Question 2	Confidential
Respondents a) Specific: 2M, CAA, EANAG, Hacan, HAL, Hammersmith & Fulham Council, Hillingdon Council, Kensington and Chelsea Council, LAANC, RHC, Richmond Council, Wandsworth Council, Windsor & Maidenhead Council, Mayor of London, Gatwick (15) b) Other: Reports submitted by AEF, NATS and Virgin Atlantic that are not question specific	
Question Does the Environmental Noise Directive enable the UK to meet fully the criticisms that were made in the Heathrow Terminal Five Public Inquiry Report that the 57 decibel noise contour was by itself an inadequate measure for assessing the full impact of air traffic noise?	
Background In his report to the Secretary of State on the Heathrow Terminal Five Public Inquiry, Roy Vandermeer QC (Vandermeer Report) was critical of the reliance that the Government placed on the 57 decibel contour as the sole indicator of the impact of air traffic noise. Specifically, he found that people living in areas outside Heathrow's 57 decibel contour were affected by noise; that the research (dating from the early 1980s) does not support the claim that annoyance from air traffic noise is significant only at and above 57 decibels; that the 57 decibel contour does not reflect the impact of the large increase that had taken place in the number aircraft movements at Heathrow; that the 57 decibel contour does not measure the benefit of runway alternation at Heathrow in providing predictable periods of respite; and that the 57 decibel contour does not evaluate noise from movements in the night period (2300-0700). The Environmental Noise Directive replaces the 57 decibel contour (0700-2300) with the more comprehensive LDEN contour: 55 decibels for the day and evening periods (0700-1900 and 1900-2300) and 50 decibels for the night period (2300-0700), with the option of setting lower contour values and of applying supplementary noise indicators. We are interested to learn whether the Directive enhances or hinders the delivery of a more comprehensive noise assessment along the lines identified by the Vandermeer Report.	
Template updated 15 Dec 14 PJW	

2M, Hillingdon Council and Kensington and Chelsea Council

The T5 Inquiry Inspector criticised the continued use of the 57 LAeq,16 contour, a metric based upon a social study in the early 1980s (the ANIS study) when the airport was only handling 221,513 movements a year (LAHT5 evidence para 21.3.14). The Government undertook a piece of work following the conclusion of the T5 Inquiry aimed at reviewing the community annoyance metric. This was the ANASE study. The study reported in 2007 and the conclusions indicated that the proportion of people highly annoyed had increased and that people were becoming more sensitive to the increasing numbers of aircraft movements. On the eve of publication, a peer review criticism of the study was published, but the authors were not asked to respond to the criticism and the whole report and its findings was shelved and never revisited.

In our response to the Aviation Policy Framework consultation, we submitted a technical paper which highlighted our concerns on this issue.

This paper examined the differing aircraft annoyance studies included in the European Environment Agency (EEA) 2010 report. It was intended to help policymakers and competent authorities to understand and fulfil the requirements of the Environmental Noise Directive, and the UK's ANASE 2007 study. The paper concluded that both the EEA report and the ANASE study showed that there had been a significant shift

in terms of peoples' attitudes to aircraft noise and that this now caused annoyance at lower levels than it did previously, as found in the older ANIS study.

We were very disappointed that the Government did not take the opportunity to put this right when publishing the Aviation Policy Framework, which still supports the use of the 57Laeq contour to evaluate community annoyance.

The Airports Commission has similarly failed to get to grips with the key issue that it is unacceptable to continue with a metric that suggests peoples' attitudes remain the same some 30 years later and with a doubling of flight numbers. To this end, as part of the 2M Group, we paid for the ANASE study team to respond to the criticism of their original work. We have submitted this to the Airports Commission and can make it available for the Inquiry.

In terms of ensuring all noise impacts are adequately quantified, it should be noted that the use of either the Leq metric or the Lden as adopted by the EEA still suffer from a number of deficiencies. As both are based upon average conditions, they cannot account for runway alternation. They do not indicate the maximum noise of individual events and therefore cannot account for the number of times activities, e.g. school lessons, are interrupted. Both also fail to give adequate weight to the number of aircraft movements. However, whilst these issues remain to be resolved, what is clear is that aircraft noise now causes annoyance at lower levels than previously found 30 years ago and that this issue must be addressed immediately. As an interim measure the 55Lden adopted by the EU may represent a more realistic measure of community annoyance.

If the Parliamentary Group finds our evidence persuasive, we would welcome its support to urge the Government to make its decisions on the extent of community impacts based on sound science and accounting for all the differing noise impacts. This is essential if the impacts are to be properly mitigated. There should also be an aim to correlate future noise metrics with the WHO guidelines for the protection of health of the most vulnerable in society.

CAA

The Terminal 5 Public Inquiry Report made three broad criticism of the 57 decibel noise contour: the level used to describe what is called the onset of annoyance (57 dB $_{LAeq}$ the metric's insensitivity to numbers of events; and its insensitivity to changes outside the 16 hour daytime period.

The 2002 END does not say what interpretation to put on values of $_{LDEN,}$ so does not directly address the Public Inquiry's first criticism. However, in supporting papers from the European Commission, about 10% of the population exposed to 55dB LDEN is estimated to be likely to be highly annoyed. 55 dB $_{LDEN}$ is equivalent to approximately 53.4 dB $_{Laeq\ 16h}$ [1] . ln 1984 the UK Aircraft Noise Index Study (AN1S) suggested that for 57 dB, $_{Laeq\ 16h}$ around 8.5% of the population would be likely to be highly annoyed, suggesting people became less tolerant of noise between 1984 and 2002. This interpretation would support the view expressed by the Public Inquiry.

The criticism of insensitivity to numbers of events applies equally to $_{LDEN,}$ since the END indicators give the same weighting to numbers of events as $_{Laeq\ 16hr}$ does.

The criticism of $_{LAeql6hr}$ not addressing noise outside the 16-hour period has been addressed by the END requirement to produce 8-hour night contours, and the recent Aviation Policy Framework (APF) policy that

[1] Based on 2011 END results for the London designated airports.

the designated airports (which includes Heathrow) should routinely produce separate daytime (0700-2300) and night-time (2300-0700) contours.

