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## Comments to "Sound insulation of dwellings at low frequencies"

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## Comments to the article "Sound insulation of dwellings at low frequencies"<sup>1</sup>

It is well known that, at low frequencies, the sound level normally varies substantially with position within a room. It is thus not straight-forward to measure and characterize indoor sound levels and to describe sound insulation from the outside to the inside of a building. It is therefore with significant interest and motivation that we have read this article.

In the work reported, the sound insulation was measured for the same rooms using three different methods to measure the indoor sound level. Unfortunately, the authors forgot to report results from the first method, and even more unfortunately, a critical error was made in the second method. The comparisons between the second and third methods are thus flawed, and the conclusions as well as the main outcome of the work, a set of recommended sound insulation data for the second method, are wrong.

To confuse matters further, the authors seem to be unaware that the measurement methods have different objectives and aim at different measures for the indoor sound level.

With the present comments, we want to call attention to these detrimental errors, which – if unnoticed – may lead to serious misunderstandings and misuse of the data in the community. We will abstain from discussing in general the quality of the work, its use of statistics, and its presentation.

### Indoor measurement methods

The first method is the indoor measurement procedure of ISO 140-5 [1]. The method aims at the room power average, and it uses the power average of measurements in five positions selected within certain geometrical restrictions. This is the method from which the results are missing.

The second method, denoted LFM, is given in the Danish guidelines for low-frequency sound [2,3]. The method is meant for use in cases of noise complaints, and it uses the power average of measurements in three positions. Two positions should be chosen, where the complainant perceives the noise as being loudest. Some geometrical restrictions exist, fairly similar to those of the ISO method. Unless the complainant fails to appoint positions with the highest level, the power average of all three positions will be near the highest level, regardless of the level in the third position. Thus, the method obviously aims at a level close to the highest level that persons are exposed to in the room – and not the room average.

In practice, it is difficult for complainants to appoint measurement positions correctly. In particular with non-steady noise sources, this is nearly impossible. Not only may the level change with time, which makes it difficult to compare positions subjectively, but if the frequency changes, high- and low-level areas will move around in the room.

The third method was therefore proposed by some of us as a method to "catch" the high levels of the room without relying on the complainant to appoint measurement positions [4]. The method, denoted the 3D-corner method, uses the power average of four three-dimensional corners, i.e. where the floor or ceiling meets two walls. From measurements in real rooms with a variety of sound signals, it was shown that the method gives a level close to the maximum, however avoiding levels that only exist in a very small part of the room.

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<sup>1</sup> Hoffmeyer, D. and Jakobsen, J., "Sound insulation of dwellings at low frequencies", J. Low Frequency Noise, Vibration and Active Control, Vol. 29, No. 1, 2010.

In short, the ISO method aims at the room power average, whereas the LFM and 3D-corner methods – in each their way – aim at levels near the maximum.

The reason for having different goals is obvious: The ISO standard uses indoor measurements in calculations of sound power transmitted through façades or façade elements, whereas measurements with the LFM and 3D-corner methods are used to describe actual sound pressure levels that persons may be exposed to in the room, and which are thus relevant for their response.

### **The LFM method as accomplished**

Unfortunately, the LFM method was not accomplished as prescribed. Only physical sound insulation was measured in the study, and no complainant was involved. Consequently, the measurement positions were not appointed, where the noise was loudest. Without this important detail, it is obvious that the method fails its objective.

Without proper appointing of positions, the LFM method is roughly identical to the ISO method, although with fewer measurement positions. Results are hence expected to be around the room average, or, as the ISO method seems to underestimate the room average in the low frequency range [5], more likely some decibels below the average.

Since the 3D-corner method aims at a level near the room maximum and was properly carried out, it is not surprising that Hoffmeyer and Jakobsen found substantial differences, when they compared the LFM and 3D-corner methods. However, with the flawed LFM data, their conclusion that the 3D-corner method gives 5-7 dB, occasionally up to 10 dB, lower sound insulation than the LFM method (higher indoor levels), is unfounded.

The results from the LFM method were also compared with sound insulation data from the literature, and better agreement was found with these. However, none of the other studies were meant to catch the high levels of the room, hence the agreement basically confirms that the LFM method did not work as intended.

Hoffmeyer and Jakobsen combined their results of the LFM method with earlier, unfortunately equally defective, LFM data [6], to derive low frequency sound insulation data for typical (Danish) living houses. Clearly, the resulting data are not valid for the method.

### **Calculation of indoor sound pressure levels**

Nevertheless, the Danish Environmental Protection Agency recommends Hoffmeyer and Jakobsen's insulation data to be used for calculation of low frequency indoor noise from wind turbines. It is obvious that these data cannot be used to predict what will be measured, when the measurement positions are properly appointed in a prospective situation of complaints. The data cannot be used to estimate indoor sound levels relevant for the assessment of effects of noise, and we have to warn strongly against use of the data.

At a first glance, the data may seem solidly founded due to the many measurements, but because of the fundamentally wrong approach during execution of the sound insulation measurements, the data are clearly invalid and should be discarded.

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