HEGLEY ACOUSTIC
CONSULTANTS

FROST BOSS C49 FROST FAN
FIELD TESTING
NOISE REPORT

INTRODUCTION

This report sets out the results of field measurements undertaken on the night of 11 – 12 August 2010 of a Frost Boss C49 frost fan. Measurements were undertaken at 300m from the frost fan at 382 Twyford Road, Hastings as shown on Figure 1.

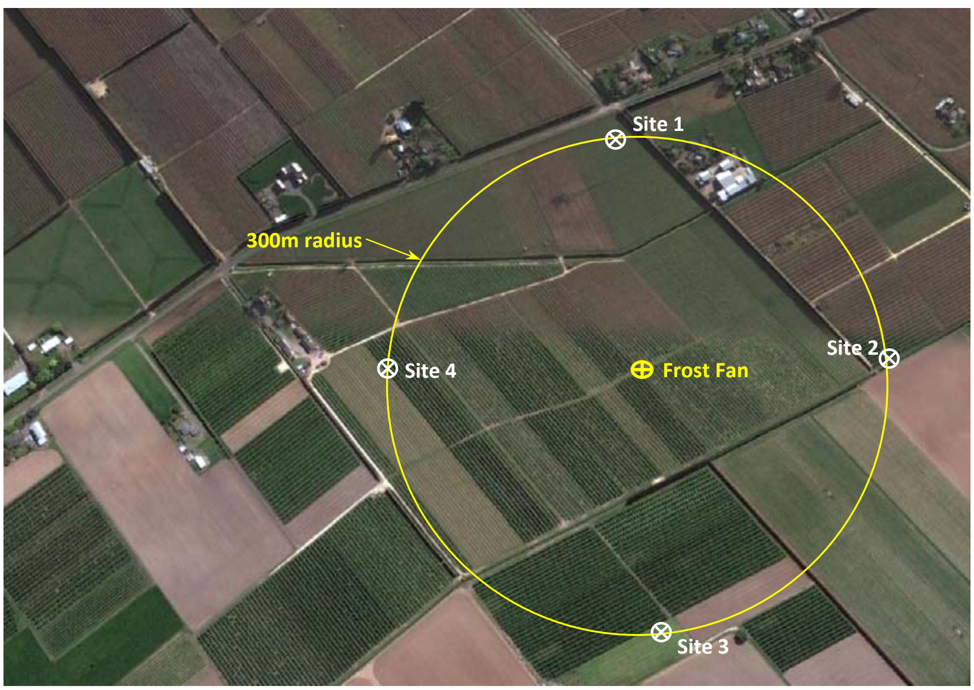

Figure 1. Test Locations

TEST CONDITIONS

The weather during the noise monitoring was fine and the sky was clear. It was generally calm although there was the occasional gust of wind as shown on Figure 2.

Normally these gusts would have shut the frost fan down but for the testing the automatic sensor was turned off. This did result in some temporary higher noise levels which have been included in the assessment (and are highlighted later in the report). The meteorological conditions were compatible with those set out for Category 5 in Concawe[1], which gives slightly enhanced meteorological conditions. Testing commenced with the temperature at 0^0C dropping to -2^0C at the completion of the testing. Even taking into account the occasional gust of wind, which did not have any significant effect on the results of the measurements, the conditions were considered ideal for monitoring the frost fan noise. The topography was flat with apple trees in a dormant state without any leaves in the orchard tested.