EANAG
No. Heathrow's Noise Action Plan in response to the Directive contains statements that amount to saying that the airport will continue as before, with no significant change. Indeed following a stated action in its revised Plan, the airport has abolished its Noise and Track-keeping Working Group, to which LAs and HACC nominated members, and replaced it by a Noise Forum whose members are appointed by Heathrow.

Hacan
There are key flaws in using the LAeq metric to measure noise:

a. The noise is averaged out over a 16 hour period. Averaging out noise over a given period might work for a busy main road where traffic is fairly constant throughout the day but average measurements are not suitable for the more intermittent nature of aircraft noise. The averaging out of aircraft noise includes the quiet periods of the day and the quiet days of the year, so underestimates the noise people actually hear. It does not reflect the way people are disturbed by the noise. In London, there is an additional problem that the noise from City and Heathrow aircraft are measured separately and so the cumulative impact on communities which experience both is not captured.

b. The method used to average out the noise does not give enough weight to the number of aircraft flying overhead. It concentrates on the noise made by each individual aircraft. It assumes annoyance levels will remain the same if the number of aircraft operations are doubled so long as the individual aircraft noise levels are reduced. Under this system, one Concorde followed by 3 hours and 58 minutes of relief is said to be as disturbing as four hour's worth of non-stop noise from Boeing 757s at a rate of one every two minutes (*The Quiet Con*, Hendin, R). This is clearly not a reflection of reality!

This means that the noise metrics have not captured what has been happening in recent decades: the impact on residents of the huge increase in the number of aircraft passing overhead. It is instructive to note what happened in the 1990s. The decade saw less noisy aircraft introduced but also saw a big increase in flight numbers…..and complaints. It was the decade when HACAN membership grew like never before or since. The increase in flight numbers was the all-important factor – not reflected in the noise metrics. Using those metrics, the aviation industry and government could claim that the noise contour was shrinking. Technically that was true but it masked what was happening on the ground.

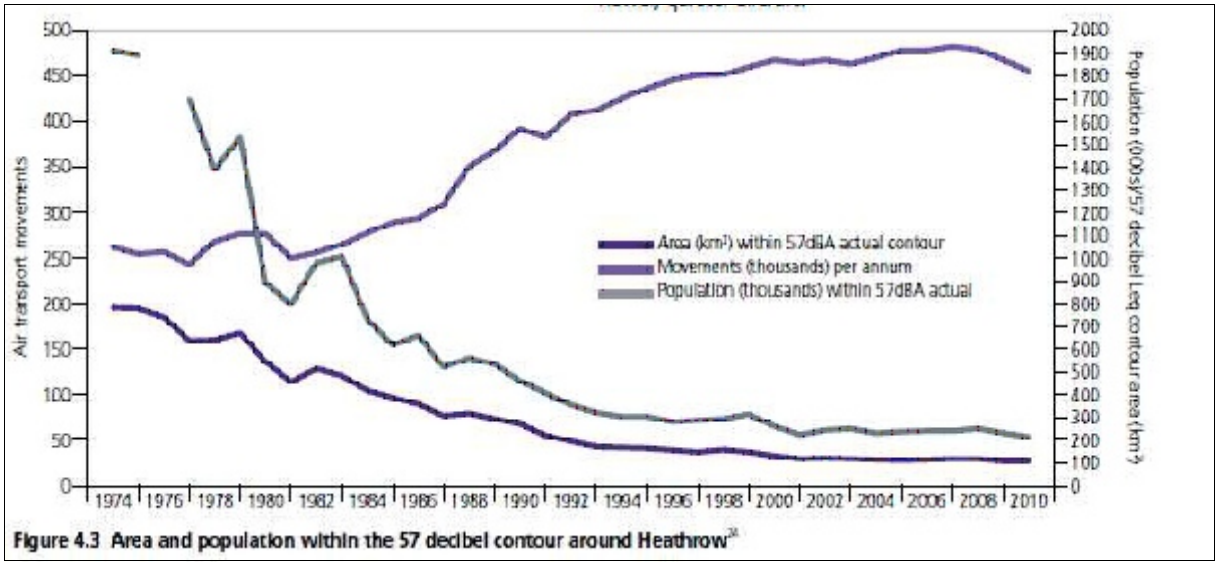


Figure 4.3 Area and population within the 57 decibel contour around Heathrow[24]

We believe that this, taken from *A Quieter Heathrow* (Heathrow Airport, 2013), is accurate but also misleading. It shows that since 1972 the number of flights has nearly doubled yet but it also purports to show that both the area and population disturbed by noise has shrunk. The latter claims are simply not true! In 1974 the campaigns which did exist were made up of people living only a few miles from the airport. Today HACAN's membership reaches from Greenwich in the east to Reading in the west. The main reason for this increase has been the growth in the number of planes. It cannot be emphasized enough that the number of flights passing overhead is the key factor affecting the level of noise annoyance and disturbance.

c. The point at which people are said to become annoyed by the noise is unrealistic. To repeat what we said earlier, it is claimed annoyance only sets in when the noise averages out at 57 decibels across the 16 hour period. This excludes places like Putney and Fulham! We do appreciate that acousticians point out that the 57 decibel cut off point does not technically imply that nobody suffers from noise outside the contour. But politicians, the public and the press do not live in the rarefied world of acousticians! The perception that 57 is the cut off point is false and needs to be countered.

d. The low-frequency content of aircraft noise is likely to be underestimated. The World Health Organisation (Berglund et al, 2000) has recommended: *"Special attention should also be given to: noise sources in an environment with low background sound levels; combinations of noise and vibrations;* ***and to noises with low-frequency components"*** (our emphasis). WHO recommends that, whenever aircraft noise, using 'C' or 'D' weighted measurements, is around 10 decibels higher than when the conventional 'A' weighted measurements are used, it indicates the presence of significant levels of low-frequency. In these circumstances, 'A' weighted measurements do not fully capture the impact of the noise and 'C' or 'D' weighted measurements should be used.

A study carried out by HACAN showed that aircraft using Heathrow fell into this category (Hendin, 2003). It suggested that a reason why people may not be responding positively to less noisy aircraft is that "the improvements have been in the mid to higher frequencies." An exception to this may be the A320 family of aircraft which emit what residents, some distance from the airport, have described as 'a high-pitched whine'.

HAL

There is no one perfect measure to assess or describe the impact of noise and each measure can be useful provided that its purpose is understood.

