Specified Technologies Inc.

Restoring STC Through Proper Firestopping

Learning Objectives

- Learn the basics of sound physics and how sound travels.
- Understand how sound transmission loss is tested and how it is converted to STC and other single number ratings
- Know what STC means, and more importantly, what it does not mean
- Understanding the key component leading to sound transmission and how proper application of materials helps to mitigate sound travel.
- Evaluate the effectiveness of various firestopping materials and applications in addressing fire containment and sound transmission requirements.

Introduction

- Know your enemy, and know yourself
- What is sound?
- Frequency and Amplitude
- Direct vs. Indirect Paths
- Testing for Sound Transmission Loss and Sound Transmission Class (STC)
- Loudness and the decibel
- Where there is smoke, there is sound
- Construction methods to improve STC

Know your enemy, know yourself

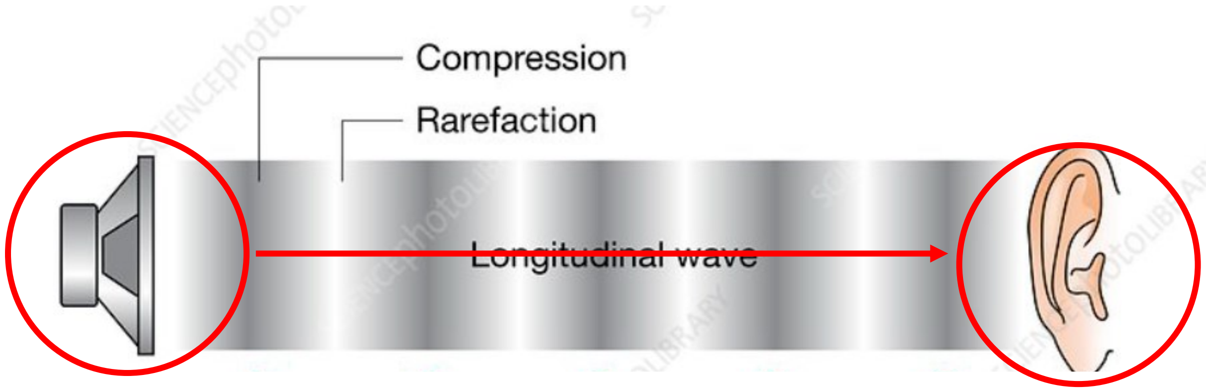
The Enemy	The Damage	The Weapon	The Win

Philosphical Question

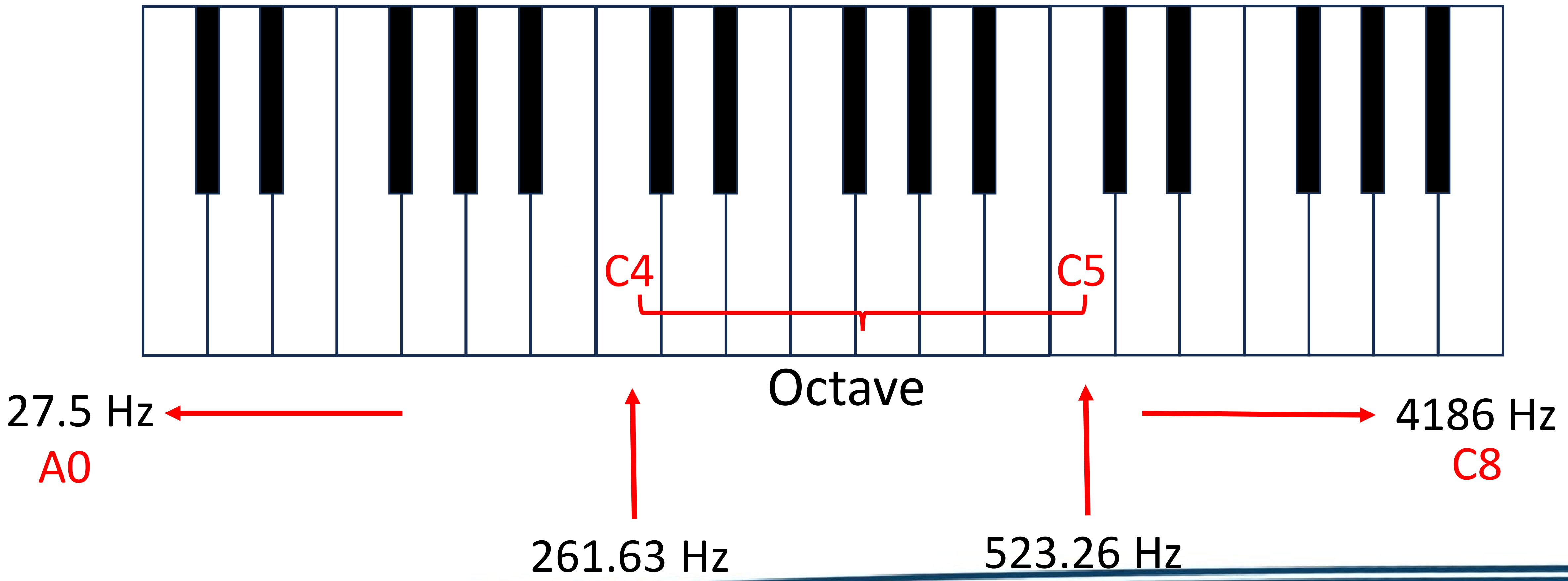
- When a tree falls in the woods and nobody is there to hear it, does it make a sound?

What is sound?

- A series of pressure pulses that travel as a wave through a medium.
- Difference between sound and noise
- Longitudinal vs. Transverse
- Amplitude (dB)
- Frequency (Hz)
- Vibrating source creates the pulse waves.
- Ears and microphones hear them

