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Standard Guide for Identification of Metals and Alloys in Computerized Material Property Databases[1]

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1. Scope

1.1 This guide covers the identification of metals and alloys in computerized material property databases. It establishes essential and desirable data elements that serve to uniquely identify and describe a particular metal or alloy sample as well as properties that identify a given metal or alloy in general.

1.1.1 This guide does not necessarily provide sufficient data elements to describe weld metal, metal matrix composites, or joined metals.[2]

1.1.2 The data element identified herein are not all germane to every metal or alloy group.

1.1.3 Different sets of data elements may also be applied within a given metal or alloy group depending on conditions or applications specific to that metal or alloy group. Further, within a particular metal or alloy group, different sets of data elements may be used to identify specific material conditions.

1.1.4 Table 1 on Recommended Data Elements and Tables 2-17 on values for specific data elements appear at the end of this guide.

1.2 Some of the data elements in this guide may be useful for other purposes. However, this guide does not attempt to document the essential and desirable data element for any purpose except for the identification of metals and alloys in computerized material property databases. Other purposes, such as material production, material procurement, and material processing, each may have different material data reporting requirements distinct from those covered in this guide. A specific example is the contractually required report for a material property testing series. Such a report may not contain all the data elements considered essential for a specific computerized database; conversely, this guide may not contain all the data elements considered essential for a contracted test report.

1.3 Results from material tests conducted as part of the procurement process are often used to determine adherence to a specification. While this guide includes a number of test result data elements, such data elements are included in this guide only for the purposes of material identification.

1.4 Reporting of contracted test results, such as certification test results, shall follow the requirements described in the material specification, or as agreed upon between the purchaser and the manufacturer.

1.5 This guide contains a limited number of data elements related to material test results. These data elements are for material identification purposes and are not intended to replace the more detailed sets of data elements listed in guides such as Guide E 1313 covering data recording formats for mechanical testing of metals. For material identification purposes, the data elements in this guide include typical, nominal, or summary properties normally derived from a population of individual specimen tests. If warranted by the scope of a particular database system, the system might provide links between the material identification data elements given in this guide, and the individual specimen test results recorded in accordance with other guides corresponding to particular test methods.

1.6 *Material Classes*—See ANSI/AWS A9.1-92 for arc welds, Guide E 1308 for polymers, Guide E 1309 for composite material, and Guide E 1471 for fibers, fillers, and core materials. ASTM Committee E-49 is developing guides for other material classes.

2. Referenced Documents

2.1 *ASTM Standards:*

E 8 Test Methods for Tension Testing of Metallic Materials[2]

E 8M Test Methods for Tension Testing of Metallic Materials [Metric][2]

E 380 Practice for Use of the International System of Units (SI) the Modernized Metric System[3]

E 527 Practice for Numbering Metals and Alloys (UNS)[4]

E 616 Terminology Relating to Fracture Testing[5]

E 1308 Guide for Identification of Polymers (Excludes Thermoset Elastomers) in Computerized Material Property Databases[6]

[1] This guide is under the jurisdiction of ASTM Committee B-8 on Metallic and Inorganic Coatingsand is the direct responsibility of Subcommittee B08.01 on Ancillary Matters. This guide was developed in cooperation with Committee B-7 on Light Metals and Alloys.

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[2] *Annual Book of ASTM Standards,* Vol 03.01.

[3] Discontinued. See *1997 Annual Book of ASTM Standards,* Vol 14.02.

[4] *Annual Book of ASTM Standards,* Vol 01.01.

[5] Discontinued. See *1997 Annual Book of ASTM Standards,* Vol 03.01.

[6] *Annual Book of ASTM Standards,* Vol 14.01.

