FIFTH INTERNATIONAL CONGRESS ON SOUND AND VIBRATION

DECEMBER 15-18, 1997
ADELAIDE, SOUTH AUSTRALIA

Invited Paper

HOW CAN WE IMPROVE WAYS TO DESCRIBE FUTURE NOISE IMPACTS TO DECISION MAKERS AND THE COMMUNITY?

THE LESSONS FROM SYDNEY AIRPORT

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Following the opening of the new 'third runway' at Sydney Airport in November 1994 there was a public outcry over the way future noise impacts had been explained during the Environmental Impact Statement (EIS) process for the project. There was a widespread view that the award winning EIS had been grossly misleading. Using the third runway EIS as an example, this paper examines the weaknesses of the conventional approach to describing noise through cumulative noise indices. Complex 'averaging' noise indices can not generally be understood by the layperson and do not provide information in a useful form. Instead the public is seeking information that is more readily digestible. To meet this demand information is being provided on flight paths, the number of noise events per hour, the maximum noise level of each event and the amount of time per day when areas will receive 'respite' from noise. Information on daily and seasonal variations in noise exposure is also being provided. This paper shows new approaches to describing aircraft noise exposure that have been trialed in recent formal reports and discusses their potential.

1 INTRODUCTION

Sydney Airport is a prime example of an environmental noise issue that has the potential to have major economic impacts. Sydney Airport is Australia's major aviation hub yet its operations are subject to strong public opposition due to the aircraft noise it generates. Approximately 45,000 complaints a year are now reported to the Airport's Noise Enquiry Unit. About forty persons are working full time directly on Sydney Airport noise issues in federal agencies. Around ten times this number of persons are employed by outside companies on the Airport's noise insulation program.

While Sydney Airport has a long history of aircraft noise problems the issue has escalated considerably since the opening of the third runway in November 1994. When the runway opened many residents throughout Sydney were surprised by the levels of aircraft noise to which they were exposed. The noise exposure levels did not seem to relate to those which the community had been led to expect by the Environmental Impact Statement (EIS) [1] process which had been carried out prior to construction of the runway.

A vehement and widespread public campaign against the Airport followed the runway opening and, inevitably, included a sustained attack on the noise assessment aspects of the EIS. The Australian Noise Exposure Forecast (ANEF) system [2], which until 1994 had been used as almost the sole way of describing and assessing aircraft noise, and which formed the core of the Third Runway EIS noise analysis, was a main target of criticism. As a result of the third runway experience wide sectors of the Sydney community now strongly distrust any description of aircraft noise in 'technical' terms.

This reaction from the public has forced aircraft noise advisers to rethink the conventional strategies for describing noise impacts to decision makers and the community. The previous approach where noise experts tried to get interested parties to understand technical noise indicators has had to be modified by developing much simpler 'user friendly' noise metrics as supplementary descriptors. This shift away from technically 'correct' but complex metrics towards simple descriptors is attracting resistance from some noise experts who feel uncomfortable with the 'unscientific' aura of the new descriptors.

2 KEY INFORMATION PROBLEMS

The third runway experience has shown that cumulative noise indicators such as L_{eq} and the Australian Noise Exposure Forecast (ANEF), while essential tools for noise experts [3], are woefully inadequate for describing noise exposure patterns to the layperson.

Community representatives and decision makers are now expressing strong demands for noise to be described in 'physical' terms that the layperson can relate to and, at least to some extent, independently monitor. Common community requests for noise information include questions about where the aircraft will fly; at what time; how many overflights there will be; how high they will be; how loud each event will be; and how the noise will vary from hour to hour, day to day or season to season. ANEFs reduce the answers to all these questions, for any particular location, down to a single exposure level for an annual average day. In general this very 'concentrated' form of information is meaningless or even misleading to the layperson.

Moreover, the demands for noise information very frequently concern areas outside the conventional ANEF noise contours which commonly stop at 20 ANEF (≈ 55 L_{eq}). This is consistent with the fact that a high proportion of complaints about aircraft noise in Sydney originates from areas well outside the 20 ANEF. These communities are no longer willing to accept the assurances of noise experts that noise exposure is not significant in areas outside some 'abstract' outermost ANEF contour.

