23rd International Congress on Acoustics

The Acoustic Group
CONSULTING ACOUSTICAL AND VIBRATION ENGINEERS

The use of synthesised or actual wind turbine noise for subjective evaluation purposes

Steven Cooper

Two distinct steps to be undertaken in establishing the Relationship of wind farm noise to impacts.

Step 1

- **Use Acousticians and Psychoacousticians**
- **Acoustic measurements of wind farm noise**
- **Psychoacoustic assessment of community response**
- **Determine acoustic signature**
- **Accurately re-create acoustic signal**

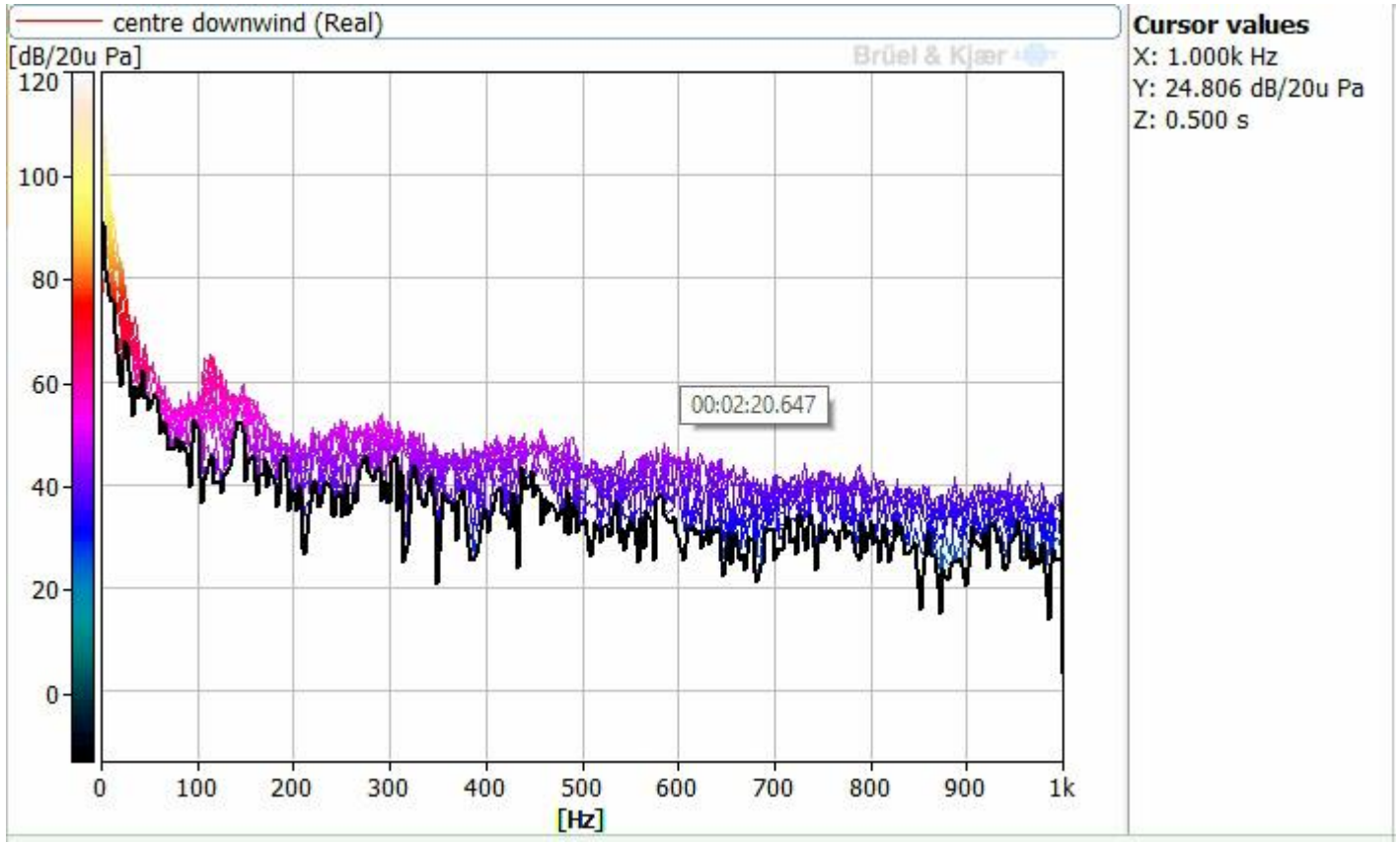
Two distinct steps to be undertaken in establishing the Relationship of wind farm noise to impacts.

Step 2 (Following Step 1 + on site sleep studies, with acoustic measurements)

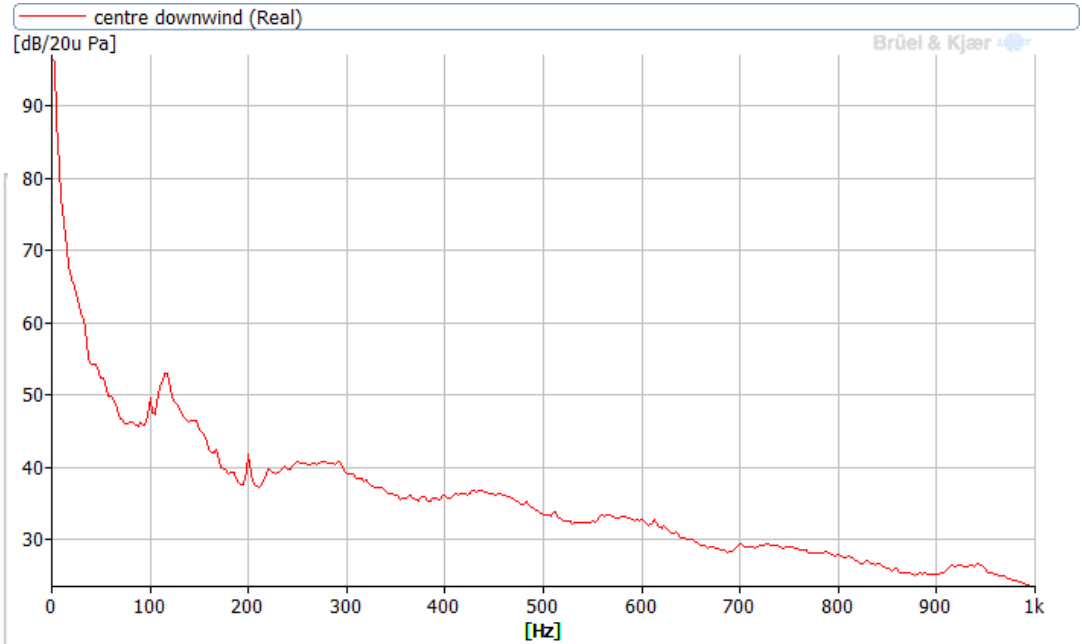
This involves multidisciplinary research involving acousticians and psychoacousticians, together with experienced medical practitioners, researchers and clinicians, including but not limited to the following speciality areas:

- **Sleep Physicians & physiologists**
- **Ear Nose & throat physicians and physiologists**
- **Neuroscientists**
- **Psychiatrists & Psychologists**
- **Cardiologists and cardiac physiologists**
- **Endocrinologists**
- **Rural General Practitioners**
- **Occupational Health Physicians**

