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Standard Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials[1]

This standard is issued under the fixed designation D8335; 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 establishes essential and desirable identification elements for fiber-reinforced composite materials and for fibers, fillers, and core materials, matrices, preforms, prepregs, processes, and parts used in these composite materials. This guide is intended for preparing test reports, databases, and material documents.

1.2 These guidelines are specific to fiber-reinforced polymer-matrix composite materials. Composite materials, which also contain particulates or precipitated particles, are also included, provided they can be described adequately as a filler in the matrix.

1.3 The materials covered by this guide include fibers, both continuous and discontinuous, and fillers of various geometries which are used as reinforcements in composite materials, as well as core materials used in sandwich composites, matrices both thermoset and thermoplastic, fiber preforms, prepreg product forms, manufacturing processes, and generic part forms. Cores may be foam, honeycomb, or naturally occurring materials such as balsa wood. These materials are distinguished from bulk materials by the importance of their specialized geometric forms to their properties. This difference is reflected in the use of geometry, along with chemistry, as a primary basis for classification. Additional data elements that are considered desirable, but not essential, are also defined. The purpose is to allow the meaningful comparison of data from different sources.

1.4 Data elements in this guide are relevant to test data, data as obtained in the test laboratory and historically recorded in laboratory notebooks. Property data, data that have been analyzed and reviewed, may only need a subset of these data elements.

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

1.6 *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]

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3878 Terminology for Composite Materials

D6507 Practice for Fiber Reinforcement Orientation Codes for Composite Materials

IEEE/ASTM SI 10 American National Standard for Metric Practice

2.2 *Other Document:*[3]

CMH-17 Composite Materials Handbook-17, Revision G or latest

3. Terminology

3.1 *Definitions*—Terminology in accordance with Terminology D3878 shall be used where applicable.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *data element, n*—one individual piece of information used in describing a material or to record test results.

3.2.1.1 *Discussion*—For example, a variable name, test parameter, and so forth.

3.2.2 *essential data element, n*—a data element in a record which must be completed in order to make the record meaningful in accordance with the pertinent guidelines or standard.

3.2.2.1 *Discussion*—Data elements are considered essential if they are required to make a comparison of property data from different sources meaningful. A comparison of data from

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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.

[3] Available from www.cmh17.org.

different sources may still be possible if essential information is omitted, but the value of the comparison may be greatly reduced.

4. Significance and Use

4.1 This guide provides the recommended data elements for the identification of fiber-reinforced composite materials and the information which is considered essential to uniquely describe a fiber, filler, or core material.

4.2 The intent of this guide is to provide sufficient detail that values are known for the material parameters that may influence test results or material property values.

4.3 This guide is for material identification and description only. It does not include the recommended data elements for mechanical test data or other specific types of test data. Such items are covered by separate formats to be referenced in material specifications or other test standards.

4.4 Composite materials are defined as two or more materials that are combined on a macroscale. There is a gray area between composites and other material classes. Two examples of this gray area between polymer matrix composites and plastics are toughened polystyrene and liquid crystal polymer. Appendix X1 contains a table, which provides guidelines for distinguishing between reinforced polymers and polymer matrix composites.

4.5 Composite materials consist of a matrix phase and one or more discrete reinforcements. Reinforcements may be interpreted broadly to include any macroscale second material, including fibers, particulates, precipitated particles, or structured domains of the parent material. The reinforcements covered in this guide include fibers and such particulates and precipitated particles that can be described adequately as filler within the matrix. The reinforcements may be polymers, metals, ceramics, or other materials. Sandwich constructions are covered by this guide via identification of the core material. These guidelines are suitable for the identification of composites in simple shapes of constant thickness; for example, plates or tubes. For complex structures, additional information relevant to a specific application may be required.

