Emission of Sound and Vibration

Wind turbine blades produce airborne pressure waves (correctly called sound but which, when unwanted, is called noise) and ground-borne surface motion (vibration).

Recent measurements have indicated that turbines generate vibrations even when shut down, presumably from the wind causing the flexing of large blades and the tower structure, and that this vibration (when turbines are shut down) can be measured at significant distances.

The airborne energy manifests as sound across a range of frequencies from infrasonic (0 to 20 Hertz(Hz)) up through low frequency sound (generally said to be below 200 Hz), and into the higher audible frequency range above 200 Hz. (Hertz is the variation in a particular changing level of sound pressure, at the rate of one cycle (or period) per second).

Sound at 100 Hz is audible at sound levels of around 27dB (decibels) for an average person, whilst the level of sound required for average audibility rises quite quickly below frequencies of, say, 25 Hz. Sensation, being non-auditory but bodily recognition of airborne pressure waves, occurs at lower pressure levels of infrasonic frequencies than can be heard. At infrasonic frequencies the “sounds,” i.e., pressure waves, exist and may be detected by the body and brain as pressure pulses or sensations, but via different mechanisms to the perception of audible noise.

Periodic pressure pulses are created by each turbine blade passing the supporting pylon. This is an inherent consequence of the design of horizontal axis wind turbines. These energy pulses increase with increasing blade length, as does the power generating capacity. People living near turbines have described the effect of these pulses on their homes as “like living inside a drum”.

Larger turbines produce a greater percentage of their total sound emissions as low frequency noise and infrasound than do smaller turbines. Therefore replacing a number of small turbines to a lesser number of larger turbines, whilst keeping the total power output of a wind project constant, will increase the total infrasound and low frequency noise (ILFN) emitted by the development. This effect will be compounded by increased wake interference, unless the turbines have also been repositioned further apart in accordance with the spacing specifications for the larger turbines. Wake interference results in turbulent air flow into adjacent turbines, with a consequent loss of efficiency, and increased ILFN generation.

If estimated sound contours have been used in seeking planning permits then replacing the permitted turbines with larger turbines will significantly increase the persistence of the wake turbulence, and thereby the sound emitted by adjacent turbines (and the proportion of ILFN emitted) will be significantly above the predicted contours. This is what occurred at the Waubra development; and will occur when a lesser number of larger turbines are used to maintain the generating capacity of the development, as occurred at Macarthur, (both projects being in Western Victoria).

Infrasound

Infrasound is common in our world, but most natural infrasound is irregular and random, or is caused by a transient event (e.g. earthquakes). Some frequency bands below 20 Hz have been shown experimentally to cause a physiological stress response in humans at below audible levels. Industrial machinery noises are often regular and repetitive, as is the case with wind farm noise emissions, across the audible and infrasonic frequency spectrum.

Infrasonic pulsations travel much larger distances than audible noise and easily penetrate normal building materials, and once inside can resonate building elements (i.e., increase in impact), inside rooms.

Infrasonic pulsations from a single 4 MW wind turbine were measured 10km from their source by NASA researcher William Willshire in 1985. Recent data collected by acoustician Les Huson in Australia and in the United Kingdom at onshore and offshore wind developments has shown that attenuation (reduction in sound level with increasing distance from the source) can be much less than the 3dB per doubling of distance found by Willshire in 1985.

Some acoustic pressure pulsations are relatively harmless and indeed even pleasant to the body, including waves on a beach. Organ music at frequencies just below 20 Hz generates ‘feelings” in people that can be either pleasant or unpleasant, and have been designed to produce emotive effects. Once it is understood that different frequencies can have very different effects on humans it is easy to understand the importance of accurate acoustic measurement.

Dr Neil Kelley and his colleagues from NASA demonstrated in the 1980’s that wind turbine generated energy pulses and noise in the infrasonic and low frequency bands, which then penetrated and resonated inside the residents’ living structures, directly caused the range of symptoms described as “annoyance” by acousticians and some researchers. A more accurate general descriptor would be mild, serious or intolerable “impacts”.

Residents and their treating medical practitioners know these symptoms and sensations include repetitive sleep disturbance, feelings of intense anxiety, nausea, vertigo, headaches, and other distressing symptoms including body vibration. American Paediatrician, Dr Nina Pierpont, gave this constellation of symptoms the name “wind turbine syndrome” in 2009. Dr Geoff Leventhall, a British acoustician who was one of two peer reviewers of the NHMRC's 2010 Rapid Review, has accepted these symptoms and sensations as "annoyance" symptoms, which he attributes to a stress effect, known to him to be caused by exposure to environmental noise, one source of which is wind turbine noise.