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January 7, 2011

Pat Eaton, Supervisor; and
Bob Phillips, Planning Board Chair
Town of Allegany
52 West Main St.
Allegany, NY 14706

Re: Everpower project proposal; CRA Background Sound Study

Dear Pat and Bob,

The Planning and Town Boards received new data and analysis from CRA on or after September 27 regarding the important outstanding issue of noise impacts that can be expected from the Everpower wind project. Thus, this new information was not available during previous opportunities for public comment on the project proposal.

Enclosed is a six-page technical memo prepared for Concerned Citizens by Richard James that includes serious criticisms of the new CRA background sound study. In two previous memos by Mr. James submitted to you, basic *methodological* flaws in the approach to noise assessment taken by Everpower's consultant David M. Hessler were identified. Mr. James now finds some of these flaws underlying the new CRA study.

Generally, Hessler improperly elevates the estimated background level at the locations where existing sound levels were measured on the one hand, and improperly discounts his estimate of the sound levels that would be generated by the Everpower project. Understanding the consultants' differences regarding these two sides of the noise assessment equation is crucial because the level of noise impact, all sides agree, is determined by comparing a proper baseline, existing sound level to the expected project operational sound level. If, as the enclosed James memo shows, baseline sound levels at designated sensitive receptors are significantly lower than Hessler or CRA calculate, noise effects will be more significant than they predict.

Underpredicting noise effects of wind farms is a common problem, and a growing body of technical research into wind turbine noise faults the methods utilized by Hessler and CRA. Nevertheless, it is important to note that CRA's data provides the basis for James' evaluation. The primary difference between CRA and James is the selection of the right data.

It is customary that when taking a series of long term background sound level tests that the lowest L90 found in any of the test results be used for the background sound level. This may seem to be a bias but what it really means is that the test had the least influence from short term events or near-by noise sources that are not representative of background. Thus, the proper number from CRA's tests are the Minimum L90s, found in the top row of the table at page 7, in CRA's September 27 memo. The night averages reported in the bottom row are contaminated with traffic noise or some other events not part of the background. The L90 test periods should be those periods covered only by the bottom of the graph lines as marked on James' reproduction of CRA's graphs (attached as the last page of James' memo). CRA's *average* night L90s include data from periods prior to and after the bottom (actual background) levels are reached. Because of the log function used to express decibels it only takes a few samples with results more than 10 dB above the bottom to push the average up, close to the levels during unusually noisy periods.

Based on this analysis, James concludes the Everpower project would violate the noise limit in Allegany's zoning code at all four locations. Specifically, the Town's 3 dBA limit over background at identified sensitive receptors would be exceeded by between 3 and 18 dBA, depending on whether one relies on CRA's new or James' previously submitted background sound studies. While most people cannot notice a volume change of less than 3 dBA, the NYSDEC guidelines note that a volume change of 3–5 dBA is clearly noticeable.

The goal of the local code is to preserve the amenity people living near the project area now enjoy, namely night time quiet. Unless Everpower offers to relocate the turbines farther from sensitive receptors, the project as proposed will not qualify for town approval.

Sincerely yours,

Gary A. Abraham

gaa/enc.

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Review of CRA Memorandum on Ambient Sound Level Assessment Town of Allegany, New York, September 27, 2010

Submitted: January 6, 2011

INTRODUCTION

Thank you for the opportunity to provide my findings on behalf of the Concerned Citizens of Cattaraugus County (CCCC) regarding the Memorandum from CRA of September 27, 2010. This Memorandum presents a third-party technical review of the results of the noise study CRA conducted to assess the sound levels at sensitive receiver properties.

This is the third report prepared on behalf of CCCC by E-CS. The first report submitted on February 22, 2010 focused on the fundamental flaws of the noise study report prepared by Mr. David Hessler, titled: "Environmental Sound Survey And Noise Impact Assessment." Hessler's report was conducted on behalf of Everpower, LLC. The second E-CS report was submitted on May 3, 2010. It presented the results of a series of sound tests to determine the background sound levels present at selected sensitive receiver properties. This was conducted for the purpose of assessing whether the proposed wind utility would be in compliance with the Town of Allegany's Wind Energy Regulations requirement that the "*The sound level from the operation of a Commercial WECS shall not increase by more than 3 dB(A) the nighttime or daytime ambient sound level at any sensitive noise receptors, i.e., residences, hospitals, libraries, schools, places of worship and similar facilities within 2500 feet of the turbine and/or* ***at other sensitive receptor points that may be identified by the Planning Board.***" (emphasis added) This second study focused on four representative sensitive receiver properties identified by the Planning Board. It found that the Everpower Wind Project would exceed the permitted sound limits at 3 of the 4 sites identified as sensitive receiver properties.

DISCUSSION

This review of the September 27 CRA report finds that the rationale presented for substituting the sound levels caused by human activities and nature are similar to those presented in Mr. Hessler's report as is some of the same protocols for measurement. As discussed in the earlier E-CS report the methods used by Mr. Hessler follow procedures that do not comply with U.S. practices based on ASA and ANSI standards for outdoor measurement of sound. The Hessler report followed procedures developed in the U.K. by the British Wind Energy Association as guidelines for siting wind turbines. Ontario adopted measurement procedures similar to the British procedures. CRA's measurement protocol is influenced by these two non-standard guidelines. They include the Ontario MOE's procedure as a reference for their work in New York. (Specifically NPC-233 and NPC 103.)

