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A NOISE REDUCTION SYSTEM FOR PERMANENT OUTDOOR ENCLOSURES OF STANDBY GENERATING EQUIPMENT

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INTRODUCTION

Many companies prefer to have alternative means of power supply and back-up generators. This is particularly true where the supply of power to an installation needs to be guaranteed at all times. An example of this use is with regard to the supply of power to a computer installation where the continuous need for operation occurs once a programme has commenced.

ORIGINS OF THE NOISE PROBLEM

In general, standby generators are used as a back-up facility for essential services such as hospitals, police and military purposes. In such circumstances the prime requirement is for reliability followed by reasonable operating economy and a long period between overhauls. This generally leads to the adoption, for the larger systems, of a massive, slow-running, diesel engine originally designed for bus or truck operation. Such an engine is inherently difficult to silence, having a pronounced diesel knock as well as a relatively low frequency noise spectrum. The system upon which the programme was based consisted of an 8 litre capacity diesel engine of 105.6 h.p. continuous rating at 1500 rpm. As initially installed, the generator set was located inside a brick-walled building, having a chipboard and felt-covered flat roof. Ventilation for both cooling purposes and for the aspiration of the engine was provided by a pair of louvred doors located side by side at the front of the generator building (Figure 1). Owing to the suburban location of the company, both the louvred doors and the exhaust outlet were only 15 m away from a private house, from which complaints had been received. An analysis based upon the procedures set out in BS 4142 showed that the noise from the generating set was 29 dB above the corrected background level, indicating that the complaints were highly justified and that an overall reduction in sound pressure level of over 20 dB would be required.

NOISE REDUCTION PROGRAMME

It was clear from the outset that the majority of noise from the generator escaped through the louvred doors, and that, although at first regarded with suspicion, the roof structure of high density chipboard, felt and tar was providing a reasonable acoustic performance when coupled with a building height of approximately 3.6 m. An additional potent noise source was the exhaust pipe for the diesel engine, the outlet end of which was above the louvred doors and thus on the side of the generator building immediately facing the complainant's house, as can be seen from the general arrangement diagram, Figure 1.

During the initial noise survey, the temperature in the generator house rose continuously whilst the generator was running, thus casting considerable doubt upon the adequacy of the air flow to the radiator provided by a pair of louvred doors. The cooling system was subsequently found to have an air requirement of 4000 cu. ft. per minute and to be able to withstand a maximum pressure drop of 0.8" water gauge. A forced air circulation system was devised using an axial flow fan to supplement the engine cooling fan. In order to provide silencing at both the air inlet and the air outlet, expanded cross-section silencers were designed, based upon the theory set out by Davis et al [1].

As may be seen from Table 1, an octave band analysis showed that the bulk of the noise generated was in the 63 Hz octave band, consistent with the known speed of 1500 rpm of the diesel engine, corresponding to a frequency of 75 Hz. However, this noise is generally emitted mainly via the exhaust system, whilst much of the remainder is of a more broad band nature. The expanded cross-section silencers in the air flow system were tuned to give peak attenuations at frequencies of 250 Hz, 750 Hz, 1250 Hz etc., to correspond with the known harmonic frequencies of the engine of 150 Hz, 300 Hz, 600 Hz and 1200 Hz. Initially, these expanded cross-section silencers were designed as an integral part of a double-skinned roof structure so that sound transmission through the roof could be reduced at the same time, as is shown in Figure 2. However, this scheme was rejected on cost grounds and simple expansion boxes were constructed from high density chipboard as was all the ducting, as is shown in Figure 3.

The silencer system was re-routed so that the exhaust was away from the complainant's house and fitted with an additional, low back pressure, expanded cross-section silencer as shown in Figure 3, the maximum attenuation frequency in this case being 75 Hz. Finally, the two louvred doors were replaced by half-hour fire doors, fitted with neoprene seals and a central demountable pillar against which the doors were sealed by using wedge bolts.

The effectiveness of the overall strategy may be judged from Table 1, where it is seen that, measured on the A scale, the corrected sound pressure level has been reduced from 91 to 67 dBA. Virtually all the work described may be carried out by a builder using readily available, low cost, materials and if carried out during the initial construction would add little to the overall cost of the installation.

REFERENCES

[1] D.D. Davis Jr., G.M. Stokes, D. Moore and G.L. Stevens Jr., "Theoretical and experimental investigation of mufflers with comments on engine exhaust muffler design", N.A.C.A. Report 1192, 1954.

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Table 1.

