GLASS
MADE EASY

NOISE CONTROL WITH GLASS

- Common terms & expressions
- Rw(C;Ctr), dB, dBA
- Coincidence dip
- Noise control solutions
- Selection of glass by calculation - example

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August 2018

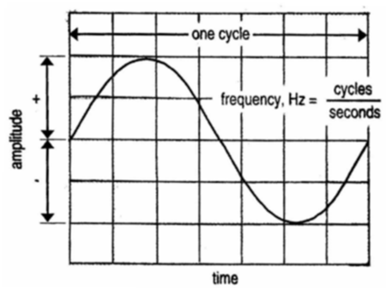
Common Terms

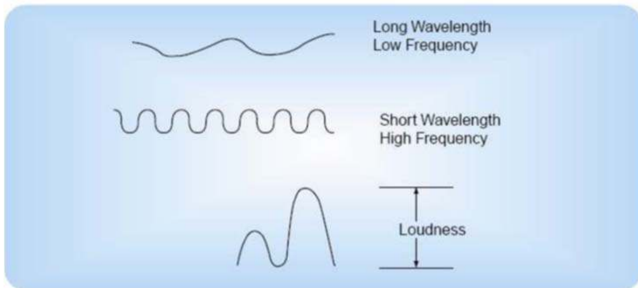
Noise: Unwanted *sound (that may impair hearing or health, annoys or interferes with verbal communication).*

Sound frequency: Number of wavelengths of sound per second in Hertz (Hz). This determines the pitch of the sound.
Low frequency sounds are below 250 Hz, mid 250 to 2000 Hz, high is 2000 Hz and above.
Human auditory field is 20 Hz to 20 kHz.

Wavelengths: One full cycle of sound displacement. Wavelength = Speed of sound / Frequency

Amplitude: Height of sound waves measured from peak to valley. This determines the loudness of the sound





Common Terms

dB: Decibel is a ratio of the measured sound pressure level compared with the quietest sound a person can hear. 0 dB is the threshold of hearing. The higher the dB, the louder the sound.

dBA: Sound level measured with an **A-weighted** meter to reflect the sensitivity of the human ear. We are less sensitive to low and high frequency sounds. Interior noise limits are often expressed in dBA. The higher the dBA, the louder the sound.

Rw: Weighted airborne sound reduction index of building elements over frequency range of 100 Hz to 3150 Hz, weighted for the human ear, determined according to ISO 717-1.

C & **Ctr**: Spectrum adaptation terms applied to Rw for different spectra of A-weighted residential and urban traffic noise, determined in accordance with ISO 717-1. Sound reduction performance of a building element is stated by Rw(C;Ctr)

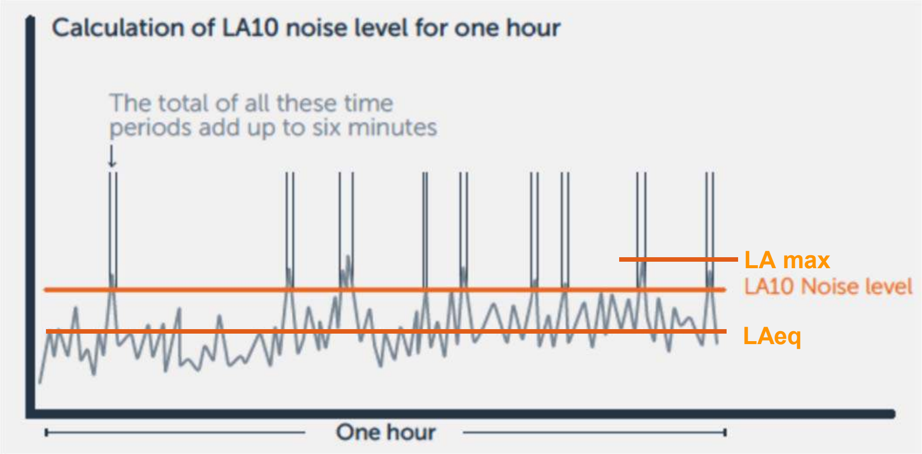
Common Terms

STC: Sound transmission class. A rating of how well a building partition insulates airborne sound over frequency range of 125 Hz and 4000 Hz (ASTM E413). *Building Code clause G6: STC 55 for common walls, floors and ceilings between occupancies*

