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.

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Standard Guide for Generation of Environmental Data Related to Waste Management Activities: Selection and Optimization of Sampling Design[1]

This standard is issued under the fixed designation D6311; 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 document provides practical guidance on the selection and optimization of sample designs in waste management sampling activities, within the context of the requirements established by the data quality objectives or other planning process.

1.2 This document (*1*) provides guidance for selection of sampling designs; (*2*) outlines techniques to optimize candidate designs; and (*3*) describes the variables that need to be balanced in choosing the final optimized design.

1.3 The contents of this guide are arranged by section as follows:

1.4 *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.*

1.5 *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]

D5956 Guide for Sampling Strategies for Heterogeneous Wastes

D6044 Guide for Representative Sampling for Management of Waste and Contaminated Media

D6051 Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities

D6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities

E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials

E943 Terminology Relating to Biological Effects and Environmental Fate

[1] This guide is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.01 on Planning for Sampling.

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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.

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2.2 *USEPA Documents:*[3]

USEPA Guidance for the Data Quality Objectives Process, EPA QA/G-4, Quality Assurance Management Staff, Washington, DC, March 1995

USEPA Data Quality Objectives Process for Superfund—Workbook, EPA 540/R-93/078 (OSWER 9355.9-01A), Office of Emergency and Remedial Response, Washington, DC, September 1993

USEPA Environmental Investigations Branch Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4—Science and Ecosystem Support Division, Athens, GA, May 1996

2.3 There are numerous useful references available from ASTM, USEPA, and private sector publishers. Appendix X1 contains a list, which is by no means comprehensive, of additional commonly used references.

3. Terminology

3.1 *accuracy, n*—closeness of a measured value to the true or an accepted reference or standard value. **(E135)**

3.2 *attribute, n*—a quality of samples or a population. **(D5956)**

3.3 *characteristic, n*—a property of items in a sample or population that can be measured, counted, or otherwise observed. **(D5956)**

3.3.1 *Discussion*—A characteristic of interest may be the cadmium concentration or ignitability of a population.

3.4 *composite sample, n*—a combination of two or more samples.

3.5 *confidence interval, n*—a numerical range used to bound the value of a population parameter with a specified degree of confidence (that the interval would include the true parameter value).

3.5.1 *Discussion*—When providing a confidence interval, the number of observations on which the interval is based should be identified.

3.6 *confidence level, n*—the probability, usually expressed as a percent, that a confidence interval will contain the parameter of interest.

3.7 *data quality objectives (DQOs), n*—qualitative and quantitative statements derived from the DQO process describing the decision rules and the uncertainties of the decision(s) within the context of the problem(s). **(D5956)**

3.8 *data quality objective process, n*—a quality management tool based on the scientific method and developed by the U.S. Environmental Protection Agency to facilitate the planning of environmental data collection activities. **(D5956)**

3.8.1 *Discussion*—The DQO process enables planners to focus their planning efforts by specifying the use of the data (the decision), the decision criteria (action level), and the decision maker's acceptable decision error rates. The products of the DQO process are the DQOs.

3.9 *decision rule, n*—a set of directions in the form of conditional statements that specifies: (*1*) how the sample data will be compared to the decision point or action level, (*2*) which decision will be made as a result of that comparison, and (*3*) what subsequent action will be taken based on the decisions.

3.10 *false negative error, n*—an error which occurs when (environmental) data misleads the decision maker(s) into not taking action when action should be taken.

3.11 *false positive error, n*—an error which occurs when environmental data misleads the decision maker(s) into taking action when action should not be taken.

3.12 *heterogeneity, n*—the condition of the population under which items of the population are not identical with respect to the characteristic of interest. **(D5956)**

3.13 *homogeneity, n*—the condition of the population under which all items of the population are identical with respect to the characteristic of interest. **(D5956)**

3.14 *representative sample, n*—a sample collected such that it reflects one or more characteristics of interest (as defined by the project objectives) of a population from which it was collected. **(D5956)**

3.15 *risk, n*—the probability or likelihood that an adverse effect will occur. **(E943)**

3.16 *sample, n*—a portion of material which is collected for testing or for record purposes. **(D5956)**

3.16.1 *Discussion*—Sample is a term with numerous meanings. The project team member collecting physical samples (for example, from a landfill, drum, or waste pipe) or analyzing samples considers a sample to be that unit of the population collected and placed in a container. In statistics, a sample is considered to be a subset of the population and this subset may consist of one or more physical samples. To minimize confusion, the term "physical sample" is a reference to the sample held in a sample container or that portion of the population which is subjected to measurement.

3.17 *sampling design, n*—(*1*) the sampling schemes specifying the point(s) for sample collection; (*2*) the sampling schemes and associated components for implementation of a sampling event.

3.17.1 *Discussion*—Both of the above definitions are commonly used within the environmental community. Therefore, both are used within this document.

4. Significance and Use

4.1 The intended use of this guide is to provide practical assistance in the development of an optimized sampling design. This standard describes or discusses:

4.1.1 Sampling design selection criteria,

4.1.2 Factors impacting the choice of a sampling design,

4.1.3 Selection of a sampling design,

4.1.4 Techniques for optimizing candidate designs, and

4.1.5 The criteria for evaluating an optimized sampling design.

4.2 Within a formal USEPA data generation activity, the planning process or data quality objectives (DQOs) development is the first step. The second and third are the implementation of the sampling and analysis design and the data quality

[3] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.