NOISE FROM A ROOF-TOP URBAN WIND TURBINE IN LONDON

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1 INTRODUCTION

Baseline background noise measurements were taken in and around Ashenden House, Elephant and Castle. Planning consent was, conditional on noise and vibration monitoring of a 6 kW wind turbine. During the initial 3 months of operation measurements were taken on the roof top and in an unused flat directly below the turbine. A Proven wind turbine was installed in June 2007. In addition, wind, weather and electricity metering information was recorded. This paper reviews the initial results, taken over summer 2007, for more information[1,2].

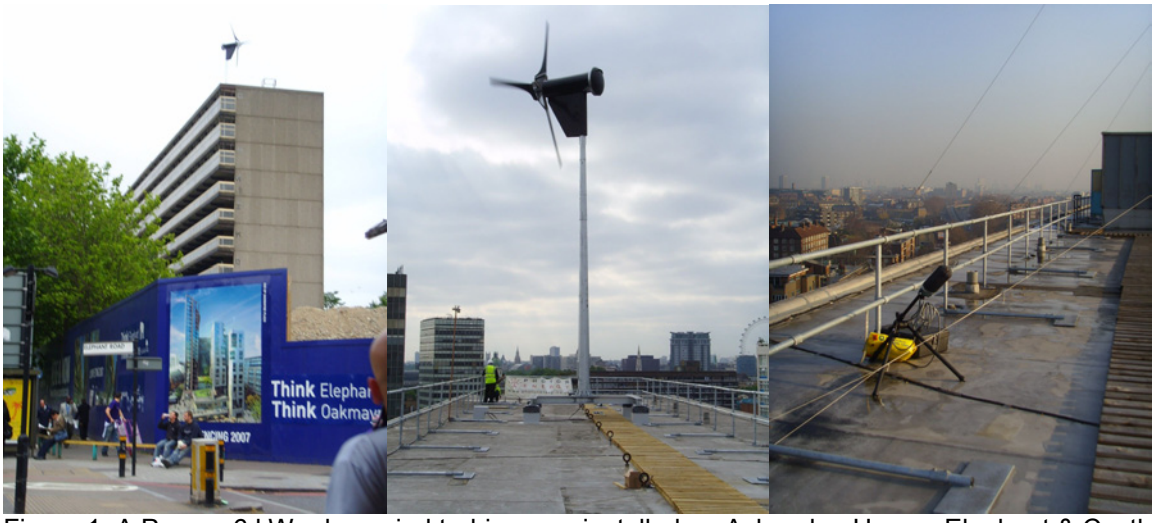

Figure 1. A Proven 6 kW urban wind turbine was installed on Ashenden House, Elephant & Castle

2 WIND TURBINE NOISE MEASUREMENTS

The noise from the wind turbine was measured at the two worst case positions, one external and one internal, see Figure 1. A CEL 593 sound level meter was positioned on the roof at 11m from the turbine. Another CEL 593 was located in the empty flat directly beneath the turbine, window partially open. The rooftop meter required an environmental measurement kit. A Nor121 weather station was used to monitor the rooftop conditions. All equipment took continuous 5 minute measurements for 1/3 octaves, L_{Aeq}, average wind velocity and peak wind velocity. Measurements were partially in accordance with BS61400:2003[3], this was due to the roof-top nature of the installation, it was not possible to measure equally around the turbine at a distance equal to the height of the turbine. Hence, it was agreed to take the roof-top measurements at a distance of 11m in the prevailing wind direction, south-westerly. It should also be noted that ETSU 97 was used for part of the noise measurement procedures[4].

BACKGROUND NOISE MEASUREMENTS

Background noise levels were taken on and around Ashenden House by 6 Masters' students on 6th March 2006. Each was given a calibrated sound level meter with a light foam windscreen, see Table 1. For determination of the measurement positions, BS7445-1:2003 was followed[5].

