Approaches for a comprehensive determination and assessment of infrasound effects in Germany

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Introduction

The need for a holistic identification and evaluation of infrasound and of low frequency noise is becoming increasingly important for modern noise protection. The fact that air pressure fluctuation in the infrasonic range is also produced by the slamming of a door shows that infrasound with sound pressure levels below the perceptual threshold exists almost anywhere in our environment.

In the context of a research study, potential sources of infrasound have been identified and the state of knowledge of potential health risks of infrasound has been analyzed. Numerous publications show that infrasonic influence disturbs sleep and recovery, and that it can be associated with a wide range of diseases.

Taking all this into consideration the question arises as to what extent existing rules that specify the requirements for measuring noise immission do justice to the specifics of metrological detection of infrasound. The existing standards are currently limited to measurement techniques that have been used for years. However, they are not specified further with regard to the measurement of infrasound levels. Therefore, these current standards show a considerable level of uncertainty. With the help of a simple experimental setup it was possible to identify difficulties with the metrological detection of infrasound and to deduce potential requirements for future infrasound measurements.

Research Study and Consortium

In the context of the current research project “Feasibility Study of Infrasound Impact” supervised by the German environment agency, it is the aim to develop study designs in order to evaluate the effects of infrasound, originated from various sources, on humans. Throughout this study the basic principles are going to be established, which are required in the second step to enable a holistic approach and evaluation of infrasound.

Infrasound Effects

Laboratory studies, which were carried out between 1966 and 1993 are shown in Figure 1. As a result it can be seen, that the human body shows extraaural reactions at a noise level of 75 dB (lin). Ising and Wysocky [1] [2] studied human reactions of infrasound at linear sound pressure levels of 75 dB. The results were deterioration of reaction time and concentration, increase of blood pressure and change in respiration frequency. It therefore has been proved that infrasonic impacts already exist below the threshold of audibility and perception (see Figure1). As the threshold of audibility is stated as the threshold used in the standards, the question has to be raised, whether the particularities of infrasound are taken enough into account by the usual procedure of noise measurements.

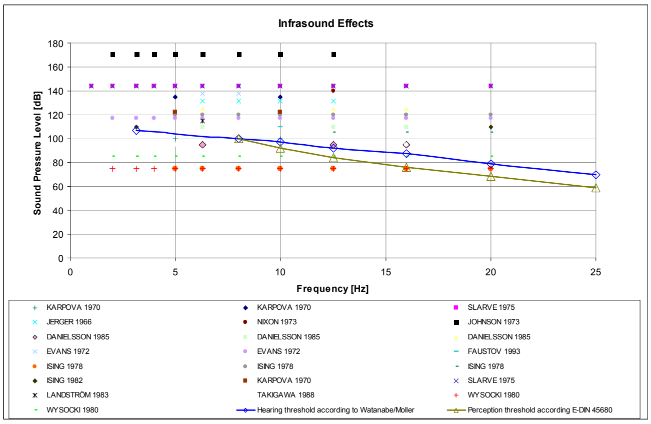

Figure 1: Extraaural Infrasound Effects [3]

Procedure; metrological detection of infrasound

If there are specific complaints about infrasound exposure from affected citizens, noise measurements are carried out following the guideline of the DIN 45680 “Measurement and assessment of low-frequency noise immissions” [4]. According to this standard, the measurement is ought to be carried out as a normal interior measurement without using a windscreen, the microphone situated as close as possible to the exposing area and with all doors and windows being closed.

Practical experience has shown that infrasound measurements react extremely susceptible to airflows. In a first step it was therefore necessary to focus on the airflow behaviour in closed spaces and to measure its wind speed. In an experimental set-up it was then attempted to evaluate the winds influence and furthermore to analyse the resulting measurement uncertainty.

Typically Windvelocity in Rooms

Orienting values of wind velocities can be found in the DIN EN ISO 7730 [6]. The most unfavourable category (Category C) contains averaged maximum wind velocities of up to 0,24 m/s.

If in addition to the typical flow rates in undisturbed premises, the typical profile of the air flow is being considered, an inhomogeneous airflow field will be established (Figure 2). In addition it can be observed, that relatively high wind velocities exist in areas which are usually occupied by people. Infrasound measurement uncertainties in the interior are therefore related to microphone position and microphone configuration without windscreen.

