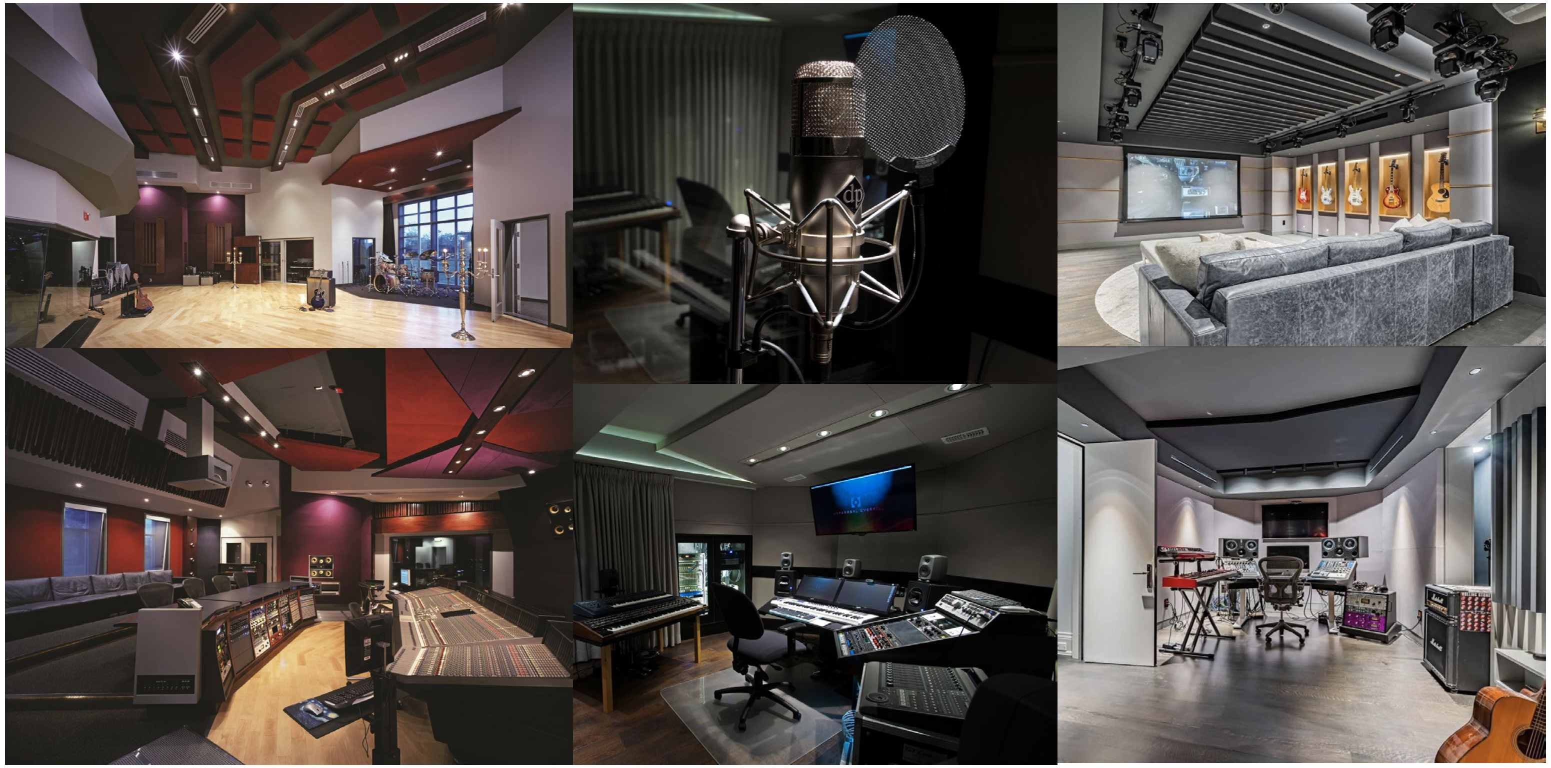
PILCHNER SCHOUSTAL
INTERNATIONAL INC

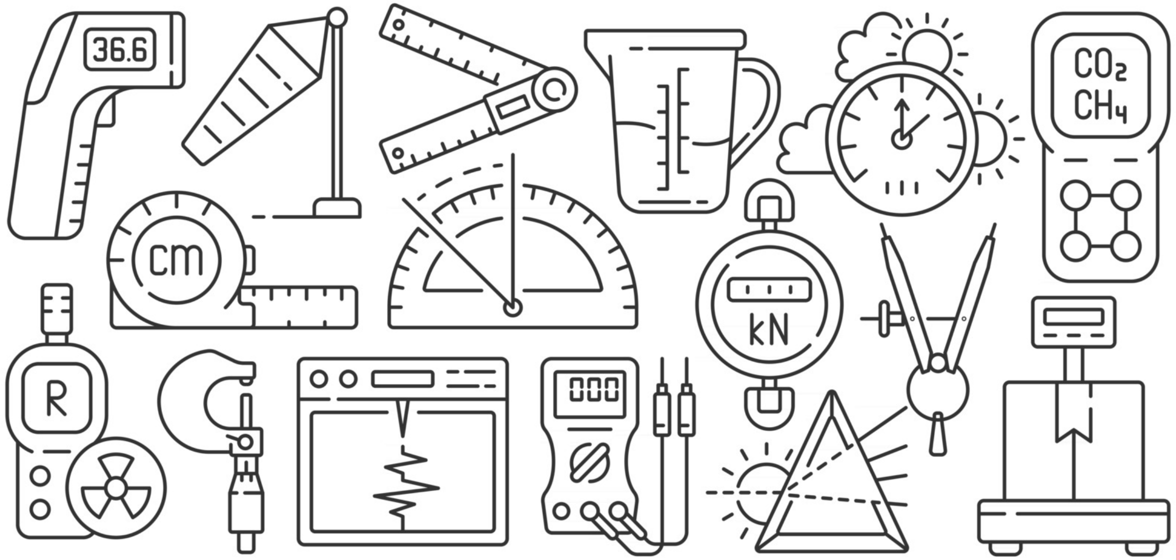


Professional Studio – Home Studio

AUDIO ES
AES

What is the difference between a Home Studio and a Professional Studio?

Quantifiable Metrics



Professional Studio vs Home Studio

Quantifiable Metrics

Size

professional

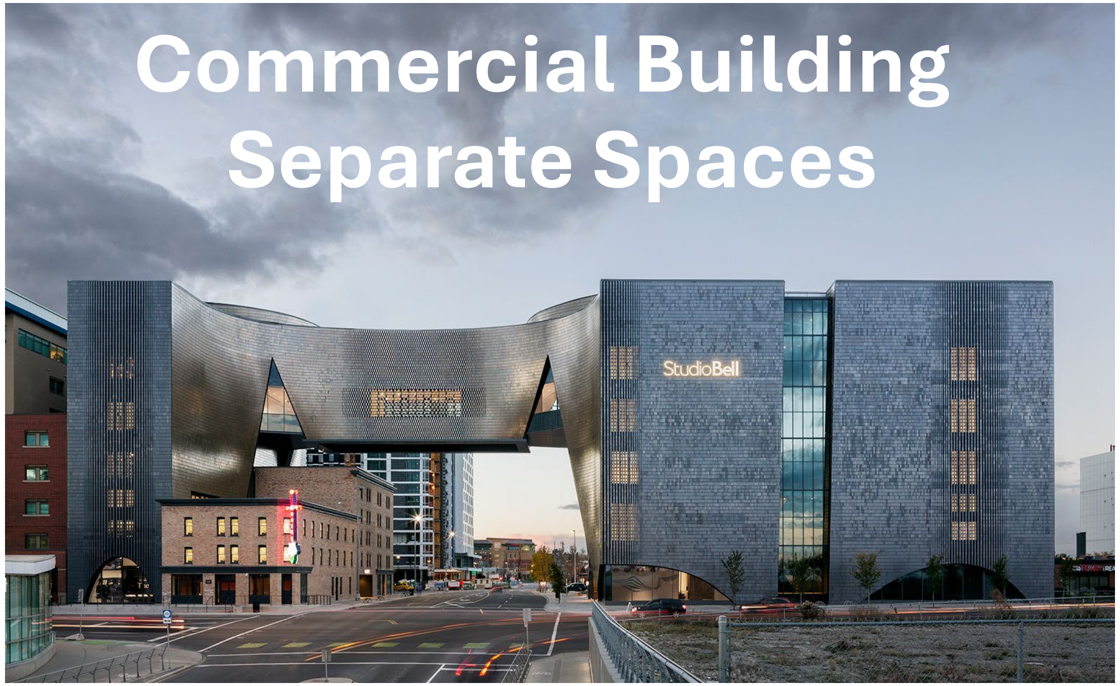
home

Professional Studio vs Home Studio

Quantifiable Metrics

Context

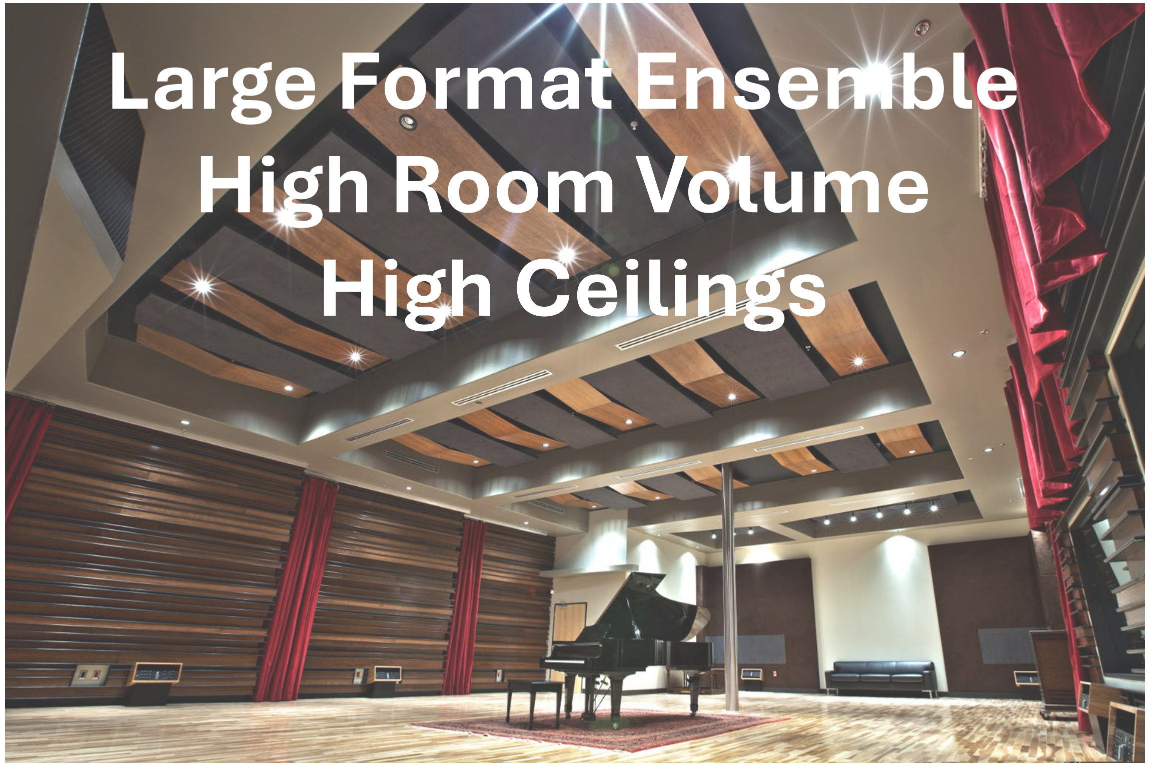
professional | **home**



Professional Studio vs Home Studio

Quantifiable Metrics

professional **Capability** home

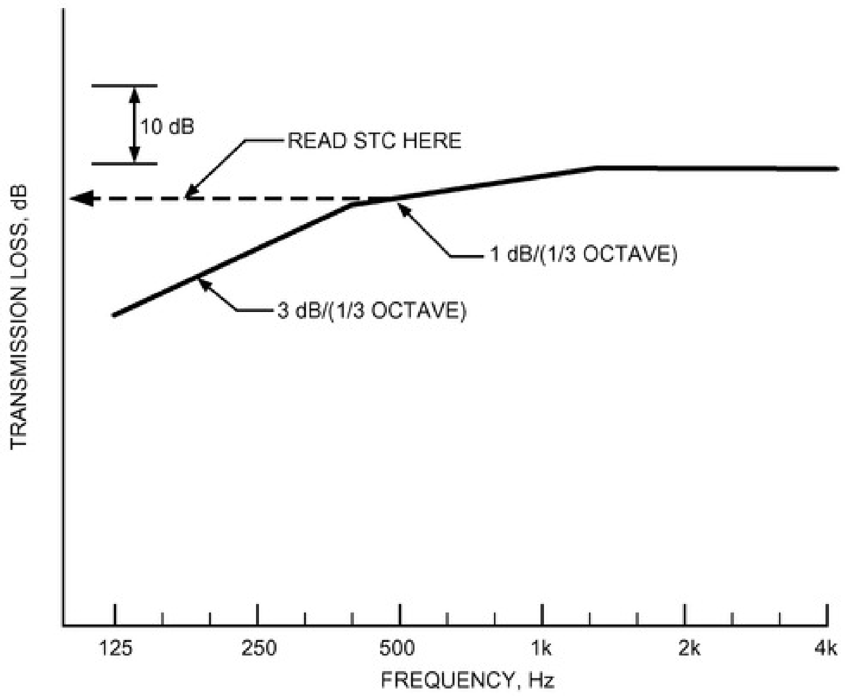


Professional Studio vs Home Studio

Quantifiable Metrics

Isolation

professional	home
High	**Moderate**
STC 80+	**STC 50+**



Professional Studio vs Home Studio

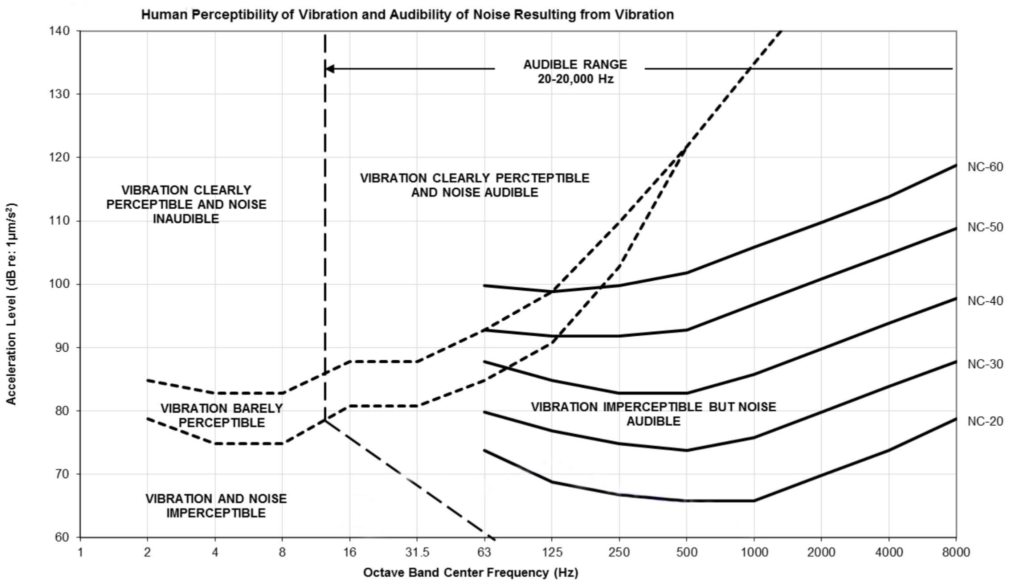
Quantifiable Metrics

professional

Vibration

home

High
Floating Floor
<75µm/sec²



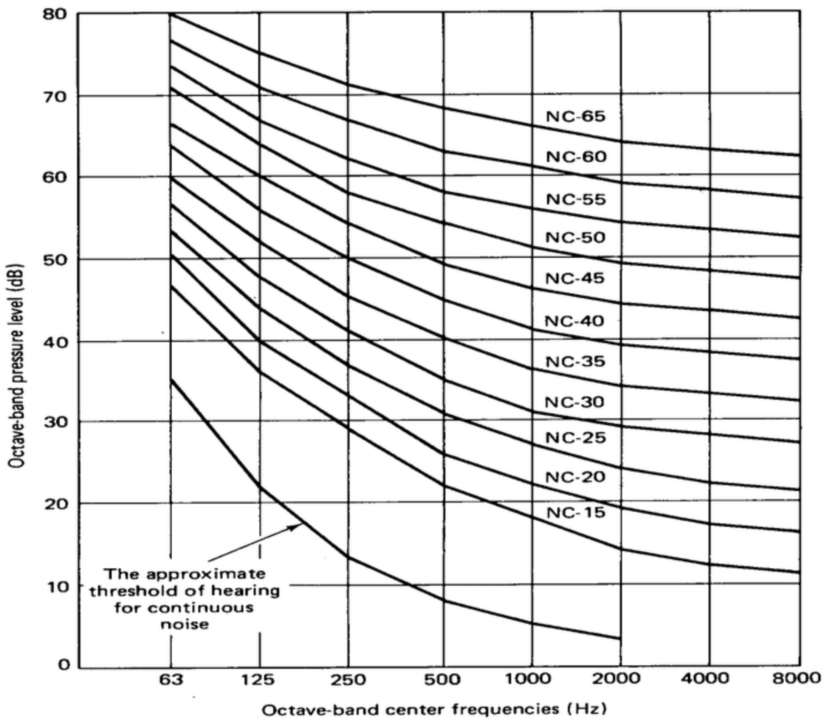
Moderate
Separate Floor
>85 µm/sec²

Professional Studio vs Home Studio

Quantifiable Metrics

Noise Floor

professional	home
Low	Moderate
NC 15-20	NC 20-30
Dedicated	Shared
Mechanical	Mechanical



Professional Studio vs Home Studio

Quantifiable Metrics

professional

Power

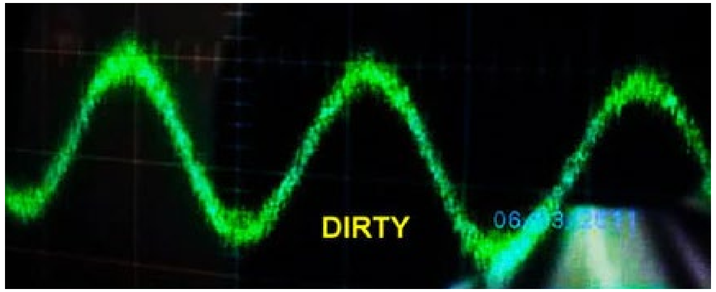
home

Technical

Filtered/Isolated

Residential

Limited Isolation



PILCHNER SCHOUSTAL INTERNATIONAL INC

Professional Studio vs Home Studio

Quantifiable Metrics

professional

Weight

home

High

$/1000ft^2$

Moderate

110,000 lbs

20,000 lbs

AUDIO AES

Quantifiable Metrics

Cost

professional	home
High	**Moderate**
$600 - $1200 ft^2	**$100 - $400 ft^2**

Professional Studio vs Home Studio

Quantifiable Metrics

professional

Cost

/1000ft²

home

High

$600,000.00+

Moderate

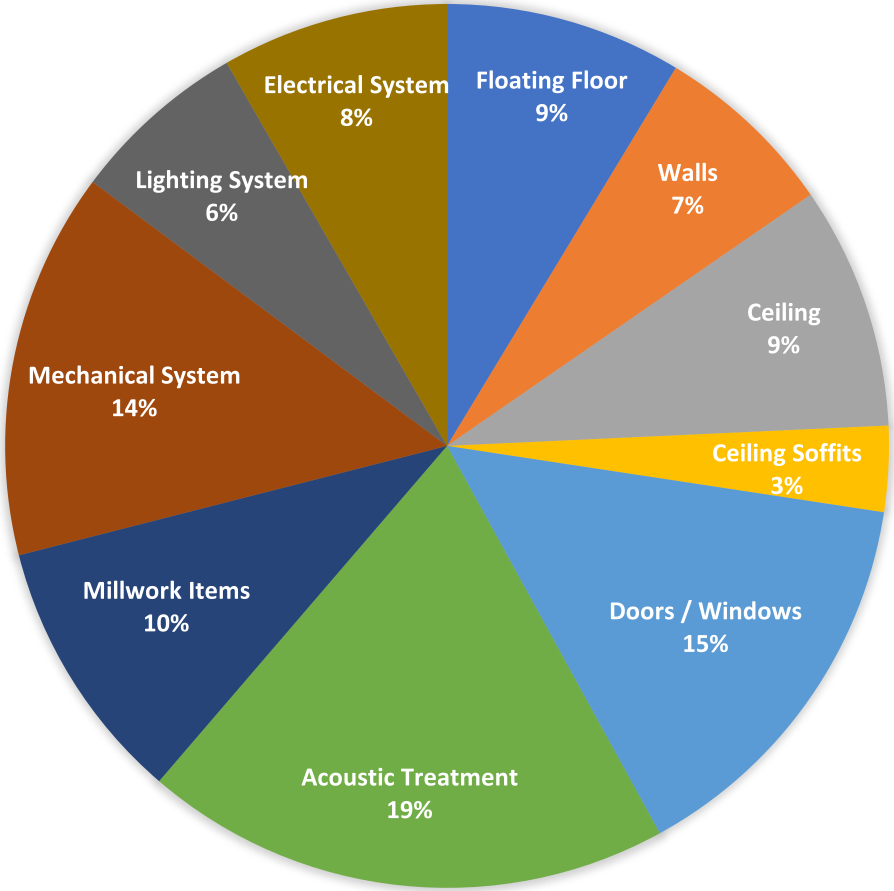
$100,000.00

Professional Studio vs Home Studio

Quantifiable Metrics

Where does the money go?

