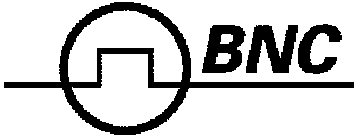


*Model 935 Surveillance and Measurement System
Dose Rate Calibration and Certification
January, 2001*

Summary Report: Model 935 - Certification of Dose Rate Measurements

**Performed at the Hazards Control Calibration Facility
Lawrence Livermore National Laboratory**

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The SAM 935 dose rate measurements have been certified as accurate when compared to calibrated laboratory instruments. These measurements were performed in the Hazards Control Calibration Facility at Lawrence Livermore National Laboratory. The instruments used to certify the accuracy of the SAM935 are as follows:

- Ludlum, Model 19, micro R meter
- Bicon, micro Analyst, micro R meter
- Eberline, Model E-530, G-M Dosimeter

The Ludlum and Bicon instruments use NaI detectors and are recognized industry standards for measurements of low dose rate (background levels to 10 $\mu\text{Sv/hr}$). These two instruments are generally calibrated with a Cs-137 standard and are therefore accurate only for Cs-137. This is because these instruments do not compensate for gamma emission of different energies. The Eberline is a G-M type instrument and is accurate for gamma flux measurements of various energies.

The ICRU Report 57 (issued August 1, 1998, page 110, Table A21) is the accepted standard and method for converting gamma flux to dose rate equivalent as a function of photon energy. The ICRU (International Commission on Radiation Units and Measurements) reports contain a complete set of definitions and notes that are the basis of radiation dose measurements (for example see report 19).

The SAM can quickly measure the photon fluence for each isotope in the spectrum. It then converts it to ambient dose equivalent $H^*(10)/\phi$ with units of $\text{pSv}\cdot\text{cm}^2$. (This data is taken from Table A21, page 110 of ICRU Report 57.) This allows the SAM to give isotope specific dose rate as well as the total dose and total dose rate. The Ludlum and Bicon instruments can not do calculations based on isotopic energies. Therefore, they are only accurate for measuring the isotope used to calibrate the instrument. The Eberline does take into account isotopic energy since ionization takes place within a defined volume of gas. However, the Eberline has no means of determining isotope specific dose rate and will not separate out the background contribution. The ability to calculate the isotope specific dose rate and add in the background contribution makes the SAM a very unique instrument. When measuring only one isotope the difference between the total value and the isotopic value is the background. Therefore, total dose rate is used on the SAM to obtain accurate comparison data for the following plots. Three isotopes were used (Co-57, Cs-137, and Co-60) to show correlation when measuring isotopes of low, medium, and high energies.

Note: Dose rate is given in $\mu\text{R/hr}$ since the Ludlum, Bicon, and Eberline instruments all read in these units (instead of Sv). For values in Sv use the conversion, $1\mu\text{Sv} = 100 \mu\text{rem}$.

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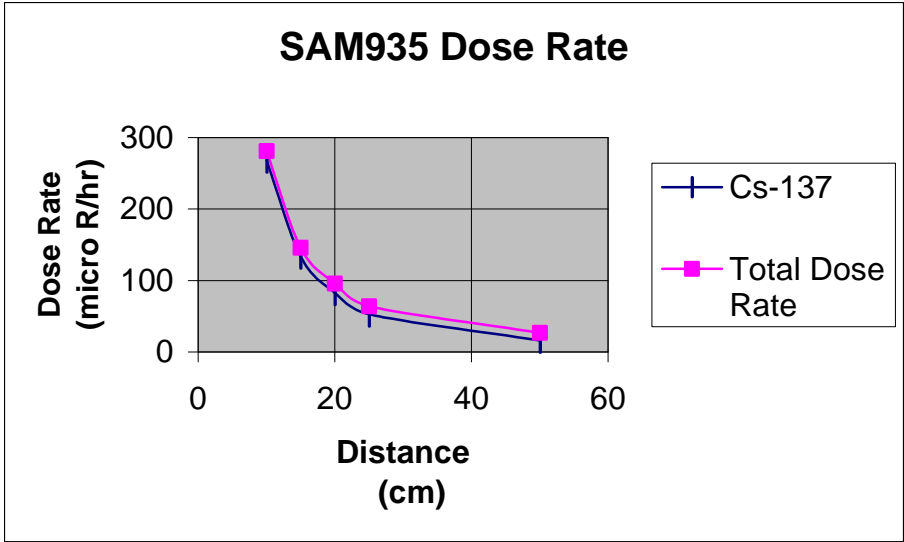


Figure 1. The SAM935 measures the dose rate of Cs-137 and the total dose rate, which includes background (background ~ 12 μ R/hr).