E 1309 Guide for Identification of Composite Materials in Computerized Material Property Databases[7]
E 1313 Guide for Recommended Formats for Data Records Used in Computerization of Mechanical Test Data for Metals[6]
E 1443 Terminology Relating to Building and Accessing Material and Chemical Databases[6]
E 1471 Guide for the Identification of Fibers, Fillers, and Core Materials in Computerized Material Property Databases[7]

2.2 *Other Standards:*

ISO Standard: 3166 Codes for Representation of Names of Countries Quantities, Units and Symbols in Physical Chemistry—IUPAC[8]
ANSI/AWS A9.1-92 Standard Guide for Describing Arc Welds in Computerized Material Property and Nondestructive Examination Databases[9]

3. Terminology

3.1 Computer-related technical terms in this guide are defined in Terminology E 1443.

4. Significance and Use

4.1 This guide describes the types of information that are indispensable for uniquely identifying a metal or alloy in a computerized database. The purpose is to facilitate standardized storage and retrieval of the information with a computer, and allow meaningful comparison of data from different sources.

4.2 Many numbering systems for metals and alloys have been developed which are based on their chemical compositions. Separate systems have also evolved to describe the thermomechanical condition of metals and alloys in order to narrow their description. It is the separation into logical data elements from these complex, historically significant, and overlapping systems of identification that is the challenge in the identification of metals and alloys within computerized databases.

4.3 This guide is intended to provide a common starting point for designers and builders of materials property databases. This guide generally identifies the contents of the database in terms of data elements, but does not recommend any particular logical or physical database design. A database builder has considerable flexibility in designing a database schema, and it is intended that this guide support that flexibility.

4.4 It is recognized that material property databases will be designed for different levels of material information and for different purposes. For example, a database developed by an industry trade group might only identify typical properties generally representative of those for a particular metal or alloy, and not actual values measured on a specific sample. On the other hand, a business might desire to manage data on specific lots it procures, or even properties of a specific piece or sample from a lot. Consequently, some of the data elements identified in this guide might not be applicable in every database instance.

4.5 The extent of material identification implemented in a particular database depends on its specific purpose. A single organization may include substantial detail in its database. Less detail may be included in a common database used by several organizations because of commercial and other considerations. Since metals and alloys are diverse and the technologies are always changing, recommendations should not be regarded as exclusive of additional data elements for material identification. The recommended data elements should be expanded if additional detailed information which serves to identify materials is to be recorded.

4.6 A number of data elements are considered essential to any database and need to exist in the database. Data elements are considered essential if they are required for users to have sufficient information to interpret the data and be confident of their ability to compare sets of data for materials from different sources. Failure to complete an essential data element may render the record unusable in a database or in data exchange. Essential refers to the quality or completeness of recorded data, and does not necessarily have direct meaning relative to database structure. In some cases, the identified data element might be accommodated within a particular database without explicitly including a field just for the essential data element. Additionally, a database schema may require additional data fields to be not null to maintain data record integrity or to implement a mandatory data relationship. These additional fields are beyond the scope of this guide. Finally, it is also noted that a data element identified as essential in this guide might not be relevant for a database created for a specific application of limited scope.

4.7 This guide presents a listing of the data elements and does not intend to define any single organization of the data elements to be used in either a logical or physical model for the database. The data element lists are divided by group headings for discussion purposes only. The group headings are not intended to identify normalization of the database model; this is left to the database designer.

4.8 Numerous data elements listed in this guide may need to be repeated to identify even a single material. Depending on the database purpose or design, it may be appropriate to design the database to enable additional repeatable data elements. How the database should accommodate multiple values for a given data element is another question left to the database designer.

5. Guidelines

5.1 The data elements recommended for material identification are listed in Table 1. Descriptions of each data element are provided in Section 6. Table 1 includes: (*1*) a data element number, (*2*) a descriptive name for each data element, (*3*) data type, and (*4*) category sets, value sets, or units.

5.1.1 *Data Element Number*—A reference number for ease of dealing with the individual data elements within this guide. The data element number has no permanent value and does not become part of the database itself.

[7] *Annual Book of ASTM Standards*, Vol 15.03.
[8] Available from ISO, 1 Rue de Varembe, Case Postale 56, Crt 1221, Geneva, Switzerland.
[9] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

5.1.2 *Descriptive Data Element Name*—The complete and unambiguous name, descriptive of the data element being identified.

5.1.3 *Data Type*—The kind of data to be included in the data element, such as the type of number, character string, and date.

5.1.3.1 *String*—Textual data element.

5.1.3.2 *Real*—Any rational, irrational, and scientific real number.

5.1.3.3 *Integer*—An integral number.