TOTAL PROJECT BREAKDOWN



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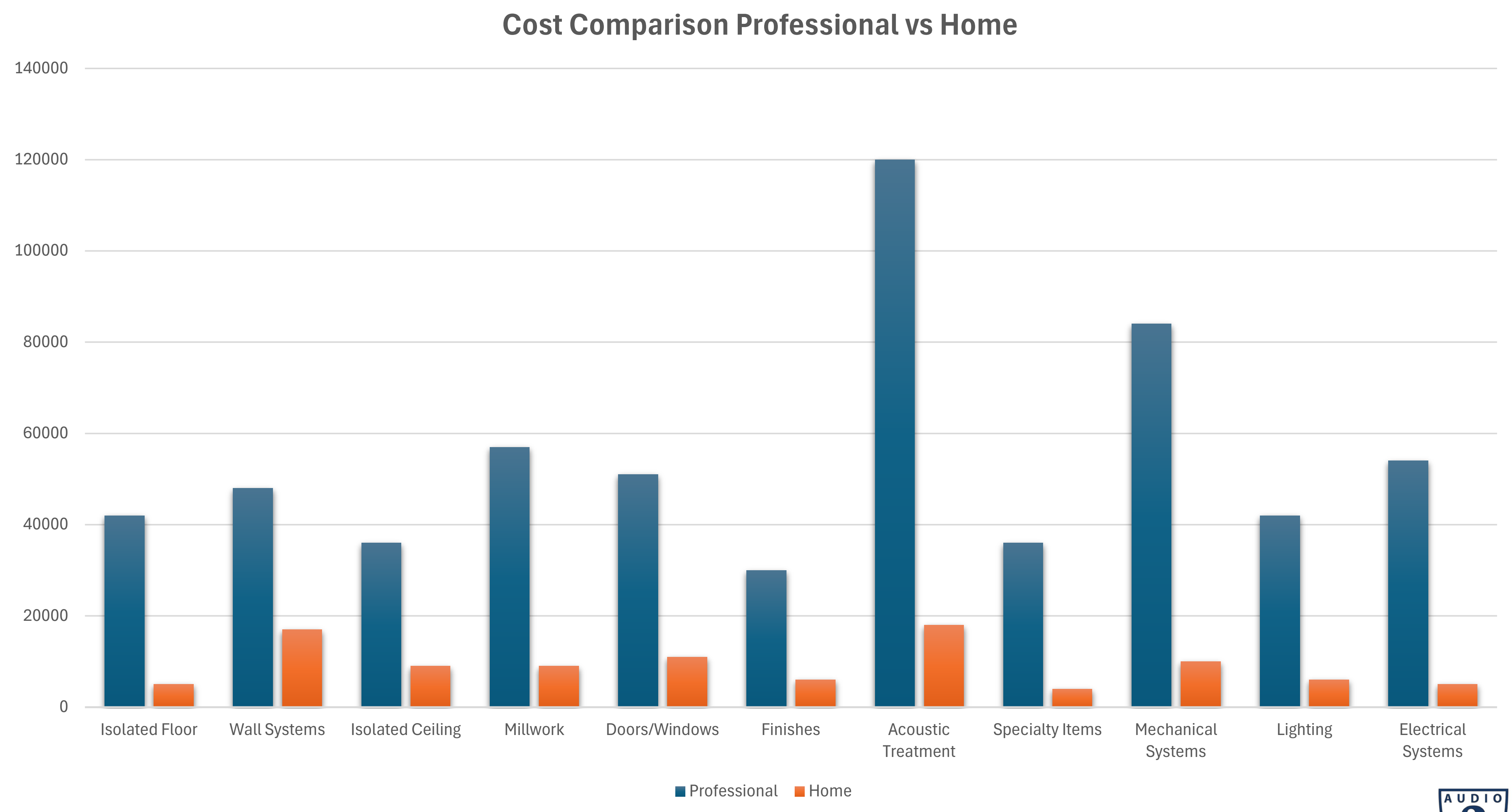
Professional Studio vs Home Studio

Quantifiable Metrics



Key Considerations for a Home Studio

Understanding the Ambitions

Understanding Workflow

Isolation

Background Noise

Room Sound Quality

Look/Feel & the Creative Act

Understanding the Ambitions

Who is the studio intended for?

How many people should it accommodate?

What is the extent of acoustic recording?

What is the extent of equipment or instruments?

What is the extent of the monitoring?

Understanding the Workflow

Who is the primary operator?

What is centered at the listening position?

What equipment/instrument needs to be nearby?

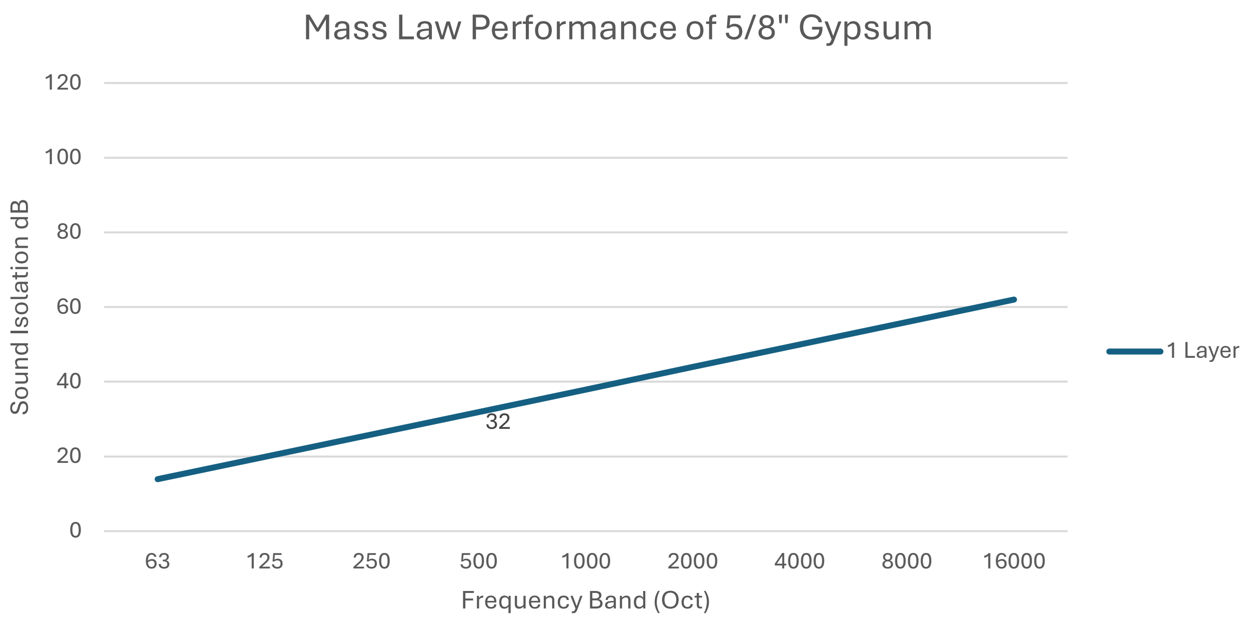
Does the main position need to serve more than one task?

Sound Isolation

General Rule for Sound Isolation is

MASS "A"

more mass=better isolation



MASS LAW

Sound Isolation

General Rule for Sound Isolation is

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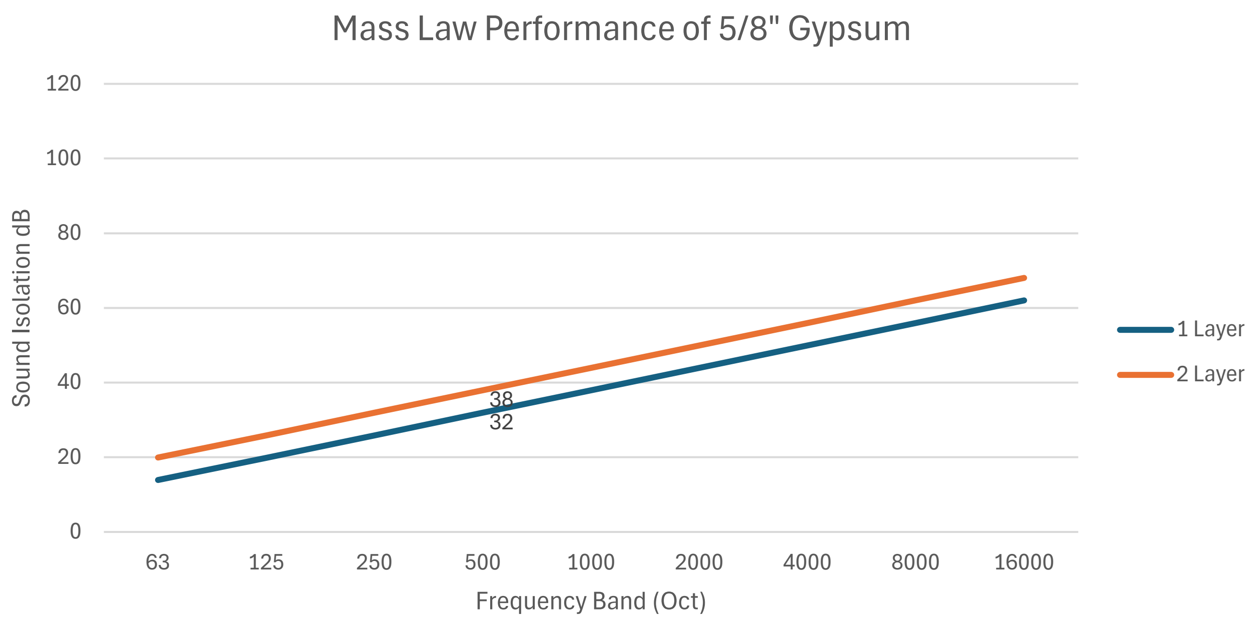
more mass=better isolation



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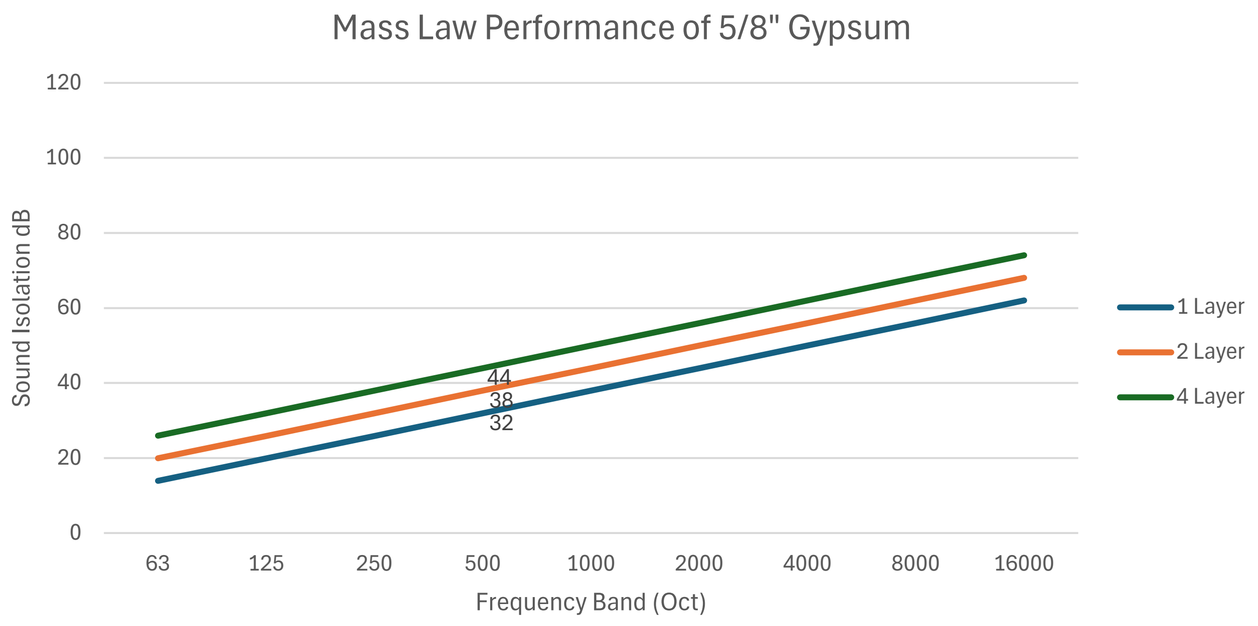

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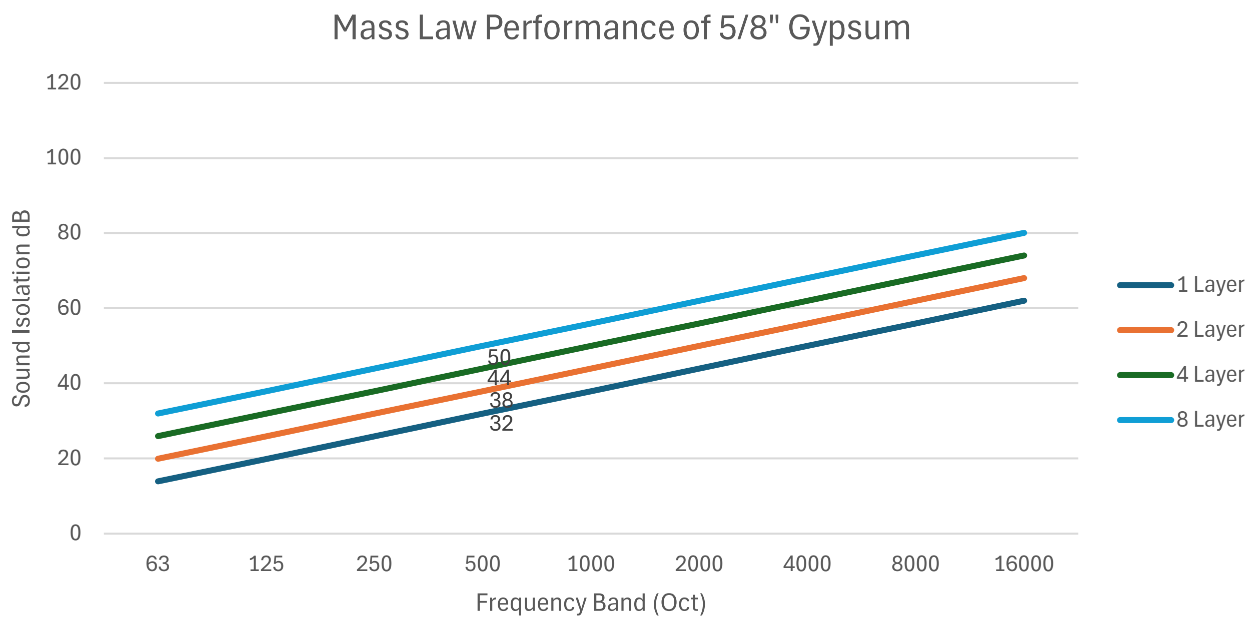
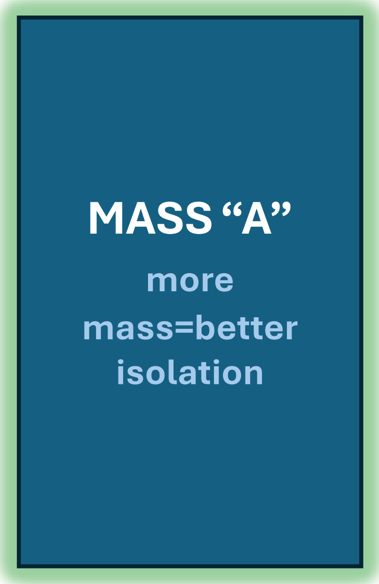
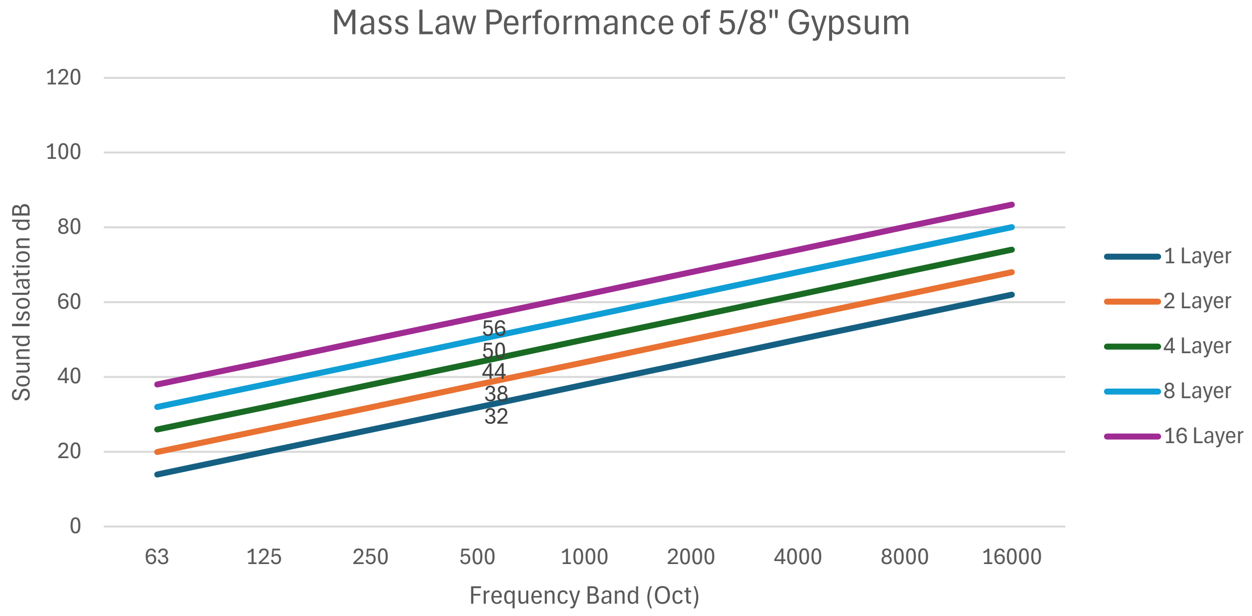


MASS LAW

Sound Isolation

General Rule for Sound Isolation is





MASS LAW

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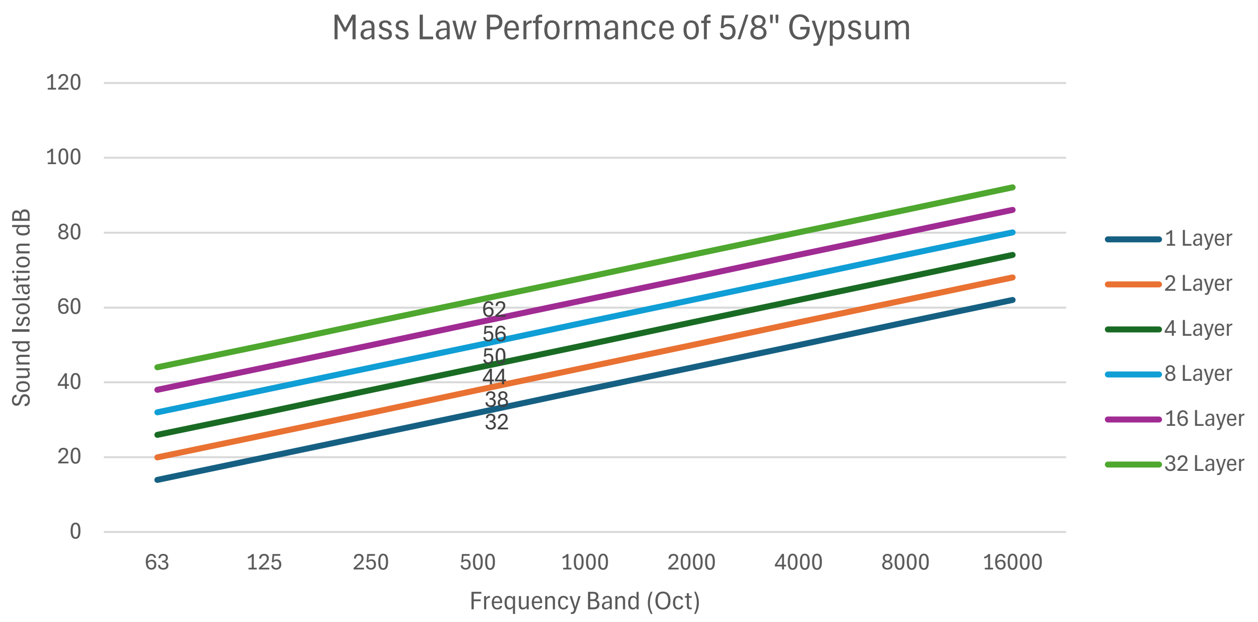

MASS LAW

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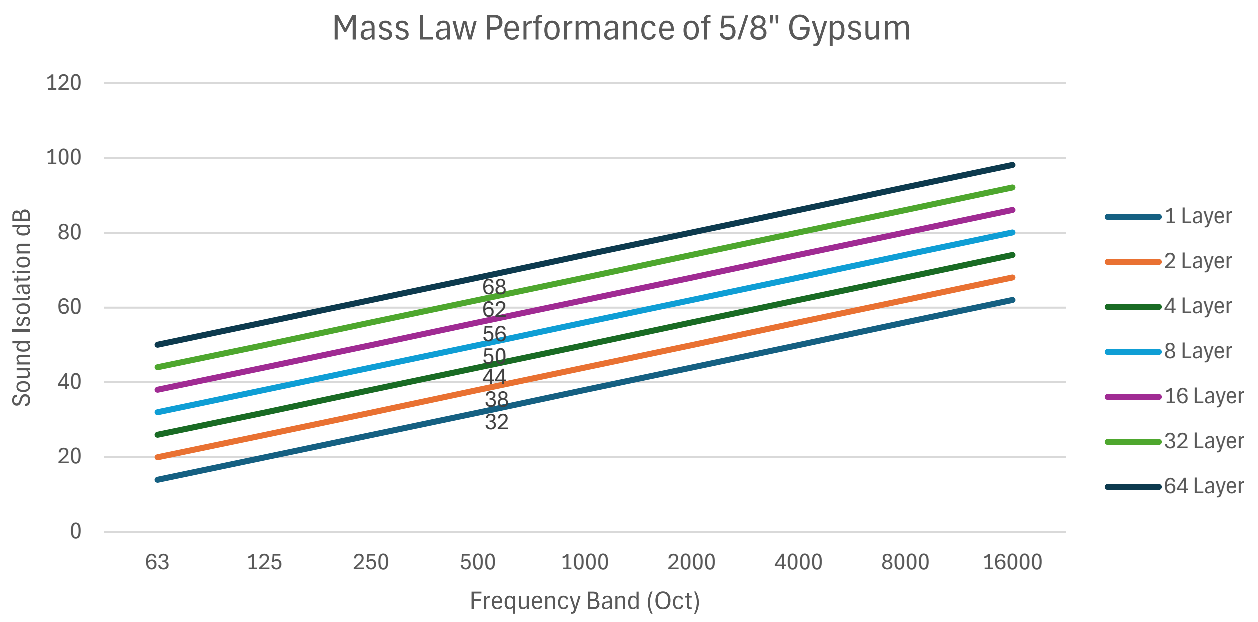

