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SURVEY OF NOISE ATTITUDES 2014

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Over the last 15 years or so, evidence has been emerging that people's annoyance arising from exposure to aircraft noise has been increasing. In the UK, the results from the Aircraft Noise Index Study of 1982 have been relied upon to assess the impact of aircraft noise. A further study entitled Attitudes to Noise from Aviation Sources in England (ANASE) was reported in 2007, and this paper describes the Survey of Noise Attitudes 2014 (SoNA 2014), also commissioned by the UK Government. It built upon previous general noise attitude studies but included a specific module regarding aircraft noise. The study also obtained corresponding aircraft noise exposure information so that the association between exposure and annoyance could be assessed and any changes in attitude since 1982 could be identified. Noise exposure was defined by a number of indicators, and, in addition to annoyance, the respondents were also asked about their health and well-being. The paper will describe the approach to the study, the sampling strategy, the determination of the noise exposure, the analytical approach and the results.
Keywords: Aviation, Annoyance, Health

1. Introduction

The current UK civil aircraft noise exposure index, $L_{Aeq,16h}$ was adopted in 1990, based on an aircraft noise attitude survey undertaken in 1982 and reported as the UK Aircraft Noise Index Study (ANIS) in 1985. The reference time period is an average summer day, from June 16th to September 15th inclusive and from 7am to 11pm. The summer day period dates back to the recommendations in the 1963 Wilson Committee report on aircraft noise, which recommended measuring noise exposure during the summer months because people were more likely to have windows open, be outdoors, and aviation activity is at its most intense. Critics of $L_{Aeq,16h}$ argue that:

- it is difficult for the public to comprehend, being on a logarithmic scale,
- an equivalent continuous level is not consistent with people's perception of aircraft noise as a number of discrete, noticeable events, and
- it is out of date, 57 dB $L_{Aeq,16h}$ no longer represents the approximate onset of significant community annoyance.

The Attitudes to Noise from Aviation Sources in England (ANASE) study was commissioned by the DfT in 2001 and was published in 2007. The aims of the study were to re-assess attitudes to aircraft noise in England, re-assess their correlation with the $L_{Aeq,16h}$ noise index and examine willingness to pay in respect of annoyance from such noise, in relation to other elements, on the basis of stated preference survey evidence.

Although the researchers concluded there was no clear policy threshold between 43 and 57dB $L_{Aeq,16h}$, the study suggested that for the same proportion of highly annoyed people as found in ANIS at 57dB $L_{Aeq,16h}$ (10%), the $L_{Aeq,16h}$ level would be approximately 10-13 dB lower. However, the independent peer review counselled against using the results and conclusions in the development of government policy".

In 2012 Defra conducted the National Noise Attitudes Survey (NNAS 2012), which provided the Government with a good estimate of current attitudes to various aspects of environmental, neighbour and neighbourhood noise from face-to-face interviews (including the percentage of the population affected). In addition, it was intended that this information would allow the Government to detect any substantive changes in attitudes to noise in the UK since the 2000 survey. The sample size of NNAS 2012 was over 2,700 respondents.

In 2013 Defra ran the first Survey of Noise Attitudes (SoNA 2013), a face-to-face survey within England to continue to establish current attitudes to noise, in particular attitudes from road and neighbour sources and a section that could vary to focus on different areas of interest without impacting on the backwards compatibility of the rest of the questionnaire. In 2013, that section concentrated on entertainment noise.

SoNA 2014 was a continuation of SoNA 2013. In this instance, it was decided that the variable section in the 2014 survey should consider civil aircraft noise in order to obtain up-to-date and detailed information regarding attitudes to aircraft noise. The Civil Aircraft Noise (CAN) section was introduced in 2014 alongside the other sections on road and neighbourhood noise and replacing the previous entertainment noise section, however, it was not made explicit to respondents that the focus of the study was aircraft noise in order to minimise potential bias. Unlike NNAS 2012 and SoNA 2013, the SoNA 2014 responses needed to be related to noise exposure. To do so, however, meant that the sample for SoNA 2014 could not be nationally representative as sampled residents had to live within different noise contour bands near airports.