The Ontario procedure is a derivative of the British ETSU-R-97 procedure that has led to many wind projects in the U.K. locating wind turbines too close to homes resulting in complaints of sleep disturbance and other effects from people living near the turbines. For this reason, my criticisms of the background noise study presented in the Hessler/Everpower report of February 22, 2010 is applicable to the CRA report. The explanation of why these procedures are not acceptable for acoustical studies conducted in the U.S. given in my first report on the Hessler study apply also to the CRA methodology and rationale.

It appears that CRA does not accept that in the U.S., acoustical consultants are expected to conduct sound studies that follow the generally accepted procedures and rationales of the ASA/ANSI S12 Committee's Standards. Rather than repeating in detail the same criticisms made for the Hessler report, I would ask that the earlier E-CS reports be considered an addendum to this report and be considered as support for my findings regarding the CRA report, procedures and rationale.

The CRA methodology is based on a procedure specified by Ontario's Ministry of Environment (MOE) that has its roots in the British procedure. These guidelines have been heavily promoted by the British Wind Energy Association and other national and international wind industry trade associations. As stated in the first E-CS report, this procedure, known as ETSU-R-97, is not based on standard acoustical consulting procedures which recognize the limitations of sound measuring instruments used in outdoor measurements. Instead, the procedure uses a contrived protocol where multi-day testing is conducted without an observer present. Under the ASA/ANSI S12 Committee's Standards, sound levels collected over that period are a mix of data that is valid and data that is invalid. The invalid data is primarily a result of instrumentation artifacts caused by wind at the microphone exceeding the ability of the windscreen to protect the diaphragm and inclusion of short term sounds in the final data set that are not appropriate to include in determination of long term background sound levels.

Wind Induced Pseudonoise

Invalid data artifacts are produced when the wind at the microphone exceeds the ability of the wind screen to protect the microphone diaphragm. This results in false readings that appear to be sound levels of 40 dBA or higher but are instead artifacts from the distortion. I have attached a paper titled: "Windscreens and Their Use" that explains this limitation. The type of windscreen used by CRA compares to the WS-03 model in this paper. Figure 6 of this paper shows the performance of the WS-03 windscreen for different wind speeds at the microphone. I have added a red line at the wind speed of 5 m/s (approximately 11 mph) and another connecting that line to the vertical axis showing the sound level produced by the windscreen failure. It shows that at 5 m/s the self generated pseudonoise will be over 40 dBA.

Because of this limitation, which affects all makes and models of instruments and windscreens commonly used by acoustical consultants, the ANSI S12.18 standard covering measurements taken outdoors states that "*To minimize the effects of wind on the microphone, sound measurements should not be taken when the wind speed is greater than 5.5 m/s (11 mph or 10 knots) at the microphone position, when measured at a height of 2 m. above the ground.*" Further, ANSI S12.18 also states that: "*If the meteorological conditions such as wind speed and direction do not fall within the specifications of either Method #1 or Method #2 as specified in Section 5, measurements do not conform with the requirements of this standard. No attempt shall be made to correct measured sound pressure levels based on wind or temperature data....*[1]" CRA's report appears to have included data that should have been excluded and used it to justify the readings they obtained that were higher than those reported by the E-CS study which excluded those conditions.

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[1] ANSI Method #1 is the "General method for routine measurements" where wind speeds are limited to 5 m/s or less when measured at a height of 2±0.2 m above the ground. Method #1 also restricts measurements to those collected only during times without precipitation or when the ground is not wet. Method #2 is the "Precision method for accurate measurements." It further restricts measurements to times when wind speeds are 1 to 3 m/s measured at a height of 2±0.2 m.

ANSI S12.9, Part 3 requires that the wind speed be monitored throughout the duration of the test: "*Wind velocity shall be measured at a height of 2+- 0.2 m above the ground.*" The CRA study presents charts and tables showing a "normalized" wind velocity at a height of 10 meters, not at 2 meters above the ground, as ANSI procedures require. Further, this 10 meter wind speed was not measured but calculated from data collected at the EverPower 55 meter met tower using a formula that assumes neutral atmospheric conditions. There is no basis for assuming that neutral atmospheric conditions were present for any period of the test provided by the CRA report. It is much more likely that unstable or stable atmospheric conditions were present. These conditions would make a dramatic difference in the subsequent calculations of the CRA report. This makes the wind speed information provided on the three charts of the CRA memorandum unsuitable for interpretation. It is noted that some of the photographs provided with the report (Location 1, Sanchez) show a weather measurement system located at the correct ground height (although possibly too close to the microphone if the anemometer produces noise when spinning.) Why the normalized wind speed data were substituted for the wind speed data collected proximate the microphone is not explained in the report.

