutonium-239 Calibration Source With Plutonium-241 Impurity
Source Identification Number: 91PU4702304

Pre-Set Energy Range: 3000 to 8000 keV

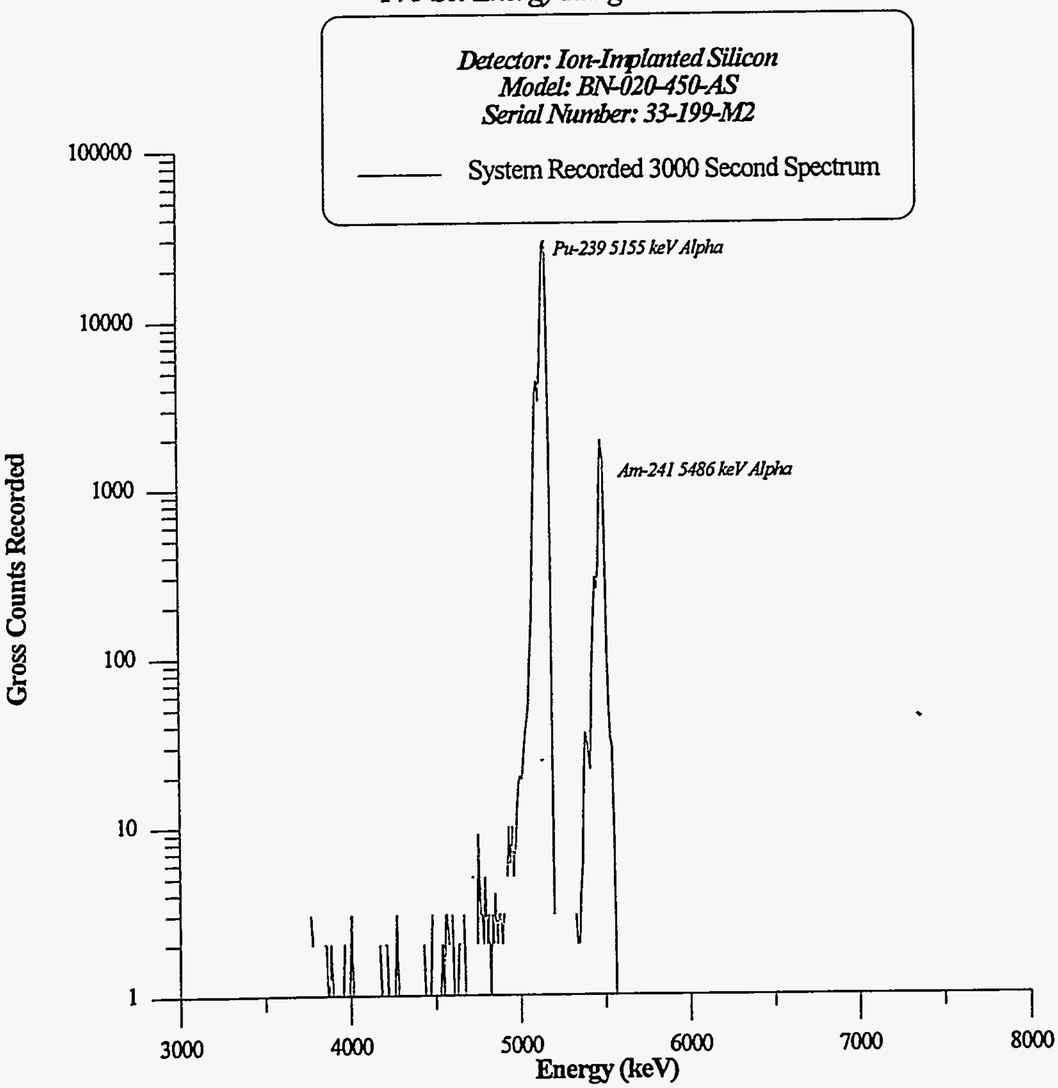


FIGURE 4

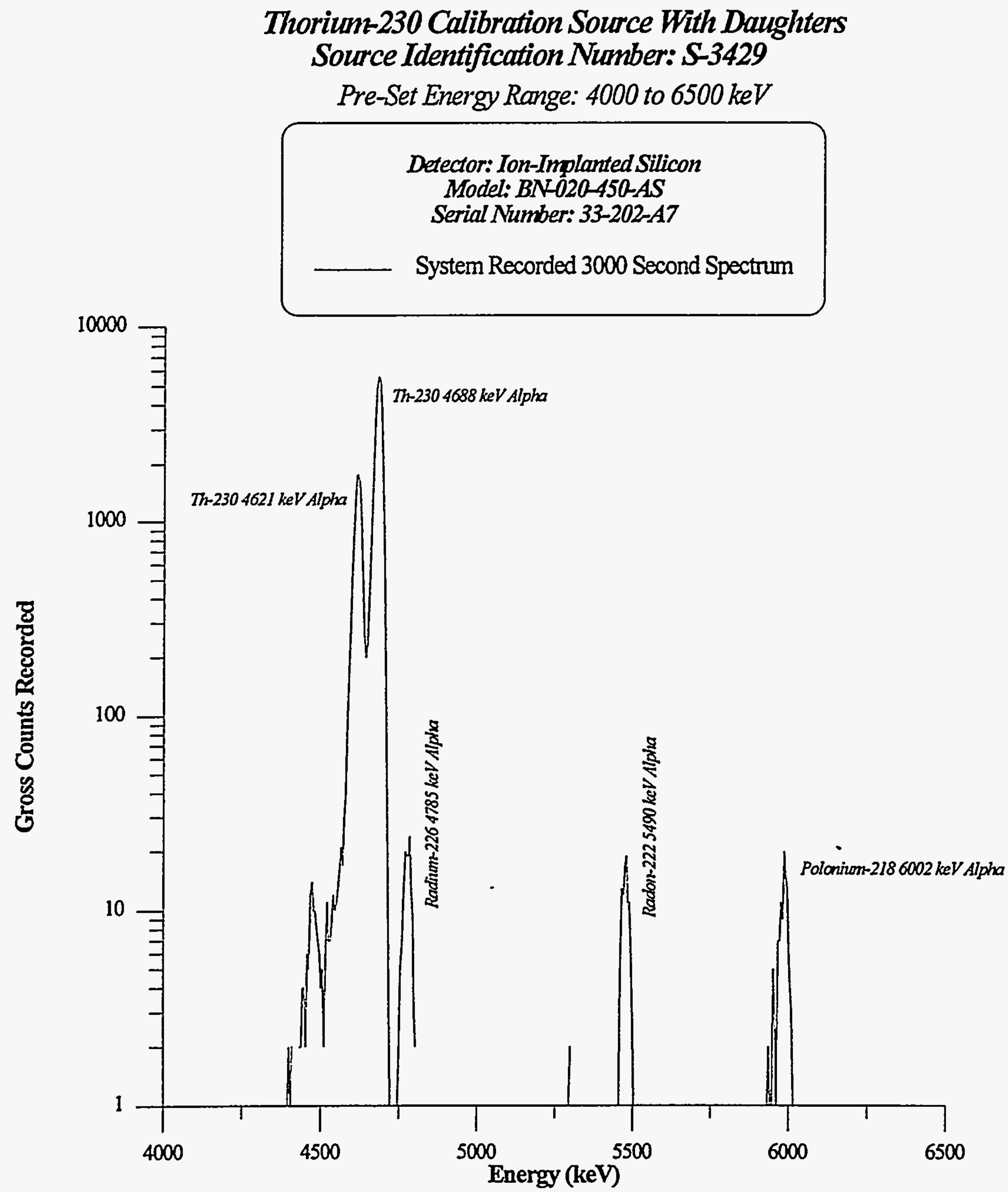

Thorium-230 Calibration Source With Daughters
Source Identification Number: S-3429
Pre-Set Energy Range: 4000 to 6500 keV
Detector: Ion-Implanted Silicon
Model: BN-020-450-AS
Serial Number: 33-202-A7
System Recorded 3000 Second Spectrum
Th-230 4688 keV Alpha
Th-230 4621 keV Alpha
Radium-226 4785 keV Alpha
Radon-222 5490 keV Alpha
Polonium-218 6002 keV Alpha
Gross Counts Recorded
10000
1000
100
10
1
4000
4500
5000
5500
6000
6500
Energy (keV)