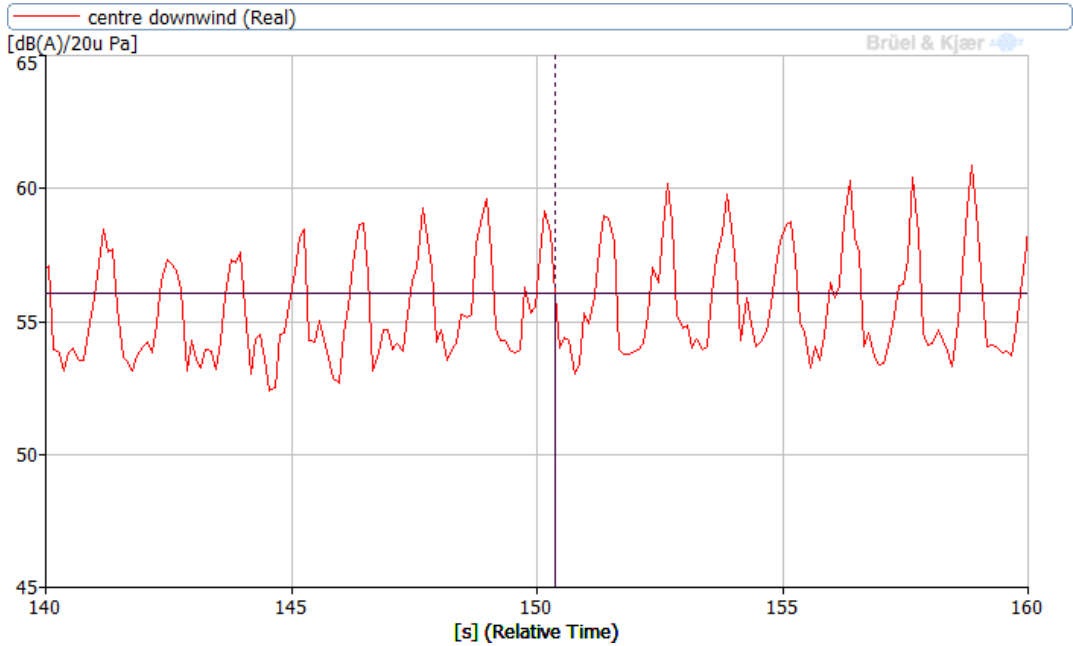
CBW Turbine 13 at 14% power



FFT vs Time (0-1 kHz, 400 lines)

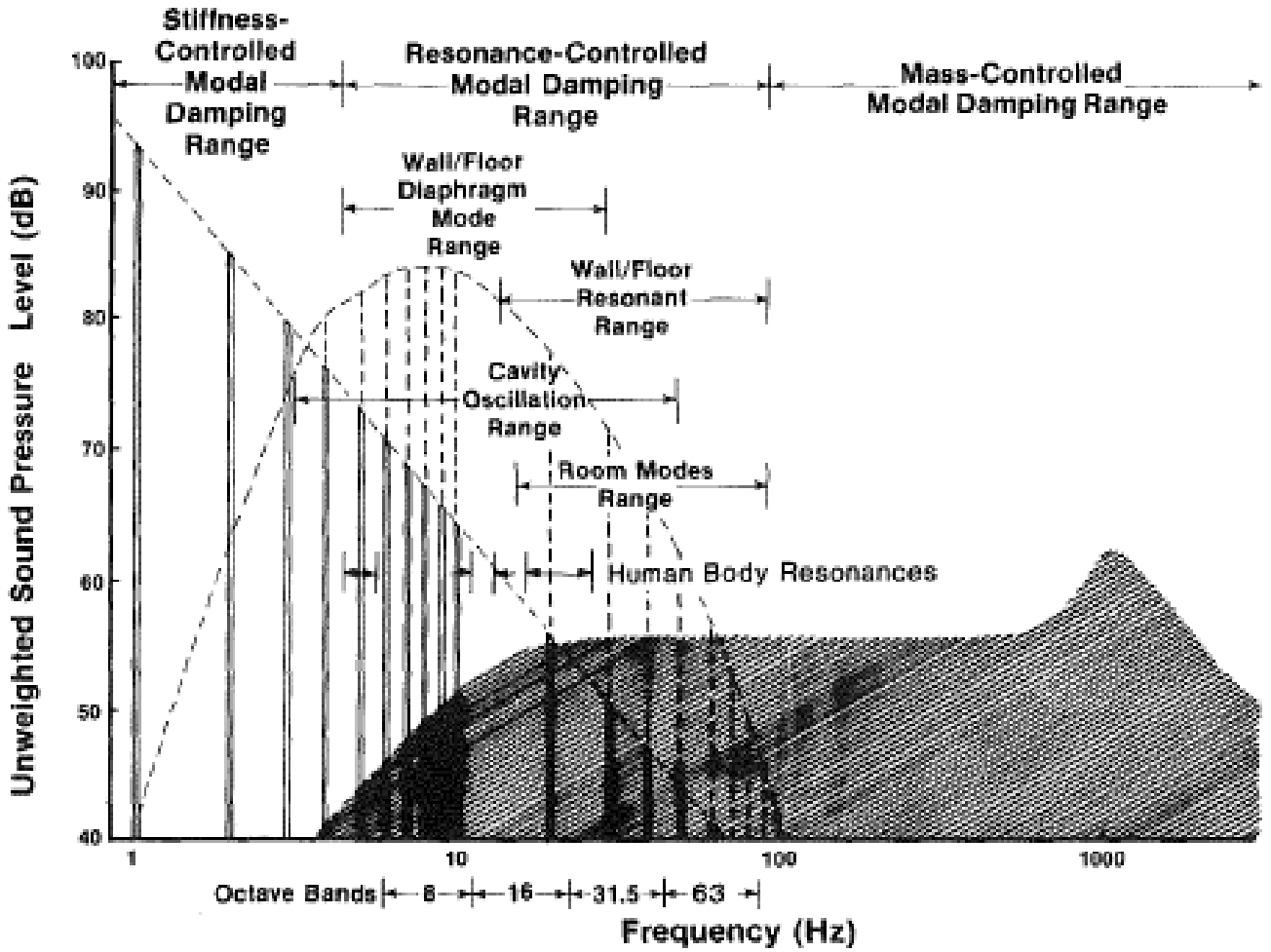


FFT (0-1 kHz, 400 lines)