5.1.3.4 *Date*—The calendar date in the Gregorian calendar in the YYYY-MM-DD format.

5.1.4 *Category Set, Value Set, or Units*—A listing of the types of information that would be included in the data element or, in the case of properties or other numeric data, the units in which the numbers are expressed. Candidate values for both category and value sets are frequently given in separate tables in this guide. The database implementation should provide some means of maintaining these lists of allowable values and presenting them to the database user. The distinction between category and value sets identified below primarily relates to the degree of control over additions to these lists of values.

5.1.4.1 A category set is a closed set listing all possible (or acceptable) values the data element may take. Because this guide is intended to apply to databases with different scopes and purposes, values listed in sample tables in this guide are generally not identified as category sets, but it may be appropriate to treat them as such in a particular database application. The database application should control or restrict the addition of a new value to a category set.

5.1.4.2 A value set is a representative set listing sample, but not necessarily all acceptable values the data element may take. In this case, the database application generally should provide some means for a new value to be added to the value set maintained by the database system.

5.1.4.3 The units listed are SI, in accordance with Practice E 380, followed by inch-pound units in parentheses. Although both sets of units are listed in this guide, it is left to the database designer to decide whether a single data unit system will be used to store values for a given data element or whether the database design will support storage of data in mixed units with necessary tracking of units for each data element entry. Data elements for tracking units are generally not identified in this guide.

5.2 This guide does not provide specific recommendations relative to either the logical or the physical design of the database for storing material property data. Accordingly, internal data element associated only with a particular database model, such as index fields or fields containing counts of repeating data, are not provided since their existence will vary depending on the particular database design.

5.3 The value sets and category sets identified in this guide are to be used for the identification of any type of metal or alloy. Aluminum, copper, and steels are three specific types of material which are identified in this guide to serve as examples and because there has been specific interest in providing guidelines for these common metal families. For some of the lists of values, candidate values are identified and associated with one of these types of metal.

5.4 Data elements are provided for characterization of a material's microstructure in terms of grain size measurements and description of its microstructure, including microstructure classification. Additional data elements should be added for other aspects of metallographic characterization if judged by the database designer to be appropriate for a particular system. Examples of additional items that should be considered for addition are the following: distribution of elements to grain boundaries, presence of voids or inclusions, phase content, and X-ray diffraction measurements. Images are often an important part of the record of materials characterization and should be made available to the user of the database if appropriate for a particular system. Although this guide does not recommend standard means to handle records of images, data elements associated with the storage or indexing of images should be added when appropriate.

6. Description of Data Elements

6.1 The individual data elements recommended for the identification of metals and alloys are described in this section. The data elements are numbered consecutively matching the numbers listed in Table 1. Section headings are used to group data elements both in the following paragraphs and in Table 1. Whether or not these logical groupings have any significance to an actual database will depend on the particular database model used in that instance. Provisions should be designed in the database for repeated values of data elements, or for sets of data elements when it is indicated that they may repeat.

6.1.1 *Primary Identifiers*—Features which distinguish one material type from another and allow materials data to be grouped by broad material type. The existence of some of the following data elements will likely vary depending on the scope of the database.

6.1.1.1 *Material Class* (1)—The broad material class, in this case, metal (as distinct from ceramic, polymer, composite, and so forth).

6.1.1.2 *Family Name* (2)—The broad alloy family defined by the primary alphabetical identifier defined in Practice E 527. Examples are copper and copper alloys and tool steels. See Table 2.

6.1.1.3 *Family Subclass* (3)—A more specific division of the family name descriptive of a particular alloy system; for example, some subclasses of AISI and SAE Carbon and Alloy Steel may be chromium-molybdenum, rephosphorized, low carbon, and high carbon. The secondary division of some of the alphabetical identifiers in Practice E 527 are additional examples of subclasses. See Table 3.

6.1.1.4 *Common Name* (4) (essential and may repeat)—Any frequently used domestic or international name for a particular metal or alloy. It may be a commercial or trade name which has broad usage or part of a specification designation, such as 4140. A specific alloy may have more than one common name. Recommended standard common names include those used in Practice E 527.

6.1.1.5 *Application Group* (5)—A broad end usage for the metal (for example, electrical conductor or pressure vessel).

