Designation: E 1332 – 90 (Reapproved 2003)

Standard Classification for Determination of Outdoor-Indoor Transmission Class[1]

This standard is issued under the fixed designation E 1332; 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 classification is part of a set of ratings for the sound isolating properties of materials, building elements, and structures. It is based on A-weighted reduction of a transportation noise source. Other ratings include Classification E 413 that rates the ability of a partition to reduce speech and other sounds within a limited frequency range, and Classification E 989 that provides a rating method for comparing the impact-insulation properties of floor-ceiling assemblies.

1. Scope

1.1 The purpose of this classification is to provide a single-number rating that can be used for comparing building facade designs, including walls, doors, windows, and combinations thereof. This rating is designed to correlate with subjective impressions of the ability of building elements to reduce the overall loudness of ground and air transportation noise.[2] It is intended to be used as a rank ordering device.

1.2 The rating does not necessarily relate to the perceived aesthetic quality of the transmitted sound. Different facade elements with similar ratings may differ significantly in the proportion of low and high frequency sound that they transmit. It is best to use specific sound transmission loss values, in conjunction with actual spectra of outdoor and indoor sound levels, for making final selections of facade elements.

1.3 Excluded from the scope of this classification are applications involving noise spectra differing markedly from those described in 4.1. Thus excluded, for example, would be certain industrial noises with high levels at frequencies below the 80 Hz one-third octave band, relative to levels at higher frequencies. However, for any source with a spectrum similar to those in 4.1, this classification provides a more reliable ranking of the performance of partitions and facade elements than do other classifications such as Classification E 413.

1.4 *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 634 Terminology Relating to Environmental Acoustics[3]

E 90 Test Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions and Elements[3]

E 413 Classification for Rating Sound Insulation[3]

E 966 Guide for Field Measurement of Airborne Sound Insulation of Building Facades and Facade Elements[3]

E 989 Classification for Determination of Impact Insulation Class (IIC)[3]

2.2 *ANSI Standard:*

S1.4 Specifications for Sound Level Meters[4]

2.3 *ISO Standard:*

ISO 532 Acoustics–Method for Calculating Loudness Level[4]

3. Terminology

3.1 *Definitions*—For definitions used in this classification, see Terminology C 634.

4. Significance and Use

4.1 This classification provides the A-weighted sound level reduction for a test specimen, based upon the sound spectrum given in Table 1. The spectrum shape is an average of three typical spectra from transportation sources (aircraft takeoff, freeway, and railroad passby). A study showed that this classification correlated well with the A-weighted and loudness reductions (see ISO 532) calculated for each of the typical spectra for the one-third octave band range of 50 to 5000 Hz. The calculated numeric value of OITC is based on the measured sound transmission loss values for a particular

[1] This classification is under the jurisdiction of ASTM Committee E33 on Environmental Acoustics and is the direct responsibility of Subcommittee E33.03 on Sound Transmission.

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[2] This classification may be used in conjunction with Test Method E 90 or Guide E 966.

[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.

TABLE 1 Reference Source Spectrum

One-third Octave Band Center Frequency	Sound Level, dB
80	103
100	102
125	101
160	98
200	97
250	95
315	94
400	93
500	93
630	91
800	90
1000	89
1250	89
1600	88
2000	88
2500	87
3150	85
4000	84

building facade and depends only on the shape of the reference source spectrum used in the calculation. The values shown in Table 1 have an arbitrary reference level.

4.2 This classification requires sound transmission loss (TL) measurements in one-third octave bands from 80 to 4000 Hz. Due to accuracy limitations given in Test Method E 90 and Guide E 966, measurements below the 100 Hz one-third octave band are not usually reported. Studies have shown that data in the 80 Hz one-third octave band are necessary to obtain acceptable correlations for transportation sound sources. For the purposes of this classification, measurements of sound transmission loss in the 80 Hz one-third octave band from qualified laboratories are deemed to be of acceptable accuracy.

4.3 Users of this classification should recognize that low frequency measurements of sound transmission loss may be affected by the test specimen size or the specimen edge restraints, or both, particularly for small modular specimens such as doors or windows. Consequently, the outdoor-indoor transmission class (OITC) may also be affected by these factors, resulting in some uncertainty of the field performance of assemblies bearing a rating number using this classification, but to what extent is unknown.

5. Basis of Classification

5.1 The outdoor-indoor transmission class (OITC) of a test specimen is calculated using its sound transmission loss in the range 80 to 4000 Hz, as measured in accordance with Test Method E 90 or Guide E 966. These transmission loss data are then used to determine the A-weighted sound level reduction of the specimen for the reference source spectrum specified in Table 1. The OITC is then equal to the calculated A-weighted sound reduction, rounded to the nearest decibel.

5.2 The OITC is calculated from the following:

$$OITC = 100.14 - 10 * \log \sum_f 10^{((L_f - TL_f + A_f)/10)} \text{ dB} \tag{1}$$

where:

L_f = reference source spectrum,
A_f = A-weighting adjustment, and
TL_f = specimen sound transmission loss, at each one-third-octave frequency band.

5.3 Table 2 and Table 3 show a worksheet for calculating OITC. The figures in Column 3 for the A-weighting corrections are taken from ANSI S1.4. A computer program for calculating OITC, written in a common form of BASIC language, is given in Fig. 1.

6. Report

6.1 It is recommended that OITC always be presented together with a graph of the sound transmission loss measurements used for the calculation. The graph should follow the format recommended in Test Method E 90. A bold horizontal line should be drawn across the graph at the OITC level.

