

Understanding UK Community Annoyance with Aircraft Noise

ANASE Update Study

Report for 2M Group

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Summary

This report highlights problems in existing UK policy on aircraft noise assessment and its evidence base. This report demonstrates that:

- The findings of the government-commissioned 2005 ANASE study are more robust than the previous ANIS study of 1982. However, government policy continues to be based on the older study.
- The ANASE findings are more up-to-date, reflecting the views of communities around 20 UK airports in 2005/6, whilst the research still being used to inform government policy obtained the views of residents in 1982, more than 30 years ago, when aircraft sound levels and numbers were very different to today.
- The ANASE findings are consistent with non survey-based sources of reported community annoyance (e.g. complaints by the public to government and aviation authorities) and corroborate these vocal indications that significant proportions of some communities outside 57 LAeq - such as areas in and around Eton & Windsor, East Sheen, Barnes and Putney - report that they find aircraft noise to be annoying.
- The ANASE findings are consistent with the current known situation across Europe – whilst the research still used by UK government may be consistent with the European situation of 30 years ago.
- The ANASE research findings provide evidence of the ratio between aircraft numbers and average sound levels that best reflects community annoyance, which is consistent with historical UK evidence (in particular, the Wilson Committee adoption of NNI).
- In contrast, the single piece of research that suggests community annoyance is more influenced by changes in aircraft sound levels than changes to aircraft numbers, ANIS, was biased in the way it asked residents to think only of the noisiest aircraft situation (with no mention of numbers of aircraft) when considering their annoyance with aircraft noise.

From a purely research evidence perspective, it is surprising that UK policy-makers continue to base their understanding of numbers of people affected by aircraft noise on out-of-date, biased, non-independently-reviewed research – especially when there is available much more up-to-date evidence of UK residents' views on aircraft noise that is consistent with all other recent and substantive pieces of research in the UK and elsewhere in Europe.

The consequence is that policy-makers continue to presume that 'the onset of significant annoyance' is 57 LAeq and that communities below this noise exposure threshold are relatively unaffected by aircraft noise – despite the fact that many such residents say that they are.

1 Introduction

1.1 This Report

- 1.1.1 This report was commissioned by the London Borough of Hillingdon on behalf of the 2M group of local authorities around Heathrow Airport to review, and where justified to rebut, any and all of the criticisms of the ANASE study made by the Department's non-SP review group; to review the results of the ANASE study against comparable studies carried out in Europe and elsewhere; and to provide a detailed commentary on the implications for assessing aircraft noise disturbance and annoyance associated with current and proposed future airport development. The views expressed in this report are those of the authors and have been derived without influence from the 2M group, or any other interested party.
- 1.1.2 It is understood that the London Borough of Hillingdon and the 2M group may wish to use this report to inform, or as part of, whatever representations that they may choose to make to the Davies Commission about future airport development. This report does not contain any recommendations about what those representations should or should not be.

1.2 Declaration of interest by the authors of this report

- 1.2.1 Ian Flindell and Paul le Masurier were both members of the ANASE project team throughout the entire research project. Dirk Schreckenberghad no involvement in the ANASE project but has been able contribute his expertise to this report based on having carried out similar projects around Frankfurt Airport in Germany.

1.3 Historical Background

- 1.3.1 Aircraft noise did not start to become a significant problem for residents around the larger UK airports until turbo-jet powered civil transports were introduced from around 1958 onwards. Legal actions for nuisance caused by civil aircraft in flight or on aerodromes were already prohibited by the Air Navigation Act since 1920 and subsequent Civil Aviation Acts imposed duties on successive Secretaries of State to provide alternative safeguards. The industry was given statutory immunity from legal actions for nuisance to prevent individuals from being able to restrict continued growth of civil aviation against the interests of the wider population who might wish to travel by air and derive economic and social benefit from the continued development of civil aviation. It therefore became a matter for Government to impose whatever steps were considered necessary to minimise nuisance while at the same time not unduly compromising the economic and social benefits provided by the industry.
- 1.3.2 In 1961, soon after jet aircraft noise had started to become significant, the Wilson Committee on '*The Problem of Noise*'¹ decided to measure the extent of the problem by commissioning a pioneering survey of aircraft noise disturbance and annoyance around Heathrow Airport. The survey was designed to establish the physical correlates of annoyance in terms of aircraft noise event sound levels and the numbers of those events. In 1963 and based on the results of this research the Wilson Committee recommended the

¹ "The Problem of Noise", MH 146 Committee on the Problem of Noise (Wilson Committee 1963: Ministry of Public Buildings and Works <http://discovery.nationalarchives.gov.uk/SearchUI/Details?uri=C11243865>)

adoption of a new Noise and Number Index (NNI) to indicate the extent of noise nuisance around major airports. Subject to limitations which are clearly set out in their report, the Wilson Committee considered that the data showed that a fourfold increase in the numbers of aircraft heard (outdoors) was *'very approximately'* equivalent to a 9 dB increase in the average maximum sound levels during each aircraft noise event, and the NNI was intended to reflect this relationship. It should be noted that the LAeq type metrics which are used for similar purposes today equate a fourfold increase in the numbers of aircraft heard (outdoors) to a 6 dB increase in the average maximum sound levels during each event. Alternatively, for LAeq type metrics, a doubling of the numbers of aircraft events is equivalent to a 3 dB increase in the average maximum sound levels, whereas for NNI type metrics a doubling of the numbers of aircraft events is equivalent to a 4.5 dB increase in the average maximum sound levels. The difference between 4.5 dB and 3 dB for a twofold increase in number may not seem very large, but it is crucial to understanding the differences between the subsequent 1982 ANIS and 2005 ANASE aircraft noise annoyance studies and the resulting controversies.

- 1.3.3 Under ideal laboratory conditions, most people can just about detect a change in subjective loudness when the sound level of a continuous sound is increased or decreased by about 1 dB. Under everyday conditions, when successive sounds are separated by one minute or more, it is much harder to detect any difference in subjective loudness unless the sound level is increased or decreased by at least 3 dB. For typical aircraft noise, the sound levels between the noisiest and quietest aircraft normally vary over a 10 to 20 dB range (or even more). Under such conditions, while adding in or taking away a particularly noisy aircraft would probably be noticeable (e.g. Concorde), increases or decreases in the average sound levels of the mid-range events of 5 or even 10 dB might not be particularly noticeable, while increases or decreases in the average sound levels of the quietest events might not be noticeable at all. There is much less scientific evidence available regarding the just noticeable differences in the numbers of aircraft noise events, but many people believe that a doubling of the numbers of aircraft events would be far more noticeable than the equivalent 3 dB change in the average sound levels assumed by LAeq type metrics.
- 1.3.4 Successive UK governments since 1963 have continued to follow the general approach adopted by the Wilson Committee by commissioning and publishing aircraft noise contours around major airports on an annual basis. Reducing aircraft noise at source or changing operating procedures to increase the distances between aircraft flight tracks and nearby residents reduces the size of the noise contours. Increasing the number of flights increases the size of the noise contours. The extent to which the noise contours either increase or decrease in area due to all causes is assumed to be indicative of the success or otherwise of the overall aircraft noise control programme. In 1990, and based on the results of consultation and on the results of the 1982 ANIS aircraft noise study (see below), the Government changed from the NNI to LAeq when plotting aircraft noise contours. From that date onwards the continuing reductions in aircraft noise at source had a proportionately greater effect on the size of the aircraft noise contours than the continuing increases in the numbers of flights, compared to what would have happened if the Government had continued to use the NNI. The balance of currently available scientific evidence suggests that this change from NNI to LAeq was probably a mistake. If the Government had not changed from NNI to LAeq, the noise contours would not have shrunk as much as they have and the estimated numbers of residents significantly affected by aircraft noise would not have been so significantly reduced. The findings of the 2005 ANASE study would probably

have been accepted more readily and this in turn might have encouraged greater emphasis on mitigation and compensation than has in fact occurred.

