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The Planning Inspectorate
National Infrastructure Applications Team
Temple Quay House
Temple Quay
Bristol
BS1 6PN

FAO: Kevin Gleeson (Lead Member of the Examining Authority)

08 December 2023

Dear Mr Gleeson,

Application for a Development Consent Order by Gatwick Airport Limited for the Gatwick Airport Northern Runway Project (Ref. TR020005) – Response to a Procedural Decision made by the Examining Authority under section 89(3) of the Planning Act 2008

We are writing in response to your Procedural Decision letter of 1 December 2023 [**PD-007**] in which the Examining Authority has requested further information relating to ES Chapter 14: Noise and Vibration [**APP-039**]. A separate response will be submitted to the Examining Authority in due course relating to the other matters set out in PD-007.

Links to Documents

The Examining Authority has identified that a number of hyperlinks in ES Chapter 14: Noise and Vibration [**APP-039**] do not work. These relate to documents published by the Independent Commission on Civil Aviation Noise (ICCAN).

ICCAN was disbanded by the Secretary of State in September 2021, with most of ICAAN's responsibilities transferred to the Civil Aviation Authority. Therefore, the links to the publications online are no longer accessible. The Applicant encloses PDF copies of those publications as annexes to this letter:

- ICCAN (2020a) Aviation noise and public health, September 2020.
- ICCAN (2020b) ICCAN Survey: Experiences of aviation noise during lockdown, October 2020.
- ICCAN (2020c) The future of aviation noise management: ICCAN's emerging view, October 2020.
- ICCAN (2020d) ICCAN best practice for engagement between airports and communities on aviation noise, December 2020.
- ICCAN (2021a) ICCAN Corporate Strategy 2021-2024, March 2021.
- ICCAN (2021b) ICCAN review of airport noise insulation schemes, March 2021.

Please note, some of the guidance and reports published are interim and were not finalised prior to the disbanding of ICCAN.

The Applicant considers that the attached addresses the request for the documents referred to in the Procedural Decision issued by the Examining Authority dated 1 December 2023. However, if the Applicant can be of any further assistance or the Examining Authority considers any further clarification is required in

response to the information and documentation submitted as part of this response, please do not hesitate to contact the Applicant using the details already provided.

Yours sincerely,

[redacted]

Jonathan Deegan

NRP Programme Lead

Gatwick Airport Limited

Enclosed as part of this letter:

- Annex A: ICCAN (2020a) Aviation noise and public health, September 2020.
- Annex B: ICCAN (2020b) ICCAN Survey: Experiences of aviation noise during lockdown, October 2020.
- Annex C: ICCAN (2020c) The future of aviation noise management: ICCAN's emerging view, October 2020.
- Annex D: ICCAN (2020d) ICCAN best practice for engagement between airports and communities on aviation noise, December 2020.
- Annex E: ICCAN (2021a) ICCAN Corporate Strategy 2021-2024, March 2021.
- Annex F: ICCAN (2021b) ICCAN review of airport noise insulation schemes, March 2021.

Annex A: ICCAN (2020a) Aviation noise and public health, September 2020

Aviation noise and public health

Rapid evidence assessment

NatCen
Social Research that works for society

Authors: Chris Grollman, Imogen Martin, Joy Mhonda
Date: July 2020
Prepared for: The Independent Commission on Civil Aviation Noise

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Acknowledgements
We thank Dr Charlotte Clark and Dr Ben Fenech for their valuable input.

Executive summary

Background and motivation

Aviation noise affects the quality of life and health of many people living close to airports and/or under flightpaths. In January 2019 the UK Government established the Independent Commission on Civil Aviation Noise (ICCAN), a new non-statutory advisory arm's length body, to act as a credible and impartial voice on civil aviation noise. The key objectives of this review are to collate and summarise the scientific evidence on the links between aviation noise and health, to identify evidence gaps and to suggest ways that further research could fill these gaps. This will support ICCAN to develop their expertise, authority and credibility in guiding aviation noise policy in the UK.

Methods

The review took the form of a rapid evidence assessment (REA) – a tool for systematically finding and synthesising available research as comprehensively as possible within a reduced timeframe. This REA was designed to build on existing systematic reviews conducted for the World Health Organisation (WHO) and the UK Department for Environment, Food and Rural Affairs (Defra). We searched academic databases and conference proceedings for findings published in the year since those reviews were conducted, in addition to the websites of relevant organisations. The findings of 12 new studies were combined with those of the WHO and Defra reviews, and the quality of evidence summarised across 58 health outcomes using a systematic approach.

Key findings

- The new evidence primarily focuses on health outcomes for sleep, quality of life, mental health and wellbeing, and cardiovascular and metabolic disorders. Several recent studies had small sample sizes – some were feasibility studies – and therefore can only give indicative findings.
- We made and collated ratings of the quality of evidence as 'high', 'moderate', 'low' or 'very low' for given health outcomes, using the GRADE approach (described in Appendix A). For a small number of outcomes, primarily in the areas of sleep and cognition, there is moderate quality evidence on the links between aviation noise and public health. Typically, it is difficult to achieve high quality evidence in environmental studies, and moderate quality evidence is therefore considered sufficiently robust to support strong policy recommendations.
- For most health outcomes, the evidence on the effects of aviation noise is low or very low quality. This low quality is primarily driven by the fact that most studies use a cross-sectional design and many have small sample sizes which limits their power.
- For some areas of health, including dementia and other neurodegenerative outcomes, cancer, and birth and reproductive outcomes, there is little or no evidence at all relating to aviation noise.
- There are therefore evidence gaps for the areas with limited or no evidence and those with low or very low-quality evidence. These areas present ICCAN and other stakeholders with opportunities for further research.

- Where evidence is of moderate quality, there is a need to quantify how interventions or operational changes impact health outcomes.
- ICCAN has a range of stakeholders, who are likely to have different priorities regarding areas for future aviation noise research. There has been relatively little data from the UK, despite having a large noise-exposed population including the busiest airport in Europe. It is welcome that two large research projects (ANCO and RISTANCO) are currently ongoing.
- In weighing up the areas for further research, ICCAN may take into account current priority areas in wider public health, including air pollution, mental health, and reducing health inequalities, as well as longer term ambitions.
- There are also opportunities for ICCAN to investigate the potential of retrospective cohorts combining noise maps with the wealth of data available in various UK cohort studies, as a means of obtaining high quality evidence without the costs and delay inherent in prospective longitudinal research.
- Collaboration among academic and other interested parties could support wider use of consistent research methods, such that even studies of lower individual quality could be combined robustly in support of stronger evidence.
- High quality evidence requires investment in longitudinal research. Whilst this is expensive, it would be an opportunity to gain insight into exposures beyond aviation noise, such as air pollution, that will be of interest to a broad range of public bodies.

1 Introduction

1.1 Background

1.1.1 Aviation noise in the UK

Aviation noise affects the quality of life and health of a substantial number of people in the UK. The impact of this noise includes health effects, such as an increased risk of hypertension, and effects of annoyance, cognitive impairment for children and lost productivity [1]. The number of people exposed to aviation noise in the UK varies according to how noise exposure is measured. For 2017, almost one million people (1.5% of the UK population) were exposed to aviation noise above 55 dB using the widely applied L_{den} 55 dBA indicator [2]. Around 65% of exposure at that level is caused by flights to/from Heathrow [3]. (L_{den} measures the average level of noise in a 24-hours period, with a penalty applied for noise in the evening and night time. Noise metrics are described in more detail in the recent ICCAN report [4].) The L_{den} indicator has also been used in guidelines published by WHO which recommend reducing noise levels produced by aircraft to below 45 dB L_{den}. Aircraft noise above this level is associated with adverse health effects [5].

The systematic reviews that informed the WHO Environmental Noise Guidelines for the European Region 2018 (WHO ENG2018) [6] assessed quality of evidence using the GRADE approach (Grading of Recommendations Assessment, Development, and Evaluation). This approach rates the quality of bodies of evidence as “high”, “moderate”, “low” or “very low”, with implications for the need for further research. This rating is based on the study designs, consistency and other features of the data on a given question. It was developed for clinical medicine [7] and has been adapted for use with environmental health exposures [8]. GRADE encourages transparency and consistency but its strict methods mean it is typically difficult to obtain high quality evidence for environmental health risks. Moderate quality evidence is therefore considered adequate to support making strong recommendations [5]. (There is more detail on the GRADE approach in Appendix A.)

The WHO reviews concluded that there is moderate quality evidence that aviation noise has a harmful effect on annoyance [9], some cognitive outcomes in children [10], some aspects of sleep disturbance [11] and change in waist circumference [12]. The reviews also show moderate quality evidence of no effect on stroke mortality [12]. There is low and very low quality evidence relating to a wide range of other health outcomes – including mental health outcomes [13], quality of life outcomes [13] and cardiovascular and metabolic outcomes [12]. This evidence generally indicates harmful effects. Due to the strict methods used to assess quality of evidence for environmental exposures such as noise via the GRADE approach (explained below in section 3.2), high quality evidence is limited.

In areas under flight paths, aviation noise is a salient issue for residents. Surveys conducted by the Civil Aviation Authority (CAA) in 2017–2018 [14] and the Department for Transport (DfT), the Department for Environment, Food and Rural Affairs (Defra) and the CAA in 2014–2015 [15] show substantial grievances about aircraft noise among residents. ICCAN published a review of the 2014–2015 Survey of Noise Attitudes findings given concerns that aspects of its methodology led to an underestimate of the impact of noise on annoyance [16].

1.1.2 Motivation for the review

In its role as an independent and impartial voice on civil aviation noise and how it impacts communities, ICCAN commissioned this rapid evidence assessment (REA) to update their knowledge on the links between aviation noise and health and bring all the evidence into one place. This work builds on the reviews conducted by the WHO and Defra. ICCAN wish to use the evidence from this REA to achieve the following:

- Identify new evidence that links aviation noise to health outcomes
- Identify evidence gaps in research that links aviation noise to health
- Put forward research methodologies that might be feasible to fill identified evidence gaps

This REA summarises the quality of the evidence relating to a wide range of health outcomes, from the WHO and Defra reviews and from the evidence published since those reviews. It also summarises the measurement metrics and research methodologies that might be used to fill identified evidence gaps.

1.1.3 Existing evidence reviews

There is a substantial body of recent evidence from many countries on health impacts of environmental noise, including aviation noise. Defra commissioned two systematic reviews, published in 2019 [17] and 2020 [18], on various types of environmental noise and a range of health outcomes. The first, prepared by the Dutch Institute for Public Health and the Environment (RIVM), covers noise effects on annoyance, sleep disturbance, cardiovascular and metabolic health outcomes. The second, prepared by Arup, covers mental health, wellbeing, quality of life, cancer, dementia, other neurodegenerative outcomes, birth and reproductive health, and cognitive health outcomes. For some outcomes, these systematic reviews identified evidence relating to other sources of noise but did not identify any evidence relating to aviation noise.

These reports followed the methodology of the eight systematic reviews that underpin the 2018 guidelines on environmental noise published by the World Health Organization (WHO) [6]. The WHO reviews covered evidence published from 2000 to 2014 or 2015 and the Defra reviews cover evidence published from the cut-off of the WHO reviews until March 2019.

1.2 Research questions

The aim of this REA is to identify and summarise evidence linking aviation noise to public health. It combines evidence from existing reviews and evidence published subsequent to those reviews (since March 2019) to identify gaps in research. The research questions for this REA are:

1. **What evidence exists about the links between aviation noise and health?**
    a. Based on this REA, what are the links between aviation noise and public health?
    b. What research approaches and methods have been used to research these links?
2. **Based on the REA, what are the key evidence gaps for research regarding links between aviation noise and health**?
    a. Where is evidence weak?
    b. What health conditions need further evidence?

c. What are the priority evidence gaps?
d. What research approaches and methods can be best used to fill these evidence gaps?

2 Methodology

This review followed the methodology and structure of a Rapid Evidence Assessment: *"A Rapid Evidence Assessment (REA) is a tool for getting on top of the available research evidence on a policy issue, as comprehensively as possible, within the constraints of a given timetable"* [19].This evidence assessment collates evidence on aviation noise from the existing WHO and Defra reviews on environmental noise, and updates that with evidence published since the cut-off of those reviews in March 2019.

This section provides a summary of our criteria and processes for searching for relevant evidence, determining the inclusion of studies, data extraction and the synthesis of findings.

2.1 Data sources

The starting point for our evidence search was the conclusions of the systematic reviews commissioned by WHO and Defra in recent years. These included:

- Systematic reviews for WHO on environmental noise and:
    - Adverse Birth Outcomes [20]
    - Cognition [10]
    - Cardiovascular and Metabolic Effects [12]
    - Sleep [11]
    - Quality of life, wellbeing and mental health [13]

The series commissioned by WHO further included a review on annoyance (which is outside the scope of this REA) and a review on permanent hearing loss and tinnitus (not considered as the sound levels causing these outcomes are higher than those caused by aviation noise for the general population).

- Systematic reviews for Defra on environmental noise and:
    - Mental health, wellbeing, quality of life, cancer, dementia, other neurodegenerative outcomes and birth, reproductive and cognitive health outcomes ("Defra-Arup") [17]
    - Annoyance, sleep disturbance, cardiovascular and metabolic health outcomes ("Defra-RIVM") [18]

We sourced new evidence on links between aviation noise and health from searches covering the period since the cut-off of the WHO and Defra systematic reviews in March 2019. In the present report, the search for evidence published subsequent to the existing systematic reviews is called the "update review", we also refer to it as the "ICCAN review". Searches included:

- Databases (Medline, Embase, Scopus and Epistemonikos)
- Online websites and repositories for relevant evidence published from 2015 onwards, as recent grey literature may not have been captured by the systematic reviews
- Proceedings of 2019 conferences

Details of the websites and conferences searched are given in Appendix B.

2.2 Inclusion criteria

Our criteria determining eligibility for inclusion are set out below. These are similar to the inclusion criteria used in the previous WHO/Defra reviews.

1. **Population:** Studies had to include evidence relating to aviation noise and health in a general human population. We excluded occupational exposure (e.g. of pilots).

2. **Exposure:** We included evidence where the exposure was aviation noise (either civil or military), measured or modelled, and expressed in decibels with no restriction as to the metric used. Noise levels had to be measured/calculated at an appropriate location for the exposure of the study participants (for observational studies, this would usually be the external noise level at the relevant location such as the home). Studies had to include people exposed across at least two sound levels, so that outcomes could be compared according to level of sound exposure (allowing, for example, conclusions about the effect of a 10 dB increase, or the effect of living in an area with average noise above 55 dB compared to an area with average noise below 45 dB). We excluded evidence where noise exposure was characterised by proxy (for example, distance or number of events) or subjectively (for example, self-reported noise exposure).

3. **Outcome:** We included evidence relating to any health condition including sleep disturbance, hypertension, strokes, heart attacks, coronary heart disease, dementia, cancer, diabetes and other metabolic conditions, cognition, birth and other reproductive outcomes, mental health, wellbeing, quality of life, and any other health conditions identified.

    a. We excluded studies where the outcome was annoyance but we included evidence where annoyance is treated as a factor that modifies the effect of noise on another health outcome. We made this exclusion because ICCAN is more confident in the evidence base regarding annoyance than regarding other health outcomes. ICCAN is already funding separate work to fill evidence gaps relating to annoyance and aviation noise.

    b. We excluded economic studies, burden of disease studies and health impact assessments as these do not report health outcomes *per se* and as such were outside scope.

4. **Study design:** We excluded review papers but included papers that presented new summary estimates derived from meta-analysis. We excluded experimental studies, such as laboratory studies or home-based studies with artificial playback of noise, due to concerns about their validity, in line with the approach taken in the WHO reviews. We did not restrict our search by any other study design and considered any primary or secondary research studies that used methodologies which appropriately addressed the research questions. This was largely quantitative evidence, but we also considered high quality qualitative evidence that linked aviation noise to quality of life, mental health or wellbeing.

5. **Publication characteristics**

    a. **Date of publication**: We included original studies published after the cut-off date of the WHO and Defra systematic reviews (April 2019) as we considered those reviews methodologically sound and comprehensive for the period they covered. We conducted our searches on 28th March 2020.

    b. **Language**: We applied no restriction based on language. Our search terms were in English only.

    c. **Type of publication:** We excluded editorials, discussion pieces, comments, errata, letters to the editor, encyclopaedia entries, results with only a title and no abstract (unless the title indicates very likely relevance) and studies for which full texts were not accessible.

    d. **Publication status**: We included all evidence coming through the database searches and conference proceedings, including published (journal) and unpublished (grey) literature. We considered grey literature identified through website searches of airport authorities and the CAA, or provided by ICCAN.

2.3 Search strategy

Studies were screened in two stages, at title and abstract, and at full text. Title and abstract screening were conducted manually. All studies meeting our inclusion criteria were screened at full text for their relevance to address all research questions and sub-questions. The full search strategy is described in Appendix B.

2.3.1 Databases

The database searches returned 552 unique results. Titles and abstracts were screened in Abstrackr [21] which is an online database screening tool which allows selections to be made by researchers. The first 30 records were checked with a second reviewer to ensure consistency. After title and abstract screening, 31 papers were included for full text review and eight were included for the update. Reasons for exclusion at full text screening are given in Appendix D. We treated references to “traffic noise” to mean road traffic rather than air traffic and excluded articles whose title or abstract did not suggest aviation noise.

2.3.2 Websites

A number of governmental, industry and aviation research websites were manually searched using a simplified version of our search strategy (see Appendix B). These searches provided a total number of 819 results which were screened at title and abstract level. Three evidence reviews from the CAA website were included for full text review [22] [23] [24], and included three papers also identified through the search of conference proceedings.

2.3.3 Conference proceedings

In total there were 1309 papers from the ICA Aachen conference (2019) and 893 from Internoise Madrid (2019). We completed a two-stage screening process. First, we screened session titles for potentially relevant sessions. Second, we screened the titles and abstracts of all proceedings within those sessions (N=123). In total we identified 10 potentially relevant papers for full text screening, of which we included four in our update review. These included three that had also been cited in the recent CAA reviews.

2.4 Data extraction and synthesis

2.4.1 From existing reviews

We summarised from the WHO and Defra reviews the GRADE assessments for the quality of the evidence relating aviation noise to individual health outcomes. In the Defra-RIVM review, which did not conduct a GRADE assessment, we summarised the findings without assessing quality of evidence. We describe the GRADE process in Appendix A.

2.4.2 From search results

After screening for final inclusion, core information about each paper was placed in an extraction table (see Appendix C) for analysis and subsequent report development. The extraction sheet was refined in consultation with ICCAN and included:

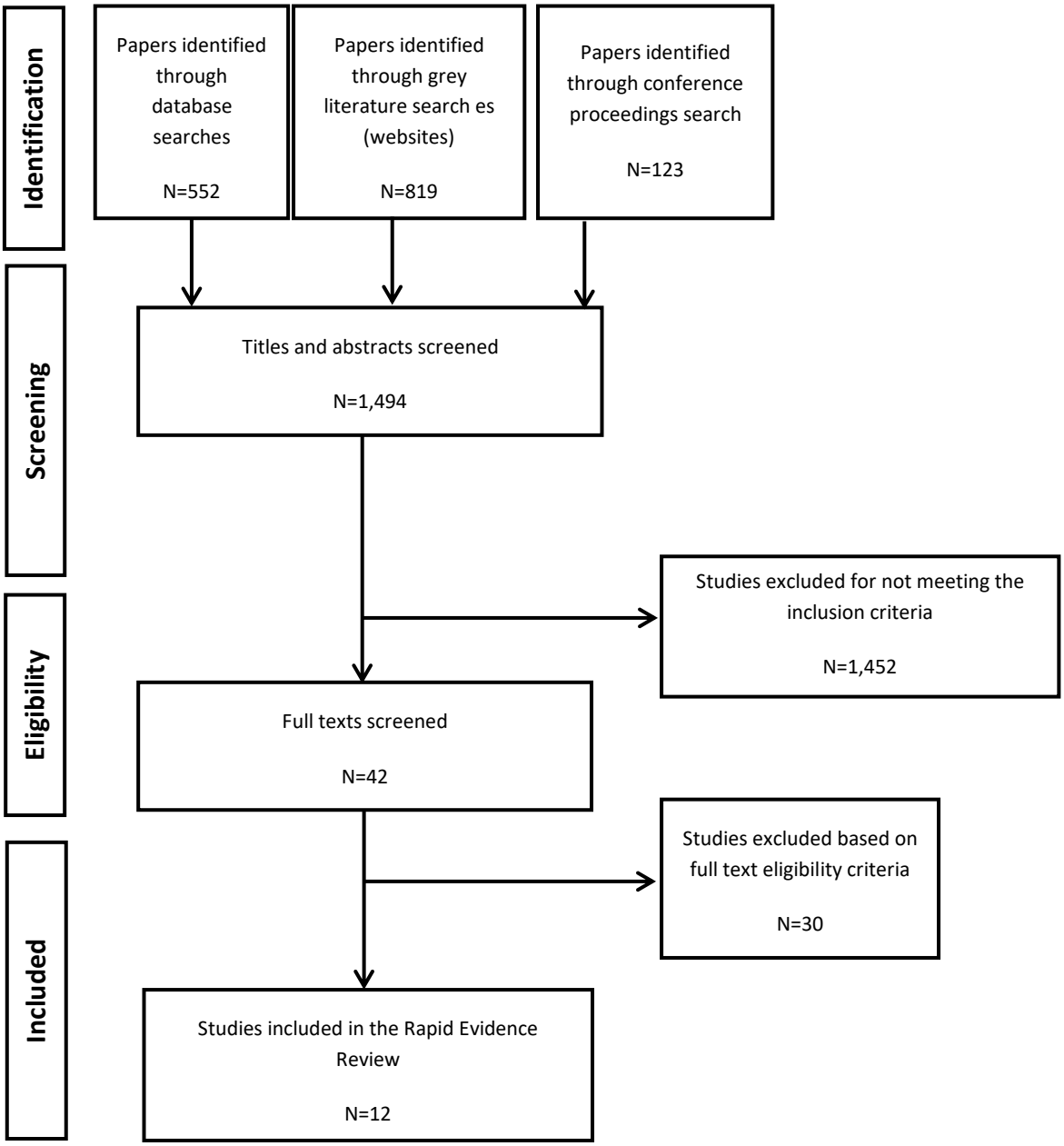
a. Sample size and study design
b. Setting/population of the research
c. Adjustments for confounders
d. Health conditions included in the paper
e. Measurement of health conditions
f. Noise assessment and noise metrics used
g. Effect size (metric and direction of association or effect)
h. Risk of bias assessment

2.5 Results

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. The PRISMA flowchart below (Figure 1) summarises the REA's screening and inclusion processes.

There were 1,494 results returned from the systematic searches across the chosen databases, websites and conference proceedings. The search terms were designed to be highly sensitive, meaning that in order to make sure we identified all relevant evidence, we expected to have a large number of "false positive" results. In screening titles and abstracts, we excluded the vast majority of results (1,452). We screened the full text of the remaining 42 results, of which 12 met the inclusion criteria and were included for data extraction.

Figure 1 PRISMA Flowchart: REA screening and inclusion



3 Findings on links between aviation noise and health

This chapter presents the state of the evidence on the links between aviation noise and health. Section 3.1 presents the new evidence added in this update. Section 3.2 summarises the overall quality of evidence and direction of effect (whether aviation noise is harmful or has no effect), drawing together the conclusions on the quality of evidence from the existing reviews and integrating new evidence where possible. Together these sections address research questions 1a on the links between aviation noise and health and 2a and 2b on where evidence is weak and where further evidence is needed.

The reviews by WHO and Defra reported the evidence of the effects of transportation noise on specific health outcomes across seven broad health areas:

- Birth and reproductive outcomes
- Cognition
- Sleep
- Cardiovascular and metabolic outcomes
- Quality of life, mental health and wellbeing
- Cancer
- Dementia and other neurodegenerative outcomes

They included evidence on the effects of aviation noise in all areas except for *Dementia and other neurodegenerative outcomes*, for which there is no evidence relating to aviation noise. These health areas are largely exhaustive although there appears to be no evidence on auto-immune diseases.

Our update identified 12 papers (eight peer-reviewed journal papers from the database search and four papers from the conference proceedings) that presented new evidence across one or more of these three areas:

- Sleep (four papers)
- Quality of life, mental health and wellbeing (two papers)
- Cardiovascular and metabolic disorders (eight papers)

3.1 Evidence from this update

3.1.1 Sleep

Brink et al. (2019) [25] reported on sleep disturbance as part of the SiRENE study, which sampled 5592 people from the population of Switzerland and calculated aviation noise levels at the outer façade of the participant's home. The survey specified the source of noise in the questions asking about sleep disturbance. They found that the odds of the participant reporting being highly sleep disturbed (%HSD) increased significantly with increasing L_{night}: for every 1 dB increase the odds of being HSD increased by 13%.

Brink et al. (2019) also reported that for a given noise level, the effect of L_{night} on %HSD varied according to other factors (known as "effect modification"). First, they used the intermittency ratio (IR) to measure the intermittency or "eventfulness" of noise, that is how much loud events stand out from the background noise levels. A high IR means the loud event interrupts otherwise quieter background noise, while a low IR means the background noise is higher. The study found that with levels of L_{night} up to around 50 dB, participants with low IR (higher background noise) reported significantly lower levels of %HSD. They also found an effect modification in degree of urbanisation, whereby for a given level of L_{night}, %HSD is highest in rural areas, lower in towns/suburbs, and lowest in cities. These two effect modifications, by intermittency and by urbanisation, are clearly consistent with one another and closely related. The authors did not discuss reasons for the effect modifications. As noise was estimated at the external façade, one possible explanation may be that residents facing greater noise exposure (as with lower IR or greater urbanisation) take more steps to insulate their homes. Another possible explanation may be that the ongoing background noise makes noise events less noticeable.

Rocha et al. (2019) [26] conducted a pilot study around Atlanta international airport to test the feasibility of using postal surveys to recruit people to a national study about sleep. It is worth noting that as a pilot study of 268 people, this was not powered to elucidate precise associations or effects, and the results are only indicative. The question about sleep disturbance did not mention noise, although the title of the survey did. The study found a significant association between L_{night} and sleep disturbance, with 15% higher odds for being highly sleep disturbed for each 1 dB increase in L_{night}. A similar result was found for annoyance (17% higher for each 1 dB increase). Although the odds were lower than for annoyance or %HSD, they also found significant links between L_{night} and other sleep-related outcomes including overall sleep quality, trouble falling asleep, trouble sleeping at night, and trouble staying awake in the day. L_{night} was also associated with greater odds of using certain coping aids against noise when trying to sleep, including: alcohol (10% higher odds per 1 dB increase); TV (5% higher); music (7% higher); and closing windows (5% higher). After adjustment for covariates, L_{night} was not significantly associated with self-reported general health, use of sleep medication, or use of earplugs, medication, sound machines or fans to cope with noise.

Rocha et al. (2019) also asked participants whether they had any previous diagnosis of sleep disorder, hypertension, migraines, arrhythmia, heart disease, stomach ulcer or diabetes. There were no significant associations between L_{night} and the odds of reporting diagnoses of any of these conditions. The authors noted that "we were underpowered to detect the small effect sizes expected for these [chronic] health outcomes".

Studies by Smith et al. (2020) and Basner et al. (2019) reported findings on sleep outcomes. **Basner et al.** (2019) [27] collected indoor noise measurements and ECG, movement and blood pressure data from 39 people living near Philadelphia airport and 40 controls not living close to an airport. This was also a pilot study and was not powered to elucidate precise associations or effects, and the results are only indicative. The median average noise (L_{Aeq}) during sleep was 43.2 dBA in the airport region and 31.8 dBA in the control region. There was no significant relationship between sleep fragmentation (awakenings per hour of sleep) and L_{Aeq} during sleep. The authors also investigated the effects of the maximum indoor sound level (L_{Amax}). They reported a significant relationship, with a 3% increase in the odds of awakening for every 1 dB increase in L_{Amax}. The percent awakened increased from around 3.5% at L_{Amax} 50 dB to 6% at 60 dB, 9% at 70 dB and 12% at 80 dB. This impact of maximum sound level rather than average sound level is consistent with the findings on intermittency reported by Brink et al. (2019).

Basner et al. (2019) also asked participants questions on sleep quality and on general health. There were significant differences in the expected direction between populations (airport vs. control) for several sleep aspects: people in the airport region were less likely to report that “My sleep was refreshing” or “I got enough sleep” and more likely to report “I had difficulty falling asleep”. Compared to the control population, they were also more likely to agree that “I expect my health to get worse” and less likely to agree that “My health is excellent”. There were no significant differences for the sleep items “My sleep was restless”, “I had trouble staying asleep”, “I had trouble sleeping” or “I was satisfied with my sleep”, or the general health items “I seem to get sick a little easier than other people” or “I am as healthy as anybody I know”. It is important to note that this was a small and underpowered pilot study whose primary aim was to test the feasibility of the data collection methods, and to keep that in mind when reading its findings (especially its findings of no effect).

Smith et al. (2020) [28] collected data on tiredness and awakenings related to noise during sleep from 34 people living around Atlanta international airport. This was also a pilot study and was not powered to elucidate precise associations or effects, and the results are only indicative. The maximum indoor noise level was marginally associated with the probability of awakening measured by ECG. This is consistent with the finding in Basner et al. (2019) above, and the authors suggest the marginal significance is likely to be due to the small sample size.

Smith et al. (2020) also reported effects of noise during sleep on questionnaire items reported by participants in the morning. They investigated both overall average sleep-time noise ($L_{Aeq,sleep}$) and maximum sleep-time noise ($L_{AS,max,sleep}$) during the time that each individual participant was measured to be asleep. In adjusted analysis, the only significant associations were for $L_{AS,max,sleep}$ with self-reported awakenings and with self-reported tiredness. They did not find any significant associations for either noise metric with sleep latency, sleepiness, difficulty falling asleep, sleep restlessness, sleep quality or disturbance by aircraft noise.

In 2018, **Trieu et al.** (2019) [29] surveyed residents living around Hanoi Noi Bai airport in two rounds, before (623 participants) and after (132 participants) an increase in night flights. The collected data was on annoyance, insomnia and a range of health problems and indicators including blood pressure and heart rate (reported below). There were associations between L_{den} and annoyance, and $L_{Aeq,night}$ and insomnia. After the increase in night flights there was greater insomnia at lower decibel exposure levels (up to around 60 dB $L_{Aeq,night}$) whereas at higher decibel levels (over 60 dB $L_{Aeq,night}$) insomnia was high before and remained high after.

3.1.2 Cardiovascular and metabolic disorders

Rojek et al. (2019) [30] investigated cardiovascular outcomes in a cross-sectional study of 201 residents of suburban Krakow, split evenly between areas exposed to high aircraft noise (>60 dB L_{den}) and low aircraft noise (<55 dB L_{den}). The outcomes investigated were a range of blood pressure measurements (measured in a study clinic and through 24-hour ambulatory monitoring), and arterial stiffness and a range of echocardiographic indicators selected for association with asymptomatic organ damage (measured in a study clinic). The study was designed to detect a difference in pulse wave velocity (PWV), a measure of arterial stiffness, in people living in the two areas. Greater arterial stiffness, indicating organ damage, means a higher PWV.

Significant differences were found between exposure groups for several outcomes. The results were stratified by hypertension status, as roughly half of participants in each area had hypertension. Among people who did not have hypertension (“normotensive” people), those in the exposed high noise area had higher PWV than those in the unexposed low noise area, and one measure of cardiac function was slower (the early

diastolic mitral annulus mean velocity). This group also had higher diastolic blood pressure in both the clinic setting, and the ambulatory measure at night. Among hypertensive participants, the 24-hour heart rate and the central systolic blood pressure were higher in the exposed group.

Rojek et al. (2019) reported that in the unexposed group there is a trend for increasing PWV by age. In the noise-exposed group the increased PWV at younger ages means this trend by age is lessened and made non-significant, as though noise exposure causes premature aging related to this outcome. All differences between exposed and unexposed groups were in the expected direction, consistent with noise exposure causing worse cardiovascular health. No differences were found on a range of other parameters of blood pressure and cardiac health, including hypertension.

The authors also investigated the relationship between aircraft noise annoyance and PWV among exposed participants (only one unexposed participant reported annoyance), and found a significant trend for normotensive participants. This suggests a mediating effect of annoyance in the relationship between noise and increased PWV, which is consistent with other findings on the role of annoyance as an effect modifier of the relationship between noise and hypertension (as PWV and hypertension are strongly associated). It is important to note that the study was relatively small and the authors only stated that it is powered to detect the PWV outcome.

Basner et al. (2019) also reported that neither systolic nor diastolic morning blood pressure were associated with the average indoor noise level (L_{Aeq}) at night.

Baudin et al. (2019) [31] combined data from studies around several major European airports: seven airports in the HYENA (Hypertension and Exposure to Noise near Airports) study (London Heathrow, UK; Berlin Tegel, Germany; Amsterdam Schiphol, the Netherlands; Stockholm Arlanda and Bromma, Sweden; Milan Malpensa, Italy; and Athens International Airport Eleftherios Venizelos, Greece) and three French airports from the DEBATS (Discussion sur les effets du bruit des aéronefs touchant la santé – Discussion of the health effects of aircraft noise) study (Lyon Saint Exupéry, Toulouse-Blagnac, and Paris-Charles de Gaulle). They investigated the association between aviation noise and levels of cortisol, a stress hormone, found in saliva, for 1300 people. There is a natural daily cycle in which the production of cortisol varies. If the variation is reduced and there is less of a cycle and more of a constant level, this may indicate a less responsive hormonal system (specifically, disruption of the hypothalamus–pituitary–adrenal axis). Long-term exposure to stress, in this case noise, may disturb the stress response, with impacts on a range of biological outcomes. This study combined two existing cross-sectional studies, enabling analysis of cortisol outcomes stratified by sex.

The authors reported several significant associations: evening cortisol levels in women increased with increasing aircraft noise exposure measured by $L_{Aeq,16\,h}$, L_{den} and L_{night}. They also found significant reductions in cortisol variation per hour for women. This is an indicator of a poorly functioning stress response. Absolute variation per hour fell with increasing L_{night}, and relative variation per hour in women fell with increases in both L_{night} and L_{den}. Morning cortisol levels were unchanged with all noise exposure indicators. There were no statistically significant associations between aircraft noise exposure and cortisol levels for men.

Baudin et al. (2019) also found that the effects of noise exposure on cortisol were not modified by annoyance or noise sensitivity.

Nassur et al. (2019) [32] investigated associations between sleeping heart rate and several indicators of sound levels for people living near airports in Paris and Toulouse. This was a small study with 92 participants, self-selected from the larger DEBATS

cross-sectional study and therefore with a moderate risk of selection bias and potentially underpowered. Looking at average sound levels across 15-second intervals, they found an increase in the heart rate associated with the sound from all sources. They found no association for the equivalent measurement for aviation noise alone and a smaller increase in heart rate looking across levels of sound from all sources exceeded for 90% of the measurement period.

Looking at maximum 1-second indoor sound levels during aviation noise events ($L_{Amax,1s}$) the authors found no difference in heart rate following events, but found an increase in heart rate amplitude during the event. Heart rate amplitude was the difference between the maximum and minimum heart rate during an event, and increased as the maximum 1-second sound level increased. The study recorded relatively low levels of $L_{Amax,1s}$, with a mean of 31 dB compared to 45+ dB in similar studies. The authors suggest this may be why there was no significant heart-rate elevation following an aircraft noise event.

In their survey of residents living around Hanoi Noi Bai airport, **Trieu et al.** (2019) [29] collected data on blood pressure. In the first round, all data were self-reported, while in the second round, blood pressure was measured. The prevalence of high blood pressure was 47% in round 1 and 62% in round 2, but the measurement differences mean direct comparison is not possible. The data showed a high prevalence of high blood pressure across the study population, but there was no significant association between high blood pressure and L_{den} (odds ratio 1.02, 95% CI: 0.97 to 1.08).

Vienneau et al. (2019) [33] published a meta-analysis of the impact of aviation noise on incidence of ischaemic heart disease (IHD) and diabetes. They found five new studies relating to aviation noise and IHD, giving a non-significant risk ratio of 1.03 (95% CI: 0.98 to 1.09) for every 10 dB increase in L_{den}. The authors found evidence of an increased risk of IHD from road traffic noise, but a similarly sized effect for aviation noise was non-significant and judged to be at a high risk of bias–2. They judged this estimate to be at high risk of bias as three of the five studies had high risk of bias, including one of the two large studies.

For diabetes incidence, the authors found three new studies resulting in a pooled risk ratio of 1.20 (95% CI: 0.88 to1.63) per 10 dB increase in L_{den}. This is a relatively large risk ratio but the wide confidence interval means the estimate is consistent with there not being a true effect. Estimates from the three contributing studies varied widely.

Weihofen et al. (2019) [34] published a meta-analysis of the impact of aviation noise on incidence of stroke. They included seven studies in the meta-analysis and found a pooled risk ratio of 1.013 (95% CI: 0.998 to 1.028), meaning a 1.3% increase in the incidence of stroke per 10 dB increase in L_{den}. The authors wrote that “the result is so close to the significance threshold that an actual effect seems likely”. They also noted that noise is a marginal risk factor compared to other risk factors for stroke, and that even if people were universally exposed to high levels of aviation noise the effect on overall stroke incidence would still be minimal.

3.1.3 Mental health and wellbeing

Benz et al. (2019) [35] conducted a secondary analysis of the NORAH (Noise-Related Annoyance, Cognition, and Health) panel study around Frankfurt Airport. They investigated the relationship between noise and diagnosis of depression in the 12 months following operational changes comprising a new runway and a ban on night flights for 3319 participants. The authors also investigated the role of annoyance in mediating the relationship between noise and depression.

Benz et al. (2019) found that there was no direct association between L_{den} in the period after the new runway and night flight ban (t_1) and depression a year later (t_2). By contrast annoyance at t_1 was strongly associated with depression at t_2, and the authors showed that even though noise exposure had no direct effect on depression, there was a significant indirect effect from noise exposure to depression via annoyance. This suggests an important role of annoyance in mediating the relationship between noise and mental health outcomes. The authors also reported that the relationship between annoyance and depression may work in both directions, in that depression may also predict annoyance.

Spilski et al. (2019) [36] presented a secondary analysis of data from the NORAH panel study, looking at 8-year-old children's wellbeing and health as reported by children and their parents. 1200 children were included in the analysis. The authors hypothesised that increased aircraft noise exposure leads to increased stress responses in children and subsequently affects their well-being and health, mediated through aircraft annoyance. They also tested for effect modification by urbanisation and by imperviousness (that is, the level of sealed spaces such as buildings in the surrounding area: high imperviousness = many buildings, low imperviousness = many open spaces).

Physical wellbeing was estimated by two child-reported outcomes, "Last week I had a headache and stomach ache" and "Last week I felt sluggish and tired". Mental wellbeing was estimated by "Last week I laughed a lot and had a lot of fun" and "Last week I was bored". These outcomes were not commonly reported standardised measures. The parent-reported health outcomes were a set of diseases including asthma, migraine and speech and language disorders, and the intake of medically prescribed drugs.

The study found no significant direct effect of aviation noise on physical wellbeing. There were, however, significant indirect effects of noise on both indicators of physical wellbeing, mediated through annoyance. That is, where aviation noise increases annoyance, this in turn negatively affects physical wellbeing. The authors reported a similar finding for mental wellbeing on the boredom outcome but not on the outcome "Last week I laughed a lot and had a lot of fun".

There were neither direct nor indirect effects of aviation noise on children's health measured by parental report. However, after the inclusion of urbanisation and imperviousness in two extended models the direct relationship of noise with children's increased prescription drug use became significant in areas with medium levels of urbanisation and areas with low levels of imperviousness. The authors interpret this as suggesting that the impact of aircraft noise is greatest where "other stressors are less pronounced and therefore aircraft noise is more prominent".

3.1.4 Mediation through annoyance

Two studies found outcomes where there was no direct effect of noise exposure, but there was an indirect effect via annoyance. That is, for people who experienced annoyance due to aviation noise, there was an effect on the health outcome. These outcomes were prevalence of depression (Benz et al. 2019) [35] and general physical health of children (Spilski et al. 2019) [36]. There was also a role of annoyance in mediating the relationship between noise exposure and arterial stiffness (Rojek et al. 2019) [30]. There was no role of annoyance in mediating the relationship between aviation noise and cortisol levels (Baudin et al. 2019) [31].

3.2 Quality of the evidence, considering the WHO and Defra reviews and the current findings

Previous reviews assessed the quality of evidence relating aviation noise to given health outcomes using the GRADE approach, and we have taken the same approach for the new studies included in this REA. GRADE is a method of assessing quality of evidence in a structured and consistent manner. It was developed for assessing quality of evidence in clinical medicine, and has been adapted for use with environmental health risks. In this approach, quality is rated as 'High', 'Moderate', 'Low' or 'Very low'. These ratings have implications for the need for further research:

- High quality evidence means further research is *very unlikely* to change the certainty of the effect estimate
- Moderate quality evidence means further research is *likely* to have an important impact on the certainty of the effect estimate and *may* change the estimate
- Low quality evidence means further research is *very likely* to have an important impact on the certainty of the effect estimate and is *likely* to change the estimate
- Very low quality evidence means any effect estimate is *uncertain*

The GRADE process is described in Appendix A.

For some outcomes, evidence was only available in the update review (also referred to as the ICCAN review). We have made GRADE ratings for these outcomes (Appendix E). For some outcomes there was evidence from both the update review and the WHO/Defra reviews. For these outcomes, we took the conclusion of the WHO/Defra reviews as the starting level for the quality of evidence, applied the GRADE process to the additional evidence from the update review and decided whether to revise the GRADE rating (Appendix F). In the quality of evidence tables below (tables 1-6), this is referred to as the ICCAN synthesis. For some outcomes we combined the findings of the WHO and Defra reviews with one another (Appendix G). For outcomes only reported in either the WHO or Defra reviews, we report the GRADE ratings from those reviews (Appendix H). Tables Table 1 to

Table 6 summarise the quality of evidence across all these health outcomes, grouped by the health areas covered in the WHO/Defra reviews, with an additional “General health” category. In these tables we have indicated where the GRADE assessment of quality of evidence comes from. Where there are quality of evidence assessments from multiple sources, we have indicated these separately, along with a synthesis GRADE assessment conducted as part of the current REA. The above-named appendices present the detail of those synthesis assessments. The Defra–RIVM review did not conduct GRADE assessments but we include the conclusions of that review regarding the direction of effect. In the quality of evidence tables this is indicated with the label GRADE not conducted”.

Moderate or high quality ratings require a body of evidence based on multiple high quality studies with low risk of bias in their methods and consistent findings. This is a demanding threshold and consequently the quality of evidence for most outcomes is very low or low. This primarily reflects features of the studies that have contributed the evidence. First, most studies are cross-sectional rather than longitudinal, which means the evidence they provide is inherently of lower quality. Second, many studies have relatively small samples. This makes it hard to obtain high certainty that observed associations are not due to chance. Small samples also mean that it is harder to detect a real association if there is one. We discuss study designs in the next chapter.

