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ACTIVE SILENCING OF A TRANSPORTABLE GENERATOR SET

P.D. WHEELER AND T.S. FARRAMORE*

WOLFSON UNIT FOR NOISE AND VIBRATION CONTROL, I.S.V.R., UNIVERSITY OF SOUTHAMPTON.
*MOD(ARMY), MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT, CHRISTCHURCH.

INTRODUCTION

The major low frequency noise source associated with the internal combustion engines of fighting vehicles and field generator sets is the engine exhaust noise. This component, at the engine firing frequency and its harmonics, will, in general, control the aural detectibility of the engine in its operational role.

Although conventional reactive mufflers can provide adequate attenuation for constant frequency exhaust components, this may not be the case for variable speed engines, or for the run-up phase of a generator set.

This work has been concerned with the development of a broad-band active silencing system for the exhaust noise components of i.c. engines, with the ability to cope with varying source frequencies in the low frequency range.

Some ten years ago, experimental work on active silencing of exhaust noise was carried out at MVEE, Christchurch (Refs 1, 2) using a bifurcated duct arrangement, and tape-recorded engine noise, replayed through a loudspeaker, as the primary source. Attenuations of up to 20 dB in engine firing frequencies in the range 60-330 Hz were measured in a laboratory rig.

SOURCE CHARACTERISTICS

A commercially produced generator set has been used as a test-bed during the experimental work described here. A rudimentary degree of noise control treatment was a feature in the set as delivered, as indicated in schematic form in Figure 1.

The major source area on the set is the cooling air exit duct into which the engine exhaust is delivered, having a noise spectrum of the form shown in Figure 2.

In order to carry out experimental work, the exit duct was extended in length, and active silencing was applied to the combined cooling air mass flow and the exhaust gas stream. Although the presence of a high cooling air mass flow ameliorates the environment in terms of temperature and gas content, thus allowing the use of conventional materials for loudspeakers and microphones exposed to the flow, the high air flow velocity generates an undesirable degree of turbulence in the duct. However, since the large area of the cooling air exit is a major radiator of low frequency airborne noise from the set, it would require separate consideration in term of noise control, if it were not integrated with the exhaust treatment.

DETECTABILITY

If the generator set noise spectrum of Figure 2 is corrected for sound propagation characteristics over a distance, and compared to a typical rural ambient noise environment, the 'signal-to-noise ratio' situation of Figure 3 is seen to apply. The highest excess of exhaust noise components to background is not at the engine firing frequency (25 Hz), but in the range 75-125 Hz, related to higher harmonics of the firing frequency.

Taking, therefore, excess over background as the criterion for detectability the target range for active silencing is not the fundamental firing frequency, but those harmonics dominant in the spectrum, in the range 75-125 Hz.

EXPERIMENTAL SYSTEM

The exhaust duct was sub-divided vertically into two equal sections in order to ensure dominance of plane-wave mode propagation in the frequency range of interest. Each section houses a "virtual earth" active silencing system comprising a flush-mounted loudspeaker unit, and a centrally-mounted sensing microphone. The sensing microphone mounting is such as to minimise regenerated turbulence which would otherwise create an undesirable load upon the loudspeaker.

Each active silencing system operates independently in electronic terms, and acoustic interaction is again minimised by the form of construction adopted.

RESULTS

Under maximum stable gain conditions, a reduction of 14-16 dB in engine firing frequency harmonics in the range 75-125 Hz is achieved, as measured in the duct, and at the duct exit. Measurements made at a distance from the duct in free space corroborate this performance, although hampered by background noise from other sources in the generator set.

No reduction in gain is necessary when comparing performance in simulated source, zero airflow laboratory conditions, to field results with airflow, indicating the system's ability to operate successfully in the high mass airflow present.