1.3.5 The limitations of the first studies of aircraft noise disturbance and annoyance carried out in the 1960s were recognised at the time and increasing numbers of similar studies were then carried out at different locations around the world. Different researchers in different countries had different ideas about the best ways to carry out the research, and taken together with considerations of national pride, this eventually led to a confusing proliferation of different noise scales and indicators, all purporting to measure much the same thing but with many subtle and sometimes significant differences. By the late 1970s, people had begun to doubt whether the NNI was still the most appropriate indicator for aircraft noise in the UK and so the Directorate of Operational Research and Analysis (DORA) at the Civil Aviation Authority (CAA) commissioned a new 'Aircraft Noise Index Study' (ANIS) with the field work carried out in 1980 and 1982². Based on this new data, and after further consultation and research, the UK Government changed over in 1990 from using the NNI to a new 16 hour day 3 month summer average LAeq metric for indicating the extent of noise nuisance around major airports. The benchmark for the '*onset of annoyance*' was defined as 57 LAeq. Over the next few years this became the '*onset of significant annoyance*', possibly reflecting comments that there is some annoyance at much lower values of LAeq.

1.3.6 At around this time, older noisier jet aircraft types were increasingly being replaced by newer quieter aircraft types, leading to continuing reductions *in average maximum sound levels* over time. Overall traffic was steadily increasing at the same time. The practical effect of changing over from NNI to LAeq when plotting aircraft noise contours around major airports was that the reductions in average maximum sound levels achieved by replacing older noisier types by newer quieter types had a proportionately greater effect on the areas enclosed within the noise contours than the increases in traffic. Over the next few years from 1990 onwards, the areas within the noise contours continued to shrink, providing clear demonstration of the benefits achieved from aircraft noise reduction at source. However, the problem of aircraft noise, judging from the increasing areas around major airports from which noise complaints were being received, did not appear to have been reduced in proportion, suggesting that the effects of increasing traffic had not been sufficiently taken into account by the new LAeq based methods of indicating the extent of noise nuisance around major airports. These issues were discussed at length at the Heathrow Terminal 5 public inquiry and the Inspector subsequently identified the need for policy makers to have more up-to-date insights into the attitudes and opinions of local residents.

1.4 The Need for ANASE

1.4.1 In August 2001 the Department for Transport invited tenders for a new Attitudes to Noise from Aviation Sources in England (ANASE) research study to meet the following main aims and objectives, with various subsidiary clauses which are not relevant to this discussion; '*The study is to re-assess attitudes to aircraft noise in England; their correlation with the Leq noise index; and to examine (hypothetical) willingness to pay in respect of nuisance from such noise, in relation to other elements, on the basis of stated preference (SP) survey evidence. The study is to be of sufficient scale and scope to provide a methodologically*

² "The Use of Leq as an Aircraft Noise Index", DORA Report 9023, 1990 Critchley & Ollerhead (CAA) on behalf of the department of Transport <http://www.caa.co.uk/docs/33/ERCD9023.PDF>

robust re-assessment of the validity of the LAeq family of noise indices as a proxy for relative community annoyance; and in particular the relative weightings on average event noise level and number of events'.

- 1.4.2 Following a competitive review, the contract for the work was awarded to an independent research team led by MVA Consultancy. It is a matter of record that the CAA, who carried out the 1982 ANIS study, also bid for the work but were unsuccessful. The Department set up a large steering group of interested stakeholders to oversee the work and also set up an International Peer Review group and a specialist SP review group to review the plans and progress. An extensive series of Phase 1 pilot studies was carried out to test and develop different aspects of the research design proposed methodology. The Phase 2 main study was eventually carried out mainly in 2005 (with some parts of the data collection running over into early 2006) and only after the entire steering group had reached agreement on the design and methodology. This agreement was to a considerable extent based on the results of the extensive pilot studies which had been carried out.
- 1.4.3 As soon as the first ANASE data became available in 2006, the results from the SP exercises were reviewed by the specialist SP review group who largely agreed with the research team's interpretations of the data that the hypothetical monetary values, whilst statistically robust, and indicative of relative differences in monetary values, appeared to be much higher in absolute terms than would be expected on the basis of more conventional hedonic house price studies. The Department then appointed a separate non-SP review group comprising one representative from the CAA and one representative from the Department of the Environment, Food and Rural Affairs to review all other (non-SP) aspects of the study. The non-SP review group did not agree with the preliminary interpretations of the data provided by the research team and instead decided to challenge the methodology and sought alternative explanations.
- 1.4.4 Both review groups requested further analyses of the data to resolve outstanding issues where possible and progress was reported to the full steering group from time to time. As far as the research team understood from the various meetings which had been held with the non-SP review group, all outstanding issues had been resolved by the time the final report was published in November 2007. However, the Department published separate reports by the two review groups at the same time as publishing the final report and appendices. Policy continued to be based on the 1982 ANIS study, and this remains the case today. The need identified by the T5 inspectorate for policy makers to have more up-to-date insights into the attitudes and opinions of local residents remains unfulfilled.

*'This brings me on to another criticism of LAeq. It was pointed out that the original study which led to its adoption had taken place in 1982 ... and people's perceptions of noise may well have changed in the 18 years since the ANIS report was produced. The Department recognised that ... it would have been useful if further social surveys had been carried out. **I strongly endorse this view.** If parties are to have confidence on the indices used to measure the noise climate they need to be founded on a sound basis of **up-to-date research**'*

[T5 Inspector, Roy Vandermeer, source: HACAN Appendix II; our emphasis]

2 Social Survey Design

2.1 Summary of the Method adopted for data collection within ANASE

2.1.1 The ANASE social survey was designed with the following agreed principles and steps.

- the population of interest was agreed to be residents within the 65 LA_{max} footprint of the noisiest aircraft operating out of the 20 largest commercial airports;
- aircraft noise exposed areas (based on Census Output Areas) were categorised according to event sound level (L) and number of aircraft movements (N);
- a stratified random sample of areas was drawn so that all residents of every candidate area had the same probability of selection, subject to a limit placed on the numbers of sites selected around Heathrow which might otherwise have been over-represented;
- within each selected survey site, addresses were selected at random;
- the standard Market Research mechanism, a kish grid, was used to systematically determine the adult at each selected address whom should be interviewed;
- the fieldwork was undertaken between August 2005 and February 2006;
- each selected resident was invited to participate in a survey *“on local community noise”* [note, reference was made to noise but not specifically aircraft noise];
- the interview rate was approximately 50% (refusals and non-contact after 5 or more visits accounted for the other half). A sample of 2,733 residents was obtained;
- each interview took place in the respondent’s home, and at selected SP sites, the interviewer had with them a small loudspeaker for playing some noise recordings to assist with a latter part of the interview (this may have alerted the respondent to the likelihood of a noise survey but they were already aware of this anyway);
- the questionnaire followed the recommendations set out in the International Organization for Standardization (ISO)’s current specification for noise survey questionnaires (ISO/TS 15666). The questionnaire included eight other possible neighbourhood noise sources that could lead to annoyance;
- the questionnaire at selected SP sites included a series of SP questions designed (and tested in Phase 1 pilot studies) to obtain hypothetical monetary valuations in accordance with the specification; and
- the final data was weighted to account for the facts that: the sampling unit was the household but the information was obtained from a single individual, and to reflect any other differences in profile between sample and population due to differences in survey response rates – i.e. older residents were more willing to participate.

