Designation: D4460 – 97(Reapproved 2009)

Standard Practice for Calculating Precision Limits Where Values are Calculated from Other Test Methods[1]

This standard is issued under the fixed designation D4460; 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 practice covers techniques for calculating precision limits when values are calculated from two other methods having precision limits.

1.2 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples

D2041 Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

D3203 Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Definitions

3.1 For definitions of terms used in this document, consult Practice E177, or a standard dictionary, or a statistical text.[3,4,5]

4. Significance and Use

4.1 Precision limits for a test result that is calculated by addition, subtraction, multiplication, or division of two other test results that have valid precision limits can be calculated directly. This saves the cost and delay of conducting an interlaboratory study.

4.2 At the heart of statistical theory is the concept of a frequency distribution of a random variable. The precision limit of the random variable is determined by the standard deviation of the variable. The standard deviation of a random variable that is the sum, difference, product, or quotient of two other random variables can be calculated simply so long as the individual variables are independent and the standard deviations are small relative to their mean values. These restrictions are usually met in ASTM methods. In those cases where these restrictions are not met, other methods can be used. Only cases complying with the restrictions are covered in this standard.

5. Procedure

5.1 The standard deviation on which precision limits for a test result are based can be calculated from the following equations:

$$\sigma_{x\pm y} = \sqrt{\sigma_x{}^2 + \sigma_y{}^2} \quad (1)$$

where:

$\sigma_{x\pm y}$ = standard deviation for determining precision limits of a test result for a new standard based on either an addition or subtraction of test results from two other standards,

σ_x = standard deviation from precision statement of one of the standards on which new standard is based, and

σ_y = standard deviation from precision statement of other standard on which new standard is based.

The distributions of the test results from the two standards should be independent.

$$\sigma_{xy} = \sqrt{\bar{y}^2\sigma_x{}^2 + \bar{x}^2\sigma_y{}^2} \quad (2)$$

where:

σ_{xy} = standard deviation for determining precision limits of test results for a new standard based on the products of two other test results from two other standards,

σ_x = standard deviation from precision statement of one of the standards on which new standard is based,

$\bar{x}$ = mean or average value of X variable,

[1] This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.94 on Statistical Procedures and Evaluation of Data.

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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] Geary, R. C., "The Frequency Distribution of a Quotient," *Journal of the Royal Statistical Society*, Vol 93, 1930, pp. 442–446.

[4] Fieller, E. C., "The Distribution of the Index in a Normal Bivariate Population," *Biometrika*, Vol 24, 1932, pp. 428–440.

[5] Ku, H. H., "Notes on the Use of Propagation of Error Formulas," *Journal of Research of the National Bureau of Standards*, Vol 70C, No. 4, 1966, pp. 331–341.