18.1 SOUND TRANSMISSION

Sound transmission deals with the science of managing sound transmission levels between living areas. Noise control is an issue whether the sound originates from within or outside the structure. Sound transmission within a structure has been of greater concern in multi-family and commercial building applications than in one- and two-family dwellings. However, sensitivity to "sound pollution" has grown to be a topic of general concern. The minimum Sound Transmission Class (STC) and Impact Insulation Class (IIC) ratings of 45/50 established by most codes for partition and floor assemblies often prove insufficient for many occupants. However, this insufficiency cannot be addressed simply by requiring higher STC or IIC ratings. Most often, the failure of the assemblies to perform as expected is related either to the manner in which the individual assemblies are connected or to poor construction practices. Both allow noise to flank the assemblies.

The following list includes some of the ASTM Sound Standards:

E90-99 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E336-97 Standard Test Method for Measurement of Airborne Sound Insulation in Buildings

E413-87 (1999) Standard Classification for Rating Sound Insulation

E492-90 (1996) Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

E497-99 Standard Practice for Installing Sound-Isolating Lightweight Partitions

E596-96 (2002) Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures

E989-89 (1999) Standard Classification for Determination of Impact Installation Class (IIC)

E1007-97 Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures

E1264-98 Standard Classification for Acoustical Ceiling Products

E1289-97 Standard Specification for Reference Specimen for Sound Transmission Loss

E1414-00a Standard Test Method for Airborne Sound Attenuation Between Room Sharing a Common Ceiling Plenum

E1574-98 Standard Test Method for Measurement of Sound in Residential Spaces

For additional information on Standards, contact ASTM at www.astm.org.

The Southern Pine Council (www.southernpine.com), APA-The Engineered Wood Association (www.apawood.org), the North American Insulation Manufacturers Association (www.naima.org), the Gypsum Association (www.gypsum.org), as well as manufacturers of proprietary sound control products, all include information on STC and IIC ratings and detail how to use their products to control sound transmission.

Knowledge of how the sound and impact ratings are tested or calculated is necessary before installation and application issues can be discussed. Kirk Grundahl, P.E., Qualtim, Inc., wrote the following, which originally appeared in the *Southern Pine Joists & Rafters* brochure produced on behalf of the Southern Pine Marketing Council.

STC Rating	Privacy Afforded
25	Normal speech easily understood
30	Normal speech audible, but not intelligible
35	Loud speech audible and fairly understandable
40	Loud speech barely audible, but not intelligible
45	Loud speech barely audible
50	Shouting barely audible
55	Shouting inaudible

Table 18.1.1 Privacy afforded according to the STC rating.

Description	STC High Frequency	IIC Low Frequency
Basic wood floor - consisting of wood joist (I-joist, solid-sawn or Truss) 3/4" decking and 5/8" gypsum wallboard directly attached to ceiling	36	33
Cushioned vinyl or linoleum	0	2
Non-cushioned vinyl or linoleum	0	0
1/2" parquet flooring	0	1
3/4" Gypcrete® or Elastizel®	7-8	1
1 1/2" lt. wt. concrete	7-8	1
1/2" Sound Deadening Board (USG)[3]	1	5
Quiet-Cor® underlayment by Tarkett, Inc.[3]	1	8
Enkasonic® by American Enka Company[3]	4	13
Sempafloor® by Laminating Services, Inc.[3]	1	11
R-19 batt insulation	2	0
R-11 batt insulation	1	0
3" mineral wool insulation	1	0
Resilient channel	10	8
Resilient with insulation	13	15
Extra layer of 5/8" gypsum wallboard	0-2	2-4
Carpet & padding	0	20-25

Table 18.1.2 Contribution of various products to STC and IIC ratings.

Description	STC	IIC
Carpet & Pad	0	20
3/4" Gypcrete®	7	1
Wood I-joist Floor	36	33
Resilient Channel	10	8
Total	***53***	***62***

Table 18.1.3. Example calculation.

Sound transmission ratings are closely aligned with fire endurance ratings for assemblies. This is due to the fact that flame and sound penetrations follow similar paths of least resistance.

Sound striking a wall or ceiling surface is transmitted through the air in the wall or ceiling cavity. It then strikes the opposite wall surface, causing it to vibrate and transmit the sound into the adjoining room. Sound also is transmitted through any openings into the room, such as air ducts, electrical outlets, window openings, and doors. This is airborne sound transmission. The Sound Transmission Class (STC) method of rating airborne sounds evaluates the comfort ability of a particular living space. The higher the STC, the better the airborne noise control performance of the structure. An STC of 50 or above is generally considered a good airborne noise control rating. Table 18.1.1 describes the privacy afforded according to the STC rating.

