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An American National Standard

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

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

INTRODUCTION

This standard was 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 this standard 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 This standard covers 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 This standard applies only to those product standards which include this standard or parts thereof as a requirement.

1.4 In cases of conflict, the product specification requirements shall take precedence over the requirements of this standard.

1.5 Attention is directed to Practice A 880 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:*

A 880 Practice for Criteria for Use in Evaluation of Testing Laboratories and Organizations for the Examination and Inspection of Steel, Stainless Steel, and Related Alloys[2]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[3]

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron[4]

E 50 Practices for Apparatus, Reagents, and Safety Precautions for Chemical Analysis of Metals[4]

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition[4]

E 60 Practice for Photometric and Spectrophotometric Methods for Chemical Analysis of Metals[4]

E 212 Test Method for Spectrographic Analysis of Carbon and Low-Alloy Steel by the Rod-to-Rod Technique[5]

E 293 Test Method for Spectrographic Determination of Acid-Soluble Aluminum in Low-Alloy Steel By the Solution Technique[5]

E 322 Method for X-Ray Emission Spectrometric Analysis of Low-Alloy Steels and Cast Irons[5]

E 327 Test Method for Optical Emission Spectrometric Analysis of Stainless Type 18-8 Steels by the Point-to-Plane Technique[5]

E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron[4]

E 352 Test Methods for Chemical Analysis of Tool Steels and Other Similar Medium- and High-Alloy Steels[4]

E 353 Test Methods for Chemical Analysis of Stainless,

[1] These test methods, practices, and terminology are under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel and Related Alloys, and are the direct responsibility of Subcommittee A01.13 on Methods of Mechanical Testing.

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[2] *Annual Book of ASTM Standards*, Vol 01.03.
[3] *Annual Book of ASTM Standards*, Vol 14.02.
[4] *Annual Book of ASTM Standards*, Vol 03.05.
[5] *Annual Book of ASTM Standards*, Vol 03.06.

Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys[4]
E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys[4]
E 403 Test Method for Optical Emission Spectrometric Analysis of Carbon and Low-Alloy Steel by the Point-to-Plane Technique[5]
E 404 Test Method for Spectrographic Determination of Boron in Carbon and Low-Alloy Steel by the Point-to-Plane Technique[5]
E 415 Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel[5]
E 421 Test Method for Spectrographic Determination of Silicon and Aluminum in High-Purity Iron[5]
E 485 Test Method for Optical Emission Vacuum Spectrometric Analysis of Blast Furnace Iron by the Point-to-Plane Technique[5]
E 548 Guide for General Criteria Used for Evaluating Laboratory Competence[3]
E 572 Test Method for X-Ray Emission Spectrometric Analysis of Stainless Steel[5]
E 663 Practice for Flame Atomic Absorption Analysis[5]
E 743 Guide for Spectrochemical Laboratory Quality Assurance[5]
E 851 Practice for Evaluation of Spectrochemical Laboratories[5]
E 882 Guide for Accountability and Quality Control in the Chemical Analysis Laboratory[5]
E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, Oxygen, and Hydrogen in Steel and in Iron, Nickel, and Cobalt Alloys[4]
E 1024 Guide for Chemical Analysis of Metals and Metal Bearing Ores by Flame Atomic Absorption Spectrophotometry[5]
E 1063 Test Method for X-Ray Emission Spectrometric Determination of Cerium and Lathanum in Carbon and Low-Alloy Steels[5]
E 1086 Test Method for Optical Emission Vacuum Spectrometric Analysis of Stainless Steel by the Point-to-Plane Excitation Technique[5]
E 1087 Practice for Sampling Molten Steel from a Ladle Using An Immersion Sampler to Produce a Specimen for Emission Spectrochemical Analysis[5]
E 1097 Guide for Direct Current Plasma Emission Spectrometry Analysis[5]
E 1184 Practice for Electrothermal (Graphite Furnace) Atomic Absorption Analysis[5]
E 1282 Guide for Specifying the Chemical Compositions and Selecting Sampling Practices and Quantitative Analysis Methods for Metals and Alloys[4]
E 1329 Practice for Verification and the Use of Control Charts in Spectrochemical Analysis[5]

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.

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.