2.2 Concerns expressed by the non-SP review group and our Rebuttal

2.2.1 The non-SP review group published a critical review of the ANASE report and appendices on the same date as the main report was published. The non-SP review report described the sequence of meetings that were held with the research team and itemised a series of technical notes provided by the research team in response to a range of issues raised by the non-SP reviewers and which had only received cursory treatment in the preliminary draft

reports up to that time. By and large, the meetings and discussions were helpful during which a number of minor errors were picked up and corrected and a number of other matters were clarified and resolved. The research team, however, do not understand why the non-SP review group then included in their final report all those matters which had in fact been resolved along with the few outstanding matters where disagreement remained.

- 2.2.2 There were five main outstanding issues on which the non-SP review group and the research team could not reach agreement. These were as follows; a) '*possible bias*' in the design of the questionnaire; b) the use of loudspeakers during the interview; c) the use of noise monitoring equipment for calibrating aircraft noise calculation models in the areas where the interviews were taking place; d) the effect of public antagonism to then current Government aviation policy; and e) differences between aircraft noise sound levels calculated for the ANASE study and subsequently calculated by the CAA using their proprietary aircraft noise model. We deal with each of these issues in turn below;

Possible bias

- 2.2.3 In their paragraph 7.6, the non-SP review group summarised their opinion that they were not satisfied with the various further analyses which were carried out by the research team to test for the '*possible biases*' suggested by the non-SP review group. Obviously, one of the most important tasks for any scientific research team is to minimise any possibility of bias, and there are many methodological techniques available for achieving this. The ANASE research team, with the agreement of the DfT steering group and after extensive pilot testing, followed the recommendations of ISO/TS 15666 as representing current industry best practice. In accordance with ISO/TS 15666, the 2005 ANASE questionnaire used direct and simple questions so that respondents understood exactly what they were being asked and could have confidence that the survey was being carried out as fairly and honestly as possible. The non-SP review group preferred the concealed approach adopted in the 1982 ANIS study questionnaire. The 1982 ANIS questionnaire was purposely designed to conceal the true purpose of the questionnaire for as long as possible by including 15 largely irrelevant questions prior to the key aircraft noise annoyance questions. This was a common approach in the early 1980s but it was no longer considered entirely ethical at the time of carrying out the 2005 ANASE study. Respondents can only give informed consent to take part in any study if they have been properly informed about the purpose of the study. In any case, there is no evidence that attempting to conceal the true purpose of the questionnaire makes any material difference to the results. Irrelevant questions simply waste time and effort because the results do not contribute to meeting the objectives of the research, and risk boredom/tiredness amongst respondents by the time they get to the questions that the researchers are actually interested in. This point was covered in some detail by a sub-group of the International Commission on Biological Effects of Noise³ leading eventually to the ISO/TS 15666 recommendations.
- 2.2.4 A matter of greater concern to the ANASE research team was the fact that the 1982 ANIS questions appeared to be biased against the number variable. In 1982, respondents were led through a series of questions about their satisfaction with the general area in which they live onto more specific questions about noise disturbance and annoyance which drew

³ Fields, J.M., DeJong, R.G., Gjestland, T., Flindell, I.H., Job, R.F.S., Kurra, S., Lercher, P., Vallet, M. Guski, R., Felscher-Suhr, U. & Schuemer, R. (2001): Standardized general-purpose noise reaction questions for community noise surveys: Research and a recommendation. *Journal of Sound and Vibration*, 242(4), 641-679.

attention onto the most significant recent events and not necessarily onto how often those disturbances and annoyances might have occurred. For information, the sequence of the key questions in the main ANIS study questionnaire was:

- 10a) *What are the different kinds of noises you hear round here?*
- 10b) PROMPT AS NECESSARY: *Do you **ever** hear aircraft fly by here?* [our emphasis]
- *How about road traffic – do you ever hear it go by?*
- *Do you hear any other kinds of noises?*
- 10c) *Which is the **most bothersome** noise you hear round here?* [our emphasis]
- 11a) [FOR EACH NOISE HEARD] *Please look at this scale and tell me how much the noise from aircraft here bothers or annoys you? very much, moderately, a little, not at all, don't know.*
- 11b) *How often does the noise from aircraft bother you these days? Many times a day, a few times a day, a few times a week, a few times a month, less than a few times a month, don't know.*

NOTE: The question numbers in the earlier pilot ANIS questionnaire were all one less.

- 2.2.5 These few questions, asked consecutively, required residents to, first, think of the most *bothersome* or *annoying* aircraft event, then give an annoyance rating, and are only then asked about the perceived frequency of such (most annoying) events. By setting the key annoyance question 11a within this context, the ANIS researchers (wittingly or unwittingly) biased the responses to this question against the number variable. The subsequent frequency question 11b does not feature in the reported ANIS curves. Taking the design of the ANIS questionnaire into account, it is possibly not surprising that the ANIS study found that responses to aircraft noise were more strongly weighted towards sound level, relative to number of events, than had been found in the previous NNI study. Accordingly, the main conclusion of ANIS – subsequently accepted by government – was to reject the NNI and replace it with LAeq, which then had the effect of reducing the relative importance of the increasing numbers of aircraft in the assessment of aircraft noise.

The use of loudspeakers during the interview

- 2.2.6 As part of the interview procedures at the selected SP sites, interviewers brought in and set up a portable loudspeaker so as to be able to reproduce a range of aircraft sounds during the SP part of the questionnaire towards the end of the interview. The non-SP review group suggested that setting up a loudspeaker before the actual interview started would have biased respondents to report higher annoyance than would otherwise have been the case, even though the loudspeakers were not in fact used until after the key annoyance questions had been dealt with. Obviously, setting up a loudspeaker would have alerted the respondent that at least part of the interview might be or even probably would be about noise, but there was nothing to suggest that it would be focussing specifically on aircraft noise. The non-SP review group appeared to be under a mis-apprehension that interviewers not only set up the loudspeakers preparatory to being able to reproduce the aircraft sounds towards the end of the interview but also went through an intrusive acoustic calibration procedure. There was no such calibration as, although it had been considered as a possibility during the design phase, it had been rejected as both un-necessarily intrusive and

technically outside the range of expertise expected amongst most interviewers. The technical support team carried out all necessary calibrations before issuing the loudspeaker equipment to the interviewers. In their paragraph 4.3, the non-SP review group continued to criticise the research team for including intrusive loudspeaker calibration procedures even though there were no such loudspeaker calibration procedures and the non-SP review had been informed of this.

- 2.2.7 For completeness, the ANASE research team also looked for any differences in response between the SP interviews which used a loudspeaker and the non-SP interviews which did not. There was no evidence of any effect such as had been suggested by the non-SP review group.