Position	*Sound level meter position*	*Equipment*
A	11th floor bedroom of flat 223 with no furniture, windows/doors closed	CEL 593
B	11th floor balcony opposite flat 223	B&K 2231
C	Roof top in the centre of the middle	B&K 2231
D	By the road site 3.5m from the wall boundary on New Kent Road	CEL 328
E	3.5m from the far garages behind the building	CEL 328
F	85m behind the building(3.5 m from edge of football play area)	B&K 2231

Table1. Measurement positions and Sound Level Meter details.

The measured values, $L_{Aeq,15min}$, for all positions were recorded simultaneously. Measurements were synchronised to begin at the following times: 14:40,16:00, 17:00,18:00,19:00,22:00,23:00, see Figure 2. Conditions were light winds, clear skies and dry roads.

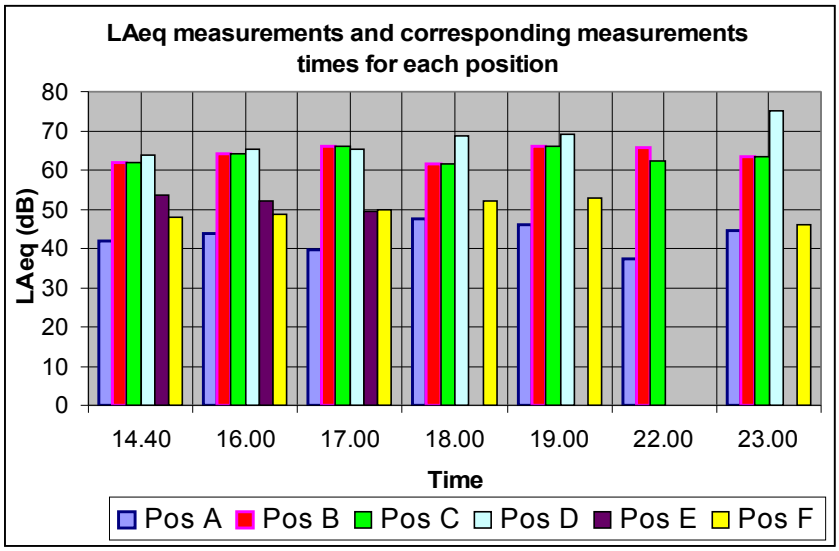

Figure 2. Analysed measured L_{Aeq} values for each measurement position

It can be seen from Figure 2 that the road noise is dominant, Pos B, C and D. Inside the flat the noise levels were significantly reduced. These levels would have been further reduced if a well fitting door rather than a temporary metal security door was fitted.

3 WIND MEASUREMENTS

Wind velocity measurements were monitored for 20 days in July 2007, giving 5300 5 minute events. Cyclic behaviour of average wind speeds was observed, see Figure 3.

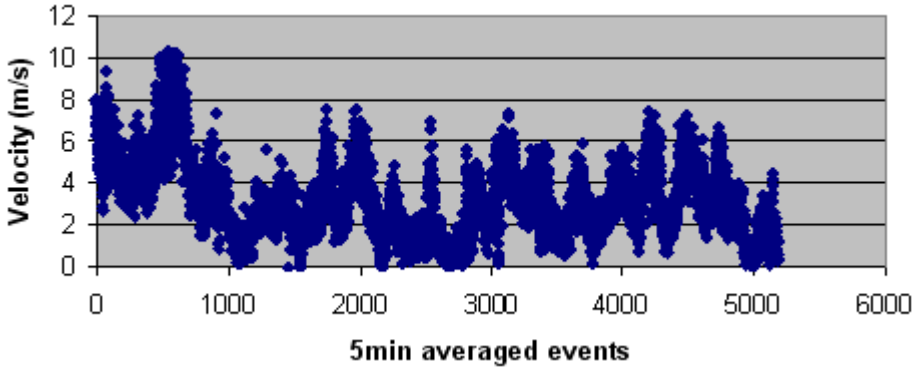

Figure 3. Roof top averaged wind velocity in July 2007 on Ashenden House

Analysing the data the median wind velocity was 3 m/s. It should be noted that approximately 57% of the wind speeds recorded were 2,3 or 4m/s, see Figure 4. There is also a long tail of higher wind velocities with a maximum of 11 m/s.