2. Survey Design

Face-to-face interviews from a representative sample of approximately 2,000 adults aged 18 and over were collected from those living in residential dwellings in proximity to nine of the largest airports in England by aircraft movements, and where noise from aircraft is estimated to be more than 51 dB $L_{Aeq,16h}$ during an average summer day.

The sampling was designed such that one-third of the interviews were carried out in the 51-54 dB $L_{Aeq,16h}$ band, and two-thirds for noise exposure in the >54dB L_{Aeq16h} band (stratification based on estimated population numbers falling within these bands). This was done to increase statistical power at higher noise exposure levels, where populations decrease as noise exposure levels increase.

The survey questionnaire built on that developed by Defra for its 2013 Survey of Noise Attitudes (SoNA 2013), which itself was developed from its 2012 National Noise Attitude Survey (NNAS 2012).

The survey questionnaire comprised of five sections:

- A general section
- An optional Road Traffic Noise section
- An optional Neighbourhood Noise section
- A Civil Aircraft Noise section, which included both a 5-point scale question and an 11-point scale question on aircraft annoyance
- A health section

The civil aircraft noise section included two questions on noise annoyance that sought responses on a 5-point scale and an 11-point scale, recommended by ICBEN and ISO respectively, which allow direct comparison with the 2007 ANASE study. Such questions explicitly sought views on annoyance due to aircraft noise. The survey also asked residents early in the interview 'Is there anything

you particularly dislike about this neighbourhood?' and specifically looked for responses mentioning aircraft or aircraft noise amongst other reasons mentioned.

The SoNA 2014 questionnaire design was both peer-reviewed and underwent cognitive testing to confirm people's understanding of the questions asked, and to identify any need for questionnaire improvement and simplification. The survey questionnaire can be found in Appendix C of the final study report (ref CAP 1506).

3. Fieldwork

Fieldwork was conducted between 5 October 2014 and 8 February 2015. The survey selected respondents at random, according to the populations around the following sample airports: Birmingham (BHX), East Midlands (EMA), Gatwick (LGW), Heathrow (LHR), London City (LCY), Luton (LTN), Manchester (MAN), Newcastle (NCL) and Stansted (STN).

The sample was allocated in proportion to the population exposed at each airport during the summer of 2013. Thus, the sampling defined was mainly comprised of people living around London Heathrow, since the majority of people exposed to aircraft noise in England live around Heathrow airport.

The Civil Aircraft Noise section was preceded by a question checking that respondents were resident during summer 2014. As 122 interviewees were not resident during summer 2014, they were excluded. The remaining sample across all airports was 1,877 interviews.

4. Noise Modelling

The reference time period for noise exposure was the 2014 average summer day (16th June to 15th September inclusive). Although, interviews took place from early October 2014 through to February 2015, respondents were asked their views on noise during summer 2014.

To enable questionnaire responses to be correlated with noise exposure information, noise exposure was estimated for the following indicators: $L_{Aeq,16h}$, L_{den}, N70 and N65.

For Birmingham, Gatwick, Heathrow, Manchester, Newcastle and Stansted airports, noise exposure was estimated using the CAA's ANCON model. For East Midlands, London City and Luton airports, noise exposure was estimated using the US Federal Aviation Administration's Integrated Noise Model (INM) by Bickerdike Allan and Partners on behalf of the respective airport. Although noise exposure information was estimated using two different noise models, the approach used is consistent since both models accord with international best practice by ECAC, and are adjusted to reflect measurements obtained around each airport in question. $L_{Aeq,16h}$ noise exposure information for Luton airport for 2014 was not available and thus data for 2013 was used instead. N70 information was available for all airports except Luton. L_{den} information was limited to Gatwick, Heathrow and Stansted airports. N65 data was limited to Heathrow Gatwick and Stansted airports.