Contamination from Short Term Sounds

CRA's assessment of the daytime and nighttime ambient sound levels is largely dependent on two procedures, long term unattended monitoring and the inclusion of sounds of short-term events and nearby sounds. But outside of Ontario or other countries that have adopted wind turbine noise criteria following the wind industry sponsored ETSU-R-97 guidelines, these procedures are not appropriate. ANSI standards call for these sounds to be removed from the data set when evaluating long term background sound levels. For long term tests without an observer present, which is the method CRA used, ANSI S12.18 requires that: "A means shall be available to inhibit data collection whenever a short-term background sound occurs. ...These means shall be used to eliminate the contribution of short-term background sounds." If there is data in a data set caused by short term events (car pass-bys, bird chirps, talking, wind in leaves, etc.) ANSI S12.18 requires that the data set be cleaned of any such data. "*Omit the sound pressure levels or sound exposure for any block (of time) corrupted by short-term background sounds.*"

The reason for these limitations on the sounds included in such a study is that the long term background sound level is defined as the constant sound level from noise sources in the distance that is present during periods when there are no nearby or transient sound events. It is this "baseline" level against which new, intruding sound sources become more or less noticeable, and thus potentially annoying. That is why the statistical descriptor "L90" is often used to assess long term background sound levels. The L90 test results will reflect these quieter periods between the noise events. The Leq or L10 descriptors, on the other hand, include the contribution of these noise events. Thus, errors in assessing the baseline level will result in <u>under predicting</u> the likelihood of complaints after a proposed project begins operating.

The L90 is the proper measure of long-term background sound level. See NYSDEC, Assessing and Mitigating Noise Impacts (2001), at 12 ("*L(90) is often used to designate the background noise level*"). However, the data CRA reports in its Table of Leq, L10, and L90 sound levels for each of their three test sites does not meet the criteria specified in ANSI for assessing and reporting background sound levels. The effects of short term events on the over-all metrics were not removed from the final data set used to compile the data for the Table. The close relationship between the Leq and L10 values for each hourly data set (often only 2 to 3 dB apart) add further support to the conclusion that high noise level, short duration events were responsible for the higher than normal daytime background sounds. The upward bias on the over-all metrics caused by not removing these short term events will be greatest on the L10 and Leq values. Because of these problems, the graphs and table entries for the Leq and L10 metrics should be disregarded for purposes of evaluating the long term background (ambient) sound level of the sensitive receiver sites.

There is no assurance that the L90 sound levels were not also biased upwards by these short term events. This is especially true for the daytime samples where the graphs of Figure 2, 3, and 4 show some of the L90 hourly values as sharp spikes tracking the spikes in the Leq and L10 traces. CRA should have included an explanation for these periods and should have removed them from the final computation as they did the periods with precipitation. The L90 sound levels during the night time hours may have less bias from short term events since there are few if any activities late at night in rural areas other than an infrequent vehicle on the road or aircraft flyover.

The two CRA test sites not located near roads (Location 1, Sanchez and Location 3 Koebelin) are less susceptible to artifact from traffic noise. The Kelly test site (Location 2) was near a road (based on the GPS locations shown in the included photographic documentation and review of the other photos). Thus, the plateau and peaks of the Leq and L10 hourly daytime data in Figure 3 are higher than for the other two locations. Locating a test site near a road, when the purpose of the test is to protect the home which is located at some greater distance from the road, is prohibited by ANSI standards. It biases the sound level upwards resulting in sound levels that are not representative of the area near the homes.

This is an issue addressed in E-CS's first report on Hessler's report. Dr. Paul Schomer, Chair of the Acoustical Society of America stated in his review of a study by Mr. Hessler for another New York wind project that locating test sites proximate to roads or other locations where the sound of short term events will be louder than what is experienced close to the home is not correct. Unfortunately, CRA makes this error for location 2. The conclusion can be made that had the test site been located close to the home the resulting sound metrics would be lower that what is reported by CRA.

INTERPRETATION

To assist in understanding the CRA data a graphic has been created that uses segments from each of the three graphs shown in Figures 2, 3, and 4 to form a composite graphic for all three sensitive receiver test sites. This graph is included as an attachment to this report. It is titled: "CRA Sensitive Receiver Test Site Composite." Segments of each of the three graphics have been inserted side-by-side starting at Location 1, Sanchez at the far left; Location 2, Kelly in the center; and Location 3, Koebelin, at the right side. To make it easier to separate the night from day periods, a gray box has been inserted between the wind data along the bottom axis and the sound data traces above to highlight the approximate nighttime period. Green arrows are used to connect the part of the graphs representing nighttime L90 sound levels to the vertical axis (dBA).

The pattern for day and night L90 values is clear for all three test sites. The sound levels rise and fall according to the time of day with the most noise occurring during the daytime and the least during the night. The nighttime L90 sound levels for the two test sites that are not near a road (Locations 1 and 3) range from just under 20 dBA to just over 20 dBA. This data is repeatable for many of the nights. This is an expected result. If the traces had not followed a diurnal pattern it would indicate that there were non-standard activity patterns in the community. Nighttime periods are the most likely time for complaints of sleep disturbance or other effects of turbine sounds. The nights when stable atmospheric conditions are present will be the worst case situation for annoyance complaints.[2]

While the data for the two sites with nighttime background sound levels centered around 20 dBA L90 is in line with expectations, the L90 data for the Kelly property is almost 8-10 dBA higher. The Sanchez property is located along the same road as Location 2 and is closer to a major traffic artery than Location 2 yet it has much lower L90 levels. This difference cannot be entirely accounted for by the test site at Location 2 being proximate the road. In order for the L90 levels at night to be consistently higher than the other sites some other factor must be adding to the traffic noise.

Photos of the test site at Location 2 show the instruments set up in high grass and shrubs. It is possible that the higher levels are the result of leaf rustle being picked up by the instrument or, if insects were still active, it could be the sounds of insect chirps. Whatever the cause, the higher levels at Location 2 should be a warning that something is not right with the test data. If the test site had been closer to the home, or behind it (if bedrooms are located in back), it is expected that the nighttime sound levels would be comparable to what was measured by E-CS in April of 2010 at the test sites for the Boser and Mosman properties located near the Kelly property.