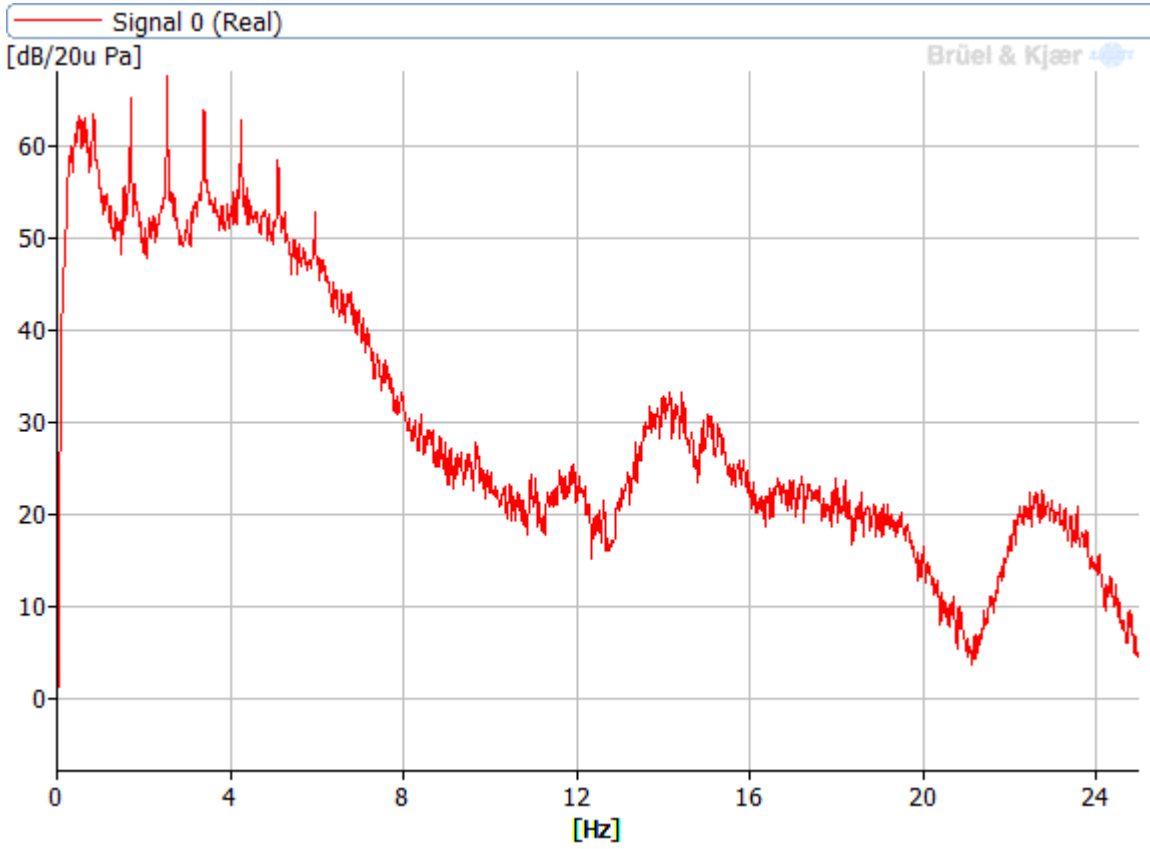
A-weighted Time Splice

Kelley N.D., Hemphill R.R. and McKenna H.E. A Methodology for Assessment of Wind Turbine Noise

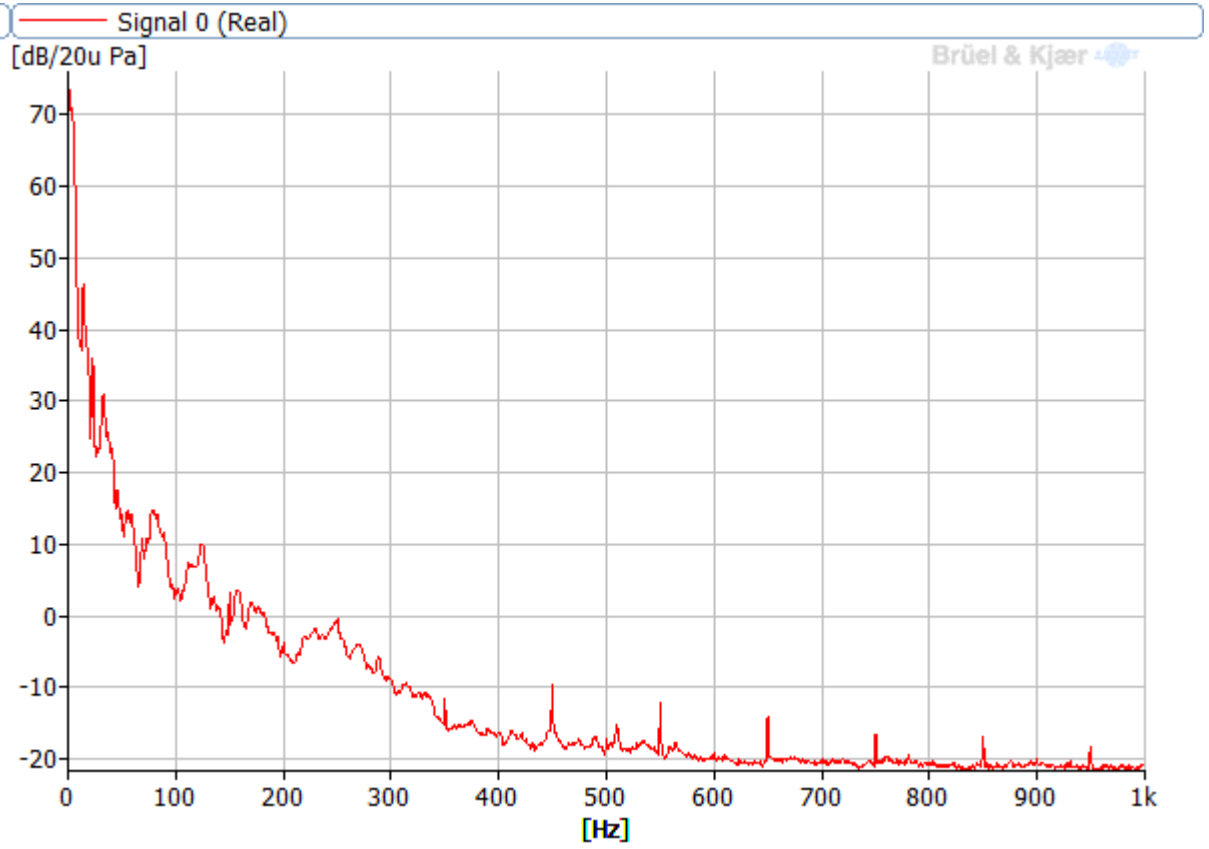


Turbine noise emission components with building and human body resonances superimposed

Cape Bridgewater Wind Farm, House 87 Bedroom, 5:30 am 22 May 2014, $L_{eq,\ 10\ minute}$ FFT (1600 lines)

