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Standard Terminology of C26.10 Nondestructive Assay Methods[1]

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ε[1] NOTE—Corrections were made throughout editorially in October 2007.

1. Scope

1.1 The terminology defined in this document is associated with nondestructive assay of nuclear material.

1.2 All of the definitions are associated with measurement techniques that measure nuclear emissions (that is, neutrons, gamma-rays, or heat) directly or indirectly.

1.3 definitions are relevant to any standards and guides written by subcommittee C26.10.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E456 Terminology Relating to Quality and Statistics

2.2 *DOE Orders:*[3]

DOE Order 435.1 Low-level Waste Requirements

DOE Order 5820.2 Radioactive Waste Management

3. Terminology

(alpha, n) reaction, *n*—a reaction that occurs when energetic alpha particles collide with low atomic number nuclei resulting in the emission of a neutron

^{240}Pu-effective mass, *n*—the mass of ^{240}Pu that would produce the same coincident neutron response in the instrument as the assay item.

DISCUSSION—It is a function of the quantity of even mass isotopes of plutonium in the assay item and fundamental nuclear constants, sometimes referred to as effective ^{240}Pu mass.

absorber foils, *n*—foils, usually of copper, tin, cadmium, or lead, used to attenuate the gamma flux reaching a detector.

DISCUSSION—Absorber foils are used to reduce the count rate, typically from intense low-energy X or gamma rays.

accidentals, *n*—the detection of multiple neutron events within the gate width that are not produced from the same fission.

DISCUSSION—Accidental events take their name from the fact that it is the accidental or random summing of neutrons, which are not time correlated with a common origin (fission or cosmic-ray burst), that give rise to the appearance of a signature like that from genuine correlated events.

accuracy, *n*—*(1)* bias; *(2)* the closeness of a measured value to the true value; and (3) the closeness of a measured value to an accepted reference or standard value.

active assay, *n*—assay based on the observation of radiation(s) induced by irradiation from an external source.

alpha, α, *n*—the ratio of the uncorrelated neutron emission rate from (α, n) reactions to the spontaneous neutron emission rate from a non-multiplying item.

aperture, *n*—the size of the opening in the collimator through which the radiation of interest is intended to pass.

assay, *v*—to determine quantitatively the amount of one or more nuclides of interest contained in an item.

attenuation correction, *n*—correction to the measured count rate for attenuation of radiation that provides an estimate of the unattenuated radiation emission rate of the radionuclides being assayed.

attenuation, *n*—reduction of radiation flux due to the interaction of radiation with material between the source of the radiation and the detector.

background, *n*—extraneous signal superimposed on the signal of interest.

Beers Law, *n*—the fraction of uncollided gamma rays transmitted through layers of equal thickness of an absorber is a constant.

benign matrix, *n*—bulk material that has a negligible effect on the result of the measured parameter.

blank, *n*—a prepared item containing a matrix as similar as practical to the items being measured that is free, to the extent possible, of the radionuclides of interest.

[1] This terminology is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.10 on Non Destructive Assay.

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[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.

[3] Available from the U.S. Department of Energy (DOE), 1000 Independence Ave., SW Washington, DC 20585.

DISCUSSION—The most important matrix parameters are those that affect the result of the measurement technique being used.

calibration standard, *n*—an item similar to the items to be assayed, for which the parameters of interest and all properties to which the measurement technique is sensitive are known.

calorimeter, *n*—a device to measure heat or rate-of-heat generation.

calorimetric assay, *n*—determination of the mass of radioactive material through the measurement of its thermal power by calorimetry and the use of nuclear decay constants and, if necessary, additional isotopic measurements.

certification, *n*—a written declaration from a certifying body or its legitimate designee that a particular measurement process or measurement personnel comply with stated criteria or that a measured item has the stated characteristics.

code validation, *n*—process to determine that the software performs its intended functions correctly, ensure that it performs no unintended functions, and provides information about its quality and reliability.

coincidence gate length, *n*—the time interval following the detection of a neutron during which additional neutrons are considered to be in coincidence with the original neutron.

coincident neutrons, *n*—two or more neutrons emitted simultaneously from a single event, such as from a nucleus during fission.

collimated detector, *n*—a detector surrounded by a shield that imposes a directional response on the collimated detector.

collimator, *n*—a shield that imposes a directional response on the detector. Generally, for gamma ray detection the collimator is a hollow cylinder or rectangular prism of high atomic number (Z) and high density material, mounted coaxially to the detector and extending over the detector and beyond the detector face.

Compton scattering, *n*—scattering of gamma rays that may or may not be from the radionuclide of interest.

DISCUSSION—The scattering reduces the energy of the gamma ray and results in a continuum of gamma ray energies.

computed tomography, *n*—see *tomography*.

confidence interval, *n*—The range of values, calculated from the probability distribution (often sufficiently well characterized by the estimate of the mean and standard deviation), which is expected to include the population mean with a stated level of confidence or likelihood.

DISCUSSION—For more details see Test Method E456.

contact measurement, *n*—a special case of a near-field measurement in which measurements are made with the detector assembly in contact with the item, for example, tank, pipe, ductwork, being assayed.

control chart, *n*—a graphical plot of test results with respect to time or sequence of measurement together with limits in which they are expected to lie when the system is in a state of statistical control.

control limits, *n*—the limits beyond which it is statistically highly improbable that one or several point(s) could lie while the system remains in a state of statistical control.

data quality objective, *n*—measurement uncertainty and confidence levels specified by the scope of work.

dead time, *n*—the period following the detection of an event during which the detection electronics cannot register a subsequent event.

DISCUSSION—Dead time is usually expressed as a percentage of elapsed time.

delayed neutrons, *n*—neutrons emitted by the item that are produced from decay of the fission products.

DISCUSSION—These neutrons are produced at a time after the initial fission event.

depleted uranium, *n*—uranium containing less than the naturally occurring fraction of ^{235}U isotopes (< 0.7 weight percent).

die-away time, *n*—the average life time of the neutron population as measured from the time of emission to detection, escape, or absorption. The average lifetime is the time required for the neutron population to decrease by a factor of 1/e.

doubles, *n*—the detection of neutron pairs produced from the same fission event.

DISCUSSION—The doubles terminology is often used in reference to multiplicity counting, but it is the same as the reals from coincidence counting.

effective specific power, p_{eff}, *n*—the rate of energy emission per unit mass of radionuclide at the time of measurement.

far-field measurement, *n*—a measurement geometry where the analyst can assume that all gamma rays emitted from the item enter the detector along paths parallel to each other.

field of view, *n*—the entire solid angle subtended by the collimated detector.

fissile isotopes, *n*—isotopes that can be induced to fission by thermal neutrons.

DISCUSSION—^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu are the most common fissile isotopes.

flux monitors, *n*—detectors in the measurement chamber that measure the neutron flux of interrogating neutrons (cavity flux monitor) or item neutrons (drum flux monitor).

heat-flow calorimeter, *n*—a calorimeter so constructed that the heat generated in the calorimeter flows past a temperature sensing element, through a thermal resistance, to a constant temperature heat sink.

holdup, *n*—the residual nuclear material remaining in process equipment and facilities.

homogeneous matrix, *n*—a matrix whose characteristics important to the measurement result is uniform throughout the item.

infinite thickness, *n*—the thickness of material through which 99.9 % of the gamma rays of the designated energy cannot penetrate.

DISCUSSION—This is nominally equal to 7 mean-free paths in pure material.

item, *n*—material potentially containing radioisotope to be measured.