



Standard Practice for Extreme Value Analysis of Nonmetallic Inclusions in Steel and Other Microstructural Features¹

This standard is issued under the fixed designation E 2283; 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 describes a methodology to statistically characterize the distribution of the largest indigenous nonmetallic inclusions in steel specimens based upon quantitative metallographic measurements. The practice is not suitable for assessing exogenous inclusions.

1.2 Based upon the statistical analysis, the nonmetallic content of different lots of steels can be compared.

1.3 This practice deals only with the recommended test methods and nothing in it should be construed as defining or establishing limits of acceptability.

1.4 The measured values are stated in SI units. For measurements obtained from light microscopy, linear feature parameters shall be reported as micrometers, and feature areas shall be reported as micrometers.

1.5 The methodology can be extended to other materials and to other microstructural features.

1.6 *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

- E 3 Methods of Preparation of Metallographic Specimens
- E 7 Terminology Relating to Metallography
- E 45 Test Methods for Determining the Inclusion Content of Steel
- E 178 Practice for Dealing with Outlying Observations
- E 456 Terminology Relating to Quality and Statistics
- E 768 Practice for Preparing and Evaluating Specimens for Automatic Inclusion Assessment of Steel
- E 883 Guide for Reflected-Light Photomicrography

E 1122 Practice for Obtaining JK Inclusion Ratings Using Automatic Image Analysis

E 1245 Practice for Determining the Inclusion Content or Second-Phase Constituent of Metals by Automatic Image Analysis

3. Terminology

3.1 *Definitions*—For definitions of metallographic terms used in this practice, refer to Terminology, E 7; for statistical terms, refer to Terminology E 456.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 A_f —the area of each field of view used by the Image Analysis system in performing the measurements.

3.2.2 A_o —control area; total area observed on one specimen per polishing plane for the analysis. A_o is assumed to be 150 mm² unless otherwise noted.

3.2.3 N_s —number of specimens used for the evaluation. N_s is generally six.

3.2.4 N_p —number of planes of polish used for the evaluation, generally four.

3.2.5 N_f —number of fields observed per specimen plane of polish.

$$N_f = \frac{A_o}{A_f} \quad (1)$$

3.2.6 N —total number of inclusion lengths used for the analysis, generally 24.

$$N = N_s \cdot N_p \quad (2)$$

3.2.7 *extreme value distribution*—The statistical distribution that is created based upon only measuring the largest feature in a given control area or volume **(1,2)**.³ The continuous random variable x has a two parameter (Gumbel) Extreme Value Distribution if the probability density function is given by the following equation:

$$f(x) = \frac{1}{\delta} \left[\exp\left(-\frac{x-\lambda}{\delta}\right) \right] \times \exp\left[-\exp\left(-\frac{x-\lambda}{\delta}\right)\right] \quad (3)$$

and the cumulative distribution is given by the following equation:

³ The boldface numbers in parentheses refer to the list of references at the end of this standard.

¹ This practice is under the jurisdiction of ASTM Committee E04 on Metallography and is the direct responsibility of Subcommittee E04.09 on Inclusions. Current edition approved Nov. 1, 2003. Published December 2003.

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.