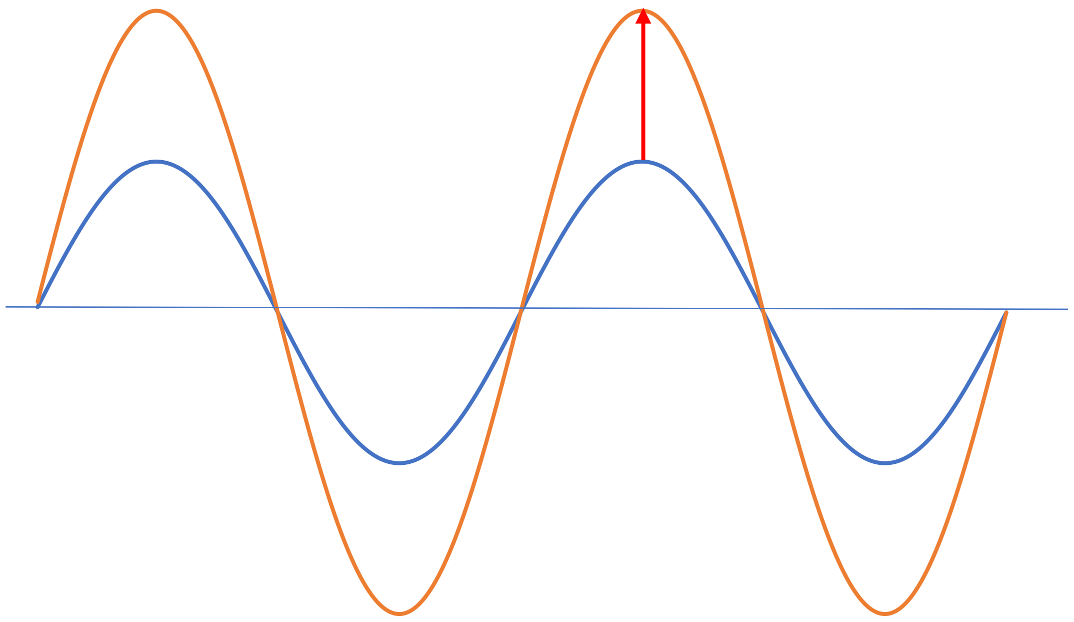


Frequency – Practical Example

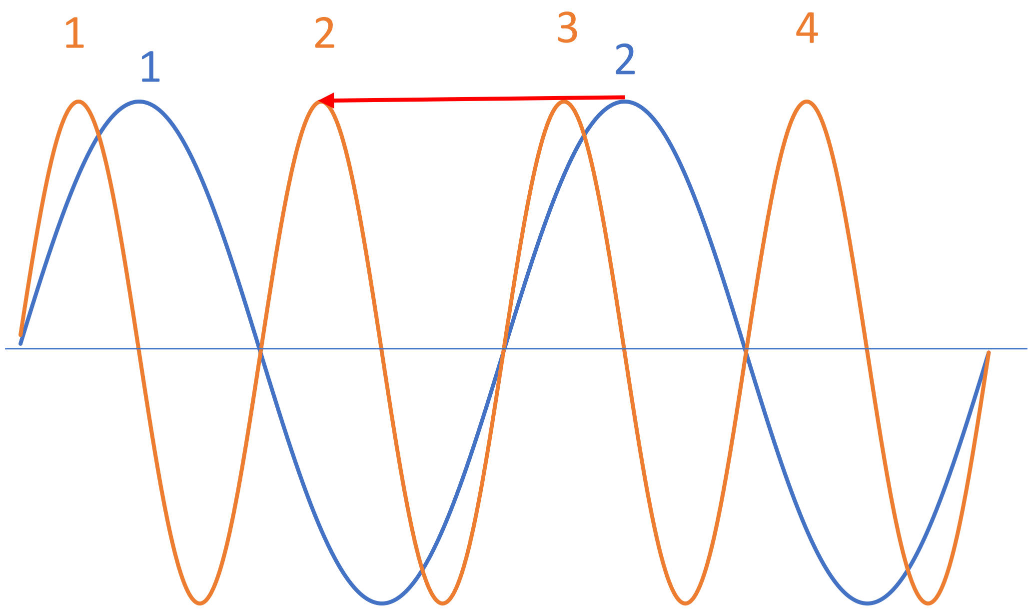


Amplitude and Frequency

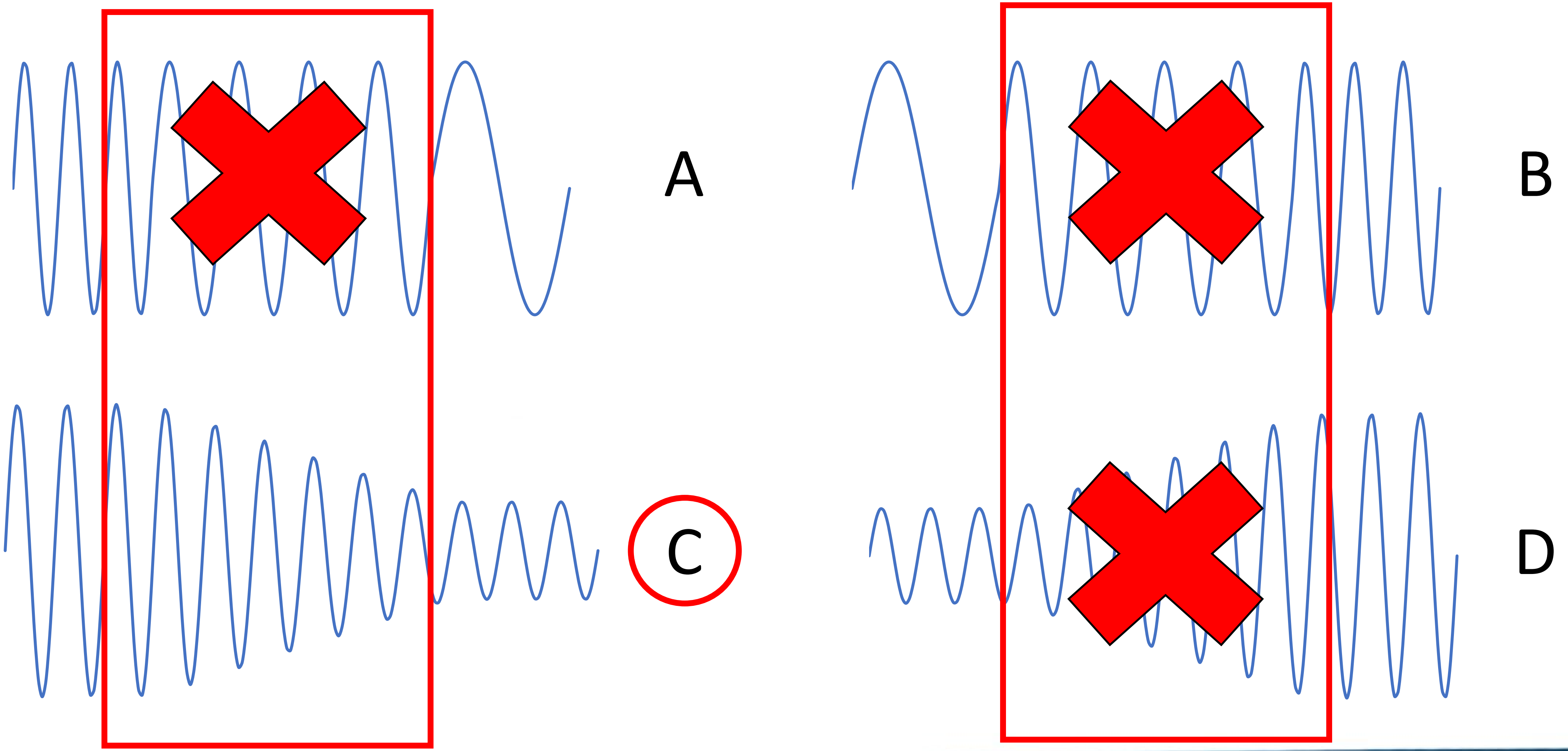
Amplitude and Volume



Frequency and Pitch

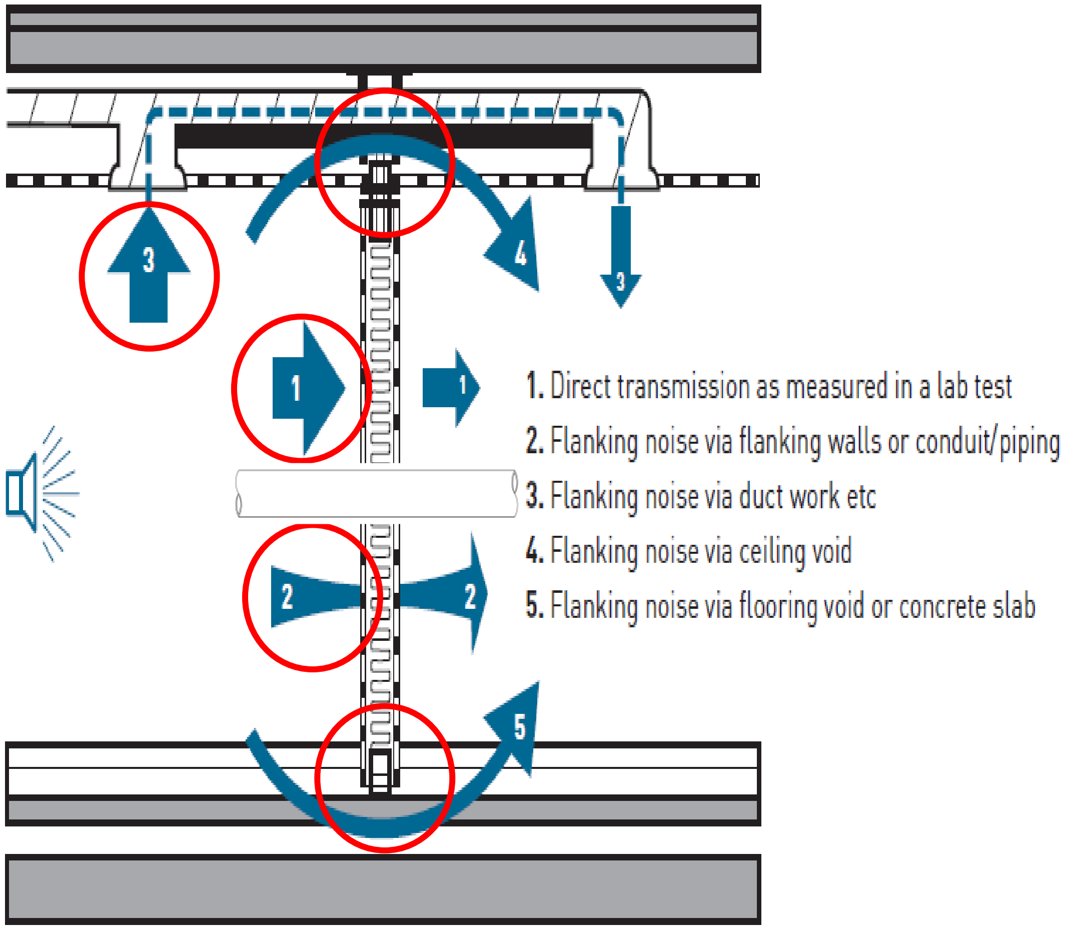


A little quiz



Direct path vs Indirect path

- Two paths for sound transmission
- Direct Path – Enters an adjacent room directly through a barrier.
- Indirect Path – Also called flanking path, enters an adjacent room through peripheral means.
  - Structural
  - Non Structural



Measuring the noise

- Over 1000 ASTM standards related to sound in some way
- 53 ASTM standards relevant to Building and Environmental Acoustics
- 2 ASTM standards are used to measure and identify STC.
- Laboratory Measurement
- Airborne Sound Transmission

Designation: E90 – 09 (Reapproved 2016)

Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements[1]

This standard is issued under the fixed designation E90; 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 U.S. Department of Defense.

INTRODUCTION

This test method is part of a set for evaluating the sound-insulating properties of building elements. It is designed to measure the transmission of sound through a partition or partition element in a laboratory. Others in the set cover the measurement of sound isolation in buildings (Test Method E336), the laboratory measurement of impact sound transmission through floors (Test Method E492), the measurement of impact sound transmission in buildings (Test Method E1007), the measurement of sound transmission through building facades and facade elements (Guide