Comparison to the Town of Allegany Sensitive Receiver limits

For the sake of argument we will assume that the CRA L90 data is valid and can be used to assess the Town of Allegany rule for Sensitive Receivers. That rule, as formulated in the Town of Allegany Wind Energy Regulations, is:

> *The sound level from the operation of a Commercial WECS shall not increase by more than 3 dB(A) the nighttime or daytime ambient sound level at any sensitive noise receptors, i.e., residences, hospitals, libraries, schools, places of worship and similar facilities within 2500 feet of the turbine and/or at other sensitive receptor points that may be identified by the Planning Board.*

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[2] This is because the stable atmosphere near the ground surface has little or no wind to produce leaf rustle or other sounds as it flows around structures. A stable atmosphere means the surface level winds will be calm. But, above the temperature inversion boundary the wind speeds will be at full operating levels. This means that during a period of high turbine sound emissions there will be no winds to produce masking sounds at the ground level. This condition has been shown to be present about 1 out of every three nights for locations in temperate zones.

Temperature inversion boundaries can form at heights up to 100 meters above ground. This will put the boundary above the lowest point of the blade's rotation. When this occurs, the blades must dip into the calm air for some portion of the rotation.

The blade's angle of attack and rotational speed has been calculated using weather data collected by the hub level meteorological instruments. These instruments use a formula to estimate the wind speed at the top and bottom of the rotation which is then used to set the blade's angle of attack and rotation speed. These are set for maximum power extraction. but below that boundary, the wind speeds will be calm and not what is predicted from the wind gradient formula. The hub level instruments do not have any way of knowing if there is a temperature inversion boundary layer below the hub. When the blade dips into this calm layer it is no longer extracting wind energy efficiently, but instead is in a very inefficient configuration. Noise and heat are two of the most common side effects of inefficient operation of machines and this also applies to wind turbines. It is quite likely that stable atmospheric conditions will be accompanied by increased wind turbine noises. These extra noises are emitted by processes that are triggered by the blade's encounter with calm air and not present when turbines operate in neutral atmospheric conditions. Since this in-efficient region only occurs for a part of the blade's rotation the sound will be intermittent. For a three bladed wind turbine operating at 20 rpm there will be a whoosh or thump produced about once a second. At 10 rpm this will be once every two seconds.

Because wind turbines operate on a 24/7 schedule the controlling part of the rule is the nighttime sound level. Table 1 shows the results of both the E-CS and CRA noise studies for the nighttime periods.

Table 1- E-CS and CRA Test Results (dBA L_{A90})

		E-CS Background[1] Sound Level Test Results	CRA Rpt. 9/27/10 Background Sound Levels (Minimum LA90 night levels)	Permitted Wind Turbine Sound Level (dBA + 3 dB)	CRA Model Prediction (Table 2)	Pass/Fail Criteria
Test Site #	**Property Owned By:**	**dBA L_{A90}[2]**	**dBA L_{A90}[2]**	**E-CS / *CRA***	**dBA (L_{eq})**	**E-CS/CRA dB**
1 [R4]	R. Mosman	26	27.1 (Kelley-CRA Loc. 2)	29/*30.1*	38.2	Fail by 9 / 8 dB
2 [R3]	J. Sanchez	22	18.3 (Sanchez-CRA Loc. 1)	25/*21.3*	39.2	Fail by 14 / 18 dB
3 [R2]	W. Boser	28	27.1 (Kelley-CRA Loc. 2)	31/*30.1*	34.1	Fail by 3 / 4 dB
4 [R8]	D. Koebelin	28	20.2 (Koebelin-CRA Loc. 3)	31/*23.2*	30.9	At Limit / Fail by 8

(1) Long-Term Background Sound Level L_{A90} (As defined Per ANSI S12.9 Part 3 and S12.18) for comparing new noise source to existing community sound levels to assess community response. The nighttime LTB would be equal to or lower than the daytime results.

(2) It should be noted that night time tests when man-made sounds are not present will often show that the Background Sound Level (L_{90}) and Average Sound Level (L_{eq}) are very close (1 to 7 dB). It would take only one or two short term events that were significantly louder than the background sound level to make for this much difference, especially at night in quiet rural areas.

The final column shows the **Pass/Fail** status for the Sensitive Receiver Locations tested by E-CS and CRA. The results of the computation are shown with the E-CS result a "/" followed by the CRA result. If the test fails the results are posted in red. The results show that the Everpower project will not meet the Town of Allegany Wind Energy Regulations. This is supported by both the E-CS and the CRA nighttime test LA90's.

