Designation: E 1375 – 90 (Reapproved 2002)

Standard Test Method for Measuring the Interzone Attenuation of Furniture Panels Used as Acoustical Barriers[1]

This standard is issued under the fixed designation E 1375; 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.

INTRODUCTION

This test method is one of a series for the measurement and evaluation of acoustical components affecting speech privacy in open-plan spaces. This test method provides a means of objectively measuring the relevant acoustical characteristics of one component of the open-plan space, furniture panels used as acoustical barriers.

1. Scope

1.1 This test method covers the measurement of the interzone attenuation of furniture panels used as acoustical barriers in open-plan spaces to provide speech privacy or sound isolation between working positions.[2]

1.2 This test procedure was originally developed using the foot-pound system of units for prescribing measurement positions and distances. However, the use of SI units is preferred by ASTM. For this reason, dimensions are provided in SI units, with approximate foot-pound conversions indicated.

1.2.1 Unless otherwise qualified, all dimensions specified in this test method shall be understood to have a tolerance of ±25 mm (±1 in.), even though the indicated approximate conversions of the numerical dimensions given will not always be accurate to this extent. All measurements shall be made in SI units or the corresponding exact foot-pound units.

1.3 *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:*

C 423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method[3]

C 634 Terminology Relating to Environmental Acoustics[3]

E 795 Practices for Mounting Test Specimens During Sound Absorption Tests[3]

E 1110 Classification for Determination of Articulation Class[3]

E 1130 Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index[3]

E 1179 Specification for Sound Sources Used for Testing Open Office Components and Systems[3]

2.2 *ANSI Standards:*

S1.4 Specification for Sound Level Meters[4]

S1.6 Preferred Frequencies and Band Numbers for Acoustical Measurements[4]

S1.11 Specification for Octave Band and Fractional-Octave Band Analog and Digital Filters[4]

S1.12 Specification for Laboratory Standard Microphones[4]

3. Terminology

3.1 *Definitions*—For definition of terms used in this test method see Terminology C 634. The term *source point* is defined in Specification E 1179.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *furniture panel*—a furnishing that does not extend to the ceiling, and that is used to subdivide an open-plan space and provide some degree of visual and acoustical privacy. Furniture panels include interlocking systems furniture and freestanding screens.

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[1] This test method is under the jurisdiction of ASTM Committee E33 on Environmental Acoustics and is the direct responsibility of Subcommittee E33.02 on Open Plan Spaces.

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[2] This test method is similar to a procedure developed by the United States Government General Services Administration, Public Buildings Service, designated "PBS-C.2, Test Method for the Sufficient Verification of Speech Privacy Potential Based on Objective Measurements including Methods for the Rating of Functional Interzone Attenuation and NC-Background, August 1972."

[3] *Annual Book of ASTM Standards*, Vol 04.06.

[4] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

3.2.2 *interzone attenuation*—at a specified position, for a one-third octave-band, the difference between the sound pressure level at a nominal reference position 0.9 m (3 ft) from the sound source and the sound pressure level at the point in question.

3.2.3 *nominal interzone attenuation*—for a one-third octave-band, at a specified point, the arithmetic mean interzone attenuation calculated using the interzone attenuation for the point in question and for two adjacent positions 0.3 m (1 ft) to either side. (See Figs. 1 and 2.) For example, in Fig. 1, the nominal interzone attenuation at the 3.0-m (10-ft) position is the arithmetic mean of the interzone attenuations at the 2.7, 3.0, and 3.3-m (9, 10, and 11-ft) positions.

4. Summary of Test Method

4.1 The test facility is a room constructed such that sound reflections from the walls and ceiling are negligible. The test specimen is a furniture panel arranged as an acoustical barrier, that is, arranged such that it blocks the direct path of sound from the sound source to the measuring microphones. Sound generated by the sound source on one side of the furniture panel under test reaches the other side chiefly by diffracting over its top edge. A potential secondary path is transmission through the panel. The differences in sound pressure levels measured on each side of the furniture panel provide a measure of its effectiveness as an acoustical barrier.

