Designation: E 1282 – 98

Standard Guide for Specifying the Chemical Compositions and Selecting Sampling Practices and Quantitative Analysis Methods for Metals, Ores, and Related Materials[1]

This standard is issued under the fixed designation E 1282; 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.

1. Scope

1.1 This guide covers procedures for specifying compositional requirements and identifying appropriate sampling and quantitative analysis methodologies to be referenced in product specification standards for metals, ores, and related materials. It is not intended to replace or conflict with either individual product specifications or standards covering broad classifications of products such as Test Methods A 751.

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:* [2]

A 276 Specification for Stainless and Heat-Resisting Steel Bars and Shapes[3]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[4]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys[5]

E 135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Material[5]

E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition[5]

E 342 Test Method for Chromium Oxide in Chrome Ores[5]

E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron[5]

E 1061 Practice for Coducting an Interlaboratory Study to Evaluate the Performance of an Analytical Method[6]

3. Significance and Use

3.1 This guide is intended to assist those writing or revising compositional specification, sampling practice, and analysis method standards for ferrous and non-ferrous metals, ores, and related materials. It is directed toward those areas which must be addressed to properly coordinate compositional specification, sampling practice, and analytical method standards. Its use will help ensure that compositional requirements are clearly defined and that sampling practices and analytical methods are available to meet product specifications.

3.2 This guide does not attempt to define which elements should be controlled, where samples should be taken, or how they should be analyzed. These items are addressed in standards such as Specification A 276, Methods, Practices and Terminology A 751, Test Method E 34, Practice E 255, Test Method E 342, and Test Methods E 350.

3.3 A primary purpose for ASTM sampling practices and analytical method standards is to provide widely-accepted and tested methodology for use in meeting ASTM product specifications. Although it is recognized that individual laboratories are free to use other methods, the availability of ASTM approved methodology is essential for referee purposes and to demonstrate that properly equipped laboratories can make the required measurements.

3.4 Sampling practices and analysis methods to be recommended for use in testing a given product are most easily selected cooperatively by the specification-writing and the methods-writing committees which have jurisdiction for the product. When existing sampling or analysis standards do not meet the needs of the new product specification standard, the specification-writing committee should request that the methods-writing committee develop the required standards. ASTM Committee E-1 is responsible for methods and practices covering the sampling and analysis of most metals, ores, and related materials.

4. Procedure

4.1 List those elements which either positively or negatively influence the product's processing, properties, or performance.

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[1] This guide is under the jurisdiction of ASTM Committee E-1 on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.20 on Fundamental Practices and Measurement Traceability.

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[2] The documents referenced in this guide were selected only as examples of the types of standards used to specify the composition and define sampling and analysis methodology. Numerous other documents from Vols 01.01 through 03.06 of the *Annual Book of ASTM Standards* apply as well.

[3] *Annual Book of ASTM Standards*, Vol 01.05.

[4] *Annual Book of ASTM Standards*, Vol 01.03.

[5] *Annual Book of ASTM Standards*, Vol 03.05.

[6] *Annual Book of ASTM Standards*, Vol 03.06.

Do not list elements for which no justification exists for exercising compositional control or for which no methods of analysis exist. Nonessential compositional specifications increase testing costs with no benefit to producer or consumer.

4.2 Establish the compositional requirements for each element identified in 4.1 as a concentration range, a maximum or a minimum. Where possible, it is desirable to express concentrations in weight percent, however, other concentration units, such as parts per million, may also be used. Always list the element in the stoichiometric form in which the composition is to be reported. For example, depending on the material, calcium might be specified and reported as Ca, $CaCO_3$, or CaO. Occasionally, it may be necessary to specify that the sum of a limited number of specific element concentrations must not exceed some maximum value or must remain above some minimum value. Make sure that measurement uncertainties, particularly at the lower quantitation limits, do not contribute significantly to calculated sums.

4.2.1 Nonspecific phrases such as *balance* or *remainder* may be listed for informational purposes only, but must have an accompanying footnote stating that quantitative measurement is not required. An example of an acceptable footnote is: "For information only. Quantitative determination of this element is not required." Avoid assigning quantitative compositional specifications to nonspecific items such as "all other elements" or "all residuals." It is not possible to use element-specific analytical methods to meet a non-element-specific compositional specification (Note 1).

NOTE 1—The purity of high purity metals is often best ascertained by the determination of residual elements. In these cases, each element to be determined must be listed with either a maximum concentration for each element or a minimum concentration for the sum of the listed determinations. See Table 1.

4.2.2 When specifying the composition of components in a composite, define the components consistent with both commercial requirements and testing capabilities. For example, if a specification requires that both the coating and base metal be analyzed separately, make sure that it is possible to quantitatively separate the coating from the base metal prior to analysis.

4.2.3 If compositional requirements differ among various applications for a given alloy, it may be necessary to specify composition by application within a grade, or to create a separate grade for those applications.

