



Designation: D4167 – 21

Standard Specification for Fiber-Reinforced Plastic Fans and Blowers¹

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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. It is acceptable for internal structures to include encapsulated metal fastening devices, hubs, and shafts.

1.2 Reinforcing materials other than fibrous glass 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 purchasers, system designers, specifiers, and suppliers 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 known ISO equivalent to this standard.

NOTE 2—Appendix X2 contains a list of documents 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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.*

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Thermosetting Resin Piping Systems and Chemical Equipment.

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2. Referenced Documents

2.1 ASTM Standards:²

C582 Specification for Contact-Molded Reinforced Thermo-setting 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 Handbook³

AMCA Fan and Air System Applications Handbook (AMCA 200, 201, 202, 203)³

AMCA Bulletin 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating³

AMCA 300 Reverberant Room Method for Sound Testing of Fans³

AMCA 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data³

ACGIH Industrial Ventilation: A Manual of Recommended Practice⁴

NFPA 91 Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids⁵

3. Terminology

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

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 purchaser and supplier agree to use a different resin for the inner surface and interior layer than for the structural layer.

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 Air Movement and Control Association International, 30 West University Dr., Arlington Heights, IL 60004, <http://www.amca.org>.

⁴ Available from American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Dr., Cincinnati, OH 45240, <http://www.acgih.org>.

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

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 non-continuous glass-fiber strands applied in a minimum of two plies of chopped-strand mat equivalent to a total of 3 oz/ft² (0.92 kg/m²). 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/ft² (0.92 kg/m²). Each ply of mat or pass of chopped roving shall be rolled to eliminate voids 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 meet the minimum material requirements of the corrosive application, 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/ft² (4.57 g/m²) 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 meet the minimum material requirements of the corrosive application.

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 to prevent air from entering the fan and with an open outlet. Acceptance criteria for the design limits movement of the housing to 0.5 % of the wheel diameter.

4.6 Where the purchaser or supplier determines that system design is such that 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 supplier and purchaser 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 meet the minimum material requirements of the corrosive application, or be encapsulated with a laminate reinforced with at least two layers

of 1½ oz/ft² (45.7 g/m²) 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 supplier and purchaser. Resins that exhibit air inhibition shall be paraffinated for use in the final coat.

6. Spark-Resistant Construction

6.1 Fans built in accordance with this specification will be spark-resistant, providing the outer surface of the wheel and the inner surface of the housing are rendered electrostatically conductive (6.1.1). To be considered acceptably conductive, the surface resistivity between all points of the airstream surface and ground shall be no more than 1 MΩ when tested with an insulation resistance tester.⁶

6.1.1 The purchaser shall electrically ground all fan parts in order to maintain spark resistance.

7. Shaft-Hole Closures

7.1 It is possible that gas will flow either into or out of the shaft holes of the fan housing, depending on pressure distribution in the system and type of fan wheel. The shaft-hole closure shall be one of the following types, as specified by the user:

NOTE 4—The purchaser needs to determine the importance of restricting gas flow through the shaft holes before selecting the type of closure required.

7.1.1 Shaft encapsulated with an FRP sleeve to at least 0.4 in. (10 mm) outside the fan housing, with the shaft hole no larger than the sleeve diameter plus 0.08 in. (2 mm). (An acceptable alternative is to mount a membrane onto the housing to maintain the 0.08-in. maximum space).

7.1.2 Lubricated lip seals or stuffing boxes must ride on smooth metal shafts or shaft sleeves, necessitating the use of shafts or shaft sleeves made of material selected to withstand the corrosive environment.

8. Balancing and Test Running

8.1 The fan manufacturer shall perform one of the following methods of checking balance of wheel/shaft assemblies and complete fans:

⁶ The sole source of supply of the apparatus known to the committee at this time is the Danaher Corporation, 2200 Pennsylvania Avenue, NW, Suite 800W, Washington, DC 20037, to Everett, Washington. Their testers are sold by many companies and can be located on their web site: www.danaher.com. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.