L_{A10} Noise level equal or exceeded for 10% of the measurement period in dBA

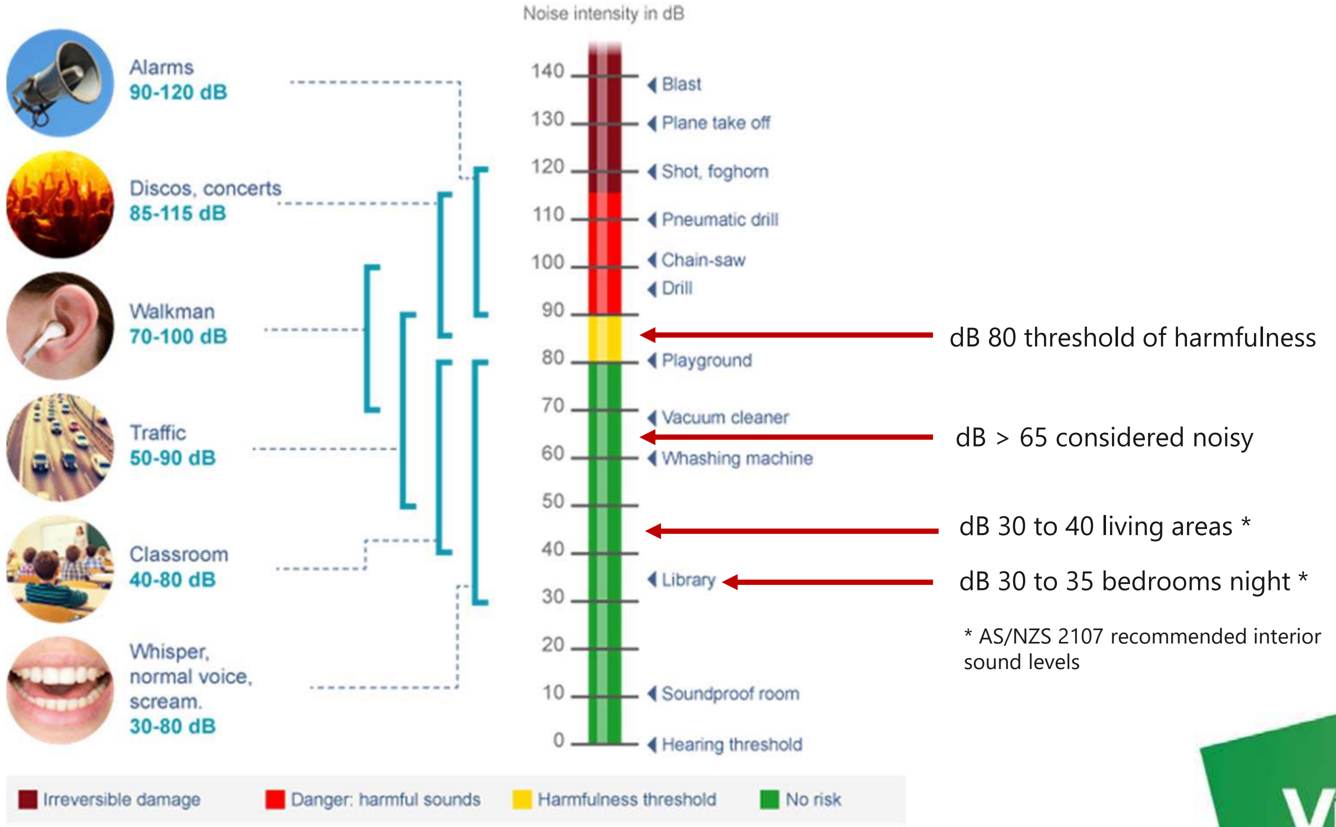
$L_{A\ max}$ Maximum sound pressure level during measurement period in dBA

L_{Aeq} Equivalent continuous sound pressure level in dBA for measurement period t



Noise Source & Perception

Source: Cochlea.org



* AS/NZS 2107 recommended interior sound levels

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Measurement of Airborne Sound Insulation of Building Elements
ISO 10140-2:2010

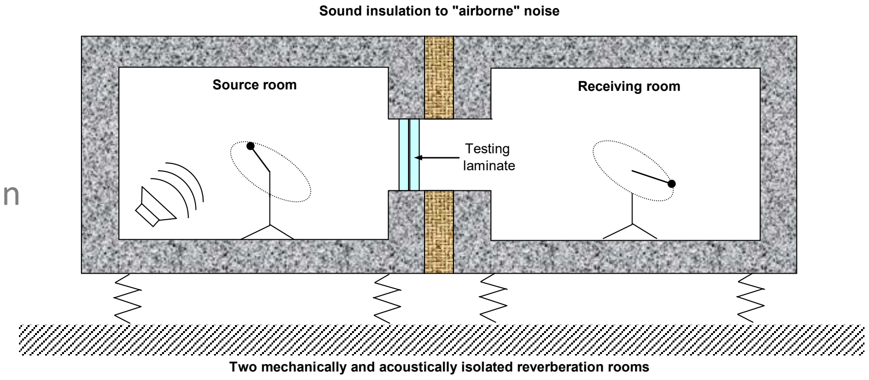
Source: Eastman Chemicals for diagram

1. Measurement is made by constructing a wall between two specially isolated rooms. By isolating the rooms, sound only travels between the two rooms via the test panel.

