ACOUSTICS 2025
JOONDALUP
SOUNDS OF THE SUNSET COAST

Aircraft Noise Exposure within a Modern Australian Home

Steven Walker (1), George van Hout (2)

(1) WSP Australia, Brisbane
(2) WSP New Zealand, Christchurch

ABSTRACT

Aircraft noise remains a significant environmental concern, particularly in urban areas experiencing increased air traffic and residential growth near airports. This study investigated noise from individual aircraft events affecting a modern Australian home located within the flight path of Brisbane Airport. Through synchronised indoor and outdoor measurements, quantification of both the level and character of aircraft flyovers was undertaken, with results highlighting distinct variations based on aircraft type and operational mode. While the construction of modern homes can reduce noise exposure, certain frequency components define the aircraft noise experienced indoors, potentially in rooms that can affecting occupant comfort and sleep. The paper presents detailed maximum noise levels and spectral data to inform the assessment of aircraft noise and support effective building design in residential areas exposed to aviation noise.

1 INTRODUCTION

Australia's airport network continues to adapt to growing demand for passenger and freight services. As new infrastructure comes online, Brisbane Airport remains a key part of the national system. Its curfew-free operations support 24-hour scheduling for long-haul passenger and freight services, with direct international connections across Asia-Pacific, the Americas, and Europe. This provides key operational and social benefits including enabling overnight freight, supporting time critical deliveries, maintaining 24-hour access for travellers, and supports the economic activity across Queensland.

While the airport itself is not directly bordered by residential communities, the flight paths traverse the densely populated city of Brisbane (Brisbane Airport Corporation, 2020). The location of the flight paths places aircraft noise as a significant consideration for urban planning, environmental impacts, and public health (Moyo et al. 2019). Effective controls on land zoning and development play a key role in ensuring that growth across the metropolitan region remains compatible with the airport's operations. For areas affected by aircraft noise, applying the guidance of Australian Standard AS2021 (AS2021, 2015) in building design and construction can help support long-term liveability and improve acoustic comfort.

To support the understanding of aircraft noise in residential regions, a noise survey was conducted in a suburb south of Brisbane Airport. The area is influenced by operations from both the legacy runway 01R/19L and the newer runway 01L/19R, which commenced service in 2020. The site provided a representative setting to examine noise exposure across multiple aircraft types and assess internal noise levels within a residential dwelling.

2 DESCRIPTION OF THE NOISE SURVEYS

2.1 Location

The measurement site was a steel-frame two-storey detached home located in the suburb of Morningside, approximately 10 kilometres south of Brisbane Airport. The measurement room, situated at the front of the residence, faced aircraft traffic landing/departing to the south on runway 01R/19L, while landing/departing southbound traffic from runway 01L/19R passed to the rear of the property.

The straight approach distances from the nearest points on each runway centreline, defined under AS2021, are detailed in Table 1. Aircraft were at an average altitude of approximately 1,000 m during take-off and 450 m on approach for landing. The elevation of the building site was within ±10 m of the airport.

Table 1: AS2021 distances to measurement site

Runway	Runway centre line distances		
	DL	DT	DS
01L/19R	9.0	12.3	1.4
01R/19L	7.6	11.0	0.9

2.2 Measurement survey

Continuous noise monitoring was simultaneously undertaken at:

- A free-field location outside the front of the property, positioned at first-floor window height, approximately 4 m from the building façade.
- Inside the master bedroom on the first floor at a height of 1.5 m above the floor and 2 m from windows.

Details of the room's construction are provided in Table 2. The space was conventionally furnished with a bed, and roller blinds installed on all windows. A solar powered ventilation unit (whirlybird) is located on the property roof, above the bedroom, and operates intermittently during daylight hours.

Table 2: Description of the indoor noise measurement room

Room element	Dimensions/ features
Floor area	21.1 m^2
Volume	51.6 m^3
Window glazing	Single pane sliding windows, glass thickness 4 mm
Glazing area	5.25 m^2 (~40% front internal façade area)
Floor finishes	Carpeted
Wall/ceiling finishes	Plasterboard (external walls rendered blue board)

This dual measurement strategy enabled direct comparison between external aircraft noise exposure and the corresponding indoor acoustic environment.

Noise measurements were conducted using Acoustic Research Labs NGARA Sound Acquisition Systems which conforms to the class 1 requirement (AS IEC 61672.1, 2004) with each unit within relevant calibrations. Both NGARAs were configured to continuously record A-weighted sound pressure levels and audio and were time synced. This facilitated identification of aircraft movements influencing both the level and acoustic characteristics of the internal and external ambient environments.

The real-time flight tracking platform Flightradar24 was used to identify individual aircraft movements from each runway, supplying aircraft type, and estimated speed and altitude data throughout the noise monitoring period.

Using the recorded audio, outdoor aircraft noise events were isolated from the measurement data. The corresponding timeframes were then referenced to identify concurrent noise events within the bedroom. The octave-band maximum (L_{max}) levels for each aircraft movement indoors and outdoors was then identified.

The application of the L_{max} metric minimised the influence of ambient or extraneous noise sources during aircraft operations, supporting the ability to isolate the overall aircraft noise within the residence.

