Designation: E 413 – 87 (Reapproved 1999)

Classification for Rating Sound Insulation[1]

This standard is issued under the fixed designation E 413; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This classification provides methods of calculating single-number acoustical ratings for laboratory and field measurements of sound transmission obtained in one-third octave bands. The method may be applied to laboratory or field measurements of the sound transmission loss of a partition in which case the single-number ratings are called sound transmission class (STC) or field sound transmission class (FSTC), respectively. The method may also be applied to laboratory and field measurements of the sound isolation between two spaces, in which case the single-number ratings are called the noise isolation class (NIC) or normalized noise isolation class (NNIC).

2. Referenced Documents

2.1 *ASTM Standards:*

C 634 Terminology Relating to Environmental Acoustics[2]

E 90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions[2]

E 336 Test Method for Measurement of Airborne Sound Insulation in Buildings[2]

E 596 Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures[2]

2.2 *ISO Standard*

ISO717 Rating of Sound Insulation for Dwellings[3]

3. Terminology

3.1 For definitions of terms used in this classification, see Terminology C 634.

4. Significance and Use

4.1 The procedure may be applied to one-third octave band sound transmission losses of test specimens measured in accordance with Test Method E 90 to derive sound transmission class (STC). It can also be applied to (*1*) similar quantities measured in accordance with Test Method E 336, to derive field sound transmission class (FSTC), noise isolation class (NIC), and normalized noise isolation class (NNIC) and to (*2*) noise reductions measured in accordance with Method E 596 to derive noise isolation class.

4.2 These single-number ratings correlate in a general way with subjective impressions of sound transmission for speech, radio, television, and similar sources of noise in offices and buildings. This classification method is not appropriate for sound sources with spectra significantly different from those sources listed above. Such sources include machinery, industrial processes, bowling allies, power transformers, musical instruments, many music systems and transportation noises such as motor vehicles, aircraft and trains. For these sources, accurate assessment of sound transmission requires a detailed analysis in frequency bands.

4.3 The single-number ratings obtained can be used to compare the potential sound insulation of partitions or floors tested in laboratory conditions or the actual sound isolation between different suites in buildings. The rating for a partition built and tested in a building may be lower than that obtained for a partition tested in a laboratory because of flanking transmission or construction errors.

NOTE 1—A similar rating procedure, described in ISO 717, provides single figure sound insulation ratings with a frequency range that extends from 100 to 3150 Hz and with no maximum deficiency specified at individual frequencies.

5. Procedure

5.1 The reference contour is defined by the array of levels given in Table 1 and shown in Fig. 1.

TABLE 1 Reference Sound Insulation Contour for Calculation of Single-Number Ratings

NOTE 1—Reference sound insulation contour for calculation of single-number ratings. This contour has a rating of zero. Other contours may be derived by adding the same integer simultaneously to all values in the table.

Frequency, Hz	125	160	200	250	315	400	500	630
Level, dB	−16	−13	−10	−7	−4	−1	0	1
Frequency, Hz	800	1000	1250	1600	2000	2500	3150	4000
Level, dB	2	3	4	4	4	4	4	4

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

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

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

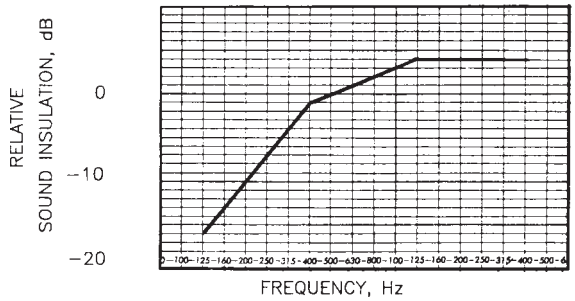

FIG. 1 Reference Contour for Calculating Sound Transmission Class and Other Ratings

5.2 Round the data to which the contour is to be fitted to the nearest integer if this is not already specified in the measurement standard.

5.3 Fit the reference contour to the data by increasing simultaneously all the values in Table 1 in 1 dB increments until some of the measured data are less than the shifted reference contour.

5.4 At each frequency calculate the difference between the shifted reference value and the measured data. Only deficiencies, that is, where the measured data are less than the reference contour, are counted in the fitting procedure. Continue to increase the reference contour values until the most stringent of the following conditions is satisfied:

5.4.1 The sum of the deficiencies is less than or equal to 32 dB;

5.4.2 The maximum deficiency at any one frequency does not exceed 8 dB.

5.5 The STC, FSTC, NIC, or NNIC rating is given by the value of the shifted reference contour at 500 Hz.

NOTE 2—This fitting procedure can be done numerically or graphically. One graphical technique involves placing a transparent overlay of the reference contour over a graph of measured data to the same scale, adjusting initially by trial and error, then making finer adjustments until the criteria are satisfied.

6. Presentation of Results

6.1 It is recommended that the data be plotted to the scale sizes recommended in Note 3, along with the shifted reference contour (see Fig. 2). This type of presentation draws attention to the frequency regions of the measured data that limit the single-number rating.