E966), the measurement of sound transmission through a common plenum between two rooms (Test Method E1414), a quick method for the determination of airborne sound isolation in multiunit buildings (Practice E597), and the measurement of sound transmission through door panels and systems (Test Method E1425).

1. Scope

1.1 This test method covers the laboratory measurement of airborne sound transmission loss of building partitions such as walls of all kinds, operable partitions, floor-ceiling assemblies, doors, windows, roofs, panels, and other space-dividing elements.

1.2 Laboratories are designed so the test specimen constitutes the primary sound transmission path between the two test rooms and so approximately diffuse sound fields exist in the rooms.

1.3 *Laboratory Accreditation*—The requirements for accrediting a laboratory for performing this test method are given in Annex A4.

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:*[2]

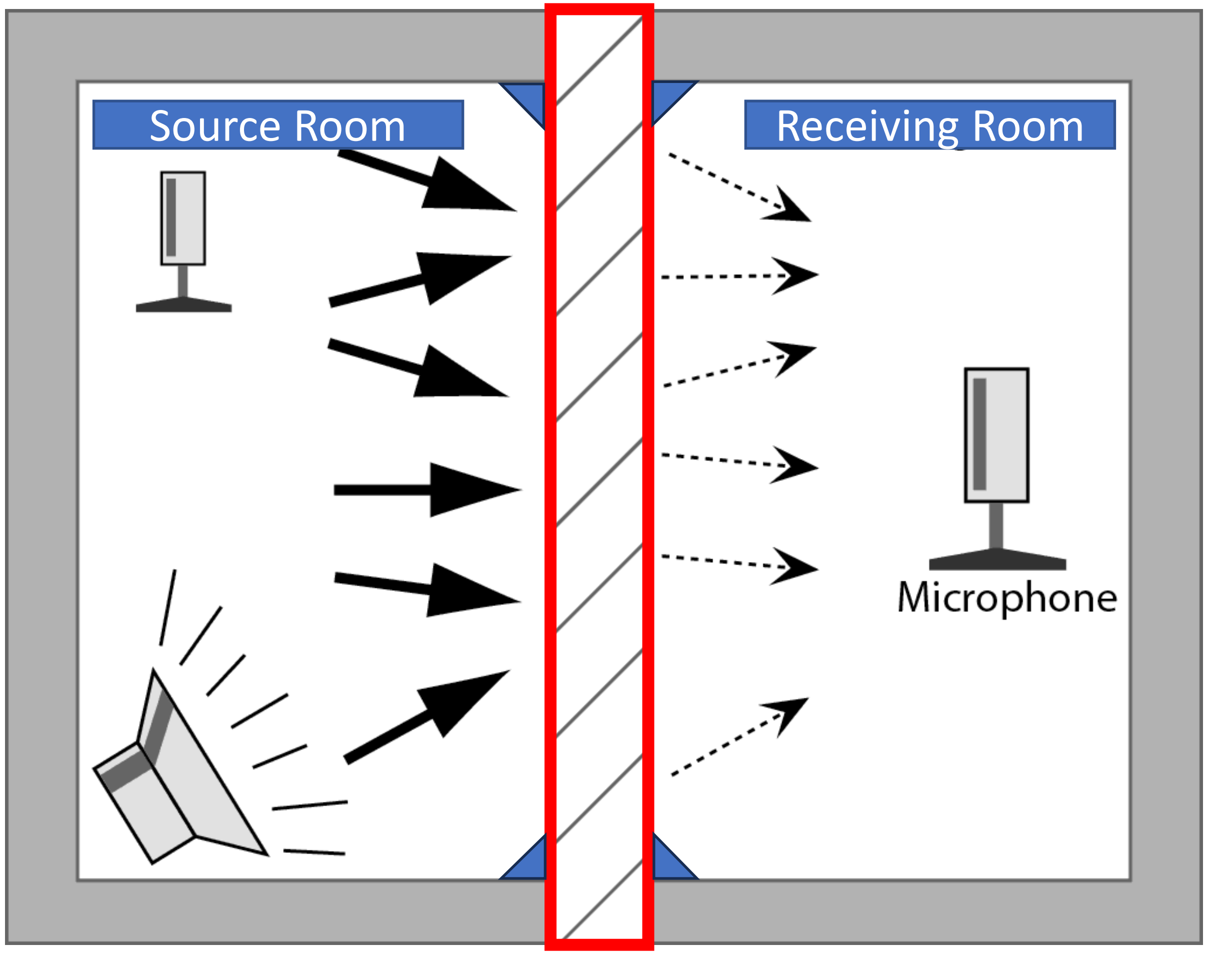
C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
C634 Terminology Relating to Building and Environmental Acoustics
E336 Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
E413 Classification for Rating Sound Insulation
E492 Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
E966 Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements
E1007 Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures
E1111 Test Method for Measuring the Interzone Attenuation of Open Office Components
E1289 Specification for Reference Specimen for Sound Transmission Loss
E1332 Classification for Rating Outdoor-Indoor Sound Attenuation