5. Significance and Use

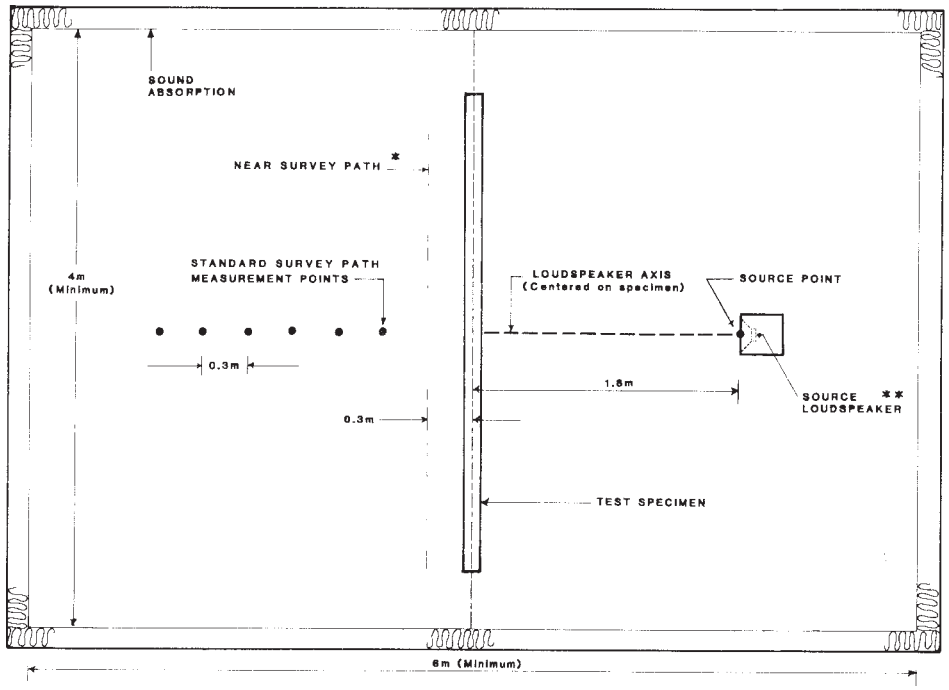
5.1 In open plan spaces, furniture panels are often used in lieu of full height walls to visually and acoustically separate workstations. The use of these units, compared to full-height walls, can significantly lower the degree of speech privacy or noise isolation afforded between workstations. The degree of speech privacy or noise isolation depends upon many factors. In travelling from one workstation to another, sound may be reflected from the ceiling system, may be diffracted over or around intervening furniture panels that act as acoustical barriers, may be transmitted through the furniture panels, or may be reflected around the panel by furniture or fixed constructions, such as walls or columns. Providing adequate speech privacy in open-plan spaces requires the use of an acoustically absorbent ceiling and often the use of controlled background masking sound, in addition to partial height acoustical barriers.

5.2 This test method measures one of the relevant acoustical properties of one component of the open office environment: the effectiveness of furniture panels as acoustical barriers. The method measures the degree to which sound is diffracted over the top edge and transmitted through the panel. Other test methods deal with the evaluation of the degree to which reflected sound is attenuated by open-plan components, such as the ceiling system, furniture panels, and wall finishes. Test Method E 1130 is available to evaluate the overall speech privacy between workstations that results from a specific configuration of components.

6. Apparatus

6.1 A sound source meeting Specification E 1179 is required.

6.2 Microphones shall meet the requirements in ANSI S1.12.



NOTE 1—See Fig. 2 for near survey line measurement positions.
NOTE 2—See Fig. 3 for measurement positions for reference levels.

