



Designation: E 966 – 02

## Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements<sup>1</sup>

This standard is issued under the fixed designation E 966; 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.

### INTRODUCTION

The sound transmission of a building facade or facade element as measured under field conditions is dependent not only on the physical characteristics of the facade, but also on the characteristics of the incident sound field used to make the measurement. This is also true for laboratory tests of panels using the two-room method described in Test Method E 90E 90; however, the incident sound field in these controlled tests is made uniformly diffuse. The same is approximately true for field measurements of noise reduction and transmission loss by Test Method E 336E 336. Such uniformity is not possible for facade measurements in the field where each situation is unique, resulting in incident sound fields that may range all the way from free field produced by a point source to quasi-diffuse produced by a line source.

At this time, there are insufficient data available to specify a single, standard measurement procedure suitable for all field situations. For this reason, this guide provides a number of alternative test procedures for the measurements of facade field level reduction and transmission loss.

### 1. Scope

1.1 This guide covers field procedures for measuring the sound level reduction or sound transmission loss of an installed building facade or facade element in specified frequency bands. These values may be used separately to predict interior levels or combined into a single number such as by Classification E 413E 413 (with precautions) or Classification E 1332E 1332 to estimate the sound insulating properties of the test element, FOITC, in the field. The results are applicable to installations similar to that tested when exposed to an outdoor sound field similar to that used during the measurement.

1.1.1 The facade element may be the exterior wall of a room in the building, or a portion of that wall such as a door or window, when the remainder of that wall has substantially greater sound insulation than the portion under test.

1.2 To cope with the variety of outdoor test geometry that may be encountered, several testing techniques are presented. These techniques and their general applicability are summarized in Table 1 and Figs. 1-6.

1.3 This guide may be used to determine the outdoor-indoor level reduction (OILR), which is the difference in sound pressure between a specified outdoor sound field and the resulting sound pressure level in the room abutting the test

facade or facade element. The outdoor sound field and its measurement must be thoroughly described. The resulting level reduction or transmission loss value will depend on the outdoor field geometry and the point at which it is measured or represented.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are provided for information only.

1.5 *This standard does not purport to address 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<sup>2</sup>
- C 634 Terminology Relating To Environmental Acoustics<sup>2</sup>
- E 90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions<sup>2</sup>
- E 336 Test Method for Measurement of Airborne Sound Insulation in Buildings<sup>2</sup>
- E 413 Classification for Rating Sound Insulation<sup>2</sup>
- E 1332 Classification for Determination of Outdoor-Indoor Transmission Class<sup>2</sup>

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E33 on Environmental Acoustics and is the direct responsibility of Subcommittee E33.03 on Transmission.