Within the Aviation Policy Framework the Government states that it will continue to treat the 57dB LAeq 16 hour contour as the average level of daytime aircraft noise marking the approximate onset of significant community annoyance. However, it also notes that this does not mean that all people within this contour will experience significant adverse effects from aircraft noise. Nor does it mean that no-one outside of this contour will consider themselves annoyed by aircraft noise.

The preferred metric of the Environmental Noise Directive END (and the London Mayor) is the Lden which, although covering the full 24 hour period for a full year, is still a derivative of the other long term average measure the LAeq which is the basis of "57 decibel contour". The same can be said of Lnight, Lday and Leve also used by the END. Broadly speaking they each describe an average noise level over a period of time.

Table D1 Heathrow L_{den} area, population and household cumulative estimates for years 2006 and 2012

L_{den} contour (dBA)	2006	2012	Change	% Change
	Area (km^2)			
> 55	244.7	216.9	-27.8	-11%
> 60	92.7	80.4	-12.3	-13%
> 65	37.1	31.8	-5.3	-14%
> 70	13.7	10.9	-2.8	-20%
> 75	5.0	3.9	-1.1	-22%
	Population (x1000)			
> 55	756.1	725.0	-31.1	-4%
> 60	194.6	179.3	-15.3	-8%
> 65	54.3	44.2	-10.1	-19%
> 70	9.6	5.5	-4.1	-43%
> 75	0.7	0.1	-0.6	-86%
	Households (x1000)			
> 55	338.5	312.5	-26.0	-8%
> 60	81.6	74.5	-7.1	-9%
> 65	21.4	17.3	-4.1	-19%
> 70	3.5	2.0	-1.5	-43%
> 75	0.3	< 0.1	-0.3	-100%

Table D4 Heathrow L_{night} area, population and household cumulative estimates for years 2006 and 2012

L_{night} contour (dBA)	2006	2012	Change	% Change
	Area (km^2)			
> 50	84.4	73.7	-10.7	-13%
> 55	34.2	27.3	-6.9	-20%
> 60	11.9	9.1	-2.8	-24%
> 65	4.5	3.2	-1.3	-29%
> 70	1.8	1.4	-0.4	-22%
	Population (x1000)			
> 50	207.2	197.0	-10.2	-5%
> 55	62.0	59.8	-2.2	-4%
> 60	16.3	12.3	-4.0	-25%
> 65	1.7	1.6	-0.1	-6%
> 70	0.0	0.0	0.0	(n/a)
	Households (x1000)			
> 50	88.9	82.2	-6.7	-8%
> 55	24.1	23.0	-1.1	-5%
> 60	6.0	4.4	-1.6	-27%
> 65	0.6	0.5	-0.1	-17%
> 70	0.0	0.0	0.0	(n/a)

That is why we voluntarily publish a range of different noise measures. These include the measures used in the Environmental Noise Directive and the long-standing day and night measures used by the UK Government.

All average noise contours show that fewer people are affected by noise from Heathrow than in the past. Using the UK Government's preferred measure, since the early 1970s, the number of people in Heathrow's

noise footprint has fallen nearly tenfold even as the number of flights has nearly doubled. Similarly as can be seen from the tables below both the Lden and Lnight contours show reductions in area, population and households between their adoption in 2006 and 2012 according to the CAA annual report (ERCD REPORT 1305). Population encroachment and new development over the same time period means that the reductions in population and households would have been greater. This is important context when considering these numbers as it illustrates that developers have continued to seek opportunities to develop and people continue to choose to live close to Heathrow. We recognise the need to supplement average noise contours with other measures. Over the past few years we have worked with a range of stakeholders to help identify potential supplementary metrics. This has included making a joint submission to the DfT with HACAN.

Indeed our submission to the Airports Commission includes measures such as theN70 (number of noise events above 70 dBA) and also other measures which our community engagement has identified as more accessible. These included for example measures of respite and days of over-flight.

Hammersmith & Fulham Council
We agree that the 57dB noise contour is not an adequate means of measuring the community impacts of aircraft noise. Hammersmith &Fulham lies outside this contour but our residents are affected by noise from flights overhead. The use of the 55dB Lden contour, as advocated by the Noise Directive, seems to be a closer fit to the areas affected.

Hillingdon Council
See 2M

Kensington & Chelsea Council
See 2M

LAANC and Wandsworth Council [text colour: black- common to both submissions, green-LAANC only, red-Wandsworth only]

In our view the END does not fully meet the criticisms that were made by the T5 inspector. For ease of reference the two main criticisms of the T5 Inspector (Roy Vandermeer QC) as stated in his main report at paragraph 34.4.42 are reproduced below:

"The measure of the noise climate used by the Government to test the success of its policy is the LAeq,16hour index. This was the subject of severe criticism much of which I consider to be well-founded.

..... It does not reflect the operation of runway alternation which is a key feature of Heathrow (para 21.3.30) nor does it give any indication of the number of times activities are interrupted by passing aircraft (para 21.3.31).

.....More significantly I believe that it fails to give adequate weight to the number of aircraft movements (para 21.3.34). Many local residents are unconvinced by the Government's argument that the noise climate has improved. They believe that it has become worse over the last 5-10 years and this appears to be a reflection of the substantial increase in movements over that period (para 21.3.34)."

Although the END recognizes the increased sensitivity of populations exposed during the evening and night periods the prescribed END noise metrics Lden and Lnight are based on the Leq index which averages noise across both runways and between westerly and easterly operations of the airport. In doing so the resultant

noise contours at Heathrow do not accurately reflect the levels of noise that people actually hear and consequently the way they are disturbed. The leq principle assumes community annoyance levels will remain the same even if the aircraft operations are doubled, providing the noise energy emitted from individual aircraft events is halved. A halving of noise energy equates to a 3dB reduction. Although a halving of noise energy sounds impressive it is for most people a barely perceptible change in perceived noise.

There is evidence from work undertaken by the"ANASE" research team as part of its UK study in 2007 that above a certain number of aircraft movements the leq principle becomes uncalibrated and from then on annoyance reaction becomes triggered more by numbers of movements which are heard rather than the individual noise levels of each event. We urge the APPG to seek further evidence on this point.

In our view there is evidence to support a hypothesis which says that the point at which people become annoyed by aircraft has shifted over 35 years. The ANASE report found that over the last 30 years or so levels of reported annoyance, in terms of percentages of the population annoyed, formerly at around 57decibels were now being reported at 50 decibels.

