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'APPLIANCE NOISE'

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A PROPOSED METHOD FOR ASSESSING THE NOISE OF DOMESTIC APPLIANCES

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Average domestic rooms are neither free-field nor highly reverberant, so that the noise levels produced by an appliance, when installed in a domestic room, will be governed by the characteristics of the noise source (its power output and directivity factor) as well as by the acoustics of the room via the "room constant". This may be expressed in terms of the mean square pressure

$$\overline{p^2} = W \rho c\left[\frac{Q}{4 \pi r^2} + \frac{4}{R}\right] \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where the W is the acoustic power output and Q the directivity factor of the appliance when installed in a room of room constant R. ρc is the characteristic impedance of air and r the distance between appliance and listening point. The term involving R gives the reverberant level and depends upon the surface area, S, and average absorption, $\bar{\alpha}$ in the room. $R = S\bar{\alpha}/1-\bar{\alpha}$. Fifty living rooms and fifty kitchens have been studied in order to obtain average characteristics for these rooms (1).

Convential reverberation chamber measurements of power output and free-field room measurements of directivity factor of an appliance produce values for the parameters which are characteristic of the appliance as modified by the measurement environment. These parameters may also be modified by the domestic room, but not necessarily in the same manner as in the test rooms.

From equation (1) we see that if a test room is designed with room constant R simulating that of an average domestic room, then the reverberant levels in the two rooms are similar and the direct field acts according to the characteristics of the appliance. No calculations or directivity measurements are involved in determining the level in the simulated domestic room.

The simulation of domestic rooms was achieved in a noise attenuating room of approximately 30 cubic metres volume (approx. 2x3x4m) using easily available commercial absorbing materials secured to the internal surfaces of the test room. For the living room simulation the walls were covered with alternate one foot wide strips of acoustic tile and hardboard panel on a one inch thick wooden frame. Some of the hardboard panels were backed with soft fibreglass to broaden their absorption bands, whilst the remaining mid and high frequency absorption was provided by acoustic tiles on the walls and scattered on the floor of the room. Fifty per cent of the ceiling was covered with one foot wide strips of unbacked hardboard panel absorbers. Kitchen conditions were produced from the living room by removing all the acoustic tiles and wall coverings, except for one of the fibreglass backed panels. Standard perforated hardboard panels were used to provide the necessary absorption. Figures 1 and 2 show worm's eye views of the simulated rooms.

The state of diffusion in the reverberant field of the test room was studied using a loudspeaker and octave bands of random noise. Microphone traverses in a variety of directions in the room showed the variations in S.P.L. to be about ± 3dB in the 125 Hz band, reducing to ± 0.5 dB in the 4 kHz and higher bands. Using pure tones, the variations were typically ± 6 dB in the 125 and 250 Hz regions. As a check on the accuracy of the simulations, levels produced by a standard noise source in fifty living rooms and fifty kitchens were studied. Variations in level in these rooms were in excellent agreement with those in the simulated rooms. Figures 3 and 4 show the levels measured in the test room and the average and spread in actual domestic rooms. It will be noted that the test room levels tend to be a little higher than the field measurements. This was shown to be due to the effective reduction in power output of the standard noise source due to positioning on absorbing surfaces (e.g. fireside rugs) in the domestic rooms. The degree of power output reduction caused by the appliance mounting depends upon the directional characteristics of the appliance and the absorption of the surface.

This aspect of the simulated rooms is of interest when measurements are being compared with reverberation chamber predictions of noise level, the reverberant levels in the simulated rooms generally being lower than predicted, due to the appliance mounting. In the vicinity of the appliance, the direct sound will add according to the directivity of the appliance under test and will bring the measured level up to, or above, the reverberation chamber predicted level. It has been found that reverberation chamber comparisons of different appliances may show them to have the same acoustic power output, but, due to differences of mounting and directivity patterns, the simulated living room levels may differ by 4 dB or more.