CONCLUSION

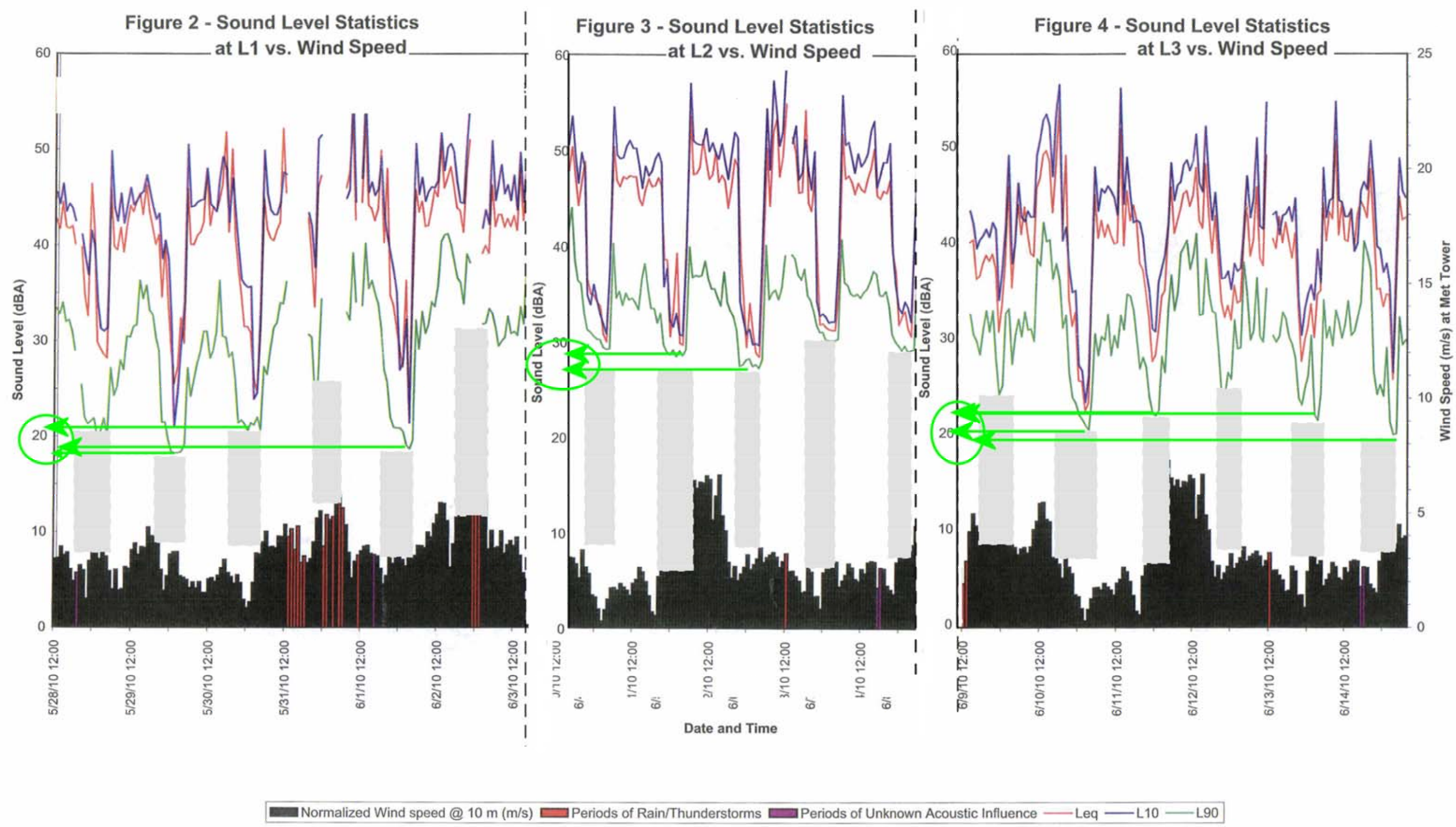
The CRA study used a protocol for conducting the background sound study that does not meet the standards set for acoustical consulting work in the U.S. set by ASA and ANSI standards for outdoor measurement. This affected the daytime and nighttime Leq and L10 data leading to a conclusion that it should be disregarded for decision making. The daytime L90 data was also affected by the non-standard protocol and it too should be disregarded. The nighttime L90 data for two of the CRA sensitive receiver locations (#1, Sanchez and #3, Koebelin) are consistent and within the range of what is expected for quiet rural communities at night. The test data for Location 2, Kelly is not consistent with expectations because the test site is too close to the road and set in an area with high weeds and shrubs. The vegetation could create sounds from wind moving through the leaves or be host to insects which could affect readings from their "chirps." The nighttime L90's levels for this site are close to 30 dBA while the other two sites are close to 20 dBA. More weight should be given to the CRA data for Locations #1 and #3 than to the data for Location #2.

Using the data from both the E-CS and CRA noise studies and the data from the CRA computer model, the Town of Allegany's Wind Energy Regulation rule for Sensitive Receivers was evaluated. This evaluation shows that the Everpower wind energy project does not meet the requirements set by the Town of Allegany for Sensitive Receiving properties. On this basis, the Everpower project should not be approved.

Sincerely,
E-Coustic Solutions

Richard R. James, INCE

CRA Sensitive Receiver Test Site Composite



WIND SCREENS AND THEIR USE

1. Introduction

The job of a wind screen is to reduce noise generated by wind near the microphone.

An ideal wind screen should have no acoustic influence on the microphone, and at the same time it should be effective in making large reductions in the level of wind noise.

Wind screens can be broadly divided into two categories, general-purpose types for use only at the time of sound level recording, and all-weather types that are used in the case of long-term continuous measurements. The genera-al-purpose types are sufficient to reduce or eliminate the influence of wind and dust, while the all-weather types must of course do this and also protect the microphone from the influences of rain, snow, and the like.

Due to the demands placed on wind screens, the authors have examined the problems of wind screen materials, properties, and practicality.

2. Wind Screen Materials

In general, the materials used in wind screens are fabric, punched metal, metal screens, and the like, and most recently polyurethane foam has also come into use. These various materials can be examined in terms of their acoustical characteristics and durability.