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

Current edition approved Dec. 1, 2016. Published January 2017. Originally approved in 1955. Last previous edition approved in 2009 as E90 – 09. DOI: 10.1520/E0090-09R16.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Sound Transmission Coefficient (STC) Ratings



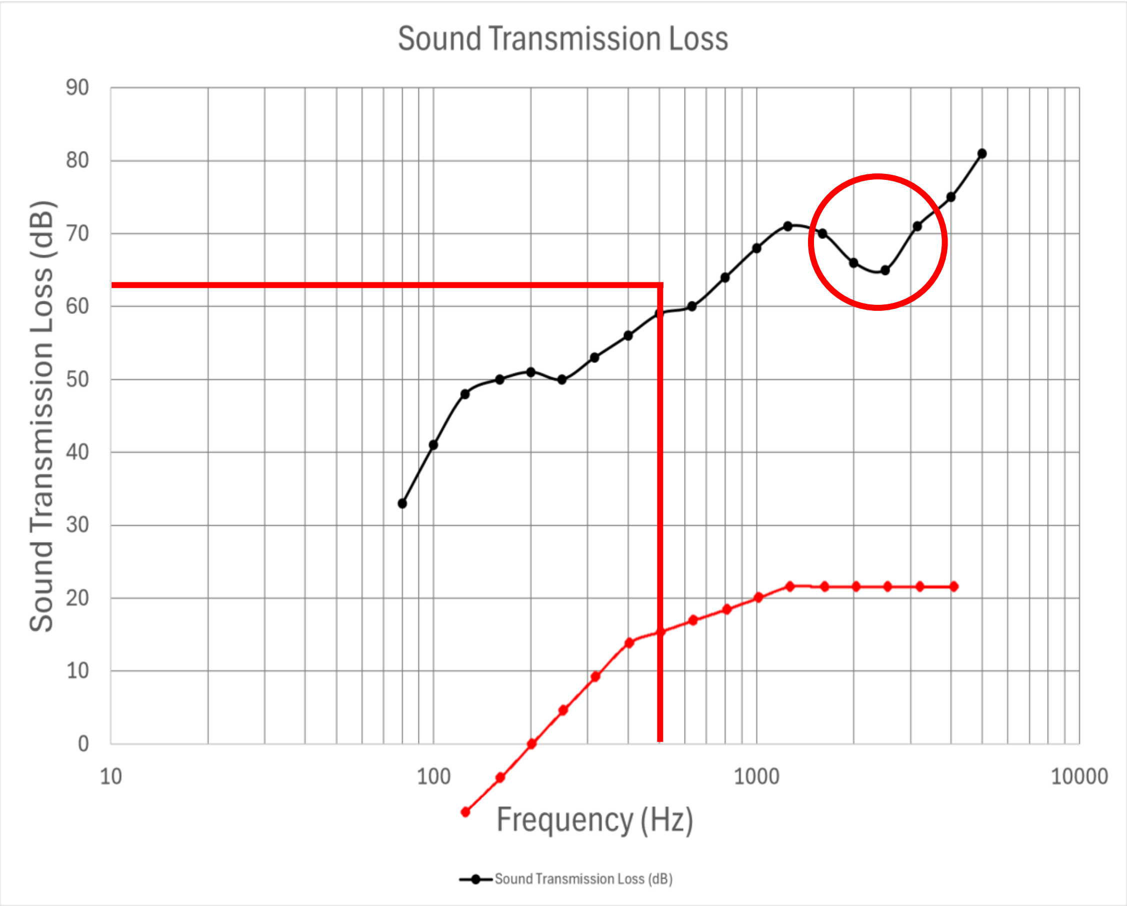
Why Pink Noise and not White Noise?

- White and Pink noise consist of a multitude of frequencies within a specified range that are played simultaneously.
- White noise is produced when the energy level is the same at every frequency.
- Pink noise is produced when the collective energy level across each octave is the same.
- Pink noise is said to have calming effects, similar to a rainstorm.
- Pink noise represents the sound energy most close to that of human perception.

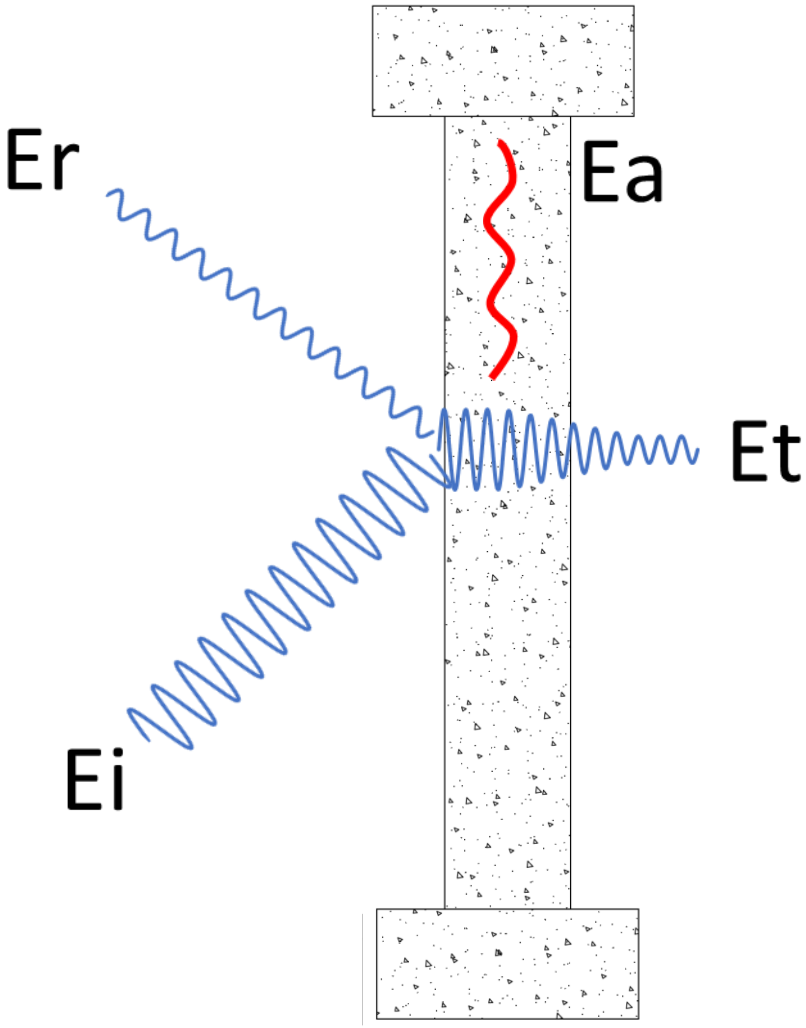
The testing path to an STC

- Begins with testing for Sound Transmission Loss (STL) using ASTM E90
- Each incremental frequency is evaluated as a change in dB from the source to the receiving room
- Data is converted to STC using ASTM E413
- Can be field tested as well, producing Normalized Noise Isolation Class (NNIC) using ASTM E336