3 NEW APPROACHES

In response to the 'customer' demands for different ways to explain aircraft noise Australian aviation authorities are now using a wider range of noise indicators. Decision makers and the community can use any or all of the indicators to gauge the noise impacts according to their level of interest and understanding.

Most of the 'new' noise indicators have been used, at least to a limited extent, in the past but have largely been rejected. This is because they were perceived as not 'technically correct', because they were computationally too demanding or because it was previously not readily possible to present the information in a reasonably simple form. However, as a result of advances in computing capabilities, and in particular the advent of geographic information systems and related graphics software, noise information can now often be presented in a more user friendly format. A suitable form of presentation is generally a key to understanding.

A number of high profile public reports and information bulletins have been released on Sydney aircraft noise issues over the past two years. In particular documents associated with the revised operating arrangements under the Sydney Airport Long Term Operating Plan (LTOP) [4,5] and the draft EIS for the Second Sydney Airport have made greater use of supplementary noise metrics.

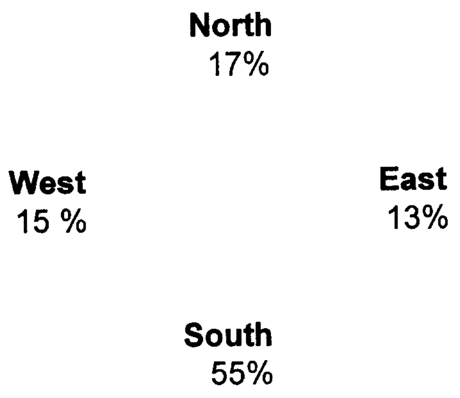

Figure 1: *Target distribution of total movements at Sydney Airport under the 1997 Long Term Operating Plan.*

3.1 Runway usage data - information on how many aircraft movements there are on each of the runways at Sydney Airport has recently become an official measure of aircraft noise distribution around Sydney. Figure 1 shows the form in which this information has been presented in public documents.

There is considerable community support for this indicator essentially because it is easy to understand and, with experience, allows a community to broadly gauge its level of noise exposure even if it is situated well outside conventional noise contours.

Indicating noise exposure through runway usage data has, on the other hand, been criticised as simplistic since this neither takes into account the differences in the levels of noise exposure from different aircraft types nor the flight paths the aircraft use when approaching or departing the runways.

3.2 Flight path maps - for the layperson with limited knowledge of airport operations or aircraft noise issues, flight path maps are probably the most popular source of information about likely future noise impacts.