CONCLUSIONS

Domestic rooms may be simulated in a small test chamber. The error due to imprecise simulation generally being less than ± 1 dB. The method permits direct measurement of the noise an appliance will produce when installed in the home. The test room was developed with the support of the Society of British Gas Industries for measurements on domestic gas appliances, but provides a simple and effective noise test method for manufacturers of all types of domestic appliances.

REFERENCES

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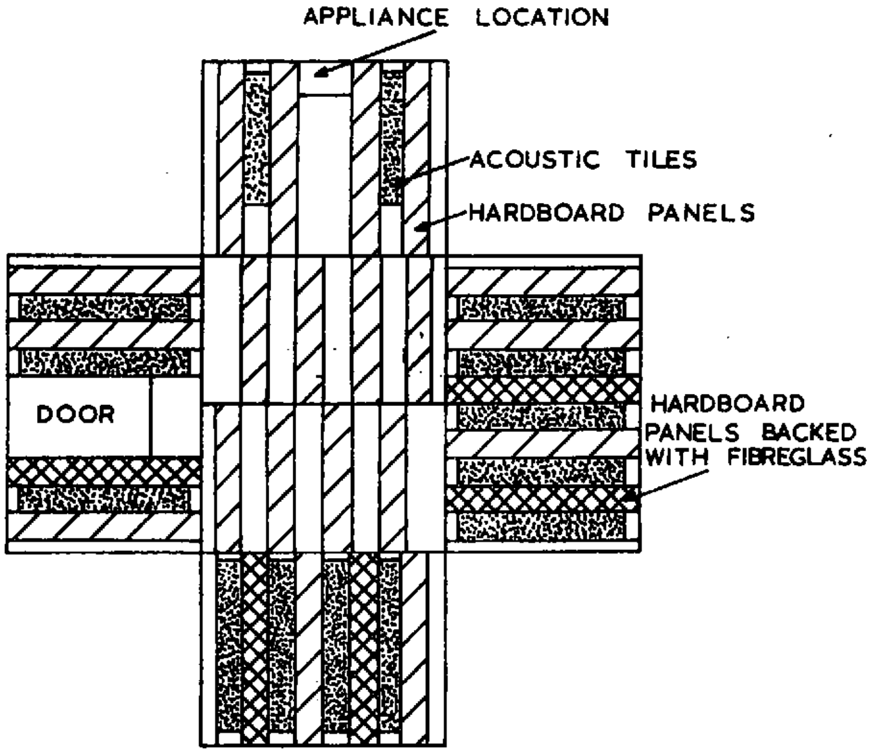
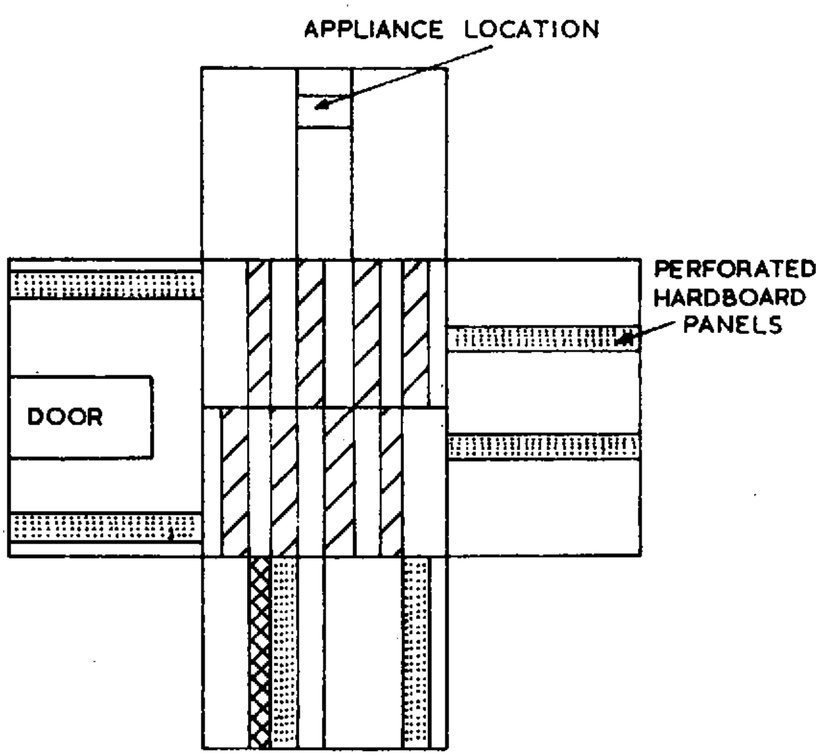