2. Sound pressure are measured on both side of the wall, in 16 frequency bands between 100 Hz and 3150 Hz.

3. Results are plotted on a graph and a reference curve adjusted until the number of points below the graph is just less than 32 db.

4. The value of the reference curve at 500 Hz is Rw.



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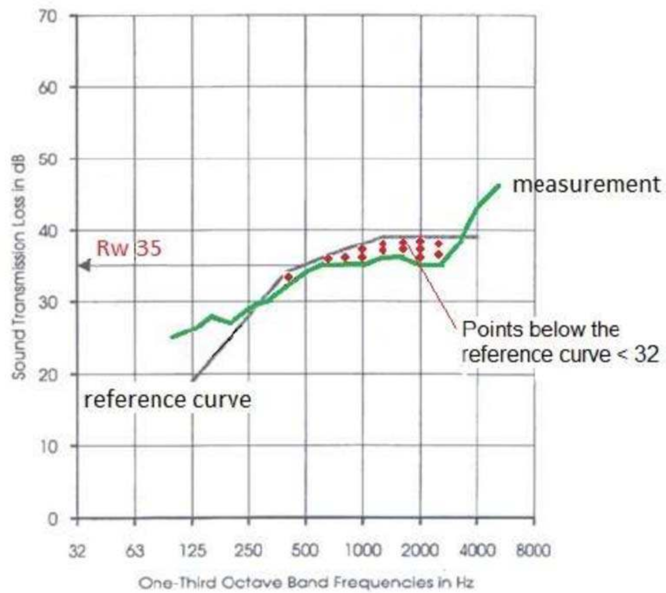
Measurement of Sound Insulation

Source: Marshall Day Acoustics

Calculation of Rw

(single number rating)



6 mm laminated glass sound transmission loss and Rw contour.

Weighted sound reduction index Rw and Spectrum Adaptation Terms C and Ctr. When to apply these terms?

When noise is caused by:

- Living activities (talking, music, radio TV)
- Children playing
- Railway traffic at medium and high speeds
- Highway road traffic at > 80 km/hr
- Jet aircraft, short distance
- Factories emitting mainly medium and high frequency noise

Use **Rw** + **C**

When noise is caused by:

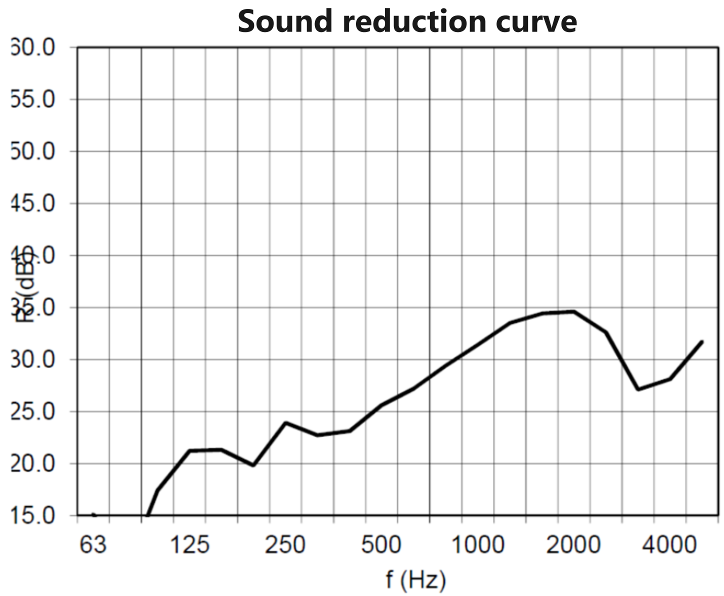
- Urban road noise
- Railway traffic at low speeds
- Aircraft, propeller driven
- Jet aircraft, large distance
- Disco music
- Factories emitting mainly low and medium frequency noise

Use **Rw** + **Ctr**

Rw and Spectrum Adaptation Terms C and Ctr
Example: Airborne sound reduction of 4 mm Glass

