



# Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>1</sup>

This standard is issued under the fixed designation A751; 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.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## INTRODUCTION

These test methods, practices, and terminology were prepared to answer the need for a single document that would include all aspects of obtaining and reporting the chemical analysis of steel, stainless steel, and related alloys. Such subjects as definitions of terms and product (check) analysis variations (tolerances) required clarification. Requirements for sampling, meeting specified limits, and treatment of data usually were not clearly established in product specifications.

It is intended that these test methods, practices, and terminology will contain all requirements for the determination of chemical composition of steel, stainless steel, or related alloys so that product specifications will need contain only special modifications and exceptions.

### 1. Scope\*

1.1 These test methods, practices, and terminology cover definitions, reference methods, practices, and guides relating to the chemical analysis of steel, stainless steel, and related alloys. It includes both wet chemical and instrumental techniques.

1.2 Directions are provided for handling chemical requirements, product analyses, residual elements, and reference standards, and for the treatment and reporting of chemical analysis data.

1.3 These test methods, practices, and terminology apply only to those product standards which include these test methods, practices, and terminology, or parts thereof, as a requirement.

1.4 In cases of conflict, the product specification requirements shall take precedence over the requirements of these test methods, practices, and terminology.

1.5 Attention is directed to ISO/IEC 17025 when there may be a need for information on criteria for evaluation of testing laboratories.

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 appro-*

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

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials
- E60 Practice for Analysis of Metals, Ores, and Related Materials by Spectrophotometry
- E322 Test Method for Analysis of Low-Alloy Steels and Cast Irons by Wavelength Dispersive X-Ray Fluorescence Spectrometry
- E350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
- E352 Test Methods for Chemical Analysis of Tool Steels and Other Similar Medium- and High-Alloy Steels
- E353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
- E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

<sup>1</sup> These test methods, practices, and terminology are under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and are the direct responsibility of Subcommittee A01.13 on Mechanical and Chemical Testing and Processing Methods of Steel Products and Processes.

Current edition approved Oct. 1, 2014. Published October 2014. Originally approved in 1977. Last previous edition approved in 2014 as A751 – 14. DOI: 10.1520/A0751-14A.

<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.

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

- E415** Test Method for Analysis of Carbon and Low-Alloy Steel by Spark Atomic Emission Spectrometry
- E548** Guide for General Criteria Used for Evaluating Laboratory Competence (Withdrawn 2002)<sup>3</sup>
- E572** Test Method for Analysis of Stainless and Alloy Steels by Wavelength Dispersive X-Ray Fluorescence Spectrometry
- E743** Guide for Spectrochemical Laboratory Quality Assurance (Withdrawn 1998)<sup>3</sup>
- E851** Practice for Evaluation of Spectrochemical Laboratories (Withdrawn 1998)<sup>3</sup>
- E882** Guide for Accountability and Quality Control in the Chemical Analysis Laboratory
- E1019** Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E1085** Test Method for Analysis of Low-Alloy Steels by X-Ray Fluorescence Spectrometry
- E1086** Test Method for Analysis of Austenitic Stainless Steel by Spark Atomic Emission Spectrometry
- E1097** Guide for Determination of Various Elements by Direct Current Plasma Atomic Emission Spectrometry
- E1184** Practice for Determination of Elements by Graphite Furnace Atomic Absorption Spectrometry
- E1282** Guide for Specifying the Chemical Compositions and Selecting Sampling Practices and Quantitative Analysis Methods for Metals, Ores, and Related Materials
- E1329** Practice for Verification and Use of Control Charts in Spectrochemical Analysis
- E1476** Guide for Metals Identification, Grade Verification, and Sorting
- E1806** Practice for Sampling Steel and Iron for Determination of Chemical Composition
- 2.2 *ISO Standards*:<sup>4</sup>
- ISO/IEC 17025** General Requirements for the Competence of Testing and Calibration Laboratories

### 3. Terminology

#### 3.1 Definitions:

##### 3.1.1 *Pertaining to Analyses:*

3.1.1.1 *cast or heat (formerly ladle) analysis, n*—applies to chemical analyses representative of a heat of steel as reported to the purchaser and determined by analyzing a test sample, preferably obtained during the pouring of the steel, for the elements designated in a specification.

3.1.1.2 *product, check, or verification analysis, n*—a chemical analysis of the semifinished or finished product, usually for the purpose of determining conformance to the specification requirements. The range of the specified composition applicable to product analysis is normally greater than that applicable to heat analysis in order to take into account deviations associated with analytical reproducibility (Note 1) and the heterogeneity of the steel.

NOTE 1—All of the chemical analysis procedures referenced in these test methods include precision statements with reproducibility data, with the exception of Test Methods E50.

3.1.1.3 *product analysis tolerances (Note 2), n*—a permissible variation over the maximum limit or under the minimum limit of a specified element and applicable only to product analyses, not cast or heat analyses.

NOTE 2—The term “analysis tolerance” is often misunderstood. It does not apply to cast or heat analyses determined to show conformance to specified chemical limits. It applies only to product analysis and becomes meaningful only when the heat analysis of an element falls close to one of the specified limits. For example, stainless steel UNS 30400 limits for chromium are 18.00 to 20.00 %. A heat that the producer reported as 18.01 % chromium may be found to show 17.80 % chromium by a user performing a product analysis. If the product analysis tolerance for such a chromium level is 0.20 %, the product analysis of 17.80 % chromium would be acceptable. A product analysis of 17.79 % would not be acceptable.

3.1.1.4 *proprietary analytical method, n*—a non-standard analytical method, not published by ASTM, utilizing reference standards traceable to the National Institute of Standards and Technology (NIST) (when available) or other sources referenced in Section 10.

3.1.1.5 *referee analysis, n*—performed using ASTM methods listed in 9.1.1, NIST reference standards or methods, and reference standards agreed upon between parties. The selection of a laboratory to perform the referee analysis shall be a matter of agreement between the supplier and the purchaser.

3.1.1.6 *certified reference material, n*—a specimen of material specially prepared, analyzed, and certified for chemical content under the jurisdiction of a recognized standardizing agency or group, such as the NIST, for use by analytical laboratories as an accurate basis for comparison. Reference samples should bear sufficient resemblance to the material to be analyzed so that no significant differences are required in procedures or corrections (for example, for interferences or inter-element effects).

3.1.1.7 *working reference materials, n*—reference materials used for routine analytical control and traceable to NIST standards and other recognized standards when appropriate standards are available.

##### 3.1.2 *Pertaining to Elements:*

3.1.2.1 *intentionally added unspecified element, n*—an element added in controlled amounts at the option of the producer to obtain desirable characteristics.

3.1.2.2 *residual element, n*—a specified or unspecified element, not intentionally added, originating in raw materials, refractories, or air.

3.1.2.3 *specified element, n*—an element controlled to a specified range, maximum or minimum, in accordance with the requirements of the product specification.

3.1.2.4 *trace element, n*—a residual element that may occur in very low concentrations, generally less than 0.01 %.

### 4. Concerning Specification of Chemical Composition Requirements

4.1 It is recommended that Guide E1282 be consulted as a guide for specifying the chemical compositions for steels.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.