Due to the presence of extraneous noise, the external aircraft noise events were individually reviewed to ensure they were clearly distinguishable above non-aircraft sound sources. Events where aircraft noise was not audibly dominant due to masking were excluded from analysis. As a result, most aircraft movements between 11:00 am and 3:00 pm were omitted from the survey.

2.3 Aircraft operations

At the start of the noise measurement survey period, Brisbane Airport was operating with take-off flights to the south, later switching to landings from the south. This enabled both take offs and landings to be measured at the property. Both runways were also in operation throughout the survey period.

Sound levels during take-off and landing were recorded for a range of aircraft types, including regional jets, and medium and heavy jet aircraft.

Based on the audio samples, the analysis identified the highest sound levels were recorded during take-off, when engines operate at elevated thrust settings. During landings, engine noise and airframe noise, such as that generated by the deployment of landing gear, were the main sources contributing to the measured sound levels.

3 NOISE EMISSION BASED ON AIRCRAFT

3.1 Octave band noise emission levels

The frequency content of aircraft noise plays an important role in assessing noise intrusion and informing the design of acoustic elements in residential buildings. Particularly in AS2021 assessments where the aircraft noise reduction (ANR), the sound level difference from outdoor to indoor, is 30 dB(A) or more.

The maximum octave band spectra (L_{max}) were averaged across common aircraft types, with the noise levels normalised at the 1 kHz octave band. The sample offers a representative profile of typical noise profiles of aircraft commonly operating at major airports across Australia.

The average maximum outdoor noise spectra for a sample of the jet aircraft included in the survey are shown in Figure 1 (take offs) and Figure 2 (approach).

External noise measurements showed that arriving aircraft typically exhibited the highest sound energy at the 125 Hz octave band, while departing aircraft displayed greater variability in dominant frequencies. The variation in octave-band frequency between approaching and departing aircraft is likely due to shifts in dominant noise sources. During departure, sound emissions are primarily driven by engine thrust during climb, whereas arrival noise is largely influenced by airframe elements such as wing flaps and deployed landing gear.

The outdoor normalised sound levels of the measured aircraft are presented in Figure 1 for departing aircraft and Figure 2 for arriving aircraft. The dataset for these sound levels is limited, with only 3 to 5 movements per aircraft type used for averaging. This constraint should be considered when interpreting the frequency-level results.

Regardless of aircraft type or flight phase (arrival or departure), normalised sound levels were positive below 1 kHz and negative above, indicating that aircraft noise emissions are dominated by lower-frequency energy.

When assessing the airborne noise reduction (ANR) requirements of a building, it is essential to consider how well its components attenuate lower-frequency sound, typically in the range of 63 Hz to 250 Hz. These frequencies can be more challenging to control due to their long wavelengths and ability to transmit through common building materials. The glazing systems, and lightweight roof and ceiling assemblies often exhibit poor low-frequency performance.

When airborne noise reduction (ANR) requirements are assessed using single-number values (e.g., ANR < 30 dB), the analysis may overlook the influence of dominant noise frequencies, particularly in the low-frequency range. While the overall noise level might meet compliance thresholds, such simplified metrics can mask frequency-specific deficiencies. As a result, occupants may still experience discomfort due to inadequate attenuation of critical frequency bands.

Incorporating spectral data into the design process leads to more accurate predictions of acoustic performance and better outcomes for occupant comfort and regulatory compliance. This is especially important in mixed-construction buildings where high-performing façades may be undermined by acoustically weaker components.