Previous studies have shown that noise attitudes may be more highly correlated with noise exposure just prior to interview. To test for this hypothesis, each noise indicator was also estimated based on runways use during the 7 days and 30 days immediately preceding interview. For all airports, except Luton (data not available), the following different temporal noise exposures were also estimated for each respondent's location, for each available noise indicator. Note that, irrespective of the modal split applied, the number and types of aircraft operating were for a 16 hour average summer day for $L_{Aeq,16h}$, N70 and N65 respectively, and the 24 hour average annual day for L_{den}.:

- 100% westerly-mode
- 100% easterly-mode
- 7 day average-modal split prior to interview
- 30 day average-modal split prior to interview

- 92 day summer average-modal split
- The highest noise level from either the 100% westerly or 100% easterly modes

The last indicator simply used the highest noise exposure from either the 100% westerly or 100% easterly operating modes.

5. Results

5.1 Noise Exposure and Annoyance

When looking at evidence on attitudes to noise, many surveys obtain a number of responses within a narrow geographical location that can be defined as a single noise exposure value and compare attitudes across different geographical locations that are exposed to different noise levels.

For SoNA 2014, a slightly different approach was taken to maximise the number of locations considered and it was therefore necessary to group annoyance responses by noise exposure band. A 3 dB wide band was chosen to balance noise exposure variation and sample sizes. In practice, because locations were randomly sampled within each noise band, the average exposure within each band was close to the mid-band interval. For example, the average $L_{Aeq,16h}$ exposure in the 51-54 dB band was 52.5 dB.

All respondents who had been resident at their current address during summer 2014 were asked questions on Civil Aircraft Noise. However, some questions were not asked if the respondent answered that they were not at all bothered by civil aircraft noise of any kind at any time.

Two core questions were included as recommended by ISO, one with a five-point verbal rating scale (CAN1) and one with an 11-point numerical rating scale (CAN34). For both questions annoyance was characterised as 'being bothered, disturbed or annoyed', however throughout this paper such responses are simply referred to as annoyance responses.

CAN1 was presented as a matrix question, seeking views on overall annoyance from civil aircraft, but also views on noise associated with specific types of operation and specific times of day. Question CAN34 used an 11 point numerical scale, but unlike CAN1, was presented as a single question with no time of day subdivision. In addition to questions CAN1 and CAN34, an earlier question, A9a, was asked seeking general attitudes on aircraft, airport or airfield noise, using the ISO recommended methodology and a 5-point verbal scale. This question was followed by similar questions on other sources of noise, including both transport and non-transport sources.

Although some comparisons can be made across the different survey questions despite them using different scales, this limits the extent to which direct comparisons can be made. It has therefore become standard practice in this field to transform annoyance scales used in such surveys onto a 0 to 100 scale. This technique has been used by Miedema & Oudshoorn (2001), van Kempen & van Kamp (2005) and in the ANASE study (2007). Different scales are transformed onto a 0 to 100 scale assuming equal width categories such that:

$$\text{Annoyance Score}_i = {100(i - 1/2)}/{m}$$

This gives the relationships between the 5 and 11 point scales and annoyance scores.

Table 1 shows the mean annoyance score for the three questions as a function of average summer day $L_{Aeq,16h}$ noise band:

Table 1: Mean annoyance scores in SoNA 2014 survey as a function of average summer day $L_{Aeq,16h}$ noise exposure

		Mean annoyance score			95% Confidence Interval		
Average summer day L (dB)	N	A9a	CAN1i	CAN34	A9a	CAN1i	CAN34
48-50.9	79	31.2	28.2	23.1	5.4	5.0	5.2
51-53.9	790	30.2	28.2	27.4	1.7	1.6	1.6
54-56.9	515	40.0	39.6	41.5	2.3	2.3	2.4
57-59.9	260	45.1	44.5	43.9	3.1	3.2	3.5
60-62.9	129	47.1	45.4	46.5	4.0	4.3	4.7
≥63	71	50.0	48.6	51.8	6.1	6.0	6.2
Total	1,844	-	-	-			

Similar tables were produced for the other indicators, L_{den}, N70 and N65, along with corresponding graphs.