Table 1 Summary of the quality of evidence for birth and reproductive health outcomes

Outcome	**Quality of evidence – Direction of effect**	**Source of GRADE assessment**
Congenital malformations	Very low quality – No overall effect stated in GRADE assessment but harmful effects reported in narrative review	WHO review
Low birth weight	Very low quality – No overall effect stated in GRADE assessment but harmful effects reported in narrative review	WHO review
Preterm birth	Very low quality – No overall effect stated in GRADE assessment but harmful effects reported in narrative review	WHO review

Table 2 Summary of the quality of evidence for cognition outcomes

Outcome	**Quality of evidence – Direction of effect**	**Source of GRADE assessment**
Assessments of student distraction	Very low quality – Harmful effect	Defra-Arup review
Attention	Low quality – No effect	WHO review
Executive function deficit (working memory capacity)	Very low quality – No effect	WHO review
Impairment assessed through SATs	Moderate quality – Harmful effect	WHO review

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Reading and oral comprehension	Moderate quality – Harmful effect Very low quality – Harmful effect Moderate quality – Harmful effect	WHO review Defra-Arup review ICCAN synthesis
Short-term and long-term (episodic) memory	Moderate quality – Harmful effect	WHO review

Table 3 Summary of the quality of evidence for sleep outcomes

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Physiologically measured awakenings in adults	Moderate quality – Harmful effect Low quality – Harmful effect Moderate quality – Harmful effect	WHO review ICCAN review ICCAN synthesis
Self-reported sleep quality	Very low quality – Harmful effect	ICCAN review
Self-reported sleep coping behaviours	Very low quality – Harmful effect	ICCAN review
Self-reported awakenings	Low quality – Harmful effect	ICCAN review
Self-reported sleep disorder	Very low quality – No effect	ICCAN review
Self-reported sleep disturbance in adults (source not specified)	Very low quality – Harmful effect	WHO review
Self-reported sleep disturbance in adults (source specified)	Moderate quality – Harmful effect GRADE not conducted – Harmful effect Low quality – Harmful effect Moderate quality – Harmful effect	WHO review Defra-RIVM review ICCAN review ICCAN synthesis

Table 4 Summary of the quality of evidence for cardiovascular and metabolic outcomes

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Arterial stiffness	Low quality – Harmful effect	ICCAN review
Blood pressure	Very low quality – No effect	ICCAN review
Blood pressure in children	Very low quality – No effect	WHO review
Cortisol levels	Very low quality – Harmful effect	ICCAN review
Diabetes incidence	Low quality – No effect GRADE not conducted – Harmful effect Low quality – Harmful effect Low quality – Harmful effect	WHO review Defra-RIVM review ICCAN review ICCAN synthesis
Diabetes prevalence	Very low quality – No effect	WHO review
Heart rate	Very low quality – Harmful effect	ICCAN review
Hypertension incidence	Low quality – No effect GRADE not conducted – Harmful effect Low quality – Harmful effect	WHO review Defra-RIVM review ICCAN synthesis

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Hypertension prevalence	Low quality – No effect	WHO review
Incidence of central obesity	GRADE not conducted – Harmful effect	Defra-RIVM review
Ischaemic heart disease incidence	Very low quality – Harmful effect GRADE not conducted – Harmful effect Low quality – Harmful effect Low quality – Harmful effect	WHO review Defra-RIVM review ICCAN review ICCAN synthesis
Ischaemic heart disease mortality	Low quality – No effect	WHO review
Ischaemic heart disease prevalence	Very low quality – No effect	WHO review
Asymptomatic heart damage	Very low quality – Harmful effect	ICCAN review
Obesity (change in BMI)	Low quality – No effect	WHO review
Obesity (change in waist circumference)	Moderate quality – Harmful effect	WHO review
Obesity (incidence of overweight)	GRADE not conducted – Harmful effect	Defra-RIVM review
Obesity (weight gain)	GRADE not conducted – Harmful effect	Defra-RIVM review
Self-reported diagnosis of arrhythmia	Very low quality – No effect	ICCAN review
Self-reported diagnosis of diabetes	Very low quality – No effect	ICCAN review
Self-reported diagnosis of heart disease	Very low quality – No effect	ICCAN review
Self-reported diagnosis of hypertension	Very low quality – No effect	ICCAN review
Stroke incidence	Very low quality – Harmful effect Moderate quality – Harmful effect Moderate quality – Harmful effect	WHO review ICCAN review ICCAN synthesis
Stroke mortality	Moderate quality – No effect GRADE not conducted – Harmful effect Moderate quality – No effect	WHO review Defra-RIVM review ICCAN synthesis
Stroke prevalence	Very low quality – No effect	WHO review

Table 5 Summary of the quality of evidence for quality of life, mental health and wellbeing outcomes

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Wellbeing of children	Very low quality – No effect	ICCAN review
Depression prevalence	Low quality – No effect	ICCAN review
Depression prevalence mediated by annoyance	Low quality – Harmful effect	ICCAN review

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Emotional and conduct disorders in children	Low quality – No effect	WHO review
Hyperactivity	Low quality – Harmful effect	WHO review
Interview measures of depression and anxiety	Very low quality – Harmful effect Low quality – Harmful effect Low quality – Harmful effect	WHO review Defra-Arup review ICCAN synthesis
Medication intake to treat anxiety and depression	Very low quality – Harmful effect	WHO review
Self-reported QOL or health	Very low quality – No effect Very low quality – No effect Very low quality – No effect	WHO review Defra-Arup review ICCAN synthesis
Wellbeing	Very low quality – Harmful effect	Defra-Arup review
Self-reported diagnosis of chronic headaches/migraine	Very low quality – No effect	ICCAN review
Children's medication intake	Very low quality – No effect	ICCAN review
Children's physical diseases	Very low quality – No effect	ICCAN review

Table 6 Summary of the quality of evidence for cancer and general health outcomes

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Incidence of breast cancer	Low quality – Harmful effect	Defra-Arup review
Self-reported general health	Very low quality – No effect	ICCAN review
Self-reported diagnosis of stomach ulcer	Very low quality – No effect	ICCAN review
General physical health of children	Low quality – No effect	ICCAN review
General physical health of children mediated by annoyance	Low quality – Harmful effect	ICCAN review

4 Evidence gaps and potential for new research

This chapter will outline ways of thinking about gaps in the evidence (section 4.1), and principles that could guide decision-making on what to prioritise in future research (4.2). It will address research questions 2b on where further evidence is needed, 2c on where the priority evidence gaps are, and 2d on research approaches and methods which could fill the evidence gaps.

4.1 Evidence gaps

4.1.1 Gaps in the evidence

There are several ways in which evidence on the effects of aviation noise is lacking. Health outcomes for which evidence is lacking include all of those relating to dementia and neurodegenerative outcomes, as well as many birth and reproductive outcomes; quality of life, mental health and wellbeing; and many outcomes relating to cardiovascular and metabolic health. Although there is a good representation of moderate quality evidence for sleep-related and cognitive outcomes, there are still many outcomes in these areas for which the quality is low or very low.

Across all outcomes where there is evidence, the large majority is of low or very low quality (of the 58 outcomes shown in Tables Table 1 to

Table 6, evidence for 16 is of a low quality and for 30 of a very low quality). Considering low quality evidence as a form of gap, the evidence base consists primarily of gaps. It is however important to distinguish between a lack of evidence and a lack of evidence *of an effect*. Quality of evidence relates primarily to study design and execution. It is possible to have high quality evidence of no effect.

The smaller the effect, the more difficult it is to gain evidence that allows us to be certain of the effect. We discuss study "power" and the difficulty of detecting small effects below. It is worth noting that even if the effects of noise across various outcomes are small, these may add up to a substantial health burden at a population level if there is a large number of people exposed. This may, however, be difficult to detect with certainty.

All the health outcomes considered have causes beyond aviation noise. The likely role of aviation noise in overall morbidity, compared to other environmental, social and genetic factors, will vary between outcomes. As noted by Weihofen et al. (2019) in relation to stroke [34], the low relative importance of aviation noise as a cause of most chronic disease outcomes means that even with universal exposure to high levels of aviation noise, the effect on overall morbidity and mortality would be small. We would therefore expect larger effects for outcomes where aviation noise was a more important exposure.

Given the difficulty in achieving "high" quality evidence on the GRADE scale for environmental exposures, WHO in its 2018 recommendations [6] used evidence of moderate quality as the basis for setting "strong" recommendations, which "can be adopted as policy in most situations". It is reasonable to consider outcomes for which there is already moderate quality evidence, such as those in Table 7, as not a priority for further research. However, even for these outcomes, there would be value both in quantifying the adverse effect with more precision, and in assessing the potential for interventions and operational changes to reduce the harmful effect.

Table 7 Outcomes for which there is moderate quality evidence from WHO, Defra and ICCAN reviews

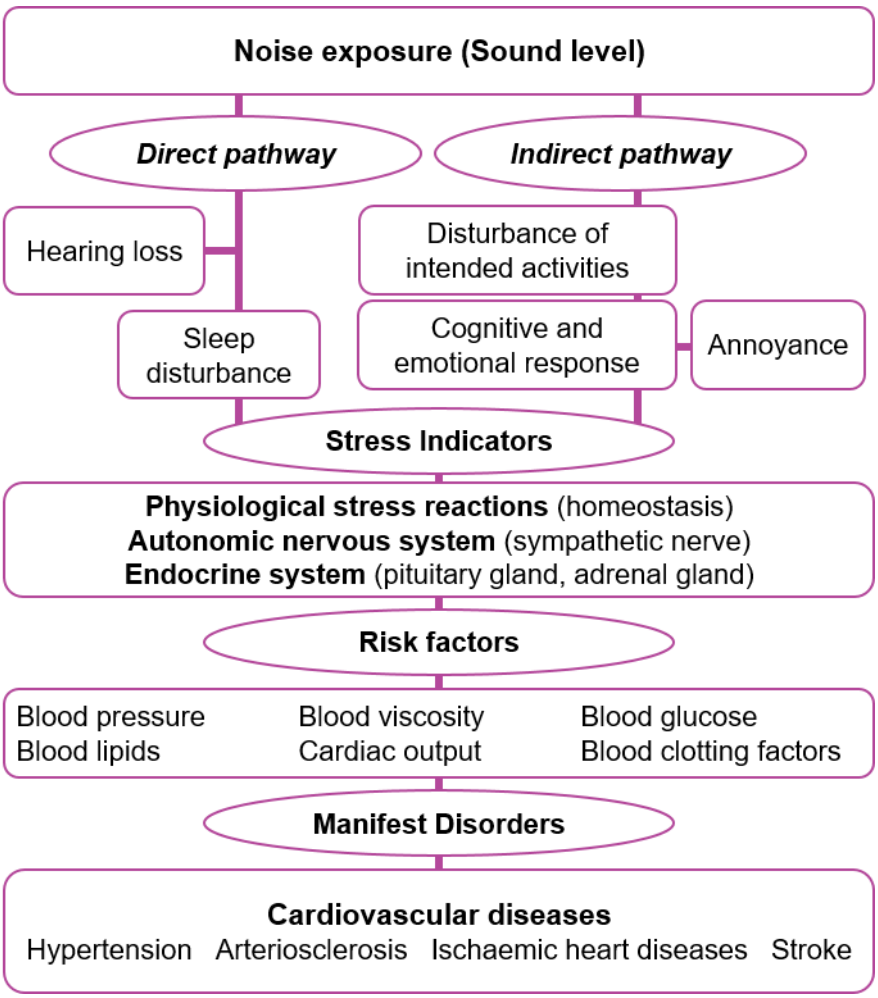
Outcome	**Direction of effect**
Stroke mortality	No effect
Stroke incidence	Harmful effect
Self-reported sleep disturbance in adults (source specified)	Harmful effect
Physiologically measured awakenings in adults	Harmful effect
Change in waist circumference	Harmful effect
Reading comprehension	Harmful effect
Impairment assessed through SATs	Harmful effect
Short-term and long-term (episodic) memory	Harmful effect

As well as chronic and acute health outcomes it is also possible to study the intermediate mechanisms by which aviation noise causes ill health. Figure 2 shows how noise might manifest in cardiovascular ill-health, and the mechanisms via stress indicators are plausible also for metabolic disorders. Measurable biological indicators ("biomarkers") of stress responses include cortisol, which is regulated by the endocrine system. Our update includes a paper [31] which investigates the role of aviation noise in cortisol level and rhythms. Although there has long been an interest in the role of stress indicators in the relationship between noise and health outcomes (e.g. [37]), there is relatively little recent literature. The WHO and Defra reviews did not include

evidence relating to these intermediate mechanisms, and how they are affected by aviation noise has not recently been systematically reviewed. This is an important area for further research.

Higher quality evidence on the relationship between aviation noise and risk factors (including stress hormones) may be easier to obtain than higher quality evidence on downstream disease outcomes, as risk factors are more prevalent. It is worth noting that evidence related to sleep disturbance meets this description, since sleep disturbance has a role in physiological stress reactions, as well as being a quality-of-life issue in its own right.

Figure 2 Noise effects pathway for cardiovascular diseases (from Babisch 2014 [38])



4.1.2 How to prioritise filling evidence gaps

There is no single answer as to which of these outcomes is “most important” and for which to seek higher quality evidence of the effect of aviation noise. This section outlines several possible approaches to choosing what to prioritise when seeking stronger evidence on the health impacts of aviation noise, and concludes with some suggestions for priority areas for new research.

What is adequate evidence to support action?

From the perspective of potential policy responses, it may be worth taking a step back from the specific outcome-related evidence to consider what policy options are

available, and what evidence would be required to decide to undertake or to rule out those options. ICCAN engages with a wide range of stakeholders, whose different priorities may require different new evidence. These include residents affected by aviation noise, airlines, airports, local authorities and regulatory bodies. ICCAN aims to understand aviation noise issues from various perspectives and this approach may also be important when prioritising health outcomes. The responses to ICCAN's corporate strategy reflect the various health priorities for different stakeholders [39]. This ranges from campaign groups emphasising the mental health effects of aviation noise on communities, to local authorities calling for evidence to support their local public health and wellbeing commitments.

To take a specific example, there is moderate quality evidence of harmful effects on several cognitive outcomes related to children's learning and low/very low quality evidence on other outcomes (Table 2). Different actors may respond differently to this mixed evidence base. For example, the implications for action are different for those whose work relates to the exposure, namely those making aviation policy, compared to those whose work relates to the outcome, in this case those educating children in an area of high aviation noise.

For those educating children, it may be valuable to have better quality evidence across the whole range of cognitive outcomes, including those for which evidence is currently low quality, to support targeted remedial responses. From a policy perspective however, including for those setting aviation policy, one may conclude that the evidence of a harmful effect on reading comprehension is adequate to support efforts to reduce the impact of aviation noise on the school environment. Evidence across multiple measures of cognitive ability may not be needed if reading comprehension can be treated as a good proxy for subsequent attainment and life chances. Aviation policymakers, or industry actors seeking to minimise their impact on local communities, might focus attention and further research on how to achieve those reductions. Such mitigation efforts, including understanding the effects of different airspace organisation measures, fall beyond the scope of this REA but there is a further systematic review in the WHO series considering the topic of interventions [40].

Disease endpoints versus intermediate mechanisms

Some of the outcomes studied are disease endpoints, particularly chronic diseases such as diabetes, heart disease or depression. Other outcomes are intermediate mechanisms that increase individual risk for disease, such as cortisol levels, increased waist circumference or arterial stiffness. Outcomes related to sleep disturbance both have a short-term negative effect on people's lives and are risk factors for longer term morbidity. Cognitive outcomes may not cause physical or psychological morbidity, but affect people's lives through educational attainment and social development, in part determining future opportunities and challenges. Both exposures and outcomes are likely to reflect broader social and health inequalities characterised by factors such as social class and ethnicity.

Since effects of noise on sleep and on metabolic disruption potentially affect multiple chronic disease outcomes, a robust understanding of these effects on upstream factors would be beneficial for certainty about the extent of the role noise may play in these outcomes. There is already moderate quality evidence relating to some sleep effects, although more could be done. For indicators of metabolic disruption, the evidence base is lower quality, and this is a potential area of focus.

What is the disease burden (attributable to aviation noise)?

Burden-of-disease or economic studies can quantify the population impact of environmental health risks, which could be aggregated across health outcomes to give

an overall burden attributable to aviation noise. This may be desirable, particularly to support cost–benefit analyses, but it is worth noting that these generally rely in turn on estimates of association for which the evidence may be of low quality. Where evidence comes from underpowered studies (see section 4.2.1 for a discussion of study power) the benefits may be underestimated as true effects may not have been detected.

Priority areas for new research?

The above considerations will help to guide decision-making on what new research areas to prioritise. Some possible starting points for prioritisation include the following.

Under-researched areas

There is currently no evidence on the effects of aviation noise on dementia and other neurodegenerative outcomes. Combined with the high prevalence of such disorders among the older population, this lack presents a rationale for seeking evidence on these outcomes.

Similarly, diabetes and hypertension are also sources of substantial morbidity at the population level, for which the evidence is currently only of low or very low quality. There is only evidence (low quality) of the impact of aviation noise on a single cancer outcome.

There is very low quality evidence on birth and reproductive outcomes. The potential contribution of aviation noise exposure, via maternal stress responses, to outcomes such as low birth weight or prematurity may be minimal compared to other exposures (as is true for many cardiovascular and metabolic outcomes). The importance of studying birth-related outcomes is increased by the long-term morbidity that they can cause and they could be considered as an area for further research.

Finally, neither the update review nor the systematic reviews for WHO and Defra include any evidence relating to auto-immune disorders.

Areas of high salience

ICCAN will know from its stakeholder engagement what topics are most salient for affected communities. In terms of areas of contemporary policy focus in the recovery from the coronavirus pandemic, it may be salient to emphasise outcomes related to the disadvantage caused by the pandemic and measures taken in response. These include educational attainment, which related to aviation noise through the effect on cognition, as well as potentially childhood obesity (on which there is currently no evidence related to aviation noise) and mental health outcomes at all ages.

In the short term, research relating to the impact of the massive reduction in flights during the pandemic response, and their subsequent resumption, may be of great public interest. However, the potential is limited as the most plausible short-term outcomes are those related to the quality of life, mental health or wellbeing, all of which will have been simultaneously impacted by the broader pandemic beyond its effect on aviation noise.

There are several priority areas for Public Health England in 2020 to 2025 [41] for which aviation noise may be a relevant exposure or co-exposure. Air pollution is an important exposure that commonly occurs alongside aviation noise. For cardiovascular disease especially, it would be beneficial to understand how these exposures interact. Mental health is a priority area of health policy and there are evidence gaps relating to the effect of aviation noise on adult mental health per se, and effects on people with pre-existing poor mental health. Regarding children's mental health, there are systematic reviews currently underway on the effects of aviation noise. Research using standard mental health interview measures should be encouraged for comparability

with other work on mental health. Childhood obesity is another priority outcome for which aviation noise may be a relevant exposure but for which there is no evidence. Aviation noise may also act in concert with other pollutants and social stressors, including air pollution and poverty, to exacerbate health inequalities, reducing which is another health priority.

Intermediate mechanisms
It would be valuable to improve our understanding of the role of aviation noise in causing stress responses that contribute to multiple chronic cardiovascular and metabolic disorders. Attention should be paid within such research to the potential for mediation by annoyance: the present update found that annoyance mediated effects on several outcomes but not on cortisol disruption. There is potential to study this relationship further to determine whether stress responses constitute a separate pathway to ill health from those mediated by annoyance. Similarly, it would be desirable to understand the role of sleep disruption as an intermediate mechanism for longer-term ill health.

4.2 Research options and considerations

This section will outline metrics and approaches that have been used in studies of aviation noise and health, and available study designs and their strengths and weaknesses. It addresses research questions 1b, on the research approaches and methods used to link aviation noise and health, and 2d on the research approaches and methods which could fill the evidence gaps.

4.2.1 Potential study designs and their strengths and weaknesses

There are a range of trade-offs that characterise the choice of study design, involving statistical certainty, public health relevance, cost, duration, timeliness and feasibility. Feasibility, in turn, relates to factors including the invasiveness/intrusiveness of data collection, and the likelihood of individuals adhering to the research protocol.

Study designs

Longitudinal studies
Longitudinal studies (which include cohort studies and panel studies) involve recruiting people who are followed over time, with repeated data collection on both exposures and outcomes. From the point of view of certainty in the findings, longitudinal studies are generally ideal as they allow the greatest confidence that the exposure preceded the outcome. This is particularly important for chronic disease outcomes that take a long time to manifest. It is also important when considering upstream risk factors as there is natural variation in, for example, the cortisol cycle. Knowing how such factors change over time alongside known noise exposure makes for greater certainty in any observed association. The starting level for longitudinal studies in the WHO review of cardiovascular and metabolic outcomes [12] was “high” quality.

The length of time required to generate the evidence is the main downside to longitudinal studies. The duration of cohort studies has cost implications, and from a policy-making point of view, may miss a window of policy relevance or opportunity. Cohort studies also have to be large and lengthy to detect differences in relatively rare outcomes with high certainty. One of the largest cohort studies to have contributed important evidence on the relationship of aviation noise to health is NORAH (Noise-Related Annoyance, Cognition, and Health, Germany [42]), which conducted three

waves of data collection over three years, one wave before and two waves after a new runway opened at Frankfurt airport and night flights were banned.

Cross-sectional studies

Cross-sectional studies involve finding out the population health and noise exposure status at a single point in time. These findings are analysed to determine whether there are associations between health outcomes and noise exposures. For example, you might ask people exposed to different noise levels whether they had been diagnosed with heart disease in the last year. An association between heart disease and noise would mean that, for example, there were more diagnoses of heart disease among those who were exposed to higher noise levels. A cross-sectional study doesn't enable you to say with certainty that the noise caused the heart disease, but as long as other plausible explanations have been taken into consideration (through adjusting your results for confounders), an association helps to generate hypotheses, and may be sufficient to inform policy.

Although evidence gathered over time is ultimately stronger, some outcomes can reasonably be studied with cross-sectional approaches. This is particularly the case for those that occur on short timescales such as sleep-related outcomes or cognitive disruption.

Cross-sectional studies offer a way to generate evidence relatively quickly and at a lower cost than longitudinal studies. Most studies in the field of aviation noise and health are cross-sectional. The starting level for cross-sectional studies in the WHO review of cardiovascular and metabolic outcomes [12] was "low" quality, which contributes to the widespread low quality evidence for many health outcomes. One of the better known cross-sectional studies that have contributed evidence to the understanding of aviation noise effects on health is HYENA, a multicounty study in Europe.

Case–control studies

An alternative to longitudinal or cross-sectional methods, particularly suited to studying rare outcomes, is the case–control methodology. In a case–control study, you begin with a group of people called "cases" who have an outcome, and you seek to compare them to a group of people called "controls" who do not have the outcome. The controls are generally chosen to be similar to the cases in some ways, such as in their age or the neighbourhood they live in. Comparing those who developed an outcome with those who were similar but did not develop the outcome, can help to understand what the cases might have been exposed to that the controls were not. The starting level for case–control studies in the WHO review of cardiovascular and metabolic outcomes [12] was "high" quality. There were no case–control studies among the new studies included in this REA, but an example of this type of study is that by Zeeb et al. (2017) [43]. In that study, cases were all new diagnoses of hypertension in a large health insurance database, and controls were all those in the database without hypertension.

When there are small numbers of cases in the general population, you need a very large cross-sectional or longitudinal study to have adequate statistical power to detect real differences. Case–control studies avoid this problem by starting out with a group of cases. This generally makes them a cheaper study design for rare outcomes. Important disadvantages of the case–control method are the difficulty in choosing the controls so as to avoid selection bias, and the high potential for recall bias regarding what people were exposed to. Recall bias occurs when someone's outcome status (for example, having or not having a disease) affects their likelihood to recall what they were exposed to. Objective measures of exposure (such as address-based noise mapping, as mentioned below in the section Measuring noise) can reduce this risk.

Ecological studies

In contrast to longitudinal, cross-sectional or case–control studies, ecological studies do not assess health outcomes or noise exposure at the individual level. Instead, they assess outcomes and exposure at the population level. For example, health outcomes recorded at the level of electoral wards, publicly available in aggregated, anonymised datasets such as the Local Health dataset published by Public Health England [44], can be combined with noise maps to investigate broad, population-level associations. As they do not involve collecting data from individual participants, ecological studies are relatively cheap and subject to minimal selection biases. They lack precision in that there is no way to tell whether any relationship between exposure and outcome is true for individual people. It is also likely that within the area covered by, for example, an electoral ward there will be variation in sound levels, so the exposure assessment is necessarily crude.

Ecological studies can generally only investigate outcomes that are recorded in administrative datasets, and their data on confounders may be limited. They have the advantage that for those outcomes, their population coverage will be very high, potentially meaning fairly small differences or relatively rare outcomes can be studied, or high precision achieved. However, their lack of individual assessment of exposure and outcome mean they only provide low quality evidence. The starting level for ecological studies in the WHO review of cardiovascular and metabolic outcomes [12] was “very low” quality. There were no ecological studies among the new studies included in this REA, but an example of this type of study is that by Hansell et al. (2013) [45] who assessed hospital admissions for and mortality from cardiovascular conditions in areas exposed to different levels of noise around Heathrow airport.

Meta-analysis

Meta-analysis is a research method that combines the results of multiple studies to give a summary result across all those studies. This effectively increases the sample size, which increases study power and the precision of estimates. Studies included in a meta-analysis need to measure the same outcome in the same way, and the same exposure in the same way. For example, if studies use a cut-off to categorise noise exposure into “high” and “low” categories, this cut-off needs to be the same or very similar for the meta-analysis to be valid. The study populations should be similar, so that combining them is valid. For example, combining multiple studies of adults of similar age ranges from different settings may be fine, but combining studies with very different age eligibility for participants may not. This consistency of methods is the greatest challenge to meta-analysis, but where it can be achieved this is a powerful tool to make the most of existing studies. Meta-analysis doesn’t have a starting level for quality in GRADE. For our GRADE synthesis we have treated meta-analysis as having a starting level of “high” quality.

Table 8 provides a summary of the strengths and weaknesses of each of the potential study designs.

Table 8 Study design strengths and weaknesses

Study design (GRADE starting level [12])	**Strengths**	**Weaknesses**
Longitudinal (high)	High quality of evidence due to prospective assessment of exposures and outcomes Less potential for recall bias	Relatively long time to generate evidence High cost Potential differential attrition
Cross-sectional (low)	Relatively quick and low cost	Cannot assess causation
Case–control (high)	Efficient for rare outcomes	Subject to recall bias

		Require careful attention to confounding
Ecological (very low)	Low cost High population coverage	Descriptive only, individual-level analysis not possible
Meta-analysis (no starting level)	Can increase power and precision of estimates	Require multiple similar studies to be done robustly

Considerations when designing studies

Selection biases
Selection biases occur when people who take part in a study differ in a non-random way from the populations they are supposed to represent. These biases can affect all studies. This is especially true where individuals consent to take part (as opposed to studies using anonymised area-based medical records, for example). Selection bias can affect:

- who is considered for participation (if, for example, a sampling frame doesn't include all people living in an area)
- who is approached for participation (if, for example, recruitment is conducted via a channel that is not accessible to all participants, or at a time when some types of people are not at home)
- who consents to participate (if, for example, understanding or willingness to participate or motivation to participate differ by population group)
- who manages to participate (if, for example, ability or willingness to ultimately take part in the research differs for different types of people)

Longitudinal studies can additionally be subject to differential attrition: in addition to differences between who does and does not initially agree to take part, the people who remain in the cohort may be systematically different to those who drop out (or are "lost to follow-up"). People stop participating in studies for many reasons, including reasons related to the exposure or outcome. For example, people may stop participating because they are sick, or may move home due to aviation noise.

Statistical power
When you want to find something out about a whole population by looking only at a sample of the population, you might miss something that is true about the whole population because your sample was too small. Statistical power tells you how likely you are to detect that true finding in a sample of a given size. Studies ought generally to be designed to have statistical power to detect a given difference in a given outcome. Inadequate power can lead to findings of no effect when a larger study may have found a true effect. Uncertainty over power can therefore make it difficult to know how strongly to interpret the many findings of little or no significant difference.

In practice, it is unusual that authors report explicitly what their studies were powered to detect, but it can be particularly important where a study reports multiple outcomes. An example is the study by Rojek et al. (2019) on indicators of cardiac health, which reported over 40 combinations of outcome and population stratum. The authors reported that the study was powered to detect a difference in pulse wave velocity (PWV), and reported indicators related to asymptomatic heart damage alongside PWV. Among those indicators of asymptomatic heart damage, some had significant associations with the noise level and some did not. It is possible that the study lacked power to detect meaningful differences in some or all of those indicators. A study may in practice be powered for secondary outcomes, but it is good practice to specify a primary outcome and calculate the necessary sample size with regard to that outcome.

The smaller the absolute effect you wish to detect, the greater power is needed: to detect a difference of 30% vs 33% prevalence of an indicator requires more power than to detect a difference of 30% vs 40% prevalence. Likewise, smaller relative effects require greater power: to detect a difference of 3 percentage points between 30% and 33% requires greater power than to detect a difference of 3 percentage points between 10% and 13%. Power is directly related to sample size, and to get more precise estimates or detect smaller effects, larger sample sizes are needed.

4.2.2 Measuring noise

Variation in how noise exposure is assessed relates to choice of metric, measurement versus modelling and indoor versus outdoor measurement.

Choice of noise metrics

There is a thorough consideration of the range of noise metrics in the recent ICCAN review of aviation noise metrics and measurement [4]. Appropriate metrics depend on the health outcome of interest and the mechanism by which noise is thought to cause harm. Where the harmful noise exposure is thought to be the overall level, causing cumulative chronic stress, studies may choose to use average sound-level metrics based on L_{eq} such as the L_{den} metric. The weightings in L_{den} emphasise evening and night-time noise and thus incorporate the adverse consequences of noise into the metric itself. Where the harm primarily comes through short-term disturbance rather than overall level, as may be the case for sleep-related outcomes and cognitive outcomes, studies may use maximum sound level metrics (such as L_{Amax}), number above metrics (for example N65, the number of sound events exceeding 65 dB) or measures of intermittency.

The European Noise Directive [46] mandates strategic noise mapping using of L_{den} to assess annoyance and L_{night} to assess sleep disturbance. This requirement appears in English law in the Environmental Noise (England) Regulations 2006, and the legislation has also been transposed into law in Scotland, Wales and Northern Ireland. L_{den} and L_{night} are also the main indicators used in the WHO ENG2018 recommendations for the European region [6], a recommendation which in turn reflects their widespread use. To enable comparability between studies, it is important to include these metrics if average sound pressure level metrics are appropriate, although researchers report a wider range of metrics (and the aviation industry also uses a range of other metrics). It is valuable to be able to combine the findings of different studies in meta-analysis, which requires the use of comparable metrics. Particularly when using thresholds of “high” and “low” noise, researchers should consider in their study design and reporting how to ensure their findings will be comparable with others on the same topic.

Authors do not always describe why they choose specific metrics over others, and sometimes report similar metrics within the same paper. For example, in the study of salivary cortisol [31] the authors reported both L_{den} and $L_{Aeq,24hr}$, which are both average continuous sound pressure level metrics measured for the whole day, with L_{den} having a penalty added for evening and night-time noise. The authors did not state why they included both or how their interpretation of the presence or absence of an association with the outcome would vary according to which of the two metrics was associated.

The L_{eq} based metrics measure time-averaged sound pressure, whereas other metrics measure the degree to which sound is “eventful”. According to Brink et al. (2019), the intermittency ratio “expresses the energetic contribution of individual noise events from a specific noise source relative to the total sound energy (produced by all noise sources together) in a given time period” [25]. Another type of event-related metric is the “number above” metric which indicates the number of events within a specified time

period exceeding a given decibel level. This metric is less frequently used than sound pressure metrics (either continuous or event-related) and did not feature in any of the studies included in our update. Nonetheless, similar to the intermittency ratio, it has the potential to quantify how much ongoing disturbance is caused by aircraft noise events, which a sound-pressure event measure such as L_{Amax} cannot.

Analytical approaches to noise exposure include categorisation by high and low noise areas (as in Rojek et al. (2019) [30]) and analysis by decibel level, using noise level as a continuous variable or bands of exposure (such as 5 dB or 10 dB bands).

For any given level of sound pressure (that is, physical energy), the human ear experiences the sound as more or less loud depending on the pitch. Up to very high frequencies, low sounds are experienced as quieter than high sounds, for any given level of sound pressure. In order to accurately assess noise as people experience it, noise studies use a long-established method called “A-weighting” which takes account of pitch. Most sound metrics (including L_{den} and L_{night}) are A-weighted, even if this is not explicitly stated in study reports.

Measurement and modelling

Noise modelling is an established and efficient method of determining external noise levels at a geographical location. A commonly used programme in the UK for modelling noise contours is ANCON (Aircraft Noise CONtour model) which is owned and operated by the CAA. Another modelling programme is AEDT (Aviation Environmental Design Tool), which is commercially available and developed by the FAA in the USA. Noise modelling uses multiple factors such as flight patterns and aircraft type to estimate how noise from aviation is experienced at ground level. Noise maps generated through modelling are routinely produced by airport authorities and regulators and provide the large-scale estimates of the numbers of people affected by given levels of aviation noise.

In contrast to noise modelling, monitoring noise involves using microphones to record the actual sound levels in a given setting. Modelling is used for estimating outdoor noise by the aviation industry, but measurements via monitoring are catered. This is an important part of ratifying the modelled outputs to real-world values. Monitoring is also useful for gathering specific local information.

Noise monitoring can be conducted by researchers both indoors and outdoors. In social and health research it is particularly important to have accurate levels of noise at the participant’s location indoors, most notably for studies of sleep-related and cognitive outcomes, to determine exposure more accurately than with outdoor measurements alone. Ideally it is possible to separate aviation noise from ambient noise, which is also recorded by measurement equipment, and some studies have attempted to do this (for example, Nassur et al. 2019 [32]).

Indoor and outdoor estimation

Whether noise levels are modelled or determined via monitoring outdoors, there is the inherent problem that outdoor noise does not necessarily determine indoor noise.

Residents may take different steps to mitigate their indoor noise level exposure depending on the levels of outdoor noise and personally perceived annoyance. Such steps may include installing double glazing or roof noise insulation. In terms of how this may influence effect estimates, if mitigation efforts are more likely with higher indoor noise levels, this would probably dampen any apparent effect comparing exposures classified by outdoor noise levels as the indoor level reduction will be greater for those who have installed insulation.

There are methods for estimating indoor noise from outdoor noise: for example, Brink et al. (2019) [25] describe accounting for the position of the bedroom within the dwelling, and also reducing the indoors exposure based on the position at which the participant keeps their window (open/half-open/closed).

Residential or other address-based measures all suffer from the limitation that people's noise exposure may not be the same as the noise level at their address, particularly for daytime levels. People may therefore experience noise exposures away from their homes and not experience noise exposure at their homes. The amount of time spent at home during the day will differ according to factors related to work (daytime work away from the home versus working from home, or shift work including daytime sleeping) and caring responsibilities (home-based carers for children, disabled people or elderly people).

4.2.3 Measuring health

Methods used to measure health outcomes include diagnoses of physical or mental health conditions, and short-term measurements by self-report, interview or monitoring. Harmonised, standardised methods are increasingly used, which is positive for encouraging comparability and the potential for meta-analyses.

Chronic diseases such as diabetes and cardiovascular outcomes tend to be measured by reported medical diagnosis. Mental health outcomes such as depression and anxiety are usually assessed by interview during data collection but can also be assessed by participant-reported diagnosis. Similarly, high blood pressure can be ascertained either by reported diagnosis, by reported medication use or by measurement during the study (either measurement by study staff or by self-administered equipment). Diagnoses can also be measured without involving participants, for outcomes recorded in administrative health databases (see below on ecological studies).

Some outcomes are mainly subjective, including many measures of quality of life or wellbeing (or annoyance), and are based primarily on self-reports although validated questionnaire instruments are available. That said, the WHO quality of life, mental health and wellbeing review included evidence, for non-aviation noise sources, related to a range of diagnosed conditions (such as children's hyperactivity or emotional and conduct disorders) or physical outcomes (such as measured cortisol levels).

Some outcomes are measured by both self-report and objective measures. For example, sleep quality and sleep disturbance can be measured by a range of self-reported measures (tiredness, trouble falling asleep, remembered awakenings etc.) and can also be defined by measures such as awakenings or movement derived from physiological monitoring equipment. Polysomnography is the gold standard approach to measuring sleep disturbance physiologically, and involves monitoring individuals' brain activity, eye movements, muscle tone, breathing, movement and other signals. Polysomnography is expensive and intrusive, however Basner et al. (2019) report that a simpler combination of monitoring heart activity and movement only performs almost as well [27].

For self-reported items, there are often standard questions, which enables comparability between studies. Among the studies summarised in this update, for example, sleep quality was measured using the Pittsburgh sleep quality index, children's wellbeing was assessed using the KINDL-R questionnaire, and sleep disturbance was measured using an adapted ICBEN scale. There are standardised tests for assessing children's cognitive abilities, and children's mental health (such as the Strengths and Difficulties Questionnaire).

Some intermediate risk factors might not commonly be ascertained outside the study setting, and require collection during the study. These include biomarkers which may be collected by the participant themselves (for less invasive procedures, such as a saliva sample for cortisol) or by study nurses (for procedures such as a blood sample for C-reactive protein).

4.2.4 Potential ways of filling evidence gaps

Here we outline some options for studies that could help improve the quality of evidence relating to many health outcomes.

Retrospective cohort methods

The UK has a series of high quality population cohorts that collect data on birth and other cohorts over many years. Birth cohorts include those of people born in 1958, 1970 and 2000, with around 18,000 members each and data collection every few years. The UK Household Longitudinal Survey has followed 40,000 households (100,000 individuals) with annual data collection since 2009 and is integrated with the British Household Panel Survey following 10,000 people back to 1991. The Avon Longitudinal Study of Parents and Children (ALSPAC) has intensively followed the families of 14,000 pregnant women recruited to the study in 1991 and 1992. Biobank recruited 500,000 participants aged between 40 and 69 in 2006 to 2010, and has followed them since, collecting biological and genetic samples and other health-related information. All these studies have rich data on a wide range of characteristics adequate to adjust for confounding, and some include biomarkers. Biobank also includes noise data modelled for participants' home addresses for some years.

Most cohorts do not contain noise data, so the feasibility of retrospective cohort methods to study aviation noise exposure would depend on the ability to map noise levels back on to study participants' addresses. The first step in considering such a study would be to seek expert opinion on such backward mapping including asking whether there are enough cohort members who experience high levels of aviation noise to have sufficient power to detect health effects of interest.

Perhaps the most promising cohort for retrospective noise mapping is the Southall And Brent REvisited Study (SABRE) which has followed the health of around 5000 people recruited in 1988 to 1991. Due to its West London location and proximity to Heathrow, this cohort has a greater chance of adequate numbers of participants exposed to aviation noise to be able to be powered for studying health outcomes. There is ongoing work analysing SABRE and Biobank data in the Aircraft Noise and Cardiovascular Outcomes (ANCO) study [48], which there may be potential to build upon with further funding. There is also an ongoing retrospective study to investigate short-term variation in cardiovascular outcomes associated with short-term changes in aviation noise exposure: the Reduced noise Impacts of Short-Term Aircraft Noise and Cardiovascular Outcomes (RISTANCO) study is using historical data on flight movements to generate address-based noise estimates linked to data on hospital admissions and mortality [49].

There are examples of similar work being done with non-aviation noise. For example, Smith et al. (2017) modelled road traffic noise onto addresses of a retrospective cohort of births to estimate the impact of road traffic noise and air pollution on birth weight in London [50], and Zeeb et al. (2017) used retrospective exposure mapping in their case–control study [43]. The latter study also describes the steps taken to ensure protection of sensitive data.

Baseline data for operational or infrastructure changes

Any infrastructure added or removed, or any operational change, presents an important opportunity to assess impacts of those changes, especially on shorter-term outcomes. Airspace change is strictly regulated and all potential changes ought to be notified to an appropriate agency. The lead time of operational or infrastructure changes varies and for longer term or larger project, there is potential to build research activities into the change process. In order to be able to generate evidence from shorter term changes, it may be worthwhile to pre-emptively collect baseline data on outcomes of interest from airports.

Further meta-analyses

Meta-analysis involves combining the results of existing studies on the same topic to get a single pooled estimate of the effect. This has the advantage of generally increasing the statistical power of the estimate and therefore the certainty of the effect. However, it requires studies to be similar in their definition of exposure and outcome and their study design, otherwise combining studies may be impossible or give spurious results. The WHO review on cognition [10] made a similar observation and added that “many studies group exposure into high and low, using different thresholds for high and low, which again makes combining study data challenging as the range of noise exposure within the high and low categories is often unknown and cannot be estimated reliably from the data provided. The potential to be able to conduct meta-analyses within this field will be greatly enhanced if future studies report effect estimates for a 1 dB and 5 dB increment in noise exposure” (p19).

In studies of quality of life, mental health and cognition, use of standard outcome measures should be encouraged so as to eventually make possible further meta-analyses. Researchers should also consider applying minimum quality cut-offs for inclusion in meta-analyses, to avoid undermining the certainty that might be derived from considering higher quality studies only. This rationale is why, for example, the Defra–RIVM review only included evidence from cohort studies and case–control studies to inform its findings on cardiovascular and metabolic outcomes.

Ideal study design

Here we outline an ideal study design to achieve the highest quality evidence, against which reasonable compromises relating to time, cost and priority can be assessed. The ideal study design to investigate effects of aviation noise on health in the UK would be a large cohort study of populations living around UK airports. Including sufficient airports would mean it could assess differences in exposures related to how airports operate, including night flights and flight path rotation. The study would want to have the following features:

- collecting data every year or two for a decade or more
- strong measures to minimise loss to follow-up including following cohort members who move
- data collection on multiple health outcomes, including:
    - recent and lifetime diagnoses of physical and mental ill health
    - sleep quality via ECG and actigraphy
    - self-completed quality of life and mental health measures
    - interview measures of psychiatric morbidity
- repeated collection of biomarkers from saliva and blood

- data on confounders and effect modifiers, including:
    - air pollution
    - access to green space
    - other noise
    - occupational noise exposure
    - annoyance
    - noise sensitivity
    - dwelling attributes
    - actions taken to mitigate noise
    - age, sex, ethnicity, household income, alcohol and tobacco use, diet, physical activity
- noise measurement and/or modelling to allow calculation of a range of metrics including equivalised overall noise measures of varied durations, maximum noise levels, intermittency ratios and number-above metrics
- noise measured in the bedroom during sleep and in the classroom for cognitive outcomes

Suggestions of specific studies

- A cohort study such as that outlined above would be expensive to set up and run, and would be best undertaken with a view to gathering evidence on a wider range of exposures than just aviation noise. It would be an important investment in generating evidence that could improve certainty of the relationship between aviation noise and a range of outcomes and should be explored as a priority. There may be scope to partner with other agencies to establish a longitudinal research programme that could also add value to evidence bases for exposures beyond aviation noise.
- It is highly advisable to investigate the potential of retrospective cohort methods using UK cohort data, to generate evidence in a relatively timely and cost-effective way. This would include evidence relating to chronic disease outcomes as well as birth and reproductive outcomes. This should begin with investigating the potential of building on the ANCO work to investigate further outcomes, and could also involve assessing the potential for aviation noise analyses with one or more of the large UK general population cohorts. Where cohorts cannot be used for such purposes, retrospective ecological studies using routine health datasets could be considered as an alternative. Such studies could build on the work of the RISTANCO study, which is due to end in late 2020.
- A longitudinal study including data on stress biomarkers, annoyance and disease outcomes would be valuable for being able to distinguish effects mediated through annoyance from those attributable directly to physiological stress responses.
- Despite the potential confounding effects of the pandemic and its response, short term surveys of outcomes including sleep, quality of life, mental health and wellbeing should be considered. These would be followed by further surveys of the same people in future waves over the following year or two to assess the impacts of “return to normal” after the present reduction. This is of course time sensitive and would require rapid action to achieve a baseline during the period of reduced flight activity.

- This could be combined with a baselining study of operations at major airports to provide a comparator for when operations and therefore exposures change.

- The Defra-RIVM study suggested four new meta-analyses in the area of cardiovascular and metabolic health. Three of these (on IHD, stroke and diabetes) have been conducted and are reported above. The fourth, on hypertension, could be considered although this may already be in process.

5 Discussion

This REA has brought together the evidence available on the health effects of aviation noise. Between the existing WHO and Defra systematic reviews and evidence published subsequently, there is a wealth of data available on a wide range of health outcomes. However, the systematic assessment of quality of evidence using GRADE has found that the large majority of the evidence is of low or very low quality. There is therefore great potential for further research.

Our review found relatively little data from the UK, despite having a large noise-exposed population including the busiest airport in Europe. We have suggested some potential areas for further exploration, including under-researched health outcomes such as dementia and other neurodegenerative outcomes, and birth outcomes alongside health outcomes with low or very low quality evidence. There is no single way to determine what should be studied. Instead, decisions on the research for ICCAN to take forward should be informed by these gaps, combined with the priorities of its stakeholders and current priority areas in wider public health.

In focusing ideas for further research, study design should be a key consideration. This evidence update and the reviews conducted by the WHO and Defra identify design limitations, such as low sample sizes and cross-sectional studies, which tend to result in inconclusive results and therefore low or very low quality evidence.

Longitudinal studies are generally viewed as gold standard and tend to provide high quality evidence. However, they require a substantial budget and time investment. In section 4.2.4 we discuss how such a study could be approached. We have also put forward other types of studies including retrospective cohorts using the rich cohort data available in the UK which would be lower cost but benefit from some of the strengths of longitudinal methods. It remains to be seen what the coming months will bring with regard to the effects of the coronavirus pandemic on aviation noise, but there may be immediate opportunities to exploit the (presumably temporary) reduced exposure.

Generating an evidence base generally involves more than one study, however well designed. A further useful step toward improving the evidence base would be to support collaborative multi-study and international efforts to generate evidence using consistent methods. At present, particularly for sleep-related outcomes but also in other areas, there is some inconsistency in what specific measures are reported for particular outcomes (for example, what question(s) should be used to elicit self-reports of sleep disturbance). Multiple high-quality longitudinal studies may be difficult to achieve in practice, which makes a more consistent approach even more vital: meta-analysis of comparable cross-sectional studies, even if these studies individually offer low quality evidence, would make it possible to generate more precise estimates, which would strengthen the evidence base.

There have been such efforts in the past, including the European Network on Noise and Health (ENNAH) which reported in 2013 and in which UK universities participated [51]. The ENNAH project made a number of recommendations for further research, some of which have been acted upon but many of which remain. Those recommendations are oriented toward a specialist research community and continued engagement with such a community will be vital for ICCAN to make the most of the findings of this REA.

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Appendix A The GRADE approach

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) process is an approach to supporting the development of recommendations, the key aspect of which is assessing the quality of evidence. GRADE was initially developed for clinical medicine and has been adapted to other areas including environmental health. This approach encourages transparency consistency in assessing the quality of evidence for a relationship between an exposure and a health outcome [8].

GRADE assesses bodies of evidence against structured criteria to determine the overall quality of evidence for the presence or absence of a causal relationship. The process results in an assessment of “high”, “moderate”, “low” or “very low” evidence, with implications for the need for further research:

- High quality evidence means further research is *very unlikely* to change the certainty of the effect estimate;
- Moderate quality evidence means further research is *likely* to have an important impact on the certainty of the effect estimate and *may* change the estimate;
- Low quality evidence means further research is *very likely* to have an important impact on the certainty of the effect estimate and is *likely* to change the estimate;
- Very low quality evidence means any effect estimate is *uncertain*.

The WHO review of cardiovascular and metabolic outcomes [12] gives some commentary on how to use GRADE for environmental exposures. Study design is a key feature of quality and determines the “starting level” for the assessment. Where the bulk of evidence is from longitudinal or case–control studies, the starting level is “high”. Where it is largely from cross-sectional studies the starting level is “low”, and where it is from ecological studies, the starting level is “very low”. The authors of that review also downgraded the quality of evidence if based on only one study, regardless of the quality of that study.

From the starting level, quality of evidence can be downgraded across the following five domains. It is not always possible to assess each domain (for example, it was beyond the scope of the present review to assess publication bias).