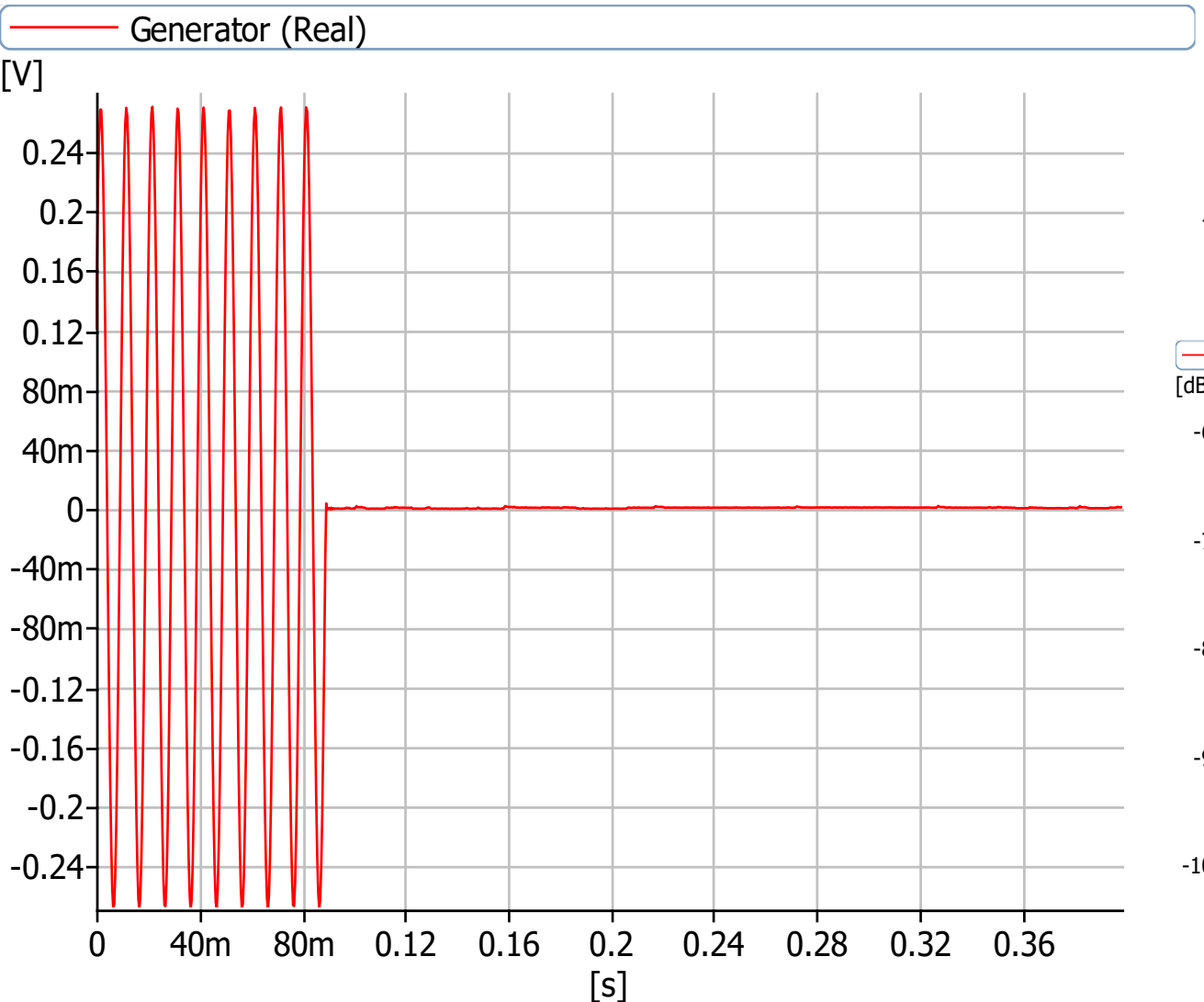


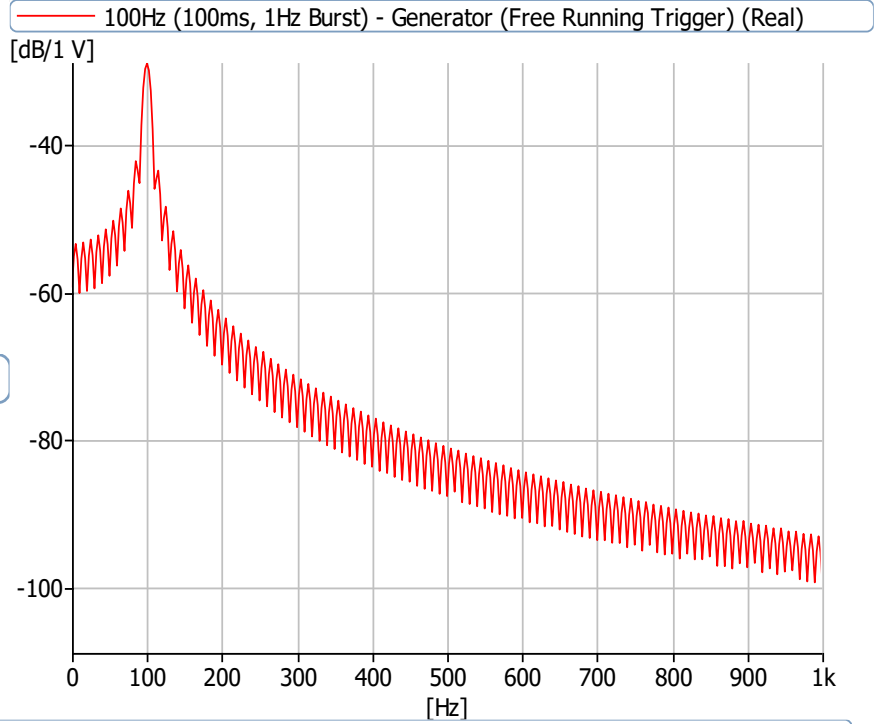
0 – 25 Hz

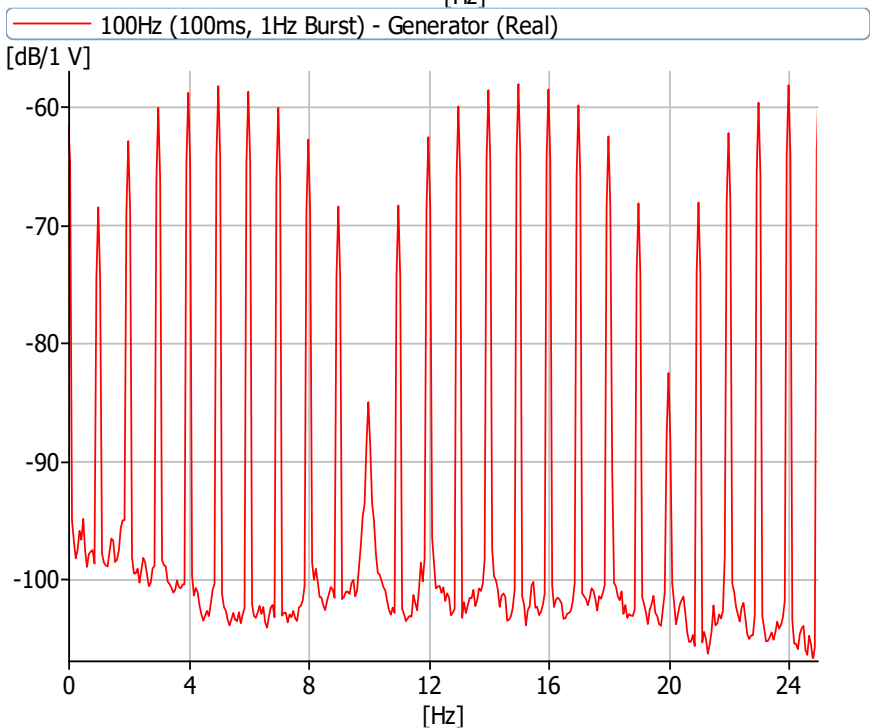


0 – 1 kHz

100 Hz 100 ms Burst







Health Psychology

0278-6133/13/$12.00 http://dx.doi.org/10.1037/a0031760

Can Expectations Produce Symptoms From Infrasound Associated With Wind Turbines?

