BRISBANE FLIGHT PATH COMMUNITY ALLIANCE

BFPCA Supplementary Submission to the 2024 Senate Inquiry into the Impact and Mitigation of Aircraft Noise

13 May 2024

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Executive Summary

Dear Senators

We thank you for inviting BFPCA to provide evidence at the public hearing in Brisbane on 15 April 2024, as well as allowing us to lodge this supplementary submission.

In the Brisbane public hearing, we heard statements and responses from representatives of the aviation and tourism industry. In **part A** of this supplementary submission we fact check and rebut some of the key misleading statements that amount to deception and lies.

In **part B**, we present Dr Sean Foley's latest research article, which calls on Australia to establish national aviation noise pollution standards, emphasising the inadequacy of current measures and advocating for the adoption of the "Z" unweighted decibel scale to better monitor low frequency and infrasound noise. It calls for government intervention to mandate comprehensive noise monitoring, research prioritisation on the health impacts of low frequency and infrasound, and adaptation of equipment and protocols by manufacturers, to ensure citizens' health and socio-economic wellbeing are protected from the adverse effects of aircraft noise pollution.

We reiterate our demand for direct and legislated operational restrictions on noise as they are in force in Sydney, Adelaide, Essendon and at the Gold Coast. Unlike other minimally effective operational tweaking and noise sharing actions, which have been proposed and unsuccessfully tried over many years, direct operational restrictions actually reduce noise pollution.

There is no other practical short-term solution that can actually reduce the already unacceptable noise harms in the face of increasing traffic. That is why many infelicitously sited airports around the world have been forced to accept them and yet still manage to operate successfully, in spite of BAC's assertion of catastrophe.

Curfew and cap restrictions are moreover fully in line with the ICAO international guidelines, since ICAO's three preferred strategies to create any noise mitigation have so far failed over the years since the new runway opening (viz. reducing noise at source, planning, and modifying operational procedures). This failure is clearly evident in Brisbane and it is backed by objective data and multiple independent reviews.

Any attempts to convince residents of a miracle breakthrough in the near future by continuing the existing approaches are not credible. TRAX reports will not solve the problem of low noisy residential overfly. Their previous recommendations have not been implemented in any case.

There remains the necessary task for the Inquiry to also recommend an evidence-based, independent and scientific review and assessment of noise harms and their extent across Greater Brisbane, and for the government to meet their duty of care and act on those insights.

BFPCA is happy to provide further input on various aspects of both our original and this supplementary submission should Senators wish our further input or clarification during this Inquiry and associated hearings.

Brisbane, 13 May 2024

Professor Marcus Foth
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Chairperson
Brisbane Flight Path Community Alliance, Inc. (BFPCA)

Acknowledgements

BFPCA is grateful for the assistance and contributions from various BFPCA committee members and community members, and would like to specifically thank Professor John Quiggin (Section 2 – The cost of a curfew) and Dr Sean Foley (Australia – Aircraft Noise Metrics) for their written contributions to this supplementary submission.

About BFPCA

With the launch of Brisbane Airport's New Parallel Runway on 12 July 2020 came a new airspace design and flight paths that concentrate aircraft noise over densely populated residential areas.

Brisbane Airport and Airservices Australia sold this project to Brisbane communities suggesting the New Parallel Runway will enable them to prioritise "over water" operations that direct planes away from residential areas. The CEO Gert-Jan de Graaff is on the record saying, "the net effect of aircraft flying over the city will decrease."

Brisbane families and communities are suffering from excessive noise pollution and associated health and related impacts from Brisbane Airport's new flight paths launched in July 2020. The Aircraft Noise Ombudsman report, the Brisbane Airport PIR Advisory Forum (BAPAF) and flight path design consultants TRAX International have all confirmed that Brisbane communities were misled using flawed noise modelling, deceiving community engagement, and offered inadequate noise abatements.

Brisbane Flight Path Community Alliance (BFPCA) came together in 2020 to fight back on behalf of all Brisbane families and communities experiencing this noise pollution.

For more information about BFPCA and our community advocacy work, visit: https://bfpca.org.au/

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Part A
Rebuttals

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1. Quieter planes

In the Brisbane public hearing on 15 April, we heard from AAB Chair Ron Brent, from Brisbane Airport Corporation, and from Qantas, all arguing that a noise reduction of 2, 3 or 4 decibels is too small and thus apparently not perceptible to the human ear. Instead, the public is supposed to sit and wait for new aircraft to be purchased, which are apparently up to 50% quieter.

We present the following evidence and fact checking.

Hansard Excerpt #1 (p. 56): BAC

CHAIR: I have a few questions; we are over time, so I'll try and get through these quickly. I want to get your specific thoughts on some of the proposals put to us, especially by the community groups this morning. There were complaints about this full runway trial. Do you know about that? There was a trial done using the full runway and there were apparently issues about whether the actual flight path used was different and, therefore, was a real test of whether that would reduce noise. Did you see that or do you have any comments on those complaints?

Mr de Graaff: I'll let Tim talk again. Tim, by the way, is an adviser to the AAB— _

CHAIR: So he'd be well aware of these particular issues. Mr Boyle, do you understand my question?

Mr Boyle: I do. Brisbane Airport was very supportive of the trial, for any improvements that can be delivered. Without wanting to get too technical, to improve noise outcomes for people underneath the departure path the aircraft has to climb at quite a significant angle. An appreciable difference is measured and generally accepted as being a reduction of three decibels or more in the noise an aircraft makes. To achieve a positive outcome from the trial, it would show that this Qantas jet was three decibels quieter when it was—

Hansard Excerpt #2 (p. 61): Qantas

Senator WATERS: Thanks to both of you for appearing today and for your respective statements. This question is for Qantas. Apparently in October 2023 the Brisbane Airport Corporation told Minister King that Jetstar was going to be fitting new vortex generators to its A320s. I heard your reference to the A321s and that sounded fine, but where is at regarding the new vortex generators for the A320s? Was that ever genuinely a commitment made? If not, why not? And what's happened with that?

Capt. Passerini: The vortex generation modification—the vortex generator being an airflow control device, in this case on the A320—is located close to the fuel vent port. There was a modification introduced in production since 2015. At this moment, approximately 20 per cent of the Jetstar fleet have the vortex generator installed. With our delivery of A321neo aircraft, of which we currently have 10 in the Jetstar fleet, that will be growing to 18 by the end of this calendar year. That will mean 35 per cent of the Jetstar fleet will be equipped with the vortex generator. It is likely that within the next two years, with our fleet renewal program, the majority of those vortex generator equipped aircraft will be retired.

On the subject of the vortex generator, I will say that the manufacturer does not have any conclusive benefit for the installation of the vortex generator. At best, the estimates by some European carriers are up four decibels reduction, though typically two is reported. According to the Australian federal noise ombudsman, four decibels is barely perceptible. **Frankly, the best and most advantageous aspect is the fleet renewal program, because those aircraft are up to 50 per cent quieter than the previous generation aircraft.** […]

So the fleet renewal is a much more advantageous way of getting the vortex generators but also, more importantly, of getting the benefit of those new aircraft, **with those new generation engines that are up to 50 per cent quieter than what they represent, which is far more significant than the reduction of up to four decibels, which is barely perceptible.**

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Hansard Excerpt #2 (p. 62): Qantas

Capt. Passerini: Yes, correct. Again, I press the point that most of the industry reporting relates to approximately two decibels, up to four at the outside, and, according to the federal noise ombudsman, that is barely perceptible. **The most powerful driver in reducing aircraft noise is fleet renewal**, and we're embarking on the largest in Australian history. The important point: there'll be one new aircraft every three weeks for the next few years—just to your point in terms of the rapid rate.

BFPCA: We disagree. These statements are false and misleading. ❌

BFPCA's main submission explains the decibel scale used to measure noise pollution:

> **Decibels**
>
> *"Decibels (dB) are a unit used to measure the intensity or loudness of sound. Noise perception varies subjectively among individuals due to factors like personal sensitivity and context. Relying solely on decibels to convey noise pollution has flaws because it fails to capture the full range of human reactions and sensitivities to different noise volumes and the frequency of noise events. Additionally, the decibel scale is logarithmic. For example, an increase from 60 dB to 70 dB represents a tenfold increase in intensity."* ***(p. 33)***

To determine the decrease in decibels corresponding to a 50% reduction in noise pollution as claimed by Qantas in their testimony, we can use this formula for calculating the change in decibels:

$$\text{Change in decibels} = 10 \times \log_{10}\left(\frac{\text{New Intensity}}{\text{Old Intensity}}\right)$$

Given that Qantas claims their new aircraft will be up to 50% quieter, the new intensity would be half of the old intensity. Using this information:

$$\text{New Intensity} = 0.5 \times \text{Old Intensity}$$

We plug this into the formula:

$$\text{Change in decibels} = 10 \times \log_{10}\left(\frac{0.5 \times \text{Old Intensity}}{\text{Old Intensity}}\right)$$

$$= 10 \times \log_{10}(0.5)$$

$$= 10 \times (-0.3010)$$

$$= -3.010$$

So, a 50% reduction in noise level corresponds to a decrease of approximately **–3.01 decibels** on the logarithmic scale. Therefore, if the old noise level was, for instance, 70 dB, the new noise level would be approximately 70dB – 3.01dB = 66.99dB, which can be rounded to 67 dB.

If the aviation industry cartel first claims that a 3 decibel reduction is too miniscule and barely noticeable, then it stands to reason that their argument for the community to wait for quieter aircraft that will only achieve up to 3 decibels reduction in noise pollution is similarly miniscule and barely noticeable. **So Qantas' statement that, "The most powerful driver in reducing aircraft noise is fleet renewal" is misleading and a lie.**

The aviation industry invests in quieter modern planes, not primarily for the reduction in noise but, for the increase in fuel efficiency. And there is a trade off between these two. The impressive sounding quietness reduction figures are misleading tweaked averages of sound pressure that do not reflect

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additional noise reductions over current modern aircraft models will take a significant redesign of the whole aircraft.

The dBA sound reduction measures (specified by manufacturers under perfect operating conditions) also omit low frequency aircraft noise, which is a significant component of aircraft sound, and which is both disturbing AND damaging to health. It is also much less amenable to reduction through the current approaches. **We refer to Dr Sean Foley's report on this topic in Part B beow: Australia – Aircraft Noise Metrics.**

As small percentages of the airlines' fleets are renewed every year, and there are dozens of airlines operating at every airport, it will take decades for quiet planes to be used on all flights, including the heavy international night-time flights and the older aircraft typically favoured for night time operations by the freight companies.

The aviation industry's empty promises of quieter aircraft is a perpetual tactic of avoiding taking real action on noise pollution as the below news article from 1985 demonstrates: *"… the curfew [in existence at the old Brisbane Airport in Eagle Farm prior to 1988] might be eased to allow quieter jet aircraft to use special flight paths…"* (Figure 1).

SAT 30 NOV 85

THE COURIER-MAIL — 15

Night flights to airport unacceptable: Minister

ANY relaxation of the 11 p.m. to 6 a.m. curfew at Brisbane Airport would be totally unacceptable, the State Transport Minister, Mr Lane, said last night.

Mr Lane said the Federal Government should be patient in reviewing the airport curfew.

A report by the House of Representatives select committee on aircraft noise recommended this week that the curfew might be eased to allow quieter jet aircraft to use special flight paths at the airport up to midnight and after 5 a.m.

Such aircraft include Boeing 737-300s on order by Australia's two major domestic airlines, Ansett and Trans Australia Airlines.

Mr Lane said the Federal Government should not review the curfew until the new bayside airport was opened.

"We have been putting up with aircraft noise for years now," he said. "I have received hundreds of complaints. The Federal Government should inject more funds into the new airport and bring its completion date forward."

The Labor MHR for Lilley, Mrs Darling, last night joined Mr Lane in condemning a curfew relaxation, but said some of the committee's recommendations, if adopted, would result in less aircraft noise around the airport.

Mrs Darling, whose electorate includes the airport, said she supported a recommendation that smaller aircraft such as Lear jets and propeller aircraft be subject to the same curfew as larger aircraft.

"Small jets and propeller aircraft like the notoriously noisy Fokker Friendship flying late at night can be more annoying than a fleet of jets," she said.

Both Ansett and TAA said a curfew relaxation would allow them to schedule more services in busy holiday periods, resulting in advantages for passengers.

A TAA spokesman said, however, that the recommendations had not gone far enough.

"We have been proposing 24-hour services into Brisbane Airport for months," he said. "The curfew discriminates against jets because they are based on engine types rather than acceptable noise levels."

Figure 1: "Night flights to airport unacceptable: Minister" – Courier Mail, 30 Nov 1985

Perpetual promises of quieter planes are a convenient excuse for avoiding any restrictions now that might interfere with profits, scheduling and operational cost efficiency. The onus is on the community to wait for a fantasy future. Meanwhile, **increased noise from projected air traffic increases will more than offset any reduction in quietness from more modern aircraft.**

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2. The cost of a curfew

The following additional rebuttal of BAC's economic figures prepared by Queensland Economic Advocacy Solutions (Submission #49) has been kindly prepared by **ARC Laureate Fellow Professor John Quiggin**, University of Queensland (his original submission #3):

QEAS Submission to Senate RRAT Committee Inquiry into Aircraft Noise: Response

Prof. John Quiggin, University of Queensland

The purpose of this response is to note that the data present in the QEAS submission is consistent with the conclusion that the imposition of a curfew and capacity caps on Brisbane Airport would yield benefits to Brisbane residents substantially in excess of the costs imposed on air travellers.

Curfew

As shown in Figure 1, the number of flights by hour of day occurring between 10pm and 6am averages around 2,000 (2018-29), less than 10 per cent of the total. These flights could be accommodated during lower demand periods: 6am – 8am, 8am – 10pm, 11am – 5pm, without exceeding existing caps.

Freight

Again as shown in Figure 1, most flights during the proposed curfew hours are carrying freight. Other freight carriers (trains and heavy trucks) make substantial efforts to minimise disturbance associated with night-time operations. By contrast, Brisbane Airport Corporation's strategic plans involve expansion of 24-hour freight operations (see also Section 8 – Aerotropolis – turning Brisbane into the Detroit of Australia).

If, as a result of the poor design decisions associated with the construction of the second runway, it is impossible to pursue this strategy without substantial noise impacts, then BAC, rather than Brisbane residents, should bear the costs.

Given the inability of BAC to manage noise associated with its operations, it would be preferable for freight operations to use other airports in SEQ, such as Wellcamp, which is a dedicated cargo airport, or to use alternative modes such as rail.

Growth projections

The growth projections on which the QEAS submission is based take no account of the very weak growth in air transport observed in recent years. More importantly, they imply no role for democratic decisionmaking about transport policy. The view implicit in the QEAS submission is that demand for the services of Brisbane Airport should be met at all costs, regardless of disamenity and health impacts on Brisbane residents.

Size of the affected population

Aircraft noise will have different effects on different people living under the flight path. Everyone will be affected to some extent, some more so than others. Nevertheless, the suggestion that it is impossible to estimate welfare effects displays an ignorance of the vast international literature on the topic of hedonic pricing, including analysis of the cost of airport noise.

Supply and demand analysis

The QEAS analysis in Figure 9 is correct as far as it goes, but needs to be completed with an analysis of welfare effects. A standard welfare analysis shows that the net reduction in economic welfare is given by 0.5 (P1 – P2)(Q1 – Q2). To explain this, observe that the consumers deterred from

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and greater than P1 (otherwise they would not fly even in the absence of restrictions). There are Q1 – Q2 such passengers, and their average value for the flight is 0.5 (P1 – P2).

We can quantify this for the case when the number of flights is reduced by 10%. That is (Q1 – Q2) = 0.1 Q2. The associated difference in willingness to pay, given by (P1 – P2), depends on the elasticity of demand. Typical estimates are close to 1, that is a 10% price change is associated with a 10% quantity change.

The standard formula then shows that the loss in economic welfare is approximately equal to 0.5% of the initial revenue P1 Q1. As noted in my previous submission (#3), this would be of the order of $10 million per year, a tiny fraction of the economic loss associated with aircraft noise.

Conclusion

Throughout this process, the position of Brisbane Airport Corporation and the consultants it employs has been to assume that the operations of the airport are so essential that no restriction can be justified, and that the economic and health impacts on Brisbane residents should be disregarded. This is no different from the position taken by other polluting industries prior to the passage of Clean Air and Clean Water acts. The data supplied by QEAS shows that the economic impact of appropriately designed restrictions on airport operations would be modest.

BFPCA Addendum:

BAC—through QEAS—present a narrowly scoped Economic Impact Analysis (EIA). Forsyth et al. (2021) argue that, "**EIA does not address the problem [how to evaluate investments in airports] satisfactorily, and it misleads air transport policy.** But this evaluation contrasts sharply with practice. EIA has been extensively used to decide on airport investment." They recommend the use of a proper Cost–Benefit Analysis (CBA) or a more extensive and detailed Computable General Equilibrium (CGE) model.

Forsyth, P., Niemeier, H.-M., & Njoya, E. T. (2021). Economic Evaluation of Investments in Airports: Recent Developments. *Journal of Benefit-Cost Analysis*, 12(1), 85–121. https://doi.org/10.1017/bca.2020.31

In the following, we also refer the Senators to Chapman, A. (2023). *Losing Altitude: The economics of air transport in Great Britain.* New Economics Foundation. https://neweconomics.org/2023/07/losing-altitude

Why increasing levels of air travel won't lead to growth in UK productivity or GDP

https://www.aef.org.uk/2023/07/17/why-increasing-levels-of-air-travel-wont-lead-to-growth-in-uk-productivity-or-gdp/

17 July 2023

Aviation reports by the industry and Government almost always begin with a statement about the supposed economic benefits of air travel. But up-to-date, independent evidence to substantiate these claims has been lacking. Old statistics, when repeated regularly enough, are prone to being accepted without further question.

Economic arguments are often used to justify an increase in noise and emissions, especially when it comes to airport expansion plans. With 2023 bringing a fresh round of airport applications to increase capacity, the Aviation Environment Trust provided funding for the New Economics Foundation to analyse whether these claims can be substantiated.

NEF's report

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Framework a decade ago. It was peer-reviewed by the respected economist John Siraut, and casts doubt on many of the aviation industry's key claims.

Analysis shows the boom in air travel since 2015 has failed to increase UK productivity or GDP growth, while business use of air travel – a key argument for expansion – has declined by 50% since 2013. Similarly, air travellers spend £32 billion more abroad than foreign travellers spend when visiting the UK. NEF argues this compounds regional inequality and damages the domestic tourism sector.

Job creation could compensate for some of these impacts, but even before the pandemic, at a time of record passenger numbers, jobs in the air transport sector had declined since 2007. In fact, NEF's assessment shows that the sector is one of the poorest job creators per pound of revenue, with wages lower than they were in 2006.

The Government's Jet Zero strategy aims to deliver a net zero emissions air travel sector by 2050, but allows for unlimited growth in flying. It forecasts over 200 million more passengers a year by 2050 and at least nine airports across the UK have permission or are currently attempting to expand. There have been numerous studies questioning whether the aviation industry will be able to meet its net zero goals without reducing growth in air traffic and the Climate Change Committee has argued that there should be no further airport expansions in the UK until the Government has developed a 'capacity management framework'.

The NEF report recommends that the Government pause all growth in air travel, including airport expansions, until it has conducted a comprehensive, independent review of the economic evidence of expanding the UK's air travel sector, and the compatibility of air transport growth with policies on climate change, levelling-up, and domestic tourism.

Dr Alex Chapman, senior researcher at the New Economics Foundation (NEF), said:

"For years, this government has let the air travel industry balloon in size, based on dangerously outdated claims that it is boosting the UK's economy. The reality is declining business air travel, declining wages for air travel workers, declining job numbers, and declining domestic tourism spending in the UK. And that's before you consider the rise in noise, air pollution and dangerous emissions driven by UK airports. So who exactly is benefitting from ever more air travel? You needn't look much further than the highly paid executives, the private shareholders, and the wealthy minority of ultra-frequent flyers."

Cait Hewitt, Policy Director at the Aviation Environment Federation, said:

"The question of whether or not airports should expand is often assumed to be about balancing environmental harms against economic benefits. This new analysis suggests we should think again; while flying definitely causes harm in terms of noise and emissions, it's uncertain if it actually brings any economic benefits. Obviously, people benefit from going on holiday, but policies that support British tourism and leisure – rather than increasing travel abroad – would be good for the UK economy as well as the climate."

Read the full report here: https://www.aef.org.uk/uploads/2023/07/Losing-altitude-The-economics-of-air-transport-in-Great-Britain-.pdf

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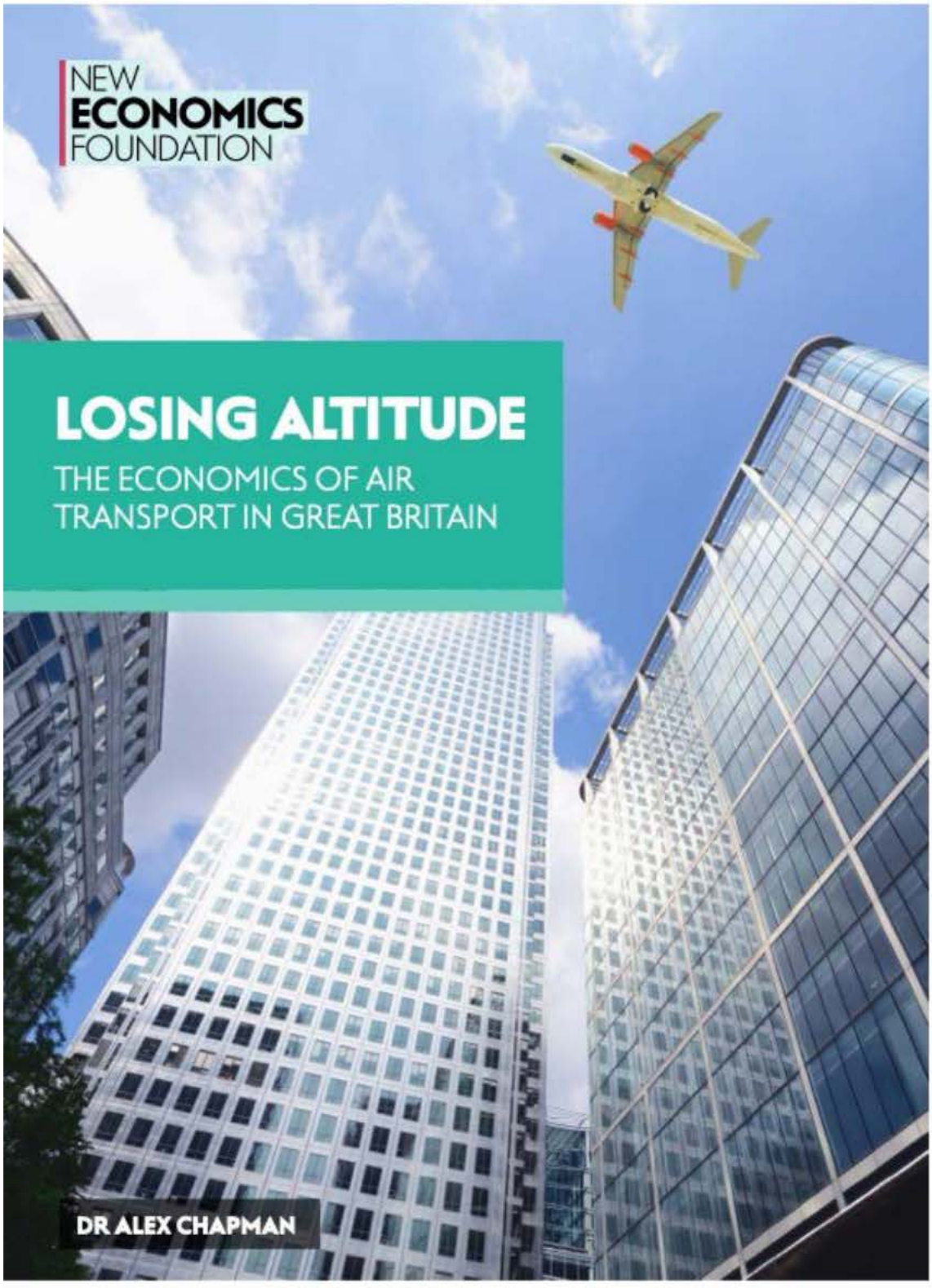

Figure 2: Chapman, A. (2023). Losing Altitude: The economics of air transport in Great Britain. *New Economics Foundation.* https://neweconomics.org/2023/07/losing-altitude

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3. Social licence to operate

Hansard Excerpt (p. 20): AAB

Mr Brent: […] The notion that there are degrees in noise and that any small improvement is a benefit to people below, and that you have to pay a price for making small improvements because **that's the price of a social licence to operate an airport**, was something that I don't think was built into the culture of the organisation.