Noise source: children playing
Reduction in noise
Rw + C = 30 – 1 = 29 dB

Noise source: urban traffic
Reduction in noise
Rw + Ctr = 30 – 3 = 27 dB



Sound reduction at 3rd octave bands

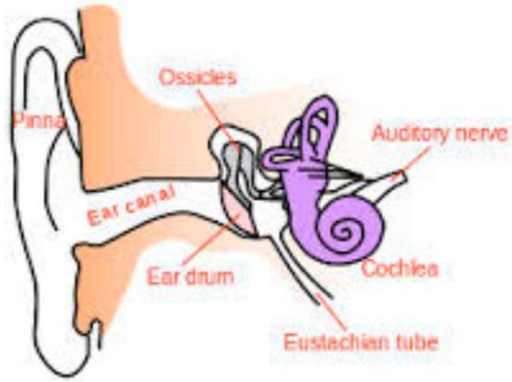
Frequency f Hz	R dB	Octave bands Roct dB
63	15.1	
80	9.4	
100	17	
125	21	20
160	21	
200	20	
250	24	22
315	23	
400	23	
500	26	25
630	26	
800	27	
1000	29	31
1250	31	
1600	34	
2000	34	34
2500	35	
3150	33	
4000	27	29
5000	28	

Rw(C;Ctr)   30 (-1;-3) dB

Relative Loudness

Relationship between dB and relative loudness as perceived by our ears

- A difference of 1 dB is not perceptible
- 3 dB is just perceptible
- 5 dB represents clear a difference
- 10 dB halves or doubles the noise



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Road Traffic Noise

Road traffic noise decays by approximately 3 dB with doubling of distance at right angles to the road.

Source VicRoads and Pilkington technical bulletin

Road traffic noise decreases by approximately 3dB with doubling of distance at right angles to the road. If, for example, L is the dB noise level at 5 meters, then the decay follows the pattern:

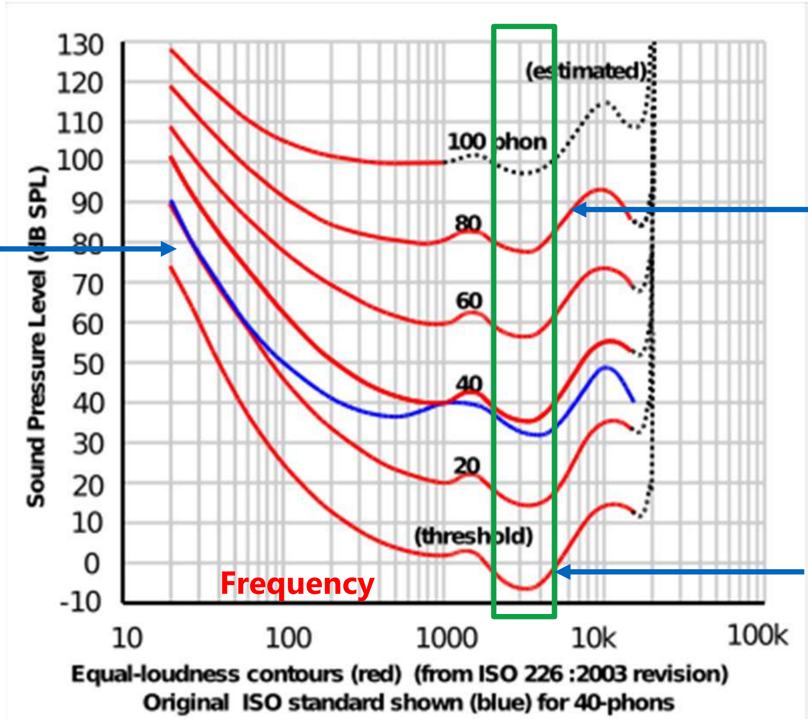
5 meters	L	dB
10 meters	(L-3)	dB
20 meters	(L-6)	dB
40 meters	(L-9)	dB
80 meters	(L-12)	dB
160 meters	(L-15)	dB

Hearing Sensitivity

ISO 226-2003 equal loudness contours.

The human ear is most sensitive to frequencies in range 2,000 to 5,000 Hz, peaking at 3,000 to 4000 Hz

As sound frequency drops, higher sound pressure levels are required for the sounds to be heard with equal loudness



Phon is unit of perceived loudness of sounds)