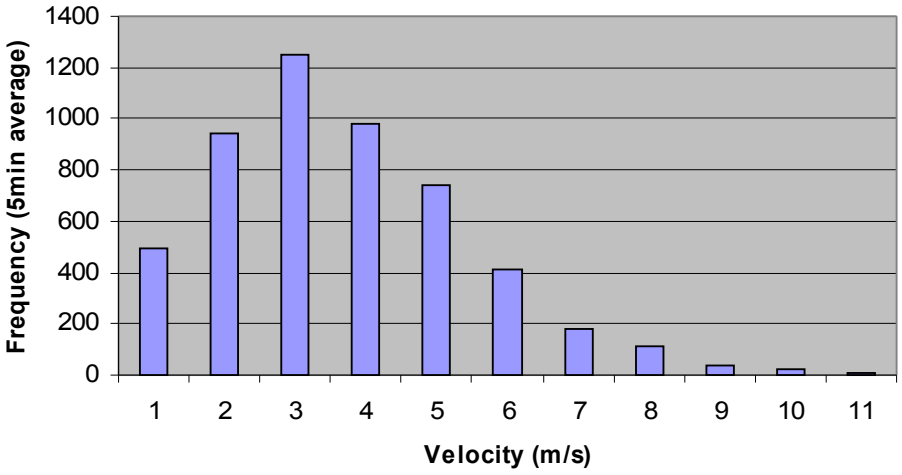

Figure 4. Frequency curve of wind velocities in July 2007 on Ashenden House

Wind measurements were also recorded over the month of August 2007. In total 28 days worth of data was collected, approximately 8000 5 minute averages, see Figure 5.

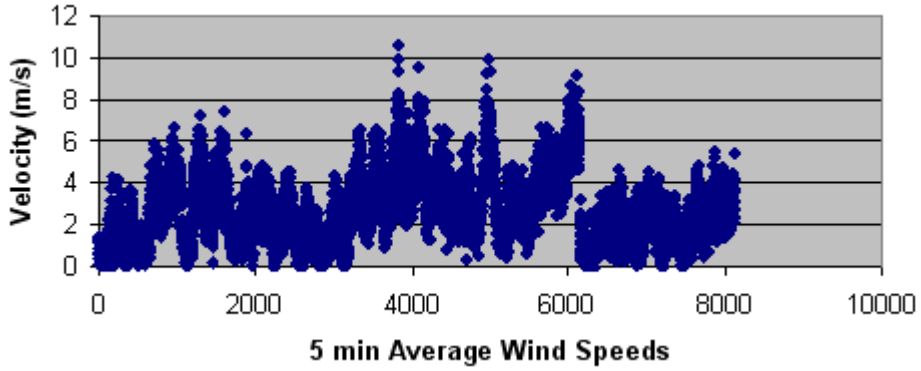

Figure 5 Roof top averaged wind velocities in August 2007 on Ashenden House

Similar results were seen for August, a median wind velocity of 3 m/s and approximately 47% of events being wind speeds of either 2,3 or 4 m/s. There is also a long tail of higher wind velocities with a maximum of 12 m/s. The cut in speed for the wind turbine was 3.5 m/s.