4.6 Classification of composite materials is complicated by the fact that composites are formed by combining different materials in varying amounts and configurations; this results in an infinite number of possibilities. An effective identification scheme must be capable of possible combinations without overburdening the system with details relevant only to a limited number of material systems. This guide provides both essential data elements and data elements that are considered desirable but not essential. Data elements are considered essential if they are required to make a meaningful comparison of property data from different sources.

4.7 Identification of constituent materials of the composites is included to the level considered necessary for identification of the composite.

4.8 Comparison of property data from different databases will be most meaningful if all the essential information defined by the guide is present. Comparison may still be possible if essential information is omitted, but the usefulness of the comparison may be greatly reduced.

4.9 For identification of composite materials, Table 1 (Part A) and Tables 2 and 3 shall be used.

4.10 For identification of fiber, filler, and core, Table 1 (Part B), Tables 4-10, and Tables 11-14 shall be used.

4.11 For identification of matrix, Table 1 (Part C) and Tables 15-17 shall be used.

4.12 For identification of preform, Table 1 (Part D) and Tables 18-20 shall be used.

4.13 For identification of prepreg, Table 1 (Part E), Table 5, and Tables 21 and 22 shall be used.

4.14 For identification of process, Table 1 (Part F), Table 16, and Tables 23-26 shall be used.

4.15 For identification of composite parts, Table 1 (Part G) and Table 27 shall be used.

5. Reporting

5.1 This guide is intended to provide common elements for material identification when used for reporting testing and material properties based on accumulated results from a number of tests. The data reporting section of standard test methods may reference this guide for material identification. In addition, such a data reporting section may identify any usage specific to that document. These requirements do not mean that the information must be reported separately for each specimen or that all information must be reported separately for each batch. Any data elements that are the same for a series of specimens or for a series of batches may be reported once for the entire series, as long as it is clearly indicated that they apply to all specimens or all batches.

6. Traceability and Batch/Lot Control

6.1 The types of information needed to establish composite materials traceability and batch/lot control thereof have been determined (Tables 1-27). Other information that may be required per contractual agreement between the end user and supplier towards establishing full traceability are:

6.1.1 The names of the manufacturers of the composite material and its starting constituents.

6.1.2 Any applicable standards (for example, Specifications and Test Methods). The latest revision shall be assumed unless the preferred revision number or letter is explicitly stated.

6.1.3 *Manufacturer's Identification*—Code, part number, lot number, or other identification used by the manufacturer(s) to identify the composite material and any of its starting constituents.

6.1.4 Date of impregnation or mixing (uncured prepreg).

6.1.5 Processing equipment (type, model number).

6.1.6 Processing procedure (time, temperature, and pressure profile).

7. Composite Material Identification

7.1 A listing of the types of qualitative information needed to establish composite material traceability, and numerical data needed verify conformance to a material specification, is given

