



Designation: E2580 – 07

Standard Practice for Ultrasonic Testing of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications¹

This standard is issued under the fixed designation E2580; 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 practice establishes two procedures for ultrasonic testing (UT) of flat panel composites and flat sandwich core panels (parallel surfaces). Typical as-fabricated lay-ups include uniaxial, cross ply and angle ply laminates; as well as honeycomb sandwich core materials. These procedures can be used throughout the life cycle of the materials; product and process design optimization, on line process control, after manufacture inspection, and in service inspection. Contact methods such as angle-beam techniques using shear waves, or surface-beam techniques using Lamb waves, are not discussed.

1.2 Ultrasonic testing is a common sub surface method for detection of laminar oriented discontinuities. Two techniques can be considered based on panel surface accessibility; pulse echo for one sided and through transmission (bubblers/squirters) for two sided. As used in this practice, both require the use of a pulsed straight-beam ultrasonic longitudinal wave followed by observing indications of either the reflected (pulse-echo) or received (through transmission) wave. The general types of anomalies detected by both techniques include foreign materials, delamination, disbond/un-bond, fiber debonding, inclusions, porosity, and voids.

1.3 This practice provides two ultrasonic test procedures. Each has its own merits and requirements for inspection and shall be selected as agreed upon in a contractual document.

1.3.1 *Test Procedure A, Pulse Echo (non-contacting and contacting)*, is at a minimum a single transducer transmitting and receiving a longitudinal wave in the range of 0.5 to 20 MHz (see Fig. 1). This procedure requires access to only one side of the specimen. This procedure can be conducted by automated or manual means. Automated and manual test results may be imaged or recorded.

1.3.2 *Test Procedure B, Through Transmission*, is a combination of two transducers. One transmits a longitudinal wave and the other receives the longitudinal wave in the range of 0.5 MHz to 20 MHz (see Fig. 2). This procedure requires access to

both sides of the specimen. This procedure is automated and the examination results are recorded.

1.4 This practice does not specify accept-reject criteria.

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

2. Referenced Documents

2.1 ASTM Standards:²

- C274 Terminology of Structural Sandwich Constructions
- D3878 Terminology for Composite Materials
- D5687/D5687M Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation
- E114 Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method
- E543 Specification for Agencies Performing Nondestructive Testing
- E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases
- E1316 Terminology for Nondestructive Examinations
- E1434 Guide for Recording Mechanical Test Data of Fiber-Reinforced Composite Materials in Databases
- E1471 Guide for Identification of Fibers, Fillers, and Core Materials in Computerized Material Property Databases

2.2 SAE Standards:³

- ARP 5605 Solid Composite Laminate NDI Reference Standards, Issued 2001-09
- ARP 5606 Composite Honeycomb NDI Reference Standards, Issued 2001-09