Fiona Crichton, George Dodd, Gian Schmid, Greg Gamble, and Keith J. Petrie
University of Auckland

Method

A total of 54 university students (34 women, 20 men) were exposed to 10 min of infrasound and 10 min of sham infrasound (no sound). Exposure sessions, which were counterbalanced, were conducted at the Acoustic Research Centre University of Auckland, in a listening room designed for subjective listening experiments and constructed to International Electrotechnical Commission standards (IEC 268–13). Infrasound transmitted during exposure sessions (40dB at 5Hz) was created using a combination of the Adobe® Audition software package with a Presonus® Firepod audio interface, and a Mackie® HR 150 active studio woofer. Participants were told they were being exposed to infrasound during both 10-min exposure sessions and the experimenter was also unaware when exposure was to infrasound or to sham infrasound.

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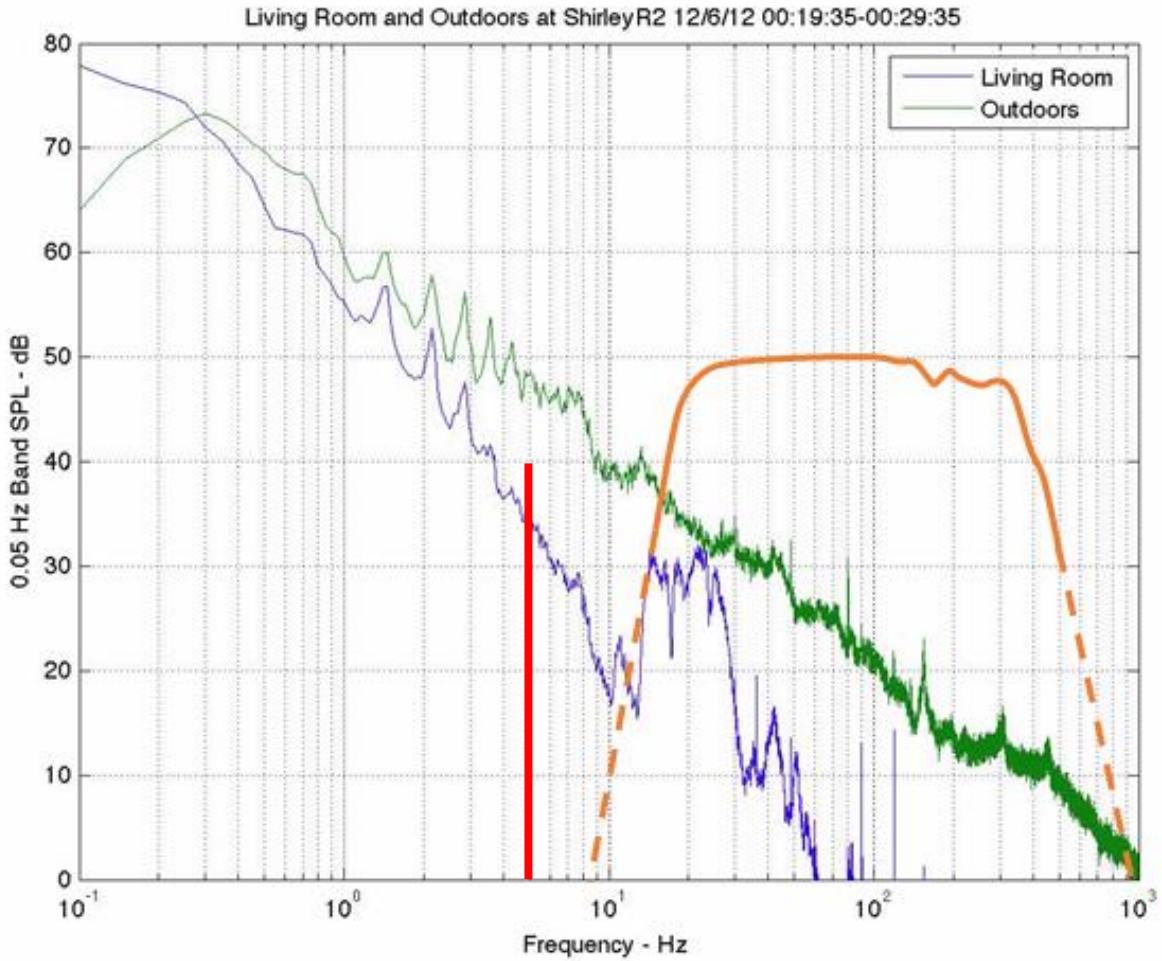
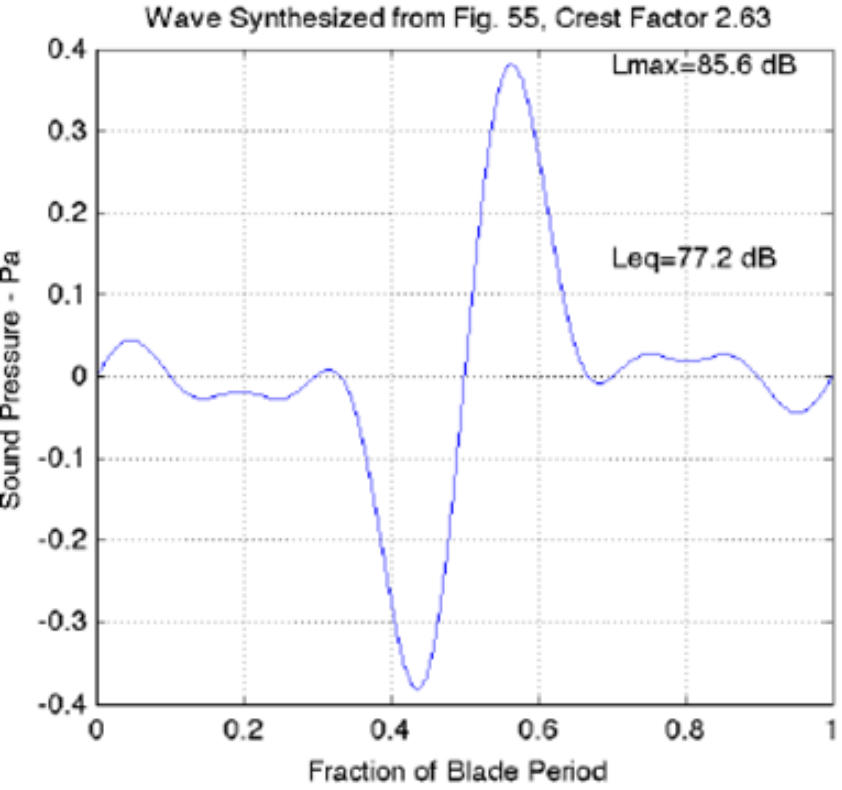
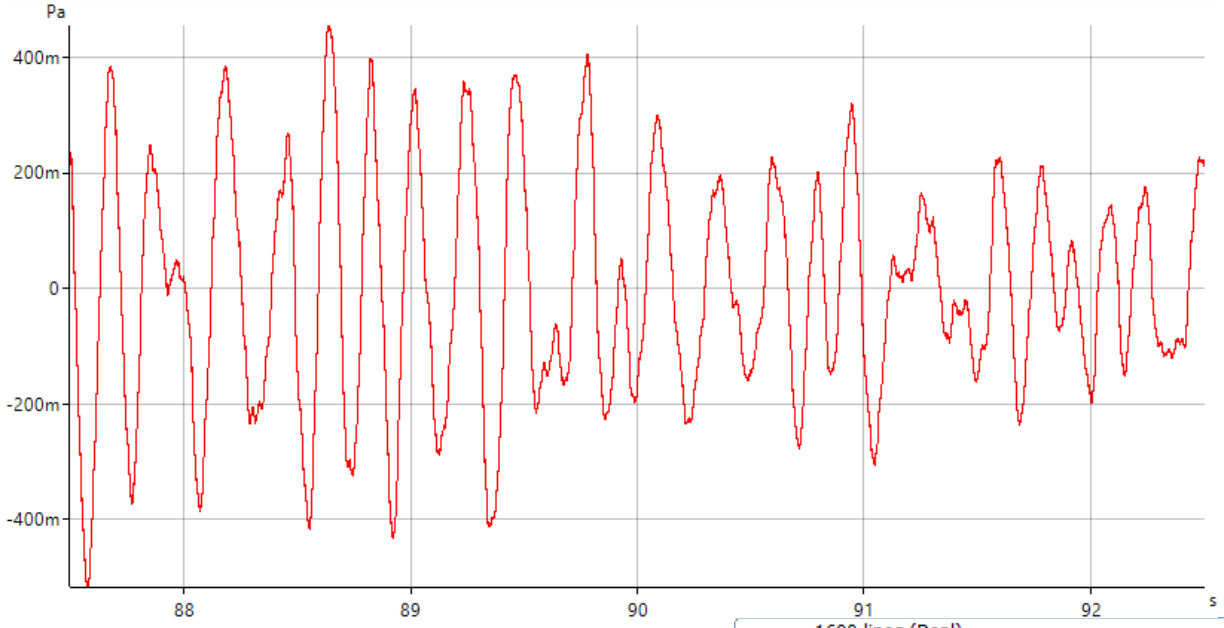