In our response to the Aviation Policy Framework consultation LAANC submitted a technical review (Author: Mike Rickaby) we submitted jointly with other "2M" local authorities a technical paper which highlighted concerns on this issue. The paper examined the differing aircraft annoyance studies across the EU including the findings of a European Environment Agency (EEA) 2010 report. The technical paper was submitted to the DfT to help policymakers understand the need at an early stage to reconsider the UK approach of judging annoyance caused by aircraft noise by reference to the 57decibel contour. The paper also shows how the findings of UK's ANASE 2007 study are in retrospect well aligned with other recent EU studies on aircraft noise and annoyance. It was intended to help policymakers and competent authorities to understand and fulfill the requirements of the Environmental Noise Directive, and the UK's ANASE 2007 study.

The paper concluded that both the EEA report and the ANASE study showed that there had been a significant shift in terms of peoples' attitudes to aircraft noise and that this now caused annoyance at lower levels than it did previously, as found in the older ANIS study.

We were very disappointed that the Government did not take the opportunity to put this right when publishing the Aviation Policy Framework, which still supports the use of the 57L_{aeq} contour to evaluate community annoyance.

A copy of this paper Is annexed to this response and the group is welcome to use it in any way that it finds useful. [See end of Template 2]

We believe The Airports Commission has similarly failed to get to grips with the key issue that it is unacceptable to continue with a metric that suggests peoples' attitudes remain the same some 30 years later and with a doubling of flight numbers. To this end the 2M Group funded further work by the ANASE study team to enable the team to respond to the criticism of their original work. We have submitted this to the Airports Commission and can make it available for the Inquiry.

In terms of ensuring all noise impacts are adequately quantified, it should be noted that the use of either the Leq metric or the Lden as adopted by the EEA still suffer from a number of deficiencies. As both are based upon average conditions, they mask the effect of runway alternation. They do not indicate the maximum noise of individual events and therefore cannot account for the number of times activities, e.g. school lessons, are interrupted. Both also fail to give adequate weight to the number of aircraft movements. However, whilst these issues remain to be resolved, what is clear is that aircraft noise now causes

annoyance at lower levels than previously found 30 years ago and that this issue must be addressed. As an interim measure the 55Lden adopted by the EU may represent a more realistic measure of community annoyance than the 57decibel contour used by the government.

If the Parliamentary Group finds our evidence persuasive, we would welcome its support to urge the Government to make its decisions on the extent of community impacts based on sound science and accounting for all the differing noise impacts. This is essential if the impacts are to be properly mitigated. There should also be an aim to correlate future noise metrics with the WHO guidelines for the protection of health of the most vulnerable in society.

Appendix
to
LAANC Submission to APPG
LAANC Response to the Aviation Policy Framework Consultation

LAANC
Local Authorities' Aircraft Noise Council
Director. Colin Stanbury
Tel 01737 373868
President Mr Michael Elliot
Chairman Councillor Malcolm Beer

2 Rivermount
Sunbury on Thames
Middlesex.
TW16 5PH

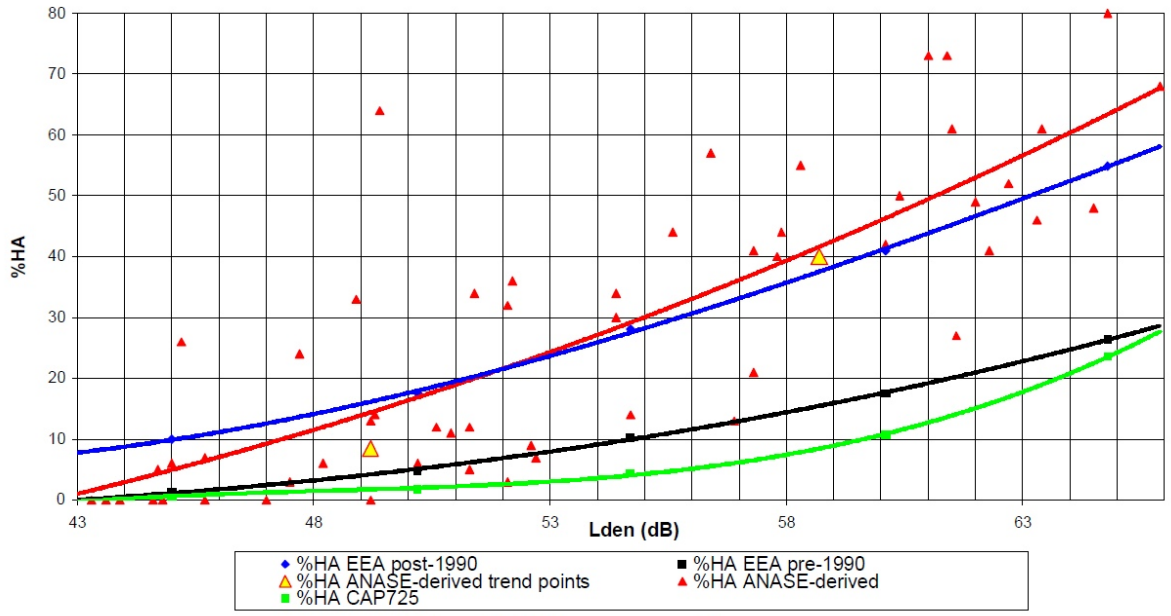
Website: http://www.laanc.org.uk/

Appendix 3 -

Update of Noise Dose Response Data Introduction
This paper presents evidence that there is a useful correlation between the aircraft noise annoyance studies reported in a recent European Environment Agency (EEA)report and the UK Government's ANASE study. Both sets of studies have found a significant shift in that aircraft noise now causes annoyance at lower levels than it did previously. The significance of this, in relation to the current framework scoping consultation, is that it provides some support for the use of the ANASE findings in the development of future aviation policy. This is important, as without this support, the ANASE findings have been set aside. However, until the ANASE issue can be resolved, the conclusion is that the EEA findings should be accepted for the development of future aviation policy, in relation to annoyance. There remains an important caveat to this, in that the EEA evidence itself needs to be improved by including the significance of flight numbers in any noise annoyance assessment. Only once this is resolved can the question of acceptable aviation capacity be addressed fully. So, in spite of the various study deficiencies, the message remains clear, that aircraft noise now causes annoyance at lower levels than it did previously, and this issue must be addressed in any future aviation policy.