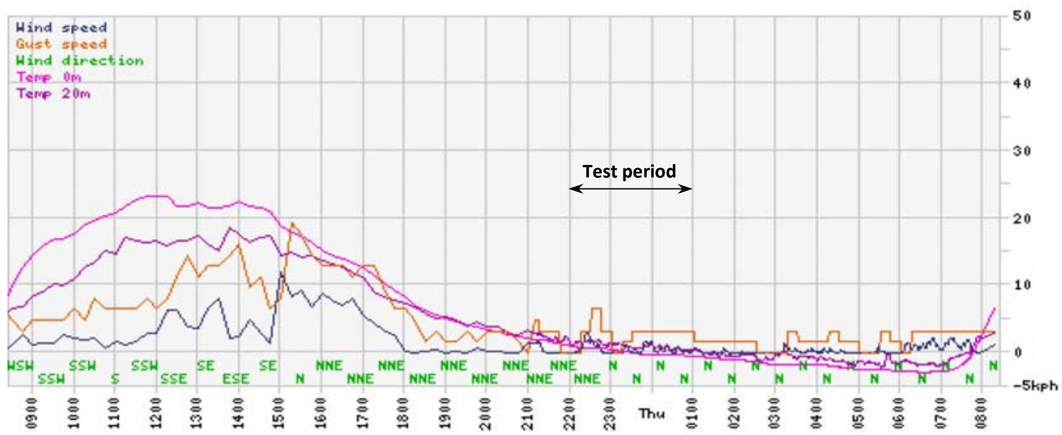

Figure 2. Meteorological Conditions

The technical information of the frost fan tested is:

- C49 Frost Fan
- 5.5m diameter
- fixed pitch (it cannot be changed)
- manufactured in composite materials by NZ Frost Fans
- upper gearbox is a DeRan GB11 ratio 42:25 = 1.68;
- lower gearbox is DeRan CT10 ratio 41:16 = 2.56;
- overall ratio of 4.3;

[1] The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities, Report No 4/81, May 1981 prepared by C J Manning, Acoustic Technology for Concawe's Special Task Force on Noise Propagation

- fan speed at 418rpm when the engine is at 1800rpm;
- external rotation ring gear teeth number = 112;
- rotation pinion teeth number = 8;
- procession time 6 minutes 40 seconds;
- engine details:
  - i) perkins 1006-6T (6 cylinder turbo diesel);
  - ii) 160 hp;
  - iii) diesel powered;
  - iv) muffler manufactured by NZ Frost Fans to Perkins specification;
  - v) engine rubber mounted and housed in a fully enclosed noise attenuated metal cabinet manufactured by NZ Frost Fans;
- tower height 10.5m.

The noise measurement equipment used was:

- Brüel & Kjær 2250 Hand-held Analyser platform with Sound Level Meter Software BZ 7222, Frequency Analysis Software and BZ 7225 Enhanced Logging Software. Re-calibration is next due in May 2011;
- Brüel & Kjær ½" type 4189 microphone, serial number 2650951. Re-calibration is next due in May 2011;
- Brüel & Kjær 4230 calibrator serial number 930422. Re-calibration is next due in September 2010;
- Brüel & Kjær type UA0237 90mm diameter Windscreen;
- All measurements were undertaken in accordance with the requirements of NZS 6801:2008 Acoustics - Measurement of Environmental Sound and assessed in accordance with the requirements of NZS 6802:2008 Acoustics – Environmental Noise.

TEST RESULTS

Measurements were undertaken at four locations at 300m; one upwind, one downwind and two at 90^0 clockwise from these two measurements as shown on Figure 1 and labelled Sites 1 – 4. Each site was measured for a minimum of 15 minutes, which gave just over two full rotations of the frost fan. The real time noise trace was recorded as well as the sound spectrum for each measurement.

Figure 3 - 6 shows an example of the real time trace for Sites 1 - 4.