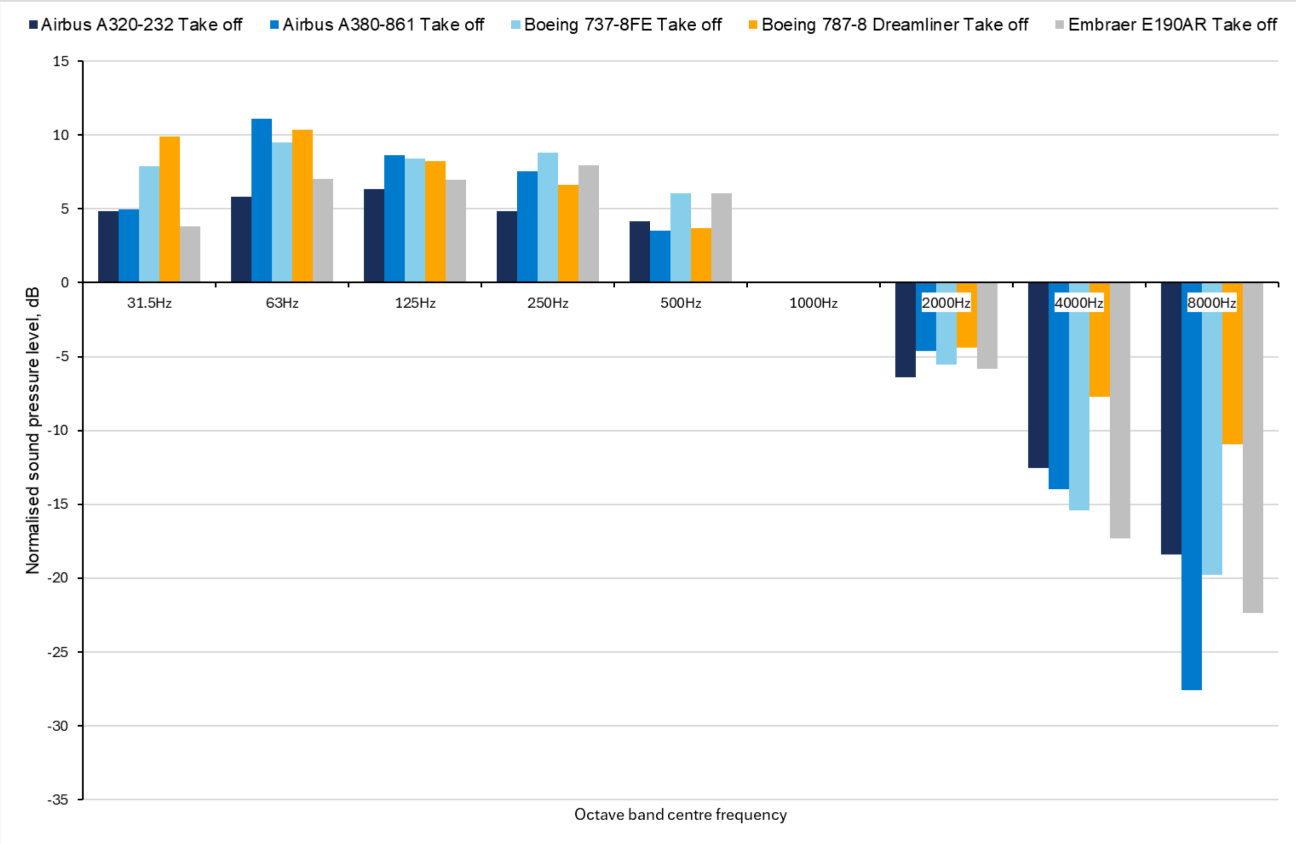

Figure 1: External normalised frequency spectra of departing aircraft at a site near Brisbane Airport