Shirley Wind Farm Report with manufacturers frequency response of speaker used in Crichton paper shown in orange trace

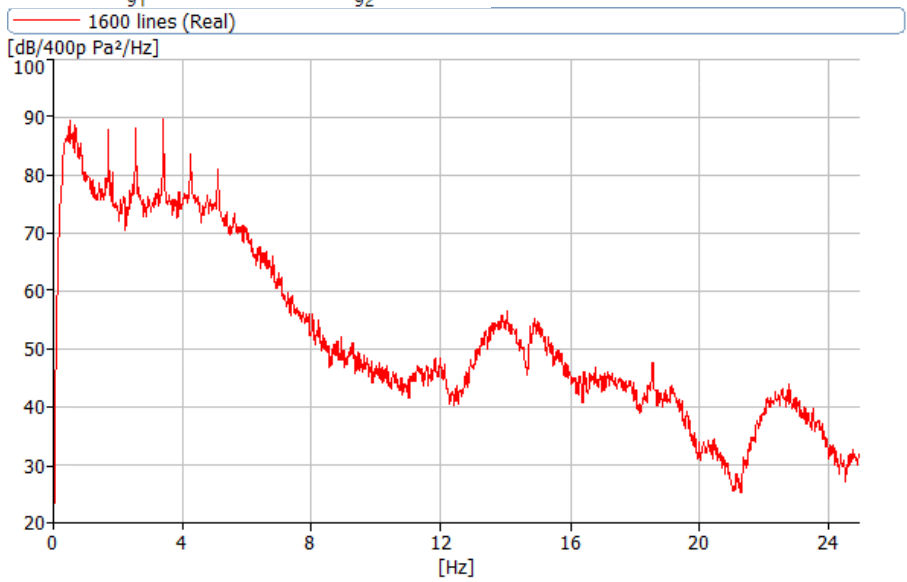
Walker B & Celano J “Progress Report on Synthesis of Wind Turbine Noise and Infrasound”



Walker Synthesised Waveform



Original Waveform



Original FFT (1600 lines, 0-25 Hz)

Original Article

Journal of LOW FREQUENCY NOISE, VIBRATION AND ACTIVE CONTROL

Journal of Low Frequency Noise, Vibration and Active Control
2016, Vol. 35(1) 77–90

DOI: 10.1177/0263092316628257
lfn.sagepub.com

SAGE

The effect of infrasound and negative expectations to adverse pathological symptoms from wind farms

Renzo Tonin[1], James Brett[2] and Ben Colagiuri[3]

Abstract

An investigation was conducted on the effect of reported pathological symptoms of simulated infrasound produced by wind turbines. There is ongoing debate in the scientific community concerning the cause of the negative health effects reported by people living near wind farms, whether those effects are caused by the infrasound itself, or alternatively by a psychogenic response (such as a nocebo effect) to a presumption that the infrasound is the cause. In this study, a simulated wind turbine infrasound pressure waveform was generated using a custom-built headphone apparatus. Volunteers were influenced into states of high expectancy of negative effects from infrasound, and low expectancy of negative effects and their reactions to either infrasound or a sham noise were recorded. It was found, at least for the short-term exposure times conducted here-in, that the simulated infrasound has no statistically significant effect on the symptoms reported by volunteers, but the prior concern volunteers had about the effect of infrasound has a statistically significant influence on the symptoms reported. This supports the nocebo effect hypothesis.

