



Fundamental Acoustics

In Wall And Room Structures

Acoustics – It's Not Rocket Science!

It's actually much harder! Rocket science deals primarily with well understood physics and mathematical formulas surrounding thrust, trajectory, time and distance.

Acoustics deals with complex environments with an infinite number of variables in a very dynamic environment.

So..... Don't sweat it!! Understanding a few terms and concepts will allow you to answer the vast majority of the questions you will ever be asked regarding acoustics. Remember, the person asking the question probably doesn't know the answer either.

Acoustics – Why Bother?

Acoustics, If Understood On Even An Elementary Level, Can Add High Value To Any Building Material Selection Discussion

Acoustics Are A Major Factor In Modern Construction Decisions And Are One Of The Least Understood Areas Of Design

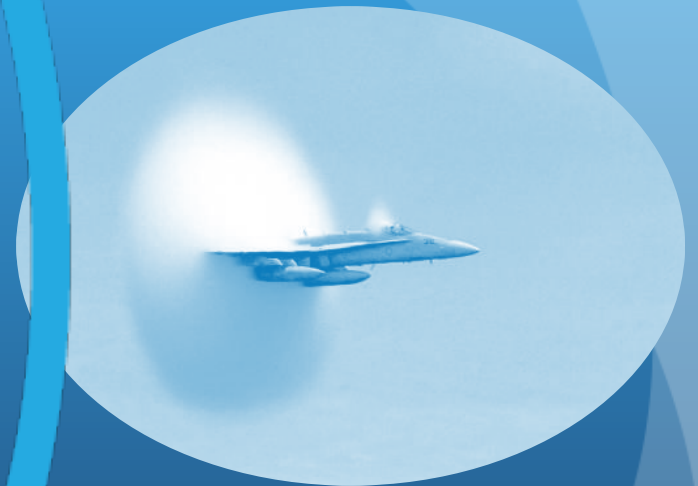
Poor Acoustics Can Ruin An Otherwise Beautiful Wall Installation

In Many Cases, Building Codes Now Require An Acoustical Assessment

Primary Terms

Sound

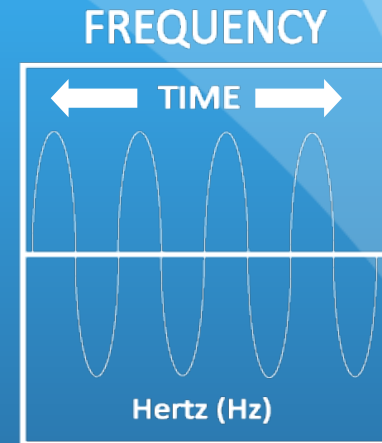
Is an oscillating wave of pressure which can travel through solids, liquids, and gases and is within a frequency range and of sufficient power level to be perceived by receptive organs.



Primary Acoustic Terms

Frequency

Measured in Hertz (Hz) and is the number of wave cycles of sound per time, usually a second. The higher the frequency, the higher the perceived pitch.



Pitch

The perceived sensation of sound frequencies as interpreted by the brain in a scale from high to low. Pitch is subjective and can be influenced by the environment, distortion, reflections, movement, etc.

The Audible Spectrum

20Hz - 20,000Hz

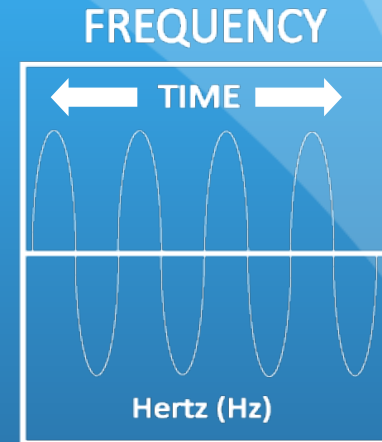
The human ear is typically capable of hearing between 20Hz - 20kHz

Females can usually hear slightly higher frequencies than males

Frequencies above 20kHz are ultrasonic

Frequencies below 20Hz are infrasonic

The human voice is usually in the 500Hz to 3500Hz range and is where the majority of acoustic tests are centered