BFPCA: We agree. ✅

Hansard Excerpt (pp. 74 – 75): Community voices

Ms Handley: The Brisbane Airport operates with a social licence from the community. It is a licence for the benefit of that community, not for use and abuse. […] We as a community were misled about the effects of the second runway at Brisbane Airport. **Brisbane Airport Corporation does not have a social licence to profit at the cost of health, decreased property values and other adverse effects on your host community.** The safety of the aircraft industry does not come at the cost of community safety. Private profit should not be at public cost.

BFPCA: We agree. ✅

Hansard Excerpt (p. 46): BAC

Mr de Graaff: […] The benefits of aviation are broad, benefiting the public economically and socially. But the burdens of aviation, most particularly the noise, are borne very locally around airports. We acknowledge that, for some people, aircraft noise is a genuine problem, and we are very sympathetic to their distress. We know, however, that reducing aircraft noise is complex. It requires airports, airlines, aircraft manufacturers and airspace managers to work together with common purpose and commitment. There is no easy fix. There are no silver bullets.

BFPCA: We disagree. This is false. ❌

There are in fact (some) easy fixes. They must not operate in isolation but conjointly and are easy to implement instruments that have been used at other Australian airports and many more internationally. They include:

- **Curfew**: Legislate a Brisbane Airport Curfew Act that introduces a curfew from 10 pm to 6 am. Australian examples: Sydney, Essendon Melbourne, Gold Coast, Adelaide.
- **Airport Capacity Declaration**: Issue an Airport Capacity Declaration for Brisbane Airport of 45 flights an hour as provided for under the *Airports Act* 1996, Section 195, in order to provide Brisbane families and communities with certainty about the maximum number of flights to expect in a given day as well as into the future. Australian example: Sydney.
- **Collect Aircraft Noise Levies**: Declare Brisbane Airport a leviable airport under the *Aircraft Noise Levy Act* 1995 to impose and collect aircraft noise levies. These levies are to be distributed as compensation to all Brisbane residents in the vicinity of any of Brisbane Airport's flight paths and within the noise contours associated with compromised health and educational outcomes. Australian examples: Sydney, Adelaide, and proposed by this Albanese government for Western Sydney.

Such easy fixes have even been advocated for by now Prime Minister Anthony Albanese when he first entered parliament in 1996. In his maiden speech, this is what he had to say about Sydney Airport's enormous noise pollution issue affecting people in his seat of Grayndler:

"The third runway cost $243 million to build. ***As the enormity of the noise problem emerged, noise amelioration measures became necessary.*** *Their cost will far exceed the $270 million already allocated. The Keating government moved to minimise the impact of the noise. It launched a project to acquire 151 of the worst affected homes and insulate 20 schools, 21 preschools and child-care centres, 24 places of worship, eight nursing homes and 4,380 homes.* ***In the longer term, however, the solution must be to lower the number of aircraft movements over the inner west. It must not be forgotten that this area is the most densely populated in Australia.***"

Anthony Albanese MP, Member for Grayndler, maiden speech, 6 May 1996: video | speech

Figure 3: Anthony Albanese's maiden speech | SBS News, source: https://youtu.be/0LBPctS1RHA

Albanese then introduced a private member's bill, the *Sydney Airport (Regulation of Movements) Bill* 1996 that sought to legislate:

"Not more than 80 aircraft movements per hour shall be permitted at Sydney (Kingsford-Smith) Airport."

Sydney Airport (Regulation of Movements) Bill 1996

In his Second Reading speech on 18 Nov 1996, Albo said:

"Despite policies of sharing the noise, ***there is no doubt that thousands of residents in my electorate are still subjected to excessive aircraft noise****. In fact, many hundreds of people in my electorate who sold their homes under the old flight path, at a massive loss, and moved to unaffected neighbouring areas* ***are now being plagued with the noise that they paid dearly to escape****. [...] A vote for this bill is* ***a vote for a limit to noise at KSA*** *[Kingsford Smith*

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> Anthony Albanese MP, *Sydney Airport (Regulation of Movements) Bill* 1996 (Second Reading), 18 Nov 1996: video | speech

While Mr Albanese's Bill did not proceed, John Howard's government did pass the Sydney Airport Demand Management Act 1997, which limits flight movements in Sydney to 80 per hour to this day. Note that **John Howard's seat of Bennelong was also in the firing line of Sydney Airport**, and right next to Albo's seat of Grayndler.

The double standards between Albo '96 vs King '23 could not be any starker:

> ***"They've basically said if I don't do a curfew, they're going to protest and, unfortunately, then they're going to have to protest because I can't do what they're asking me to do."***
>
> Catherine King MP, Minister for Infrastructure and Transport, National Press Club address, 1 March 2023: video| speech

Families and communities living in cities hosting airports are paying the costs but are not sharing in the benefits. This is a clear inequity. **Brisbane Airport's current unregulated operations represent a wealth transfer from ordinary Australians to a privately held corporation guided by the neoliberal premise to privatise the profits and socialise the losses.**

Right now, airports, airlines, aircraft manufacturers, airspace managers and all three levels of government **are** working VERY closely together with common purpose and commitment: To maximise the profit of the aviation industry at the expense of the community. There is evidence of this:

Airservices' "Key Messages" document

BFPCA acquired Airservices' "Key Messages" document (Figure 4), which they publicly released by mistake as it was obviously **never intended to be seen by Brisbane communities**. This document (copy below) was created 02/02/2022 and published in error on the Airservices Engage portal, but then **quickly removed from view** as it was only intended for Airservices' airport and airline stakeholders, not for view by the community – it is easy to see why.

This document shows Airservices' true colours: The key messages or "talking points" that Airservices here recommends to their aviation industry stakeholders suggest we are dealing with Australia's government-controlled airspace regulator that is portraying to be simply a service provider in servitude to a national aviation industry cartel that is strategically colluding to privatise profits and socialise losses.

Some particularly appalling passages from this document:

- **"To enable long-term growth at Brisbane Airport (BNE), Brisbane Airport Corporation Pty Ltd (BAC) must maintain the ability to operate with minimal operational constraints.** This will be achieved through the **management of community and political responses**…"
- "As evidenced both internationally and within Australia, increased public pressure has resulted in operational restrictions at various airports, which have **significantly impacted route development opportunities, aircraft efficiency, infrastructure utilisation and ultimately, long-term growth**."
- "The **future profitability** of Australia's major airlines will in part depend on BAC's ability to

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provides **significantly greater efficiency and capacity than any other airport in Australia** and relieves pressure on the east coast network, given the 80-movement cap and curfew in Sydney Airport and the LAHSO [land and hold short operations] / weather constraints at Melbourne Airport."

- "The long-term benefits of Brisbane's parallel runway system will only be realised **if operational restrictions such as movement caps and curfews are avoided**."
- "Brisbane Airport's airspace and runway system provides significantly greater efficiency and capacity than any other airport in Australia and relieves pressure on the east coast network, given the 80-movement cap and curfew in Sydney and the Land and Hold Short Operations (LAHSO) / weather constraints in Melbourne. **Without the proactive management of both community expectations and aircraft noise more broadly, long-term aviation growth at Brisbane Airport could be constrained through the imposition of operational restrictions."**

airservices

Proposal to Increase Allowable Tailwind at Brisbane Airport – Key Messages

- To enable long-term growth at Brisbane Airport (BNE), Brisbane Airport Corporation Pty Ltd (BAC) must maintain the ability to operate with minimal operational constraints. This will be achieved through the management of community and political responses to increased aircraft noise complaints and the balanced optimisation of Flight Path Operations for noise benefit and efficiency.
- Despite COVID-19 causing a significant reduction in aircraft movements, both BAC and Airservices have seen an increase in noise complaints from sections of the Brisbane community since the opening of Brisbane Airport's New Parallel Runway in July 2020.
- As evidenced both internationally and within Australia, increased public pressure has resulted in operational restrictions at various airports, which have significantly impacted route development opportunities, aircraft efficiency, infrastructure utilisation and ultimately, long-term growth.
- The future profitability of Australia's major airlines will in part depend on BAC's ability to keep the parallel runway system unconstrained as movements along the east coast of Australia are set to double over the next 20-30 years. The airspace and runway system provides significantly greater efficiency and capacity than any other airport in Australia and relieves pressure on the east coast network, given the 80-movement cap and curfew in Sydney Airport and the LAHSO/weather constraints at Melbourne Airport.
- The long-term benefits of Brisbane's parallel runway system will only be realised if operational restrictions such as movement caps and curfews are avoided.
- Brisbane Airport's airspace and runway system provides significantly greater efficiency and capacity than any other airport in Australia and relieves pressure on the east coast network, given the 80-movement cap and curfew in Sydney and the Land and Hold Short Operations (LAHSO) / weather constraints in Melbourne. Without the proactive management of both community expectations and aircraft noise more broadly, long-term aviation growth at Brisbane Airport could be constrained through the imposition of operational restrictions.
- The increased use of Simultaneous Opposite Direction Parallel Runway Operations (SODPROPS) is one way of achieving greater efficiency for airlines while reducing the impacts of aircraft noise on the community. While the current 5 knot tailwind restriction results in night-time (10pm – 6am) "over the bay" use of around 50-52%, there is an opportunity to safely increase tailwind operations to enable greater "over the bay" night-time operations by ~20%. This increase in SODPROPS utilisation would also allow flexibility for more "over the bay" movements in the shoulder periods (before 10pm and after 6am).

Figure 4: Proposal to Increase Allowable Tailwind at Brisbane Airport – Key Messages, Airservices Australia, created 2 Feb 2022

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BFPCA asks:

i. **Why should Brisbane communities provide the buffering capacity for the rest of the East Coast at the expense of our amenity, liveability, health and wellbeing?**

ii. What precisely does Airservices mean by "**the management of community and political responses**"?

iii. The document says, "As evidenced both internationally and within Australia, increased public pressure has resulted in operational restrictions at various airports…" **– Yet, this is exactly what we want Airservices to do**: Implement NET MOVEMENT REDUCTIONS which bring about actual NET NOISE REDUCTIONS. How does Airservices' reconcile its industry key messages with Airservices' own "Community Engagement Framework," which promises "meaningful and transparent engagement with communities"? Airservices are telling communities that they will "fix" the Brisbane noise issue, yet at the same time they're telling industry to fear "increased public pressure" like the devil the holy water. **Airservices are lying to Brisbane communities.** And this entire smoke and mirrors community engagement theatre is paid for by Australian tax payers.

iv. The ANO in his 2021 report "Investigation into complaints about the flight paths associated with the Brisbane Airport new parallel runway" also found Airservices provided blatant lies to Brisbane communities, which were given to Brisbane Airport also wrapped up as key messages or "talking points" (see ANO report section 6.5–6.7, 7.16, 7.20, and report appendix B). **Has Airservices learnt any lessons from this unethical behaviour at all?** Considering the Airservices Board of Directors have agreed to implement all recommendations put forward by the ANO following his 2021 investigation, **why is it that less than a year later, Airservices are found yet again blatantly lying to communities?**

v. How does Airservices reconcile these key messages denying Brisbane communities essential noise protections with their legislated obligations under the *Air Services Act* 1995, s9 (Manner in which AA must perform its functions), which **requires Airservices to protect communities from "the effects of and associated with the operation and use of aircraft"**?

4. What happened to the cross-runway?

Hansard Excerpt (p. 46): BAC

Mr de Graaff: […] We designed our runway system to deliver better noise outcomes than we've seen today. […] We, the airport operators, need to design and build the runway systems that offer the best noise solutions, **and that's exactly what we did in Brisbane**.

BFPCA: We disagree. This is false. ❌

With the launch of the New Parallel Runway, Brisbane Airport's cross-runway (14/32, see photo below) was decommissioned. **What happened?**

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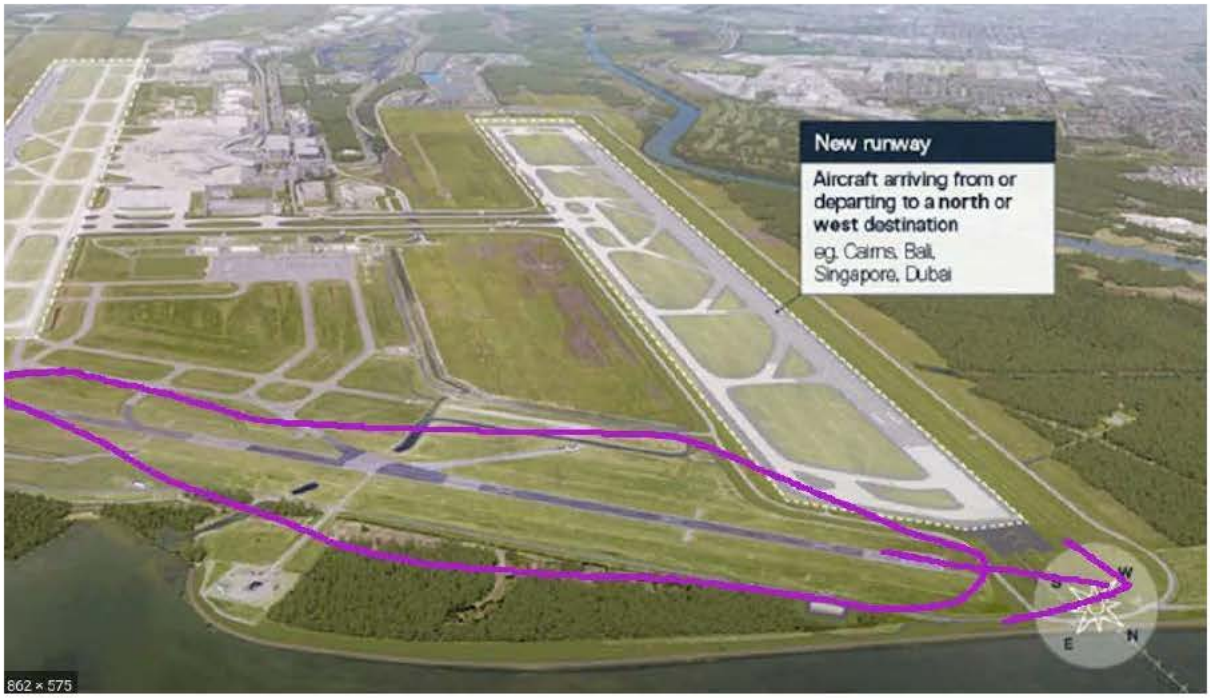

Figure 5: Brisbane Airport's cross-runway

A cross-runway design can help to **reduce aircraft noise pollution** much better than a parallel runway design by changing the direction of takeoff and landing. By having intersecting runways, an airport can choose to use the runway that is most aligned with the prevailing wind, which can reduce the need for planes to fly over residential areas during takeoff and landing. See the below screenshot of the previous cross-runway departure flight path over water for northerly winds. We are told 8-12 aircraft per hour (even some B737s) used the cross-runway prior to its mothballing AND the ONLY reason for the cross-runway's decommissioning was **profit greed**.

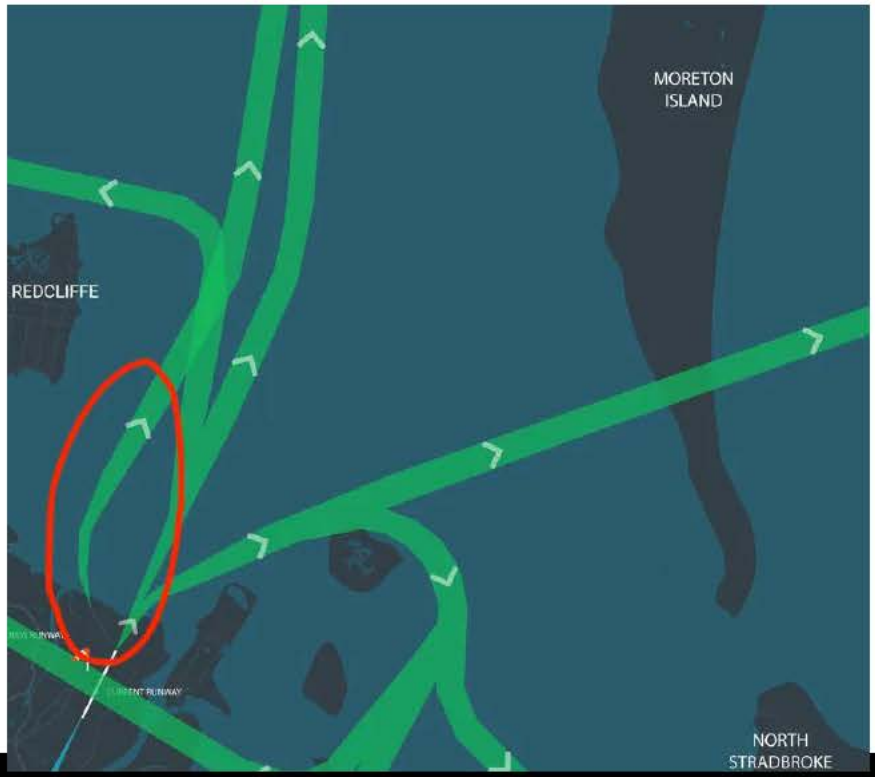

Figure 6: Decommissioned over water flight path attached to the old cross-runway

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The Brisbane Airport Master Plan 2003 contained a comparison of various options. What we are stuck with now is Option 3. The extension of the cross-runway was Option 5.

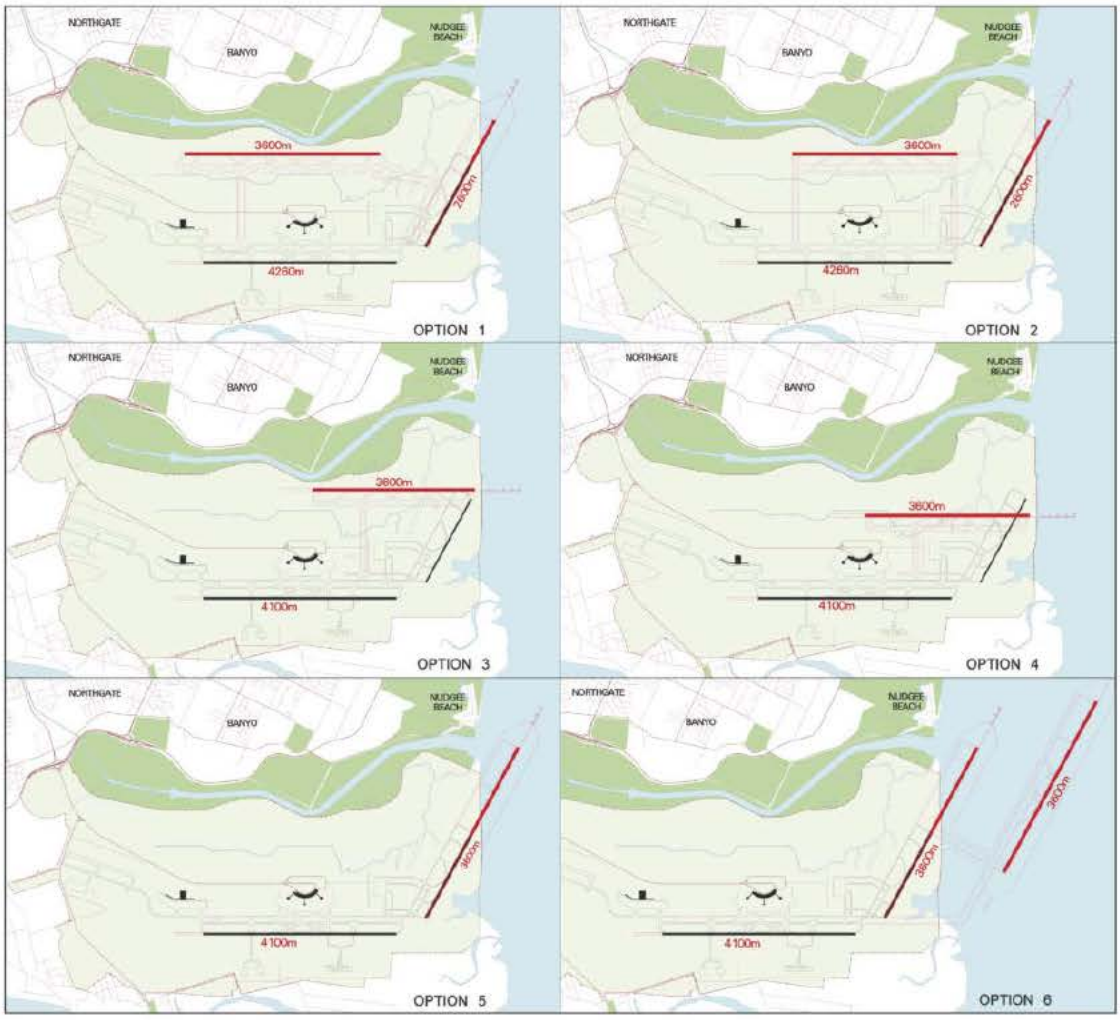

Figure 7: Runway options from the 2003 BAC Master Plan

- Option 3 (parallel runway) was estimated to provide a capacity of 390,000 – 435,000 flights at a cost of **$295M**. It has caused a significant overall **INCREASE** in noise impacts for communities.
- Option 5 (cross-runway extension) was estimated to provide a capacity of 210,000 – 235,000 flights at a cost of **$315M**. It would have caused a significant overall **REDUCTION** in noise impacts for communities. Note that an area to enable the cross-runway extension is still excluded from the Moreton Bay Marine Park **today** (see map below).

Moreton Bay Marine Park User Guide

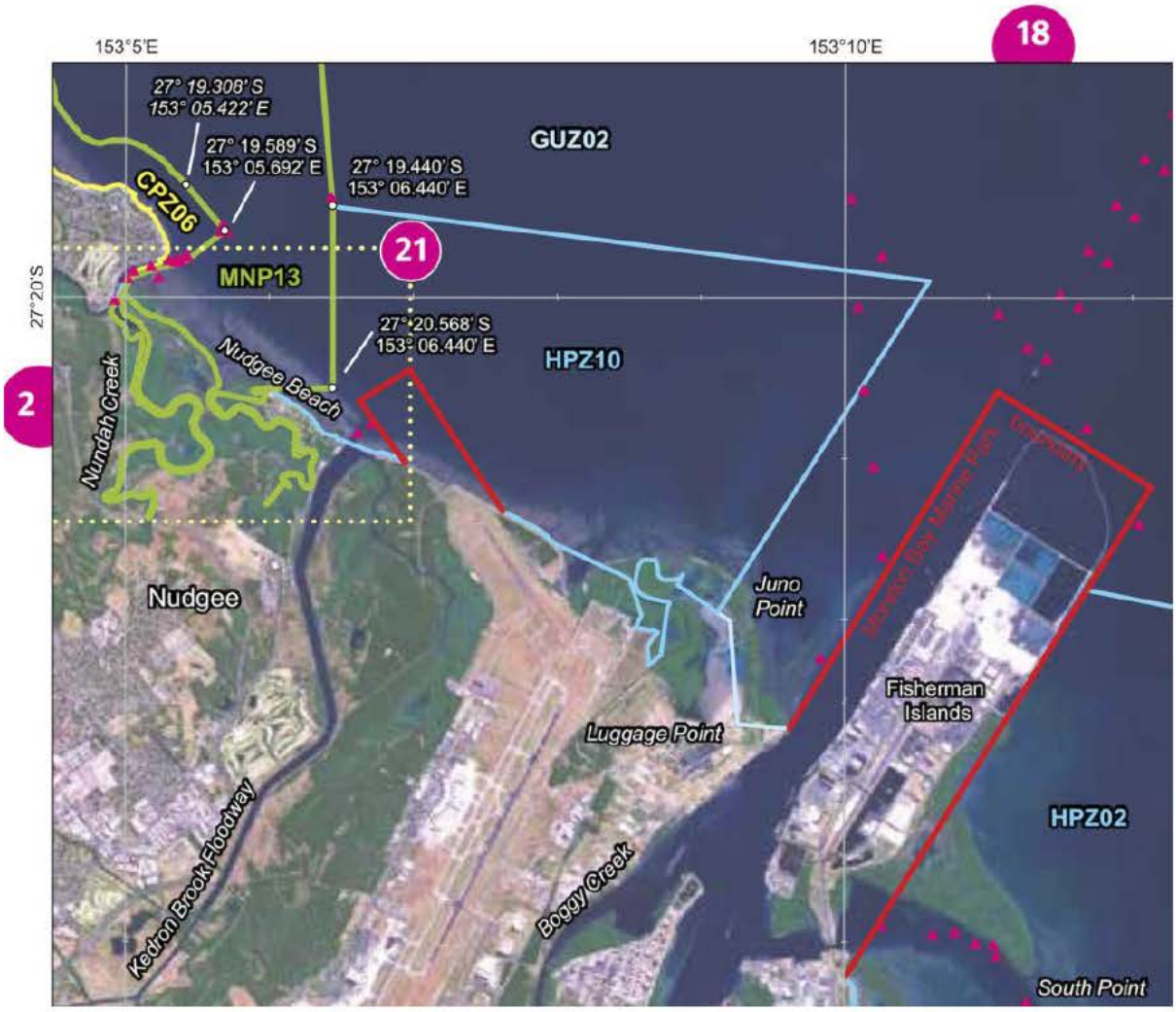

Figure 8: Moreton Marine Park User Guide showing provisions for the extension of the cross-runway

These options were then revisited in the 2007 MDP/EIS. Of course, BAC preferred Option 3: **maximum throughput and profit for them and maximum noise for us**.