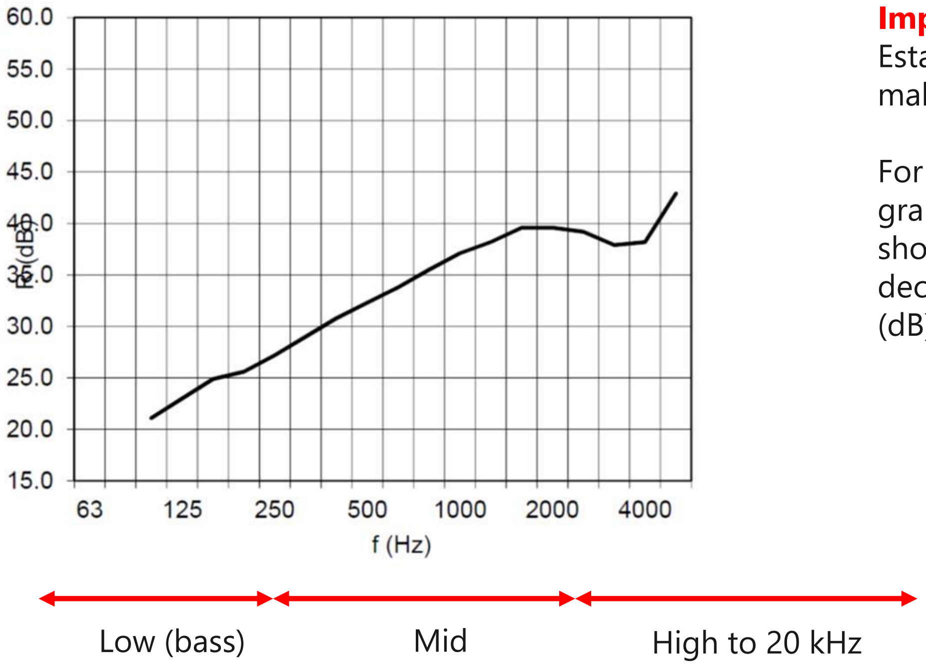
Higher sound pressure levels are required for high frequency sounds > 5000 Hz to be heard with equal loudness

Most sensitive hearing range for humans. Low sound pressure levels for sounds to be heard with equal loudness

Effectiveness of Glass

Glass is less effective at reducing low frequency airborne sounds

Sound reduction curve of 6.5 mm VLam Silence

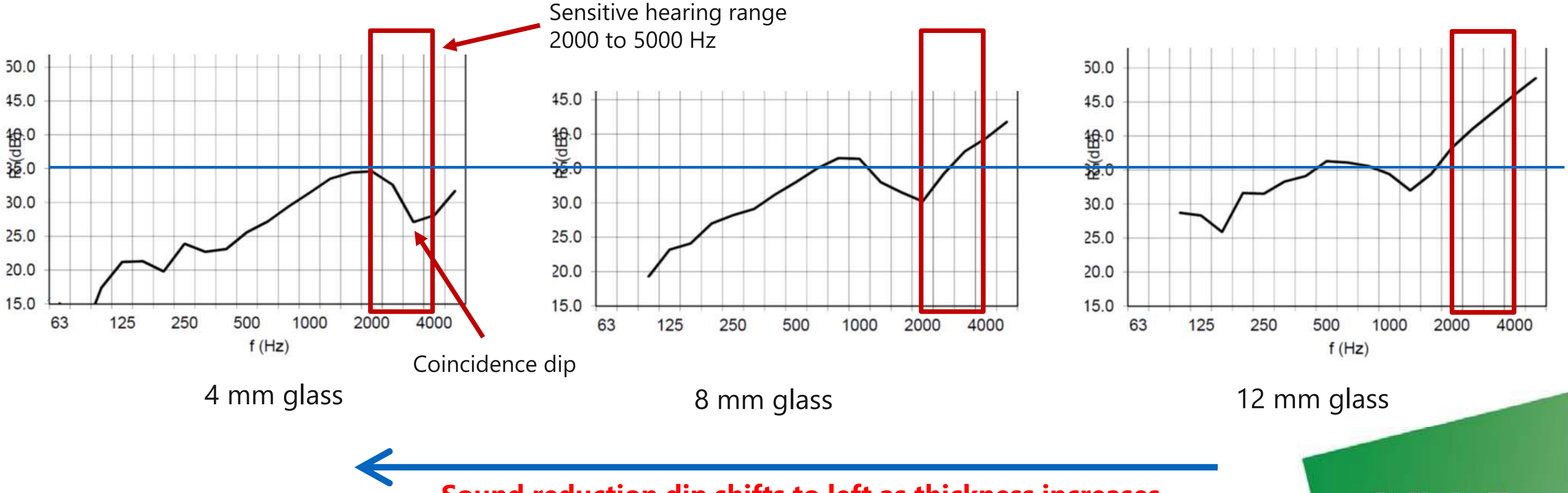


Important:
Establish the noise source before making a recommendation !!

For example, the sound attenuation graph for 6.5 mm VLam Silence shows that as sound frequency (Hz) decreases, the sound reduction R (dB) also decreases.

Coincidence Dip in Sound Reduction

A dip in sound insulation when sound frequency matches natural frequency of glass
Critical Frequency Fc = 12,000 / d where d is the glass thickness
The thicker the glass, the lower the critical frequency.



