

Aviation Low Frequency Noise

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Low frequency noise pollution is an intrusive and unhealthy by-product of aviation. In addition, the current acceptance of A-weighted noise measurements largely understates the degree that low frequency noise pollution impacts the environment. For example, using A-weighting...a low frequency noise of 50 Hz which vibrates homes and is felt in the body, is *under measured by 30 dB* as compared to 1.3 dB in measurements taken with C-weighting. Overall measurements are *under measured* by 7-8 dB A-weighting as compared to C-weighting. This discrepancy results in millions of homeowners being denied the soundproofing that they should be entitled to.

The following excerpts from documents published by the World Health Organization support our position that low frequency noise pollution is *dangerous* and is not measured or accounted for accurately by current measures. WHO's findings are in support of our belief that the sound pressure level of noise pollution emanating from heavy machinery such as airplanes must be measured using a more linear scale such as that of C-weighting.

From WHO's Community Noise (1995)

3.5.3 Limitations of A-Weighted SPL as a Measure of Loudness or Annoyance

As pointed out by Hellman and Zwicker (1982), A-weighted SPL was first introduced into a sound level meter in 1936. Due to its simplicity and convenience, the A-weighting has become a popular and often useful frequency weighting also for assessing the perceived magnitude of noise. However, for many years international commissions have been aware that dBA is an overall value which may simulate neither the spectral selectivity of human hearing nor its nonlinear relation to sound intensity. Thus, if sounds with different spectral envelopes are compared (e.g., various community noises), the dBA-value obtained may be an inaccurate indicator of human subjective response. Human hearing is possible to simulate much better via computer software or/and signal processors.

In the past, sound pressure level has been measured widely by A-weighting. At the same time, both in the laboratory and in the field evidence has accumulated that A-weighting predicts loudness and annoyance of community noise rather poorly. Not only does A-weighted sound pressure level underestimate the impact of the low-frequency components of noise (Goldstein, 1994), but it is also strongly dependent on the exposure pattern with time. For sounds that exceed 60 dB the reliability of A-weighting decreases. Moreover, A-weighted sound pressure level neither considers the effects of mutual masking among the components in a complex sound nor the asymmetry of masking patterns produced in the auditory system (Zwicker & Fastl, 1990). Yet, despite these well-known limitations, the A-weighted sound pressure level is widely used in practice.

The A-filter is unrepresentative of the loudness of sounds containing a mixture of noises and tonal components. In such cases, A-weighted sound pressure level is less suitable for the prediction of loudness or annoyance. That is also true for noise containing most of its energy in

the low-frequency range of 15-400 Hz. It may then underpredict perceived loudness by 7 to 8 dBA, relative to a 1,000 Hz target noise (Kjellberg & Goldstein, 1985). The reason is that loudness increases due to bandwidth increase and that spectrum shape is not accounted for to a satisfactory degree by the A-filter (cf. Zwicker, 1987). A decrease in A-weighted sound pressure level can result in a corresponding increase in loudness (Hellman & Zwicker, 1982) or annoyance. This clearly reveals the shortcoming of using overall SPL, either unweighted or A-weighted, as an indicator of loudness and annoyance

7.9.6.4 Low frequency noise and vibration

Low frequency noise is common as background noise in urban environments and as an emission from many artificial sources: road vehicles, aircraft, industrial machinery, artillery and mining explosions, and air movement machinery including wind turbines, compressors, and indoor ventilation and air conditioning units (Tempest, 1976; Leventhall, 1988). The effects of low-frequency noise are of particular concern because of its pervasiveness due to numerous sources, efficient propagation and reduced efficacy of many structures (dwellings, walls, and hearing protection) in attenuating low frequency noise compared with other noise (B. Berglund, Hassmén, & Job, 1994).

Intense low frequency noise may produce clear symptoms including respiratory impairment and aural pain (von Gierke & C.W. Nixon, 1976; see also von Békèsy, 1960). Although the effects of lower intensities of low frequency noise are difficult to establish for methodological reasons, evidence suggests that a number of adverse effects of noise in general may be greater for low frequency noise than for the same noise energy in higher frequencies: loudness judgments and annoyance reactions are greater for low frequency noise than other noises for equal sound pressure level regardless of which weighting scheme is employed (Goldstein, 1994); annoyance is exacerbated by rattle or vibration induced by low frequency noise; speech intelligibility may be reduced more by low frequency noise than other noises (except those in the frequency range of speech itself because of the upward spread of masking) (Pickett, 1959; Loeb, 1986).

Noises with low-frequency components contribute to annoyance in at least three different ways (Lindberg & Backteman, 1988):

(1) A feeling of static pressure is produced by low-frequency components if they reach levels and frequencies above a certain threshold. Such “ear-pressure” may be produced, for example, by riding in a car for at least half a minute with the window slightly opened so constituting a Helmholtz resonator.

(2) Low-frequencies produce periodic masking effects in medium and higher frequencies. Speech sounds are strongly amplitude modulated, and conversation is disturbed although speech remains intelligible. The effect can be measured quantitatively by so-called masking-period patterns.

(3) Strong low-frequency components produced by aircraft may rattle doors, windows, and other contents of houses. These secondary physical sound sources may be much more annoying than the original primary low frequency component.

The general use of the A-weighting filter attenuates the low frequencies so that the A-weighted sound pressure level does not reflect the true impact of the noise load. A common practice is, therefore, to measure both A-weighted and C-weighted sound pressure levels, and by comparison identify the potential impact of low-frequencies in exposures.

With various sources, such as heavy trucks and trains or particular industrial plants, both noise and vibration effects occur. People are disturbed and annoyed by both factors; they also tend to “mix up” these effects or to perceive vibration as noise (Kryter, 1985, 1994; Griffin, 1990; Howarth & Griffin, 1990; Meloni & Krüger, 1990; Kastka & Paulsen, 1991).

Although firm scientific evidence is lacking, some consider by experience, that noise with a high proportion of low frequency components in some instances may be better tolerated by people than noises with a high proportion of high frequency components. However, comparison of socioacoustic survey results from different noise sources supports a greater reaction (for equal loudness) to sources with more low frequency noise. Reaction to aircraft noise is, thus, generally greater than reaction to road noise and this difference has been identified in direct comparison (Hall, Birnie, Tayler, & Palmer, 1981).

From WHO’s Guidelines for Community Noise (1999)

3.9. Effects of Combined Noise Sources

The evidence on low-frequency noise is sufficiently strong to warrant immediate concern. Various industrial sources emit continuous low-frequency noise (compressors, pumps, diesel engines, fans, public works); and large aircraft, heavy-duty vehicles and railway traffic produce intermittent low-frequency noise. Low-frequency noise may also produce vibrations and rattles as secondary effects. Health effects due to low-frequency components in noise are estimated to be more severe than for community noises in general (Berglund et al. 1996). Since A-weighting underestimates the sound pressure level of noise with low-frequency components, a better assessment of health effects would be to use C-weighting.

A-weighted sound level measurements reflect the technology and industrial environment of the 1930’s! It’s time to update the noise pollution standards and references that are used today in a manner that reflects contemporary industrial technology and current research.