WORM'S EYE VIEW OF :- FIG 1. SIMULATED LIVING ROOM

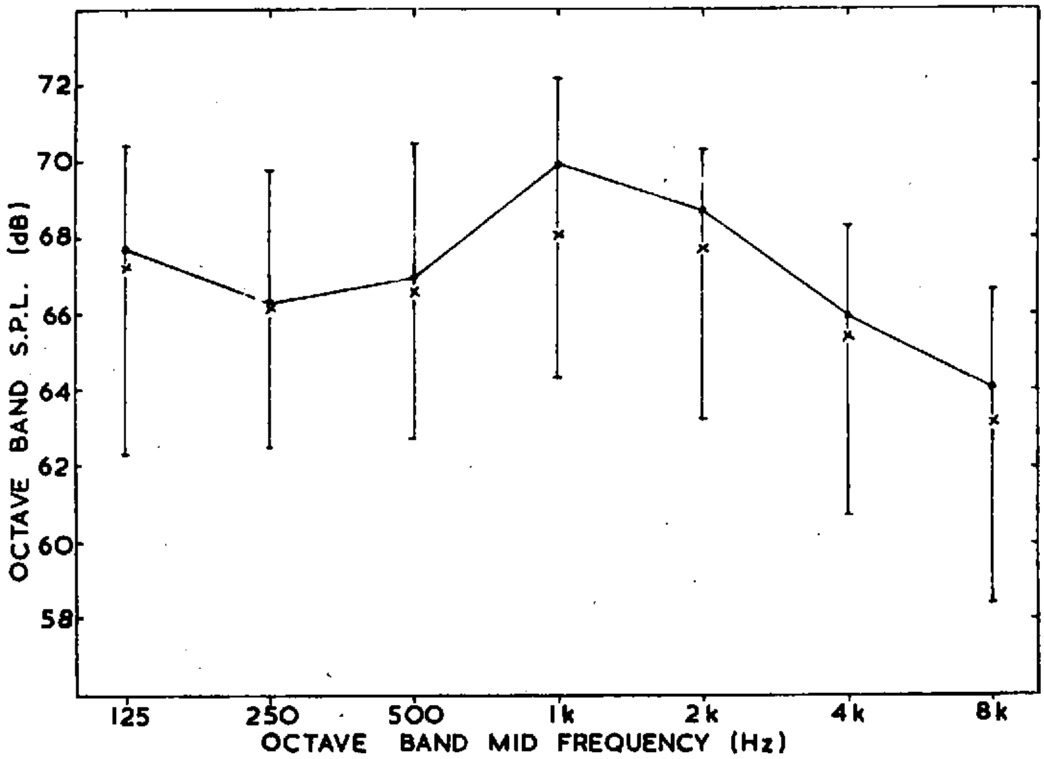
AND

FIG 2. SIMULATED KITCHEN



FIELD AND SIMULATED ROOM LEVELS PRODUCED BY A STANDARD NOISE SOURCE IN :-

(a) FIG. 3 LIVING ROOM



AVERAGE AND SPREAD OF FIELD MEASUREMENTS

AVERAGE LEVEL IN SIMULATED ROOM

(b) FIG. 4 KITCHEN