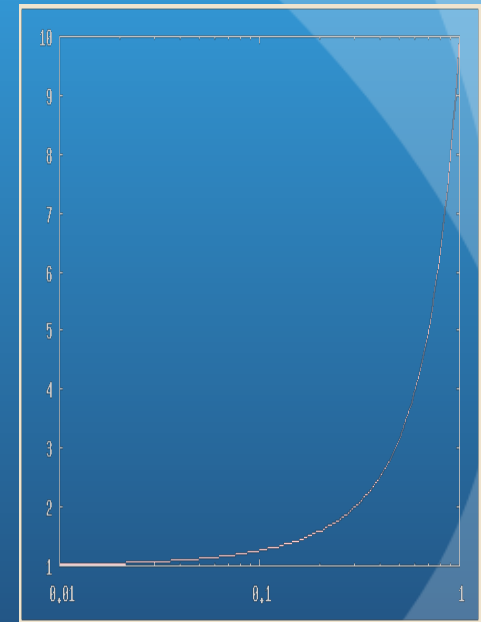
Now For The Really Hard Stuff!

Decibel (db)

A logarithmic unit that expresses intensity or power of something. In acoustics it measures Sound Pressure Level (SPL) as compared to a reference level (0db). 0 db is not dead silent!

In humans, the ratio of SPL intensity causing permanent damage to the quietest perceived sound is over a trillion so it is expressed logarithmically base $10^{12} = 12$ which is expressed as 0-120 (db)

Every -10db is half as loud



Common db Levels

Decibel (db)