Sound reduction dip shifts to left as thickness increases

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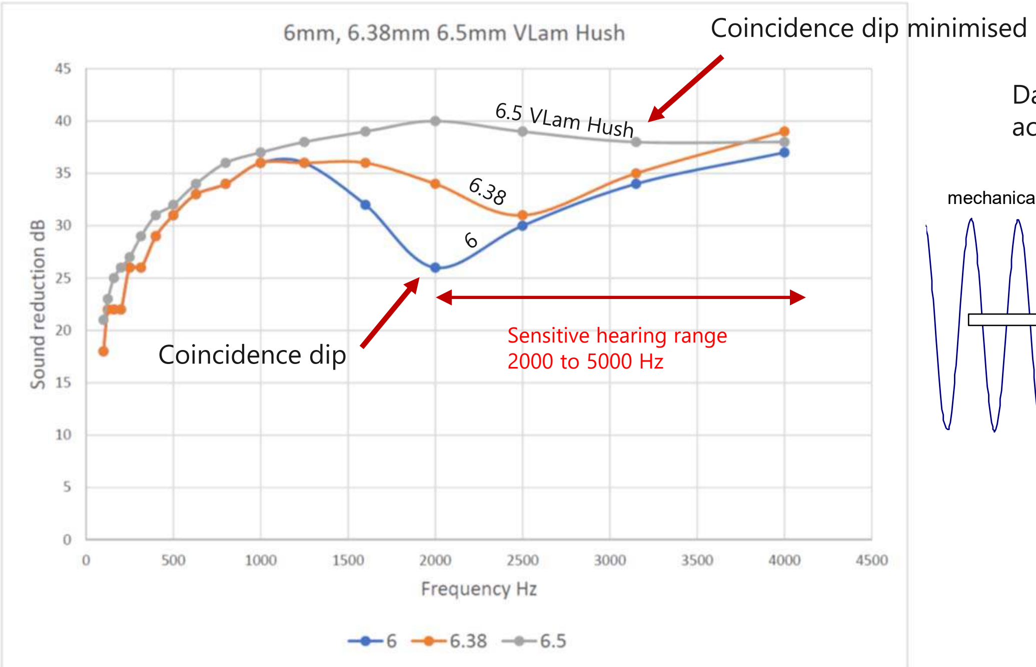
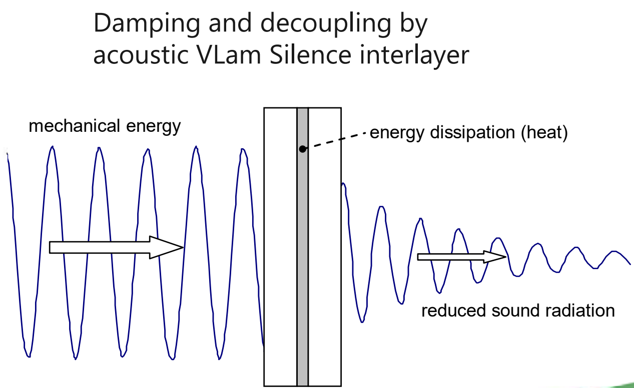
Noise Control Solution for Coincidence Dip in Monolithic Glass

PVB and **EVA** interlayers provides damping to reduce coincidence dip at high frequency
(the softer the interlayer the better. SentryGlas is stiff)

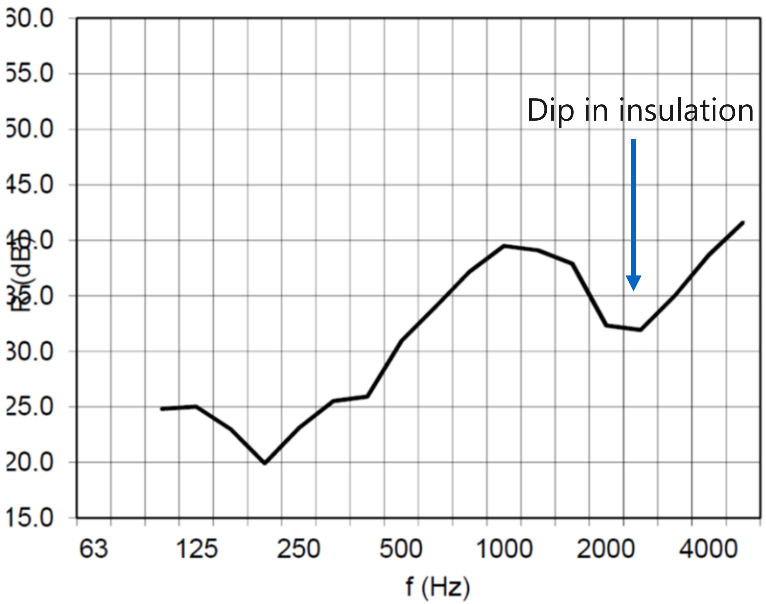
Acoustic **VLam Silence** (or Hush) interlayer provides damping and decoupling to minimise coincident dip
Source: Viridian source reduction data