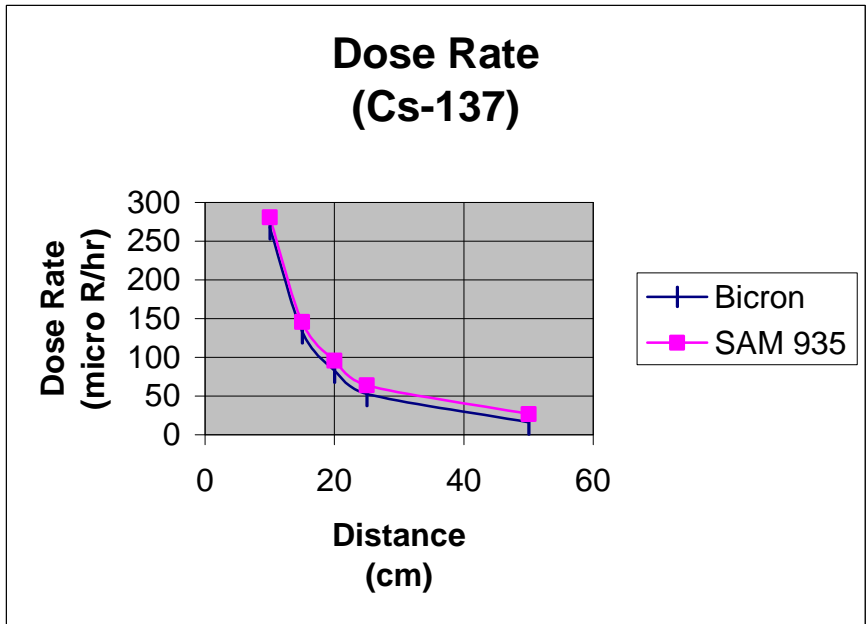


Figure 2. The SAM935 is compared to the Bicron dosimeter for Cs-137.

Figure 3. The SAM 935 is compared to the Ludlum dosimeter for Cs-137.