Rain

40 db

Normal Conversation

60 db

Busy Traffic

85 db

Rock Concerts

105 db

Maximum I-pod Volume

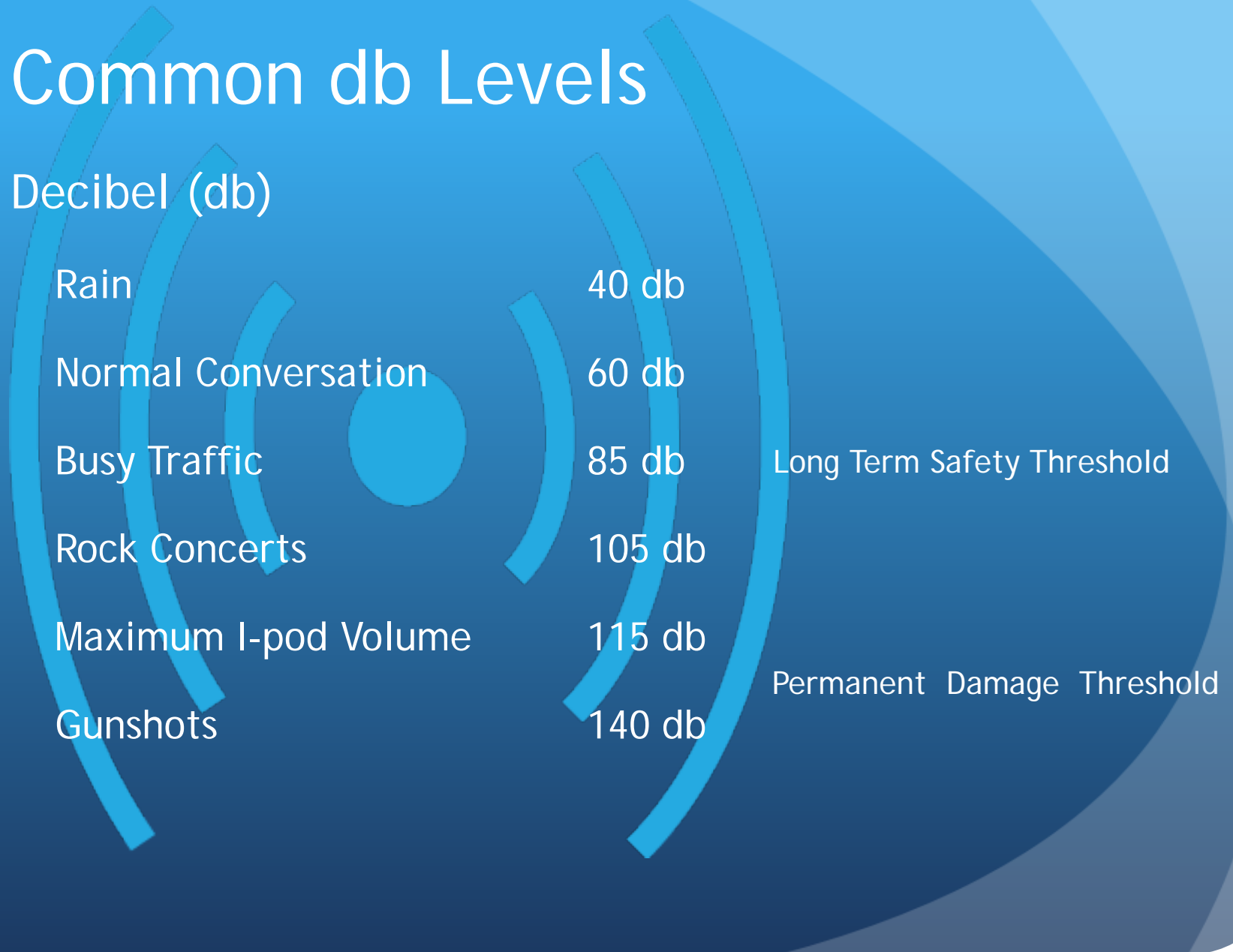
115 db

Gunshots

140 db

Long Term Safety Threshold

Permanent Damage Threshold



Primary Terms

Reflections

The condition where sound bounces off a surface(s) before reaching the receiver.



Reverberation

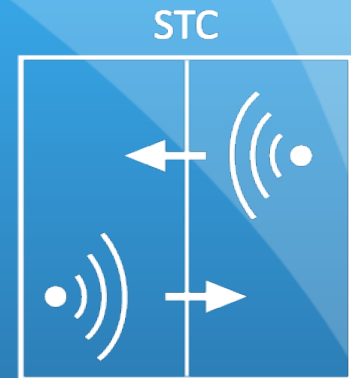
The continued reflections of sound within an enclosed space after the sound source has stopped. Long delays are called discrete echoes.



Primary Terms

STC - Sound Transmission Class

Number rating of a wall or structures ability to block the transfer of sound



NRC - Noise Reduction Coefficient

Number rating which categorizes the sound absorptive or reflective properties of a material or environment



STC – Privacy Anyone?

STC – Sound Transmission Class

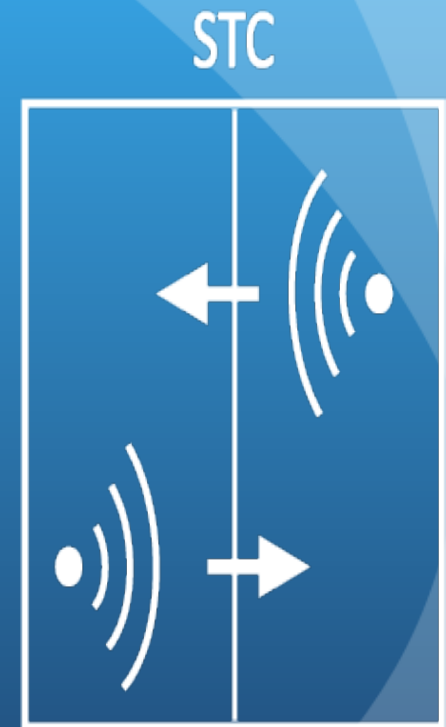
It is the primary way to infer how isolated a room or environment is relative to other rooms.

General Guidelines

30-35 STC = Loud talking understood

40-50 STC = Loud talking not easily understood but may have occupant awareness

60+ STC = Loud talking not audible



STC – What's The Big Deal?

Behind The Scenes Voodoo

Generally measured by gathering transmission loss data along 16 different frequencies from 125Hz-4000Hz

Centered on human voice frequencies

Does not cover low frequency industrial noise, music, etc.

Example: If an 80db sound on one side of wall is reduced to 50db on the other the STC is 30

Remember every -10db = ½ as loud!