Impact Insulation Class
Noise Isolation Class
Noise Reduction Coefficient
Normalized Noise Isolation Class
Sound Absorption Average
Sound Transmission Class
Absorption Normalized High Frequency Impact I
Apparent Impact Insulation Class
Apparent Outdoor-Indoor Transmission Class
Apparent Sound Transmission Class
Ceiling Attenuation Class
Door Transmission Class
Field Outdoor-Indoor Transmission Class
High Frequency Impact Rating Class
High Frequency Impact Rating
Impact Sound Rating
Normalized Impact Sound Rating
Normalized Noise Isolation Class
Outdoor-Indoor Noise Isolation Class
Outdoor-Indoor Transmission Class

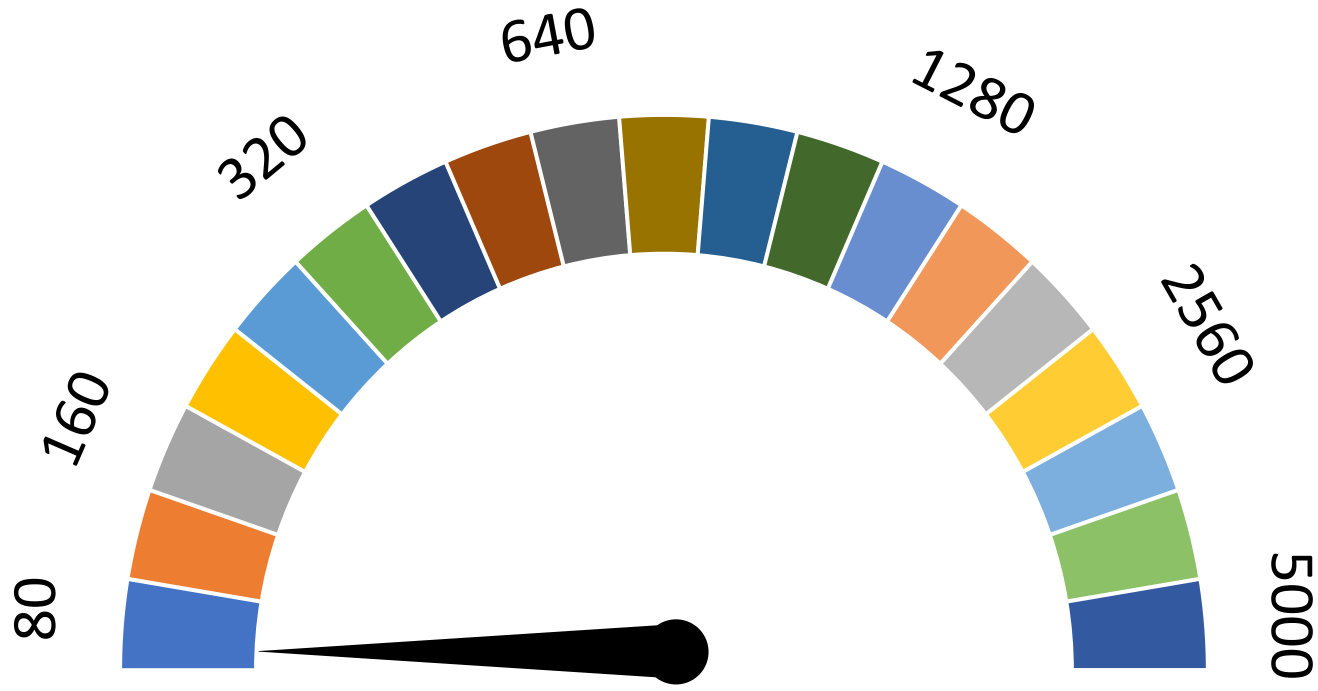


Energy Balance



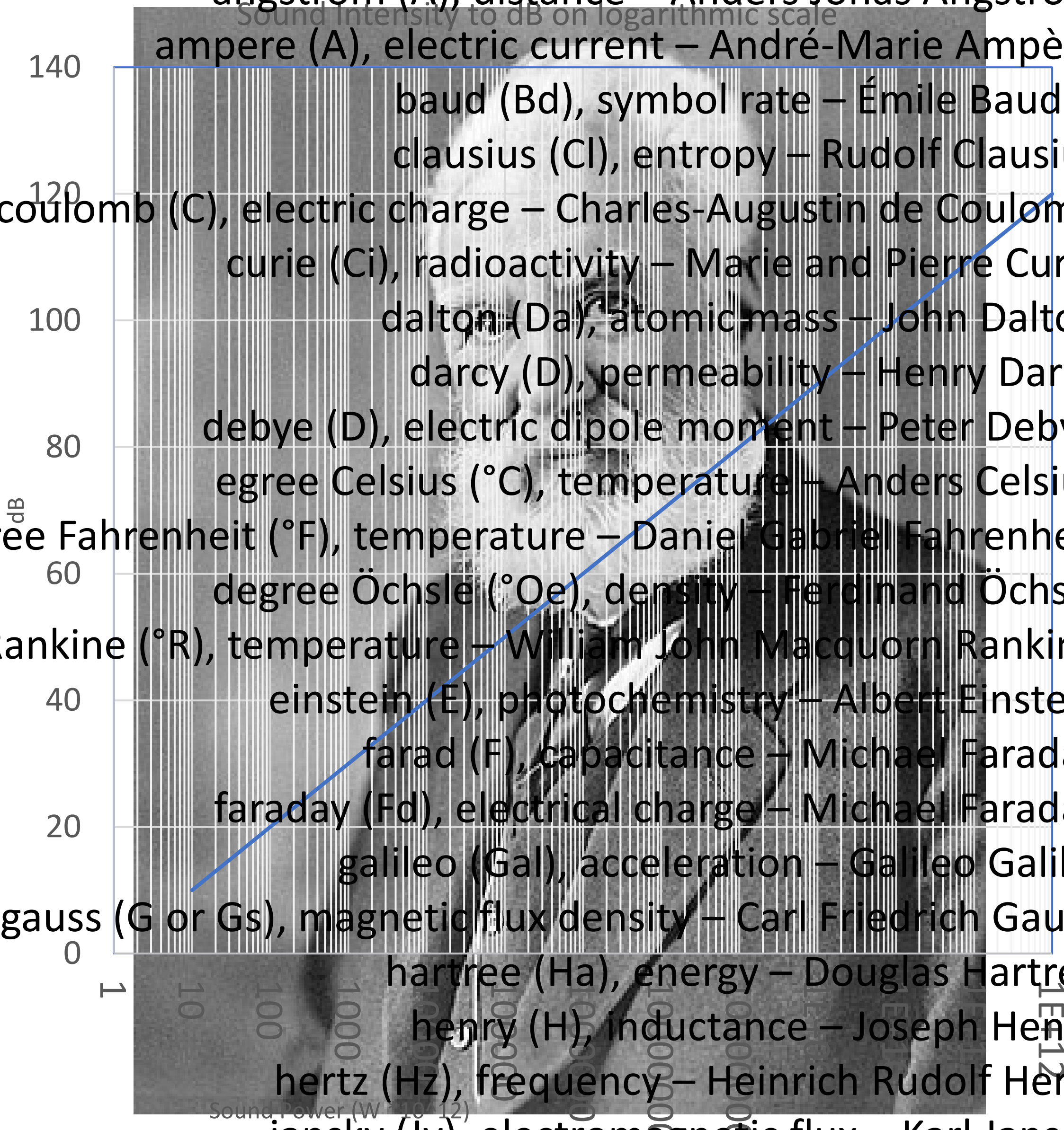
- Energy is always balanced
- Total or Incident Energy (Ei)
- = Energy Reflected (Er)
- + Energy Transmitted (Et)
- + Absorbed or Transformed Energy (Ea)
- Mass walls reflect more than framed walls.
- Flexibility translates to improved STC

