~~Designation:A751–01 (Reapproved 2006)~~ Designation: A 751 – 07

Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[1]

This standard is issued under the fixed designation A 751; 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.

This standard has been approved for use by agencies of the 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.

~~1.5Attention is directed to Practice A880~~

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~A880Practice for Criteria for Use in Evaluation of Testing Laboratories and Organizations for Examination and Inspection of Steel, Stainless Steel, and Related Alloys~~

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron[3]

E 50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition[0]

E 60 Practice for Analysis of Metals, Ores, and Related Materials by Molecular Absorption Spectrometry

[1] These test methods, practices, and terminology are under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related ~~Alloys.~~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 May 1, 2006. Published May 2006. Originally approved in 1977. Last previous edition approved in 2001 as A751–01.~~

Current edition approved April 1, 2007. Published April 2007. Originally approved in 1977. Last previous edition approved in 2006 as A 751 – 01 (2006).

[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] Withdrawn.

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

E 212 Test Method for Spectrographic Analysis of Carbon and Low-Alloy Steel by the Rod-To-Rod Technique[0]
E 293 Test Method for Spectrographic Determination of Acid-Soluble Aluminum in Low-Alloy Steel by the Solution Technique[0]
E 322 Test Method for X-Ray Emission Spectrometric Analysis of Low-Alloy Steels and Cast Irons
E 327 Test Method for Optical Emission Spectrometric Analysis of Stainless Type 18-8 Steels by the Point-To-Plane Technique[0]
E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
E 352 Test Methods for Chemical Analysis of Tool Steels and Other Similar Medium- and High-Alloy Steels
E 353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
E 403 Method for Optical Emission Spetrometric Analysis of Carbon and Low-Alloy Steel by the Point-To-Plane Technique[0]
E 404 Test Method for Spectrographic Determination of Boron In Carbon and LowAlloy Steel by the Point-To-Plane Technique
E 415 Test Method for Atomic Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel
E 421 Test Method for Spectrographic Determination of Silicon and Aluminum in High-Purity Iron[0]
E 485 Test Method for Optical Emission Vacuum Spectrometric Analysis of Blast Furnace Iron by the Point-to-Plane Technique
E 548 Guide for General Criteria Used for Evaluating Laboratory Competence
E 572 Test Method for Analysis of Stainless and Alloy Steels by X-ray Fluorescence Spectrometry
E 663 Practice for Flame Atomic Absorption Analysis[0]
E 743 Guide for Spectrochemical Laboratory Quality Assurance[0]
E 851 Practice for Evaluation of Spectrochemical laboratories[0]
E 882 Guide for Accountability and Quality Control in the Chemical Analysis Laboratory
E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
E 1024 Guide for Chemical Analysis of Metals and Metal Bearing Ores by Flame Atomic Absorption Spectrophotometry
E 1063 Test Method for X-Ray Emission Spectrometric Determination of Cerium and Lanthanum in Carbon and Low-Alloy Steel[0]
E 1086 Test Method for Atomic Emission Vacuum Spectrometric Analysis of Stainless Steel by Point-to-Plane Excitation Technique
E 1087 Practice for Sampling Molten Steel From a Ladle Using an Immersion Sampler to Produce a Specimen for Emission Spectrochemical Analysis [0]
E 1097 Guide for Direct Current Plasma-Atomic Emission Spectrometry Analysis
E 1184 Practice for Electrothermal (Graphite Furnace) Atomic Absorption Analysis
E 1282 Guide for Specifying the Chemical Compositions and Selecting Sampling Practices and Quantitative Analysis Methods for Metals, Ores, and Related Materials
E 1329 Practice for Verification and Use of Control Charts in Spectrochemical Analysis

2.2 *ISO Standards*[4]
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*—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*—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 this document include precision statements with reproducibility data with the exception of Test Methods E 30.

3.1.1.3 *product analysis tolerances (*Note 2*)*—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.

[4] Some sources of reference materials are listed in ASTM Data Series Publication No. DS2, issued 1963.
[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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* —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*— performed using ASTM methods listed in 9.1.1 and 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* —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 National Institute of Standards and Technology, 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* —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*—an element added in controlled amounts at the option of the producer to obtain desirable characteristics.

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

3.1.2.3 *specified element*—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*— a residual element that may occur in very low concentrations, generally less than 0.01 %.

4. Concerning the Specification of Chemical Composition Requirements

4.1 It is recommended that Guide E 1282be consulted as a guide for specifying the chemical compositions for steels.

4.2 The recommended practice for specifying chemical composition limits is to limit the number of significant figures for each element so that the number of figures to the right of the decimal point conforms to the following:

Chemical Concentration		Maximum Number of Figures to the Right of the Decimal Point
Up to 0.010 %	—	0.XXXX or may be expressed as ppm
Up to 0.10 %	—	0.XXX
0.10 to 3.00 %	—	0.XX
Over 3.0 %	—	0.X

4.3 For those cases in which the composition range spans either 0.10 % or 3.0 %, the number of figures to the right of the decimal is to be determined by that indicated by the upper limit.

4.4 Technical considerations may dictate the employment of less than the number of figures to the right of the decimal as previously recommended.

NOTE 3—The recommendations should be employed to reduce the number of significant figures, such as from 18.00 % to 18.0 %, but a significant figure should never be added unless there is a technical reason for so doing.

5. Cast or Heat Analysis

5.1 The producer shall perform analyses for those elements specified in the material specification. The results of such analyses shall conform to the requirements specified in the material specification.

5.1.1 For multiple heats, either individual heat or cast analysis or an average heat or cast analysis shall be reported. If significant variations in heat or cast size are involved, a weighted average heat or cast analysis, based on the relative quantity of metal in each heat or cast, shall be reported.

5.1.2 For consumable electrode remelted material, a heat is defined as all the ingots remelted by the same process from a primary heat. The heat analysis shall be obtained from one remelted ingot, or the product of one remelted ingot, from each primary melt. If this heat analysis does not meet the heat analysis requirements of the specification, one sample from the product of each remelted ingot shall be analyzed, and the analyses shall meet the heat analysis requirements.

5.2 If the test samples taken for the heat analysis are lost, inadequate, or not representative of the heat, a product analysis of the semifinished or finished product may be used to establish the heat analysis.

5.2.1 If a product analysis is made to establish the heat analysis, the product analysis shall meet the specified limits for heat analysis and the product analysis tolerances described in Section 6 do not apply.

6. Product Analysis Requirements

6.1 For product analysis, the range of the specified chemical composition is normally greater (designated product analysis