



Standard Practice for Sampling Special Nuclear Materials in Multi-Container Lots¹

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1. Scope

1.1 This practice provides an aid in designing a sampling and analysis plan for the purpose of minimizing random error in the measurement of the amount of nuclear material in a lot consisting of several containers. The problem addressed is the selection of the number of containers to be sampled, the number of samples to be taken from each sampled container, and the number of aliquot analyses to be performed on each sample.

1.2 This practice provides examples for application as well as the necessary development for understanding the statistics involved. The uniqueness of most situations does not allow presentation of step-by-step procedures for designing sampling plans. It is recommended that a statistician experienced in materials sampling be consulted when developing such plans.

1.3 The values stated in SI units are to be regarded as the standard.

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.*

2. Referenced Documents

2.1 ASTM Standards:

E 300 Practice for Sampling Industrial Chemicals²

2.2 Other Standard:

NUREG/CR-0087, Considerations for Sampling Nuclear Materials for SNM Accounting Measurements³

3. Terminology Definitions

3.1 *analysis of variance*—the body of statistical theory, methods, and practice in which the variation in a set of measurements, as measured by the sum of squares of the measurements, is partitioned into several component sums of squares, each attributable to some meaningful cause (source of variation).

¹ This practice is under the jurisdiction of ASTM Committee C-26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.06 on Statistical Applications.

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² *Annual Book of ASTM Standards*, Vol 15.05.

³ Available from National Technical Information Service, Springfield, VA 22161.

3.2 *confidence interval*—(a) an *interval estimator* used to bound the value of a population parameter and to which a measure of confidence can be associated, and (b) the *interval estimate*, based on a realization of a sample drawn from the population of interest, that bounds the value of a population parameter [with at least a stated confidence].

3.3 Estimation, Estimator, Estimate:

3.3.1 *Estimation*, in statistics, has a specific meaning, considerably different from the common interpretation of guessing, playing a hunch, or grabbing out of the air. Instead, estimation is the process of following certain statistical principles to derive an approximation (estimate) to the unknown value of a population parameter. This estimate is based on the information available in a sample drawn from the population.

3.4 *estimator*—a function of a sample ($X_1, X_2, \dots, X_n$) used to estimate a population parameter.

NOTE 1—An estimator is a random variable; therefore, not every realization ($x_1, x_2, \dots, x_n$) of the sample ($X_1, X_2, \dots, X_n$) will lead to the same value (realization) of the estimator. An estimator can be a function that, when evaluated, results in a single value or results in an interval or region of values. In the former case the estimator is called a *point estimator*, and in the latter case it is referred to as an *interval estimator*.

3.5 *estimate, (a: n)*—a particular value or values realized by applying an estimator to a particular realization of a sample, that is, to a particular set of sample values ($x_1, x_2, \dots, x_n$). (b: v)—to use an estimator.

3.6 *nested design*—one of a particular class of experimental designs, characterized by “nesting” of the sources of variation: for *each* sampled value of a variable *A*, a given number of values of a second variable *B* is sampled; for each of these, a given number of values of the next variable *C* is sampled, etc. The result is that each line of the “Expected Value of Mean Square” column in an analysis of variance table contains all but one of the terms of the preceding line.

3.7 *random variable*—a variable that takes on any one of the values in its range according to a [fixed] probability distribution. (Synonyms: chance variable, stochastic variable, variate.)

3.8 *standard deviation (s.d.)*—the positive square root of the variance.

3.9 *variance*—(a: *population*) the expected value of the square of the difference between a random variable and its own expected value; that is, the second moment about the mean. (b: *sample*) The sum of squared deviations from the sample mean