



Designation: E 2076 – 00

Standard Test Method for Examination of Fiberglass Reinforced Plastic Fan Blades Using Acoustic Emission¹

This standard is issued under the fixed designation E 2076; 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 test method provides guidelines for acoustic emission (AE) examinations of fiberglass reinforced plastic (FRP) fan blades of the type used in industrial cooling towers and heat exchangers.

1.2 This test method uses simulated service loading to determine structural integrity.

1.3 This test method will detect sources of acoustic emission in areas of sensor coverage that are stressed during the course of the examination.

1.4 This test method applies to examinations of new and in-service fan blades.

1.5 This test method is limited to fan blades of FRP construction, with length (hub centerline to tip) of less than 10 ft, and with fiberglass content greater than 15 % by weight.

1.6 AE measurements are used to detect emission sources. Other nondestructive examination (NDE) methods may be used to evaluate the significance of AE sources. Procedures for other NDE methods are beyond the scope of this test method.

1.7 Values stated in inch-pound units are to be regarded as the standard. SI units given in parentheses are provided for information only.

1.8 *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:

- E 543 Practice for Agencies Performing Nondestructive Testing²
- E 650 Guide for Mounting Piezoelectric Acoustic Emission Sensors²
- E 750 Practice for Characterizing Acoustic Emission Instrumentation²
- E 976 Guide for Determining the Reproducibility of Acous-

tic Emission Sensor Response²

E 1067 Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels²

E 1106 Method for Primary Calibration of Acoustic Emission Sensors²

E 1316 Terminology for Nondestructive Examinations²

2.2 ASNT Documents:

SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel Qualification and Certification³

ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel³

2.3 Military Standards:

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification⁴

2.4 Aerospace Industries Association Document:

NAS 410 Certification and Qualification of Nondestructive Testing Personnel⁵

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology E 1316.

4. Summary of Test Method

4.1 This test method consists of subjecting individual FRP fan blades to increasing load while monitoring with sensors that are sensitive to acoustic emission (transient stress waves) caused by growing flaws.

4.2 This test method provides guidelines to determine the zonal location of structural flaws in FRP fan blades.

4.3 The test load, applied at the blade tip is calculated to provide 100 % of the maximum allowable operating (bending) load at the blade-hub interface.

4.4 This test method is intended to simulate the bending load. Torsional and centrifugal loads are not simulated by this test method.

4.5 Structurally insignificant flaws may produce acoustic emission.

¹ This test method is under the jurisdiction of ASTM Committee E-07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.04 on Acoustic Emission Method.

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² *Annual Book of ASTM Standards*, Vol 03.03.

³ Available from American Society for Nondestructive Testing, Inc., 1711 Arlingate Lane, Columbus, OH 43228.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁵ Available from Aerospace Industries Association of America, Inc., 1250 Eye St. NW, Washington D.C. 20005.

5. Significance and Use

5.1 The AE examination method detects structurally significant flaws in FRP structures via test loading. The damage mechanisms that are detected in FRP include resin cracking, fiber debonding, fiber pullout, fiber breakage, delamination, and secondary bond failure.

5.2 Flaws in unstressed areas will not generate detectable AE.

5.3 Flaws located with AE may be examined by other methods.

6. Basis of Application

6.1 *Personnel Qualification*—If specified in the contractual agreement, personnel performing examinations to this standard shall be qualified in accordance with a nationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, MIL STD-410, NAS-410, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be specified in the contractual agreement between the using parties.

6.2 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E 543. The applicable edition of Practice E 543 shall be specified in the contractual agreement.

6.3 *Extent of Examination*—The extent of examination shall be in accordance with 10.2 unless otherwise specified.

6.4 *Reporting Criteria/Acceptance Criteria*—Reporting criteria for the examination results shall be in accordance with Section 12 unless otherwise specified. Since acceptance criteria, for example, for reference radiographs, are not specified in this test method, they shall be specified in the contractual agreement.

6.5 *Reexamination of Repaired/Reworked Items*—Reexamination of repaired/reworked items is not addressed in this test method, and if required, shall be specified in the contractual agreement.

6.6 *Personnel Training*—It is recommended that personnel performing the examination have additional training on the following topics:

6.6.1 Basic technology of AE from FRP;

6.6.2 Failure mechanism of FRP;

6.6.3 AE instrument and sensor checkout on FRP;

6.6.4 Loading of FRP components for AE testing;

6.6.5 Data collection and interpretation; and

6.6.6 Examination report preparation.

7. Apparatus

7.1 Essential features of the apparatus required for this test method are shown in Fig. 1. Specifications are provided on Annex A1.

7.2 Couplant must be used to acoustically couple sensors to the blade surface. Adhesives that have acceptable acoustic properties and ultrasonic couplants are acceptable.

7.3 Sensors may be held in place with elastic straps, adhesive tape, or other mechanical means.

7.4 Sensors are to be positioned on the fan mounting drive hub for background noise detection only; on the blade within 6 in. (152.4 mm) of the shank; on the blade midway between the shank and the blade tip; and within 6 in. (152 mm) of the blade tip for background noise detection only. Additional sensors may be added when more complete coverage is desired.

NOTE 1—The sensors indicated in Fig. 1 may be placed on either the top or bottom surface of the blade.

7.5 Instrumentation shall be capable of recording AE hits above a low-amplitude threshold, AE hits above a high-amplitude threshold (both within a specific frequency range) and have sufficient channels to localize AE sources in real time. Hit detection is required for each channel. An AE hit amplitude measurement is recommended for sensitivity verification. Amplitude distributions are recommended for flaw characterization.

7.6 Preamplifier may be enclosed in the sensor housing or in a separate enclosure. If a separate preamplifier is used, sensor cable length, between the sensor and the preamplifier, must not result in a signal loss of greater than 3 dB. Typically, 6 ft (1.8 m), is acceptable.

7.7 Power/signal cable length (between preamplifier and signal processor) shall not result in a signal loss of greater than 3 dB. Typically, 500 ft (152.4 m) is acceptable.

7.8 Signal processors are computerized instruments with independent channels that filter, measure, and convert analog

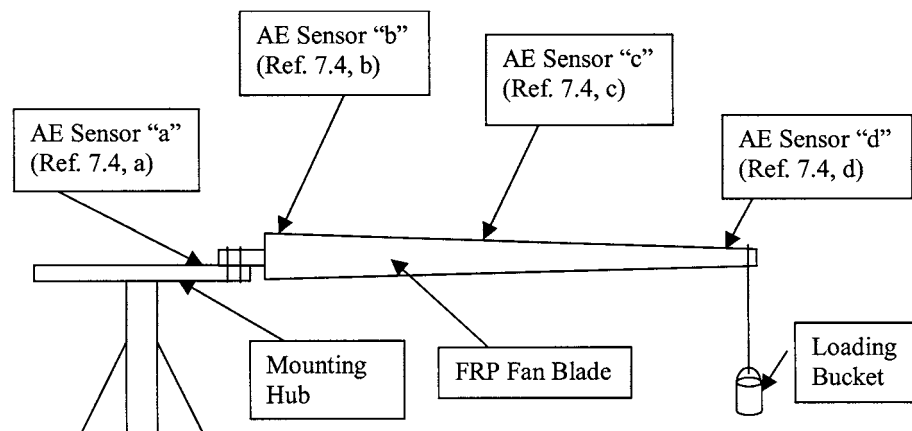


FIG. 1 Apparatus