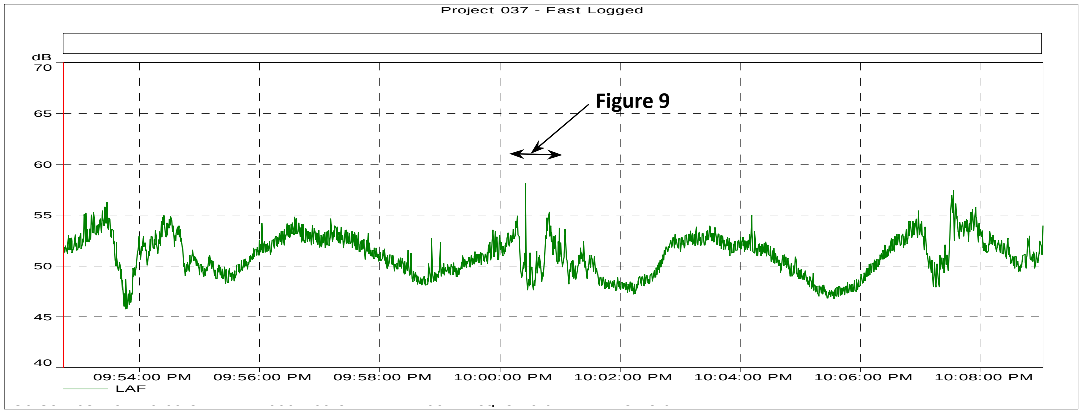

Figure 3. Real Time Noise Trace for Site 1

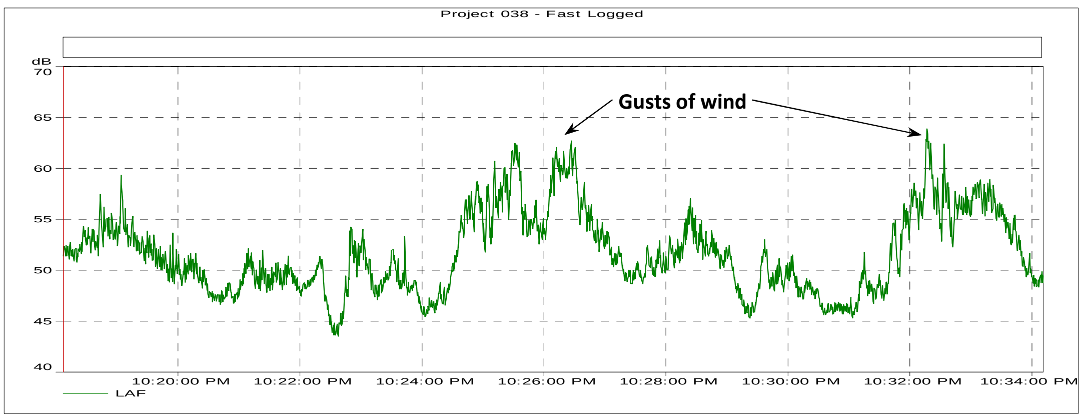

Figure 4. Real Time Noise Trace for Site 2

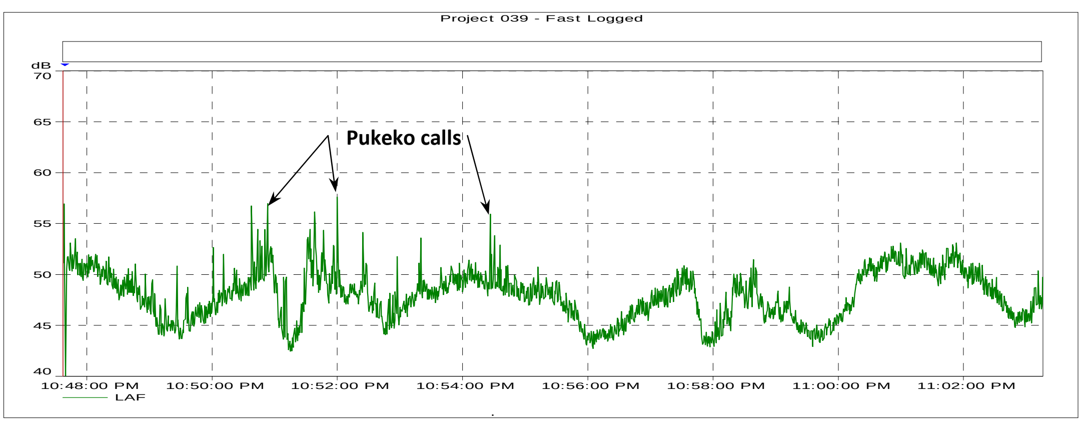

Figure 5. Real Time Noise Trace for Site 3

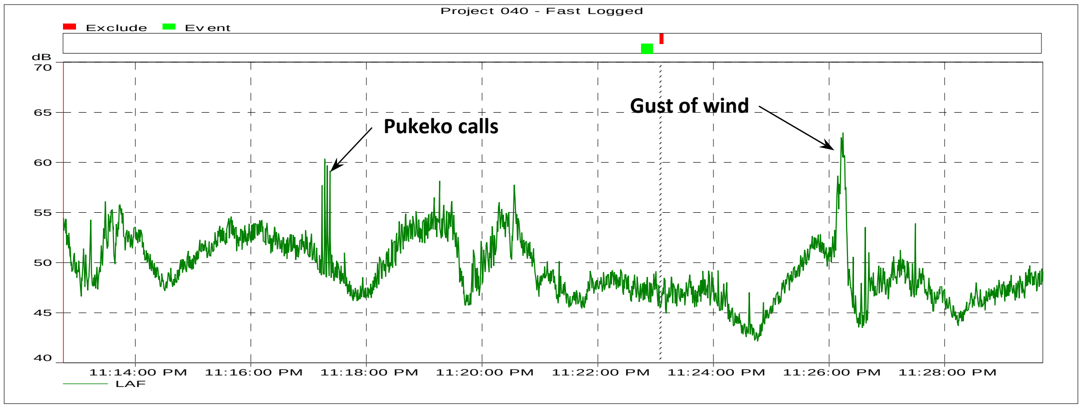

Figure 6. Real Time Noise Trace for Site 4