In order to identify whether one noise indicator was more strongly associated with mean annoyance score, a logistic function was fitted through the mean annoyance scores plotted for each noise indicator. A logistic function was preferred as it is naturally bounded between 0 and 100%, unlike other types of functions. Instead, various parameters indicating the goodness of fit of the logistic function are shown in Table 2.

Table 2: Correlation between different noise indicators and mean annoyance score

Noise indicator	Weighted responses	r^2
92 day $L_{Aeq,16h}$	1,460	0.874
Annual L_{den} (24h)	1,460	0.707
92 day N70 (16h)	1,460	0.598
92 day N65 (16h)	1,460	0.619

Whilst numerically, the correlation coefficients, r^2, show that $L_{Aeq,16h}$ correlates better with mean annoyance score, in practice, all the noise indicators show adequate correlation and the functions are similar in nature. There is, however, no evidence to suggest that any of the indicators assessed is better than $L_{Aeq,16h}$.

To examine the effects of changes in noise exposure in the time preceding interview, for each respondent's dwelling location, a logistic function was fitted to mean annoyance score and $L_{Aeq,16h}$ noise level based on the six temporal variations defined above (Table 3).

Table 3: Correlation between temporal variations of $L_{Aeq,16h}$ noise exposure and mean annoyance score

Noise indicator	N	r^2
92 day average mode	1,844	0.882
30 day average mode	1,844	0.828
7 day average mode	1,844	0.687
Westerly day	1,844	0.207
Easterly day	1,844	0.952
Highest noise level of either westerly or easterly mode	1,844	0.877

Of the average-modes, the 92 day average correlates with mean annoyance score better than a 30 day or 7 day average. Somewhat surprisingly, easterly day noise exposure had the highest r^2 (0.95), whereas a westerly day has the lowest r^2 (0.21). Closer examination showed that 70% of survey respondents were exposed to westerly noise, consistent with prevailing wind direction and noise exposure at English airports. The mean annoyance scores, however, show that attitudes to easterly or westerly noise differ markedly below 55dB $L_{Aeq,16h}$. When, westerly day noise exposure falls below 51dB $L_{Aeq,16h}$, indicating easterly noise dominates, annoyance scores remain constant, leading to poor correlation. In contrast annoyance scores continue to reduce with reducing easterly noise exposure, even for the majority exposed to predominantly westerly-mode noise. The higher annoyance associated with easterly noise exposure, as opposed to westerly operations, may be due to the relatively infrequent use of easterly operations at UK airports.

The easterly noise exposure is highly correlated (r^2=0.95) and the indicator based on highest noise exposure from either the easterly or westerly modes, correlates with annoyance almost as well as the 92-day summer average.

5.2 Noise Exposure and % Highly Annoyed

In aircraft noise policy, it has become common practice to focus on those individuals that are said to be highly annoyed. In their landmark works, both Shultz and Miedema et al defined high annoyance as a cut-off of 72 on a 100 point scale.

- Using the 100 point scales in table 11, the cut-offs for the 5 and 11 point scales are:
- 5-point scale: ‘Extremely annoyed’ (category 5) + 0.4 x ‘Very annoyed’ (category 4)
- 11-point scale: A score of 8, 9 or 10

Using these criteria, Figure 1 presents the percentage of respondents calculated as highly annoyed As was the case for mean annoyance scores, the percentage of respondents highly annoyed is very consistent for both questions. Overall, 12% of responses to the CAN1i question (the 5 point scale) indicated high annoyance, whilst 11% of responses to the CAN34 question (the 11 point scale) indicated high annoyance.