MASS LAW

Sound Isolation

General Rule for Sound Isolation is

MASS / AIR-CAVITY / MASS

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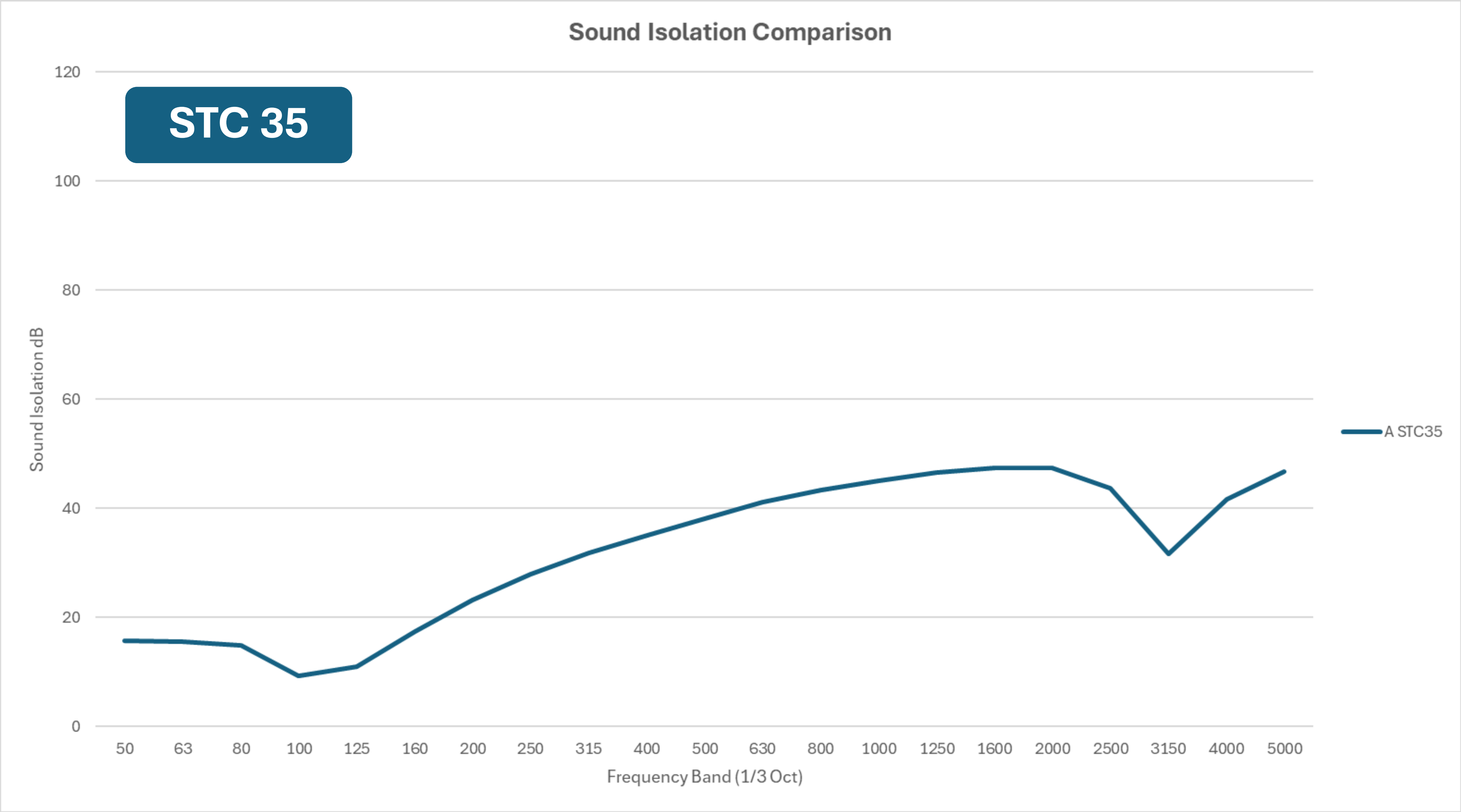
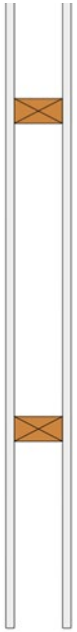
Sound Isolation



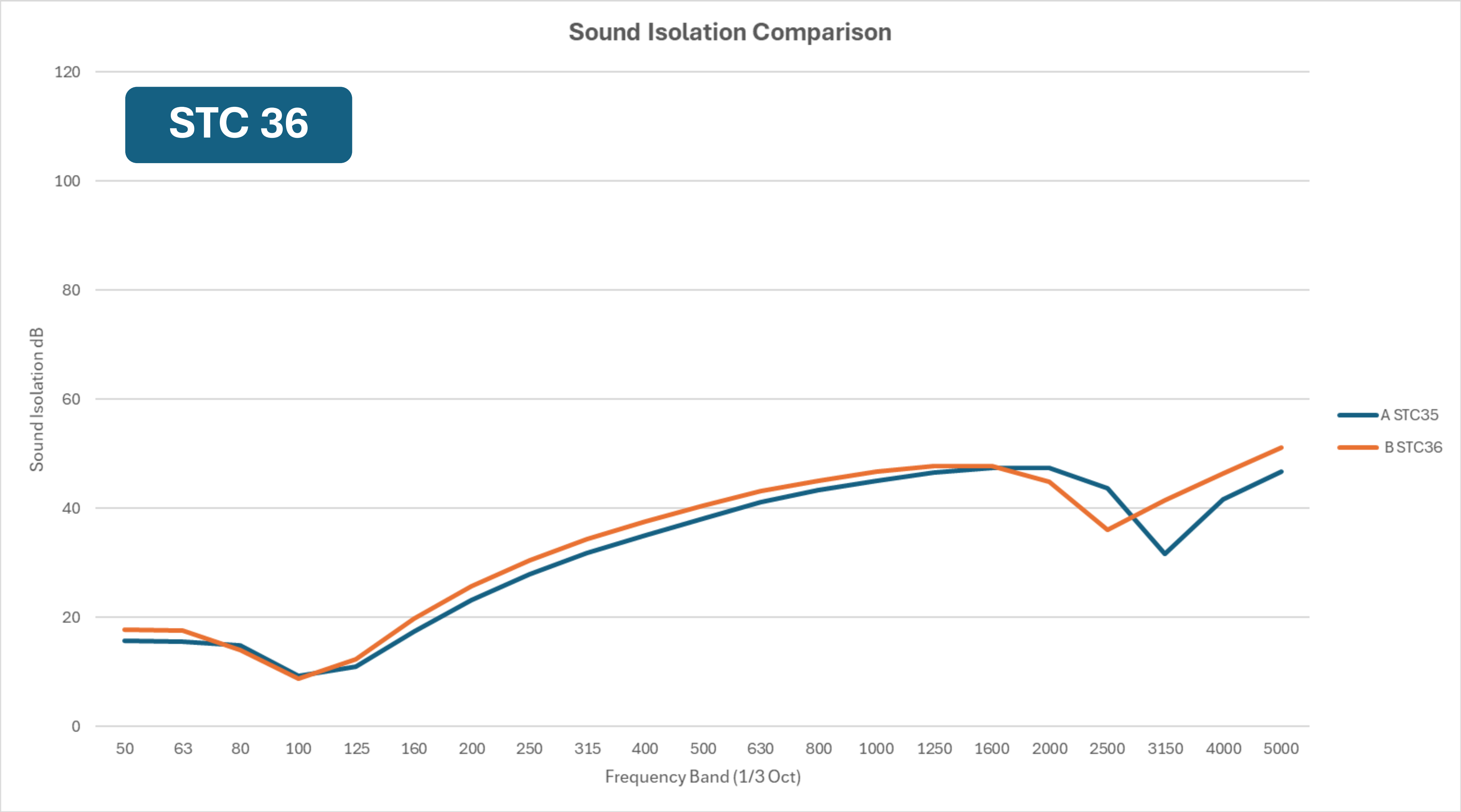
½" Gypsum
½" Gypsum

AUDIO AES

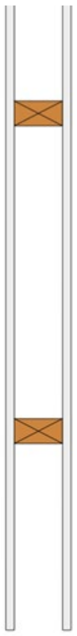
Sound Isolation



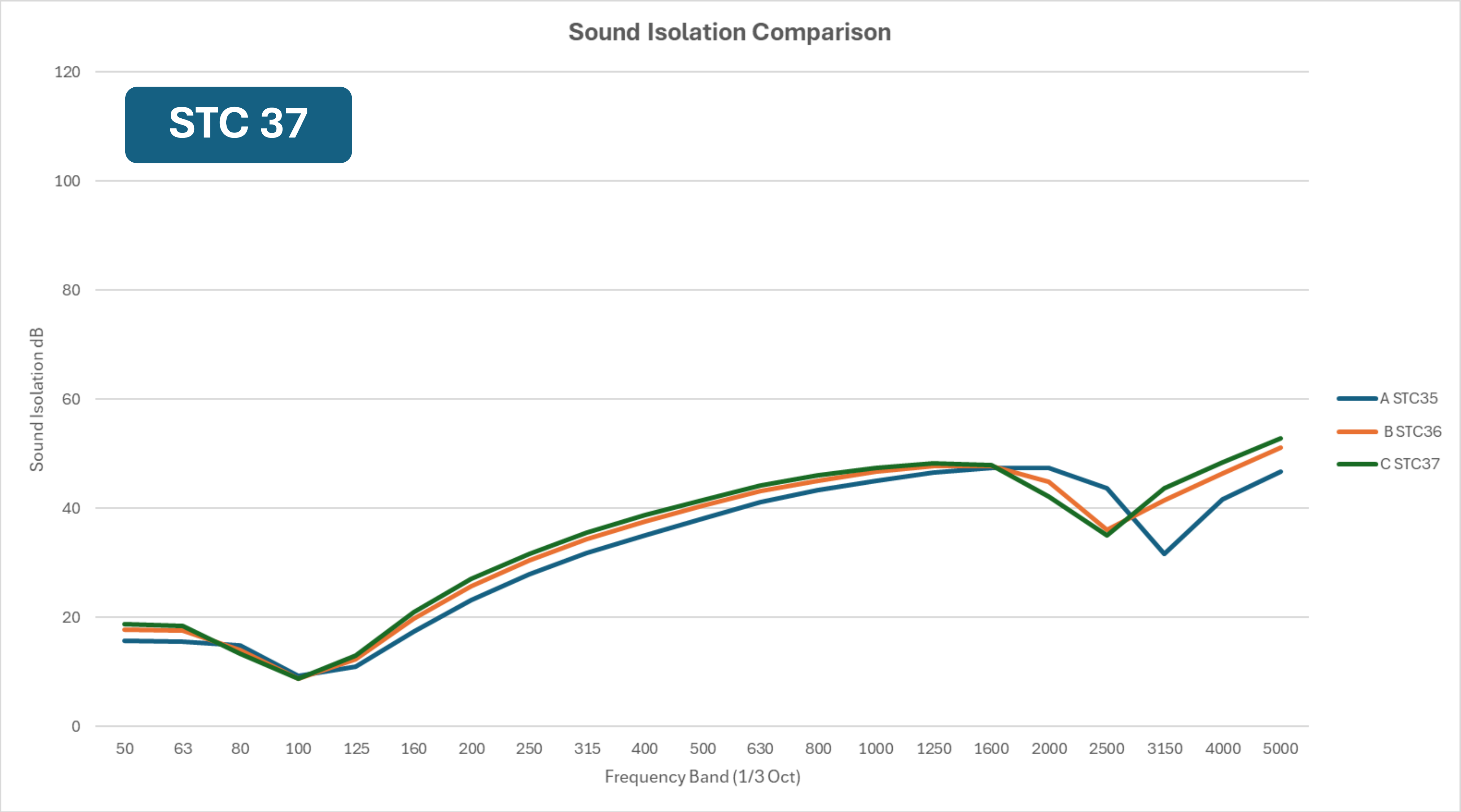
5/8” Type X
5/8” Type X



Sound Isolation

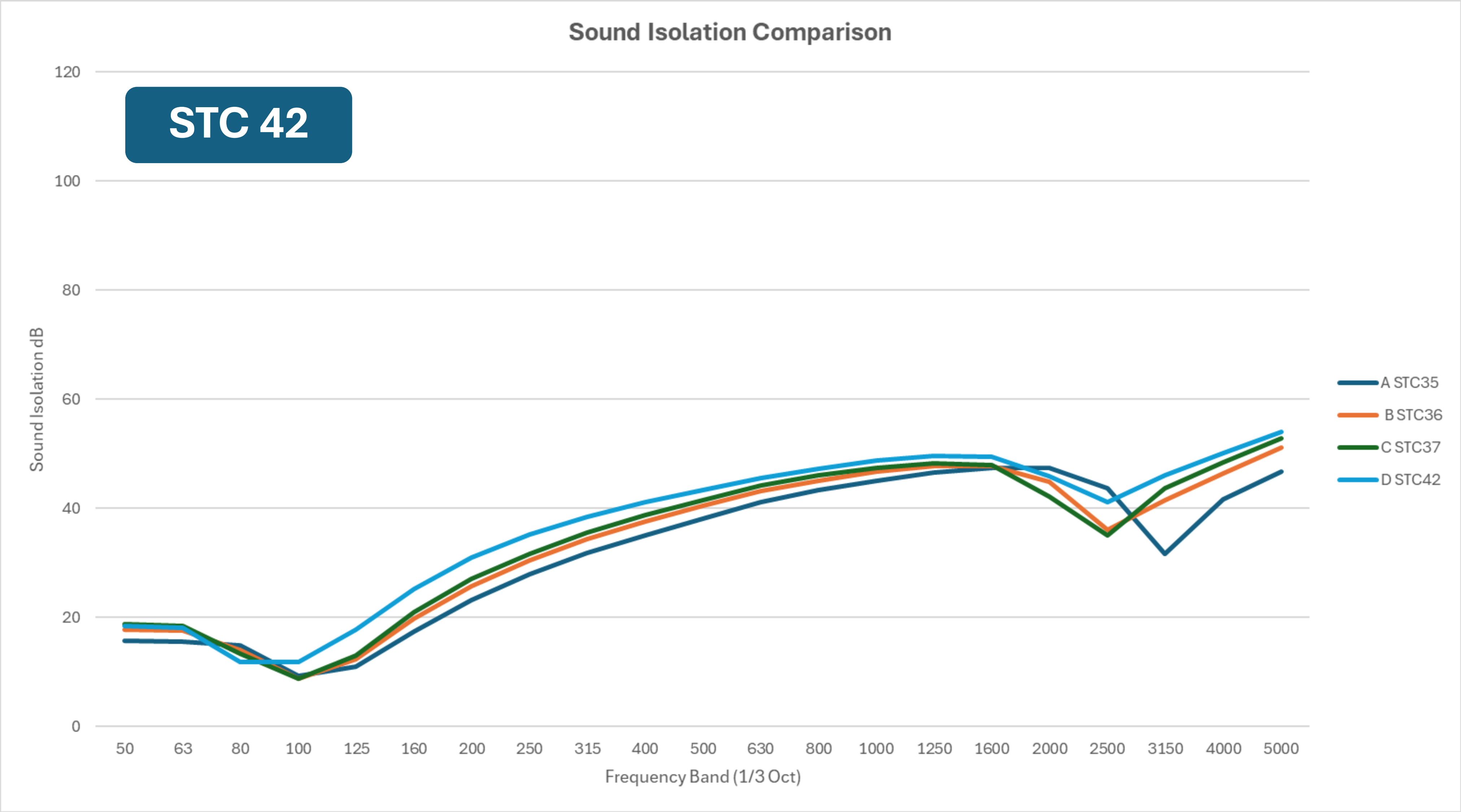


5/8” Type C
5/8” Type C

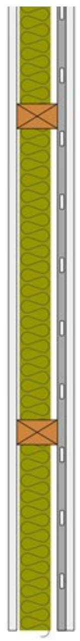


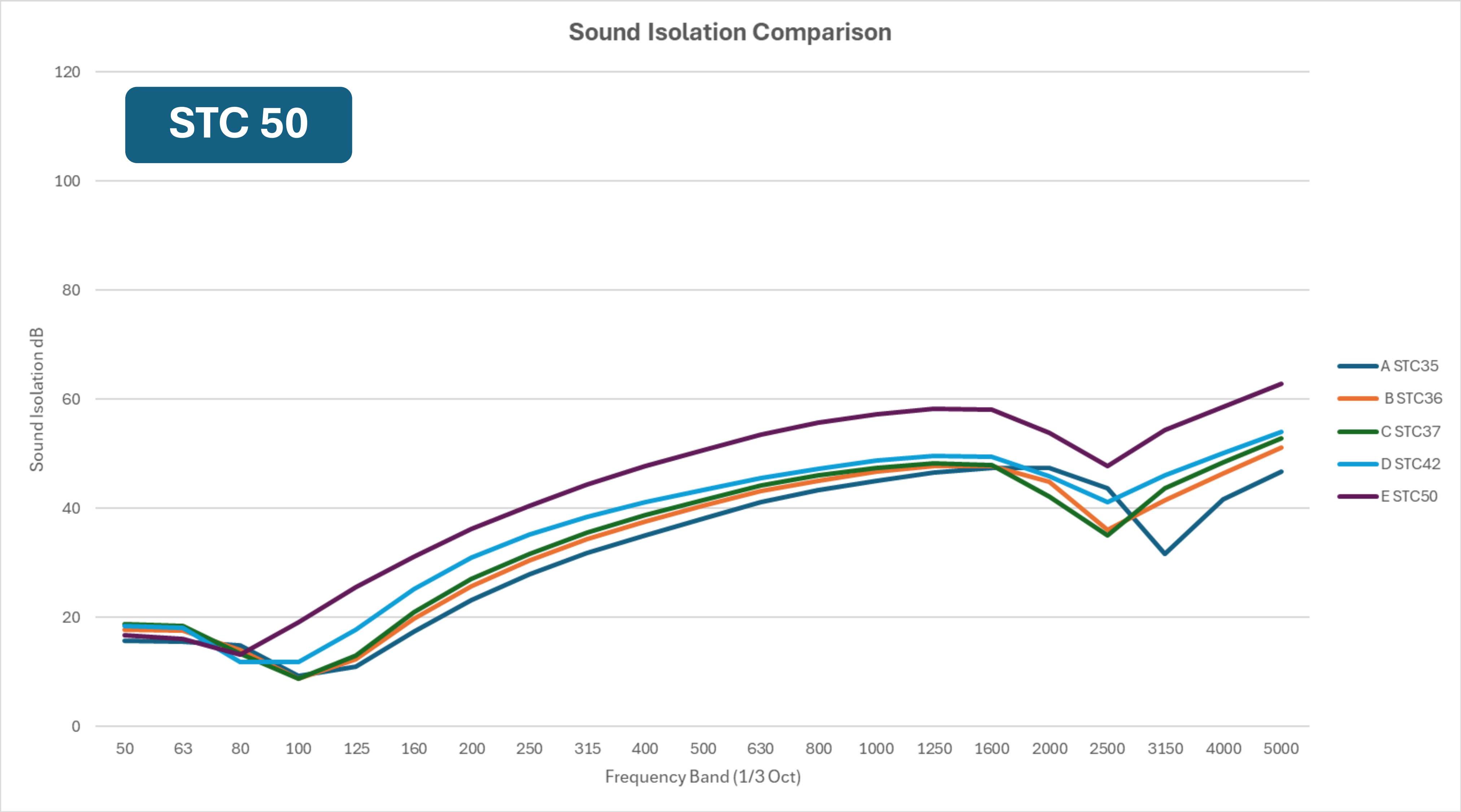
Sound Isolation

5/8” Type C
Insulation
5/8” Type C

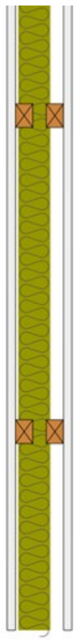


Sound Isolation

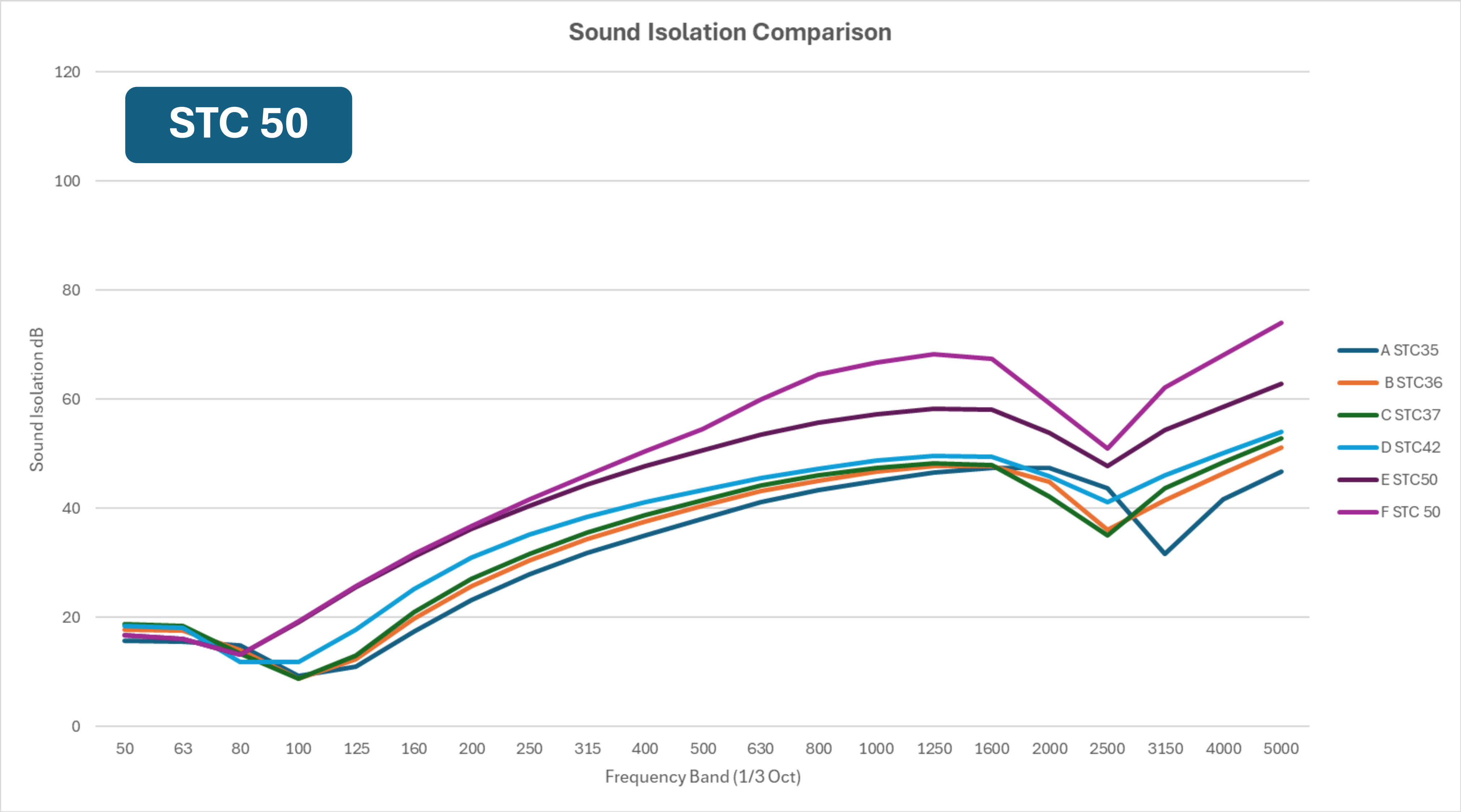




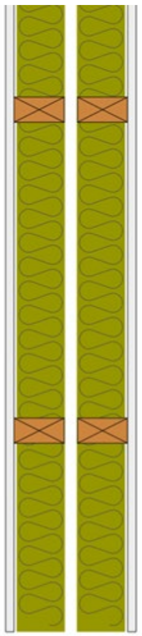
Sound Isolation



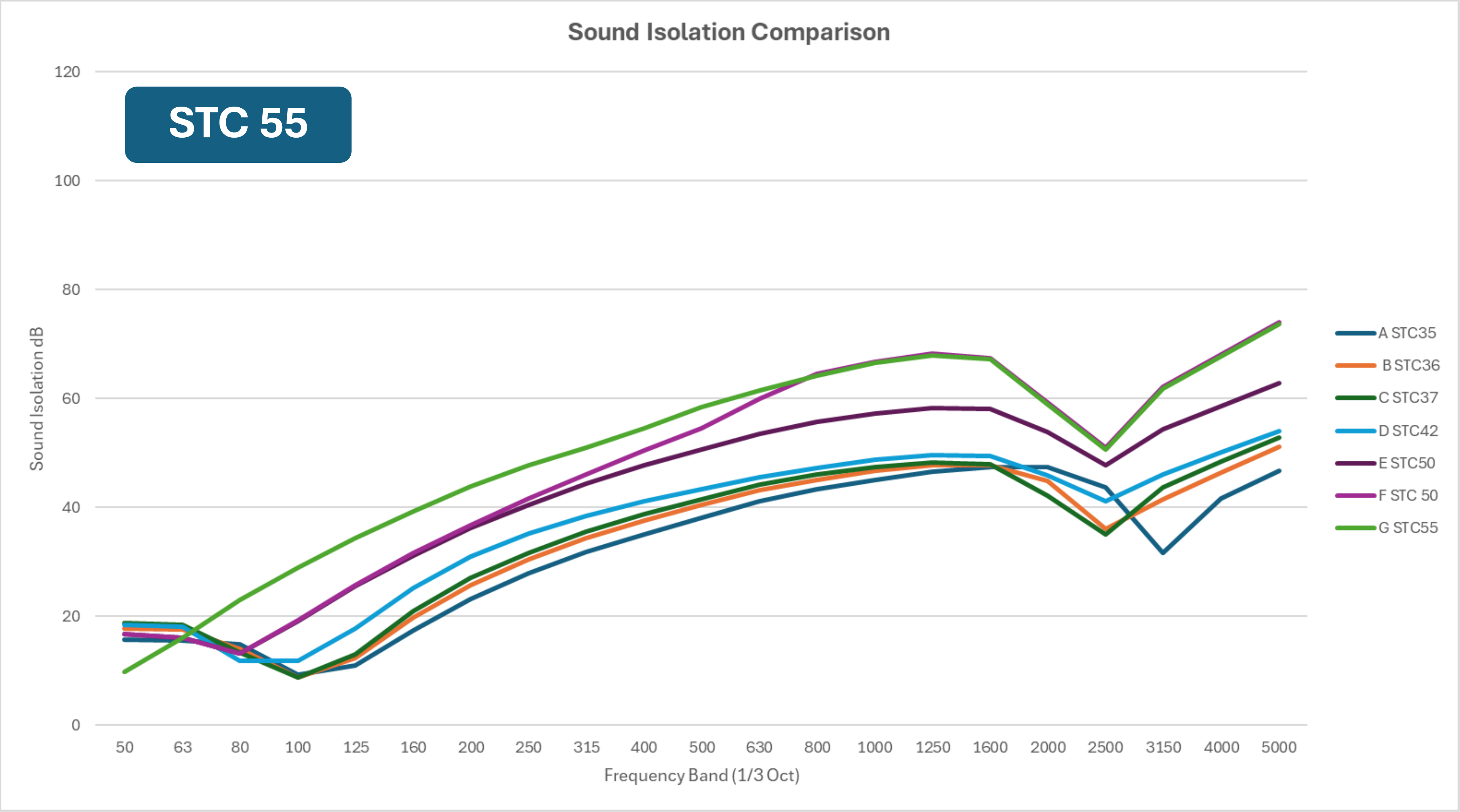
5/8” Type C
Insulation
5/8” Type C
Double Stud