4.2.4 Refer to Table 1 as an example of a possible format for presenting compositional specifications.

TABLE 1 Example of Typical Alloy Compositional Requirements

Element	Composition[A]	
	Grade A	Grade B
Carbon:	0.20–0.30	0.45–0.75
Manganese:	1.0, max	1.3, max
Chromium	20.0–28.5	32.5–38.0
Iron	25, min	balance[B]
Copper + Vanadium	0.02, max	0.50, min
Oxygen	25 ppm, max	50 ppm, max
Aluminum[C]	0.02–0.10	0.20–0.30

[A] All concentrations are given in weight percent, unless otherwise stated.
[B] For information only. Quantitative determination of this element is not required.
[C] The aluminum concentration requirement applies only to material made for high-temperature applications and its quantitative determination is not required on material designated for other uses.

4.3 Identify standard sampling practices that can be used at each processing step or for each product form for which compositional requirements are identified as described below (see Note 2).

NOTE 2—For additional information on a recommended practice designed for the steel industry, consult the literature.[7]

4.3.1 Ensure that each selected sampling practice can be carried out without unacceptably interrupting production, interfering with product quality, or risking the health or safety of employees.

4.3.2 Ensure that the selected sampling hardware and practices are reliable. For example, in heat analysis sampling, ensure that the ratio of successful (solid, non-porous, completely filled mold) to unsuccessful samplings is acceptable. Also, provision should be made for resampling when needed.

4.3.3 Ensure that the concentration of each element to be determined in the sample is representative of the bulk material. For example, many commercially available molten-metal sampling devices used in the steel industry contain deoxidizing elements, such as aluminum, which alloy with the test sample. Samples taken using such devices cannot be used to determine these elements in the bath. In addition, the unusually high concentration of the deoxidizing element may interfere with the determination of other elements in the sample. If any of these elements are to be included in the product specification, more than one sampling device will be required.

4.3.4 Ensure that adequate samples are taken to permit the determination of all elements to be included in the specification. Some determinations, such as hydrogen, may require special sampling and storage practices.

4.3.5 Ensure that each selected sampling practice provides samples of sufficient size and shape for both production and referee analyses. Samples should be in a form amenable to rapid transport to the laboratory, and should require a minimum of time and effort to prepare for chemical analysis. Following production analysis, sufficient representative material must remain for any recheck analyses by the same or other techniques, as required.

4.4 Identify all analytical methods standards that can be used to determine all elements for which compositions are to be specified as described in 4.4.1-4.4.4.

4.4.1 Using the lists of elements and associated concentrations generated in 4.2, identify the analytical method standards that cover the listed concentration ranges for in-process and check analyses. Most in-process (control) analyses are performed by spectrometric methods using solid samples, while most check or referee analyses are performed by a combination of wet chemical and instrumental methods. The latter frequently require that a dissolved sample be obtained from drilled or machined chips.[8]

4.4.2 Eliminate from further consideration any methodologies that are subject to uncorrectable chemical or spectral

[7] AISI Recommended Guidelines for Quantitative Evaluation of New Samplers or Sampling Procedures, available from the American Iron and Steel Institute, 100 16th St., N.W., Washington, DC 20036-5761.

[8] Analytical methods for most metals and alloys can be found in the *Annual Book of ASTM Standards*, Vols 03.05 and 03.06.

interferences due to elements expected to exist in the sample, including those for which compositions are not specified. Such interferences are identified in each ASTM analytical standard method. The Scope and Interferences sections of each method must be carefully interpreted by a skilled analyst before that method is applied to the analysis of a material that was not considered by the authors of the method.

4.4.3 Ensure that the identified analytical methodologies are capable of attaining sufficient precision to comply with the intended compositional requirements. Refer to the performance data in the ASTM standard methods of analysis to ensure that the repeatability (*r*) and reproducibility (*R*) obtained during interlaboratory testing for each method are sufficient to meet the intended requirements. Definitions of *r* and *R* can be found in Terminology E 135, and Practice E 1601. State compositional requirements using the number of significant figures which is consistent with the *R* performance data associated with the selected analytical methodology and the needs of the product specification. Most compositional specifications will contain between one and three significant figures.

4.4.4 Ensure that the sample preparation requirements that are part of the analytical method are compatible with the selected sampling practice and that the sampling, sample preparation, and analysis work can be completed within the time available.

4.5 In addition to listings and explanations of compositional specifications, include in each product specification standard sufficient instructions and references to the appropriate ASTM sampling practices and analysis methods standards to allow a producer or user of the material to completely test for compliance with all compositional requirements. References to sampling practices and analysis method standards can be either listed directly in the product specification standard, or referenced through a generic standard such as Methods, Practices and Terminology A 751. When the latter option is selected, be sure that the generic standard provides all of the required information in an unambiguous fashion.

5. Keywords

5.1 quantitative analysis; sampling; specification