Airservices also preferred the parallel runway, because for them it means they can operate Brisbane Airport with less ATCs and simply send all aircraft (now including turbo-props) onto automated flight paths (SIDs / STARs). They played the safety card, too, despite cross-runway designs being safely operated at Frankfurt, Amsterdam, Dallas, Beijing, London, Chicago, Paris, Dubai, San Francisco, Sydney, and many other airports.

33 years ago (and 12 years before the 2003 BAC Master Plan), Brisbane residents signed a petition, which we found in the Hansard of the Australian Parliament. It reads:

> *To the Honourable the Speaker and Members of the House of Representatives Assembled in Parliament:*
>
> *We, the undersigned petitioners, reject the final report of the Brisbane Airport Task Force, because it* ***failed in its basic charter to "minimise the impact of aircraft noise on surround***

*It failed to recommend their own conclusions that an **extended cross-runway would "significantly reduce aircraft noise"** and that an extended cross-runway could operate as the "main or supplementary runway," which, along with the Main Runway would **enable 80% or more planes to go in and out over Moreton Bay, as promised.***

*Although it rejected these solutions because the cost would be $105 million, it recommended that a future Parallel Runway be built at a cost of $395 million (today's price) which could escalate to double or more in 15 to 20 years, **thus forcing north and southside citizens to suffer increasing aircraft noise with no end in sight.***

We urgently request that money be made available for an extended cross-runway as the most cost effective and practical solution to Brisbane Airport noise and safety.

Hansard, 22 August 1991

Brisbane Airport Task Force

To the Honourable the Speaker and Members of the House of Representatives Assembled in Parliament:

We, the undersigned petitioners, reject the final report of the Brisbane Airport task Force, because it failed in its basic charter to "minimise the impact of aircraft noise on surround communities."

It failed to recommend their own conclusions that an extended Cross Runway would "significantly reduce aircraft noise" and that an extended cross runway could operate as the "main or supplementary runway," which, along with the Main Runway would enable 80% or more planes to go in and out over Moreton Bay, as promised.

Although it rejected these solutions because the cost would be $105 million, it recommended that a future Parallel Runway be built at a cost of $395 million (today's price) which could escalate to double or more in 15 to 20 years, thus forcing north and southside citizens to suffer increasing aircraft noise with no end in sight.

We urgently request that money be made available for an extended Cross Runway as the most cost effective and practical solution to Brisbane Airport noise and safety.

We also request that changes be made to flight paths over Hemmant, Tingalpa and Bulimba-Balmoral, Morningside areas.

by **Mr Jull** (from 33 citizens).

Figure 9: federal petition response, source: Hansard, 22 August 1991

A community representative on BACACG asked BAC CEO Gert-Jan de Graaff at the 30 Nov 2022 meeting:

*"In view that some countries actually build runways in the ocean to get both approaches over water **what was the rationale to close the cross-runway with both approaches over***

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BAC's answer: silence.

What's the cross-runway used for these days? **A parking lot for planes.**

Based on our refutation, BFPCA thus strongly rejects BAC's statement that they have designed and built runway systems that offer the best noise solutions for Brisbane. **They have instead opted to design and build a runway system that maximises their corporate profits while offering the WORST noise outcomes for Brisbane families and communities.**

Our refutation is further corroborated by TRAX International. BFPCA's early community advocacy and pressure throughout 2020/2021 led to then Deputy PM and Transport Minister Barnaby Joyce giving in to our demands for an independent review of Airservices' dodgy handiwork.

In Senate Estimates 22 March 2021, Airservices' CEO Jason Harfield referred to flight path design as their **"bread and butter."**

We beg to differ in that assessment, and whistle blowers who contacted us and our own technical advisors, too. They argue that Airservices have cut costs and have thus **not adequately invested in the professional development of their staff** as well as the type of advanced technology commonly used overseas such as flight path modelling using AI running on supercomputers.

What is worse, **Airservices let go of 184 senior Air Traffic Controllers** (some with up to 52 years of experience) between 1 Oct 2021 and 8 Dec 2022 – 144 of them due to a Retirement Incentive Scheme, which cost **$58 million**.

Barnaby Joyce made Airservices engage UK-based Trax International as a specialist advisory firm on 20 December 2021. Trax brought significant international experience having delivered similar airspace change initiatives at some of the world's busiest airports, including London's Heathrow Airport. The initial value of the contract totalled **$590,450 + GST** for 4 months of work (Jan – April 2022).

Early April 2022, the Trax interim report was first leaked and then properly released. **It listed:**

49 improvement recommendations!

Australia's national flight path design agency Airservices created and launched a new airspace architecture for Brisbane on 12 July 2020. They worked on this continuously from the 2006/2007 MDP/EIS to the launch in 2020 – some **13 years**!

It took Trax only three months (and over half a million dollars in consultancy fees) **to identify 49 ways Airservices' handiwork can be improved.** So much for "flight path design is our bread and butter" – yes, when you optimise all design options for your mates at Brisbane Airport Corporation to maximise their profits and throw communities under the Airbus.

In a number of the community workshops, the Trax representatives suggested on multiple occasions that the Brisbane flight path architecture is **so flawed** that if it were to be lodged in the UK it would have been challenged by a judicial review and "called in" by the courts before it could proceed any further.

Airservices Australia advised on 31 August 2022 that they "will adopt all recommendations in the recently released Brisbane New Parallel Runway Flight Paths Post Implementation Review (PIR) Independent Review Final Report by Trax International." In Senate Estimates they also advised that they have "initially allocated **$15 million** to the project as part of Airservices investment program."

Airservices were also asked in Senate Estimates, why did they fail to implement ANY of the 49 TRAX recommendations for noise mitigation and abatements ON THEIR OWN when the new airspace was launched on 12 July 2020?

> *"Given that Trax was appointed after the opening of the new runway its recommendations were unable to be considered in the airspace design and commissioning of the new parallel runway at Brisbane Airport in 2020."*

Airservices are not just incapable of implementing international best practice noise abatements due to their **capture by the aviation industry**, they are also **unrepentant and arrogant**.

5. A gulf of lies

Hansard Excerpt (p. 58): BAC

Ms Crowley: […] I believe that our engagement was very broad and it was extensive. I absolutely understand that there are members of the community whose concern is that the way we described the runway and the runway system operating is not how they're operating today. Therein lies the gulf between what we described and what is happening now. So I believe that engagement genuinely was extensive. It genuinely was extensive. For example, we had more than 55 million impressions from our ad campaigns. We had 65,000 visitors to our different on-site discovery centres and visits. We met with hundreds and hundreds of members of the community. Nearly 400,000 people went to our online flight path tool. We did extensive work, but I think **the gulf lies between the way we described it operating as the way that the runway system was designed and the way that it's operating now**.

BFPCA: We disagree. This is false. ❌

BAC euphemises lies as a 'gulf' when in fact it is a gulf of lies: More than 55 million impressions from BAC's misleading ad campaigns. 65,000 visitors to on-site discovery centres and visits where people were lied to. BAC met with hundreds and hundreds of members of the community and lied to them. Nearly 400,000 people went to BAC's online flight path tool, which shows misleading data and noise forecasts.

Both Airservices and BAC have argued that they have "consulted widely" in the lead-up to the 2020 launch of Brisbane's new flight path architecture. **NOBODY has received ANY honest, easy-to-understand and accurate information.** This is what honest, easy-to-understand and accurate information would have looked like:

- Your home will be directly under a flight path.
- There will be more than 100 flights per day directly over your home.
- The noise pollution will be regularly in the range that the World Health Organisation deems harmful to human health.
- These noise levels are scientifically proven to be detrimental to childhood learning.
- There will be peak periods where flights will be every 2 minutes for several hours. These peak periods are early morning and early evening i.e. during family time.
- There will regularly be flights at night between the hours of 10 pm and 6 am over your home that will be disruptive to your family's sleep.
- We recommend that you move away from Brisbane if any of the above points are likely to cause you distress. We will not offer any support or compensation for this.
- Airservices and BAC assume no responsibility whatsoever for financial harm or harm to human health.

Despite numerous government reports and guidelines (see BFPCA main submission, Section 3.1 – Previous Government Reports and Senate Inquiries) being published well before the 2007 EIS/MDP was written and submitted by Brisbane Airport Corporation and Airservices Australia, their noise forecast data continued to be flawed and misleading (Figure 10; Figure 11; Figure 12).

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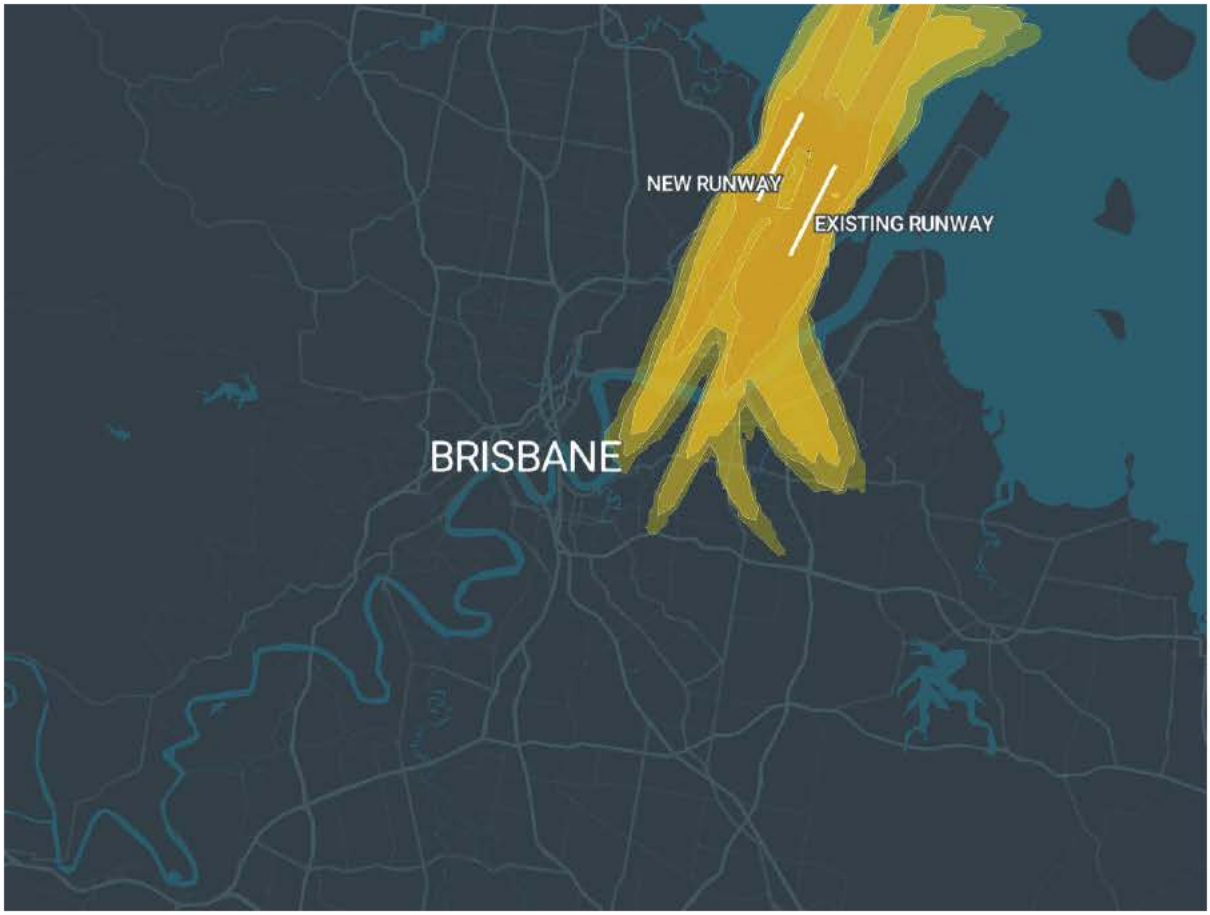

Figure 10: BAC's misleading Flight Path Tool showing Brisbane largely unaffected by aircraft noise pollution

Figure 11: ExPlane data points showing location of citizen scientists recording significant aircraft noise pollution outside the predicted noise contours provided by Brisbane Airport Corporation

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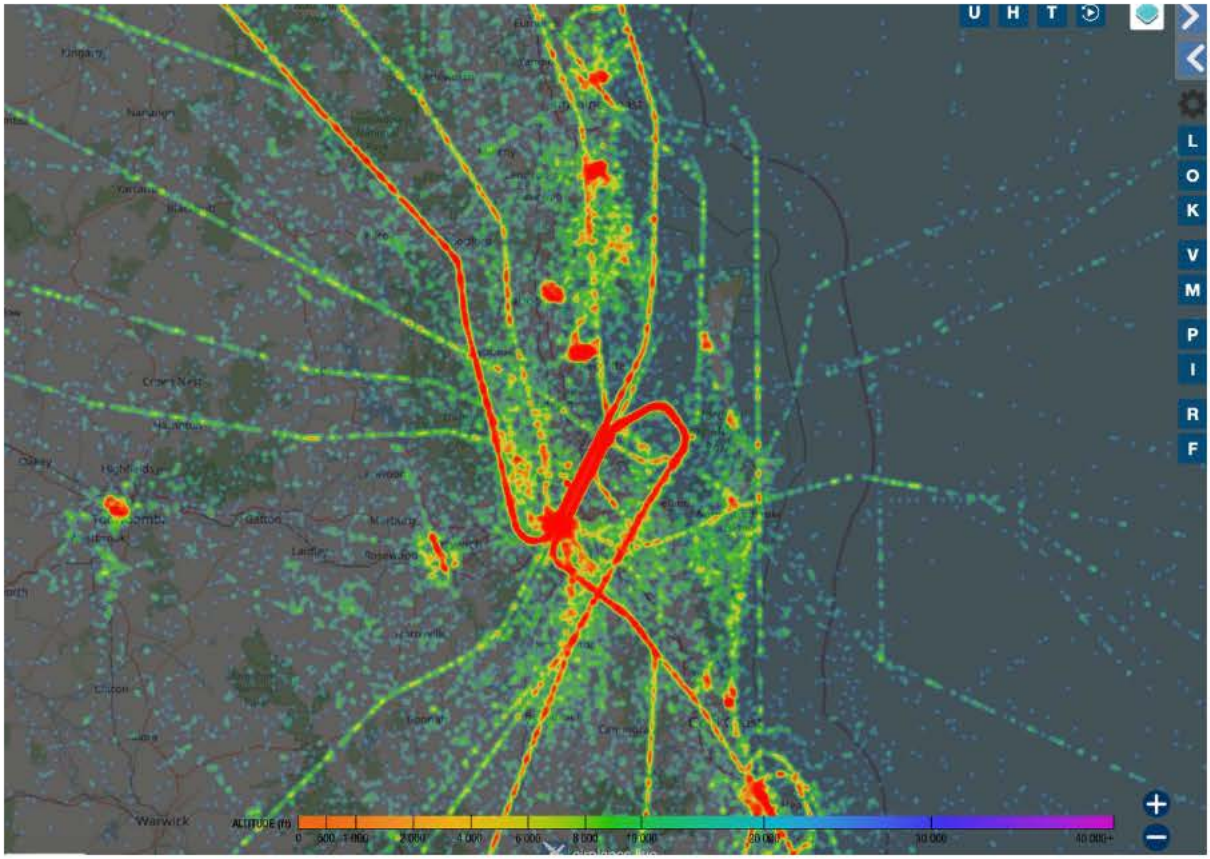

Figure 12: Heatmap of flights being tracked above Brisbane over a 48 hour period (3rd and 4th April 2024). Source.

Airservices' Baseline Model

Relatedly, we draw Senators' attention to the fact that Airservices' new "Baseline Model"[1] is rubbish. There has been a great deal of confusion and angst expressed by aircraft noise affected residents following the release of Airservices' Flight Paths Baseline Model which was meant to indicate the number of flights and other data above our homes. Once again Airservices have adopted a simplistic and half-baked approach to providing a "lived experience" solution to the community. Airservices have built their model based on a series of gridded cells/tiles (750 x 750m) covering the Brisbane region. The model's data (flights, heights, etc.) displayed to the public in popup widgets is based on the premise that where the centreline intersects a cell value will be shown. In other words, your home can be 10 metres away from the centerline of a flight path and it will register zero/near to zero flights (Figure 13). **This is highly inaccurate and could be interpreted as providing misinformation especially when the community are making important lifetime decisions to purchase a home away from flight paths.**

A possible improvement could be for Airservices to reduce the cell size to say 10 to 20m and adopt a nominal flight path width of impact 1000m either side of the centreline. In this respect all the cells covered by the 2km wide flight path would display more accurate information. The trade-off here is that the model would be more complex and require greater storage capacity and technical administration. There will never be a perfect solution, however this option would ensure that more accurate information is provided to the end user. It is unknown what software platform the Airservices model was based on, however as a comparison extremely complex 3D geological

[1] https://caportal.com.au/asa/brisbane-baseline-model

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models have been used successfully in the resources industry for many decades. **Complexity is no longer a valid excuse for mediocrity.**

If the model was based on a geographic information system (GIS) a possible solution could be to modify the grid size and intersection parameters. This service is normally provided by GIS professional developers/analysts using "world best practice" ESRI software. **Do it once and do it right does not appear to be high on the priority list for Airservices when it comes to providing relief or even just accurate information to affected communities.**

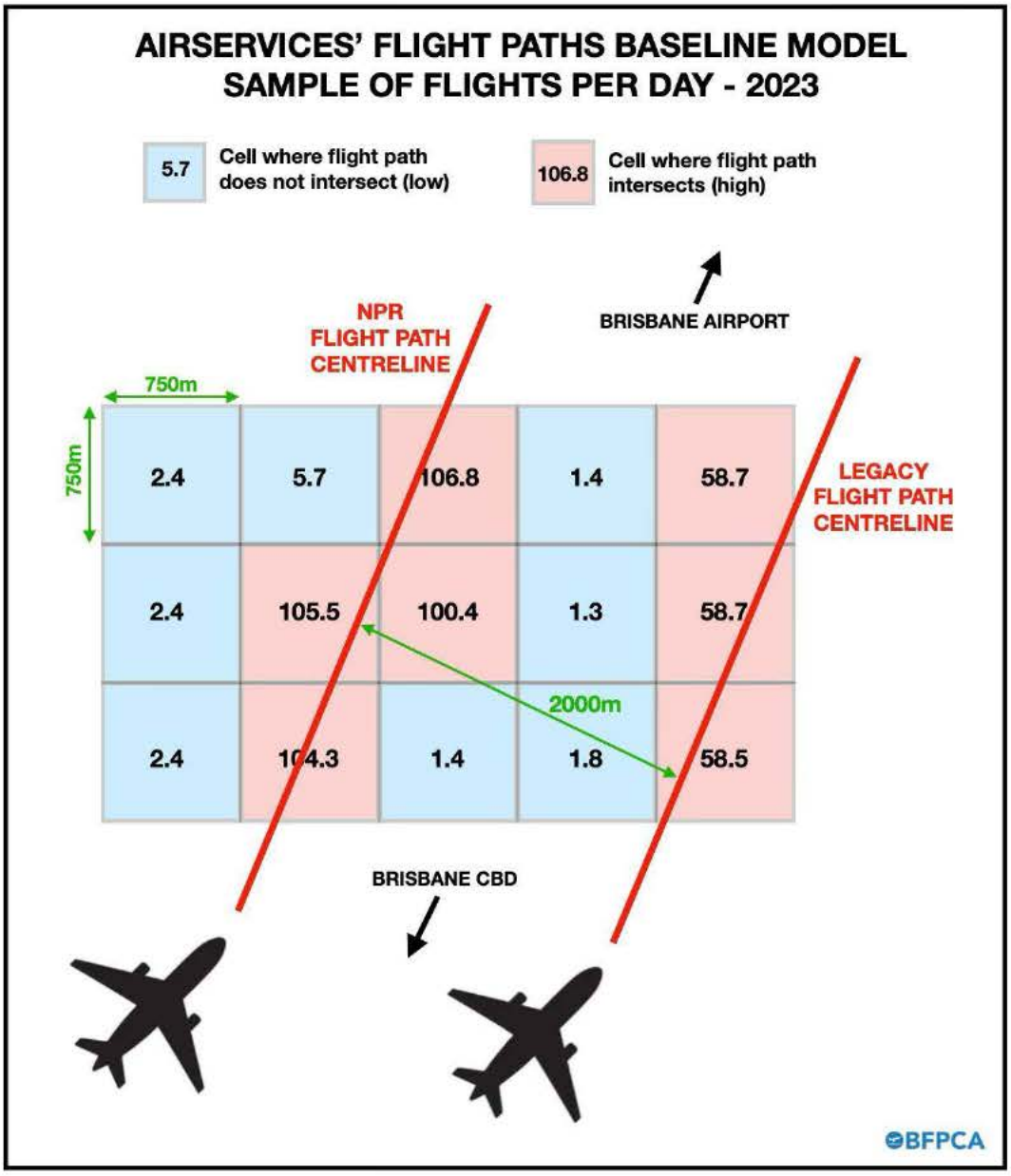

Figure 13: Airservices' flight path baseline model – sample of flights per day 2023

The issue is exacerbated by noise contours that are calculated using an 'average' aircraft and cleaned in an unknown way. There are no comprehensive noise maps (N contour maps) of Brisbane to enable residents to see the extent and nature of the impacts visually. Airservices uses models to

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monitor-measured noise at ALL monitoring locations, current and past. Only a few locations close to the airport have been checked within the original 70+dB forecast, and no areas outside this very limited area (since the models were wrong).

Noise is modelled using LAmax, a measure which omits the disturbing and damaging low frequency component of aircraft noise, which attenuates less readily through air and buildings (very difficult to insulate against), and which comprises a considerable portion of the noise energy emanating from aircraft (see dedicated report in Part B). At these frequencies, noise propagates over long distances and travels freely through structures.

The current noise measure approach called ANEF (for regulatory purposes) has been known as inappropriate by government / industry for decades. But no replacement has been proposed—perhaps because it understates noise harms?

In an international comparison, the ANEF approach appears outdated and an outlier compared to what other countries have adopted (Figure 14). ANEF and other averaged models to calculate exposure to noise are technocratic fabrications that have little bearing on reality, because the ear responds to changes in sound, not to 'average' levels. For example, a soft buzz on an averaged model would be the same level as complete silence punctuated by loud whistles every hour. Clearly the annoyance impact and potential for waking from sleep would be vastly different in these two situations. People even use "white noise" to fall asleep, but who has proposed loud infrequent noise punctuations over relative silence to assist with sleep 'hygiene'?

Table 1 Noise metrics in different countries

Country	Before	Now
US	NEF	L_{dn}, CNEL
Canada		NEF
Australia		ANEF, N70
New Zealand		L_{dn}
UK	NNI	L_{den}, L_{night}, L_{AeqT}
Japan	WECPNL	Metrics based on L_{eqT}
Germany	Störindex "Q"	L_{den}, L_{night}
France	IP	L_{den}, L_{night}
Greece	NEF	L_{den}, L_{night}
Sweden	FBN	L_{den}, L_{day}, L_{evening}, L_{night}
Belgium	IP	L_{dn}, L_{AE}
Denmark		L_{den}, L_{night}
Finland		L_{den}, L_{night}, L_{AeqT}
Netherlands	K_e, B	L_{den}, L_{night}, L_{AeqT}
Ireland		L_{den}, L_{night}, L_{AeqT}, L_{Amax}
Norway		EFN

Figure 14: Noise metrics in different countries[2]

[2] Feng, H., Zhou Y., Zeng, W., & Ding, C. (2023). Review on Metrics and Prediction Methods of Civil

https://doi.org/10.1007/s42405-023-00609-0

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For reference, hourly wake-ups at night (8 hours) of a 45 second burst of 75dB from a background of 30dB (common in many Brisbane suburbs) would register as merely 46dB on an averaged sound pressure Leq. The health effect is much more accurately predicted from the loudness and frequency of the noise occurrence.

As per Section 2.3 of our original submission:

Abolish and replace ANEF noise contour maps and forecasts

- Recommend that all future airport master plans in Australia also include N65 and N60 contours as per the recommendations in the Australian Government's own guidelines of the National Airports Safeguarding Framework 2016.
- Recommend that the real noise impacts beyond the limited area indicated by the ANEF noise contours are being properly assessed and communicated to communities as the discrepancy between modelled noise forecasts and the lived experience is vast.
- Recommend that the Australian Government revisits previous government reports on best practice noise forecasts and communication (see reports quoted above from 2000 and 2003), and turns the recommendations of these reports into policies and legislation.
- Recommend that the Minister issues Airservices with revised "Manner of Endorsement" of noise forecasts that do take the government's own advice into account based on the above three points. The Australian Government must abolish and replace the flawed ANEF framework, require honest and accurate noise forecast information, and set revised "manners of endorsement" for such forecasts.