FIG. 1 Plan of Test Arrangement

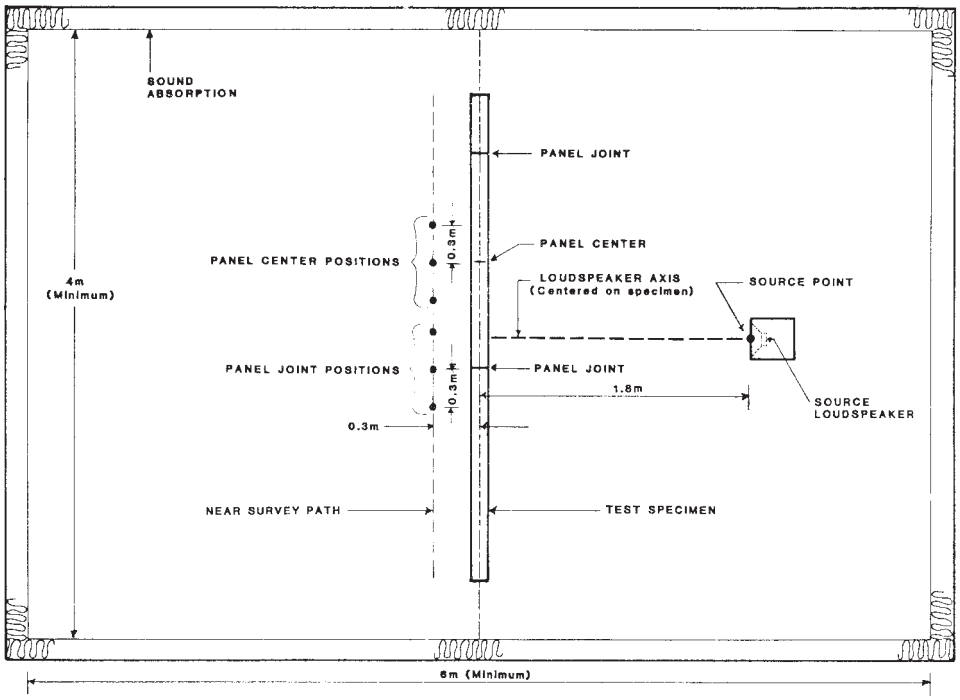


FIG. 2 Plan of Test Arrangement Showing Near Survey Path Positions

6.2.1 The microphones shall satisfy the requirements of 11.1.

6.3 Electronic instruments used to process the microphone signals shall conform to the relevant sections of ANSI S1.4 and shall meet Type 1 requirements.

7. Test Facility

7.1 The preferred test facility is a hemi-anechoic room, a room with negligible reflections from the walls and ceilings, in the frequency range of the measurements. A room meeting the requirements of 7.2 is satisfactory. The floor shall be made from a hard, sound-reflective material, such as concrete or wood, covered with carpet as specified in 7.3.

7.2 The wall and ceiling coverings shall have random incidence sound absorption coefficients of at least 0.95 at all frequencies at which measurements are to be made.

NOTE 1—Since reflections from the walls and ceiling of the facility may reduce the measured attenuations, it is important to eliminate these reflections as much as possible.

7.2.1 The random incidence sound absorption coefficients of the wall and ceiling coverings shall be measured following Test Method C 423 and Practices E 795. The mounting used shall be those that will be used in the actual test facility.

7.3 The floor shall be of solid material such as concrete or plywood. It shall be covered with carpet, without underpad, typical of those used in open-plan spaces. The carpet shall have a noise reduction coefficient (NRC) in the range of 0.20 to 0.40 when measured in a Type A mounting (see Practices E 795) according to Test Method C 423. The carpet may be installed and tested using tape or adhesive in the mounting.

7.4 The ceiling of the test facility should be at least 0.3 m (1 ft) from the edge of the test specimen. (See also 7.5 and 8.3.)

7.5 The dimensions of the facility will limit the size of specimens that can be tested. The required minimum set of plan-view room dimensions is 4 by 6 m (13 by 20 ft) measured to the inner face of the absorptive coverings. The height of the facility, measured from the floor to the inner face of the sound-absorptive covering on the ceiling, shall be 2.7 m (9 ft).

