



Standard Practice for High-Resolution Gamma-Ray Spectrometry of Water¹

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1. Scope

1.1 This practice covers the measurement of gamma-ray emitting radionuclides in water by means of gamma-ray spectrometry. It is applicable to nuclides emitting gamma-rays with energies greater than 20 keV. For typical counting systems and sample types, activity levels of about 40 Bq are easily measured and sensitivities as low as 0.4 Bq are found for many nuclides **(1)**.² Count rates in excess of 2000 counts per second should be avoided because of electronic limitations. High count rate samples can be accommodated by dilution or by increasing the sample to detector distance.

1.2 This practice can be used for either quantitative or relative determinations. In tracer work, the results may be expressed by comparison with an initial concentration of a given nuclide which is taken as 100 %. For radioassay, the results may be expressed in terms of known nuclidic standards for the radionuclides known to be present. In addition to the quantitative measurement of gamma radioactivity, gamma spectrometry can be used for the identification of specific gamma emitters in a mixture of radionuclides. General information on radioactivity and the measurement of radiation has been published **(2,3)**. Information on specific application of gamma spectrometry is also available in the literature **(4)**. See also Practice D 1066, Test Method D 1943, Practice D 3084, Practice D 3085, Practices D 3370, and Method E 181.

1.3 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitation prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 1066 Practice for Sampling Steam³

D 1129 Terminology Relating to Water³

D 2777 Practice for Determination of Precision and Bias of

Applicable Test Methods of Committee D-19 on Water³
D 3085 Practice for Measurement of Low Level Activity in Water⁴

D 3370 Practices for Sampling Water from Closed Conduits³

D 3648 Practices for Measurement of Radioactivity³

E 181 General Methods for Detector Calibration and Analysis of Radionuclides⁵

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D 1129. For terms not defined in this practice or in Terminology D 1129, reference may be made to other published glossaries **(5)**.

4. Summary of Practice

4.1 Gamma ray spectra are measured with modular equipment consisting of a detector, an analyzer, memory, and a permanent data storage device.

4.2 Lithium-drifted germanium, Ge(Li), or high-purity germanium (HPGe) detectors, p-type or n-type, are used for the analysis of complex gamma-ray spectra because of their excellent energy resolution. These germanium systems, however, are characterized by high cost and require cooling with liquid nitrogen.

4.3 In a germanium semiconductor detector, gamma-ray photons produce electron-hole pairs. The charged pair is then collected by an applied electric field. A very stable low noise preamplifier is needed to amplify the pulses of electric charge resulting from gamma photon interactions. The output from the preamplifier is directly proportional to the energy deposited by the incident gamma-ray. These current pulses are fed into an amplifier of sufficient gain to produce voltage output pulses in the amplitude range from 0 to 10 V.

4.4 A multichannel pulse-height analyzer is used to determine the amplitude of each pulse originating in the detector, and accumulates in a memory the number of pulses in each amplitude band (or channel) in a given counting time. Computerized systems with stored programs and interface hardware can accomplish the same functions as hardwired multichannel analyzers. The primary advantages of the computerized system

¹ This test method is under the jurisdiction of ASTM Committee D-19 on Water and is the direct responsibility of Subcommittee D19.04 on Methods of Radiochemical Analysis.

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² The boldface numbers in parentheses refer to the list of references at the end of this test method.

³ *Annual Book of ASTM Standards*, Vol 11.01.

⁴ *Discontinued*—See 1988 *Annual Book of ASTM Standards*, Vol 11.02.

⁵ *Annual Book of ASTM Standards*, Vol 12.02.