



Standard Test Method for Nondestructive Analysis of Special Nuclear Materials in Homogeneous Solutions by Gamma-Ray Spectrometry¹

This standard is issued under the fixed designation C 1221; 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 test method is applicable to the determination of the concentration of gamma-ray emitting special nuclear materials dissolved in homogeneous solutions. The test method corrects for gamma-ray attenuation by the sample and its container by measurement of the transmission of a beam of gamma rays from an external source (Refs. (1), (2), and (3)).²

1.2 Two sample geometries, slab and cylinder, are considered. The sample container that determines the geometry may be either a removable or a fixed geometry container. This test method is limited to sample containers having walls or a top and bottom of equal transmission through which the gamma rays from the external transmission correction source must pass.

1.3 This test method is typically applied to radionuclide concentrations ranging from a few mg/L to several hundred g/L. The assay range will be a function of the specific activity of the nuclide of interest, the physical characteristics of the sample container, counting equipment considerations, assay gamma-ray energies, sample matrix, gamma-ray branching ratios, and interferences.

1.4 *This standard does not purport to address all of the safety problems, 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 limitations prior to use. For specific hazards, see Section 9.*

2. Referenced Documents

2.1 ASTM Standards:

C 859 Terminology Relating to Nuclear Materials³

C 982 Guide for Selecting Components for Energy Dispersive X-Ray Fluorescence (XRF) Systems³

C 1133 Test Method for Nondestructive Assay of Special Nuclear Material in Low Density Scrap and Waste by Segmented Passive Gamma-Ray Scanning³

C 1168 Practice for Preparation and Dissolution of Plutonium Materials for Analysis³

nium Materials for Analysis³

E 181 General Methods for Detector Calibration and Analysis of Radionuclides⁴

2.2 ANSI Standards:

ANSI N15.20 Guide to Calibrating Nondestructive Assay Systems⁵

ANSI N15.35 Guide to Preparing Calibration Material for Nondestructive Assay Systems that Count Passive Gamma Rays⁵

ANSI N15.37 Guide to the Automation of Nondestructive Assay Systems for Nuclear Material Control⁵

ANSI/IEEE 645 Test Procedures for High-Purity Germanium Detectors for Ionizing Radiation⁵

2.3 U.S. Nuclear Regulatory Commission Regulatory Guides:

Regulatory Guide 5.9, Rev. 2, Guidelines for Germanium Spectroscopy Systems for Measurement of Special Nuclear Materials⁶

Regulatory Guide 5.53, Rev. 1, Qualification, Calibration, and Error Estimation Methods for Nondestructive Assay⁶

3. Terminology

3.1 For definitions of terms used in this test method, refer to Terminology C 859.

4. Summary of Test Method

4.1 Many nuclear materials spontaneously emit gamma rays with energies and intensities characteristic of the decaying nuclide. The analysis for these nuclear materials is accomplished by selecting appropriate gamma rays and measuring their intensity to identify and quantify the nuclide.

4.1.1 The gamma-ray spectrum of a portion of solution is obtained with a collimated, high resolution gamma-ray detector.

4.1.2 Count-rate-dependent losses are determined and corrections are made for these losses.

4.1.3 A correction factor for gamma-ray attenuation in the sample and its container is determined from the measurement of the transmitted intensity of an external gamma-ray source. The gamma rays from the external source have energies close

¹ This test method is under the jurisdiction of ASTM Committee C-26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.10 on Non-Destructive Assay.

Current edition approved Nov. 15, 1992. Published July 1993.

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 12.01.

⁴ Annual Book of ASTM Standards, Vol 12.02.

⁵ Available from American National Standards Institute, 11 W. 42nd St., 13th Fl., New York, NY 10036.

⁶ Available from U.S. Nuclear Regulatory Commission, Washington, DC 20555.