EU and UK models for aircraft annoyance
The recent European Environment Agency report [1] is a good practice guide intended to assist policy makers and competent authorities in understanding and fulfilling the requirements of Directive 2002/49/EC [2], commonly referred to as the Environmental Noise Directive, relating to the assessment and management of environmental noise. It summarises the latest European view on issues such as exposure-response relationships and thresholds for health endpoints (annoyance, sleep disturbance, cardiovascular effects and cognitive impairment). Individual annoyance relationships with the noise metric Lden are given for road, rail and aircraft noise.

Figure 1: Comparison of EU and UK aircraft noise annoyance models



HA = "Highly annoyed"

The EEA report gives a previously used European aircraft noise annoyance relationship based on studies carried out prior to 1990. This is the same relationship as given in the 2002 EU Position Paper [3]. The relationship gives an estimate of the percentage of persons highly annoyed at a given Lden noise exposure. The EEA report mentions studies showing a trend change in annoyance around 1990,and gives an updated European annoyance relationship based on aircraft noise studies carried out after 1990. These were all European studies (Switzerland, Germany, Netherlands) regarded as more appropriate for the EU than the pre-1990 studies, which were mainly carried out in the USA and Australia.

Figure 1 gives the results for the pre-1990 and post-1990 studies in terms of percentage highly annoyed in relation to Lden. It can be seen that levels of annoyance at a given noise level are much higher for the post-1990 studies than for the pre-1990 studies. The analysis given in Figure 1 is confined to the range of noise levels in the ANASE study (40.9 to 64.2dB LAeq,16h).

At 59 dB Lden, for example, the relationship adopted for the pre-1990 studies in Figure 1 gives 16% highly annoyed. In the case of the post-1990 studies, the relationship adopted gives the same percentage highly annoyed at around 49 dB Lden.

Thus, the EEA report suggests that levels of annoyance (expressed as percentage highly annoyed) that occurred at 59 dB Lden in the pre-1990 studies occurred at around 49 dB Lden in the post-1990 studies, a reduction of around 10 dB Lden.

The Government's aviation policy uses 57 dB LAeq,16h as the level of daytime noise marking the approximate onset of significant community annoyance. This level is based on the Aircraft Noise Index Study (ANIS) [4] carried out in the UK in the 1980s.

The CAP725 document [5] produced by the Civil Aviation Authority in 2007 outlines methodologies for environmental assessment of an airspace change proposal. It gives an aircraft noise annoyance response relationship for calculating percentage of people highly annoyed using LAeq,16h noise levels. The

relationship is based on the Schultz curve produced in 1978 [6]. The document states that the ANIS results exhibit the same general trend as the aircraft studies in the Schultz analysis. The EU annoyance relationships use the Lden noise metric rather than the LAeq,16h noise metric used in the UK.

Analysis of data [7,8] relating to Heathrow airport in 2006 shows that Lden is typically around 1.7 dB higher than LAeq,16h. This 1.7 dB adjustment has been used to convertLAeq,16h to Lden to give the CAP725 annoyance relationship shown in Figure 1.

The Attitudes to Noise from Aviation Sources in England (ANASE) study [9]reported in 2007 that annoyance with a given level of aircraft noise is much higher than when the ANIS study was carried out. The ANASE study made a direct comparison with the ANIS study in terms of "mean annoyance" with aircraft noise. This showed that the level of mean annoyance found at 57 dB LAeq,16h in the ANIS study was found in the ANASE study at a level of just over 50 dB LAeq,16h, a reduction of just less than 7 dB LAeq,16h.

The Government accepted that the ANASE study demonstrated that annoyance with a given level of aircraft noise is higher than found in the ANIS study. However, on advice contained in an independent peer review report [10], the Government decided that the detailed findings of the ANASE study should not be relied on.

Most of the analysis in the ANASE report related to "mean annoyance", and trend lines were fitted to graphs of mean annoyance versus LAeq,16h. Figure 7.2 of the ANASE report gave a graph of percentage "at least very annoyed" versus LAeq,16h, but no trend line was fitted to the plotted data points. In the ANASE study, responses from respondents were recorded using an annoyance scale of (i) "Extremely annoyed", (ii) "Very annoyed", (iii) "Moderately annoyed", (iv) "Slightly annoyed"and (iv) "Not at all annoyed". The annoyance scale did not include a response of"Highly annoyed" as used in the EEA and CAP725 reports so comparison of the results of the different studies is not straight forward.

However, section 6 of the ANASE peer review report [10] assumes that the ANASE term "at least very annoyed" is equivalent to the term "highly annoyed" used in other studies. This assumption allowed the peer reviewers to deduce (apparently by eye)two trend points for the plotted ANASE data points. The two ANASE trend points given in the peer review report are 8.5% highly annoyed at 47/48 dB LAeq,16h, and around 40% highly annoyed at 57 dB LAeq,16h. These trend points relate to the corrected version of ANASE report Figure 7.2 given in the Erratum dated 1stNovember 2007 contained in the ANASE final report dated October 2007. This paper therefore tentatively plots the ANASE data, but makes plain that the ANASE values for "highly annoyed" have been derived.

The two ANASE derived trend points are plotted in Figure 1, after converting LAeq,16h to Lden by adding 1.7 dB, derived from Heathrow data for 2006. Using the same assumptions that (i) the ANASE term "at least very annoyed" is equivalent to "highly annoyed" in other studies, and (ii) Lden can be estimated from LAeq,16h by adding 1.7dB, the results derived for all ANASE sites have been plotted in Figure 1. That figure also shows a third order polynomial trend line fitted to the ANASE derived results. The relatively poor agreement between the plotted data points and the fitted trend line ($R2 = 0.667$) reflects the spread of the data points, but this is not unusual in social surveys of this kind.

It is important to note that Figure 1 shows that the annoyance levels at a given noise level are much higher for the EEA post-1990 studies than for the EEA pre-1990 studies. For example, percentage highly annoyed at 57 LAeq,16h (approximately equivalent to 58.7 dB Lden) is more than doubled from around 15% for the pre-1990 studies to around 37% for the post-1990 studies.