6. SODPROPS claims

Hansard Excerpt (p. 53): BAC

Mr de Graaff: It's a great question. We would really like to rectify that statement this morning, that 90 per cent of the flights would go over the bay. **That was definitely never communicated** and it isn't going to be the case, ever.

BFPCA: We disagree. This is false. ✗

BAC established a pattern of inaccurate or misleading communication early in the project's life, and frequently framed information in ways that minimised adverse impacts and contributed to community misunderstanding.

The first exposure of many residents to major projects can be crucial in establishing a narrative in the minds of community members. Particularly where it has the effect of suggesting there is little need to be concerned about the impacts, early inaccurate information can be particularly damaging to the engagement process.

The 1999 newspaper article (Figure 15; Figure 16) demonstrates the early positioning of the project by BAC as "low impact." The ability of a new parallel runway to increase the utilisation of over-the-bay (OTB) operations was presented as a significant benefit, which would effectively mitigate the noise impact on affected suburbs. BAC Airport operations manager Cam Spencer, is quoted stating 80 – 95% of total operations between 6am and 9am could be directed over Moreton Bay. Further data was presented suggesting that OTB operations could be achieved for 80% of *all* daytime operations if the tailwind limit could be relaxed to 10 knots.

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DOW JONES

The Courier Mail

Wind taken out of new airport runway scheme.

By Neale Maynard.
557 words
18 September 1999
Courier Mail
COUMAI
6
English

BRISBANE Airport Corporation's plan to use its proposed parallel runway to direct nine out of 10 flights over Moreton Bay could be difficult to achieve in the face of prevailing winds, an analysis of weather patterns suggests.

Bureau of Meteorology data for the past 49 years suggests daytime wind conditions would limit exclusive over-the-Bay operations for all flights between 6am and 6pm to about three days out of seven.

But the airport corporation says wind conditions are generally suitable when it matters most - at the busiest time between about 5am and 9am.

Airport operations manager Cam Spencer said that in the early morning conditions were far more favourable for what it calls simultaneous opposite direction runway operations.

Using the runways both ways, which is already happening overnight, and the proposed new parallel runway, the corporation wants to land planes on one runway while taking off on another.

Weather bureau data confirms residents would be spared most noise during the early morning, when the airport could direct most 6am arrivals and departures over the Bay for about five days out of seven.

By 9am, as wind speeds pick up, the data suggests later flights would have to either approach or depart over land about half the time. That figure worsens significantly by mid-afternoon but generally improves by early evening.

Mr Spencer said the corporation was aiming for 90 percent and there might be "days in a row" when it might not be achievable.

"It might be we can get 95 percent for nine months of the year and only 80 percent for the other three months," he said.

Last month, for example, a total of 97.5 percent of jet aircraft flights between 10am and 6am landed from over the Bay and 89.1 percent took off over the Bay, Mr Spencer said.

That was possible because wind conditions overnight were generally calm and traffic densities were low until about 5.30am or 6am.

"With a parallel runway we could extend that later in the morning with both takeoffs and landings over the Bay," he said.

One of the factors limiting increased take-offs and landings over the Bay is a five-knot daytime restriction on tailwinds set by the International Civil Aviation Organisation. Higher tailwinds mean planes land faster and are harder to slow down, and on take-off require more runway to get airborne.

The restriction means that when tailwinds exceed five knots, planes should take off and land from the opposite direction although it is understood pilots have landed in Brisbane with tailwinds of eight knots.

The night-time standard allows 10 knots of tailwind as the cooler and denser air allows planes to operate more efficiently.

Figure 15: Wind taken out of new airport runway scheme, Neale Maynard, 18 Sep 1999, Courier Mail, p. 1

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Mr Spencer said the airport corporation would not compromise safety but was examining the difference between the daytime and night-time recommendations on tail winds.

According to bureau data, if the 10 knot limit was introduced during the day, simultaneous landings from opposite ends of the runways could be achieved about 80 percent of the time.

At 6am, that figure would rise to about 97.5 percent, falling to 87 percent at 9am, 58 percent at 3pm and rising to almost 80 percent at 6pm. - SECT-News.

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Search Summary

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Figure 16: Wind taken out of new airport runway scheme, Neale Maynard, 18 Sep 1999, Courier Mail, p. 2

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The capacity of the new parallel runway to support OTB operations during the daytime and evening periods at post-COVID air traffic levels is in fact effectively **zero**, and this fact should have been evident in 1999 and especially in 2007 when the MDP/EIS was finalised, given the project had been under long term consideration by BAC. Furthermore, recent BAC estimates suggest that even if the 10 knot tailwind limit were to be implemented, it would permit the use of OTB modes during only very limited windows with low traffic, for example occasional use on a Sunday morning.

The widespread misconception in the community that OTB operations would be the predominant mode of operations remains to this day, and the genesis can likely be traced to early project communications such as this example. The misrepresentation of OTB utilisation was carried forward ambiguously in communications with the public by BAC and Airservices for almost two decades. The effect was to encourage residents to disengage or "tune-out" of the EIS consultation process based on a wholly inaccurate understanding of the noise pollution and health harm impacts.

7. Complaint statistics understate the problem

Hansard Excerpt (p. 47): BAC

Senator McKENZIE: How does the increase in aircraft movement since the opening of the NPR correlate with noise complaints.
Mr de Graaff: That's a very good question. Tim, do you have that to hand?
Mr Boyle: I do. Since the opening of the new parallel runway in 2020 we have seen an increase in noise complaints. I can provide some actually numbers. In 2023, for example, we received at Brisbane Airport 5,900 complaints. To put that into context, 5,000 of those were from two complainants only.

BFPCA: This is misleading as these complaint statistics understate the problem. ❌

BAC—and in Senate Estimates we also heard Airservices do the same—point to the relatively low numbers of complaints on a population basis to imply that those complaining about the harms of aircraft noise are a minority of "NIMBY residents" opposed to progress. The implication is that some of the complainants are repeat complainers and thus being "difficult." As a counterpoint, if two people sent 5,000 complaints, they must have been very very seriously disturbed by noise.

To conclude that merely 249 people were affected by aircraft noise is a convenient fiction.

First, this total is not from a publicly promoted complaints process. BAC redirects complainants to Airservices Noise Complaints and Information Services (NCIS) team, and their totals are much larger, even though still dramatically understated for the following reasons.

- Complaint fatigue: many people have given up complaining about noise as it takes time and results in no proper actions.
- Noise complaints are collected by ASA after being "cleaned" for relevance.
- The complaints process is not widely known and moreover it is difficult, complex and time consuming to register and then find the fragmented information required to make an allegedly actionable complaint.
- People are specifically warned that making more than one complaint (in an unspecified time period) will be ignored.
- One has to give a 'valid' reason for the complaint. What is deemed valid?
- Responses are typically delayed by several weeks, sometimes months, if indeed any response is provided.
- Most people give up because the process is so complex and depressing: the letter of response is generic and mostly excuse-filled, no discernable action results from the complaint, and the noise keeps increasing.

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We want to take this opportunity to contrast the complaint handling we experience by Airservices' NCIS team with the **Commonwealth Ombudsman's 2023 edition of the Better Practice Complaint Handling Guide**.[3] The Department of Infrastructure, Transport, Regional Development, Communications and the Arts is responsible for overseeing Airservices' failures in this regard, yet has not intervened in Airservices' approach to community engagement and complaints handling that are entirely **insincere and tokenistic**.

Excerpt from the Better Practice Complaint Handling Guide (page 5) with BFPCA annotations in red:

> **Why does complaint handling matter?**
>
> Australian Public Service agencies and contractors must deliver high quality programs and services to the Australian community in a way that is fair, transparent, timely, respectful and effective. – The Department and Airservices fail on all five accounts.
>
> Errors, misunderstandings, dissatisfaction and unexpected problems occur in all administrative systems.
>
> **A good complaint handling service can:**
>
> • fix problems before they escalate – ✗ Not done. In Senate Estimates Airservices confess that they have never conducted a single noise improvement investigation (see below).
>
> • provide better remedies for complainants – ✗ Complainants are being told that aircraft noise is entirely unregulated and nothing can be done.
>
> • help you understand your customers
>
> • increase customer satisfaction and improve customer interactions
>
> • increase staff satisfaction
>
> • produce data and insights that help you continuously improve – ✗ Complaints data is cleansed so that only one complainant per day is counted, not the number of times that complainant is being harmed by aircraft noise as a result of overflights and subsequent submissions of individual complaints.
>
> • inform decisions about future services and programs
>
> • enhance your agency's reputation and strengthen public trust in government. – ✗ The community has lost all trust in the Department and in Airservices.
>
> **Compare this with what can happen if you don't handle complaints well:**
>
> • customer disengagement – Yes. Complainants are being stonewalled, so they give up.
>
> • more complaints escalated internally and to Ministers, MPs and oversight agencies – Yes. BFPCA has set up a one-click complaint link that allows people to email Minister King directly.
>
> • missed opportunities to improve – Yes. Airservices are unable and unwilling to meet their obligations to keep communities safe from harm.
>
> • loss of valuable data
>
> • reputational damage – Yes.
>
> • loss of trust in government. – Yes.

---

https://www.ombudsman.gov.au/__data/assets/pdf_file/0025/290365/Better-Practice-Complaint-Handling-Guide-February-2023.pdf

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To this day, Airservices Australia's NCIS team systematically stonewalls community members with legitimate complaints about aircraft noise: https://bfpca.org.au/ncis/

Community complaints manuals obtained by BFPCA through Freedom of Information requests show how Airservices staff are instructed to **provide pre-scripted answers** designed to quash complaints and prevent them from progressing to investigation or referral to the Civil Aviation Safety Authority (CASA) or to the Department of Infrastructure and Transport.

Of the total 207 pages of staff training materials BFPCA obtained under FOI, just under half a page deals with "noise improvement investigations." The remaining pages instruct NCIS staff in how to **send boilerplate responses** arguing that complaints are unjustified and nothing can be done. Suggested replies include, "this cannot be changed," "investigations already conducted," "no investigation will be conducted," "no direct transfer to Department."

If complainants do not give up and submit further complaints, Airservices staff are instructed to treat this as "unreasonable behaviour." **The training manual suggests these 'difficult people' are to be put on a management plan.** This imposes access restrictions such as limiting phone calls or email contact "including deleting without reading submissions."

Of a total of 207 pages of internal complaint handling procedures and training resources released under Airservices FOI 21-24, only half a page (180 words) are dedicated to noise improvement investigations. Such investigations appear to be so rare that Airservices deemed no further detail was required.

4.3 Noise improvement investigations

A noise improvement investigation may be conducted for reasons including:

- to progress findings of a complex investigation
- after a complaint trend analysis has indicated a potential opportunity for improvement
- at the suggestion of a complainant or the Aircraft Noise Ombudsman (ANO).

Noise improvement investigations will be conducted by the Investigations team and/or senior team members.

In investigating potential noise improvements, consideration will be given to

- safety
- air traffic management efficiency

[1] Airport Noise Monitoring and Management Software

Document 4 (FOI-21-24)
Page 18 of 30

- whether a better noise outcome can be achieved overall.

Proposals that compromise safety will not be progressed.

Moving noise from one part of the community to another generally will not be considered a better noise outcome overall.

Internal and external consultation will occur as required, for example, with air traffic control, operators, airports and airport operators.

Noise improvement investigations will be documented in an Investigation Report.

If the initial proposal came from a complainant, a copy of the Investigation Report will be provided together with a written response.

If the investigation finds that the proposal is feasible it will be progressed through the Flight Path Change Process for further analysis.

Figure 17: Document 4 (FOI-21-24), section 4.3, pages 17 / 18 of 30

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Airservices confessed in Senate Estimates that they received **14,019 complaints** and enquiries from 2,956 complainants between 12 July 2020 and 31 October 2022. (The latest figure from Estimates Oct 2023 was 23,000+ complaints.) They were then asked, *how many noise improvement investigations has Airservices complaints team conducted anywhere in Australia for any airport annually since 2018?*

Answer: Nil

While the *Air Services Act* 1995 requires Airservices to protect communities from aircraft noise, we now have hard evidence that **Airservices prioritises 'air traffic management efficiencies'** instead. The Minister and the Department are at fault for standing by for years while Airservices hosts a dedicated team charged with purposefully stonewalling communities. It conveniently shields decision makers from hearing people suffering harm as a result of aviation noise pollution.

Airservices now offer free mental health and suicide counselling to affected communities. In Senate Estimates we hear that in severe cases, they instruct the Queensland Police Service to visit people's homes to **conduct welfare checks**. Airservices' community engagement framework is fraudulent as it has the claimed goal of reducing noise "impacts" without there being any metrics to evaluate actual net noise and thus harm reductions. The term "impacts" is used as a euphemism for **harms**, which they acknowledge only by way of their suicide counselling program.

Q2790. Police welfare checks

Senator the Hon Janet Rice asked the Minister representing the Minister for Infrastructure, Transport, Regional Development and Local Government, In writing, on 20 November 2023

Following up from Question on Notice 93 from Supplementary Budget Estimates 2022 – 2023 (SQ23-003272), Airservices confirmed that "since the opening of Brisbane's new runway, eight complainants have been referred to Airservices Security with three referred to police for a welfare visit

1. Could you provide updated figures.
2. Given the Brisbane Flight Path Community Alliance survey, which found that 69% of respondents suffered mental distress from aircraft noise, has ASA been in discussions with the Department or any other agencies to support people suffering mental health impacts from flight noise, and what action if any has been taken to support people.

Answer: Senator the Hon Murray Watt – The Minister representing the Minister for Infrastructure, Transport, Regional Development and Local Government has provided the following answer to the honourable Senator's question: Since the opening of Brisbane's new runway, ten complainants have been referred to Airservices Security, and four have been referred to police for welfare visits.

Since August 2023, Airservices' Employee Assistance Program (EAP) has been available to Brisbane community members feeling negatively affected by aircraft noise, to provide confidential counselling support at no cost to the community member. Details have been published on the Engage Airservices website and in brochures handed out during engagement sessions.

Airservices also contracted a LifeLine counsellor to provide support at Phase 2 and 3 engagement sessions in communities where high degrees of distress were identified in previous engagement sessions.

8. Aerotropolis – turning Brisbane into the Detroit of Australia

Royal Schiphol Group and specifically BAC have long been guided by the vision of turning their host

8. Aerotropolis Business Concepts

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The aerotropolis vision is about turning a city with an airport into an airport with a city attached to it. It renders a once-liveable city into a feeder city for the airport including the aggressive expansion of aviation-related businesses, logistics facilities, and other related industries near residential areas in the pursuit of growth and profit.

There are several negative aspects associated with the development of an aerotropolis. One of the most significant issues is the **noise pollution** caused by the increase in aircraft traffic itself. The constant noise from an aerotropolis leads to **sleep disturbance**, **hearing impairments**, **learning difficulties** in children, and other **health and mental health issues** for those living and working under Brisbane's flight paths. Additionally, noise pollution can negatively impact wildlife and natural habitats in the surrounding areas.

The concentration of industries around an airport also leads to increased **air pollution**, which can have a detrimental effect on public health. The increased traffic and transportation in and out of the aerotropolis also leads to **congestion** and **increased carbon emissions**.

Furthermore, the development of an aerotropolis risks **displacing local communities and small businesses** as the noise makes residential areas unliveable and the land and resources are repurposed for aviation-related industries. This results in **social and economic inequalities** and the loss of community amenity and identity.

BFPCA expects this Senate Inquiry to assist the community in stopping BAC from turning Brisbane into an aerotropolis.

Hansard Excerpt (p. 57): BAC

CHAIR: So you're not considering a big growth in freight-only flights?

Mr de Graaff: No. For example, I know that this morning facilities like DHL and Australia Post were mentioned to a large degree. That's just the e-commerce that's currently also taking place at the airport. They're only moving into new facilities. **But it's definitely not a growth market** we're foreseeing for now and in the future, especially when it comes to domestic freight. We don't see an increase in— _

BFPCA: We disagree. This is false. ❌

Exhibit #1: The mysterious world of air freight, BAC website, 14 March 2019, accessed 12 May 2024, https://www.bne.com.au/blog/behind-scenes/mysterious-world-air-freight

> The future of air freight is solid
>
> There are some incredible statistics that illustrate the depth of trade enabled by air freight, with 94.8 per cent of all Queensland's chilled fish exports sent via air (97.9 per cent of which are ex-BNE) and 97.5 per cent of all Queensland's avocado, mango and pineapple exports also sent by air (75.6 per cent are ex-BNE).
>
> When you hear numbers like this, the importance of Brisbane's new runway truly cannot be overstated.
>
> While other Australian airports like Sydney and Melbourne reach capacity, Brisbane Airport is on the cusp of exponential growth.
>
> Unlike Sydney Airport, BNE is an airport that never sleeps (it operates curfew-free). And when the new runway opens in 2020, BNE will have the greatest capacity of any airport in the southern hemisphere and the most efficient runway system in Australia, able to handle more than 100 aircraft movements an hour.

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Australia Trade Coast, customer trends and what the next decade holds. Excerpt from a YouTube video (Figure 18) published by the Brisbane Economic Development Agency on 5 June 2019:

> "On top of all that it is a 24/7 precinct that people really like to know because you know **the planes can fly cargo in at any time of day or night**, the ships everything can operate both procedures can operate 24/7 curfew free and that's a huge advantage."

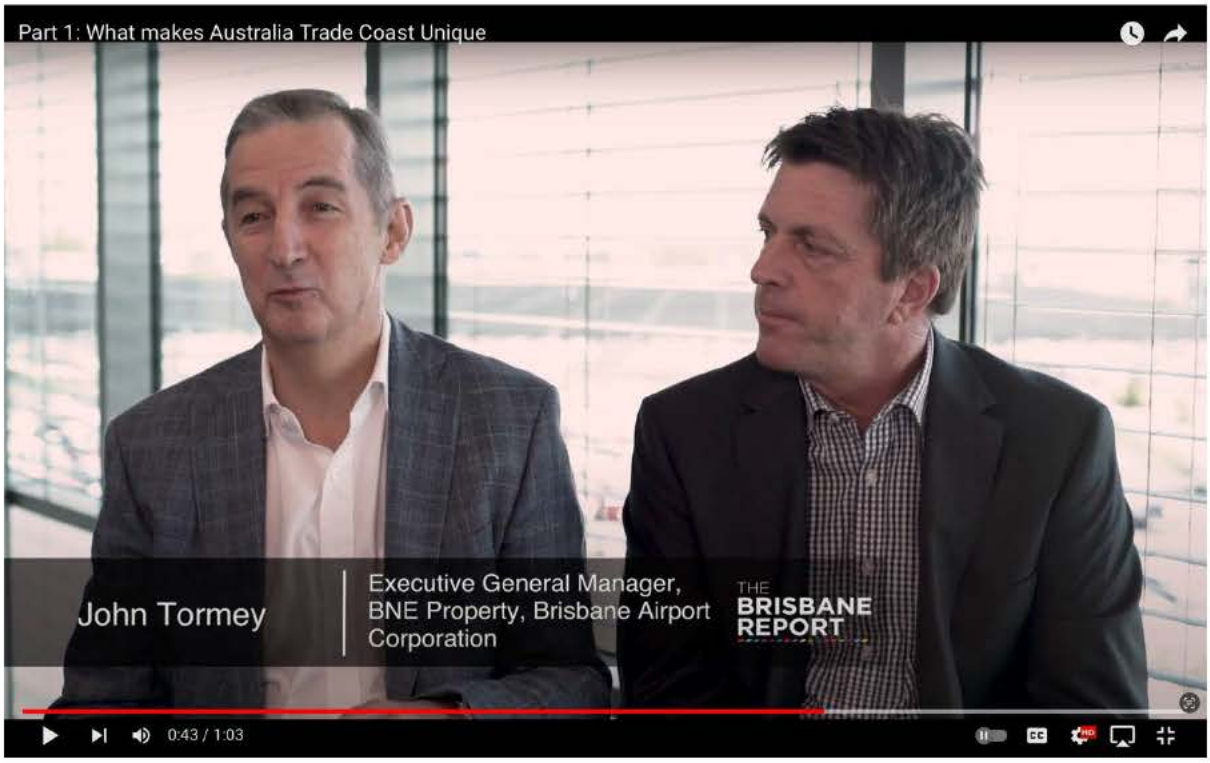

Figure 18: What makes Australia Trade Coast Unique, source: https://youtu.be/p0uNtz134-Q

Exhibit #3: Stockwell International moves in at Brisbane Airport, BAC press release 27 May 2021, https://newsroom.bne.com.au/stockwell-international-moves-in-at-brisbane-airport/

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Leading international freight forwarder Stockwell International is now calling Brisbane Airport home, after the grand opening of their new warehouse last month.

[…]

"Being here at the airport, it's a great gateway for our clients, being able to pick up the freight and move it quickly. For anyone in logistics, it is the logical place to be," Mr Stockwell concluded.

[…]

About Stockwell International:

Stockwell International is one of Australia's largest family-owned freight forwarders that is dedicated to improving efficiency with their own trucking fleet & warehouses. Stockwell International specialises in many other areas including sea freight, air freight, customs brokerage, port transport, global warehousing and logistics, supply chain consulting, project cargo management.

Exhibit #4: Aramex attracted to mega-warehouse in new Brisbane Airport logistics hub, BAC press release 30 Jan 2024, https://www.bne.com.au/aramex-attracted-to-mega-warehouse-in-new-brisbane-airport-logistics-hub

[…]

This marks the first stage of development of the landmark estate, which is a 100-hectare-plus master-planned warehousing, logistics and manufacturing precinct, more than five times the size of Brisbane's South Bank.

[…]

Martin Ryan, Brisbane Airport Corporation Executive General Manager Commercial, said securing Aramex as the first anchor tenant within the new industrial precinct demonstrates its attractiveness amongst global brands.

"We are excited to welcome Aramex to launch Airport Industrial Park with us," he said. "The size of this development highlights the potential for logistics and industrial development at Brisbane Airport at scale.

"With freight and logistics industries becoming increasingly important, the unrivalled transport links of Brisbane Airport offer an ideal home for companies providing these essential services."

[…]

This development is part of BAC's 2,700-hectare overall lease holding, among the biggest sites under single ownership in SEQ and the premier gateway to Queensland. With Australia's freight demand growing significantly – tipped to rise 60 per cent on pre-pandemic levels in urban areas by 2040 according to government estimates – Brisbane Airport is well-placed to meet demand for quality industrial land development.

Logistics and supply chain companies are a growing sector at Brisbane Airport

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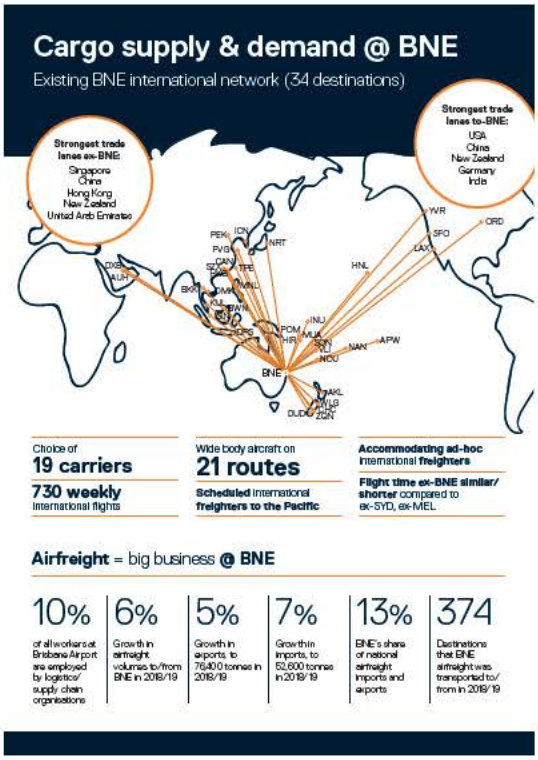
of national and international companies among more than 425 businesses located across the Airport.

Exhibit #5: BNE Cargo, BAC website, accessed 12 May 2024, https://www.bne.com.au/corporate/partner-with-us/aviation-business/bne-cargo

As the third busiest airport in Australia, Brisbane Airport is recognised as a trade hub providing world-class infrastructure that assists in expanding Queensland's exports to the world. Significant factors such as operating 24/7, close proximity to multi-national businesses such as FedEx and DHL, along with increased airline launches have significantly contributed to the growth in airfreight volumes.