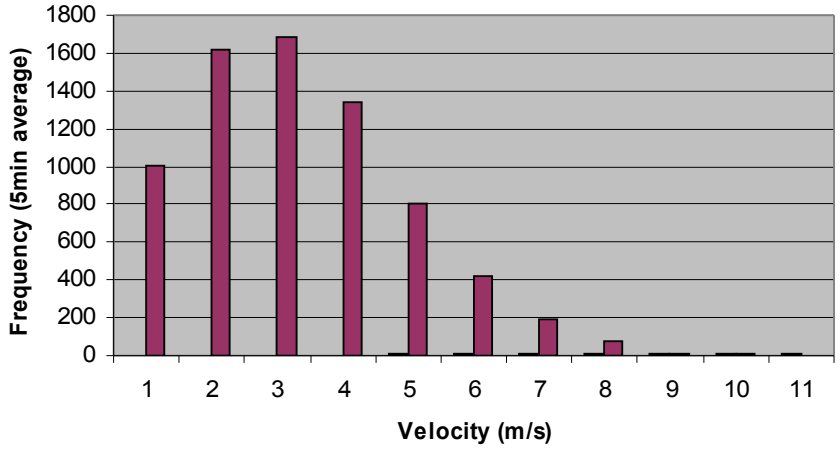

Figure 6. Frequency curve of the wind velocities in August 2007 on Ashenden House

4 INTERNAL NOISE MEASUREMENTS

Weekdays and weekends noise levels were measured inside the empty flat, see Figure 7 and 8.

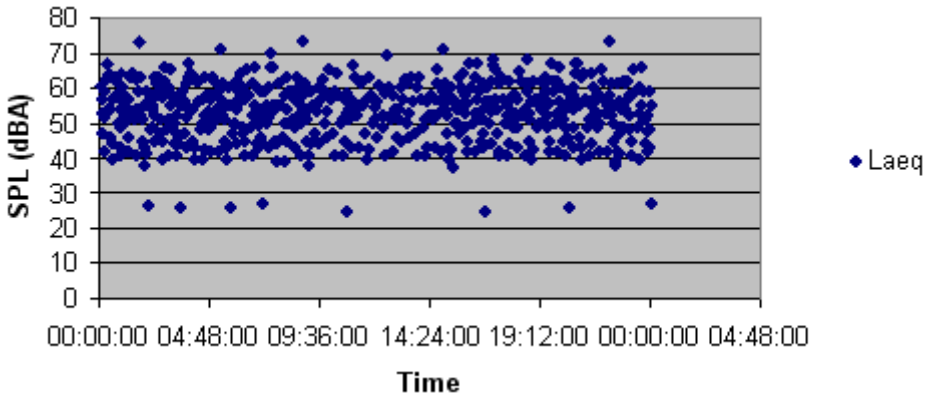

Figure 7. Noise levels ($L_{Aeq,\ 5min}$) in flat 223 Ashenden House during the week.

Figure 7 shows that over 3 days during the week that the noise levels ranged from 40-65 dBA inside the flat. This was in agreement with the previous background noise measurements, see Figure 2.

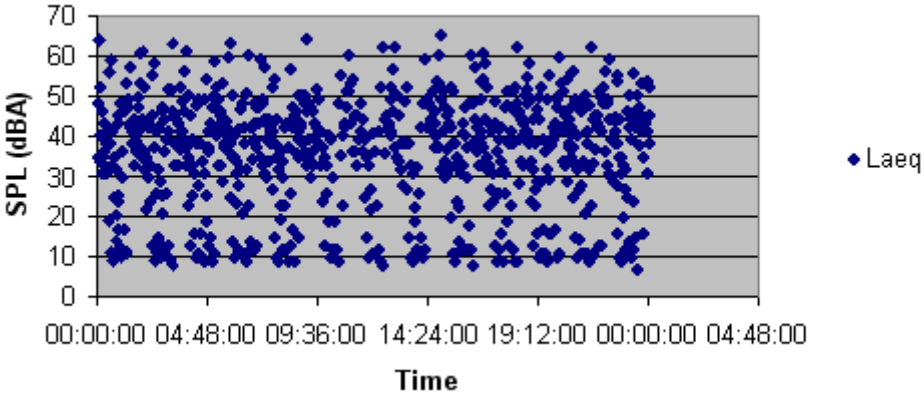

Figure 8. Noise levels ($L_{Aeq, 5min}$) in flat 223 during the weekend

It can be seen from Figure 8 that over the weekend the levels were lower than during the week, typically values were between 30 and 50 dBA. A possible hypothesis is that it is the road noise causing the difference in noise levels. Traffic flow data has not been made available.