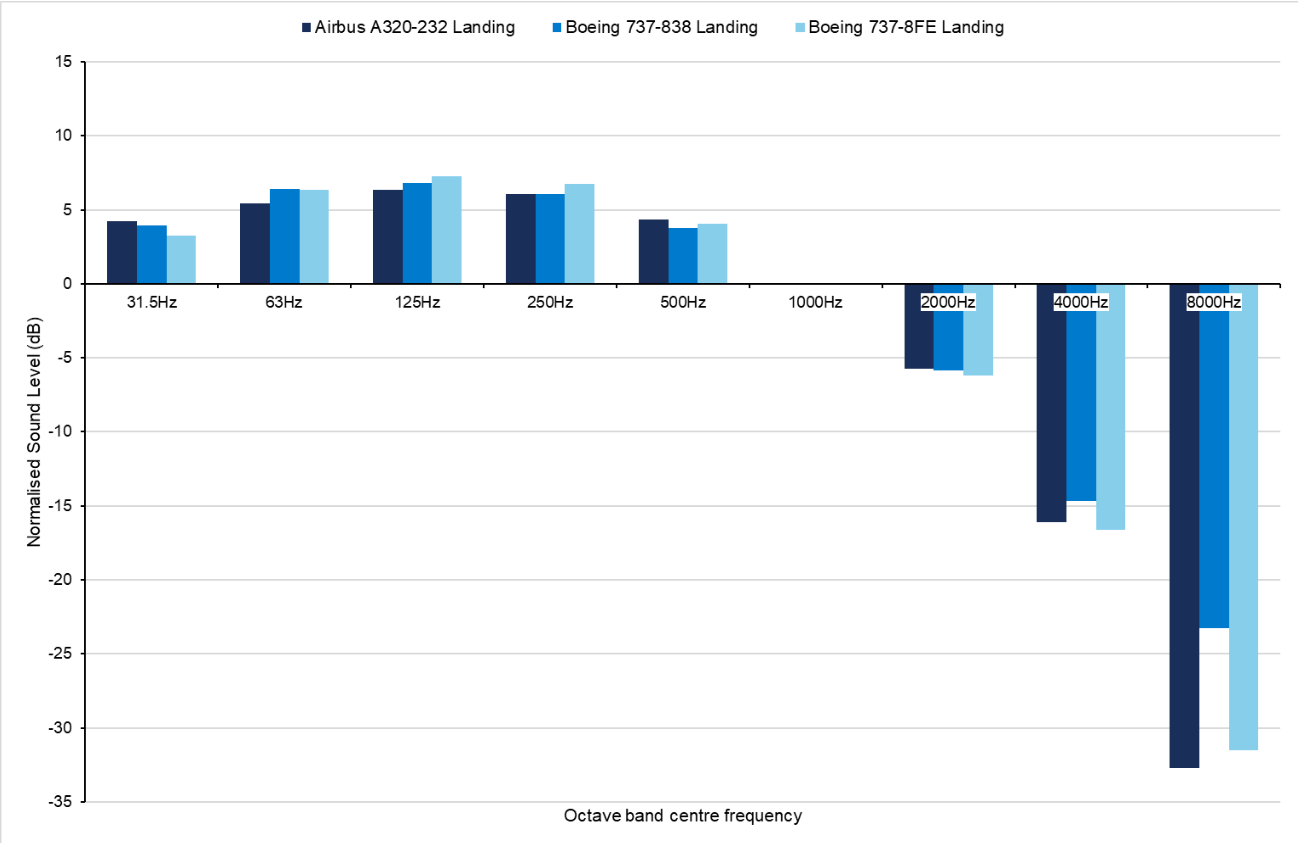

Figure 2: External normalised frequency spectra of arrival aircraft at a site near Brisbane Airport

3.2 Variation in Maximum Aircraft Noise Levels

Measured aircraft noise levels showed variation both across different aircraft types and among repeated events of the same type. Several factors contribute to this variability, including slight deviations in flight paths, local weather conditions, aircraft thrust (particularly during departures), pilot operating procedures, and the application of noise abatement measures.

Figure 3 displays the measured outdoor L_{max} noise levels during take-off events, grouped by aircraft type. The data shows a range of more than 20 dB between the aircraft types, with differences of more than 10 dB observed among separate events involving the same aircraft type.

The variation in measured aircraft noise levels highlights the importance of conducting noise surveys over a sufficient duration to ensure that peak noise events are captured. AS2021 recommends a minimum of five relevant aircraft overflights, with ten preferred where practical.

At the subject site, the Airbus A380 take-off was identified as producing the highest measured noise levels. This is in part due to the size of the aircraft and its associated thrust, and these take-offs were at a relatively low altitude of 450 m to 600 m.

As A380 departures from Brisbane Airport may occur only once or twice daily, peak noise events could be overlooked depending on runway usage and operational timing. Consequently, a monitoring period of at least five days may be required to capture ten overnight events involving the highest L_{max} exposures.

In practice, longer durations may be necessary, particularly when measurements are affected by adverse weather or limited aircraft movements over the subject site due to runway usage patterns or operational constraints.