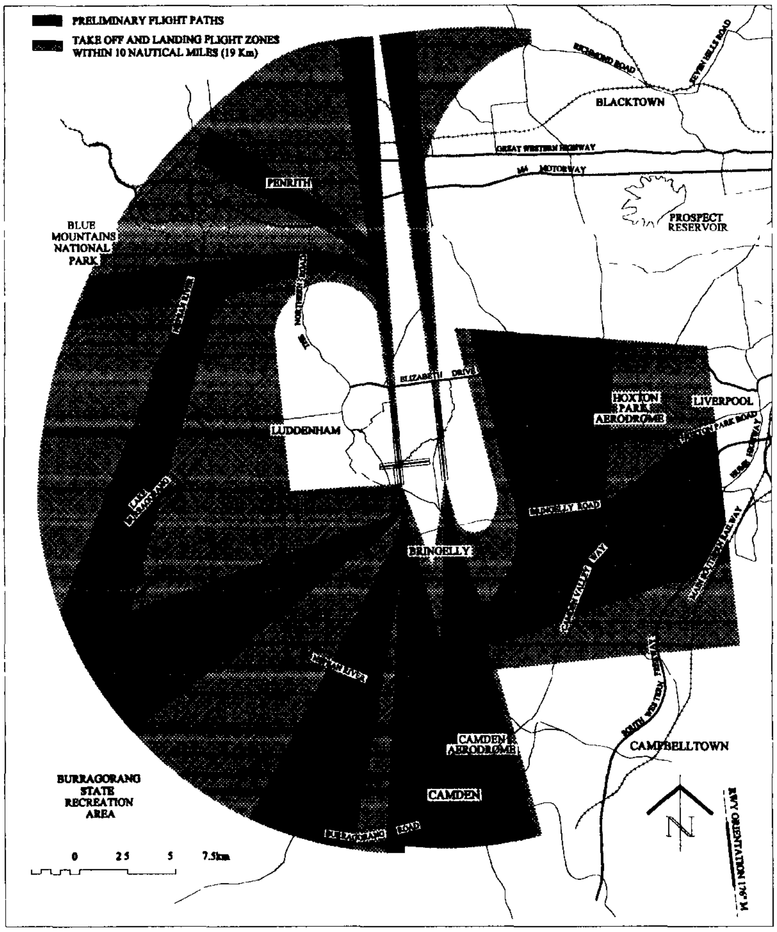

Figure 2: *Example of graphical representation of flight path spreading in documentation released as part of the EIS process for the Second Sydney Airport [6].*

The danger in using flight path maps lies in the fact that their usual representation as sharp lines on base maps is often misleading. Since aircraft do not follow a strict line but spread around that line, these maps have led people to erroneously believe that they will be free of aircraft noise if their residence is just to the side of the lines on the maps. On the other hand, alternative forms of presentation, see Figure 2, designed to overcome this problem have the potential to result in the likely noise impacts being overestimated.

No matter how flight paths are graphically presented there remains the problem of people inherently 'weighting' all flight paths equally no matter how often (once an hour or once a month) or when a particular flight path will be used, what type of aircraft will use it or at what heights the aircraft will typically be.

3.3 Single event contours - single event noise contours (LA_{max}) which show, for example, the 70 dB(A) contour for a single operation by a particular aircraft type, have proven to be popular both with decision makers and the community.

Unlike runway movement or flight path information single event contours contain actual information on noise levels and thus require some basic appreciation of what LA_{max} noise levels mean. Attempts to provide this have been made through the use of standard noise 'thermometers'. Importantly, worst case single event contours extend well beyond the position of the 20 ANEF contour as shown in Figure 3.

Single event contours are essentially flight paths with some LA_{max} information added on to them. As such they suffer from the same deficiencies as flight path maps *ie* they do not show the number of movements or the time distribution of those movements. The use of these contours to depict a complete noise 'picture' of an airport would be very inefficient because it would require a multiplicity of - often intersecting - contours if they were used to represent every aircraft type on every flight path. Single event contours have nevertheless proven useful for assessing noise conditions at individual sites.

3.4 Number above (NA) contours - this approach to portraying noise impacts has only recently been introduced to overcome some of the limitations of single event noise contours. An example is shown in Figure 4.

Initial response from decision makers to this metric has been positive. Community reactions have generally been supportive of the concept of this descriptor but critical of the specific number cut-off of 15 noise events per average day used in the Sydney Long Term Operating plan which was regarded as too high.

Number above contours are produced using the same computer model and input data as for ANEFs [7] but they represent an output which can be far more easily understood by the layperson.

The problem with number above as with any other 'average' noise metrics is that fluctuations in noise levels over time have been averaged out. This problem is discussed in Section 4.