Figure 7 shows the sound spectrum in one third octave bands as measured over a 15 minute period for the tests undertaken at 300m and 1800rpm and Figure 8 shows the same information in octave bands for Sites 1 – 4. It is noted that the higher level recorded at Site 2 between 250 – 630Hz is the result of a gust of wind passing through.

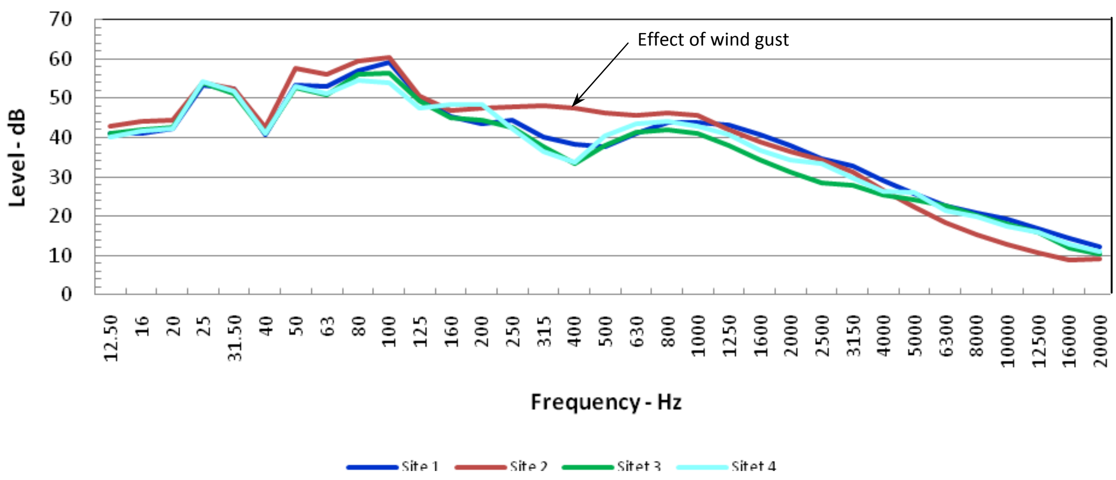

Figure 7. Sound Spectrum at 300m and 1800rpm (One Third Octave)