It can be seen from Figure 1 that the annoyance levels for the UK's CAP725relationship are generally lower than given by the EEA pre-1990 studies relationship, and much lower than given by the EEA post-1990

studies. This implies that continued use in the UK of the CAP725 annoyance relationship will seriously under estimate levels of aircraft annoyance. The ANASE trend line is generally similar to the EEA post-1990 studies relationship, and certainly in much better agreement with the EEA post-1990 studies relationship than is the CAP725 relationship.

The Government rejected the detailed findings of the ANASE study and continues to rely on the ANIS, Schultz and CAP725 aircraft noise annoyance relationships, even though these relationships are based on social surveys carried out more than 25 years ago. It seems doubtful that these relationships remain in calibration for current public attitudes, flight numbers, aircraft fleet mixes and aircraft noise characteristics. The EEA report supports this doubt on the continued validity of these relationships. This is because the EEA report suggests that levels of annoyance at a given noise level are much higher than suggested by previous European guidance. Furthermore, these EEA findings of much higher levels of annoyance seem to be replicated by the results of the recent ANASE study.

Objectives and findings of the ANASE study

The ANASE study was commissioned by the Government in 2001 in order to update the ANIS study of 1982 which led to LAeq,16h noise index being adopted by the Government for measuring aircraft noise.

The ANASE report recognises that the amount of air traffic has increased significantly since 1982 whilst the sound levels generated by individual aircraft events have been significantly reduced as older, noisier aircraft have been replaced by more modern aircraft types with quieter engines and much improved climb performance. It is also recognised that attitudes to aircraft noise may have been changed due for example to the general growth in personal income, higher expectations of a peaceful living environment and less tolerance of environmental intrusion.

The main findings of the ANASE study are reviewed below against the study objectives.

Objective 1: Re-assess attitudes to aircraft noise in England

The study found that the annoyance level of respondents increased as the noise indicator LAeq,16h increased, and that a large proportion of measured variation in annoyance can be accounted for by LAeq,16h.

However, for a given LAeq,16h, there is a range of reported annoyance indicating that annoyance is not determined solely by the amount of aircraft noise as measured byLAeq,16h. The main additional influences on the level of annoyance were found to be respondent's household income and socio-economic group.

The study found that for the same amount of aircraft noise, measured by LAeq,16h,people were more annoyed in 2005 than they were in 1982.The study showed that people are much more sensitive to aircraft noise at night(particularly around midnight and the early hours thereafter). In contrast, people are least sensitive to aircraft noise in the morning and early afternoon. Ideally, therefore, a noise indicator for aircraft noise should reflect these times of day sensitivities. In contrast, LAeq,16h does not reflect weighting for sensitivities by time of day.

Objective 2: Re-assess their correlation with the LAeq,16h noise index

The study considered whether LAeq,16h is the appropriate measure of aircraft noise for predicting annoyance.

The study found that while LAeq,16h continues to be a good proxy for measuring community annoyance at a given point in time, the relationship between LAeq,16h and annoyance is not stable over time. Because of this, use of LAeq,16h to predict future levels of annoyance may be misleading. In particular, where numbers of aircraft are increasing significantly, the ANASE results suggested that under-prediction of

annoyance is likely. The study recognised that the LAeq,16h noise index incorporates a mathematical trade off of 10 between event noise level and number of noise events [1], which means that each doubling or halving of the numbers of aircraft noise events counts as equivalent to a 3 dB increase or decrease in average noise levels [2]. The results from the study suggested that the LAeq,16h noise indicator gives insufficient weight to aircraft numbers, and a relative weight of 20 appears more supportable from the evidence than the relative weight of 10 inherent in LAeq,16h.

Objective 3: Examine willingness to pay to remove aircraft noise

The study was required to examine (hypothetical) willingness to pay in respect of nuisance from aircraft noise, and whether attitudes might be affected if cash transfers or, for example, noise insulation grants were made available. The study found that aircraft event noise level, aircraft type, time of day and personal characteristics (in particular household income) influence annoyance and willingness to pay.

Aircraft noise action plans

The EEA report [1] provides the dose-effect relationships intended to be used to assess the effects of noise on populations as required by the Directive [2]. Section 6 of the EEA report suggests that the lower noise thresholds for mapping are intended to delimit the area where noise is "considered to be a problem". These thresholds are noise levels above which health effects start to occur.

The EEA report accepts that use of the current threshold levels for noise mapping of 55 dB Lden and 50 dB Lnight is understandable as a first step because of the large scale noise mapping required. However, the report points out that Member States are free to choose their own noise thresholds from where to start action planning, and the Lden threshold for noise mapping of 55 dB Lden does not take into account differences that exist between different noise sources. These differences are illustrated in Table 6.1 of the EEA report giving respective percentages highly annoyed at 45, 50and 55 dB Lden for road, rail and aircraft noise. Table 6.1 of the EEA report is reproduced here (in part) as Table 1.

Table 1: Transportation noise annoyance (reproduced from EEA report)

	Percentages of highly annoyed		
Lden	Road	Rail	Aircraft
55 dB	6%	4%	27%
50 dB	4%	2%	18%
45 dB	1%	0%	12%

The EEA report states that while 55 dB Lden is a "fair" threshold for rail noise, use of 55 dB Lden for other noise sources leads to an underestimate of the actual burden.

Table 1 gives the percentage highly annoyed at 55 dB Lden for rail noise as 4%, while the percentage highly annoyed at 45 dB Lden for aircraft noise is given as 12%. This means that to achieve annoyance levels approaching that regarded as "fair" for rail noise, the threshold for aircraft noise may have to be lower than 45 dB Lden. In fact, Section 2 of the EEA report gives 42 dB Lden as a general noise threshold above which annoyance effects start to occur or rise above background.

---

[1] Laeq, T = SEL + 10LogN – 10LogT, where SEL is event noise level (dB) for N events inT seconds

[2] 10Log(2/1) = +3dB and 10Log(1/2) = -3dB

It would therefore appear that the EEA report implies that the threshold for noise mapping where aircraft noise is considered to be a problem should be significantly lower than 55 dB Lden as currently used.

Conclusions

The EEA report recognises that levels of annoyance with aircraft noise are much higher for post-1990 studies than for pre-1990 studies.

This paper compares the results for different annoyance models over the range of noise levels in the ANASE study (40.9 to 64.2 dB LAeq,16h). Analysis in this paper shows that annoyance levels predicted by the UK's CAP725 relationship are generally lower than given by the EEA pre-1990 relationship, and much lower than given by the EEA post-1990 relationship.