STC – Design With Confidence

Considerations

Most codes require minimum of 40 STC in commercial installations

It is harder to block low frequencies than high frequencies as the wave form is much more powerful and longer

Adding mass to the partition wall along with decoupling and insulation will vastly improve STC

Beware of flanking paths!



STC – FLANKING PATHS

Common Flanking Paths

Ceiling And Floor Joists

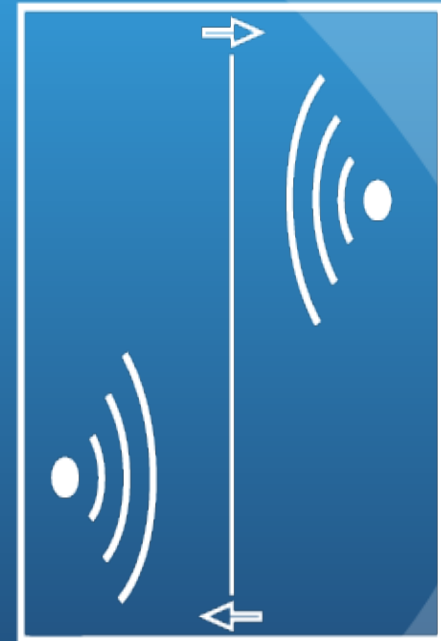
Common Duct Work

Missing Or Poor Fitting Door Sweeps

Back-To-Back Electrical Or Utility Boxes In
Same Stud Cavity

Outlet Gaps

FLANKING PATH



STC – Improve Your Ratings

Gain Weight And Isolate

Decouple And Add Length To The Ventilation

Double The Wallboard

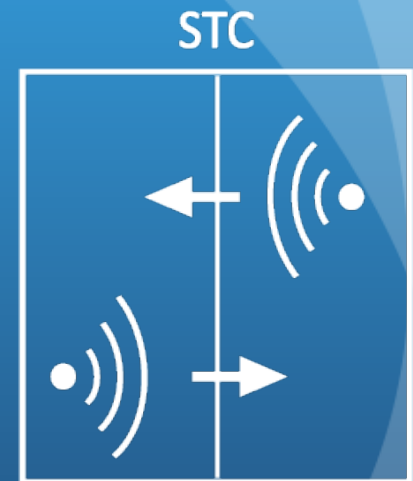
Insulate The Stud Cavity

Insulate The Ceiling Plenum & Floor Plenum

Seal All Flanking Paths

In Extremely Sensitive Areas Use Double Walls With Dead Head Ventilation

Plan Ahead For Today & Tomorrow



NRC – What's All The Noise About?

Noise Reduction Coefficient

Number rating which categorizes the sound absorptive or reflective properties of a material or environment

NRC



NRC – Doesn't Tell You Everything

Noise Reduction Coefficient

Is just an average of mid range frequencies (usually 250Hz, 500Hz, 1000Hz, and 2000Hz) rounded to the nearest 5% shown as a decimal.

0.0 = Perfectly Reflective

1.0= Perfectly Absorbent

NRC



NRC – Be Careful

Number Can Be Misleading

Does Not Rate A Materials Ability To Absorb High And Low Frequencies

Averaging Allows For Different Materials To Have The Same Rating But Different Frequency Bias

Does Not Have Any Relevance To A Materials STC Rating

NRC



NRC – Common Ratings

Absorptive Ratings

Brick	.00-.03
Wood	.05-.15
Heavy Carpet	.30-.55
18oz Drapery	.60-.65
Fiberglass 3.5"	.80-.90

NRC



NRC – Control The Reflections

Don't Strive For Perfectly Absorbent

Most People Do Not Desire A Room That Is Totally Absorbent

A Little Reverb Is Usually A Good Thing

Angular Geometry Can Be A Good Alternative When Highly Absorbent Materials Cannot Be Used

Avoid Parallel Low NRC Walls

NRC



Acoustics 101 – You Made It!

You Now Have The Tools To Answer Most Of The Acoustic Questions That You Will Ever Be Asked

Do Not Be Afraid To Contact An Acoustician With Questions, Most Love To Talk About It

Remember

Acoustics.... It's More Than Just Sound



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