NOTE 2—The facility may be intended for use with other test procedures whose requirements may be more or less stringent than these. These standards should be consulted so that for newly engineered facilities, an optimum design is achieved.

8. Test Specimens

8.1 Furniture panels to be tested shall be assembled in accordance with the manufacturer's instructions and shall be arranged as they would normally be arranged in an open office. Joints between panels shall be sealed by no other means than those provided or recommended by the manufacturer.

8.2 In order to prevent flanking around the ends of a panel, the width of the specimen shall be at least twice its height or its width may be the same as the width of the test facility. Two or more panels may be placed or joined edge to edge to meet these recommendations. Normal installation procedure shall be followed.

8.3 The height of the specimen should not exceed 2.4 m (8 ft). If the specimen is higher than 2.4 m (8 ft), the height shall be completely documented in the test report as discussed in 13.2.1.

8.4 Furniture panels may be tested with accessories attached to them. The accessories and the positions where they are attached shall be fully described in the test report.

8.5 Furniture panels that are significantly asymmetrical, such as curved screens, shall be tested twice, once with each

face toward the sound source. The test results for each orientation shall be reported separately.

9. Test Signal

9.1 *Signal Spectrum*—The electrical signals used to generate the sound signals used for this test shall form a series of bands of random noise containing an essentially continuous distribution of frequencies over each test band.

9.1.1 The generated sound shall be adequate to maintain, at each of the desired measurement locations, one-third octave-band sound pressure levels at least 10 dB above the background noise levels of the test facility and the measuring instrumentation.

9.2 *Bandwidth*—The measurement bandwidth shall be one-third octave. Specifically, the overall frequency response of the electrical system, including the filter or filters in the source or sound measurement sections, shall for each test band meet the requirements of ANSI S1.11 for one third octave band filters of Order 3 or higher, Type 1 or better.

9.2.1 Filters in the sound measurement system serve to filter out extraneous noise lying outside the test bands, including possible distortion produced in the source system.

9.3 *Standard Test Frequencies*—The minimum range of measurements shall be a series of contiguous one-third octave bands with center frequencies from 200 to 5000 Hz conforming to ANSI S1.6. If desired, the range may be extended provided that the requirements of 7.1 and 7.2 are met.

10. Procedure

10.1 *Measurement of Sound Pressure Levels*:

10.1.1 Orient microphones so that for each frequency band they have a uniform directional response within ±1 dB in the plane that is perpendicular to the floor and that passes through the source point and the microphone. A vertical orientation of the microphone axis is preferred. (Measure the directional responses of the microphones under laboratory-empty conditions, not with the specimen in place, or take them from the manufacturer's literature.)

10.1.1.1 Individually calibrate multiple microphones where they are used and make corrections for differences in sensitivity during the calculations.

10.1.2 *Measurement of Reference Levels*:

10.1.2.1 Position the sound source so that the loudspeaker axis is parallel to the floor and 1.2 m (4 ft) above it.

10.1.2.2 The reference sound pressure level in each one-third octave-band is the arithmetic average of the levels on the loudspeaker axis at 0.6, 0.9, and 1.2-m (2, 3, and 4 ft) from the source point (see Fig. 3). Obtain these levels with no specimen or hard surface present in the test facility and with the carpet exposed. Alternatively, these reference values may be obtained with the source moved away from the specimen and the walls provided that any sound reflecting surfaces are covered with sound absorptive material.

10.1.2.3 Measure the electrical signal fed to the source and maintain it at the same level during the measurement of the sound transmitted beyond the test specimen. This may be accomplished by measuring the voltage fed to the loudspeaker.

NOTE 3—Some precision sound level meters may be used as wide-band voltmeters by removing the microphone and driving them directly with an electrical signal. (Consult instruction manual for applicability.)