2.3 AIA Standard:⁴

- NAS-410 Nondestructive Testing Certification of Personnel

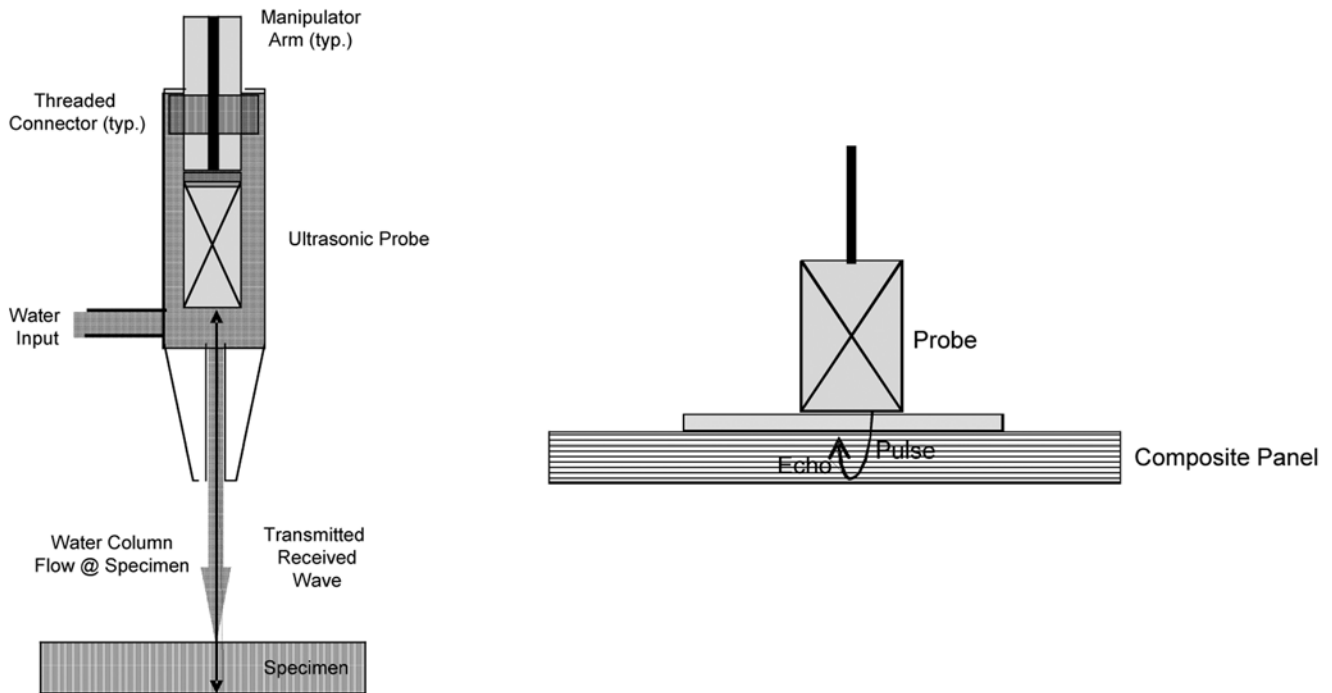
² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

⁴ Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

¹ This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.06 on Ultrasonic Method.

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Automated

Manual

FIG. 1 Test Procedure A, Pulse Echo Apparatus Set-up

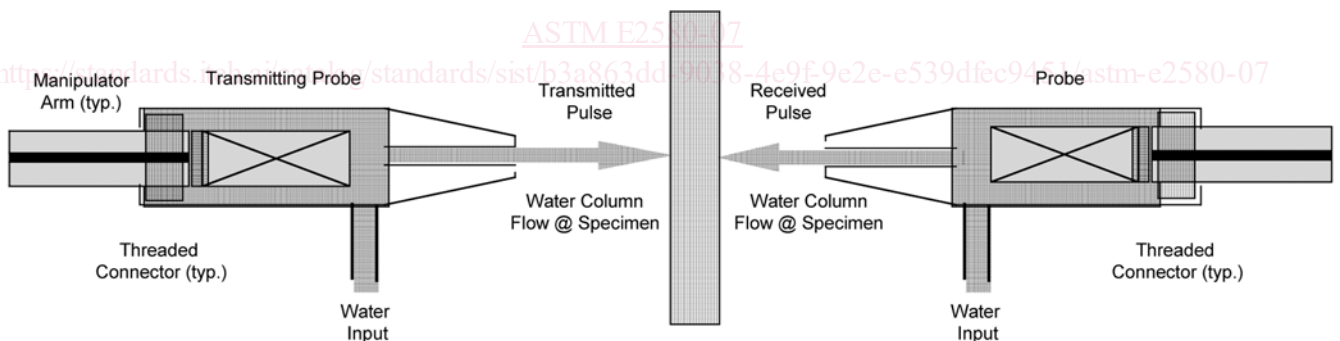


FIG. 2 Test Procedure B, Through Transmission Apparatus Set-up

2.4 ASNT Standards:⁵

- SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
- ANSI/ASNT CP-189 Standard for Qualification and Certification or Nondestructive Testing Personnel

3. Terminology

3.1 Definitions—Terminology in accordance with Terminologies C274, E1316, and D3878 shall be used where applicable.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 flat panel composite, n—any fiber reinforced composite lay-up consisting of laminate (plies) with one or more orientations with respect to some reference direction that are

⁵ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

consolidated by press or autoclave to yield a two-dimensionally flat article of finite thickness.

3.2.2 *sandwich core material, n*—a structural panel made up of two relatively thin outer skins of composite laminate or other material, such as metal or wood, separated by and bonded to a relatively thick lightweight inner core such as honeycomb, open and close cell foam, wave formed material, bonded composite tubes, or naturally occurring material such as balsa wood.

