NREL
NATIONAL RENEWABLE ENERGY LABORATORY

# Acoustic Noise Test Memo for the Alstom ECO100 at the NWTC 22 March 2013

## 1. Background

This report details a test conducted on 8 Oct 2012 to investigate the effect of measuring the acoustic emissions of the Alstom ECO 100 over the range of microphone distances allowable by the standard at the downwind position, from the nearest to the furthest. It was initiated in an attempt to further investigate a 3dB difference between measured and expected sound power levels. Three positions were considered and are detailed in the below table. Measurements were taken simultaneously at the close and center position, then measurements were taken simultaneously at the center and far positions. One minute averages were used in all cases, with averaging periods being the same for the two positions.

| **Location** [-] | **Position Relative To Turbine [deg true]** | **Reference distance** [-] | **Reference distance Ro [m]** | **Slant Distance $R_1$ [m]** |
|---|---|---|---|---|
| Close | 112 | Ro-20% | 118.2 | 153.2 |
| Center | 112 | Ro | 144.2 | 175.4 |
| Far | 112 | Ro+20% | 172.2 | 200.6 |
| IEC Test | 112 | Ro | 144.7 | 176.4 |

## 2. Acoustic emissions in background levels

It was observed during the test that the noise from the ECO 100's cooling fans were present in much of the background measurements, artificially increasing background levels and making these levels dependent upon measurement location (higher closer to the turbine). Total background corrections were, on the average, 0.5 dBA for this test and for the previous IEC data set. This fan noise is present in some of the IEC background data as well. Accounting for variations in background level with measurement position, even though they are likely derived from turbine noise and not true background shifts with position, changes the background correction by less than 0.1 dBA. Boards further away see a slightly higher correction, since separation actually goes down in these cases.

# 3. Results

The data has been filtered for turbine status and valid wind direction. Since the previous IEC data set was gathered at the center board location, all results presented here are in reference to that location and include:

- Figure 1 shows a plot of the measured data at the three measurement locations.
- Figure 2 shows a plot of background-corrected sound power levels for each of the three locations compared to those from the previous IEC data set.
- Table 1 details the average differences in calculated sound power levels for the closest and furthest locations as compared to the center.
    - Since the measured cooling fans caused an artificially higher background correction at the further distances, as described above, the second row shows uncorrected sound power levels.
    - The third row shows a comparison of corrected sound power levels. Background levels used to correct each data point at the center location were derived from the linear fit to the background data measured at that location, shown in Figure 1. This curve was shifted up or down by the average difference in measured sound pressure level at the close and far locations as compared to the center location to derive the background levels used to correct each of these locations.