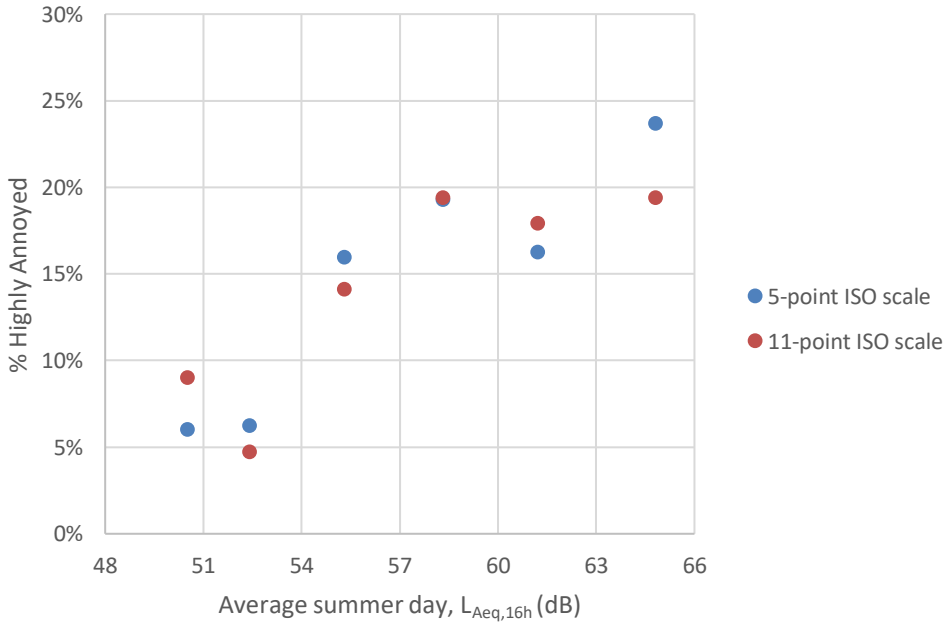

Figure 1: Percentage of respondents calculated as highly annoyed

5.3 Comparison with ANIS and ANASE and Miedema?

Mean annoyance scores calculated from the SoNA 2014 survey, from ANASE and those derived for ANIS by the ANASE researchers are plotted in Figure 2. SoNA 2014 is seen to produce similar mean annoyance scores as for ANIS, whilst ANASE calculated somewhat higher values.

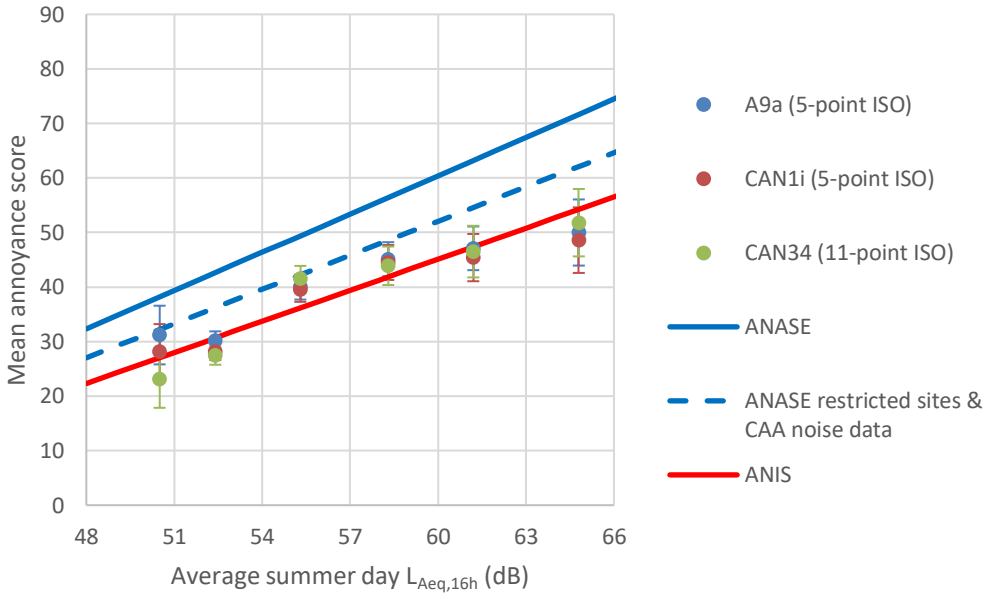

Figure 2: Comparison of mean annoyance scores for SoNA, ANASE and ANIS

Figure 3 shows the comparison in terms of the percentage of respondents calculated as highly annoyed from the three surveys, with the ANASE results based on the update from 2013 as the original report did not calculate a percentage highly annoyed. The results are also compared with the EU or 'Miedema' curve. It is apparent that for values below 60dB $L_{Aeq,16h}$, the SoNA 2014 results lie between ANASE and ANIS. At levels above 63dB $L_{Aeq,16h}$ the SoNA 2014 estimates lie below ANIS. This may be due to small sample sizes at higher exposure levels for SoNA 2014 not being representative. The SoNA 2014 results are somewhat similar to the EU.