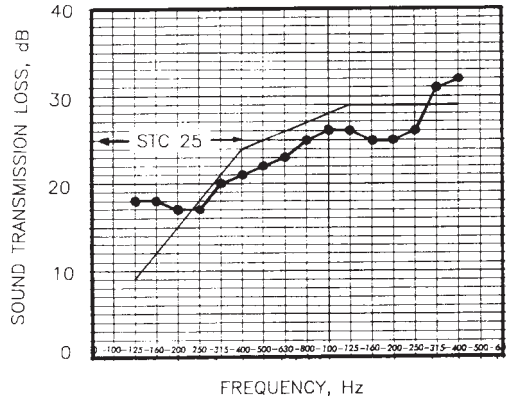

FIG. 2 Example of Reference Contour Fitted to Transmission Loss Data (STC 25)

NOTE 3—Recommended graph scale sizes are 2 mm/dB for the ordinate and 50 mm per 10 to 1 frequency ratio for the logarithmic abscissa. The ordinate scale should start at 0 dB. If larger or smaller scale sizes are unavoidable, the same aspect ratio of 25 dB per 10 to 1 frequency ratio should be retained.

7. Keywords

7.1 architectural acoustics; building design; field sound transmission class (FSTC); noise isolation class (NIC); normalized noise isolation class (NNIC); sound insulation rating; sound transmission class (STC); partitions (buildings)

APPENDIX

(Nonmandatory Information)

X1. METHODS OF CALCULATING STC

X1.1 *Calculating STC Using a Worksheet:*

NOTE X1.1—Although X1.1 and X1.2 describe calculation of sound transmission class from sound transmission loss data, the method is equally suitable for calculating the other single-number ratings mentioned in the standard.

X1.1.1 The STC may be calculated numerically using the worksheet at the end of this section. The procedure is as follows:

X1.1.2 Write the transmission loss for each one-third octave center frequency from 125 through 4000 Hz in the column labelled "TL" on the worksheet.

X1.1.3 For each frequency add the number in the "Adjustment" column algebraically to the TL and write the result in the "Adjusted TL" column.

X1.1.4 Draw a circle around the lowest adjusted TL. Add eight to the circled number to get the first trial STC. Write this trial STC at the top of the first column under "Trial STCs and deficiencies."

X1.1.5 For each frequency subtract the adjusted TL from the current trial STC. If this number is positive, write it under the trial STC opposite the frequency; otherwise leave a blank.

X1.1.6 Add the deficiencies for the trial STC. Write the sum at the bottom of the column.

X1.1.7 If the sum of the deficiencies is 32 or less, the trial STC is the true STC, and the calculation is complete.

X1.1.8 If the sum of the deficiencies is greater than 32, subtract one from the current trial STC to get a new trial STC. Write the new trial STC at the top of the next column. (This can be done after each subtraction in X1.1.5.)

X1.1.9 Repeat X1.1.5-X1.1.8 until the correct STC is found.

X1.2 *Calculating STC Using a Computer Program:*

X1.2.1 The BASIC program shown in Fig. X1.1 can be used as a subroutine in other programs and altered as necessary to calculate single-number ratings based on the reference contour.

NOTE X1.2—See Note X1.1.

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00010 rem      Routine to calculate STC, FSTC, NIC or NNIC
00020 rem      The data values are in array TL.
00030 rem      Differences between data and reference contour
00040 rem      are in the array DIFFERENCE
00050 rem      The reference contour is read into STC_CONT.
00060 rem
00100 for BAND=21 to 36   ! Band numbers corresponding to 125 and 4000 Hz
00120   read STC_CONT(BAND)              ! GET REFERENCE STC 0 CONTOUR
00130 next BAND
00140 data -16,-13,-10,-7,-4,-1,0,1,2,3,4,4,4,4,4,4
00150 rem
00155 rem    To reduce computation time, first increase the estimated STC
00160 rem    so that at 125 hertz the reference contour is 8 dB above the
00165 rem    data at this frequency.  The trial STC value is a further
00170 rem    16 dB above this contour value.  The program then lowers the
00175 rem    reference contour until the criteria are satisfied.
00185 rem
00190 let STC=INT(TL(21)+.5+16+8) ! STC eventually becomes the correct value
00200 SUM=0  ! for sum of deficiencies
00210 for BAND=21 to 36
00240   let DIFFERENCE(BAND)=STC_CONT(BAND)+STC-INT(TL(BAND)+.5)
00250      rem 8 dB rule - no deficiency greater than 8 dB
00260   if DIFFERENCE(BAND)>8 then STC=STC-1:GO TO 200
00270      rem Count only deficiencies i.e. data below contour
00360   if DIFFERENCE(BAND)>0 then let SUM=SUM+DIFFERENCE(BAND)
00370      rem sum of deficiencies must not be greater than 32 dB
00380   if SUM>32 then STC=STC-1:GO TO 200
00480 next BAND
00490 rem
00500 rem      After exit from the routine, STC is the correct value of
00520 rem      STC, NIC, FSTC or NNIC as appropriate
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FIG. X1.1 BASIC Computer Program to Calculate Single-Number Ratings

TABLE X1.1 Worksheet for Calculating STC and Similar Ratings

Frequency	TL	Adjustment	Adjusted TL	Trial STCs and Deficiencies				
				29	28	27	26	25
125	18	16	34	...	...	...	...	...
160	18	13	31	...	...	...	...	...
200	17	10	27	2	1	...	...	...
250	17	7	24	5	4	3	2	1
315	20	4	24	5	4	3	2	1
400	21	1	22	7	6	5	4	3
500	22	0	22	7	6	5	4	3
630	23	−1	22	7	6	5	4	3
800	25	−2	23		5	4	3	2
1000	26	−3	23			4	3	2
1250	26	−4	22			5	4	3
1600	25	−4	21				5	4
2000	25	−4	21				5	4
2500	26	−4	22					3
3150	30	−4	26					
4000	31	−4	27					
		Sum of deficiencies:		>32	>32	>32	>32	29