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

This standard is issued under the fixed designation E1338; 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 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.

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 E1313 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 E527 for Metal and Alloys in the Unified Numbering System (UNS), Guide E1308 for polymers, Guide E1309 for composite material, and Guide E1471 for fibers, fillers, and core materials.

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:*[2]

E8 Test Methods for Tension Testing of Metallic Materials [Metric] E0008_E0008M

[1] This guide is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.01 on Ancillary Activities. This guide was developed in cooperation with Committee B07 on Light Metals and Alloys.

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[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.

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 E527
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	
	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

TABLE 1 *Continued*

Number[A]	Data Element Descriptive Name	Data Type	Category Set, Value Set, or Units
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	
	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 E527

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

E8M Test Methods for Tension Testing of Metallic Materials [Metric] (Withdrawn 2008)[3]
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
E616 Terminology Relating to Fracture Testing (Withdrawn 1996)[3]
E1308 Guide for Identification of Polymers (Excludes Thermoset Elastomers) in Computerized Material Property

[3] The last approved version of this historical standard is referenced on www.astm.org.

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 E616 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 E8 or E8M)

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
Electroslag 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

Databases (Withdrawn 2000)[3]

E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases (Withdrawn 2015)[3]

E1313 Guide for Recommended Formats for Data Records Used in Computerization of Mechanical Test Data for Metals (Withdrawn 2000)[3]

E1443 Terminology Relating to Building and Accessing Material and Chemical Databases (Withdrawn 2000)[3]

E1471 Guide for Identification of Fibers, Fillers, and Core Materials in Computerized Material Property Databases (Withdrawn 2015)[3]

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 E8 and E8M

After fracture
At fracture

TABLE 17 Category Set for Charpy Specimen Size

Full
One half
One quarter
One eighth

IEEE/ASTM SI 10 American National Standard for Metric Practice

2.2 *Other Standards:*

ISO Standard: 3166 Codes for Representation of Names of Countries Quantities, Units and Symbols in Physical Chemistry—IUPAC[4]

ANSI/AWS A9.1-92 Standard Guide for Describing Arc Welds in Computerized Material Property and Nondestructive Examination Databases[5]

3. Terminology

3.1 Computer-related technical terms in this guide are defined in Terminology E1443.

[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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