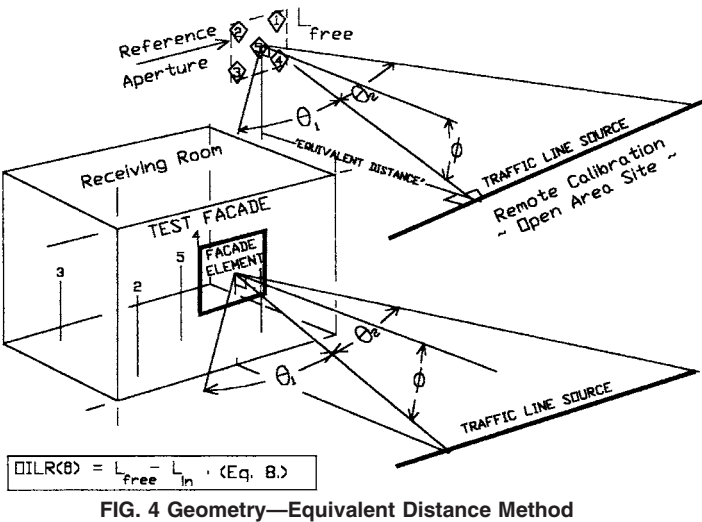
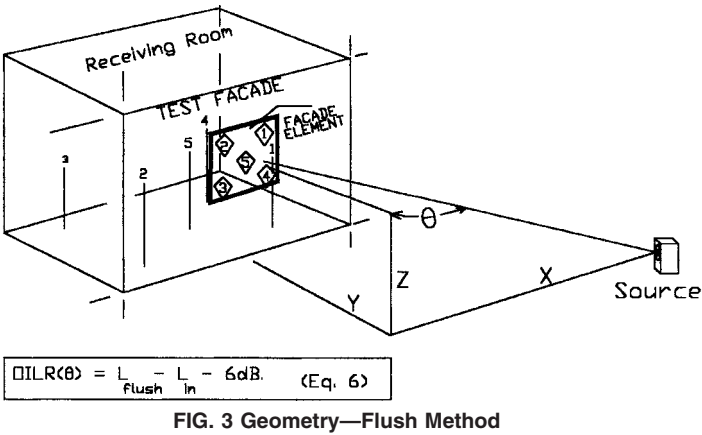
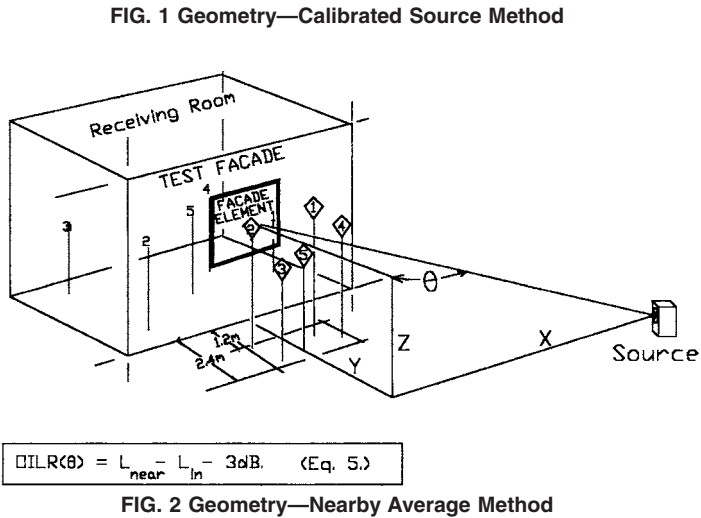
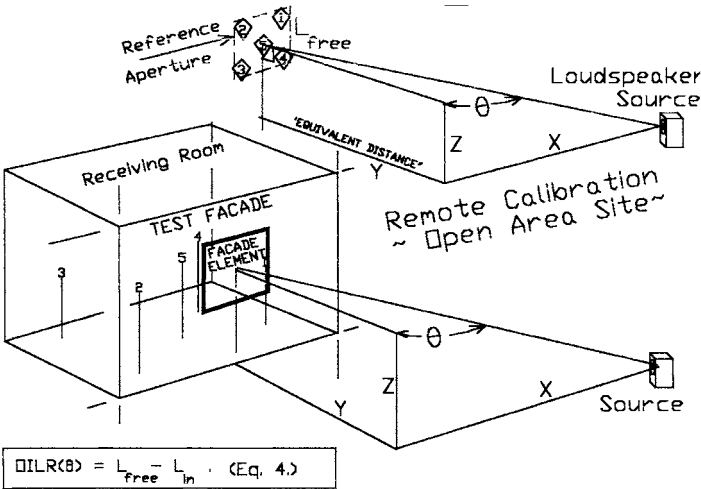
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<sup>2</sup> Annual Book of ASTM Standards, Vol 04.06.