In contrast, the analysis shows that the much higher annoyance levels in the EEA post-1990 studies seem to be replicated by the ANASE study. Despite this, the Government continues to rely on the ANIS, Schultz and CAP725 aircraft noise relationships derived from social surveys carried out more than 25 years ago.

Until the issues of the ANASE study are addressed, it is suggested that Government policy should be based on guidance in the EEA report, including the specified relationship between annoyance and aircraft noise level.

Although the EEA report gives increased levels of aircraft noise annoyance, it does not address all the objectives of the ANASE study. These objectives include the suitability of LAeq,16h as an indicator of community annoyance, the importance of numbers of aircraft flights, the relative importance of different times of day, and determining willingness to pay to reduce annoyance from aircraft noise. Further work is necessary to address these objectives.

It is concluded that there is an urgent need for updated guidance from the Government on the annoyance relationship for aircraft noise, and the threshold level at which aircraft noise is considered to be a problem.

References

[1] Good practice guide on noise exposure and potential health effects. EEA Technical Report No.11/2010. European Environment Agency, 2010.
[2] Directive 2002/49/EC. Directive of the European Parliament relating to the assessment and management of environmental noise, 2002. Official Journal of the European Communities, L 189, 12-25.
[3] Position paper on dose response relationships between transportation noise and annoyance. European Commission Working Group, 2002.
[4] United Kingdom Aircraft Noise Index Study. DR report 8402, Civil Aviation Authority, 1985.
[5] CAP725, CAA Guidance on the application of the airspace change process. Civil Aviation Authority, 2007.
[6] Synthesis of social surveys on noise annoyance. Schultz, Theodore J. Journal of the Acoustical Society of America, 64(2), 1978.
[7] London Heathrow Airport Strategic Noise Maps 2006. ERCD Report 0706. Civil Aviation Authority, 2007.
[8] Noise exposure contours for Heathrow Airport 2006. ERCD Report 0701. Civil Aviation Authority,2007.
[9] ANASE: Attitudes to Noise from Aviation Sources in England. Final Report prepared for Department for Transport by MVA Consultancy, October 2007.
[10] Attitudes to Noise from Aviation Sources in England. Non SP Peer Review. Civil Aviation Authority and Bureau Veritas, draft July 2007, final October 2007.File: Aircraft noise annoyance_3

Author:
Mike Rickaby
L.B Hillingdon

Richmond Heathrow Campaign
The Planning Inspector who presided over the Heathrow Terminal Five Public Inquiry (Roy Vandermeer QC) was - in his report and recommendations to the Secretary of State in 2000 - highly critical of what he saw as the undue reliance that the Department for Transport placed on the 57 decibel contour as the sole indicator of the impact of air traffic noise. Specifically, Vandermeer found from evidence to the Public Inquiry that:

- people living in areas outside Heathrow's 57 decibel contour were affected by air traffic noise;
- research at Heathrow did not support the claim that annoyance from air traffic noise is significant only at and above 57 decibels;
- the 57 decibel contour did not reflect the impact of the large increase that had taken place in the number aircraft movements at Heathrow;
- the 57 decibel contour did not measure the benefit of runway alternation at Heathrow in providing periods of respite;
- the 57 decibel contour did not evaluate noise from movements in the night period (2300-0700).

The Environmental Noise Directive (adopted in 2002 [3]) requires major airports to undertake five-year noise assessments based noise maps with the LDEN contour: 55 decibels for the day and evening periods (0700-1900 and 1900-2300) and 50 decibels for the night period (2300-0700). Although the LDEN contour shares some of the weaknesses of the 57 decibel contour that were identified at the Heathrow Terminal Five Public Inquiry, the Directive stipulates only the minimum criteria to be used for noise assessments. National Governments can therefore set lower values for noise mapping (e.g. the WHO values). Furthermore, the Directive acknowledges that it may be advantageous to use supplementary noise indicators for special cases, with several examples listed in Annex 1 to the Directive. The Directive therefore permits national Governments to supplement the noise contour maps with other noise indicators.

The Department for Transport has accepted that 57 decibels is not the cut off point below which air traffic noise does not have any adverse effect, but it has not suggested a lower value. The Department has also invited airport operators to adopt supplementary noise indicators; but it has not suggested upon what such indictors should be based, apart from the 57 decibel contour. And the Department itself appears to have drifted back to sole reliance on the 57 decibel contour, despite the evidence of its shortcomings from the Heathrow Terminal Five Public Inquiry

Therefore, in answer to the question, the Directive has put in place a framework that would enable the UK to set lower values for the contours on noise maps and to set supplementary indicators for noise features that the contours cannot capture. But unfortunately the Government has not used these powers to address the weaknesses in the 57 decibel contour identified by Vandermeer., and the debate about the noise impact of a third runway is being dominated by the discredited 57 decibel contour.

Richmond Upon Thames Council
The limitations of the 57LAeq metric are well understood, and all but accepted by the Government, short of actually replacing it. Meantime the Lden metric has been adopted across Europe, enabling inter comparison. It is on the basis of this metric that we now know that Heathrow ranks as the worst European airport, in terms of the number of people affected. What is now needed is a metric that is sensitive to the

[3] Directive 2002/49/EC of the European Parliament and the Council of 25 June 2002 relating to the assessment and management of environmental noise (Official Journal of the European Communities L 189, Volume 45 (18 July 2002).

increasing numbers of flights, together with a fresh social survey that can calibrate the metric, both with an initial value and as a longitudinal indicator of trend. From the surveys that have been done, we now know that people have become more sensitive to aircraft noise. We need a metric that can reflect such changes. What we then need is for regulators to appreciate what the metric indicates, and call a halt to unnecessary and harmful expansion development.

The Royal Borough of Windsor and Maidenhead
RBWM strongly support the factors raised by LBH; advocating the need for a revised study into aircraft noise annoyance (such as the ANASE study). This study should therefore underpin any conclusions made as to what constitutes as acceptable & applicable noise metric.

Furthermore, the manner in which the aircraft operates needs to be taken into consideration when assessing which metric to use; such that it may be considered inappropriate to apply a 16hr L or L, average noise level to a community that is being subjected to a period of 'intense' noise (due to alternation), thus failing to reflect the difference between quiet and intense periods of noise. As such, as an interim measure, RBWM would support the 551-den proposal put forward by LBH as a more realistic measure of annoyance whilst reiterating the need for a further study as above.