Impact Sound Transmission is produced when a structural element is set into vibration by direct impact – someone walking, for example. The vibrating surface generates sound waves on both sides of the element. The impact Insulation Class (IIC) is a method of rating the impact sound transmission performance of an assembly. The higher the IIC, the better the impact noise control of the element. An IIC of 55 is generally considered a good impact noise control.

Estimated Wood Floor Sound Performance[1,2]

Sound transmission and impact insulation characteristics of a floor assembly can be calculated in a manner similar to fire calculations — by adding up the value of the individual components. The contributions of various products to an STC or IIC rating are shown in Table 18.1.2. An example calculation is given in Table 18.1.3.

1. Yerges, Lyle F., Sound, Noise and Vibration Control, 1978.

2. Catalog of STC and IIC Ratings for Wall and Floor/Ceiling Assemblies, California Dept. of Health Services, Office of Noise Control, Berkley, CA.

3. Estimates based on proprietary literature. Verify with individual companies.

Tables 18.1.4 & 18.1.5 are excerpted from the Appendix of ANSI/TPI 1-1995. They document specifically tested assemblies with various floor coverings.

Tables 18.1.4 & 5 Taken from Appendix E of Commentary and Appendices to ANSI/TPI 1- 1995.

STC & IIC RATINGS FOR UL L528/L529			
FLOOR COVERING	STC	IIC	TEST NUMBER
Carpet & Pad	48	56	NRC 1039 & 1040
Vinyl	45	37	NRC 1041 & 1042
Lightweight Concrete, Carpet & Pad	57	72	NRC 1044 & 1045
Lightweight Concrete and Vinyl	57	50	NRC 1047 & 1048
Gypcrete & Cushioned Vinyl®	--	53	6-442-2 Gypcrete
Gypcrete, Carpet & Pad®	--	74	6-442-3 Gypcrete
	58	--	6-442-5 Gypcrete

Table 18.1.4 Courtesy of TPI.

STC & IIC RATINGS FOR FC-214			
FLOOR COVERING	STC	IIC	TEST NUMBER
Carpet & Pad	48	54	NRC 1059 & 1060
Vinyl	47	35	NRC 1063 & 1064
Lightweight Concrete, Carpet & Pad	56	72	NRC 1053 & 1054
Lightweight Concrete and Vinyl	56	48	NRC 1051 & 1052
Gypcrete, Carpet & Pad®	52	63	NRC 1076 & 1077
Gypcrete®	53	43	NRC 1085 & 1086

Table 18.1.5 Courtesy of TPI.

Description of Materials:

Gypcrete®	3/4"
Lightweight Concrete	1"
Carpet	2.63 kg/m^2
Pad	1.37 kg/m^2

18.2 SOUND TRANSMISSION REDUCTION

The best designs for sound transmission can be deflected by poor installation practices. Assemblies with an STC or IIC rating of 50 are often compromised by inadequate attention to flanking paths. Flanking paths are those paths sound takes through connected structural components, especially at the intersections of walls and floors. It is even possible that the object flanking the noise can amplify noise. A practice as simple as running the subfloor continuously under a rated partition wall can reduce the STC rating by as much as two points. Some of the required fireblocking techniques actually reduce the effectiveness of sound containment. However, fire protection concerns need to take precedence over sound control.

Some methods to reduce sound transmission include:

- Use sound rated assemblies and design/install them with attention to how they inter-relate.
- Include resilient channel in the assembly. There is perhaps no greater single sound reduction gain than from the proper use of resilient channel.
- Reduce the effects of noise that bypass the sound control: heating ducts that are not properly isolated, electrical boxes and plumbing outlets in the same stud or joist spaces, and open joist spaces that continue over partitions.
- Use acoustical caulk. It can close spaces that sound can be transmitted through as well as serve to dampen the sound transmitted from one surface to another. A one-inch square opening can reduce an effective STC rating by as much as two points.
- Increase the mass of the system though the use of products like lightweight concrete on floors and include or add layers of gypsum board on ceilings. These, however, should not be undertaken as remedial methods if the supporting system was not designed to carry the additional loads.
- Avoiding construction continuity, which breaks the vibration path by staggering studs in walls and joists in floors to avoid transmission through the material.
- Break the vibration path by avoiding construction that connects piping or duct work directly to structural framing.
- Include sound mat material in the assembly per the manufacturer's recommendation.
- Include cavity sound insulation, especially where the vibration path has been broken. Note that thickness of insulation has a greater effect than its density. Also note that insulation designed for heat flow resistance is not the same as insulation designed for sound transmission resistance.