5 EXTERNAL NOISE MEASUREMENTS

Roof top measurements were taken in 1/3 octave bands to determine if the turbine was tonal in nature, a level 5 dB higher than an adjacent 1/3 octave band[6]. Measurements, taken at similar times of day, have been analysed with wind speeds to determine tonality, see Figure 9. Noise levels tended to decrease with frequency and no tonality was detected for wind speeds 3 to 9.7 m/s.

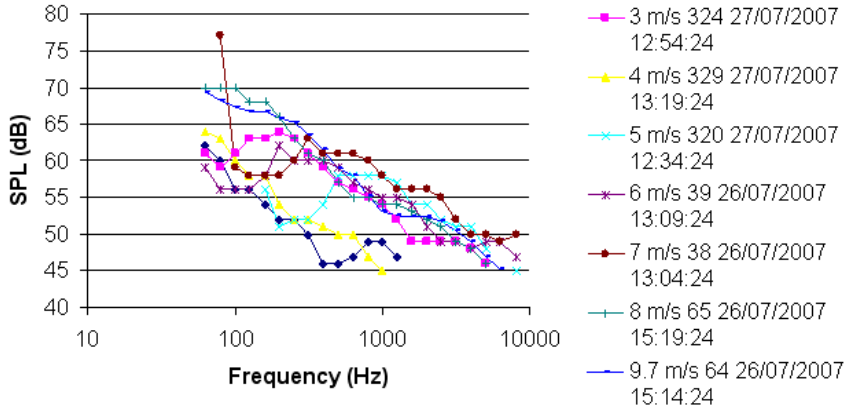

Figure 9. 1/3 octave band roof-top measurements of a 6 kW turbine on Ashenden House

6 NOISE VS WIND VELOCITY

Wind speeds and noise levels were compared for three 3 day periods, Figures 10-12. The measurements were all taken during weekdays on the roof-top. It can be clearly seen that roof-top noise was uncorrelated with wind speeds.