FIGURE 5

Typical Radon Daughter Spectrum
Collected With Three Micron Flouropore Filter

Pre-Set Energy Range: 4000 to 6500 keV

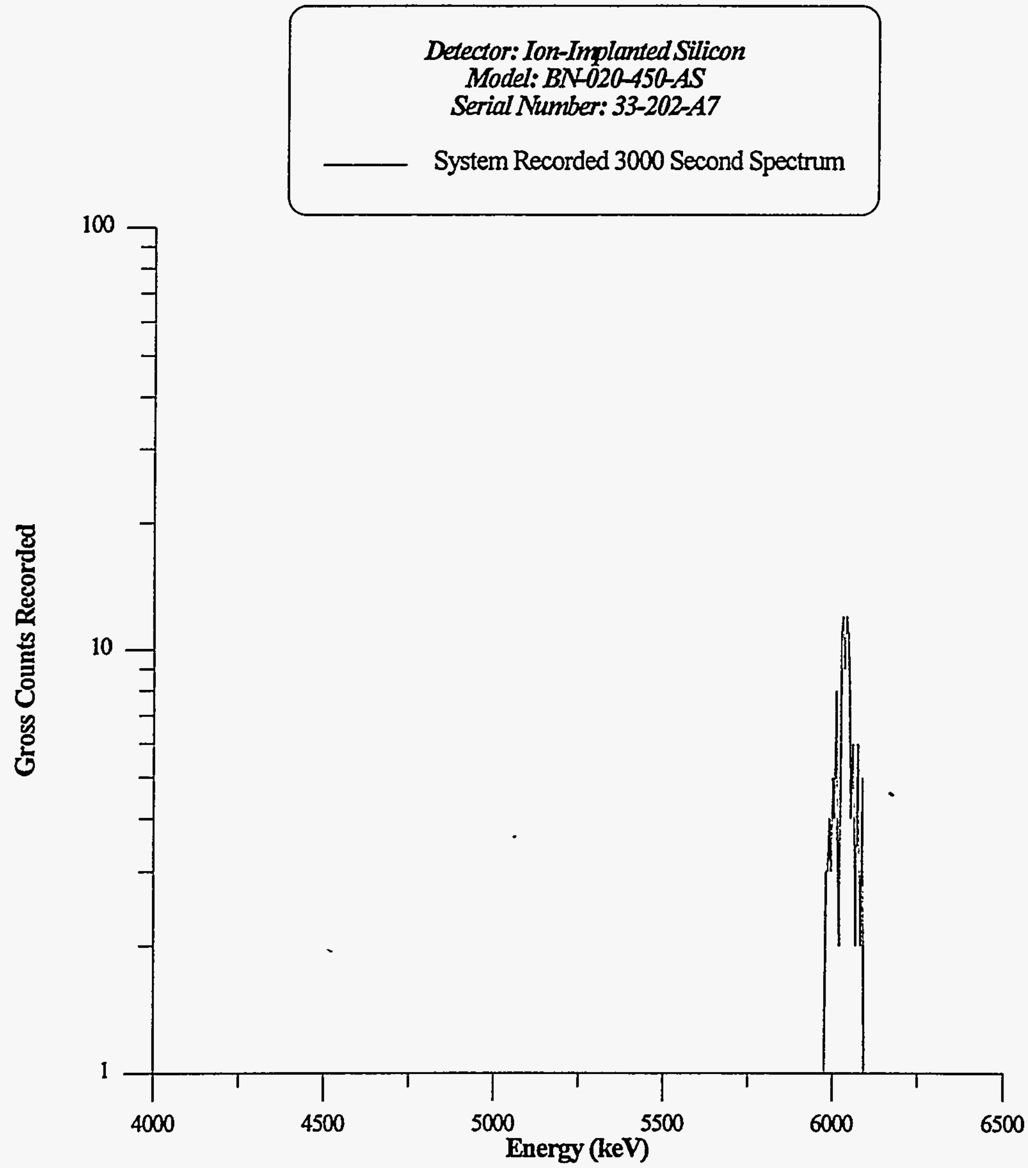
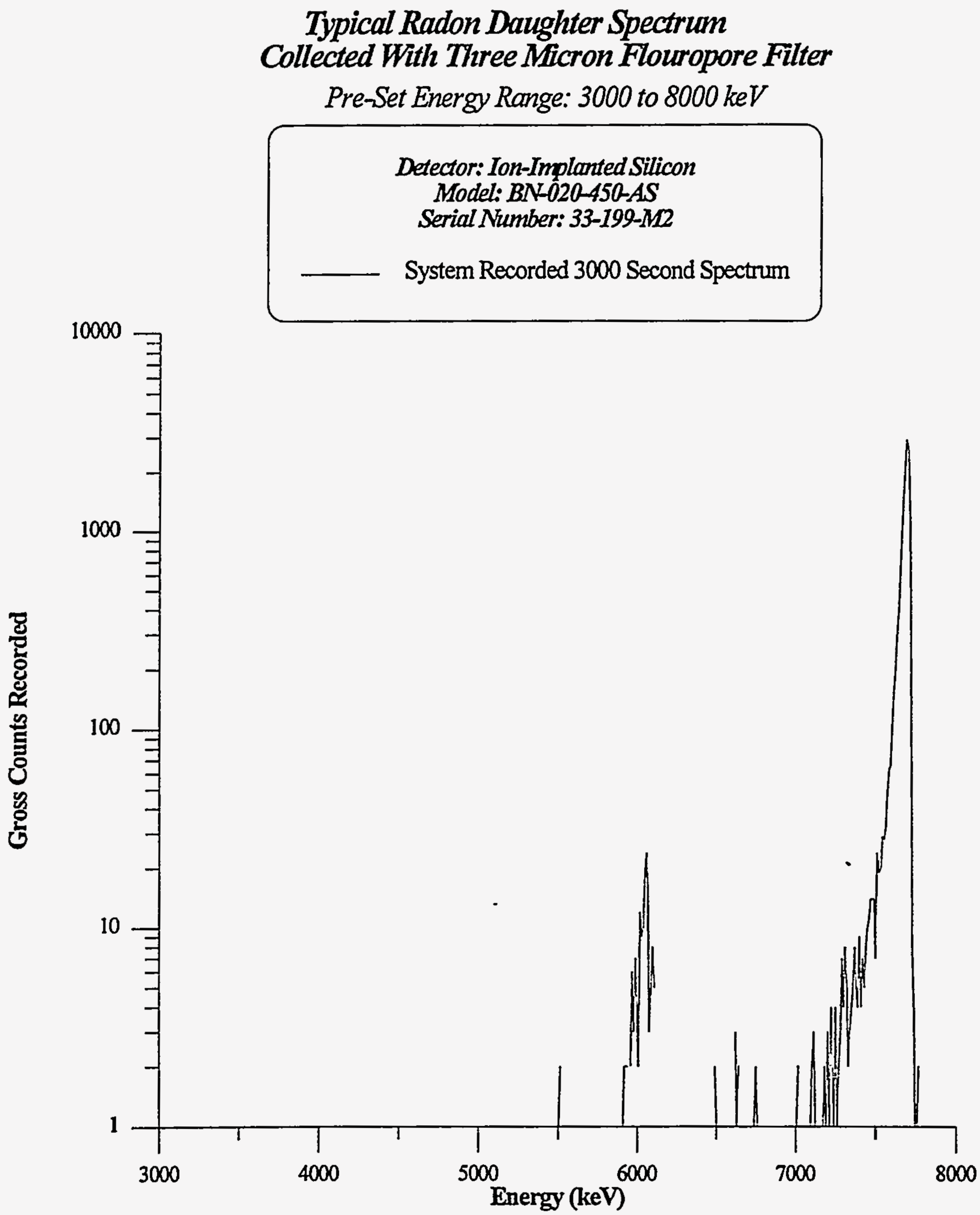


FIGURE 6


Typical Radon Daughter Spectrum
Collected With Three Micron Flouropore Filter
Pre-Set Energy Range: 3000 to 8000 keV
Detector: Ion-Implanted Silicon
Model: BN-020-450-AS
Serial Number: 33-199-M2
System Recorded 3000 Second Spectrum
Gross Counts Recorded
10000
1000
100
10
1
3000
4000
5000
6000
7000
8000
Energy (keV)