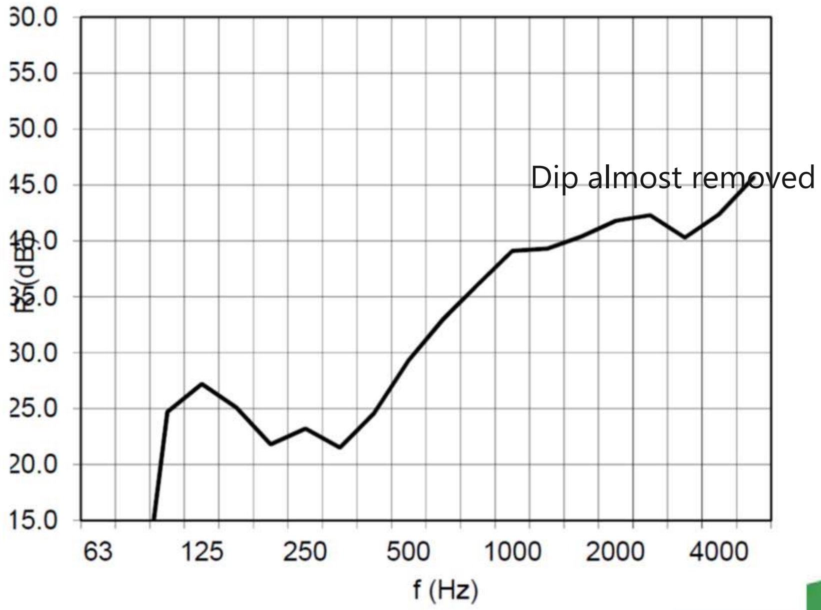


Noise Control Solution for Coincidence Dip in IGU

Asymmetrical make-up so that when one pane is at its coincident frequency, the other is not.



6-12-6



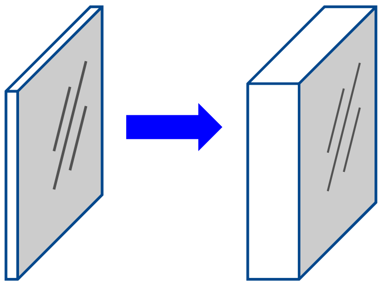
8-12-4
Asymmetrical make up

Noise Control Solutions For Glass

Source: Eastman Chemicals for illustrations

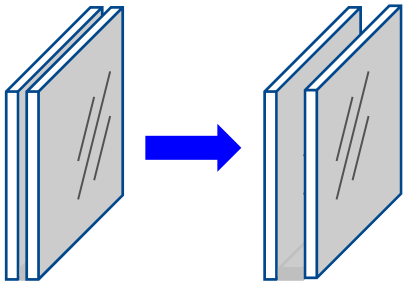
Thicker glass to increase mass

Doubling glass thickness increases sound reduction by 4 dB

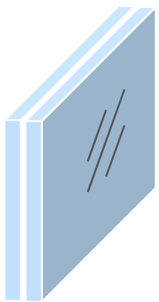


Increase cavity > 50 mm (secondary glazing)

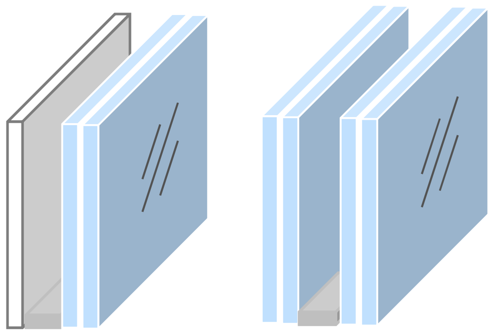
Marginal difference in size of IGU cavity