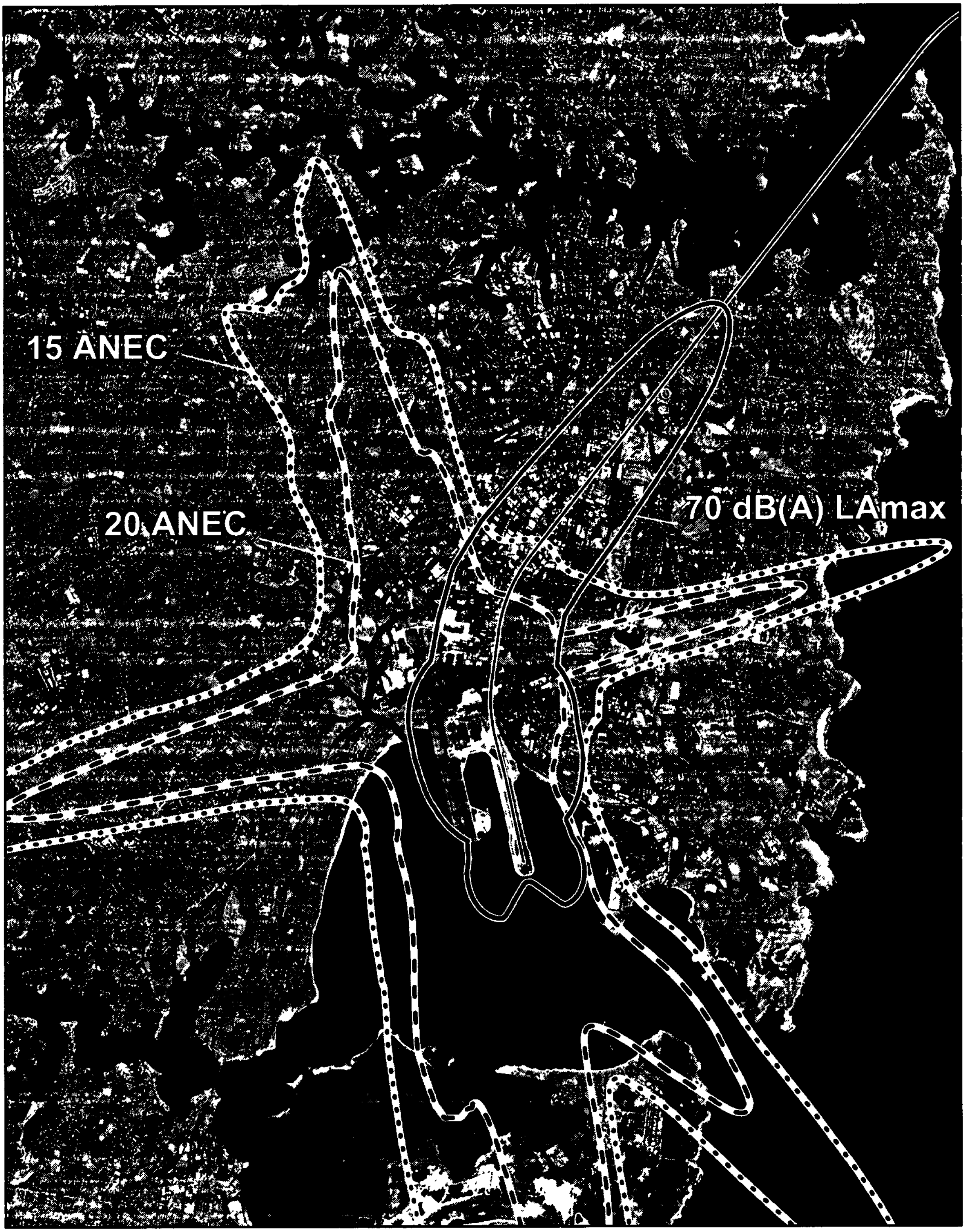

Figure 3: *Examples of spatial coverage: ANEC contours of the Sydney Airport Long Term Operating Plan of 1997 vs a 70 dB(A) single event contour (D34R by B767300). Noise exposure levels in the sector to the north-east of the Airport are such that communities within this area cannot deduct noise information from a standard ANEF type contour plot. Provision of single event information can help alleviate the problem.*

INM input data courtesy of Airservices Australia. Technical restrictions are discussed in the Proponent's Statement of the Long Term Operating Plan [5].

