



## Standard Specification for Fiber-Reinforced Plastic Fans and Blowers<sup>1</sup>

This standard is issued under the fixed designation D4167; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification covers centrifugal and axial fans and blowers with airstream components fabricated of fiber-reinforced thermoset plastics (FRP) for corrosion resistance. ~~Internal structures may~~ It is acceptable for internal structures to include encapsulated metal fastening devices, hubs, and shafts.

1.2 Reinforcing materials other than fibrous glass ~~may be used~~ are acceptable for use in the fabrication, provided the fans and blowers produced meet all the requirements of this specification.

1.3 The term “fans” as used in this specification includes fans and blowers, both centrifugal and axial.

1.4 The purpose of this specification is to provide users, system designers, specifiers, and manufacturers of FRP fans with minimum standards for fan construction and a common basis for determining safe operating speeds.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

NOTE 1—There is no ~~similar or equivalent ISO known~~ ISO equivalent to this standard.

NOTE 2—~~Appendix X2~~ contains a list of documents that ~~may be~~ potentially of interest to designers of fan systems.

1.6 ~~This standard does not purport~~ to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[C582 Specification for Contact-Molded Reinforced Thermosetting Plastic \(RTP\) Laminates for Corrosion-Resistant Equipment](#)

[D883 Terminology Relating to Plastics](#)

[D2563 Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts](#)

2.2 *Other Standards:*

[AMCA 99 Standards Handbook](#)<sup>3</sup>

[AMCA Fan and Air System Applications Handbook \(AMCA 200, 201, 202, 203\)](#)<sup>3</sup>

[AMCA Bulletin 210 Laboratory Methods of Testing Fans for Rating Purposes](#)<sup>3</sup> [Certified Aerodynamic Performance Rating](#)<sup>3</sup>

~~ANSI S2.19~~ [AMCA 300 Balance Quality of Rotating Rigid Bodies](#) [Reverberant Room Method for Sound Testing of Fans](#)<sup>3</sup>

[AMCA 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data](#)<sup>3</sup>

[ACGIH Industrial Ventilation: A Manual of Recommended Practice](#)<sup>4</sup>

[NFPA 91 Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids](#)<sup>5</sup>

### 3. Terminology

3.1 *Definitions*—The definitions of terms used in this specification are the same as those found in Terminology [D883](#).

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee [D20](#) on Plastics and is the direct responsibility of Subcommittee [D20.23](#) on Reinforced Plastic Piping Systems and Chemical Equipment.

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<sup>2</sup> 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.

<sup>3</sup> Available from Air Movement and Control Association—Association International, 30 West University Dr., Arlington Heights, IL 60004-60004, [http://www.amca.org](#).

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, [http://www.ansi.org](#). [Conference of Governmental Industrial Hygienists \(ACGIH\)](#), 1330 Kemper Meadow Dr., Cincinnati, OH 45240, [http://www.acgih.org](#).

<sup>5</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269, [http://www.nfpa.org](#).

\*A Summary of Changes section appears at the end of this standard

#### 4. Construction of Fan Housings

4.1 *Laminate Construction* shall conform to Specification **C582**. The same resin shall be used throughout a housing unless the user and manufacturer agree to use a different resin for the inner surface and interior layer than for the structural layer.

4.1.1 The inner surface exposed to the chemical environment shall be a resin-rich layer 0.010 to 0.020 in. (0.25 to 0.5 mm) thick reinforced with a suitable chemical-resistant glass-fiber surface mat or with an organic-fiber surface mat.

4.1.2 The inner surface layer shall be followed with an interior layer composed of resin reinforced only with ~~noncontinuous~~non-continuous glass-fiber strands applied in a minimum of two plies of chopped-strand mat equivalent to a total of 3 oz/ft<sup>2</sup> ~~(0.92)~~(0.92) kg/m<sup>2</sup>. As an alternative, a minimum of two passes of chopped roving of minimum length of 0.5 in. (13 mm) to a maximum length of 2.0 in. (50.8 mm) shall be applied uniformly to an equivalent weight of 3 oz/ft<sup>2</sup> ~~(0.92)~~(0.92) kg/m<sup>2</sup>. Each ply of mat or pass of chopped roving shall be well rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than 0.10 in. (2.5 mm).