PVB or EVA laminated glass, or VLam Silence to reduce coincidence dip



Asymmetrical PVB, EVA or VLam Silence laminated IGU



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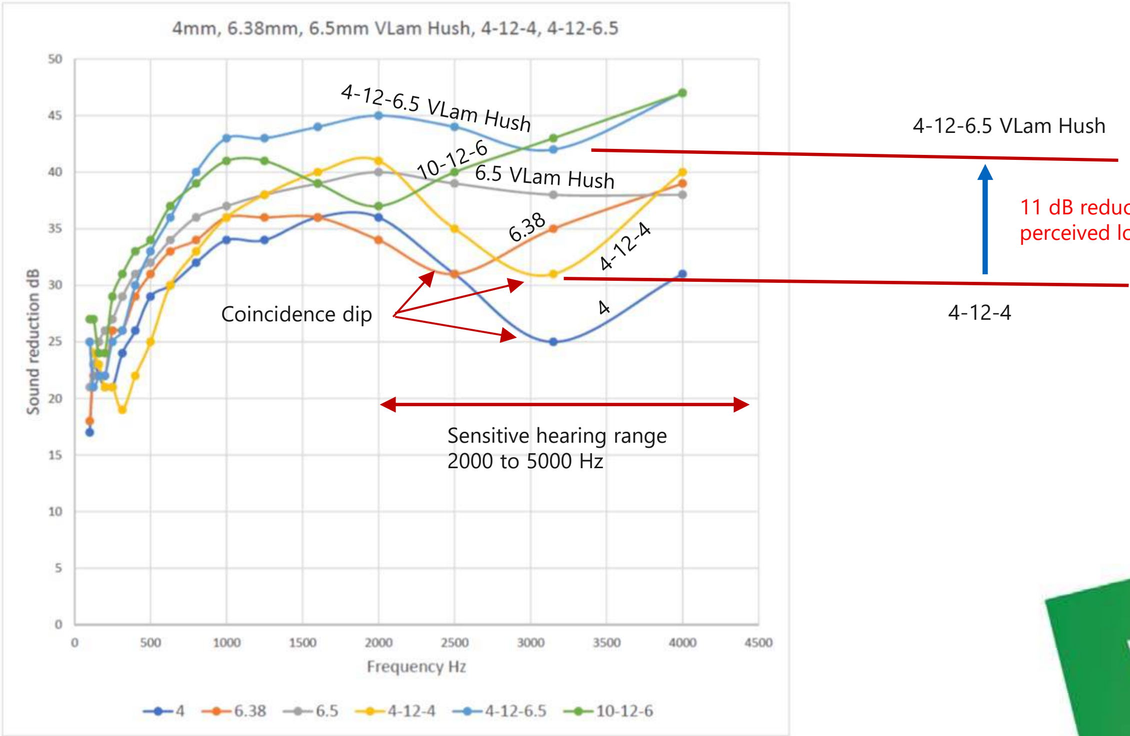
Performance of 4, 4-12-4, 6.38, 6.5 & 4-12-6.5 VLam Hush, & 10-12-6

IGU 4-12-6.5 VLam Silence provides best performance between 1000 – 3000 Hz *(or 6.5-12-4)*

Source: Viridian sound reduction data



Selection of Glass to Reduce Urban Traffic Noise

Calculation Method: Noise level dBA – recommended sound level dBA = Rw+Ctr required

Example: Residential unit located 10 m from road

L_{Aeq} 5 m from road, measured with A-weighted meter	70 dBa
L_{Aeq} 10 m from road 70 – 3 =	**67** dBa
Rec. noise level for sleeping areas, inner city	35 dBA AS/NZS 2107
Noise reduction Rw+Ctr required	67 – 35 = 33 dB

5 meters	L	dB
10 meters	(L-3)	dB
20 meters	(L-6)	dB
40 meters	(L-9)	dB
80 meters	(L-12)	dB
160 meters	(L-15)	dB

Glass	Rw (C;Ctr)	Rw+Ctr for urban traffic noise
4-12-4	29 (0;-3)	29 - 3 = 26
5-12-4	33 (-1;-4)	33 - 4 = 29
6.38-12-4	34 (-1;-3)	34 - 3 = 31
6.5-12-4	36 (-1;-3)	36 - 3 = 33
10-12-6	38 (-2;-4)	38 - 4 = 34

From the list above, IGU make-up required to provide minimum Rw+Ctr of 33 is:
6.5-12-4 or **10-12-6**

Notes:

- Glass alone will not solve noise problem. The whole building needs to work (i.e. roof, walls, floor, window and doors frames etc)
- Sound only needs a small gap or hole to enter a building (watch out for gaps in old windows and doors before making recommendation).
- For new build, district plan may require design report from acoustic specialist.
- Auckland Unitary Plan – watch out for sound reduction requirement of **45 dB at 63 Hz** and **40 dB at 125 Hz** for noise sensitive spaces.
  This is virtually unachievable with glass !!

Table E25.6.10.1 Noise levels for noise sensitive spaces in the Business – City Centre Zone, Business – Metropolitan Centre Zone, Business – Town Centre Zone, Business – Local Centre Zone, Business – Neighbourhood Centre Zone or the Business – Mixed Use Zone

Unit affected	Time	Level
Bedrooms and sleeping areas in the Business – Local Centre Zone and in the Business – Neighbourhood Centre Zone	Between 10pm and 7am	35dB LAeq 45dB at 63 Hz Leq; and 40dB at 125 Hz Leq
Bedrooms and sleeping areas in the Business – City Centre Zone, Business – Metropolitan Centre Zone, Business – Town Centre Zone and the Business – Mixed Use Zone	Between 11pm and 7am	35dB LAeq 45dB at 63 Hz Leq and 40dB at 125 Hz Leq
Other noise sensitive spaces	At all other times	40 dBA LAeq

END