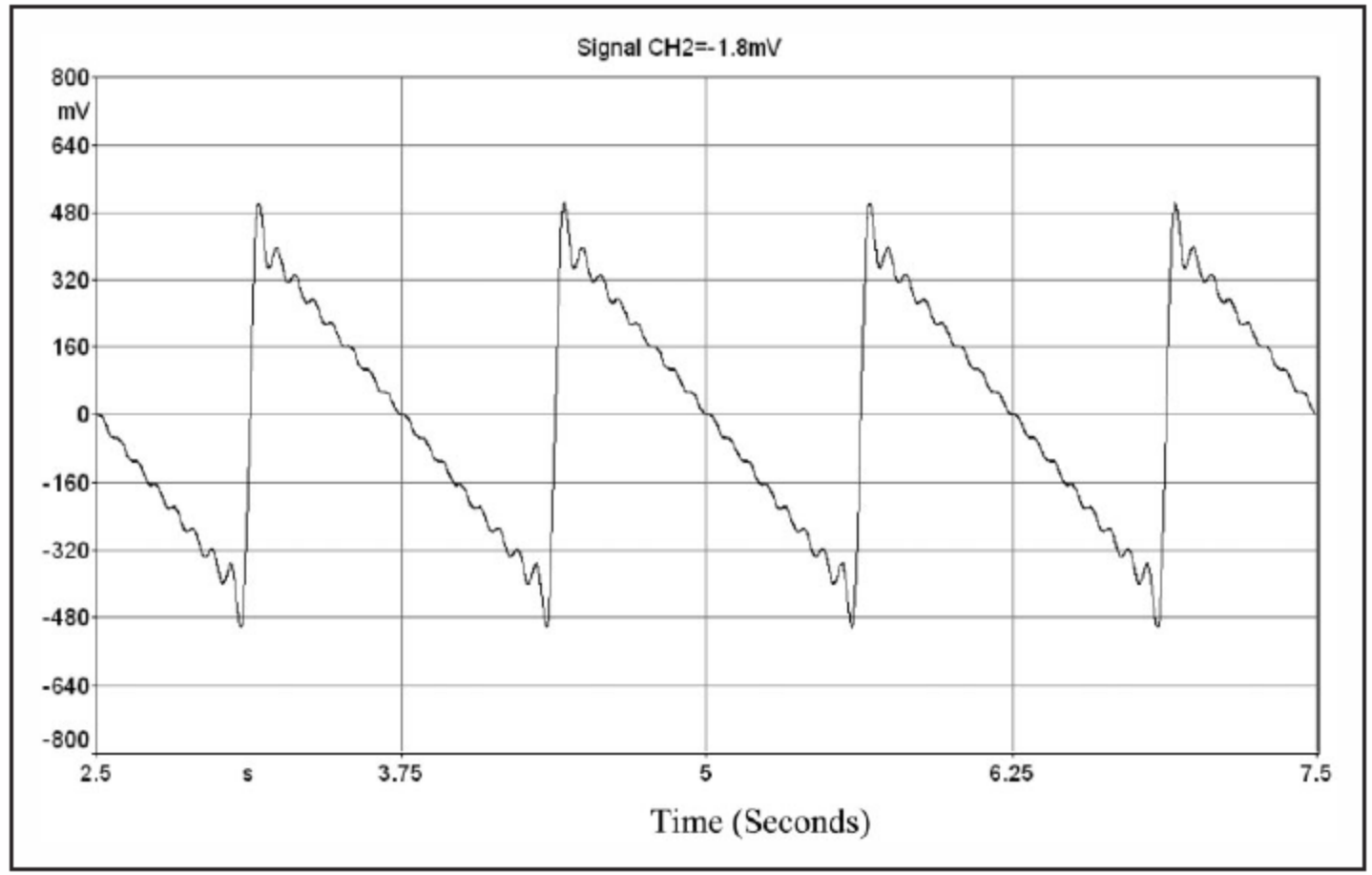
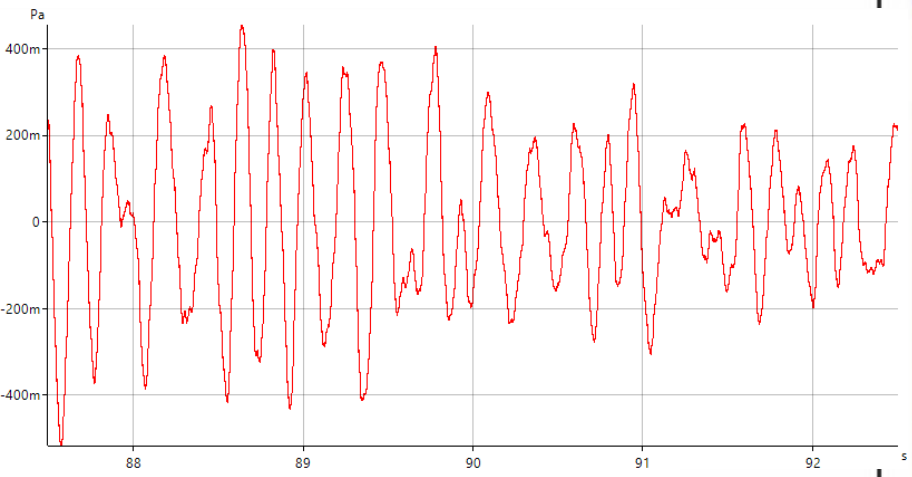


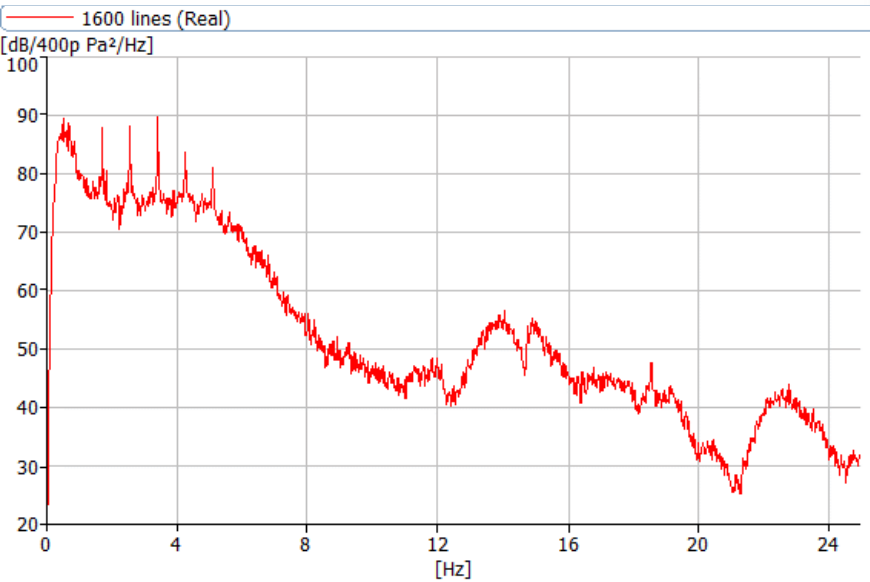
Figure 1. Infrasound signal used in experiment.

Cooper Results (field measurements)

Tonin Results (synthesised)



Waveform



FFT (0-25 Hz, 1600 lines)