Centre band frequency	31.5	63	125	250	500	1k	2k	4k	8k	16k	dBA
Door open	75	89	83	79	82	87	80	75	65	51	91
Background	64	71	65	62	55	58	55	51	34	34	62
Corrected	75	89	83	79	82	87	80	75	65	51	91
Door closed	65	76	67	60	59	60	65	58	47	35	68
Background	64	71	65	62	55	58	55	51	34	34	62
Corrected	58	74	63	50	57	56	65	57	47	28	67
A weighted corrected	-	-	16	9	3	0	-1	-1	+1		
Corrected background	-	-	49	53	52	58	56	52	33	-	62
A weighted corrected Door closed	-	-	47	41	54	56	66	58	46	-	67
A weighted uncorrected Door closed	-	-	51	51	56	60	66	59	46	-	68

FIGURE 1

ORIGINAL ARRANGEMENT OF GENERATOR HOUSE

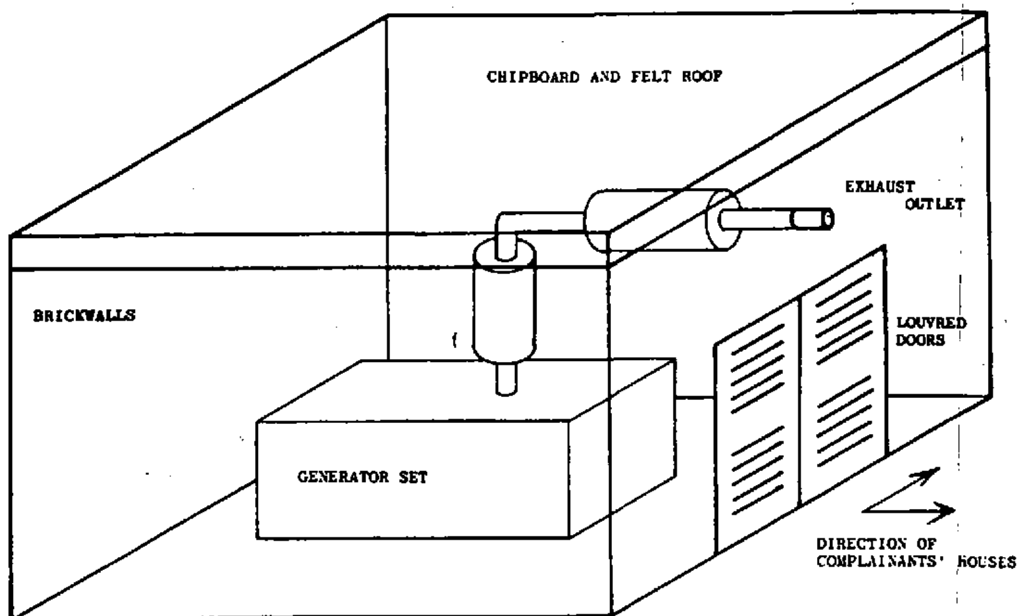

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FIGURE 2

FIRST DESIGN

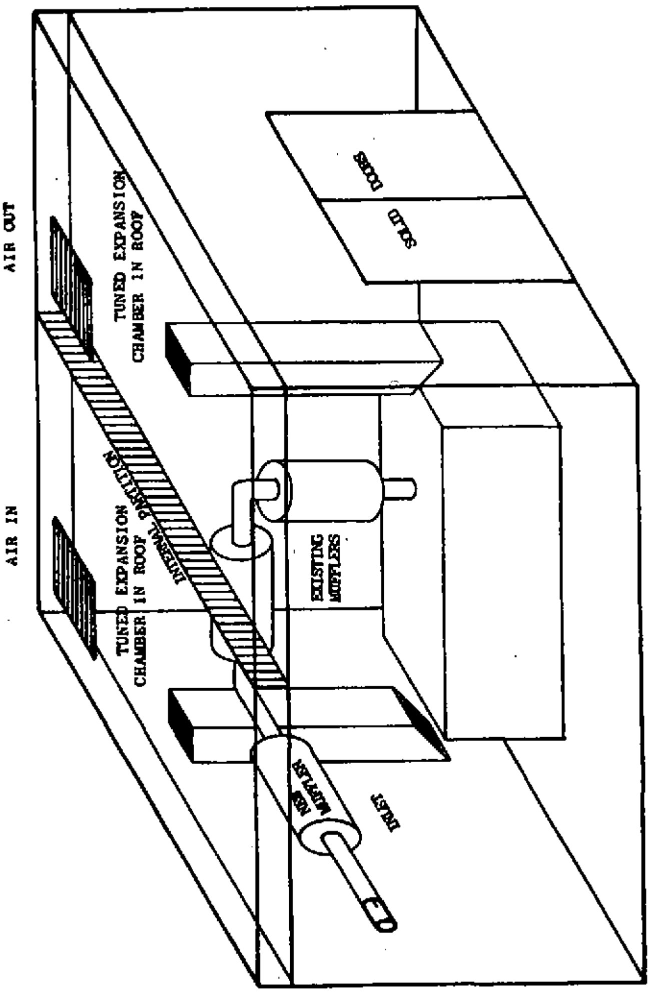

FIGURE 3

FINAL ARRANGEMENT OF GENERATOR HOUSE SILENCING