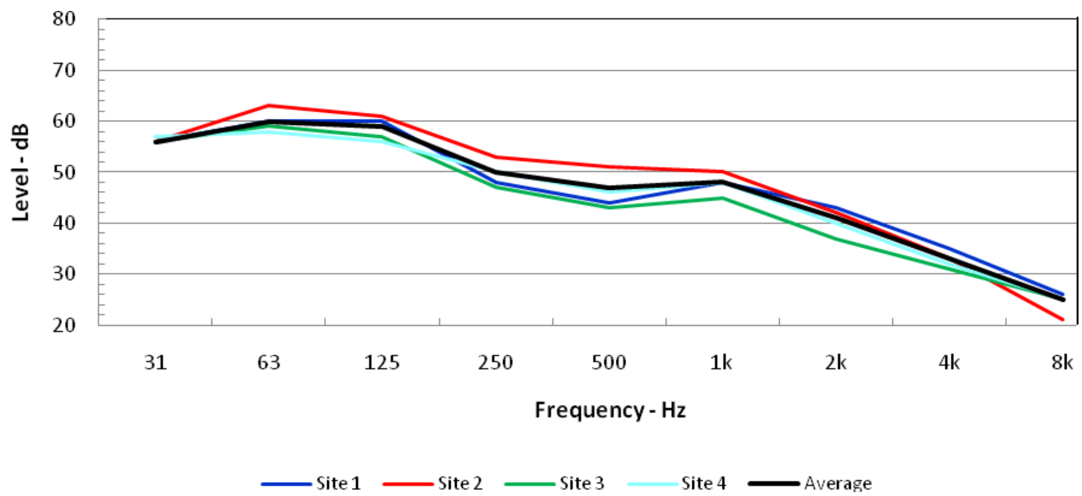

Figure 8. Sound Spectrum at 300m and 1800rpm (Octave)

The overall logarithmic average noise level over a minimum of 15 minutes duration at each of the four sites tested around the Frost Boss C49 frost fan at 300m is 51dB $L_{Aeq(15\ min)}$ with a ±2dB variation in four of the tests when operating at 1800rpm. This difference includes the effects of the wind gust, which would not normally occur as the machine would have automatically been shut down.

This gives a level of 55dBA $L_{Aeq(15\ min)}$ at 240m.

Appendix B4 of NZS 6802:2008 Acoustics – Environmental Noise sets the test to determine if there is a tone to the sound of interest. To determine if a tone is present the relevant section of the Standard states:

B4.2 Objective test methods

Where there is doubt about the presence of tonality, the following two methods provide an objective measure for tonality. The simplified test method may be carried out using one-third octave band measurement equipment. The reference test method requires the use of narrow band analysis. If the simplified method does not indicate tonality, it may still be necessary to use the reference method to confirm the presence or absence of tonality. In addition, the reference method can properly assess modulated tones or complex tones.

B4.3 Simplified test method for tonality

A test for the presence of a prominent discrete-frequency spectral component (tonality) can be made by comparing the levels of neighbouring one-third octave bands in the sound spectrum. An adjustment for tonality shall be applied if the LEQ in a one-third-octave band exceeds the arithmetic mean of the LEQ in both adjacent bands by more than the values given in table B2.

Table B2 - One-third octave band level differences

One-third octave band	Level difference
25 - 125 Hz	15dB
160 - 400 Hz	8dB
500 - 10000 Hz	5dB
NOTE - At frequencies below 500Hz the criterion could be too severe and tones might be identified where none is actually audible. For complex spectra the method is often inadequate and the reference method should be used.	

A visual check of the individual frequencies as set out on Figures 4 and 5 (1/3 octave and octave bands) does not indicate any tonal characteristic to the sound. In addition, a mathematical check of the differences in the frequencies has been undertaken, which verifies there is no tonal characteristic to the sound from the C49 frost fan operating. That is, there is no special audible characteristics to the sound.