6.1.1.6 *Product Group* (6)—A broad end product (for example, water tube, bus bar, wire, or rivet).

6.1.2 *Material Specification* (may repeat)—The following data elements identify the material specification which is recorded on drawings, requisitions, standards document, and design data in order to procure or fabricate a material. The material being described may be covered by more than one specification. Material standard and specification are synonyms.

6.1.2.1 *UNS Number* (7) (essential if a UNS number has been defined for the particular alloy)—The assigned number of the metal or alloy within the United Numbering System which generally identifies the chemical composition and corresponds to one or more standard material specifications.

6.1.2.2 *Specification Organization* (8) (essential)—A company; industry; or national, regional, or international organization issuing the specification (for example, ASTM or SAE).

6.1.2.3 *Specification Number* (9) (essential)—The specification number within the previously referenced organization.

6.1.2.4 *Specification Version* (10) (essential)—The year or revision code of the specification.

6.1.2.5 *Designation Keyword* (11) (essential and may repeat)—The keyword used in the material specification to identify the type of designation or classification for the metal or alloy as identified by the Designation Value data element. Provisions for repeated pairs of Designation Keyword and Designation Value data elements should be provided. See Table 4.

6.1.2.6 *Designation Value* (12) (essential and may repeat)—The value defined in the material specification for the material type or classification identified in the Designation Keyword data element.

6.1.3 *Specified Properties*—The following data elements identify chemical composition and mechanical properties identified in the material specification as requirements for certification of the material relative to the material specification.

6.1.4 *Composition Requirements* (may repeat)—The limits for chemical composition for the material identified in the material specification are recorded by repetition of the following data elements for the chemical element, fraction type, units, and limiting values.

6.1.4.1 *Element Symbol* (13)—The IUPAC symbol for the chemical element or the identifier for a combination of chemical elements which might be specified to be measured as a unit.

6.1.4.2 *Fraction Type* (14)—The parameter that labels the fractional composition value. Preferred values are mass, volume, or mole. Due to their extensive usage for metals, weight fraction is an acceptable alternative to mass fraction, and atomic fraction is likewise an alternative to mole fraction. This data element is optional if the definition of the database restricts chemistry values to a single fraction type.

6.1.4.3 *Composition Units* (15)—The scale of the composition fraction. Allowable values are percent (%) and parts per million (ppm). This data element is optional if the definition of the database restricts chemistry values to a single set of units.

6.1.4.4 *Minimum Specified Composition* (16)—The minimum value of chemical composition specified in the material specification in terms of the Fraction Type and Composition Units.

6.1.4.5 *Maximum Specified Composition* (17)—The maximum value of chemical composition specified in the material specification in terms of the Fraction type and Composition units.

6.1.5 *Mechanical Properties Requirements* (may repeat)—Data element numbers 17 through 38 listed in Table 1 catalog the tensile, hardness, and Charpy impact energy property requirements identified in the material specification. Data elements are included to record the conditions for these tests if specific ones are identified in the specification. All of these data elements are self-descriptive. Tables 5-8 contain value sets or category sets for data elements associated with mechanical properties. The database designer should generalize and add to the data element numbers 35–38 for Charpy impact energy to fracture requirements if needed to encompass other types of impact requirements.

6.1.6 *Primary Material Producer*:

6.1.6.1 *Original Producer* (40)—The name of the manufacturer who made the metal or alloy.

6.1.6.2 *Country of Origin* (41)—The three-character code described in ISO 3166 for the producer's country.

6.1.6.3 *Producer's Facility* (42)—The name of the manufacturing plant.

6.1.6.4 *Production Date* (43)—The date of material production assigned by the primary material producer.

6.1.6.5 *Primary Process Type* (44)—Identification of the primary process used to produce the material.

6.1.6.6 *Melt Practice* (45)—The name of the melting procedure. See Table 9.

6.1.6.7 *Cast Practice* (46)—The name of the primary casting procedure, for example, ingot or continuous. See Table 10.

6.1.6.8 *Heat Number* (47) (essential)—The identifying number assigned by the material producer which generally identifies all the material produced in the same primary process event. This number is often associated with the final melt and identifies the common chemical composition of the heat of material.