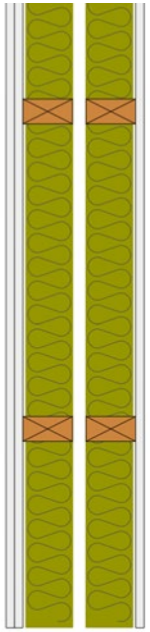
Sound Isolation



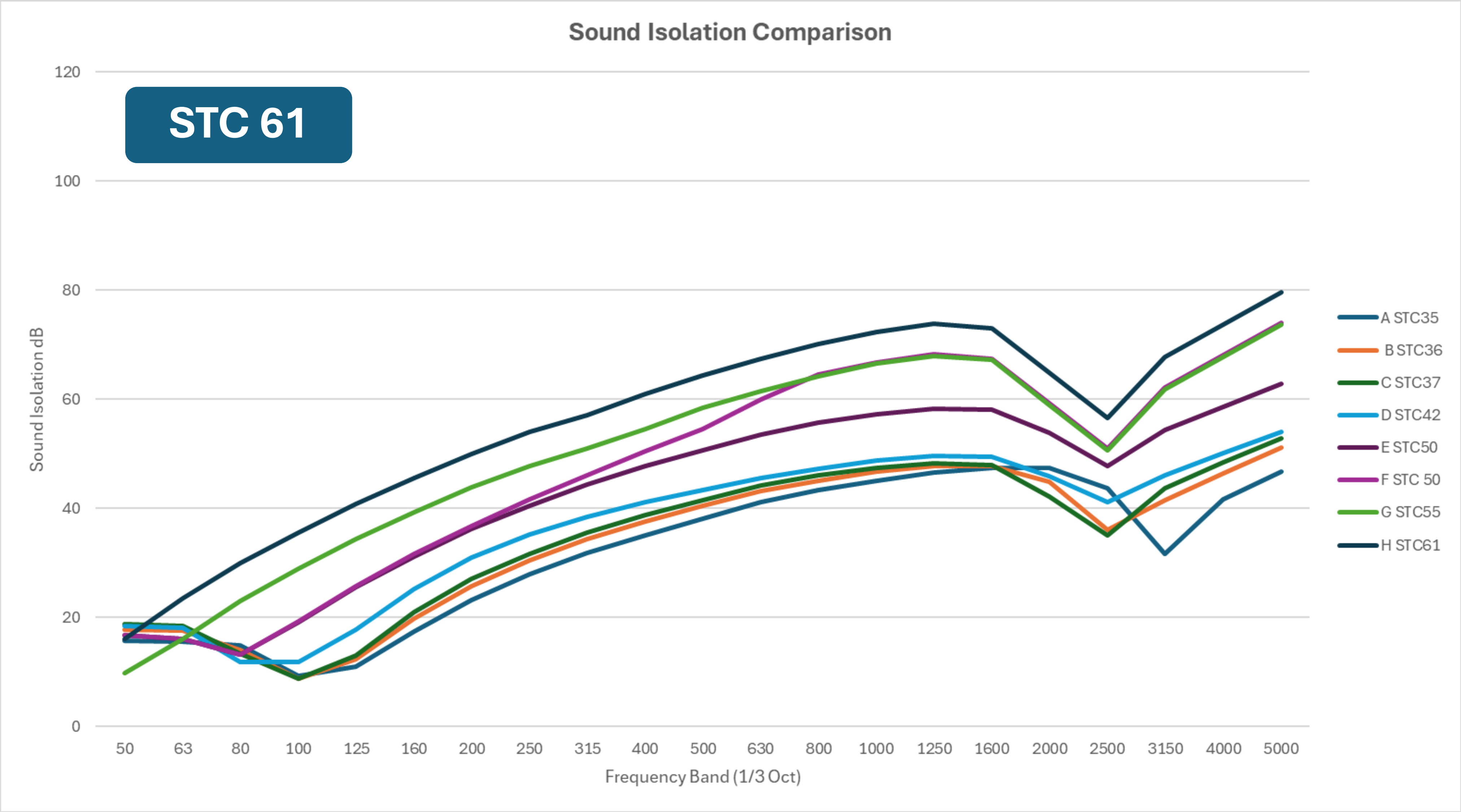
5/8” Type C
Insulation
5/8” Type C
Full Depth
Double Stud



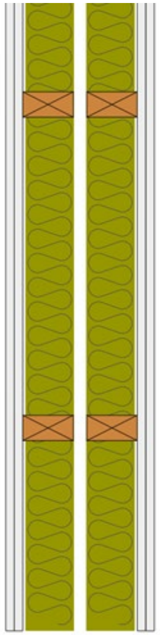
Sound Isolation



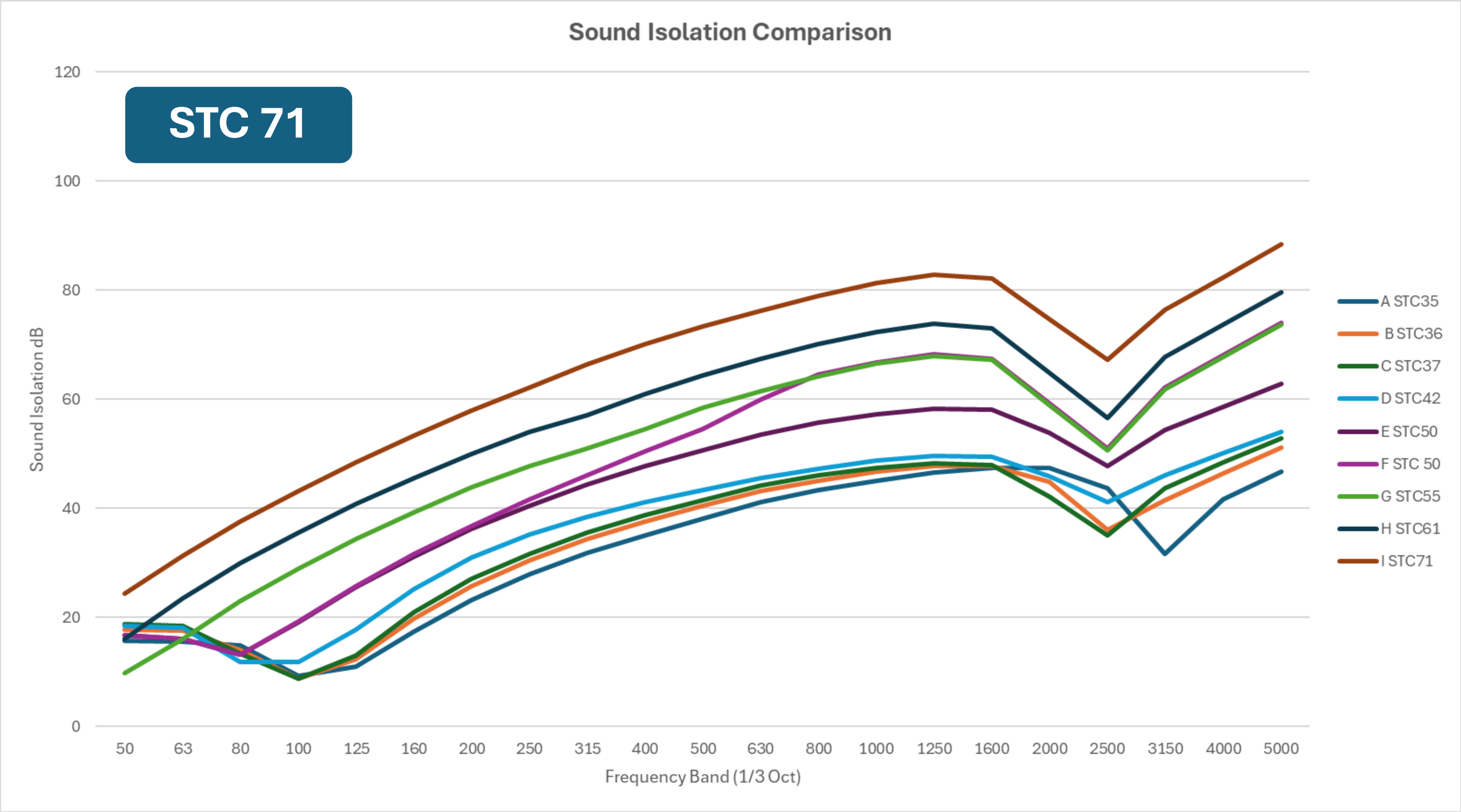
Double
5/8” Type C
Insulation
Single
5/8” Type C
Full Depth
Double Stud



Sound Isolation



Double
5/8” Type C
Insulation
Double
5/8” Type C
Full Depth
Double Stud



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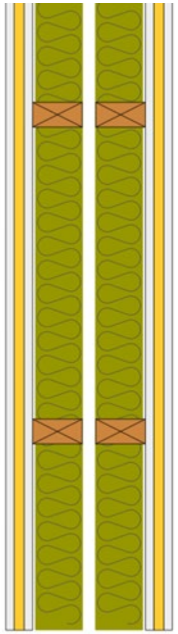
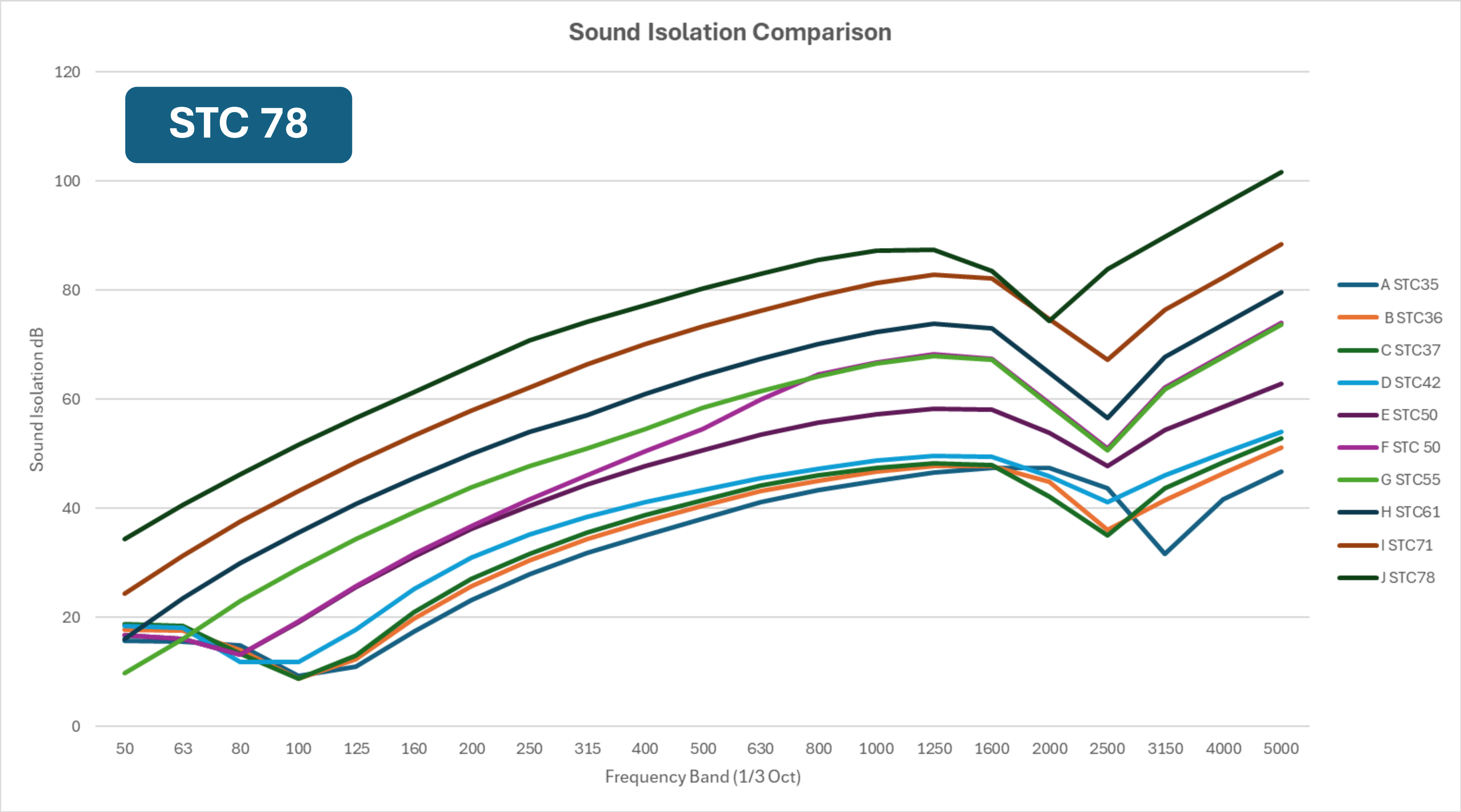
Sound Isolation



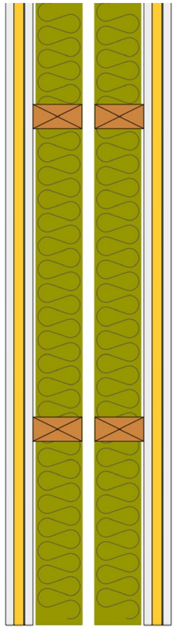
Double
5/8” Type C
MDF
Insulation
Double
5/8” Type C
MDF
Full Depth
Double Stud



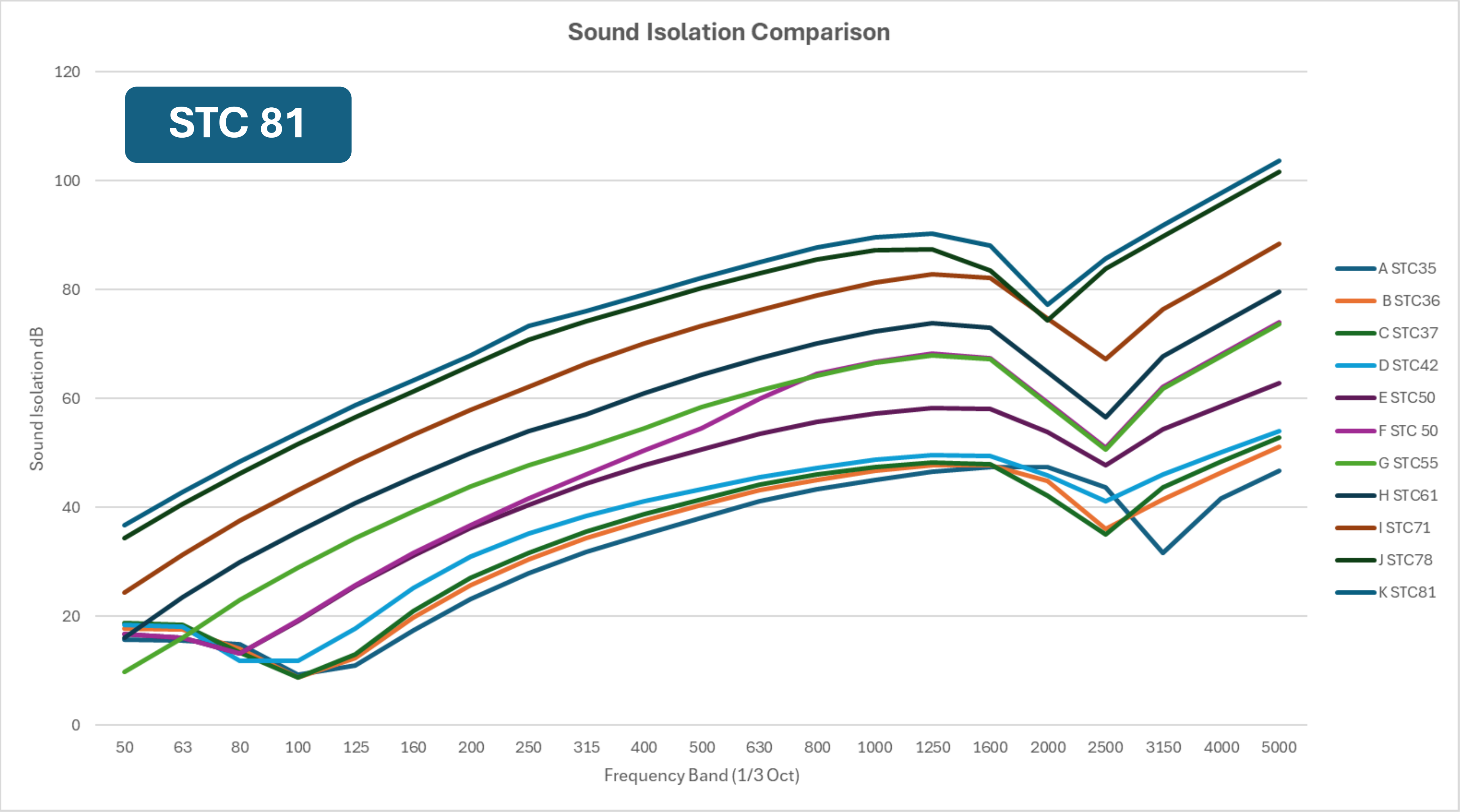
AUDIO ES AES

PILCHNER SCHOUSTAL INTERNATIONAL INC

Sound Isolation

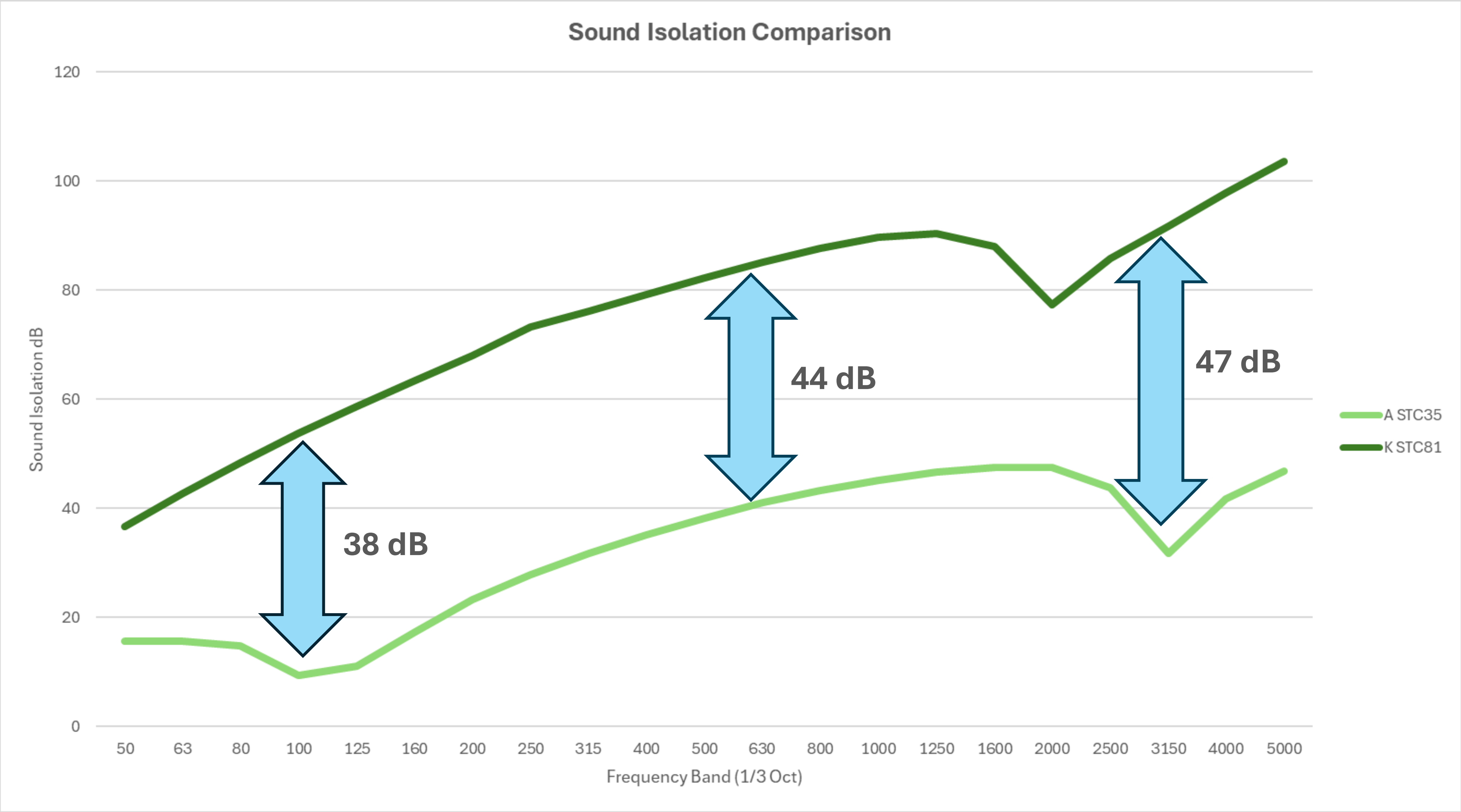


Double
5/8" Type C
MDF/MLV
Insulation
Double
5/8" Type C
MDF/MLV
Full Depth
Double Stud



AUDIO ES AES

Sound Isolation



Keeping the studio quiet

To be functional the studio should be capable of maintaining a low background noise.