4.1.3 The structural layer comprises the balance of the housing laminate.

NOTE 3—Although fan housings are subject to vibrational stresses, the design considerations regarding construction of the laminate are similar to those used for static FRP process system components.

4.2 *Fastening Devices*, such as bolts, shall be made of material the user and manufacturer agree is at least as corrosion-resistant to the specified corrosive environment as is the laminate construction, or shall be embedded in a laminate in such a way that the laminate covering the device is reinforced with at least two layers of 1½ oz/ft<sup>2</sup> (4.57 g/m<sup>2</sup>) chopped-strand glass mat and with the same surface finish used in the housing laminate.

4.3 *Gasketing*, used where housings are constructed so that sections or inspection panels are removable, shall be of elastomeric material sufficiently resilient to seal the sections. The gasketing shall be of material the user and manufacturer agree is suitable for the corrosive environment.

4.4 *Housings*, shall have minimum inside corner radii of 0.6 in. (15 mm).

4.5 Suitable housing construction design shall be determined by running the fan at maximum-rated speed with the inlet blocked tight and with an open outlet. The design will be deemed acceptable if the test does not cause any part of the housing to move more than a distance equal to ½ of 1 % of the wheel diameter from the position with the fan not running.

4.6 Where the user determines that system design is such that ~~liquid may~~it is possible that liquid will collect in housings, the fan housings shall be specified with drains.

#### 5. Construction of Fan Wheels

5.1 Where a history of service acceptable to the manufacturer and the user shows that resin systems and joint designs selected for use in the construction of fan wheels are acceptable, destruction tests need not be run. Where acceptable history does not exist, destruction tests shall be performed in accordance with Section 10.

5.2 Defects visible in fan wheels shall be limited to those shown in **Table 1** (taken from Practice **D2563** and modified for specific use with fan wheels).

5.3 Metal hubs, fasteners, and shafts shall be made of material at least as corrosion-resistant to the specified corrosive environment as is the laminate construction, or be encapsulated with a laminate reinforced with at least two layers of 1½ oz/ft<sup>2</sup> ~~(45.7)~~(45.7) g/m<sup>2</sup> chopped-strand mat with the same surface finish that is used in the laminate.

5.4 Shafts not made of corrosion-resistant alloy shall be protected by a sleeve of FRP extending out through the fan housing a minimum of 0.4 in. (10 mm) (see Section 7).

5.5 Additives that obscure visual inspection shall be used only in the final surface coat(s) for the purpose of enhancing corrosion resistance or preventing the buildup of static electricity, or both.

5.6 Acceptable surface treatments include the following: resin coating without reinforcement; resin coating with reinforcement, such as glass flakes, graphite, or surface veil; or resin coating reinforced with other materials agreed upon by the fabricator and user. Resins that exhibit air inhibition shall be paraffinated for use in the final coat.

