



Designation: A751 – 21

## Standard Test Methods and Practices 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 and practices 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 and practices 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 and practices cover definitions, reference methods, practices, and guides relating to the chemical analysis of steel, stainless steel, and related alloys. They include 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 and practices apply only to those product standards which include these test methods and practices, 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 and practices.

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 appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

<sup>1</sup> These test methods and practices 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.

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1.7 *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:*<sup>2</sup>

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

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 (Withdrawn 2021)<sup>3</sup>

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

<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.

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

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

### 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
  - 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 Inert Gas Fusion Techniques
  - E1085** Test Method for Analysis of Low-Alloy Steels by Wavelength Dispersive 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 (Withdrawn 2019)<sup>3</sup>
  - 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 For definitions of terms used in these test methods and practices, see Terminology **A941**.

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

3.2.1 *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.

3.2.1.1 *Discussion*—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**.

3.2.2 *product analysis tolerances, 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**).

**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.

3.2.3 *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.

3.2.4 *referee analysis, n*—performed using ASTM test methods listed in 9.1.1, NIST reference standards or methods, and reference standards agreed upon between parties.

3.2.4.1 *Discussion*—The selection of a laboratory to perform the referee analysis shall be a matter of agreement between the supplier and the purchaser.

3.2.5 *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.

3.2.5.1 *Discussion*—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).

3.2.6 *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.

<sup>4</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.