Cloth has practically no acoustical influence, but its durability does present problems. Punched metal offers a good level of durability, but since the ratio of the opening area to the total area is small, it causes acoustical influences, and since the influence is great when measurements are being made at 1,000Hz or above, it is not practical for such uses. Metal screens are seldom used alone, and cloth is usually used inside or outside. In such cases, there are difficulties with both the durability of the cloth and the processing of the metal screens, so that such combinations cannot be called too desirable. Polyurethane foam offers sufficient durability, but there can be great differences in the acoustical influence of the materials depending on the type of polyurethane foam.

Polyurethane foam generally comes in two types, 'open cell' and 'closed cell'. Since the latter has closed cells, the acoustical characteristics decline in middle and high frequency ranges. In the case of open-cell polyurethane, however, very excellent results can be derived depending on the materials used.

Open-cell polyurethane is created through a special process that removes the cell walls between independent cells in the foam bubbles, creating a latticework structure. The acoustic characteristics of such materials are closely linked to the density of the material; the greater the density, the lower the acoustical performance. In the present study, the best results were obtained by using foam with 70 to 150 cells per 10 cm.

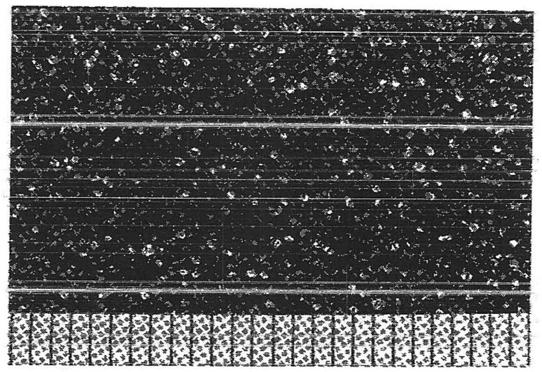


Photo 1. Normal polyurethane foam

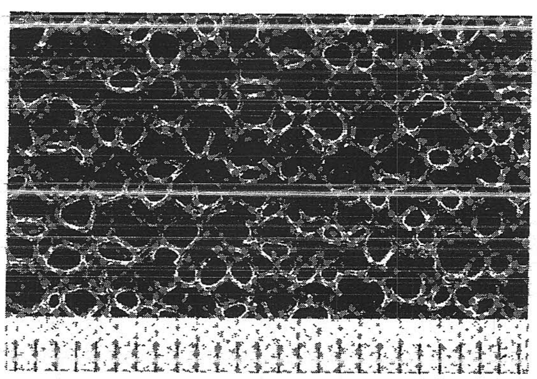


Photo 2. Open-cell polyurethane foam

Next, turning to the materials used for all-weather types the materials need to offer good acoustical characteristics as well as effective protection of the microphone from rain, snow and the like (i.e., durability). In this study, attention was turned to non-woven nylon such as that generally used in homes and factories. This study indicated that excellent results could be obtained with such materials 5–7 mm in thickness treated with silicon for waterproofing.

Non-woven fabric is a special material in which the fibers are not woven but simply placed together to form the fabric. Non-woven nylon fabric offers sufficient durability, and it also has a high resistence to water.

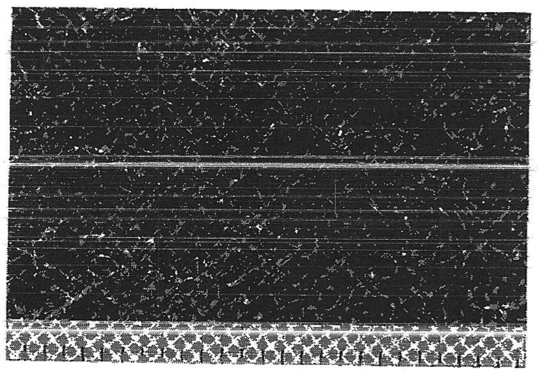


Photo 3. Non-woven nylon

3. Wind Screen Diameters

The noise reduction effect of the wind screen can also be influenced by the screen's size. The diameter of open-cell polyurethane wind screens was thus changed and a study was made of the degree of reduction of wind noise (Fig. 1). From this study it appears that the degree of wind noise reduction is in ratio to diameter, with a doubling of the diameter bringing a 6dB reduction.

In light of the wind noise reduction effect and the ease of use, the study indicated that the necessary diameter of a general-purpose wind screen should be approx. 9 cm, while that of the all-weather type should be at least 13 cm.

Based on the above results, the authors developed three types of wind screen, and below is presented the structure and the characteristics of each type.

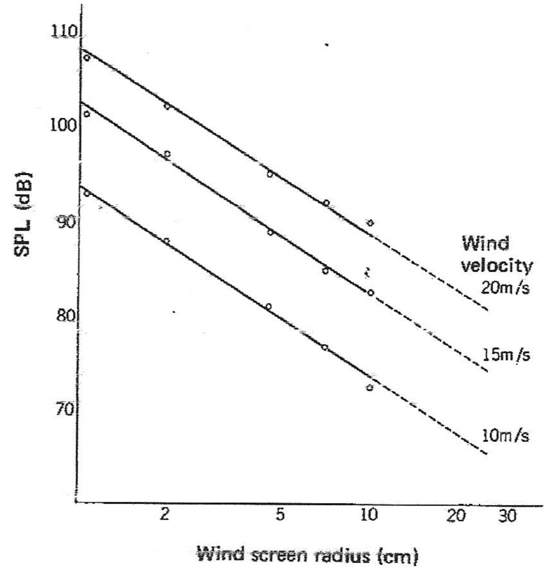


Fig. 1. Relation between wind screen size and wind noise

4. Characteristics of Each Wind Screen

4-1. General-purpose wind screens (Model WS-01, WS-02)

These wind screens are general-purpose type with a convenient diameter of 9 cm, using open-cell polyurethane foam. The mikes used are a 1-inch type (WS-01) and a half-inch type (WS-02), and the microphone can be attached directly without use of a mounting attachment. On a noise-level basis, the wind noise reduction (sound level meter A weighting) of each wind screen is approx. 25dB, and on a sound pressure level (flat) is approx. 15dB. The acoustical influence on the microphone is thus up to 12.5 kHz, ± 1.0dB, as shown in Fig. 2 through 4.