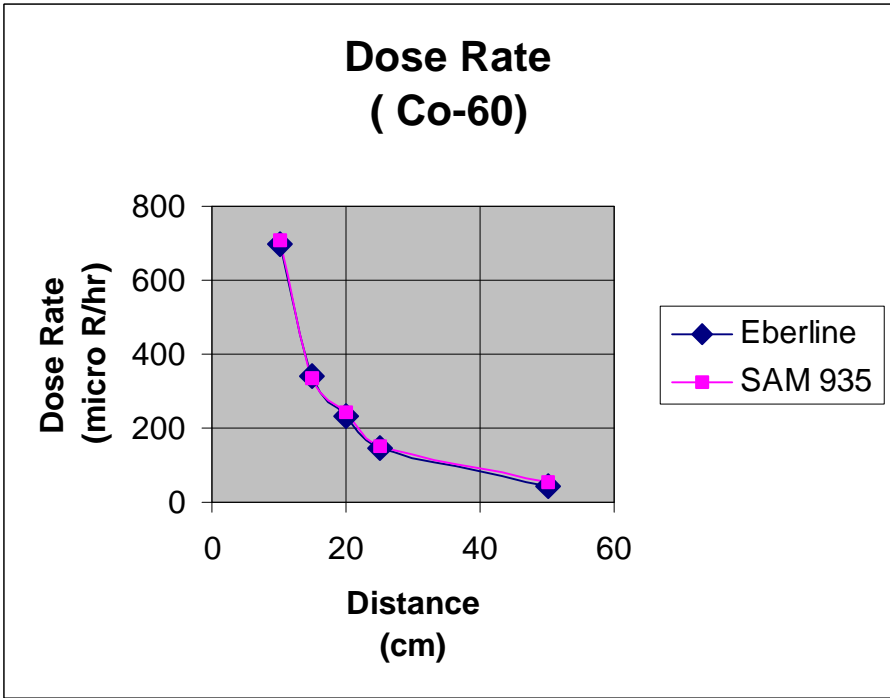
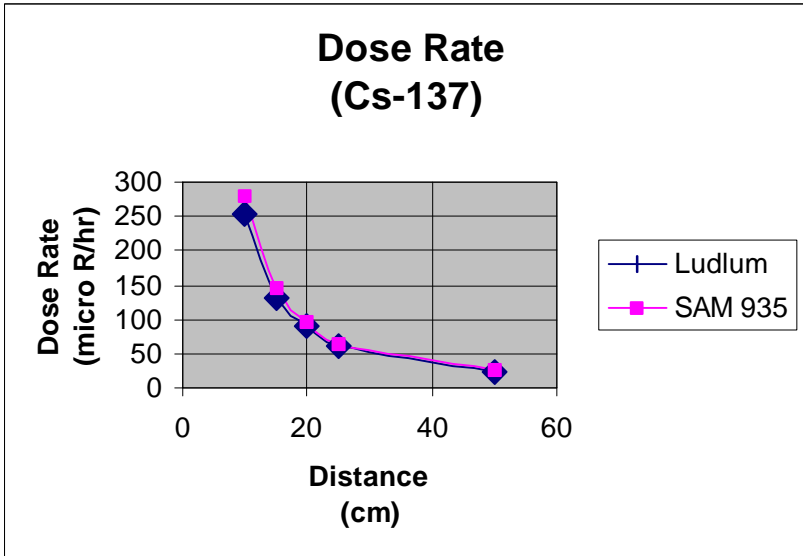


Figure 4. The SAM935 is compared to the Eberline dosimeter for Co-60.



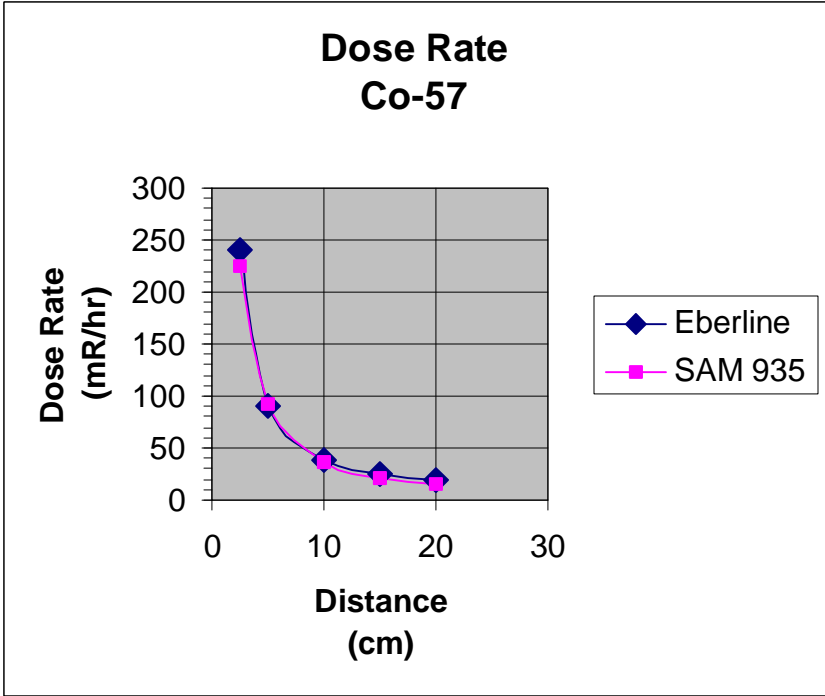


Figure 5. The SAM 935 is compared to the Eberline dosimeter for Co-57.