ACKNOWLEDGEMENTS

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REFERENCES

1. T.S. PARRAMORE unpublished MOD Report

2. T.S. PARRAMORE UK Patent No: 1357330

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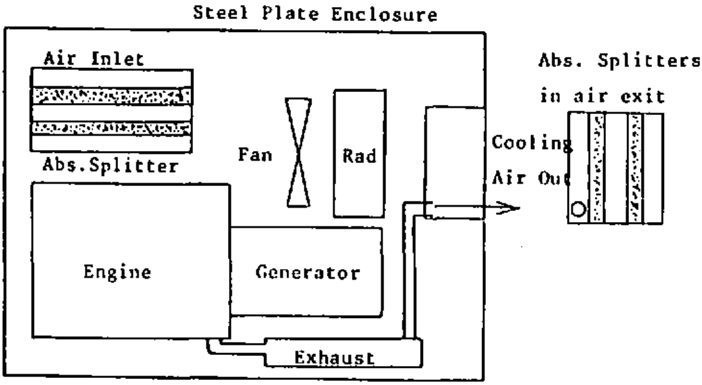

FIGURE 1 - NOISE CONTROL SCHEMATIC DIAGRAM

(pre-active control)

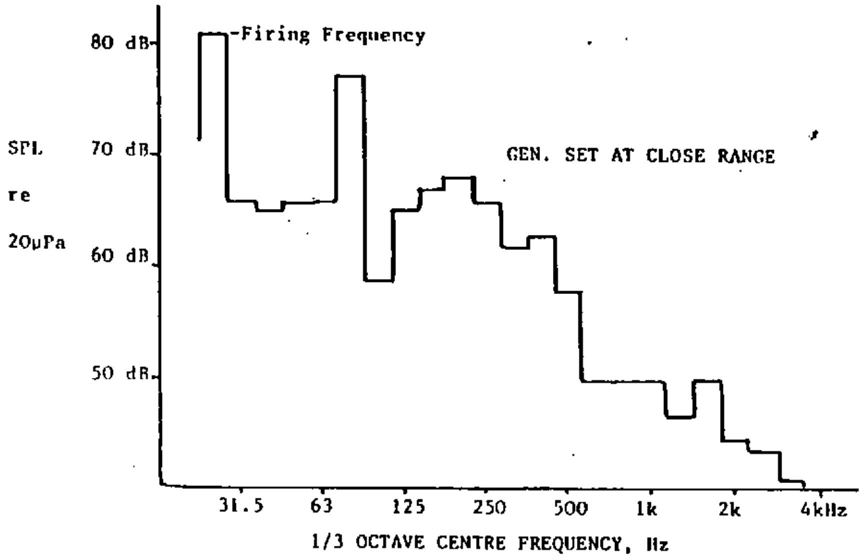

FIGURE 2 - GENERATOR SET NOISE SPECTRUM

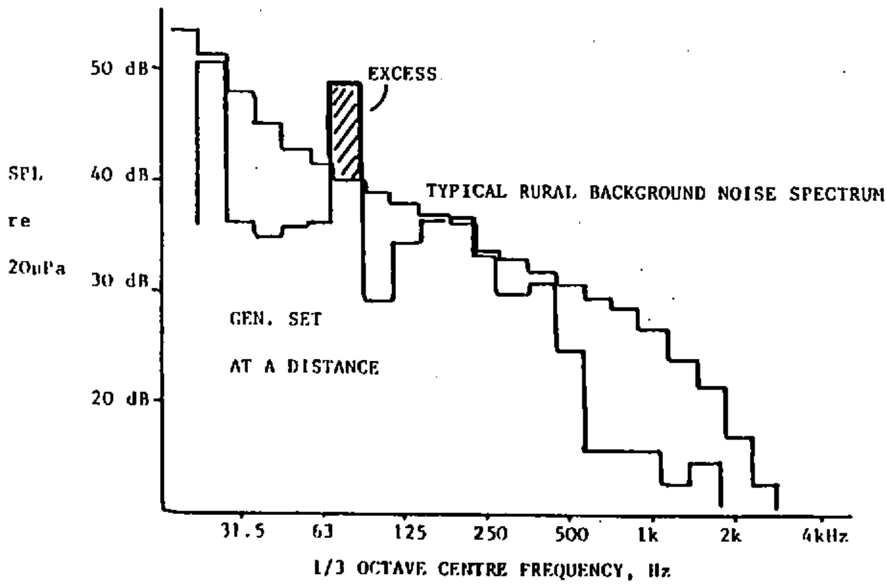

FIGURE 3 - EXCESS OVER AMBIENT NOISE