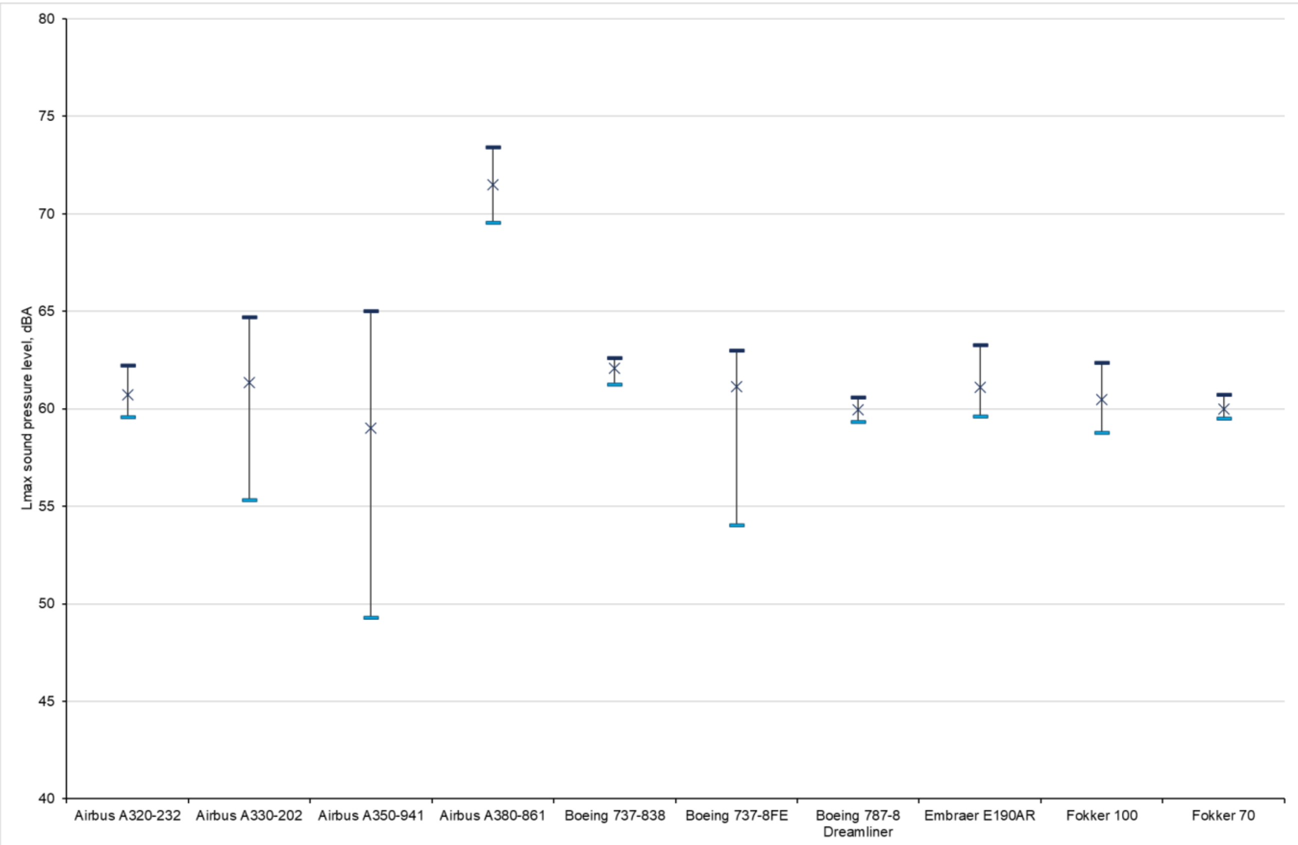

Figure 3: Range and average take off outdoor noise levels for aircraft types

3.3 AS2021 Noise Emission Comparison

AS2021 provides forecast noise levels for jet aircraft that are both commonly operated and representative of the highest expected maximum noise events. In this study, the outdoor measured average L_{max} levels for the surveyed aircraft types were compared with the guideline values specified in AS2021.

As shown in Table 3, the forecast sound emission levels in AS2021 were, on average, 3 dB higher than the measured values across all aircraft operations. These findings indicate that AS2021 does not underestimate aircraft noise exposure and, by providing a potentially conservative estimate, support a higher level of amenity than the measured noise data. This affirms the reliability of AS2021 as a reference standard for acoustic design in residential reverse sensitivity assessments.

Table 3: Comparison of the outdoor Lmax noise levels, measured and AS2021

Aircraft Type	Measured sound level (dB L_{max})	AS2021 sound level (dB L_{max})	Difference
Airbus A320 (departure)	61	61	0
Airbus A320 (arrival)	58	60	+2
Airbus A380 (departure)	72	72	0
Boeing 737 (departure)	62	67	+5
Boeing 737 (arrival)	63	64	+1
Boeing 787 (departure)	60	62	+2

3.4 Indoor Noise Emission Review

Internal bedroom noise levels for a sample of take-off events, grouped by aircraft type, are shown in Figure 4. The data shows a variation of more than 15 dB between the aircraft types, highlighting the importance of identifying which aircraft contribute the highest noise at a subject site.

Relative to the recommended bedroom design objective of 50 dBA L_{max}, from Table 3.3 of AS2021, indoor levels were often near this threshold, with the Boeing 777 and Boeing 737 up to 48 dBA L_{max}. The noise from the Airbus A380 surpassed it, reaching 53 dBA L_{max} during take-off.