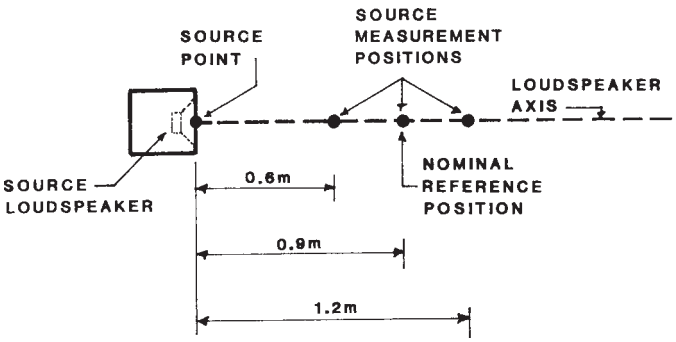


FIG. 3 Measurement Positions for Reference Levels

10.1.3 *Measurements With the Test Specimen: Standard Survey Path* (see Fig. 1):

10.1.3.1 Position the sound source so that the loudspeaker axis is parallel the floor and 1.2 m (4 ft) above it with the source point 1.8 m (6 ft) from the centerline of the specimen. In plan view, center the loudspeaker axis on the specimen (see Fig. 1).

10.1.3.2 Make measurements on the side of the panel away from the sound source on the loudspeaker axis at distances of 2.1, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, and 4.2 m (7, 8, 9, 10, 11, 12, 13 and 14 ft) from the source point (see Fig. 1). Additional measurements may be made at greater or smaller distances, as desired.

10.1.3.3 Make all measurements with the microphone or microphones positioned 1.2 m (4 ft) above the floor.

10.1.4 *Measurements With Test Specimen: Near Survey Path*—(see Fig. 2):

10.1.4.1 Additional measurements are made as described in 10.1.4.2-10.1.4.5 to assess the direct transmission of sound through the specimen or through specimen joints. These additional measurements are made at positions on the near survey line parallel to the specimen and 0.3 m (1 ft) from the specimen on the side away from the sound source (see Fig. 2).

10.1.4.2 Leave the sound source positioned at the same location and with the same orientation as in 10.1.3.1.

10.1.4.3 Make measurements near the plan-view center of the specimen (if the specimen consists of a single furniture panel) or near the plan-view center of the panel closest to the specimen center line (if the specimen consists of panels joined as in 8.2). Make measurements at three positions along the near survey line, including a position directly opposite the panel center and at positions 0.3 m (1 ft) to either side of this position (see Fig. 2).

10.1.4.4 If the specimen consists of two or more furniture panels joined as in 8.2, make measurements near the joint closest to the plan-view centerline of the specimen. Make measurements at three positions along the near survey path; at a position directly opposite the joint, and at positions 0.3 m (1 ft) to either side of this position (see Fig. 2).

10.1.4.5 Make all measurements with the microphone or microphones positioned 1.2 m (4 ft) above the floor.

11. Calculation

11.1 Determine the interzone attenuation for each receiving position in each one-third octave band by calculating the difference, rounded to the nearest decibel, between the reference sound pressure level and the level measured at the receiving position.

11.2 Calculate the nominal interzone attenuations along the standard survey path for each of the 2.4, 2.7, 3.0, 3.3, 3.6, and 3.9-m (8, 9, 10, 11, 12, and 13-ft) positions.

11.3 Calculate the nominal interzone attenuations along the near survey path as follows. Calculate the nominal interzone attenuations for the panel-center position by averaging the values obtained at the three positions described in 10.1.4.3. If measurements were made as described in 10.1.4.4, calculate the nominal interzone attenuation for the panel-joint position by averaging the values obtained at the three positions described in 10.1.4.4.

12. Single Number Classification

12.1 The articulation class (AC) shall be calculated according to Classification E 1110 for the 2.4, 2.7, 3.0, 3.3, 3.6, and 3.9-m (8, 9, 10, 11, 12, and 13-ft) nominal interzone attenuations. The articulation class shall also be calculated for the panel-center and (if measured) panel-joint positions. The articulation class values shall be reported for all of these positions, with the positions clearly identified. The minimum of these AC values may be reported as the "minimum articulation class," without a qualifying distance or location.