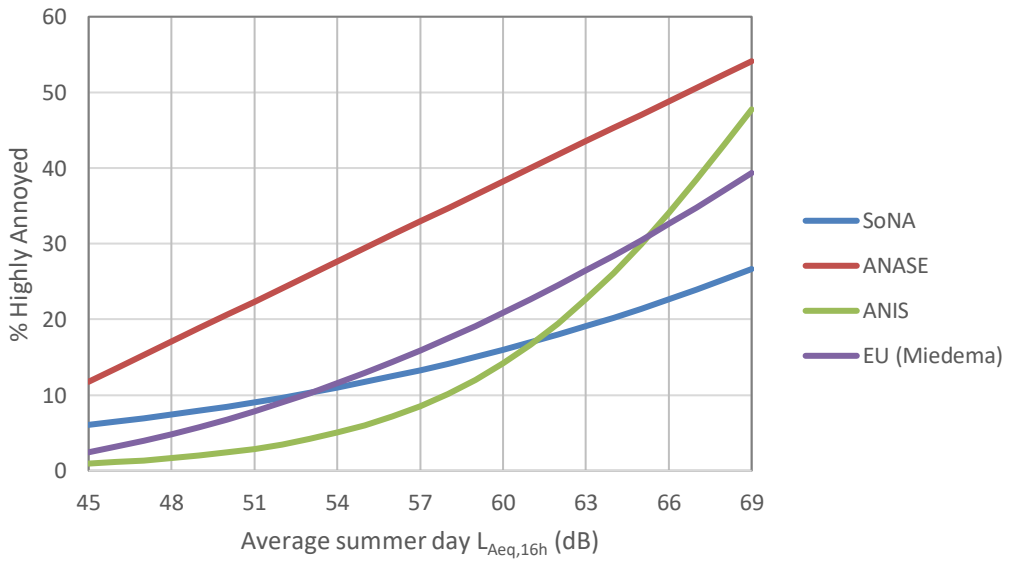

Figure 3: Comparison of % highly annoyed for SoNA, ANASE, ANIS and EU (Miedema)

Table 4 updates the values previously used from the ANIS study in CAA guidance

Table 4: Percentage highly annoyed as a function average summer day noise exposure, $L_{Aeq,16h}$

Average summer day noise exposure, $L_{Aeq,16h}$ (dB)	% Highly annoyed	
	ANIS 1982	SoNA 2014
51	3%	7%
54	5%	9%
57	9%	13%
60	14%	17%
63	23%	23%
66	34%	31%
69	48%	39%

It can be seen that the same percentage of respondents said by ANIS to be highly annoyed at 57 dB $L_{Aeq,16h}$ now occurs at 54 dB.

6. Other Analysis

6.1 Health and Well-Being

The study report also provides analysis of self-reported health and annoyance and also a measure of mental health using the Short Warwick-Edinburgh Mental Well Being Scale. An association was found both between self-reported health and annoyance and also self-reported mental health well-being and annoyance. The was however, no association between noise exposure and either of those well-being measures.

6.2 Non-acoustic factors

Various non-acoustic factors were examined. Evidence was found that the factors influenced annoyance included noise sensitivity; approximated social grade; and expectations both in terms of when the respondent oved to their property and of what aircraft noise would be like in the future.

7. Conclusions

The following conclusions were found:

- The summer average mode $L_{Aeq,16h}$ still correlated better with annoyance than any other indicator;
- There is a greater of proportion of people highly annoyed at a given aircraft noise exposure compared with 30 or so years ago.

REFERENCES

Civil Aviation Authority, CAP 1506 Survey of Noise Attitudes 2014: Aircraft (2017)