ASTM INTERNATIONAL

Designation: E3222 – 20a

Standard Classification for
Determination of High-frequency Impact Sound Ratings[1]

1. Scope

1.1 This classification provides methods for calculating single-number ratings of high-frequency impact sound transmission, based on one-third-octave-band impact sound pressure levels generated by the standard tapping machine as described in Test Methods E492, E1007, and E2179.

1.2 This classification defines ratings that are not defined in other standards. Within their purview, other standards shall define additional ratings based on the methods of this classification.

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

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C634 Terminology Relating to Building and Environmental Acoustics

E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

E989 Classification for Determination of Single-Number Metrics for Impact Noise

E1007 Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

E2179 Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors

3. Terminology

3.1 The following terms used in this classification have specific meaning that are defined in Terminology C634: average sound pressure level; decibel; flanking transmission; impact insulation class; level; octave band; sound insulation; sound isolation; sound pressure; sound pressure level.

3.2 The following terms used in this classification have specific meaning that are defined in Test Method E1007: absorption normalized impact sound pressure level, ANISPL; apparent impact insulation class, AIIC; impact sound pressure level, ISPL; impact sound rating, ISR; normalized impact sound rating, NISR; receiving room; reverberation time normalized impact sound pressure level, RTNISPL.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *absorption-normalized high-frequency impact rating, AHIR, n*—the single-number rating calculated in accordance with this classification using the absorption normalized impact sound pressure levels measured in a building, as described in Test Method E1007.

3.3.1.1 *Discussion*—This rating is the high-frequency analog of the apparent impact insulation class (AIIC).

3.3.2 *high-frequency impact insulation class, HIIC, n*—of a floor-ceiling assembly installed in a laboratory, the single-number rating calculated in accordance with this classification using the normalized impact sound pressure levels as described in Test Method E492.

3.3.2.1 *Discussion*—This rating is the high-frequency analog of the impact insulation class (IIC).

3.3.3 *high-frequency impact rating, HIR, n*—the single-number rating calculated in accordance with this classification using the non-normalized impact sound pressure levels measured in a building, as described in Test Method E1007.

3.3.3.1 *Discussion*—This rating is the high-frequency analog of impact sound rating (ISR).[3]

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[3] LoVerde, J.J. and Dong, W.D., "A dual-rating method for evaluating impact noise isolation of floor-ceiling assemblies," *Journal of the Acoustical Society of America*, Vol. 141, 2017, pp. 428-440.

3.3.4 *improvement in high-frequency impact insulation class, ΔHIIC, n*—the improvement in HIIC due to floor coverings, as described in Test Method E2179 except calculated with HIIC instead of IIC.

3.3.4.1 *Discussion*—This rating is the high-frequency analog of ΔIIC.[4]

3.3.5 *normalized high-frequency impact rating, NHIR, n*—the single-number rating calculated in accordance with this classification using the reverberation time normalized impact sound pressure levels measured in a building, as described in Test Method E1007.

3.3.5.1 *Discussion*—This rating is the high-frequency analog of normalized impact sound rating (NISR).

4. Significance and Use

4.1 This classification provides a family of single-number ratings for describing high-frequency impact sound insulation. "High-frequency" in this context refers to the third-octave bands from 400 to 3150 Hz, which is approximately the upper half of the frequency range of interest in building acoustics measurements. Common sources of high-frequency impact sound include the impact of hard-heeled shoes, dragging furniture, dog toenails, and dropping objects on hard-surfaced flooring.

4.2 The high-frequency impact sound insulation of an assembly is primarily determined by the characteristics of the floor topping, largely independent of the other details of the assembly.[3] For many assemblies, the existing ratings (such as IIC) become controlled by frequency bands below 400 Hz. For these assemblies, the existing ratings are not representative of the impact insulation at high frequencies. The high-frequency ratings defined here have been shown to accurately represent the behavior of assemblies at high frequencies.[4,5] These ratings are intended to aid the acoustical professional in evaluating the high-frequency insulation of an assembly, and in evaluating, rank-ordering, and specifying floor topping products that will affect the level of high-frequency impact sound.

4.3 The ratings in this classification have similar numerical range and behavior as the existing ratings of Classification E989. Further, the ratings in this classification can be calculated from existing test reports without additional testing. This was done to take advantage of the existing test results and body of knowledge.

4.4 This classification describes only the high-frequency range of impact sound and no other aspects of impact noise. It does not address impact sound below 400 Hz, such as thudding from footfalls, and additional ratings are required to describe impact sound in these frequency ranges. This classification does not replace Classification E989 (Impact Insulation Class)

and is not interchangeable with it. For example, the HIIC rating of an assembly does not determine its IIC rating and cannot be used to show compliance with an IIC requirement. The expectation is that the high-frequency ratings would be reported alongside the existing ratings.

4.5 The family of ratings described use the same calculation method and differ only in the origin of the third-octave data used in the calculation. There is a high-frequency version of each existing impact rating, in which this classification is used instead of Classification E989 to calculate the single-number rating.