External factors in the surrounding area

- 2.2.8 The non-SP review group (paragraph 4.3) suggested that placing portable aircraft noise monitoring equipment in the surrounding area before and during the interviewing periods could have led to significant and sustained 'gossip' in the local community which could have encouraged respondents to exaggerate their reported annoyance responses. In fact, there was no evidence of any statistically significant difference in response between sampling areas which had received noise monitoring and those which had not. In addition, the technical support teams are always careful to find unobtrusive sites to position portable noise monitors so as to minimise any risk of interference or vandalism. Quite often, the only people who have any awareness of the deployment of portable noise monitoring equipment are the property owners who have given permission for the equipment to be deployed on their land.
- 2.2.9 The non-SP review group (paragraph 4.6) also referred to the possibility of 'public antagonism' to the Government's then current (2005) aviation policy and the extensive media interest which is still ongoing, which in the non-SP review group's opinion, could have also encouraged respondents to exaggerate their reported annoyance responses. Clearly, any response to the Government's then current aviation policy could have influenced people to feel either more, or less, annoyed by aircraft noise depending on whether they either supported or opposed it. However, it is much more difficult to separate out how much influence this might have, or have not, had on reported annoyance. A like-for-like comparison would have required questionnaire surveys to be carried out over separate time periods during which all other input variables were exactly the same except for an absence of any recent announcements of Government aviation policy and associated media attention during which responses could be compared. Because there is usually at least some aircraft noise issue or other at different times, it would probably be impossible to ever find a 'good' time to be able to carry out a supposedly unbiased aircraft noise questionnaire survey. In fact, if there was no public interest, there would be much less justification for expending public resources on this type of research.
- 2.2.10 Both of these external issues raised by the non-SP review group were given as reasons for not having confidence in the ANASE study. More recent qualitative research carried out by members of the ANASE research team has shown that most residents have little or no prior interest or understanding of detailed operations at their nearby airport and pay little attention to current media attention to the topic. Many nearby residents are disturbed or annoyed by aircraft noise from time-to-time, but this does not mean that they will choose to exaggerate (or underplay) their degree of annoyance when invited to provide their response

using the ISO/TC 15666 standard questionnaire, and in fact, if there is any groundswell of opinion against current Government aviation policy, then it would be better to take this into account rather than dismissing it as bias. Higher than expected levels of reported annoyance, such as occurred in the 2005 ANASE study when compared to expectations based on extrapolation from the previous 1982 ANIS study, should be taken as an indication that further action needs to be taken, rather than simply attempting to dismiss the findings as being not a true reflection of public opinion – hence biased or exaggerated. The non-SP review group's comments suggest a fundamental misunderstanding of the nature of noise annoyance, that it is somehow some kind of underlying and fixed physiological or neurological response to noise which is always the same regardless of any changes in attitudes and opinions in the people concerned. It has been demonstrated many times that this is not the case (see section 3.2.3 below). However the most important point to emphasise is that to whatever degree the 2005 ANASE study results might have been affected by various forms of so-called bias, the 1982 ANIS study, given that it was a much less sophisticated study using non-standardised and now out-of-date questionnaires and other methodological techniques (see later) than the 2005 ANASE study, would probably have been affected by any or all of these 'biases' to a much greater extent.

Aircraft noise sound levels

- 2.2.11 Aircraft noise sound levels vary depending on the type of aircraft and how it is flown; the height of the aircraft, the lateral displacement of the flight track to either side of the measurement point, and the number of aircraft events within any defined period if considering an average or aggregate measure of the average sound level or of the overall amount of sound energy received. Because of this large variation from one receiver site to the next and because of similarly large variation from one day to the next, in any national study of ANASE's magnitude, it is not practical to be able to determine long term average sound levels by any method of measurement alone. To solve this problem a number of sound level calculation models have been developed with varying degrees of complexity depending on the application. It has now become widely accepted as best practice to first calculate sound levels from basic input data using a standard mathematical model and then to test, and if necessary re-calibrate, the input data used to construct the model against a limited sample of field measurements which do not need to be carried out at every receiver site.
- 2.2.12 The two most commonly used aircraft noise sound level calculation models in the UK are the CAA's proprietary model known as ANCON, which is used to produce 'official' annual aircraft noise contours for designated UK airports, and the United States Federal Aviation Administration's Integrated Noise Model (INM) which is widely used both in the UK and internationally. Both models, providing that they are used correctly, are fully compliant with current best practice international guidance as set out in ECAC.CEAC Doc 29⁴. It should be noted that all calculation models are subject to varying degrees of uncertainty which increase at lower sound levels. There is no a priori reason to assume that the residual levels of uncertainty associated with either ANCON or INM are not similar.

⁴ ECAC.CEAC Doc No. 29, 3rd Edition, Report on Standard Method of Computing Noise Contours Around Civil Airports Volume 1: Applications Guide & Volume 2: Technical Guide, Dec 2006

- 2.2.13 For ANASE we used INM version 6.2 as the basic aircraft sound level calculation engine because this approach provided the maximum flexibility for calculating alternative sound level indicators for use in subsequent statistical analyses. The basic aircraft sound level data calculated using INM was then aggregated together to produce a range of composite sound level indicators using simple EXCEL spreadsheets as required.
- 2.2.14 A series of field measurements was carried out at 19 sites during ANASE during the summer and autumn in 2005. The results were used to re-calibrate the input assumptions used to inform the INM models against actual operations at a sample of UK airports rather than relying completely on overseas data where aircraft performance could be marginally different due to differences in climate, for example.
- 2.2.15 The comparisons showed some variations between modelled and measured data which were in all cases attributable to small differences between the input assumptions made to produce the initial set of aircraft sound levels for use in the sample survey selection process and more realistic assumptions based on actual field observations. For example, it was found that assuming greater departure stage lengths than the default assumptions applied as standard within INM provided closer correspondences between modelled and measured data in most cases.
- 2.2.16 There were a number of detailed modelling questions raised by the non-SP review group that the ANASE team then tested against the measured data:
- data on actual stage lengths as flown during the survey periods were not available, but detailed perusal of scheduled flight destinations provided some support for the ANASE assumptions;
 - it was not possible, in ANASE, to take into account actual flight track dispersion recorded for every flight during the survey period. Comparisons between modelled data with a range of different flight track dispersion assumptions and the field measurement data showed that LAeq calculations were relatively insensitive to the flight track dispersion assumptions made. Therefore, for this aspect of the work, we simply used the default assumptions set out in ECAC/CEAC Doc 29. It should be noted that actual flight track dispersion, while generally having little effect on LAeq sound levels, can have more significant effects on L_{av} and N_{av} calculated separately, particularly where a range of different LA_{max} cut-off values are used; and
 - for arrivals traffic, it was found expedient for some aircraft types to model marginally different glide slopes (by up to 0.5°) from the standard 3° glide slope as actually flown in order to obtain the closest possible correspondence between modelled and measured data.
- 2.2.17 The aircraft noise sound level calculations carried out for ANASE demonstrated a high degree of correspondence obtained between modelled and measured Sound Exposure Level (SEL) values for arrivals with the adjusted glide slope assumptions applied as set out above. The ANASE data also showed a similarly high degree of correspondence between modelled and measured SEL values for departures with the adjusted departure stage length assumptions applied as set out above.
- 2.2.18 In the event, the aircraft noise sound level calculations for the ANASE report were found to be robust against probing and detailed scrutiny by the non-SP review group. It is hard to think of any other study of aircraft noise that has had such a thorough review of modelling

assumptions and sensitivity tests. Certainly, the aircraft noise sound level calculations calculated for the 1982 ANIS study were not independently reviewed either at the time or at any time since.