This is often challenging given the context, budget and structural constraints of a typical residential setting.

Sound Isolation is the single most expensive part of building a studio.

Keeping the space quiet means protecting it from unwanted external noise sources and making sure there are no noise sources in the room.

Mechanical Noise

The isolated studio space requires air circulation for temp/humidity control and ventilation (fresh air). This usually means cutting holes in the room boundary sound isolation.

Despite the holes, we must maintain the sound isolation. This implies the openings should be protected and provide “insertion loss”.

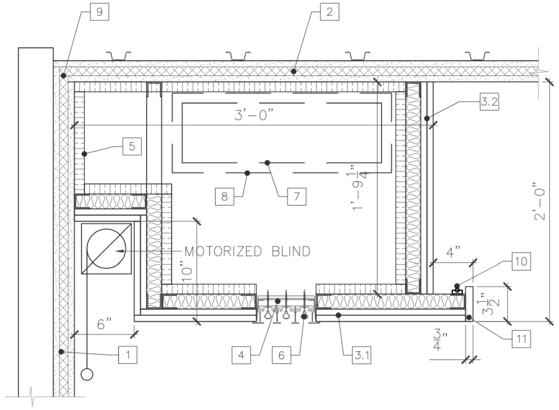
We cannot just connect sheet metal ductwork to the room, because we end up with our sound isolation being only as good as the ductwork.

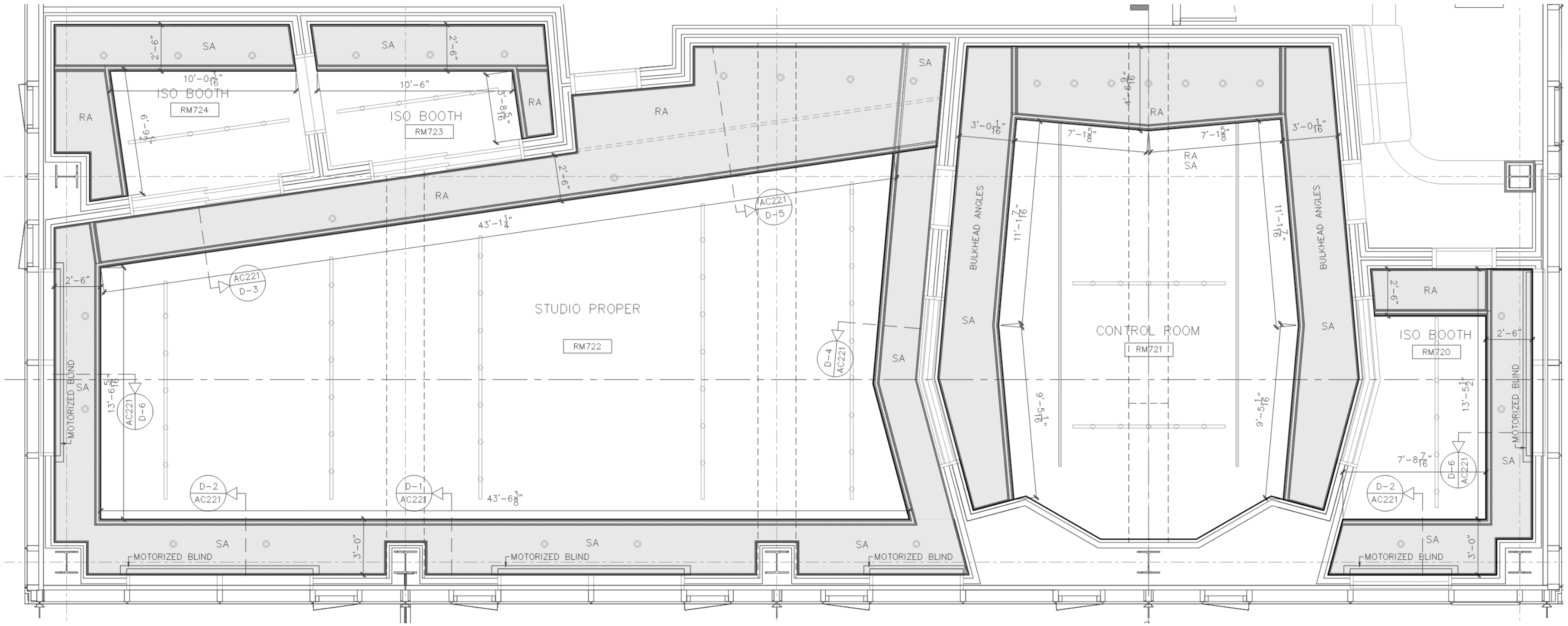
The duct work should have enough sound absorption to reduce the noise from the air handler, but also must be protected from any “Break-in” or “Break-out” noise near the opening.

Background Noise

Mechanical Noise

The ductwork is either lagged externally or special bulkheads are built in the space to silence the air path and protect the openings.





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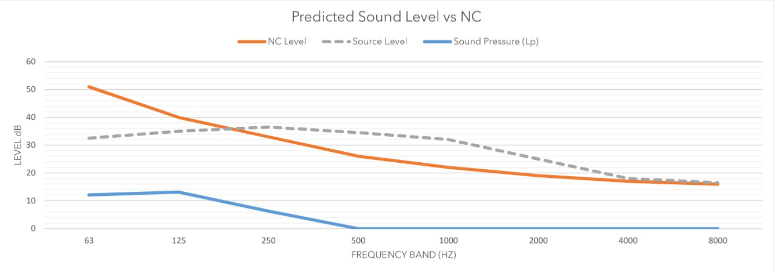
Background Noise

MECHANICAL SYSTEM NOISE PERFORMANCE										
	Edit green cells to input system information								Room Dimensions	
Project	Sarkara Recording					MFP	11.4		Length (ft)	26.7
Date	2024-09-03			**Unit ID**		AC-7-03			Width (ft)	22.6
Room	Control Room A (nearest terminal)			**System Side**		Supply Air			Height (ft)	10.6
PSII2022!										
Number of Terminals	4	Frequency Band	63	125	250	500	1000	2000	4000	8000
Power Split (%)	50	%	29.5	32.0	33.5	31.5	29.0	22.0	15.0	13.5
End Reflection	Terminated	20	9	5	2	1	0	0	0	0
Directivity	Q	1/2 Space	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Room Volume (ft³)	6396.252	Air Attenuation	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0029	0.0039
Room Surface (ft²)	2252		Room Effects							
Room Absorption	Medium Dead	Room Avg Alpha	0.26	0.27	0.18	0.25	0.30	0.36	0.42	0.46
Distance (ft)	4.6	Room Constant	586	608	405	563	676	834	1020	1136
Reverb Time (secs)	(Typical)	RT60	0.535	0.515	0.773	0.557	0.464	0.376	0.307	0.276
		Approx Duct Size (in)	Duct System Insertion Loss							
Main Duct	Length (ft)	72x72	0.1	0.1	0.05	0.2	0.2	0.2	0.2	0.2
For Custom Use Below	0	Set to 0 if Custom	0	0	0	0	0	0	0	0
Custom Width (in)	Custom Height (in)	Liner Thickness (in)								
20	8	1	0.38	1.16	2.57	5.87	12.44	12.69	8.59	5.38
Custom	Custom Length (ft)	3								
Duct Area (in²)	160	Air Velocity (ft/min)	720.00	Air Volume (ft3/min)		800	Air Flow Generated Noise			28.28
Branch 1	Length (ft)	48x48	0.15	0.1	0.07	0.2	0.2	0.2	0.2	0.2
For Custom Use Below	0	Set to 0 if Custom	0	0	0	0	0	0	0	0
Custom Width (in)	Custom Height (in)	Liner Thickness (in)								
12	8	1	0.54	1.75	3.96	8.52	18.14	19.66	12.78	7.38
Custom	Custom Length (ft)	4								
Duct Area (in²)	96	Air Velocity (ft/min)	600.00	Air Volume (ft3/min)		400	Air Flow Generated Noise			22.10
Branch 2	Length (ft)	24x24	0.25	0.2	0.1	0.03	0.03	0.03	0.03	0.03
For Custom Use Below	0	Set to 0 if Custom	0	0	0	0	0	0	0	0
Custom Width (in)	Custom Height (in)	Liner Thickness (in)								
12	8	1	1.08	3.49	7.91	17.04	36.28	39.32	25.56	14.76
Custom	Custom Length (ft)	8								
Duct Area (in²)	96	Air Velocity (ft/min)	600.00	Air Volume (ft3/min)		400	Air Flow Generated Noise			22.10
Elbow 1	Qty	Lined 10 > 20	0	1	5	16	18	16	17	17
	1		0	1	5	16	18	16	17	17
Elbow 2	Qty	Unlined 10 > 20	0	0	0	8	4	3	3	3
	1		0	0	0	8	4	3	3	3
Elbow 3	Qty	Unlined 10 > 20	0	0	0	8	4	3	3	3
	1		0	0	0	8	4	3	3	3
Elbow 4	Qty	Lined 10 > 20	0	1	5	16	18	16	17	17
	0		0	0	0	0	0	0	0	0
Flex Duct	Qty x3'	6"	2	3	4	8	10	10	7	5
	0	0	0	0	0	0	0	0	0	0
		Flex Length (Ft)	Additional Duct Silencers							
Primary Silencer			0	0	0	0	0	0	0	0
Secondary Silencer			0	0	0	0	0	0	0	0
			System Summary							
Source Level	Unit Noise Data (Lw)		32.5	35	36.5	34.5	32	25	18	16.5
Insertion Loss (IL)			11.0	12.4	21.4	64.4	92.9	93.7	69.9	50.5
System Level (Lw)	Source Level - IL	Sound Power (Lw)	18.5	19.6	12.0	0.0	0.0	0.0	0.0	0.0
Sound Pressure (Lp)	Thompson (calc)	Including Room Effects	12.1	13.2	6.3	0.0	0.0	0.0	0.0	0.0
NC Level	20	Allowable BKGD Noise	51	40	33	26	22	19	17	16
			Red cells indicate insufficient sound attenuation							
Net Result			**38.9**	**26.8**	**26.7**	**26.0**	**22.0**	**19.0**	**17.0**	**16.0**



Mechanical Noise

Insertion is calculated by taking the air handler noise and subtracting the attenuation of each mechanical system component to arrive at the expected level in the space.

This level is compared to the background noise criteria.

If adjacent spaces are sharing the same ductwork, the insertion loss is also calculated between spaces.

Environmental Noise

Environmental noise is external noise from weather such as wind/rain, or sources such as planes, trains, and automobiles.




Professional studios go to great lengths to mitigate these sources which may not always be possible in a residential setting.

There is less risk of this posing a problem in a residential setting compared to a large studio with session players on the clock where any interference or delay is costly.

Professional studios have a much lower tolerance for unwanted noise.

Adjacencies

Both commercial and home studios require diligence when considering adjacent spaces.

It is always best not to put quiet and noisy spaces next to each other.

Consider the studio to be both a quiet and noisy space.

Careful planning can leverage neutral spaces between critical adjacencies to achieve significant sound isolation.

Room Sound Quality

There are a number of factors which affect the sound quality of a studio space which include:

Room Modes

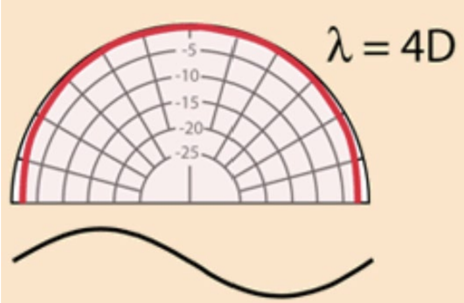
Boundary Interference

Specular Reflections

Decay Time

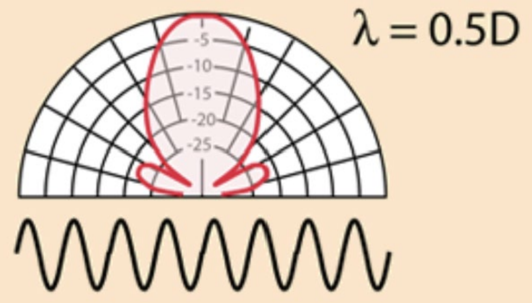
ETC - Energy Time Curve

Acoustics in small rooms have two distinct behaviors:



Where sound acts as a wave (LF)

Where sound acts geometrically (MF/HF)



The crossover between the wave and geometric behavior is often defined as the Schroeder frequency:

$$F_s = 2000\sqrt{T_{60}/V_{(m^3)}}$$

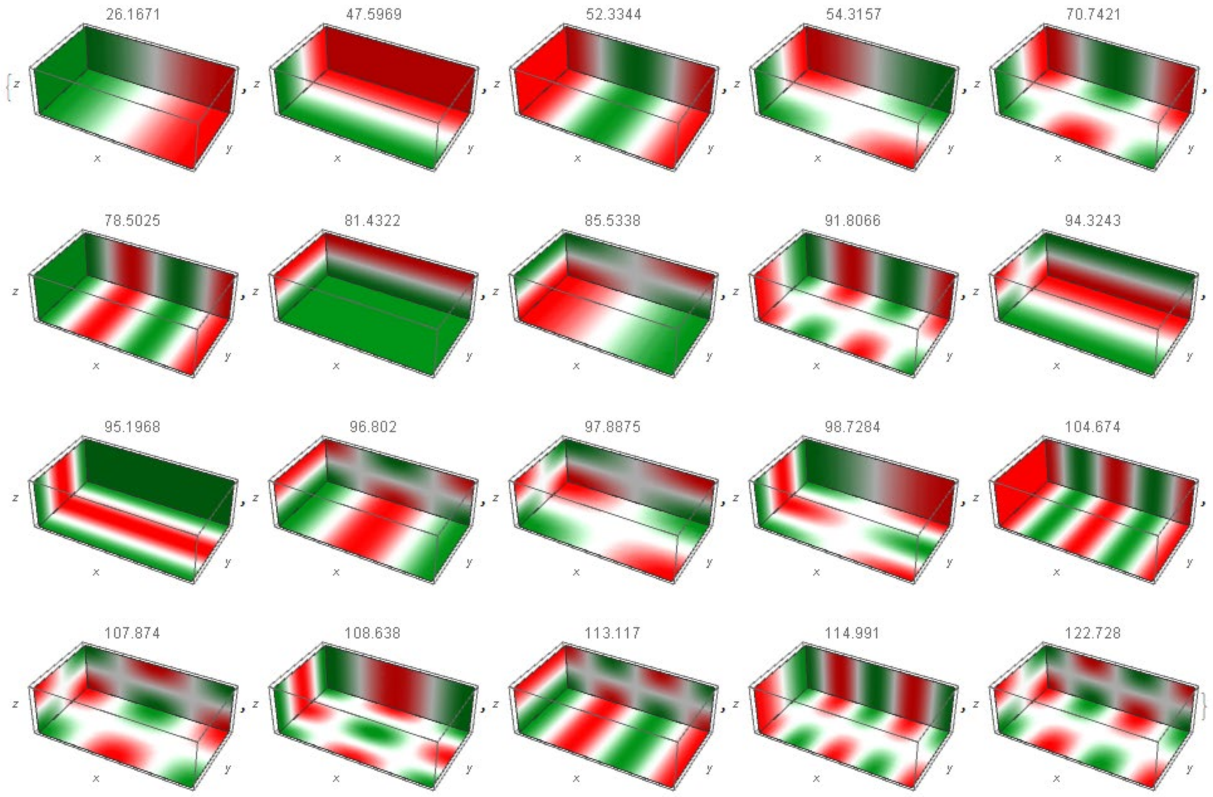
For most studios this falls between 150-300 Hz.

When considering psychoacoustic effects, 400 Hz is usually considered.

Room Sound Quality

Room Modes

Room modes, also known as standing waves or modal resonances, are the collection of resonant frequencies that occur in a room due to its dimensions and shape.



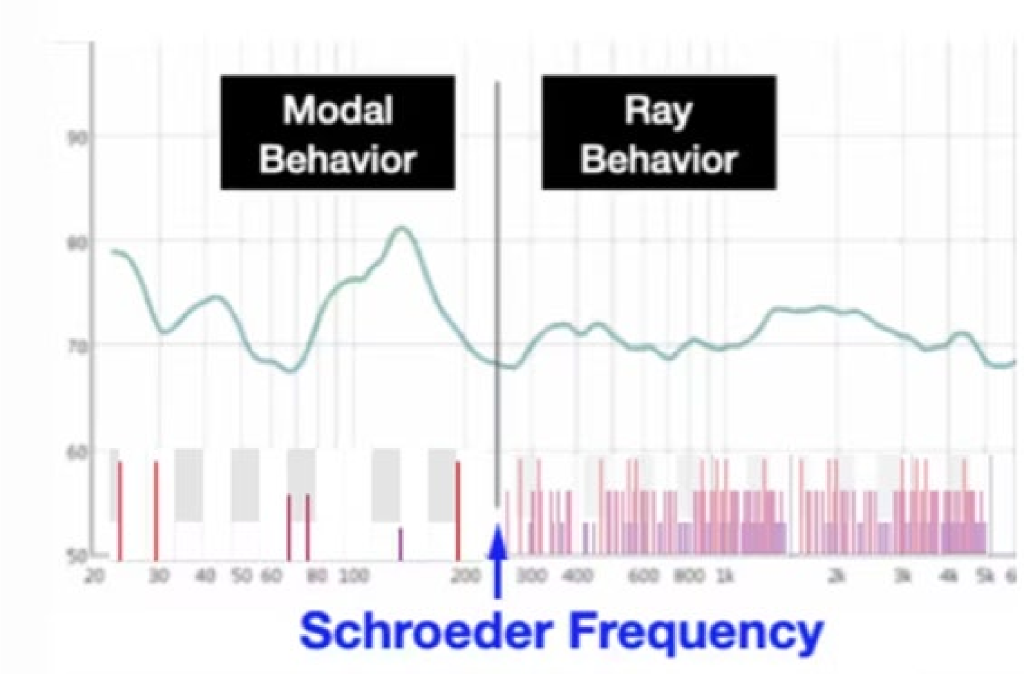
When the wavelength of a specific frequency coincides with a room dimension, a standing wave is created. This standing wave results in a specific pressure pattern in the room where the sound is louder or quieter as you move about spatially.

These "modes of vibration" occur in each direction at the fundamental frequency and its harmonics.

In a well isolated room, the pressure difference between the "peak" and "nulls" can be over 20 dB.

Room Modes

In small rooms modal behavior is important as it is high enough in frequency to be in the lower portion of the audible spectrum. In a typical studio space, there are a limited number of modes at low frequencies, making each more pronounced. At higher frequencies there are enough modes per octave to become far less critical not realistically perceivable.



For a typical studio mode distribution is examined from 300 Hz down.

How good a room is at low frequencies is related to the distribution of the modal fundamentals and harmonics.

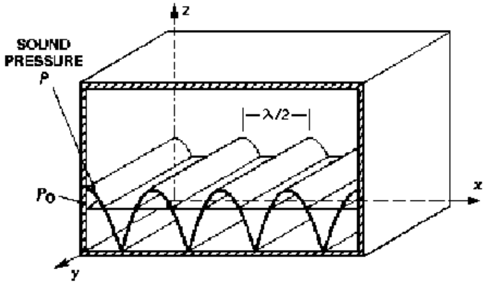
The number of modes should increase with frequency exponentially.

Any buildups or gaps in the frequency distribution highlight potential problems.

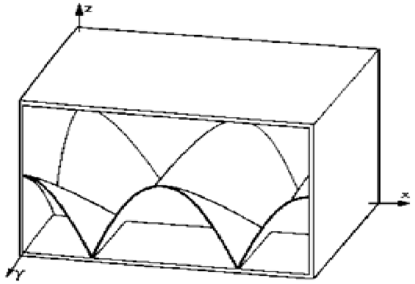
Room Modes

There are three types of modes considered:

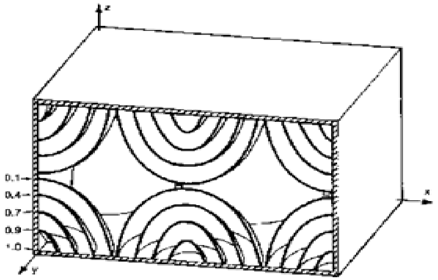
Axial modes are 1 dimensional modes that exist between opposing surfaces in one direction. These have the strongest influence on room response. They occur in each direction.



Tangential modes are resonances that occur in two directions at a time involving two pairs of opposing surfaces. They have about 6 dB less influence than an axial mode.

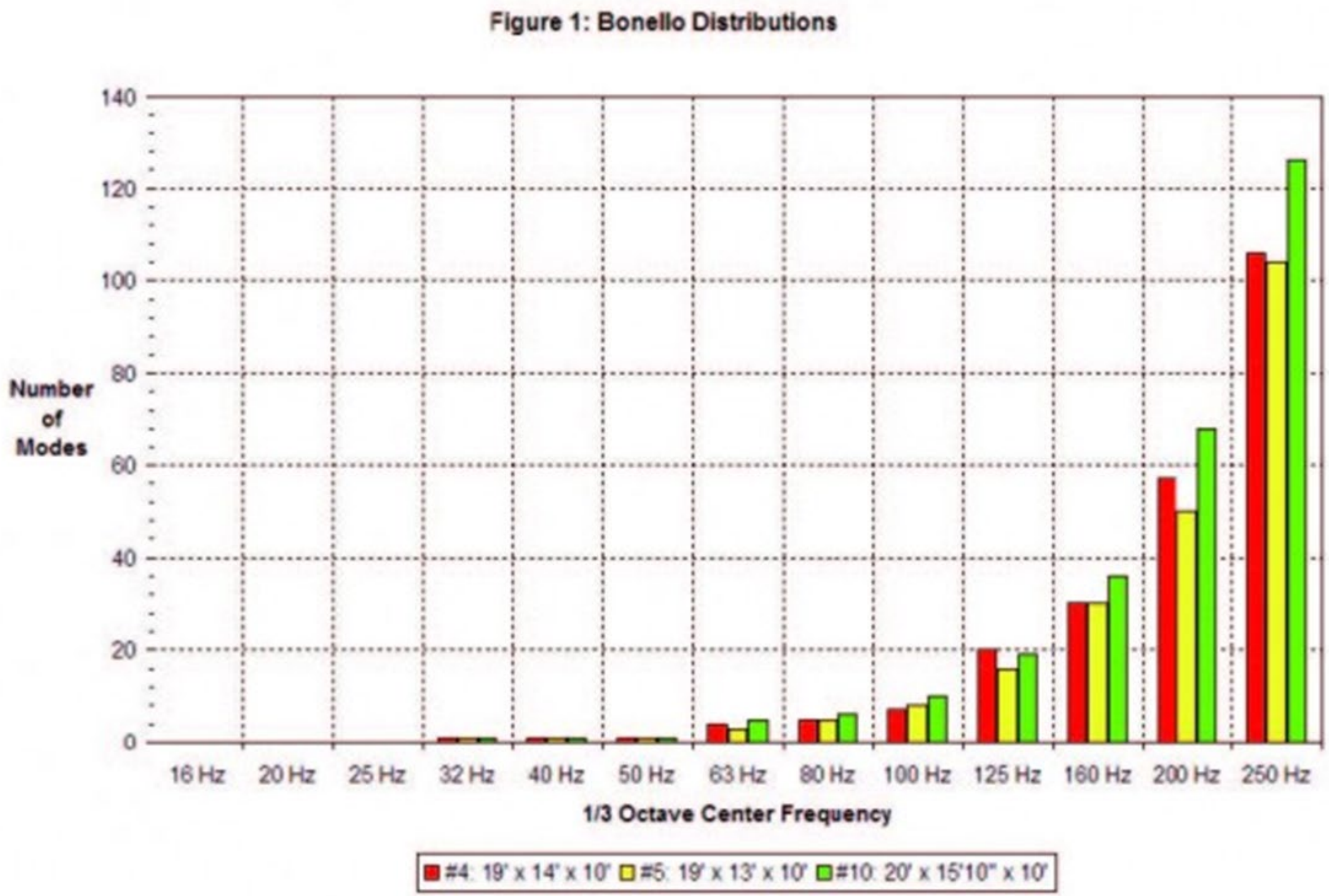


Oblique modes are resonances that occur in all three directions involving all the room surfaces. They have about 6 dB less influence than a tangential mode.