Frequency Intervals of Testing



What is a Decibel (dB)

- A ratio of a measured quantity over a referenced quantity.
- Why is the B capitalized?
- It is logarithmic – an exponential relationship
  - 20dB has 10x more sound power than 10 dB
  - 30dB is 10x more sound power than 20 dB
  - 30dB is 100x more sound power than 10 dB
  - 100dB is 1 bil. x more sound power than 10dB



angstrom (Å), distance – Anders Jonas Ångström
ampere (A), electric current – André-Marie Ampère
baud (Bd), symbol rate – Émile Baudot
clausius (Cl), entropy – Rudolf Clausius
coulomb (C), electric charge – Charles-Augustin de Coulomb
curie (Ci), radioactivity – Marie and Pierre Curie
dalton (Da), atomic mass – John Dalton
darcy (D), permeability – Henry Darcy
debye (D), electric dipole moment – Peter Debye
egree Celsius (°C), temperature – Anders Celsius
degree Fahrenheit (°F), temperature – Daniel Gabriel Fahrenheit
degree Öchsle (°Oe), density – Ferdinand Öchsle
degree Rankine (°R), temperature – William John Macquorn Rankine
einstein (E), photochemistry – Albert Einstein
farad (F), capacitance – Michael Faraday
faraday (Fd), electrical charge – Michael Faraday
galileo (Gal), acceleration – Galileo Galilei
gauss (G or Gs), magnetic flux density – Carl Friedrich Gauss
hartree (Ha), energy – Douglas Hartree
henry (H), inductance – Joseph Henry
hertz (Hz), frequency – Heinrich Rudolf Hertz
jansky (Jy), electromagnetic flux – Karl Jansky
joule (J), energy, work, heat – James Prescott Joule
kelvin (K), thermodynamic temperature – Lord Kelvin

Sound Power vs. Loudness

- Pressure measurement vs. Perception
- ff – f – mf – mp – p – pp – Very loud or strong to very soft
- Typical decibel range of a symphony orchestra is 70 dB to 110 dB.
- Decibel range is 40 points
- Wave amplitude is 10000x higher
- Perception is about 16 times louder

dB Rise	Result in Sensitivity
3	Noticeable Rise
5	Highly Noticeable
10	About twice as loud, not 10X

NOISE LEVELS

Decibels (dB)