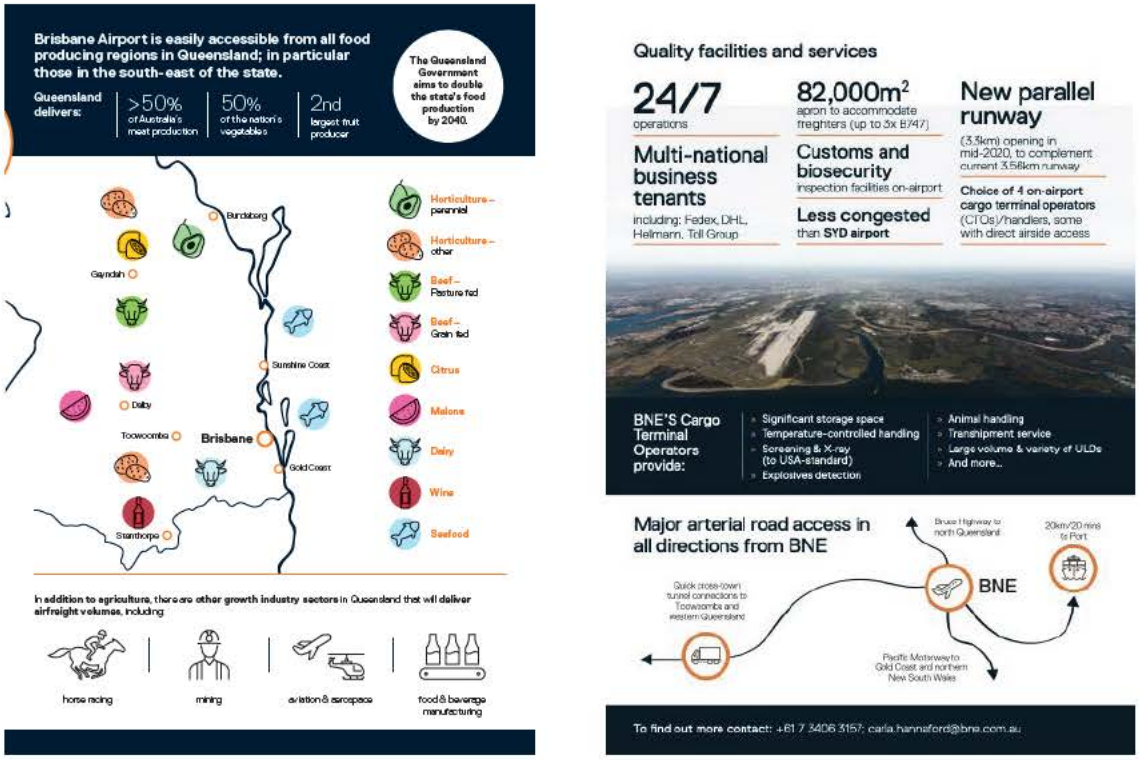


Figure 19: BNE Cargo Supply And Demand brochure, https://www.bne.com.au/sites/default/files/no-index/Brisbane-Airport-Cargo.pdf

9. Brisbane Olympics 2032

Hansard Excerpt (p. 36): Tourism and Events Queensland

Mr Elliott: Looking ahead to 2032 and the Olympics and Paralympic games, there is significant opportunity to attract visitors to Queensland and disperse them across the state. This is not only an opportunity to develop more international services into Queensland but it has the potential to expand the interstate and intrastate domestic aviation networks.

BFPCA: We disagree. This is unsubstantiated and doubtful at best. ❌

We refer the Senators to the submission by Professor Sara Dolnicar. We also draw attention to this post-Olympics 2000 analysis by Hensher & Brewer (2002):

> "The anticipated Olympic flight bonanza did not happen, with over 60% of initial bookings, more than 2200 flights, cancelled. Domestic tourism was the major casualty with 800 flights cancelled over the Games' 14-day period. The optimism in January 2000 when there were bookings for 3700 flights evaporated to 1400 flights. Almost all the cancelled flights were domestic, with the initial bookings of 3150 reducing to 2300. Internationa flights and business jets were as expected at 330 and 220 respectively. On the peak incoming days—15 and 15 [sic, 16] September—bookings fell from 958 and 949 to 899 and 873." (p. 387)
>
> Hensher, D. A., & Brewer, A. M. (2002). Going for gold at the Sydney Olympics: How did transport perform? *Transport Reviews*, 22(4), 381–399. https://doi.org/10.1080/01441640110121112

Part B
Aircraft Noise Metrics

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The following document has been prepared by Dr Sean Foley as part of BFPCA's supplementary submission.

Australia – Aircraft Noise Metrics

Dr Sean Foley

April 2024

*The audible aircraft noise annoying you is **not** the low frequency noise harming you.*

Abstract

In Australia urban areas adjacent to airports are plagued by unregulated aircraft noise a significant, too often overlooked, threat to public health, social wellbeing, and economic prosperity. Despite undeniable harms on communities, businesses, and individuals caused by aircraft noise pollution, Australia lacks an adequate legislative framework and technical standards to effectively to regulate the aviation industry. This article examines the **urgent need for Australia to establish its own national aviation noise pollution standards** and proposes a more comprehensive approach to measuring, monitoring, and regulating aircraft noise.

Drawing on extensive peer-reviewed research and international best practice, the article highlights the limitations of existing measures, such as the ANEF (Australian Noise Exposure Forecast) that use the narrow and outdated A-weighted decibel scale, for measuring noise. **It argues for adoption of the "Z" unweighted decibel scale, to ensure incorporating both low frequency and infrasound in aircraft noise monitoring protocols and practice.** This is imperative, considering low frequency and infrasound's documented links to adverse health effects and harms, including cardiovascular disease and cognitive impairment.

The article also advocates for a shift in research methodologies to prioritise investigation of the effects of low and infrasound frequencies on human health and socio-psychological wellbeing. It calls for government intervention to mandate comprehensive aircraft noise monitoring and reporting encompassing the whole frequency spectrum, and urges manufacturers to adapt their equipment and protocols accordingly.

Ultimately, by embracing a holistic approach to aircraft noise metrics and regulation, Australia can safeguard citizens' health, mitigate socio-economic disruptions, and pave the way for more ethical and responsible aviation practices in the 21st century.

Australia - Aircraft Noise Metrics

Dr Sean Foley

April 2024

The audible aircraft noise annoying you is *not* the low frequency noise harming you.

Background

This Senate Inquiry's task, in brief, is to identify means for reducing the harmful effects of aircraft noise on Australian society.[1] It assumes, correctly, that aircraft noise harms people, communities and businesses. This submission relates most directly to points (a) and (c) in the Inquiry's terms of reference. By implication including identifying metrics and means for measuring, monitoring and regulating aircraft noise pollution.

Currently there are no adequate legislative means to limit or control aircraft noise. Since the 1970s legislative initiatives have been enacted as necessary to reduce pollution, including noise, in all other sectors of the Australian economy. Without a legal framework for monitoring and enforcement it is difficult to imagine how aircraft noise can be controlled and harms reduced. Arguably, legislation is the first essential step, followed by regulations defining technical standards and education and enforcement.

We contend there are two intertwined issues for the Inquiry to consider. First, is it necessary for Australia to enact its own aviation noise pollution standards as means of reducing harms? Second, if the answer is Yes, what might the Inquiry recommend be the basis for these standards, with respect to aircraft noise. The first issue is for the Inquiry alone to decide, the choices for second, basis for standards, is discussed here.

Lack of Australian Standards – Impacts

Australia has no modern technical standards or mandated regulations controlling aircraft noise pollution. Airservices confirms on their website:

> *"There is* ***no regulated maximum noise level for aircraft flying over residential areas****. Without any maximum level set out in legislation or regulation, there is no objective measure to determine whether any aircraft flying in Australia is 'too noisy,' or whether the combined load of aircraft experienced by a community is 'too much' noise."*[2] [emphasis added]

The *Air Navigation (Aircraft Noise) Regulations* 2018, stipulate import certifications but do not regulate noise emissions or exposure as per Airservices explanation:

> *"In Australia, aircraft noise standards apply* ***before*** *an aircraft is allowed to operate here, rather than in the course of its day-to-day flying activities. Before an aircraft begins operating in Australia it is required to meet international noise standards that specify the amount of noise that may be emitted by that type or model of aircraft. … once an aircraft passes this certification process,* ***there is no legislation or regulation that enables any agency, including Airservices, to police its noise levels.****"* (*ibid.*) [emphases added]

In this regard we are a global laggard among advanced economies. The reasons for this lack are complex and not explored here. We are taking this opportunity to submit to the Senate Inquiry, some 'in principle' standards necessary to keep Australians not just safe in the air but on the ground **safe** and to protect them from harm. These take account of

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[1] The impact and mitigation of aircraft noise on residents and business in capital cities and regional towns, with particular reference to: (a) the effect of aircraft noise on amenity, physical and mental wellbeing and everyday life of residents; (b) the effect of aircraft noise on small business; (c) any proposals for the mitigation and limitation of aircraft noise, including flight curfews, changes to flight paths and alternatives to air travel; (d) any barriers to the mitigation and limitation of aircraft noise.

[2] https://aircraftnoise.airservicesaustralia.com/2020/04/30/how-much-noise-are-aircraft-allowed-to-make/

current knowledge of the relevant parts of the acoustic spectrum of aircraft noise, to reduce health, social and economic impacts on people, communities and businesses.[3]

Low flying jet aircraft (<4,000') typically subject people at ground level to noise at or above 70 dBA, disrupting communications and concentration, annoying and angering people. Chronic aircraft noise at these levels also damages people's health. Arriving aircraft in Brisbane and other cites, for example, commonly fly at low altitude for some 10-25 km approaching an airport for landing, travelling across densely populated urban residential, educational, commercial areas. As a result hundreds of thousands of people have their lives, work and study disrupted by aircraft noise up to 100 times a day. Night flights over urban areas disrupt the sleep of tens of thousands of people. In Brisbane our conservative estimates suggests nearly one million people live and work in suburbs afflicted by severe or moderate aircraft noise day and night.[4] The actual figures may be much higher.

Currently the means used to define 'allowable' intensity and extent of aircraft noise are derived from land use zoning standards, originally intended for urban planning. The definition (ANEF[5]) is based on responses to an out-dated sociological survey from about 1982 (ibid). Current ANEF modelling is geographically limited to the area adjacent to airports – out to about 10 km. In Brisbane the inadequacy of ANEF is starkly apparent, with continuing complaints about severe aircraft noise coming from some 30 km west and northwest of the airport. Nor is ANEF suitable for use in already densely populated urban areas, e.g. where new runways, increased air traffic and ever denser urban populations multiply the number of residents and communities affected by aircraft noise.

The flawed and outdated ANEF approach to model noise contours – required under the *Airports Act* 1996 – is not sufficient to inform communities of what experiences to expect, this has been known since 2003:

> *"… these [ANEF] contours do not normally show a picture of current or near-term noise exposure patterns around an airport. Experience has shown these contours, which are based on logarithmically averaged 'annual average day' aircraft noise energy, do not portray noise in a way that the non-expert can readily relate to. Given the above, land use planning contours such as* ***ANEFs are not considered suitable for use as an aircraft noise information tool.****"*[6]

---

[3] To avoid repetition, 'aircraft noise' includes other forms of aviation pollution: jet exhaust combustion products - gases, particulates and fluids; turboprop exhaust products, especially lead and heavy metals. Likewise'low frequency' noise/sound includes both low frequency noise and infrasound.

[4] Foley, S (2023) "Brisbane - Aviation Noise Pollution and Community Health" see BFPCA website.

[5] Australian Noise Exposure Forecast, has been used [for three decades] to delineate where and what type of development can take place around airports; to determine which buildings have been eligible for insulation around Sydney and Adelaide airports; for technical assessments of airport operating options in Environmental Impact Statement (EIS) processes; and as a tool for providing information to the public on noise exposure patterns around airports.

[6] *Guidance Material for Selecting and Providing Aircraft Noise Information*, July 2003, p. 7, ironically this government report is still available at the Australian Government's Department of Infrastructure, Transport, Regional Development, Communications and the Arts: https://www.infrastructure.gov.au/media-centre/publications/guidance-material-selecting-and-providing-aircraft-noise-information.

Residential development is only deemed "acceptable" outside the ANEF 20 contour, which represents an average noise exposure level of 20 aircraft noise events per day. Residential developments located within or near the ANEF 20 contour are typically subject to additional planning assessments and mitigation measures to manage the potential noise impacts on future residents. For example, near the proposed Western Sydney Airport new residential developments will not be permitted where the ANEF exceeds 20. However, the term "acceptable" itself is questionable as this quote explains:

> *"In the first instance it is considered important that the wording 'acceptable' and 'unacceptable' in the [ANEF] Standard be replaced by more objective terms such as 'no building restrictions' or 'building not permitted/recommended.' As discussed at a number of points in this paper, what is considered to be 'acceptable' by the Standard is not necessarily 'acceptable' to the individual."*[7]

The Australia Government in its 2016 National Airports Safeguarding Framework suggested again that the ANEF approach is flawed:

> *"Experience has shown a* ***range of problems*** *with relying solely on the ANEF as a noise information tool as there are limitations in using the ANEF to describe aircraft noise exposure to laypeople.*
>
> *While the populations with the highest aircraft noise exposure often live within the 20 ANEF contour, experience shows the* ***majority of noise complaints that are received come from residents living outside the 20 ANEF contour****. Traditionally the residents of these areas have been given* ***little information*** *on aircraft noise through the ANEF system other than that the area is considered 'acceptable' for housing. Some people living outside the 20 ANEF contour have been given an expectation of receiving little or indeed no aircraft noise and as a consequence find the levels of noise actually experienced to be* ***unacceptable****.*
>
> *[…] land use planning could be improved through recognition that* ***aircraft noise does not suddenly stop at the 20 ANEF contour.****"*[8]

Land use planning policies in states and territories, as well as the current "manner of endorsement"[9], of ANEFs approved by the Minister of Infrastructure and Transport in April 2017 do not take the government's **own** advice into account.

The experience with Brisbane Airport's flawed noise modelling in the 2007 MDP/EIS and since then has shown that:

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[7] *Expanding Ways to Describe and Assess Aircraft Noise*, March 2000, p. 55, ironically this government report is also still available at the Australian Government's Department of Infrastructure, Transport, Regional Development, Communications and the Arts: https://www.infrastructure.gov.au/media-centre/publications/expanding-ways-describe-and-assess-aircraft-noise-discussion-paper

[8] *National Airports Safeguarding Framework, Guideline A: Measures for Managing Impacts of Aircraft Noise, Attachment 1 – Supplementary Aircraft Noise Metrics*, 2016, p. 1, ironically this government report is still available at the Australian Government's Department of Infrastructure, Transport, Regional Development, Communications and the Arts: https://www.infrastructure.gov.au/infrastructure-transport-vehicles/aviation/aviation-safety/aviation-environmental-issues/national-airports-safeguarding-framework/national-airports-safeguarding-framework-principles-and-guidelines

[9] https://www.infrastructure.gov.au/sites/default/files/migrated/aviation/environmental/airport_safeguarding/files/2017_ANEFs.pdf

- Communities are not easily able to translate decibel noise levels provided in an ANEF contour into a lived experience, and the comparisons are often flawed, e.g. "70 db = Passenger car at 60 km/h and 7m distance."
- The level of noise nuisance is also impacted by the frequency of overhead flights, the topography, the difference between experienced ambient noise levels in residential areas and flight events, and whether any respite – if at all – is being afforded to residents. Brisbane Airport and Airservices have created an aviation super highway above Brisbane that provides no respite whatsoever.
- The logarithmic units of the decibel metric are difficult to understand.

The aviation industry's predictions of growth in air traffic appear overly optimistic (5-6% pa) in the near-term and wholly unrealistic in the medium- to long-term. While there is little doubt there will be modest increases for some years into the future, the need for aviation to meet increasingly stringent GHG emissions reduction targets will likely impose external limits on allowable emissions and, consequently, air traffic. These are likely to make air travel more expensive, curtailing non-essential travel, e.g. tourism.

There is ample, long-term scientific evidence from overseas – UK, EU, US – of the harmful effects of chronic exposure to severe aircraft noise pollution on health, and learning. Significant economic losses include reduced productivity, disrupted education and higher health costs, all increasing as air traffic increases. There are a wealth of overseas peer-reviewed results to draw upon, despite no substantive research being conducted in Australia. This does not diminish the need for initiating well planned, executed and funded short- and long-term research in Australia.

The almost universal metric used for measuring aviation noise is narrow and outdated. It is called the A-weighted decibel scale – abbreviated 'dBA' – it does quite a good job of measuring noise (sounds) in the frequency range (1,000 Hz-6,000 Hz) humans normally hear. Noise above about 60 dBA is historically classified as 'annoying'. There is no well-founded linkage of aircraft noise in this frequency range to clinical harms to humans health, but this harm is well documented.

The A-weighting scale was selected, in part, due to technical limitations on capability of instrumentation available prior to integrated circuits becoming more common in the 1960s. Today, fairly accurate sound/noise monitors are available for download and use in smart phones. These can be used to quickly monitor and display noise using the A-, C- and Z-weightings, the *OpeNoise* app is an example, more accurate professional equipment is also available.

Aircraft noise spans a wide frequency range from infrasound (0-20 Hz) to low frequency sound (20-200 Hz), a significant amount is typically between 200 Hz and 500 Hz, and up to well above 6,000 Hz. The lower frequencies travel for great distances (>10-20 km) and transmit most of the sound energy, higher frequency energy is quickly attenuated by the atmosphere. The A-weighted decibel scale is insensitive to the almost inaudible low frequencies, especially those below about 500 Hz.

As discussed later, it has been known for a long time that human tissue and organs resonate to a range of low and very low frequencies, typically 1-200 Hz. More recently it has been shown noise energy from aircraft flying up to ~4,000' has sufficient energy

to cause resonance and damaging changes in human tissue. This is the altitude of most aircraft arriving in Brisbane. Extensive research, mainly in Europe, has shown chronic aircraft noise is definitively linked to increasing risks for cardiovascular disease (CVD) and other ailments. This is a major concern, as these low frequencies are not captured by the A-weighted scale and, consequently, ignored when establishing 'safe' levels of exposure to chronic, severe aircraft noise.

Criteria for Standards

It is regarded as essential any proposed Australian standard take into account the full spectrum of aircraft noise, especially frequencies below 500 Hz. This is most simply done by making the Z-weighting – i.e. no preferentially weighting – the standard for measurements. This will ensure aircraft noise considered 'annoying', i.e. that measured by dBA, and that known to damage human health, i.e. below 500 Hz, are all measured and monitored.

Scientific Context

There is a substantial and growing body of research that clearly identifies aircraft noise as responsible for increasing the risk of a wide range of human ailments (see Annex). Until less than a decade ago these linkages, while definitive, were based on epidemiological findings, and clinical effects in the human body remained unidentified. Much exploratory work has since been done in Europe and the US. In the last decade the clinical causes of these ailments have been identified and the types of damage caused painstakingly uncovered. There are now several lines of evidence indicating the proximate cause is vibrational resonances in the human body, and its vital organs and systems initiated by infrasound and low frequency aircraft noise (1-200 Hz).

Scale of the Challenge

Transport noise is a sufficiently significant health problem in Europe that managing and reducing it has led to a range of scientific reports, standards definitions, and enactment of the European Noise Directive (END) in 2020. The END includes the major classes of transport: road, rail and aircraft, plus industry. It has also led to annual estimates of the geographical extent of problems, including health and socioeconomic effects. The latter are called DALYs/year (Disability Adjusted Life Years). The DALYs for aviation can be considered as a 'time slice' of accumulating socioeconomic damage, caused by aircraft noise.

In 2017 over four million people in Europe were exposed to 'harmful' levels of aircraft noise. Of these, over one million people were suffering 'high annoyance' and a further quarter of a million from 'high sleep disturbance' from aircraft noise (EEA 2020). These people are a relatively small portion of the over 100 million people exposed to harmful levels of noise in Europe.

It is regarded as likely many of these people are being affected by infrasound (<20 Hz) and/or low frequency (20-200 Hz) noise. These frequencies are not captured by the monitoring standards commonly used – dBA – which selectively monitors noise to which the human ear is sensitive in the range 1,000-6,000 Hz.

As discussed below, in 2017 DALYs/year for 'Ischaemic heart disease' can reasonably be considered to be mainly caused by infrasound and low frequency sound from

aircraft; infrasound and low frequency noise from road, rail and industry is also important. It is almost certain the number of people affected by aircraft noise has increased since, due to population growth and increased air traffic.

Noise Metrics

There are two noise measurement standards in common use: the 'A-weighting' (dBA) which probably accounts for almost all professional and other measurements, and the C-weighting (dBC) which accounts for only a small proportion of measurements. For example, the UK Civil Aviation Authority (CAA) only uses and reports measurements using the A-weighting.

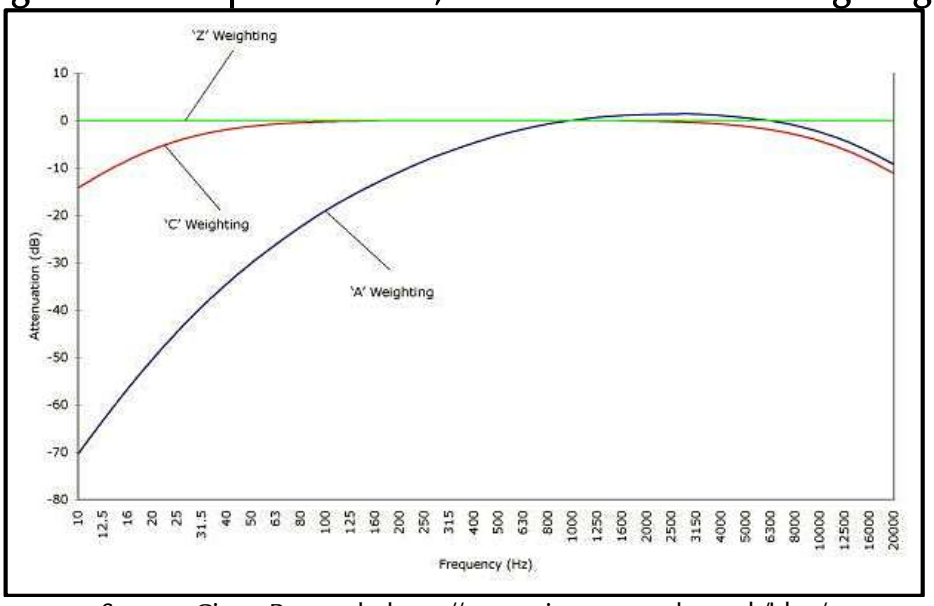
Measurements using A-weighting approximate the frequency sensitivity of human hearing (range 20Hz-20kHz, most sensitive ~500 Hz-6 kHz), while the C-weighting also includes frequencies below 500 Hz. The figure below illustrates the characteristics of both A- and C-weightings. An alternative to both is the Z-weighting (dBZ) where there is zero weighting to any part of the spectrum. Z-weighting may be particularly appropriate when measuring or discussing infrasound (1-20 Hz) or low frequency (20-200 Hz) sound. A flat line at '0' dB in the figure below illustrates the dBZ 'weighting'. If this is not available for low frequency noise then a C-weighting is to be preferred.

It made sense to develop and use the A-weighting early in development of modern aviation, as it captured, and still does, the range of frequencies best heard by the human ear and consequently, most closely associated with what is called aircraft noise 'annoyance'. However, we now know that the focus on aircraft noise *annoyance* has unwittingly masked attention to lower frequency aircraft noise closely associated with a range of life threatening ailments – it is a long list, see Table 4. In brief, noise monitoring using the A-weighting needs to be complemented, ideally, with the Z-weighting, less ideally with C-weighting measurements.

To improve monitoring and policy surrounding management of aircraft noise it is essential that standards systematically that take account of the full sound spectrum be employed. This particularly important when it is realised the frequencies now known to be most harming are those below 500 Hz, frequencies systematically diminished using the A-weighting.

The table below provides a quantitative perspective of the differences between A- and C-weighting; the Z-weighting makes no changes to the relative importance of different frequency bands. The diminution below 500 Hz in A-weighting inevitably results in monitoring known effects of low frequency aircraft noise being 'masked' and ignored.

Figure 1 – Comparison of A-, C- and Z- Acoustic Weightings



Source: Cirrus Research: https://www.cirrusresearch.co.uk/blog/

Using a C- or Z-weighting draws greater attention to the magnitude of aircraft noise at low frequencies. However, further work is required to determine the range of noise frequencies that should be included in monitoring data, not just singular decibel readings. Assuming further research is able to identify which frequency bands appear to be associated with specific or a cluster of ailments would, potentially, allow mitigation measures to be directed to reducing noise in these frequency bands. A corollary of this would be the possibility of defining and/or refining dose-response curves for aircraft noise.

Table 1 – One-Third Octave Band Frequency Ranges, A- and C-weighting

Centre Frequency (Hz)	Effective Band (Hz)	A Weighting (dBA)	C Weighting (dBC)
31.5	22.1 - 44.2	-39.4	-3
63	44.2 - 88.4	-26.2	-0.8
125	88.4 - 177	-16.1	-0.2
250	177 - 354	-8.6	0
500	354 - 707	-3.2	0
1000	707 - 1,414	0	0
2000	1,414 - 2,828	1.2	-0.2
4000	2,828 - 5,657	1	-0.8
8000	5,657 - 11,314	-1.1	-3

Source: https://www.vernier.com/til/3500; IEC 61672:2013

Aircraft noise is a complex mixture of sounds spanning several thousand Hertz, at the low end sounds down to 0.1-2 Hz, at the upper end to over 15 kHz, it includes many harmonics. The human body and its internal organs and system are known to resonate at a wide range of frequencies, almost all well below about 200 Hz. Fairly recent work suggest the whole human body resonates at approximately 12 Hz with a range of 9 to

16 Hz.[10] However, parts of the human body have differing resonant frequencies, and the resonant frequency varies with body mass and magnitude/amplitude of the sound.