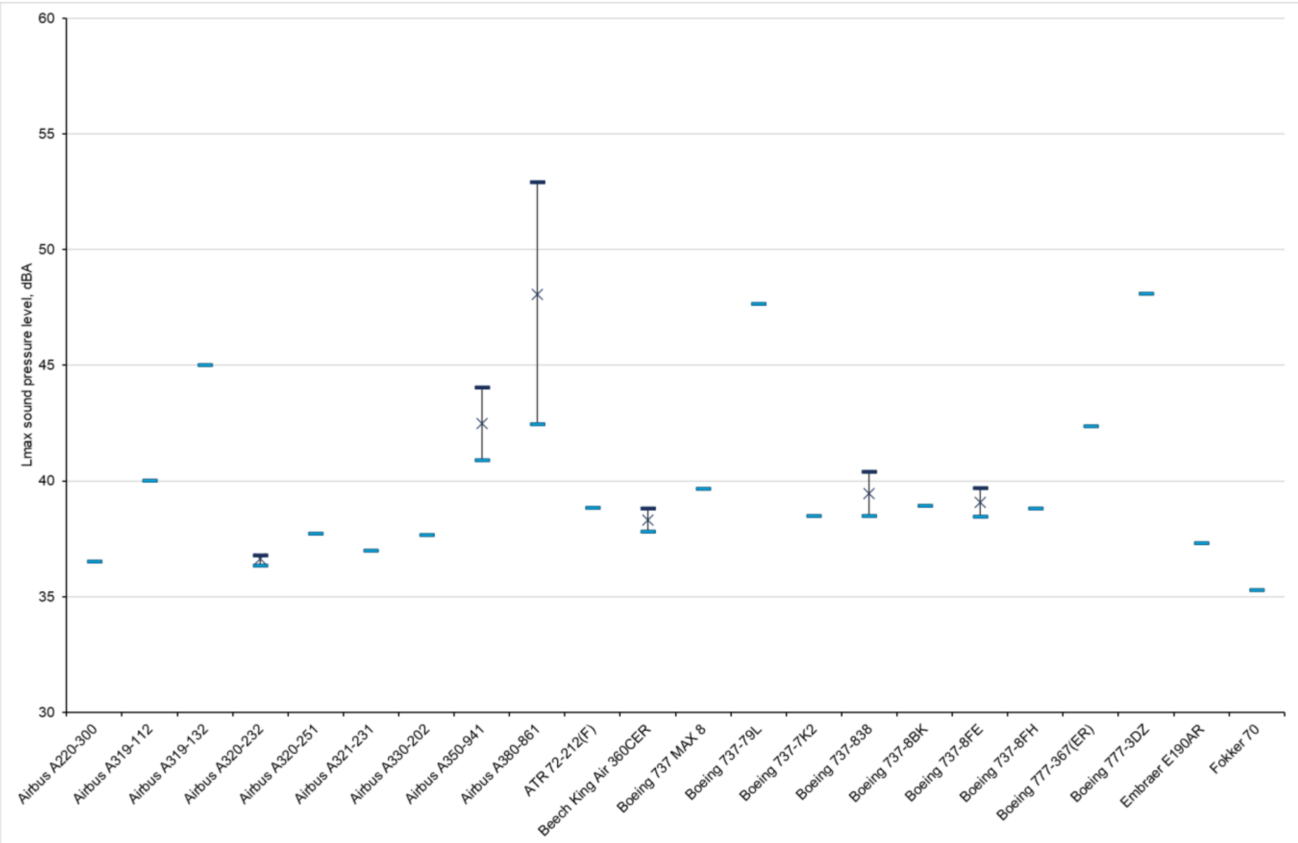

Figure 4: Range and average take off indoor noise levels for aircraft types

Octave band noise levels were reviewed to assess the buildings effectiveness in reducing aircraft noise within the bedroom with windows closed. Indoor and outdoor octave band L_{max} noise levels for the Airbus A350 and A380 aircraft types, representative of all jet aircraft in the survey, are shown in Figures 5 and 6 respectively.