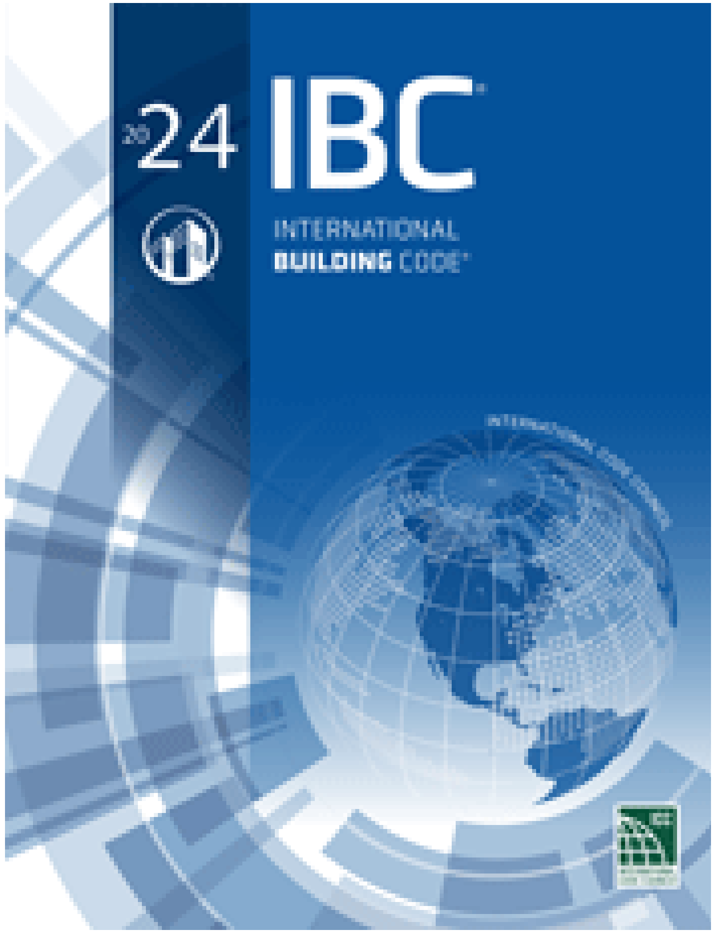
Gunshot

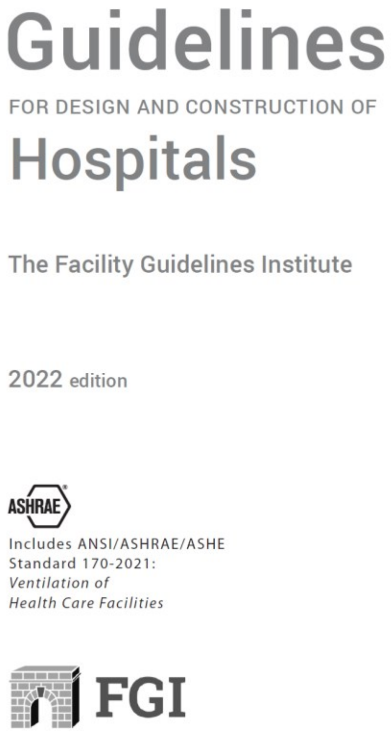
135

140

Jet engine
rom 100
ards

STC Requirements in Code



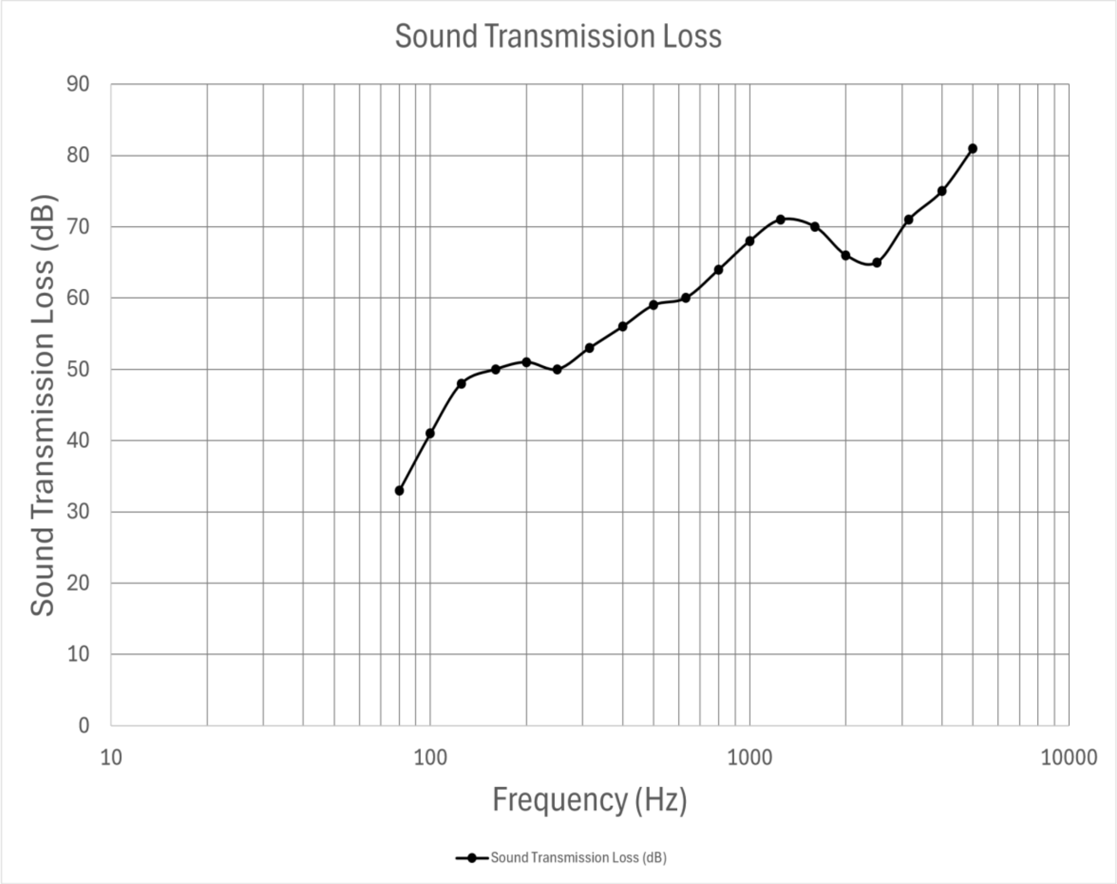


- Chapter 12 of the IBC
- Section 1206
- ICC A117.1 for Enhanced Classroom Acoustics
- Guidelines and Specifications

STC values for privacy

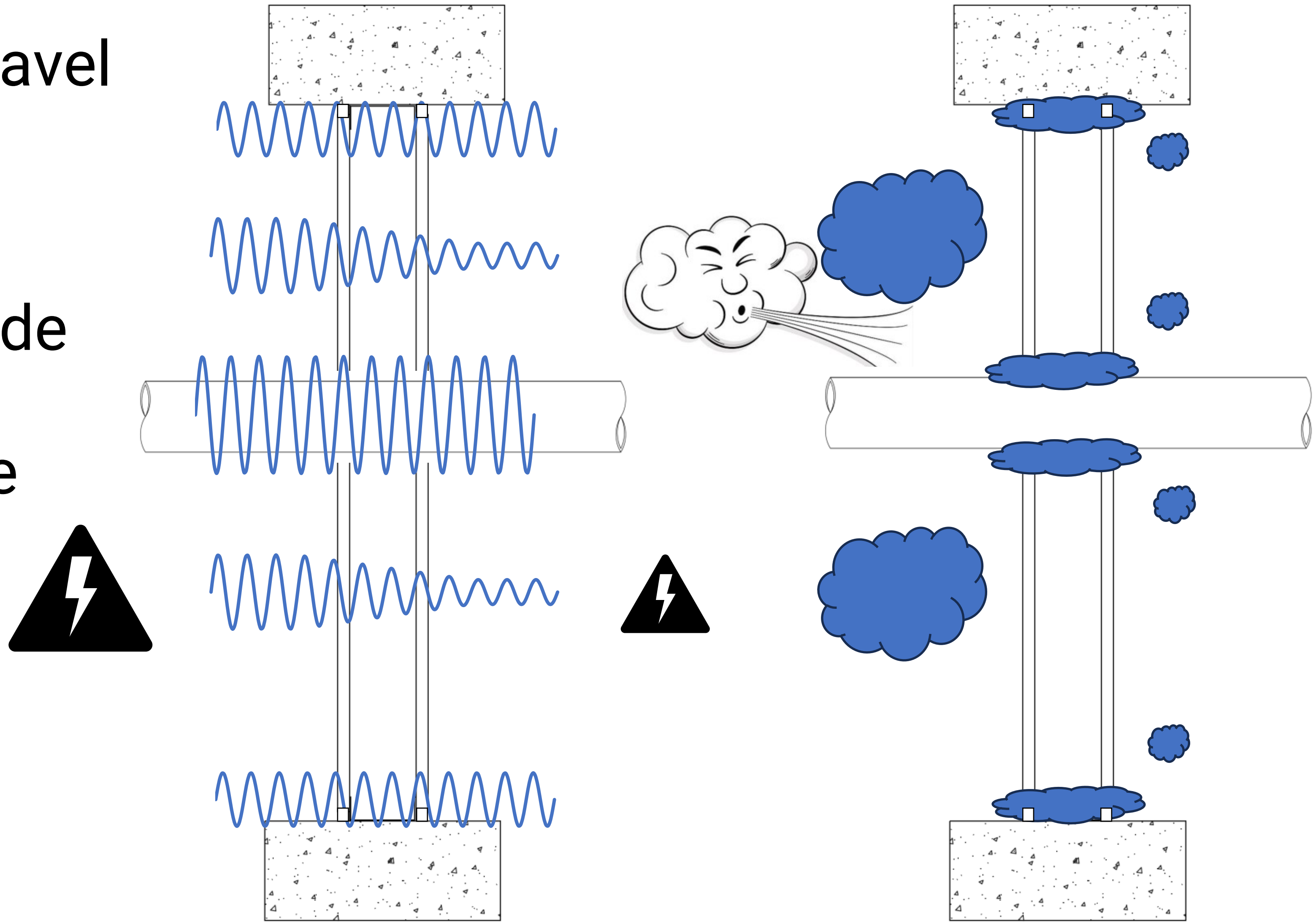
- STC roughly relates to reduction in decibels, but it is more complicated than that.
- General conversation is about 60 dB
- Privacy levels begin around STC 40
- STC 40 wall will reduce the sound inte roughly 60-40 or to about 20 dB

STC	General Conversation (60 dB)
40	Heard but not understood
45	Virtually cannot be heard
50	Not heard



