



# Standard Guide for Optimizing, Controlling and Assessing Test Method Uncertainties from Multiple Workstations in the Same Laboratory Organization<sup>1</sup>

This standard is issued under the fixed designation E2093; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This guide describes a protocol for optimizing, controlling, and reporting test method uncertainties from multiple workstations in the same laboratory organization. It does not apply when different test methods, dissimilar instruments, or different parts of the same laboratory organization function independently to validate or verify the accuracy of a specific analytical measurement.

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:<sup>2</sup>

- E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials
- E350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
- E415 Test Method for Analysis of Carbon and Low-Alloy Steel by Spark Atomic Emission Spectrometry
- E1329 Practice for Verification and Use of Control Charts in Spectrochemical Analysis
- E1601 Practice for Conducting an Interlaboratory Study to Evaluate the Performance of an Analytical Method
- E2027 Practice for Conducting Proficiency Tests in the Chemical Analysis of Metals, Ores, and Related Materials

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.22 on Laboratory Quality.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

### 2.2 ISO Standards:<sup>3</sup>

- ISO/IEC 17025 General Requirements for the Competence of Calibration and Testing Laboratories
- ISO 9000 Quality Management and Quality System Elements

### 2.3 Other Standards:

- Measurement Systems Analysis Reference Manual<sup>4</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology E135.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *workstation, n*—a combination of people and equipment that executes a specific test method using a single specified measuring device to quantify one or more parameters, with each report value having an established estimated uncertainty that complies with the data quality objectives of the laboratory organization.

## 4. Significance and Use

4.1 Many competent analytical laboratories comply with accepted quality system requirements. When using standard test methods, their test results on the same sample should agree with those from other similar laboratories within the reproducibility estimates index (R) published in the standard. Reproducibility estimates are generated as part of the interlaboratory studies (ILS), of the type described in Practice E1601. Competent laboratories participate in proficiency tests, such as those conducted in accordance with Practice E2027, to confirm that they perform consistently over time. In both ILS and proficiency testing protocols, it is generally assumed that only one work station is used to generate the data.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, [www.ansi.org](http://www.ansi.org) or from International Organization for Standardization (ISO) at [www.iso.ch](http://www.iso.ch).

<sup>4</sup> *Measurement Systems Analysis Reference Manual*, Copyright 1990, 1995, Chrysler Corporation, Ford Motor Company, and General Motors Corporation, available from AIAG, 26200 Lahser Rd., Suite 200, Southfield, MI 48034-7100, [www.aiag.org](http://www.aiag.org).

4.2 Many laboratories have workloads, or logistical requirements, or both, that dictate the use of multiple workstations. Some have multiple stations in the same area (central laboratory format). Other stations are scattered throughout a facility (at-line laboratory format) and in some cases may even reside at different facilities. Often, analysis reports do not identify the workstation used for the testing, even if workstations differ in their testing uncertainties. Problems can arise if clients mistakenly attribute variation in report values to process rather than workstation variability. These problems can be minimized if the laboratory organization determines the overall uncertainty associated with results reported from multiple workstations and assesses the significance of the analytical uncertainty to the production process.

4.3 This guide describes a protocol for efficiently optimizing and controlling variability in test results from different workstations used to perform the same test. It harmonizes calibration and control protocols, thereby providing the same level of measurement traceability and control to all workstations. It streamlines documentation and training requirements, thereby facilitating flexibility in personnel assignments. Finally, it offers an opportunity to claim traceability of proficiency test measurements to all included workstations, regardless on which workstation the proficiency test sample was tested. The potential benefits of utilizing this protocol increase with the number of workstations included in the laboratory organization.

4.4 This guide can be used to identify and quantify benefits derived from corrective actions relating to under-performing workstations. It also provides means to track improved performance after improvements have been made.

4.5 It is assumed that all who use this guide will have an established laboratory quality system. This system shall include the use of documented procedures, the application of statistical control of measurement processes, and participation in proficiency testing. ISO/IEC 17025 describes an excellent model for establishing this type of laboratory quality system.

4.6 The general principles of this protocol can be adapted to other types of measurements, such as mechanical testing and on-line process control measurements, such as temperature and thickness gauging. In these areas, users may need to establish their own models for defining data quality objectives and proficiency testing may not be available or applicable.

4.7 It is especially important that users of this guide take responsibility for ensuring the accuracy of the measurements made by the workstations to be operated under this protocol. In addition to the checks mentioned in 6.2.3, laboratories are encouraged to use other techniques, including, but not limited to, analyzing some materials by independent methods, either within the same laboratory or in collaboration with other equally competent laboratories. The risks associated with generating large volumes of data from carefully synchronized, but incorrectly calibrated multiple workstations are obvious and must be avoided.

4.8 This guide is not intended to provide specific guidance on development of statements of measurement uncertainty

such as those required by ISO/IEC 17025. However, the statistical calculations generated using this guide may provide a useful estimate of one Type A uncertainty component used in the calculation of an expanded uncertainty.

4.9 This guide does not provide any guidance for determining the bias related to the use of multiple workstations in a laboratory organization.

## 5. Summary

5.1 Identify the test method and establish the data quality objectives to be met throughout the laboratory organization.

5.2 Identify the workstations to be included in the protocol and harmonize their experimental procedures, calibrations, and control strategies so that all performance data from all workstations are directly statistically comparable.

5.3 Tabulate performance data for each workstation and ensure that each workstation complies with the laboratory organization's data quality objectives.

5.4 Perform statistical analysis of the data from the workstations to quantify variation within each workstation and assess acceptability of the variation of the pooled workstation data.

5.5 Document items covered in 5.1 – 5.4.

5.6 Establish and document a laboratory organization-wide proficiency test policy that provides traceability to all workstations.

5.7 Operate each workstation independently as described in its associated documentation. If any changes are made to any workstation or its performance levels, document the changes and ensure compliance with the laboratory organization's data quality objectives.

## 6. Procedure

6.1 *Test Method Identification and Establishment of the Data Quality Objectives:*

6.1.1 Multi-element test methods can be handled concurrently, provided that all elements are measured using common technology, and that the parameters that influence data quality are tabulated and evaluated for each element individually. An example is Test Method E415 that covers the analysis of plain carbon and low alloy steel by atomic emission vacuum spectrometry. Workstations can be under manual or robotic control, as long as the estimated uncertainties are within the specified data quality objectives. Avoid handling multi-element test methods concurrently that use different measurement technologies. Their procedures and error evaluations are too diverse to be incorporated into one easy-to-manage package. An example of test methods that should not be combined into one program is Test Methods E350 because those methods cover many different measurement technologies.

6.1.2 Set the data quality objectives for the application of the method throughout the laboratory organization, using customer requirements and other available data. Possible sources of other data may include production process data demonstrating the need for and values of specific analytical