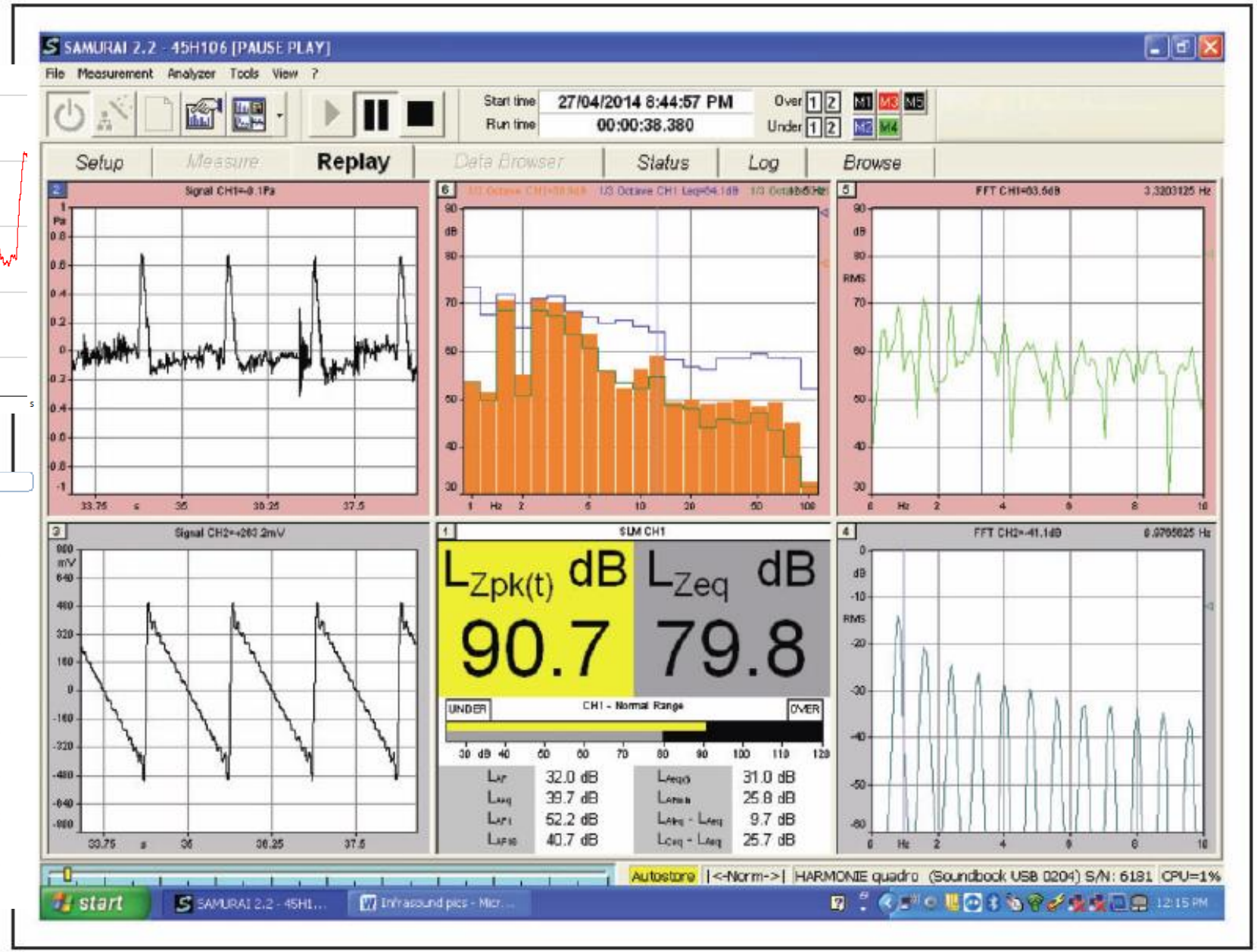


Figure 6. Soundbook with SAMURAI 2.0 software display during typical test.

Annexure D of ANSI/ASA S12.9-2016/Part 7 “Advanced Signal Processing Techniques”

It has been observed (Bray, Swinbanks, Walker, et al) that for complex low-frequency signals (those comprising multiple frequencies), the temporal relationship between the components can have a significant influence on their subjective assessment. (Indeed, al one needs do is listen to the difference between a gun-shot and an extended Galois sequence signal to observe the two signals with the exact same spectrum can sound dramatically dissimilar.)

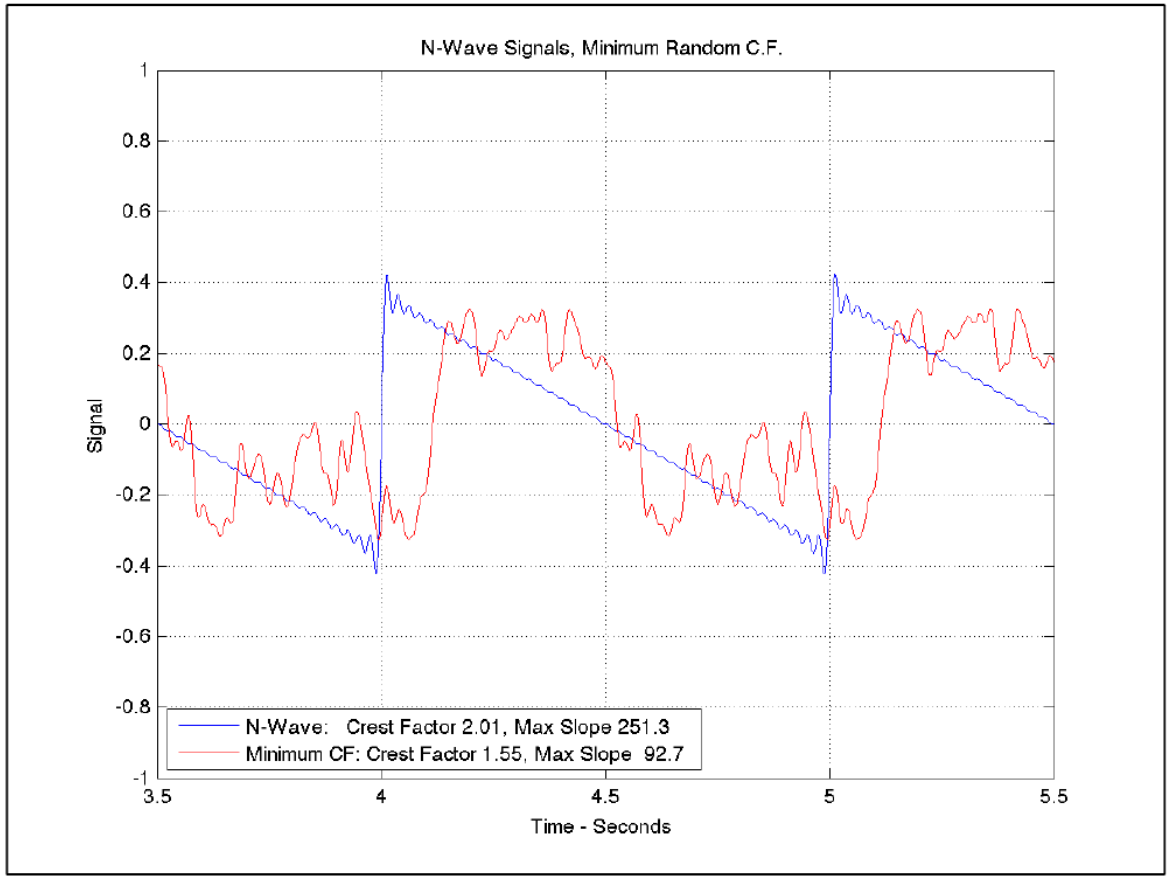


Figure D.1 – Two signals with exact same power spectrum and (therefore) autocorrelation function

Line Array Speaker System (2.5 inch rivers) showing the Cape Bridgewater Signal

Conclusion

- Testing of wind turbine infrasound should use actual signals of wind turbines and not a tone or a synthesised signal
- Infrasound levels attributed to wind turbine noise are less than the threshold of audibility for constant tones and therefore should be inaudible.
- Why test for infrasound only when wind turbine noise contains frequencies in the audible spectrum?
- The infrasound signature obtained by narrowband FFT analysis is the result of an analysis of transient pulses that can be derived by modulating sounds of much higher frequency
- For testing of wind turbine noise (including infrasound?) in a more practical sense, would be easier and realistic to simply use wave file recordings