- Study design (no downgrade if most studies have low risk of bias);
- Inconsistency (no downgrade if results across studies are consistent);
- Indirectness (on downgrade if studies are comparing like with like and have comparable populations and assessment of exposures and outcomes);
- Precision (no downgrade if the confidence intervals around the effect estimates are narrow); and
- Publication bias (no downgrade if no publication bias).

Although it is structured, GRADE is not a deterministic approach that gives an automatic outcome. GRADE is applied to bodies of evidence, taking into account all eligible data. As such, studies of differing quality are considered together and reviewers must ultimately judge the balance of that evidence. To avoid the results of inherently lower quality studies affecting the certainty derived from higher quality studies, some authors have treated only studies with a high quality starting level as eligible. While

there is scope for reviewers to arrive at different conclusions, the structure and set criteria encourage consistency.

Appendix B Strategies for searches

Databases

Medline

1 ((aviation or aircraft or airport* or air-traffic* or "air traffic" or flight* or airfield* or "air base*" or airbase* or airline* or flight or flights or runway* or aerodrome* or airspace or "air space") adj5 (noise or sound or sounds or decibel* or respite)).ti,ab,kw.
2 Noise, Transportation/ or Environmental Exposure/ or Environmental Monitoring/
3 Aircraft/ae, lj [Adverse Effects, Legislation & Jurisprudence]
4 Aviation/ae, in, lj, pa, px [Adverse Effects, Injuries, Legislation & Jurisprudence, Pathology, Psychology]
5 Airports/
6 2 and (3 or 4 or 5)
7 1 or 6
8 limit 7 to yr="2019 -Current"

Embase

1 ((aviation or aircraft or airport* or air-traffic* or "air traffic" or flight* or airfield* or "air base*" or airbase* or airline* or flight or flights or runway* or aerodrome* or airspace or "air space") adj5 (noise or sound or sounds or decibel* or respite)).ti,ab,kw.
2 ((noise injury/ or noise pollution/ or noise/ or environmental monitoring/ or environmental exposure/) and (aviation/ or aircraft/ or airport/ or helicopter/)) or aircraft noise/
3 1 or 2
4 limit 3 to yr="2019 -Current"
5 limit 4 to exclude medline journals
6 limit 4 to embase
7 5 or 6

Scopus

((aviation OR aircraft OR airport* OR air-traffic* OR "air traffic" OR flight* OR airfield* OR "air base*" OR airbase* OR airline* OR flight OR flights OR runway* OR aerodrome* OR airspace OR "air space") W/5 (noise OR sound OR sounds OR decibel* OR nuisance)) AND ((health OR disease* OR disorder* OR mortality) OR (sleep* OR well-being OR wellbeing OR hypertension OR blood-pressure OR "blood pressure" OR "heart disease*" OR ihd OR angina-pectoris OR "angina pectoris" OR myocard*-infarct* OR "myocardial infarct*" OR cardio* OR *vascular OR stroke OR cva OR diabetes OR diabetic OR obes* OR overweight OR bmi OR body-mass-index OR "body mass" OR dementia OR cancer OR immun* OR endocrine* OR birth OR pregnan* OR fetus OR foetus OR preterm OR pre-term OR gestation OR infert* OR steril* OR malformation* OR labor OR labour OR *natal OR teratogen* OR depress* OR anxiety OR quality-of-life OR stress OR cortisol) OR (cogniti* OR memory OR hyperactiv* OR attention OR comprehen* OR read OR learn)) AND (LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019)) AND (LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "MEDI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "MULT"))

Epistemonikos

(title:(((aviation OR aircraft OR airport* OR air-traffic* OR "air traffic" OR flight* OR airfield* OR "air base*" OR airbase* OR airline* OR flight OR flights OR runway* OR aerodrome* OR airspace OR "air space") AND (noise OR sound OR sounds OR decibel* or respite))) OR abstract:(((aviation OR aircraft OR airport* OR air-traffic* OR "air traffic" OR flight* OR airfield* OR "air base*" OR airbase* OR airline* OR flight OR flights OR runway* OR aerodrome* OR

airspace OR "air space") AND (noise OR sound OR sounds OR decibel*)))) – **(April 2019-Dec 2020)**

Websites

We searched the following websites:

Appendix table 1 Online websites and repositories

Authority	Website address
UK Government	www.gov.uk
Civil Aviation Authority	www.caa.co.uk
Five busiest UK airports (Heathrow, Gatwick, Manchester, Stansted, Luton)	www.heathrow.com; www.gatwickairport.com; www.manchesterairport.co.uk; www.stanstedairport.com; www.london-luton.co.uk
Chartered Institute of Environmental Health	www.cieh.org/
International Transport Forum	www.itf-oecd.org/
Strategic Aviation Special Interest Group	www.sasig.org.uk/

UK Government

We searched www.gov.uk with the string “noise health” restricted to items published after 31/12/2014. We included results of the type “Research and statistics” or “Policy papers and consultations” under the following topics (number of results in brackets):

- Environment > Pollution and environmental quality (21)
- Business and industry > Business and the environment (5)
- Corporate information (11)
- Health and social care ("noise" search only) (0)

We screened all 37 results and included none for full text review.

Civil Aviation Authority

We searched www.caa.co.uk with the search terms ‘health’ and ‘aviation noise health’. In total, 37 results were screened and three included for full text review.

Airports

We searched the websites of the 5 busiest airports in the UK with the search terms "health" then "noise" and then "noise and health" (number of results screened in brackets):

- Heathrow airport www.heathrow.com (75)
- Gatwick airport www.gatwickairport.com (125)
- Luton airport www.london-luton.co.uk (103)
- Manchester airport www.manchesterairport.co.uk (150)
- Stanstead airport www.stanstedairport.com (150)

In total, 603 results were screened and none were included for full text review.

Chartered Institute of Environmental Health
We searched https://www.cieh.org/ with the search term ‘aviation noise’ and separately ‘noise’. In total, 22 results were screened and none were included for full text review.

International Transport Forum
We searched https://www.itf-oecd.org/ with the search terms ‘aviation noise’ and ‘noise and health’. In total, 61 results were screened, and none were included for full text review.

Strategic Aviation Special Interest Group
We searched https://www.sasig.org.uk/ with the search terms ‘health’, ‘aviation noise and health’ and ‘noise and health’. In total, 15 results were screened and none were included for full text review.

Conference proceedings

In total there were 1309 papers from ICA Aachen and 893 from Internoise Madrid. In order to find all relevant papers we completed a two-stage screening process based on the conference sessions which were organised by topic.

ICA (Aachen, September 2019)
We screened all 182 session titles to decide which were likely to have relevant papers, including sessions which were directly and indirectly relevant. After this process, 11 sessions were selected for title and abstract screening of all papers (total 54).

Internoise (Madrid, June 2019)
We screened all 95 session titles to decide which were likely to have relevant papers, including sessions which were directly and indirectly relevant. After this process, 8 sessions were selected for title and abstract screening of all papers (total 69).

In total, 10 papers of relevance were identified for full text screening from both conferences and of these, six had already been included for full text screening from previous citation tracking. Of the four papers left for screening, all were from the ICA conference. In total, one of these papers was included in our update from the conference searches.

Appendix C Data extraction tables

Appendix table 2 Data extraction table template

Title	Country	Setting/population (e.g. age or social restrictions such as residents, students)	Study design (Longitudinal, case-control, cross-sectional, other)	Sample size (number of individuals)	Adjustment for confounders (Appropriate consideration of obvious potential confounders)	Health conditions summary	Health conditions included (all that are eligible)	Measurement of health conditions (e.g. self-report, individually measured in-study, ecologically measured)	Noise assessment (how measured/modelled)

Noise metrics used (e.g. Lden, LAeq,16h etc; dB levels/bands)	Effect size (Metric and direction of association or effect (odds ratio, risk ratio etc; harmful or protective)	Bias due to exposure assessment	Bias due to confounding	Bias due to selection of participants	Bias due to health outcome assessment	Bias due to not blinded outcome assessment	Total risk of bias	Notes

Appendix table 3 Data extraction (study characteristics)

Paper	Study characteristics	Adjustment for confounders
Basner et al. 2019 [27]	Cross-sectional study (n=80) of residents living both around Philadelphia airport and an area without air-traffic. Examined aviation noise and sleep quality measures through both objective and subjective methods.	Adjusted for various confounders (different models adjusted differently).
Baudin et al. 2019 [31]	Cross-sectional study (n=1300) of residents living near one of seven major European airports in seven countries (Italy, Greece, the Netherlands, Sweden, Germany, the UK, France). Data is from the HYENA and DEBATS studies. Examined aviation noise and saliva cortisol levels.	Adjusted for age, sex, BMI, country, smoking habits, alcohol consumption, physical activity and education level as a proxy for income.
Benz and Schreckenberg 2019 [35]	Panel study with three waves (n=3319). First wave was before and second and third wave following new runway and then night flight ban near Frankfurt airport. Data is from the NORAH study. Examined aviation noise and diagnosis of depression.	Adjusted for age, sex, BMI, migration background, period of residence, hours spent out of home, home ownership, socio-economic status, noise sensitivity, sports, railway noise exposure, road noise exposure, alcohol consumption and tobacco consumption.
Brink et al. 2019 [25]	Cross-sectional study (n=5592) of whole population in Switzerland (ages 19-75). Examined aviation noise and self-reported sleep disturbance.	Adjusted for age, sex, German language and postal mode.
Nassur et al. 2019 [32]	Cross-sectional study (n=92) of residents living near the Paris-Charles de Gaulle and Toulouse-Blagnac airports in France. Examined aviation noise and heart rate during sleep.	Adjusted for age, sex, BMI, physical exercise, smoking and alcohol consumption as well as the presence of cardiovascular or hypertensive problems. Models were also adjusted for time since onset of sleep.
Rocha et al. 2019 [26]	Cross-sectional study (n=268) of residents in households around Hartsfield-Jackson Atlanta international airport (ATL) which a minimum night noise of 35 dB. Examined aviation noise and self-reported sleep disturbance and quality.	Adjusted for age, sex, BMI, hearing problems, noise sensitivity and income.
Rojek 2019 [30]	Cross-sectional study (n=126) which compared residents of Krakow, Poland in areas exposed to high and low aircraft noise. Examined aviation noise and blood pressure, arterial hypertension and indices of asymptomatic organ damage.	Adjusted for age, sex, BMI, education, time spent at home, smoking status, alcohol consumption and antihypertensive treatment.
Smith et al. 2020 [28]	Cross-sectional study (n=34) of adult residents living around Atlanta Hartsfield Jackson international airport (ATL). Examined aviation noise and self-reported sleep disturbance.	Adjusted for age, sex, BMI, and time from sleep onset.
Spilski et al. 2019 [36]	Panel study with three waves (n=1200). First wave was before and second and third wave following new runway and then night flight ban near Frankfurt airport. Data is from the NORAH study. Examined aviation noise and health-related quality of life among children who were second-graders (mean age eight years, four months).	Adjusted for age, sex, socio-economic status, road-traffic and railway noise.

Paper	Study characteristics	Adjustment for confounders
Trieu et al. 2019 [29]	Cross-sectional study (n=755) of residents around Noi Bai airport, Vietnam. Examined aviation noise and cardiovascular disease (blood pressure and heart rate).	
Vienneau et al. 2019 [33]	Meta-analysis of five aircraft studies (accepted study designs were cohorts, case-control and small-area studies). Examined aviation noise and cardio-metabolic diseases (Ischemic Heart Disease and diabetes)	Various adjustments. Studies were only included if basic adjustments for socio-economic status were performed.
Weihofen et al. 2019 [34]	Systematic review and meta-analysis with seven studies were included in the meta-analysis. Examined aviation noise and incidents of stroke for residents of various countries.	Studies which were included were adjusted for various combinations of confounders including age, sex, ethnicity and socioeconomic status.

Appendix table 4 Data extraction (noise exposure and effect)

Paper	Noise assessment	Effect
Basner et al. 2019 [27]	Aviation noise measured through microphones set up near the participant's bed and also outside the participant's bedroom window. Noise metrics used were L_{night} for outside measurements and $L_{AS,max}$ and $L_{Aeq,1min}$ for inside measurements.	There was a significant exposure-response function (ERF) between the sound level of aircraft noise and the probability of awakening. In a random effect adjusted logistic regression model, the coefficient for $L_{AS,max}$ was positive and significant (0.0262, SE 0.0098, p=0.0117). The ERF for percent awakened increased with $L_{AS,max}$: visually, around 3.5% at $L_{AS,max}$ 50dB, 6% at 60 dB, 9% at 70 dB and 12% at 80 dB. Neither systolic nor diastolic morning blood pressure differed between the region with air traffic and the region without. It was also found that retrospective one-month sleep quality index measurements were significant and morning survey on last night's sleep not significant.
Baudin et al. 2019 [31]	Aviation noise modelled for each participant's home. For all countries except the UK, noise levels were provided from the Integrated Noise Model (INM) which is a computer model. In the UK, the Aircraft Noise Contour Model (ANCON v2) was used. Noise metrics used were $L_{Aeq,24hr}$, $L_{Aeq,16\ h\ (06:00\text{-}22:00)}$, L_{den} and L_{night}.	There were statistically significant increases of evening cortisol levels in women with a 10 dB increase in aircraft noise exposure in terms of $L_{Aeq,16\ h}$ (exp(β) = 1.08; CI95% = 1.00–1.16), L_{den} (exp(β) = 1.09; CI95% = 1.01–1.18), L_{night} (exp(β) = 1.11; CI95% = 1.02–1.20). Statistically significant association also found in women between a 10 dB increase in terms of L_{night} and the absolute cortisol variation per hour (exp(β) = 0.90; CI95% = 0.80–1.00). Statistically significant decreases in relative variation per hour in women were also shown, with stronger effects with the L_{night} (exp(β) = 0.89; CI95% = 0.83–0.96) than with other noise indicators. The morning cortisol levels were unchanged with all noise exposure indicators. No statistically significant association found between aircraft noise exposure and cortisol levels for men. Annoyance and noise sensitivity found not to modify the results when included as covariates.
Benz and Schreckenberg 2019 [35]	Aviation noise modelled for the most exposed façade of the participant's address. Noise metric used was L_{den}.	In the adjusted analysis the coefficient for L_{den} in t_1 (before the new runway and night flight ban) on prevalence of depression diagnosis in t_2 (after the new runway and night flight ban) was 0 (-0.03 to 0.03, p=0.89). In that adjusted analysis the coefficient for annoyance was -0.20 (-0.34 to -0.05, p<0.01). Structural equation modelling showed no significant direct effect of t_1 aircraft noise exposure on t_2 prevalence of depression but showed significant effects of the indirect path of exposure to annoyance and annoyance in t_1 to depression in t_2. It was shown that annoyance as a mediator from aviation noise to mental health conditions is very important. This relationship may be bi-directional, in that depression may also predict annoyance.
Brink et al. 2019 [25]	Aviation noise measured through one to three receiver points per façade segment and floor. The noise exposure assessment for each façade point comprised yearly averages of the 1-hour- L_{Aeq} and Intermittency Ratio. Based on this, source-specific L_{night} ($L_{Aeq,\ 23\text{-}07h}$) and IR were calculated and assigned to the dwelling units. Noise metrics used were L_{day} and L_{night}.	There was a statistically significant association between nighttime aviation noise level and the probability of reporting high sleep disturbance. There was an adjusted odds ratio of 1.1270 (p=<0.01) for high sleep disturbance (HSD) per 1 dB increase. Urbanization was an effect modifier, with aviation noise most sleep disturbing in rural areas. There were significant paired differences for %HSD due to aircraft noise between cities and towns/suburbs (-0.537 on the log odds ratio scale, p <2, Tukey-adjusted), and cities and rural areas (-0.914 on the log odds ratio scale, p <0.03). Season and temperature were found not to affect the relationship between aviation noise and HSD.

Paper	Noise assessment	Effect
Nassur et al. 2019 [32]	Aviation noise measured inside and outside of the participant's bedroom continuously for 8 days using a sound level meter on the outside wall of the bedroom and a second on the bedside table. An algorithm was then used to determine aircraft noise in the bedroom, taking account of the transfer between inside/outside as well as filtering out other acoustic events. Noise metrics used were $L_{Aeq,15s}$, $L_{Aeq,aero,15s}$, $L_{A90,15s}$ and $L_{Amax,1s}$.	Positive and significant associations were found between the energy indicators ($L_{Aeq,15s}$ and $L_{A90,15s}$) and the heart rate. A 10 dB increase in $L_{Aeq,15s}$ was associated with an increase of 0.71bpm in heart rate for all noise sources. However, there was no significant relationship between aircraft noise alone ($L_{Aeq,aero,15s}$) and heart rate in the multivariate models. A further model assessed aircraft noise exposure characterized by $L_{Amax,1s}$ and differences between heart rates recorded during or 15/30 seconds after the aircraft noise events. No significant relationships were found. In contrast, a positive association was found between $L_{Amax,1s}$ and the heart rate amplitude during an aircraft noise event. Heart rate amplitude was calculated as the maximum and minimum heart rate during an acoustic event, in beats per minute.
Rocha et al. 2019 [26]	Aviation noise modelled using the Integrated Noise Model (INM) to give noise levels for each aircraft over 84 nights. Noise metric used was L_{night}.	The adjusted OR (95%CI) for L_{night} (per dB) with sleep disturbance was 1.15 (1.10-1.23), overall sleep quality 1.04 (1.00-1.08), trouble falling asleep 1.06 (1.02-1.10), trouble sleeping at night 1.04 (1.00-1.08) use of sleep medication 0.98 (0.94-1.03) and trouble staying awake 1.05 (1.00-1.11). Noise sensitivity was also found to be highly associated with all sleep disturbance outcomes. L_{night} was also associated with a greater odds of using certain coping aids against noise when trying to sleep; alcohol (1.10, 1.00-1.21), TV (1.05, 1.01-1.10), music (1.07, 1.01-1.13) and closing windows (1.05, 1.01-1.09). After adjustments, L_{night} was not significantly associated with self-reported general health.
Rojek 2019 [30]	Aviation noise measuring using two groups. The groups included those who were more and less exposed to aircraft noise and lived in different areas of Krakow. One group were exposed to high aircraft noise (more than 60 dB L_{den}) and the other were exposed to low aircraft noise (less than 55 dB L_{den}). Noise metric used was L_{den}.	Long-term aircraft noise exposure was related to higher office and nighttime diastolic blood pressure (DBP) and more advanced arterial stiffness and unfavorable left ventricle diastolic function changes. Exposure to aircraft noise did not increase the prevalence of arterial hypertension (50%, both groups) but was associated with higher office (88.3 vs. 79.8 mmHg, $p<0.001$) and night-time DBP (66.6 vs. 63.6 mmHg, $P<0.01$). Participants exposed to higher aircraft noise level had a higher carotid–femoral pulse wave velocity (PWV) (10.3 vs. 9.4 m/s, $p<0.01$) and lower early mitral annulus velocity (e0) (8.4 vs. 9.2 cm/s, $P=0.047$). Accelerated arterial stiffening was also observed to a degree depending on noise annoyance.
Smith et al. 2020 [28]	Aviation noise measured using recording equipment shipped to participants. Equipment recorded raw audio data so that aircraft noise could be separated by trained research personnel who manually screened the audio recordings. Noise metrics used for indoor noise were $L_{AS,max,ANE}$, $L_{Aeq,sleep}$ and $L_{AS,max,sleep}$. L_{night} was used for outdoor noise.	Self-reported awakenings increased alongside the highest maximum aircraft noise level occurring during the sleep period. Adjusted model for random effect logistic regression was 0.0254 (SE 0.0126). This effect was of only borderline statistical significance ($p=0.057$), likely due to the low sample size of this pilot study. Comparisons of questionnaires and $L_{Aeq,sleep}$ and $L_{AS,max}$ were also made. No statistically significant effects of $L_{Aeq,sleep}$ were found. With increasing $L_{AS,max,sleep}$ there were significant increases in tiredness ($\beta = 0.118$, $p=0.005$) and self-reported awakenings ($\beta=0.051$, $p=0.001$). There was a significant effect of sleeping with open windows on awakenings in the $L_{AS,max,sleep}$ model.

Paper	Noise assessment	Effect
Spilski et al. 2019 [36]	Aviation noise modelled using spatial and urban planning data. Noise metric used was $L_{Aeq,16\ h\ (06:00\text{-}22:00)}$.	Authors hypothesized that increased aircraft noise exposure leads to increased stress responses in children and subsequently affects their well-being and health, mediated through annoyance at aircraft noise. They also tested urbanization as an effect modifier. A 10 dB $L_{Aeq,16\ h\ (06:00\text{-}22:00)}$ increase in aircraft noise was associated with an increase of 0.81 scale points for physical well-being which led to increases in headaches and stomach aches. The inclusion of annoyance as a mediator led to a non-significant direct effect (b=-0.003, SE =0.004, p>0.05, 95% CI: -0.011,0.006), indicating a mediation effect. Results for psychological well-being and aviation noise were not consistent and urbanization was found not to be a significant modifier.
Trieu et al. 2019 [29]	Aviation noise measured using noise monitors in each resident's house during the first phase. For the second phase, noise exposure was modelled using noise contour maps and operation data. Noise metrics used were L_{den} and $L_{Aeq,night}$.	The results suggested that although there was a high rate of high blood pressure around the airport there was no significant relationship with noise exposure levels (OR 1.024, 95% CI 0.969-1.082). However, a significantly higher rate of insomnia was found at survey phase 2 when the number of night flights had increased.
Vienneau et al. 2019 [33]	Various noise assessment techniques used but exposure had to be modelled or measured to be included in the meta-analysis. Noise metric used in the meta-analysis was L_{den}.	Authors concluded that the inclusion of the most recent studies into WHO findings is important. There were indications of associations with aircraft noise and IHD incidence but in the sample the current studies were heterogeneous indicating there was variation on study outcomes (relative risk [RR] 1.03, 95%CI, 0.98- 1.09 per 10 dB L_{den}). Risk of bias was also high. For diabetes, there was a higher but non-significant RR per 10 dB L_{den} rate of 1.20 (0.88-1.63) and risk of bias was low.
Weihofen et al. 2019 [34]	Various noise assessment techniques used in different papers included in the meta-analysis. Various noise metrics used in the different papers but L_{den} used in the meta-analysis.	The meta-analysis found a relative stroke risk of 1.013 (0.998-1.028) per 10 dB. Although the overall finding just fails to reach statistical significance the authors conclude that as the result is so close, an effect seems likely.

Appendix table 5 Risk of bias

Paper	Bias due to exposure assessment	Bias due to confounding	Bias due to selection of participants	Bias due to health outcome assessment	Bias due to not blinded outcome assessment	Total risk of bias
Basner et al. 2019 [27]	Low	Low	Unclear. Very low response to recruitment	Low	Low	Low
Baudin et al. 2019 [31]	Low	Low	Unclear. Participation rates from 30% to 78%	Low	Low	Low
Benz and Screnckenberg 2019 [35]	Low	Low	Low	Low	Low	Low
Brink et al. 2019 [25]	Low	Low	Moderate. 31% response	Low	N/A	Low
Nassur et al. 2019 [32]	Low	Low	Moderate. Self-selection into DEBATS follow-up	Low	Low	Low
Rocha et al. 2019 [26]	Low	Low	High. 8.5% response	Low	N/A	Moderate
Rojek 2019 [30]	Low	Low	Moderate. 42%/48% response	Low	Low	Low
Smith et al. 2020 [28]	Low	Low	Moderate. 10% response but attenuation of bias by selection into field study	Low	Low	Low
Spilski et al. 2019 [36]	Low	Low	Low	Low	Low	Low
Trieu et al. 2019 [29]	Low	Moderate. Not adjusted for gender	Unclear	High for blood pressure, low for insomnia	Low	High
Vienneau et al. 2019 [33]	N/A (meta-analysis)	N/A (meta-analysis)	N/A (meta-analysis)	N/A (meta-analysis)	N/A (meta-analysis)	Low. Most studies with low ROB and high quality)
Weihofen et al. 2019 [34]	N/A (meta-analysis)	N/A (meta-analysis)	N/A (meta-analysis)	N/A (meta-analysis)	N/A (meta-analysis)	Low. Most studies high quality (cohort/ case–control)

Appendix D Reason for exclusion at full text screening

Appendix table 6 Reasons for exclusion of papers

Paper	Source	Reason for exclusion
L. M. Argys, S. L. Averett and M. Yang, "Residential noise exposure and health: evidence from aviation noise and birth outcomes," *IZA DP,* vol. No. 12605, 2019.	Citation tracking	Aircraft noise measured by distance to airport
S. Bartels, J. Quehl and D. Aeschbach, "Effects of nocturnal aircraft noise on objective and subjective sleep quality in primary school children," in *Proceedings of the 23rd International Congress on Acoustics*, Aachen, Germany, 2019.	Citation tracking	Aircraft noise measured by number of noise events
T. W. Collins, S. E. Grineski and S. Nadybal, "Social disparities in exposure to noise at public schools in the contiguous United States," *Environmental Research,* vol. 175, pp. 257-265, 2019.	Database search	Doesn't look at health
T. W. Collins, S. Nadybal and S. E. Grineski, "Sonic injustice: disparate residential exposures to transport noise from road and aviation sources in the continental United States," *Journal of Transport Geography,* vol. 82, p. 102604, 2020.	Database search	Doesn't look at health
E. Generaal, E. J. Timmermans, J. E. C. Dekkers, J. H. Smit and B. W. J. H. Penninx, "Not urbanization level but socioeconomic, physical and social neighbourhood characteristics are associated with presence and severity of depressive and anxiety," *Psychological Medicine,* vol. 49, no. 1, pp. 149-161, 2019.	Database search	Aviation noise not separated from other noise sources
J. I. Halonen, "Transportation noise and cardiovascular health: role of multiple noise sources," *Occupational and Environmental Medicine,* vol. 76, pp. 199-200, 2019.	Database search	Paper is a commentary
H. Héritier, D. Vienneau, M. Foraster, I. C. Eze, E. Schaffner, K. de Hoogh, L. Thiesse, F. Rudzik, M. Habermacher, M. Köpfli, R. Pieren, M. Brink, C. Cajochen, J. M. Wunderli, N. Probst-Hensch and M. Röösli, "A systematic analysis of mutual effects of transportation noise and air pollution exposure on myocardial infarction mortality: a nationwide cohort study in Switzerland," *European Heart Journal ,* vol. 40, no. 7, pp. 598-603, 2019.	Database search	Already included in a previous review
S. Kleyn, I. May and D. Kiryanov, "Hygienic analysis of potential risks of health harm in the implementation of airport complexes activity," *Hygiene and Sanitation,* vol. 98, pp. 268-275, 2019.	Database search	Paper not accessible
D. Leger and C. Guilleminault, "Environmental open-source data sets and sleep-wake rhythms of populations: an overview," *Sleep Medicine,* vol. 11, no. 69, pp. 88-97, 2020.	Database search	No data

Paper	Source	Reason for exclusion
G. B. Marks, A. L. Hansell and F. H. Johnston, "The environment is a first order issue for lung health," *International Journal of Tuberculosis and Lung Disease,* vol. 23, no. 12, pp. 1239-1240, 2019.	Database search	Editorial
T. Munzel, S. Steven, O. Hahad and A. Daiber, "The sixth sense is involved in noise-induced stress responses and vascular inflammation: evidence for heightened amygdalar activity in response to transport noise in man," *European Heart Journal ,* vol. 41, no. 6, pp. 783-785, 2020.	Database search	Editorial
A. M. Nassur, D. Léger, M. Lefèvre, M. Elbaz, F. Mietlicki, P. Nguyen, C. Ribeiro, M. Sineau, B. Laumon and A. S. Evrard, "The impact of aircraft noise exposure on objective parameters of sleep quality: results of the DEBATS study in France," *Sleep Medicine ,* vol. 54, pp. 70-77, 2019.	Database search	Already included in a previous review
A. M. Nassur, M. Lefevre, B. Laumon, D. Leger and A. S. Evrard, "Aircraft noise exposure and subjective sleep quality: the results of the DEBATS study in France," *Behavioral Sleep Medicine,* vol. 17, no. 4, pp. 502-513, 2019.	Database search	Already included in a previous review
M. Oh, K. Shin, K. Kim and J. Shin, "Influence of noise exposure on cardiocerebrovascular disease in Korea," *Science of the Total Environment ,* vol. 651, no. 2, pp. 1867-1876, 2019.	Database search	Aviation noise not separated from other noise sources
M. T. Osborne, A. Radfar, M. Hassan, S. Abohashem, B. Oberfeld, T. Patrich, B. Tung, Y. Wang, A. Ishai, J. A. Scott, L. M. Shin, Z. A. Fayad, K. C. Koenen, S. Rajagopalan, R. K. Pitman and A. Tawakol, "A neurobiological mechanism linking transportation noise to cardiovascular disease in humans," *European Heart Journal ,* vol. 41, no. 6, pp. 772-782, 2020.	Database search	Aviation noise not separated from other noise sources
D. Pillay and B. L. Vieira, "Noise, screaming and shouting: classroom acoustics and teachers' perceptions of their voice in a developing coun," *South African Journal of Childhood Education,* vol. 10, no. 1, p. 681, 2020.	Database search	No health data
A. Pyko, N. Andersson, C. Eriksson, U. de Faire, T. Lind, N. Mitkovskaya, M. Ögren, Ö. C. G, P. N. L, D. Rizzuto, W. A. K and G. Pershagen, "Long-term transportation noise exposure and incidence of ischaemic heart disease and stroke: a cohort study," *Occupational and Environmental Medicine,* vol. 76, no. 4, pp. 201-207, 2019.	Database search	Already included in a previous review
C. Ribeiro, F. Mietlicki and P. Jamard, "Health impact of noise in Greater Paris Metropolis: assessment of health life years lost," in *Madrid Internoise 2019: noise control for a better environment*, Madrid, Spain, 2019.	Citation tracking	Aircraft noise measured by number of noise events
F. Z. Sakhvidi, M. J. Z. Sakhvidi, A. H. Mehrparvar and A. M. Dzhambov, "Environmental noise exposure and neurodevelopmental and mental health problems in children: a systematic review," *Current Environmental Health Reports ,* vol. 5, pp. 365-374, 2018.	Database search	Systematic review of papers pre-2019
Saucy, A. et al., "Aircraft noise exposure assessment for a case-crossover study in Switzerland" in *Madrid Internoise 2019: Noise control for a better environment*, Madrid, Spain, 2019.	Citation tracking	No health outcome

Paper	Source	Reason for exclusion
M. Schubert, J. Hegewald, A. Freiberg, S. K. R, F. Augustin, R.-H. S. G, H. Zeeb and A. Seidler, "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,* vol. 16, no. 18, p. 3336, 2019.	Database search	Aviation noise not separated from other noise sources
A. Seidler, J. Hegewald, A. L. Seidler, M. Schubert and H. Zeeb, "Is the whole more than the sum of its parts? Health effects of different types of traffic noise combined," *International Journal of Environmental Research and Public Health ,* vol. 16, no. 9, p. 1665, 2019.	Database search	Aviation noise not separated from other noise sources
M. Sorensen and G. Pershagen, "Transportation noise linked to cardiovascular disease independent from air pollution," *European Heart Journal ,* vol. 40, no. 7, pp. 604-606, 2019.	Database search	Editorial
K. Wolf, U. Kraus, M. Dzolan, G. Bolte, T. Lakes, T. Schikowski, H. K. Greiser, O. Kuß, W. Ahrens, F. Bamberg, H. Becher, K. Berger, H. Brenner, S. Castell, A. Damms-Machado, B. Fischer, F. C. W, S. Gastell, G. K, B. Holleczek, L. Jaeschke, R. Kaaks, T. Keil, Y. Kemmling, L. Krist, N. Legath, M. Leitzmann, W. Lieb, M. Loeffler, C. Meinke-Franze, K. B. Michels, R. Mikolajczyk, S. Moebus, U. Mueller, N. Obi, T. Pischon, W. Rathmann, S. Schipf, B. Schmidt, M. Schulze, I. Thiele, S. Thierry, S. Waniek, C. Wigmann, K. Wirkner, J. Zschocke, A. Peters and A. Schneider, "Nightime transportation noise annoyance in Germany: personal and regional differences in the German National Cohort Study," *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz,* vol. 63, no. 3, pp. 332-343, 2020.	Database search	Health outcome is annoyance
Y. Yu, K. Paul, O. A. Arah, E. R. Mayeda, J. Wu, E. Lee, I. F. Shih, J. Su, M. Jerrett, M. Haan and B. Ritz, "Air pollution, noise exposure, and metabolic syndrome: a cohort study in elderly Mexican-Americans in Sacramento area," *Environment International,* vol. 134, p. 105269, 2020.	Database search	Paper does not include aviation noise

Appendix E GRADE for present REA outcomes only

Outcomes for which there was evidence from the present REA only

Self-reported diagnosis of sleep disorder

Appendix table 7 GRADE assessment for the effect of aviation noise on self-reported sleep disorder

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI fairly narrow	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Self-reported sleep coping behaviours

Appendix table 8 GRADE assessment for the effect of aviation noise on self-reported sleep coping behaviours

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	Mixed results within study	Downgrade
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	Unable to summarize	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – harmful effect**

Self-reported awakenings

Appendix table 9 GRADE assessment for the effect of aviation noise on self-reported awakenings

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	No CI but p value (0.057) consistent with fairly narrow CI	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Low quality – harmful effect**

Self-reported sleep quality

Appendix table 10 GRADE assessment for the effect of aviation noise on self-reported sleep quality

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	Three cross-sectional studies	Low
Study design	Majority of studies with low ROB	Majority of studies with low ROB	No
Inconsistency	Conflicting results, high I^2	Some inconsistency	Downgrade
Indirectness	Direct comparison, same PECCO	Multiple different items	Downgrade
Precision	CI narrow	CI fairly narrow	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – harmful effect**

Arterial stiffness

Appendix table 11 GRADE assessment for the effect of aviation noise on arterial stiffness

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	No CI but p<0.001 consistent with narrow CI	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Low quality – harmful effect**

Asymptomatic heart damage

Appendix table 12 GRADE assessment for the effect of aviation noise on asymptomatic heart damage

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	Mixed results within study	Downgrade
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	Unable to assess	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – harmful effect**

Blood pressure in adults

Appendix table 13 GRADE assessment for the effect of aviation noise on blood pressure in adults

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	Three cross-sectional studies	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	Conflicting results across studies	Downgrade
Indirectness	Direct comparison, same PECCO	Some differences in exposure assessment	Downgrade
Precision	CI narrow	Unable to summarize	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Heart rate

Appendix table 14 GRADE assessment for the effect of aviation noise on heart rate

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	Two cross-sectional studies	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	Conflicting results within and across studies	Downgrade
Indirectness	Direct comparison, same PECCO	Some differences in population	Downgrade
Precision	CI narrow	Unable to summarize	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – harmful effect**

Cortisol levels

Appendix table 15 GRADE assessment for the effect of aviation noise on cortisol levels

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	Mixed results within study	Downgrade
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	Unable to summarize	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – harmful effect**

Self-reported diagnosis of arrhythmia

Appendix table 16 GRADE assessment for the effect of aviation noise on self-reported diagnosis of arrhythmia

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI fairly wide	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Self-reported diagnosis of diabetes

Appendix table 17 GRADE assessment for the effect of aviation noise on self-reported diagnosis of diabetes

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI modest	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Self-reported diagnosis of heart disease

Appendix table 18 GRADE assessment for the effect of aviation noise on self-reported diagnosis of heart disease

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI wide	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Self-reported diagnosis of hypertension

Appendix table 19 GRADE assessment for the effect of aviation noise on self-reported diagnosis of hypertension

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No

Domain	Criterion	Assessment	Quality & downgrading
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI includes 1	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Wellbeing of children

Appendix table 20 GRADE assessment for the effect of aviation noise on wellbeing of children

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One panel study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CIs fairly wide	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Note: the design alone would give a starting point of Moderate quality, but as there is only one study we have downgraded this starting point to Low quality, consistent with the WHO review on cardiovascular and metabolic disorders [12].

Depression prevalence

Appendix table 21 GRADE assessment for the effect of aviation noise on prevalence of depression

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One panel study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	Narrow CI	No
Publication bias	Funnel plot indicates	Unable to assess	No

Domain	Criterion	Assessment	Quality & downgrading
Overall judgement			**Low quality – harmful effect through annoyance**

Note: the design alone would give a starting point of Moderate quality, but as there is only one study we have downgraded this starting point to Low quality, consistent with the WHO review on cardiovascular and metabolic disorders [12].

Self-reported general health

Appendix table 22 GRADE assessment for the effect of aviation noise on self-reported general health

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI fairly narrow	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

General physical health of children

Appendix table 23 GRADE assessment for the effect of aviation noise on general health of children

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One panel study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	No CIs but p>0.05 consistent with wide CIs	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Note: the design alone would give a starting point of Moderate quality, but as there is only one study we have downgraded this starting point to Low quality, consistent with the WHO review on cardiovascular and metabolic disorders [12].

Self-reported diagnosis of chronic headaches/migraine

Appendix table 24 GRADE assessment for the effect of aviation noise on self-reported diagnosis of chronic headaches/migraine

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI fairly wide	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Self-reported diagnosis of stomach ulcer

Appendix table 25 GRADE assessment for the effect of aviation noise on self-reported diagnosis of stomach ulcer

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One cross-sectional study	Low
Study design	Majority of studies with low ROB	Moderate ROB	Downgrade
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	CI fairly wide	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Children's medication intake reported by the parent

Appendix table 26 GRADE assessment for the effect of aviation noise on children's medication intake reported by the parent

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One panel study	Low

Domain	Criterion	Assessment	Quality & downgrading
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	No CIs but p>0.05 consistent with moderate CIs	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Note: the design alone would give a starting point of Moderate quality, but as there is only one study we have downgraded this starting point to Low quality, consistent with the WHO review on cardiovascular and metabolic disorders [12].

Children's physical diseases reported by the parent

Appendix table 27 GRADE assessment for the effect of aviation noise on children's physical diseases reported by the parent

Domain	Criterion	Assessment	Quality & downgrading
Starting level	Intervention/longitudinal	One panel study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	NA – single study	No
Indirectness	Direct comparison, same PECCO	No indirect comparison	No
Precision	CI narrow	No CIs but p>0.05 consistent with wide CIs	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Very low quality – no effect**

Note: the design alone would give a starting point of Moderate quality, but as there is only one study we have downgraded this starting point to Low quality, consistent with the WHO review on cardiovascular and metabolic disorders [12].

Appendix F GRADE for WHO/Defra and present outcomes combined

Outcomes for which there was evidence from the WHO or Defra reviews and from the present REA

Self-reported sleep disturbance in adults where noise was specified in the survey instrument GRADE assessment
For self-reported sleep disturbance in adults where noise was specified in the survey instrument, the WHO review concluded there was moderate evidence of a harmful effect of aviation noise. The Defra-RIVM review found 15 further studies on self-reported sleep disturbance; the authors did not report whether or not noise was specified in the survey instrument. The authors described the results as "not consistent, primarily due to methodological differences between the studies, nevertheless pointing in the same direction", which we consider to be consistent enough with the finding of the WHO review. The present review found two further papers reporting on this outcome [26] [25], both of which were cross-sectional and one of which had moderate risk of bias [26]. Both papers found a harmful effect. We conclude that the quality of evidence remains moderate for a harmful effect of aviation noise on self-reported sleep disturbance in adults where noise was specified in the survey.

Appendix table 28 GRADE assessment for self-reported sleep disturbance in adults where noise was specified in the survey instrument

Existing evidence from WHO/Defra reviews		WHO review (6 studies) Defra-RIVM review (5 studies)	Moderate – harmful effect No GRADE conducted – Harmful effect
Additional evidence			
Domain	*Criterion*	*Assessment*	*Quality & downgrading*
Starting level	Intervention/longitudinal/meta-analysis	New evidence cross-sectional	Low
Study design	Majority of studies with low ROB	1 of 2 had low ROB	No
Inconsistency	Conflicting results, high I^2	Consistent results	No
Indirectness	Direct comparison, same PECCO	Did not make indirect comparison	No
Precision	CI narrow	Unable to summarize	No
Publication bias	Funnel plot indicates	Unable to assess	No

Overall judgement			**Moderate – harmful effect**

Physiologically measured awakenings GRADE assessment

For cortical awakenings measured by polysomnography, the WHO review concluded there was moderate quality evidence of a harmful effect. Polysomnography involves multiple monitors attached to the body to measure brain, eye, muscle and other signals. It is the state of the art for objective measures of sleep but is expensive and logistically difficult to implement and relatively invasive. The study by Basner et al. (2019) [27] involved using a less invasive single monitor of heart activity and movement that participants could apply themselves. Since the authors report that the agreement between this method and polysomnography was near perfect, we feel it is appropriate to consider this evidence together as "physiologically measured awakenings". The study by Basner et al. (2019) was a small cross-sectional study that on its own could only offer low quality evidence. Nonetheless, we conclude that given the strong result consistent with the finding of the WHO review it is appropriate to maintain the finding of moderate quality evidence of a harmful effect of aviation noise on physiologically measured awakenings.

Appendix table 29 GRADE assessment for physiologically measured awakenings

Existing evidence from WHO/Defra reviews		WHO review (1 study)	Moderate quality – harmful effect
Additional evidence			
Domain	*Criterion*	*Assessment*	*Quality & downgrading*
Starting level	Intervention/longitudinal/meta-analysis	1 cross-sectional study	Low
Study design	Majority of studies with low ROB	Low ROB	No
Inconsistency	Conflicting results, high I^2	Consistent results	No
Indirectness	Direct comparison, same PECCO	Difference in exposure assessment (as discussed)	No
Precision	CI narrow	No CI but low p value (0.012) consistent with narrow CI	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Moderate quality – harmful effect**

Incidence of IHD GRADE assessment

For incidence of IHD, the WHO review concluded there was very low quality evidence of a non-significant harmful effect. Its estimate was based on two ecological studies. The Defra-RIVM review concluded there was a small harmful effect but did not assess quality of evidence. The meta-analysis by Vienneau et al. (2019) [33] also concluded there was evidence of a non-significant harmful effect. Given the increased size of the evidence base and consistency of the results, on the one hand, and the high risk of bias in contributing studies on the other hand, we conclude that there is low quality evidence of a small harmful effect of aviation noise on the incidence of IHD.

Appendix table 30 GRADE assessment for incidence of IHD

Existing evidence from WHO/Defra reviews		WHO review (2 studies) Defra-RIVM review (4 studies)	Very low quality – harmful effect No GRADE conducted – harmful effect
Additional evidence			
Domain	*Criterion*	*Assessment*	*Quality & downgrading*
Starting level	Intervention/longitudinal/meta-analysis	Meta-analysis (of 5 studies)	High
Study design	Majority of studies with low ROB	Included studies had high risk of bias	Yes
Inconsistency	Conflicting results, high I^2	Inconsistency among large studies in meta-analysis	Yes
Indirectness	Direct comparison, same PECCO	Did not make indirect comparison	No
Precision	CI narrow	CI fairly narrow	No
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Low quality – harmful effect**

Incidence of diabetes GRADE assessment

For incidence of diabetes, the WHO review concluded there was low quality evidence of no effect of aviation noise. The Defra-RIVM review did not assess the quality of evidence but reported there was inconsistent evidence between high quality studies, with two cohort studies respectively indicating a harmful effect and no effect. Vienneau et al. (2019) [33] conducted a meta-analysis that included the studies from the WHO and Defra-RIVM reviews and concluded there was evidence of a harmful effect (a fairly large effect too, with a risk ratio of 1.20, 95% CI 0.88 to 1.63) but that this was not statistically significant. We made our GRADE assessment on the meta-analysis, considering that this was the most thorough treatment of the evidence available. As the contributing studies had high-quality designs (being all cohorts or case-control studies) the evidence started out at high quality, but was downgraded for inconsistency and lack of precision. We conclude that there is low quality evidence of a harmful effect of aviation noise on the incidence of diabetes.

Appendix table 31 GRADE assessment for incidence of diabetes

Existing evidence from WHO/Defra reviews		WHO review (1 study) Defra-RIVM review (2 studies)	Low quality – no effect No GRADE conducted – some evidence of harmful effect
Additional evidence			
Domain	*Criterion*	*Assessment*	*Quality & downgrading*
Starting level	Intervention/longitudinal/meta-analysis	Meta-analysis of 3 cohorts/case-control studies	High
Study design	Majority of studies with low ROB	Most studies had low ROB	No
Inconsistency	Conflicting results, high I^2	Highly conflicting results	Downgrade
Indirectness	Direct comparison, same PECCO	Did not make indirect comparison	No
Precision	CI narrow	CI wide	Downgrade
Publication bias	Funnel plot indicates	Unable to assess	No
Overall judgement			**Low quality – harmful effect**

Incidence of stroke GRADE assessment

For incidence of stroke, the WHO review concluded there was very low quality evidence of a non-significant effect of aviation noise. Weihofen et al. (2019) [34] conducted a meta-analysis that found a small (1.3%), marginally significant increased risk of stroke per 10 dB increase in aircraft noise exposure. We made our GRADE assessment on the meta-analysis, considering that this was the most thorough treatment of the evidence available. We considered meta-analysis to offer a high starting quality of evidence. The methodological quality of the included studies was low, for which we downgraded the quality of evidence. The confidence interval contained 1 (0.998 to 1.028) but counteracting this we note the authors' comments about the likelihood of confounding working toward underestimation of the association and we did not downgrade further. We conclude that there is moderate quality evidence of a small harmful effect of aviation noise on the incidence of stroke.