- 2.2.19 The non-SP review group also highlighted small differences observed between the aircraft noise sound level calculations produced using INM for the ANASE study and their own (CAA) aircraft noise calculations produced using ANCON for the equivalent sampling areas and only for Heathrow. In para 3.4 of their report they confirm that while *“the key methodological concerns initially by the reviewers have been addressed, there is still a discrepancy between the values used in the study and the equivalent value from the annual contour production as can be seen from Table 1”* (included in the non-SP review group report). The non-SP review group referred to their own calculated sound levels as ‘published’ sound levels whereas these sound levels were not, and never have been, published anywhere else except in this particular report. This gave an impression that ANCON sound levels should be considered as some kind of industry standard with a stated accuracy of +/- 1 dB, against which the relative accuracy of any other calculations can be judged; although this argument is weakened by their subsequent acknowledgement in para 3.15 of their report that modelling aircraft noise becomes increasingly inaccurate at sound levels lower than 57 LAeq. In which case, where small differences exist at the lower sound levels within the expected levels of uncertainty, who can say which set of sound levels is the more accurate? In addition, the non-SP review group appear to have failed to understand that the extent to which inaccuracy increases at lower sound levels is not simply a function of LAeq because it depends on increasing inaccuracy at lower event sound levels (LAm_{ax}) and not at all on the number of events component in LAeq. At the lower values of LAeq, calculations representing small numbers of noisy events are likely to be much more accurate than calculations representing high numbers of quieter events. Contrary to the view expressed in para. 3.16 of the non-SP review report, this and any other factors likely to affect the accuracy of the calculations carried out specifically for the ANASE study were taken into account in the design of the noise monitoring carried out for the ANASE study.
- 2.2.20 In addition, further analyses of the ANASE data using the non-SP review group’s values of LAeq showed that the small differences in calculated sound levels made no material difference to the overall findings anyway [ANASE, Appendix A9, para 3.3].

2.3 Overall Conclusions Regarding Recognised International Best Practice in Social Survey Design

- 2.3.1 Since a large part of the non-SP review group’s arguments appear to be based on the observed differences between the earlier 1982 ANIS study and the later 2005 ANASE study, in addition to being 30 years out-of-date, it is important to consider to what extent the 1982 ANIS study would actually be considered acceptable under present day standards of conduct and design. It should be noted at this point that the ANASE study complied to all relevant guidelines within the UK’s Market Research Society Code of Conduct, the UK Social Research Association’s Ethical Guidelines and ISO.
- 2.3.2 In contrast, the 1982 ANIS study does not meet current industry best practice in many respects as follows:

- the ANIS sample points were arbitrarily selected by the researchers – inclusions and exclusions appear to have been defined for cost-effectiveness reasons or data availability⁵;
- ANIS used the electoral register for selecting addresses to be surveyed. Any new-builds or properties where the occupier had not registered were excluded from the survey. The ANIS report says that individuals at each selected address was chosen at ‘random’ but there is no explanation as to how – and given that this is difficult to do (hence the reason for the adoption of a kish grid by researchers when absolute rigour is required) there is a question over whether ANIS interviewers simply interviewed those residents who were most accessible when they called; and
- ANIS adopted non-ISO-compliant questioning which was biased towards the average aircraft noise sound level variable over the number variable. Of course, there was no relevant ISO standard available in 1982 and it was precisely to avoid similar kinds of errors being made in the future that the ISO standard was produced.

⁵ i.e. some sites were excluded on the basis that their associated noise exposure levels would, reportedly, make it difficult for the research team to separate Number and NNI impacts, whilst others were surveyed twice because they had noise exposures of particular interest to the researchers; and some were included simply because noise exposure data already existed for them

3 Comparable European Aircraft Noise Research

3.1 Similar Studies elsewhere in Europe

- 3.1.1 Figure 3.1 overleaf shows the results of the most recent aircraft noise annoyance studies (including ANASE) carried out around major airports in Europe plotted out against the standard EU curve⁶. The EU curve was originally produced by Miedema et al. in 2001 based on meta-analysis of all available and comparable survey data collected in many different separate research studies carried out in Europe and America from 1965 to 1992. The purpose was to support the 2002 Environmental Noise Directive⁷ which required fully harmonised noise mapping and noise action plans. Also shown is the data for the 1982 ANIS study⁸ for comparison purposes. For clarity, Figure 3.2 shows just the regressions for the same data sets without the individual data points shown on Figure 3.1.
- 3.1.2 It should be noted that any comparison between different studies with differences in questionnaire formats, noise indicators, and other methodologies requires a range of normalising and averaging assumptions to be applied to the different data sets to ensure comparability. Different researchers may disagree about the precise effects of these assumptions. The meta-analyses carried out for the EU curve used standardised scaling assumptions wherever possible, and this may have lessened the problem to some extent. In addition, the problem has become less important for the most recent data sets because of increasing standardisation of measurement.
- 3.1.3 In detail, the horizontal axis data points for the UK are based on 24 hour LAeq, whilst the data points for Amsterdam, Frankfurt, Paris and the EU curve are based on Ldn. While 24 hour LAeq and Ldn are technically different in detail, in practice for typical day-evening-night distributions of noise events the actual differences are likely to be small or even negligible. The 24 hour LAeq includes no weighting; whereas Ldn has no weighting for the daytime and a 10 dB weighting for the US-defined night-time (10 pm to 7 pm); and Lden has no weighting for daytime (7am to 7pm), a 5 dB weighting for the evening (7pm to 11pm), and a 10 dB weighting for the European defined night-time (11pm to 7pm).
- 3.1.4 The vertical axis data points have all been rescaled to a 100 point annoyance scale to facilitate comparison. Where the original data was collected using an ISO/TS 15666 compliant 11 point questionnaire scale, a threshold of 72 points is used to define 'highly annoyed'. Where the 5 point ISO/TS 15666 scale has been used, the proportion of 'highly annoyed' has been calculated as: all extremely annoyed responses and 0.4 of the very annoyed responses. Where an older 4 point scale has been used such as in ANIS, all very much annoyed responses are counted as 'highly annoyed'. These scaling assumptions may seem a little arbitrary but they are all consistent with the procedures established by Miedema et al (2001), and which were in turn based on earlier research.

⁶ "Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals" (H M Miedema and C G Oudshoorn) Leiden, Netherlands: TNO-PG, 2001

⁷ The Environmental Noise Directive (2002/49/EC) adopted by the European Parliament and Council on 25 June 2002

⁸ "United Kingdom Aircraft Noise Index Study" (ANIS) Main Report (DR Report 6402) January 1985, prepared on behalf of the Department for Transport by the Civil Aviation Authority

3.1.5 The figures show that the 1982 ANIS data is reasonably well represented by the EU curve at the lower aircraft noise sound levels (55 Ldn or 24 hour LAeq and below). At higher sound levels (65 to 70 Ldn or 24 hour LAeq), the EU curve underestimates the percentage highly annoyed in the 1982 ANIS data by the equivalent of around 2-3 dB. What is more striking however is the general degree of agreement between the more recent studies (ANASE, Paris, Amsterdam, Frankfurt) and the clear difference equivalent to around 5-6 dB between the average trend of all of these more recent studies and the much older ANIS data. This implies that using the data of older studies such as ANIS and the contemporaneous and even earlier data represented by the EU curve is likely to significantly under-estimate the extent of reported annoyance around any of the major European airports represented in the figures under present day or at least more recent conditions.