6.1.7 *Material Processing* (may repeat)—The following set of data elements should be repeated for each of the significant processes applied to the material following its primary production.

6.1.7.1 *Processor's Name* (48)—The name of the organization that processed the material after initial production.

6.1.7.2 *Processor's Country* (49)—The three-character code described in ISO 3166 for the producer's country.

6.1.7.3 *Processor's Facility Name* (50)—The name of the processing plant.

6.1.7.4 *Processor's Assigned Production Date* (51)—The date of the material's processing assigned by the processor.

6.1.7.5 *Process Type* (52) (essential)—Descriptive term or phrase identifying the process performed.

6.1.7.6 *Process Lot Number* (53)—The number assigned by the processor to identify the material from the same heat and of the same form, condition, and size, and receiving the same heat treatment in a batch process or one continuous process under

the same conditions of temperature, time at heat, and atmosphere. This material processing stage is often associated with the certification of the material in accordance with the material specification.

6.1.8 *Heat Treatment* (may repeat)—The following set of data elements should be repeated for each heat treatment cycle applied to the material. Provision should be included to know the sequence the cycles are applied.

6.1.8.1 *Thermal Step Type* (54)—The name or description of one step of the thermal process.

6.1.8.2 *Time of Thermal Step* (55)—The time in hours of the thermal processing step.

6.1.8.3 *Thermal Step Temperature* (56)—The temperature used during the thermal processing step.

6.1.8.4 *Heating Environment* (57)—A brief description of the environment in which the heating treatment was performed.

6.1.8.5 *Heating Rate* (58)—The rate of temperature increase in degrees per hour.

6.1.8.6 *Cooling Environment* (59)—A brief description of the environment in which the cooling treatment was performed.

6.1.8.7 *Cooling Rate* (60)—The rate of temperature decrease in degrees per hour.

6.1.9 *Product Detail*—Data elements which identify the characteristic size and shape of the product or sample being identified, if applicable.

6.1.9.1 *Product Forming Method* (61)—The name of the procedure for forming the final shape of the product.

6.1.9.2 *Product Identifier* (62)—The manufacturer's code for a product, which may be a key to a record describing the product attributes.

6.1.9.3 *Product Shape* (63)—The overall geometry of the product, such as cylindrical or rectangular.

6.1.9.4 *Product Form* (64)—The overall form of the product, such as strip, bar, or wire.

6.1.9.5 *Dimension Type* (65)—A term describing the basis for the dimensional values, such as nominal or measured.

6.1.9.6 *Length* (66)—The longest dimension of the product.

6.1.9.7 *Width* (67)—The second longest dimension of the product for noncircular sections.

6.1.9.8 *Thickness* (68)—The third longest dimension of the product for noncircular sections.

6.1.9.9 *Outside Diameter* (69)—The outside diameter dimension of a circular section.

6.1.9.10 *Wall Thickness* (70)—The wall thickness of hollow sections in circular sections or a characteristic wall thickness for irregular forgings.

6.1.9.11 *Weight* (71)—The weight of the product or sample being identified.

6.1.9.12 *Fabrication History* (72)—Identification or description of processes such as machining, joining, forming, or assembling. Examples include: machined and welded per ABC Company Manufacturing Routing 12345; final machined using low-stress grinding.

6.1.9.13 *Service History* (73)—Indicates briefly any service exposure conditions encountered by the material, such as nuclear radiation or high-temperature exposure.

6.1.10 *Material Characterization*—The actual chemical composition, mechanical properties, and microstructure descriptors measured on a sample or samples of the material and used to certify or otherwise characterize the material being identified. The specific nature of these properties will vary depending on the purpose of the database, but generally speaking, the data used to characterize a material for identification purposes will be summary or average data from more than one individual test. If specific lots of material are being identified, then these properties will often be recorded as part of the certification data measured for that particular material. If materials are being described in a more general sense, then the purpose of the database might be to record typical properties representing many different heats or lots of material. The data elements listed in this guide are intended to provide for either of these purposes. On the other hand, if individual specimen results from multiple tests are being recorded, then guides such as Guide E 1313, which provide standard data recording formats for specific tests, should be consulted as additional data elements are recommended to record test details.