Appendix table 32 GRADE assessment for incidence of stroke

Existing evidence from WHO/Defra reviews		WHO review (2 studies)	Very low quality – harmful effect
Additional evidence			
Domain	*Criterion*	*Assessment*	*Quality & downgrading*
Starting level	Intervention/longitudinal/meta-analysis	Meta-analysis (of 7 studies)	High
Study design	Majority of studies with low ROB	Majority of studies with inadequate quality	Downgrade
Inconsistency	Conflicting results, high I^2	Consistent results	No
Indirectness	Direct comparison, same PECCO	Minor differences in health outcome assessment	No
Precision	CI narrow	CI modest with confounding toward underestimation	No
Publication bias	Funnel plot indicates	Assessed as low risk	No
Overall judgement			**Moderate quality – harmful effect**

Appendix G GRADE for WHO and Defra review findings combined

Outcomes for which there was evidence from both the WHO and Defra reviews

Unlike in the preceding sections, for these outcomes we did not conduct a formal GRADE process. This is because we did not have the original papers that went into the reviews. Here we narratively summarise the quality of evidence combining the findings of the WHO and Defra reviews.

Reading comprehension GRADE assessment
The WHO review included 14 studies and concluded that there was moderate quality evidence of a harmful effect of aviation noise on reading and oral comprehension. The Defra-Arup review included four studies and concluded there was very low quality evidence of a harmful effect. The authors of the latter wrote that they had made their assessment based on a smaller number of studies some of which had had methodological weaknesses leading to downgrading, and recommended that the finding of the WHO review stand. We consider therefore that the WHO finding stands and that there is moderate quality evidence of a harmful effect of aviation noise on reading comprehension.

Stroke mortality GRADE assessment
For stroke mortality, the WHO review included three studies and concluded that there was moderate quality evidence of no effect of aviation noise. The Defra-RIVM review included three studies and concluded there was a non-significant harmful effect but did not rate quality of the evidence. As the WHO review evidence was based on longitudinal studies, and the suggestion of effect in the Defra-RIVM review was of a small and non-significant effect, we consider the finding of the WHO review to stand and conclude there is moderate quality evidence of no effect on stroke mortality.

Incidence of hypertension GRADE assessment
The WHO review included one study and concluded that there was low quality evidence supporting an association between aviation noise and incidence of hypertension. The Defra-RIVM review added evidence from two cohort studies showing a harmful effect of aviation noise and one case-control study showing no effect. We conclude that given the finding of an effect in those two cohort studies, the evidence may point toward a harmful effect and that given the inconsistency, the quality of the evidence remains low.

Interview measures of depression and anxiety GRADE assessment
The WHO review included one study and concluded there was very low quality evidence of a harmful effect of aviation noise on interview measures of depression and anxiety. The Defra-Arup review included two studies and concluded that this should be upgraded to low quality evidence in light of new data from cohort studies. There is no new evidence in this update so the conclusion of low quality evidence of a harmful effect of aviation noise on interview measures of depression and anxiety stands.

Self-reported QOL or health GRADE assessment
The WHO review included seven studies and the Defra-Arup review included four studies. Both reviews concluded there was very low quality evidence of no effect of aviation noise on self-reported quality of life or health. There is no new evidence on this outcome so that conclusion stands.

Appendix H GRADE for WHO or Defra reviews alone

Outcomes for which there was evidence from only the WHO or Defra reviews

This table shows the GRADE assessments for the quality of evidence concluded in the WHO and Defra reviews for outcomes where no new evidence was available.

Appendix table 33 Summary of the quality of evidence for birth and reproductive health outcomes from the WHO and Defra reviews where no new evidence was available

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Congenital malformations	Very low quality – Not stated in GRADE but harmful effects reported	WHO review
Low birth weight	Very low quality – Not stated in GRADE but harmful effects reported	WHO review
Preterm birth	Very low quality – Not stated in GRADE but harmful effects reported	WHO review

Appendix table 34 Summary of the quality of evidence for cognition outcomes from the WHO and Defra reviews where no new evidence was available

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Assessments of student distraction	Very low quality – Harmful effect	Defra-Arup review
Attention	Low quality – No effect	WHO review
Executive function deficit (working memory capacity)	Very low quality – No effect	WHO review
Impairment assessed through SATs	Moderate quality – Harmful effect	WHO review
Short-term and long-term (episodic) memory	Moderate quality – Harmful effect	WHO review

Appendix table 35 Summary of the quality of evidence for sleep outcomes from the WHO and Defra reviews where no new evidence was available

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Self-reported sleep disturbance in adults (source not specified)	Very low quality – Harmful effect	WHO review

Appendix table 36 Summary of the quality of evidence for cardiovascular and metabolic outcomes from the WHO and Defra reviews where no new evidence was available

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Blood pressure in children	Very low quality – No effect	WHO review
Diabetes prevalence	Very low quality – No effect	WHO review
Hypertension prevalence	Low quality – No effect	WHO review
Incidence of central obesity	GRADE not conducted – Harmful effect	Defra-RIVM review
Ischaemic heart disease mortality	Low quality – No effect	WHO review
Ischaemic heart disease prevalence	Very low quality – No effect	WHO review
Obesity (change in BMI)	Low quality – No effect	WHO review
Obesity (change in waist circumference)	Moderate quality – Harmful effect	WHO review
Obesity (incidence of overweight)	GRADE not conducted – Harmful effect	Defra-RIVM review
Obesity (weight gain)	GRADE not conducted – Harmful effect	Defra-RIVM review
Stroke prevalence	Very low quality – No effect	WHO review

Appendix table 37 Summary of the quality of evidence for quality of life, mental health and wellbeing outcomes from the WHO and Defra reviews where no new evidence was available

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Emotional and conduct disorders in children	Low quality – No effect	WHO review
Hyperactivity	Low quality – Harmful effect	WHO review
Medication intake to treat anxiety and depression	Very low quality – Harmful effect	WHO review
Wellbeing	Very low quality – Harmful effect	Defra-Arup review

Appendix table 38 Summary of the quality of evidence for cancer and general health outcomes from the WHO and Defra reviews where no new evidence was available

Outcome	Quality of evidence – Direction of effect	Source of GRADE assessment
Incidence of breast cancer	Low quality – Harmful effect	Defra-Arup review

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Annex B: ICCAN (2020b) ICCAN Survey: Experiences of aviation noise during lockdown, October 2020

October 2020

Aviation noise during lockdown

Report for ICCAN

Ben Marshall, Kyra Xypolia, Alice Walford

Ipsos MORI

Contents

1

Summary

1. Summary

- Ipsos MORI conducted a telephone survey during **18 June-13 July** for the Independent Commission on Civil Aviation Noise (ICCAN). This involved interviews with 2,006 18+ year old adults living at addresses within postcodes covered by the 2018 average summer day 54 dB $L_{Aeq,16h}$ contours around a selection of airports; Gatwick, Edinburgh, Manchester and Heathrow. East Midlands airport was also sampled using the 2019 average summer day 54 dB $L_{Aeq,16h}$ contours (further details are provided in Appendix A).

- Before the start of the coronavirus lockdown:
    - almost all of those living within the noise contour areas said they could hear aeroplane noise from where they live (92%);
    - two-thirds (66%) were bothered by aviation noise during the day, and 44% were bothered during the night;
    - just under half were moderately or slightly bothered by noise during the day (47%); and
    - noise did not impact on very high levels of satisfaction with the local area.

- Since the start of lockdown:
    - the vast majority (86%) reported hearing less aeroplane noise;
    - 61% had not noticed any changes to flight paths (29% had);
    - 13% were bothered by aeroplane noise at night, a drop from 44%;
    - the intensity and regularity of how much aeroplane noise bothers or disturbs also dropped significantly; and
    - aeroplane noise interferes with homelife significantly less than it did.

	Pre-lockdown (Q18)		Since lockdown started (Q11)	
	The day and evening (7am-11pm)	The night (11pm-7am)	The day and evening (7am-11pm)	The night (11pm-7am)
Bothered	66%	44%	28%	13%
Extremely/ very bothered	19%	11%	3%	2%
Moderately/ slightly bothered	47%	33%	25%	11%
Not bothered **at all**	34%	55%	71%	86%

Source: Ipsos MORI/ICCAN; Base: All respondents who hear aeroplane noise from where they live (pre-lockdown 1,845; since lockdown started 1,986); Fieldwork dates: 18th June – 13th July 2020. Findings might not sum to 100% due to computer rounding; more information can be found in section 2.3 of this report.

- The impact of lockdown on aeroplane noise was more pronounced than it was on other transport noise such as road or rail noise. Although a slightly higher proportion recalled hearing aeroplane noise before the lockdown period than did the same of other transport noise (92% vs. 86%), many more thought that aviation noise had decreased (86% vs. 66%).

- Around half (48%) said they would not mind if aviation noise returned to pre-lockdown levels. While fewer disagreed (38%), the strength of opinion was equally spread; a fifth strongly agreed and the same proportion strongly disagreed. The remainder, 14%, did not give an answer either way, or answered don't know.

- Younger age groups were less exposed to and bothered by aeroplane noise than other age groups, meaning that they were less likely to have noticed a reduction since lockdown. They were more likely to prioritise the environment over the industry's recovery.

- Those living around Heathrow were more likely to hear the most aeroplane noise before lockdown, with almost half saying they had heard a lot. And since lockdown started, 84% of those bothered by aeroplane noise near Heathrow reported some interference with homelife, more than elsewhere.

In summary, most of those living near to this handful of airports recall having been bothered by aeroplane noise before lockdown and said they experienced a reduction in noise since lockdown.

But despite this period of relief, far more said they 'wouldn't mind' if aviation noise returned to pre-lockdown levels than took the opposite view, and more agreed than disagreed that their local airport brings economic benefits which outweigh the disadvantages. On balance, though, local people prioritised a 'green recovery' over an aviation one.

These sentiments could change in the months and years ahead. While our annual Aviation Index for NATS has pointed to a sea change in public attitudes towards aviation and the environment as well as scepticism about the ability of the industry to become carbon neutral, coronavirus and its economic impacts might change perspectives. This means that there will be value in monitoring public sentiment as well as the experiences and attitudes of communities as air traffic movement gradually recovers to normal, or near-normal, levels.

2

Introduction

2. Introduction

This report presents findings from analysis of a survey commissioned by the Independent Commission on Civil Aviation Noise (ICCAN) undertaken during June-July 2020.

The aim of the research was to secure a quantitative measurement of local attitudes and experiences towards aviation noise during the COVID-19 period which has seen reduced levels of aviation and noise. Key research questions are as follows:

1. Has exposure to aviation noise changed during the 'lockdown' period from respondents' experiences?
2. What are the current attitudes towards aviation noise?
3. Have there been any changes in the extent to which aviation noise bothers, disturbs or annoys people?
4. Are there any factors which are contributing to people's current exposure to aviation noise, e.g. a decrease in other transport noise (rail and road), working from home or spending more time at home/ in garden?

2.1 Survey methodology

The survey was conducted using the following methodology:

- a telephone survey of 2,006 18+ year old adults living at addresses within postcodes covered by the 2018 average summer day (2019 for East Midlands) 54 dB $L_{Aeq,16h}$ contours around a purposively chosen selection of airports in Great Britain, involving a 15-minute questionnaire designed by Ipsos MORI and ICCAN;

- participants were sourced through postcodes provided by Civil Aviation Authority, from which we identified residential areas and purchased Random Digit Dialling landline telephone numbers supplemented with 'targeted' samples including mobile phone numbers;

- airports were purposively selected and split across three bands based on the volume of air transport movements around them; the 'small' band included East Midlands and Edinburgh airports, the 'medium' band involved Gatwick and Manchester airports and the 'large' one Heathrow airport;

- sampling was structured to secure a total of 2,000 interviews;

- quotas were set by age, gender and working status at aggregate level and, disproportionately, to ensure sufficient respondents within the 'small' and 'medium' bands to allow for robust disaggregation at the analysis stage;

- data has been weighted to the known population profile of the three airport bands at the aggregate level (using Census and other data sources) – by age, gender and working status – and by their respective population sizes. A more detailed breakdown of the sample can be found in **Appendix A**.

2.2 Fieldwork period and lockdown

Fieldwork was undertaken between **18 June-13 July**. Fieldwork occurred **after the easing of lockdown restrictions** announced by the Prime Minister on 10 May followed by additional easing occurring variously in different parts of the UK from 1 June. While this would *not* have had a bearing on questions using the pre-lockdown period as a reference period, it may have impacted on the amount of time spent at home, as some participants might have had to return to work after the easing of lockdown in May.

The **lockdown** was described in the questionnaire as follows:

> "As you may know, on Monday 23rd March the UK Government announced measures sometimes referred to as the 'lockdown'. These included requiring individuals to stay at home unless they could not work from home, needed to buy essential supplies, wanted to do one exercise session a day or attend a medical appointment; and closing shops selling non-essential items. The Prime Minister announced an easing of these measures on Sunday 10th May. There have also been announcements in Scotland, Wales and Northern Ireland and different rules are in place."

2.3 Interpreting data

Appendix C provides the questionnaire. Some questions generating data on the level of disturbance and type of interference from aeroplane noise were only asked of those who reported these experiences before and/or since the start of lockdown. Consequently, it should be noted that when comparing the level and type of disturbance experienced pre/post lockdown, the findings refer to separate sub-sets of the sample who reported that they had been disturbed at each time period meaning that like-for-like comparisons are indicative only.

Findings might not sum to 100% due to computer rounding. This is also the reason why combinations may not match the sum of constituent percentages e.g. the percentage 'agree' matching the percentage who 'strongly agree' and for 'tend to agree'.

The participants who took part in the survey were a selection of the total population living within the airport noise contours. We can expect an overall sampling tolerance, the upper and lower limit of error, of +/- 2.2 percentage points for a 50% finding at the '95% confidence interval' for the survey overall (this will vary for sub-groups and geographies according to their sample sizes). More information is provided in **Appendix B**.

Results are subject to some unmeasurable biases including recall bias which occurs when participants do not remember previous events or experiences accurately or omit details with the accuracy and volume of memories potentially influenced by subsequent events and experiences, as well as associated factors like social desirability bias (e.g. when reporting attitudes to the environment). Our survey measures perceptions whether or not they accord with reality.

2.4 Report structure

Following this introduction, our report covers:

3. Noise: what has changed?

4. Noise: do different sub-groups have different attitudes and experiences?

Appendices

2.5 Acknowledgements

Ipsos MORI would like to thank the 2,006 people who took the time to participate in the survey, plus Sheila Honey, Sophie Hossack and Joanna Lawino of ICCAN's Analysts team, for their help in setting up and designing the survey.

3

Noise: what has changed?

3. Noise: what has changed?

This section provides detail about the context to the survey – that is, the nature of our sample, and participants' experiences and attitudes to aeroplane noise before the lockdown started on 23rd March. It addresses two key research questions as follows:

- How much aeroplane noise could people hear from where they live before the lockdown?
- How much and how often did aeroplane noise bother, disturb or annoy them before lockdown started?

We then move on to detail participants' experiences of aeroplane noise since the lockdown started on 23rd March and cover several questions:

- How much aeroplane or other transport noise (rail or road) could people hear from where they live since the lockdown started?
- How much and how often did aeroplane noise bother, disturb or annoy them since the lockdown started?
- What aspects of the home life of those who have been bothered, disturbed or annoyed, does aeroplane noise interfere with?
- What issues have concerned people the most?
- Have people noticed any changes in flight paths since the lockdown started?

3.1 Coronavirus and impacts

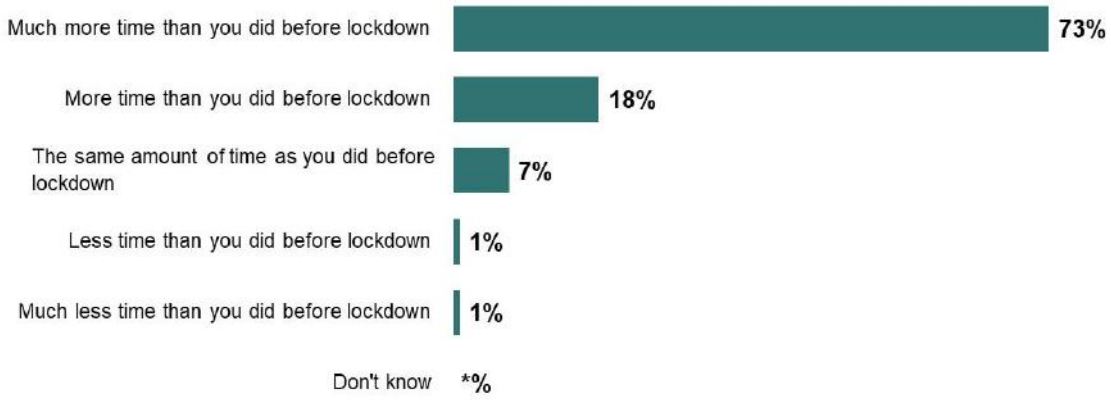
Fieldwork was conducted after the gradual easing of lockdown restrictions following 10 May, however, aspects of participants' lives still appeared to be impacted by coronavirus to a degree, including their work lives, ability to leave home as well as time spent at home.

Around a fifth of local residents said they or their colleagues had to work from home (21%) or had been a key worker (18%) since lockdown started, while one in ten reported being put in the Government's furlough scheme (10%).

One in ten reported being in a vulnerable or shielded group themselves (10%), meaning they were unable to leave home for at least 12 weeks except for an emergency, while 9% said they had someone else in the household in a vulnerable or shielded group. Around a quarter, however, said that 'none of these' aspects applied to them (28%): of which a third (34%) were retired.

Since lockdown started, there was a significant increase in the time spent at home compared to previously. Almost all of those who live near to the chosen airports (91%) reported having spent more time at home, and only 1% said they had spent less time. Seven per cent said they have spent the same amount of time at home as they did before lockdown.

Q8. Since lockdown started, how much time have you spent at home compared to previously? Would you say you have spent...?

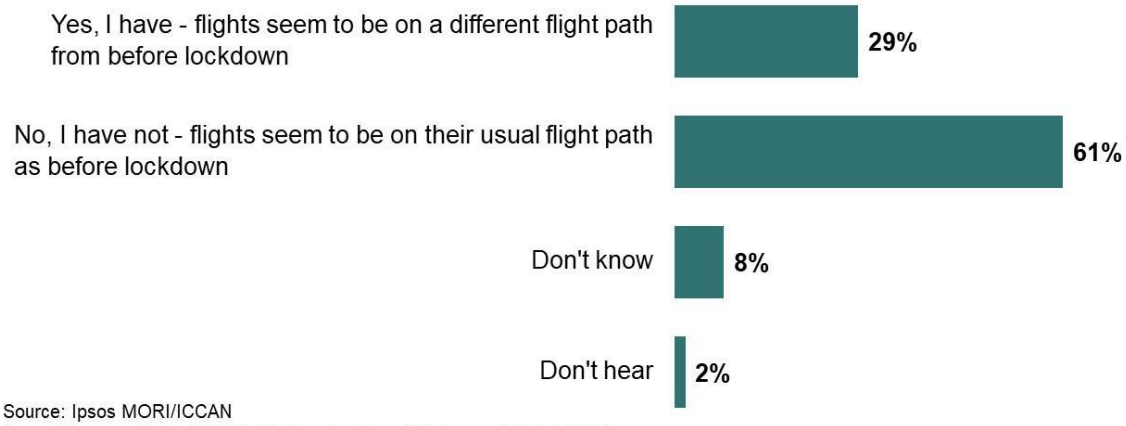


Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

Almost all of those living within the noise contour areas (96%) said they have an outdoor space at the place where they live, such as a garden, terrace, balcony or communal gardens, and only 4% said they had no outdoor space at all.

Despite the increased time spent at home, and a change in flight paths for some airports, six in ten residents living within noise contour areas had not noticed any changes (61%), although three in ten (29%) had.

Q15. During the period since lockdown started, have you noticed any changes in flight paths, or not? That is the routes that aeroplanes follow while flying in the sky. I'm interested in what you have seen rather than what you have heard in the news or anywhere else.

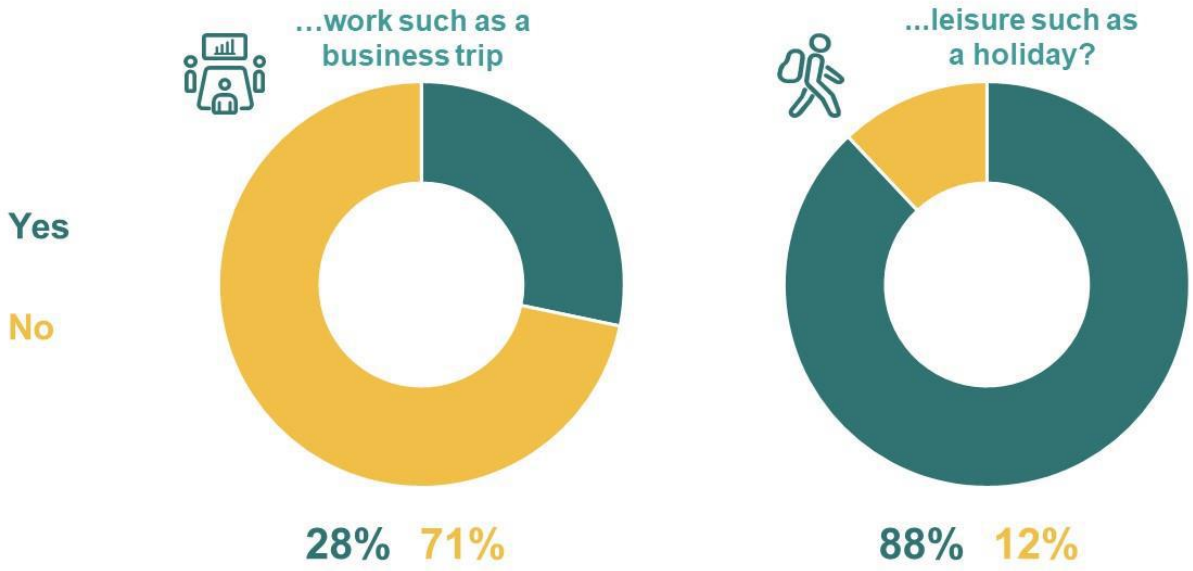


Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

3.2 Most use airports for leisure and almost half see the economic value of living nearby

The majority of residents living close to the selected airports said they had used airports for leisure, such as going on holiday in the past five years (88%). Approaching half had used airports more than once a year (45%), and a slightly lower proportion do so about once a year or less often (42%). A smaller proportion take flights from UK airports for work such as a business trip (28%); 16% do so more than once a year and 12% about once a year or less often for this reason.

Q22. In the past five years, have you personally taken any flights from any UK airport for the following reasons…?



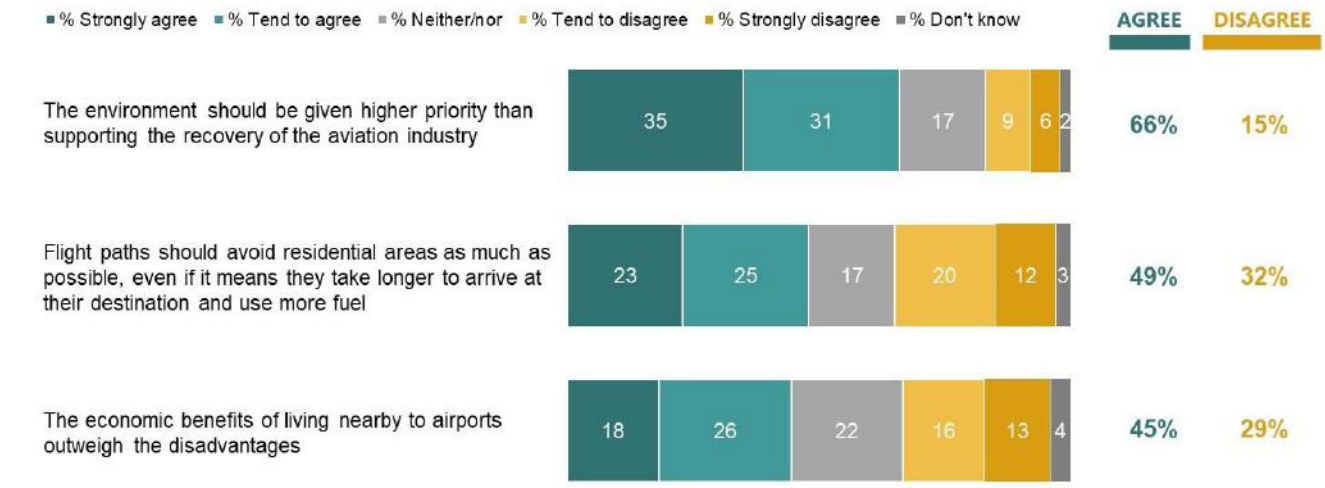
Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

A fifth reported having a connection to the aviation industry (21%) – by either themselves currently working (7%) or having used to work (8%) for an airport, an airline or a company that benefits from the aviation industry, or someone else in their household did so (5%). The majority, however, reported no connection to the aviation industry in any of these ways (79%).

Despite the majority not being connected to the aviation industry, almost half (45%) agreed that the **economic benefits** of living nearby to airports outweigh the disadvantages, more than the 29% who disagreed and 22% who neither agreed nor disagreed.

Although a clear majority (66%) believed that the **environment** should be given higher priority than supporting the recovery of the aviation industry, half (49%) thought that flight paths should avoid residential areas as much as possible, even if that means they take longer to arrive at their destination and use more fuel.

Q20. To what extent do you agree or disagree with the following statements?



Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

3.3 Most were affected by noise before lockdown…

Before lockdown began on 23 March, almost all of those living within the noise contour areas said they could hear aeroplane noise from where they live (92%). Of those who said they could hear this type of noise, four in five reported hearing it either a lot or a moderate amount (81%).

Slightly fewer reported hearing noise from other transport, such as road or rail, though this was still high at 84%. Two-thirds of those who reported hearing road or rail noise from where they live said they could hear it either a lot or a moderate amount (66%).

	Amount of aeroplane noise that could hear from where they live (Q16)	Amount of other transport noise, such as rail or road noise, that could hear from where they live (Q17)
Yes – a lot	44%	20%
Yes – a moderate amount	30%	35%
Yes – a little	18%	28%
No – not at all	**8%**	**16%**
Yes (a lot/moderate/a little)	**92%**	**84%**

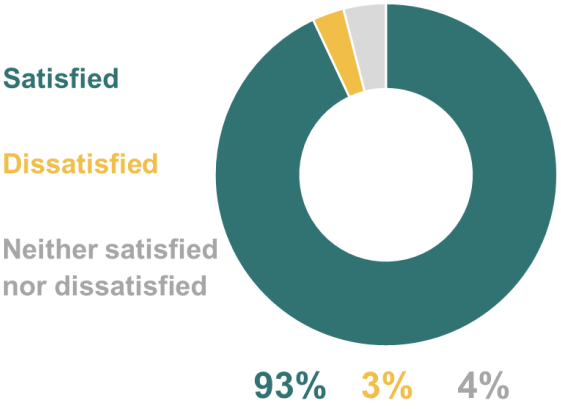
Source: Ipsos MORI/ICCAN; Base: All respondents (2,006); Fieldwork dates: 18th June – 13th July 2020

3.4 …however this did not impact their satisfaction levels with their local area

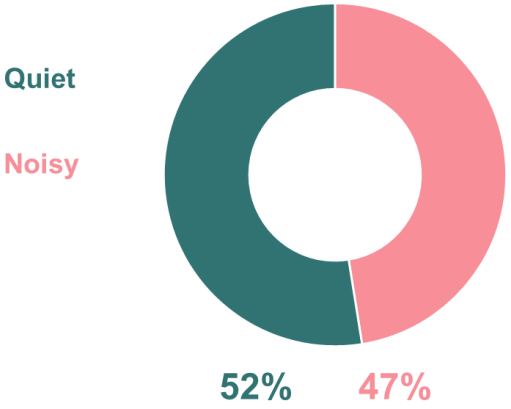
There was an even split in participants' perceptions on how noisy or quiet their local area is as a place; almost half said it is noisy (47%) and half that it is quiet (52%) (to note, we offered no definition of noisy and the questions collected participants' perceptions).

However, this did not seem to have an impact on satisfaction levels; the vast majority said they were satisfied with their local area as a place to live (93%). Only 3% expressed dissatisfaction with 4% neither satisfied nor dissatisfied.

Q5. Thinking about the local area - that is the area within 10-15 minutes' walk from where you live - overall, how satisfied or dissatisfied are you with it as a place to live?



Q6. Still thinking about the area within 10-15 minutes' walk from where you live, how noisy or quiet would you say it is as a place? Is it...?

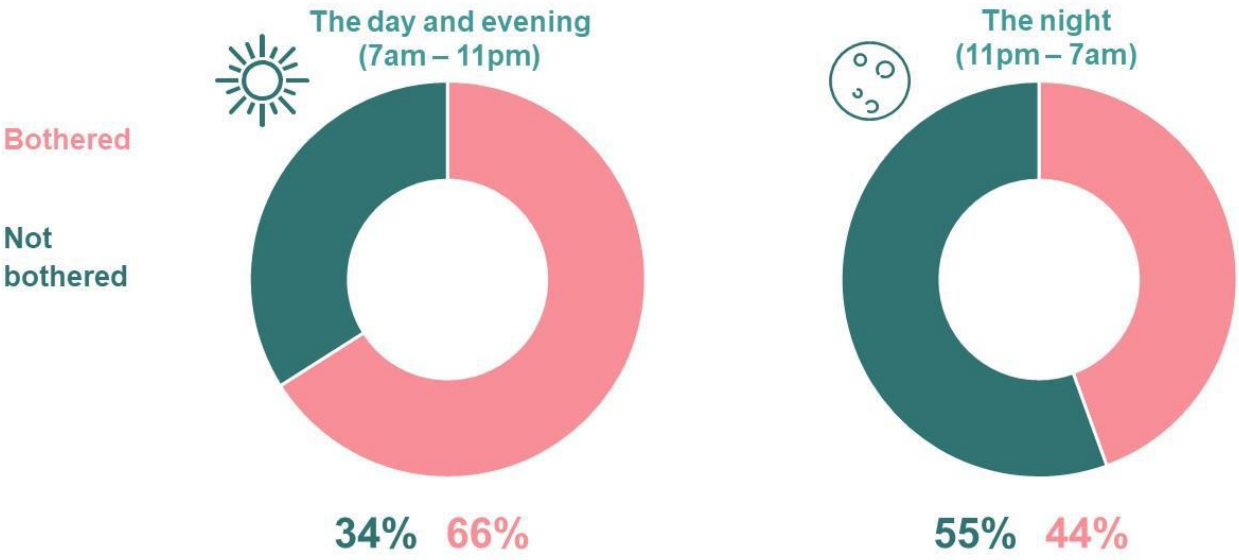


Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

3.4 Two-thirds were bothered by aviation noise during the day pre-lockdown

A higher proportion said they were bothered, disturbed or annoyed by aeroplane noise **during the day and evening** (66%) than **during the night** (44%) with day and evening defined as between 7am – 11pm and night as between 11pm – 7am.

Q18 Before the lockdown period started when you were at home during ... on average, how much, if at all, did aeroplane noise bother, disturb or annoy you?

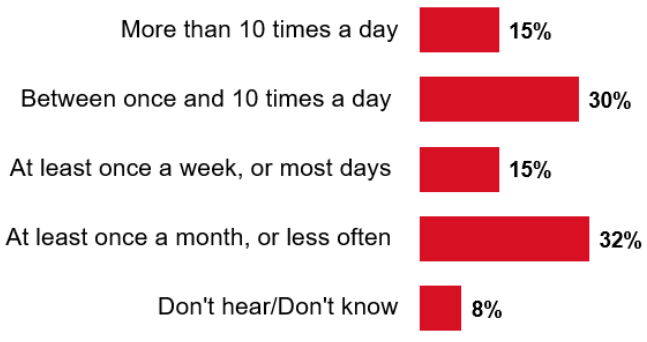


Source: Ipsos MORI/ICCAN
Base: All respondents who hear aeroplane noise from where they live (1,856) : Fieldwork dates: 18th June – 13th July 2020

Just under half were moderately or slightly bothered by noise during the day (47%), whilst 34% were not bothered by aeroplane noise during the day at all. Fewer were moderately or slightly annoyed (33%) and over half were not bothered at all by aeroplane noise at night (55%).

In the period before the start of the lockdown, the majority of those living in noise contour areas said they were bothered by aeroplane noise between once a day and ten times a day (45%). A small proportion reported high levels of disruption of more than ten times a day (15%), whilst a quarter (27%) were disturbed by this less than once a month.

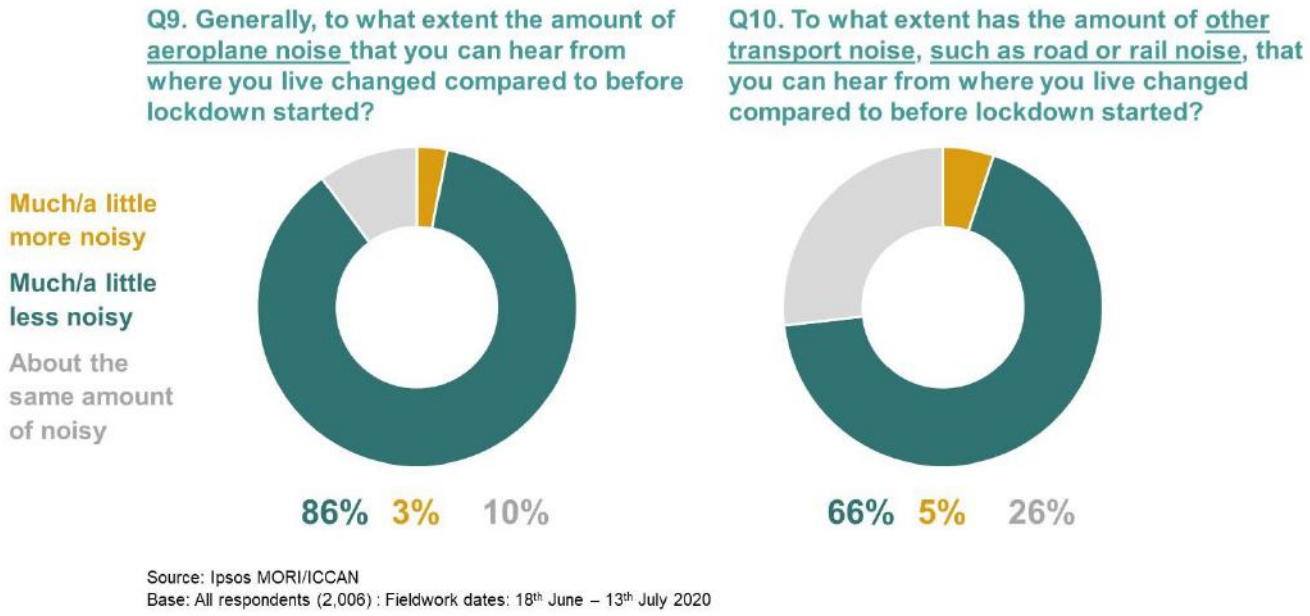
Q18A. Still thinking about the period before lockdown started, on average, how often, if at all, were you bothered, disturbed, or annoyed by aeroplane noise when you were at home?



Source: Ipsos MORI/ICCAN
Base: Q18. All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

3.5 Just under nine in ten report less aeroplane noise since lockdown started…

Despite 73% spending ***much*** more time at home than they would have done previously, the vast majority (86%) reported hearing **less aeroplane noise** from where they live compared with before lockdown started. Very few have found it more noisy (3%), and one in ten (10%) felt that the level of noise produced by aircrafts has stayed the same.



Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

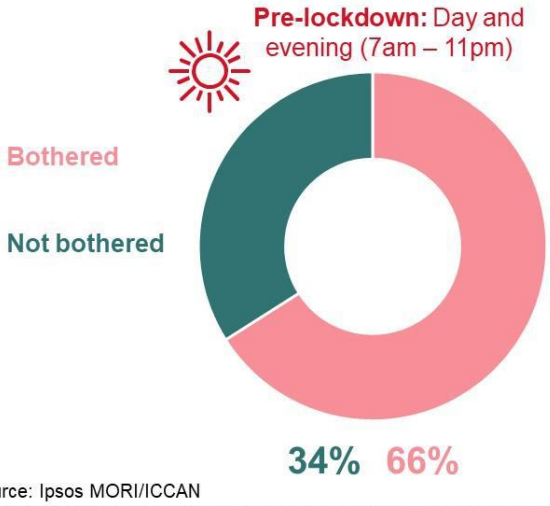
Although a slightly higher proportion recalled hearing aeroplane noise before the lockdown period than did the same of other transport noise such as road or rail noise (92% vs. 84% respectively), many more thought that aviation noise **had decreased** (86% vs. 66%) and fewer, one in ten (10% vs. 26%), thought this type of noise had stayed the same.

3.6 …and noise as being less bothersome

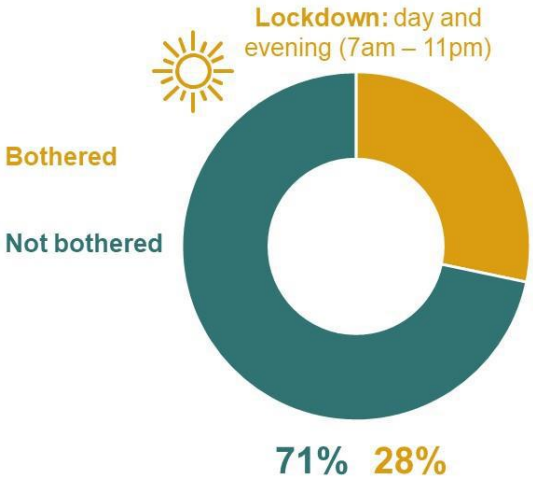
A reduction in aeroplane noise levels has been accompanied by a **significant decline** in the proportion of people **feeling bothered** by this type of noise throughout the lockdown period, both during the day and night.

Among those who can hear aeroplane noise from where they live, 71% felt that aeroplane noise has **not** been a bother or annoyance during the day and evening, compared with half that proportion, 34%, pre-lockdown. Moreover, the **intensity** of feeling bothered has also dropped significantly; 1% said they have felt extremely bothered by aeroplane noise between 7am – 11pm since the start of lockdown compared with 7% who said the same before lockdown.

Q18 Before the lockdown period started when you were at home during ... on average, how much, if at all, did aeroplane noise bother, disturb or annoy you?



Q11. Still thinking about the period since the lockdown started, when you have been at home during ... on average, how much, if at all, has aeroplane noise bothered, disturbed or annoyed you?



Source: Ipsos MORI/ICCAN
Base: Q18. All respondents who could hear aeroplane noise from where they live before lockdown started (1,856); Q11. All respondents who could hear aeroplane noise from where they live since lockdown started (1,978) : Fieldwork dates: 18th June – 13th July 2020

There is an even greater difference between reported disturbance levels as a result of aeroplane noise heard at night (between 11pm – 7am) expressed before and during lockdown. Only 13% were bothered by aeroplane noise **at night** during lockdown, significantly lower than pre-lockdown levels at 44%.

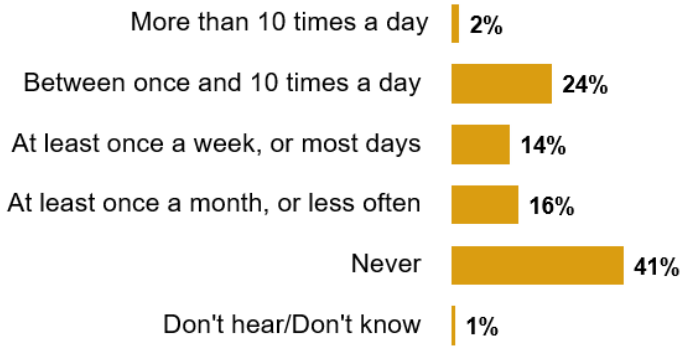
The proportion who are **not** bothered by aeroplane noise during the day, evening or night has increased significantly. The majority reported that this type of noise has not bothered them at all since the lockdown started (with 71% not being bothered during the day and evening and 86% during the night), compared with 34% (day and evening) and 55% (night) who did not find this noise disturbing before lockdown.

	Pre-lockdown (Q18)		Since lockdown started (Q11)	
	The day and evening (7am-11pm)	The night (11pm-7am)	The day and evening (7am-11pm)	The night (11pm-7am)
Extremely/ very bothered	19%	11%	3%	2%
Moderately/ slightly bothered	47%	33%	25%	11%
Bothered	**66%**	**44%**	**28%**	**13%**
Not bothered at all	34%	55%	71%	86%

Source: Ipsos MORI/ICCAN; Base: All respondents who **hear aeroplane noise from where they live** (pre-lockdown 1,856; since lockdown started 1,978); Fieldwork dates: 18th June – 13th July 2020

The **regularity** of how much aeroplane noise bothers or disturbs those living nearby airports has also dropped significantly since lockdown started. Among those saying they hear any noise from where they live, the greatest proportion answered they were never disturbed, annoyed or bothered by aeroplane noise in the period since lockdown started (41%). A quarter (26%) reported being bothered between once to more than ten times a day when they have been at home, compared with 45% previously. Additionally, only 2% reported more than 10 instances a day of aeroplane noise disturbances since lockdown started, much less than the 15% pre-lockdown.

Q12. On average, how often, if at all, would you say you have been bothered, disturbed, or annoyed by aeroplane noise when you have been at home in the period since lockdown started? Has it been…?



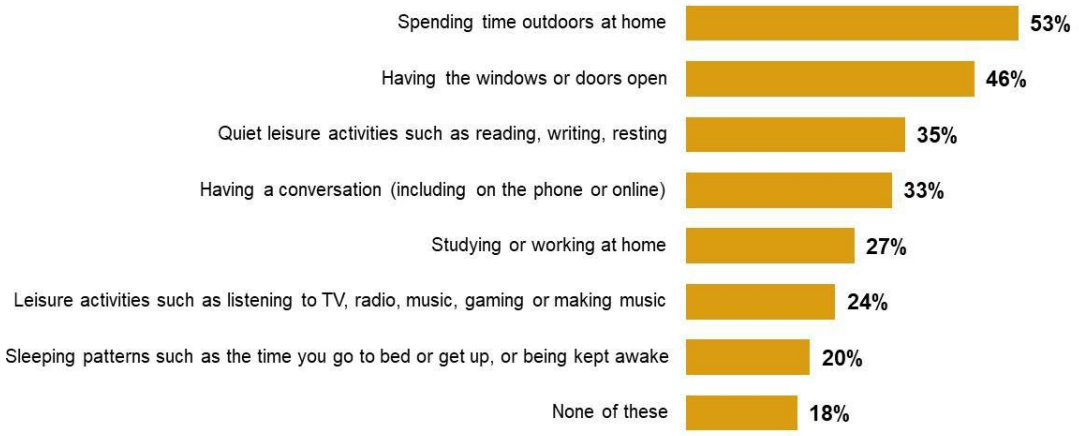
Source: Ipsos MORI/ICCAN
Base: Q12. All respondents who hear aeroplane noise from where they live (1,955)

3.7 Most interference is with time outdoors plus having windows and doors open

Among the 56% who reported feeling bothered, disturbed or annoyed by aeroplane noise in the period since lockdown started, 53% said that this interferes with them spending **time outdoors** whilst at home.

The second main aspect of home life that aeroplane noise interferes with is being able to have windows or doors open (chosen from a read-out list by 46%). Aeroplane noise during lockdown was considered least disruptive to sleeping patterns and leisure activities such as listening to TV or music, with only 20% and 24% reporting these as problems.

Q13. You said that you had been bothered, disturbed, or annoyed by aeroplane noise in the period since lockdown started. Which of these aspects of your home life, if any, does this interfere with?

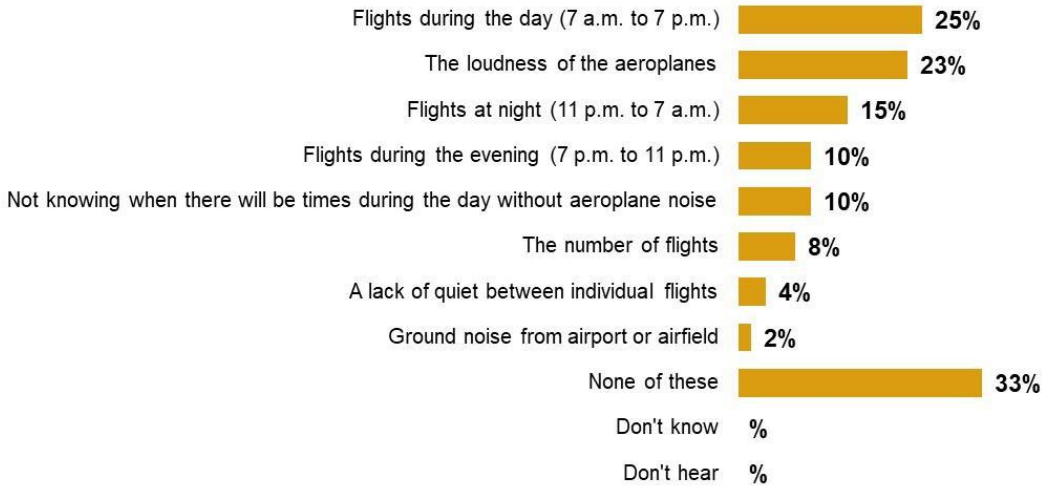


Source: Ipsos MORI/ICCAN
Base: All respondents who are bothered, disturbed or annoyed by aeroplane noise since lockdown (1,023) : Fieldwork dates: 18th June – 13th July 2020

The greatest concern for residents who were bothered by aeroplane noise throughout lockdown was flights that occur during the day between 7am and 7pm. 25% chose this from a list read out by interviewers as something that has concerned them the most, closely followed by the loudness of planes (23%). Additionally, people were more concerned about flights during the night from 11pm – 7am (15%) than they were of flights between 7pm – 11pm (10%).

Issues considered least concerning were the ground noise from the airport (2%), a lack of quiet between individual flights (4%) and the number of flights (8%).