There is also the potential of an impulsive sound from the frost fans this aspect of the sound has been considered. In the evaluation of the impulsive nature of the frost fan the testing undertaken during the wind gusts has not been included in the analysis as in normal conditions the frost fans would have turned off automatically under such conditions. This feature was overridden during the testing in order to ensure the 15 minutes required in accordance with the Council requirement was achieved.

When checking for impulsive noise guidance was taken from a DELTA[2] paper Objective Method for the Measurement of Prominence of Impulsive Sounds and for Adjustment of L_{eq} by Torben Holm Pederson, December 2000. Essentially, this paper adopted an approach that the sudden onset of a sound is defined as an impulse where the onset of a sound is defined as part of the positive slope of a time history of L_{pAF} where the gradient exceeds 10dB/s.

Figure 9 is an example of the checking undertaken where the most impulsive part of the sound trace shown in Figure 3 has been evaluated. Figure 3 shows the sound plotted at 10 times a second so the rise time can be evaluated accurately. From this trace the noise from the frost fan was not impulsive and this confirmed the subjective effect of these frost fans although as already noted, if the fans operate with a wind blowing there is the potential for there to be impulsive noise to the sound. However, operating the frost fans in windy conditions can damage the machines so they have automatic shut offs to ensure this does not occur during normal operation.

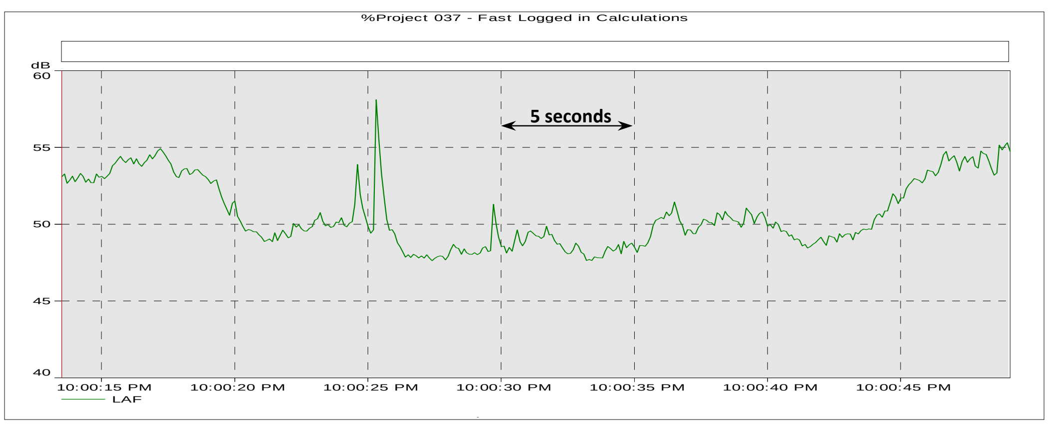

Figure 9. Inspection of Potential Impulsive noise

CONCLUSIONS

Based on the above, when measured in accordance with the requirements of NZS 6801:2008 Acoustics - Measurement of Environmental Sound and assessed in

[2] Danish Electronics, Light & Acoustics

accordance with the requirements of NZS 6802:2008 Acoustics – Environmental Noise, the noise from the Frost Boss C49 frost fan operating at 1800rpm is 51dB $L_{Aeq(15\ min)}$ when measured at 300m.

Based on field testing there are no special audible characteristics to the frost fan noise.

Field measurements have also been undertaken at 100m, 1700rpm and 1900rpm. While fewer measurements were undertaken for these tests, based on the more detailed testing undertaken at 1800rpm and 300m the additional measurements will be within ±2dB of any more detailed monitoring.

The sound power level has been calculated for 1800rpm and the sound power at 1700rpm will be 3dB lower and at 1900rpm 2dB higher than for 1800rpm.

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September 2010