

ON MEASURING LOW-FREQUENCY NOISE INDOORS

Steffen Pedersen, Henrik Møller

Aalborg University
Acoustics, Department of Electronic Systems
Fredrik Bajers Vej 7-B5
DK-9220 Aalborg Ø, Denmark
[stp], [hm]@es.aau.dk

Kerstin Persson Waye

Gothenburg University
Occupational and Environmental Medicine
Medicinaregatan 16
40530 Gothenburg, Sweden
kerstin.persson-waye@amm.gu.se

1. INTRODUCTION

Due to standing waves, the sound pressure within a room may vary 20-30 dB at low frequencies. For assessment of annoyance from noise, it is important to measure the level that gives rise to the annoyance. Thus, mainly areas of the room with high sound pressure levels are of interest. This is in contrast to other measures of technical interest (e.g. sound transmission) where the energy is of interest, and a room's power average is sought.

2. METHODS

Principal properties of low-frequency sound in rooms were studied using finite-difference time-domain simulations, at both modal and non-modal frequencies (Figure 1). Key observations were that at modal frequencies, the highest level appears in all three-dimensional corners of a room, and either extends far into the room, or repeats in other positions. At non-modal frequencies the highest level will always appear in at least one three-dimensional corner and either extend far into the room or repeat in other positions.

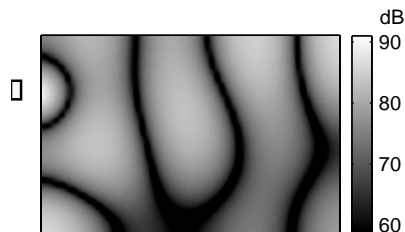


Figure 1: Example of sound pressure distribution at non-modal frequency.

The Sound pressure distribution of the entire room as well as the performance of current Swedish and Danish measurement procedures was studied by measurements in three rooms. At the same time, the

level in all three-dimensional corners of the rooms was measured.

3. CONCLUSIONS

The level that is exceeded in 10% (L_{10}) of the room is proposed as an objective target for a measurement method.

The Swedish method showed good results close to the target. However, it uses C-weighting in its scanning of corners. However, this means the method may fail if the C-weighted level is not dominated by the annoying sound. The Danish method was found to have a high risk of significantly underestimating the noise present in a room, unless complainants can precisely appoint measurement positions, where the sound is loudest/most annoying. An alternative method using measurements in four three-dimensional corners of the room is proposed. This easy and straightforward method seems to give reliable results close to the proposed target (Figure 2).

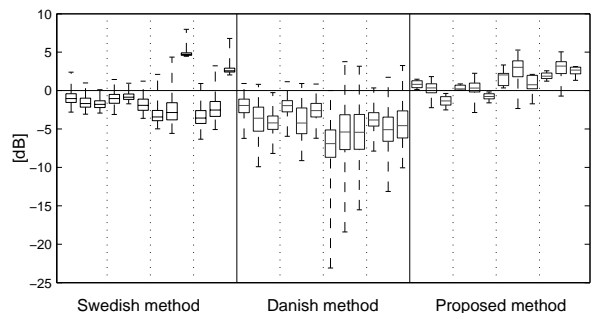


Figure 2: Statistics (range, quartiles and median) from Monte Carlo analyses of the measurement methods in the three rooms. Results are relative to the L_{10} target. For each method, results are ordered by signal (31.5/33 Hz tone, 31.5 Hz third-octave noise, 125 Hz tone, 125 Hz third-octave noise – separated by dashed lines) and for each signal by room (office, living room, bedroom).