Q14. Still thinking about aeroplane noise and the period since lockdown started, which one or two of the following issues, if any, have concerned you the most?

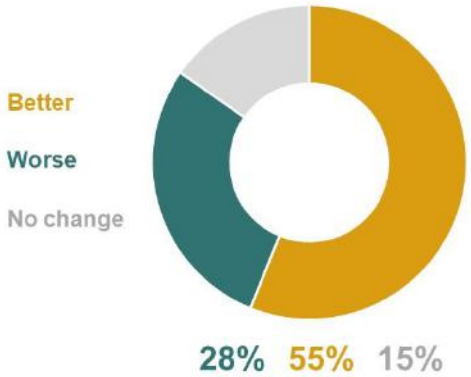


Source: Ipsos MORI/ICCAN
Base: All respondents who are bothered, disturbed or annoyed by aeroplane noise since lockdown (1,023) :
Fieldwork dates: 18th June – 13th July 2020

3.8 Aeroplane noise interferes with homelife significantly less than it did

Just over half, 55%, of the 46% of all residents bothered by aeroplane noise since lockdown started, believe that its interference with homelife has **got better** since the start of the lockdown period. However, three in ten maintain that interference has **got worse** since lockdown started (28%).

Q18B. You said earlier that aspects of your home life are interfered with because of aeroplane noise. In general, was this worse or better before lockdown started or has there been no change?



Source: Ipsos MORI/ICCAN
Base: All respondents who home life has been interfered with by aeroplane noise (801) :
Fieldwork dates: 18th June – 13th July 2020

Among the 28% who felt that interference got worse, most said that aeroplane noise interferes with spending time outdoors at home (65%), having the windows or doors open (59%), quiet leisure activities such as reading, writing, resting (49%) and having a conversation, including on the phone or online (46%). Three in ten of this group also said that this type of noise interferes with studying or working at home (34%), leisure activities such as listening to TV (30%) and sleeping patterns (30%).

Around half (48%) of all respondents said they would not mind if aviation **noise returned to pre-lockdown levels**. While fewer disagreed with this statement (38%), more strongly held opinion was equally spread; a fifth strongly agreed (20%) and the same proportion strongly disagreed (20%). Among those who agreed with the statement, two fifths were bothered less often than once a month before the lockdown (39%) and around a third were bothered once to ten times a day (30%).

	I don't mind if noise from aviation goes back to what it was before lockdown
Strongly agree	20%
Tend to agree	29%
Neither agree nor disagree	12%
Tend to disagree	18%
Strongly disagree	20%
Agree	**48%**
Disagree	**38%**

Source: Ipsos MORI/ICCAN; Base: All respondents (2,006); Fieldwork dates: 18th June – 13th July 2020

4

Noise: where is there difference?

4. Noise: where is there difference?

This section summarises some differences among different **geographic and demographic** groups of interest, particularly in respect of the following research questions:

- Do experiences of and attitudes to aeroplane noise differ among geographic and demographic groups?
- Have experiences and attitudes changed among different groups since lockdown started? If so, how?
- Are there any factors which are contributing to people's current exposure to aviation noise?

Our focus is commentary on the similarities and differences between different groups meaning that we have **not** confined analysis to statistically significant difference. We comment on differences among age groups and those living near to 'small' (East Midlands and Edinburgh), 'medium' (Manchester and Gatwick) and 'large' (Heathrow) airports based on air transport movements provided by the Civil Aviation Industry (CAA) via ICCAN. However, we should recognise that differences between geographies and groups are likely to reflect numerous, overlapping factors – for example, age and time spent at home since lockdown started, while the population living near to Heathrow was younger than the population elsewhere.

Again, questions that report on the level of disturbance and type of interference from aeroplane noise were only asked to those who reported these experiences before and/or since the start of lockdown. It should therefore be noted that when comparing the level and type of disturbance experienced pre/post lockdown, the findings refer to separate sub-sets of the sample who reported that they had been disturbed at each time period meaning that a like-for-like comparison is not possible.

Differences by age

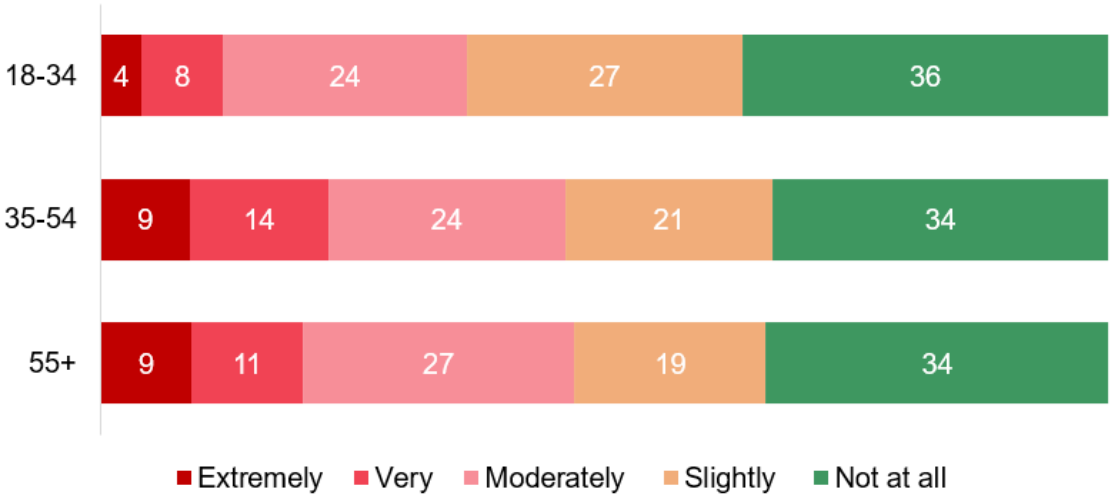
4.1 Younger age groups felt less exposed to and bothered by aeroplane noise…

There was a disparity in perception of exposure to aeroplane noise among different age groups before lockdown. Almost half of those aged 35-54 (48%) and those aged 55 or older (48%) were more likely to hear a lot of aeroplane noise, compared with a just a third of younger 18-34-year olds (35%). The younger age group were also more likely to not hear *any* aeroplane noise at all (12%), compared with just 8% of 35-54-year olds and only 4% of those aged 55+.

The young were, though, no more likely to say they heard other transport noise, such as road or rail, before lockdown than older age groups (83% for both). Middle-aged groups stand out more here; a quarter of 35-54-year olds were more likely to hear a lot of other transport noise compared with a fifth of younger and older groups (23% vs. 19%).

Those aged 35-54 or 55+ were more likely to have been extremely (9% for both) or very (14% and 11% respectively) **bothered, disturbed or annoyed** by aeroplane noise during the day or evening before the lockdown, compared with those aged 18-34-year olds (4% saying extremely and 8% very bothered). The younger group were more likely to be only slightly bothered; 27% compared to 21% of 35-54-year olds and 19% of 55+ year olds.

Q18. Before the lockdown period started when you were at home during the day and evening (7am-11pm) on average, how much, if at all, did aeroplane noise bother, disturb or annoy you?



Source: Ipsos MORI/ICCAN
Base: Q18. All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

A fifth of those aged 35-54 and 55+ were more likely to say they were bothered more than 10 times a day (20% and 17% respectively) compared with only 8% of 18-34-year olds. Younger groups were more likely to be bothered less often than that, i.e. at least once a week or at least once a month.

4.2 …meaning they were less likely to have noticed a reduction since lockdown

Since the start of lockdown, those aged 35-54 or 55+ experienced a significant decrease in this type of noise since lockdown started, with around three quarters saying it has been much less noisy (74% and 76% respectively). Even though not significantly different compared to other age groups, half of 18-34-year olds still said it has been much less noisy (51%). By comparison, those aged 18-34 were more likely to say it has been a little less noisy (29% vs.14% of those aged 35-54 and 16% of 55+ year olds) or about the same amount of noisy (14% vs. 9% of those aged 35-54 and 5% of 55+ year olds).

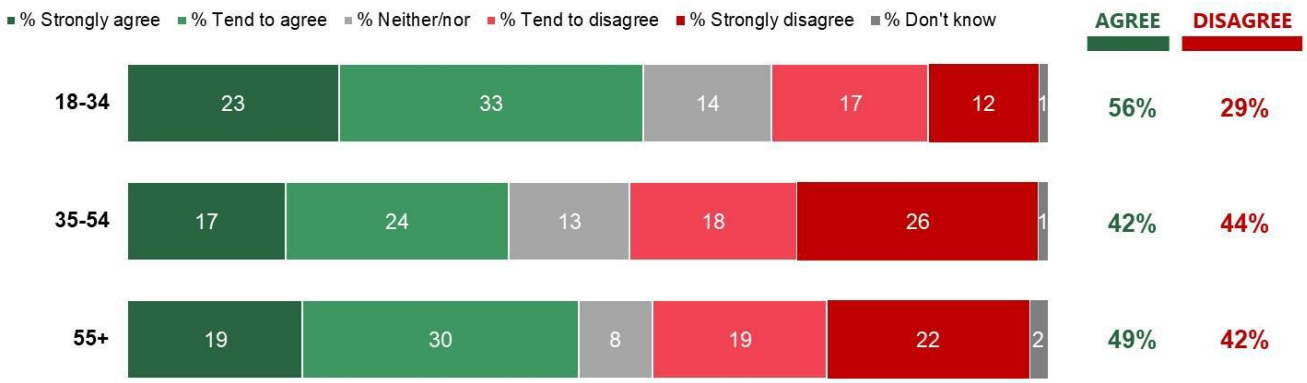
	Amount of aeroplane noise that I can hear from where I live has changed compared with before lockdown		
	18-34 year olds	**35-54 year olds**	**55+ year olds**
Much more noisy	1%	1%	1%
A little more noisy	3%	1%	1%
About the same amount of noisy	14%	9%	5%
A little less noisy	29%	14%	16%
Much less noisy	51%	74%	76%
Don't know/Don't hear	2%	1%	1%
More noisy	**4%**	**2%**	**2%**
Less noisy	**80%**	**88%**	**91%**

Similarly, those aged 35-54 and 55+ were more likely than younger age groups to report a drop in the amount of other transport noise (road or rail) they can hear from where they live, with about two fifths saying it has been much less noisy (39% and 41%) since the start of the lockdown, compared with only one fifth of 18-34 (20%).

Levels of annoyance among those who could hear aeroplane noise since lockdown started, varied across age groups. Thus, three-quarters of 35-54-year olds were more likely to be not bothered at all during the day or evening (74%) compared with 67% of 18-34-year olds and 72% of 55+ year olds. A third of the younger group were more likely to still be bothered during the day or evening (33%) compared with 35-54-year olds (25%). During the night, there were no significant differences among age groups, but 55+ year olds were slightly more likely to not be bothered at all compared with the average (88% vs. 86% respectively).

Nonetheless, over half of those aged 18-34-years old were more likely to not mind if noise from aviation goes back to what it was before lockdown (56% vs. 42% of 35-54s and 49% of those 55+). In contrast, those in older groups were more likely to **disagree**, meaning they would mind if noise levels returned to those before lockdown (44% of 35-54-year olds and 42% of 55+year olds vs. 29% of 18-34-year olds).

Q20. To what extent do you agree or disagree with the following statements? I don't mind if noise from aviation goes back to what it was before lockdown



Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

4.3 Since lockdown started, age groups have been affected by noise in different ways

Of those who said they had been bothered by aeroplane noise since lockdown started, 18-34-year olds were most likely to say that aeroplane noise interfered with quiet leisure activities (43%) or studying or working at home since lockdown started (40%). Interference was more likely to be moderately better (26%) or not changed (23%) compared to before lockdown.

Sleeping patterns were more likely to be affected for those aged 35-54-years old, with a quarter of them saying so (24%). However, along with those aged 55+, 35-54-year olds were also more likely to say that aeroplane noise didn't interfere with *any* of these aspects of home life (21% of 35-54s and 26% of those 55+ year olds). Of those who said aspects of their home life are interfered with because of aeroplane noise, both the older age groups were more likely to say that compared with before lockdown, it has been either a lot better (47% of 35-54s and 49% of 55+ year olds) or a lot worse (19% 35-54s and 16% of 55+s).

There were some differences among age groups in the issues concerning them the most. For example, of 18-34-years old who were bothered by aeroplane noise since lockdown, they were relatively more likely than other older age groups to be concerned by:

- not knowing when there will be times during the day without aeroplane noise (13%);
- flights during the evening (7pm to 11pm) (11%); and
- a lack of quiet between individual flights (6%).

Those aged 35-54-years old were more likely to be concerned than one or the other age groups by:

- flights at night (11pm to 7am) (20%);
- 'none of these' aspects (36%);
- flights during the evening (7pm to 11pm) (12%); and
- and a lack of quiet between individual flights (3%).

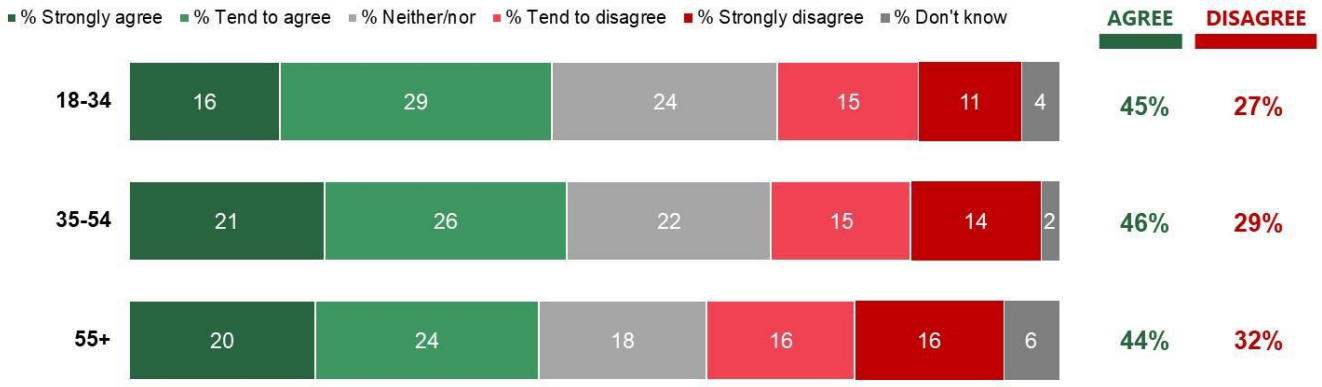
Those aged 55 or older were more likely to be concerned than those aged 18-34-years by:

- flights at night (11pm to 7am) (17%); and
- 'none of these' aspects of home life (40%).

4.4 Older age groups more likely to see the economic value of living close to an airport…

There were few notable differences among age groups in their attitudes to the economic benefits of living nearby to airports outweighing the disadvantages, with only two exceptions; 18-34-year olds were more likely to neither agree nor disagree compared with 55+ year olds (24% vs. 18%) and 35-54-year olds were more likely to strongly agree compared with 18-34 year olds (21% vs. 16%). However, those aged 55+ were more likely to disagree compared with the average (32% vs. 29%).

Q20. To what extent do you agree or disagree with the following statements? The economic benefits of living nearby to airports outweigh the disadvantages



Source: Ipsos MORI/ICCAN
Base: All respondents (2,006) : Fieldwork dates: 18th June – 13th July 2020

4.4 …while younger age groups more likely to prioritise the environment over the industry's recovery

Those in the younger group were more likely to agree that the **environment should be given higher priority** than supporting the recovery of the aviation industry (72% of 18-34-year olds vs. 62% of 35-54-year olds and 65% of 55+ year olds).

A consistent pattern in attitudes to the environment is also evident in terms of 'flight paths should avoid residential areas as much as possible, even if it means they take longer to arrive at their destination and use more fuel'. Younger groups were more likely to disagree (47% vs. 28% of 35-54-year olds and 20% of those 55+). Conversely, **older groups were more likely to agree** (54% of 35-54-year olds and 61% of those 55+ vs. 32% of 18-34-year olds).

	The environment should be given higher priority than supporting the recovery of the aviation industry			Flight paths should avoid residential areas as much as possible, even if it means they take longer to arrive at their destination and use more fuel		
	18-34s	**35-54s**	**55+s**	**18-34s**	**35-54s**	**55+s**
Strongly disagree	4%	7%	6%	18%	11%	8%
Tend to disagree	8%	9%	9%	30%	17%	11%
Neither agree nor disagree	15%	19%	16%	19%	16%	15%
Tend to agree	37%	28%	29%	20%	28%	28%
Strongly agree	36%	34%	36%	13%	26%	33%
Don't know	1%	2%	4%	2%	2%	4%
Agree	**72%**	**62%**	**65%**	**32%**	**54%**	**61%**
Disagree	**12%**	**17%**	**15%**	**47%**	**28%**	**20%**

Source: Ipsos MORI/ICCAN; Base: All respondents (2,006); Fieldwork dates: 18th June – 13th July 2020

Differences by age in summary:

- **Younger age groups felt less exposed to and bothered by aeroplane noise than other age groups, meaning that they were less likely to have noticed a reduction since lockdown. They were more likely to prioritise the environment over the industry's recovery, and less likely to mind if aviation noise would go back to what it was before lockdown.**
- **Older age groups were more likely to see the economic value of living close to an airport, and more likely to prioritise the industry's recovery over the environment. They felt more exposed than younger people before lockdown, but they were more likely to have noticed a significant reduction in aeroplane noise since lockdown started.**
- **Since lockdown started, age groups have been affected by noise in different ways. Aeroplane noise interfered with different aspects of their home life; quiet leisure activities or studying or working at home for younger people, sleeping patterns for older age groups. The latter group were more likely to notice a major improvement since lockdown started, with almost half saying it has been a lot better.**

Differences by airport band

4.5 Heathrow's local community most affected

Those around Heathrow were more likely to **hear the most aeroplane noise** before lockdown, with almost half saying they had heard a lot (46%), compared with around a third of those around small (28%) or medium airports (32%). Those living around small or medium airports were more likely to hear this type of noise a little (28% and 25% respectively) with those close to small airports also more likely to say not at all compared with those living close to Heathrow, albeit a minority (12% vs 7%).

Those around small airports were also more likely to hear other transport noise (road or rail) a little before the lockdown (36% against 27% of medium and 28% of Heathrow). Although by comparison, there were no other significant differences among airport bands, around at least a third could hear a moderate amount (35% of small-airport communities, 39% of medium, 34% of Heathrow).

Some differences in levels of annoyance between airport bands were also observed. Those living around small or medium airports were more likely to not be bothered neither during the day or evening (53% and 51%) nor the night (61% and 74%) before the lockdown. Those near to Heathrow airport were more likely to be bothered; 70% during the day or evening (against 47% of small and 48% for medium) and 47% during the night (against 39% for small and 25% for medium).

Those living around Heathrow were more likely to be bothered more than 10 times a day (16% vs. 9% around small or medium airports), and more likely to be bothered most days (6% vs. 2% around small and 3% around medium airports). Those living around small or medium airports were more likely to be bothered less often (45% and 47% respectively, against 23% of Heathrow).

4.6 Communities around medium airports experienced the biggest decrease in aeroplane noise

Three-quarters of people living near to medium airports (i.e. Gatwick and Manchester) think aeroplane noise has been **much less noisy** (75%) compared with around two-thirds of those living around Heathrow or small airports (65% and 58%). A fifth of those living around Heathrow were more likely to say it has been a little less noisy (21%) for them, while those around small airports were more likely to say that the amount of aeroplane noise has remained about the same (18%) – however, they also felt less exposed to this type of noise before lockdown.

A decrease in exposure to other transport noise was experienced across different airports. Four in ten of those living around medium airports were more likely to say it has been much less noisy (40%) compared with a third, 32%, of those around Heathrow.

Those living near to Heathrow and small airports were more likely to **still be bothered** during the day and evening (32% of Heathrow and 17% of small, against 10% of medium) with around a quarter of them being moderately or slightly bothered. The majority of those living around small or medium airports, however, were more likely to say they have not been bothered at all since lockdown started (82% and 90% respectively, against 67%).

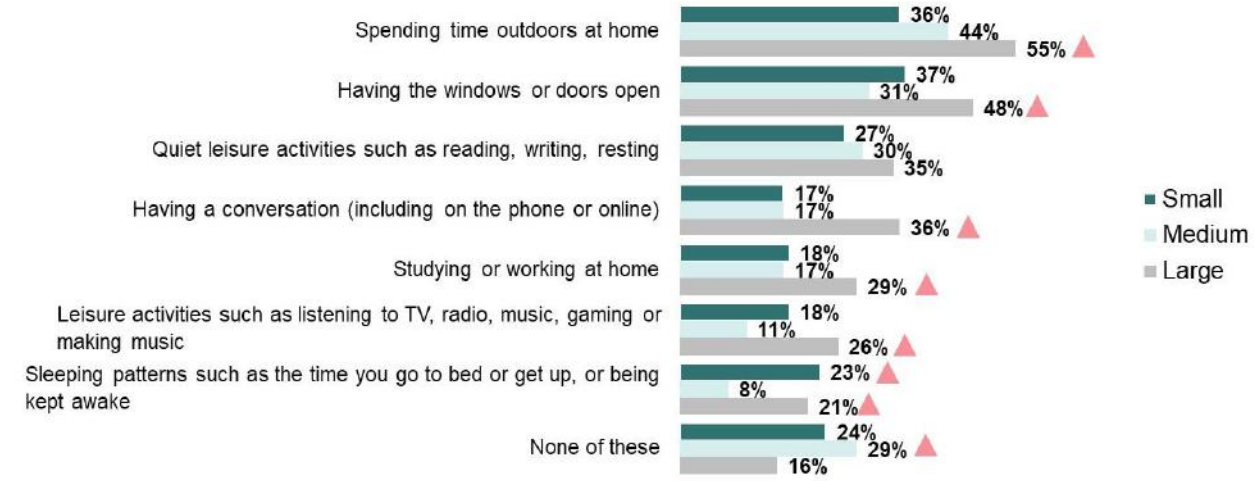
During the night, the vast majority of those around medium airports said they were not bothered at all (97%) compared with 88% of small and 84% of Heathrow. Those around Heathrow or small airports were more likely to have still been moderately or slightly bothered (12% and 15% vs. 2%).

Reflecting their experiences and levels of annoyance, there was a disparity in attitudes to future aviation noise. Those around small or medium airports were more likely to agree that they don't mind if aviation noise returned to pre-lockdown levels (63% and 65% respectively against 45% of Heathrow), whereas those around Heathrow airport were more likely to disagree (42% vs. 23% near to small and 21% for medium airports).

4.7 84% of people bothered by noise near Heathrow reported some interference with homelife since lockdown started

Those living around Heathrow and who were bothered by noise were more likely to say that aeroplane noise interferes with *any* of the aspects of their home life provided in the list (shown in the figure below). While more than a quarter of those around medium airports chose 'none of these' (29%) it was just 16% of those around Heathrow.

Q13. You said that you had been bothered, disturbed, or annoyed by aeroplane noise in the period since lockdown started. Which of these aspects of your home life, if any, does this interfere with?



Source: Ipsos MORI/ICCAN
Base: All respondents who are bothered, disturbed or annoyed by aeroplane noise since lockdown (1,023) : Fieldwork dates: 18th June – 13th July 2020

▲ Statistically significant difference compared to other groups (see Appendix B)

Overall, of those bothered by aeroplane noise during lockdown, over half (55%) felt that interference with homelife has got better since lockdown started. However, those around small and medium airports were more likely to say there was **no change** compared to the period before lockdown started (24% and 23% against 14% of those around Heathrow). Residents living in proximity to Heathrow airport were more likely to say it has **been worse** since lockdown started (29%), compared with those around small airports (15%).

4.7 Different issues concerned each airport band the most

There were also a few differences among airport bands in terms of the issues concerning them the most. Over a half of those around medium airports were more likely to say 'none of these' aspects (56% against 35% of small airports and 31% of Heathrow).

Those around small airports were more likely to be concerned than one or other airport bands by:

- flights at night (11pm to 7am) (27%);
- flights during the evening (7pm to 11pm) (13%); and
- ground noise from airport or airfield (5%).

Those around Heathrow airport were more likely to be concerned than one or other airport bands by:

- flights during the day (7am to 7pm) (26%);
- flights at night (11pm to 7am) (16%);
- flights during the evening (7pm to 11pm) (11%); and
- not knowing when there will be times during the day without aeroplane noise (11%).

4.8 Airports also a factor in differences in attitudes

Over half of those around medium airports were more likely to agree that the economic benefits of living nearby to airports outweigh the disadvantages (58% respectively vs. 49% of small airports and 43% of Heathrow). On the contrary, those around Heathrow were more likely to disagree (32% vs. 22% of small and 17% of medium airports).

A majority of those around Heathrow were more likely to say that the environment should be given higher priority than supporting the recovery of the aviation industry (68% against 56% of small and 62% medium airports). A fifth of those living near to small airports were more likely to disagree with that statement (22% vs. 14% and 15% of Heathrow and medium airports).

Only those around medium airports were more likely to disagree with 'flight paths should avoid residential areas as much as possible, even if it means they take longer to arrive at their destination and use more fuel' (37%) compared with those around Heathrow (31%) and small airports (33%).

4.9 Newly overflown not more exposed and less likely to be bothered since lockdown started

Some of the residents around Heathrow that we interviewed live in areas which were overflown only since lockdown started and not before. We call this group 'newly overflown', and have included a definition in Appendix A. The most notable points of comparison with the 'not newly overflown', were as follows:

- Those who live in newly overflown areas were no more or less likely to notice **any changes in flight paths** since lockdown started. Almost six in ten of them had *not* noticed any changes in flight paths (59%), while a quarter of them had (25%).
- There were *no* significant differences in perception of noise levels to noise since lockdown started either; the majority of those in newly overflown areas thought it has been less noisy (88%).
- However, those in newly overflown areas were ***less* likely to have been bothered**, disturbed, or annoyed during the day or evening since lockdown started compared with those in *not* newly overflown areas around Heathrow, both during the day and evening (22% bothered against 33%).
- The regularity of bother, disturbance or annoyance since lockdown started also differed between the two groups; newly overflown were more likely to have never been bothered (50% vs. 36%) or to have been bothered at least once a month (8% vs. 4%). On the contrary, those in *not* newly overflown areas were more likely to have been **bothered more regularly**, i.e. between once to more than ten times a day (30% vs. 18%).
- There were no notable differences in the issues concerning the two groups the most. However, there were a couple of differences in aspects of home life interfered with by aeroplane noise since lockdown started, with those in newly overflown areas being *less* likely to say the following compared to the other group of residents around Heathrow:
    - Spending time outdoors at home (42% vs. 56%)
    - Quiet leisure activities such as reading, writing, resting (24% vs. 37%)

Differences by airport bands in summary:

- **Communities around Heathrow were more likely to hear the most aeroplane noise and be bothered by it before lockdown. Although they noticed a small reduction in noise levels since lockdown started, they were more likely than those near to other airports to still be bothered. Most of those who were bothered reported some interference with homelife; again, more than elsewhere.**
- **Those living around small or medium airports were more likely to *not* be bothered by aeroplane noise during the day or evening before and after lockdown. They were also more likely to *not* have noticed any change in noise levels since lockdown started, but they were also more likely to hear aeroplane noise only a little before.**
- **Residents around medium airports more likely to see the economic benefits of living close to an airport, and less likely to think that 'flight paths should avoid residential areas as much as possible, even if it means they take longer to arrive at their destination and use more fuel'**
- **Those in newly overflown areas around Heathrow were no more or less likely to have noticed any changes in flight paths since lockdown started, with most saying they have not noticed any change. They were less likely to have been bothered by aeroplane noise since lockdown started, and when they did it has been less often compared with those in *not* newly overflown areas.**

Differences by connection to aviation industry

4.10 Much less noisy since lockdown started for those associated with the aviation industry

We compared those who had a connection to/association with the aviation industry (by currently working or used to be working or living with someone else in the household who currently works for an airport, an airline or a company that benefits from the aviation industry) and those had no such connection or association. There were a few notable differences as follows:

- Those with a connection to the aviation industry were more likely to agree that **the economic benefits** of living nearby to airports outweigh the disadvantages compared with those with no connection (63% vs. 40%). Those with no connection were more likely to *disagree* (32% vs. 17%).
- Those with a connection were more likely to *disagree* that **the environment** should be given higher priority than supporting the recovery of the aviation industry (23% against 13% of those with no connection). Almost seven in ten of those with no connection were more likely to agree (69%) compared with almost six in ten of those with a connection to the aviation industry (59%).
- A similar pattern was also seen in response to the statement 'flight paths should avoid residential areas as much as possible, even if it means they take longer to arrive at their destination and use'; those with a connection were more likely to disagree (39% vs. 30%), whereas those with no connection were more likely to agree (50% vs. 43%).

- Seven in ten of those who were associated with the aviation industry said that it had been ‘much less noisy’ since lockdown started (72% against 65% of those with no association). However, there were no significant differences in perceived exposure levels before lockdown between the two groups, with the majority of both saying they could hear a lot or a moderate amount of aeroplane noise.
- There were also no significant differences between them in views on whether they would like noise from aviation to go back to what it was before lockdown, with half of those associated with the aviation industry not minding this (53%).
- Four in ten of those with a connection were more likely to say they were not bothered at all during the day or evening before lockdown (40% vs. 32%), whereas the majority of those with no connection were more likely to be bothered (68% vs. 60%).
- There were no significant differences in **regularity of annoyance** since lockdown started, however, those associated with the aviation industry were more likely to be bothered less regularly before lockdown i.e. at least once a week (13% vs. 9%) but also to say they ‘don’t hear’ (9% vs. 5%). Those with no association were more likely to say they were bothered between once to more than ten times a day (46% vs. 40%).
- Finally, those with a connection to the aviation industry were more likely to have spotted changes in flight paths (34% against 28% of those with no connection).

5

Appendices

Appendices

Appendix A – Sampling and sample profile

The survey involved interviews with 2,006 18+ year old adults living at addresses within postcodes covered by the 2018 average summer day 54 dB $L_{Aeq,16h}$ contours (2019 for East Midlands) around a selection of airports. CAA provided a list of postcodes covered by the contours.

More information can be found in ICCAN's *A review of aviation noise metrics and measurement* published in July 2020.[1]

Table A.1: Sample size, unweighted and weighted %s for selected population groups

Population group	Sample size (unweighted)	Unweighted %	Weighted %
Adults aged 18+ living within postcodes	2,006	100	100
East Midlands	71	4	1
Edinburgh	168	8	3
Gatwick	125	6	2
Manchester	401	20	12
Heathrow	1,241	62	82
Small airports by air transport movements	239	12	4
Medium airports by air transport movements	526	26	14
Large airports (Heathrow) by air transport movements	1,241	62	82
Male	854	43	49
Female	1,149	57	51
18-34	391	19	35
35-54	761	38	36
55+	835	42	28
Working full-time/part-time	1,176	59	63
Not working	766	38	34

Where percentages do not sum to 100, this may be due to computer rounding

Table A.2: Definition of 'Newly overflown'

CAA created overflight contours for Heathrow easterly departures, based on the sample periods April 2019 (09R) and April/May 2020 (09L). These contours included the areas that experienced an increase in average daily overflight due to current 09L departures of more than double ('2X') and more than 10

[1] https://iccan.gov.uk/wp-content/uploads/2020_08_11_ICCAN_review_of_aviation_noise_metrics_and_measurement.pdf

times (‘10X’) compared to ‘normal’ 09R departures. The postcodes covered by these areas were used for sampling the ‘newly overflown’. This definition includes all post code districts that fall in the 54db contour.

Postcodes covered
KT8
TW1
TW2
TW3
TW4
TW5
UB1
UB2
UB3
W13
W7

Appendix B – Statistical reliability

It is important to note that, strictly speaking, confidence intervals relate only to samples that have been selected using strict probability sampling methods but, in practice, it is reasonable to assume that these calculations provide a good indication of the confidence intervals relating to this survey given the approach used.

Table B.1 shows that we can expect an overall sampling tolerance (this refers to the upper and lower limit of error) of up to +/- 2.2 percentage points at the '95% confidence interval' for a 50% finding from the survey overall.

Table B.1: Survey sampling tolerances: overall level

Size of sample on which survey result is based	Approximate sampling tolerances applicable to percentages at or near these levels		
	10% or 90%	30% or 70%	50%
1,000	1.9	2.8	3.1
2,006	1.3	2.0	2.2

For example, with a sample size of 2,006 where 27% say that they have travelled by car, then the chances are 19 in 20 that the 'true' value (i.e. the one which would have been obtained if the whole UK population had been interviewed) will fall within the range of +2.0 percentage points from the survey result (i.e. between 25.0% and 29.0%).

The following table indicates the sampling tolerances when comparing different groups of participants. If we once again assume a '95% confidence interval', the differences between the results of two separate groups must be greater than the values given in the following table in order to be deemed 'statistically significant':

Table C.2: Survey sampling tolerances: sub-group level (rounded)

	Differences required for significance at or near these percentage levels		
Size of sample on which survey result is based	10% or 90%	30% or 70%	50%
239 vs. 526 (Small airports vs. Medium airports by population)	5	7	8
239 vs. 1,241 (Small airports vs. Heathrow airport by population)	3	5	6
526 vs. 1,241 (Medium airports vs. Heathrow airport by population)	3	5	5

For example, if 30% of people around medium airports by population give a particular answer compared with 35% of those around Heathrow airport (assuming sample sizes in the table above), then the chances are 19 in 20 that this five-point difference is statistically significant.

Appendix C – Questionnaire

Introduction and consent

Good morning/afternoon/evening. My name is …… and I'm calling from Ipsos MORI, the research organisation, and we are carrying out a survey about living near to an airport during the coronavirus lockdown.

Could you help by running through some questions at the moment, please?

(IF NECESSARY) **If you would like to read the Privacy Notice beforehand you can access it online at <URL>. (This explains the purposes for processing your personal data as well as your rights under data protection regulations to access your personal data, withdraw consent, object to processing of your personal data and other required information.)**

(IF ASKED) **The interview will take around 10 minutes.**

IF RESPONDENT ASKS WHO CLIENT IS, SAY THAT WE WILL TELL THEM AT THE END OF THE SURVEY. IF THEY INSIST THAT THEY WANT TO KNOW AT THIS STAGE, TELL THEM, BUT OTHERWISE WAIT UNTIL END OF SURVEY **This research is being conducted on behalf of ICCAN, the Independent Commission on Civil Aviation Noise, an advisory non-departmental public body that investigates aviation noise and its impact.**

ASK ALL
QConsent. **Before we start, I just want to clarify that participation in the survey is voluntary and you can change your mind at any time.**

Are you to proceed with the interview?
SINGLE CODE
1. Yes
2. No – THANK AND CLOSE

Section 1: Quotas

ASK ALL
Q1_Gender. **Which of the following describes how you think of yourself?**
SINGLE CODE
1. Male
2. Female
3. In another way
4. Prefer not to say – THANK AND CLOSE

ASK ALL
Q2_Age. **What was your age on your last birthday?**
SINGLE CODE
DO NOT READ OUT
1. Under 18 - THANK AND CLOSE
2. 18-24
3. 25-34
4. 35-44

5. 45-54
6. 55-59
7. 60-64
8. 65-69
9. 70+
10. Refused (DO NOT READ OUT)

ASK ALL
Q3_Working status. **Which of these best applies to you? Are you…?**
SINGLE CODE
READ OUT

1. Working full-time as an employee or self-employed (30+ hours)
2. Working part-time as an employee or self-employed (9-29 hours)
3. Full-time education at school/college/university
4. On a government supported training programme
5. Unemployed and available for work
6. Permanently sick/disabled
7. Wholly retired from work
8. Looking after the home
9. Doing something else (SPECIFY) (DO NOT READ OUT)
10. Refused/don't know (DO NOT READ OUT)

Section 2: Area and noise (general)

ASK ALL
Q4. **Can I check, at the place you live do you have use of an outdoor space such as a garden, terrace, balcony or communal gardens with other properties?**
MULTICODE

1. Yes – I have outdoor space
2. No – I don't have outdoor space
3. Prefer not to say (DO NOT READ OUT)

ASK ALL
Q5. **Thinking about the local area – that is the area within 10-15 minutes' walk from where you live – overall, how satisfied or dissatisfied are you with it as a place to live?**
SINGLE CODE

1. Very satisfied
2. Fairly satisfied
3. Neither satisfied or dissatisfied
4. Fairly dissatisfied
5. Very dissatisfied
6. Don't know [DO NOT READ OUT]

ASK ALL
Q6. **Still thinking about the area within 10-15 minutes' walk from where you live, how noisy or quiet would you say it is as a place? Is it…**
SINGLE CODE
READ OUT

1. Very noisy

2. Fairly noisy
3. Fairly quiet
4. Very quiet
5. Don't know [DO NOT READ OUT]

Section 3: Lockdown and noise

ASK ALL

As you may know, on Monday 23rd March the UK Government announced measures in order to contain the outbreak of the coronavirus, sometimes referred to as the 'lockdown'.

For this next set of questions we'd like you to think only about the period since 'lockdown' started on Monday 23rd March and up until today.

(IF NECESSARY) **These included requiring individuals to stay at home unless they could not work from home and closing shops selling non-essential items. The Prime Minister announced an easing of these measures on Sunday 10th May. There have also been announcements in Scotland, Wales and Northern Ireland and different rules are in place.**

ASK ALL

Q8. **Since 'lockdown' started, how much time have you spent <u>at home</u> compared to previously? Would you say you have spent…**

SINGLE CODE

READ OUT

1. Much more time than you did before lockdown
2. More time than you did before lockdown
3. The same amount of time as you did before lockdown
4. Less time than you did before lockdown
5. Much less time than you did before lockdown
6. Don't know [DO NOT READ OUT]

ASK ALL

Q9. **Generally, to what extent has the amount of <u>aeroplane noise</u> that you can hear from where you live changed compared to before 'lockdown' started? Please include large and small commercial and private aeroplanes flying, but <u>not</u> helicopters or military aircraft.**

Is it now…?

SINGLE CODE

READ OUT

1. Much more noisy
2. A little more noisy
3. About the same amount of noisy
4. A little less noisy
5. Much less noisy
6. Don't know [DO NOT READ OUT]
7. Don't hear this type of noise [DO NOT READ OUT]

PLEASE REMIND PARTICIPANTS, IF NECESSARY, THAT THESE QUESTIONS REQUIRE THEM TO THINK ABOUT THE PERIOD BETWEEN WHEN LOCKDOWN START ON MONDAY 23RD MARCH UP UNTIL TODAY

ASK ALL

Q10.**To what extent has the amount of other transport noise, such as road or rail noise, that you can hear from where you live changed compared to before 'lockdown' started? Is it now…**

SINGLE CODE

READ OUT

1. Much more noisy
2. A little more noisy
3. About the same amount of noisy
4. A little less noisy
5. Much less noisy
6. Don't know [DO NOT READ OUT]
7. Don't hear this type of noise [DO NOT READ OUT]

These next questions are about aeroplane noise. Again, please include large and small commercial and private aeroplanes flying, but not helicopters or military aircraft.

ASK IF Q9= NOT 7

Q11. **Still thinking about the period since the lockdown started, when you have been at home … on average, how much, if at all, has aeroplane noise bothered, disturbed or annoyed you?**

A) during the day and evening (7am-11pm)
B) during the night (11pm-7am)

SINGLE CODE

READ OUT

1. Extremely
2. Very
3. Moderately
4. Slightly
5. Not at all
6. Don't know [DO NOT READ OUT]
7. Don't hear [DO NOT READ OUT] (EXCLUSIVE)

ASK IF Q9= NOT 7 OR Q11=NOT 7

Q12. **On average, how often, if at all, would you say you have been bothered, disturbed, or annoyed by aeroplane noise when you have been at home in the period since lockdown started? Has it been…**

SINGLE CODE

READ OUT

1. More than 10 times a day
2. Between 5 and 10 times a day
3. Between twice and 4 times a day
4. Once a day
5. Most days
6. At least once a week
7. At least once a month
8. Less often
9. Never
10. Don't know [DO NOT READ OUT]
11. Don't hear [DO NOT READ OUT]

ASK IF Q12= NOT CODES 9-11

Q13. **You said that you had been bothered, disturbed, or annoyed by aeroplane noise in the period since lockdown started. Which of these aspects of your home life, if any, does this interfere with?**

MULTICODE

READ OUT

1. Studying or working at home
2. Having a conversation (including on the phone or online)
3. Quiet leisure activities such as reading, writing, resting
4. Leisure activities such as listening to TV, radio, music, gaming or making music
5. Spending time outdoors at home
6. Having the windows or doors open
7. Sleeping patterns such as the time you go to bed or get up, or being kept awake
8. None of these [SINGLE CODE]
9. Don't know [DO NOT READ OUT]

ASK IF Q12= NOT CODES 9-11

Q14. **Still thinking about aeroplane noise and the period since lockdown started, which one or two of the following issues, if any, have concerned you the most?**

READ OUT

MULTICODE UP TO TWO

1. Flights at night (11pm to 7am)
2. Flights during the evening (7pm to 11pm)
3. Flights during the day (7am to 7pm)
4. The number of flights
5. The loudness of the aeroplanes
6. A lack of quiet between individual flights
7. Not knowing when there will be times during the day without aeroplane noise
8. Ground noise from airport or airfield
9. None of these
10. Don't know [DO NOT READ OUT]
11. Don't hear [DO NOT READ OUT]

ASK ALL

Q15. **During the period since lockdown started, have you noticed any changes in flight paths, or not? That is the routes that aeroplanes follow while flying in the sky. I'm interested in what you have seen rather than what you have heard in the news or anywhere else.**

SINGLE CODE

READ OUT

1. Yes, I have - flights seem to be on a different flight path from before lockdown
2. No, I have not - flights seem to be on their usual flight path as before lockdown
3. Don't know [DO NOT READ OUT]
4. Don't hear [DO NOT READ OUT]

Section 4: Pre-lockdown and noise

ASK ALL

Now, I would like you to think back to the period BEFORE the 'lockdown' started on Monday 23rd March.

ASK ALL

Q16. **Could you hear aeroplane noise from where you live, or not?**

SINGLE CODE

IF YES, READ OUT…

1. Yes – a lot
2. Yes – a moderate amount
3. Yes – a little
4. No – not at all
5. Don't know/can't remember [DO NOT READ OUT]

ASK ALL

Q17. **Could you hear other transport noise, such as road or rail noise from your where you live, or not?**

SINGLE CODE

IF YES, READ OUT…

1. Yes – a lot
2. Yes – a moderate amount
3. Yes – a little
4. No – not at all
5. Don't know/can't remember [DO NOT READ OUT]

ASK IF Q16= CODES 1-3 OR 5

Q18. **Before the lockdown period started when you were at home … on average, how much, if at all, did aeroplane noise bother, disturb or annoy you?**

A) during the day and evening (7am-11pm)
B) during the night (11pm-7am)

SINGLE CODE
READ OUT…

1. Extremely
2. Very
3. Moderately
4. Slightly
5. Not at all
5. Don't know/can't remember [DO NOT READ OUT]
6. Don't hear [DO NOT READ OUT]

ASK ALL

Q18A. **Still thinking about the period before lockdown started, on average, how often, if at all, were you bothered, disturbed, or annoyed by aeroplane noise when you were at home?**

SINGLE CODE
READ OUT

1. More than 10 times a day
2. Between 5 and 10 times a day
3. Between twice and 4 times a day
4. Once a day
5. Most days
6. At least once a week
7. At least once a month
8. Less often
9. Don't know [DO NOT READ OUT]
10. Don't hear [DO NOT READ OUT]

ASK IF Q13= NOT CODES 8

Q18B. **You said earlier that aspects of your home life are interfered with because of aeroplane noise. In general, was this worse or better before lockdown started or has there been no change?**

SINGLE CODE
READ OUT

1. A lot worse
2. Moderately worse
3. No change
4. Moderately better
5. A lot better
6. Don't know [DO NOT READ OUT]

Section 5: Attitudes

ASK ALL

Q20. **To what extent do you agree or disagree with the following statements?**

SINGLE CODE

READ OUT
RANDOMISE ORDER

a. I don't mind if noise from aviation goes back to what it was before lockdown
b. The economic benefits of living nearby to airports outweigh the disadvantages
c. The environment should be given higher priority than supporting the recovery of the aviation industry
d. Flight paths should avoid residential areas as much as possible, even if it means they take longer to arrive at their destination and use more fuel

1. Strongly disagree
2. Tend to disagree
3. Neither agree nor disagree
4. Tend to agree
5. Strongly agree
6. Don't know [DO NOT READ OUT]

Section 6: Classification

ASK ALL

Now, I would like you ask some questions to help put your answers into context. All the information you provide will be treated in the strictest confidence and cannot be used to identify you or your household in the results. You don't have to answer any questions you don't want to.