6.1.11 *Measured Chemical Composition* (may repeat)—The chemical composition measured on a sample or samples of the material used to certify or otherwise characterize the material. The following group of data elements should be repeated for each of the chemical elements.

6.1.11.1 *Source of Chemical Composition Data* (74)—Identification of the source for the chemical composition data. Examples are: producer's ladle analysis and check analysis on a product sample.

6.1.11.2 *Element Symbol* (75)—The IUPAC symbol for the chemical element or the identifier for a combination of chemical elements which might be measured as a unit to characterize the material.

6.1.11.3 *Fraction Type* (76)—The parameter that labels the fractional composition value. Preferred values are mass, volume, or mole. Due to their extensive usage for metals, weight fraction is an acceptable alternative to mass fraction, and atomic fraction is likewise an alternative to mole fraction. This data element is optional if the definition of the database restricts chemistry values to a single fraction type.

6.1.11.4 *Composition Units* (77)—The scale of the composition fraction. Allowable values are percent (%) and parts per million (ppm). This data element is optional if the definition of the database restricts chemistry values to a single set of units.

6.1.11.5 *Measured Composition* (78)—The actual or typical composition value for the element measured for the particular material being identified in terms of the Fraction Type and Composition Units.

6.1.12 *Measured Mechanical Properties and Microstructure* (may repeat)—Data elements Numbers 77 through 103, listed in Table 1, record mechanical properties, and Numbers 104 through 107 record microstructure descriptors measured on a sample or samples of the material being identified. These data elements are self-descriptive. Tables 5-8, Table 16, and Table 17 contain value sets or category sets for data elements associated with mechanical properties. Depending on the purpose of the database and the value assigned to the data elements for recording the source of each property, either

average, individual, or typical values can be used to characterize the material. These fields will need to repeat to accommodate individual results from multiple tests and tests at a variety of conditions. Similar data elements should be added to record other physical or mechanical properties if they are used to characterize the material. Specifically, the database designer should generalize and add to the data element Numbers 98–103 for Charpy impact energy to fracture measurements if needed to encompass other types of impact test results.

7. Keywords

7.1 alloys; computerized databases; computerized material property databases; databases; data elements; metals

TABLE 1 Recommended Data Elements for the Identification of Metals and Alloys

Number[A]	Data Element Descriptive Name	Data Type	Category Set, Value Set, or Units
	Primary Identifiers		
1	Material class	String	metal
2	Family name	String	Category set in Table 2
3	Family subclass	String	Value set in Table 3
4[B]	Common name[C]	String	
5	Application group[C]	String	
6	Product group[C]	String	
	Material Specification[C]		
7[B]	UNS Number	String	Category set defined in Practice E 527
8[B]	Specification organization	String	
9[B]	Specification number	String	
10[B]	Specification version	String	
11[B]	Designation keyword[C]	String	Category set in Table 4
12[B]	Designation value[C]	String	
	Composition Requirements[C]		
13	Element symbol	String	IUPAC symbol(s)
14	Fraction type	String	mass, volume, or mole
15	Composition units	String	% or ppm
16	Minimum specified composition	Real	
17	Maximum specified composition	Real	
	Mechanical Properties Requirements		
	Tensile Test Requirements[C]		
18	Orientation of tensile specimen for certification	String	Value set in Table 5
19	Location of tensile specimen for certification	String	Values set in Table 6
20	Tensile test temperature for certification	Real	°C (°F)
21	Minimum ultimate tensile strength	Real	MPa (ksi)
22	Maximum ultimate tensile strength	Real	MPa (ksi)
23	Minimum yield strength	Real	MPa (ksi)
24	Maximum yield strength	Real	MPa (ksi)
25	Yield strength determination method	String	Category set in Table 7
26	Yield strength offset or extension	Real	%
27	Minimum elongation	Real	%
28	Maximum elongation	Real	%
29	Original gage length	Real	mm (in.)
30	Minimum reduction of area	Real	%
31	Maximum reduction of area	Real	%
	Hardness Requirements[C]		
32	Location of hardness measurement for certification	String	Value set in Table 6
33	Minimum hardness	Real	
34	Maximum hardness	Real	
35	Hardness scale	String	Category set in Table 8
	Charpy Impact Energy to Fracture Requirements[C]		
36	Location of Charpy specimen for certification	String	Value set in Table 6
37	Temperature of Charpy test for certification	Real	°C (°F)
38	Minimum Charpy impact energy	Real	J (ft-lbf)
39	Maximum Charpy impact energy	Real	J (ft-lbf)
	Primary Material Producer		
40	Original producer	String	
41	Country of origin	String	
42	Producer's facility	String	
43	Production date	Date	
44	Primary process type	String	
45	Melt practice	String	Value set in Table 9
46	Cast practice	String	Value set in Table 10
47[B]	Heat number	String	