TABLE 1 Data Elements for Identification of Composite Materials

Data Element Descriptive Name	Category Set, Category, or Units	Level
A. Composite Material Identification		
Material identifier		Essential
Data source identification		Essential
Composite material name		Essential
Material class	"Composite"	Essential
Material subclass		Essential
Material form		Essential
Matrix class	"Polymer"	Essential
Reinforcement class	Table 2	Essential
Reinforcement subclass	Table 3	Essential
Material specification	[Specification]	Recommended
Material source (if not from manufacturer)	[Organization]	Recommended
Material maximum temperature, nominal	C(F)	Optional
Material minimum temperature, nominal	C(F)	Optional
Material SDS and assigning organization		Optional
Contract number		Optional
Data restrictions		Optional
B. Fiber Information		
Fiber class	Table 4	Recommended
Fiber chemical class	Table 5	Essential
Fiber chemical family	Table 6	Recommended
Fiber modulus subfamily	Table 7	Optional
Fiber commercial name		Essential
Fiber additional name information		Recommended
Fiber manufacturer's specification	[Specification]	Recommended
Fiber user's specification	[Specification]	Optional
Fiber manufacturer's internal designation		Optional
Fiber manufacturer	[Organization]	Recommended
Fiber lot		Essential
Fiber date of manufacture		Recommended
Fiber batch certification number		Optional
Fiber density	g/cm^3	Essential
Fiber density test method	[Test method]	Essential
Tow or yarn filament count		Essential
Tow or yarn filament count test method	[Test method]	Recommended
Tow/strand linear density	tex	Optional
Tow/strand linear density test method	[Test method]	Optional
Tow yield	m/g	Optional
Fiber filament diameter	mm	Essential
Fiber filament diameter test method	[Test method]	Recommended
Filament cross-section type	Table 8	Recommended
Surface treatment type	Table 9	Recommended
Surface treatment detail		Recommended
Tow or yarn sizing identification		Recommended
Tow or yarn sizing amount		Recommended
Tow or yarn twist amount	t/m	Recommended
Tow or yarn twist direction	Table 10	Recommended
C. Matrix Information		
Matrix subclass	Table 15	Essential
Matrix chemical family	Table 16	Essential
Matrix subfamily	Table 17	Optional
Matrix commercial name		Essential
Matrix manufacturer	[Organization]	Essential
Matrix lot number		Recommended
Matrix date of manufacture		Recommended
Matrix filler type		Recommended
Matrix filler amount		Recommended
Matrix nominal density	g/cm^3	Recommended
Matrix nominal density test method	[Test method]	Recommended
Matrix internal designation		Optional
Matrix manufacturer specification	[Specification]	Optional
Gel time		Optional
D. Preform Information		
Preform architecture	Table 18	Essential
Preform identifier		Essential
Preform manufacturer	[Organization]	Essential
Preform method of manufacture	Table 19	
Number of preform layers		Essential
2-D Fabric Information		
Fabric manufacturer	[Organization]	Essential
Fabric weave type	Table 20	Essential
Fabric style number		Essential
Fabric lot		Essential
Fabric date of manufacture		Recommended
Fabric batch certification number		Optional

Fabric manufacturer specification	[Specification]	Optional
Fabric user specification	[Specification]	Optional
Fabric sizing identification		Essential
Fabric sizing content		Essential
Fabric end count (warp)	/m	Essential
Fabric fill fiber (if different)		Essential
Fabric pick count (fill)	/m	Essential
Fabric nominal fiber areal weight	g/mm^2	Optional
Tracer warp name		Optional
Tracer warp linear density	g/m	Optional
Tracer warp spacing	/mm	Optional
Tracer warp sizing		Optional
Tracer fill name		Optional
Tracer fill linear density	g/m	Optional
Tracer fill spacing	/mm	Optional
Tracer fill sizing		Optional
3-D Woven Materials		
Interlock description		Essential
Warp fiber filament count		Essential
Weft fiber filament count		Essential
Angle fiber filament count		Essential
Weaver yarn filament count		Essential
Percentage of warp yarn	%	Essential
Percentage of weft yarn	%	Essential
Angle of angle yarn (positive with respect to axial yarn)	degrees	Essential
Percentage of angle yarn	%	Essential
Percentage of weaver yarn	%	Essential
Percentage of through-thickness yarn	%	Essential
Pitch length	in.	Essential
Warp end count	tow/in.	Essential
Weft end count	tow/in.	Essential
Unit cell width	in.	Optional
Unit cell length	in.	Optional
Unit cell depth	in.	Optional
Stitching Information		
Stitch type		Essential
Stitch thread		Essential
Stitch axial pitch	degrees	Essential
Stitch row spacing	in.	Essential
Stitch denier	denier	Recommended
Stitch filament count		Essential
Bias yarn end count		Essential
Bias yarn angle	degrees	Essential
Braiding Information		
Braid description		Essential
Axial fiber type		Essential
Braid fiber type		Essential
Axial fiber filament count		Essential
Braid fiber filament count		Essential
Braid angle	degrees	Essential
Percentage of axial yarn	%	Essential
Percentage of braid yarn	%	Essential
Axial yarn spacing in braids	in.	Recommended
Unit cell width	in.	Optional
Unit cell length	in.	Optional
Braider identification		Recommended
Number of carriers		Recommended
Winding Information		
Winding description		Essential
Winder identification		Recommended
Mandrel identification		Essential
E. Prepreg Information		
Prepreg Identification		
Prepreg type	Table 21	Essential
Prepreg commercial name		Essential
Prepreg manufacturer	[Organization]	Essential
Prepreg manufacturer's internal spec	[Specification]	Optional
Prepreg source	[Organization]	Optional
Prepreg dimension parameter	Table 22	Recommended
Prepreg dimension value		Recommended
Prepreg reinforcement orientation(s)		Recommended
Scrim fiber chemical class	Table 5	Recommended
Scrim fabric style		Recommended
Prepreg additional information		Recommended
Prepreg Batch Information		
Prepreg batch number		Essential
Prepreg batch certification date		Optional