For almost a century it has been known that human cells vibrate and external sounds can cause resonances. Since then considerable work has been done to quantify the frequencies and magnitudes of these vibrations and determine resonance frequencies of various parts of the body.

Bryan Johnson (2018) proposed 'health based criteria' be the basis for managing aircraft noise.[11] This makes intuitive and practical sense. It is widely recognised that chronic and severe aircraft noise is a public health issue affecting millions of people in Europe, as recognised, for example, in the WHO (Europe) guidelines.

Johnson demonstrated that even noise from high flying aircraft had sufficient strength at ground level to cause vibrations in human tissue. Using an innovative experimental set up he identified low frequency sounds (<200 Hz) as the source of harm, measuring these vibrations using a container of 'ballistic gel' to observe and measure resonances caused by low frequency aircraft noise.

For our purposes the most relevant of his specific objectives was:

- To determine the significance of the contribution of infrasound and the vibrations they produce towards degraded cardiovascular health consequences and if these effects apply to aircraft noise. (p.5)

Human Body and Resonance

The human body and its internal tissues and organs responds to a wide range of sound frequencies including infrasound and low frequency sound. They have natural resonant frequencies, whole body exposure to external low frequency sound can cause internal resonance which amplify the strength of vibrations, in some cases leading to subtle internal damage.

Table 2 – Human Resonant Frequencies

Organ/ Body Part	Resonant Frequency
Inner ear	0.5 to 10 Hz
Eye	20 to 90 Hz
Head	20 to 30 Hz
Chest wall	50 to 100 Hz
Abdomen	4 to 8 Hz
Lungs	4 to 8 Hz
Spinal column	10 to 12 Hz
Shoulders	4 to 8 Hz
Hands and arms	20 to 70 Hz
Maxilla	100 to 200 Hz
Skin – Merkel Cell	5-15 Hz
Skin – Meisser's corpuscles	20-50 Hz
Skin – Pacinian corpuscles	60-400 Hz

[10] Brownjohn, J. & Zheng, . "Discussion of human resonant frequency." Proceedings of SPIE, 02 February 2016. https://doi.org/10.1117/12.429621

[11] Bryan Johnson (2018) "Health Based Criteria for use in Managing Airport and Aircraft Noise." Masters thesis, Harvard University. https://dash.harvard.edu/handle/1/37945140

Source: Havas & Colling, Leventhall, Duarte and Pereira [12]

The list in Table 2 is a limited sample of the range of organs affected by resonance to low frequency sound, currently it is not known precisely which and at what intensity external sounds leads to specific clinical conditions. It appears the cardiovascular and lymphatic systems – specifically the endothelium - are particularly sensitive to sounds below about 200 Hz. It is noted that chronic exposure to aircraft noise also results in psychosomatic conditions, e.g. depression, anger, migraine, dizziness or vertigo.

Health Impacts

Table 3 lists the responses of human organs and systems that have resonant frequencies affected by low frequency aircraft noise. These have been identified over the last two decades in a range of epidemiological (medical and psychological) studies. Not all of the responses have negative consequences or increase risks. On the other hand, there are well established cause-effect linkages between aircraft noise and, for example, increases in blood pressure and heart rate.

Table 3 – Health Impacts from Infra and Low Frequency Sound

Organ, Process	Effect	Frequency Range
Thyroid function*	Increased activity	14 Hz
Brain function *	Response rate	12 & 36 Hz
Cognitive learning *	Reduced	6-25 Hz, peak 13 Hz
Balance	Interference	40 Hz
Blood pressure #	Significant increase	Systolic 6 & 16 Hz
Blood pressure #	Significant increase	Diastolic 12 & 16 Hz
Heart rate @	Increase	2.14 Hz
EEG rhythms **	Variations in morphology	13 Hz

Source: * Persinger, 2014, # Danielsson & Landström, 1985, @ Qibai & Shi, ** Kasprzak, 2013.[13]

Comparing human body organs and processes affected by low frequency, listed above, with the ailments listed below (Table 4) indicates the strong likelihood it is indeed whole body exposure to chronic low frequency aircraft noise is the probable cause. Table 4 lists the clinical and biomedical, mental and social effects of aircraft whole body noise exposure. The caveat being that chronic noise exposure increases the risks of these ailments occurring, even if it is not the direct cause.

[12] Havas, M., & Colling, D. (2011). Wind turbines make waves: Why some residents near wind turbines become ill. Bulletin of Science, Technology & Society, 31(5), 414-426. oi:10.1177/0270467611417852. Leventhall, G Pelmear, P & Benton, S (2003) A Review of Published Research on Low Frequency Noise and its Effects, Defra Publications, UK.
M.L.M. Duarte and M. de Brito Pereira (2006) "Vision influence on whole-body human vibration comfort levels." Shock and Vibration 13 (2006) 367–377, IOS Press.

[13] Persinger, M (2014) "Infrasound, human health, and adaptation - An integrative overview of recondite hazards in a complex environment.", Nat Hazards (2014) 70:501–525, DOI 10.1007/s11069-013-0827-3; Qibain, CHY & Shi, H, "An Investigation on the Physiological and Psychological Effects of Infrasound on Persons." J. Low Frequence Noise, Vibration and Active Control, p. 71-6; Kasprzak, C (2013) "The influence of infrasound on humans ." 20th International Congress on Sound and Vibration, Bangkok.

Table 4 – Clinical & Biomedical, Mental & Social Effects

Clinical/Biomedical	Mental & Social
Cardiovascular diseases	Delays student learning
Endothelial dysfunction	Delayed cognitive development
Blood pressure elevated	Psychological/social stress
Increased stress hormone	Depression, anxiety, suicide
Ischemic heart disease	Migraines, headaches
Myocardial infarction	Sleep disturbance
Heart failure	Cognitive impairment
Haemorrhagic stroke	Annoyance
Ischemic stroke	Reduced deep sleep
Dysregulates genes	Disrupts communications
Diabetes mellitus	Disrupts social activities

Sources: As for Tables 2 and 3. Notes: Clinical/biomedical ailments resonances caused by aircraft noise increase risks of their occurrence or exacerbate existing conditions. Aircraft noise appears to be the direct cause of many mental and social ailments and exacerbate underlying conditions.

Illustrating Aircraft Noise

To clearly illustrate the prevalence and importance of low frequency aircraft noise a free Android app called 'OpeNoise' was used to capture noise spectra from jet aircraft departing from Brisbane airport, Australia. Generally speaking, there are no publicly available detailed sound spectra for aircraft noise, the most important probably being for departures when aircraft are under 'full power'; even exhaustive internet search provided slim pickings.

These aircraft directly (exactly) overfly the author's home at about 2,500'-4,000' on departure from Brisbane airport located about 7 km northeast.[14] The reading were taken outside from a point where there is an unobstructed view of the sky and the aircraft. When the wind changes to a more northerly direction aircraft arriving from the southwest also pass directly over our home, usually at an altitude of about 1,500'.

The OpeNoise app makes provision for observing (and recording) sound in 1/3 octave bands (a standard metric) using the Z-weighting. The amplitude of each band is displayed as a stacked, coloured column from 16 Hz up to16 kHz: LZ_{max} (blue), $LZ_{eq(t)}$ (purple), $LZ_{eq(1s)}$ (red), LZ_{min} (green). Aircraft noise was monitored for approximately 15 seconds as aircraft approached, passed overhead and then recording stopped. A photograph of the screen was then taken, to illustrate the amplitude of each 1/3 octave band (see Figure 4 below).

This approach has the significant advantage of monitoring the complete aircraft noise spectrum in detail, rather than depending on a single measurement of loudness, i.e. decibels, to measure aircraft (or other) noise.

It is highly likely by focusing on a single metric we have been missing critical information about the source of the known harm caused by chronic exposure to aircraft

[14] Very heavy aircraft – B777 and A380 – departing the airport usually have only climbed to about 2-2,500' by the time they pass over our house.

noise. The common metric, dBA, provides a useful insights into the severity of aircraft noise that is 'annoying', but no information on if or why it might be harmful. None of the unitary metrics, e.g. 65 dBA or even 65 dBZ, provides information on this aspect of aircraft noise. It is only by examining the frequency spectrum we can gain insights into how the composition of noise affects human wellbeing and/or causes illnesses.

We are aware that (chronic) aircraft noise is damaging to humans and other living beings. In brief, there are social and psychological effects of all kinds: annoyance, anger, conversations lost, migraines, additional stress, interrupted concentration and learning, etc. In addition, there are (subtle) clinical effects, e.g. increased risks of cardiovascular disease, hypertension, diabetes, etc. that have been definitively identified through extensive epidemiological research, mainly in Europe and the US; no studies have been done in Australia (to the best of my knowledge).

Until recently the mechanisms causing these clinical effects in the body had not been definitively identified. A few years ago Drs Thomas Munzel and Omar Hahad in Mainz, Germany identified disruption of the endothelium - the fine, single-cell lining of all blood vessels, the heart and lymphatic system - as the source of these clinical effects.[15] Despite being thin – a single layer of squamous cells - the endothelium is responsible for a range of critical control functions affecting blood flow and pressure in the body.

It has been known for about 100 years the human body and its internal organs react to low frequency sound (20-200 Hz) and infrasound (0-20 Hz) sounds. In 2018 Bryan Johnson, an engineer in the US, showed that low frequency and infrasound noise from aircraft at up to an altitude of at least ~4,000' still had sufficient energy at ground level to cause resonance in human organs. He did this as part of his thesis research at Harvard University.

A number of lines of evidence now suggest disruption of the endothelium is caused by resonances generated by low frequency and infrasound aircraft noise. These frequencies are 'excluded', de-emphasised, by the A-weighting, better captured by the C-weighting and more accurately still by the Z-weighting. Also note, low frequency sound carries for great distances, >10's of km, while higher frequencies are quickly attenuated by the atmosphere.

The sample of aircraft noise spectra from five types of medium and heavy jet aircraft on departure – all at about the same altitude, clearly illustrates the great similarity of their noise spectra. The bulk of the acoustic vibration and energy is below 500 Hz (Figure 4); the B737 being the most common type in use in Australia. The dBA Leq(1s) reading in large figures above each graph represents the lesser sound energy above about 1,000 Hz – essentially the noise we hear – the rest, the majority, having been filtered out by A-weighting.

In these figures there is a red down arrow showing the 500 Hz point, below which the A-weighting de-emphasises lower frequencies – the lower the frequency the greater the reduction. The lowest frequencies (vibrations), i.e. below 200 Hz, carry the majority of the sound energy causing resonances in the human body and its internal organs. It is

[15] Münzel et al (2023) "Too Loud to Handle? Transportation Noise and Cardiovascular Disease" Canadian Journal of Cardiology - (2023) 1-15, https://doi.org/10.1016/j.cjca.2023.02.018

probable, although more work is needed, these frequencies disrupt the normal functioning of the endothelium and other internal organs.

If these findings are independently validated they imply the need for significant revisions of the metrics used to monitor aircraft noise, so as to measure frequencies known to damage human health and increase risks of disease.

Modern Aircraft – Less Noisy?

The exploration of noise spectra for a range of aircraft revealed something unexpected. We have been repeatedly told technological advances over the last decades have made aircraft less noisy, the measure used is the familiar A-weighted decibel metric (dBA). For audible noise this is generally probably true, although rarely checked in the field, as opposed to accepting manufacturer's and official data.

The measured spectra of a small sample of modern heavy aircraft (e.g. A350, B787, A380), using the same methodology previously described, confirms that audible noise levels measured using the A-weighted measurement is somewhat lower as compared to older aircraft.

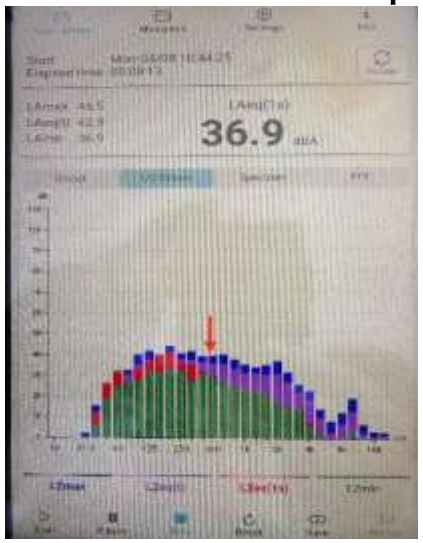
When the noise spectra of these newer aircraft is examined more closely, however, it appears there is little change in the amplitude of the frequencies below 500 Hz. These are very similar overall to those of older aircraft. These may be less noisy in the audible part of the spectrum above about 1,000 Hz, but below this frequency there is little difference. (See Figure 4)

This lack of a significant reduction is low frequencies and infrasound is of serious concern, because these are the frequencies that are known to be harmful to humans.

The similarity of the shape of noise spectra between older and newer aircraft, i.e. the preponderance of low frequencies – illustrates the inadequacy of relying on a single metric (dBA), especially when the metric is known to be insensitive to low frequencies. That is, while noise annoyance due to higher frequencies may be lower, the likely health effects of low frequency and infrasound remain largely unchanged.

This lack of significant reduction in low frequency noise has potentially serious policy implications when taken in conjunction with the anticipated increase in air traffic in coming decades. Briefly, it suggests health impacts will continue to increase as the frequency of overflights increases, despite there being some reduction in aircraft noise annoyance. Unless aviation industry regulators, i.e. governments, and the general public are aware of this divergence, i.e. health risk rising or unchanged while noise annoyance declines, the narrative from the aviation industry may lead to policy and regulatory complacency regarding the need to limit aircraft movements and markedly reduce low frequency noise.

Figure 4 – Aircraft Noise Spectra – Departures Brisbane Airport: B737, A330, B767 (x3), B767 & A350



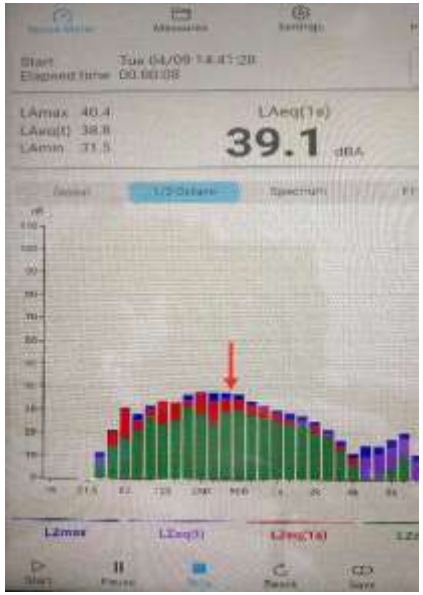
08Apr24-1045 Dep QF986-B737-8 3500’

08Apr24-1053 Dep QF61-A330-3 3500’

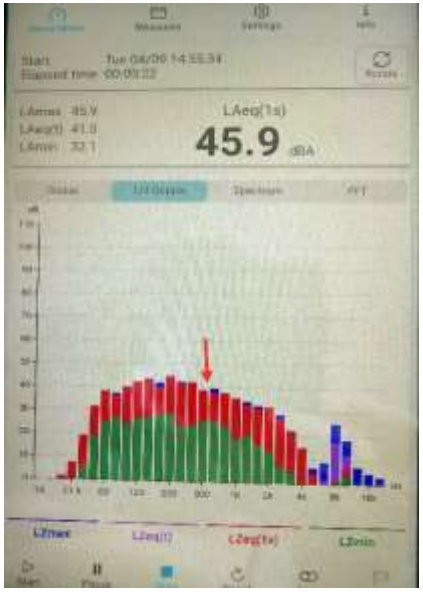
08Apr24-1100 Dep ANG4-B767-3 3500’

9-Apr-24-1000 Dep - QF708-B737-8 3500’

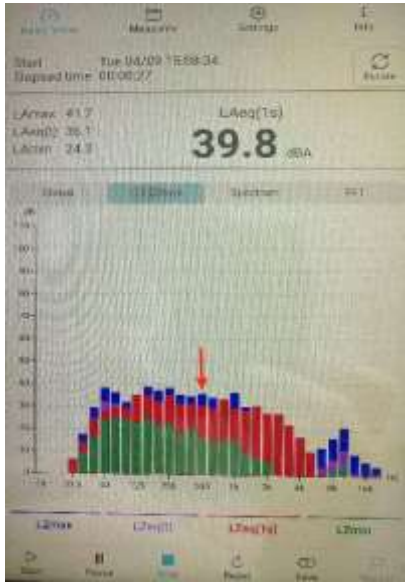
9-Apr-24-1005 Dep - QF57-B737-9 3500’



9-Apr-24-1441 Dep - VOZ375 B737-8 4000’



9-Apr-24-1455 Dep - ANG6-B767-3 4500’



9-Apr-24-1500 Dep - SQ236-A350-9 3500’

Summary of Findings

There no longer remains any doubt that chronic whole body exposure to aircraft noise damages human health, increasing the risks of various serious ailments. In the last few decades the biochemical mechanisms underlying this damage have been identified, most recently those leading to increased risks of cardiovascular disease.

Nor can there be much doubt it is highly likely the main causes of human harms are low frequency and infrasound from aircraft noise. These frequencies have been ignored for too long in biomedical and related research, and now require thorough investigation to confirm and quantify their importance to provide detailed evidence of does-response relationships.

Although not discussed in detail here, the social and mental health effects of aircraft noise have also been documented beyond reasonable doubt. These included delaying children's cognitive development and learning, sleep deprivation, disrupting of family communication and increased personal and social stress.

The range and depth of peer-reviewed scientific literature concerning the above issues is contained in hundreds of publicly available articles; additional confirmations being published almost monthly. This in itself indicates the seriousness of the public health issues posed by aircraft noise.

Almost total dependence by regulatory agencies and researchers on A-weighted decibel measurements has 'hidden' the critical role of low frequency and infrasound aircraft noise in harming humans and society. Once this oversight is corrected, and linked to how the human body responds to the resonances caused by low frequency sounds, it becomes apparent these frequencies are most likely the main source of clinical harm to humans. Noting, however, 'annoyance' by higher frequency aircraft noise remains important because of the social and psychological disruption it causes.

Recommendations

- We propose the name "Full Spectrum Metric" (**FSM**) for the revised policy, protocols and practice of using the complete sound spectrum from 0 Hz to 20,000 Hz for measuring and monitoring aircaft noise pollution.
- Governments and other organisation consider making it mandatory for the full spectrum of aircraft noise to be monitored and reported. Including testing, measuring and reporting on aircraft noise conducted for aircraft certification.
- Research protocols investigating the effects of aircraft noise be revised to ensure low frequency and infrasound frequencies are competently monitored, so that correlations and causation with clinical and socio-psychological effects can be explored and documented.
- Aircraft noise monitoring protocols of regulatory and commercial organisations be modified to ensure low frequency and infrasound aircraft noise is recorded for use in biomedical research, pollution control, enforcement and mitigation.
- Manufacturers be advised of these findings and requested to make the necessary modifications to their equipment, operation protocols and training to ensure low frequency and infrasound can be and is monitored and reported.

Having adopted the Full Spectrum Metric as a national standard we urge governments to propose and advocate its adoption in international fora, beginning with the UN ICAO.

About the Author

Dr Sean Foley BSc (Hons) PhD FRGS is an esteemed Australian environmental scientist. His academic journey commenced with a Bachelor of Science with Honours from Murdoch University in Western Australia, followed by the successful completion of a PhD in Human Ecology at the Australian National University (ANU). Recognised for his exceptional contributions to geography and environmental science, Dr Foley was elected as a Fellow of the Royal Geographical Society (FRGS). His work is widely acknowledged in the academic community, with more than 2,500 citations and an h-index of 17. His extensive research portfolio includes numerous peer-reviewed publications in renowned scientific journals, reflecting his commitment to scientific communication and public outreach. Dr Foley's interdisciplinary expertise spans natural resource and environmental management, environmental legislation, public health economics, international aid and development, policy analysis, and project design and management. He has also served as an Environmental Specialist with the World Bank, contributing his expertise to global environmental and developmental initiatives. Dr Foley's leadership extends beyond academia; he has been an Executive Board Member of the Australia and New Zealand Society for Ecological Economics, and since 2003 a Fellow and now immediate ex-Chair of The Samdhana Institute.

Annex - Select Bibliography

Aguilar, R., Flacke, J., Simon, D., & Pfeffer, K. (2023). Stakeholders Engagement in Noise Action Planning Mediated by OGITO: An Open Geo-Spatial Interactive Tool. *Journal of Urban Technology*, 1–24. https://doi.org/10.1080/10630732.2023.2190705

Alquezar, R. D., & Macedo, R. H. (2019). Airport noise and wildlife conservation: What are we missing? *Perspectives in Ecology and Conservation*, *17*(4), 163–171. https://doi.org/10.1016/j.pecon.2019.08.003

APHA. (2021). *Noise as a Public Health Hazard* (No. 202115). American Public Health Association. https://apha.org/Policies-and-Advocacy/Public-Health-Policy-Statements/Policy-Database/2022/01/07/Noise-as-a-Public-Health-Hazard

Armitage, H. (2015, September 1). Lack of sleep puts you at higher risk for colds, first experimental study finds. *Science*. https://doi.org/10.1126/science.aad1697

Australian Government Department of Health. (2024). *The health effects of environmental noise* (No. 12214). Department of Health. https://www.health.gov.au/resources/publications/enhealth-guidance-the-health-effects-of-environmental-noise

Bączalska, J., Wojciechowska, W., Rojek, M., Hahad, O., Daiber, A., Münzel, T., & Rajzer, M. (2022). Cardiovascular consequences of aircraft noise exposure. *Frontiers in Public Health*, *10*, 1058423. https://doi.org/10.3389/fpubh.2022.1058423

Baek, K., Park, C., & Sakong, J. (2023). The Impact of Aircraft Noise on the Cognitive Function of Elementary School Students in Korea. *Noise & Health*, *25*(117), 83–91. https://doi.org/10.4103/nah.nah_71_22

Banks, J., & Fink, D. (2022). Noise as a Public Health Hazard. *The Hearing Journal*, *75*(5), 6. https://doi.org/10.1097/01.HJ.0000831140.87139.eb

Barber, J. R., Fristrup, K. M., Brown, C. L., Hardy, A. R., Angeloni, L. M., & Crooks, K. R. (2010). Conserving the wild life therein: Protecting park fauna from anthropogenic noise. *Park Science*, *26*(3), 26–31. https://irma.nps.gov/DataStore/Reference/Profile/2201563

Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet*, *383*(9925), 1325–1332. https://doi.org/10.1016/S0140-6736(13)61613-X

Basner, M., Clark, C., Hansell, A., Hileman, J. I., Janssen, S., Shepherd, K., & Sparrow, V. (2017a). Aviation Noise Impacts: State of the Science. *Noise & Health*, *19*(87), 41–50. https://doi.org/10.4103/nah.NAH_104_16

Basner, M., Clark, C., Hansell, A., Hileman, J. I., Janssen, S., Shepherd, K., & Sparrow, V. (2017b). Aviation Noise Impacts: State of the Science. *Noise & Health*, *19*(87), 41–50. https://doi.org/10.4103/nah.NAH_104_16

Basner, M., & McGuire, S. (2018). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep. *International Journal of Environmental Research and Public Health*, *15*(3), 519. https://doi.org/10.3390/ijerph15030519

Basner, M., Witte, M., & McGuire, S. (2019). Aircraft Noise Effects on Sleep-Results of a Pilot Study Near Philadelphia International Airport. *International Journal of Environmental Research and Public Health*, *16*(17), 3178. https://doi.org/10.3390/ijerph16173178

Baudin, C., Lefèvre, M., Babisch, W., Cadum, E., Champelovier, P., Dimakopoulou, K., Houthuijs, D.,

Lambert, J., Laumon, B., Pershagen, G., Stansfeld, S., Velonaki, V., Hansell, A., & Evrard, A.-S. (2020). The role of aircraft noise annoyance and noise sensitivity in the association between aircraft noise levels and hypertension risk: Results of a pooled analysis from seven European countries. *Environmental Research*, *191*(110179), 110179. https://doi.org/10.1016/j.envres.2020.110179

Baudin, C., Lefèvre, M., Champelovier, P., Lambert, J., Laumon, B., & Evrard, A.-S. (2018). Aircraft Noise and Psychological Ill-Health: The Results of a Cross-Sectional Study in France. *International Journal of Environmental Research and Public Health*, *15*(8), 1642. https://doi.org/10.3390/ijerph15081642

Baudin, C., LefÈvre, M., Champelovier, P., Lambert, J., Laumon, B., & Evrard, A.-S. (2021). Self-rated health status in relation to aircraft noise exposure, noise annoyance or noise sensitivity: the results of a cross-sectional study in France. *BMC Public Health*, *21*(1), 116. https://doi.org/10.1186/s12889-020-10138-0

Baudin, C., Lefèvre, M., Selander, J., Babisch, W., Cadum, E., Carlier, M.-C., Champelovier, P., Dimakopoulou, K., Huithuijs, D., Lambert, J., Laumon, B., Pershagen, G., Theorell, T., Velonaki, V., Hansell, A., & Evrard, A.-S. (2019). Saliva cortisol in relation to aircraft noise exposure: pooled-analysis results from seven European countries. *Environmental Health: A Global Access Science Source*, *18*(1), 102. https://doi.org/10.1186/s12940-019-0540-0

Baumgaertner, E., Kao, J., Lutz, E., Sedgwick, J., Taylor, R., Throop, N., & Williams, J. (2023, June 9). Noise Could Take Years Off Your Life. Here Are the Health Impacts. *The New York Times*. https://www.nytimes.com/interactive/2023/06/09/health/noise-exposure-health-impacts.html

Bendtsen, K. M., Bengtsen, E., Saber, A. T., & Vogel, U. (2021). A review of health effects associated with exposure to jet engine emissions in and around airports. *Environmental Health: A Global Access Science Source*, *20*(1), 10. https://doi.org/10.1186/s12940-020-00690-y

Benz, S., Kuhlmann, J., Jeram, S., Bartels, S., Ohlenforst, B., & Schreckenberg, D. (2022). Impact of Aircraft Noise on Health. In L. Leylekian, A. Covrig, & A. Maximova (Eds.), *Aviation Noise Impact Management: Technologies, Regulations, and Societal Well-being in Europe* (pp. 173–195). Springer International Publishing. https://doi.org/10.1007/978-3-030-91194-2_7

Berry, B., & Sanchez, D. (2014). The economic and social value of aircraft noise effects: A critical review of the state of the art. *11th International Congress on Noise as a Public Health Problem, Nara, Japan*. https://www.researchgate.net/profile/Diana-Sanchez-19/publication/273385664_The_economic_valuation_of_aircraft_noise_effects_A_critical_review_of_the_state_of_the_art/links/5721e39908aee857c3b5ca69/The-economic-valuation-of-aircraft-noise-effects-A-critical-review-of-the-state-of-the-art.pdf

Besedovsky, L., & Born, J. (2015). Sleep, Don' t Sneeze: Longer Sleep Reduces the Risk of Catching a Cold [Review of *Sleep, Don' t Sneeze: Longer Sleep Reduces the Risk of Catching a Cold*]. *Sleep*, *38*(9), 1341–1342. https://doi.org/10.5665/sleep.4958

Beutel, M. E., Brähler, E., Ernst, M., Klein, E., Reiner, I., Wiltink, J., Michal, M., Wild, P. S., Schulz, A., Münzel, T., Hahad, O., König, J., Lackner, K. J., Pfeiffer, N., & Tibubos, A. N. (2020). Noise annoyance predicts symptoms of depression, anxiety and sleep disturbance 5 years later. Findings from the Gutenberg Health Study. *European Journal of Public Health*, *30*(3), 516–521. https://doi.org/10.1093/eurpub/ckaa015

Beutel, M. E., Jünger, C., Klein, E. M., Wild, P., Lackner, K., Blettner, M., Binder, H., Michal, M., Wiltink, J., Brähler, E., & Münzel, T. (2016). Noise Annoyance Is Associated with Depression and Anxiety in the General Population- The Contribution of Aircraft Noise. *PloS One*, *11*(5), e0155357. https://doi.org/10.1371/journal.pone.0155357

Black, D. A., Black, J. A., Issarayangyun, T., & Samuels, S. E. (2007). Aircraft noise exposure and resident' s stress and hypertension: A public health perspective for airport environmental management.