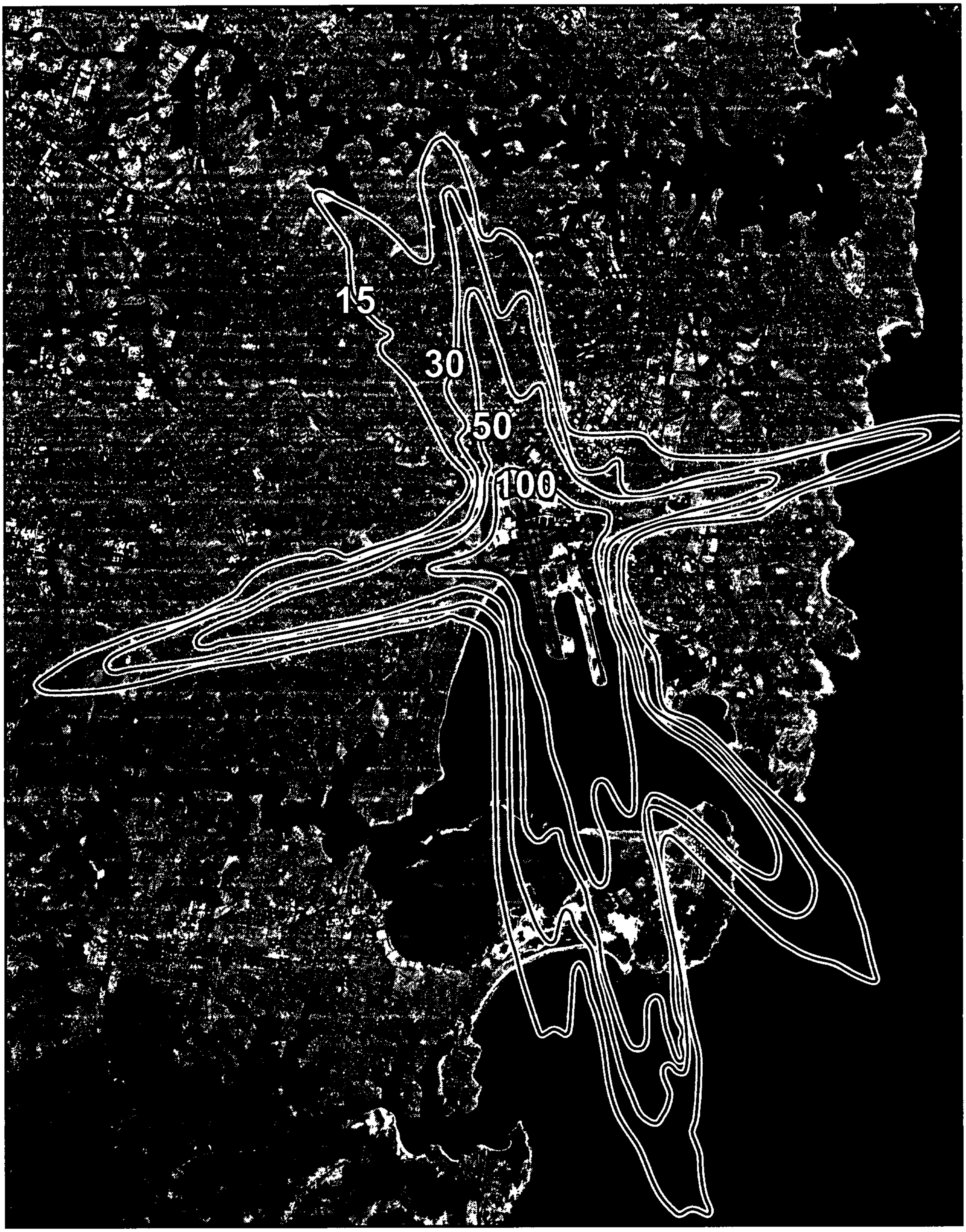

Figure 4: *Estimated number of noise events louder than 70 dB(A) LAmax on an average day under the Sydney Airport Long Term Operating Plan of 1997.*

INM input data courtesy of Airservices Australia. Technical restrictions are discussed in the Proponent's Statement of the Long Term Operating Plan [5].

3.5 Cumulative noise contours - ANEF metrics are, and will continue to be, the basis for land use planning decisions around Australian airports and the criterion for determining eligibility for property insulation around Sydney Airport. They will also continue to be used as a fundamental 'technical' tool for describing aircraft noise. Noise metrics of this type are used as the basic aircraft noise descriptor in almost all countries which perform systematic aircraft noise assessments (*eg* L_{eq}, L_{dn}, *etc*) [3].

While the other metrics discussed are easier to understand none of them is as well studied and established as ANEF [2,8]. They should therefore be seen as supplementing rather than replacing ANEFs.