Prepreg batch expiration date		Recommended
Prepreg batch roll number		Recommended
	Prepreg Auxiliary	
Prepreg fiber areal weight	g/m^2	Essential
Prepreg volatile content, wt%	wt%	Essential
Prepreg fiber content, vol%	vol%	Recommended
Prepreg matrix content, wt%	Wt%	Recommended
Prepreg matrix flow	Wt%	Recommended
Prepreg matrix gel time		Recommended
Prepreg tack		Optional
Prepreg drape		Optional
	F. Process Information	
Process specification	[Specification]	Recommended
Process reinforcement application	Table 23	Essential
Process mold type	Table 24	Essential
Tackifier common name		Recommended
Tackifier chemical class	Table 16	Recommended
Tackifier form	Table 25	Recommended
Tackifier manufacturer		Recommended
Process stage type	Table 26	Recommended
Process stage temperature	C(F)	Recommended
Process stage pressure	psig	Recommended
Process stage vacuum	psig	Recommended
Process stage duration	min	Recommended
Process ramp rate	C/min (F/min)	Recommended
Process stage other parameter	degrees	Recommended
Processor	[Organization]	Essential
Process start date		Recommended
Process end date		Recommended
Process records reference		Recommended
	G. Part Information	
Part form	Table 27	Essential
Material orientation code		Essential
Part specification	[Specification]	Recommended
Part dimension parameter		Recommended
Part dimension value		Recommended
Part history		Essential
Part additional information		Recommended
Part resin content by weight	wt%	Essential
Part fiber content, by volume	vol%	Essential
Part fiber areal weight	g/m^2	Essential
Part void content, by volume	vol%	Essential
Part mass density	g/cm^3	Essential
Part glass transition temperature—dry	C(F)	Essential
Part glass transition temperature—wet	C(F)	Essential
Footnotes		Essential

TABLE 2 Category for Reinforcement Class

Fiber	Filler	Core

by Table 1. The information and data listed in Table 1 are categorized as being essential, recommended, or optional. The units listed for numerical data are SI, in accordance with IEEE/ASTM SI 10, followed by inch-pound units in parentheses. The tables (Tables 2-10 and Tables 15-27) referenced in Table 1 provide more detailed information needed to define a composite material in terms of its fiber, filler, core, matrix, preform, prepreg, process, orientation, and part properties. Note that the third column indicates the level of requirement. The information for identifying materials is divided into seven blocks: Composite, Fiber, Matrix, Preform, Prepreg, Process, and Part. Depending on the constituents of the material and how the fibers are manipulated or organized during fabrication, several of the blocks may be required to adequately identify a material while others are unnecessary. For example, a two-dimensional fabric that is laid up and cured into a laminate would require Material, Fiber, Matrix, Preform/Fabric, Prepreg, Process, and Part blocks. A filament wound material that is resin transfer molded would require Material, Fiber, Matrix, Preform/Winding, Process, and Part blocks.