Room Modes

Ideal Modal Frequency Distribution:



Room Sound Quality

Room Modes

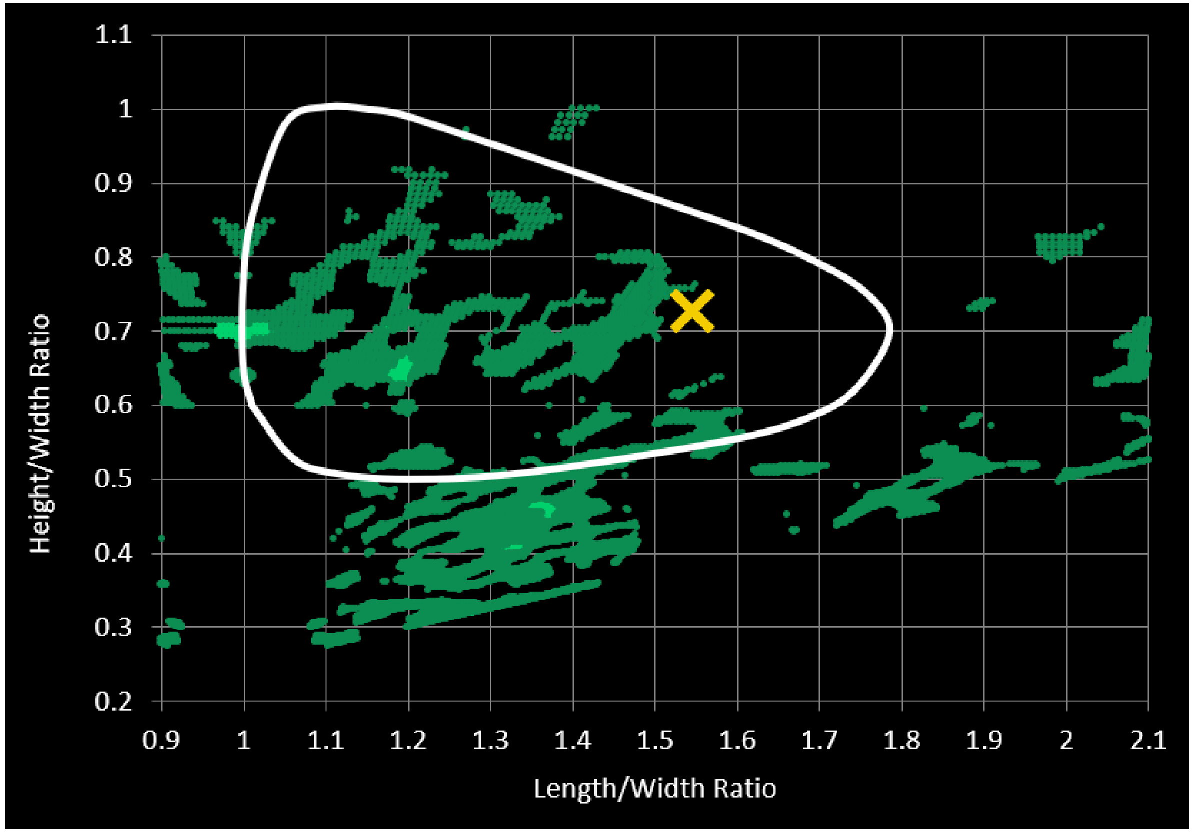
Well known Room Ratios:

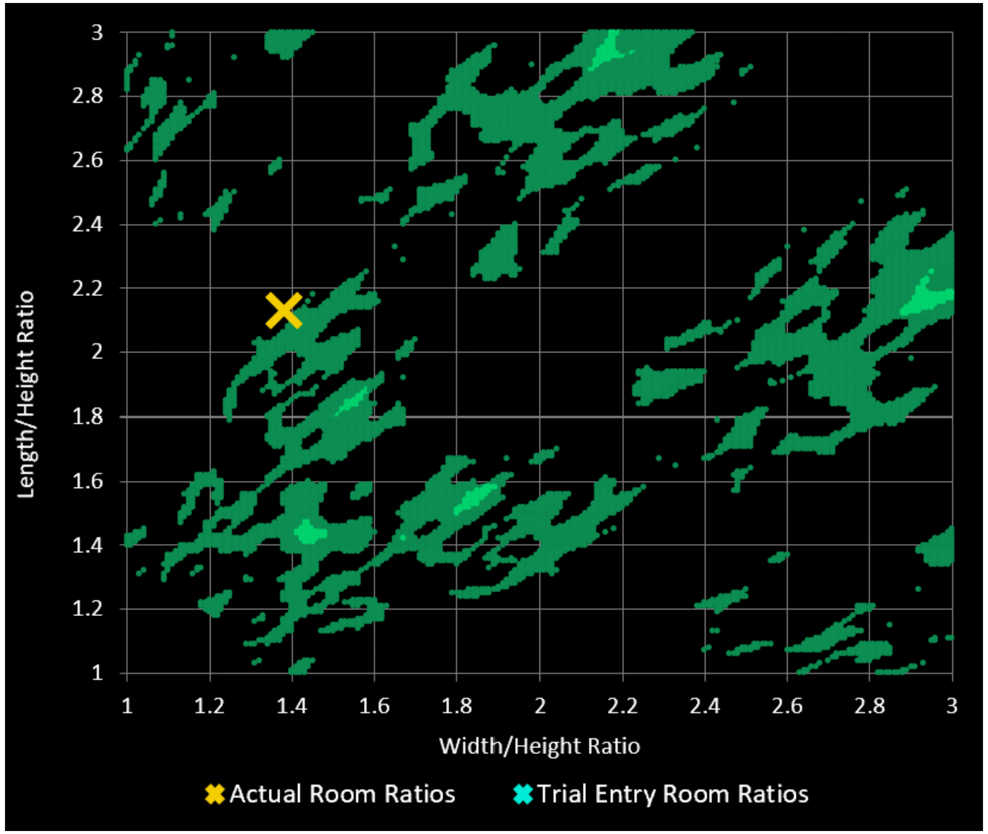
Source	H	W	L
J.E. Volkman, 1942	2.00	3.00	5.00
C.P. Boner, 1943	1.00	1.26	1.59
L. W. Sepmeyer, 1965	1.00	1.14	1.39
L. W. Sepmeyer, 1965	1.00	1.28	1.54
L. W. Sepmeyer, 1965	1.00	1.60	2.33
M. M. Louden, 1971	1.00	1.40	1.90
M. M. Louden, 1971	1.00	1.30	1.90
M. M. Louden, 1971	1.00	1.50	2.10
Richard H. Bolt, 1946	1.00	1.50	2.50
Richard H. Bolt, 1946	1.00	1.26	1.59
IEC 60268-13, 1998	1.00	1.96	2.59
The Golden Ratio	1.00	1.62	2.62
Dolby Lab Recommendations	1.00	1.49	2.31
Worst ratio (RPG Inc.)	1.00	1.07	1.87

Room Sound Quality

Room Modes

Acceptable Room Ratios (Salford University):





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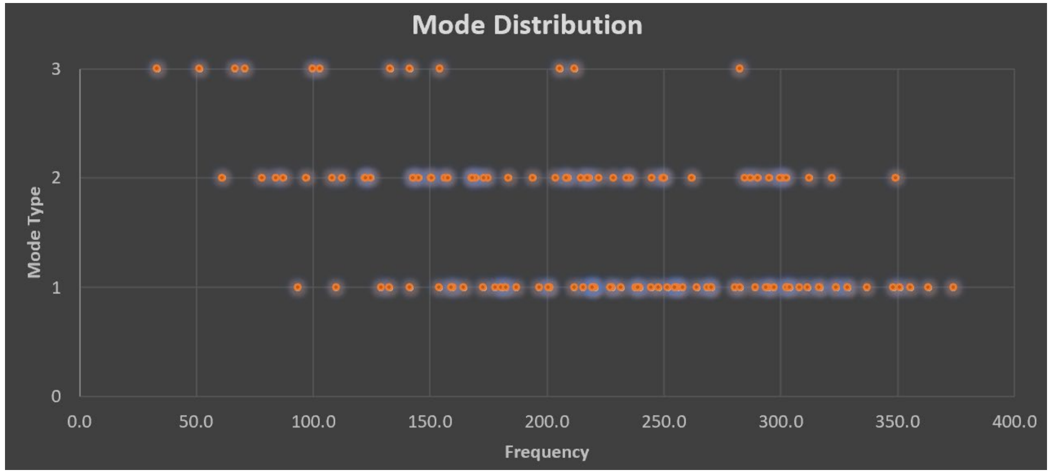
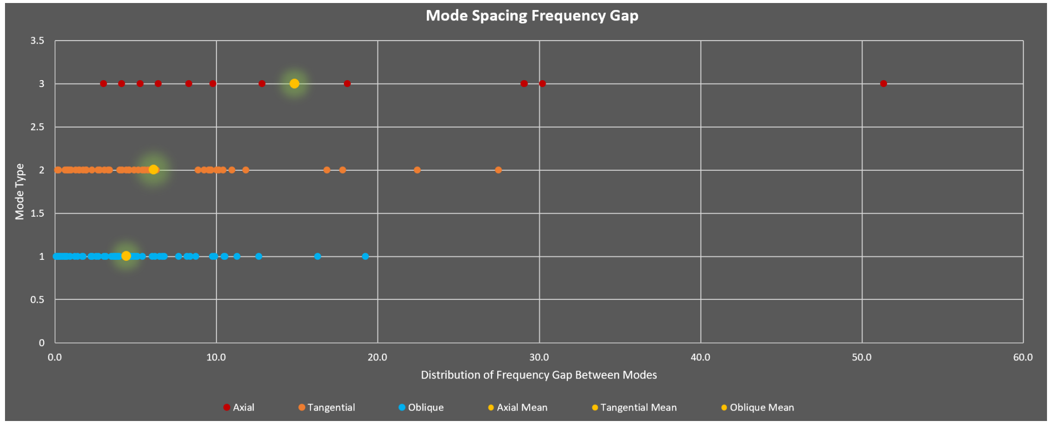
Room Sound Quality

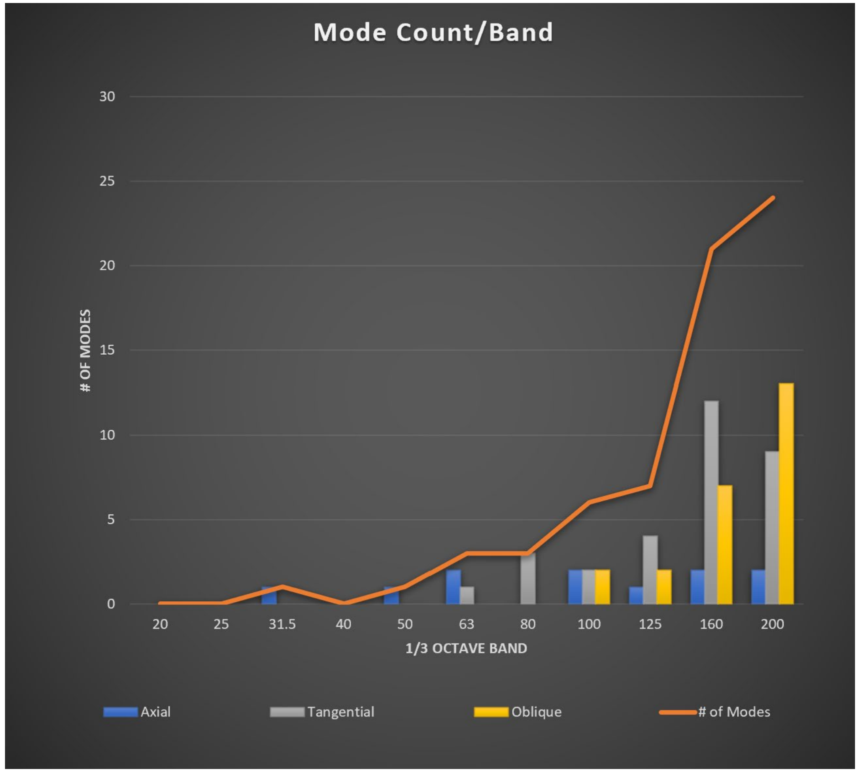
Room Modes

Typical modal frequency distribution would look like this:

Room Dimensions	
Length	17
Width	11
Height	8







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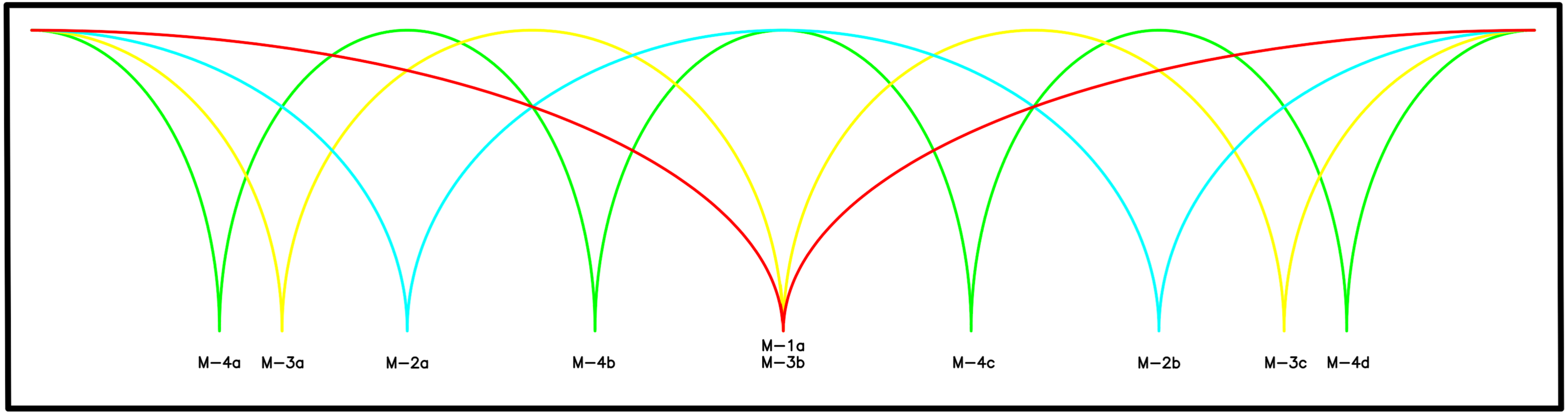
Room Sound Quality

Room Modes

It is important to track the null points in relation to the Speaker location and mic position:

Room Dimensions	
Length	17
Width	11
Height	8

AXIAL MODE SPATIAL NULL POINT DIMENSIONS



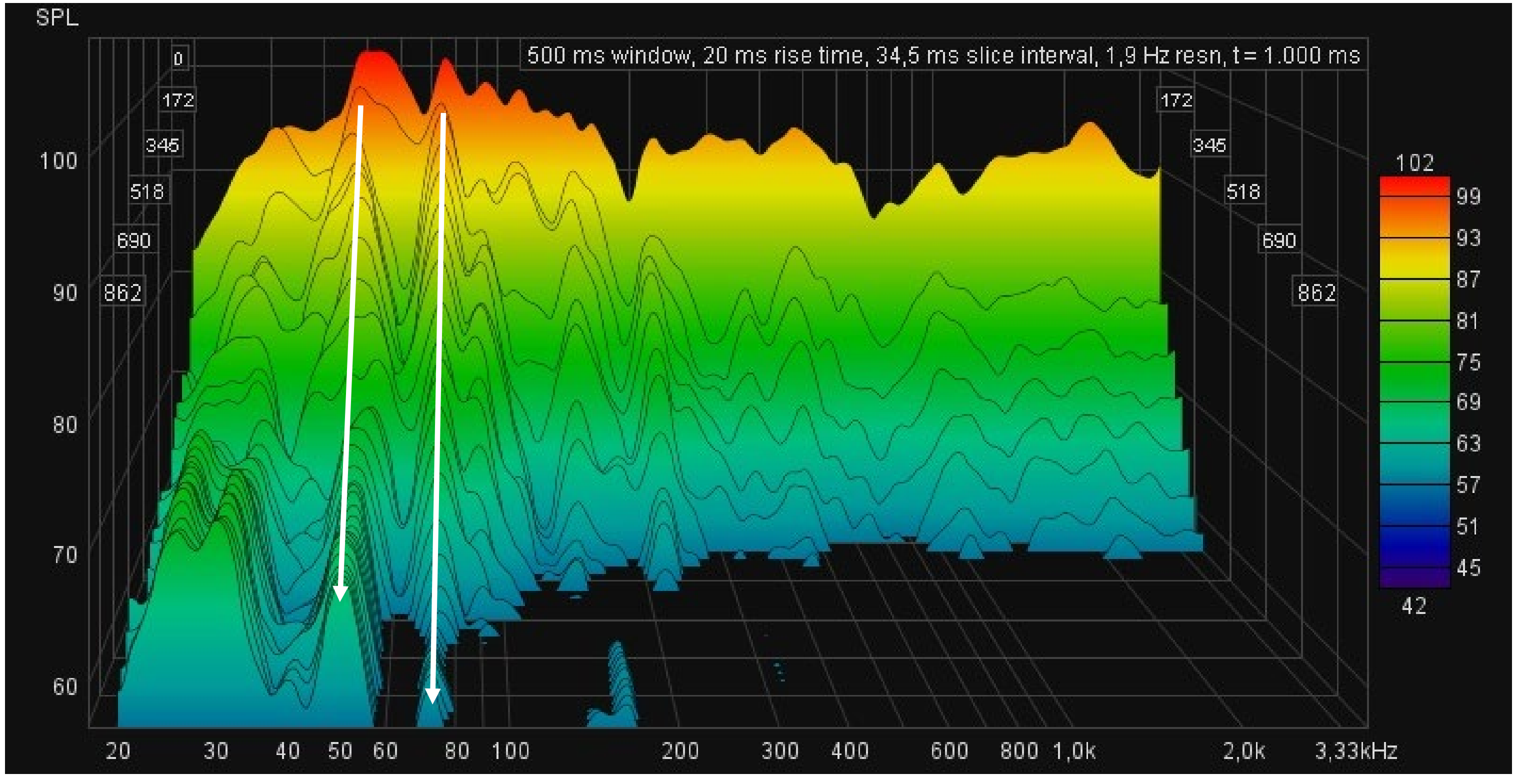
AXIAL Mode Null Point location (Shown in Feet for each direction)

Length	2.13	2.83	4.25	6.38	8.50	10.63	12.75	14.17	14.88
Width	1.38	1.83	2.75	4.13	5.50	6.88	8.25	9.17	9.63
Height	1.00	1.33	2	3.00	4.00	5.00	6	6.67	7.00

AUDIO ES AES

Room Modes

The room resonant response will favor these modal frequencies, and they will affect the low frequency decay time.

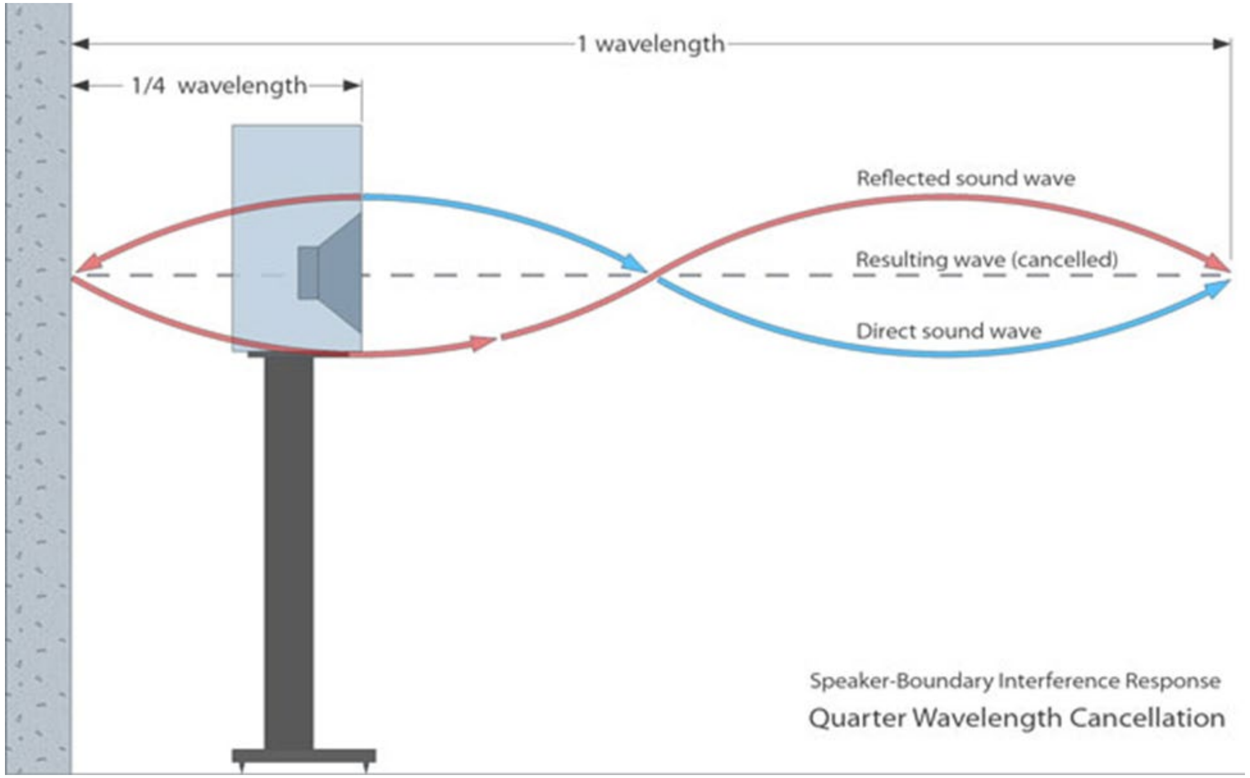


The bandwidth of the mode is also affected by the room reverb time:

$$BW = 2.2 / T_{60}$$

Boundary Interference

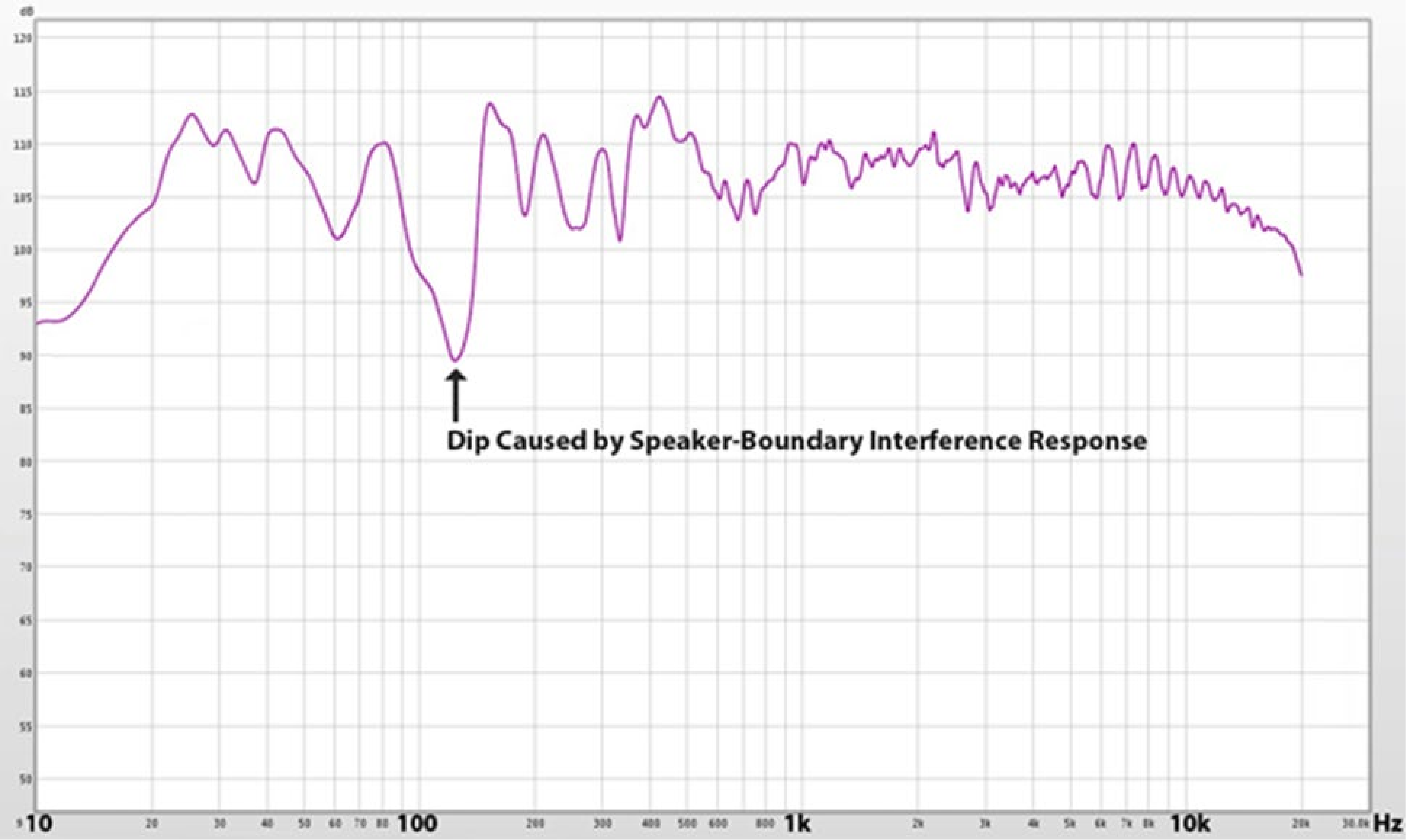
Speaker Boundary Interference Response (SBIR) refers to the phenomenon where sound waves from a speaker interact with nearby boundaries, such as walls, floors, and ceilings. This interaction can cause significant changes in the sound quality, particularly in the bass frequencies.