TABLE 1 Application Guide to Measurement of Outdoor-Indoor Level Reduction (OILR) of Facade Elements<sup>4</sup>

| Outdoor Signal Source                                           | Outdoor Microphone Position                                          | Calculation Reference Section | Applications Remarks                                                                                           |
|-----------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------|----------------------------------------------------------------------------------------------------------------|
| Calibrated loudspeaker at $\theta = 45^\circ$ from test element | Incident sound pressure inferred from separate calibration of source | 8.3.1, Fig. 1; Eq 4           | Use when traffic noise is not available or when outdoor measurement at or near facade is not possible.         |
| Loudspeaker at $\theta = 45^\circ$ from test element            | Several locations averaged about 1.2 m 2.4 m from the facade element | 8.3.2, Fig. 2; Eq 5           | Use when calibrated source or flush measurement is not possible.                                               |
| Loudspeaker at $\theta = 45^\circ$ from test element            | Several locations less than 17 mm from facade element                | 8.3.3, Fig. 3; Eq 6           | Use when traffic noise is not available and when loudspeaker cannot be calibrated.                             |
| Traffic or equivalent                                           | Simultaneous measurement remote from the facade                      | 9.5.1, Fig. 4; Eq 8           | Source far from facade (that is, consistent traffic or aircraft overflights).                                  |
| Traffic or equivalent, moving parallel with facade              | Simultaneous measurement 2 m (79 in.) from facade                    | 9.5.2, Fig. 5; Eq 9           | Suitable when facade faces traffic. Smooth or rough facades. OILR and OITL down to 80 Hz.                      |
| Traffic or equivalent, moving parallel with facade              | Simultaneous measurement less than 17 mm from facade surface         | 9.5.3, Fig. 6; Eq 10          | Smooth or rough facade element test (for example, window, wall air conditioner, etc.); OILR & OITL to 5000 Hz. |

<sup>4</sup>See 5.1, 8.3 and 9.2.



2.2 ANSI Standards:<sup>3</sup>

- S1.4 Specification for Sound Level Meters
- S1.11 Specification for Octave-Band and Fractional-Octave Analog and Digital Filter Sets

S1.31 Precision Methods for the Determination of Sound Power Levels of Broadband Sources in Reverberation Rooms

2.3 IEC Standards:<sup>3</sup>

- IEC Publication 651—Sound Level Meters
- IEC Publication 804 Integrating-Averaging Sound Level Meters

<sup>3</sup> Available from the American National Standards Institute, 11 W. 42nd. St., 13th Floor, New York, NY, 10036.

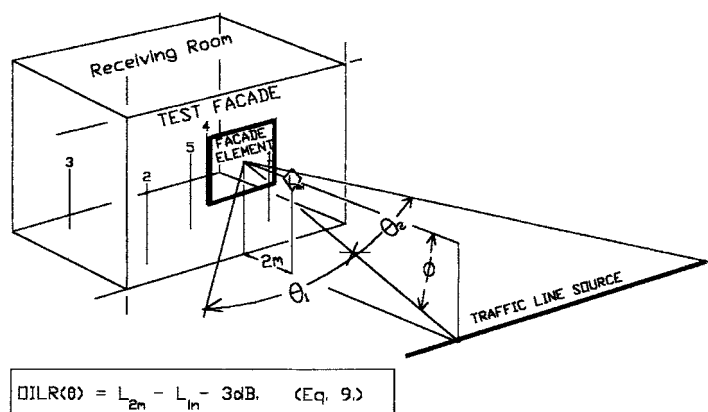


FIG. 5 Geometry—2 m (79 in.) Position Method

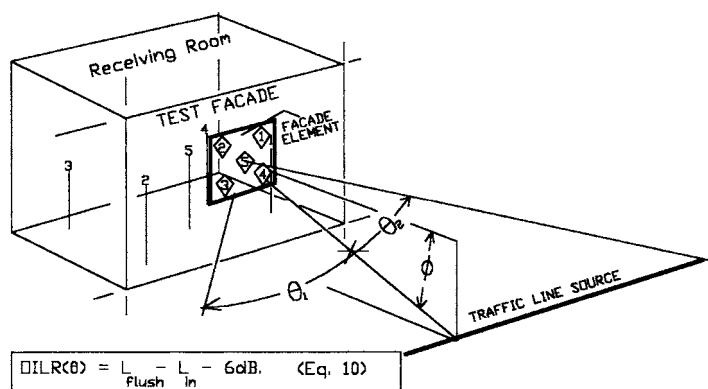


FIG. 6 Geometry and Formulas—Line Source Flush Method

### 3. Terminology

3.1 *Definitions*—For acoustical terms used in this guide, see Terminology C 634C 634.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent outdoor-indoor transmission loss, apparent OITL* ( $\theta$ )—the value of outdoor-indoor transmission loss obtained on a test facade element as installed, without flanking tests to identify or eliminate extraneous transmission paths; the apparent OITL is the lower limiting value of the outdoor-indoor transmission loss of the facade element.