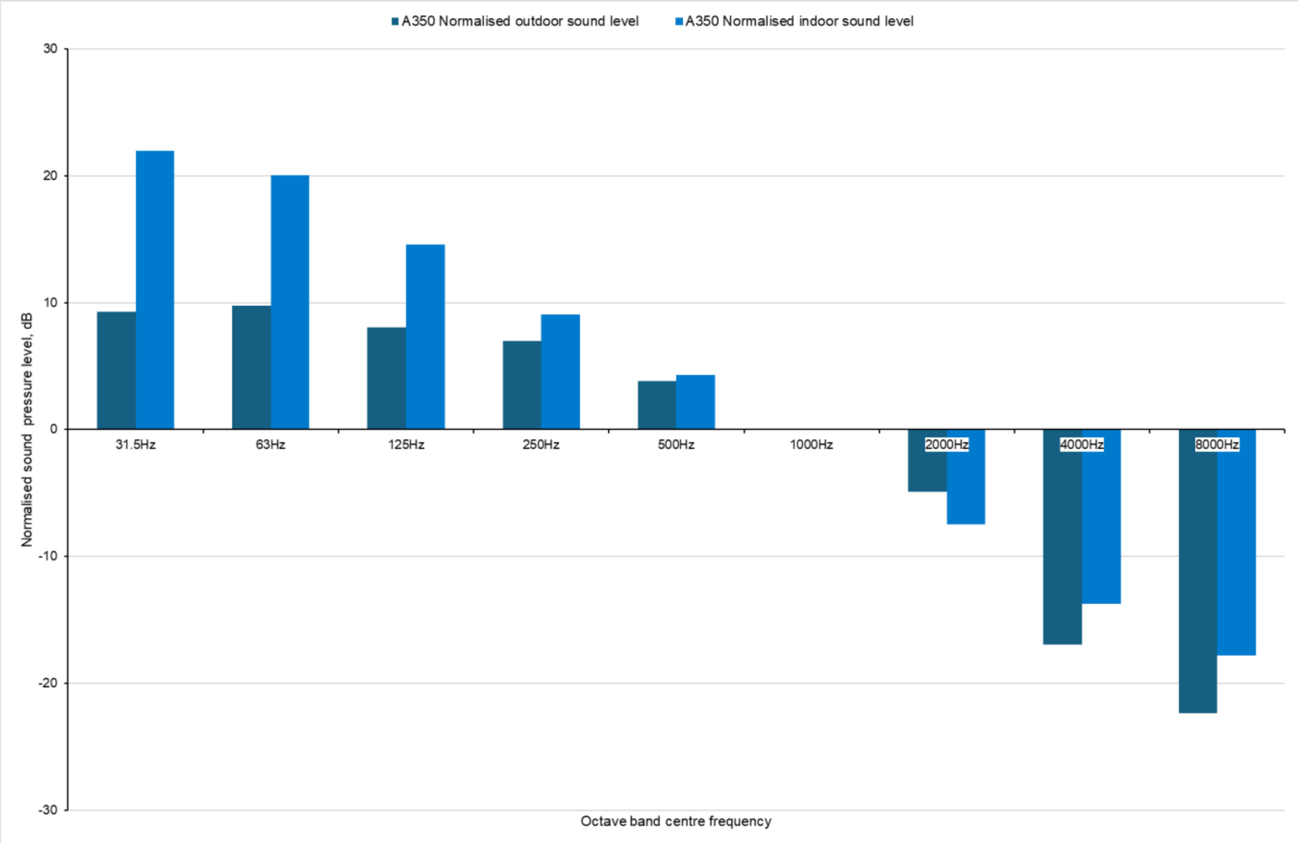

Figure 5: Indoor and outdoor normalised noise levels for Airbus A350

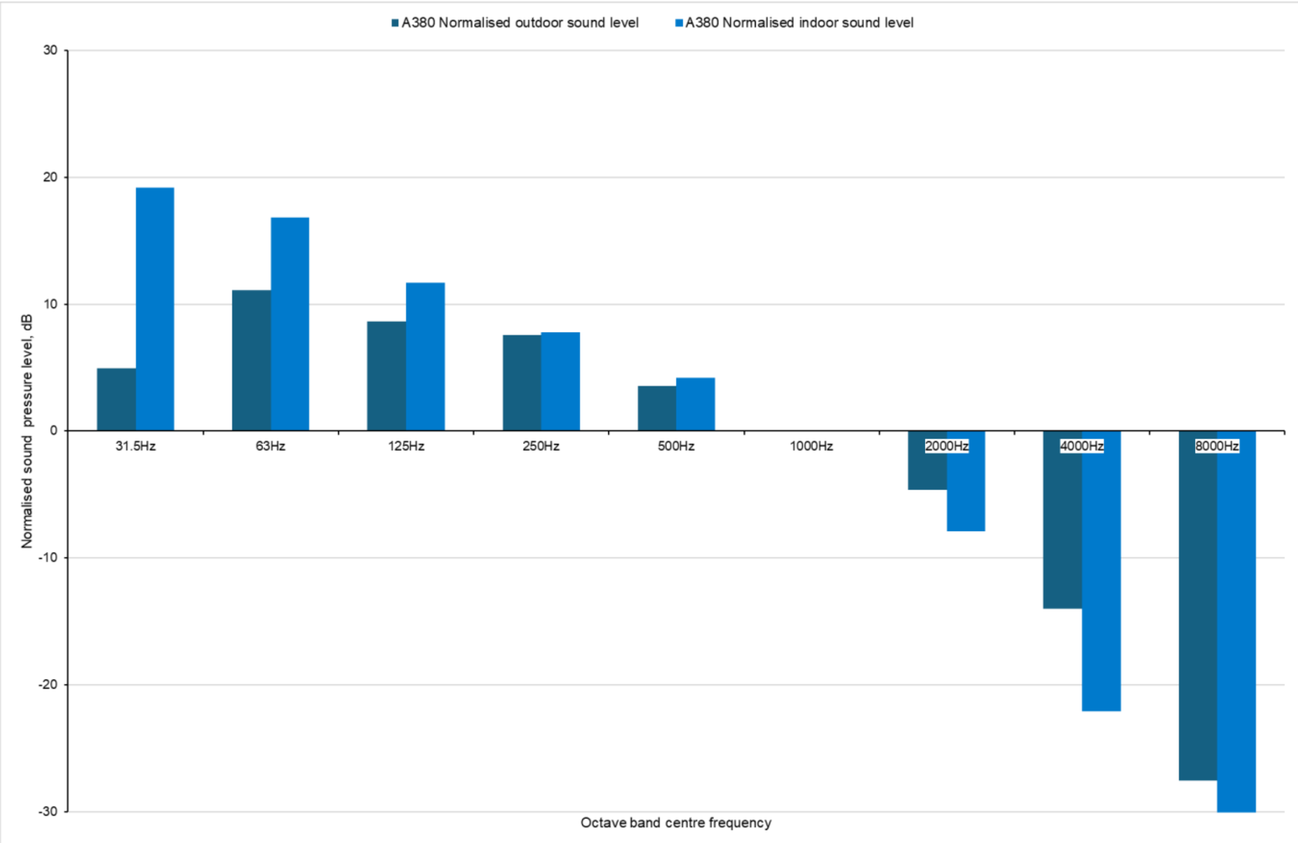

Figure 6: Indoor and outdoor normalised noise levels for Airbus A380

The analysis of the aircraft noise signature revealed a pronounced contribution in the lower frequency range. This is an expected outcome, as typical residential construction, being relatively lightweight, is generally less effective at attenuating low-frequency sound.

The perceptible sound in the bedroom has clearly audible lower frequency contributions, especially during night-time hours when ambient noise levels are reduced. This effect is amplified by the greater attenuation of the higher frequency sounds, resulting in the residual low-frequency components becoming more dominant within the room.

Figure 7 presents the typical outdoor-to-indoor noise reductions observed with windows closed. Noise reduction across each octave band was calculated by subtracting the measured indoor levels from the corresponding outdoor levels. These results underscore the importance of carefully selecting the aircraft noise spectrum used in assessing Acoustic Noise Reduction (ANR) performance.

The pattern of noise reduction across octave bands aligns closely with findings from a substantial study into measured indoor and outdoor aircraft noise in residential buildings (Federal Aviation Administration, 2016). That investigation similarly identified that indoor noise levels tend to be dominated by lower frequency sounds and, as with this study, emphasised the need for careful consideration when choosing a representative noise spectrum to define the required ANR performance for residential structures.

