Wind farms, sound and health

health

Community information

Sound and hearing are complex concepts. This fact sheet explains these concepts, particularly as they relate to wind farms and health, and provides definitions of the most commonly used language.

What is sound?

Sound is produced by vibrations which cause pressure changes in a medium such as air. The resulting waves of pressure travel in all directions away from their source. When these sound waves fall on the human ear, the sensation of hearing is produced.

Audibility refers to whether or not a sound can be heard; sounds which we can hear are **audible**; sounds which we can not hear are **inaudible**.

Noise is unwanted sound.

Environmental noise (also known as noise pollution) can be caused by air and road transport, industry, and commercial and domestic activities.

Sound level refers to the intensity of a sound. Generally, the higher the level, the louder a sound will seem. As sound waves travel away from a source, the level decreases (the sound gets 'quieter').

Sound level is measured in **decibels (dB)**. The scale of human hearing is typically 0 dB to 130 dB (threshold of pain).

Loudness is how intense a sound seems when heard by the human ear. Loudness depends on the sound level, but also on other factors, such as the frequency, duration and character of the sound, and the hearing sensitivity of the listener.

Frequency of sound (also referred to as **pitch**) is the rate of reception of the sound pressure wave. It is measured in **hertz (Hz)** or cycles per second.

Sounds with mostly low frequencies often sound like a rumble, such as thunder. Sounds with mostly high frequencies often sound like a buzz or whine, such as mosquitoes.

Sounds can be grouped into categories according to frequency:

Infrasound (very low frequency sound)	Below 20 Hz
Low frequency sound	Below 200 Hz
Mid frequency sound	200–2,000 Hz
High frequency sound	2,000–20,000 Hz
Ultrasound	Above 20,000 Hz

For example:

- the lowest note of a double bass is 41 Hz (low frequency)
- the highest note on a piano is 4,186 Hz (high frequency)
- most human speech is in the range 300–3,000 Hz (mid to high frequency).

Most sounds contain a mix of many frequencies.

State Government Victoria

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What sounds can people hear?

The **frequency range of human hearing** is typically 20 Hz to 20,000 Hz for young healthy adults. However, frequencies outside of this range are audible if the sound is loud enough.

The ear is most sensitive to sounds in the 300–10,000 Hz range, similar to the range of speech. We are less sensitive to sounds outside of this range, particularly sounds below 20 Hz.

How is loudness measured?

Simply measuring the sound level does not tell us how loud a sound seems to the human ear, because the loudness of a sound depends not only on its level, but also on its frequency. Most sounds are a combination of many frequencies.

dBA is a sound measurement technique which takes account of the frequencies, as well as the levels, in the sound. It is representative of how our ears respond to noise.

Table 1: Typical dBA levels of environmental sounds

Noise source	Sound level (dBA)
Quiet bedroom	20–25
Rural night-time background	20–40
Wind farm (at moderate wind speed 7 m/s)	**35–45**[1]
Car at 64 km/h at 100 m	55
Busy general office	60
Pneumatic drill at 15 m	95
Jet aircraft at 50 m	105
Threshold of pain	130

dBG can be used for sounds where infrasound may be significant. Infrasound levels at a short distance (< 360 m) from wind farms have been shown to be below 85 dBG, which is the hearing threshold for infrasound. At this level, the infrasound will be imperceptible, even for people with sensitive hearing.

How are low frequency sounds different from higher frequency sounds?

Sound levels decrease as sound waves travel away from their source. However, sound levels of lower frequencies decrease less quickly than higher frequencies.

For example, when standing next to a road, the higher frequency sounds of the tyre against the road are most obvious. At a large distance, the sound which remains is the rumbling low frequency noise from the engines.

It is more difficult to insulate against low frequency sound than mid and high frequency sound. This explains why bass sounds are often the main component of music heard from the next-door neighbour's sound system. It also explains why low frequency sound from wind farms can seem more prominent than higher frequency sound inside houses.

Infrasound

Infrasound is very low frequency sound; it usually refers to sounds with a frequency below 20 Hz. It is commonly believed that infrasound is inaudible. While it is true that we are less sensitive to sounds below 20 Hz, the human ear can perceive sounds in this range if they are at very high levels.

Infrasound is perceived by the ear like other frequencies, so it has to be audible to be detected. However, the sensation it produces is different to that of higher frequencies. This has led to confusion regarding how infrasound is detected and how it affects the body.

Most infrasound is accompanied by sounds at other frequencies, so it is unusual to experience pure infrasound.

There are **many sources of infrasound,** as shown in Table 2.

