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THE INFLUENCE OF REPETITION RATE ON THE SUBJECTIVE IMPRESSION OF BLADE SLAP

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1. INTRODUCTION

As a part of the continuing investigation into the subjective effects of helicopter blade slap, surveys have been carried out in an attempt to establish the dependency of the annoyance penalty on the blade passing frequency. Previous emphasis has been placed on evaluating the effect of crest factor (Ref.1-3) and keeping the repetition rate constant.

A simulated pulse was used and combined with a Wessex Hover (nose on) signal which was essentially broadband in character. The repetition rate was allowed to vary between 10Hz and 40Hz.

2. TEST SIGNALS

The impulse shape used is shown in Figure 1. The rise time of the single sine wave was modified in order to equate the subjective impression with true helicopter blade slap. The test was split into two parts:

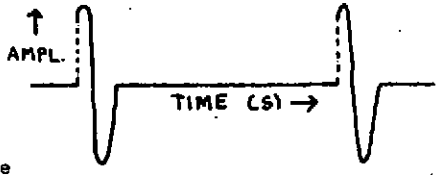

Figure 1 - Impulse Shapes

(a) The pulse frequency was held constant at 250Hz so that the crest factor varied with repetition rate and

(b) The pulse frequency was varied between 160 Hz and 670 Hz so that the crest factor was held constant. The impulses were combined with broadband helicopter noise in such a manner that the peak of the pulse relative to the mean peak of the broadband noise was 17dB - a value that typically occurs in practice with high levels of blade slap.

3. TEST PROCEDURE

The signals were presented to the subjects via a pair of Stax - SR5 electrostatic stereo headphones. A Knowles miniature microphone was situated inside one earpiece shell. The subjects were asked to compare the level of the test signal with a reference Wessex broadband noise type signal so that they judged each of the sounds to be equally annoying. The broadband noise level was fixed at 80dB(A) and when the subjects had adjusted the level of the test sound, the dB(A) level at the ear was monitored.

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4. TEST SUBJECTS

Twenty one subjects were used - nineteen male and two female. The majority had been audiometrically screened. Seven of the subjects were from within the Acoustics Department.

5. RESULTS

The mean results of the experiment where crest factor was held constant are shown in Figure 2. Analysis of the signals has been carried out in terms of dB(A) and PNL levels. The standard deviation of the results varied between 4 and 6 dB.

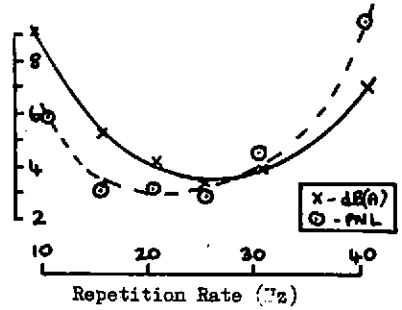

Figure 2 - Mean Results with Constant Crest Factor

The results of the constant pulse frequency tests are shown in Figure 3. In this case, data is shown in terms of dB(A) levels only.

6. DISCUSSION

It can be seen from Figure 2 that the subjective penalty decrease with increasing repetition rate (blade passing frequency) until 25 Hz, thereafter the trend reverses and the impression increases. It is not possible for the majority of people to distinguish individual impulses when the repetition rate increases above 25Hz and this is probably the reason for the minimum subjective penalty at this frequency. It is not clear, however, why there is an increase above this value.

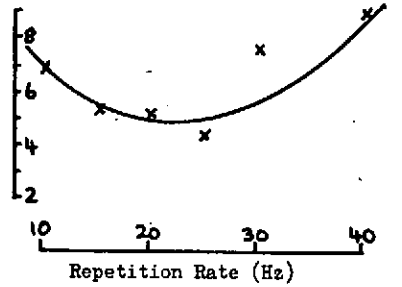

Figure 3 - Constant Pulse Frequency

There is a difference between analyses in terms of dB(A) and PNL. Figure 2 shows that the PNL has lower values than dB(A) for repetition rates up to 25 Hz, thereafter greater values are noted. It is important, therefore, that the relevant units for the subjective penalty are always quoted. The tone correction for a blade slap type spectrum is small and would not be expected to be greater than 0.5dB for all the signals used.

A comparison of the results in terms of dB(A) for the two test series (Figure 4) shows that the general trend in the results is similar but the constant pulse frequency results are lower at low repetition rates and

higher at high repetition rates. This was expected since the crest factor of the test signals varies and this will, in itself, affect the subjective impression.

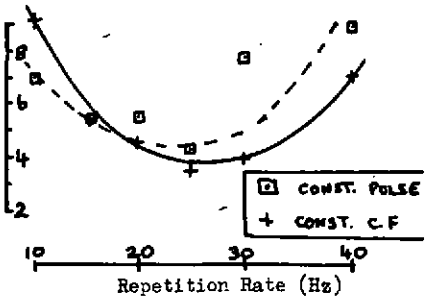

Figure 4 - dB(A) Results

7. CONCLUSIONS

- The subjective penalty decreases with increasing repetition rate up to 25Hz, thereafter the trend is reversed.
- Analysis in terms of dB(A) and PNL shows significant differences with the latter being less at low repetition rates and greater at the higher rates tested.
- For typical helicopter repetition rates (10 - 20 Hz), impulse corrections of 4 - 9 dB(A) and 3 - 6 PNL were found.

8. REFERENCES

(1) B.J. SOUTHWOOD and A.C. PIKE 1976 WHL Applied Acoustics Group Note 1147 - The Rating and Subjective Assessment of Helicopter Blade Slap.

(2) J.W. LEVERTON 9th International Congress on Acoustics, Madrid, July 1977. Subjective Assessment of Blade Slap - Paper A23.

(3) J.W. LEVERTON, B.J. SOUTHWOOD and A.C. PIKE. Proceedings of an International Symposium at NASA Langley, May 22nd - 24th 1978. Rating Helicopter Noise-Paper 21.