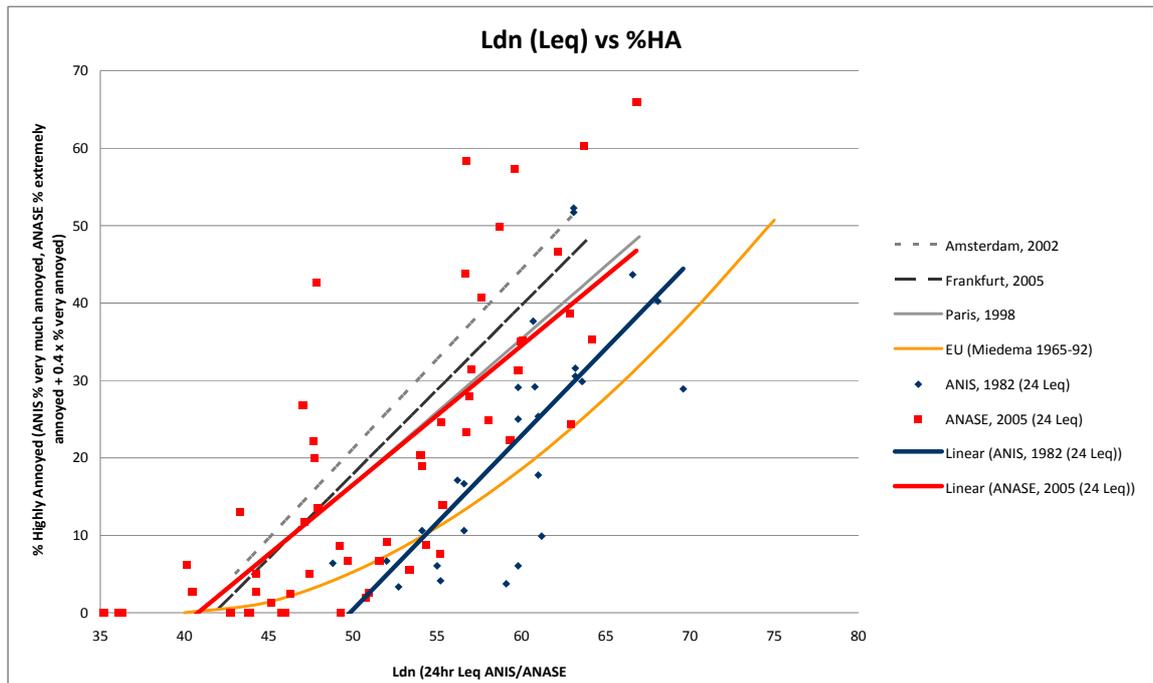


Figure 3.1 Recent Aircraft Noise Annoyance Studies [with ANASE & ANIS co-ordinates]

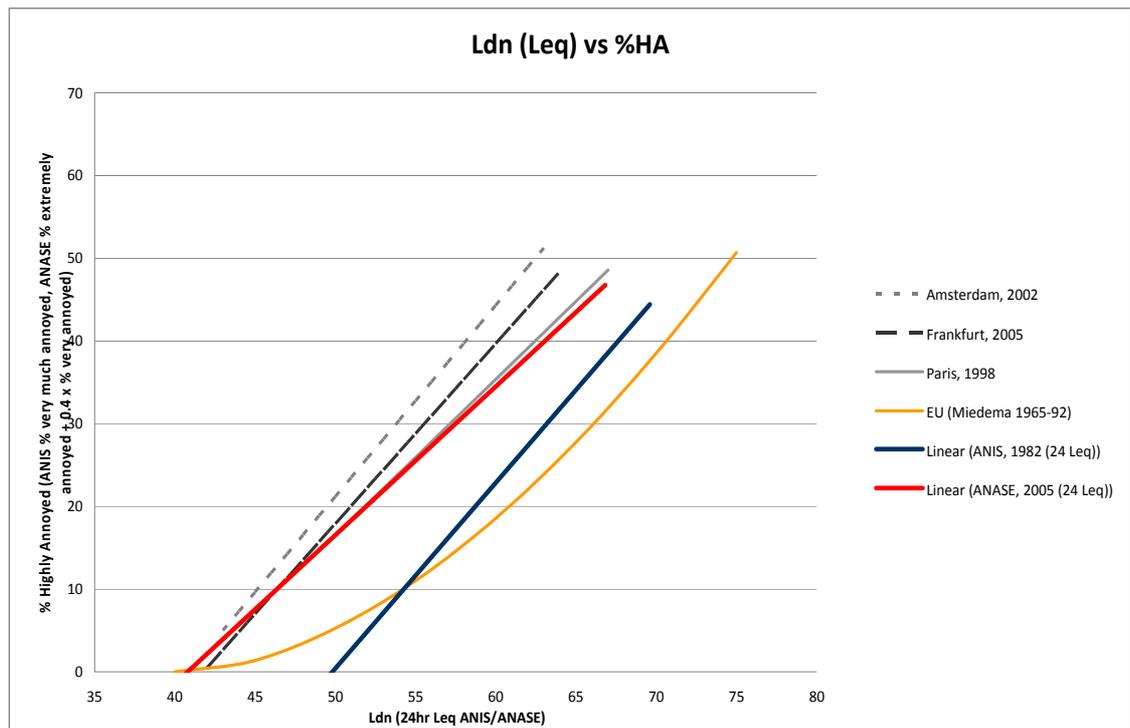


Figure 3.2 Recent Aircraft Noise Annoyance Studies [Curves only]

3.1.6 In a recent meta-analysis, the Dutch researchers Sabine Janssen and Henk Vos⁹ compared the exposure-response relationship for aircraft noise annoyance of seven recently published field studies (1996-2005) with older studies (1965 – 1992) included in meta-analyses of Miedema and colleagues that led to the generalized EU curve depicted in Figures 3.1 and 3.2. The studies, included in the comparison of old and new exposure-response curves, are presented in Table 3.1.

⁹ Janssen, S., Vos, H. (2009). A comparison of recent surveys to aircraft noise exposure-response relationships. TNO-Report TNO-034-DTM-2009-01799. Delft, The Netherlands.