TABLE 1 *Continued*

Number[A]	Data Element Descriptive Name	Data Type	Category Set, Value Set, or Units
	Material Processing[C]		
48	Processor's name	String	
49	Processor's country	String	see ISO 3166
50	Processor's facility name	String	
51	Processor's assigned production date	Date	
52[B]	Process type	String	
53	Process lot number	String	
	Heat Treatment[C]		
54	Thermal step type	String	
55	Time of thermal step	Real	h
56	Thermal step temperature	Real	°C (°F)
57	Heating environment	String	Values set in Table 11
58	Heating rate	Real	°C/h (°F/h)
59	Cooling environment	String	Value set in Table 12
60	Cooling rate	Real	°C/h (°F/h)
	Product Detail		
61	Product forming method	String	Value set in Table 13
62	Product identifier	String	
63	Product shape	String	Value set in Table 14
64	Product form	String	Value set in Table 15
65	Dimension type	String	nominal or actual
66	Length	Real	cm (in.)
67	Width	Real	cm (in.)
68	Thickness	Real	cm (in.)
69	Outside diameter	Real	cm (in.)
70	Wall thickness	Real	cm (in.)
71	Weight	Real	kg (lb)
72	Fabrication history	String	
73	Service history	String	
	Measured Chemical Composition[C]		
74	Source of chemical composition data	String	
75	Element symbol	String	IUPAC symbol(s)
76	Fraction type	String	mass, volume, or mole
77	Composition units	String	% or ppm
78	Measured composition	Real	
	Measured Mechanical Properties		
	Measured Tensile Properties[C]		
79	Source or basis for tensile properties	String	
80	Orientation of test specimen	String	Value set in Table 5
81	Location of tensile specimen	String	Value set in Table 6
82	Tensile test temperature	Real	°C (°F)
83	Ultimate tensile strength	Real	MPa (ksi)
84	Number of tensile strength tests, if averaged	Integer	
85	Yield strength	Real	MPa (ksi)
86	Yield strength method	String	Category set in Table 7
87	Yield strength offset or extension	Real	%
88	Number of yield strength tests, if averaged	Integer	
89	Total elongation	Real	%
90	Original gage length	Real	mm (in.)
91	Number of elongation tests, if averaged	Integer	
92	Type of elongation	String	Value set in Table 16
93	Reduction of area	Real	%
94	Number of reduction of area tests, if averaged	Integer	
	Measured Hardness[C]		
95	Source or basis for hardness measurement	String	
96	Location of hardness measurement	String	Value set in Table 6
97	Hardness value	Real	
98	Hardness scale	String	Category set in Table 8
99	Number of hardness readings, if averaged	Integer	
	Measured Charpy Impact Energy to Fracture[C]		
100	Source or basis for Charpy measurements	String	
101	Location of Charpy specimen	String	Value set in Table 6
102	Temperature of Charpy test	Real	°C (°F)
103	Charpy specimen size	String	Category set in Table 17
104	Charpy impact energy	Real	J (ft-lbf)
105	Number of Charpy tests, if averaged	Integer	

TABLE 1 *Continued*

Number[A]	Data Element Descriptive Name	Data Type	Category Set, Value Set, or Units
	Measured Microstructure Descriptions[C]		
106	Grain size measurement	Real	
107	Scale for grain size	String	
108	Basis for grain size	String	
109	Description of microstructure	String	

[A] Data element numbers are provided for information only.
[B] Essential data element, as described in 4.6.
[C] Provisions should be made in the database for repeated values of this data element, or for the set of data elements in this section.