ASK ALL

Q21. **Which, if any, of these apply to you?**

SINGLE CODE
READ OUT

1. I currently work for an airport, an airline or a company that benefits from the aviation industry
2. I don't currently work for an airport, an airline or a company that benefits from the aviation industry, but used to
3. Someone else in my household currently works for an airport, an airline or a company that benefits from the aviation industry
4. None of these

ASK ALL

Q22. **In the past five years, have you personally taken any flights from any UK airport for the following reasons?...**

SINGLE CODE

READ OUT

a) **…<u>work</u> such as a business trip?**

b) **…<u>for leisure</u> such as a holiday?**

1. Yes, more than once a year
2. Yes, but only about once a year or less often
3. No, not at all
4. Don't remember [DO NOT READ OUT]

ASK ALL

Q23. **How long have you lived in this home?**

SINGLE CODE

READ OUT

1. Less than 6 months
2. 6 months – 1 year
3. 1 – 2 years
4. 2 – 5 years
5. 5 – 10 years
6. 10 years or more
7. Don't know [DO NOT READ OUT]

ASK ALL

Q25. **Which, if any, of the following applies to you personally?**

SINGLE CODE

READ OUT

1. I am a 'key worker' or in an essential service or critical sector as defined by the Government
2. During lockdown, I was in a vulnerable or "shielded" group, meaning I could not leave the home for at least 12 weeks except for an emergency
3. During lockdown, someone else in my household was in a vulnerable or "shielded" group
4. I/colleagues were told to work from home during lockdown
5. I/colleagues were told to work on rota, sometimes in the office, sometimes not during lockdown
6. I have returned to working at an office/workplace since lockdown
7. I have been put in the Government's furlough scheme
8. None of these
9. Refused/prefer not to say [DO NOT READ OUT]

Q26_Consent_Quant. **Thank you for taking part in this survey. Our aim is to conduct a similar one with the same people in the next 6 months or so. We will get in touch with you in the usual way. Would you be interested in taking part?**

1. Yes, I am interested in taking part
2. No, I am not interested in taking part

Q27_Consent_Qual. **We might want to follow up with you to ask you to take part in a longer interview with an Ipsos MORI researcher. If so, somebody from Ipsos MORI will be in touch within the next 6 months by either email or phone, to arrange an interview with you. We would give you a thank you payment for your time.**

If you agree, we will ask for your contact details – name, email and phone number – so that we can get in touch. We will keep your contact details securely for a maximum of six months, and will not use them for any other purpose. Would you be willing to be recontacted for this purpose?

1. Yes, willing to be recontacted
2. No, not willing to be recontacted

Q28. **Thank you for your interested in taking part in further research we may undertake. Please could you tell us your…?**

1. Name SPECIFY BOX
2. Email SPECIFY BOX
3. Phone number SPECIFY BOX

THANK AND CLOSE.

Ipsos MORI's standards and accreditations

Ipsos MORI's standards and accreditations provide our clients with the peace of mind that they can always depend on us to deliver reliable, sustainable findings. Our focus on quality and continuous improvement means we have embedded a 'right first time' approach throughout our organisation.

ISO 20252

This is the international market research specific standard that supersedes BS 7911/MRQSA and incorporates IQCS (Interviewer Quality Control Scheme). It covers the five stages of a Market Research project. Ipsos MORI was the first company in the world to gain this accreditation.

ISO 27001

This is the international standard for information security designed to ensure the selection of adequate and proportionate security controls. Ipsos MORI was the first research company in the UK to be awarded this in August 2008.

ISO 9001

This is the international general company standard with a focus on continual improvement through quality management systems. In 1994, we became one of the early adopters of the ISO 9001 business standard.

Market Research Society (MRS) Company Partnership

By being an MRS Company Partner, Ipsos MORI endorses and supports the core MRS brand values of professionalism, research excellence and business effectiveness, and commits to comply with the MRS Code of Conduct throughout the organisation.

Data Protection Act 2018

Ipsos MORI is required to comply with the Data Protection Act 2018. It covers the processing of personal data and the protection of privacy.

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Annex C: ICCAN (2020c) The future of aviation noise management: ICCAN's emerging view, October 2020

The future of aviation noise management

ICCAN's emerging view

October 2020

Independent Commission on Civil Aviation Noise

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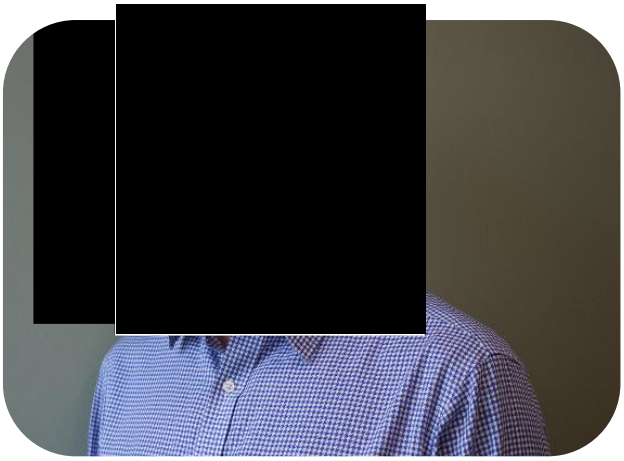
Foreword



No one could have predicted how the events of the early part of 2020 would affect our lives or impact on the future of aviation. Many hoped Covid-19 would be over within weeks and that by late summer normal activity would resume. The reality facing us as we enter winter in 2020 is that Covid-19 is likely to have a significant impact well into 2021, with the long-term economic and social effects lasting years.

As we try to anticipate just what the post-Covid aviation world will be like, some things are clear: the economic impact on businesses and individuals will be deep, severe and, for some, personal behaviours will simply not return to the pre-Covid ways. Despite understandable attempts to boost public confidence in travel, it is now clear aviation activity will not return quickly, and demand will remain well below 2019 activity for some time to come.

It would be dangerous to assume social attitudes won't have changed too. Quieter skies and cleaner air have been noticed and working patterns for some will change for good; all of which may well lead to greater awareness, more sensitivity and less tolerance of aviation noise in the future. Given the complexity of the current way of managing aviation noise, the public demands for Government and regulators to act in the future may be greater than ever before.

Without doubt, most previous flyers will fly again but how soon and how often remains unclear. What is certain is the economic effect on airports, airlines and the wider industry will be severe and last well beyond the return to previous activity levels. Understandably, there will be a desire in some quarters simply to return to business as usual, but there is now a huge opportunity to build back better and lay the foundations that will sustain aviation in the future.

ICCAN prides itself as being a new, fresh organisation with a new and fresh approach to the old complexities of aviation noise management. Our focus is not to tinker with processes of the past but work with others to shape a long-term noise management system that enables aviation to serve the economic, social and health needs of the country.

Our work over the last two years has sought to reach consensus on the need for change in the way aviation noise is managed and we are heartened by the positive support for this from both industry and communities. We recognise that embracing change in the midst of a crisis is challenging, particularly when, for many airports and airlines, mere survival is the primary focus.

ICCAN wants to ensure that improving noise management is a catalyst for recovery not an impediment.

We were created by the Department for Transport following the Airports Commission report because it was recognised that aviation noise was not well managed and, without a significant change in approach, this would impede future growth. These issues have not gone away during the Covid crisis, they have merely become dormant. We will ensure each of our proposals offers a route map through recovery, so that we can deliver the change needed at a pace that is achievable.

Over recent months, ICCAN has been reviewing how aviation noise management works in practice, whether it delivers the outcomes society expects, and whether it achieves the right balance between proportionality and the desire for improved personal wellbeing. We have heard from across the sector how the breakdown in trust is a major obstacle; over time we think we can help fix many of the issues that contribute to the erosion of trust. However, we have also seen a growing frustration with how noise regulation is applied and enforced by different bodies and that's not just from communities. This amplifies the need to make a change to how aviation noise is managed in the future.

We see inconsistency alongside a lack of transparency and recognise the damage that does. We also see how present regulation appears unfair and complex to those who look to it for help and support. Moreover, we appreciate the need to reduce emissions, but aviation noise needs to be considered as another form of pollution, which must be tackled alongside climate change.

In the coming few years, during a period of lower than previously expected aviation activity, we believe there is a unique opportunity to move aviation noise management forward in partnership with industry and communities, and that ICCAN has the credibility across the spectrum to do this.

We acknowledge any change will be difficult at this time for the industry and that the pace of change will not be as swift as some communities will desire; however, we also sense the willingness from most to improve noise management and believe ICCAN can provide the practical route to achieve this.

The ideas set out in this document are for our second Corporate Strategy (2021-24) and seek to build a shared vision of the destination alongside a route map for how we can get there. Put simply, we want the UK to be the world leader in managing aviation noise.

We welcome your views on our vision and goals and how we are seeking to achieve them. We also invite your views on our progress so far, and your thoughts on how aviation noise should be managed in the future. Whether you respond via our online survey or attend one of our planned virtual focus groups, I look forward to hearing from you.

Rob Light

Head Commissioner, ICCAN

Chapter 1: Introduction

The Independent Commission on Civil Aviation Noise (ICCAN) was established at the start of 2019 to act as the impartial advisory body on all matters relating to civil aviation noise and how it affects communities. Our role is to provide expert research and advice to government, industry and other stakeholders, on issues such as noise measurement, monitoring and abatement, consultation and engagement, and airspace use and modernisation.

We were established following a series of consultations run by the government, after the Airports Commission recommended in 2015 that an independent noise enforcement body was needed. The government decided to first set up ICCAN as a non-statutory advisory body, and our establishment was delayed, but at the end of 2018 Head Commissioner Rob Light was appointed, and at the start of 2019 we began building a team of commissioners and staff, establishing an office and identity, and developing our first set of priorities.

"We set ourselves three objectives: increase trust, transparency and clarity in the aviation noise debate; promote consistency, responsibility and accountability within the aviation industry and beyond; and establish our expertise, authority and credibility."

Our first Corporate Strategy, available to read here, covers our first two years, 2019-2021, and sets out how we intended to achieve our objective of improving public confidence and trust in the management of aviation noise. We set ourselves three objectives: increase trust, transparency and clarity in the aviation noise debate; promote consistency, responsibility and accountability within the aviation industry and beyond; and establish our expertise, authority and credibility. The work programme that lay behind the objectives included a number of reports, research projects and advice that we have, or intended to, develop and issue over the first two years of our life.

As we approach the end of those first two years, the aviation landscape we now find ourselves in is markedly different. The impact of Covid-19 on the industry has been profound, with measures taken to combat the pandemic leading to a dramatic fall in numbers of flights globally. This has had a severe impact on the aviation industry in the UK, which has already seen many thousands of job losses, with many more potentially at risk. There are serious implications for other areas of the economy that rely on aviation as well as certain towns and geographic areas, such as Crawley, Luton and Slough, which have suffered as a result.

"The reduced levels of flight offer us a once-in-a-generation chance to re-think the way in which aviation noise is managed, by whom it is co-ordinated and overseen, and to improve the outcomes for those who are currently overflown or might be in the future."

We are also aware that, especially during the period of lockdown in the UK from late Spring into Summer, many people living close to major airports will have experienced some benefits from there being fewer flights, in terms of quieter skies. A low benchmark has been set – and it is entirely possible that as the aviation industry recovers, and flights return to the skies, people will

be more sensitive to the increasing noise. We see this as an opportunity, not a threat. The reduced levels of flight offer us a once-in-a-generation chance to re-think the way in which aviation noise is managed, by whom it is co-ordinated and overseen, and how outcomes can be improved for those who are currently overflown or might be in the future.

At a time when the UK has set its sights on becoming a net zero carbon emitter by 2050 and will be hosting the UN Climate Change Conference of the Parties ('COP26') in 2021, much attention is rightly being given to how we can reduce greenhouse gases and make sectors like aviation more sustainable. ICCAN wants noise – another environmental pollutant with serious and potentially harmful impacts on the health and lives of people exposed to it over long periods – to be considered as a priority by policymakers alongside climate change. And having fully established ourselves as an expert, credible and independent body, we stand ready to ensure that it is, and that we provide the lead in making the UK the world's leader in managing aviation noise.

"ICCAN wants noise – another environmental pollutant with serious and potentially harmful impacts on the health and lives of people exposed to it over long periods – to be considered as a priority by policymakers alongside climate change."

Chapter 2: The future of aviation noise management

As well as delivering the work programme we set ourselves during 2019 and 2020, we have spent much of our time working towards a key task the government set us – considering whether further powers are needed for the current regulation and enforcement of aviation noise matters and, if so, to whom they should be given.

The current map of regulation and guidance is complex, with responsibilities ranging from international organisations and regulators, through continental, national, sub-national, and local government, to the airports themselves. A regular, and obvious, criticism is that this complexity does not lend itself to allowing clear, consistent and transparent rules around aviation noise management, nor fair and equitable outcomes across the country. We have much sympathy for this view, and we have made initial recommendations in our work so far that ICCAN should be empowered to act as the one independent source of advice, guidance and standard setting across the UK.

“We have made initial recommendations in our work so far that ICCAN should be empowered to act as the one independent source of advice, guidance and standard setting across the UK.”

We recognise that there is little clarity or consistency to those outside the aviation world as to how the regulation of noise works. The average person on the street would not understand, for example, why some airports have night flight bans and some don’t, or why some aircraft fly directly over their heads and some to the side. This complexity and inconsistency, through no fault of industry, can also hide good practice in certain areas.

We have seen good examples of noise mitigation, noise abatement procedures, noise reduction strategies, operating restrictions and community engagement in place in airports across the UK. However, they may differ from those in place at a local competitor, and it can be hard for people affected by aircraft noise to understand why that would be the case.

“Land use and planning is one area, in particular, where a central set of standards and expectations, issued by ICCAN, would be likely to result in better and more consistent outcomes for communities and industry.”

Equally, we have heard from airports that they feel powerless to stop local authorities developing land or existing buildings for new housing that will be subject to aircraft noise; the local planning authorities, themselves under pressure to use land and build houses, sometimes do not feel equipped with the expertise to challenge developers’ proposals on the basis of the noise impacts. Land use and planning is one area, in particular, where a central set of standards and expectations, issued by ICCAN, would be likely to result in better and more consistent outcomes for communities and industry.

In its Aviation 2050 green paper at the end of 2018, available to read here, the Government set out a series of suggestions for better noise management, on issues such as routine restrictions (through noise envelopes or similar), insulation and compensation, community funds and engagement, and airspace change. Understandably, the Government's aviation strategy development has been delayed, and is likely to be quite different, due to the impact of Covid-19, but nevertheless we consider that there were good proposals and suggestions in Aviation 2050 for ICCAN to lead on in the future.

In a post-Covid world where the aviation industry is recovering, having the support and guidance of a central noise advisory body, empowered to set standards, will give confidence to affected communities that noise remains a crucial factor in decisions about expansion or airspace use.

Our emerging thoughts on changes needed to the current system are based on our experience and discussions so far, the views of many of our stakeholders across the sector, and an assessment of the current regulatory regime. We have asked ourselves the question – to achieve the outcomes we wish to see, is it enough for ICCAN to be an advisory body, with no statutory status or formal powers?

"We will not achieve our vision for the UK to be the world leader in managing aviation noise unless there is a clear single and empowered voice to ensure noise mitigation is at the heart of decision-making."

Through information and education, engagement and influence, we have seen evidence of behaviour change among the industry, regulators and communities. But recent events are likely to put further pressure on the consideration of noise impacts, with economic, efficiency and climate concerns given a higher status. We understand why this might be the case; but we will not achieve our vision for the UK to be the world leader in managing aviation noise unless there is a clear single and empowered voice to ensure noise mitigation is at the heart of decision-making.

As the industry recovers, as we approach airspace modernisation, and as future technologies continue to evolve at pace, our emerging conclusion is that ICCAN needs to be put on a statutory footing, with powers to issue advice, guidance and set standards (while others retain enforcement powers) that must be considered and responded to. Our recent work and engagement suggest that this would be a proportionate, but effective, step forward in helping achieve our future vision and goals, which we set out in the next chapter.

"Our emerging conclusion is that ICCAN needs to be put on a statutory footing, with powers to issue advice, guidance and set standards (while others retain enforcement powers) that must be considered and responded to."

Chapter 3: ICCAN's future role, vision and goals

ICCAN vision 2021-24:

"To make the UK the world leader in managing aviation noise."

As Britain rebuilds after the Covid-19 pandemic and the health and economic consequences borne from it, in line with the Government's wish to build back better, we are determined to ensure that the aviation industry's recovery, and future technological advances, are developed in a sustainable way. Our vision is to make the UK the world leader in managing aviation noise; by doing so, we can ensure that all environmental impacts – crucially, including noise – are fully taken into account in decisions about aviation.

In order to achieve our vision, we will set ourselves three goals. These cover our core role in setting clear, transparent and consistent standards that will ensure a sustainable recovery, build the evidence base for noise and health/wellbeing research, and make sure that future technological advances have noise management baked into their strategies and regulation.

Draft goals:

1. 'Setting standards'

Increase the consistency and transparency in the management of aviation noise by setting enforceable standards and providing guidance to regulators.

Key activities:

- Setting enforceable standards, issuing best practice guidance and advice on all matters relating to aviation noise (e.g. insulation, compensation, mitigation, metrics, modernisation)
- Advising regulators/decision-makers on the setting of clear and enforceable targets (and, where necessary, restrictions) for aviation noise management
- When applicable, advising on planning applications
- Providing advice on noise restrictions, noise envelopes, and noise mitigation activities in airspace change proposals
- Setting consistent standards for industry and community engagement and collaboration.

2. ‘Putting people’s health and wellbeing at the heart of aviation noise policy’

Lead research into the health and wellbeing impacts of aviation noise

Key activities:

- Build partnerships with academia and health research establishments to deliver research priorities
- Design and run the next series of Aviation Noise Attitude Surveys in order to inform government policy on annoyance
- Equip decision-makers in Government and industry with a clearer view of impact of aviation noise on public health.

3. ‘Focus on the future’

Ensure future policy and regulatory systems for managing noise are fit-for-purpose, and that future technological advances have noise management at the heart of their development

Key activities:

- Play critical role in advising on airspace modernisation and future aviation strategy
- Engage fully in development of regulations around new technologies, including drones, urban air mobility (UAM), supersonic, alternative fuel aeroplanes
- Encourage and facilitate innovation in the measurement and communication of aviation noise impacts, including geospatial advancements
- Ensure noise reduction sits alongside carbon reduction as the fuel for advancement in technological improvements.

Chapter 4: Tell us what you think

We have set out what we see as the future challenges and direction of travel for aviation noise management in a post-Covid era, and the role we think ICCAN should play in achieving better outcomes for all. As we said in the last chapter, these are our emerging views rather than our final conclusions and recommendations to government – and we want to hear from you about them.

As has been one of our guiding principles since our establishment, the views of our stakeholders across the sector are crucial to us in reaching our conclusions on the future of aviation noise management.

We have set out some questions below, which should be answered **here on our website**.

We will also be hosting a number of focus groups where you will be able to give feedback on these questions direct to one of our board of commissioners – you can find out how to book these on our website.

ICCAN's survey will close at

5pm on Friday 18 December 2020

You have **until 18 December to give us your views**, after which we will consider the responses, as well as further work we will have done on the case for changes to responsibilities and regulation, before we finalise our views, make recommendations to government, and publish our Corporate Strategy 2021-24.

Survey questions

1. Future of aviation noise management

- Our emerging view is that in the short term ICCAN should have statutory status, with power to set standards, be a statutory consultee on planning applications and airspace change proposals, give advice to government and others that must be considered, but that existing regulators (CAA, government, local planning authorities) should retain an enforcement role. Do you agree with our emerging view on the future of aviation noise management, and the role ICCAN should play?

2. ICCAN's future vision and goals

- Do you agree with our draft vision to make the UK the world leader in managing aviation noise?

- Do you agree with the draft goals which will help us achieve our vision? If not, how should they be framed?

- Are the key activities we identify to help us achieve our goals the right ones? Do you have any views on which activities should take priority over others?

3. ICCAN's performance to date

- What are your reflections on ICCAN's establishment, and its work so far?
- Are you confident that ICCAN plays a truly objective independent role in aviation noise management?
- Do you think ICCAN's work has materially helped the way in which decisions about aviation noise are taken?
- Has ICCAN's existence and role given you more or less confidence that aviation noise will be managed better in the future?

Please **visit our website** to respond to the above questions and complete the survey by 5pm on Friday 18 December 2020.

Annex D: ICCAN (2020d) ICCAN best practice for engagement between airports and communities on aviation noise, December 2020

ICCAN best practice for engagement between airports and communities on aviation noise

December 2020

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Introduction

The Covid-19 pandemic has had a devastating impact on aviation, as well as many other areas of the economy, and it will continue to affect all our lives for some time to come. We feel great empathy for all those that have been affected and the many thousands employed in the aviation industry who face an uncertain future. It remains by no means clear when we might return to something resembling ‘normality’.

When ICCAN was formed in 2019, airports around the UK were planning to expand their operations and increase capacity, with proposals for new terminals and runways being designed and discussed. In parallel, a complete overhaul of the UK’s flightpaths, as part of the airspace modernisation programme, was in its early stages.

This landscape has been dramatically altered and we’re now experiencing fewer aircraft in the sky. As a result, people living close to UK airports are experiencing something new to them: less noise. While this is an uncertain time for airports and aviation, we must acknowledge that it may take many years to return to the kind of aviation levels experienced in 2019, but in due course we know that noise will return, and communities will notice it, perhaps even more so than before.

An unprecedented situation like the Covid-19 crisis provides us all with a moment to pause and reflect on previous ways of working and consider how they can be improved in the future, so they are undertaken in a more sustainable way. One of the ways we can make an immediate change is through our communication and the ways we choose to engage with people.

How airports and local communities engage on the issue of noise is crucial, not only for building better relations and trust, but also for the future of aviation itself. If done well, engagement can help to forge relationships, building trust and understanding in the process. If done poorly, it can breed distrust and opposition.

One of ICCAN’s main observations during its first year of existence was that trust between airports and communities had, in many places, broken down, and that relationships needed to be rebuilt and repaired. We believe that two-way, constructive engagement will play an instrumental part in achieving this.

While the downturn in activity has, understandably, led many airports to reduce their engagement, ICCAN sees this as an opportune moment to invest that time in building and repairing those relationships, particularly while some communities are experiencing quieter skies. Despite there being fewer planes in the sky, the issues around noise haven’t gone away so engagement is just as important. It is especially important that airports build upon any social capital they have already established in their local areas, and bring affected communities with them as they start to plan for recovery.

This document sets out best practice on how airports engage key stakeholders and local communities about noise, both during this quieter period, and as aviation levels return.

We are fully aware that airports are going through a turbulent time, so this document contains best practice recommendations that can be adopted over time: in the short-term, there are recommendations while aviation levels are low, as well as other ideas that may be more appropriate in the medium and longer-term as operational activities build back up and resources become more available again.

It is ICCAN's view that, even during this quieter time, some engagement activities should continue as it is vital to keep providing communities with information and update them on how operating levels are changing as well as any future plans. Effective communication doesn't have to come at a considerable cost, but poor or no communication can be very costly over time.

Keeping communication channels open now can, we believe, nurture and maintain trust so that when the skies do get busier and louder, these relationships can be built on and lead to even more meaningful dialogue taking place.

In producing this best practice, we have considered why engagement is so important to building good community relations and where improvements could be made. To help us better understand this we have spoken with airports, community representatives, we have worked with the Consultation Institute and carried out our own community survey. We have also looked further afield to understand how airports around the globe engage about noise with their communities.

As a result, we focus on two areas of good practice that we encourage airports to consider when preparing their engagement strategies either now, or as they are building back:

- Key principles that we believe should be considered by airports when seeking to develop and run noise forums.

- Considerations on how to develop and implement a continuous process of engagement.

The recommendations that ICCAN makes in this document are not prescriptive and given the circumstances, should be followed as appropriate in the short-term. However, it is our view that this advice provides key points that we think should be considered as good practice when engaging with local communities about aviation noise as levels return.

Engagement – an overview

Good community engagement should be a fundamental part of how an airport operates. It promotes greater understanding among communities and stakeholders, generates closer working relationships, and makes for a more sustainable operating model.

Engagement is a two-way process that enables people to stay informed and provides an opportunity for communities to get involved in the process regarding an airport's operational matters as well as its future proposals.

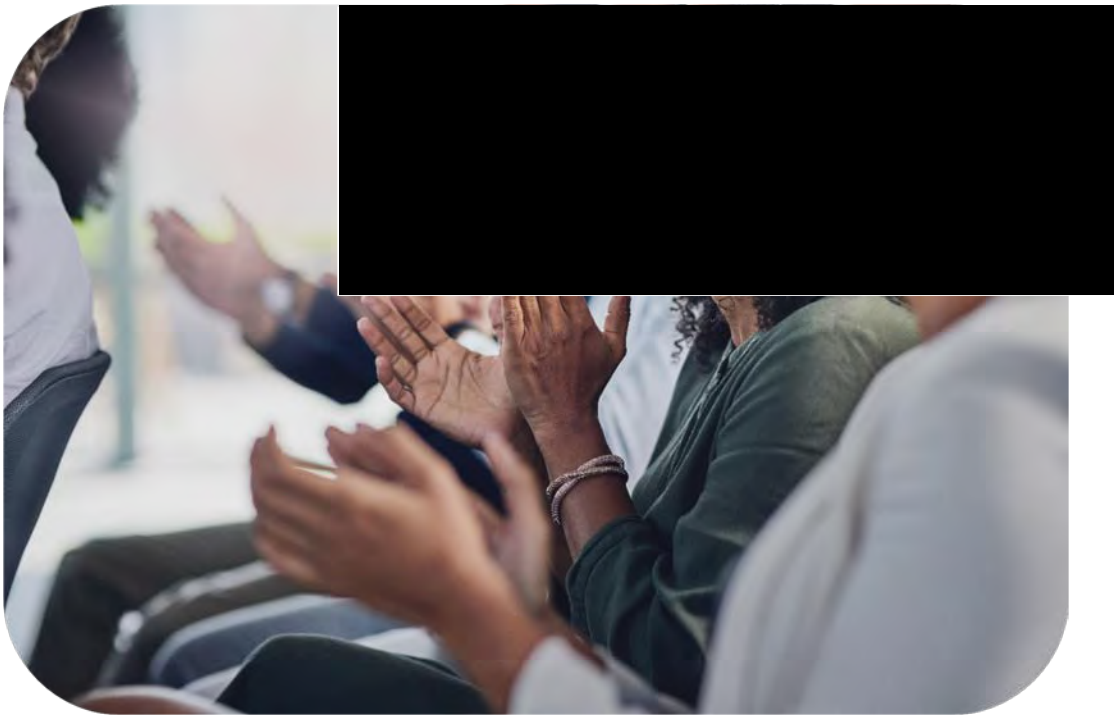
Engagement should not be viewed as a 'tick-box' exercise, i.e. done for the sake of it, rather it should be seen as something that has clear benefits for the business.

Good engagement can help build 'social capital'. It can enable an airport to be a transparent, honest and responsible neighbour, and help it make decisions based on understanding and trust. Developing effective methods of two-way communications should be as high a priority for airports as investing in capital projects, such as terminal refurbishments or runway resurfacing.

While communities will not always agree with the actions of their local airport, having genuine conversations and providing the rationale behind decisions, enables people to better understand how and why decisions have been made.

Engagement is an important resource as communities possess a wealth of local knowledge and experience that can help airports better understand the local area, which in turn can inform and shape decisions, and identify solutions that could have a more positive impact for all.

A lack of engagement, without the right structures in place to deliver it, can result in distrust, leading to fractious relationships and in-built opposition to any future change.



Good community engagement should be viewed as an essential part of any airport's operations, as it can:

- Promote meaningful partnerships between local communities and airports
- Help develop and build trust between decision-makers and the community
- Enable an airport to gain, build and maintain community understanding for their activities
- Create an open exchange of ideas for the benefit of all
- Improve reputation and reduce potential local opposition
- Demonstrate transparency and accountability.

Without proper engagement, a local community can often feel that they have little say over decisions that could impact their lives. People should be given the opportunity to better understand aviation noise and how it impacts them and be able to access the appropriate methods to engage about it.

There are many ways that airports can engage with their local communities regarding noise and its impacts. These range from formal meetings where noise is the main agenda item to making noise data available online or community outreach work.

In seeking to develop our best practice recommendations we have sought to build on existing methods used by airports to engage with their communities about noise. They are by no means all the channels used but are ones that we feel are particularly key. These fall under the headings of:

- Airport consultative committees
- Noise forums
- Wider community engagement practices

Airport consultative committees

What are they?

Airport Consultative Committees, or ACCs, are forums airports are required by law to hold with key stakeholders to discuss airport matters and issues. The committee must have an independent chair and should feature representatives from airport users, such as passengers and airlines; local authorities, representing constituents about economic, planning and environmental topics; and others who might be affected, such as community and environmental groups, residents' associations, and local business and consumer groups.

How and when the chair and membership are refreshed is a matter for the committee to decide. There are no set terms for representation on the committee.

What is their role?

Each airport is required to have an ACC under the Civil Aviation Act 1982, and although the government does have guidance, it is not prescriptive for how big or small a committee should be, or what should be discussed at each meeting. That is for the committee to decide.

While they are intended to generate constructive conversations between the airport and all parties, ACCs do not have any executive power, but can propose recommendations which need to be given due consideration by the airport.

They are a useful way for airports to update their stakeholders and engage them about their plans, be it operational or about future proposals, and can enable them to demonstrate transparency. Senior airport management are required to attend and report to the committee, presenting an opportunity to be questioned by members and held accountable.

ACCs are an important mechanism for stakeholders to raise concerns directly with the airport and hold them to account in a publicly documented forum.

How is noise addressed?

Noise issues are handled at the discretion of the airport. In some cases, noise has a permanent agenda item on the ACC, and in others is included as part of the environmental round-ups. At some other ACCs it is included as part of a separate sub-group which allows members to dedicate more time into having detailed discussions about statistics, complaints and other noise related topics. Nevertheless, a packed ACC agenda may not always allow enough time or scope to discuss noise as fully as communities or other stakeholders would like, and an ACC alone cannot fulfil the role of community engagement.

If sub-groups are used, it is usual for a representative from each group to sit on the main committee and feedback to members about the work of that specific group.

How are communities involved?

It is important that committees have a fair mix of representation which reflect the local area. As each committee varies, they will have different rules about how the public can be incorporated into meetings.

In some cases, the public are invited to meetings and can ask questions, in others an annual open meeting will take place where people are welcome to attend.

Minutes and agendas should be publicly available to view online. Not publishing minutes online is in breach of the Government guidance.

Noise forums

What are they?

So far, a limited number of noise forums have been established so that airports and stakeholders can dedicate time to focus on the noise impacts and mitigations associated with an airports' current operations, or to address concerns about changes to future operational requirements.

There are currently three noise forums within the UK; the Heathrow Community Noise Forum, the Gatwick Noise Management Board, and the Edinburgh Airport Noise Advisory Board.

There is no specific guidance on how a noise forum should be structured or chaired. Each of the three groups have been set up with the purpose of addressing local concerns regarding noise and to provide a space where people can better understand the complexities around noise through data and analysis. The regularity of meetings is decided upon by each forum.

What is their role?

As mentioned, noise forums have been set up to generate constructive conversations around the issue of noise and to establish ways of working that will be beneficial to all parties.

As a relatively new concept and without any external guidance around length of term or membership, airports have so far shown a willingness to adapt and evolve as lessons are learnt about how to achieve useful outcomes.

As noise is an emotive issue and the meetings are most commonly attended by representatives from the most impacted communities, it is inevitable that there can be conflict and opposing views as part of the discussions. Noise forums, as with ACCs, are at their most successful however when members adopt a 'critical friend' approach, so that feedback and genuine two-way conversation leads to meaningful recommendations and change.

How is noise addressed?

Noise forums present an opportunity for stakeholders and the airport to dig deeper into a specific subject area, providing communities with a better understanding of how noise impacts them as well as providing the opportunity to have meaningful conversations around the issues of noise. Local circumstances will often dictate what aspects of noise are featured and covered within the forum. This could include a range of subjects, such as noise reduction and operational restrictions, night noise quotas, monitoring, tracking and airspace change. Some forums produce a work programme which is discussed and agreed by forum members, setting out specific initiatives and ambitions that are monitored and delivered against.

How are communities involved?

Representatives from impacted communities attend the current noise forums alongside representatives from local authorities, the airport, regulators and operators such as National Air Traffic Services (NATs) and the Civil Aviation Authority (CAA). Noise forums represent those communities that are affected by airports' operations and feature individuals who have an interest, and/or, knowledge of noise.

Noise forums, therefore, present a good opportunity for relevant stakeholders and local communities who have an interest in noise to get involved and have meaningful conversations around the subject.

Wider community engagement practices

What are they?

A wider community engagement strategy will see airports engaging with the public about several issues, with noise being one of the topics covered. A wider engagement strategy is usually built around methods that are used to discuss and inform on subjects such as an airport's operational activities, its work and upcoming plans.

This could include community outreach work, information provision and by trying to capture a range of views from different communities and stakeholder groups.

What is their role?

Wider engagement is usually built around the concept of informing the public and seeking their input on issues which might be of interest or affect them on an ongoing basis. A range of activities could be used, either run directly by the airport or by using third parties such as local media, to promote these issues or topics to the wider public.

Different activities will be chosen to complement the objective of that engagement, so for example, if that it is to inform the public, this might include updates via digital channels such as newsletters, website stories or social media promotion, if seeking active participation it might include hosting meetings or events that allow people to directly engage with airport staff, or if to gather feedback it might be through the delivery of a questionnaire or survey.

How is noise addressed?

This will be dependent on the local circumstances and the overall strategy adopted. Noise might feature heavily if that is a key issue and the primary objective for engaging with a wider audience. However, as mentioned, noise might just be one of many issues that the airport is seeking to address.

How are communities involved?

Wider engagement will be driven by the audience that the airport is seeking to reach. Different methods will be more appropriate for different audiences, so the channels adopted need to be selected because of their suitability, reach and the kind of participation they are likely to achieve. Depending on the focus of the engagement, it might be that the activities are promoted to a very specific audience, e.g. several impacted communities, in which case the approach would be different than if it was a more general message promoted to a much wider audience.

ICCAN's survey on community engagement

To try to better understand existing methods of engagement used by airports with their local communities, and their effectiveness, we undertook a survey in February 2020 to find out what people thought worked well and where they felt improvements could be made.

We received 136 responses from a cross-section of individuals and organisations, representing community groups, local authorities, industry and business and ACCs.

Respondents felt that some airports communicated their plans well, particularly on topics such as airspace change, expansion and operational matters, through the production of materials and by holding stakeholder meetings and community surgeries.

However, there were several areas where they wanted to see improvements. These were particularly around:

- Understanding the impact of noise from a community perspective
- Developing a genuine two-way dialogue
- Improving the quality of information provided by making it less technical
- Being more honest when discussing the negative impacts.

We have sought to incorporate this feedback into our best practice recommendations. To read the full analysis of results, see Annex A.

International examples

We have also looked beyond the UK to consider what novel or innovative methods have been used by international airports which could be adopted or adapted by airports in the UK. While by no means exhaustive, we have looked at examples of noise engagement that reflect different approaches used by airports to engage with their communities about noise.

These are intended as practical examples that, given the current circumstances, airports can draw on as they should not require substantial additional resource.

In each of the below cases we have looked at the approach taken as well as the activities delivered. We include these as illustrations, to demonstrate how such approaches can work in practice.

Providing information

To coincide with the opening of its new runway in July 2020, Brisbane Airport produced information for residents across multiple channels about aviation noise and how people might be affected by the new operations.

This included the development of an online portal featuring search functionality that would allow residents to find out where their homes sit in relation to flight paths. The portal also acts as an informative tool providing more details about noise, such as how flights paths are designed and operated, how noise is measured and monitored, and through the provision of frequently asked questions (FAQs).

The airport also sought to provide information about the new runway, through the delivery of a wider community outreach programme and by launching a mobile information centre. The

centre could travel to local communities providing residents with an opportunity to talk to airport staff and technical experts about the proposed changes and impacts. Displays and interactive screens were used to try and explain the more technical concepts.

Alongside this, the airport also produced a series of videos to further try to explain its plans and their impact. More information can be found here.

Discussing ideas and solutions

Charlotte Douglas International Airport established its Airport Community Roundtable in 2017 at the request of the Federal Aviation Authority (FAA) to try and incorporate local voices into a discussion around noise impacts and to identify possible solutions. Having identified and defined the impacted local communities, 25 representatives from those areas were invited to attend the roundtable alongside regulators, industry groups and technical experts to help guide members through the process and discussion.

Membership preference was given to residents that had filed noise complaints with the airport and no technical knowledge of aviation was required. Meeting regularly under the stewardship of an independent chair, ground rules were established which members had to abide by. All meetings were recorded in audio, and minutes and presentations were published online.

The roundtable sought to develop a framework for identifying noise improvement opportunities, to discuss mitigation around operating procedures and to provide recommendations for the airport and regulators the FAA. The roundtable's recommendations can be found here. More information on the Airport Community Roundtable can be found here.

Working together

In 2017, Toronto Pearson Airport developed a deliberative engagement process so that they could involve representatives from neighbouring communities to help set measures, standards, and commitments that they could adopt while also trying to deliver future growth plans. The Residents' Reference Panel on Airport Growth and Noise Fairness was established to help balance the airport's desire for growth against the needs of locally impacted communities.

Panel members were selected via a civic lottery to ensure that a representative cross-section of the community was involved in the process. In the most impacted areas, 20,000 households received an invitation to volunteer, setting out the purpose of the panel and how participants would play a role in helping to deliver this approach. From the 286 people that volunteered after receiving a direct invitation, 36 were randomly chosen to sit on the panel.

Meeting across four Saturdays, members used the day-long sessions to learn more about the airport's operations, to better understand the impact of noise on local communities and to understand what kind of noise mitigation measures could be introduced. Members were then expected to deliberatively produce a set of recommendations for the airport that would address future growth, aviation noise and how to lessen the impact on local communities.

As a result of the process, the panel produced a report setting out the key issues the airport faced alongside a series of recommendations for consideration and adoption as well as a set of principles and values for the airport to adhere to.

The report's recommendations were incorporated into the airport's Noise Management Action Plan (2018-2022) document, available to view here. More information on the Residents' Reference Panel can be found here.

There are other examples of how to deliver a deliberative process in this sector, such as the Dialogue Forum, which Vienna Airport established to engage with local stakeholders, communities and interested groups over a longer-period of time to create a binding agreement. More information can be found here.

Engagement during the Covid-19 pandemic

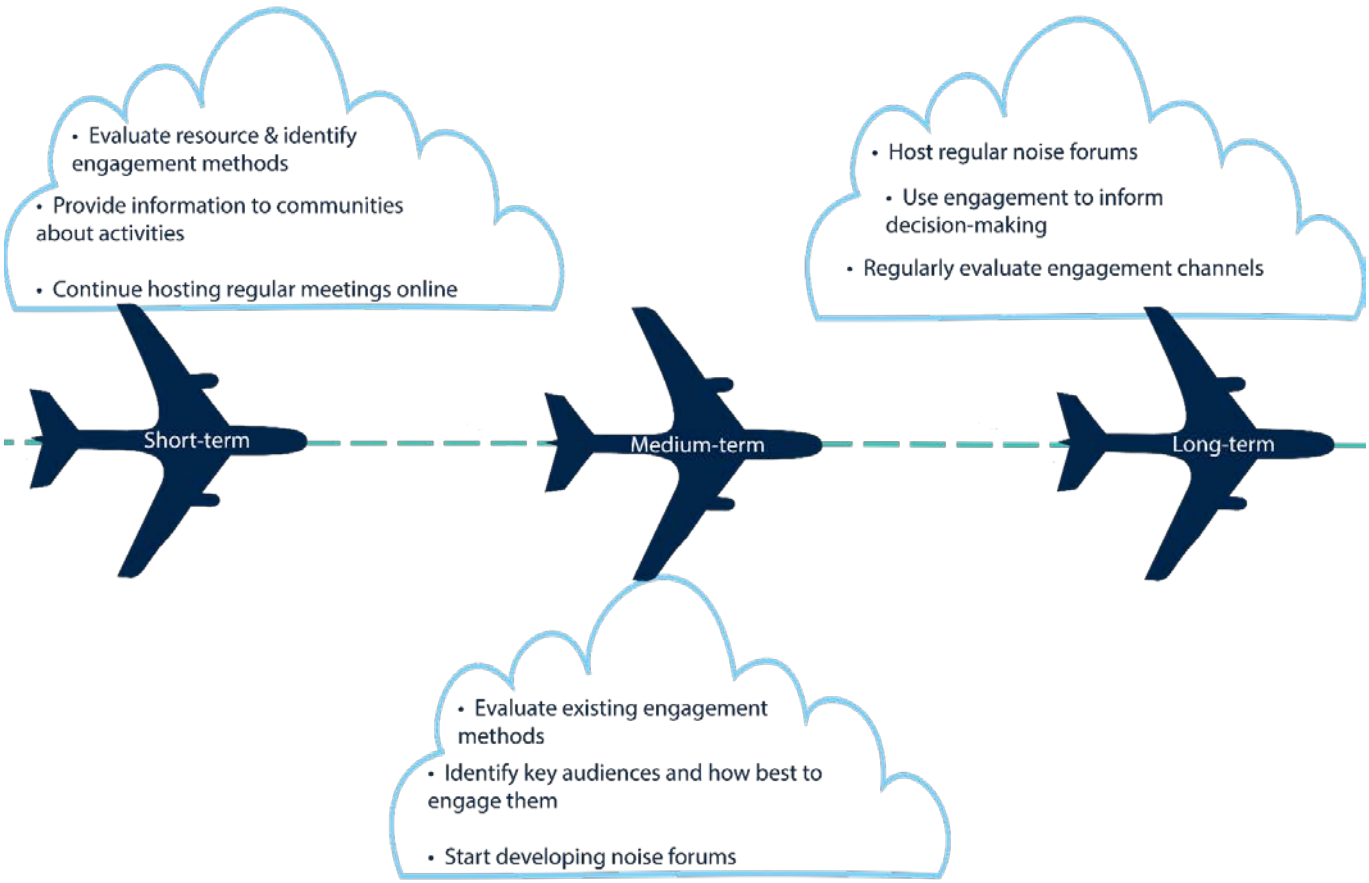
ICCAN is fully aware of the significant impact the Covid-19 pandemic has had on airports, so the best practice in this document has been developed to reflect these unprecedented circumstances.

Although we recommend a number of methods or mechanisms to help improve engagement, it is not our expectation that airports will be in a position to consider and adopt all of this advice immediately, especially while resources are limited, and aviation levels are low.

The advice produced here is designed to help airports to continue engaging and develop future engagement plans during this period.

It will also support airports to increase the level of their engagement in a more sustainable way as the situation improves, by seeking to involve their local communities in that process.

The phasing outlined below sets out the pace at which we expect this advice to be adopted over a short, medium and longer period. Given the nature of the pandemic, these timings will be different for each airport, so this advice should be implemented in a way that is most appropriate and reflects the individual local circumstances.



Short-term

In the immediate term it is vital to maintain good communication as people need to be aware of what is happening at the airport as well as what to expect when aviation levels begin to increase.

So, in the short-term, we would expect that airports:

- Evaluate the existing resources available for engagement and decide how they could best be used, identifying the most applicable methods to do so
- Keep providing information to local communities about airport activities and operations
- Where relevant, continue to host regular meetings online, making use of new digital technologies, so that people have a way to communicate with the airport.

Medium-term

As aviation levels start to increase and more resource becomes available, consideration should be given as to what engagement processes could be implemented and what their objectives would be.

Therefore, in the medium-term, airports should:

- Evaluate existing methods of engagement, assessing what channels work well and where improvements could be made
- Identify key audiences and how best to engage with them as part of a new continuous process
- Provide information on how the airport is building back more sustainability, using meaningful dialogue and two-way conversations to help develop and build trust
- Develop a noise forum to help people become more informed about technical aspects of noise, to discuss new approaches for managing and reducing noise impacts, and to better understand operational issues (for airports with a Noise Action Plan).

Long-term

In the long-term, and with aviation levels steady and rising, there will be an opportunity for new, or improved methods of engagement to be adopted. Airports need to be ready to implement such initiatives with identified audiences able to engage using new channels and mechanisms.

In the long-term, airports should be prepared to:

- Operate a noise forum with a clear mandate and deliverable programme of objectives (for airports with a Noise Action Plan)
- Use engagement channels to involve people in decision-making about any future plans, including airspace change or expansion proposals
- Regularly evaluate engagement to ensure that it is delivering against its objectives and is helping to create a meaningful partnership with local communities.

Noise forums

As a two-way process, a noise forum can present a real opportunity for people to become more informed about the technical aspects of noise and enable an airport to better understand how its noise footprint impacts people's lives. A forum can be an important tool for trying to form and strengthen relationships between airports and impacted communities as well as create a conduit for productive and meaningful stakeholder dialogue.

It is ICCAN's view that every airport in the UK which is required to produce a noise action plan (NAP) - setting out how noise issues are managed at the airport and the effects of departing and arriving aircraft - should also host a noise forum of some shape, designed proportionately to its activity levels. This will demonstrate transparency and accountability for communities as part of its noise mitigation process.

We are aware that the resource, in terms of time and people, needed to develop a noise forum could be considerable and it might not be appropriate or realistic for every airport to try to develop one in the current climate. However, it is our view that as aviation levels return it is advisable for airports with a NAP to have a noise forum in operation.

There is not a 'cut and paste' approach for developing a noise forum, as each must reflect local circumstances and be representative of that airport, its communities and the individual operational aspects.

However, there are several key points that must be addressed before setting up a forum to ensure that it has a clear purpose and objective.

ICCAN has identified a series of key considerations that airports should explore before embarking on this process. These are not prescriptive, so should be seen as helpful pointers as to the type of things that should be considered before establishing a noise forum.

These fall under the headings of:

- **Purpose**: the need to define the purpose and objective of the forum
- **Governance**: the need to define how the forum should be structured and take decisions
- **Membership**: the need to define who should be involved in the membership of the forum
- **Operations**: the need to define certain operational aspects of the forum.

As mentioned earlier, several airports in the UK already have noise-specific forums or groups that address noise as part of wider environmental concerns. Recognising that these airports may wish to retain or build on their existing groups, the advice provided here has been designed to create a series of principles that can be used alongside existing mechanisms.

Purpose

What is the purpose of the forum?

Before deciding what a forum could look like, or who might be involved, it is essential to establish and agree the overarching aim and purpose of the noise forum.

Defining this is key if the noise forum is to be a value-adding mechanism that people from all sides of the debate wish to participate in.

Airports should identify what they are hoping to achieve by developing a noise forum, and ensure it has a clear purpose. Within this, there is a need to consider the scope of the forum and whether it will be able to influence decision-making by the airport.