Mayor of London
2.1. EU Directive 2002/49/EC - more commonly known as the Environmental Noise Directive (END) - concerns noise from road, rail and air traffic and from industry. It focuses on the impact of such noise on individuals, complementing existing EU legislation which sets standards for noise emissions from specific sources. The END requires:

- the determination of exposure to environmental noise, through noise mapping;
- provision of information on environmental noise and its effects on the public;
- adoption of action plans, based upon noise mapping results, which should be designed to manage noise issues and effects, including noise reduction if necessary;
- preservation by the member states of environmental noise quality where it is good.

2.2. The END requires noise maps to represent the annual average cumulative noise levels over the 24 hour period, with 5 and 10 decibel corrections for the day and night periods respectively. In addition the EU directive requires the use of additional parameters, Lday (07.00 - 19.00), Levening (19.00 - 23.00), Lnight (23.00 - 07.00), and Lden, all based on an annual average day.

2.3. It is common practice in the UK to produce aircraft noise contours for an average summer's day based on the 16 hour period between 0700 and 2300 (i.e. LAeq).

2.4. By contrast, the END noise metrics Lden, Levening and Lnight allow the dose response to be updated to reflect the greater sensitivity found nowadays – for example in line with the EEA Good practice guide annoyance dose response.

2.5. Nonetheless, there is room for improvement; the ideal noise index for assessment of aviation noise would have at least the following attributes:

- The absolute or peak noise level of the over flight;
- The duration the noise of the over flight is audible at a location;
- The degree to which the over flight noise exceeds the ambient noise;
- How often the over flight noise occurs;
- Correlates well with the different impacts of the aviation noise for example annoyance, sleep and activity disturbance, speech interference;
- Be easily measured;
- Be capable of modelling/prediction;

- Be readily understood by non-specialists.

2.6. No single noise index has yet been developed (and probably never will) that can meet all the above requirements. Consequently, an approach that uses a core primary noise index that covers as many of the above attributes as possible could be used, for example Lden and Lnight, coupled with supplementary indices, which address the remaining attributes; taken together the core and primary indices might meet all of the above requirements. This is explored in more detail below.

Core Primary Noise Index

Day-Evening-Night Level: Lden and Night Level: Lnight

2.7. Lden moves beyond LAeq,t by adding extra weightings, of 5 dB and 10 dB, to aircraft noise levels occurring in the evening and at night respectively. It has three component parts: Lday measured over a 12 hour day period from 0700 to 1900, Levening measured over a 4 hour evening period from 1900 to 2300 and Lnight measured over an 8 hour night period from 2300 to 0700. It is the index specified for the environmental noise maps produced under the European Noise Directive (Directive 2002/49/EC). The default day/evening/night time periods in the EU Directive are 0700 to 1900, 1900 to 2300 and 2300 to 0700, but it is possible to shorten the evening period by one or two hours if desired to and lengthen the day and/or the night period accordingly. The Lden can be used to assess annoyance and the impacts of noise on physical health. Annoyance and impacts on physical health start to be detectable at approximately Lden 55 dBA, although they may not become significant until higher noise levels are exceeded. Lnight can be used in the assessment of sleep disturbance. The WHO advise that the lowest observed adverse effects on sleep disturbance start around an external Lnight of 40 dBA.

Supplementary noise indices

2.8. Other noise indices to be considered include SEL (Sound Exposure Level) and LAmax.

2.9. SEL treats a noise event as uniformly compressed into a reference time of one second and can be used to assess sleep disturbance. Research has shown that sleep disturbance tends not to increase until external SEL values reach 80 to 90 dBA.

2.10. LAmax is the maximum noise recorded. Indices based on LAmax do not take into account the duration of the noise, and hence are possibly less representative of the disturbance due to the noise event. However, they are easier to measure and often much simpler for the public to understand. The LAmax can be used to assess speech and activity interference, sleep disturbance and impacts on children's cognitive development. Depending on the baseline, noise level speech interference and effects on children's cognitive development starts to occur at LAmax values of 60 dBA, and sleep disturbance at approximately LAmax 45 within a bedroom.

Other indices

2.11. It is also useful to supplement these technical acoustic parameters with other indices perhaps more accessible to the public.

2.12. 'Time Above' is the amount of time that sound exceeds a given decibel level during a given period – for example the time in minutes that the aviation noise level is above noise in 5 dBA bands from 50 to 75 dB Ldn.

2.13. 'Number Above' is the number of times that sound exceeds a given maximum decibel level during a day, evening or night period e.g. noise in 5 dBA bands from 70 to 100 dB Lmax.

2.14. For example, a substantial number of complaints about noise following opening of a second runway

at Sydney airport led to use of 'Number Above' measures:

- N70 – 70 dBA Lmax based on an average summer's 16-hour day;
- N60 – 60 dBA Lmax based on an average summer's 8-hour night.

2.15. At Heathrow today, more than 340,000 people experience over 20 noise events exceeding 70dBA during the day (N70). More than 220,000 people experience over 25 noise events exceeding 60dBA during the night (N60). This would increase fourfold, to almost a million people, with a third runway.

In summary

2.16. It is important that decisions should be based on a series of measures and metrics. Development of the right suite of metrics is essential and must fully represent sensitivity to and the impacts of aviation noise and how individual aircraft events are experienced during different times of day and night.

2.17. The Heathrow Terminal Five Public Inquiry Inspector identified the need for policy makers to have more up-to-date insights into the attitudes and opinions of local residents[4]. It did not seem that the effects of increasing traffic had 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 but there is little evidence of progress in the intervening years.

Gatwick

GAL acknowledges criticisms made by the Inspector at the T5 Inquiry of the use of 57 Leq noise metric. For this reason GAL considers that it is important to use a range of noise metrics/measures, including the Leq metric, to assess noise impacts.

The Airports Commission appraisal framework has introduced a noise 'scorecard' encompassing a range of metrics which enable an overall understanding of the effects of airport noise. These include the number of aircraft 'events' above a certain noise level that populations would be exposed to. GAL supports the adoption of a wide range of metrics.

[4]Understanding UK Community Annoyance with Aircraft Noise ANASE Update Study, 2013