TABLE 2 Category Set for Family Name as Listed in Practice E 527

Aluminum and aluminum alloys	Zinc and zinc alloys
Copper and copper alloys	Cast irons
Rare earth and rare earth-like metals and alloys	Cast steels
	Carbon steels
Low melting point metals and alloys	Alloy steels
Nickel and nickel alloys	AISI H-steels
Precious metals and alloys	Heat and corrosion-resistant (stainless) steels
Reactive and refractory metals and alloys	Tool steels
	Cobalt alloys

TABLE 3 Example Value Sets for Family Subclass Name for Aluminum, Copper, Steel, and Other Metals and Alloys

Aluminum:	*Copper:*
Commercially pure aluminum	Copper
Aluminum-copper alloy	High copper alloy
Aluminum-manganese alloy	Beryllium copper
Aluminum-silicon alloy	Chromium copper
Aluminum-manganese-silicon alloy	Copper-zinc alloy (brass)
Aluminum-magnesium alloy	Copper-zinc-lead-alloy (leaded brass)
Aluminum-magnesium-silicon alloy	Copper-zinc-tin alloy (tin brass)
Aluminum-zinc alloy	Copper-tin-phosphorus alloy (phosphor bronze)
Other aluminum alloy	Copper-tin-lead-phosphorus alloy (leaded phosphor bronze)
Steel:	
Chromium-molybdenum	
Low carbon	
High carbon	
Austenitic	
Ferritic	
Martensitic	
Precipitation hardening	

TABLE 4 Category Set for Designation Keyword

Grade
Type
Composition
Temper
Condition
Class

TABLE 5 Value Set for Specimen Orientation

Unnotched Specimen:
Longitudinal (parallel to working direction)
Transverse (perpendicular to working direction)
Long transverse
Short transverse
Tangenital
Radial
Diagonal (to rolling direction)
Cracked or Notched Specimen:
See Terminology E 616 for orientation codes

TABLE 6 Value Set for Location Within Product

Outer surface
Internal
Inside surface
Surface
Quarter thickness
Center of thickness
Leading edge
Trailing edge

TABLE 7 Category Set for Yield Strength Method (as explained in Test Methods E 8 or E 8M)

Offset
Extension under load
Upper
Lower

TABLE 8 Category Set for Hardness Scale

Brinell
Knoop
Rockwell A
Rockwell B
Rockwell C
Rockwell E
Rockwell F
Shore
Vickers
Rockwell 15t
Rockwell 30t
Rockwell 45t
Rockwell 15N
Rockwell 30N
Rockwell 45N

TABLE 9 Value Set for Melt Practice

Argon oxygen decarburization
Basic oxygen furnace
Open hearth
Electric furnace
Remelt
Ladle refining
Vacuum degassing
Vacuum arc remelt
Vacuum oxygen decarburization
Vacuum induction melting
Air induction melting
Electro slag remelt
Electroflux remelt
Electron beam melting
Reverbatory furnace

TABLE 10 Value Set for Cast Practice

Continuous
Ingot
Powder metallurgy
Spin

TABLE 11 Value Set for Heating Environment

Air
Vacuum
Inert gas
Hydrogen
Other reducing gas
Oxidizing gas atmosphere

TABLE 12 Value Set for Cooling Environment

Quenched in oil
Air-cooled
Inert gas-cooled
Quenched in water
Quenched in brine
Quenched in polymer
Quenched in air and water

TABLE 13 Value Set for Forming Method

Forging
Casting
Extrusion
Hot rolling
Cold rolling
Powder compaction
Drawing/coining
Bending

TABLE 14 Value Set for Product Shape

Flat
Round
Hexagonal
Square
Structural
Irregular
Profile

TABLE 15 Value Set for Product Form

Bar	Rod
Block	Sheet
Pipe	Shift
Plate	Strip
Powder	Tube
Ring	Wire
	Extruded profile

TABLE 16 Value Set for Type of Elongation as Explained in Test Methods E 8 and E 8M

After fracture
At fracture

TABLE 17 Category Set for Charpy Specimen Size

Full
One half
One quarter
One eighth