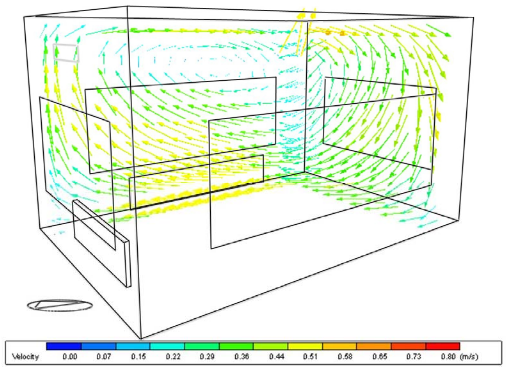

Figure 2: Typically Thermally Induced Airflow

Experimental Setup

Using a (simple) experimental set-up airflows were created to evaluate and assess the airflow induced noise level of frequencies below 20Hz and to analyse the airflow influence during a standardized noise-measurement procedure.

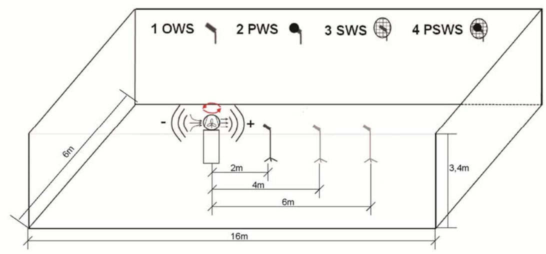

Figure 3: Experimental Setup

The airflows were created using an axialventilator. An infrasound microphone (Condenser Measuring Microphone Cartridge Type MK 222) (Microtech Gefell) at a frequency range in free field response of 0,5 Hz…. 20 kHz (+-2dB) measured the sound pressure.

Measurements were carried out with four different windscreen configurations

- without windscreen (OWS)
- primary windscreen (PWS)
- secondary windscreen (SWS)
- primary + secondary windscreen (PSWS)

and at variable distances to the axialventilator. In total 5 wind speed settings were used of which the upstream flow and downstream flow directions were recorded. All the possible settings combined resulted in a total of 144 measurement configurations. One minute was measured for each configuration. In addition to the sound pressure, the wind velocities were measured and recorded using a hot wire anemometer.

The results show, that for example at windsepeeds of 0,2 m/s (Figure 4), there is a direct influence of the rotational pressure field, created by the ventilator, with the recorded third octave spectra at infrasound level. The best effect to avoid air induced noise levels was when using the secondary windscreen. It can be seen, that the weighted single values Leq and LAeq have the same value within in all three spectra using the four different windshield configurations. However the unweighted sum level is 10dB higher when not using a windshield compared to when using the PSWS.

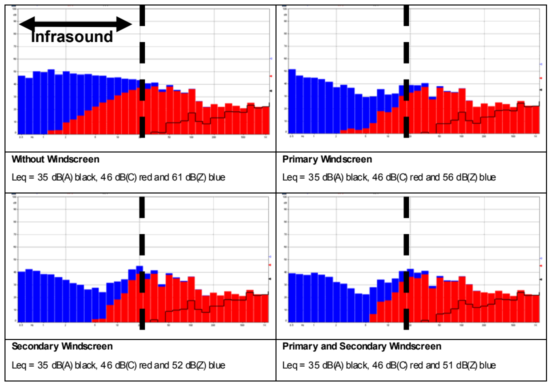

Figure 4: Measurement Results (exemplary); airvelocity: 0,2 m/s (airpressurefield from fan)

Furthermore it has to be taken into account, that the level difference of LC – LA is only 11dB in all four windshield measurements and therefore below the evaluation criteria of 20dB cited in the DIN 45680 or of 15dB in the draft [4] of the new standard.

Conclusion

By only showing a small excerpt of the measurement results it becomes clear, that further development of the existing standards and the implementation of indoor infrasound measurement procedures are necessary. The major findings of this study are listed below:

Measurement:

Higher wind- and airspeeds result in larger sound pressure fluctuations. Indoor Infrasound-measurement should be performed with windscreens. Additionally to the sound pressure level the airvelocity should be detected.

Assessement

Pure Infrasound-immissions are not detected by (L_C – L_A). The assessement should consider the G-weighted sound pressure or e.g. (L_{Zeq} – L_{Ceq}) and maybe a ratio of both sound pressure differences should be tested. The assessement should regard to the frequency noise level curve.

References

[1] Ising, H. et al.,"Auswirkungen mehrstündiger Infraschallexposition auf Versuchspersonen".Forum Städtehygiene 30 (1979) 49-52

[2] Wysoki, K. et al. "Experimentelle Untersuchungen zum Einfluß von Infraschalldruck auf den Menschen" Z. gesamte Hyg. 26 (1980), 436-440

[3]Ebner, F. "Identification and classification of infrasound sources under the consideration of various parameters…", Munich, January 2012

[4] DIN 45680 „Measurement and assessment of low-frequency noise immission in the neighbourhood" March 1997 and draft August 2011

[5] DIN EN ISO 7730 Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (ISO 7730:2005)