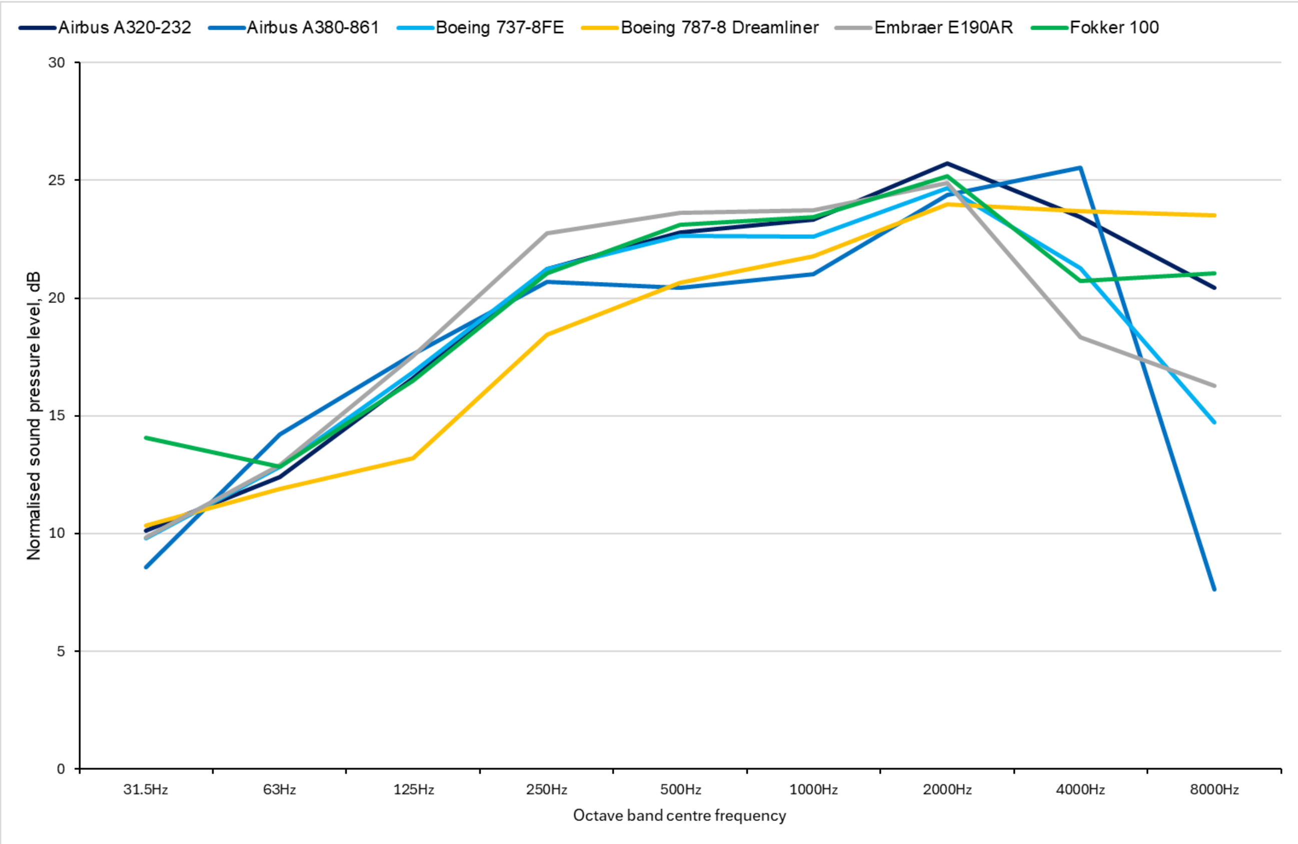

Figure 7: Equivalent outdoor to indoor noise level reductions for various aircraft

4 SUMMARY

An opportunity to measure aircraft noise at a residence located near one of Australia’s major airports revealed that jet aircraft take-off events can impact the indoor environment, even at distances of approximately 10 km from the runways. While indoor noise levels were substantially reduced with windows closed, typically remaining within the AS2021 guideline of L_{max} 50 dB(A), night-time aircraft noise remained clearly perceptible inside the dwelling, with a distinct contribution of energy in the lower frequency bands.

As airport operations continue to expand, the overlap of sensitive land use and aircraft noise exposure presents an ongoing planning and acoustic challenge. This study confirms the importance of accurately determining the level and character of aircraft noise in areas with significant aviation activity, particularly as new airports are constructed, and modern aircraft enter operation. The information is significant when determining the ANR and recommending a building construction elements to meet AS2021 and support improved indoor acoustic comfort.

5 REFERENCES

Australian Standard AS2021:2015. Acoustics – Aircraft noise intrusion – Building siting and construction.

Brisbane Airport Corporation. 2020. Flight Path and Aircraft Noise Information Booklet. 4th version.

Moyo, C., Latimore, M., Fenner, B., and Zissermann, P. 2019. Assessing the environmental impacts of aircraft noise.

Federal Aviation Administration. 2016. Review and Evaluation of Aircraft Noise Spectra used to Estimate Noise Level Reduction for Airport Sound Insultation Programs based on the Loudspeaker Test Method. HMMH Report No. 305220.008.