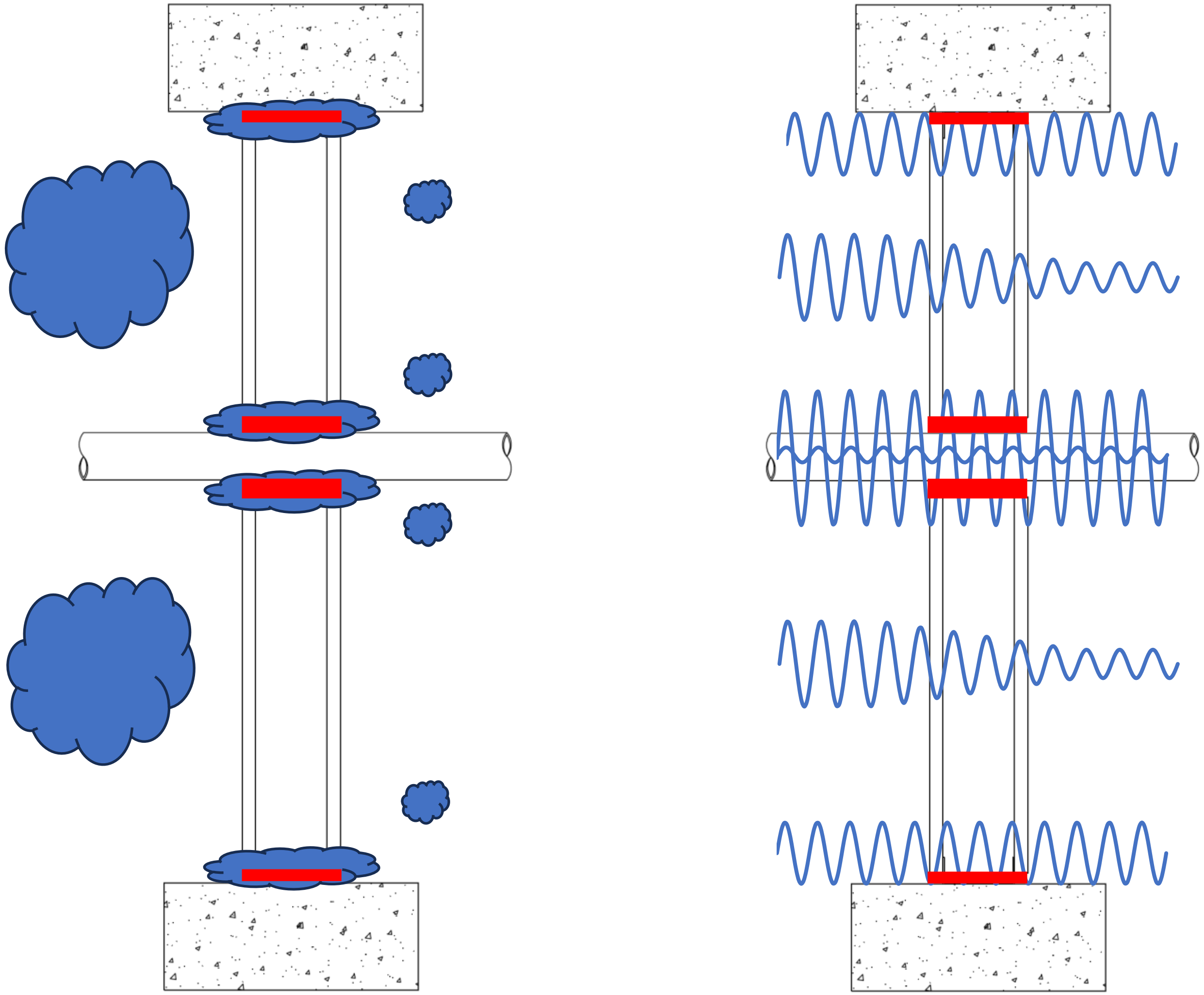
Where there is smoke there is sound

- Smoke and sound travel freely in air.
- Continuous wall is effective to reduce sound wave amplitude
- Continuous wall is effective as a smoke barrier
- Discontinuities
  - Joints
  - Penetrations



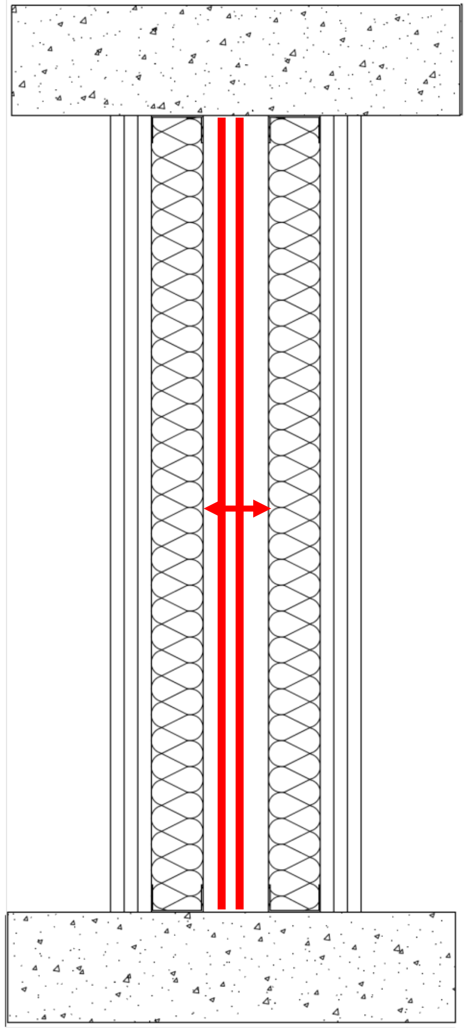
The affect of firestop on Smoke and Sound

- Proper firestopping stops smoke by stopping air flow
- Proper firestopping stops sound by stopping air flow
- Some flanking can occur with penetrations.



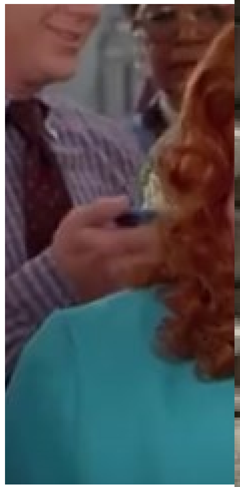
Construction Practices to Improve STC

- About 35 – 39 STC - single
- About 45 – 50 STC - insulated
- About 50 – 55 STC - layered
- About 55 – 60 STC – divided
- About 60 – 65 STC – divided insulated
- About 65 – 70 STC – narrowed and divided with layers
- 70+ STC – narrowed, divided, insulated, layered



Masking Sound

- Sound



Other ways to improve STC

- Resilient Channels
- Materials that trap air in cavity spaces or on surfaces.
- Sound attenuating underlayments
- Absorbing materials in rooms, such as furniture, wall hangings, and rugs.
- Acoustical ceiling panels
- Sound attenuating gypsum panels

that improve STC

Classified by
Underwriters Laboratories, Inc.
to ASTM/UL1479 (ASTM E814)

System No. F-A-2246

F Ratings - 2 and 3 Hr (See Item 3)

T Ratings - 0, 1/4, 1, 1-1/4, 1-1/2 and 3 Hr (See Item 3)

L Rating At Ambient - Less Than 1 CFM/sq ft (See Items 3, 4 and 6)

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F-A-2246
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Conclusions

- Don't cut corners.
  - Use the proper screw spacing
  - Use the same gauge of framing as tested.
  - Build to the design
- Lighter framing helps STC, but hurts fire-resistance.
- Seal against air leakage where practical
- If the barrier is not fire rated, seal with materials designed for smoke and sound
- When designing, consider flanking paths and try to mitigate
- There is no such thing as an STC rating for a product.
- The falling tree does indeed make a sound, but if no living creature is there to hear it, it does not make a noise.