U.S. Department of Commerce
Juanita M. Kreps
Secretary

ıal Bureau of Standards
est Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 4233-B

Cesium-137 Burn-Up Standard

This Standard Reference Material consists of cesium-137 in equilibrium with its daughter, barium-137m, in 5.0566 ± 0.0059 grams of solution in a flame-sealed borosilicate-glass ampoule. The solution, which contains 19 micrograms of high-purity cesium chloride per gram of approximately 1 molar hydrochloric acid, has a density of 1.015 ± 0.002 grams per milliliter at 20°C.

One hundred and thirty four ampoules were prepared. Each was measured in the NBS "4π"γ ionization chamber and the solution in 31 of the ampoules was weighed. The average mass of solution in the 134 ampoules, 5.0566 grams, was calculated from the average mass of solution in the 31 weighed ampoules and the ionization-chamber measurements of the 134 ampoules, assuming a proportional relationship between mass of solution and ionization-chamber response. The uncertainty, 0.0059 gram, is half the range of the ionization-chamber measurements.

The number of cesium-137 atoms per gram of solution at 0001 EST August 29, 1979, was

$$*1.009 \times 10^{15} \pm 0.48\%*.$$

The concentration of cesium-137 atoms was measured by the method of mass-spectrometric isotope dilution in terms of natural cesium chloride of known cesium concentration. The ratios of cesium-137 to cesium-133 atoms were measured in four unspiked and nine spiked samples of the master solution. The mass spectrometer used was a 30-cm radius-of-curvature 68°-analyzer-tube instrument with a single-filament platinum-ribbon ion source.

The uncertainty in the number of atoms, 0.48 percent, is the linear sum of 0.10 percent, which is the limit of the random error at the 99-percent confidence level of the mass-spectrometric measurements (3.355 S_m, where S_m is the standard error calculated from independent measurements of 9 samples) and 0.38 percent, which is the linear sum of the estimated upper limits of conceivable systematic errors.

The radioactivity concentration of the cesium-137 at 0001 EST August 29, 1979, was

$$*7.432 \times 10^{5}\ s^{-1}g^{-1} \pm 1.39\%*.$$

The solution from which this Standard Reference Material was prepared was calibrated by $4\pi\beta$-γ efficiency-extrapolation coincidence and anti-coincidence counting using cesium-134 as a tracer.

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The uncertainty in the radioactivity concentration, 1.39 percent, is the linear sum of 0.25 percent, which is the limit of the random error at the 99-percent confidence level (3.355 S_m, where S_m is the standard error calculated from independent measurements of nine sources) and 1.14 percent, which is the linear sum of the estimated upper limits of conceivable systematic errors.

Assuming a gamma-ray probability per decay of 0.850 ± 0.005, the number of 0.6616-MeV gamma rays of barium-137m emitted per second per gram of solution at 0001 EST August 29, 1979, was

$$*6.32 \times 10^5 \pm 2.0\%*.$$

The uncertainty in the gamma-ray-emission rate, 2.0 percent, is the linear sum of 0.59 percent, which is the uncertainty associated with the gamma-ray probability per decay, and 1.39 percent, which is the uncertainty attributable to the radioactivity concentration.

The solution from which this Standard Reference Material was prepared was examined for photon-emitting impurities with a Ge(Li)-spectrometer system and only cesium-134 was found to be present. At the time of certification, the activity of the impurity relative to that of the principal radionuclide was $2.45 \times 10^{-5} \pm 1.23 \times 10^{-5}$. Conservative detection limits for photons from other possible impurities, expressed as percentages of the gamma-ray-emission rate of the 0.6616-MeV gamma ray emitted in the decay of barium-137m, are approximately 0.1 percent for photons with energies between 0.090 MeV and 0.657 MeV, and 0.01 percent for those between 0.667 MeV and 1.900 MeV.

This Standard Reference Material was prepared and the radioactivity concentration determined in the Center for Radiation Research, Radiation Physics Division, Radioactivity Group, W. B. Mann, Principal Scientist. Solutions for spectrometric analyses were prepared jointly by L. M. Cavallo, Radioactivity Group and by L. A. Machlan and T. J. Murphy, Inorganic Analytical Research Division. The mass spectrometric measurements were made in the Inorganic Analytical Research Division by E. L. Garner.

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George A. Uriano, Chief
Office of Standard Reference Materials