Key questions to ask include:

Will the forum give impacted communities an opportunity to become involved in decisions affecting them and help identify local issues and priorities?

- Could the forum be used to seek ideas on how to reduce and mitigate noise and to develop best practice?
- Will it be used as a mechanism to promote greater understanding of noise?
- Will it be used to allow communities to better hold airports to account?
- Could it be set up to help steer airport policy around noise?

Whatever decisions are reached here, it is ICCAN's view that relevant noise data should be shared with a forum.

It is important to keep referring to the core purpose of the forum as it will have an impact on decisions that need to be made regarding other aspects of its structure and operation. Noise forums should be set up with a clear purpose in mind. If an airport wants to develop a new approach to simply share information about noise and its impacts, including its noise data, then it might be better placed to do this via continuous engagement processes. This is covered in the next section of the document.

What role will the forum have?

In defining the aim and purpose, it will also be important to specify what kind of role the forum will have and define the level of influence it might have over practical changes.

Key questions to consider are:

- Will the forum act as a collaborative mechanism where members will have a say in the decision-making process? and/or;
- Could it be used as a consultative mechanism for airports to seek community input on its operations and proposals?

It is important to recognise that forums with too wide a remit often run the risk of failing to deliver, and those that do not have a clear purpose can also lose focus and become hard to manage. Ensuring that the forum's purpose is clearly defined and communicated to members is key to ensuring effective operation. This can often be summarised in a mission statement.

Such a mission statement can also be called a 'community contract' or 'mandate' but are essentially taking on the role of a mission statement, helping to clarify what the forum is seeking to achieve.

When establishing the forum and attempting to define objectives and purpose, it can often be helpful to hold independently facilitated discussions as these can help the community and the airport to better define and agree the mandate and objectives for the forum.

An example mandate could look like:

- We…(the noise forum)
- Will seek to develop…(the purpose of the forum e.g. to develop an open dialogue of communication with impacted communities)
- In particular on…(the specific issues relating to aviation noise)
- In order to…(what is the objective of the forum e.g. to seek to improve noise management)
- And we will undertake…(activities / actions will the forum undertake to help achieve this)
- By…(when this activity / action needs to be done by)
- To achieve…(how this activity / action helps achieve the purpose and objectives of the forum)

It is ICCAN's view that a noise forum should seek to act in a 'critical friend' capacity, so that members work in a productive manner, seeking to deliver a set of agreed objectives.

A work programme and strategy should be formulated so that the group has a clear direction.

Setting objectives and targets allows members to measure and monitor the impact it is having and make it more straightforward to shift focus onto any emerging areas.

It will also be important to specify the expected outputs so that participants have a clear understanding of what the noise forum is seeking to achieve. Deliverable objectives must be appropriate for each airport and its communities, so they must be developed to reflect local circumstances.

What will be the scope of the forum?

Before deciding on how the membership is made up, due consideration should be given as to what extent the noise forum needs to be representative of the local communities that are impacted by noise; or whether there is a desire to focus more on engaging with more informed and active voices.

Linked to defining the scope is a decision about whether the noise forum should be a mechanism for a wider discussion, or should it have a more focused approach?

Based on these considerations, decisions can be made about whether the forum would be best populated by people with experience, both professional stakeholders and residents, or by people who are representative of the local community and able to work collaboratively to develop solutions to noise issues.

The choices made here will also have an impact on the structure, recruitment and operation of the forum.

Governance

What structure should the noise forum have?

A noise forum needs to be proportionate to the airport and the local area but should always remain a manageable size.

A key consideration here is to define which audiences are to be included in the structure of the forum and decide whether sub-groups could be a useful tool as this could include a wider number of community representatives and stakeholders.

Sub-groups could be useful to reflect different audiences and could feature nominated representatives who attend the main forum meetings to represent the views of a sub-group.

It is important to give consideration as to how some existing audiences, such as noise campaign groups, will be incorporated in to a noise forum as well as lay people i.e. residents from impacted communities who may not have engaged with the issue of aviation noise before.

If sub-groups are used, then decisions would also have to be made as to whether they have their own projects as part of an agreed work programme, and how they would feed back into the main noise forum.

How should the forum be led?

It is ICCAN's view that a noise forum should have an independent chair to ensure that meetings are transparent and due process is followed.

It is essential to have a chair with a relevant skillset and knowledge so that they can steer the group in setting and delivering the agreed agenda, yet at the same time ensure that everyone's views are respected, and that participants behave in an appropriate way. The chair should also play a key role in ensuring that conclusions are appropriately communicated to those whom the forum is seeking to influence i.e. airport management and/or policy makers.

A chair is vital to ensuring that the voices of everyone are heard, seeking fair representation from all members and avoiding certain elements dominating the agenda. Equally groups, individuals and the airport need to recognise the independence and position of the chair.

The main challenges with appointing a chair is ensuring that the selected person is able and willing to act in an independent capacity and has the ability to carry the confidence of different participants.

As part of the recruitment process it can be beneficial to seek external support to ensure the right appointment is made. Consideration should also be given as to how long a chair should be in position for, and whether there should be fixed terms and a maximum tenure.

How are decisions reached?

Defining decision-making processes and setting these in the Terms of Reference is an important element of establishing a noise forum.

It is important to consider whether the forum will need to secure a consensus opinion or whether members should be given the opportunity to vote with the aim of seeking a majority opinion approach.

If trying to seek a consensus the chair will play a key role in determining how decisions are reached and agreed, so as mentioned above, appointing someone with the relevant skills will be crucial. When there is no consensus on an issue, a way forward should be agreed; whether that is a majority decision, to agree or disagree, an expression of minority views, or for no action to be taken.

What type of administrative support could the forum have?

Having a secretariat is useful in terms of ensuring smooth operation and transparency of proceedings, but where should that responsibility lie and is there suitable funding to support this?

Whether the secretariat role should be outsourced from the airport or kept in-house will need to be considered.

Clear governance is needed to ensure effective operation of a noise forum and this needs to be factored in to the administrative support provided so that meeting arrangements are handled and that papers are produced and distributed, so it is key to determine who is responsible for that.

How will the forum sit alongside the airport consultative committee?

How the forum works alongside the statutory structure of the airport consultative committee (ACC) needs careful consideration to ensure there is a clear understanding of the role and remit of both groups.

Some ACCs include noise on the agenda, but it is ICCAN's view that noise forums should be the main body responsible for reporting on noise and this should be fed back, possibly as a statutory discussion item, at each meeting of the ACC.

Membership

Who should be involved?

As discussed earlier, the membership of a forum will depend on its purpose and structure but should also feature fair representation from those areas and communities that are most impacted by the airport's noise footprint.

Ensuring a balanced mix of members is essential. Trying to involve everyone could result in the group becoming unmanageable and lose focus from its main purpose. Similarly, if the membership is too narrow then there will be criticism from those who feel they aren't properly represented.

It is difficult to achieve the right balance and to some extent local circumstances will help dictate what the make-up of participants could look like, but it is crucial to define who should be involved in the membership of the noise forum.

The use of sub-groups, as previously mentioned, could help to include wider audiences, without losing focus from the work programme.

How to identify the right membership

It is important that, whatever the purpose and role of the forum, the right potential participants are identified. Involving the right people at the forum will also help the airport to build social capital on other important areas aside from noise.

ICCAN has produced guidance on identifying and mapping stakeholders as part of its toolkit for consulting on airspace change. Although this has been designed to identify audiences for a consultation, the principles can still be applied. More information can be found here.

It is ICCAN's view that the following four groups should be core members of any noise forum:

Local authorities:

Local authority representatives must play a role in the noise forum, particularly from the designated local planning authority who will be instrumental in implementing noise restrictions for the airport.

Senior council representatives, such as cabinet members and senior technical officers, would help reinforce the importance of the forum and help to represent the voices of other important stakeholders, such as hospitals and schools.

The number of local authorities represented at the forum will again be dictated by the geography of the airport and as some airports already have existing local authority engagement groups, consideration should be given as to how these groups would interact and function to ensure there is no duplication.

ACCs and noise forums should not contain the same local authority representatives as it is ICCAN's view that the two should complement, not duplicate each other.

Community representatives:

Existing community representatives have dedicated a lot of time trying to better understand the complexities around noise, so will play an important role as part of any noise forum.

A decision will need to be taken on how they are represented and how many community groups the forum can accommodate. If the forum is seeking to engage every relevant community group, then it will have to decide how it will deliver this in practice. An open-to-all approach could be harder to accommodate so it might be beneficial to establish dialogue with those impacted by noise by developing a strategy for continuous, collaborative and community-oriented engagement away from the noise forum.

In seeking to accommodate existing groups, an approach could be adopted where fully constituted groups are invited to attend the sub-group, allowing for more in-depth discussion away from the general forum. Members of the sub-group could then nominate participants to represent them at the main meetings of the forum.

When seeking to include existing community representatives, geography should also play a key consideration as it would be wise to try and involve groups that reflect all areas impacted by the airport's noise footprint and not just areas where there are most groups.

Wider community:

The forum could be used as an opportunity to invite people who might be affected by noise, but do not currently engage with the airport, to play more of a role.

These people will live under the flight path but do not feel they either have a voice or have not considered that an airport would be interested in hearing their view before. In this way, seeking to incorporate local residents can offer a wider range of views as part of any deliberations or decision-making.

This could allow for broader geographic representation, help to further build social capital and ensure the forum is representative of the local community. There are several ways to seek wider representation which could include working with councils to better understand local demographics, undertaking a stakeholder mapping exercise that takes into consideration those seldom heard groups, or through local promotion such as newspapers, websites, leaflets and local blogs. Depending on the scope of the forum, you could seek to involve more representatives from the wider community as part of a continuous engagement process adopted alongside the forum.

Airport management & industry representatives:

Although featuring an independent chair, the forum should be used as a mechanism to help drive change and improve conversations around noise, so it is important the airport is appropriately represented.

If the forum is seeking practical ways to reduce and mitigate aviation noise, then having airline representatives as participants could help move the agenda forward by working on and proposing changes that can be implemented by the airport and airlines together.

Similarly, consideration should be given as to whether the Civil Aviation Authority and National Air Traffic Services should have representation.

How to ensure an agreed way of working

If the forum is to help create a meaningful dialogue, it is vital that all members agree to a set of behaviours so that this can be achieved and create a way of working that ensures meetings are run in a productive manner and deliver against the agreed objectives.

There should be an acknowledgement that discussions might include disagreement or a degree of conflict and that this should be recognised, embraced and managed from the early stages of establishing a noise forum.

To help address this there could be an open discussion on how conflicting opinions and perspectives will be managed and establish a clear set of rules for how the meeting should progress after such situations arise.

As the membership of the forum should act, as much as possible, in a 'critical friend' capacity, there must be an understanding that decisions may not always benefit everyone, but through discussion, participants are clear as to how an outcome has been reached. Once a position is agreed, airports and other key stakeholders should report back to the forum in a timely manner on the progress made.

By establishing some key rules, members would acknowledge a way of working that would ensure that behaviours are upheld, and progress is continually strived for.

ICCAN recommends that noise forums should where possible operate using the Nolan principles of public life which although established for people in public life, represent a good baseline of behaviours and expectations for an agreed way of working. More information on the Nolan Principles can be found here.

This would mean that people participating in a noise forum should demonstrate the behaviours of: selflessness, integrity, objectivity, accountability, openness, honesty and leadership.

ICCAN also recommends that noise forums should consider offering induction packages to all new participants to provide clarity on their roles, the ways of working and give them a better understanding of what the forum is seeking to achieve.

Operations

How do you agree a work programme?

A forum should be able to demonstrate that its work is having an impact so implementing a programme of activities that can be delivered over a set period of time can help to achieve this. What such a programme looks like will vary from airport to airport, given each will need to reflect the local issues and circumstances.

While it might be the case that some activities are suggested by the airport or chair, the work programme will only succeed if it has buy-in from the membership. This suggests that once a forum is established it would be useful to spend time discussing ideas and suggestions that could be considered for inclusion in the work programme. This will enable members to help steer the programme in a way that would be most beneficial for the people that they represent. Consideration should also be given as to what the short, medium and long-term ambitions of the forum are and reflect this in the work programme.

If sub-groups are being used, then different strands of the work programme could be divided between them with progress and results fed back into the forum by the nominated representatives for those groups.

How often should the forum meet?

Consideration should also be given as to the frequency and length of noise forum meetings taking into account the size and availability of the membership. The time and location of the meeting is also key, so thought should be given as to the accessibility of the venue and the most appropriate time for it to be held.

There could be scope for hosting virtual meetings online as this reduces the amount of time people need to dedicate to the forum as well as alleviate the geographic constraints of travelling to meetings. Online meetings also present more options when addressing the make-up of the membership as they could be used as a way to invite some people to observe the meetings, potentially with the option to ask pre-arranged questions.

A hybrid meeting could be adopted which would allow some members to physically attend while others login remotely. There are benefits to this approach as it could be more convenient and appealing to potential members from the wider community. If sub-groups are used, then these considerations will also have to be applied.

There is a need to also consider the regularity of ACC meetings and ensure that the noise forum is consistent with this and able to inform the ACC of its deliberations. Standards should be specified in terms of the notice given for a meeting of the noise forum and any support papers circulated well in advance.

How do you evaluate the forum’s success?

It is important that the forum builds in processes that enable it to track against its objectives and help highlight areas that might need more focus. Consideration should be given as to what success for the forum looks like, whether this is tangible change for communities, a better understanding by those impacted, projects delivered etc.

Evaluating successes and learnings is a useful way to ensure that the forum evolves as it delivers against its objectives.

To ensure that a noise forum is delivering against its objectives and work programme, it is good practice to review how it is operating after a certain period of time.

It is ICCAN's view that reviews should be carried out to coincide with length of term, so if a forum operates for a fixed five-year term, an evaluation should be carried out to complement this before the next term commences.

It is also good practice to review progress at a mid-point to ensure that the noise forum is delivering against its objectives and work programme. To demonstrate transparency and accountability, evaluations should be, where possible, carried out by an independent third party to help track the forum's progress and avoid any potential conflict of interests.

Formal evaluation can help to identify areas that might need addressing and ensure that the forum is not deviating from the delivery of its objectives. It can also be used as an opportunity to revaluate certain aspects such as tasks and review whether the membership and chair need to be rotated to help refresh perspective and welcome in new changes.

How do you ensure transparency?

The forum should be as transparent as possible to help promote accountability, so a dedicated webpage should provide as much information as possible for the wider public.

This should include Terms of Reference, agenda, minutes and membership details as well as contact information for anyone seeking further information about the forum.

Depending on budget, forums could also be filmed and either live-streamed or uploaded onto the website as a formal record of proceedings.

Continuous engagement

Continuous engagement is a process of on-going dialogue with identified audiences to address specific issues over an extended period of time. This approach can enable participants to have a deeper, more informed dialogue, and help to develop relationships as well as improve communication around key subjects.

Implemented through a cycle of engagement activities, it can result in participants gaining a better understanding of topics, and airports developing further, more detailed, insight which could in turn help improve decision-making.

Having a longer cycle of engagement provides an opportunity to share information in a more accessible way, allowing participants to raise questions and concerns as the process develops.

Given the impact of Covid-19 on airport resources we are aware that it might not be realistic to develop a new engagement approach such as this in the short-term.

However, the current climate does provide a good opportunity to plan ahead, so this is an opportune moment to consider whether a continuous engagement process might be beneficial for airports in the longer-term and how such a strategy could be incorporated into any forward planning.

Before embarking on a continuous engagement approach, it is key to review all existing engagement activities, and understand how a continuous approach would sit alongside these current mechanisms (such as ACCs or noise forums) and whether it might replace existing methods and channels of engagement or enhance/augment such approaches.

Adopting this style of engagement can also be a useful way of seeking out and incorporating new voices into the conversation in a less formal manner than other engagement mechanisms such as noise forums.

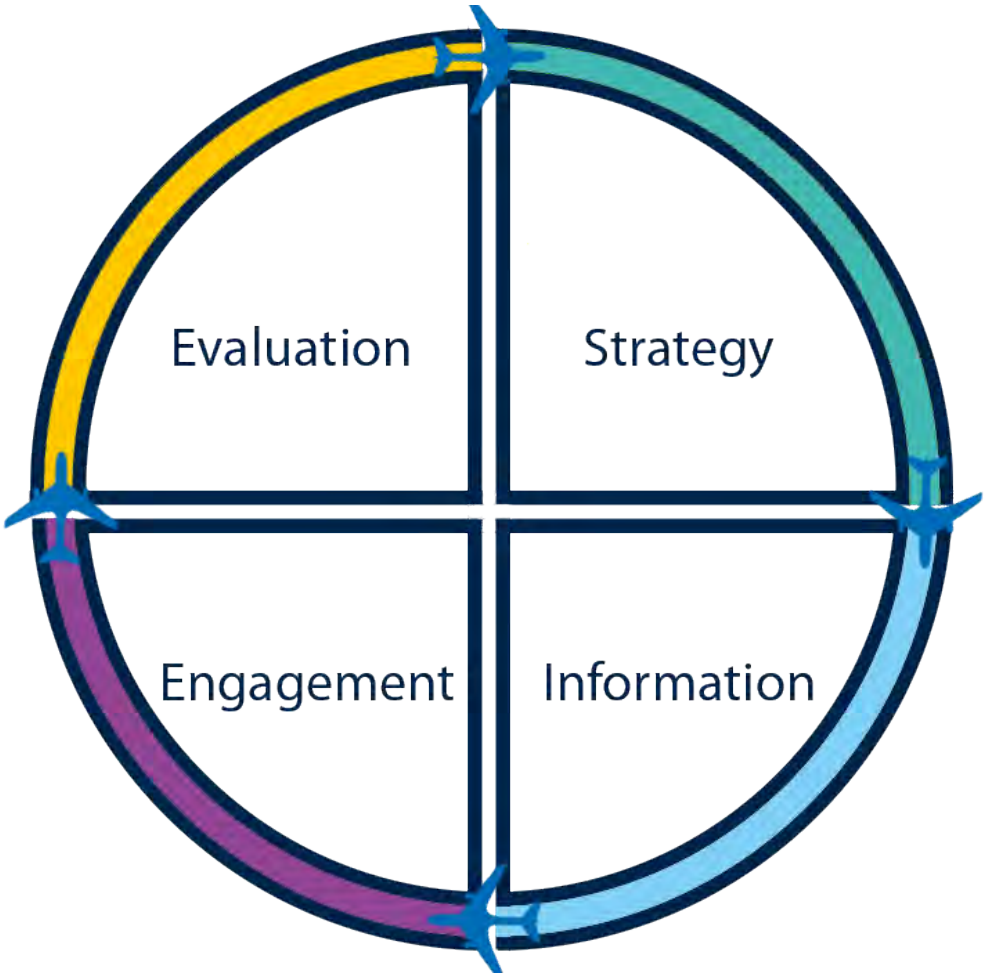
This can be an effective way to engage with seldom heard groups and individuals.

It is ICCAN's view that a continuous process of engagement provides an opportunity to instigate new ways of thinking and implement different approaches to help engage communities about noise and other issues. It should be considered seriously by airports as part of creating an effective engagement strategy.

The below diagram sets out the key aspects that will need to be considered as part of a continuous engagement process.

These fall under the headings of:

- **Strategy** – what needs to be considered when developing a strategy including purpose, role and participants?
- **Information** – what kind of information and resource will be needed before the process starts?
- **Engagement** – what kind of activities could be undertaken to ensure the process is successful?
- **Evaluation** – how best to evaluate the process and define areas for renewed focus?



Strategy

Defining the purpose and role of the engagement process

It is important to be clear about what a continuous engagement process is seeking to achieve. For example, is it to better understand views to help inform decision-making, is to be used to share information as part of a wider engagement strategy, and why does it need to be done continuously?

Consideration should also be given to the role participants will play and how much influence they might have as this will have an impact on the overarching objective.

Key questions to consider are:

- Will the process act as a communications channel to provide participants with information?
- Will participants be given a platform to share their views?
- Will there be a genuine dialogue to discuss ideas and solutions?
- Will participants help to set the agenda and have a decision-making role?

Defining the purpose and role will be key, as it will help set out other key aspects of the process such as participation, resource and approaches.

Identifying the right participants

There is a need to consider how representative the participant base should be before identifying who the right audiences are. As with noise forums it is important that the right people are involved, so consideration should be given as to how wide the reach of the process should be.

Key questions to consider, are:

- Will the process be open to all, including existing stakeholders and existing community groups?
- Will stakeholders from key representatives be identified and invited to participate?
- Will the process seek to invite new and previously unheard voices into the conversation?

It is ICCAN's view that continuous engagement presents a good opportunity to attract a broader range of stakeholders, enabling airports to widen their reach to include impacted audiences that don't currently participate through any existing channels or methods. It is important to avoid duplication so that the same voices aren't represented multiple times.

To try and identify those wider audiences, it could be useful to check against the airport's Lowest Observable Adverse Effect Level (LOAEL) and Significant Observable Adverse Effect Level (SOAEL) maps, to determine those areas impacted by noise.

It should be noted that these maps should only be used as a starting point, as impacted audiences will also be located outside of these boundaries. ICCAN's future work on the use of alternative metrics may provide assistance in identifying those impacted communities.

It is important to utilise other resources including important local knowledge about impacted audiences held by ACCs and noise forums, local authorities, voluntary and community sector organisations as well as local campaign and community groups. Engaging with local external groups can help to gain a better understanding of local networks and issues, all of which can build stronger relationships in support for the continuous engagement process.

It is also useful to consider how to identify and incorporate seldom heard audiences to better understand the views and experiences of those sections of the community who are impacted by noise but might have difficulty engaging.

ICCAN has produced guidance on identifying and mapping stakeholders as part of its toolkit for consulting on airspace change. Although this has been designed to identify audiences for a consultation, the principles can still be applied for continuous engagement. More information is available here.

Information

Identifying and providing the right information

The concept of continuous engagement centres round the idea of sharing information as a starting point for discussion and debate. For this to be effective, there must be a focus or prompt so that people can sufficiently engage in the discussion. This could be to address a specific issue, or to provide more information, for example it could be about noise monitoring, metrics and contour maps, night flights, complaints etc. Equally, continuous engagement might be used to address multiple issues with noise being one of them.

Whatever the approach, it is important that the relevant information is identified, prepared and distributed to participants so that they are supported in their understanding of the issues.

Depending on the focus, that information might be readily available, but if new documentation needs to be prepared then that will need to be factored in when deciding how much resource to allocate to the process.

It is ICCAN's view that any information developed for the use of community engagement, such as background information, agendas, minutes etc, should be made available online, and be easy to locate on an airport's website, with the option of hard-copy versions made available for those without internet access.

Resource requirements

Consideration must be given to the amount of resource that will be required to support a continuous process, so there is a need to outline the volume and breadth of the engagement as part of the planning. As the process will require a series of ongoing activities, this will need staff time to ensure it is managed correctly.

Staff will be required to deliver the communications, analysis and ongoing day-to-day management of the engagement process, as well as plan and moderate the activities. Due

consideration must be given as to how much resource there is available and how much should be dedicated to the process to ensure it is delivered appropriately and efficiently.

It is also worth considering whether experts or specialists might be needed to help with the engagement process. This might be particularly useful if trying to help participants to understand the more technical aspects or if bringing in people to share their own knowledge e.g. a representative from a campaign group relaying their experiences and lessons learned to new audiences.

Ensuring that these aspects are considered and incorporated as part the planning process is central for an effective continuous engagement strategy.

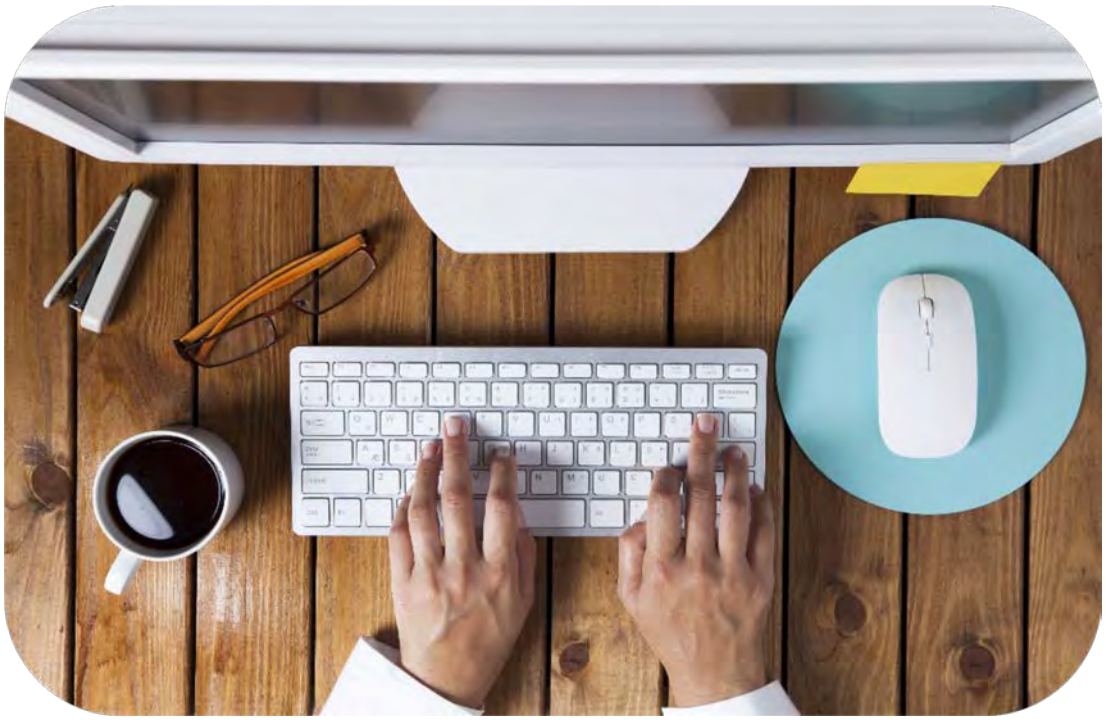
Engagement

Types of engagement activities

Having established the purpose, role and the audiences you want to involve, it is important to consider what type of techniques would be most effective to help deliver a continuous engagement strategy.

Due to Covid-19, online techniques have now been more widely adopted and they should play an important part in delivering future engagement, however they should not be completely relied upon once it is safe and appropriate to resume face-to-face interaction.

There is an opportunity to creatively combine a number of different techniques, both online and offline, to help deliver these engagement activities. The table on the following pages sets out some examples that could be adopted as part of a continuous process.



Purpose for engagement	Possible techniques
Providing information	Web based portal / websites - information relating to the issues or topic could be made available on a section of the website or through a designated portal. All relevant information could be uploaded here alongside any other materials that might help to explain the topic. Video – developing video content can be a good way to increase awareness of an issue or subject and presents an opportunity to create something visual that makes it easier for someone to understand. They can also be shared on other digital channels, including your own and stakeholders' websites. Videos can be expensive, so they must add value and help deliver against the objective. Due consideration should be given to the accessibility of the video, whether it might need to be translated, or if a sign-language version needs to be produced. Pop-in events – information can be displayed on stalls that are usually placed in public locations near a high volume of foot traffic, e.g. outside supermarkets or in a shopping centre. These can generate interest with passers-by, who might not engage in more traditional methods. This could also be used as a way to capture views.
Seeking feedback and views	Online questionnaire – setting out a series of questions to help gather opinions around a specific topic or issue. This can be targeted and tailored for certain audiences or it can be more general, but they should not be relied upon as a sole way for gathering feedback. Questionnaires can be promoted across several digital channels, such as web, social media and newsletters. Focus group - a useful method to hear the opinions of people that might not usually be as forthcoming as others with their views. They can be built around a small number of people giving their general views on the proposals or could be tailored for a specific purpose e.g. to address the noise impacts on a particular area. Focus groups can be used to target specific audiences and are usually run by an independent facilitator, which helps to create a neutral and open environment. Small incentives can be used to encourage new stakeholders to attend and contribute but need not always be. Forum discussion – a session where information is shared with a group of stakeholders providing them with the opportunity to share their views and capture feedback. This could be delivered in a more traditional meeting format, or as more of a workshop with small groups having discussions. This mechanism could also be used as a way to discuss ideas and solutions.

Discussing ideas and solutions	Deliberative events – a session where information is shared with stakeholders and a dialogue ensues about the issues, where new ideas and potential solutions can be discussed openly. In this type of event it would be useful to have a wide range of stakeholders so that multiple views are heard and debated. It is important that people are all given a chance to make their points, and that certain voices do not dominate. This could feature a larger number of participants that break out into smaller groups, followed by feedback of their discussion and ideas. A number of topics or issues could be discussed across a series of events as part of a continuous process with those stakeholders. Deliberative events are useful if you want to include a targeted and wider representation of participants. It is important that the solutions are taken away and considered as part of any future decisions. Furthermore, it is crucial that people understand what has been done with their feedback, so this must also be communicated back to them as it demonstrates how their views have been taken on board.
Working together	Citizens' assembly – similar to the Toronto Reference panel (see International examples), where a representative group of people from an area (e.g. those impacted by an airport's noise footprint) are randomly chosen to enter into a longer discussion around a specific topic with the aim of achieving an agreed outcome at the end. This model of engagement allows people the chance to consider evidence in more detail over a number of designated days, where they are given the opportunity to hear from experts and discuss the issues, before delivering a set of agreed recommendations that are representative of the views of the local population and based on a deeper understanding of the issues and opportunities. Resourcing for this type of engagement is significant, but adopting it shows a willingness to seek a deliberative outcome and adopt a new way of working.

Table 1: A table of engagement techniques according to purpose.

Incorporating digital engagement

Online engagement can complement more traditional approaches, particularly as it removes many of the geographical and time restraints of physical activities, making it more convenient for most people to attend. It is also a vital way to communicate with people while the Covid-19 pandemic restricts our ability to meet face-to-face.

However, it is important to remember that not everyone has access to the internet. There is always a need to consider how non-digital approaches can be used to ensure those audiences who are unable, or do not wish, to engage online can also be incorporated in the process.

There are multiple digital methods that can be used for engagement such as online meetings and focus groups, web chats, or even hosting question and answer sessions on social media. However, it is important that the technique supports the overarching objective of the engagement.

Advantages of using digital engagement approaches	Disadvantages of using digital engagement approaches
Is more attractive to people that might not respond to more traditional methods	Excludes those that don't have internet access
Can reach a larger audience as no geographic constraints	Requires at least basic technological skills for people to take part
No requirement for a physical venue, which keeps costs down	Communication can be more difficult as conversation is more structured and less free flowing
Offers flexibility and is more convenient for people that have limited free time	Loss of participant attention during discussions
Less intimidating to raise questions online compared to more public forums	Managing conflicting views can be difficult
Provides option to show visual content, such as images or videos, that help explain subjects	Participants might be less committed to a digital process, as easier to duck in and out of

Table 2: A table setting out advantages and disadvantages of using digital engagement approaches.

Evaluation

Reviewing the engagement process

To understand whether a continuous engagement process is delivering against its main objective it is important to regularly evaluate the activities and review whether progress has been made. To help do this, it is useful to gather feedback from the participants on how they think the activities have been delivered, whether they think the engagement is having an impact and if they have a better understanding of the key issues. It is crucial that participants have an opportunity to give an honest assessment of the engagement, so that they can feel invested in the process.

This feedback should be analysed and reported back to participants, as it will help highlight what is working as well as if there are any problems that need addressing. Doing so demonstrates a willingness to build and improve on the original activities. If people don't feel like their opinions are valued and changes are not made, they could become frustrated and choose not to take any further part.

Reviewing the process should help to evolve the strategy for the next cycle of engagement, bringing new ideas for engagement and highlighting new issues and areas to focus on as the process continues, enabling participants to agree the next steps together.

Building social capital

By entering into a regular and open dialogue with communities and stakeholders, airports can help to build social capital which can ultimately lead to a stronger degree of understanding and trust.

With the majority of airspace change proposals and expansion plans on hold, airports have an opportunity to enter into honest conversations without the added caveat of having to get community buy-in for a specific proposal.

As highlighted in ICCAN's community survey, people want to feel like they are being listened to and doing this earnestly, in this quieter period, can demonstrate a willingness to forge a new way of working. This is an opportunity for airports to put communities at the heart of its decision-making and develop a shared understanding where people feel like they are invested in the process.

Developing these relationships now can help create a more sustainable platform from which to build upon when noise levels return. Having that structure in place so that you can demonstrate that you understand the local community impact and have fully engaged with them will be key if aviation is to return in a more sustainable way.

ICCAN's recommendations for engagement best practice – a summary

As previously stated, it is not our expectation that airports should implement all our recommendations in this current climate. A phased programme of engagement that can be adopted over a short, medium and long-term is set out earlier in this document. It is ICCAN's view that establishing a noise forum and a continuous engagement approach are two mechanisms which would help to create an appropriate framework for more effective dialogue as the situation improves and change programmes re-start**.**

To help ensure these methods are adopted successfully, it is ICCAN's view that:

- Every airport in the UK which is required to produce a noise action plan (NAP) - setting out how noise issues are managed at the airport and the effects of departing and arriving aircraft - should also host a noise forum of some shape, designed proportionately to its activity levels. This will demonstrate transparency and accountability for communities as part of its noise mitigation process
- It is essential to establish and agree the overarching aim and purpose of the noise forum and define how it will add value
- Noise forums should seek to act in a 'critical friend' capacity, so that members work in a productive manner, seeking to deliver a set of agreed objectives and a work programme and strategy should be formulated so that the group has a clear direction
- Noise forums should have an independent chair to ensure that meetings are transparent and due process is followed
- Noise forums should be the main body responsible for reporting on noise and this should be fed back, possibly as a statutory discussion item, at each meeting of the ACC
- Reviews should be carried out at mid-point and at end-of-term to evaluate progress and ensure that objectives are being met
- Continuous engagement should be adopted to attract a broader range of stakeholders, enabling airports to widen their reach to include impacted audiences that don't currently participate through any existing channels or methods
- Any information developed for the use of community engagement, such as background information, agendas, minutes etc, should be made available online, and be easy to locate on an airport's website, with the option of hard-copy versions made available for those without internet access
- Relevant noise data should be shared with the noise forum and communicated to people as part of a continuous engagement process
- A continuous engagement process must be sufficiently evaluated, and feedback given to participants to ensure that it is delivering against its objectives and remains a two-way process.

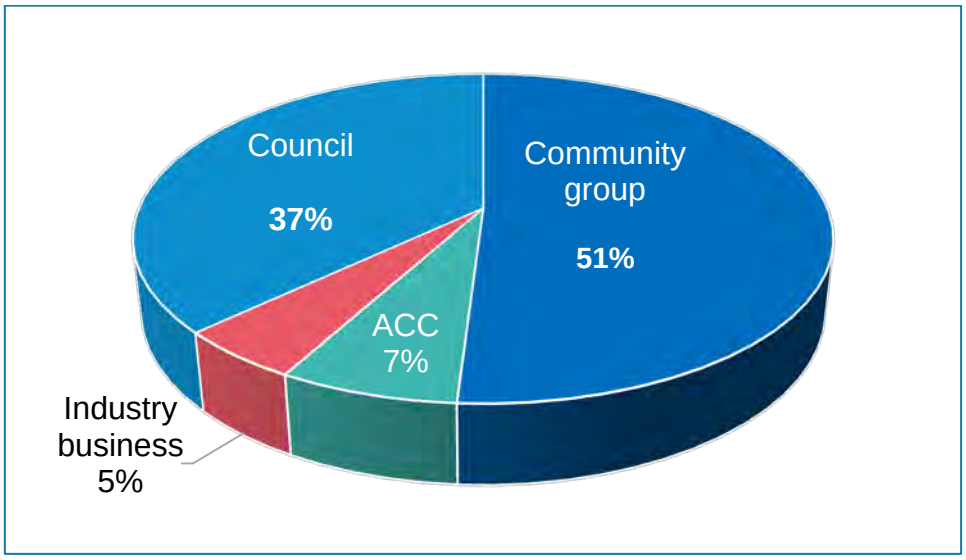
ANNEX:

ICCAN community survey

In February 2020, ICCAN ran an online survey seeking to find out more about how airports engage with local communities so that we could better understand what approaches worked well and where improvements could be made.

This survey was taken before the UK entered lockdown, so the results reflect engagement delivered pre-Covid. The survey featured nine specific questions about engagement as we sought to find individual experiences of airport engagement across the country, and how it was received within local communities. We gathered feedback over a three-week period, publicising the survey through our social media channels, an online newsletter, and by using organisations such as UK's Airport Consultative Committees, the liaison group representing the country's AC Cs, to circulate it to its members.

- The survey received 136 responses, of those 95 were individuals and 41 were from respondents representing organisations. Those organisations can be broken down as:
- Community groups including noise forums, action groups and residents' associations
- Councils including local, county and parish
- Airport consultative committees
- Representative bodies for industry and business



Graph 1: Graph showing breakdown of survey responses by groupings

We asked respondents to identify the airport or airports that were geographically closest to them, were regularly engaged or impacted by. Several respondents listed more than one airport, but for our analysis we have assigned their response to the airport that most reflected their feedback. The results provided a good representation from people across the UK and even a small number from Europe. The table on the next page tracks the number of responses against the airport recorded.

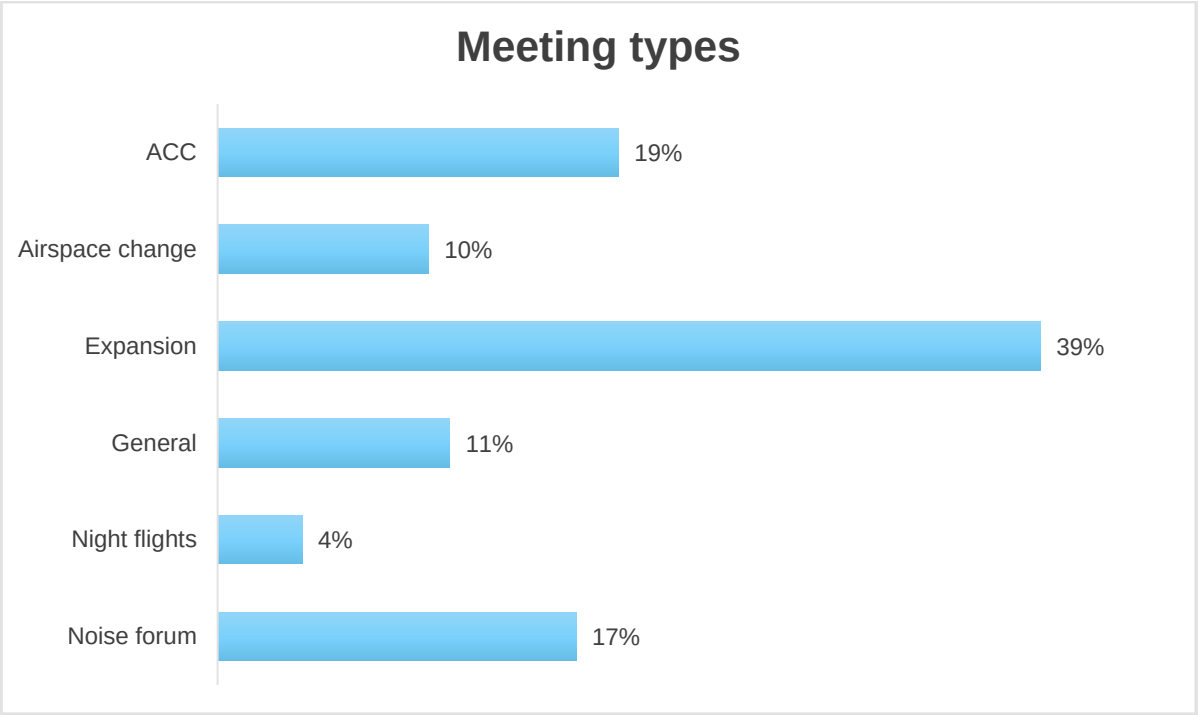
Region	Airports	Number of Responses
South East	Gatwick	30
	Heathrow	24
	Luton	11
	Biggin Hill	8
	London City	6
	Manston	2
	Southampton	1
Midlands	Leeds Bradford	24
	Doncaster Sheffield	1
Scotland	Edinburgh	6
	Glasgow	3
	Inverness	1
North	Newcastle	8
	Manchester	3
South West	Bristol	4
Europe	Amsterdam Airport Schiphol	3
	Brussels	1

Table 3: Breakdown of responses by airport and region.

Airport contact

The survey revealed that almost 75 per cent of respondents had previously been contacted by their local airport or had attended a meeting, indicating an existing relationship or awareness of engagement. The most common responses as to why they were contacted tended to focus around upcoming airspace change programmes, planning proposals including terminals and runway expansion, and responses to noise complaints.

The below graph breaks down the type of meetings respondents attended.



Graph 2: A graph breaking down the type of meetings respondents attended.

Almost half told us they had attended a meeting where they were updated about the airport's proposed plans including airspace change and expansion. Slightly more than a third of respondents informed us that they regularly attended meetings, in the form of either noise forums or ACCs, and the remaining 15 per cent can be described as reactive engagement.

By that, we mean meetings that were arranged as a direct reaction to an enquiry, held to discuss more general topics such as residents' concerns about night flights, specific community concerns or operational updates.

Almost half of respondents felt that they were kept informed about what was happening at the airport, but only a third felt that airports proactively engaged with local communities.

What do airports do well?

We gave people the opportunity to provide examples of good practice where airports engaged well with their communities. The below summary covers responses to this question.

Communication

Some respondents felt that airports were good at communicating their plans to people, particularly around subjects including airspace change, expansion and operational matters.

They felt that staff were enthusiastic and knowledgeable, presenting accessible information on sometimes complex topics. They also adopted communications channels well to keep people

informed. Several examples cited user-friendly websites, busy social media accounts and newsletters that promoted updates, future plans and other news.

In some cases, airports responded well to queries, whether about noise complaints or other individual responses, in a quick and efficient way.

What was said:	
"It (the airport) has been particularly good in engaging with interested parties in the design of its new flight paths."	"Excellent social media (if people want to engage), and a good website."
"Transparent and regular updates on what goes on behind the scenes and information about their future plans."	

Table 4: Comments about communication

Meetings

Stakeholder meetings, arranged to promote day-to-day operations or future plans, was another area airports engaged well on. In some cases, this was quite extensive with several specialised forums such as focus groups, consultative committees and passenger and access forums, held to encourage active engagement. Some respondents noted that the presence of senior staff at those meetings was well received and gave them credibility.

Another area where some airports generated goodwill in the community was through surgeries, as they provided an opportunity for team members to talk directly to local residents in impacted areas. In some cases, this also meant supporting specific community initiatives such as charities or local organisations.

What was said:	
"The airport has a long and strong link with the local community through working with schools and charitable work. I have found the airport very willing to discuss any issue raised in an honest and open manner."	"The community relations department have an excellent programme of outreach events, giving people the opportunity to ask questions within their own locality."

Table 5: Comments about meetings

Where could airports improve?

The survey also provided people with an opportunity to highlight areas for improvement, enabling them to specify exactly what kind of activities and behaviour they would like to see airports carry out to enhance their community engagement.

The below summary covers responses to this question:

Community perspective

A large proportion of the feedback focused on people's desire for airports to better understand the local communities and recognise the impact its operations have on them. They indicated a desire to see an improvement in the knowledge of the local area and the ability for staff to identify all those towns and villages that are impacted by the noise footprint of the airport. There

was also a call for better and fairer representation on airport affiliated groups such as noise forums and ACCs, so that those communities who consider themselves often overlooked, have a more prominent voice.

Respondents wanted airports to see things from the communities' perspective, so they could better appreciate what the impact of noise looks and feels like to them. It was proposed that one way to remedy this would be for airport teams to get out into the community more and not just rely on their messages being delivered through the usual digital channels.

What was said:	
"Allow local representatives on its bodies, listen to concerns over noise and air quality, consider local residents when using flight paths and planning for expansion."	"Liaise with all neighbourhoods affected by their flight path. They do liaise with some but not ours."
"Have more direct contact with local residents and not rely too heavily on local community groups, the press or social media to spread their message."	

Table 6: Comments about community perspectives

Genuine dialogue

Respondents felt that airports could improve engagement by entering into a genuine dialogue with people. By this, they meant that they would like to have a two-way conversation where residents felt that they were not only being listened to, but that both parties were working to achieve genuine outcomes.

The feedback showed that airports were often keen to engage when they were publicising their plans but often failed to address the issues head on, to avoid having to discuss bad news. The feedback showed that people would rather airports were transparent and upfront as this would go some way to repairing trust.

Some respondents felt that their concerns were not properly being addressed, so wanted airports to demonstrate how they have listened and learnt from communities in the past.

What was said:	
"Being transparent, fair and truthful regarding the negative impact on surrounding communities. Taking complaints of people seriously and take relevant measures to decrease these impacts."	"Probably give clearer explanations to individuals who complain about changes to noise and flight paths in their area."
"Presentations are often viewed as a PR exercise and could perhaps give more emphasis on the negative aspects and challenges of how to address negative impacts with opportunity for communities to explore issues and identify with the airport areas for further consideration."	

Table 7: Comments about genuine dialogue

Information sharing

Respondents indicated that they often found the information airports shared to be too complex or technical. As a result, they would prefer clearer explanations to be provided in a way people can understand. It was also felt that some negative impacts can be buried in technical materials, so will often be missed or overlooked by communities who have neither the time nor the experience to fully translate and digest what is being proposed.

It was suggested that direct information from the airport to community groups and representatives would be much appreciated. This would provide airports with a good opportunity to raise any negative impacts with the communities directly, therefore starting an open dialogue about mitigation.

There was also support for airports hosting open days, so they could invite people in to help them better understand the day-to-day operational aspects.

