



Designation: D3084 – 20

Standard Practice for Alpha-Particle Spectrometry of Water¹

This standard is issued under the fixed designation D3084; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the processes that are required to obtain well-resolved alpha-particle spectra from water samples and discusses associated problems. This practice is generally combined with specific chemical separations, mounting techniques, and counting instrumentation, as referenced.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

C859 Terminology Relating to Nuclear Materials

C1163 Practice for Mounting Actinides for Alpha Spectrometry Using Neodymium Fluoride

D1129 Terminology Relating to Water

D3648 Practices for the Measurement of Radioactivity

D3865 Test Method for Plutonium in Water

D3972 Test Method for Isotopic Uranium in Water by Radiochemistry

D7282 Practice for Set-up, Calibration, and Quality Control of Instruments Used for Radioactivity Measurements

¹ This practice is under the jurisdiction of ASTM Committee **D19** on Water and is the direct responsibility of Subcommittee **D19.04** on Methods of Radiochemical Analysis.

Current edition approved July 1, 2020. Published July 2020. Originally approved in 1972. Last previous edition approved in 2012 as D3084 – 05 (2012). DOI: 10.1520/D3084-20.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D7902 Terminology for Radiochemical Analyses

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in this standard, refer to Terminologies **D1129**, **D7902**, and **C859**. For terms not found in these terminologies, reference may be made to other published glossaries (**1**, **2**).³

4. Summary of Practice

4.1 Alpha-particle spectrometry of radionuclides in water (also called alpha-particle pulse-height analysis) has been carried out by several methods involving magnetic spectrometers, gas counters, scintillation spectrometers, nuclear emulsion plates, cloud chambers, absorption techniques, and solid-state counters. Gas counters, operating either as an ionization chamber or in the proportional region, have been widely used to identify and measure the relative amounts of different alpha-emitters. However, more recently, the solid-state counter has become the predominant system because of its excellent resolution and compactness. Knoll (**3**) extensively discusses the characteristics of both detector types.

4.2 Of the two gas-counting techniques, the pulsed ionization chamber is more widely used as it gives much better resolution than does the other. This is because there is no spread arising from multiplication or from imperfection of the wire such as occurs with the proportional counter.

4.3 The semiconductor detectors used for alpha-particle spectrometry are similar in principle to ionization chambers. The ionization of the gas by α -particles gives rise to electron-ion pairs, while in a semiconductor detector, electron-hole pairs are produced. Subsequently, the liberated charges are collected by an electric field. In general, silicon detectors are used for alpha-particle spectrometry. These detectors are *n*-type base material upon which gold is evaporated or ions such as boron are implanted, making an electrical contact. A reversed bias is applied to the detector to reduce the leakage current and to create a depletion layer of free-charge carriers. This layer is thin and the leakage current is very low. Therefore, the slight interactions of photons with the detector produce no signal.

³ The boldface numbers in parentheses refer to a list of references at the end of this standard.