4. Summary of Practice

4.1 This practice describes two procedures for detecting anomalies in flat panel composite and flat sandwich core panels using ultrasonic longitudinal waves coupled by either contact (Procedure A) or bubbler/squirter (Procedure B). Equipment, reference blocks, examination and evaluation procedures, and documentation are described in detail.

5. Significance and Use

5.1 This practice is intended primarily for the testing of flat panel composites and sandwich core panels to an acceptance criteria most typically specified in a purchase order or other contractual document.

5.2 *Basis of Application*—There are areas in this practice that require agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

6. Equipment and Materials

6.1 Equipment

6.1.1 *Operation*—Test equipment shall be capable of providing uniform, repeatable, and controlled operation.

6.1.2 *Electronic Equipment*—The electronic equipment should be capable of producing and processing electronic signals at frequencies in the range of search unit frequencies being used.

6.1.3 *Search Unit(s)*—The search unit(s) selected should be compatible with the electronic equipment being used and with the material to be inspected. The search unit should match the intended squirter(s) or contact. Only straight-beam (longitudinal) search units, with flat or focused acoustic lenses, should be used.

6.1.4 *Alarm*—The alarm or threshold level should be adjustable to allow triggering at any commonly required level of indication amplitude. Alarms are not required on systems that record amplitude recordings.

6.1.5 *Alarm Gate Synchronization*—In the pulse echo mode ensure that the alarm gate tracks the inspection area. The gate should lock on the first interface pulse from the test piece rather than on the initial pulse from the system. In the through transmission mode the alarm gate should be wide enough to cover any negative or positive movement (left to right) in the horizontal plane.

6.1.6 *Manipulating Equipment* should be provided to adequately support the search tube(s) and allow angular adjustment in two mutually perpendicular planes. The search unit manipulator shall be capable of providing the adjustments necessary to properly position the search unit during testing.

The scanning and indexing apparatus should have sufficient structural rigidity to provide support for the manipulator and should allow smooth, accurate positioning of the search unit. The scanning apparatus should be sufficiently rigid to keep search unit backlash to within tolerances as specified in the contractual agreement.

6.1.7 *Tank or Gantry System*—The tank or gantry system should permit accurate positioning of the search unit, reference standards, and part or material to be examined.

6.1.8 *Squirter*—The squirter equipment shall be capable of supplying a laminar flow of coupling fluid from the transducer to the part being tested at all angles used.

6.1.9 *Scan-Record*—The recording shall not exhibit backlash or hysteresis that would hinder detection or evaluation of discontinuities.

6.1.10 *Composite Reference Blocks*—For the applicable testing system the responses from reference block and part shall be similar to the extent that standardization of the testing system can be accomplished and demonstrated to provide a known and acceptable detection level in the part. Reference blocks contain either structural anomalies or foreign inclusions. Structural anomalies are those that are known to be possible during the life cycle of the material. Debonding during manufacturing or delamination during in-service may be represented by the block. Foreign inclusions most commonly encountered during manufacturing are used in the reference blocks.

6.1.11 *Transfer Cutouts*—When non-contact through-transmission is used transfer cutouts may be used in lieu of reference blocks when agreed upon contractually. The size of the transfer cutouts shall be agreed contractually. The transfer cutouts must provide sufficient attenuation to simulate voids or unbonds in the part. Transfer cutouts shall be attached to the part and be placed to cover changes in part configuration and alignment.

6.2 Materials:

6.2.1 *Flat Panel Specimens*—Processing guidelines that facilitate fabrication of flat panel composite specimens made from unidirectional tape or using orthogonal weave patterns are found in Guide **D5687/D5687M**. For specimen preparation using other processing techniques, for example, pultrusion, filament winding and resin transfer molding, processing guidelines are not available and shall be agreed upon by the using parties.

6.2.2 *Sandwich Core Specimens*—Processing guidelines for fabrication of sandwich construction specimens are diverse and shall be agreed upon by the using parties.

6.2.3 *Transfer Cutouts*—Transfer cutouts shall be made of two layers of lead foil tape cut to size.

6.2.4 *Couplants*—Immersion and contact couplants shall provide intimate coupling between search unit and part; shall be compatible with the part; and shall be easily removed from the part using an applicable cleaning process.

7. General Requirements

7.1 In-process testing of flat panel composite or honeycomb structure shall be conducted using automated equipment capable of electronically recording the test output or manual contact during indication evaluation. There shall be a direct