5. Basis of Classification

5.1 This classification applies only to excitation by the standard tapping machine defined in Test Methods E492 and E1007 and shall not be used with any other impact source.

5.2 This classification shall only be used with one-third-octave-band data.

5.3 This procedure applies to the calculation of HIR, NHIR, AHIR, HIIC and ΔHIIC.

5.4 Table 1 lists the sound pressure levels defining the shape of the reference contour, C(f), for the ten one-third-octave bands from 400 to 3150 Hz.

5.5 The impact sound pressure levels, L(f), where f refers to the one-third-octave-band center frequency, are rounded to the nearest 0.1 decibel (dB).

5.6 A deficiency is the difference between the measured level and the reference contour. Only unfavorable (non-negative) deficiencies, where the measured level is higher than the reference contour, are counted. Increase the reference contour in increments of 1 dB until the sum of unfavorable deficiencies is as large as possible but less than or equal to 20.0.

5.7 The rating is given by 110 minus the value of the fitted reference curve at 500 Hz.

6. Keywords

6.1 floors; high-frequency impact noise; impact noise; high-frequency impact insulation class; high-frequency impact rating; normalized high-frequency impact rating; HIIC; HIR; AHIR; NHIR; ΔHIIC; tapping machine

**TABLE 1 Reference High-frequency Impact Rating Contour Values**

One-Third-Octave-Band Center Frequency, Hz	Contour value, dB
400	1
500	0
630	−1
800	−2
1000	−3
1250	−6
1600	−9
2000	−12
2500	−15
3150	−18

[4] LoVerde, J. and Dong, W.,"Development of a rating for evaluating the improvement of high-frequency impact isolation," *24th International Congress on Sound and Vibration, Paper 720*, 2017, pp. 1-7.

[5] LoVerde, J. and Dong, W.,"Developing classifications using a dual-rating method of evaluating impact noise," Proceedings of *INTER-NOISE 2018*, 2018.

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE CALCULATION

X1.1 Fig. X1.1 shows an example of the reference contour fitted to an array of impact sound pressure level data. Table X1.1 shows the same data.
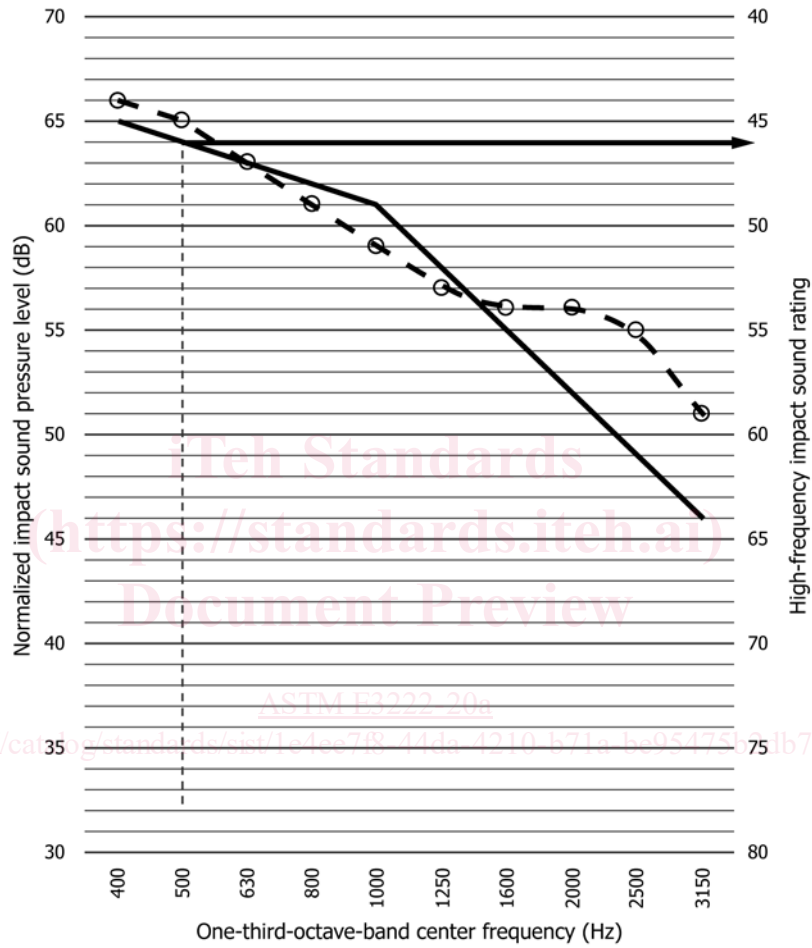
NOTE 1—One-third-octave-band impact sound pressure level spectrum (dashed line with open circles) with a high-frequency rating of 46. The positive differences are graphed as bars at the bottom; their sum is 19.7. The solid line is the fitted contour.

FIG. X1.1 Example Calculation