6.2 The OITC shall always be accompanied by a statement, if true, that it was calculated in accordance with this classification. This statement shall also include whether Test Method E 90 or Guide E 966 was used to obtain the sound transmission loss data, and the following statement: "This rating is based on an average transportation noise source spectrum and an A-weighted sound level reduction, either of which may be inappropriate for some applications."

7. Precision

7.1 A study[5] of forty two sound attenuating gypsum board wall assemblies compared the calculated A-weighted sound reduction of each assembly, for three sound spectra representing railroad, freeway, and aircraft noise sources over the one-third-octave band center frequency range of 50 to 4000 Hz, to the calculated OITC. The study gave the following statistical data:

Source	Slope, dB	Intercept, dB	Correlation	Standard Deviation, dB
Railroad	0.977	−2.4	0.990	1.2
Freeway	1.088	−2.5	0.981	1.6
Aircraft	1.099	2.8	0.961	2.4

8. Keywords

8.1 A-weighting; aircraft; buildings; classification; facade; freeway; indoor; insulation; isolation; loudness; noise; outdoor-indoor transmission class (OITC); outdoor; railroad; sound; traffic; transmission; transportation

[5] Walker, K. W., "Single Number Ratings for Sound Transmission Loss," *Sound and Vibration*, Vol. 22, July 1988.

TABLE 2 Worksheet for Calculating OITC

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Band Center Frequency, Hz	Reference Sound Spectrum, dB (L_f)	A-weighting Correction, dB (A_f)	Column 2 + Column 3	Specimen TL_f	Column 4 − Column 5
80	103	−22.5	80.5		
100	102	−19.1	82.9		
125	101	−16.1	84.9		
160	98	−13.4	84.6		
200	97	−10.9	86.1		
250	95	−8.6	86.4		
315	94	−6.6	87.4		
400	93	−4.8	88.2		
500	93	−3.2	89.8		
630	91	−1.9	89.1		
800	90	−0.8	89.2		
1000	89	0	89.0		
1250	89	0.6	89.6		
1600	88	1.0	89.0		
2000	88	1.2	89.2		
2500	87	1.3	88.3		
3150	85	1.2	86.2		
4000	84	1.0	85.0		

$$\text{Total Column 4 (dBA)} = 10 \log \sum_f 10^{(\text{Column } 4_f/10)}$$

$$= 100.13 \text{ dB}$$

$$\text{Total Column 6 (dBA)} = 10 \log \sum_f 10^{(\text{Column } 6_f/10)}$$

$$\text{OITC} = 100.13 - (\text{total Column 6})$$

where:

f = each one-third-octave frequency band.

TABLE 3 Sample Worksheet for Calculating OITC

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Band Center Frequency, Hz	Reference Sound Spectrum, dB	A-weighting Correction, dB	Column 2 + Column 3	Specimen TL, dB	Column 4 − Column 5
80	103	−22.5	80.5	26	54.5
100	102	−19.1	82.9	26	56.9
125	101	−16.1	84.9	29	55.9
160	98	−13.4	84.6	29	55.6
200	97	−10.9	86.1	31	55.1
250	95	−8.6	86.4	32	54.4
315	94	−6.6	87.4	32	55.4
400	93	−4.8	88.2	30	58.2
500	93	−3.2	89.8	32	57.8
630	91	−1.9	89.1	36	53.1
800	90	−0.8	89.2	40	49.2
1000	89	0	89.0	44	45.0
1250	89	0.6	89.6	46	43.6
1600	88	1.0	89.0	48	41.0
2000	88	1.2	89.2	49	40.2
2500	87	1.3	88.3	47	41.3
3150	85	1.2	86.2	46	40.2
4000	84	1.0	85.0	50	35.0

$$\text{Total Column 4 (dBA)} = 10 \log \sum_f 10^{(\text{Column } 4_f/10)}$$

$$= 100.13 \text{ dB}$$

$$\text{Total Column 6 (dBA)} = 10 \log \sum_f 10^{(\text{Column } 6_f/10)}$$

$$\text{OITC} = 100.13 - (\text{total Column 6})$$
$$= 100.13 - 66.15$$
$$= 34$$

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10 DIM A(18):A = 100.13:B = 0:rem A = A-weighted Reference
   Source level
20 FOR X = 1 TO 18
30 READ C
40 PRINT "TL AT";C;"HZ";:INPUT A(X):rem A(X) = TL
50 NEXT X
60 FOR X = 1 TO 18
70 READ C
80 A(X) = C-A(X):rem C = A-weighted Reference Source
   Spectrum, A(X) now = A-weighted receive spectrum
90 NEXT X:RESTORE
100 FOR X = 1 TO 18
110 B = B+10^(A(X)/10):rem  add sound levels in the receive
room
120 NEXT X
130 E = 10*LOG(B)/LOG(10):rem E = A-weighted receive level
140 PRINT:PRINT:PRINT "THE OITC IS";INT(A-E+.5)
150 END
160 DATA 80,100,125,160,200,250,315,400,500,630,800
170 DATA 1000,1250,1600,2000,2500,3150,4000
180 DATA 80.5,82.9,84.9,84.6,86.1,86.4,87.4,88.2,89.8
190 DATA 89.1,89.2,89,89.6,89,89.2,88.3,86.2,85
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FIG. 1 Computer Program to Calculate OITC