Table 3.1 Studies in the meta-analysis of aircraft noise annoyance in the study of Janssen & Vos (2009)

Fields' Code	N	Name of the study (year)
<i>Studies used in previous meta-analyses in order to establish exposure-response curves for annoyance due to aircraft noise (Miedema & Vos, 1998; Miedema & Oudshoorn, 2001)</i>		
AUL-210	3207	Australian Five Airport Survey (1980)
CAN-168	631	Canadian National Community Noise Survey (1979)
FRA-016	1301	French Four-Airport Noise Study (1965)
FRA-239	565	French Combined Aircraft/Road Traffic Survey (1984)
NET-240	573	Schiphol Combined Aircraft/Road Traffic Survey (1984)
NOR-311	1396	Oslo Airport Survey (1989)
NOR-328	673	Bodo Military Aircraft Exercise Study (1991-1992)
NOR-366	321	Vaernes Military Aircraft Exercise Study (1990-1991)
SWE-035	1491	Scandinavian Nine-Airport Noise Study (1969, 1970, 1971, 1972, 1974, 1976)
SWI-053	3076	Swiss Three-City Noise Survey (1971)
UKD-024	3845	Heathrow Aircraft Noise Survey (1967)
UKD-242	1993	Heathrow Combined Aircraft/Road Traffic Survey (1982)
UKD-238	598	Glasgow Combined Aircraft/Road Traffic Survey (1984)
USA-022	2235	U.S. Four-Airport Survey (phase I of Tracor Survey) (1967)
USA-032	1540	U.S. Three-Airport Survey (phase II of Tracor Survey) (1969)
USA-044	1612	U.S. Small City Airports (Small City Tracor Survey) (1970)
USA-082	374	LAX Airport Noise Study (1973)
USA-203	586	Burbank Aircraft Noise Change Study (1979)
USA-204	599	John Wayne Airport Operation Study (1981)
USA-338	839	U.S.A. 7-Air Force Base Study (1981)
Sum 1	27455	
<i>Recently added field studies</i>		
GER-531	2235	Frankfurt Airport Study (2005)
NET-371	11143	Schiphol Airport GES Survey (1996-97)
NET-379	154	Groningen Eelde Airport Survey (1998)
NET-522	746	Schiphol Sleep Disturbance Study (2000)
NET-533	5192	Schiphol 2002 GES Study (2002)
SWI-525	1374	Zurich Airport Noise Survey (2001)
SWI-534	1229	Zurich Airport Noise Survey (2003)
Sum 2	22073	
Total	49528	

3.1.7 The results of the comparison undertaken by the Dutch colleagues (Figure 3.3) confirm the recent evidence of greater annoyance with aircraft noise for a given sound level (Lden). Janssen and colleagues also found that, although study characteristics such as type of annoyance scale, the type of contact, and the response rates were found to be sources of heterogeneity in annoyance, they concluded that none of these factors could explain the trend of an increase in annoyance over time¹⁰.

¹⁰ Janssen, S., Vos, H. van Kempen, E.E.M.M., Breugelmans, O.R.P., Miedema, H.M.E. (2011). Trends in aircraft noise annoyance: The role of study and sample characteristics. J. Acoust. Soc. Am. 129 (4), 1953-1962.

- 3.1.8 They further stated: "Given the large part of the heterogeneity explained by year of the study, it does not seem justifiable to pool recent and older studies into one single relationship. While this could imply that the relationship needs to be updated on the basis of recent studies using similar methodologies, it is important to obtain further insight into the factors responsible for the change and the large heterogeneity found in the annoyance response." (Janssen et al., 2011, p. 1961).

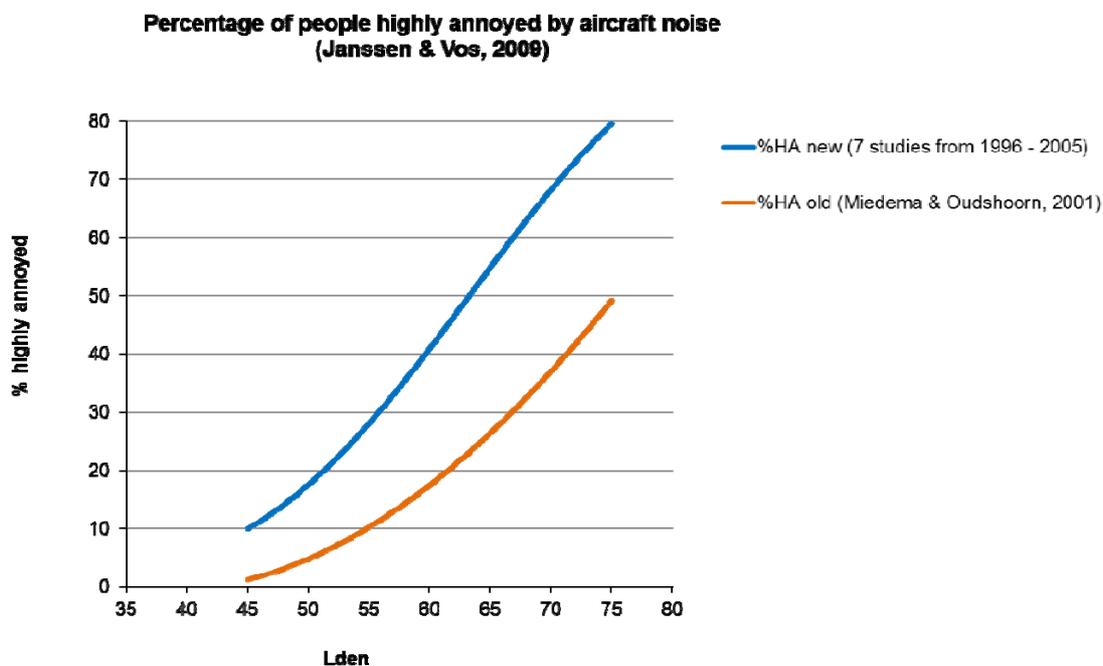


Figure 3.3 Comparison of Dose - Annoyance Relationships of old and recently published data. Source: Janssen & Vos, 2009

3.2 Discussion

- 3.2.1 There are two key questions arising from the comparisons between the different studies:

- a) *what is the explanation for the observed differences shown on the figures; and*
- b) *what are the implications for policy?*

- 3.2.2 There are in general two alternative scientific hypotheses which can be invoked to explain the differences (question a) above). If we hypothesise that there IS a fundamental underlying relationship between the amount of aircraft noise measured outdoors using some form of long-time A-weighted energy average (LAeq, Ldn, or Lden, etc) and the resulting degree of disturbance and annoyance, then any differences in observed dose-response relationships arise from, or are caused by, uncertainties in measurement along either the horizontal axis representing the noise 'dose' or input variable and/or the vertical axis representing the reported annoyance or outcome variable. Improved consistency of measurement achieved by using standardised questionnaire scales for reported annoyance (i.e. ISO TS 15666), and standardised methods for measuring and calculating aircraft noise sound levels (i.e. ECAC CEAC Document 29) have improved comparability in recent years, but there are still large differences in response at different receiver sites even where averaging across all receiver sites included within particular studies has reduced apparent

differences between different studies. The scatter of individual receiver site data points shown on Figure 3.1 should make this point clear. Note that the receiver site data points shown on Figure 3.1 have already been averaged across individual responses which always show further variance above and below receiver site averages. It should also be noted that minor uncertainties regarding the comparability of annoyance questions asked in different languages or different ways of adding up day, evening and night-time noise included in different versions of LAeq based metrics could all be responsible for small differences, but none of these uncertainties seem to be big enough, on their own, to explain all the observed differences between the recent studies and the older studies represented by the EU curve.