4-2. All-weather type wind screen (WS-03)

This wind screen is designed for long-term use outside; it of course reduced wind noise but also satisfies the needs for durability and protection of the mike from rain.

The wind screen is composed of two parts, that for reducing wind noise and that for protecting the mike from water. Wind noise reduction is provided, as in the WS-01, by open-cell polyurethane foam 20 cm in diameter, while water protection is provided by an non-woven nylon cloth near the microphone.

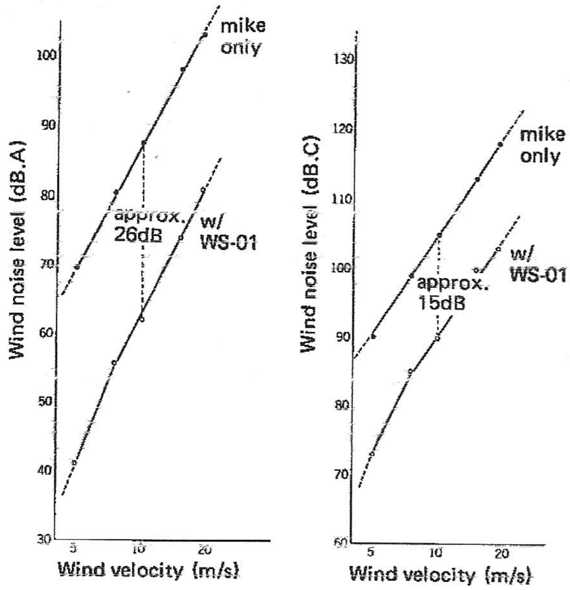


Fig. 2. Wind noise reduction effect of wind screens WS-01, 02

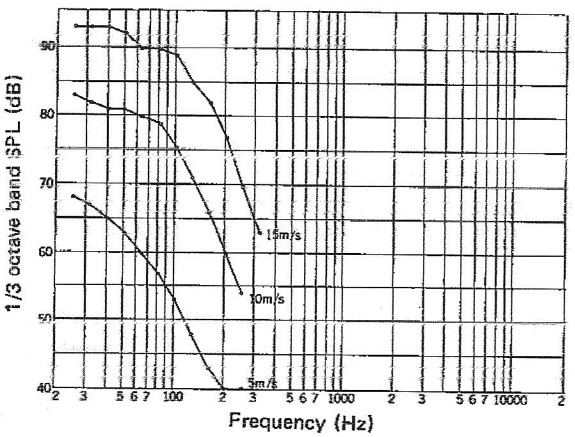


Fig. 3. Wind noise frequency characteristics of WS-01, 02

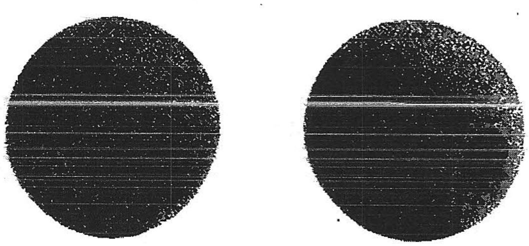


Photo 4. General-purpose wind screens

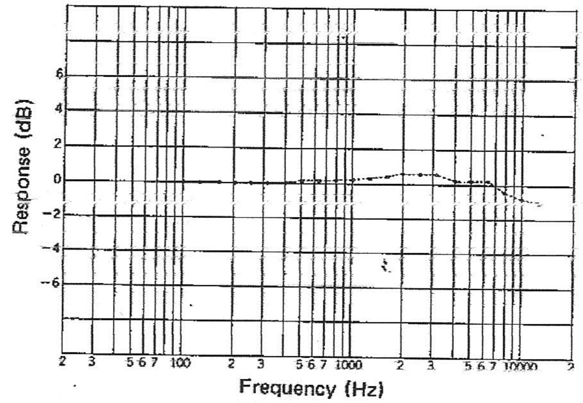


Fig. 4. Frequency response of WS-01, 02 (based on characteristics of microphone alone)

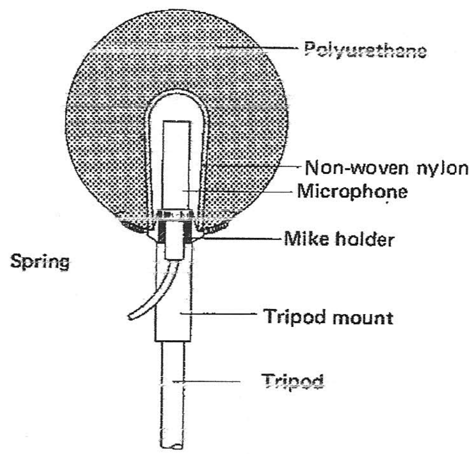


Fig. 5. WS-03 Structure

Because of the lattice structure of open-cell polyurethane, water penetrates easily but also passes out easily, so that little remains in the foam. Also, because of the structure of the non-woven nylon, it can be stretched into shape over the mike. Water can thus be diverted before it can reach the mike itself, making it possible to waterproof the shield.

