Wideband Noise Signatures from Low Altitude Military Jet Overflights

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Abstract: Public concern about noise from low altitude military jet overflights and its alleged effects on the health and annoyance of those overflown has resulted in some restrictions on flying activities at low level, particularly in certain countries, being imposed. Much past research into aircraft noise emissions has been based on band limited noise measurements. Full pressure signatures are required if all possible noise effects are to be fully understood. In 1995 a series of trials was completed in the UK under controlled conditions, and typical wide band noise signatures obtained for a variety of speeds and heights of a Tornado aircraft. Samples of these signatures are presented and the various pertinent characteristics highlighted. The question as to whether these signatures should be considered impulsive is discussed.

INTRODUCTION

Close to the flight path of a low flying aircraft, noise levels can be relatively loud and the Ministry of Defence (MoD) have taken precautions to minimise the exposure of persons in the UK to the highest noise levels by restricting the height, speed and operating procedures of military aircraft on training sorties. Nevertheless, some members of the general public in low flying areas remain concerned.

Traditionally, the study of noise in the community has relied on assessment of annoyance to set limits. It is however, also important to take account of possible health effects, particularly when the noise is loud and sudden. Community noise is typically assessed using A-weighted RMS measurements, principally L10max, an energy based descriptor. Impulsive noise sources, particularly gunfire, are assessed using Damage Risk Criteria, based on the Peak Sound Level and duration of the waveform.

The noise from low flying aircraft shares characteristics with both impulsive and continuous noise, and could be said to fall between the two definitions. It is unclear which criteria is most suitable to form a complete assessment of this type of noise, and indeed whether either would provide sufficient information to take account of both annoyance effects and possible health effects. To begin to address these issues, full pressure signatures of low flying aircraft noise were obtained from a series of field trials held at the MoD Ranges at West Freugh in the UK. The recorded waveforms were then examined to consider the application of current assessment techniques.

AIRCRAFT NOISE TRIALS

In general, approximately 1% of low flying is permitted by fixed wing jet aircraft in the UK between 250 and 100ft. These trials were carried out to acquire broadband data for the assessment of noise from such low flying operations and measurements were made, using wide band instrumentation, of a Tornado aircraft flying at heights and speeds which spanned the currently imposed low flying limits. A comprehensive set of results was obtained over two flying days (1). The results showed that directly beneath the flight path, high noise levels might be expected. The noise level diminishes rapidly with distance from the flight path, particularly for flights at lower altitudes. Onset rates were also measured. Table 1 shows the A-weighted RMS maximum level (L10max) and ASEL, the wide band peak level (LLF 0.001Hz), the B-duration and the onset rate (calculated using the NPL method (2)) measured directly under the flight path for four representative Tornado fly-overs at different heights and speeds. The height and speed shown are the values measured when the aircraft was closest to the microphone position directly beneath the flight path. Pressure versus time waveforms for these events are presented in figures 1 to 4.

<table>
<thead>
<tr>
<th>DATE</th>
<th>FLIGHT</th>
<th>HEIGHT (feet)</th>
<th>SPEED (knots)</th>
<th>L10max (dB re 20µPa)</th>
<th>ASEL (dB re 20µPa)</th>
<th>PEAK LEVEL (dB re 20µPa)</th>
<th>B-DURATION (ms)</th>
<th>ONSET RATE (dBA/s)</th>
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<tbody>
<tr>
<td>3/8</td>
<td>B</td>
<td>227</td>
<td>427</td>
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<td>107.8</td>
<td>122.2</td>
<td>1180</td>
<td>22.3</td>
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<td>462</td>
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<td>115.3</td>
<td>133.5</td>
<td>1135</td>
<td>54.3</td>
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<tr>
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<td>229</td>
<td>537</td>
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<td>118.0</td>
<td>137.0</td>
<td>1110</td>
<td>54.3</td>
</tr>
<tr>
<td>2/8</td>
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<td>167</td>
<td>559*</td>
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<td>120.6</td>
<td>141.1</td>
<td>910</td>
<td>107.5</td>
</tr>
</tbody>
</table>

* outside training limits in UK public areas
DISCUSSION

Detailed examination of the above pressure waveforms shows that the noise from low flying aircraft is complex, comprising a series of pressure peaks with rapid return to zero pressure. The amplitude of the pressure peaks increases gradually as the aircraft flies overhead reaching an overall peak pressure after an amount of time, dependant on the speed and height of the aircraft. The amplitude then decays back to ambient levels. The waveform composition is comparable to the noise produced by a single gunshot recorded in reverberant conditions, but with a much slower rise time.

It is clear however, that the envelope of the noise from low flying aircraft can show large variations in duration, level and rate of onset. Considering figure 1 above (flight B), simple observation shows that this envelope is not similar to an impulsive source. The maximum A-weighted level is 111.5 dB and the B-duration is 1180 ms. The onset is gradual and the pressure fluctuates around its maximum level for a relatively long period. This would suggest assessment using continuous noise methods would be appropriate. However, by the time you get to the highest speeds the waveform appears to be more impulsive in nature as in figure 4 (flight K). The maximum A-weighted level is 125.5 dB and the B-duration is 910 ms. The onset is faster, as is the rate of decay. It may not be suitable to assess this waveform using existing continuous noise methods.

The remaining two waveforms presented fall between these clearer cases. Both have B-duration longer than 1000 ms and peak level less than 140 dB which means they are within the boundaries for assessment using ISO 1999. Looking at the actual waveforms however, it is still debatable as to whether they ought to be evaluated simply by using existing continuous techniques which are designed to deal with annoyance and may not be an appropriate metric for considering potential health effects.

Significant changes in gradient during the onset of the waveform could cause considerable differences in the calculation of onset rate when different methods are used (3). It is important to consider how changes in pressure during the onset phase will affect the triggering mechanism of the stapedius reflex. Factors like these may play important roles when considering health and annoyance effects of noise on communities and require more in depth analysis.

More work is being undertaken to address the limitations of the current assessment techniques. When considering metrics to describe the effects of this type of noise in the overflown community, whilst the development of a single energy based metric, possibly with a correction to account for the nature of the onset, might be desirable, it must embrace both health and annoyance criteria.

ACKNOWLEDGEMENTS

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