- 3.2.3 The alternative scientific hypothesis (to explain question a) above) is that there is no unique underlying relationship between the amount of aircraft noise measured outdoors using some form of long-time A-weighted energy average (LAeq, Ldn, or Lden, etc) and the resulting degree of reported disturbance and annoyance. Differences in observed dose-response relationships represent genuine differences in response caused by differences in sensitivity to different features of aircraft noise in different environments, or even to different socio-economic and attitudinal factors. There is increasing interest in these so-called non-acoustic factors (e.g. Vos 2010, Griefahn et al. 2013, Schreckenberg et al. 2010, Broer 2007¹¹ and the Aircraft Noise Non-Acoustic Group) which can more easily be revealed by newer methods of qualitative research. The general consensus, if there is one, seems to lie somewhere between these two extremes.
- 3.2.4 As a UK specific example of these kinds of problems, Figures 3.1 and 3.2 show significant differences between the observed dose-response relationships between the 1982 ANIS study and the 2005 ANASE study, both carried out in the UK. If we ignore measurement uncertainties along the horizontal and vertical axes then we must conclude either that UK residents have become more sensitive to aircraft noise over the 23 years between the two studies, or that their fundamental dose-response relationship has not in fact changed, but instead either that the noise measurement scale (in this case different variants of LAeq) has not captured or reflected any differences in the aircraft noise environment properly, or that the reported annoyance scales used in the two studies were not at all comparable. The more recent 2005 ANASE study was carried out in full compliance with current industry best practice using the same standardised questionnaires and aircraft noise measurement and calculation procedures as for the other recent European Studies. The earlier 1982 ANIS study was not compliant with current industry best practice (which had not been standardised at that time), but since it is not possible to go back in time to repeat measurements using standardised procedures, there is no way to determine what the effects of non-compliance might have been in practice.
- 3.2.5 A comprehensive statistical analysis of the differences between the 2005 ANASE study and 1982 ANIS data sets was published in 2007¹². This analysis demonstrated that by taking greater account of the number variable when measuring the aircraft noise input sound level, the apparent difference in dose-response relationships between 1982 and 2005 disappeared.

¹¹ "Factors influencing the annoyance caused by environmental sounds - A literature study" (Vos) Proc. INTER-NOISE 2010, 6168-6177 (2010); "The impact of acoustical, operational and non-auditory factors on short-term annoyance due to aircraft noise" (D. Schreckenberg, R. Schuemer,) Proc. INTER-NOISE 2010, Paper No. 333; "Moderators that influence annoyance of residents near 6 European airports" (B. Griefahn, K. Bolin, I. Flindell, J. Lambert, C. Lavandier, F. Marki, U. Müller, S. Robens) Proc. INTER-NOISE 2013, Innsbruck/Austria; "Aircraft noise and risk politics" (C. Broer,) Health, Risk & Society, 9(1), 37-53 (2007)

¹² "Attitudes to Noise from Aviation Sources in England" (ANASE) 2007 Final Report on behalf of Department for Transport, MVA Consultancy et al

The best fit to both data sets was obtained by using a number factor equivalent to the original NNI dating back to 1963 (i.e. there would be no implied change in reported community annoyance between 1963 and 2005 at a given level of noise exposure as calculated in NNI). However, it is not possible to distinguish this conclusion from an alternative hypothesis based on an assumption that the noise scale based on LAeq is definitive and that the differences in response arise either from differences in sensitivity to aircraft noise or even from different interpretations of the reported annoyance scales used.

- 3.2.6 At the time that these analyses were being reported, the CAA (who carried out the 1982 ANIS study) suggested that the apparent increase in reported annoyance at the same LAeq from 1982 to 2005 could have represented some kind of protest against then current aviation policy and did not necessarily represent underlying or actual annoyance at all¹³. Interestingly, detailed study of the non-standard annoyance questionnaires used in the 1982 ANIS study shows that the way in which respondents were gradually led from questions about their satisfaction with the general area in which they live onto more specific questions about noise disturbance and annoyance was clearly biased against the number variable. It could be argued therefore that the apparent insensitivity to the number variable observed in the 1982 ANIS data was to some extent a foregone conclusion. Unfortunately, none of the other recent European studies were designed to permit the relative effects of the number and average sound level variables to be compared in the same way that they could be compared in the 1982 ANIS and 2005 ANASE databases (and in the original 1961 Heathrow study database).
- 3.2.7 The second key question is ‘what are the implications for policy?’
- 3.2.8 Firstly, if policy makers wish to fully understand the effects in terms of standardised reported annoyance of civil aviation across Europe, then the current standard EU dose-response curve and the similar ANIS dose-response are both 30-odd years out-of-date. A further implication is that not only are the historic studies clearly out-of-date, but even the more recent studies, which generally show higher reported annoyance than predicted according to the EU curve, are themselves likely to become increasingly out-of-date as we move into the future.
- 3.2.9 Secondly, since it appears that standardised aircraft noise annoyance dose-response curves are subject to considerable uncertainty and always likely to be more or less out-of-date as circumstances change over time, then perhaps a less harmonised approach is justified.
- 3.2.10 Recent qualitative research has clearly demonstrated a wide range of individual sensitivities and concerns to different features of the overall aircraft noise environment in different situations, which no standardised dose-response curve based on long time averaged noise metrics such as 16 hour LAeq, Ldn, or Lden can possibly represent. A simple example of this problem is runway alternation at Heathrow Airport which provides scheduled respite for people living under alternative approach tracks to the airport. Scheduled runway alternation at Heathrow has no effect on LAeq or Lden contours yet is a measure which has long been held to provide benefits for many residents. Recent qualitative research is suggesting that the perceived benefits can be significantly affected by the extent to which residents are even aware of the policy. While residents are likely to be aware to at least some extent of time periods during which they are overflown, they are generally much less aware of time periods

¹³ “Attitudes to Noise from Aviation Sources in England, Non SP Peer Review”, Environmental Research and Consultancy Department CAA and Acoustics and Vibration Group Bureau Veritas, CAA: 4ER/2/1/11 BV: NGGX0072/st/07/76, October 2007

when they are not overflowed. There are many similar examples where what might in fact be relatively minor changes to aircraft fleets, flight tracks, or operating procedures can have apparently disproportionately greater effects in terms of community response. None of these possibly unexpected changes in community response should be dismissed by policy makers simply because they are above or below the harmonised EU curve. Instead they should be taken, or accepted, as clear demonstrations of an absolute requirement for individual airports to fully engage with their surrounding communities to explain and justify where noise is unavoidable and to make their economic and social contributions to general welfare much more explicit. It seems that many residents will tolerate being annoyed from time to time if they also understand what has been done to reduce the problem and why the remaining annoyance is unavoidable. Many residents can then still find the presence of an airport nearby to be, on balance, entirely acceptable.

4 Conclusions

4.1 Summary Findings

4.1.1 Differences between the ANASE and ANIS studies can be summarised thus:

Table 4.1 Comparison between ANASE and ANIS

Issue	ANIS	ANASE
Up-to-Date:	31 years old	7 years old
Sampled Sites:	Arbitrarily selected	Stratified random probability sampling in line with government guidelines
Reported Annoyance Question adopted:	Strong risk of bias against number variable	Compliant with international standard, minimising risk of bias
Context to Annoyance Question:	Unethical by today's guidance	Compliant with today's guidance
Noise Measurements:	ANCON model according to international standards	INM model according to international standards
Comparison with contemporary research:	At odds with up-to-date European studies	Consistent with up-to-date European studies
Independently reviewed:	No Review	Continuously reviewed throughout the project by a large independent steering group. Non-SP reviewers not policy independent

4.1.2 There is a strong case for Government to use the ANASE study findings when interpreting levels of community annoyance around UK airports.

4.2 Implications for Policy

4.2.1 Using the data of older studies, such as ANIS and the contemporaneous and even earlier data represented by the EU curve, is likely to considerably under-estimate the extent of

4 Conclusions

reported community annoyance around UK airports under present day, or at least more recent, conditions.