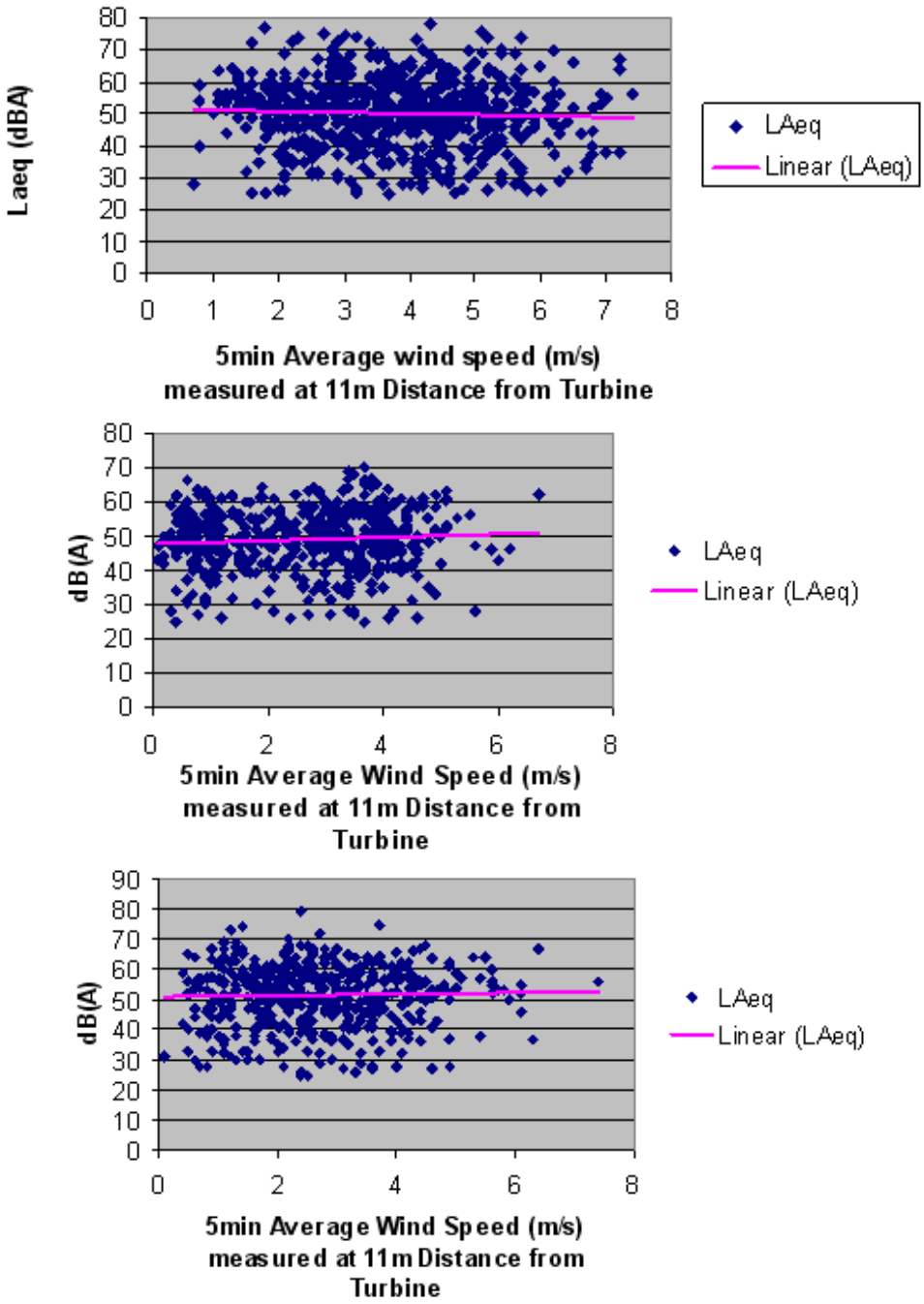

Fig 10-12.Correlation between wind speeds and rooftop noise levels for three 3 day measurements.

7 CONCLUSIONS

Background noise levels were in line with previous studies of central London. For the roof top noise measurements, in the worst case position, it was found that the dominant noise source was the arterial road, A2 New Kent Road, as the noise levels did not significantly vary with wind speed over the time period considered. The turbine did not affect the noise levels in the flat, and hence no complaints from residents are likely, and none have been received. It should be noted that wind speeds were low, as generally expected over a summer measurement period. No indication of tonality was detected at the operational wind speeds measured, 3 to 10m/s. Typical wind speeds

were 2, 3 or 4m/s over the summer measurement period. Finally, the residents on the estate were friendly and interested in the wind turbine research. No complaints or negative comments were received from the public.

8 FUTURE WORK

This work presented the summer results, monitoring has continued after the probation period for the installation. A greater range of wind speeds would be helpful, but can not be guaranteed; so long term monitoring is envisaged to at least 2009. At this point the Proven turbine will be moved to an urban University site. A new Quiet Revolution roof top turbine of similar electrical output will be installed in the spring of 2008 on the same site. Monitoring will continue on Ashenden House until 2010 when the building will be demolished and the second turbine moved to an urban site at the university. The vibration and electrical generation results will be presented at EAA Forum in Paris.

9 ACKNOWLEDGEMENTS

Southwark Council funded this research. Thanks go to Campbell Associates for the loan of the Nor121 weather station and ANV Measurement Systems for the loan of vibration meter VX54.

10 REFERENCES

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