In response to criticisms about areas outside the 20 ANEF being ignored the Sydney Long Term Operating Plan [5] showed noise exposure levels down to 15 ANEF. This received a muted response since most of the areas which voiced concern were also outside the 15 ANEF.

3.6 'Respite' - during the development of the Sydney Long Term Operating Plan one of the key issues was the demand for quiet periods or 'respite' from aircraft noise *ie* periods of absence from aircraft noise for various communities around the Airport.

While the notion of 'respite' is easy to grasp it is likely that it will be difficult to reach agreement on a definition which will allow its use as a practical assessment tool. It represents a particularly interesting challenge as a descriptor is now needed to define the inverse of usual noise metrics ('non-noise'). A respite period may generally be defined as 'a period of t minutes with less than x aircraft noise events exceeding a maximum noise level of y dB(A)'. Development work on this issue is now taking place.

4 FUTURE DEVELOPMENTS

The noise indicators in Section 3 attempt to respond broadly to two key demands by the community and decision makers for 'wider' and 'deeper' noise information. However, gaps remain. In particular there are continuing demands for the spatial coverage of the information to be increased.

Noise information can easily be extended spatially by showing contours to lower noise levels. For example, ANEF contours can be shown down to say 0 ANEF, the cut-off number of movements for NA70 contours can be reduced or NA60 rather than NA70 contours can be used. Presenting detailed information on low levels of aircraft noise exposure has the potential to cause the layperson to overestimate the impacts. There are also difficulties associated with accurately modelling and monitoring low level aircraft noise.

Another key area for further development is the provision of noise information in a form which overcomes the limitations of the 'average annual day' approach by providing supplementary information aimed at showing the time varying distribution of the noise. Concepts now being developed include ANEFs and NA70s based on time scales shorter than the conventional annual average day. Chicago O'Hare Airport, for example, uses daily L_{dn} calculations based on actual radar flight tracks and continuously updates its running annual

L_{dn} contours. A similar strategy using NA contours instead of equivalent energy noise indices, for instance, has the potential to be a very useful tool for ongoing community information.

Cumulative noise indices such as the ANEF and the L_{dn} weight evening and/or night-time movements. There is the potential for this approach to be extended to the other noise metrics. For example, Boston Logan Airport, which uses runway movement numbers for assessing noise exposure in a similar manner to Sydney, weights the number of night-time movements using the weighting factor of the L_{dn} metric (one movement between 22.00 - 07.00 is equivalent to ten during day time), and considered using weekend weightings when it set up its preferential runway system [9]. Some representatives of communities around Sydney Airport have also advocated that weekend noise exposure be weighted compared to week day exposure.

Other areas of potential improvement include enhanced graphical representations of flight paths to show the spread of flight paths and the height of aircraft.

5 CONCLUSIONS

Will the move away from synthesised noise information in the form of the ANEF contours, to fragmented information in the form of a number of different noise indicators, lead to a better and wider understanding of noise exposure patterns? Will improved knowledge lead to better decisions on how to manage aircraft noise? The answer to these questions is not clear.

While the 'new' indicators have the potential to improve the noise awareness of the wider community it is recognised that all of the noise indicators being used have shortcomings which will inevitably lead to at least some persons feeling misled. Unfortunately experience in this area has shown that, very often, the chances for misunderstandings are increased by providing more information. It is therefore essential that the new sources of information are presented in a way that avoids misunderstandings as far as possible *eg* by use of geographic information systems together with high quality data visualisation.

The well briefed decision maker with full understanding of the individual indicators is now likely to find him/herself with information which is either conflicting or 'un-benchmarked'. For example, what is preferable: exposing a population to low single event noise levels but with no respite or vice versa? How important are noise impacts at the 10 ANEF (45 L_{eq}) level? What is the value of 'respite' on the weekend compared to 'respite' on a week day? More information implies the necessity for more analysis and a structured approach to decision making.

At the very least providing information from many different angles will highlight the complexity of the aircraft noise issue and will leave the decision maker with no doubt that the answers are not likely to be straightforward.

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