7.2 *Composite Material Identification Block (A)*

7.2.1 *Composite Material Name*—This data element should be constructed, using CMH-17, as:

[Composite Material Name] = [Fiber Commercial Name] + " " + [Tow or Filament Count] + "/" + [Matrix Commercial Name] + " " + [Fabric Weave Type] + " " + [Critical Processing Information]

7.2.2 *Material Subclass*—This data element should be constructed as:

[Matrix Subclass] = [Fiber Class] + '/' + [Matrix Class]

7.3 *Fiber Identification Block (B)*

7.4 *Matrix Identification Block (C)*

7.5 *Preform Identification Block (D)*—For the purposes of this guide, preform encompasses all types of fiber assemblies that may or may not approach the final geometry of the part. These range from traditional two-dimensional fabrics to complex three-dimensional woven materials. The block contains several header elements followed by subblocks—2-D Fabric, 3-D Woven Materials, Stitching, Braiding Materials, and Winding. The appropriate subblock(s) is used based on the

TABLE 3 Category for Reinforcement Subclass

Fiber	Filler	Core
Continuous	Particulate	Honeycomb[A]
Discontinuous, long	Platelet	Close-cell foam
Discontinuous, short	Hollow sphere	Open-cell foam
Staple	Hollow cylinder	Other (specify)
Milled	Other (specify)	
Whisker		
Pulp		

[A] Includes non-hexagonal open cell shapes, such as Flexcore®, etc. Flexcore® is a registered trademark of Hexcel, Inc. and has been found satisfactory for this purpose.

TABLE 4 Category for Fiber Class

Polymer
Metal
Carbon
Ceramic

TABLE 5 Category for Fiber Chemical Class

Alumina	AlO
Aluminum	Al
Aramid	Ar
Basalt	Bs
Boron	B
Carbon	C
Glass	Gl
Graphite	Gr
Liquid crystal polymer	LCP
Lithium	Li
Metallic oxide	MO
Polybenzothiazole	PBT
Quartz/silica	Q
Silicon	Si
Silicon carbide	SiC
Titanium	Ti
Tungsten	W
Ultrahigh molecular weight polyethylene	UHMWPE

stage of assembly of fibers for the material product being identified. Note that there is some redundancy among the subblocks.

7.6 *Prepreg Information Block (E)*—Elements in the block identify and describe the combination of matrix and fiber materials in a partially cured state. Prepreg batch identification and description is included, as well as auxiliary tests that help identify the prepreg or that are performed on the prepreg to help identify the composite product. This block is used only for materials that are partially cured prior to final assembly. Both thermoset and thermoplastic materials may be covered.

7.7 *Process Information Block (F)*—Data elements in this block are appropriate for all composite materials. Subblocks are included to identify specification information and to describe the process. Depending on the level of detail desired, the process description subblock may be repeated several times to identify one material.

7.8 *Part Information Block (G)*—The final configuration of a material. Data elements in this block are appropriate for all composite materials

7.8.1 *Material Orientation Code*—The lay-up code to describe stacking sequence in a laminar composite or a braiding orientation code for braided material forms. These material orientation codes are defined in Practice D6507 based on the convention used in CMH-17. The lay-up code should also indicate the location of core if the composite is a sandwich, for example, [(0/45/90)/core/(90/45/0)].

8. Fiber, Filler, and Core Identification

8.1 As shown in Table 11, the following fields are recommended for identification of fibers, fillers, and core materials used in composites. For certain fields, lists of recommended entries are included. Where possible, entries should be chosen from these lists. However, these lists should not be regarded as exhaustive.

8.2 *Primary Identifiers:*

8.2.1 *Material Reference Number*—Identifying number or code, if any, for the particular material.

8.2.2 *Class*—Classification by form, either fiber, filler, or core.

8.2.3 *Subclass*—Further subdivision by geometric form within the class. See Table 1 for list.