**TABLE 1 Allowable Defects in the Construction of FRP Fan Wheels (adapted from Practice D2563)**

Type of Defect	Definition	Degree Allowed
Chip	A small piece broken off an edge or surface	None permitted
Crack	An actual separation of the laminate, visible on opposite surfaces, and extending through the thickness	None permitted
Crack, surface	Crack existing only on the surface of the laminate	None permitted
Crazing	Fine cracks at or under the surface of a laminate	None permitted
Delamination, edge	Separation of the layers of material at the edge of a laminate	None permitted
Delamination, internal	Separation of the layers of material in a laminate	None permitted
Dry spot	Area of incomplete surface film where the reinforcement has not been wetted with resin	0.4-in. (10-mm) diameter and 1/ft <sup>2</sup> (12/m <sup>2</sup> )
Foreign inclusion (metallic)	Metallic particles included in a laminate that are foreign to its composition	0.04-in. (1-mm) diameter and 1/ft <sup>2</sup> (12/m <sup>2</sup> )
Foreign inclusion (nonmetallic)	Nonmetallic particles of substance included in a laminate that seem foreign to its composition	0.04-in. (1-mm) diameter and 1/ft <sup>2</sup> (12/m <sup>2</sup> )
Fracture	Rupture of laminate surface without complete penetration	None permitted
Air bubble (void)	Air entrapment within and between the plies of reinforcement, usually spherical in shape	0.04-in. (1-mm) diameter and 200/ft <sup>2</sup> (2000/m <sup>2</sup> )
<u>Blister</u>	<u>Rounded elevation of the surface of a laminate, with boundaries that may be more or less sharply defined, somewhat resembling in shape a blister on the human skin</u>	<u>None permitted</u>
<u>Blister</u>	<u>Rounded elevation of the surface of a laminate, with boundaries more or less sharply defined, somewhat resembling in shape a blister on the human skin</u>	<u>None permitted</u>
<u>Burned</u>	<u>Showing evidence of thermal decomposition through some discoloration, distortion, or destruction of the surface of the laminate</u>	<u>None permitted</u>
<u>Burned</u>	<u>Showing evidence of thermal decomposition through some discoloration, distortion, or destruction of the surface of the laminate</u>	<u>None permitted</u>
<u>Fish-eye</u>	<u>Small globular mass that has not blended completely into the surrounding material and is particularly evident in a transparent or translucent material</u>	<u>None permitted</u>
<u>Fish-eye</u>	<u>Small globular mass that has not blended completely into the surrounding material and is particularly evident in a transparent or translucent material</u>	<u>None permitted</u>
<u>Lack of fillout</u>	<u>An area, occurring usually at the edge of a laminated plastic, where the reinforcement has not been wetted with resin</u>	<u>None permitted</u>
<u>Lack of fillout</u>	<u>An area, occurring usually at the edge of a laminated plastic, where the reinforcement has not been wetted with resin</u>	<u>None permitted</u>
Orange peel	Uneven surface somewhat resembling an orange peel	None permitted
Pimple	Small, sharp, or conical elevation on the surface of a laminate	None permitted
Pit (pinhole)	Small crater in the surface of a laminate, with its width approximately of the same order of magnitude as its depth	0.02 in. (0.5 mm) and 200/ft <sup>2</sup> (2000/m <sup>2</sup> )
Pit (pinhole)	Small crater in the surface of a laminate, with its width approximately of the same order of magnitude as its depth	0.02 in. (0.5 mm) and 200/ft <sup>2</sup> (2000/m <sup>2</sup> )
Porosity (pinhole)	Presence of numerous visible pits (pinholes)	None permitted
Pre-gel	An unintentional extra layer of cured resin on part of the surface of the laminate. (This condition does not cover gel coats.)	None permitted
Pre-gel	An unintentional extra layer of cured resin on part of the surface of the laminate. (This condition does not cover gel coats.)	None permitted
Resin pocket	An apparent accumulation of excess resin in a small localized area within the laminate	0.125 by 0.250-in. (3 by 6 mm) and 1/ft <sup>2</sup> (12/m <sup>2</sup> )
Resin-rich edge	Insufficient reinforcing material at the edge of molded laminate	None permitted
Shrink mark (sink)	Depression in the surface of a molded laminate where it has retracted from the mold	None permitted
<u>Wash</u>	<u>Area where the reinforcement of molded plastic has moved inadvertently during closure of the mold resulting in resin-rich areas</u>	<u>None permitted</u>
<u>Wash</u>	<u>Area where the reinforcement of molded plastic has moved inadvertently during closure of the mold resulting in resin-rich areas</u>	<u>None permitted</u>
<u>Wormhole</u>	<u>Elongated air entrapment that is either on or near the surface of a laminate and may be covered by a thin film of cured resin</u>	<u>None permitted</u>
<u>Wormhole</u>	<u>Elongated air entrapment that is either on or near the surface of a laminate and potentially covered by a thin film of cured resin</u>	<u>None permitted</u>
<u>Wrinkles</u>	<u>In a laminate, an imperfection that has the appearance of a wave molded into one or more plies of fabric or other reinforcement material</u>	<u>None permitted</u>
<u>Wrinkles</u>	<u>In a laminate, an imperfection that has the appearance of a wave molded into one or more plies of fabric or other reinforcement material</u>	<u>None permitted</u>
Scratch	Shallow mark groove, furrow, or channel caused by improper handling or storage	None permitted
Short	In a laminate, an incompletely filled out condition —Note—This may be evident either through an absence of surface film in some areas, or as lighter unfused particles of material showing through a covering surface film, possibly accompanied by thin-skinned blisters.	None permitted
Short	In a laminate, an incompletely filled out condition —Note—It is possible that this will be evident either through an absence of surface film in some areas, or as lighter unfused particles of material showing through a covering surface film, possibly accompanied by thin-skinned blisters.	None permitted