When a speaker is placed near a boundary, the direct sound wave from the speaker and the reflected sound wave from the boundary can interfere with each other. This interference can be constructive (amplifying) or destructive (canceling out certain frequencies), leading to peaks and dips in the frequency response.

Boundary Interference

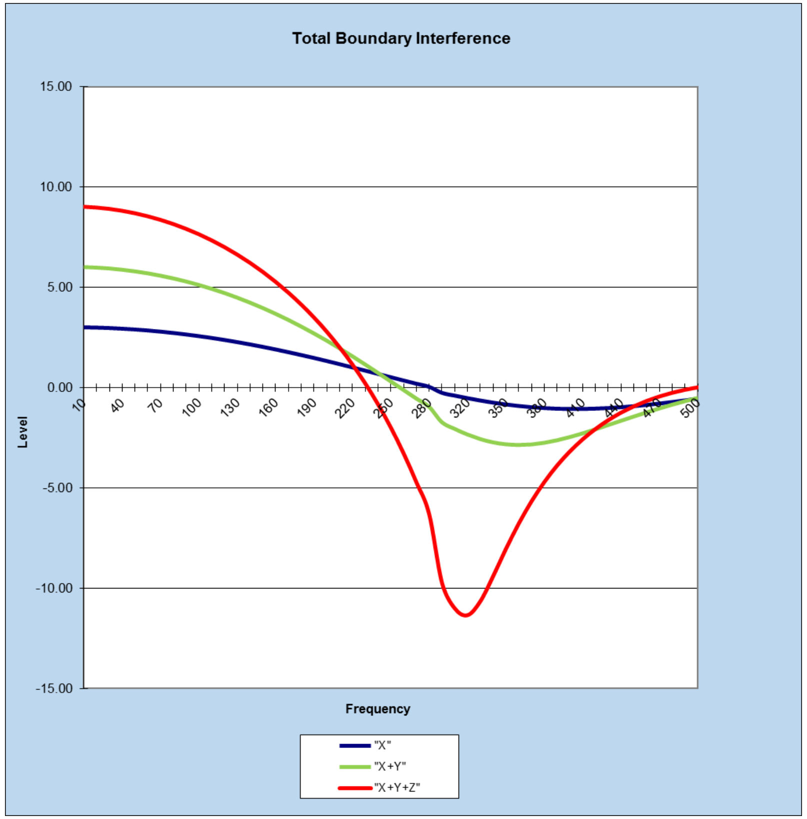
Example of boundary interference:



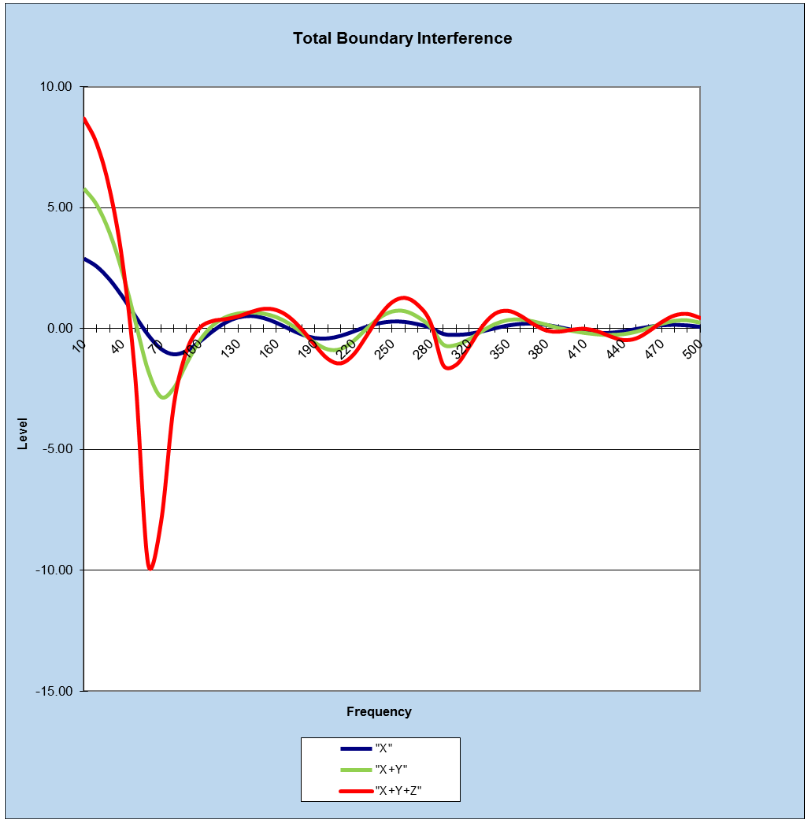
Boundary Interference

Boundary interference calculations:

x / y / z = 1’ / 1’ / 1’



x / y / z = 5’ / 5’ / 5’

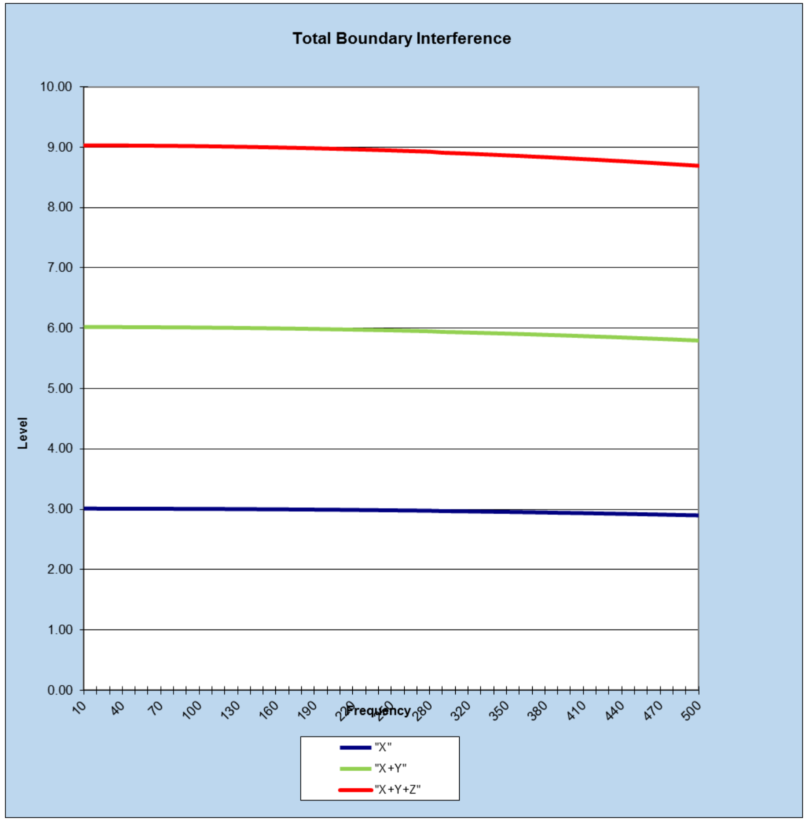


Room Sound Quality

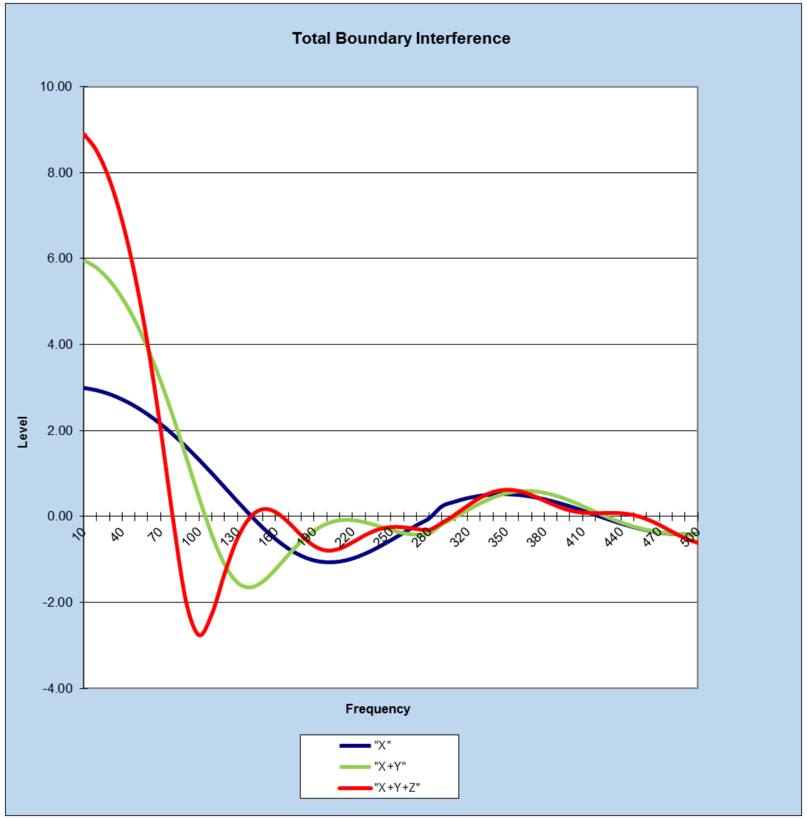
Boundary Interference

Boundary interference calculations:

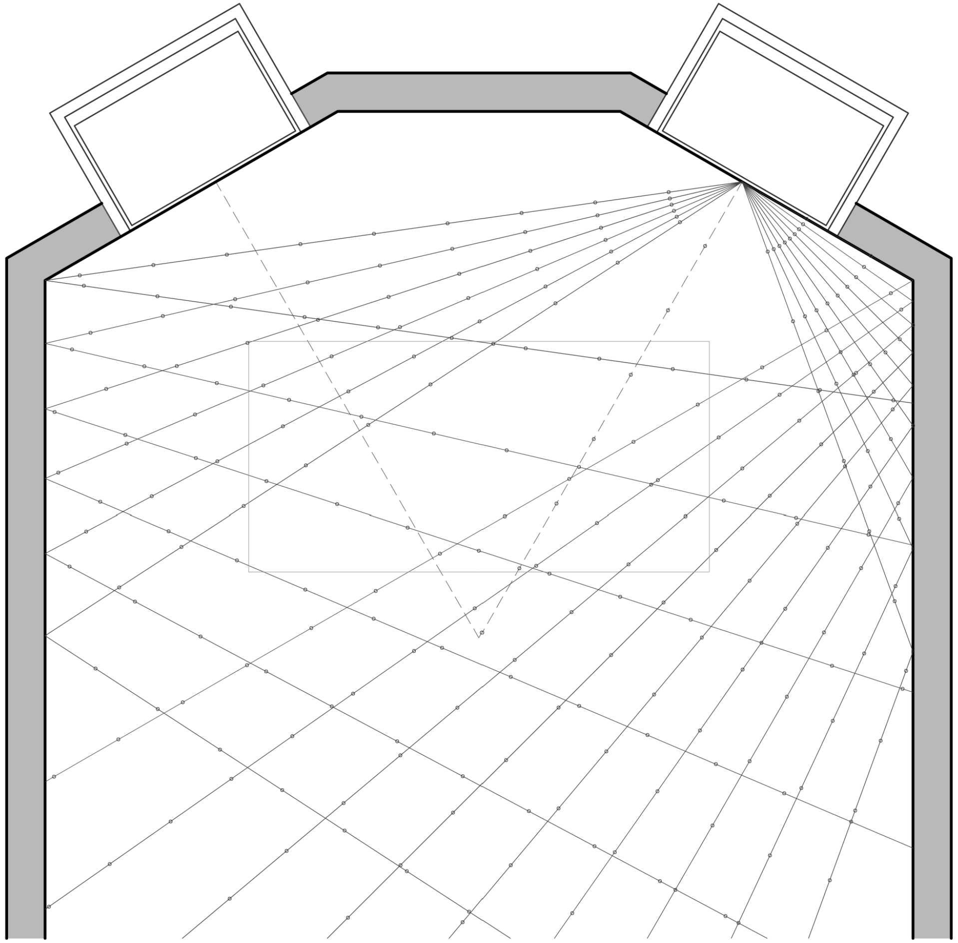
x / y / z = .1’ / .1’ / .1’



x / y / z = 2’ / 3’ / 4’



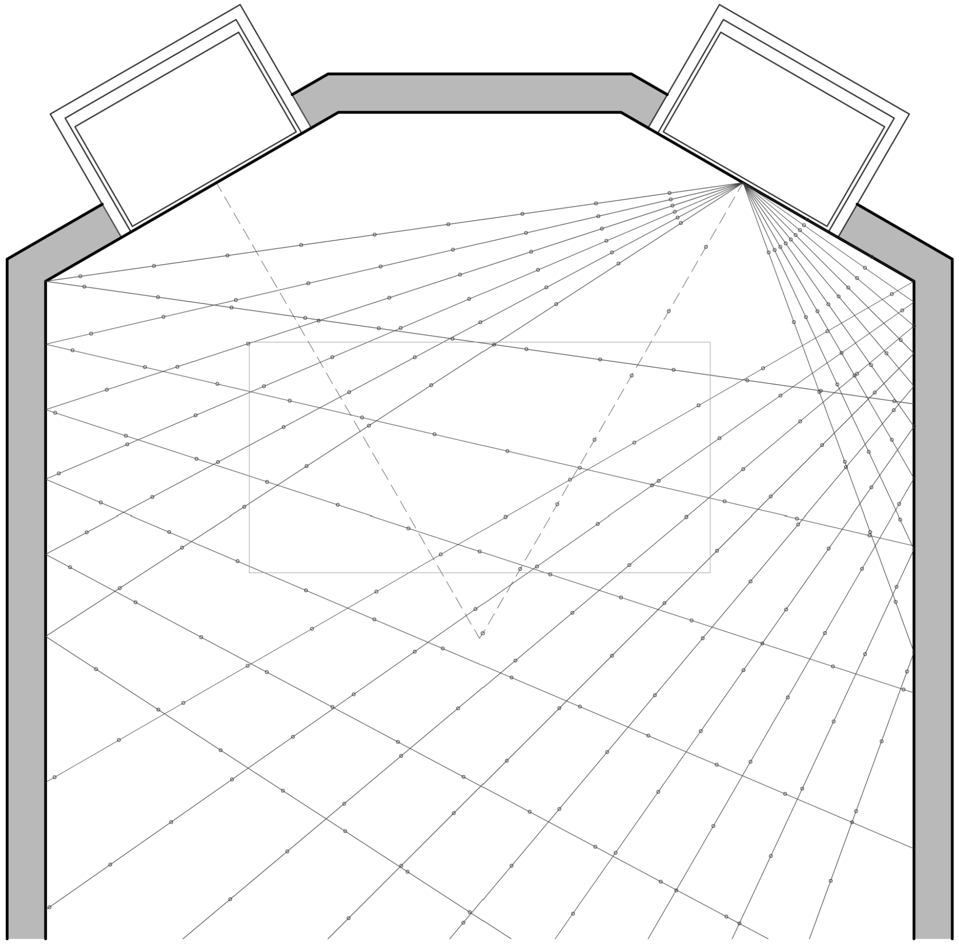
Specular Reflections



Specular reflections occur when sound waves hit a smooth, flat surface and reflect off at an angle equal to the angle of incidence, much like light reflecting off a mirror. These reflections can significantly impact the sound field at a listening position.

These reflections can cause constructive and destructive interference, leading to peaks and dips in the frequency response at the listening position. This can result in certain frequencies being overly emphasized or diminished, affecting the overall balance of the sound.

Specular Reflections



Reflection Mask Threshold (RMT) is the level difference required for a reflection to be masked (unnoticeable)

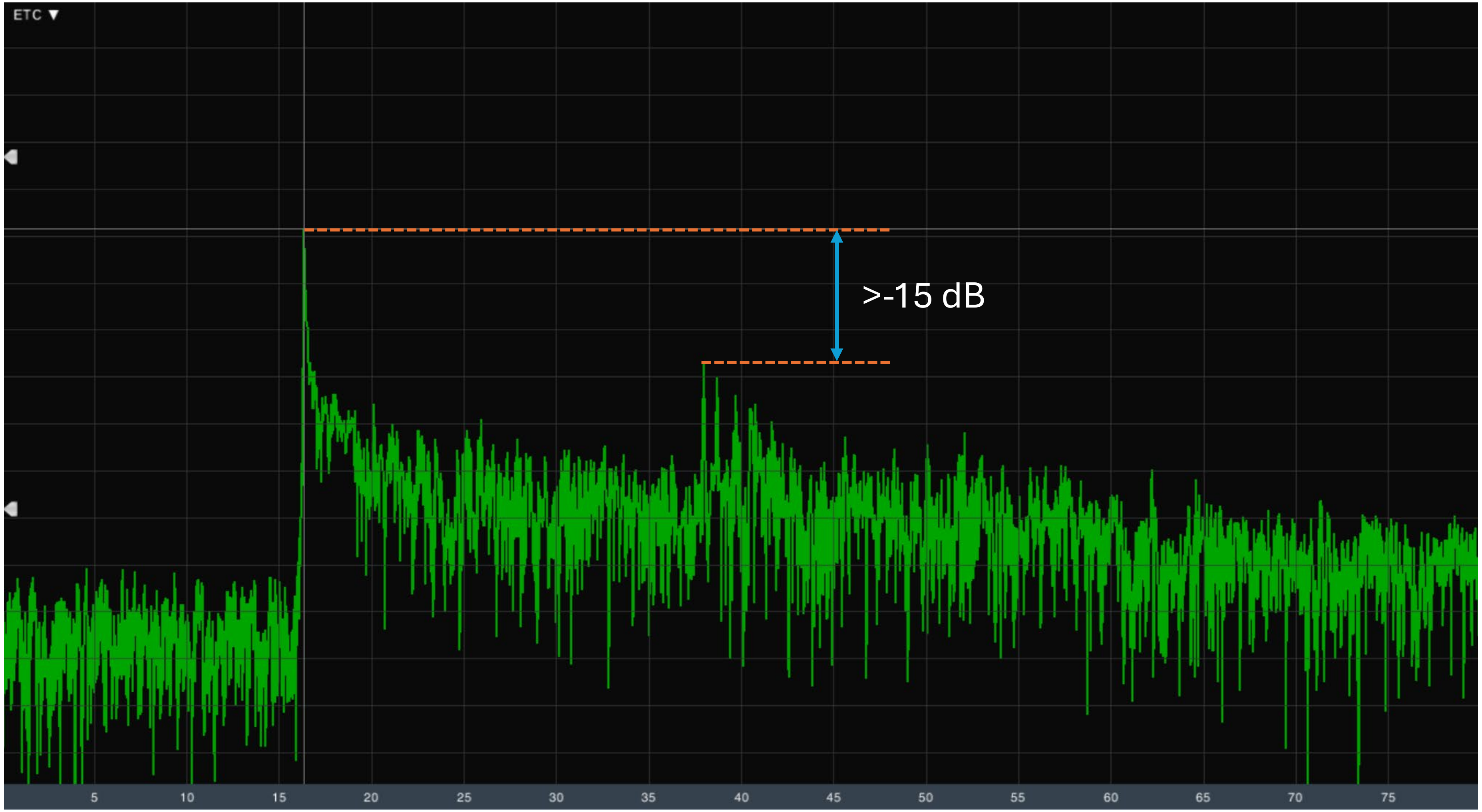
In an anechoic space this is about -50 dB, for a typical studio it is about -20 dB.

The more isolated the reflection – the more noticeable.

The closer the reflecting surface, typically the higher the level. A reflection from a surface twice as far as the direct energy would typically be only -6 dB.