Journal of Air Transport Management, *13*(5), 264–276. https://doi.org/10.1016/j.jairtraman.2007.04.003

Black, D., & Black, J. (2008). Public health and the sustainability of cities: Sydney Airport's noise pollution and community wellbeing. In T. Gilmour, E. J. Blakely, & R. E. Pizarro (Eds.), *Dialogues in Urban Planning: Towards Sustainable Regions* (pp. 153–174). Sydney University Press. https://doi.org/10.30722/sup.9781920899127

Board, T. R., National Academies of Sciences, & Medicine. (2014). *Assessing Aircraft Noise Conditions Affecting Student Learning, Volume 1: Final Report* (B. H. Sharp, T. L. Connor, D. McLaughlin, C. Clark, S. A. Stansfeld, & J. Hervey (eds.)). The National Academies Press. https://doi.org/10.17226/22433

Bozigar, M., Huang, T., Redline, S., Hart, J. E., Grady, S. T., Nguyen, D. D., James, P., Nicholas, B., Levy, J. I., Laden, F., & Peters, J. L. (2023). Associations between Aircraft Noise Exposure and Self-Reported Sleep Duration and Quality in the United States-Based Prospective Nurses' Health Study Cohort. *Environmental Health Perspectives*, *131*(4), 47010. https://doi.org/10.1289/EHP10959

Brink, M., Schäffer, B., Vienneau, D., Pieren, R., Foraster, M., Eze, I. C., Rudzik, F., Thiesse, L., Cajochen, C., Probst-Hensch, N., Röösli, M., & Wunderli, J. M. (2019). Self-Reported Sleep Disturbance from Road, Rail and Aircraft Noise: Exposure-Response Relationships and Effect Modifiers in the SiRENE Study. *International Journal of Environmental Research and Public Health*, *16*(21), 4186. https://doi.org/10.3390/ijerph16214186

Bronzaft, A. L. (1981). The effect of a noise abatement program on reading ability. *Journal of Environmental Psychology*, *1*(3), 215–222. https://doi.org/10.1016/S0272-4944(81)80040-0

Bronzaft, A. L. (2017). Impact of noise on health: The divide between policy and science. *Open Journal of Social Sciences*, *05*(05), 108–120. https://doi.org/10.4236/jss.2017.55008

Bronzaft, A. L. (2021). Supporting healthier urban environments with a sound and noise curriculum for students. *Cities & Health*, *5*(1-2), 118–121. https://doi.org/10.1080/23748834.2019.1585691

Bronzaft, A. L., & McCarthy, D. P. (1975). The Effect of Elevated Train Noise On Reading Ability. *Environment and Behavior*, *7*(4), 517–528. https://doi.org/10.1177/001391657500700406

Budd, L., Kambari, M. M., & Ison, S. (2023). Decarbonising airports: an examination of UK airports' net zero targets. *Transportation Planning and Technology*, 1–18. https://doi.org/10.1080/03081060.2023.2279711

Carpenter, D., & Moss, D. A. (Eds.). (2013). *Preventing Regulatory Capture: Special Interest Influence and How to Limit it*. Cambridge University Press. https://www.tobinproject.org/sites/tobinproject.org/files/assets/Kwak%20-%20Cultural%20Capture%20and%20the%20Financial%20Crisis.pdf

Carugno, M., Imbrogno, P., Zucchi, A., Ciampichini, R., Tereanu, C., Sampietro, G., Barbaglio, G., Pesenti, B., Barretta, F., Bertazzi, P. A., Pesatori, A. C., & Consonni, D. (2018). Effects of aircraft noise on annoyance, sleep disorders, and blood pressure among adult residents near the Orio al Serio International Airport (BGY), Italy. *La Medicina Del Lavoro*, *109*(4), 253–263. https://doi.org/10.23749/mdl.v109i4.7271

Chapman, A. (2023). *Losing Altitude: The economics of air transport in Great Britain*. New Economics Foundation. https://neweconomics.org/2023/07/losing-altitude

Cherry, E., & Dannhauser, R. W. (2016). *Corrupt Or Collaborative? an Assessment of Regulatory Capture*. CFA Institute. https://www.cfainstitute.org/advocacy/policy-positions/corrupt-or-collaborative-an-assessment-of-regulatory-capture

Clark, C., Crumpler, C., & Notley, A. H. (2020). Evidence for Environmental Noise Effects on Health for

the United Kingdom Policy Context: A Systematic Review of the Effects of Environmental Noise on Mental Health, Wellbeing, Quality of Life, Cancer, Dementia, Birth, Reproductive Outcomes, and Cognition. *International Journal of Environmental Research and Public Health*, *17*(2). https://doi.org/10.3390/ijerph17020393

Clark, C., Gjestland, T., Lavia, L., Notley, H., Michaud, D., & Morinaga, M. (2021). Assessing community noise annoyance: A review of two decades of the international technical specification ISO/TS 15666:2003. *The Journal of the Acoustical Society of America*, *150*(5), 3362. https://doi.org/10.1121/10.0006967

Clark, C., Head, J., Haines, M., van Kamp, I., van Kempen, E., & Stansfeld, S. A. (2021). A meta-analysis of the association of aircraft noise at school on children' s reading comprehension and psychological health for use in health impact assessment. *Journal of Environmental Psychology*, *76*, 101646. https://doi.org/10.1016/j.jenvp.2021.101646

Clark, C., Head, J., & Stansfeld, S. A. (2013). Longitudinal effects of aircraft noise exposure on children' s health and cognition: A six-year follow-up of the UK RANCH cohort. *Journal of Environmental Psychology*, *35*, 1–9. https://doi.org/10.1016/j.jenvp.2013.03.002

Clark, C., & Paunovic, K. (2018a). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Cognition. *International Journal of Environmental Research and Public Health*, *15*(2), 285. https://doi.org/10.3390/ijerph15020285

Clark, C., & Paunovic, K. (2018b). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Cognition. *International Journal of Environmental Research and Public Health*, *15*(2). https://doi.org/10.3390/ijerph15020285

Clark, C., & Paunovic, K. (2018c). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Quality of Life, Wellbeing and Mental Health. *International Journal of Environmental Research and Public Health*, *15*(11), 2400. https://doi.org/10.3390/ijerph15112400

Clark, C., & Paunovic, K. (2018d). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Quality of Life, Wellbeing and Mental Health. *International Journal of Environmental Research and Public Health*, *15*(11). https://doi.org/10.3390/ijerph15112400

Clark, C., & Stansfeld, S. A. (2007). The Effect of Transportation Noise on Health and Cognitive Development: A Review of Recent Evidence. *International Journal of Comparative Psychology / ISCP ; Sponsored by the International Society for Comparative Psychology and the University of Calabria*, *20*(2). https://doi.org/10.46867/ijcp.2007.20.02.10

Daiber, A., Kröller-Schön, S., Frenis, K., Oelze, M., Kalinovic, S., Vujacic-Mirski, K., Kuntic, M., Bayo Jimenez, M. T., Helmstädter, J., Steven, S., Korac, B., & Münzel, T. (2019). Environmental noise induces the release of stress hormones and inflammatory signaling molecules leading to oxidative stress and vascular dysfunction-Signatures of the internal exposome. *BioFactors* , *45*(4), 495–506. https://doi.org/10.1002/biof.1506

Diesendorf, M., & Taylor, R. (2023). Cutting the Bonds of State Capture. In M. Diesendorf & R. Taylor (Eds.), *The Path to a Sustainable Civilisation: Technological, Socioeconomic and Political Change* (pp. 125–159). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-0663-5_6

Dimakopoulou, K., Koutentakis, K., Papageorgiou, I., Kasdagli, M.-I., Haralabidis, A. S., Sourtzi, P., Samoli, E., Houthuijs, D., Swart, W., Hansell, A. L., & Katsouyanni, K. (2017). Is aircraft noise exposure associated with cardiovascular disease and hypertension? Results from a cohort study in Athens, Greece. *Occupational and Environmental Medicine*, *74*(11), 830–837. https://doi.org/10.1136/oemed-2016-104180

Douglas, O., & Murphy, E. (2016). Source-based subjective responses to sleep disturbance from transportation noise. *Environment International*, *92-93*, 450–456. https://doi.org/10.1016/j.envint.2016.04.030

Dreier, C., & Vorländer, M. (2021). Aircraft noise-Auralization-based assessment of weather-dependent effects on loudness and sharpness. *The Journal of the Acoustical Society of America*, *149*(5), 3565. https://doi.org/10.1121/10.0005040

Erbe, C., Williams, R., Parsons, M., Parsons, S. K., Hendrawan, I. G., & Dewantama, I. M. I. (2018). Underwater noise from airplanes: An overlooked source of ocean noise. *Marine Pollution Bulletin*, *137*, 656–661. https://doi.org/10.1016/j.marpolbul.2018.10.064

Eriksson, C., Hilding, A., Pyko, A., Bluhm, G., Pershagen, G., & Östenson, C.-G. (2014). Long-term aircraft noise exposure and body mass index, waist circumference, and type 2 diabetes: a prospective study. *Environmental Health Perspectives*, *122*(7), 687–694. https://doi.org/10.1289/ehp.1307115

Evrard, A.-S., Bouaoun, L., Champelovier, P., Lambert, J., & Laumon, B. (2015). Does exposure to aircraft noise increase the mortality from cardiovascular disease in the population living in the vicinity of airports? Results of an ecological study in France. *Noise & Health*, *17*(78), 328–336. https://doi.org/10.4103/1463-1741.165058

Evrard, A.-S., Lefèvre, M., Champelovier, P., Lambert, J., & Laumon, B. (2017). Does aircraft noise exposure increase the risk of hypertension in the population living near airports in France? *Occupational and Environmental Medicine*, *74*(2), 123–129. https://doi.org/10.1136/oemed-2016-103648

Feng, H., Zhou, Y., Zeng, W., & Ding, C. (2023). Review on Metrics and Prediction Methods of Civil Aviation Noise. *International Journal of Aeronautical and Space Sciences*, *24*(5), 1199–1213. https://doi.org/10.1007/s42405-023-00609-0

Fidell, S., Mestre, V., Schomer, P., Horonjeff, R., & Reid, T. (2014). A systematic rationale for defining the significance of aircraft noise impacts. *The Journal of the Acoustical Society of America*, *136*(3), 1129. https://doi.org/10.1121/1.4892933

Foth, M., Doherty, S., & Kelly, N. (2024). The dark side of creativity: A design perspective on the built environment' s chequered histories. In J. Miao & T. Yigitcanlar (Eds.), *Routledge Companion of Creativity and the Built Environment* (pp. 314–326). Routledge. https://doi.org/10.4324/9781003292821-28

Gagliardi, P., Fredianelli, L., Simonetti, D., & Licitra, G. (2017). ADS-B System as a Useful Tool for Testing and Redrawing Noise Management Strategies at Pisa Airport. *Acta Acustica United with Acustica*, *103*(4), 543–551. https://doi.org/10.3813/AAA.919083

Gjestland, T. (2020). Recent World Health Organization regulatory recommendations are not supported by existing evidence. *The Journal of the Acoustical Society of America*, *148*(2), 511. https://doi.org/10.1121/10.0001643

Gjestland, T., Nguyen, T. L., & Yano, T. (2015). Community response to noise in Vietnam: exposure-response relationships based on the community tolerance level. *The Journal of the Acoustical Society of America*, *137*(5), 2596–2601. https://doi.org/10.1121/1.4919309

Green, K. B., Pasternack, B. S., & Shore, R. E. (1982). Effects of aircraft noise on reading ability of school-age children. *Archives of Environmental Health*, *37*(1), 24–31. https://www.ncbi.nlm.nih.gov/pubmed/7059228

Gualandi, N., & Mantecchini, L. (2008). Aircraft noise pollution: a model of interaction between airports and local communities. *International Journal of Mechanical Systems Science and Engineering*, *2*(2), 137–141. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1082.1005&rep=rep1&type=pdf

Habre, R., Zhou, H., Eckel, S. P., Enebish, T., Fruin, S., Bastain, T., Rappaport, E., & Gilliland, F. (2018). Short-term effects of airport-associated ultrafine particle exposure on lung function and inflammation in adults with asthma. *Environment International*, *118*, 48–59. https://doi.org/10.1016/j.envint.2018.05.031

Hahad, O., Bayo Jimenez, M. T., Kuntic, M., Frenis, K., Steven, S., Daiber, A., & Münzel, T. (2022). Cerebral consequences of environmental noise exposure. *Environment International*, *165*, 107306. https://doi.org/10.1016/j.envint.2022.107306

Hahad, O., Beutel, M., Gori, T., Schulz, A., Blettner, M., Pfeiffer, N., Rostock, T., Lackner, K., Sørensen, M., Prochaska, J. H., Wild, P. S., & Münzel, T. (2018). Annoyance to different noise sources is associated with atrial fibrillation in the Gutenberg Health Study. *International Journal of Cardiology*, *264*, 79–84. https://doi.org/10.1016/j.ijcard.2018.03.126

Hahad, O., Beutel, M., Michal, M., Schulz, A., Pfeiffer, N., Gianicolo, E., Lackner, K., Wild, P., Daiber, A., & Münzel, T. (2022). Lärmbelästigung in der deutschen Allgemeinbevölkerung. *Herz*, *47*(3), 265–279. https://doi.org/10.1007/s00059-021-05060-z

Hahad, O., Kuntic, M., Al-Kindi, S., Kuntic, I., Gilan, D., Petrowski, K., Daiber, A., & Münzel, T. (2024). Noise and mental health: evidence, mechanisms, and consequences. *Journal of Exposure Science & Environmental Epidemiology*. https://doi.org/10.1038/s41370-024-00642-5

Haines, M. M., Stansfeld, S. A., Job, R. F., Berglund, B., & Head, J. (2001). Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children. *Psychological Medicine*, *31*(2), 265–277. https://doi.org/10.1017/s0033291701003282

Hammer, M. S., Swinburn, T. K., & Neitzel, R. L. (2014). Environmental noise pollution in the United States: developing an effective public health response. *Environmental Health Perspectives*, *122*(2), 115–119. https://doi.org/10.1289/ehp.1307272

Hansell, A. L., Blangiardo, M., Fortunato, L., Floud, S., de Hoogh, K., Fecht, D., Ghosh, R. E., Laszlo, H. E., Pearson, C., Beale, L., Beevers, S., Gulliver, J., Best, N., Richardson, S., & Elliott, P. (2013). Aircraft noise and cardiovascular disease near Heathrow airport in London: small area study. *BMJ* , *347*(oct08 3), f5432. https://doi.org/10.1136/bmj.f5432

Haralabidis, A. S., Dimakopoulou, K., Vigna-Taglianti, F., Giampaolo, M., Borgini, A., Dudley, M.-L., Pershagen, G., Bluhm, G., Houthuijs, D., Babisch, W., Velonakis, M., Katsouyanni, K., Jarup, L., & HYENA Consortium. (2008). Acute effects of night-time noise exposure on blood pressure in populations living near airports. *European Heart Journal*, *29*(5), 658–664. https://doi.org/10.1093/eurheartj/ehn013

Hauptvogel, D., Bartels, S., Schreckenberg, D., & Rothmund, T. (2021). Aircraft Noise Distribution as a Fairness Dilemma-A Review of Aircraft Noise through the Lens of Social Justice Research. *International Journal of Environmental Research and Public Health*, *18*(14), 7399. https://doi.org/10.3390/ijerph18147399

Havel, B. F., & Sanchez, G. S. (2014). *The Principles and Practice of International Aviation Law*. Cambridge University Press.

He, Q., Wollersheim, C., Locke, M., & Waitz, I. (2014). Estimation of the global impacts of aviation-related noise using an income-based approach. *Transport Policy*, *34*, 85–101. https://doi.org/10.1016/j.tranpol.2014.02.020

Hede, A. J. (2017). Using mindfulness to reduce the health effects of community reaction to aircraft noise. *Noise & Health*, *19*(89), 165–173. https://doi.org/10.4103/nah.NAH_106_16

Hener, T. (2022). Noise pollution and violent crime. *Journal of Public Economics*, *215*, 104748. https://doi.org/10.1016/j.jpubeco.2022.104748

Holt, J. B., Zhang, X., Sizov, N., & Croft, J. B. (2015). Airport noise and self-reported sleep insufficiency, United States, 2008 and 2009. *Preventing Chronic Disease*, *12*(140551), E49. https://doi.org/10.5888/pcd12.140551

Hygge, S., Evans, G. W., & Bullinger, M. (2002). A prospective study of some effects of aircraft noise on cognitive performance in schoolchildren. *Psychological Science*, *13*(5), 469–474. https://doi.org/10.1111/1467-9280.00483

Iglesias-Merchan, C., Diaz-Balteiro, L., & Soliño, M. (2015). Transportation planning and quiet natural areas preservation: Aircraft overflights noise assessment in a National Park. *Transportation Research Part D: Transport and Environment*, *41*, 1–12. https://doi.org/10.1016/j.trd.2015.09.006

Issarayangyun, T., Black, D., Black, J., & Samuels, S. (2005). AIRCRAFT NOISE AND METHODS FOR THE STUDY OF COMMUNITY HEALTH AND WELL-BEING. *Journal of the Eastern Asia Society for Transportation Studies*, *6*, 3293–3308. https://doi.org/10.11175/easts.6.3293

Itzkowitz, N., Gong, X., Atilola, G., Konstantinoudis, G., Adams, K., Jephcote, C., Gulliver, J., Hansell, A. L., & Blangiardo, M. (2023a). Aircraft noise and cardiovascular morbidity and mortality near Heathrow Airport: A case-crossover study. *Environment International*, *177*(108016), 108016. https://doi.org/10.1016/j.envint.2023.108016

Itzkowitz, N., Gong, X., Atilola, G., Konstantinoudis, G., Adams, K., Jephcote, C., Gulliver, J., Hansell, A. L., & Blangiardo, M. (2023b). Aircraft noise and cardiovascular morbidity and mortality near Heathrow Airport: A case-crossover study. *Environment International*, *177*, 108016. https://doi.org/10.1016/j.envint.2023.108016

Jarup, L., Babisch, W., Houthuijs, D., Pershagen, G., Katsouyanni, K., Cadum, E., Dudley, M.-L., Savigny, P., Seiffert, I., Swart, W., Breugelmans, O., Bluhm, G., Selander, J., Haralabidis, A., Dimakopoulou, K., Sourtzi, P., Velonakis, M., Vigna-Taglianti, F., & HYENA study team. (2008). Hypertension and exposure to noise near airports: the HYENA study. *Environmental Health Perspectives*, *116*(3), 329–333. https://doi.org/10.1289/ehp.10775

Johnson, B. (2018). *Health Based Criteria for Use in Managing Airport and Aircraft Noise* [Master of Liberal Arts in Extension Studies, Harvard University]. https://dash.harvard.edu/handle/1/37945140

Kallbekken, S., & Victor, D. G. (2022). A cleaner future for flight - aviation needs a radical redesign. *Nature*, *609*(7928), 673–675. https://doi.org/10.1038/d41586-022-02963-7

Kaltenbach, M., Maschke, C., & Heb, F. (2016). Health impairments, annoyance and learning disorders caused by aircraft noise. *Int. J. Environ*, *6*(1), 15–46. https://www.researchgate.net/profile/Christian-Maschke/publication/289365446_Health_Impairments_Annoyance_and_Learning_Disorders_Caused_by_Aircraft_Noise-Synopsis_of_the_State_of_Current_Noise_Research/links/568e03d408aef987e5661eeb/Health-Impairments-Annoyance-and-Learning-Disorders-Caused-by-Aircraft-Noise-Synopsis-of-the-State-of-Current-Noise-Research.pdf

Keuken, M. P., Moerman, M., Zandveld, P., Henzing, J. S., & Hoek, G. (2015). Total and size-resolved particle number and black carbon concentrations in urban areas near Schiphol airport (the Netherlands). *Atmospheric Environment*, *104*, 132–142. https://doi.org/10.1016/j.atmosenv.2015.01.015

Kim, C. S., Grady, S. T., Hart, J. E., Laden, F., VoPham, T., Nguyen, D. D., Manson, J. E., James, P., Forman, J. P., Rexrode, K. M., Levy, J. I., & Peters, J. L. (2022). Long-term aircraft noise exposure and risk of hypertension in the Nurses' Health Studies. *Environmental Research*, *207*(112195), 112195. https://doi.org/10.1016/j.envres.2021.112195

Kim, S. J., Chai, S. K., Lee, K. W., Park, J.-B., Min, K.-B., Kil, H. G., Lee, C., & Lee, K. J. (2014). Exposure-

Response Relationship Between Aircraft Noise and Sleep Quality: A Community-based Cross-sectional Study. *Osong Public Health and Research Perspectives*, *5*(2), 108–114. https://doi.org/10.1016/j.phrp.2014.03.004

Klatte, M., Spilski, J., Mayerl, J., Möhler, U., Lachmann, T., & Bergström, K. (2017a). Effects of aircraft noise on reading and quality of life in primary school children in Germany: Results from the NORAH study. *Environment and Behavior*, *49*(4), 390–424. https://doi.org/10.1177/0013916516642580

Klatte, M., Spilski, J., Mayerl, J., Möhler, U., Lachmann, T., & Bergström, K. (2017b). Effects of Aircraft Noise on Reading and Quality of Life in Primary School Children in Germany: Results From the NORAH Study. *Environment and Behavior*, *49*(4), 390–424. https://doi.org/10.1177/0013916516642580