Table 2: Sources of infrasound

Natural environment	Household and industry	Human body
Waves Wind Waterfalls	Air conditioning Rail traffic Power plants	Breathing Chewing Heart beat Head movement

Infrasound is produced by the body at higher levels than many external sources, including wind farms. Humans have therefore been exposed to infrasound throughout our evolution.

1 Based on sound level measurements taken from multiple resident locations near two Victorian wind farms, at distances 500–1,000 m from the nearest turbine.

What sounds do wind farms produce?

Wind farms produce a range of sounds. The types of sound that can be heard depend on the type of turbine being used and the distance of the listener from the turbine(s). Landscape and weather conditions also impact on the character of the sound. An intermittent 'swish' sound is the main sound within approximately 300 m of a wind turbine.

Wind farm sound levels

At the distance of most neighbouring residents (for example, 500–1,000 m), the **level** (dBA) of sound from wind farms is lower than that of many other sources of environmental noise. This is shown in Table 1.

Frequency of wind turbine sound

Sound from wind turbines contains many different frequencies. The 'swish' sound is in the mid to high frequencies. Low frequency sounds may be more noticeable than the 'swish' at distances further away from the turbine.

However, wind turbines actually produce more mid and high frequency sound than low frequency sound.

Masking of wind farm sounds

Wind turbines produce more sound when wind speeds are higher. This means that they are louder when ambient sounds caused by the wind are also louder. The ambient sounds may mask sounds from the wind farm, making them less noticeable. This can make the measurement of wind farm sound more complex than other environmental sound.

Special audible characteristics of wind farms

Although sound levels from wind farms are generally low, there are some **special audible characteristics (SACs)** of wind farm sound that may be present, and may make the sound more annoying than predicted. Two of these SACs are **amplitude modulation** and **tonality**.

The 'swish' sound described above is caused by the regular rise and fall of the sound level as the blades of the turbine rotate. This variation in sound level is known as **amplitude modulation**.

Under certain conditions, particularly at night, this effect may be more noticeable; the swish may become a 'beating' or 'thumping' sound. It is unclear what causes this effect, but it may be more prominent when it occurs at multiple turbines at the same time. There is less ambient noise at night, so the noise generated by the wind turbines may seem relatively louder than usual.

However, this type of 'enhanced' amplitude modulation causing annoyance has only been detected at a small number of wind farms.

Sometimes a distinctive sound such as a hum or whine can be heard. This occurs when there is a dominant frequency associated with the noise (instead of an even mix of different frequencies). This is known as **tonality**. High frequency tones can be just as annoying as low frequency tones.

These special characteristics may not be detected by standard measurement, so must be specifically assessed. They can often be minimised by changing wind farm operating conditions.

How can noise affect health?

Perception of sound

Individuals perceive and react to sounds very differently. For example, a dripping tap in the night may be unbearable to one person and barely noticeable to another.

This is because the way we perceive sounds depends on many factors, relating to both the sound itself (such as the sound level and any SACs), and the individual's response to the sound.

Can inaudible sound affect health?

The evidence indicates that sound can only affect health at sound levels that are loud enough to be easily audible. This means that if you cannot hear a sound, there is no known way that it can affect health. This is true regardless of the frequency of the sound.

Annoyance

Annoyance is a recognised health effect of noise, and can contribute to other health effects, such as sleep disturbance.

A low level of audible noise is not a problem for most people. However, people may develop a negative (annoyance) reaction to noise, depending on how the noise is perceived. As described above, this is influenced by the noise itself, as well as the individual's response to the noise.

The individual's response to a noise can contribute more to annoyance and related health effects than the level or characteristics of the noise itself.

Individual response to noise

How sensitive a person is to noise is one factor which influences how they respond to noise. **Noise sensitivity** may occur for physiological reasons (such as natural hearing ability), psychological reasons (such as generalised anxiety or beliefs about noise generally) or external reasons (such as other life stressors).

Long term exposure to an annoying noise may increase a person's sensitivity to the noise, possibly because they are more focused on the noise and its negative associations. On the other hand, tolerance or habituation may develop over time; for example train noise which is noticeable upon moving into a new house often becomes less noticeable when the listener is more accustomed to it.

How are standards applied to noise?

Noise standards are used not only for environmental noise (such as wind farms and traffic noise) but also for industry and even household appliances.

Noise standards are set to protect the majority of people from annoyance. The wide individual variation in response to noise makes it unrealistic to set standards that will protect everyone from annoyance. A minority of people may still experience annoyance even at sound levels that meet the standard. This is the case not only for wind farms, but for all sources of noise.

For further detail, please see the accompanying fact sheet *Wind farms, sound and health: Technical information.*

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