What was said:	
“When engaging with local communities it is imperative technical information is presented in a way which is easily understandable. This will ensure the public are fully aware of proposals and the impact they pose on local communities.”	“Direct information to community groups on developments rather than leaving to community groups finding out through their own resources.”

Table 8: Comments about sharing information

Contact ICCAN:
01484 240457 | ContactICCAN@iccan.gov.uk

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Annex E: ICCAN (2021a) ICCAN Corporate Strategy 2021-2024, March 2021

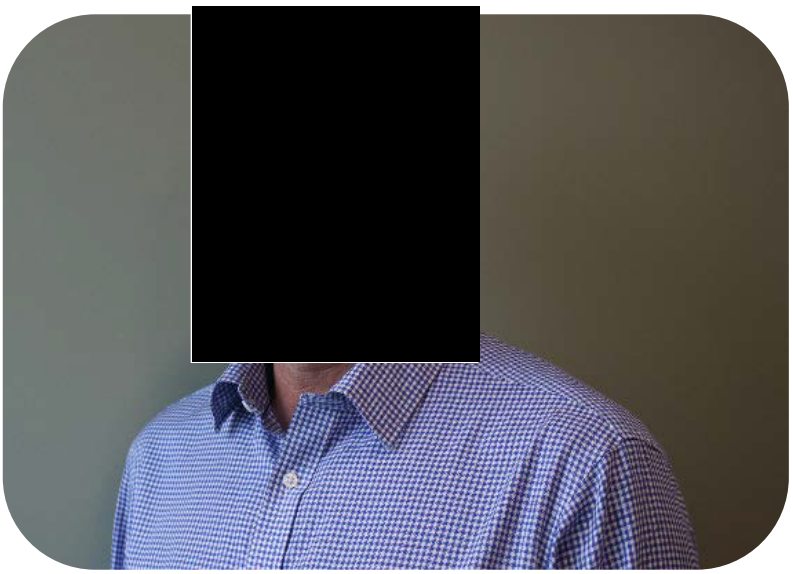
ICCAN Corporate Strategy 2021- 2024

March 2021

Contents

Foreword

We are publishing this, our Corporate Strategy for 2021 to 2024, alongside ICCAN's Report on the future of aviation noise management here.



Our Corporate Strategy sets out how we will work towards our vision of the future, and deliver on our ambitions over the coming three years. Some of this is taking forward work we have already begun. In other new work, we will begin to address recommendations in our report for how noise can be managed in the future and, importantly, how we can achieve better outcomes for communities and the aviation industry.

Two years ago, we were open about being the 'new kids' on the aviation noise block. This meant we were able to approach the issue with a fresh pair of eyes and ears and invite everyone involved to tell us their perspective before reaching any conclusions.

Since then, we have delivered the majority of our initial work programme, with only a few minor changes made to our timescales, in response to the COVID-19 pandemic. Indeed, we decided to add an extra piece of research in Summer 2020, asking people living around five UK airports about their experiences of aviation noise during lockdown.

What has been interesting to see is that the desire for noise to be managed better remains strong, despite the significant impact that Covid has had both on aviation levels and people's lives. We see ICCAN's role over the next three years as building on that desire to improve.

Working in partnership and collaboration with others, we will continue to deliver evidence-based advice, recommendations and guidance, and seek better outcomes by suggesting new approaches.

I am excited by the plans we have set out, even if - just like the aviation industry itself - we will need to remain flexible to accommodate change as a result of external events.

There are crucial areas in coming months and years where ICCAN will seek to bring our influence to bear. Not least to the airspace modernisation programme, the Government's future aviation strategy, emerging new technologies and ensuring noise is a priority alongside other environmental concerns.

As the only truly independent body in this field we recognise we must continue to grow our own expertise and develop the depth of our technical understanding, while maintaining our appreciation of the ways that aviation noise can impact the lives of people and families.

We hope everyone will agree that our vision, ambitions and goals are fair, proportionate and right for the times and issues we face. I believe that, to really make progress, we need to address some more challenging issues head on, a few of which have been simmering for some time.

We will do so in a spirit of collaboration and co-operation and, in delivering our work, we remain committed to our values of openness and transparency alongside our passion to ensure noise is managed fairly and effectively in the future.

Rob Light

Head Commissioner, ICCAN

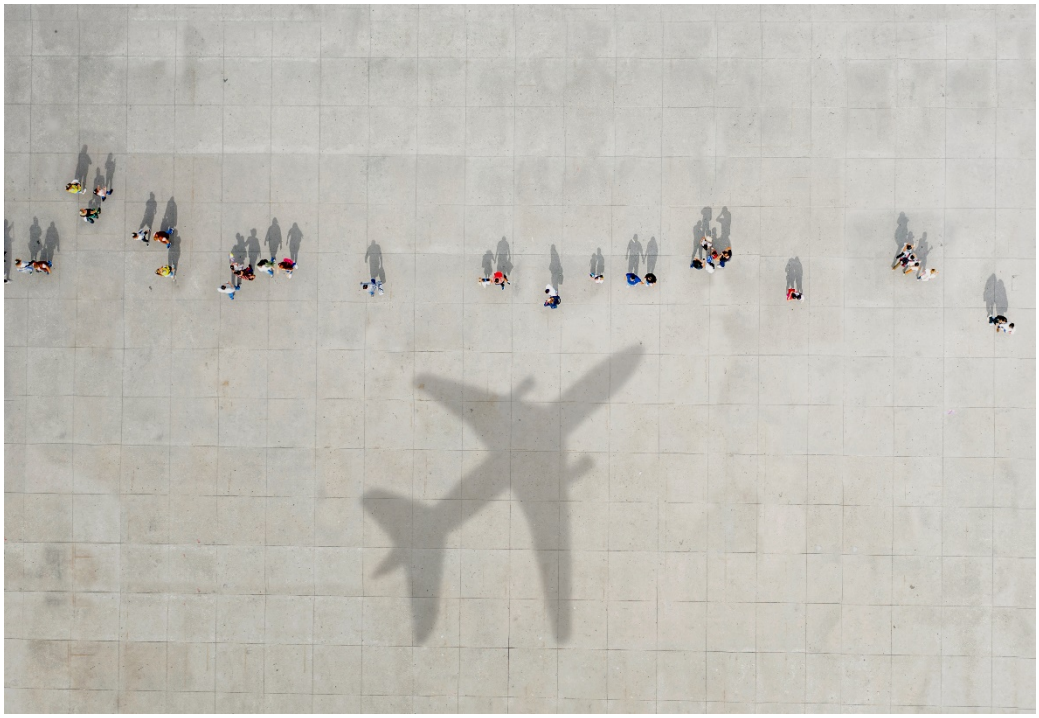
Introduction

The Independent Commission on Civil Aviation Noise (ICCAN) is a non-statutory advisory body, established in 2019 to act as the impartial expert adviser to Government and others on all matters relating to aviation noise. We were formed following a recommendation from the 2015 Airports Commission, and subsequent Government consultations. ICCAN consists of a board of five commissioners led by our Head Commissioner, Rob Light. The board is supported by a small secretariat based in Woking, Surrey.

Our role is multi-faceted and evolving. In March 2021 we made recommendations to the Government in our Report on the future of aviation noise management, and within that how we think our role should evolve to best meet the challenges of managing aviation noise. We expect Government to consider and respond to that recommendation in due course, but in the meantime, we have an ambitious ongoing programme of work that we have been developing and will continue to do so.

In this publication we set out our Corporate Strategy: our vision, objectives and work programme for the next three years, covering 2021-2024. In the next chapter we look back at our first two years' work, before considering the views and engagement we have done when devising this strategy. Having published our emerging views on ICCAN's role in the future landscape of aviation noise management in October 2020, we sought feedback and have reflected on those varied views in devising this work programme.

The impact of Covid on the aviation industry has been devastating, and the levels of aircraft movements have dropped to such an extent that overall noise has been a fraction of what it has been in the past. But it is still there at low levels and will return as aviation recovers. The work we are planning over the next three years will help provide advice and guidance to decision-makers on the best way to manage the return of aviation noise. The COVID-19 pandemic has also had practical impacts on our ability to work with partners in the industry and beyond. As a result, we have deliberately built flexibility into our work programme to allow for different approaches, dependent on the capacity of our partners to work with us. This is set out in more detail later in the document.



ICCAN's first two years

Following our establishment in January 2019, we embarked on an intensive programme of initial engagement, meeting people from across the UK who were involved in the issue of aviation noise, from communities, experts and academics, to regulators, the aviation industry and Government.

We published our first Corporate Strategy in the Spring of 2019, which set out our aims and plans for our two years to April 2021. Our key aim was to improve public confidence and trust in the management of aviation noise, by building our expertise, credibility and profile across the UK.

In our early engagement, we had seen the way that trust had broken down in some places between communities and the aviation industry, and how over time this reduced people's confidence in how aviation noise was managed and regulated. We also saw how the genuine efforts within industry to take different approaches to managing the noise impacts were rarely acknowledged or, indeed, trusted. While we know many people want to see immediate improvement, we also appreciate this of sort change can take time. As an independent body, we believe ICCAN can play a significant role in suggesting and supporting new approaches.

To deliver on our aim, we set ourselves three key objectives, which were to:

- Increase trust, transparency and clarity in the aviation noise debate
- Promote consistency, responsibility and accountability within the industry and beyond, and
- Establish our expertise, authority and credibility.

We set out a comprehensive work programme in our first Corporate Strategy, with key activities and milestones under each of these objectives.

Shortly after a year into our work, we published a report updating on our progress, at the same time as the COVID-19 pandemic had put the country into lockdown. Having decided to revise our timescales slightly, we were able to report that we had either completed, or were on track, to complete nearly all our planned work.

Having published our first major report on the Survey on Noise Attitudes (SoNA) at the end of 2019, we delivered a review of aviation noise measurement and metrics just three months later than planned, quickly followed by an online toolkit for airports, containing help and advice for them when consulting on airspace change under the Civil Aviation Authority's (CAA) CAP1616 guidance.

We also added an additional work stream, given the significant impact of Covid. We conducted a survey during the summer of 2020 to capture how the much quieter skies during lockdown were affecting the experiences of people living around five UK airports.

In the early autumn, we published a review we undertook of existing evidence of the link between aviation noise and health. This found there were significant gaps in existing research, much of which was not of a high enough quality. So, we said we would look at where further research should be conducted, and this work is underway.

In October, we set out our emerging view on the future of aviation noise management, as well as our draft goals and vision for ICCAN's next Corporate Strategy. We asked people for their feedback in a survey, which received 220 responses. We also held a series of six focus group sessions with just under 70 stakeholders to hear their views.

In December, we published our best practice for airports on how they can engage with communities about aviation noise. This included recommendations that airports with Noise Action Plans should set up noise forums, and how they can do this, as well as advice for wider engagement, especially when face-to-face meetings are not possible.

We were very conscious of the impact that Covid was having on airports' resources, both in terms of time and money. So, we set out recommendations that were spread over the short, medium and longer-term.

The below table sets out key deliverables from our first two-year work programme, our planned timescales and the actual outcome.

Key milestones (2019-21)

Deliverable	Planned timescale	Outcome
Review of Survey of Noise Attitudes (SoNA)	December 2019	Published December 2019
Review of noise metrics and measurement	April 2020	Published July 2020
Toolkit on consultation around airspace change	April 2020	Launched online July 2020
Review of evidence on links between aviation noise and health	September 2020	Published September 2020
Survey of people's experiences during lockdown	*Not in our original work programme*	Published October 2020
Emerging view on future of aviation noise management	September 2020	Published October 2020
Best practice on wider engagement between airports and communities	April 2020	Published December 2020
Report on noise insulation schemes	September 2020	Published February 2021
Report on future of aviation noise management	September 2020	Published March 2021

Table 1 – ICCAN's Key milestones 2019-21

Survey on emerging views and goals

To help us develop our plans for the coming three years, we published a document in October 2020, setting out our emerging view on how noise management could be improved upon in the future, as well as our draft proposals for how ICCAN could help seek to achieve this through specific goals and activities.

An accompanying survey, seeking feedback on the outline draft vision for ICCAN and its proposals, was launched on the same day and ran for an eight-week period, closing on Friday 18 December 2021.

The survey received 220 responses from a range of stakeholders, including communities, aviation industry, local government representatives and experts. A full survey report can be found here.

A series of six online focus groups were also held during the eight-week survey period to further capture people's views. ICCAN commissioners hosted a total of 67 participants in 90-minute sessions where the key survey questions were discussed. Notes from these groups are available here.

Key findings

There was a high level of support for the emerging view that in the short term ICCAN should have statutory status, with a combined 88% of respondents either agreeing in full or in part to the outline vision that was set out, with 12% disagreeing. This would mean that ICCAN could be given the power to set standards, be a statutory consultee on planning applications and airspace change proposals, and give advice to Government and others that must be considered. Existing regulators (CAA, Government, local planning authorities) would retain an enforcement role.

There was much support for ICCAN's vision to make the UK a world leader, with 75% of respondents agreeing with this question. However, the term 'world leader' was thought by some to be somewhat grandiose and vague. A more practical goal to improve noise management was said to be preferable, more measurable and easier to understand.

There was a majority in support for ICCAN's draft goals, with 70% of respondents agreeing with them. These were set out under three headings:

Setting standards

There was significant support for ICCAN setting standards. As an independent noise body, setting standards would reinforce noise as a priority, improve behaviours and help repair trust between communities and the aviation industry.

Some respondents felt that for ICCAN to improve aviation noise management most effectively, it should enforce the standards itself, instead of existing bodies such as the CAA, Government and local authorities. Other respondents felt it right that these organisations retained their role. There was some suggestion that if ICCAN didn't become an enforcement body, then it should review the existing enforcement mechanisms to assess whether they were achieving results for impacted communities, particularly around the complaints system, and if not, offer solutions to address this.

There was also some concern regarding a one-size-fits-all approach for standards. Many respondents indicated that noise should be managed and set at a local level. Changing this would run the risk of undermining existing good practice and could result in lower standards being adopted across the board. Those who disagreed with our emerging view generally wanted ICCAN to remain an independent, advisory body.

Putting people's health and wellbeing at the heart of aviation noise policy

ICCAN's ambition to focus on health was supported by respondents who felt that aviation noise needed to be properly addressed and prioritised as a public health issue. The feedback indicated support for further research into the subject, particularly around sleep disturbance, so that a clearer picture could be formed to better understand the adverse effect on people's physical health and mental wellbeing.

It was hoped that further research and evidence would provide guidance to Government, local authorities and regulators and have an instrumental impact on noise policy going forward. There was also support for ICCAN's proposal to work and design on the next series of Aviation Noise Attitude Surveys, as it was felt that an independent organisation would be best suited to manage and own this.

It was also suggested that ICCAN should look at aviation as part of a wider socio-economic picture, and how factors such as the economy, jobs and access to travel sit alongside the more negative effects such as noise. Some concern was raised as to how long it would take to deliver results particularly if further research was needed.

Focus on the future

As airspace modernisation is rolled out and technologies such as performance-based navigation are introduced, there was some concern that noise would exacerbate as an issue in some communities. Respondents felt that it was appropriate for ICCAN to help advise key decision-makers regarding future aviation policy so that noise was given proper consideration.

There was support for ICCAN being a key stakeholder in the airspace change process, although there were varied views on whether this should take the form of a statutory or advisory role. Some respondents felt that ICCAN could also encourage more sustainable and green advancements, ensuring that noise reduction is built into new technologies, alongside carbon reduction. It was felt that this could result in meaningful change for those most impacted by noise and help to create a more holistic approach to aviation noise management.

It was also suggested that ICCAN could focus on how better utilisation of technology could improve the way noise is explained to communities, starting with collating and sharing best practice in this area.

There was some concern that ICCAN's focus on influencing future technological development was too ambitious a goal which could jeopardise and distract from other more important areas of its work.

The feedback from the survey and the focus groups, alongside our extensive work in this area, helped to shape and form our vision, ambitions and goals for the next three years.

Our vision, ambition and goals

ICCAN's vision for the coming three years and beyond is:

- That the impact of aviation noise is a significant factor in decisions taken by Government, industry and regulators, which facilitates balanced and sustainable growth, for the benefit of affected communities and the wider economy.

Our vision for the future, and the ambitions below that underpin it, are framed by our desire to see the aviation industry's recovery support an innovative and sustainable approach to noise management.

To achieve this, we have **four longer-term ambitions**, which we will start working towards in the coming three years.

We want to see that:

- People are less affected by aviation noise
- People are empowered through being engaged and informed on issues related to aviation noise
- Exposure to aviation noise is acknowledged and managed as a public health and wellbeing issue
- Government, regulators, local authorities and the aviation industry are equipped with the tools and evidence to make robust decisions

Our new vision and ambitions are bold but practical and realistic. They align with our recommendations for how aviation noise should be managed in the longer-term. To reach them, we listened to the feedback received through our survey and focus groups.

We made recommendations to Government in March 2021 about the future role and status of ICCAN and expect the Government to consider those recommendations in due course. For the time-being, ICCAN remains an advisory, non-statutory public body, and our finances and other resources are unchanged.

So, our programme of work for the next three years reflects our current status and aims to make progress towards our longer-term ambitions and vision for the future of aviation noise management in the UK.

We have set out our planned activities for the coming three years below, under three key goals:

Goal 1 - 'Setting standards'

Increase the consistency and transparency in the management of aviation noise by providing advice and guidance on noise management

Goal 2 - 'Putting people's health at the heart of aviation noise policy'

Progress research into the health and wellbeing impacts of aviation noise

Goal 3 - 'Focus on the future'

Ensure future policy and regulation of noise is fit-for-purpose, and that future technological advances have noise management at the heart of their development

One of the many impacts of Covid has been on our ability to deliver our first work programme due to the availability of many of our partners and stakeholders, many of whom are from the industry and have been badly affected by the impact of the pandemic. We would expect this pressure to continue, given the slow pace of recovery within the industry.

Because of this, we have split some elements of our future work programme for 2021 into our expected baseline activity, which we are confident of delivering without significant partnership working if required, and more stretching targets that we would like to achieve if the context and circumstances allow.

We will review progress on our plans on a yearly basis and will revisit them, should a decision be taken to change our status and provide ICCAN with additional resources.

Work programme for 2021-24

Goal 1 - 'Setting standards'

Increase the consistency and transparency in the management of aviation noise by providing advice and guidance on noise management

To work towards our ambition that…	In 2021-22, we will...	*Timescale**	In 2022-24, we will…	*Timescale**
People are less affected by aviation noise	*As a baseline...* Start a review of the efficacy of Noise Action Plans *Subject to resource and partner availability...* Make initial recommendations on whether, and how, they could be improved	*Scope project by end Q1 2021-22* *By end Q4*	Conclude a review of the efficacy of Noise Action Plans, with full and detailed recommendations on whether, and how, they could be improved	*Publish report by Q2 2022-23*
	As a baseline... Initiate programme of work to set best practice on the use, collation, analysis and publication of noise metrics *Subject to resource and partner availability...* Make initial recommendations within progress report	*Establish working group with industry, communities and regulators Q1 2021-22* *Issue progress report by end Q3 2021-22*	Publish our best practice on the use, collation, analysis and publication of noise metrics	*By Q4 2022-23*

To work towards our ambition that…	In 2021-22, we will...	*Timescale**	In 2022-24, we will…	*Timescale**
People are empowered through being engaged and informed on issues related to aviation noise	*As a baseline...* Keep under review engagement best practice and continue to advise airports on their engagement practices *Subject to resource and partner availability...* In conjunction with the aviation industry and UKACCs, scope and undertake a review of improvements that can be made to Airport Consultative Committees' roles in relation to aviation noise	*Regularly review during 2021-22* *Initial scoping Q1 2021-22* *Review improvements by end Q3 2021*	Continue to work with airports to advise on engagement best practice and work with industry and UKACCs to recommend changes and improvements to ACCs	*Ongoing*
	As a baseline... Keep under review our Toolkit on consulting about airspace change, as work on the airspace modernisation programme progresses *Subject to resource and partner availability...* As appropriate, work with CAA and Airspace Change Organising Group to update our toolkit in light of developments on the airspace modernisation programme	*Regularly review during 2021-22* *Update as required*	Continue to keep under review our toolkit on consulting about airspace change, as work on airspace modernisation programme progresses	*Ongoing*

To work towards our ambition that…	In 2021-22, we will...	*Timescale**	In 2022-24, we will…	*Timescale**
Government, regulators, local authorities and the aviation industry are equipped with the tools and evidence to make robust decisions	*As a baseline...* Scope and initiate work with industry, as aviation levels start to recover, to investigate operational areas where improvements can be made to how noise is managed	*By end Q4 2021-22*	Continue to work with industry to investigate operational areas where improvements can be made to how noise is managed	*2022-23*
	As a baseline... Work with planners across the UK, central and devolved Government, and industry to address issues of land use and planning as a way of mitigating the impact of aviation noise *Subject to resource and partner availability...* Issue interim advice that addresses issues around airport planning applications and land use around airports, with regards to aviation noise	*Scope and establish project by end Q2 2021-22* *Publish interim advice by end Q4*	Issue full guidance and standards for the assessment of noise impacts for planning applications	*By end Q4 2022-23*
	When and where appropriate, provide advice on, and assessment of, planning applications likely to affect certain areas. ICCAN's role would be as a statutory consultee and contributor to Nationally Significant Infrastructure Projects (NSIP) applications, but not to local airport applications, where we would have a power to respond but not a duty	*As is appropriate*	When and where appropriate, provide advice on, and assessment of, planning applications likely to affect certain areas. ICCAN's role would be as a statutory consultee and contributor to NSIP applications, but not to local airport applications, where we would have a power to respond but not a duty	*As is appropriate*
	Provide advice and guidance to the Government on its night flight regime for the designated airports. Work with Government following consultation on its policy development	*As is appropriate*	N/A	*N/A*

To work towards our ambition that…	In 2021-22, we will...	*Timescale**	In 2022-24, we will…	*Timescale**
	As a baseline... Build on review of insulation to establish best practice for insulation schemes *Subject to resource and partner availability...* Work with BSI on standards for aviation noise insulation products and application	*Q4 2021-22* *Q4 2021-22*	Build on best practice by supporting the introduction of new technical standards for insulation	*Q1 2023-24*
	As a baseline... Review and assess approaches to complaints across UK airports and publish initial findings and recommendations *Subject to resource and partner availability…* Depending on the aviation recovery, go further to develop and publish best practice on complaint handling, systems and procedures for UK airports	*Initial findings and next steps by end Q2 2021* *As is appropriate*	N/A	*N/A*
	N/A	*N/A*	Complete our review of the CAA's information powers and make recommendations on the best use of them in the future	*2022-23*
	N/A	*N/A*	Develop and maintain best practice guidance relating to the CAA's Post Implementation Review process for airspace changes.	*2022-23*
	N/A	*N/A*	Develop and implement league tables with airports for their performance and data around noise management	*2022-24*

Table 2 – Goal 1: 'Setting standards'

* Quarters based on the financial year, i.e. from April 2021 to March 2022.

Goal 2 - 'Putting people's health at the heart of aviation noise policy'

Progress research into the health and wellbeing impacts of aviation noise

To work towards our ambition that…	In 2021-22, we will…	*Timescale**	In 2022-24, we will…	*Timescale**
Exposure to aviation noise is acknowledged and managed as a public health and wellbeing issue	Finalise, develop and commission a new Aviation Noise Attitudes Survey. Work with Government and industry on outstanding issues	*Publish report Q1 2021-22*	Run the survey in either 2022 or 2023 depending on expected aviation levels	*2022-23*
	Conduct a further survey to track people's experiences of aviation noise during the COVID-19 pandemic	*Q2 2021-22*	Repeat the survey	*Q2 2022*
	Finalise prioritisation of health and wellbeing research and establish working relationships Start to identify funding streams for research, and build partnerships for future work	*Q2 2021-22* *Q4 2021-22*	Continue to initiate and lead on chosen health and wellbeing impact priorities	*2022-24*
	Explore possible research stream on the change effect	*Q4 2021-22*	N/A	*N/A*

Table 3 – Goal 2: 'Putting people's health at the heart of aviation noise policy'

* Quarters based on the financial year, i.e. from April 2021 to March 2022.

Goal 3 - 'Focusing on the future'

Ensure future policy and regulation of noise is fit-for-purpose, and that future technological advances have noise management at the heart of their development

To work towards our ambition to…	In 2021-22, we will…	*Timescale**	In 2022-24, we will…	*Timescale**
Government, regulators, local authorities and the aviation industry are equipped with the tools and evidence to make robust decisions	Work with the Government on relevant areas of its Aviation Strategy and support on implementation of a balanced approach to managing noise	*2021-22*	Assess and advise on potential for new technological developments in civil aviation for reducing noise impacts	*Q1 2023-24*
	Advise Government, CAA, ACOG on noise management concerns during the airspace modernisation programme	*2021-22*	Continue to advise the Government, CAA, ACOG on noise management concerns during the airspace modernisation programme	*2022-24*
	Review impact and implications of new technologies such as drones and electric aircraft, as well as helicopters on managing aviation noise	Review at least annually 2021-22	N/A	Review at least annually 2022-24
	N/A	*N/A*	Explore potential trade-offs between noise and other environmental impacts	Q1 2022-23

Table 4 – Goal 3: 'Focussing on the future'

* Quarters based on the financial year, i.e. from April 2021 to March 2022.

Finances and resources

ICCAN is funded by the Department for Transport, which also provides a secretariat of 13 (full time equivalent) staff to support the Commissioners. Our resource settlement for the financial year 2021-22 is as follows:

2021-22	Budget (£)
Pay	920,834
Non-Pay	829,166
Total	1,750,000

Table 5 – ICCAN's financial settlement for 2021-22

During the course of the year, we will be negotiating with DfT and HM Treasury on future years' settlements, which will also be dependent on the role and status ICCAN is to have in the future. For this year, we are confident the allocated resource will allow us to achieve the milestones we have set out in our work programme.

Communications and engagement

It is the role of ICCAN's small, dedicated Communications and Engagement team to ensure our key audiences know about, understand and are engaged in our work, to support our ambitions and help us to deliver our goals.

Since we were established in 2019, ICCAN has met and spoken with hundreds of people right across the UK with an interest in aviation noise, from community groups and individual residents to the aviation industry, academics, experts and regulators.

We have been making use of online technology to continue with our programme of engagement during the COVID-19 pandemic. As national restrictions ease, and the country begins to recover, we hope to start meeting more people face-to-face as we embark on our next three years and deliver our new work programme.

We will continue to make full use of our social media channels, as well as our website and e-newsletter, to be as transparent and clear as possible about our work.

We will also ensure that we promote and talk about key issues relating to aviation noise, and raise it as an issue in the media where appropriate.

In the autumn of 2020, ICCAN ran a small campaign on Facebook targeting people living around key UK airports, to promote both our role as a new organisation and our survey on the future of aviation noise management. We plan to do further such campaigns when it would be beneficial to reach a wider audience.

While we are not yet officially listed on the Freedom of Information register, we have always welcomed any requests and publish all our responses on our website.

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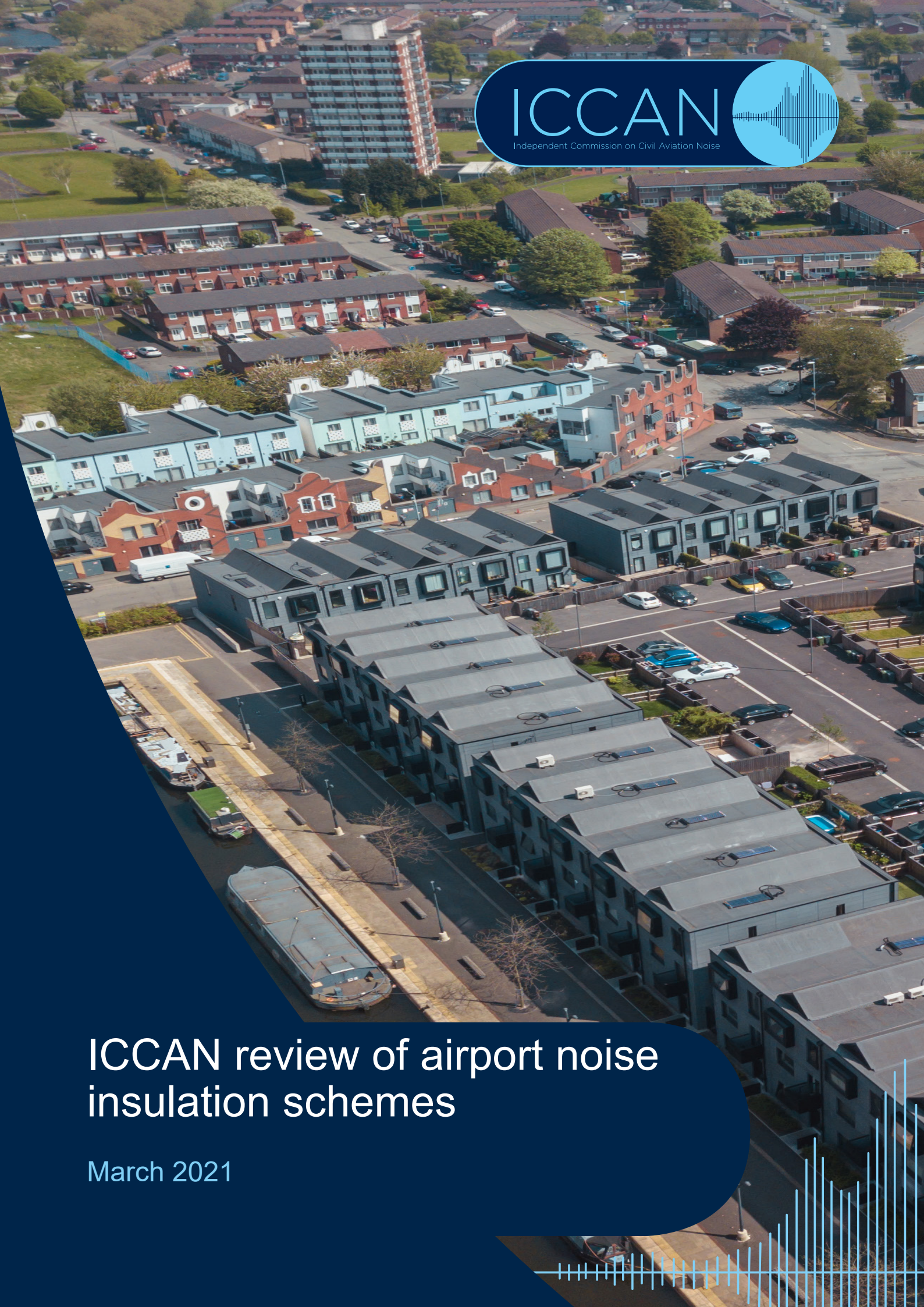
01484 240457 | ContactICCAN@iccan.gov.uk

Annex F: ICCAN (2021b) ICCAN review of airport noise insulation schemes, March 2021



ICCAN review of airport noise insulation schemes

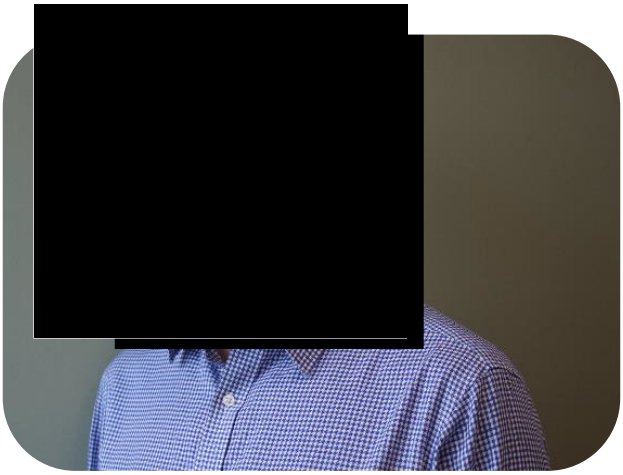
March 2021

Contents

About ICCAN

The Independent Commission on Civil Aviation Noise (ICCAN) was established in 2019 and operates as an independent and impartial body on matters related to civil aviation noise and how it impacts communities. The first aim of our two-year programme has been to improve public trust and confidence in the management of aviation noise by developing expert knowledge and understanding of the challenges associated with aviation noise. Our expert knowledge base has resulted in a range of research and publications which we continue to build on, all of which are available on ICCAN's website.

Foreword



It is widely accepted that high-quality noise insulation is an effective way to mitigate the impacts of aviation noise inside people's homes. Future growth at many UK airports has rightly been conditional on airports providing funding to insulation schemes for the homes of people most impacted. I am sure that airports genuinely believe they are providing insulation of high enough quality to meet these conditions.

The question is how to ensure that the quality and effectiveness of the insulation used in airports' schemes is sufficient.

When ICCAN was established in January 2019, the Aviation Minister asked us to look into this very issue and recommend some ways forward. We wanted to examine what airports offer, and have promised through their schemes, and how the insulation providers have responded. So, we commissioned the Building Research Establishment (BRE) to conduct a technical review. This document summarises their key findings and sets out our initial recommendations.

We recognise that the Covid-19 pandemic has brought significant challenges for the aviation industry and we have revised our timescales on this work to take account of this. Though I also know that prior to the pandemic there was no shortage of willingness from airports to work with ICCAN on this issue, and we anticipate that many would welcome further guidance on what constitutes 'good' quality and 'fair' distribution.

We hope this report is a first step towards creating best practice to ensure consistency, clarity and fairness in the way insulation is used to mitigate aviation noise impacts in the future. In our recommendations we commit to working in partnership with manufactures, installers, and airports to support new standards in the future.

Rob Light

ICCAN Head Commissioner

Rationale

Noise insulation schemes created by UK airports are not subject to central legislation, so airports are free to create their own insulation policy, resulting in a variation of noise insulation schemes. In the consultation paper Aviation 2050 – The Future of UK Aviation (UK Government, 2018), the Government proposed that new guidance be issued to airports on best practice for noise insulation schemes, to improve consistency. ICCAN's first Corporate Strategy, therefore, had a commitment to review the performance and consistency of airports approaches to noise insulation schemes and provide guidance on best practice (ICCAN, 2019).

ICCAN recognises that since its formation in 2019 and the start of its work on insulation schemes, the aviation landscape has been dramatically altered by the Covid-19 pandemic with far fewer aircraft in the sky. While this is an uncertain time for airports and aviation, with their focus understandably on survival and economic sustainability, once aviation recovery is underway noise will return, and insulation schemes will come under the spotlight again.

Given the current situation regarding Covid-19, and the associated challenges the commercial aviation industry face, this document contains a summary of the key findings from our technical review. It sets out our initial recommendations, which future, more detailed guidance should address if consistent airport insulation schemes are to be provided. We will continue to work on more detailed recommendations and standards, consulting with industry and experts in the field.

ICCAN's approach

The overall aim of this study is to develop a detailed review of the components required to implement noise insulation schemes that deliver optimal standards for noise reduction in affected household properties. To gain a better understanding of how noise insulation schemes could deliver optimal standards, ICCAN commissioned the Building Research Establishment (BRE) to conduct a technical review. The comprehensive review considers the following key issues affecting insulation schemes designed to mitigate aircraft noise in existing residential properties:

1. Insulation products and systems
2. Testing of properties
3. Installation of insulation
4. Building Regulations
5. Quality management

Insulation products and systems: this was achieved by conducting a detailed review of products and systems which can be retrofitted to properties and mitigate the noise ingress from aircraft noise. The review examines key acoustic attributes of products and systems and highlights typical performance values. To give an idea of what is achievable in terms of the performance of acoustic insulation and the resultant internal noise levels, BRE examined different ranges of sound insulation in a what-if model.

Testing of properties: this involved a robust review of testing methods used to determine the level of noise intrusion entering properties from aircraft noise before and after the installation of acoustic insulation. This approach identified the most effective methods, including advantages and disadvantages, from a practical perspective.

Installation of insulation: this reviewed different existing approaches to the installation of acoustic insulation used in the UK and overseas, highlighting the benefits and disadvantages of these approaches from the perspective of the occupants and the airports that implement the measures.

Building Regulations: this examined current Building Regulations 2010, relating to the retrofitting of products and systems that improve sound insulation properties of a household. This review also examined any unintended consequences for the building or occupants that would not be addressed through existing compliance of the Building Regulations.

Quality management: this reviewed different approaches to measuring the quality of work conducted by installers of acoustic insulation products and systems. This included examining different approaches by quality assurance schemes and their applicability to airport noise insulation schemes.

Key findings and initial recommendations

1: Insulation products and systems

1. The review found that for each of the acoustic insulation product types examined, there is already a published framework for testing, reporting and declaring acoustic performance, except for secondary glazing. However, having reviewed industry documents and centrally issued guidance, it found that very few relevant industry standards exist in relation to the mitigation of aircraft noise and the required insulation products.

2. A lack of consistency and/or detail in terms of insulation product standardisation between different airports was identified. This makes it difficult to determine whether all UK airports currently offer products of an appropriate standard.

3. There is the potential that noise insulation schemes may include products that have not been tested for acoustic performance.

4. A model of what-if scenarios, created by BRE, demonstrated that a number of acoustic insulation treatments with a range of different insulation products should be capable of resulting in internal noise levels during the daytime that achieve current (WHO) guidelines (Berglund, Lindvall, & Schwela, 1999).

ICCAN's initial recommendations

1. ICCAN is committed to improving standards related to mitigating the effects of aircraft noise and recommends that a set of guidance should be created directly related to mitigating aircraft noise including the required product standards. This would include examining current British Standards (BS) to determine how effective they are at covering aviation noise.

2. In order to create a more consistent approach to the selection of acoustic insulation products, ICCAN aims to develop a best practice toolkit that can help airports to identify an appropriate range of insulation products.

3. Given the risk of untested insulation products not providing appropriate levels of indoor noise reduction, ICCAN will only recommend the use of products that meet standards for acoustic insulation.

4. To help with the selection process for choosing insulation packages, the toolkit mentioned in recommendation 2 will consider the many different factors and requirements based on noise reduction requirements. This will include performance-based outputs for chosen acoustic insulation products.

2: Testing of properties

1. Establishing the effectiveness of installed acoustic insulation products requires testing the indoor sound levels. The review found that, between industry guidance and standards published by the British Standards Institution (BSI), there are clear protocols for testing properties for levels of noise pollution, determining current acoustic performance of the building envelope, and assessing the effectiveness of mitigation deployed.

2. The Association of Noise Consultants (ANC) guidelines provides detailed and useful information necessary for measuring sound levels within properties due to internal and external sources. This, however, is only based on internal measurements of pre and post works. The review suggests that the ANC's methodology could be improved by including the measurement of external noise over the pre and post work time period, to ensure the variation in the external noise is accounted for.

3. The most accurate approach for in-situ testing of sound insulation characteristics would require using BS EN ISO 16283-3 methods. This approach helps to better understand all noise transmission paths allowing for an optimal insulation package to be delivered. Testing of a property by an experienced acoustician has been estimated to take around half a day but it may not be practical to test all properties surrounding an airport.

4. If it is desirable to understand the noise levels within a home over a long duration e.g. over the course of a year or more, the more reliable method may be to determine the sound insulation performance of the building envelope in conjunction with long term, predicted external noise levels using noise contours. Contours can provide a picture of the long-term external noise environment and so deal with the variability of external aircraft noise. However, these noise contours need to be accurate.

5. Only one airport was found to set indoor noise reduction targets. London City Airport set a target for their noise insulation works at the 57 dB noise contour and state the work must achieve "*an average sound reduction not less than 25 dB averaged over 100 to 3150 Hz in accordance with BS EN ISO 16283-3:2016*" (BRE, 2020).

ICCAN's initial recommendations

1. ICCAN recommends that external noise monitoring is conducted in parallel to internal noise measurements and we will work with ANC to offer advice on updating their current guidelines.

2. It is important to develop an effective sampling strategy to test sound insulation in-situ. This could include testing a sample of properties of the same build type and surveying individual properties with more unique attributes, such as old stand-alone cottages.

3. The use of accurate and appropriate noise contours should be used for understanding noise levels and insulation performance over long time periods. ICCAN will be using our own forthcoming noise metrics best practice guidance to determine the best approach to the use of noise contours for estimating long-term external noise.

4. Setting a performance based indoor noise reduction target is a good approach to setting realistic expectations with property owners. ICCAN welcomes this approach; however, more work needs to be done to determine the criteria used in setting such targets throughout UK airports.

3: Installation of insulation

1. Having studied a number of UK airports' approaches to the installation of acoustic insulation (BRE Report, Appendix A), BRE found that while airports often conducted home surveys prior to the installation of properties, there was no mention of prior testing. A detailed understanding of the pathways of noise ingress into a building is required to help provide the best approaches to installation of insulation.

2. There are two key approaches to the provision of sound insulation packages i.e. pre-determined solutions and tailored solutions. The pre-determined approach uses noise contours to determine the insulation products supplied. This is similar to insulation schemes mentioned in the Noise Insulation Regulations (NIR 1975), used for sound insulation addressing road and rail noise. A tailored approach, based on testing of properties, allows for a more specific range of insulation products to be used for individual properties, which could be more costly due to greater expert input and more insulation products used.

3. Airports sometimes give property owners the option to select their own insulation products and/or appoint a contractor to conduct the installation work. BRE determined that the homeowner may not necessarily be the correct, or indeed competent, person to make decisions regarding product and contractor selection due to their lack of expertise.

4. There are generally two approaches to the installation of insulation: individual rooms or the perimeter approach. UK insulation schemes generally target the insulation of habitable rooms rather than the entire property as in the perimeter approach e.g. Sydney Kingsford Smith Airport (Burgess, Cotton, & Butler, 2000). BRE adopts the view that the room approach is fit for purpose since the concept features in the NIR 1975 specification.

ICCAN's initial recommendations

1. ICCAN recommends property inspections and testing, in line with a detailed sampling strategy as mentioned in ICCAN principle 2 of Testing of Properties above.

2. A balance of both pre-determined solutions and tailored solutions should be used, depending on the attributes of the building. The noise contour approach will generally be acceptable for a range of properties with identical build qualities. The tailored approach should be used for unusual build types.

3. ICCAN recommends that airports should appoint approved contractors to install insulation products, but householders should be given the option to make non-technical decisions such as colour or style of window frames.

4. ICCAN recognises that in the majority of cases the 'room' approach to insulation will be appropriate. The 'perimeter' approach can be used at the discretion of the airport, depending on the build type and noise levels experienced.

4: Building Regulations

1. There are Building Regulations requirements that will come into force when acoustic insulation products/packages are installed, as relevant to the product or works undertaken. It is specifically the responsibility of the person undertaking the works to demonstrate compliance with the Building Regulations, rather than the homeowner.

2. BRE identified examples of unintended consequences of installing insulation for the building and/or occupants that were not addressed through the compliance of the Building Regulations. Overheating may occur where closed windows and loft insulation may reduce heat loss. It was found that there are no specific requirements relating to overheating in the Building Regulations (Association of Noise Consultants, 2020). Whilst NIR 1975 provides details of ventilation options, these were primarily aimed at maintaining indoor air quality (Committee on the Problem of Noise, 1963).

3. Without correct detailing, condensation can build up either between the primary and secondary units or on the inside (room side) face of the secondary glazing unit (Pickles, 2016). Either situation could lead to damage to the building or represent a health risk to the building occupant if left unchecked.

ICCAN's initial recommendations

1. ICCAN recommends a best practice approach is developed to address overheating. It will also explore the possibility of including an amendment to the Building Regulations, ensuring aviation noise is factored into any acoustic insulation works, including its impact on overheating.

2. The issue of condensation and how to mitigate it should be considered during the early stages of product selection for noise insulation schemes. Details of potential condensation issues and which specialists to contact for advice will feature in the toolkit as mentioned in ICCAN principle 2 under Insulation products and systems.

5: Quality management

1. The review was unable to establish whether there is a consistent approach to quality management for airport acoustic insulation schemes in the UK. This is not to say that individual schemes do not have their own quality management systems or requirements, but this information was not available for a detailed review.

2. There are centrally endorsed competent persons schemes covering installation of many products that may be used to provide acoustic insulation to properties. The schemes are directly concerned with satisfying Building Regulation requirements. However, noise ingress into a building from aircraft noise is not currently addressed by the Building Regulations so the relevant competent persons schemes do not specifically address sound insulation.

3. The review concluded that the use of a contractor or supplier who is a member of a competent person scheme or professional body does ensure benefits relating to quality including sound insulation.

4. BRE's findings determined that there could be an opportunity for collaboration between airport operators, schemes and professional bodies to develop a guide, code of practice or a certification scheme relating to the installation of sound insulation products.

ICCAN's initial recommendations

1. ICCAN recommends that only certified contractors should be used for the installation of noise insulation products.

2. ICCAN would look forward to adopting the role of a facilitator for the collaboration of relevant stakeholders to ensure the development of robust quality management standards relating to installation of acoustic insulation products.

ICCAN's next steps

Our review confirms the lack of any standardised approach to noise insulation schemes across UK airports and an apparent lack of pre and post insulation testing of properties that would determine the effectiveness of noise insulation products. Some aspects of product installation may require scrutiny by amendments to the Building Regulations and quality management should be more focused on the installation of acoustic insulation products.

The Government has already suggested some changes to insulation policy in the Aviation 2050 consultation paper. At the time of writing, it is unclear how the Government intends to progress the proposals in the Aviation 2050 consultation document in light of the Covid-19 pandemic. However, we look forward to working with them on the future strategy once the recovery has started.

We will continue to work on more detailed recommendations and standards, in parallel with our work on metrics best practice, on which some of our future insulation standards will rely.

ICCAN plans to work in collaboration with industry experts to ensure the most accurate technical advice regarding standards is incorporated into the development of our recommendations.

Similarly, we intend to work with other industry experts and airports to help develop new, standardised approaches to the installation of noise insulation products. Our standards will be proportionate, practicable and reflective of the current challenges facing the aviation industry.

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