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Good practice guide on noise exposure and potential health effects

The report outlines how noise pollution can affect wellbeing and perhaps also health. Annoyance and heart disease are highlighted here. The report follows an EU Directive on noise pollution and aims to encourage harmonisation of responses across Europe.

For every proposed health effect of noise exposure, there is a different optimum measure of noise. Some measures emphasise total energy, some impulses, some tonal quality etc. and combinations. Thus, aircraft noise, road traffic noise, industrial noise effects have all been evaluated in different and inconsistent ways. Effects on annoyance and effects on sleep disturbance are measured as L_{den} and L_{night} respectively and defined in law. Values are expressed as dB, familiar from noise induced deafness science, but not exactly the same. So called 'A' weighting is generally used but can be replaced by sound pressure level if the key effect is impulse noise.

Directive 2002/49/EC relates to the assessment and management of environmental noise. Annex 1 defines L_{den} and L_{night}.

The day-evening-night level L_{den} in decibels (dB) is defined by the following formula:

$$L_{den} = 10 \lg \frac{1}{24}\left(12 * 10^{\frac{L_{day}}{10}} + 4 * 10^{\frac{L_{evening}+5}{10}} + 8 * 10^{\frac{L_{night}+10}{10}}\right)$$

in which:

— L_{day} is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the day periods of a year,

— $L_{evening}$ is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the evening periods of a year,

— L_{night} is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the night periods of a year;

Annoyance is therefore regarded as more likely in the evening and at night (as indicated by adding 5 and 10 respectively to actual measurements of db(A) average). lg means $\log_{10}$.

Strategic noise maps have been made available online, to inform the public e.g. http://www.scottishnoisemapping.org/public/view-map.aspx . But thus far coverage is patchy and often based on calculation rather than direct measurement. Local authorities are obliged to make accurate maps and then plan ways in which thresholds will not be exceeded.

Nuisance is the most likely theory to apply. However there are uncertainties: material interest, physical damage, causation, foreseeability and public interest tests could prove challenging for claimants. In the event that all these tests are passed by the claimant it is of interest to review the evidence on causation provided in this report. There are some indications of an appropriate standard for local authorities to aim for, but these don't directly indicate risk of harm. Injunctive relief is the most likely outcome if thresholds are clearly broken and an attribution can be made.

The report concludes that the following effects are well established:

Table 2.1 Effects of noise on health and wellbeing with sufficient evidence

Effect	Dimension	Acoustic indicator *	Threshold **	Time domain
Annoyance disturbance	Psychosocial, quality of life	L_{den}	42	Chronic
Self-reported sleep disturbance	Quality of life, somatic health	L_{night}	42	Chronic
Learning, memory	Performance	L_{eq}	50	Acute, chronic
Stress hormones	Stress Indicator	L_{max} L_{eq}	NA	Acute, chronic
Sleep (polysomnographic)	Arousal, motility, sleep quality	$L_{max,\ indoors}$	32	Acute, chronic
Reported awakening	Sleep	$SEL_{indoors}$	53	Acute
Reported health	Wellbeing clinical health	L_{den}	50	Chronic
Hypertension	Physiology somatic health	L_{den}	50	Chronic
Ischaemic heart diseases	Clinical health	L_{den}	60	Chronic

Note: * L_{den} and L_{night} are defined as outside exposure levels. L_{eq} may be either internal or external as indicated.
** Level above which effects start to occur or start to rise above background.

Some of these could be validated. Besides ischaemic heart disease the rest are at best biological effects with inefficient links to ill health. Disease mechanism would need to be understood in some detail if causation is to be argued.

Annoyed

Being highly annoyed (HA) might invoke the sympathy of the courts. Loss of enjoyment of property would seem to be implied, even if there is no obvious physical damage.

Aircraft:	$\%HA=-9.199*10^{-5}\ (Lden-42)^3 + 3.932*10^{-2}\ (Lden-42)^2 + 0.2939\ (Lden-42)$;
Road traffic:	$\%HA = 9.868*10^{-4}\ (Lden-42)^3 - 1.436*10^{-2}\ (Lden-42)^2 + 0.5118\ (Lden-42)$;
Railways	$\%HA = 7.239*10^{-4}\ (Lden-42)^3 - 7.851*10^{-3}\ (Lden-42)^2 + 0.1695\ (Lden-42)$.

For 50% of people to be highly annoyed L_{den} would be 75 dB(A) for air, 79 dB(A) for road and 85 dB(A) for rail. Precision suggests that to be quite certain that 50% would be highly annoyed these figures should be increased by 2 to 3 dB(A). However, the formulae are unreliable at above 80 dB(A).

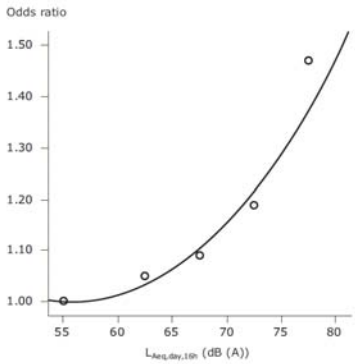
Wind turbines are much more annoying than road, rail or industry at a given average noise level. 26% find them highly annoying at 55 dB(A) compared with 6% for road and 2%-4% for rail at that level.

Sleep

The WHO-Night Noise Guidelines (2009) (http://www.euro.who.int/__data/assets/pdf_file/0004/131809/e94731.pdf) discusses in great detail the relations between, noise, sleep quality and health. Sudden loud noises either waken or change the stage of sleep. The report estimates that during 8 hours sleep, in the absence of potential disturbance a person will awaken, according to brain wave data, 24 times but be aware of only 1 or 2 per night.

Heart attack

Odds ratios for heart attack have been related to noise exposure as follows.



Excess risk of 10% (precision not stated) is observed at L_{den} = 70 dB(A) , 20% at L_{den} = 74 dB(A), 30% at L_{den} = 77.5 dB(A). In Germany, 5% are exposed at 70 – 75 dB(A) and 1.5% at greater than 75 dB(A). The authors estimate that 3% of heart attacks in Germany are statistically attributable to noise.

Planning authorities across Europe currently set very different target exposures. Average values for L_{den} road come to 58 dB(A) and L_{den} industry come to 52 dB(A). Average values for night time L_{night} are both 10 dB(A) lower. The recently issued WHO Night Noise Guidelines expanded the Community guidelines on the issue of sleep disturbance, and concluded that although biological effects kick in as low as L_{night} = 30 dB(A), L_{night} = 40 dB(A) should be an adequate health protection value, but also recommends an 'interim target' of 55 dB(A).

Comment

Insurability of harm done by environmental noise seems remote at present. Measurement and assignment of harm is very uncertain.

Annoyance is often linked to complaints of symptoms. See for example *Environmental Research* (2011) Vol. 111 p 164–170 where the alleged cause of annoyance was odour. Perception of odour was much less important than being annoyed by it. This would tend to argue against the odour having a direct chemical effect on health. Pesticides are a common cause of complaints of symptoms. Sometimes symptoms, and the response to them, lead to the appearance of there being harm.