Designation: D8215 – 21

Standard Practice for Statistical Modeling of Uncertainty in Assessment of In-place Coal Resources[1]

This standard is issued under the fixed designation D8215; 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.

INTRODUCTION

Assessment of coal tonnage in-place is a fundamental factor in evaluating the commercial feasibility of any deposit. Equally important is an appraisal of the reliability that can be placed in the drilling data available for an estimation. Traditional methods for quantitatively expressing uncertainty use reliability categories based simply on the distance between drill-hole data within the boundaries of a coal bed. A significant limitation of the distance approach is the inability to express uncertainty in terms of how close a resource estimate is to the true value.

This practice provides a geostatistical methodology to calculate the uncertainty of an in-place, coal resource estimate, both at the deposit and block level. In addition to examining the drilling pattern both within and outside the coal bed, other factors influencing the complexity in the geology are also considered, resulting in realistic estimates of uncertainty. Most importantly, the uncertainty is expressed directly in tons of coal. Like other coal properties, uncertainty can be used to rank the resources in classes.

1. Scope*

1.1 This practice covers a procedure for quantitatively determining in-place tonnage uncertainty in a coal resource assessment. The practice uses a database on coal occurrence and applies geostatistical methods to model the uncertainty associated with a tonnage estimated for one or more coal seams. The practice includes instruction for the preparation of results in graphical form.

1.2 This document does not include a detailed presentation of the basic theory behind the formulation of the standard, which can be found in numerous publications, with a selection being given in the references (**1-3**).[2]

1.3 This practice should be used in conjunction with professional judgment of the many unique aspects of a coal deposit.

1.4 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

NOTE 1—All values given in parentheses after SI units are stated in inch-pound units.

1.5 *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.*

1.6 *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:*[3]

D621 Test Methods for Deformation of Plastics Under Load (Withdrawn 1994)[4]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D5549 Guide for Contents of Geostatistical Site Investigation Report

[1] This practice is under the jurisdiction of ASTM Committee D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.07 on Physical Characteristics of Coal.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

D5922 Guide for Analysis, Interpretation, and Modeling of Spatial Variation in Geostatistical Site Investigations
D5923 Guide for Selection of Kriging Methods in Geostatistical Site Investigations
D5924 Guide for Selection of Simulation Approaches in Geostatistical Site Investigations

2.2 *ASTM Manuals, Monographs, and Data Series:*[5]
MNL11 Manual on Drilling, Sampling, and Analysis of Coal

3. Terminology

3.1 *Definitions:*

3.1.1 *average, n*—mean.

3.1.2 *bin, n*—each of a set of the adjoining intervals used for separating numerical values according to magnitude.

3.1.3 *cell, n*—any of the subdivisions of a seam whose centers are the nodes in a regular grid.

3.1.4 *confidence interval, n*—a range of values calculated from sample observations and supposed to contain the true parameter value with certain probability of coverage.

3.1.4.1 *Discussion*—For example, a 95 % confidence interval implies that if the estimation process were repeated many times, then 95 % of the calculated intervals would be expected to contain the true value.

3.1.5 *cumulative distribution function, n*—a mathematical expression providing the probability that the value of a random variable is less than or equal to any given value.

3.1.6 *estimation, n*—the process of providing a numerical value for an unknown quantity based on the information provided by a sample.

3.1.7 *geostatistics, n*—a branch of statistics in which all inferences are done by taking into account data, the style of spatial fluctuation of the variable(s), and the location of each observation.

3.1.8 *grid, n*—a regular arrangement of crossing lines, such as the threads in a square mesh. The intersection points are the nodes.

[5] For referenced ASTM publications, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org.

3.1.9 *histogram, n*—a graphical representation of an empirical probability distribution.

3.1.9.1 *Discussion*—The values of the random variable are divided into multiple intervals called bins; all values are allocated to the bins; final relative counts are displayed as bars that are proportional to the empirical probabilities.

3.1.10 *kriging, n*—a group of geostatistical estimation methods formulated to minimize estimation errors in a minimum mean square error sense.

3.1.11 *lower quartile, n*—in a split of a ranked sample into four parts of equal size, the divider between the two partitions below the median. It is synonymous with the 25th percentile.

3.1.12 *mean, n*—a measure of centrality in a sample, population, or probability distribution. For a sample, the sample mean is equal to the sum of all values divided by the sample size:

$$\bar{z} = \frac{1}{n}\sum_{i=1}^{n} z_i \tag{1}$$

3.1.13 *median, n*—in a probability distribution or ranked sample or population, the divider evenly splitting the observations into two halves of equal size: a half of lowest values and a half of highest values; it is a measure of centrality and is synonymous with the 50th percentile.

3.1.14 *normal distribution, n*—the family of symmetric, bell-shaped functions that expresses the probability, $f(x)$, that the random variable will be between any two values of x:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \cdot \exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right] \tag{2}$$

where μ is the mean and σ is the standard deviation of the probability density function. See Fig. 1.

3.1.15 *percentile, n*—in a probability distribution, sample, or population sorted by increasing observation value, each one of the 99 dividers that produce exactly 100 subsets with equal number of observations.

3.1.15.1 *Discussion*—The dividers are sequential ordinal numbers starting from the one between the two groups with the lowest values. The dividers denote the proportion of values below them.

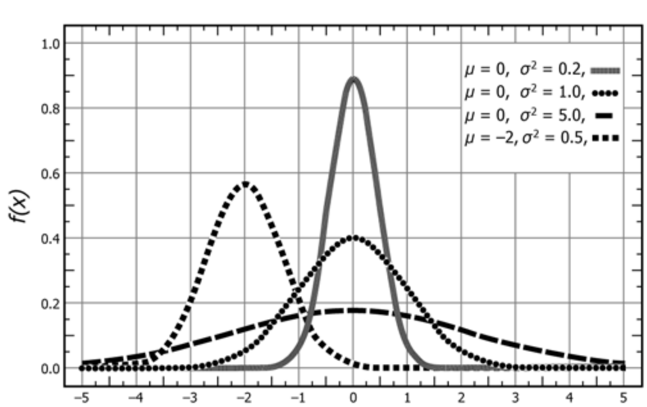

FIG. 1 Examples of Normal Distributions