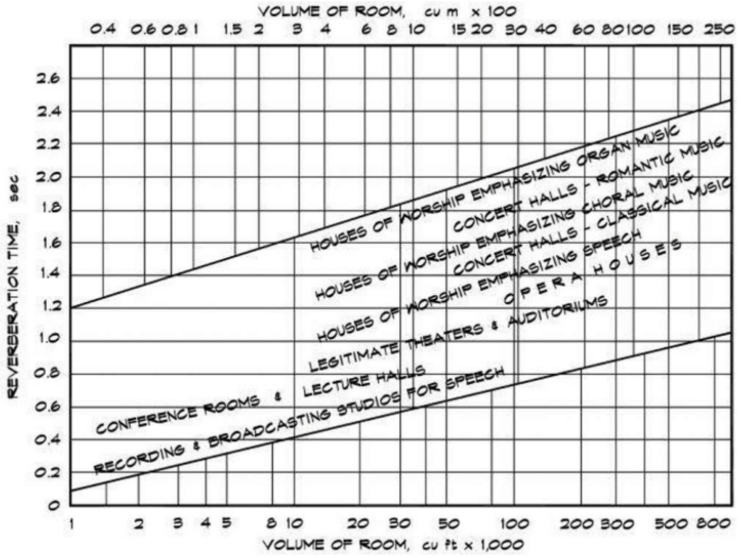
Room Sound Quality

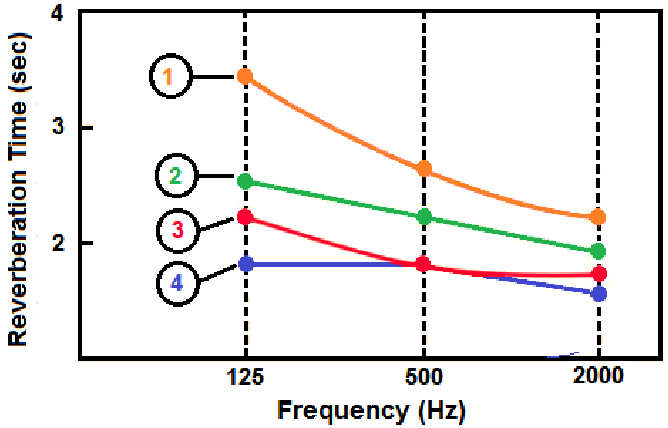
Specular Reflections



For minimal interference a good practice is to ensure specular reflections are at least -15dB down from the direct energy

Decay Time





1 - Royal Albert Hall, London
2 - Kennedy Center, Washington
3 - Symphony Hall, Boston
4 - Carnegie Hall, New York

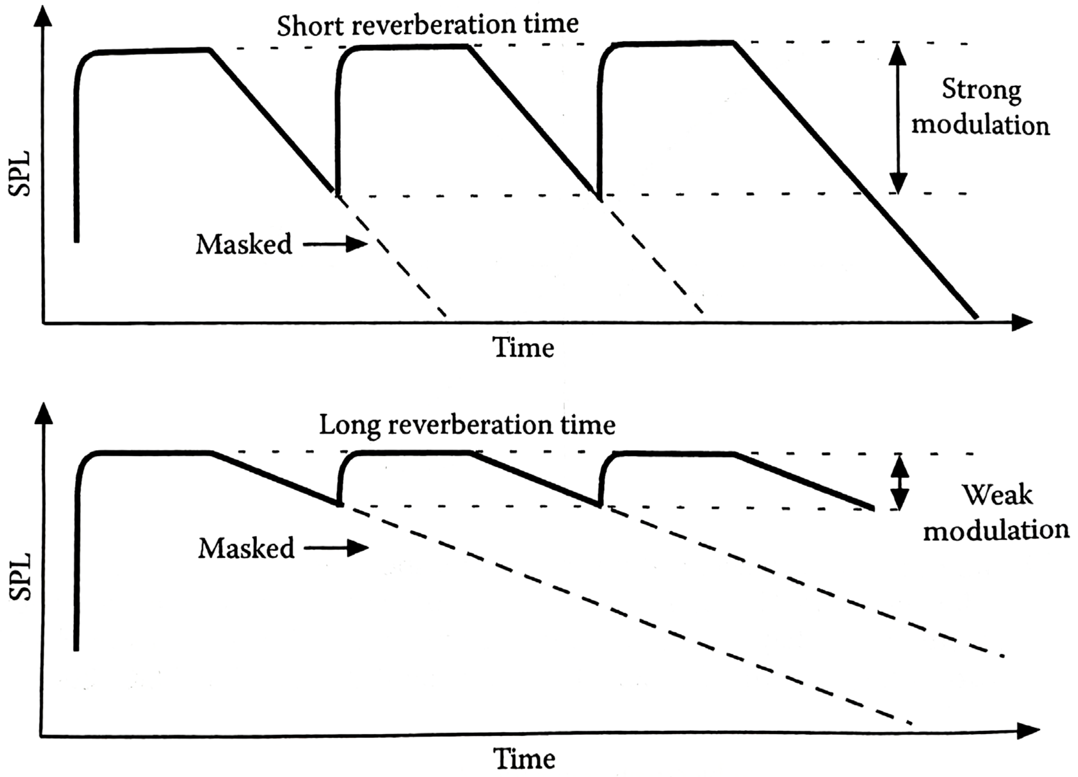
Decay time is affected by the size of the room and tailored to it intended use.

For larger spaces with more volume the decay time is longer.

Also, for large spaces, having a longer LF decay time than MF/HF decay time adds to the warmth perception of the space which is desirable for music performance.

In a small space, long decay affects the Modulation Transfer Function (MTF) which affects the ability to accurately hear the live or recorded content.

Decay Time



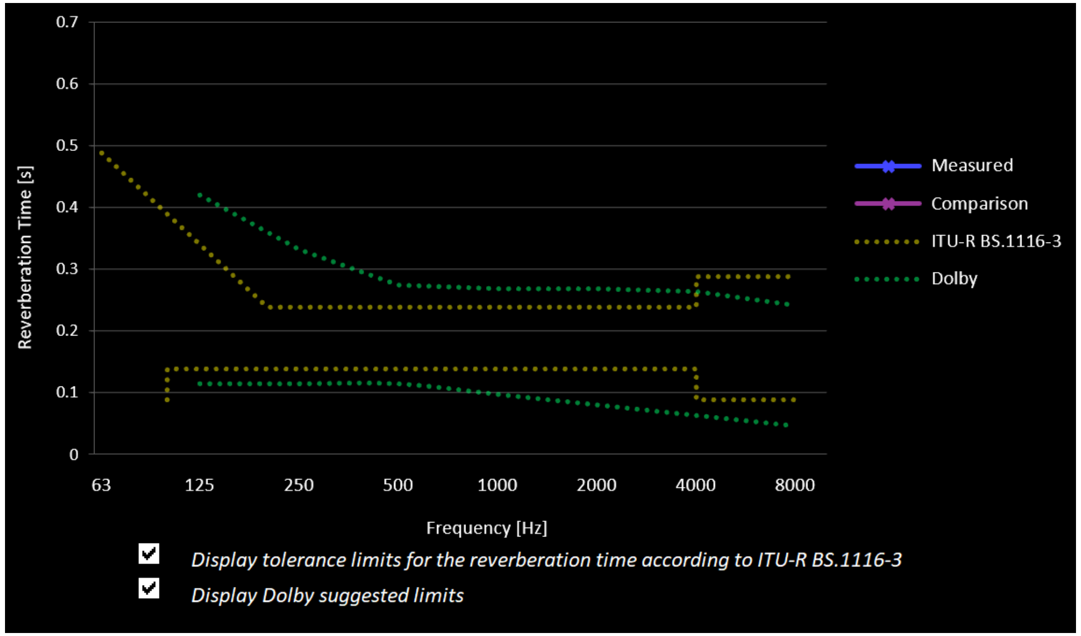
MTF describes the extent to which the modulation (variations in amplitude) of a sound signal is preserved as it travels from the source to the receiver within a room.

Higher MTF values indicate better preservation of the modulation and, consequently, better performance. Lower values suggest that the room's acoustics are degrading the signal.

A critical space would have MTF values over 0.7.

Room Sound Quality

Decay Time



There are established criteria for target decay time.

For a studio space generally the more uniform the decay time the better.

This implies the decay time is similar between the LF, MF, and HF and they are all relatively short.

This involves a good amount of LF damping to achieve. This damping is also significantly helpful in reducing modal resonances.

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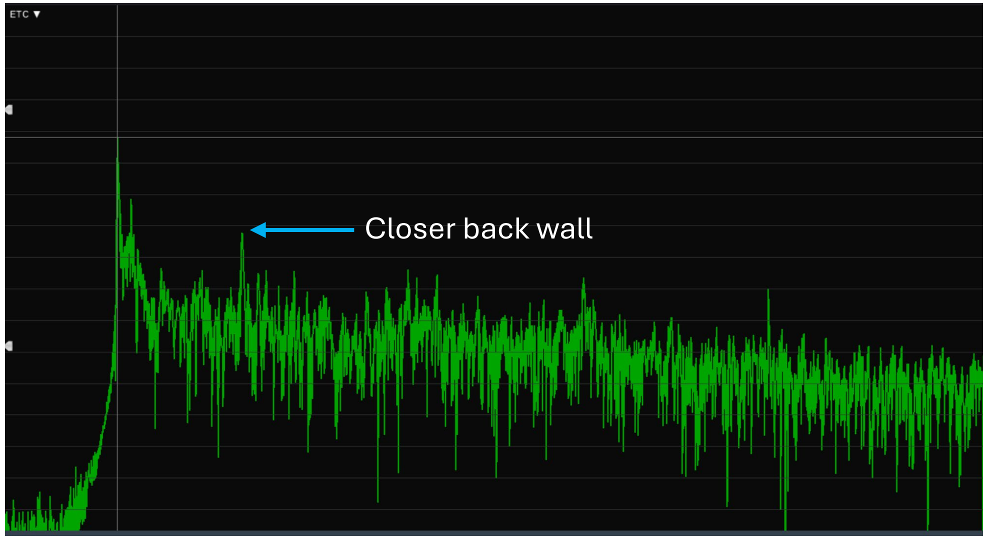
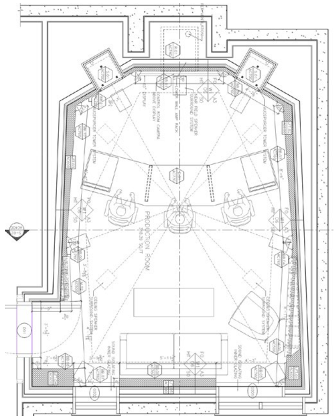
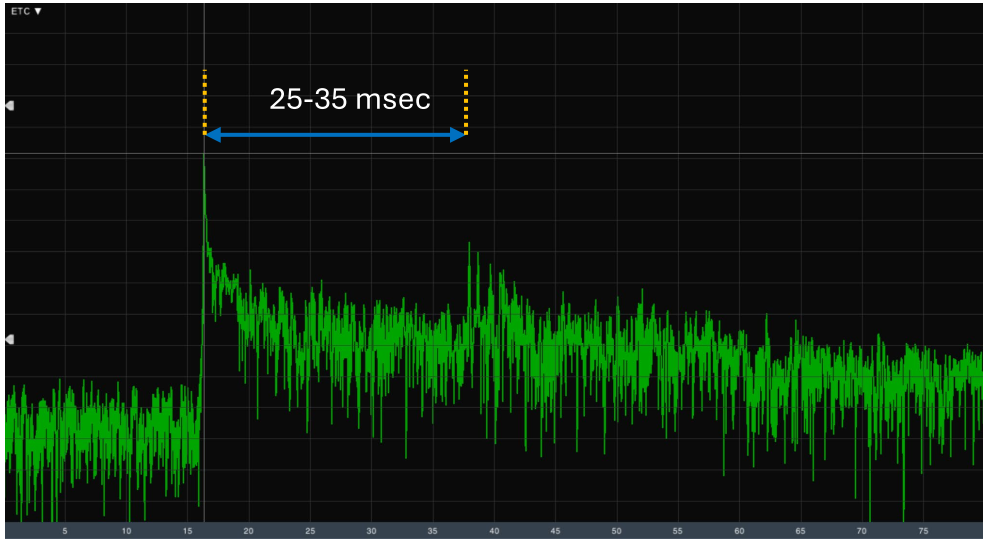
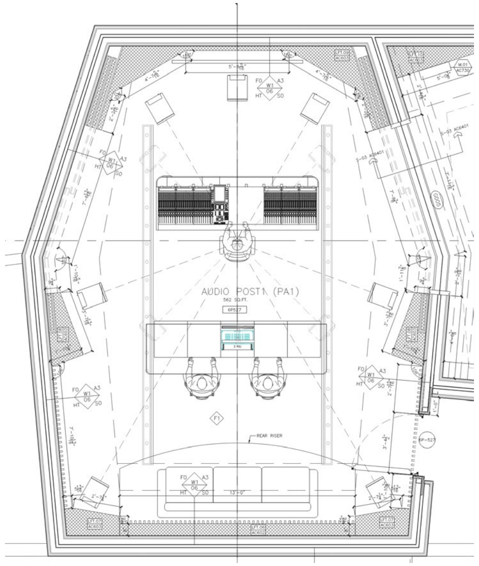
Room Sound Quality

Size vs ETC









A modern professional control room should provide primarily direct energy to the listening position and preferably have a 25-35 msec ITD gap prior to the onset of a diffuse sound field.

This requires minimum 12-15 feet of distance behind the mix position which cannot be realized in smaller spaces.

Room length is favored over room width.

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Look/Feel & the Creative Act

Design and Meaning

Who is the space intended to serve?

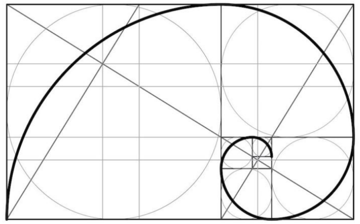
Constituent or Transitory

Is it an honest feature, or is it a gimmick?

Perceptual Tools:

- Composition
- Materiality
- Light
- Color
- Tactility
- Smell
- Sound

Multi-modal perception



Look/Feel & the Creative Act

Design and Meaning

"The ultimate pleasure of design is that impossible moment when an architectural act, brought to excess, reveals both the traces of reason and the immediate experience of space." (Bernard Tschumi)

"a place is not so simple as its locality, but consists of concrete things which have material substance, shape, texture, and color, and together coalesce to form the environment's character, or atmosphere."

" recording studios are not always in the background nor environmental in character, as they call attention to themselves throughout the recording process," (Eliot Bates ARP Journal)

Look/Feel & the Creative Act

Crawford Sound, Montreal, Quebec

Look/Feel & the Creative Act

Hyperreal Overkill, Pickering

Look/Feel & the Creative Act

Sanders Recording, Boston Mass

Look/Feel & the Creative Act

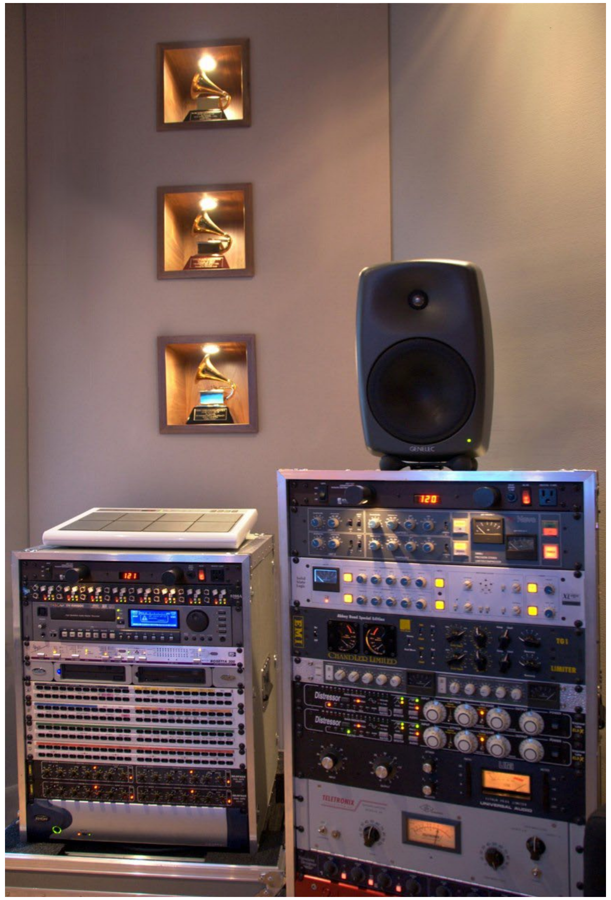
Invermere BC

Look/Feel & the Creative Act

St Aubyns, Toronto

Look/Feel & the Creative Act

Gustavo Celis, Miami



Look/Feel & the Creative Act

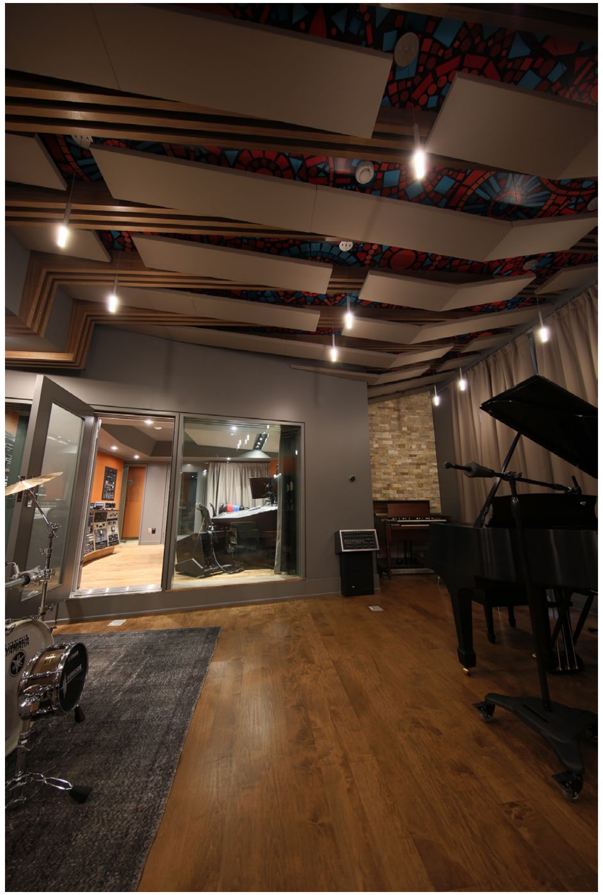
Anthem, Philadelphia, Pennsylvania

Look/Feel & the Creative Act

Great Divide, Aspen, Colorado

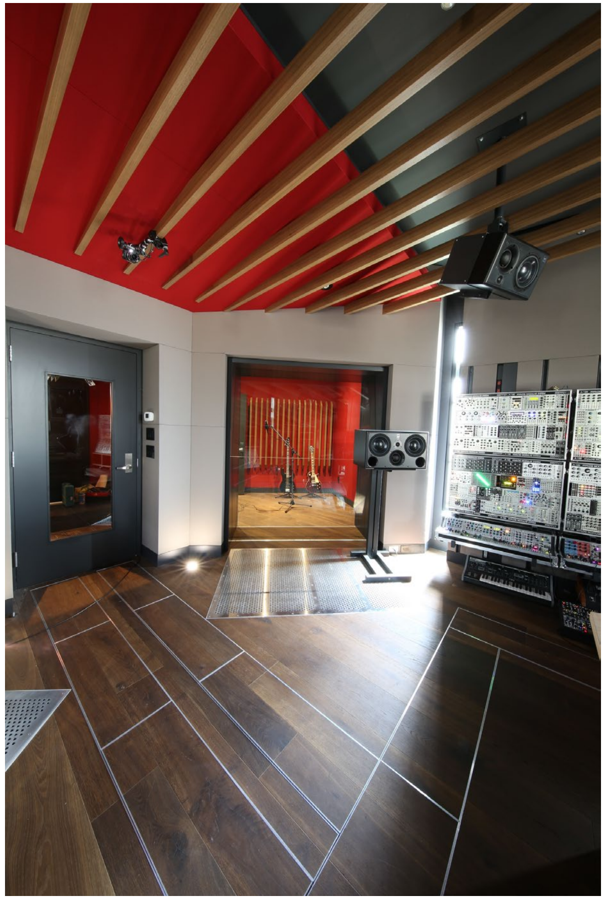
Look/Feel & the Creative Act

Sound Lens, Toronto



Look/Feel & the Creative Act

Deadmau5, Campbellville



Look/Feel & the Creative Act

Deadmau5, Campbellville

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Look/Feel & the Creative Act

Portland, Oregon

AUDIO ES AES

Look/Feel & the Creative Act

Fernando Garibay, Los Angeles

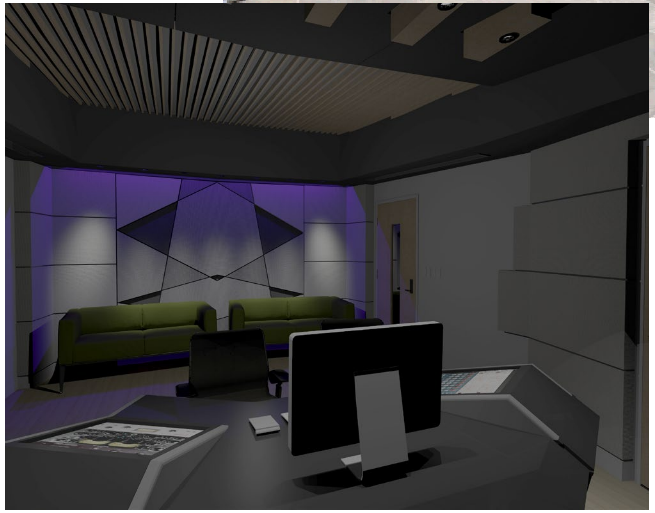
Look/Feel & the Creative Act

Bel Air, California

Pilchner Schoustal International Inc

Look/Feel & the Creative Act

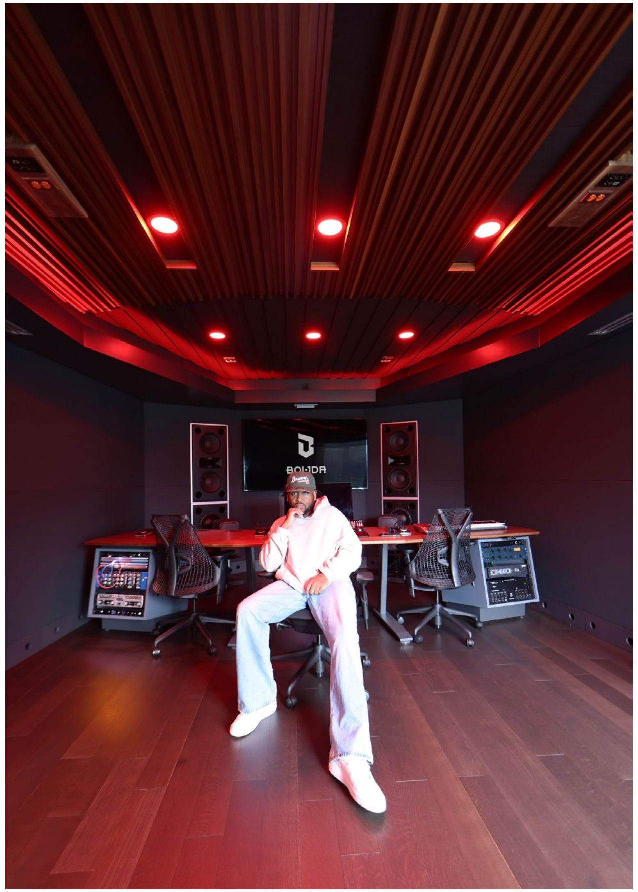
Hamptons, Long Island NY



Audio AES

Look/Feel & the Creative Act

Boi 1da, Pickering



Professional Studio vs Home Studio

Thank-you

For the opportunity to present this material

Thank-you

To the Toronto AES for being central to our professional audio community