8.2.4 *Chemical Family*—Classification of the material by its generic chemical composition family. See Table 1 for list.

8.3 *Commercial Specification:*

8.3.1 *Common Name*—Name by which the material is known in the industry.

8.3.2 *Additional Name Information*—Additional information on the name, such as chemical composition details on the material.

8.3.3 *Specification Organization*—A company, industry, government, national, regional, or international organization issuing the specification; for example, ASTM.

8.3.4 *Specification Number*—The specification number within the organization referenced.

8.3.5 *Specification Version*—The year or revision code of the specification.

8.3.6 *Specification Designation*—The designation used for the material in the specification.

8.4 *Characteristics:*

8.4.1 *Density.*

8.4.2 *Cross-Section Type*—Geometry of cross section of the material. See Table 8 for list.

8.4.3 *Dimension Parameter*—Name of dimension characteristic of the material; for example, diameter. Dimension parameter, units, and value should be given for each characteristic dimension. See Table 13 for list.

8.4.4 *Dimension Value*—Mean or nominal numerical value of the specified dimension in appropriate units.

TABLE 6 Category for Reinforcement Chemical Family

Carbon	Glass	Quartz	Boron	Silicon Carbide
PAN precursor	E-glass	Mineral	TBD	Monofilament
Pitch precursor	S-glass	Manmade		Multifilament
Rayon precursor	S2-glass			
	D-glass			
Aramid	Metallic Oxide	LCP	UHMWPE	Other
Para-aramid	TBD	TBD	TBD	TBD
Meta-aramid				

TABLE 7 Category for Fiber/Filler Modulus Subfamily

<69 GPa	<10 Msi
69-138 GPa	10-20 Msi
138-207 GPa	20-30 Msi
207-276 GPa	30-40 Msi
275-345 GPa	40-50 Msi
345-483 GPa	50-70 Msi
483-621 GPa	70-90 Msi
621-758 GPa	90-110 Msi
>758 GPa	>110 Msi

TABLE 8 Category for Fiber Cross-Section Type

Circular (round)
Annular
Rectangular
Square
Oval
Irregular

TABLE 9 Category for Fiber/Filler Surface Treatment Type

Chemical oxidation
Plasma etching
Adhesion promoting
Sizing
Anticorrosion
Finish free
Lubricant
Release treatment
No surface treatment

TABLE 10 Category for Twist Direction

S	Z	N - none	U - unknown

8.4.5 *Dimension Distribution Parameter Type*—Name of the parameter used to characterize the distribution of values for the specified dimension. See Table 14 for list.

8.4.6 *Dimension Distribution Parameter Value*—Numerical value of the distribution parameter for the specified dimension. Units are assumed to be the same as those of the dimension itself.

8.4.7 *Dimension Distribution Sample Size*—The number of samples from which the dimension distribution parameter value is determined.

8.5 *Source:*

8.5.1 *Manufacturer.*

8.5.2 *Manufacturer's Identification*—Code, part number, or other identification used by the manufacturer to identify this material.

8.5.3 *Lot Number*—Manufacturer's reference for traceability of this lot of material.

8.5.4 *Date of Manufacture*—YYYYMMDD

8.6 *Process Descriptors:*

8.6.1 *Process Conditions*—Conditions under which the material was produced.

8.6.2 *Surface Treatment Type*—Type of process used to modify the surface chemistry. See Table 9 for list.

8.6.3 *Surface Treatment Detail*—Details of the surface treatment, including time, temperature, pressure, and environment, if applicable.

8.7 *Sample Formats*—The format in Table 11 identifies, with an asterisk (*), the essential information.

9. Examples

9.1 Examples of the application of this guide to fibers, fillers, and cores are included in Tables 28-30. Only those fields appropriate to the particular material form should be used.

10. Keywords

10.1 core material; data elements; databases; fiber-reinforced polymer-matrix composite materials; fiber; filler; material identification; matrix, preform, process, part, materials databases