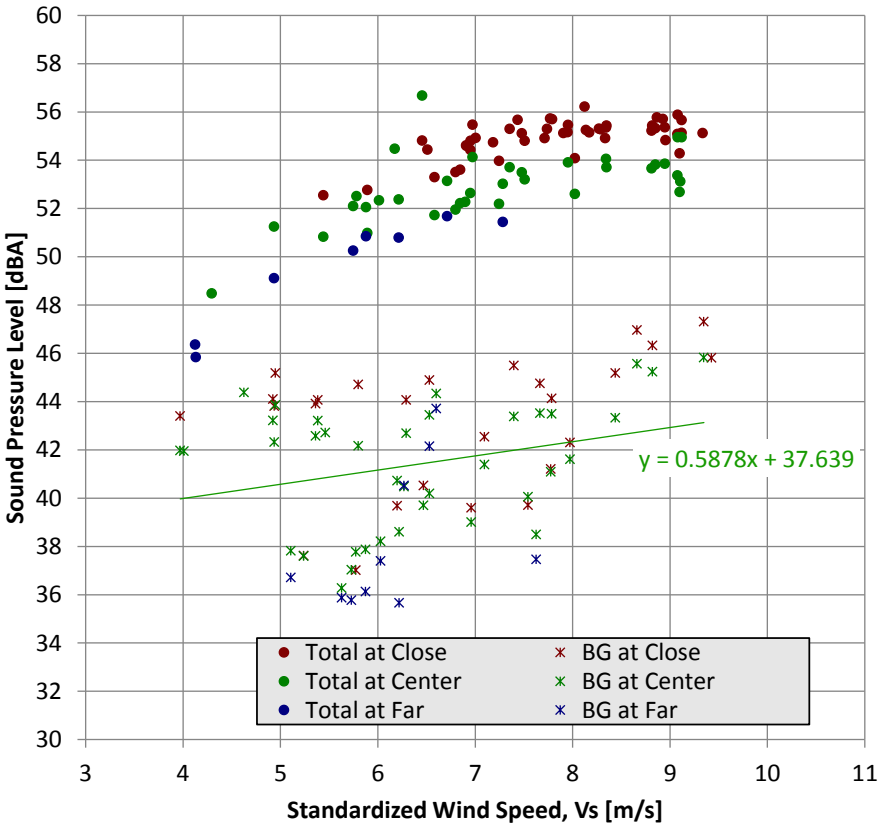


**Figure 1. Measured sound pressure level versus standardized wind speed**

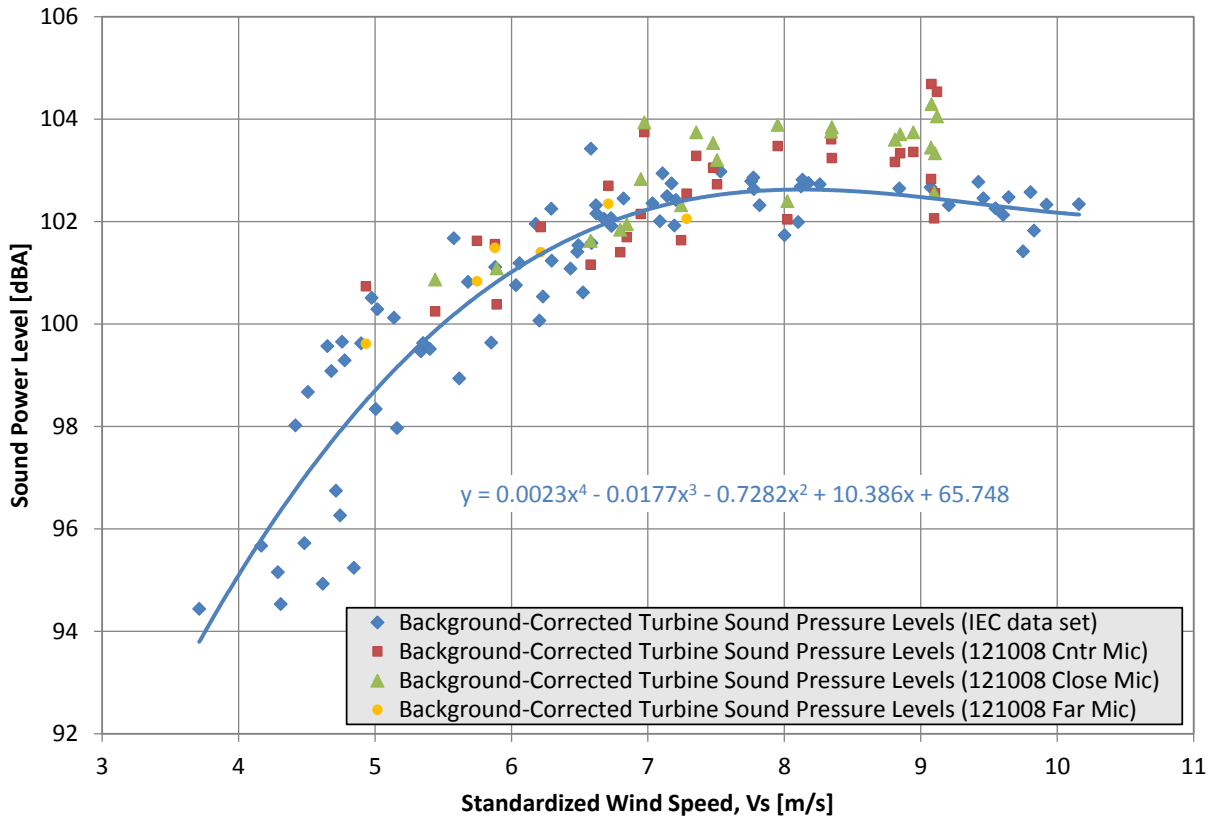


**Figure 2. Calculated sound power levels as a function of standardized wind speed**

**Table 1. Average difference in sound level as compared to center location**

| Sound level / Location: | Close | Far |
|---|---|---|
| Measured background sound pressure level | 0.95 dBA higher | 0.79 dBA less |
| Calculated sound power level without background correction | 0.36 dBA higher | 0.47 dBA less |
| Calculated sound power level with background correction | 0.40 dBA higher | 0.55 dBA less |

# 4. Conclusions

The variation in background levels with measurement position is an artifact of the cooling fans being recorded in the background levels and causes an artificially high background correction. However, since good separation exists when accounting for this unexpected, this overly high background correction does not account for a significant portion of the 3 dBA lower measured sound power levels. It would take another 3-4 dBA lower background level before the correction is reduced from 0.5 to 0.1 dBA. Background levels that low have not been observed on NREL's site for any of the recent tests.

The results, with and without an artificially high background correction, indicate that measuring at the closest IEC allowable location account for roughly 0.4 dBA higher sound power levels than at the center location. Measuring at the furthest IEC allowable location account for roughly 0.5 dBA lower sound power levels than at the center location. The choice of measurement location, by itself, cannot account for a significant portion of the 3dBA lower measured sound power levels. Furthermore, the combination of measurement location and artificially high background levels does not explain the full 3 dBA discrepancy in expected noise levels.

# 5. References


[1] IEC 61400-11: Wind turbines – Part-11: Acoustic Noise Measurement Techniques, Edition 2.1, 2006-11.

[2] Acoustic Noise Test Report for the Alstom ECO100 Wind Turbine at the National Wind Technology Center, Boulder, CO. J. Roadman, A. Huskey, and J. van Dam. 21 March 2013. (draft form)

[3] Supplementary Acoustic Noise Test Report for the Alstom ECO100 Wind Turbine at the National Wind Technology Center, Boulder, CO. J. Roadman, A. Huskey, and J. van Dam. 21 March 2013. (draft form)