3.2.2 *coincidence transmission*—transmission loss which is especially angular dependent (see 8.2.3.2).

3.2.3 *field outside-inside transmission class, FOITC*—the single number rating obtained by Classification E 413E 413 or E 1332E 1332 with the OITL values.

3.2.4 *outdoor-indoor level reduction, OILR*—in a specified frequency band, the difference between the time-averaged exterior sound pressure and the space-time average sound pressure in a room of a building.

3.2.4.1 *Discussion*—The direct field sound pressure is from a sound source at a specified angle of incidence,  $\theta$ , as defined in Fig. 2, or a range of angles in the case of a moving source, which would be present at the facade of the room, were the building and its facade not present.

3.2.5 *outdoor-indoor transmission loss, OITL* ( $\theta$ )—of a building facade element in a specified frequency band, ten times the common logarithm of the ratio of airborne sound power per unit area incident on the facade element at a

specified angle,  $\theta$ , as defined in Fig. 2, to the sound power transmitted through it and radiated to the interior; the quantity so obtained is expressed in decibels (dB).

3.2.5.1 *Discussion*—The unqualified term OITL ( $\theta$ ) signifies that flanking tests have been performed according to Annex A1 to verify that there was no significant flanking or leakage transmission. In the absence of such tests, the test result may be termed the apparent OITL (see 3.2.1).

3.2.6 *traffic noise*—noise emitted by moving transportation vehicles, such as cars, trucks, locomotives, or aircraft.

### 4. Summary of Guide

4.1 This guide provides procedures to measure the reduction in sound level from the outdoors to an enclosed room. This outside-inside level reduction is a function of angle, OILR ( $\theta$ ), where  $\theta$  is the angle of incidence of the outdoor sound. With further measurements under restricted conditions, a basic property of a facade or facade element, the outdoor-indoor transmission loss, OITL ( $\theta$ ), may be determined. This requires that the conditions of Annex A1 be met to demonstrate that flanking of sound around the test specimen is not significant. If it is not possible to meet the conditions of Annex A1, the apparent OITL ( $\theta$ ) is reported. The OILR ( $\theta$ ) and OITL ( $\theta$ ) may be reported for a range of angles.

4.2 *Sources of Test Signal:*

4.2.1 The outdoor sound pressure level produced by a loudspeaker source is either inferred from a previous calibration of the level emitted by that loudspeaker at a specific distance, or it is measured near the facade, or it is measured flush to the facade. When the outdoor sound level is measured near the facade, measurements shall be averaged over several locations near the test specimen to minimize effects of incident and reflected sound wave interference.

4.2.2 In the traffic noise method, movement of sources along a line such as a highway or flight path combined with time averaging will minimize interference effects. To account for source fluctuations using the traffic noise method, the incident sound is measured synchronously with the indoor levels.

4.3 To avoid propagation anomalies and extraneous noise sources, the measurements shall be made without precipitation and when the wind speed is less than 5 m/s (11 mph).

4.4 Measurements are preferably conducted in a series of one-third octave band frequencies from at least 80 to 5000 Hz. Octave band data in the same frequency range are optional.

NOTE 1—Where A-weighted OILR values are desired, A-weighted measurements may be used. These values shall be reported as A-weighted.

### 5. Significance and Use

5.1 The OILR and OITL produced by the methods described will not correspond to the transmission loss and noise reduction measured by Test Method E 90E 90 and E 336E 336 because of the different angular distributions that may exist in the outdoor incident sound fields (1)<sup>4</sup> and the sound intensity distribution across the test facade. Of the three methods cited

<sup>4</sup> The boldface numbers in parentheses refer to a list of references at the end of this standard.