13. Report

13.1 The report shall include a statement, if true in every respect, that the tests were conducted in accordance with the provisions of this test method. Any deviations from this test method shall be fully reported.

13.2 A complete description of the assembly under test shall be given, including all of the essential construction and dimensions. If this description has not been determined by direct examination, the test report shall so indicate.

13.2.1 Report the clearance between the top of the specimen and the absorptive covering of the test facility ceiling where the clearance is less than that recommended in 7.4.

13.3 Tabulate the measured interzone attenuations calculated in 11.1 to the nearest 1 dB for all positions and frequencies examined.

13.4 Report the nominal interzone attenuations calculated in 11.2 and 11.3, and the articulation class values calculated in 12.1.

13.5 Where both faces of a specimen are tested as in 8.5, the measured interzone attenuations, nominal interzone attenuations, and articulation class values shall be reported for each orientation separately.

14. Precision and Bias

14.1 The precision associated with the measurement of sound pressure levels depends on the interpretation of the output of the instrumentation used; for example, sound level meter, level recorder, or digital analyzer.

14.2 The bias of level measurements and differences is determined by the bias of all the associated instrumentation. Any inaccuracies in this area should be made negligible by careful calibration.

14.3 The precision of this test method should be determined annually by performing several tests on a single specimen. The test specimen should be removed and reinstalled after each test. In a laboratory routinely carrying out tests under this test method, such precision checks should be carried out within 6 months of any tests.

14.4 Studies are planned to evaluate the reproducibility of this test method.

15. Keywords

15.1 acoustical barrier; acoustical component; architectural acoustics; component test; furniture panel; interzone attenuation; open office; open office component; open-plan space; speech privacy

ANNEX

(Mandatory Information)

A1. GUIDE FOR ACCREDITATION OF TESTING LABORATORIES

A1.1 Scope

A1.1.1 This annex provides guidelines for agencies evaluating testing laboratories for the purpose of granting accreditation for this test method.

A1.2 Referenced Documents

A1.2.1 *ASTM Standards*:

C 634 Terminology Relating to Environmental Acoustics[3]

E 548 Guide for General Criteria Used for Evaluating Laboratory Competence[5]

[5] *Annual Book of ASTM Standards*, Vol 14.02.

A1.3 Terminology

A1.3.1 *Descriptions of Terms Specific to This Annex*—The acoustical terminology used in this annex is consistent with Terminology C 634 and Practice E 548.

A1.4 Organization of the Agency

A1.4.1 A description of the organization shall be given following the requirements of Practice E 548.

A1.5 Human Resources of the Agency

A1.5.1 A description of the agency personnel responsible for testing shall be supplied following the requirements of Practice E 548.

A1.6 Facility Requirements

A1.6.1 The laboratory shall produce test data demonstrating compliance with the requirements of 7.2, 7.2.1, 7.3, and 7.5.

A1.7 Source Requirements

A1.7.1 The laboratory shall produce test data demonstrating compliance with 6.1.

A1.8 Requirements for Analysis and Measurement

A1.8.1 The laboratory shall have evidence that the microphones used meet the requirements of 6.2 and 10.1.

A1.8.2 The laboratory shall have evidence that the instruments meet the requirements of 6.3.

A1.8.3 The laboratories shall have evidence that the filters used meet the requirements of 9.2.

A1.8.4 The laboratory shall produce test data to show that background noise levels for the facility will meet the requirements of 9.1.1.

A1.9 Precision and Bias

A1.9.1 Calibration records shall be produced to demonstrate compliance with 14.2.

A1.9.2 The data obtained from the procedure in 14.3 shall be produced to demonstrate that the requirements of 14.3 are satisfied.

A1.10 General

A1.10.1 Instruments, techniques, and individual capabilities may vary between testing laboratories. The accrediting agency should ensure that its accrediting personnel are competent to deal with and correctly evaluate unusual instruments or techniques.