Kok, A. C. M., Berkhout, B. W., Carlson, N. V., Evans, N. P., Khan, N., Potvin, D. A., Radford, A. N., Sebire, M., Shafiei Sabet, S., Shannon, G., & Wascher, C. A. F. (2023). How chronic anthropogenic noise can affect wildlife communities. *Frontiers in Ecology and Evolution*, *11*. https://doi.org/10.3389/fevo.2023.1130075

Kourieh, A., Giorgis-Allemand, L., Bouaoun, L., Lefèvre, M., Champelovier, P., Lambert, J., Laumon, B., & Evrard, A.-S. (2022). Incident hypertension in relation to aircraft noise exposure: results of the DEBATS longitudinal study in France. *Occupational and Environmental Medicine*, *79*(4), 268–276. https://doi.org/10.1136/oemed-2021-107921

Kranjec, N., Kuhlmann, J., Benz, S., Schreckenberg, D., Rajé, F., Hooper, P., & Jeram, S. (2021). Aircraft noise health impacts and limitations in the current research. *Proceedings of the 13th ICBEN Congress on Noise as a Public Health Problem*, 14–17. http://www.icben.org/2021/ICBEN%202021%20Papers/full_paper_27791.pdf

Kuntic, M., Kuntic, I., Krishnankutty, R., Gericke, A., Oelze, M., Junglas, T., Bayo Jimenez, M. T., Stamm, P., Nandudu, M., Hahad, O., Keppeler, K., Daub, S., Vujacic-Mirski, K., Rajlic, S., Strohm, L., Ubbens, H., Tang, Q., Jiang, S., Ruan, Y., … Münzel, T. (2023). Co-exposure to urban particulate matter and aircraft noise adversely impacts the cerebro-pulmonary-cardiovascular axis in mice. *Redox Biology*, *59*, 102580. https://doi.org/10.1016/j.redox.2022.102580

Kupcikova, Z., Fecht, D., Ramakrishnan, R., Clark, C., & Cai, Y. S. (2021). Road traffic noise and cardiovascular disease risk factors in UK Biobank. *European Heart Journal*, *42*(21), 2072–2084. https://doi.org/10.1093/eurheartj/ehab121

Kvandová, M., Rajlic, S., Stamm, P., Schmal, I., Mihaliková, D., Kuntic, M., Bayo Jimenez, M. T., Hahad, O., Kollárová, M., Ubbens, H., Strohm, L., Frenis, K., Duerr, G. D., Foretz, M., Viollet, B., Ruan, Y., Jiang, S., Tang, Q., Kleinert, H., … Münzel, T. (2023). Mitigation of aircraft noise-induced vascular dysfunction and oxidative stress by exercise, fasting, and pharmacological α1AMPK activation: molecular proof of a protective key role of endothelial α1AMPK against environmental noise exposure. *European Journal of Preventive Cardiology*, zwad075. https://doi.org/10.1093/eurjpc/zwad075

Kwak, K. M., Ju, Y.-S., Kwon, Y.-J., Chung, Y. K., Kim, B. K., Kim, H., & Youn, K. (2016). The effect of aircraft noise on sleep disturbance among the residents near a civilian airport: a cross-sectional study. *Annals of Occupational and Environmental Medicine*, *28*(1), 38. https://doi.org/10.1186/s40557-016-0123-2

Lees, J., Hewitt, C., & Johnson, T. (2016). *Aircraft noise and public health: the evidence is loud and clear*. Aviation Environment Federation (AEF). https://www.aef.org.uk/2016/01/12/new-report-finds-aircraft-noise-policies-put-the-health-of-over-one-million-people-at-risk/

Lefèvre, M., Chaumond, A., Champelovier, P., Giorgis Allemand, L., Lambert, J., Laumon, B., & Evrard, A.-S. (2020). Understanding the relationship between air traffic noise exposure and annoyance in populations living near airports in France. *Environment International*, *144*(106058), 106058. https://doi.org/10.1016/j.envint.2020.106058

Leylekian, L., Covrig, A., & Maximova, A. (2022). *Aviation Noise Impact Management: Technologies, Regulations, and Societal Well-being in Europe*. Springer International Publishing. https://doi.org/10.1007/978-3-030-91194-2

Li, A., Martino, E., Mansour, A., & Bentley, R. (2022). Environmental Noise Exposure and Mental Health: Evidence From a Population-Based Longitudinal Study. *American Journal of Preventive Medicine*, *63*(2), e39–e48. https://doi.org/10.1016/j.amepre.2022.02.020

Licitra, G., Gagliardi, P., Fredianelli, L., & Simonetti, D. (2014). Noise mitigation action plan of Pisa civil and military airport and its effects on people exposure. *Applied Acoustics*, *84*, 25–36. https://doi.org/10.1016/j.apacoust.2014.02.020

Lugten, M., Karacaoglu, M., White, K., Kang, J., & Steemers, K. (2018). Improving the soundscape quality of urban areas exposed to aircraft noise by adding moving water and vegetation. *The Journal of the Acoustical Society of America*, *144*(5), 2906. https://doi.org/10.1121/1.5079310

Mackensen, S. V., Bullinger, M., Meis, M., Evans, G. W., & Hygge, S. (1999). The psychological cost of aircraft noise for children. *The Journal of the Acoustical Society of America*, *105*(2_Supplement), 1219–1219. https://doi.org/10.1121/1.425878

Masiol, M., & Harrison, R. M. (2014). Aircraft engine exhaust emissions and other airport-related contributions to ambient air pollution: A review. *Atmospheric Environment* , *95*, 409–455. https://doi.org/10.1016/j.atmosenv.2014.05.070

Matheson, M. P., Stansfeld, S. A., & Haines, M. M. (2003). The effects of chronic aircraft noise exposure on children' s cognition and health: 3 field studies. *Noise & Health*, *5*(19), 31–40. https://www.ncbi.nlm.nih.gov/pubmed/12804210

Mazaheri, M., Johnson, G. R., & Morawska, L. (2011). An inventory of particle and gaseous emissions from large aircraft thrust engine operations at an airport. *Atmospheric Environment*, *45*(20), 3500–3507. https://doi.org/10.1016/j.atmosenv.2010.12.012

Meng, L., Zhang, Y., Zhang, S., Jiang, F., Sha, L., Lan, Y., & Huang, L. (2022). Chronic Noise Exposure and Risk of Dementia: A Systematic Review and Dose-Response Meta-Analysis. *Frontiers in Public Health*, *10*, 832881. https://doi.org/10.3389/fpubh.2022.832881

Michaud, D. S., Marro, L., Denning, A., Shackleton, S., Toutant, N., & McNamee, J. P. (2022). A comparison of self-reported health status and perceptual responses toward environmental noise in rural, suburban, and urban regions in Canada. *The Journal of the Acoustical Society of America*, *151*(3), 1532. https://doi.org/10.1121/10.0009749

Molitor, M., Bayo-Jimenez, M. T., Hahad, O., Witzler, C., Finger, S., Garlapati, V. S., Rajlic, S., Knopp, T., Bieler, T. K., Aluia, M., Wild, J., Lagrange, J., Blessing, R., Rapp, S., Schulz, A., Kleinert, H., Karbach, S., Steven, S., Ruf, W., … Wenzel, P. (2023). Aircraft noise exposure induces pro-inflammatory vascular conditioning and amplifies vascular dysfunction and impairment of cardiac function after myocardial infarction. *Cardiovascular Research*, cvad021. https://doi.org/10.1093/cvr/cvad021

Moreyra, A. E., Subramanian, K., Mi, Z., Cosgrove, N. M., Kostis, W. J., Ke, F., Kostis, J. B., & Ananth, C. (2022). THE IMPACT OF EXPOSURE TO TRANSPORTATION NOISE ON THE RATES OF MYOCARDIAL INFARCTION IN NEW JERSEY. *Journal of the American College of Cardiology*, *79*(9, Supplement), 1148. https://doi.org/10.1016/S0735-1097(22)02139-8

Mulero-Pázmány, M., Jenni-Eiermann, S., Strebel, N., Sattler, T., Negro, J. J., & Tablado, Z. (2017). Unmanned aircraft systems as a new source of disturbance for wildlife: A systematic review. *PloS One*, *12*(6), e0178448. https://doi.org/10.1371/journal.pone.0178448

Münzel, T., Daiber, A., Steven, S., Tran, L. P., Ullmann, E., Kossmann, S., Schmidt, F. P., Oelze, M., Xia, N., Li, H., Pinto, A., Wild, P., Pies, K., Schmidt, E. R., Rapp, S., & Kröller-Schön, S. (2017). Effects of noise on vascular function, oxidative stress, and inflammation: mechanistic insight from studies in mice. *European Heart Journal*, *38*(37), 2838–2849. https://doi.org/10.1093/eurheartj/ehx081

Münzel, T., Schmidt, F. P., Steven, S., Herzog, J., Daiber, A., & Sørensen, M. (2018). Environmental Noise and the Cardiovascular System. *Journal of the American College of Cardiology*, *71*(6), 688–697. https://doi.org/10.1016/j.jacc.2017.12.015

Münzel, T., Sørensen, M., Hahad, O., Nieuwenhuijsen, M., & Daiber, A. (2023). The contribution of the exposome to the burden of cardiovascular disease. *Nature Reviews. Cardiology*. https://doi.org/10.1038/s41569-023-00873-3

Münzel, T., Sørensen, M., Schmidt, F., Schmidt, E., Steven, S., Kröller-Schön, S., & Daiber, A. (2018). The Adverse Effects of Environmental Noise Exposure on Oxidative Stress and Cardiovascular Risk. *Antioxidants & Redox Signaling*, *28*(9), 873–908. https://doi.org/10.1089/ars.2017.7118

Münzel, T., Treede, H., Hahad, O., & Daiber, A. (2023). Too Loud to Handle? Transportation Noise and Cardiovascular Disease. *The Canadian Journal of Cardiology*, *39*(9), 1204–1218. https://doi.org/10.1016/j.cjca.2023.02.018

Nassur, A.-M., Lefèvre, M., Laumon, B., Léger, D., & Evrard, A.-S. (2019). Aircraft Noise Exposure and Subjective Sleep Quality: The Results of the DEBATS Study in France. *Behavioral Sleep Medicine*, *17*(4), 502–513. https://doi.org/10.1080/15402002.2017.1409224

Nassur, A.-M., Léger, D., Lefèvre, M., Elbaz, M., Mietlicki, F., Nguyen, P., Ribeiro, C., Sineau, M., Laumon, B., & Evrard, A.-S. (2019). The impact of aircraft noise exposure on objective parameters of sleep quality: results of the DEBATS study in France. *Sleep Medicine*, *54*, 70–77. https://doi.org/10.1016/j.sleep.2018.10.013

Nguyen, D. D., Whitsel, E. A., Wellenius, G. A., Levy, J. I., Leibler, J. H., Grady, S. T., Stewart, J. D., Fox, M. P., Collins, J. M., Eliot, M. N., Malwitz, A., Manson, J. E., & Peters, J. L. (2023). Long-term aircraft noise exposure and risk of hypertension in postmenopausal women. *Environmental Research*, *218*(115037), 115037. https://doi.org/10.1016/j.envres.2022.115037

Nguyen, T. L., Nguyen, T. L., Morinaga, M., Yokoshima, S., Yano, T., Sato, T., & Yamada, I. (2018). Community response to a step change in the aircraft noise exposure around Hanoi Noi Bai International Airport. *The Journal of the Acoustical Society of America*, *143*(5), 2901. https://doi.org/10.1121/1.5037567

Nguyen, T. L., Trieu, B. L., Hiraguri, Y., Morinaga, M., Morihara, T., & Yano, T. (2020). Effects of Changes in Acoustic and Non-Acoustic Factors on Public Health and Reactions: Follow-Up Surveys in the Vicinity of the Hanoi Noi Bai International Airport. *International Journal of Environmental Research and Public Health*, *17*(7), 2597. https://doi.org/10.3390/ijerph17072597

Nguyen, T. T. H. N., Trieu, B. L., Nguyen, T. L., Morinaga, M., Hiraguri, Y., Morihara, T., Sasazawa, Y., Nguyen, T. Q. H., & Yano, T. (2023). Models of Aviation Noise Impact in the Context of Operation Decrease at Tan Son Nhat Airport. *International Journal of Environmental Research and Public Health*, *20*(8). https://doi.org/10.3390/ijerph20085450

Nold, C., Haklay, M., Walker, T., Doherty, J., Morris, M., & Boon, G. (2023). Citizen Science Study of Overflight Noise from New and Old Generation Aircraft at London City Airport. *Community Science*. https://doi.org/10.21954/mtkx-h460

Osborne, M. T., Radfar, A., Hassan, M. Z. O., Abohashem, S., Oberfeld, B., Patrich, T., Tung, B., Wang, Y., Ishai, A., Scott, J. A., Shin, L. M., Fayad, Z. A., Koenen, K. C., Rajagopalan, S., Pitman, R. K., & Tawakol, A. (2020). A neurobiological mechanism linking transportation noise to cardiovascular disease

in humans. *European Heart Journal*, *41*(6), 772–782. https://doi.org/10.1093/eurheartj/ehz820

Owen, B., Anet, J. G., Bertier, N., Christie, S., Cremaschi, M., Dellaert, S., Edebeli, J., Janicke, U., Kuenen, J., Lim, L., & Terrenoire, E. (2022). Review: Particulate Matter Emissions from Aircraft. *Atmosphere*, *13*(8), 1230. https://doi.org/10.3390/atmos13081230

Patarkalashvili, T. (2022). Noise pollution is one of the main health impacts in big cities today. *Open Access Journal of Biogeneric Science and Research*, *11*(1). https://doi.org/10.46718/jbgsr.2022.11.000257

Pearson, T., Campbell, M. J., & Maheswaran, R. (2016a). Acute effects of aircraft noise on cardiovascular admissions - an interrupted time-series analysis of a six-day closure of London Heathrow Airport caused by volcanic ash. *Spatial and Spatio-Temporal Epidemiology*, *18*, 38–43. https://doi.org/10.1016/j.sste.2016.03.004

Pearson, T., Campbell, M. J., & Maheswaran, R. (2016b). Acute effects of aircraft noise on cardiovascular admissions - an interrupted time-series analysis of a six-day closure of London Heathrow Airport caused by volcanic ash. *Spatial and Spatio-Temporal Epidemiology*, *18*, 38–43. https://doi.org/10.1016/j.sste.2016.03.004

Persinger, M. A. (2014). Infrasound, human health, and adaptation: an integrative overview of recondite hazards in a complex environment. *Natural Hazards*, *70*(1), 501–525. https://doi.org/10.1007/s11069-013-0827-3

Peters, J. L., Zevitas, C. D., Redline, S., Hastings, A., Sizov, N., Hart, J. E., Levy, J. I., Roof, C. J., & Wellenius, G. A. (2018). Aviation Noise and Cardiovascular Health in the United States: a Review of the Evidence and Recommendations for Research Direction. *Current Epidemiology Reports*, *5*(2), 140–152. https://doi.org/10.1007/s40471-018-0151-2

Petri, D., Licitra, G., Vigotti, M. A., & Fredianelli, L. (2021). Effects of Exposure to Road, Railway, Airport and Recreational Noise on Blood Pressure and Hypertension. *International Journal of Environmental Research and Public Health*, *18*(17). https://doi.org/10.3390/ijerph18179145

Potera, C. (2014). In the neighborhood: metabolic outcomes among residents exposed to aircraft noise [Review of *In the neighborhood: metabolic outcomes among residents exposed to aircraft noise*]. *Environmental Health Perspectives*, *122*(7), A193. Environmental Health Perspectives. https://doi.org/10.1289/ehp.122-A193

Prather, A. A., Janicki-Deverts, D., Hall, M. H., & Cohen, S. (2015). Behaviorally Assessed Sleep and Susceptibility to the Common Cold. *Sleep*, *38*(9), 1353–1359. https://doi.org/10.5665/sleep.4968

Preisendörfer, P., Liebe, U., Bruderer Enzler, H., & Diekmann, A. (2022). Annoyance due to residential road traffic and aircraft noise: Empirical evidence from two European cities. *Environmental Research*, *206*(112269), 112269. https://doi.org/10.1016/j.envres.2021.112269

Quehl, J., Bartels, S., Fimmers, R., & Aeschbach, D. (2021). Effects of Nocturnal Aircraft Noise and Non-Acoustical Factors on Short-Term Annoyance in Primary School Children. *International Journal of Environmental Research and Public Health*, *18*(13), 6959. https://doi.org/10.3390/ijerph18136959

Rattle, R. (2015). HEALTH IMPACT ASSESSMENT, MUNICIPAL DEVELOPMENT PRACTICES, AND CHILDREN' S HEALTH. *International Journal of Child, Youth and Family Studies*, *6*(2), 308–327. https://doi.org/10.18357/ijcyfs.62201513504

Rhee, M.-Y., Kim, H.-Y., Roh, S.-C., Kim, H.-J., & Kwon, H.-J. (2008). The effects of chronic exposure to aircraft noise on the prevalence of hypertension. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, *31*(4), 641–647. https://doi.org/10.1291/hypres.31.641

Riley, K., Cook, R., Carr, E., & Manning, B. (2021). A Systematic Review of The Impact of Commercial Aircraft Activity on Air Quality Near Airports. *City and Environment Interactions*, *11*. https://doi.org/10.1016/j.cacint.2021.100066

Robinson, R., Donuata, P. B., Ete, A. A., & Rusdin, M. E. (2020). Effect of Noise Intensity of Aviation Activities on Student Learning Concentrations. *Indonesian Review of Physics*, *3*(2), 47–51. https://doi.org/10.12928/irip.v3i2.2632

Saucy, A., Schäffer, B., Tangermann, L., Vienneau, D., Wunderli, J.-M., & Röösli, M. (2021). Does night-time aircraft noise trigger mortality? A case-crossover study on 24 886 cardiovascular deaths. *European Heart Journal*, *42*(8), 835–843. https://doi.org/10.1093/eurheartj/ehaa957

Schmidt, F. P., Basner, M., Kröger, G., Weck, S., Schnorbus, B., Muttray, A., Sariyar, M., Binder, H., Gori, T., Warnholtz, A., & Münzel, T. (2013). Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults. *European Heart Journal*, *34*(45), 3508–3514a. https://doi.org/10.1093/eurheartj/eht269

Schubert, M., Hegewald, J., Freiberg, A., Starke, K. R., Augustin, F., Riedel-Heller, S. G., Zeeb, H., & Seidler, A. (2019). Behavioral and Emotional Disorders and Transportation Noise among Children and Adolescents: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *16*(18). https://doi.org/10.3390/ijerph16183336

Seabi, J., Cockcroft, K., Goldschagg, P., & Greyling, M. (2012). The impact of aircraft noise exposure on South African children' s reading comprehension: the moderating effect of home language. *Noise & Health*, *14*(60), 244–252. https://doi.org/10.4103/1463-1741.102963

Si, S., Lewkowski, K., Fritschi, L., Heyworth, J., Liew, D., & Li, I. (2020). Productivity Burden of Occupational Noise-Induced Hearing Loss in Australia: A Life Table Modelling Study. *International Journal of Environmental Research and Public Health*, *17*(13). https://doi.org/10.3390/ijerph17134667

Sordello, R., Ratel, O., Flamerie De Lachapelle, F., Leger, C., Dambry, A., & Vanpeene, S. (2020). Evidence of the impact of noise pollution on biodiversity: a systematic map. *Environmental Evidence*, *9*(1), 1–27. https://doi.org/10.1186/s13750-020-00202-y

Spilski, J., Bergstroem, K., Mayerl, J., Moehler, U., Lachmann, T., & Klatte, M. (2017). Aircraft noise exposure and children' s cognition: Evidence for a daytime NAT criterion. *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, 457–463. https://www.ingentaconnect.com/content/ince/incecp/2017/00000255/00000007/art00054

Spilski, J., Bergström, K., Möhler, U., Lachmann, T., & Klatte, M. (2020). Do we need different metrics to predict the effects of aircraft noise on children' s well-being and health? *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, *261*, 2774–2780. https://www.ingentaconnect.com/content/ince/incecp/2020/00000261/00000004/art00088

Stansfeld, S. A., Berglund, B., Clark, C., Lopez-Barrio, I., Fischer, P., Öhrström, E., Haines, M. M., Head, J., Hygge, S., van Kamp, I., & Berry, B. F. (2005). Aircraft and road traffic noise and children' s cognition and health: a cross-national study. *The Lancet*, *365*(9475), 1942–1949. https://doi.org/10.1016/S0140-6736(05)66660-3

Stansfeld, S. A., Clark, C., Cameron, R. M., Alfred, T., Head, J., Haines, M. M., van Kamp, I., van Kempen, E., & Lopez-Barrio, I. (2009). Aircraft and road traffic noise exposure and children' s mental health. *Journal of Environmental Psychology*, *29*(2), 203–207. https://doi.org/10.1016/j.jenvp.2009.01.002

Stansfeld, S., Hygge, S., Clark, C., & Alfred, T. (2010). Night time aircraft noise exposure and children' s cognitive performance. *Noise & Health*, *12*(49), 255–262. https://doi.org/10.4103/1463-1741.70504

Š timac, I., Ivaniš ević, J., & Sorić, V. (2007). Influence of Aircraft Noise on the Quality of Living Near the Airport. *Proceedings of the 3rd Congress of the Alps Adria Acoustics Association*. 3rd Congress of the Alps Adria Acoustics Association, Graz, Austria. https://www.bib.irb.hr/319045

The Royal Society. (2023). *Net zero aviation fuels: Resource requirements and environmental impacts* (No. DES8040; Policy Briefings). The Royal Society. https://royalsociety.org/net-zero-aviation-fuels

Thompson, R., Smith, R. B., Bou Karim, Y., Shen, C., Drummond, K., Teng, C., & Toledano, M. B. (2022). Noise pollution and human cognition: An updated systematic review and meta-analysis of recent evidence. *Environment International*, *158*, 106905. https://doi.org/10.1016/j.envint.2021.106905

Torija, A. J., & Clark, C. (2021). A Psychoacoustic Approach to Building Knowledge about Human Response to Noise of Unmanned Aerial Vehicles. *International Journal of Environmental Research and Public Health*, *18*(2). https://doi.org/10.3390/ijerph18020682

Trieu, B. L., Nguyen, T. L., Hiraguri, Y., Morinaga, M., & Morihara, T. (2021). How Does a Community Respond to Changes in Aircraft Noise? A Comparison of Two Surveys Conducted 11 Years Apart in Ho Chi Minh City. *International Journal of Environmental Research and Public Health*, *18*(8), 4307. https://doi.org/10.3390/ijerph18084307

Vienneau, D., Saucy, A., Schäffer, B., Flückiger, B., Tangermann, L., Stafoggia, M., Wunderli, J. M., Röösli, M., & SNC study group. (2022). Transportation noise exposure and cardiovascular mortality: 15-years of follow-up in a nationwide prospective cohort in Switzerland. *Environment International*, *158*, 106974. https://doi.org/10.1016/j.envint.2021.106974

Wang, S. S., Glied, S., Williams, S., Will, B., & Muennig, P. A. (2022). Impact of aeroplane noise on mental and physical health: a quasi-experimental analysis. *BMJ Open*, *12*(5), e057209. https://doi.org/10.1136/bmjopen-2021-057209

Wolfe, P. J., Yim, S. H. L., Lee, G., Ashok, A., Barrett, S. R. H., & Waitz, I. A. (2014). Near-airport distribution of the environmental costs of aviation. *Transport Policy*, *34*, 102–108. https://doi.org/10.1016/j.tranpol.2014.02.023

World Health Organization. (2022). Environmental Noise. In *Compendium of WHO and other UN guidance on health and environment, 2022 update* (pp. 149–154). World Health Organization. https://www.who.int/publications/i/item/WHO-HEP-ECH-EHD-22.01

Yingwani, H. M., Potgieter, J. H., & Potgieter-Vermaak, S. (2022). Elemental Analysis of Aviation Fuel and Aircraft Soot Particles. *Proceedings of the 2022 Conference of the National Association for Clean Air (NACA 2022)*, 171–178.

Zahran, S., Keyes, C., & Lanphear, B. (2023). Leaded aviation gasoline exposure risk and child blood lead levels. *PNAS Nexus*, *2*(1), gac285. https://doi.org/10.1093/pnasnexus/pgac285

Zald, D. H., & Pardo, J. V. (2002). The neural correlates of aversive auditory stimulation. *NeuroImage*, *16*(3 Pt 1), 746–753. https://doi.org/10.1006/nimg.2002.1115

Zambrano, L. G. (2001). Balancing the Rights of Landowners with the Needs of Airports: The Continuing Battle over Noise. *Journal of Air Law and Commerce*, *66*(1), 445. https://scholar.smu.edu/jalc/vol66/iss1/9

Zhang, X., Chen, X., & Wang, J. (2019). A number-based inventory of size-resolved black carbon particle emissions by global civil aviation. *Nature Communications*, *10*(1), 534. https://doi.org/10.1038/s41467-019-08491-9