Thanks to the above structure and materials, little water remains in the wind screen; there is almost no influence on the acoustical characteristics of the mike, and accurate data can be collected.

WS-03 is 20 cm in diameter, and the wind noise reduction effect is approx. 28dB on a noise-level basis (sound level meter A weighting) and approx. 19dB on a sound pressure level basis (flat). The acoustical influence of water drops is within 8kHz and is not significant (Fig. 6 – 8).

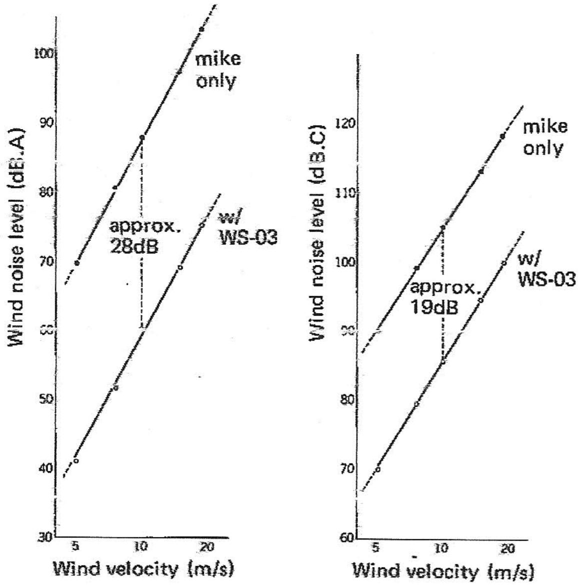


Fig. 6. WS-02 wind noise reduction

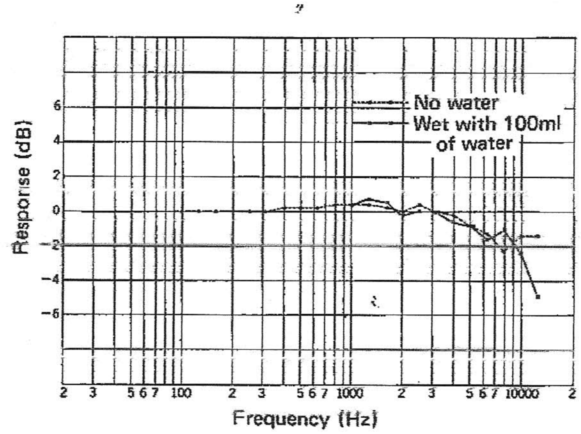


Fig. 8. WS-03 frequency response (based on characteristics of microphone alone)

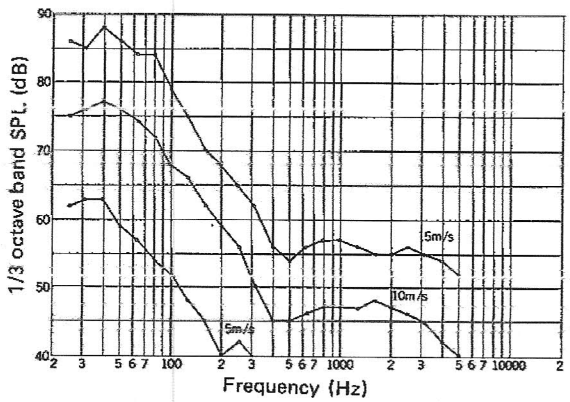


Fig. 7. WS-03 wind noise frequency characteristics

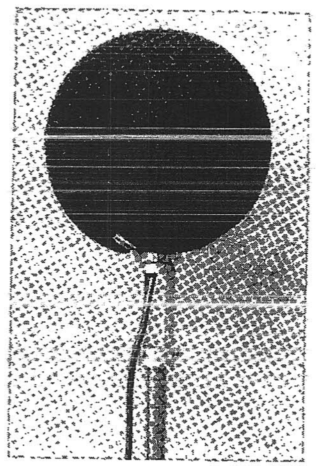


Photo 5. All-weather type wind screen

4-3. All-weather snow-protective type wind screen WS-04

This wind screen is designed for long-term outdoor measurements, particularly for winter measurements in snowy areas.

When snow or frost adheres to the wind screen or the mike during sound measurement, it can be thought to cause changes in the mike's response or frequency characteristics, thereby having an acoustical influence. Major measurement differences can result in particular when the surface of the wind screen is frozen (Photo 6).

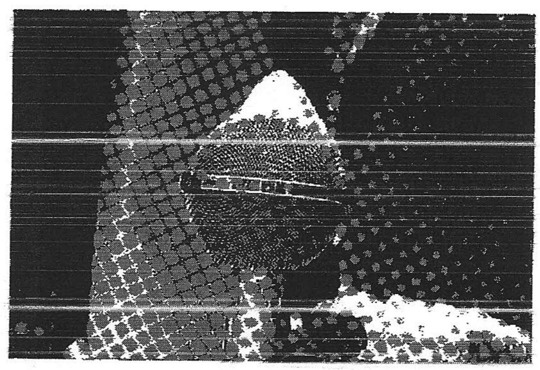


Photo 6. Example of frozen wind screen surface